JMA / WMO Workshop on Quality Management in Surface, Climate and Upper-air Observations in RA II (Asia)

Tokyo, Japan

27-30 July 2010

Japan Meteorological Agency

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Climate and Upper-air Observations in RA II (Asia)

Tokyo, Japan, 27-30 July 2010

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Opening

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Yuji Kano
Director-General of the Observations Department, JMA
Opening address
Miroslav Ondras
Chief, WMO Observing Systems Division,
Observing and Information Systems Department,
World Meteorological Organization
Self introduction of Participants
Organization for the workshop
Hakaru Mizuno (JMA)

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In Disaster Prevention and Mitigation.
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Hing-yim Mok (Hong Kong, China)

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Wind tunnel facility
JMA staffs

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Abstracts of lectures and country report presentations

Session 1: User Requirements

Climate Services Perspective

Takafumi Umeda
(Climate Prediction Division,Japan Meteorological Agency)

JMA is monitoring global surface climate in order to detect climate variability and change (e.g. extreme climate events, global warming). JMA produces weekly, monthly, seasonal, and annual reports on temperature, precipitation and hazardous climatic events (flood / drought / tropical cyclone) by using SYNOP and CLIMAT data collected through GTS. Also, JMA calculates the long-term trend of annual global average temperature to get hold of climatic change caused by global warming using land surface data (CLIMAT, GHCN-Monthly) and the result of sea surface temperature analysis (COBE-SST).

JMA is operating a climate data assimilation system (JRA-JCDAS) based on satellite, upper air (TEMP), surface (SYNOP), and ship data. By using JRA-JCDAS, COBE-SST, CLIMAT reports, and satellite observations, JMA provides diagnosis information on the climate system as background of extreme climate events.

Weather and climate reports for stations should be produced and circulated through GTS more certainly for the world-wide monitoring of extreme events. More historical datasets are necessary for a re-analysis over a longer time period (e.g. JRA-55). Accurate measurements are also important especially to detect variability and change of global average temperature precisely.

The importance of the Data Quality Controlfor the Disaster Prevention and Mitigation.

Kazuhiko Nagata
(Forecast Division, Japan Meteorological Agency)

Japan often experiences natural disasters such as sediment disasters, snow disasters, wave disasters, storm surge disasters, earthquakes, tsunamis and so on. In recent years, these disasters caused about 100 deaths and missing people. The most of these people were caused by gust, flood and snow disasters.

If hazardous weather conditions are expected, JMA delivers a variety of plain messages including warnings, advisories and bulletins to the general public and disaster prevention authorities. Warnings and advisories for appropriate municipalities are issued whenever forecasters suppose that weather elements, such as the amount of rainfall, wind speed, wave height, tide level and so on, will meet criteria.

Concerning the heavy rain warning, advisory and flood warning, advisory, which are information related to sediment disasters, flood and inundation, the criteria of these warnings and advisories are the amount of rainfall, “soil water index”, and “runoff index”. The “soil water index” shows the risk of sediment disaster and the “runoff index” shows the risk of flood. An accurate rainfall grid data are needed for these indices.

Instruments measuring the amount of rainfall are raingauges and radars.

Raingauges can measure the actual amount of rainfall, but they can observe the amount of rainfall at only single points. On the other hand, radars can observe large areas with higher spatial resolution than the raingauge network, but they may produce readings different from rainfall observed on the ground, as it does not measure the amount of rainfall directly.

JMA uses "Radar/Raingauge-Analyzed Precipitation" for the forecast operation. The "Radar/Raingauge-Analyzed Precipitation", which is calibrated radars data with raingauges data, depicts rainfall with high quantitative accuracy.

If radars and raingauges observe anomalous values, they contaminate the "Radar/Raingauge-Analyzed Precipitation" and they could obstruct the forecast operation.

In this presentation, I will show the sources of the anomalous value of the radars and raingauges and their impacts on the "Radar/Raingauge-Analyzed Precipitation" taking an example to show the importance the Quality control of observational data.

The Impact of Observational data on Numerical Weather Prediction

Hirokatsu Onoda
(Numerical Prediction Division, Japan Meteorological Agency)

A lot of observational data is assimilated in operational NWP system in JMA. In recent years, remote sensing data such as Satellite is increasing and dominates about 80% of total observational data. The data remaining 20% conventional observation such as SYNOP or Radiosonde, however, still serve as an important role for the NWP system. We show the impact of each observation on the NWP system and appeal how conventional observation is important.

JMA perform quality control (QC) about observational data operationally, and the QC plays an essential part to improve the initial value and forecast field. In some cases, we find the observational data includes false reports. We show these examples and emphasize substantiality of the observation network and the importance of its maintenance.

Finally, we introduce "the report on the quality of land surface observations in RA-II" that JMA publishes every six months as the lead center and "monthly global data monitoring report". By utilizing these documents effectively, we can maintain better observation in future.

Session 2: Standardization

WMO/CIMO Perspective

Dr Miroslav Ondráš
(WMO Observing Systems Division)

One of the purposes of WMO, as described in the WMO Convention, Part II, Article 2, is to facilitate worldwide cooperation in the establishment of networks of stations for the making of meteorological observations as well as hydrological and other geophysical observations related to meteorology, and to promote standardization of meteorological and related observations and to ensure the uniform publication of observations and statistics.

Eight technical commissions of the World Meteorological Organization were established by WMO Congress and their structure and Terms of Reference are described in Annex III to the General Regulation of WMO. The General Terms of Reference of technical commissions describe their responsibility for the development of international standards. Within the terms of responsibility and within the provisions of the General Regulations, each technical commission shall, among others, "Develop, for consideration by the Executive Council and Congress, proposed international standards for methods, procedures, techniques and practices in meteorology and operational hydrology including, in particular, the relevant parts of the Technical Regulations, guides and manuals".

WMO Congress and the Executive Council adopt Regulatory Materials that define meteorological practices and procedures to be followed by Members. In this respect, the Technical Regulations of the World Meteorological Organization are determined by Congress in accordance with Article 8(*d*) of the Convention. Their purpose of is to (a) Facilitate co-operation in meteorology and hydrology between Members; (b) Meet, in the most effective manner, specific needs in the various fields of application of meteorology and operational hydrology in the international sphere; and (c) Ensure adequate uniformity and standardization in the practices and procedures employed in achieving (a) and (b) above. The WMO Technical Regulations (WMO-No. 49) is a mandatory publication and has four volumes and six annexes:

(a) Volume I: General Meteorological Standards & Recommended Practices,
(b) Volume II: Meteorological Service for International Air navigation,
(c) Volume III: Hydrology,
(d) Volume IV: Quality Management (approved by EC-LXII following a proposal of Inter-Commission Task Team on WMO Quality Management Framework ICTT-QMF),

(a) Annex I: International Cloud Atlas (WMO-No. 407), Volume I - Manual on the observations of clouds and other meteors,
(b) Annex II: Manual on Codes (WMO-No. 306),
(c) Annex III: Manual on the Global Telecommunication System (WMO-No. 386),
(d) Annex IV: Manual on the Global Data-processing System (WMO-No.485),
(e) Annex V: Manual on the Global Observing System (WMO-No. 544),
(f) Annex VI: Manual on Marine Meteorological Services (WMO-No. 558).

While WMO Manuals describe standard practices and procedures, a number of WMO Guides have been developed to describe recommended practices and procedures. WMO has concluded cooperation agreements and working arrangements with international standardization bodies, such as International Standardization Organization (ISO) and International Committee for Weights and Measures (CIPM). The standardization effort of WMO has lead to recognition of WMO as an International Standardization Body by ISO.

Details of CBS and CIMO standardization efforts are provided based on the above mandate as well as in the context of WMO high priority areas, such as the WMO Integrated Global Observing System and its effort to further standardize practices relevant to instrument and methods of observation, exchange of data and metadata, and end product quality.

Examples of standard practices and recommended procedure are presented with a view to guide possible improvement in quality of surface and upper-air observations in the Region II (Asia) with the emphasis on quality assurance and quality control of observational data. The role of regional bodies, such as the Regional Instrument Centres, in quality management is brought to the attention of participants and the Coordination Group of the RA II Pilot project to enhance the availability and quality management support for NMHSs in surface, climate and upper-air observations.

Several decision of the Fifteenth WMO Congress are also brought to the attention of participants of the Workshop, especially a request to NMSs to quality control on-site observations and to ensure the traceability of measurements to recognized world standards approved for the use of WMO Members.

Siting Classification for Surface Observing Stations on Land

Michel Leroy, Météo-France
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Several factors have an influence on the « quality » of a meteorological measurement: the intrinsic characteristics of sensors or measurement methods; the maintenance needed to maintain the system in nominal conditions; the site representiveness.

Environmental conditions on a site may generate measurement errors larger than the uncertainty of the instrument itself, whilst more attention is usually being given to the instrument itself. WMO/CIMO has clear recommendations about siting and exposure of instruments. But they are not always possible to follow and this is scarcely documented.

Several years ago, Météo-France defined a siting classification for wind, temperature, precipitation and solar radiation, ranging from 1 (WMO recommendations) to 5 (bad environment to be representative). It has been applied and proved to be efficient both to document the siting and to improve it, by rating it.

Recently, an expert meeting was organized by WMO, to cross experience on the subject and to define a siting classification for Surface Observation at Land. This classification will be proposed for validation by the next CIMO-XV in September 2010.

Considering also the various metrological characteristics of the equipment used in different surface networks, Météo-France defined also another classification, called "maintained performance classification", including the uncertainty of the instrument and the organization of preventive maintenance and calibration.

This complementary classification was also discussed within the expert team of WMO, but was not considered enough mature to be proposed to CIMO for validation.

The principles of these two classifications will be presented, along with the experience of Météo-France in applying them.

Session 3: Siting and metadata

Russian Federation

Current state and development potential of Roshydromet surface meteorological, upper air and climate monitoring networks

Oleg M.Pokrovsky
(Main Geophysical Observatory, Roshydromet, Russian Federation)

Current state of surface meteorological, upper air and climate monitoring networks is presented. A set of observing network maps provides the survey information on coverage and density of observing stations in different areas of Russia. Time and frequency of observations at various stations is another issue of report. Maps of closed stations after nineties years of last century is considered as a set of potential locations to establish new observing sites with automatic meteorological complexes. New scenarios on optimal design and redesign of networks configurations are considered as a potential to extend existed networks in sparse data areas (e.g., Arctic and North-East domains).

Thailand

UPDATED STATION DOCUMENTATION AND METADATA PILOT CASE: PHETCHABURI OBSERVATION STATION

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Thai Meteorological Department plans to update and revise the station information for more useful usages of meteorological data. Phetchaburi Observing Station (48465). Station information and additional metadata are surveyed and collected. The data are to be formulated as a standardized Thai observation station. In addition, data in the representative area are included in the study. Further statistics for the station will be added.

Session 4: Sensors/Instruments

Lao People's Democratic Republic

Status of Meteorological Network, Observations and Data Management In Lao P D R

Singthong Pathoummady
(Department of Meteorology and Hydrology)

Lao PDR started operational weather observation since the year 1950 in some large cities and was registered as a member of WMO in 1955. In this presentation, the status of meteorological network and relating operational weather observation tasks as well as Data archiving and data quality will be discussed. Unfortunately under the least developed country status, there has not been much improvement or development in the field of meteorology during the past decades. The establishment of meteorological stations has been slightly increased and extended in most of large cities in the last 10 years. All instruments are analogue and manual types as a result, these furnished all manned stations. These existing deteriorated instruments have no means to get calibration due to lack of standard calibrating tools. This situation leads to poor data quality even though data are preliminary checked manually prior to be archived in forms of hard copies and digital recorded devices. In order to cope with the current regional or global commitment on data quality assurance and data quality control, DMH has been striving to get improved its capability, therefore has formulated strategic and implementation plan by participating in capacity building of some key projects , such as the WMO technical supported and World Bank funded, organized by UNISDR, under the project titled **"Global facility on Disaster Risk Reduction (GFDRR Track 1)»** , the component for Strengthening Meteorological and Hydrological Services in Southeast Asia" (5 countries). On the other hand DMH has been involved in the implementation of the Mekong-Integrated Water Resources Management Programme (M-IWRMP) and the Information and knowledge Management Programme (IKMP) of the Mekong River Commission (MRC).

Mongolia

Observation network of Mongolia

Battur. N
(MONGOLIA)

Meteorological and Hydrological Services of Mongolia are functioning officially since 1936 when the first meteorological observation stations were established in the country.

The National Agency for Meteorology and Environment Monitoring /NAMEM/, is the government's implementing agency.

The agency provides information of weather forecasting, hydro-meteorology and environmental condition to governmental and private organizations, coordinates all hydro-meteorological observation networks of Mongolia.

Currently there are 130 meteorological stations, 186 meteorological posts, 3 upper-air stations in observation network of NAMEM.

The observed variables in all meteorological stations: Air temperature, surface soil temperature, atmospheric pressure, humidity, velocity and direction of wind, precipitation /amount and intensity/, cloud amount and type, visibility, weather present and past, snow depth and density.

Some meteorological stations observe solar radiation, sunshine duration, deep soil temperature, soil moisture, evaporation except above stated variables.

All meteorological stations are making synoptic and climate observations 8 times per day.

National Meteorological Telecommunication Network has two GTS lines with WMO Regional Meteorological Centers in Novosibirsk, Russia and Beijing, China and twenty local lines with local centers through VSAT.

There are about 60 automatic meteorological station in our observation network, 30 of the stations are installed in 2008. Types of automatic meteorological stations in our observation network: MAWS301, SK4100, CAMS630, QLI50.

There is a need to improve meteorological observation networks of the country. Our main goal is:

- improve skills of meteorologists and technicians
- Improve quality of observational data.
- Improve observational technologies and techniques.

Sri Lanka

Meteorological Observations and Instrumental Systems for Meteorological services in Sri Lanka

M.D. Dayananda
(Department of Meteorology, Sri Lanka)

Department of Meteorology, Sri Lanka having 20 Meteorological stations, 12 of them are operational round -the-clock and doing observation at every three hour while other stations doing observation during the day time including 0000 & 1500 UTC. Only Colombo station is doing Radar/Radiosond observation while Pilot balloon observations are done at three stations

Quality controlling of data is done subjectively at the Head office checking are carried out ; Check for coding errors, Check for physical reasonableness of observation, Check against it's neighbours, spatial and temporal consistency, Check against self recording charts. The Quality managment system in Sri Lanka is not in WMO standard as such the Department of Meteorology is seeking the ways to improve the QMS.

Uzbekistan

One of issues related to replacement the manual observational weather stations with automated ones.

Aleksandr Merkushkin
(Uzhydromet, Uzbekistan)

Critical water management within the five central Asian republics (CAR) requires access to reliable climate and hydrological data. As part of the effort to strengthen trans-boundary water resources management within the region, the US Agency for International Development's (USAID) Natural Resources Management Program (NRMP) funded a pilot automated climate data collection network. Sixteen automated weather stations (AWS) were installed within Tajikistan, Kyrgyzstan, Kazakhstan, Uzbekistan and Turkmenistan during the period from February 2002 to September 2003. . Ease of use, low operational cost, suitability for remote unmanned operation, proven reliable collection of high quality data and capability to electronically store and transfer data are the primary reasons for utilizing automated climate monitoring instrumentation. Most of these stations use the USAID sponsored meteor burst radio communications to provide real time data telemetry and acquisition.

This automated data collection and telemetry system was the first of its kind deployed within the region. The national Hydromet service (NHMS) within the CAR had little experience with this technology. Two key objectives of the program was to demonstrate the utility for remote automated deployment as well as allow for simultaneous operation with familiar manual monitoring. Eight of the stations were installed at operational climate stations that were staffed by NHMS observers.

The homogeneity of accumulated long term data series by manual measurements going to be replenished with data come from automated weather stations is not to be negatively affected. This paper provides the results of the comparative analysis from some of the simultaneous manual and sensors measurements.

Session 5: QA/QC

Hong Kong,China

An Integrated Meteorological Data Quality Assurance System for operation of the Automatic Weather Station (AWS) Network in Hong Kong

H Y Mok
(Hong Kong Observatory, Hong Kong, China)

The Hong Kong Observatory has developed and operated a new Automatic Weather Station (AWS) System with a capability to carry out data quality assurance automatically. The AWS data received by the central data acquisition system are passed to the Integrated Data Quality Assurance System for real-time data quality control. The System, which is highly automatic, serves to enhance data quality and at the same time reduce manual labour. Through various real-time and non-real-time automatic data quality control processes, the system carries out quality assurance for each piece of data received from the AWS by assigning a quality assurance flag to the data, filtering out erroneous data from the AWS, and alerting maintenance staff to action via automatic email. Operation of the AWSs can also be monitored via a webpage which displays the status of the AWS network in real-time. The advantage of this automatic alerting feature is that it enables early detection and diagnosis of faults as well as enhancing data availability. Apart from monitoring the operation of the AWS, the quality assurance flags also serve as an indication of quality, facilitating reference by users in future studies. This presentation will focus on the overall design concepts and quality assurance algorithms used for the System.

Japan

Quality Assurance and Quality Control of Surface Observations in JMA

Hakaru Mizuno
(Observations Department, Japan Meteorological Agency)

JMA operates surface observation networks carried out at about 1,300 stations: 68 manned meteorological observatories, 88 unmanned meteorological observatories, and more than 1,100 AWSs. All these stations are integrated into the AWS network in Japan named as AMeDAS (Automated Meteorological Data Acquisition System).

Observational data at meteorological observatories are transmitted to the data-processing centre (AMeDAS Integrated Processing System: AIPS) in JMA headquarters every ten seconds, and ten minutes frequency for observations at other AWSs.

Observational data are quality controlled in the instruments and in the AIPS in real time. After sending SYNOP reports to GTS line and domestic BUFR reports to the external telecommunication line, processing systems in JMA-HQ implement non-real time AQC: Spatial check, sequential check and extreme value check. According to the AQC result returned from AIPS and the processing systems, the officer in the observatory corrects observation value.

Kazakhstan

Kazhydromet is National Hydrometeorological Service REPUBLIC OF KAZAKHSTAN.

Zainuldinova Dinara
(RSE Kazhydroment)

The main task KAZHYDROMET "is to provide meteorological, agrometeorological, hydrological and ecological monitoring of the Republic.

Meteorological network consists from 259 stations, and 8 upper air network stations.

Quality control of observations made by using an automated processing system (Person ISI).

Kazhydromet participates in international exchange of hydrometeorological data from the Global Telecommunication System through the regional meteorological centers in Tashkent and the world meteorological centers in Moscow.

Session 6: Training
India

Training Facilities in India Meteorological Department

M K Gupta
(Scientist-E,India Meteorological Depart,Pune)

Human resource development has always been one of the prime thrust areas of the India Meteorological Department for capacity building and to keep pace with latest trends in various activities of the Department. The Central Training Institute (CTI) of the India Meteorological Department (IMD) is situated at a pleasant location at Pashan in Pune. The training facilities for Upper Air Instrumentation and Meteorological Telecommunication are located at New Delhi.

The Central Training Institute of IMD has a distinguished history dating back to 1942 when it had a humble beginning as an outcome of World War II wherein the need for meteorological training to the personnel working in IMD was acutely felt and, consequently, a formal training course started in that year. In 1943 a full-fledged training school started in Pune, India. Since then this training institute (CTI) has undergone dramatic changes in its training capabilities, composition, objectives, contents, etc, in catering to personnel covering all levels from Class I to Class IV. Since its inception its mission has always been to achieve excellence in education researcher and service to meteorological community and thereby to the society.

The WMO Executive Council at its thirty-eight session approved the designation of the training facilities of India Meteorological Department in New Delhi and Pune as WMO Regional Meteorological Training Centre (RMTC) for the Regional Association II (Asia) in the year 1986. The activities of RMTC are periodically assessed for quality and contents, by an independent assessor, deputed by WMO. Dr. Robert Riddaway visited RMTC, India (at Pune and New Delhi) during November 26 - December 5, 2002. He was apprised of various activities of RMTC, about which he was very appreciative as evidenced by his communication to WMO.

The presentation describes the Training facilities, Syllabus of various courses offered, statistics and various programs of international co-operation in the field of training in Meteorology.

Session 7: RIC-Tsukuba and Upper air Observations

Overview of MIC

Toshihiko Kobayashi
(Head of Meteorological Instruments Center (MIC))

The Meteorological Instruments Center (MIC) has continued services of verification, inspection, investigation, development and improvement of meteorological instruments and provided reference values of meteorological instruments since the establishment in 1944. MIC has also taken charge of RIC to assist members of Regional Association II (RA II) through calibration and comparison with meteorological instruments and support to train instrument specialist since 1996. Therefore MIC has greatly contributed to the quality management of meteorological data in Asian region including Japan.

In order to carry out these services, MIC has 21 meteorological instruments experts and maintains standard meteorological instruments such as a standard platinum resistance thermometer, an air piston gauge and a chilled-mirror dew point hygrometer and calibration chambers for thermometers, hygrometers and barometers and so on.

MIC meets requirements to maintain the high-quality meteorological data to cope with the issue of worsening meteorological disaster and global climate change in the world.

Upper-air sounding network of JMA

Kenji Akaeda
(Director of Observations Division,Observations Department)

The Japanese radiosonde network consists of 16 stations employed by JMA and 2 stations by SDF, which have operational observations twice a day of 00 UTC and 12 UTC. Its spatial resolution is almost 250-300 km. There is also an upper-air network of 31 wind profilers in JMA. Its horizontal spacing is 120 km on the average over the main islands of Japan. The observational data are exchanged internationally by using Global Telecommunication System (GTS).

The Japanese upper-air sounding network started from 1938, and reach to final stage almost same as present one in 1973. All JMA sounding stations are belonged to Regional Basic Synoptic Network (RBSN) of WMO, and 6 stations (Sapporo, Tsukuba, Kagoshima, Ishigakijima, Chichijima and Minamitorishima) and Syowa station in Antarctic are incorporated into GCOS Upper-Air Network: GUAN. Through these networks, JMA is intent on stable observational data distribution.

In March 2010, all 16 sounding stations of JMA were updated to GPS radiosonde system. 8 of them are operated as unmanned system with a combination of automatic balloon launcher and hydrogen generator system. The hydrogen generator system provides hydrogen by electrolysis.

JMA operational Wind profiler network is called as WINDAS. The profiler is a ground-based multiple-beam Doppler radar unit with 1.3 GHz-band covering a range of up to 5 – 8 km from the surface and automatically performing wind measurement every 10 minutes.

All observational data of GPS upper-air sounding system and WINDAS from Japan islands are collected in JMA HQ, and quality check is executed. These GPS sounding data include descent data. In future, sophisticated observational data with position information, which is retrieved from GPS sonde system of sonde, will be provided to numerical weather prediction.

Upper-air observation at Tateno (Aerological Observatory)

Hiroatsu MAKI
(Director of Aerological Obserbatory)

Aerological observatory in Japan was established in 1920, in Tateno, where is now a part of Tsukuba, a newly developed city for research and education. And in 1924, we observed strong wind of wind speed 72m/s at just below 10km level, which is believed as the first observation of jet stream. Since then, our observatory has acted as the technical center for upper-air observation in Japan. We also contribute for the discovery of Ozone Depletion through technical support of upper-air observation at Japanese base(Showa) in Antarctic. Now, the observatory has extended their activities, as a GRUAN (GCOS Reference Upper Air Network) site, and as a BSRN (Baseline Surface observation Network) site. We also, devoted our activities for the technical development. One of the example is automation of Dobson Ozone Spectrophotometer.

Lecture on fundamentals of wind profiling radar and applications in measuring wind and temperature profiling

Ahoro Adachi
(Meteorological Research Institute)

This lecture is intended to present information and details on wind profiling radar. The goal of this lecture is to provide background information and basic theory for the novice in remote sensing especially in wind profiling radar to understand what is advantage and disadvantage of the remotely sensed data. This lecture will be divided into three parts. The first part will be devoted to a brief overview of the profiling and an introduction to radar profiling techniques including Radio Acoustic Sounding System (RASS) used for temperature profiling.

The second part will be devoted to show some operational characteristics of the MRI wind profilers including initial installation costs. Some observational results obtained from the profilers will be also presented. Comparisons with *in situ* measurements will be included in the results to show the accuracy and precision of the profiling radar. This will be followed by an introduction to some of current profiler networks in the world.

This lecture will be ended with a short excursion to the MRI field site. We may see profiling radars and other instruments there. (15-min lecture + 5-min excursion)

Lectures

JMA/WMO Workshop on Quality Management in Surface, Climate and Upper-air Observations in RA II (Asia)

Tokyo, Japan
27 – 30 July 2010

Doc.
Japan

(10.VII.2010)

Climate Services Perspective

(Submitted by Takafumi Umeda, Japan Meteorological Agency)

Summary and Purpose of Document

This document briefly presents the climate services of JMA, which monitors the global surface climate to detect climate variability and change (e.g., extreme climate events and global warming). JMA also operates a climate data assimilation system based on satellite, upper air, surface and ship data to provide diagnostic information on the climate system as background data to extreme climate events. The document will help to illustrate the importance of in-situ observation from the viewpoint of climate services.

Climate Services Perspective

1. Outline of climate services provided by CPD/JMA

The main tasks and activities of the Climate Prediction Division at the Japan Meteorological Agency are as follows:

· Provision of climatic information to the government and the public
- Climate impact assessment
- Climate system monitoring
- Seasonal outlook & El Niño outlook
- Climate change projection

· Development of climate models to support the above tasks (in conjunction with the Meteorological Research Institute)
- Atmospheric GCM & Data Assimilation System (JCDAS[1])
- Oceanic GCM & Data Assimilation System
- Coupled Atmosphere-ocean General Circulation Model (CGCM)
- Land surface analysis
- Regional Climate Model
- Long-term Re-analysis Project (JRA-25[2])

· Support for NMHS climate services in the Asia Pacific region (as the Tokyo Climate Center)

2. Surface climate monitoring

JMA monitors the global surface climate to detect indicators of climate variability and change (e.g., extreme climate events and global warming).

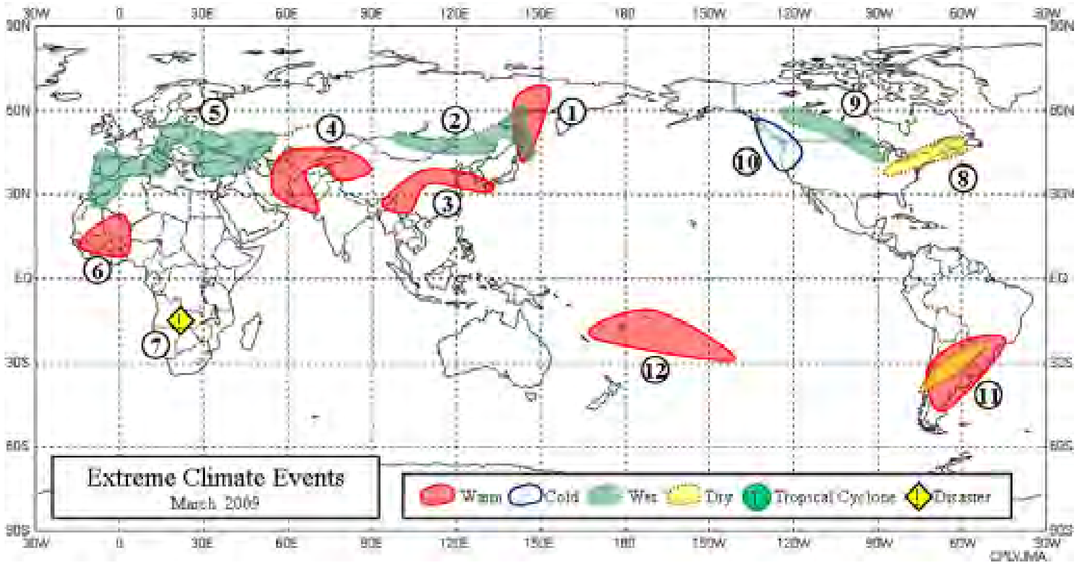
2.1 Monitoring of extreme climate events

JMA produces weekly, monthly, seasonal and annual reports on temperature, precipitation and hazardous climatic events (e.g., floods, droughts and tropical cyclones) using SYNOP and CLIMAT reports collected through GTS (Figure 1). This information is useful in international activities such as trading, transportation and disaster relief.

2.2 Monitoring of global warming

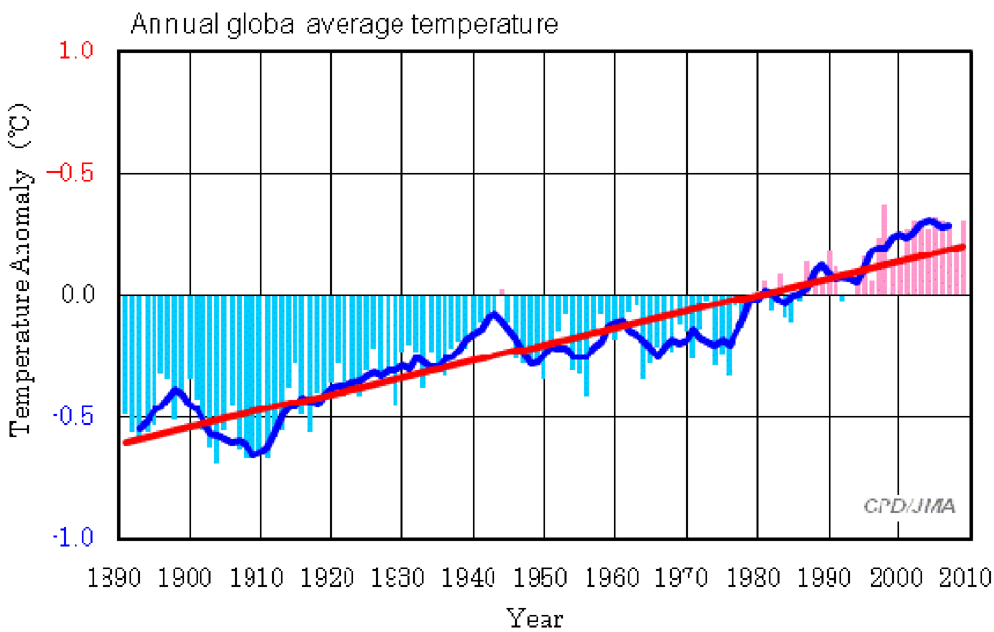
JMA calculates the annual global average temperature anomaly to keep track of the manifestation of ongoing global warming using land surface data (CLIMAT, GHCN-monthly) and the results of sea surface temperature analysis (COBE[3]-SST) (Figure 2).

[1] JCDAS: JMA Climate Data Assimilation System
[2] JRA-25: Japanese 25-year Re-analysis
[3] COBE: Centennial in-situ observation-based estimates of variability of SST and marine meteorological variables



1. High temperatures from eastern Siberia to northern Japan
2. Heavy precipitation from southeastern Siberia to northern Mongolia
3. High temperatures from western Japan to southern China
4. High temperatures from western China to eastern Iran
5. Heavy precipitation from western Kazakhstan to Morocco
6. High temperatures around Mali
7. Torrential rains in southern Africa
8. Light precipitation around the northeastern USA
9. Heavy precipitation from central Canada to the western area of the Great Lakes
10. Low temperatures from southwestern Canada to the northwestern USA
11. High temperatures and light precipitation in southern South America
12. High temperatures around southern Polynesia

Figure 1. A JMA report on extreme climate events (March 2009)



The annual anomaly of the global average surface temperature in 2009 (i.e., the average of the near-surface air temperature over land and the SST) was +0.31°C above normal (based on the 1971 – 2000 average), which was the third highest since 1891. On a longer time scale, global average surface temperatures have been rising at a rate of about 0.68°C per century.

Figure 2. JMA report on global warming (2009)

3. Climate system monitoring

The climate system consists of some subsystems including the atmosphere, oceans, land, the biosphere and so on. JMA monitors atmospheric general circulation and boundary conditions (sea surface temperature, sea-ice, snow cover, etc.) as follows:

· Atmospheric circulation (JRA/JCDAS data)
· Tropical convective activity (satellite observations: NOAA data)
· Sea surface temperature (COBE-SST)
· Snow and sea ice (CLIMAT reports & satellite observations: DMSP-SSM/I data)

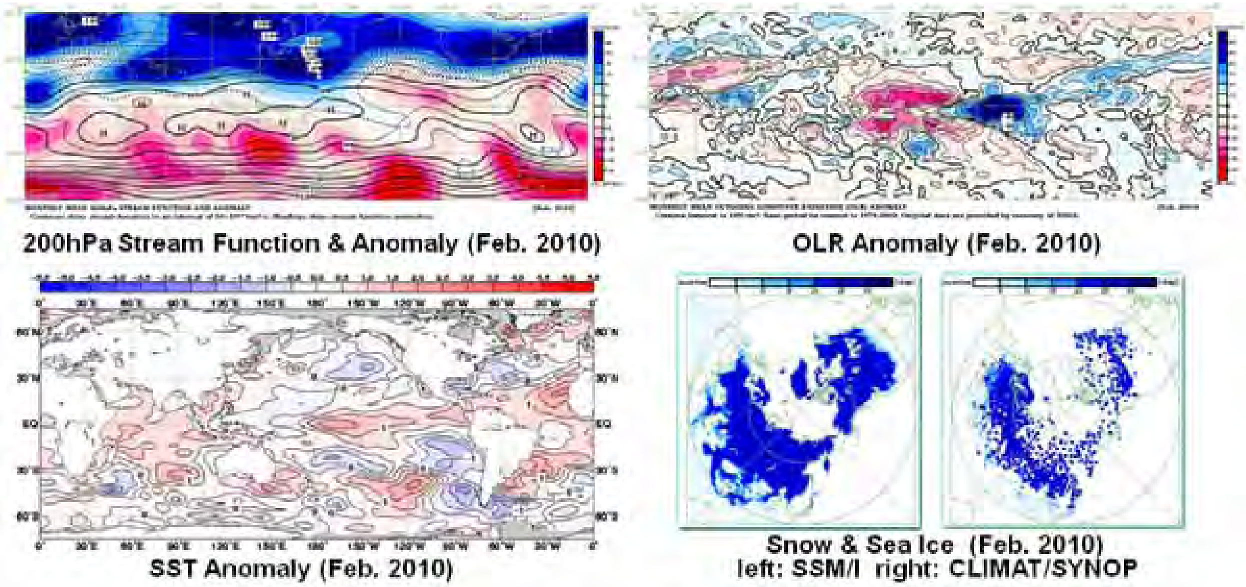


Fig. 3. Examples of JMA's climate system monitoring results

4. Diagnostic information on the climate system as background to extreme climate events

JMA provides diagnostic information on the climate system as background to extreme climate events through the TCC web site at:

http://ds.data.jma.go.jp/tcc/tcc/news/index.html
(*TCC News* is available in the "printable version" column.)

The following articles, for example, can be read in the latest TCC News (No. 20):

· Summary of Asian Winter Monsoon 2009/2010
  - Extremely low temperatures in northern Asia and extremely high temperatures in southern Asia
· Extremely Negative Arctic Oscillation in Winter 2009/2010

5. Importance of in-situ observation from the viewpoint of climate services

Surface monthly data are important for detecting not only extreme climate events but also global warming. All CLIMAT reports from around 3,000 RBCN stations (including around 1,000 GSN stations) are necessary for overall monitoring of the world climate. Past long-term monthly data sets are also important for calculating climatological normals, standard deviations and long-term trends. Accurate measurement and precise analysis are necessary to calculate the global surface temperature anomaly (which has a year-to-year variation of around 0.1°C).

Surface and upper-air daily data (SYNOP and TEMP reports) are important for monitoring and predicting the behavior of the climate system. Past long-term daily data sets are important for re-analysis projects.

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The Importance of Data Quality Control in Disaster Prevention and Mitigation

(Submitted by Kazuhiko Nagata, Japan Meteorological Agency)

Summary and Purpose of Document

Every year, Japan is affected by storm and flood damage resulting from heavy rain, heavy snow, high waves, storm surges and so on caused by typhoons, extratropical cyclones and fronts. When hazardous weather conditions are expected, JMA delivers a variety of simple messages including warnings, advisories and bulletins to the general public and disaster prevention authorities.

Heavy rain warnings/advisories and flood warnings/advisories provide information on sediment-related disasters, floods and inundation. The criteria for these warnings and advisories are the amount of rainfall, the soil water index and the runoff index.

JMA uses the radar/raingauge-analyzed precipitation, which is calibrated radar data by accurately measuring raingauges data, for forecast operations.

Anomalous values observed using raingauges or radar can contaminate radar/raingauge-analyzed precipitation data, which are used as criteria for warnings and advisories. Such values may therefore obstruct forecast operations.

Quality control for observed data is therefore important for smooth forecast operation.

1. Meteorological characteristics and natural disasters of Japan

1.1 Meteorological characteristics of Japan

Japan is located on the eastern edge of the Asian continent, and has a temperate climate with four distinct seasons.

In wintertime (from December to February), developed extratropical cyclones over the Pacific Ocean and dominant Siberian anticyclones bring snowfall to the Sea of Japan side of the country.

Conversely, in summertime (from July to August), Pacific anticyclones cover Japan and bring clear skies to the whole country along with temperatures of over 30°C. Sometimes these conditions spawn thunderstorms.

In spring and autumn, extratropical cyclones and moving highs pass over Japan alternately. Rains falls around the front of these extratropical cyclones.

In the rainy season (known as the Baiu in Japan) from June to July, the Baiu front has a tendency to bring in heavy rains. In another rainy season in September, the Akisame front also tends to bring in heavy rains.

In summer and autumn (from August to October), typhoons sometimes hit Japan.

Figure 1 shows typical seasonal weather maps.

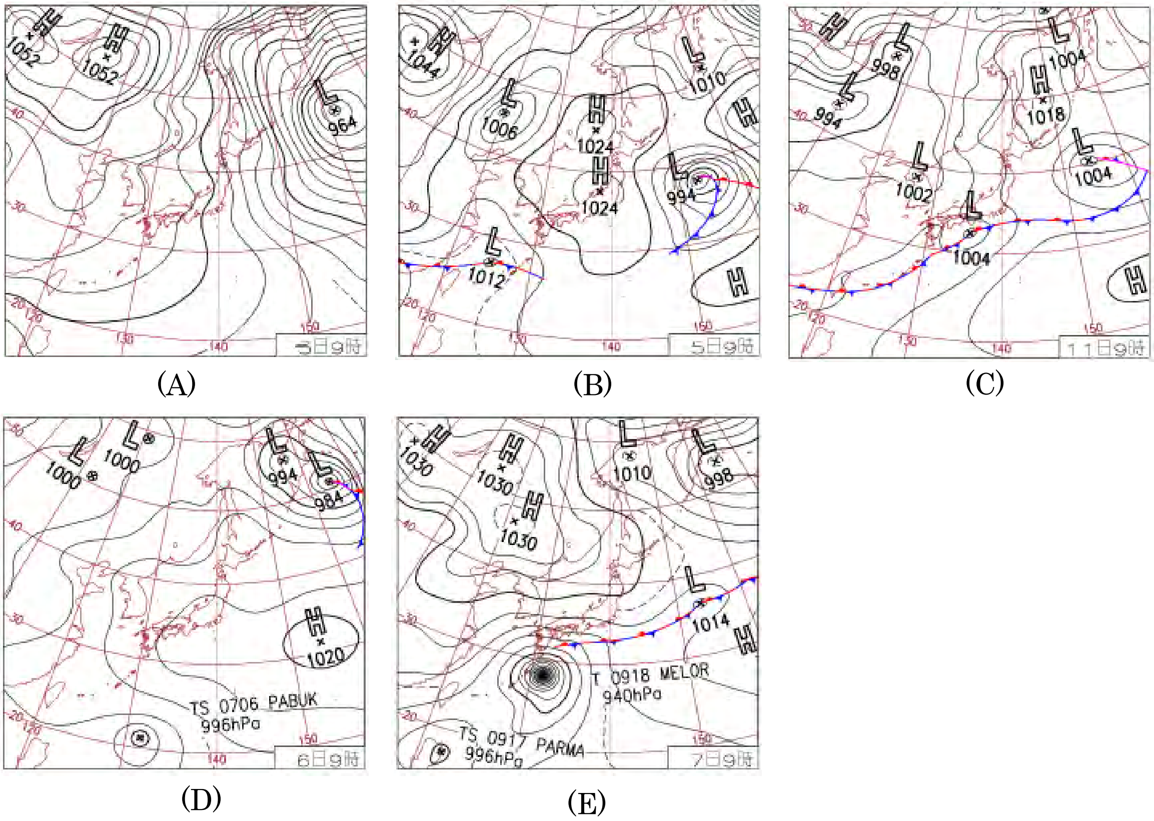

Figure 1. Typical seasonal weather maps

(A) Winter (Jan. 3, 2009) (B) Spring (Mar. 5, 2009) (C) Baiu (Jun. 7, 2006)
(D) Summer (Aug. 6, 2007) (E) Autumn with typhoon (Oct. 7, 2009)

1.2 Natural disasters in Japan

Heavy rains occur when a front such as the Baiu stalls over Japan and when extratropical cyclones or typhoons hit the country.

Heavy snow may fall on the Sea of Japan side when developed extratropical cyclones over the Pacific Ocean and dominant Siberian anticyclones are present, causing upper cold air to move southward.

Storm winds and high waves occur when developed extratropical cyclones and typhoons approach Japan.

In recent years, related disasters have resulted in about 100 fatalities or people unaccounted for, mostly as a result of gusting winds, floods and snow disasters.

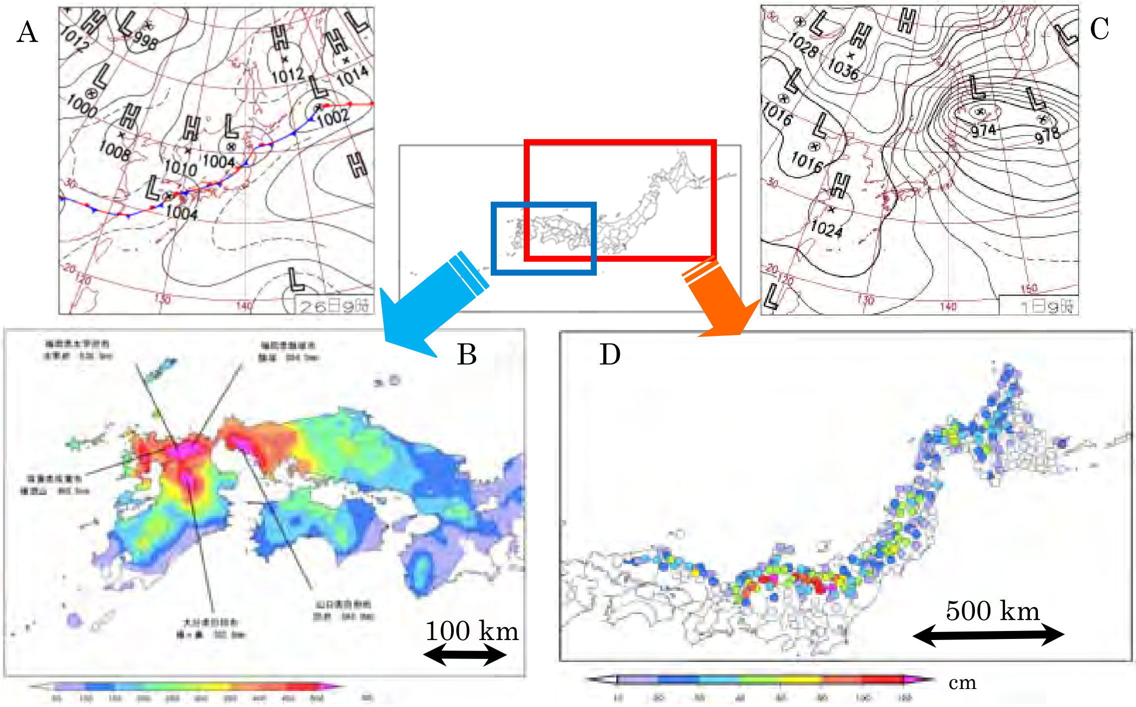

Figure 2. Examples of heavy rain and heavy snow

Figures A and B show a heavy rain event that occurred from July 19 to July 26, 2009, resulting in 30 people killed or unaccounted for.

Figure A shows a weather map for July 26, 2009.

Figure B shows cumulative rainfall from July 19 to July 26, 2009.

Figures C and D show a heavy snow event that occurred from Dec. 31, 2009 to Jan. 1, 2010, resulting in a number of injuries.

Figure C shows a weather map for Jan. 1, 2010.

Figure D shows cumulative snowfall from Dec. 31, 2009 to Jan. 1, 2010.

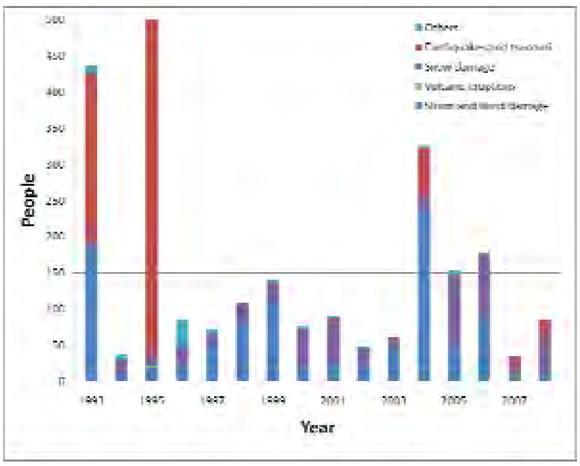

Figure 3. Temporal sequence showing numbers of fatalities and missing people

This figure shows the number of fatalities and missing people resulting from natural disasters such as storm/flood damage, volcanic eruptions, snow damage, earthquakes, tsunami and so on in recent years. In 1995, the Hyogoken Nambu earthquake (also known as the Great Hanshin-Awaji Earthquake) occurred, killing over 6,000 people. (Reference: White Paper on Disaster Management 2009)

2. Information for severe weather preparedness
2.1 Information delivered by JMA

Every year, Japan is affected by storm and flood damage resulting from heavy rain, heavy snow, high waves, storm surges and so on caused by typhoons, extratropical cyclones and fronts. When hazardous weather conditions are expected, JMA delivers a variety of simple messages including warnings, advisories and bulletins to the general public and disaster prevention authorities.

Warnings and advisories for the relevant municipalities are issued whenever forecasters expect weather elements such as rainfall, wind speed, wave height and tide level to meet the trigger criteria.

Currently, JMA issues warnings and advisories for 1,777 municipalities to support the activities of disaster prevention agencies.

2.2 Criteria for heavy rain warnings/advisories and flood warnings/advisories

Here we look at heavy rain warnings/advisories and flood warnings/advisories. These provide information on sediment-related disasters, floods and inundation, which account for a large number of fatalities and missing people.

A heavy rain warning or advisory is issued when sediment-related disasters and inundation caused by heavy rains are feared, while a flood warning or advisory is issued when a rise in water levels and flooding caused by heavy rain, persistent rain and snowmelt water may occur.

The criteria for these warnings and advisories are the amount of rainfall, the soil water index and the runoff index.

The more rain seeps underground, the higher the risk of sediment-related disasters such as debris flow, slope failure and so on. The soil water index is used to estimate the amount of water in soil, and indicates the risk of sediment-related disasters.

Additionally, rainwater accumulates in rivers and runs downstream over time. The runoff index shows the risk of flooding from the amount of rainwater in the drainage basin and the time of flow.

To calculate these indices, precipitation values with a high level of quantitative accuracy are needed.

Figure 4. Visual outlines of the soil water index and the runoff index
(Left) The soil water index indicates the amount of rainwater stored in soil.
(Right) The runoff index indicates the flow of rainwater accumulating in the drainage basin and its downstream flow over time.

3. Rainfall data for forecasting operations

3.1 Precipitation observation equipment

The basic types of equipment for observing precipitation are raingauges and radar. An advantage of raingauges is that they measure actual amounts of precipitation, while a disadvantage is that they can observe precipitation only at single points. An advantage of radar is that it observes large areas at a higher spatial resolution than the raingauge network, and a disadvantage is that it may produce readings different from those of rainfall observed on the ground as it does not measure the amount of rainfall directly.

One-hour cumulative rainfall measured using raingauges and one-hour accumulated echo intensity measured using radar for the same hour are shown in Figure 5. These images indicate that raingauges can observe rainfall only at single points, while radar can observe echoes with no spatial gap. The one-hour cumulative rainfall amount measured using raingauges is different from the one-hour accumulated echo intensity measured using radar.

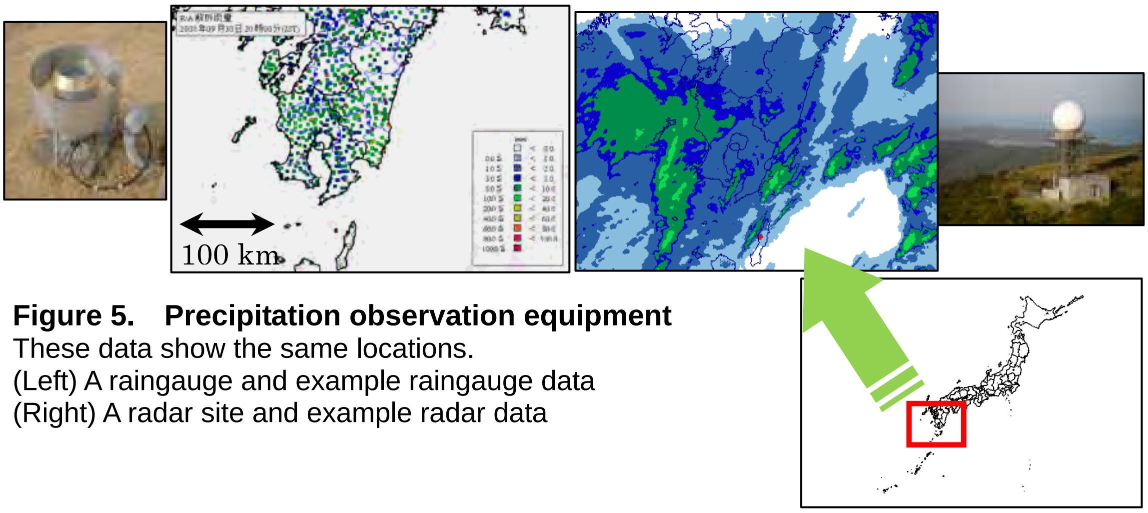

Figure 5. Precipitation observation equipment
These data show the same locations.
(Left) A raingauge and example raingauge data
(Right) A radar site and example radar data

Raingauges measure rainfall amounts automatically, and JMA collects data from around 10,000 such units belonging to JMA, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) and local governments every 10 minutes or every hour. The number of units means that a raingauge is located in every 7-km grid on average. Figure 6 shows the location of raingauges in Japan (only part of the country is shown due to space limitations). Red squares are JMA raingauges, blue squares are MLIT raingauges, and green squares are local government raingauges.

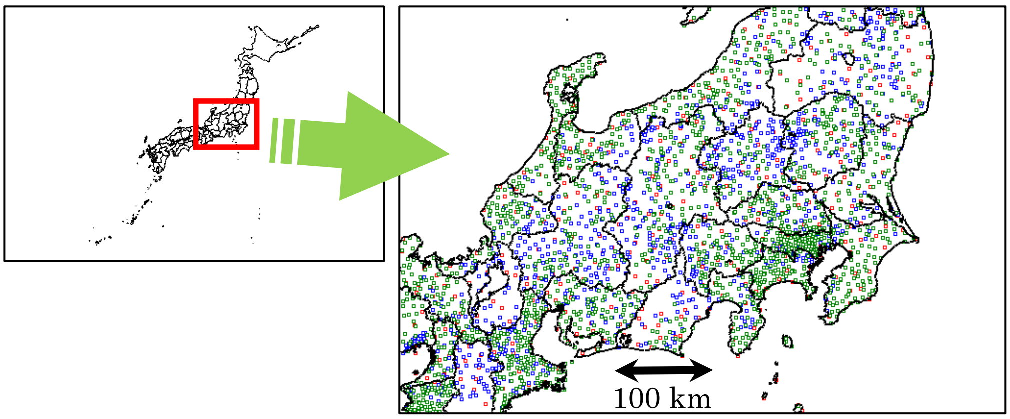

Figure 6. Locations of raingauges
This figure shows part of Japan. Red squares are JMA raingauges, blue squares are MLIT raingauges, and green squares are local government raingauges.

JMA collects data from 46 C-band radars run by JMA and MLIT. The grid size of the data is 1 km. Figure 7 shows the location of each radar site. Red circles are JMA radar sites, and white triangles are MLIT radar sites.

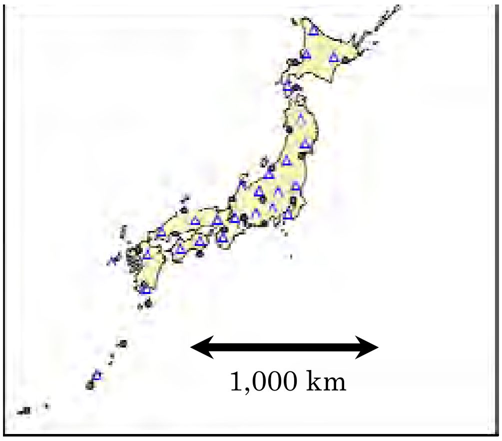

Figure 7. Locations of radar sites
Red circles are JMA radar sites, and white triangles are MLIT radar sites.

3.2 Radar/raingauge-analyzed precipitation

For the issue of warnings or advisories, accurate data on rainfall amounts over and around Japan are required, including for areas where no raingauges are located. Such accurate data are also necessary to create the soil water index and runoff index. JMA uses the radar/raingauge-analyzed precipitation, which is calibrated radar data by accurately measuring raingauges data, for forecast operations.

Precipitation amounts observed using radar generally do not match those observed using raingauges, and are therefore calibrated with raingauge data. For the convenience of forecasters, these calibrated radar data are then made into a single composite data set.

This composite data set is known as radar/raingauge-analyzed precipitation, which indicates precipitation with high dimensional accuracy and is issued every 30 minutes with a spatial resolution of 1 km.

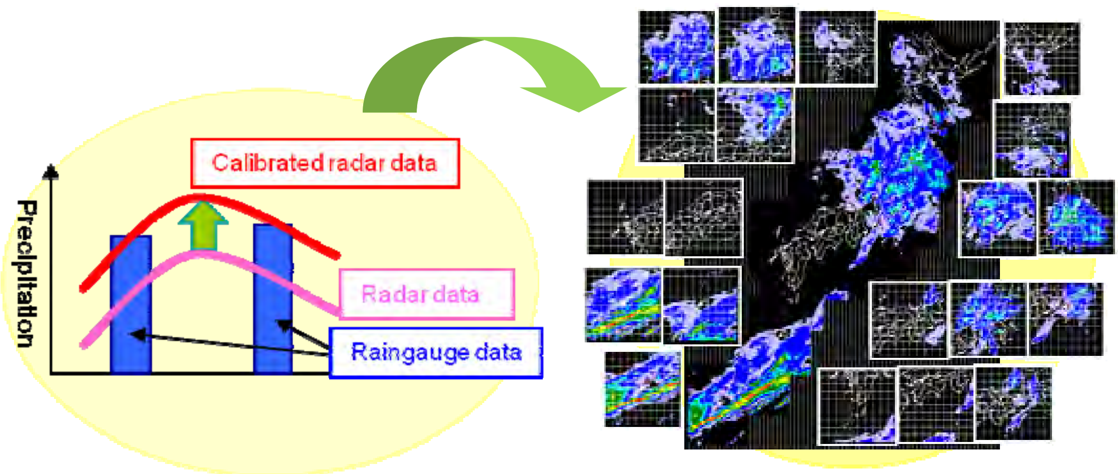

Figure 8. Development of radar/raingauge-analyzed precipitation data
(Left) Radar data are calibrated with raingauge data.
(Right) The calibrated radar data are made into a single composite data set.

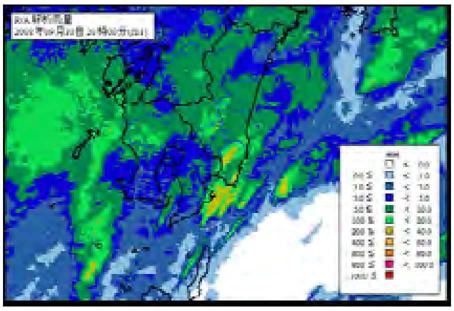

Figure 9. Example of radar/raingauge-analyzed precipitation
Radar/raingauge-analyzed precipitation is a composite data set indicating precipitation with high dimensional accuracy, and is issued every 30 minutes with a spatial resolution of 1 km. This image and those in Figure 5 show the same time and area.

4. The importance of quality control for rainfall data

Anomalous values observed using raingauges or radar can contaminate radar/raingauge-analyzed precipitation data, which are used as criteria for warnings and advisories. Such values may therefore obstruct forecast operations.

The following issues may cause anomalous values:

(1) Observation of non-precipitation data due to inappropriate performance of raingauge inspections.
(2) Observation of measurements that are higher or lower than the true values due to influences related to the raingauge installation site.
(3) Observation of inappropriate data due to raingauge blockages.

(1) is seen when a raingauge is inspected to ascertain proper operation. If the general public sees the anomalous data, they feel strange and observation data could lose its trust. . If inspections are carried out correctly, such anomalous values will not arise.

(2) is seen if a raingauge is installed near a structure such as a wall or on a pole. Walls can obstruct rainfall, and as a result raingauge measurements may be lower than the true values. Similarly, if water runs from a roof onto a raingauge, the recorded value will be higher than the true value. Raingauges in such locations should be moved to a suitable place or not used.

(3) is seen when a raingauge's funnel becomes blocked. Even if it rains heavily around the raingauge, it cannot observe this precipitation because of the blockage. Conversely, if the blockage is removed, the water sitting in the funnel will suddenly flow into the measuring part of the raingauge, causing it to record a value that is higher than the true value at the wrong time. Such anomalous values may occur at any time, so forecasters need to judge whether or not raingauge data are correct.

Forecasters must avoid the issuance of warnings or advisories based on anomalous data. To this end, quality control of raingauge data is performed by setting an upper data limit so that anomalous data are not returned. This limit must be decided carefully; if it is inappropriate, data showing large amounts of rainfall may be regarded as anomalous even if they are correct. The heavier it rains, the higher the risk of disasters becomes. However, the judgment of data showing heavy rainfall as anomalous means that forecasters cannot identify such increased risk.

Also important are metadata showing information such as the location of raingauges, observation intervals, units and so on. As an example, if the location of a raingauge is wrong, even if it observes heavy rain correctly, forecasters will misidentify the location of the precipitation.

As described above, it is clear that quality control for AWS (automatic weather station) data is important. It should also be noted that the importance of quality control for manual observation is the same as that for automatic observation.

Forecasters require accurate, prompt observation data, making it important to obtain correct measurements at fixed times and report them quickly.

WMO/JMA RA II (Asia) Workshop on Quality Management in Surface, Climate and Upper-air Observations

Tokyo, Japan
27-30 July 2010

Doc.
Japan

(10.VII.2010)

The Impact of Observational Data on Numerical Weather Prediction

(Hirokatsu Onoda,Japan Meteorological Agency)

Summary and Purpose of Document

Large amounts of observational data are assimilated in the operational NWP system at JMA. In recent years, the volume of remote sensing data such as satellite radiance has been increasing, and now accounts for about 80% of all observational data. The data remaining 20% come from conventional observation such as SYNOP and Radiosonde, however, still play an important role in the NWP system. JMA perform quality control (QC) for observational data, and this is an essential part of improving the initial value and forecast field. In some cases, observational data are found to include anomalous values. Here, we show the importance of maintenance for the observation network through examples. Finally, we introduce the Report on the Quality of Land Surface Observations in RA-II published by JMA as the lead center, and also outline the Monthly Global Data Monitoring Report.

1. Introduction

The Japan Meteorological Agency (JMA) continues to work on the development of its Numerical Weather Prediction (NWP) system. As one of the world's most advanced NWP centers, JMA now provides a variety of NWP products that play a vital role in weather services both nationally and on an international level.

Currently, JMA operates the following NWP models:

1) The Global Spectral Model (GSM) for the short- and medium-range forecast up to nine days ahead to cover the entire globe,
2) The Mesoscale Model (MSM) for warnings and the very short-range forecast of precipitation to cover Japan and its surrounding areas,
3) A low-resolution version of the GSM for ensemble prediction in one-week forecasting and long-range forecasting up to six months ahead, and
4) Others for specific targets such as ocean waves, sea ice extent and El Niño.

The specifications of the deterministic NWP models are shown in Table.1

Table.1 Specifications of JMA's NWP models (deterministic only)

	Global Model (GSM)	Mesoscale Model (MSM)
Purposes	Short- and medium-range forecast	Very short-range forecast
Forecast domain	Globe	Japan and its surrounding areas
Grid size and/or number of grids	0.1875 deg. (TL959)	5 km / 721 x 577
Vertical levels / Top	60 / 0.1 hPa	50 / 21,800 m
Forecast hours (Initial time)	84 hours (00,06,18UTC) 216 hours (12UTC)	15 hours (00,06,12,18UTC) 33 hours (03,09,15,21UTC)
Initial condition	4D-Var analysis	4D-Var analysis

2. Data use of NWP system

Large amount of observational data are assimilated in the operational NWP system at JMA. High-performance telecommunications and data processing are needed to enable this system to operate on an everyday basis. As one of the Regional Telecommunication Hubs (RTHs) in RA II of the GTS, JMA is connected to two World Meteorological Centers (Washington and Melbourne), four RTHs (Beijing, New Delhi, Bangkok and Khabarovsk), and three National Meteorological Centers (Seoul, Hong Kong and Manila).

Figure 1 shows data use of NWP models. The daily number of observational report reaches about 650,000 for the GSM and about 820,000 for the MSM. In recent years, the volume of remote sensing data such as satellite radiance has increased and now accounts for about 80% of all assimilated data. The remaining 20% come from conventional observation such as SYNOP. Although the percentage of conventional data among assimilated observational data is relatively small, it still plays an important role in the NWP system.

Observation type	Instrument	Global Analysis	Mesoscale Analysis
Conventional	SYNOP	Pressure	Pressure
	AMeDAS*		Rain (Analyzed Rain)
	Ship, Buoy	Pressure	Pressure
	RAOB	Pressure, Wind, Temperature, Relative Humidity	Pressure, Wind, Temperature, Relative Humidity
	Aircraft	Wind, Temperature	Wind, Temperature
Ground based remote sensing	Wind profiler	Wind	Wind
	Radar		Radar reflectivity (Analyzed Rain), Doppler velocity
	GPS		Total precipitable water
Satellite	VIS IR radiometer	AMV, Radiance (clear sky)	AMV
	IR MW sounder	Radiance (clear sky)	Radiance (Temperature)
	MW imager	Radiance (clear sky)	Radiance (TPW, Rain rate)
	Scattrometer	Surface wind	Surface wind
	GPS-RO**	Refractivity	

Figure 1. Data use of NWP models.

* Automated Meteorological Data Acquisition system

** GPS radio occultation

3. The impact of assimilated observations

An observation system experiment was conducted in regard to ground-based observation with the JMA global data assimilation (DA) system. An analysis-forecast cycle experiment was carried out in which ground-based conventional observation (SYNOP, RAOB) were not assimilated. The MSLP departure of observation and background (O-B) values increased in comparison with those of the operational analysis-forecast cycle. This result shows that continuous observation and dense network is important for initial value improvement.

We also investigated which type of data had the greater influence. Langland and Baker (2004) suggested a method to estimate the observation impact. The global observation impact can be expressed as the sum of contributions from all individual observations by considering sensitivity gradients. The quantities for which the system uses the observations to pull the signal from the background are called DFS (degrees of freedom for signal; see for example Wahba, 1995). DFS values according to the type investigated by JMA shows that conventional data still exert a significant influence in the DA system.

It is very important to continue and maintain the conventional observation for NWP system even though the ratio of conventional data has become smaller overall.

4. Quality control in NWP system

JMA operationally performs quality control (QC) for all observational data. QC plays an essential part in maintaining the quality of the initial value and forecast field. The QC system is composed of an automatic component called real-time QC and a manual component called non real-time QC.

The DA system performs real-time QC. If data are climatologically unrealistic, appear as duplicates, show a large difference from the first-guess field (background) of the model or significantly disagree with neighboring values, they are rejected in real-time QC.

In some cases, however, data are found to include anomalous values that are difficult to reject in real-time QC. A blacklist is kept for non real-time QC to deal with such data. Platforms (stations, airplanes, ships, etc) found to report biased or erratic observations placed on the blacklist for careful monitoring, and blacklisted observations are rejected before real-time QC procedures. The blacklist is updated manually whenever sudden deterioration occurs, and blacklisting status is lifted when the careful monitoring shows that the quality has returned to an accepted standard.

Typical causes of blacklisting include the following:

- Problems with instrumentation
- Erroneous reporting formats
- Change of tendency from new correction methods
- Data with low observation density

Some correct observation, however, deviates from the background because the NWP model is not perfect. It is difficult to discriminate wheather errors are related to observation or to the NWP model itself.

5. Data monitoring report

JMA publishes the following two reports:

1) Monthly Global Data Monitoring Report

The JMA Global Data Monitoring Report is a monthly publication intended to give an overview of the quality of observation. It should be recognised that the statistics given in this report refer to data as received by JMA in time for appropriate analysis. The information presented on data quality is based on differences between observations and the values of the most recent JMA forecast (known as first guess) of the same parameters.

2) Report on the Quality of Land Surface Observation in Region II (Asia)

As stipulated in Paragraph 22 of Attachment II.7, of the Manual on the Global Data Processing and Forecasting System (WMO No.485), the Regional Specialized Meteorological Center (RSMC) Tokyo was designated by the President of the Commission for Basic Systems (CBS) as a lead center for monitoring the quality of land surface observations (i.e. SYNOP) for Region II in March 1991. The lead center is responsible for monitoring the quality of land surface observations and composing lists of suspected low-quality observations together with adequate evidence. These lists are passed on to the WMO Secretariat and centers participating in this monitoring activity as well as to members of the Regional Association (RA) II for their reference.

6. References

Langland, R. and N. Baker, 2004: Estimation of observation impact using the NRL atmospheric variational data assimilation adjoint system. Tellus, 56A, 189-201.

Wahba, G. D. R. Johnson, F. Gao and J. Gong, 1995: Adaptive tuning of numerical weather prediction models: Randomized GCV in three and four dimensional data assimilation, *Mon. Wea. Rev.*, 123, 3358-3369.

WMO/CIMO Perspective

(Submitted by M.Ondras, WMO Observing Systems Division)

World Meteorological Organization
Working together in weather, climate and water

WMO

Workshop on Quality Management in Surface, Climate and Upper-Air Observations

(Tokyo, 27-30 July 2010)

Dr M. Ondráš
Chief, WMO Observing Systems Division

WMO/OBS www.wmo.int

WMO Convention
(Part II, Article 2, Purposes)

(a) To facilitate worldwide cooperation in the establishment of networks of stations for the making of meteorological observations as well as hydrological and other geophysical observations related to meteorology, and…;

(c) To promote standardization of meteorological and related observations and to ensure the uniform publication of observations and statistics;

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General Regulation of WMO
(Annex III, Structure and TOR of TCs)

I. Basic Commissions	II. Applications Commissions
• CBS – (A)	• CAeM – (C)
• CIMO – (A)	• CAgM - (C)
• CHy – (A)	• JCOMM - (C)
• CAS – (B)	• CCl - (C)

(A) Basic operations and facilities
(B) Research in Atmospheric sciences
(C) Applications to economic and social activities

Develop, for consideration by the Executive Council and Congress, proposed international standards for methods, procedures, techniques and practices in meteorology and operational hydrology including, in particular, the relevant parts of the Technical Regulations, guides and manuals.

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Standardization
(WMO Regulatory Material)

Cg and EC adopt Regulatory Material that define meteorological practices and procedures to be followed by Members

1. **Standard practices and procedures - Manuals**
2. **Recommended practices and procedures - Guides**

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Partnership in Standardization

- Working agreements with other UN bodies and international Organizations:
  - **ISO**: Working Agreement on joint Standards
  - **ICAO**: Issuing Standards and Recommended Practices for Aviation
  - **CIPM&BIPM**: Working Agreement on cooperation and collaboration & MRA

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Partnership in Standardization (ISO)

ISO Central Secretariat

Organisation internationale de normalisation
International Organization for Standardization

Alan Bryden
Secretary-General

TO THE ISO MEMBER BODIES AND CORRESPONDENT MEMBERS

Council 2007
2007-12-19

Recognition of the World Meteorological Organization (WMO) as an international standardizing body

Dear Sir or Madam,

I am pleased to inform you that Council has recently recognized the WMO as an international standardizing body. The relevant Council Resolution adopted by correspondence reads as follows:

Council,

noting the confirmation by the TMB that the World Meteorological Organization (WMO) fulfils the prerequisites laid down in 1.1 and 1.2 of Council resolution 42/1999,

accepts the World Meteorological Organization (WMO) as an international standardizing body for the purpose of Council Resolution 42/1999 with a view to WMO documents being processed as ISO International Standards where there is no competent ISO technical committee, following the procedure set out in Council Resolution 42/1999.

(Council Resolution 43/2007)

NOTE – The above-mentioned Council Resolution 42/1999 is attached.

I would also like to inform you that working arrangements for the implementation of the above resolution are being finalized by ISO and WMO; their aim is to strengthen the development of International Standards and to avoid duplication of work on standards related to meteorological, climatological, hydrological, marine and related environmental data, products and services.

I wish to recall that, in addition to the WMO, the following three organizations have previously been recognized by Council as international standardizing bodies:
– International Commission on Illumination (CIE);
– International Institute of Welding (IIW);
– International Union of Leather Technologists and Chemists Societies (IULTCS).

Yours faithfully,

Alan Bryden

Enclosure

cc: President, Vice-President (policy), Vice-President (technical management), Treasurer, IEC General Secretary

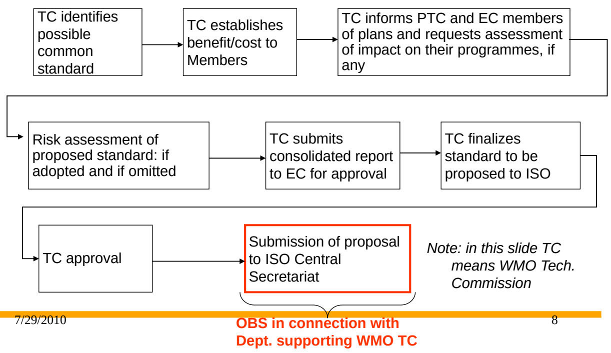
7/29/2010

Partnership in Standardization

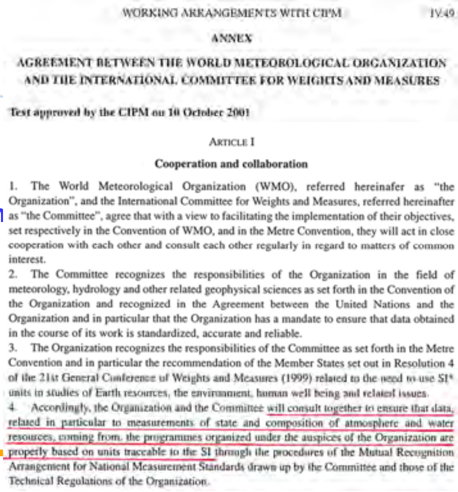
Cooperation Agreement with ISO:

1. Aimed at development of **joint** ISO/WMO tech standards
2. WMO to retain primary **control** of own standards
3. WMO could retain WMO specific standards (TCs decide which standard to propose)
4. Benefits
   - Underlines **authority** of WMO documents
   - Enhances international **recognition** and dissemination of WMO standards
5. Costs:
   - Standards need to be updated every 5 years (current revision cycle of WMO Technical Regulations variable)
   - Publication strategy – free access for Members

Partnership in Standardization



Partnership in Standardization (CIPM&BIPM)



WORKING ARRANGEMENTS WITH CIPM IV.49

ANNEX

AGREEMENT BETWEEN THE WORLD METEOROLOGICAL ORGANIZATION AND THE INTERNATIONAL COMMITTEE FOR WEIGHTS AND MEASURES

Text approved by the CIPM on 10 October 2001

ARTICLE I

Cooperation and collaboration

1. The World Meteorological Organization (WMO), referred hereinafer as "the Organization", and the International Committee for Weights and Measures, referred hereinafter as "the Committee", agree that with a view to facilitating the implementation of their objectives, set respectively in the Convention of WMO, and in the Metre Convention, they will act in close cooperation with each other and consult each other regularly in regard to matters of common interest.
2. The Committee recognizes the responsibilities of the Organization in the field of meteorology, hydrology and other related geophysical sciences as set forth in the Convention of the Organization and recognized in the Agreement between the United Nations and the Organization and in particular that the Organization has a mandate to ensure that data obtained in the course of its work is standardized, accurate and reliable.
3. The Organization recognizes the responsibilities of the Committee as set forth in the Metre Convention and in particular the recommendation of the Member States set out in Resolution 4 of the 21st General Conference of Weights and Measures (1999) related to the need to use SI* units in studies of Earth resources, the environment, human well being and related issues.
4. Accordingly, the Organization and the Committee will consult together to ensure that data, related in particular to measurements of state and composition of atmosphere and water resources, coming from the programmes organized under the auspices of the Organization are properly based on units traceable to the SI through the procedures of the Mutual Recognition Arrangement for National Measurement Standards drawn up by the Committee and those of the Technical Regulations of the Organization.

Cg-XV decisions
Res. 31 (Cg-XV) "Impl of QMS"

1. Recommended **QMS Implementation** for **NMHSs**
2. WMO **Quality Management Framework**
   - Develop overall QM **strategy** for WMO
   - Includes both the needs of Members and the implementation of WMO Programmes
   - WMO QMF aims at **ensuring** the development, use and maintenance of the **WMO technical documentation**, supporting QMS of Members

Cg-XV decisions
Res. 31 (Cg-XV)

3. Encouraged NMSs to implement QMS following appropriate **internationally recognized** standards, if possible ISO 9001
4. Encouraged NMSs to develop a QMS covering **most** of their activities
5. NMHSs may choose:
   - Whether or not to pursue certification
   - Whether to certify all or part of the activities covered by their QMS

Cg-XV decisions
Res. 32 (Cg-XV) "WMO QMF"

NMSs were requested to:

- Quality control on-site observations
- Ensure the traceability of measurements to recognized world standards approved for the use of WMO Members.

Standardization (WMO Regulatory Material)

Technical Regulations (WMO-No. 49) (Mandatory publication):

- **Volume I**: General Meteorological Standards & Recommended Practices
- **Volume II**: Meteorological Service for International Air navigation
- **Volume III**: Hydrology
- **Volume IV**: **QM** (**Generic**, a proposal of ICTT-QMF approved by EC-LXII)

→ **Five Annexes**: **WMO Manuals**

Standardization (WMO Regulatory Material)

- **Basic Commissions (CBS, CIMO, CAS, CHy)**
  - CAS: **Manual on the observations of clouds and other meteors** (Vol. I of ICA) **(I)**, GAW Reports
  - CBS: **Manuals on Codes (II)**, **on GTS (III)**, **on GDPFS (IV)**, **on GOS (V)**
  - CBS: Guides on GOS, GDPFS, GTS
  - CIMO: Guide to Met. Instruments and Methods of Obs.
  - CHy: Guide to Hydro Practices, Technical Docs
- **App. Commissions** (CCl, CAgM, CAeM, **JCOMM**)
  - Some Manuals, e.g. **Manual on Marine Met Services (VI)** but mostly Guides to xx Practices or Services, TN and other Reports, e.g. IOM Report series

NOTE: Marked red are mandatory publications and are Annexes to WMO TR

Standardization (WMO Regulatory Material-QM)

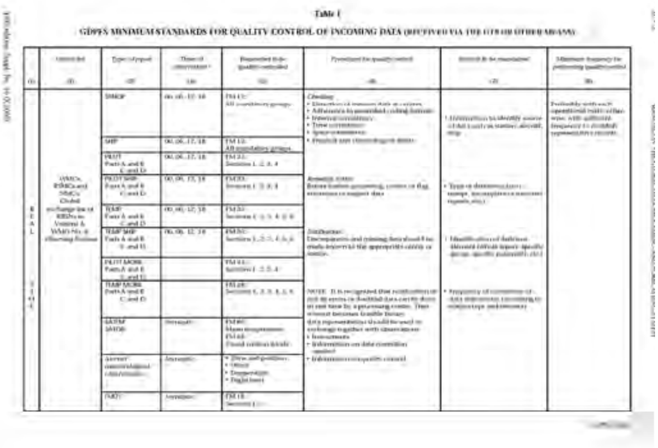
- Manual on the **GDPFS**, Part II, Ch.2 QC of observational data and their reception at GDPFS Centres in real and non-real time (**authoritative reference** on all matters related to QC issues),
- Manual on the **GOS**, Part V, QC
- Guide to the **GOS**, Part VIII, QM
- **CIMO** Guide, Part III, QA and QM of Obs. Systems
- Manual on **Marine** Met Services, Vol. I, QC of Data

(Note: Sections on QM also in other Manual and Guides)

Manual on GDPFS, P II, CH.2

(QC of observational data and their reception at GDPFS Centres in **real** time)

- QC requires that an **operational entity** (WMC, RSMC, NMC or observing site) **has the ability** to select, edit, or otherwise **manipulate** observations according to its own set of physical or dynamical principles.
- The primary **responsibility** for QC of obs data rest with the **originating** NMS.
- NMS should **ensure** that when obs data enter GTS they are **free** from errors.
- NMS should implement **minimum standards** of real-time quality control (Appendix II-1).



Manual on GDPFS, P II, CH.2

(QC of observational data and their reception at GDPFS Centres in **non-real** time)

1. Prior to storage of data they should be subject to the QC necessary to ensure a satisfactory standard of accuracy for users.
2. The primary responsibility for non-real-time QC should rest with Members which operate the centres that store the data. (Note: This apply also Members data storage.) This QC should be performed on a routine basis and should begin as soon as possible after the data have been received at the centre.
3. Prior to placing data in storage, all suspect values and proposed corrections should be appropriately marked for future users of data.

GDPFS MINIMUM STANDARDS FOR QUALITY CONTROL OF INCOMING DATA (RECEIVED VIA THE GTS OR OTHER MEANS)

Guide on GDPFS, CH.6
(QC Procedures and Techniques)

Gross-error limit checks
(against physical or climatological limits)

Table 6.4
Limit values for surface wind speed
(The value is considered suspect when MAX 1 < *ff* < MAX 2;
the value is considered erroneous when *ff* > MAX 2)

Area	*Winter*		*Summer*	
	MAX 1	*MAX 2*	*MAX 1*	*MAX 2*
45°S – 45°N	60 m s⁻¹	125 m s⁻¹	90 m s⁻¹	150 m s⁻¹
45°N – 90°N and 45°S–90°S	50 m s⁻¹	100 m s⁻¹	40 m s⁻¹	75 m s⁻¹

Guide on GDPFS, CH.6
(QC Procedures and Techniques)

Internal consistency checks
(Different parameters are checked against each other)

The different parameters in SYNOP reports are checked against each other. In the description below, the suggested checking algorithms have been divided into areas where the physical parameters are closely connected:

(*a*) Wind *dd*/*ff*

The wind information is considered to be erroneous in the following cases:

$dd = 00$ and $ff \neq 00$;

$dd \neq 00$ and $ff = 00$;

$dd = 99$ and $ff = 00$ or $ff \geq 05$ m s⁻¹;

(*b*) Visibility *VV* and weather *ww*

The values of visibility and weather are considered suspect when:

$42 \leq ww \leq 49$ and $\{10 \leq VV \leq 89$ or $94 \leq VV \leq 99\}$;

$ww = 10$ and $\{00 \leq VV \leq 09$ or $90 \leq VV \leq 93\}$;

$VV < 10$ and $\{ww < 04$ or $ww = 05$ or $10 \leq ww \leq 16$ or $20 \leq ww \leq 29$ or $ww = 40\}$;

$\{VV < 60$ or $90 \leq VV \leq 96\}$ and $ww \leq 03$;

$\{60 \leq VV \leq 89$ or $97 \leq VV \leq 99\}$ and $\{04 \leq ww \leq 07$ or $38 \leq ww \leq 39\}$;

$\{ww = 11$ or $ww = 12$ or $ww = 28$ or $ww = 40\}$ and $\{00 \leq VV \leq 09$ or $90 \leq VV \leq 93\}$;

Manual on GOS, Part V, QC

1. QC of observational data consists of examination of data at **stations** at **data centres** to detect errors so that data may be corrected or flagged.
2. A QC system should include procedures for **returning to the source** of data to verify them and to prevent recurrence of errors.
3. Within the framework of the GOS, QC shall be a **real-time activity** which has to be performed prior to the transmission of the observational data on GTS.
4. The **primary responsibility** for QC of all obs data shall rest with the Members (where observations originated).

Guide on GOS, Part VIII, QM
(Ref: QMF)

1. The key aim: to check the **entire process** not only the final product.
2. Res.27 (Cg-XIV) –initiated WMO QMF to develop the following elements: WMO **technical standards**; **QMS**, including QC; and **certification** procedures.
3. The structure of the QMF corresponds to the following aims of WMO:
   a) To ensure adequate uniformity and **standardization** in the practices and procedures used by NMSs;
   b) To ensure **quality** of observational data, since the effectiveness of any NMS depends on the quality of data and products exchanged through the WMO Systems;
   c) To ensure overall **availability** of observational data for all purposes, especially for the NWP.

CIMO Guide, Part III
"QA & QM of OS"

1. **ISO 9000: QMS – Fundamentals and vocabulary**
2. **ISO 9001: QMS – Requirements**
3. **ISO 9004: QMS – Guidelines for performance improvements**
4. **9011 : Guidelines for quality and/or environmental management systems auditing**
5. **ISO /IEC 1 7025: General requirements for the competence of testing and calibration laboratories**
6. **ISO /IEC 20000: Information technology – Service management**
7. **WMO QMF**
8. **Accreditation of Laboratories**
9. **Factors affecting Data Quality**

CIMO Guide, Part III
"QA & QM of OS"
(Factors affecting Data Quality)

a) User requirements
b) Functional and technical specifications
c) Selection of instruments
d) Acceptance tests
e) Compatibility
f) Siting and exposure
g) Instrumental errors
h) Data acquisition
i) Data processing
j) Real-time quality control
k) Performance monitoring
l) Testing and calibration
m) Maintenance
n) Training and education
o) Metadata

Manual on Marine Met Services
Para 5.6.3 "QC of Data" & App. I.15

- All Members should make every effort to apply the **minimum quality control procedures** (Appendix I.15) before dispatching the data to the global collecting centres.
- Centres should **ensure** that this minimum quality control has been **applied before** making the data available to Members.
- Details of national QC schemes should be made **available**.

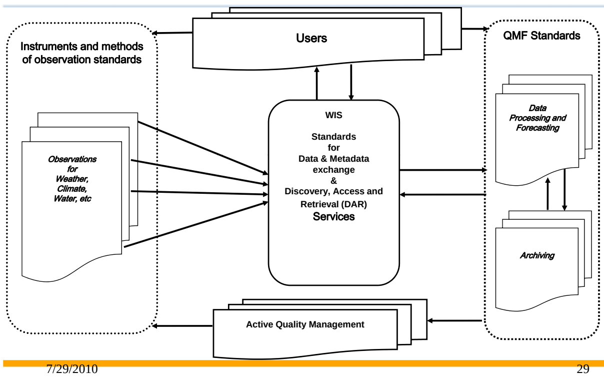
CBS

- **Responsible** for matters relating to:
  - Cooperation with Members, TCs and other bodies in the development and operation of **integrated systems for observing**, DP, TC, and DM in response to requirements;
  - **Observational systems, facilities and networks** (land, sea, air, and space) as decided by Members including, in particular, all technical aspects of the Global Observing System (GOS) of WWW.

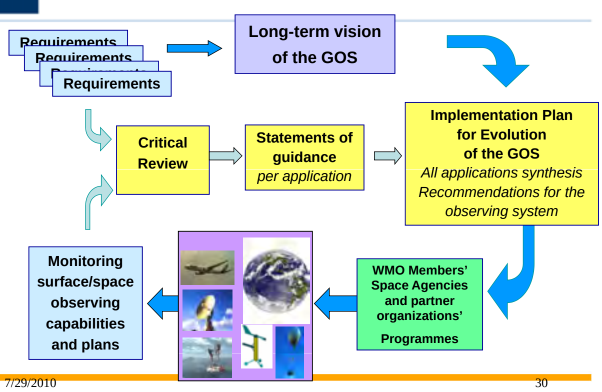
Res. 30 (Cg-XV) "WIGOS"

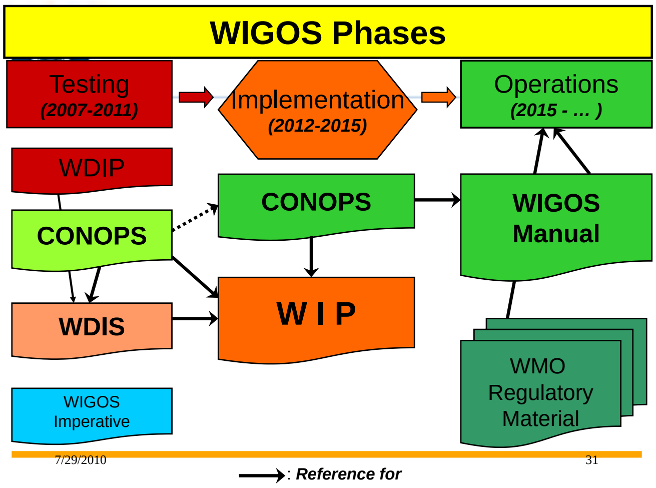
- One of the WMO's **high** priorities;
- **Framework** enabling the integration and optimized evolution of WMO observing systems, and WMO's contribution to co-sponsored systems;
- Focus on single management, governance, interoperability, **standardization**, ...

Key areas of standardization



WIGOS evolution process - RRR





CIMO

- **Responsible** for matters relating to international standardization and compatibility of instruments and methods of observation of meteorological, related geophysical, and environmental variables:
  - Advice (types, characteristics, accuracies, performance),
  - Instrument comparisons and tests,
  - Recommendations (methods, calibration, …),
  - Reference instruments.

WMO Regulatory Material

- Process for standard development defined by TC
- TR > > **Cg**
- Manuals and Guides:
  - CBS > > **EC** > > Manual and Guide on GOS;
  - CIMO > > **EC** > > CIMO Guide.
- Technical Reports > > **TCs**:
  - CBS WWW Reports;
  - CIMO IOM Report series – 99 reports on WWW web.
- **Future**: (a) WIGOS Manual; (b) CIMO Manual; (c) Joint standards with ISO.

WMO Regulatory Material and other guidance

- Resolution 6 (EC-LIX):
  - **Vision for the Global Observing System in 2025;**
  - Functional **specifications** for AWSs (GOS Guide);
  - Basic **set of variables** for a standard AWS for multiple users (GOS Guide).
- Resolution 7 (EC-LIX):
  - **Measurements in severe icing conditions**;
  - **Standardized procedure for laboratory calibration of catchment type RI gauges**;
  - ToR of RRCs, **RICs** (CIMO Guide)**;**
  - **Procedure and reference instruments for field rainfall intensity intercomparisons.**

WMO TCs and the Region

- **RA II RICs**:
  - Beijing, China
  - Tsukuba, Japan
- Recommendations 11 and 12 (CIMO-XIV):
  - **Full** and basic **capabilities** and corresponding **functions of RICs**;
  - RICs must be regularly (≤5 years) evaluated to verify their capabilities by a recognized authority.

WMO TCs and the Region

- Capabilities (must):
  - have the necessary facilities and lab EQ;
  - maintain a set of meteorological standard instruments;
  - Apply international standards for cal labs (ISO 17025).
- **Functions** (must):
  - assist M in calibrating their national meteorological standards and related instruments (how?);
  - advise M on enquiries regarding instrument performance, maintenance and the availability of relevant guidance materials;
  - actively participate, or assist, in the organization of regional workshops on instruments;
  - inform M on an annual basis on the services provided and activities carried out.

WMO TCs and the Region

- **CIMO ET on RIC** (Casablanca, 4-5 Dec.09)
  - **Evaluation** scheme for RICs (or CAL labs of M)
  - **Status** on instrument traceability;
  - **Recommended** instruments for CAL Labs;
  - Guidance on **inter-labs comparisons.**
- **WIGOS PP** (GE, 8/9 Oct.09)
  - Siting classification of surface Oss;
  - Maintained performance classification of surface Oss.

CIMO Guide

Part I. Measurement of meteorological Variables:

- CHAPTER 1. General
- CHAPTER 2. Measurement of temperature
- CHAPTER 3. Measurement of atmospheric pressure
- CHAPTER 4. Measurement of humidity
- CHAPTER 5. Measurement of surface wind
- CHAPTER 6. Measurement of precipitation
- CHAPTER 7. Measurement of radiation
- CHAPTER 8. Measurement of sunshine duration
- CHAPTER 9. Measurement of visibility
- CHAPTER 10. Measurement of evaporation
- CHAPTER 11. Measurement of soil moisture
- CHAPTER 12. Measurement of UA pressure, temperature and humidity
- CHAPTER 13. Measurement of upper wind
- CHAPTER 14. Present and past weather; state of the ground
- CHAPTER 15. Observation of clouds
- CHAPTER 16. Measurement of ozone
- CHAPTER 17. Measurement of atmospheric composition

CIMO Guide

Part II. Observing Systems:

- CHAPTER 1. Measurements at automatic weather stations
- CHAPTER 2. Measurements and observations at aeronautical met stations
- CHAPTER 3. Aircraft observations
- CHAPTER 4. Marine observations
- CHAPTER 5. Special profiling techniques for the BL and the troposphere
- CHAPTER 6. Rocket measurements in the stratosphere and mesosphere
- CHAPTER 7. Locating the sources of atmospherics
- CHAPTER 8. Satellite observations
- CHAPTER 9. Radar measurements
- CHAPTER 10. Balloon techniques
- CHAPTER 11. Urban observations
- CHAPTER 12. Road Meteorological Measurements

Part III. QA and Management of Observing Systems:

- CHAPTER 1. Quality management
- CHAPTER 2. Sampling meteorological variables
- CHAPTER 3. Data reduction
- CHAPTER 4. Testing, calibration and intercomparison
- CHAPTER 5. Training of instrument specialists

ANNEX 1.B

OPERATIONAL MEASUREMENT UNCERTAINTY REQUIREMENTS AND INSTRUMENT PERFORMANCE

	(1) Variable	(2) Range	(3) Reported resolution	(4) Mode of measurement/ observation	(5) Required measurement uncertainty	(6) Sensor time constant	(7) Output averaging time	(8) Achievable measurement uncertainty	(9) Remarks
1.	**Temperature**								
1.1	Air temperature	–80 – +60°C	0.1 K	I	0.3 K for ≤ –40°C 0.1 K for > –40°C and ≤ +40°C 0.3 K for > +40°C	20 s	1 min	0.2 K	Achievable uncertainty and effective time-constant may be affected by the design of the thermometer solar radiation screen Time-constant depends on the air-flow over the sensor
1.2	Extremes of air temperature	–80 – +60°C	0.1 K	I	0.5 K for ≤ –40°C 0.3 K for > –40°C and ≤ +40°C 0.5 K for > +40°C	20 s	1 min	0.2 K	
1.3	Sea surface temperature	–2 – +40°C	0.1 K	I	0.1 K	20 s	1 min	0.2 K	
2.	**Humidity**								
2.1	Dewpoint temperature	–80 – +35°C	0.1 K	I	0.1 K	20 s	1 min	0.5 K	
						Wet-bulb temperature (psychrometer)			
2.2	Relative humidity	0 – 100%	1%	I	1%	20 s	1 min	0.2 K	If measured directly and in combination with air temperature (dry bulb) Large errors are possible due to aspiration and cleanliness problems (see also note 11)
						Solid state and others			
						40 s	1 min	3%	Solid state sensors may show significant temperature and humidity dependence

	(1) Variable	(2) Range	(3) Reported resolution	(4) Mode of measurement/ observation	(5) Required measurement uncertainty	(6) Sensor time constant	(7) Output averaging time	(8) Achievable measurement uncertainty	(9) Remarks
3.	**Atmospheric pressure**								
3.1	Pressure	500 – 1 080 hPa	0.1 hPa	I	0.1 hPa	20 s	1 min	0.3 hPa	Both station pressure and MSL pressure Measurement uncertainty is seriously affected by dynamic pressure due to wind if no precautions are taken Inadequate temperature compensation of the transducer may affect the measurement uncertainty significantly
3.2	Tendency	Not specified	0.1 hPa	I	0.2 hPa			0.2 hPa	Difference between instantaneous values
4.	**Clouds**								
4.1	Cloud amount	0/8 – 8/8	1/8	I	1/8	n/a		2/8	Period (30 s) clustering algorithms may be used to estimate low cloud amount automatically
4.2	Height of cloud base	0 m – 30 km	10 m	I	10 m for ≤ 100 m 10% for > 100 m	n/a		~10 m	Achievable measurement uncertainty is undetermined because no clear definition exists for instrumentally measured cloud-base height (e.g. based on penetration depth or significant discontinuity in the extinction profile) Significant bias during precipitation
4.3	Height of cloud top	Not available							

	(1) Variable	(2) Range	(3) Reported resolution	(4) Mode of measurement/ observation	(5) Required measurement uncertainty	(6) Sensor time constant	(7) Output averaging time	(8) Achievable measurement uncertainty	(9) Remarks
5.	**Wind**								
5.1	Speed	0 – 75 m s^{-1}	0.5 m s^{-1}	A	0.5 m s^{-1} for ≤ 5 m s^{-1} 10% for > 5 m s^{-1}	Distance constant 2 – 5 m	2 and/or 10 min	0.5 m s^{-1} for ≤ 5 m s^{-1} 10% for > 5 m s^{-1}	Average over 2 and/or 10 min Non-linear devices. Care needed in design of averaging process Distance constant is usually expressed as response length Averages computed over Cartesian components (see Part III, Chapter 3, section 3.6 of this Guide)
5.2	Direction	0 – 360°	1°	A	5°	1 s	2 and/or 10 min	5°	
5.3	Gusts	0.1 – 150 m s^{-1}	0.1 m s^{-1}	A	10%		3 s	0.5 m s^{-1} for ≤ 5 m s^{-1} 10% for > 5 m s^{-1}	Highest 3 s average should be recorded
6.	**Precipitation**								
6.1	Amount (daily)	0 – 500 mm	0.1 mm	T	0.1 mm for ≤ 5 mm 2% for > 5 mm	n/a	n/a	The larger of 5% or 0.1 mm	Quantity based on daily amounts Measurement uncertainty depends on aerodynamic collection efficiency of gauges and evaporation losses in heated gauges
6.2	Depth of snow	0 – 25 m	1 cm	A	1 cm for ≤ 20 cm 5% for > 20 cm				Average depth over an area representative of the observing site
6.3	Thickness of ice accretion on ships	Not specified	1 cm	I	1 cm for ≤ 10 cm 10% for > 10 cm				

	(1) Variable	(2) Range	(3) Reported resolution	(4) Mode of measurement/ observation	(5) Required measurement uncertainty	(6) Sensor time constant	(7) Output averaging time	(8) Achievable measurement uncertainty	(9) Remarks
6.4	Precipitation intensity	0.02 mm h^{-1} – 2 000 mm h^{-1}	0.1 mm h^{-1}	I	(trace): n/a for 0.02 – 0.2 mm h^{-1} 0.1 mm h^{-1} for 0.2 – 2 mm h^{-1} 5% for > 2 mm h^{-1}	< 30 s	1 min		Uncertainty values for liquid precipitation only Uncertainty is seriously affected by wind Sensors may show significant non-linear behaviour For < 0.2 mm h^{-1}: detection only (yes/no) sensor time constant is significantly affected during solid precipitation using catchment type of gauges
7.	**Radiation**								
7.1	Sunshine duration (daily)	0 – 24 h	60 s	T	0.1 h	20 s	n/a	The larger of 0.1 h or 2%	
7.2	Net radiation, radiant exposure (daily)	Not specified	1 J m^{-2}	T	0.4 MJ m^{-2} for ≤ 8 MJ m^{-2} 5% for > 8 MJ m^{-2}	20 s	n/a	0.4 MJ m^{-2} for ≤ 8 MJ m^{-2} 5% for > 8 MJ m^{-2}	Radiant exposure expressed as daily sums (amount) of (net) radiation
8.	**Visibility**								
8.1	Meteorological optical range (MOR)	10 m – 100 km	1 m	I	50 m for ≤ 600 m 10% for > 600 m – ≤ 1 600 m 20% for > 1500 m	< 30 s	1 and 10 min	The larger of 20 m or 20%	Achievable measurement uncertainty may depend on the cause of obscuration Quantity to be averaged: extinction coefficient (see Part III, Chapter 3, section 3.6, of this Guide). Preference for averaging logarithmic values

I.1–22

PART I. MEASUREMENT OF METEOROLOGICAL VARIABLES

	(1) Variable	(2) Range	(3) Reported resolution	(4) Mode of measurement/ observation	(5) Required measurement uncertainty	(6) Sensor time constant	(7) Output averaging time	(8) Achievable measurement uncertainty	(9) Remarks
8.2	Runway visual range (RVR)	10 m – 1 500 m	1 m	A	10 m for ≤ 400 m 25 m for > 400 m – ≤ 800 m 10% for > 800 m	< 30 s	1 and 10 min	The larger of 20 m or 20%	In accordance with WMO-No. 49, Volume II, Attachment A (2004 ed.) and ICAO Doc 9328-AN/908 (second ed., 2000)
9	**Waves**								
9.1	Significant wave height	0 – 50 m	0.1 m	A	0.5 m for ≤ 5 m 10% for > 5 m	0.5 s	20 min	0.5 m for ≤ 5 m 10% for > 5 m	Average over 20 min for instrumental measurements
9.2	Wave period	0 – 100 s	1 s	A	0.5 s	0.5 s	20 min	0.5 s	Average over 20 min for instrumental measurements
9.3	Wave direction	0 – 360°	1°	A	10°	0.5 s	20 min	20°	Average over 20 min for instrumental measurements
10.	**Evaporation**								
10.1	Amount of pan evaporation	0 – 100 mm	0.1 mm	T	0.1 mm for ≤ 5 mm 2% for > 5 mm	n/a			

Notes:
1. Column 1 gives the basic variable.
2. Column 2 gives the common range for most variables; limits depend on local climatological conditions.
3. Column 3 gives the most stringent resolution as determined by the *Manual on Codes* (WMO-No. 306).
4. In column 4:
   I = Instantaneous: In order to exclude the natural small-scale variability and the noise, an average value over a period of 1 min is considered as a minimum and most suitable; averages over periods of up to 10 min are acceptable.
   A = Averaging: Average values over a fixed period, as specified by the coding requirements.
   T = Totals: Totals over a fixed period, as specified by coding requirements.

CHAPTER 1. GENERAL

WMO Regulatory Material

2010 updates:
- 2010 updated of the Guide on the GOS (July 2010)
- 1st Supplement to the 7th Edition of CIMO Guide (CIMO-XV, September 2010)
- 2010 updated of the Manual on the GOS (November 2010)

QM in Surface, Climate and Upper-air Observations

1. **Traceability**
   - **Accuracy**
   - **Compatibility**

2. **Responsibility**
   - **QFCS, DRR, WIGOS,**
   - **CB, Aviation Met**

Training Workshop on Calibration

?

JMA/WMO Workshop on Quality Management in Surface, Climate and Upper-air Observations in RA II (Asia)

Tokyo, Japan
27-30 July 2010

Doc.
Japan

(27.VII.2010)

Siting Classification for Surface Observing Stations on Land

(Submitted by Michel Leroy, Meteo-France)

Summary and Purpose of Document

Several factors have an influence on the « quality » of a meteorological measurement: the intrinsic characteristics of sensors or measurement methods; the maintenance needed to maintain the system in nominal conditions; the site representiveness.

Environmental conditions on a site may generate measurement errors larger than the uncertainty of the instrument itself, whilst more attention is usually being given to the instrument itself. WMO/CIMO has clear recommendations about siting and exposure of instruments. But they are not always possible to follow and this is scarcely documented.

Several years ago, Météo-France defined a siting classification for wind, temperature, precipitation and solar radiation, ranging from 1 (WMO recommendations) to 5 (bad environment to be representative). It has been applied and proved to be efficient both to document the siting and to improve it, by rating it.

Recently, an expert meeting was organized by WMO, to cross experience on the subject and to define a siting classification for Surface Observation at Land. This classification will be proposed for validation by the next CIMO-XV in September 2010.

Considering also the various metrological characteristics of the equipment used in different surface networks, Météo-France defined also another classification, called "maintained performance classification", including the uncertainty of the instrument and the organization of preventive maintenance and calibration.

This complementary classification was also discussed within the expert team of WMO, but was not considered enough mature to be proposed to CIMO for validation.

The principles of these two classifications will be presented, along with the experience of Météo-France in applying them.

WMO/JMA RA II (Asia) Workshop on Quality Management in Surface, Climate and Upper-air Observations

Doc. FRANCE

Tokyo, Japan
27-30 July 2010

Siting Classification for Surface Observing Stations on Land

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Abstract

Several factors have an influence on the « quality » of a meteorological measurement: the intrinsic characteristics of sensors or measurement methods; the maintenance needed to maintain the system in nominal conditions; the site representiveness.

Environmental conditions on a site may generate measurement errors larger than the uncertainty of the instrument itself, whilst more attention is usually being given to the instrument itself. WMO/CIMO has clear recommendations about siting and exposure of instruments. But they are not always possible to follow and this is scarcely documented.

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QUALITY OF A MEASUREMENT

Quality is the ability to satisfy implicit or explicit needs. For meteorological measurements, this is often translated to a statement of operational accuracy requirements. Several factors have an influence on the « quality » of a measurement; one can quote:

a) The intrinsic characteristics of sensors or measurement methods.
   They are coming from technical specifications, emitted by technical services, users or manufacturers. These characteristics are commonly described by the manufacturers, sometimes controlled during intercomparisons and are generally well known and mastered, at least for the classic measurements which we are dealing with. Meteorological services have been traditionally dealing with this aspect.
b) The maintenance tasks (including calibration) needed to maintain the system in nominal conditions.
   These operations are often expensive and necessitate a continuous effort. Preventive maintenance is the best guaranty to maintain a system close to its nominal performance, allowing final measurements to be close to the « intrinsic » performances of the sensor. Our experience shows that this maintenance is not always well mastered in case of a dense network.
c) The site representativeness and therefore the measurement representativeness.

SITE REPRESENTATIVENESS

This representativeness is sometimes neglected, especially when the density of a network is increasing. The people selecting a site know the exposure rules, but numerous logistic constraints exist. For cost and availability considerations, the measurement system is often (at least in France) hosted on a site not belonging to the owner (or the administrator) of the network. The access to the site, its supervision and the availability of telephone and power lines are important elements. These logistic aspects and also the topography, may surpass the strict application of exposure rules, quite restricting, especially for wind measurements (at least 10 times the height of nearby obstacles, which exclude nearby trees or buildings). A compromise is often selected. But when the rules are not applied, there may be no limits. Who have not ever seen anemometers close to high trees?

THE GENESIS OF THE SITING CLASSIFICATION

In 1998, Météo-France defined a classification for some basic surface variables to document the nearby environment of a site. Class numbers are used, ranging from 1 (the best) to 5 (the worst). This classification was first applied to select the sites of 400 AWS of a new network, named RADOME. Obviously the objective was to select class 1 sites, but compromise were sometimes necessary and it was decided to accept sites with a maximum class number of 3.
This classification was presented is some international conferences (TECO, AMS). It is applied, with some modifications, by the USA, to document their climatic reference network. Some other countries (Canada, Switzerland, …) got also an interest in this approach.
Finally, this classification was considered and discussed within WMO (CBS, CIMO and as part of a pilot project for WIGOS). Group of experts amended it and it will be proposed for consideration and possible approval to the next CIMO XV in September 2010. Therefore, it could become a standard from WMO.

SITING CLASSIFICATION

Environmental conditions of a site[1] may generate measurement errors exceeding the tolerances envisaged for instruments. More attention being usually given to the characteristics of the instrument than to the environmental conditions in which the measurement was made; it is often environmental conditions that distort results, influencing their representativeness, particularly where a site is supposed to be representative of a large area (i.e. 100 to 1 000 km2).

WMO-No. 8 indicates exposure rules for various sensors. But what should be done when these conditions are not fulfilled?

There are sites which do not respect the recommended exposure rules. Consequently a classification has been established to help determine the given site's representativeness on a small scale (impact of the surrounding environment). Hence, a class 1 site, can be considered as a reference site. A class 5 site is a site where nearby obstacles create an inappropriate environment for a meteorological measurement that is intended to be representative of a wide area (at least tenths of km2) and where meteorological measurements should be avoided. The smaller is the siting class, the higher is the representativeness of the measurement for a wide area. A site with a poor class number (large number) can stay valuable for a specific application needing a measurement in this particular site including its local obstacles.

Each type of measurements on a site is subject to a separate classification.

By linking measurements to their associated uncertainty levels, this classification may be used to define the maximum class number of a station, in order to be included in a given network, or to be used for a given application. In a perfect world, all sites would be of class 1, but the real world is not perfect and some compromises are necessary. It is more valuable to accept this situation and to document it by means of this siting classification.

By experience of Météo-France, the classification process helps the actors and managers of a network to better take in consideration the exposure rules and thus often improves the siting. At least, the siting environment is known and documented in the metadata. It is obviously possible and recommended to fully document the site, but the risk is that a fully documented site may increase the complexity of the metadata, which would often restrict their operational use. That is why this siting classification is defined to condense the information and facilitate the operational use of this metadata information.

A site as a whole has no single classification number. Each parameter being measured at a site has its own class, and is sometimes different from others. If a global classification of a site is required, the maximum value of the parameters' classes can be used.

The rating of each site should be reviewed periodically as environmental circumstances can change over a period of time. A systematic yearly visual check is recommended: if some aspects of the environment have changed, a new classification process is necessary.

A complete update of the site classes should be done at least every 5 years.

In the following text, the classification is (occasionally) completed with an estimated uncertainty due to siting, which has to be added in the uncertainty budget of the measurement. This estimation is coming from bibliographic studies and/or some comparative tests.

The primary objective of this classification is to document the presence of obstacles close to the measurement site. Therefore, natural relief of the landscape may not be taken into account, if far away (i.e. >1 km). A method to judge if the relief is representative of the surrounding area is the following: does a move of the station by 500 m change the class

[1] A "site" is defined as the place where the instrument is installed.

obtained? If the answer is no, the relief is a natural characteristic of the area and is not taken into account.

Complex terrain or urban area generally leads to high class number. In such cases, an additional flag “S” can be added to class numbers 4 or 5 to indicate Specific environment or application (i.e 4S).

The example of the classification for precipitation is given below.

CLASSIFICATION FOR PRECIPITATION

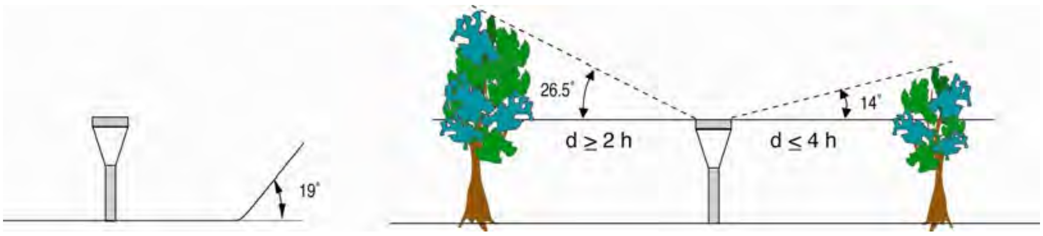
Wind is the greatest source of disturbance in precipitation measurements, due to the effect of the instrument on the airflow. Unless rain gauges are artificially protected against wind, for instance by a wind shield , the best sites are often found in clearings within forests or orchards, among trees, in scrub or shrub forests, or where other objects act as an effective wind-break for winds from all directions. Ideal conditions for the installation are those where equipment is set up in an area surrounded uniformly, by obstacles of uniform height. An obstacle represents an object with an angular width of 10° or more.

The choice of such a site is not compatible with constraints in respect of the height of other measuring equipment. Such conditions are practically unrealistic. If obstacles are not uniform, they are prone to generate turbulence which distorts measurements; this effect is more pronounced for solid precipitation. This is the reason why more realistic rules of elevation impose a certain distance from any obstacles. The orientation of such obstacles with respect to prevailing wind direction is deliberately not taken into account. Indeed, heavy precipitation is often associated with convective factors, whereby the wind direction is not necessarily that of the prevailing wind. Obstacles are considered of uniform height if the ratio between the highest and lowest height is lower than 2.

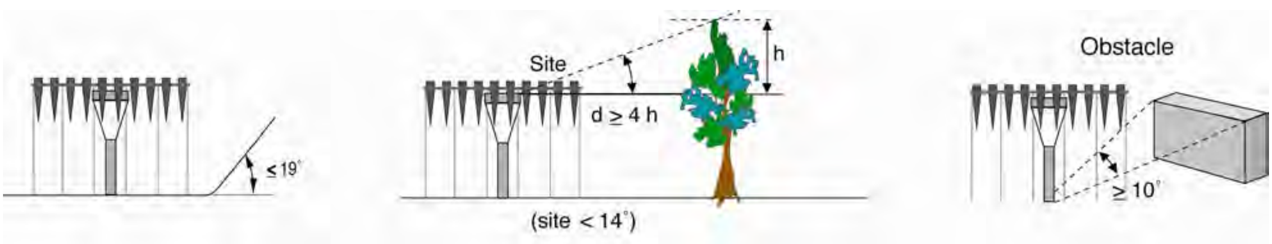
Reference for the heights of obstacles is the catchment’s height of the rain gauge.

Class 1

- Flat, horizontal land, surrounded by an open area, slope less than 1/3 (19°). Rain gauge surrounded by obstacles of uniform height, seen under an elevation angle between 14 to 26° (obstacles at a distance between 2 to 4 times their height).



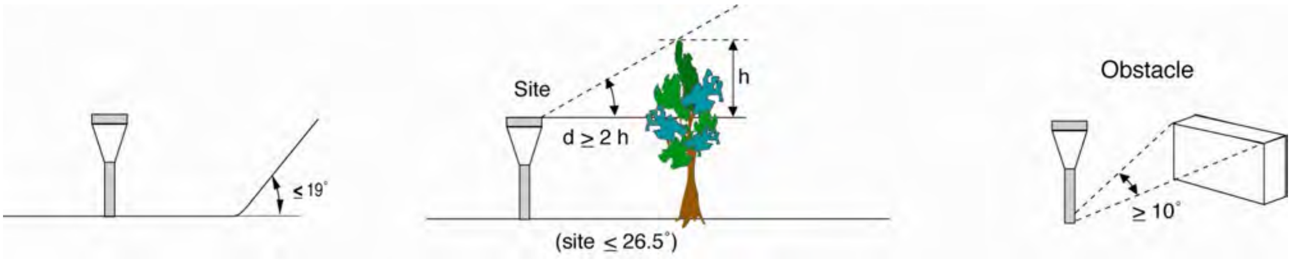
or



- Flat, horizontal land, surrounded by an open area, slope less than 1/3 (19°). For a rain gauge artificially protected against wind, the instrument does not necessarily need to be protected by obstacles of uniform height. In this case, any other obstacles must be situated at a distance of at least 4 times their height.

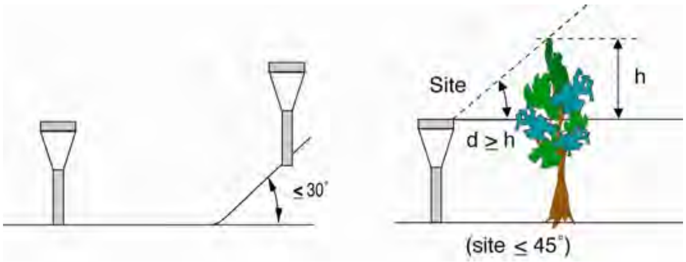
Class 2 (additional estimated uncertainty added by siting up to 5 %)

- Flat, horizontal land, surrounded by an open area, slope less than 1/3 (19°).
- Possible obstacles must be situated at a distance at least twice the height of the obstacle (with respect to the catchment's height of the rain gauge).



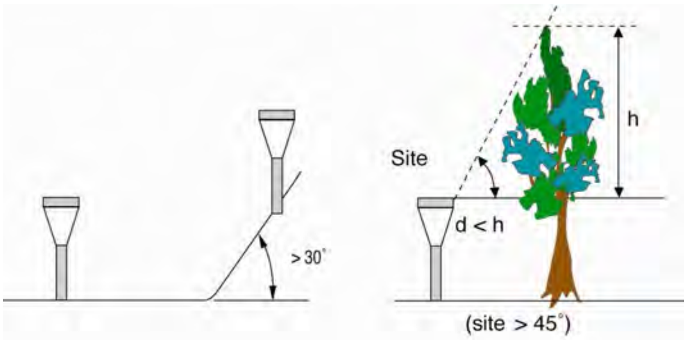
Class 3 (additional estimated uncertainty added by siting up to 15 %)

- Land is surrounded by an open area, slope less than 1/2 (≤ 30°).
- Possible obstacles must be situated at a distance greater than the height of the obstacle.



Class 4 (additional estimated uncertainty added by siting up to 25 %)

- Steeply sloping land (> 30°).
- Possible obstacles must be situated at a distance greater than one half (1/2) the height of the obstacle.



Class 5 (additional estimated uncertainty added by siting up to 100 %)

- Obstacles situated closer than one half (1/2) their height (tree, roof, wall, etc.).

MAINTAINED PERFORMANCE CLASSIFICATION

Another primary quality factor of a measurement is the set of “intrinsic” characteristics of the equipment used. They are the characteristics related to the design of the instrument. They are known from the manufacturer documentation and/or from laboratory or field tests.
Once an instrument is selected and its performance characteristics known, it is necessary to maintain the level of performance during its operational period. Preventive maintenance and calibration are therefore necessary and must be identified to maintain the desired measurement uncertainty.
When delivering observations for various applications (mainly forecasts and climatology), it should be possible to state the “guaranteed” (for example with a 95% level of confidence) accuracy of a measurement. But it is not always done, the observations may come from several networks with different characteristics and considering “by default” the “achievable measurement uncertainty” of WMO n°8, Annex 1B could be a mistake.
The required accuracy of the main surface-observing network of Météo-France, named Radome, has been stated, the instruments were selected and the maintenance and calibration are organized accordingly. Doing this, the performances are known and documented. They are generally less stringent than the WMO operational measurement uncertainty requirements.

In addition to his proprietary Radome network, Météo-France also uses observations from other AWS networks (not belonging to Météo-France) and from manual climatologic sites (cooperative network). The instruments used in such networks are often not the same that the instruments specified and selected for Radome. Therefore, their performances are different, often lower. Nevertheless, their data have been used for climatological and forecasting applications, generally without considering the “quality” of the network. This may not be satisfactory and the “quality” of the observations has sometimes to be taken into account, mainly for the climatology.

In order to document the performance characteristics of the various surface observing networks used, Météo-France defined another classification, called "maintained performance classification", including the uncertainty of the instrument and the periodicity and the procedures of preventive maintenance and calibration. The five levels are:

- Class A: WMO/CIMO required measurement uncertainty or achievable measurement uncertainty when higher. Maintenance and calibration are organized to keep this uncertainty in the field and over time. When the required measurement uncertainty is smaller than the achievable accuracy, the latter is indicated.
- Class B: Lower specifications, but still considered as quite “good”, often having a good value to money ratio and more affordable in practice. Maintenance and calibration are organized to keep this uncertainty in the field and over time.
- Class C: Specifications and/or maintenance and calibration procedures lower than class B, but known and applied. Maintenance and calibration are still organized.
- Class D: Specifications lower than class C or no maintenance and calibration organized.
- Class E: Unknown performances and/or unknown maintenance procedures.

Typical conditions to get and maintain the stated accuracy are indicated.

This classification is related to a network, considering the instruments used and the maintenance organization applied for this network. So, it is an “organization” classification. It doesn’t give the information of what has been made on a particular day on a particular site.
This classification covers the quality factors a) and b) listed above.

An example for liquid precipitation is given below.

Class A

- The larger of **5%** and **0.1mm.** (achievable measurement uncertainty).
- Reported resolution better than or equal to 0.1 mm.
- If any, error related to precipitation intensity corrected.
- Use of a wind shield.
- Daily control of the collecting cone for rain gauges using a cone.
- 6 months calibration for tipping bucket rain gauges.

Class B

- The larger of **5%** and **0.2 mm.**
- Reported resolution better than or equal to 0.2 mm.
- If any, error related to precipitation intensity corrected or at least known.
- 6 months calibration for tipping bucket rain gauges.
- Weekly control of the collecting cone for tipping bucket rain gauges.

Class C

- The larger of **10%** and **0.5 mm.**
- Unknown error related to precipitation intensity.
- Calibration period of tipping bucket rain gauges lower than 18 months.
- A preventive maintenance is defined and applied.

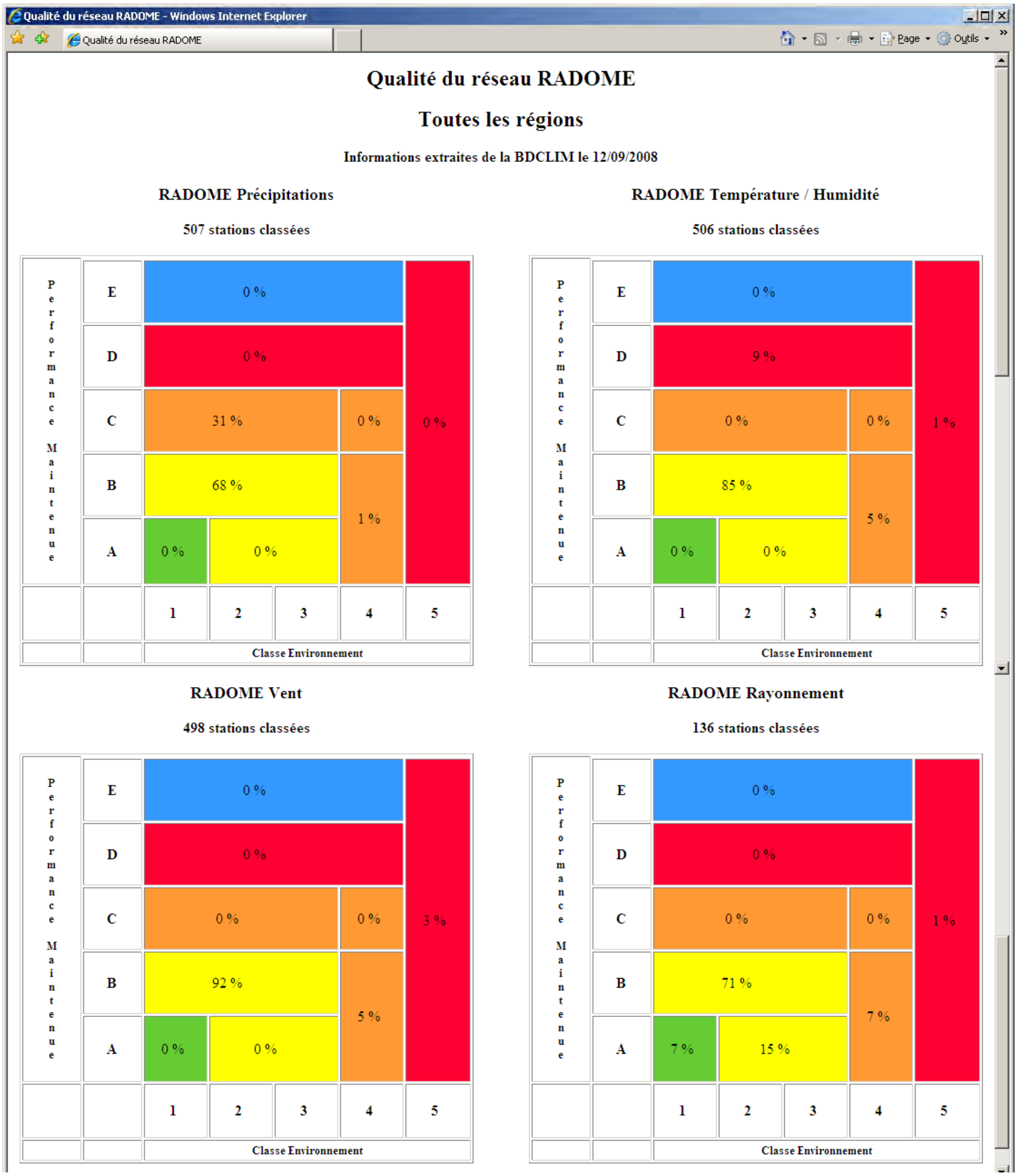
Class D

- > **10%**
- or no control and adjustment methods defined
- or no regular maintenance organized.

This classification was also discussed within the WIGOS project pilot, but was not considered as enough mature to be proposed as a WMO standard. More work is needed to reach a consensus.

EXEMPLE: STATUS OF THE RADOME NETWORK IN FRANCE

With these two classifications, a letter and a number therefore describe a measurement on a given site. So, it is possible to have a general view of the classes of a network. The following graphs show the result of the classification of the Radome network.



For each diagram, the siting class is horizontal; the maintained performance class is vertical. The color is a little bit related to the "quality" of the combination of the two classes. A1 (green) is the best; the yellow zone is still a good compromise; the usefulness of a

measurement in the orange zone begins to be questionable; no points should be in the red zone; the blue one is for the unknown maintained performance class.
We have some values in the red zone:

- We currently have some electronic drifts with some acquisition modules for temperature, leading to an uncertainty that we have flagged with a class D. We are finishing to solve this problem.
- Some sites have a bad environment for some sensors, mainly wind sensors. For such sites, the installation was accepted with derogation, registered in our quality system.

The C class for precipitation is related to the use of a rain gauge model that exhibits quite large evaporation errors. These rain gauges will be replaced.

This objective presentation of our Radome network shows that it is not perfect. But it is an honest presentation, which may also brings arguments to improve it.

CONCLUSION

The two classifications described have the advantage of being simple and therefore, easy to use as metadata. Unfortunately, the siting classification as it is defined, doesn't allow to correct the measurements. Correction methods remain possible, but independently of the siting classification. It is a clear limitation, but these classifications allow to easily document the "quality" of the design of a network. Another advantage is that it is also a didactic approach, both for network designers, financing authorities and final users. It gives a clear and honest view of a network status. The Météo-France experience is that the implementation of these classifications brought and still bring improvements in the networks' design, thus optimizing their value, not necessarily at an extra cost.

Annex : definition of site classification for air temperature and humidity, surface wind, global and diffuse solar radiation, direct radiation and sunshine duration

Air temperature and humidity

Sensors situated inside a screen should be mounted at a height determined by the meteorological service (within 1.25 m to 2 m as indicated in the CIMO Guide). The height should never be less than 1.25 m. The respect of the higher limit is less stringent, as the temperature gradient vs. height is decreasing with height. For example, the difference in temperature for sensors located between 1.5 and 2 m is less than 0.2 °C.

The main discrepancies are caused by unnatural surfaces and shading.

- Obstacles around the screen influence the irradiative balance of the screen. A screen close to a vertical obstacle may be shaded from the solar radiation or “protected” against the night radiative cooling of the air, by receiving the warmer infra red (IR) radiation from this obstacle or influenced by reflected radiation.
- Neighbouring artificial surfaces may heat the air and should be avoided. The extent of their influence depends on the wind conditions, as wind affects the extent of air exchange. Unnatural or artificial surfaces to take into account are heat sources, reflective surfaces (e.g. buildings, concrete surfaces, car parks) and water sources (e.g. ponds, lakes, irrigated areas).

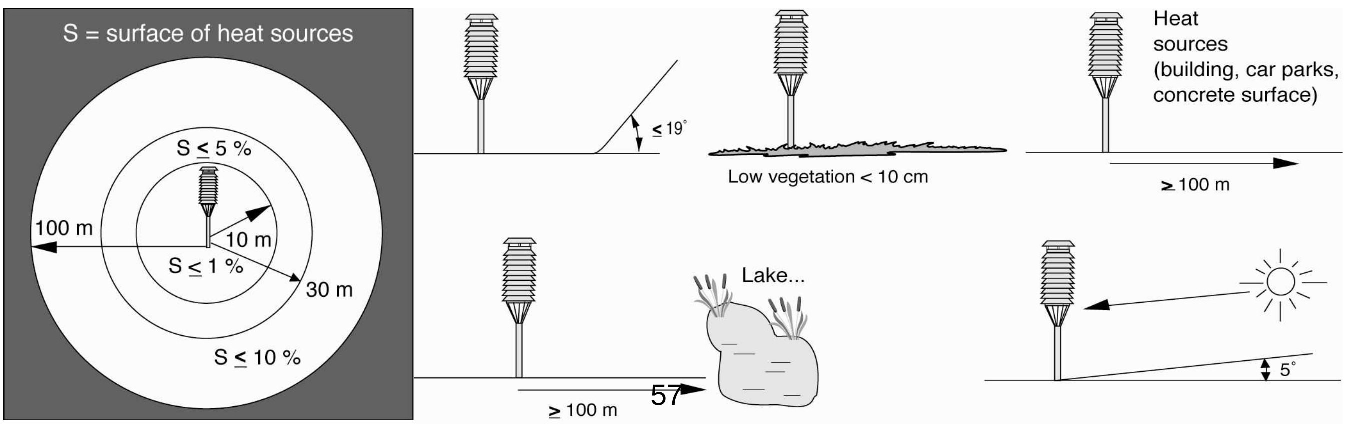
Shading by nearby obstacles should be avoided. Shading due to natural relief is not taken into account for the classification (see above).

The indicated vegetation growth height represents the height of the vegetation maintained in a 'routine' manner. A distinction is made between structural vegetation height (per type of vegetation present on the site) and height resulting from poor maintenance. Classification of the given site is therefore made on the assumption of regular maintenance (unless such maintenance is not practicable).

Class 1

- Flat, horizontal land, surrounded by an open space, slope less than 1/3 (19°).
- Ground covered with natural and low vegetation (< 10 cm) representative of the region.
- Measurement point situated:
    - o at more than 100 m from heat sources or reflective surfaces (buildings, concrete surfaces, car parks etc.)
    - o at more than 100 m from an expanse of water (unless significant of the region)
    - o away from all projected shade when the Sun is higher than 5°.

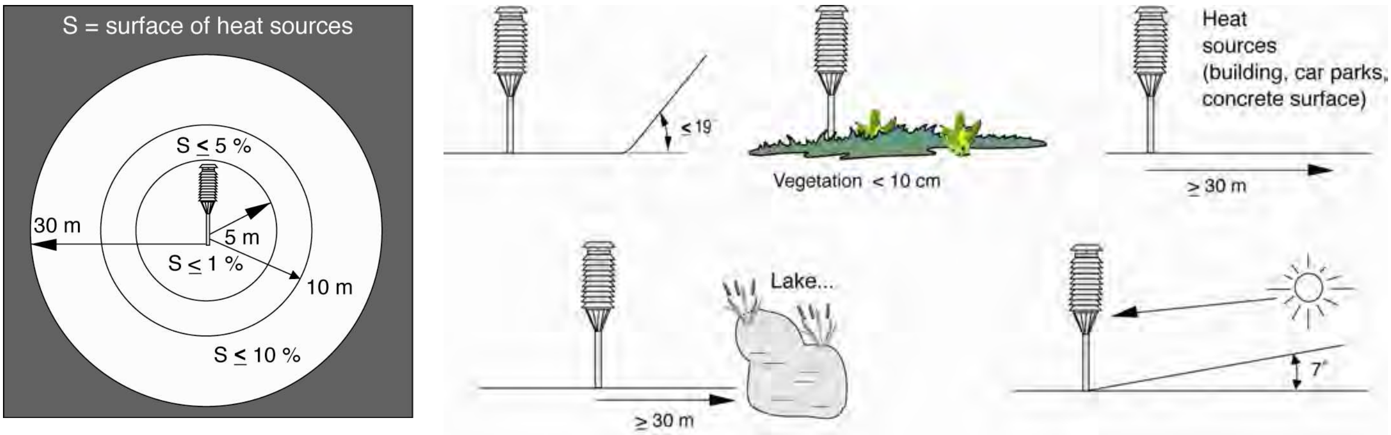
A source of heat (or expanse of water) is considered to have an impact if it occupies more than 10 % of the surface within a circular area of 100 m surrounding the screen, makes up 5% of an annulus of 10m-30m, or covers 1% of a 10 m circle.



Class 2

- Flat, horizontal land, surrounded by an open space, slope inclination less than 1/3 (19°).
- Ground covered with natural and low vegetation (< 10 cm) representative of the region.
- Measurement point situated :
  - o At more than 30 m from artificial heat sources or reflective surfaces (buildings, concrete surfaces, car parks etc.)
  - o At more than 30 m from an expanse of water (unless significant of the region)
  - o Away from all projected shade when the Sun is higher than 7 °.

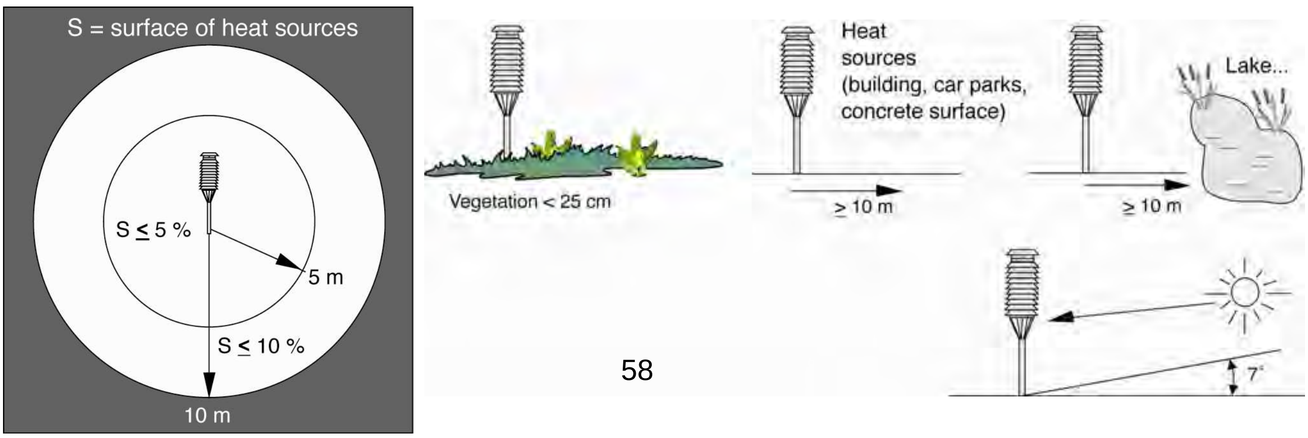
A source of heat (or expanse of water) is considered to have an impact if it occupies more than 10 % of the surface within a circular area of 30 m surrounding the screen, makes up 5% of an annulus of 5m-10m, or covers 1% of a 5 m circle.



Class 3 (additional estimated uncertainty added by siting up to 1 °C)

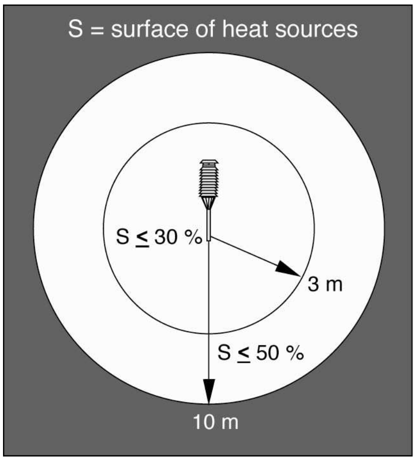
- Ground covered with natural and low vegetation (< 25 cm) representative of the region.
- Measurement point situated:
  - o at more than 10 m from artificial heat sources and reflective surfaces (buildings, concrete surfaces, car parks etc.)
  - o at more than 10 m from an expanse of water (unless significant of the region)
  - o away from all projected shade when the Sun is higher than 7 °.

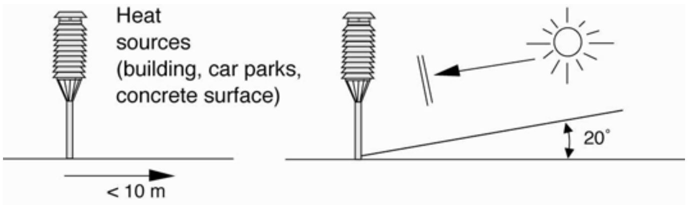
A source of heat (or expanse of water) is considered to have an impact if it occupies more than 10 % of the surface within a circular area of 10 m surrounding the screen or makes up 5% of an annulus of 5m.



Class 4 (additional estimated uncertainty added by siting up to 2 °C)

- Close artificial heat sources and reflective surfaces (buildings, concrete surfaces, car parks etc.) or expanse of water (unless significant of the region, occupying:
  - Less than 50% of the surface within a circular area of 10 m around the screen
  - Less than 30% of the surface within a circular area of 3 m around the screen
- Away from all projected shade when the Sun is higher than 20 °.





Class 5 (additional estimated uncertainty added by siting up to 5 °C)

Site not meeting the requirements of class 4.

Surface wind

Conventional elevation rules stipulate that sensors should be placed 10 m above ground surface level and on open ground. Open ground here represents a surface where obstacles are situated at a minimum distance equal to at least ten times their height.

Roughness

Wind measurements are not only disturbed by surrounding obstacles; terrain roughness also plays a role. The WMO defines wind blowing at a geometrical height of 10 m and with a roughness length of 0.03 m as the surface wind for land stations.

This is regarded as a reference wind for which exact conditions are known (10 m height and roughness length of 0.03 m).

Therefore, roughness around the measuring site has to be documented. Roughness should be used to convert the measuring wind to the reference wind, but this procedure can be applied only when the obstacles are not too close. Roughness related matters and correction procedure are described in chapter 5 of the CIMO Guide.

The roughness classification, reproduced from the CIMO Guide, is recalled here:

Terrain classification by Davenport (1960), adapted by Wieringa (1980) in terms of aerodynamic roughness length z_o		
Class index	Short terrain description	Z_0 (m)
2	Mud flats, snow; no vegetation, no obstacles	0.005
3	Open flat terrain; grass, few isolated obstacles	0.03
4	Low crops; occasional, large obstacles : x/H > 20	0.10
5	High crops; scattered obstacles : 15 < x/H < 20	0.25
6	Parkland, bushes; numerous obstacles : x/H ~ 10	0.5
7	Regular large obstacle coverage (suburb, forest)	1.0
8	City centre with high- and low- rise buildings	[illegible]2

Here x is a typical upwind obstacle distance and H is the height of the corresponding major obstacles. For more detailed and updated terrain class index descriptions see Davenport, et al. (2000).

Environment classification

The presence of obstacles (almost invariably) means a reduction in average wind readings, but less significantly affects wind gusts.

The following classification assumes measurement at 10 m which is the standard elevation for meteorological measurement.

When measurement are carried out at lower height (such as measurement carried out at 2 m, as is sometimes the case for agro-climatological purposes), a class 4 or 5 (see below) is to be used, with flag S (Specific situation).

Where numerous obstacles higher than 2 m are present, it is recommended that sensors should be placed 10 meters above the average height of the obstacles. This method allows the influence of the adjacent obstacles to be minimised. This method represents a permanent solution for partly eliminating the influence of certain obstacles. It inconveniently imposes the necessity for higher masts which are not standard and consequently more expensive. It must be considered for certain sites and where used, the height of obstacles to be taken into account is that above the level situated 10 m below the sensors (e.g. for an anemometer installed at a 13 m height, the reference "ground" level of the obstacles is at a 3 m height; an obstacle of 7 m is considered to have an effective height of 4 m).

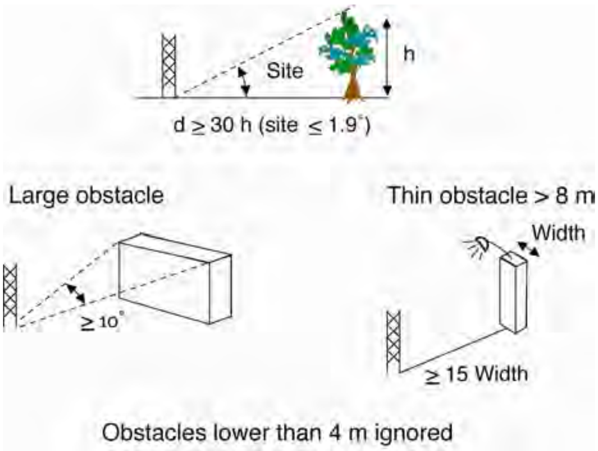
In the following, an object is considered to be an obstacle if its angular width is over 10°, except for tall thin obstacles, as mentioned below.

Changes of altitude (positive or negative) in the landscape which are not representative of the landscape, are considered as obstacles.

Class 1

- The mast should be located at a distance equal to a least 30 times the height of surrounding obstacles.
- Sensors should be situated at a minimum distance of 15 times the width of narrow obstacles (mast, thin tree) higher than 8 m.

Single obstacles lower than 4 m can be ignored.

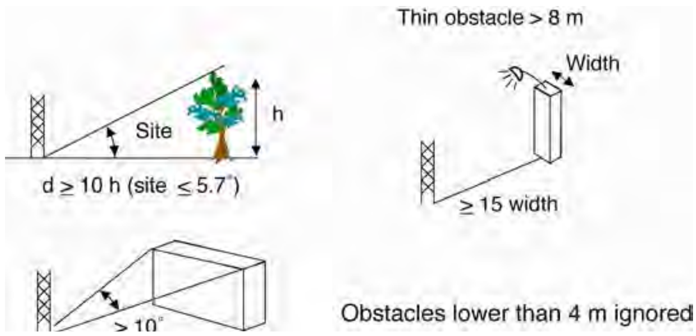


- Roughness class index is between 2 to 4 (roughness length ≤ 0.1 m).

Class 2 (additional estimated uncertainty added by siting up to 30 %, possibility to apply correction)

- The mast should be located at a distance of at least 10 times the height of the surrounding obstacles.
- Sensors should be situated at a minimum distance of 15 times the width of narrow obstacles (mast, thin tree) over 8 m high.

Single obstacles lower than 4 m can be ignored.



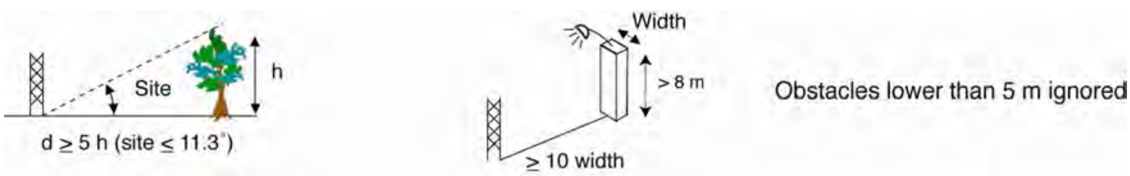
- Roughness class index is between 2 to 5 (roughness length ≤ 0.25 m).

Note: when the mast is located at a distance of at least 20 times the height of the surrounding obstacles, a correction (see CIMO Guide, wind chapter) can be applied. In case of nearer obstacles, a correction may be applied is some situations.

Class 3 (additional estimated uncertainty added by siting up to 50 %, correction cannot be applied)

- The mast should be located at a distance of at least 5 times the height of surrounding obstacles.
- Sensors should be situated at a minimum distance of 10 times the width of narrow obstacles (mast, thin tree) higher than 8 m.

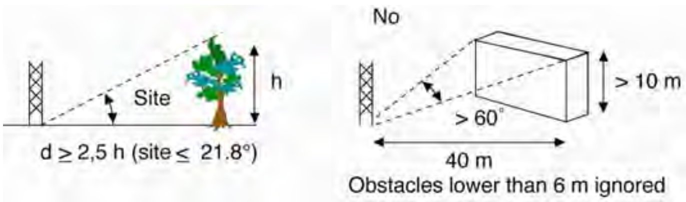
Single obstacles lower than 5 m can be ignored.



Class 4 (additional estimated uncertainty added by siting greater than 50 %)

- The mast should be located at a distance of at least 2.5 times the height of surrounding obstacles.
- No obstacle with an angular width larger than 60° and a height greater than 10 m, within a 40 m distance.

Single obstacles lower than 6 m can be ignored, only for measurements at 10 m or above.



Class 5 (additional estimated uncertainty cannot be defined)

Site not meeting the requirements of class 4.

Global and diffuse radiation

Close obstacles have to be avoided. Shading due to the natural relief is not taken into account for the classification. Non-reflecting obstacles below the visible horizon can be neglected.

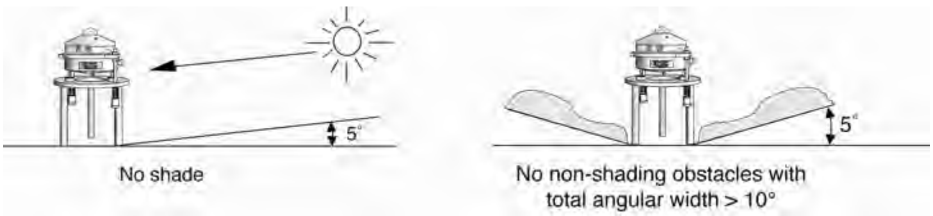
An obstacle is considered as reflecting if its albedo is greater than 0.5.

The reference position for elevation angles is the sensitive element of the instrument.

Class 1

- No shade projected onto the sensor when the Sun is at an angular height of over 5°.

  For regions with latitude ≥ 60°, this limit is decreased to 3°.
- No non-shading reflecting obstacles with an angular height above 5° and a total angular width above 10°.

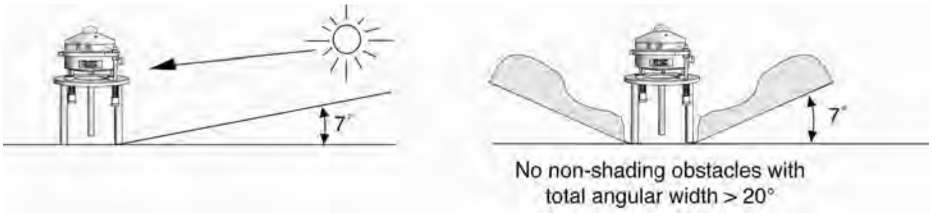


Class 2

- No shade projected onto the sensor when the Sun is at an angular height of over 7°.

  For regions with latitude ≥ 60°, this limit is decreased to 5°.

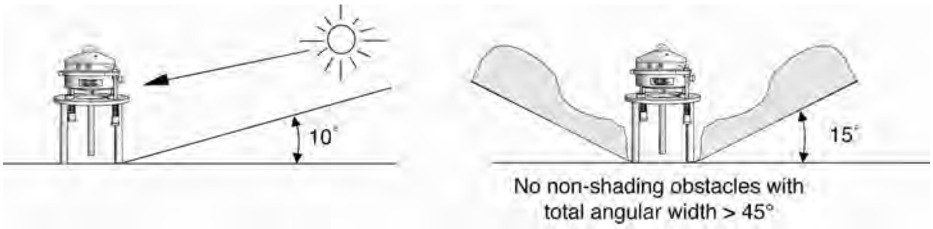
- No non-shading reflecting obstacles with an angular height above 7° and a total angular width above 20°.



Class 3

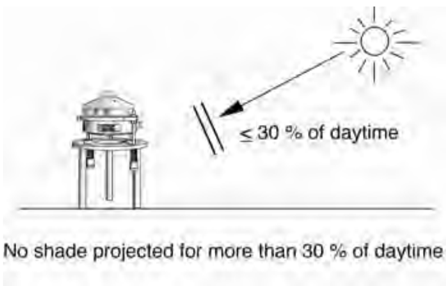
- No shade projected onto the sensor when the Sun is at an angular height of over 10°.

  For regions with latitude ≥ 60°, this limit is decreased to 7°.
- No non-shading reflecting obstacles with an angular height above 15° and a total angular width above 45°.



Class 4

- No shade projected during more than 30% of the daytime, for any day of the year.



Class 5

- Shade projected during more than 30% of the daytime, for at least one day of the year.

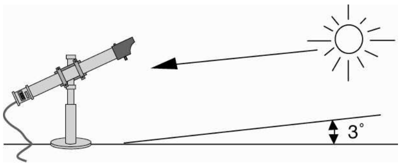
Direct radiation and sunshine duration

Close obstacles have to be avoided. Shading due to the natural relief is not taken into account for the classification. Obstacles below the visible horizon can be neglected.

The reference position for angles is the sensitive element of the instrument.

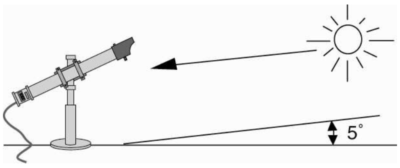
Class 1

- No shade projected onto the sensor when the Sun is at an angular height of over 3°.



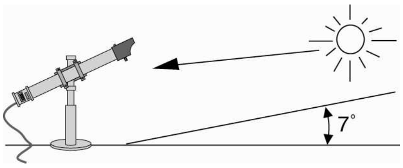
Class 2

- No shade projected onto the sensor when the Sun is at an angular height of over 5°.



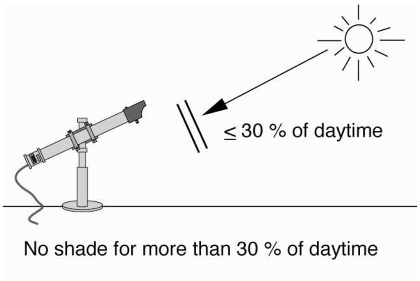
Class 3

- No shade projected onto the sensor when the Sun is at an angular height of over 7°.



Class 4

- No shade projected during more than 30% of the daytime, for any day of the year.



Class 5

- Shade projected during more than 30% of the daytime, for at least one day of the year.

Long-wave Radiation (tentative)

Close obstacles have to be avoided, because the long-wave radiation emitted by these obstacles replaces the IR radiation emitted by the sky in their direction. The influence of these obstacles is taken into account by estimating the portion of the sky hemisphere occupied by these obstacles, as viewed by the sensitive element of the pyrgeometer. An obstacle seen with an angular height of α and an angular width of β (in °), has an influence on the measurement, with a weight of $100 * \sin^2(\alpha) * \beta / 360$ in %. This weight is hereafter called “shading weight”. For example, a “ring” of obstacles seen under an elevation angle of 10°, gives a shading weight of only 3%.

Shading due to the natural relief is not taken into account for the classification. Obstacles below the visible horizon can be neglected.

The reference position for elevation angles is the sensitive element of the instrument.

Class 1

- No obstacles with shading weight more than 2%.

Class 2

- No obstacles with shading weight more than 5%.

Class 3

- No obstacles with shading weight more than 10%.

Class 4

- No obstacles with shading weight more than 20%.

Class 5

Site not meeting the requirements of class 4

JMA/WMO Workshop on Quality Management in Surface, Climate and Upper-air Observations in RA II (Asia)

Tokyo, Japan
27 – 30 July 2010

Doc.
Japan

(10.VII.2010)

Report on The Status of Weather Observation in Cambodia

(Submitted by Peou Phalla, Researching and Forecasting Office,Department of Meteorology)

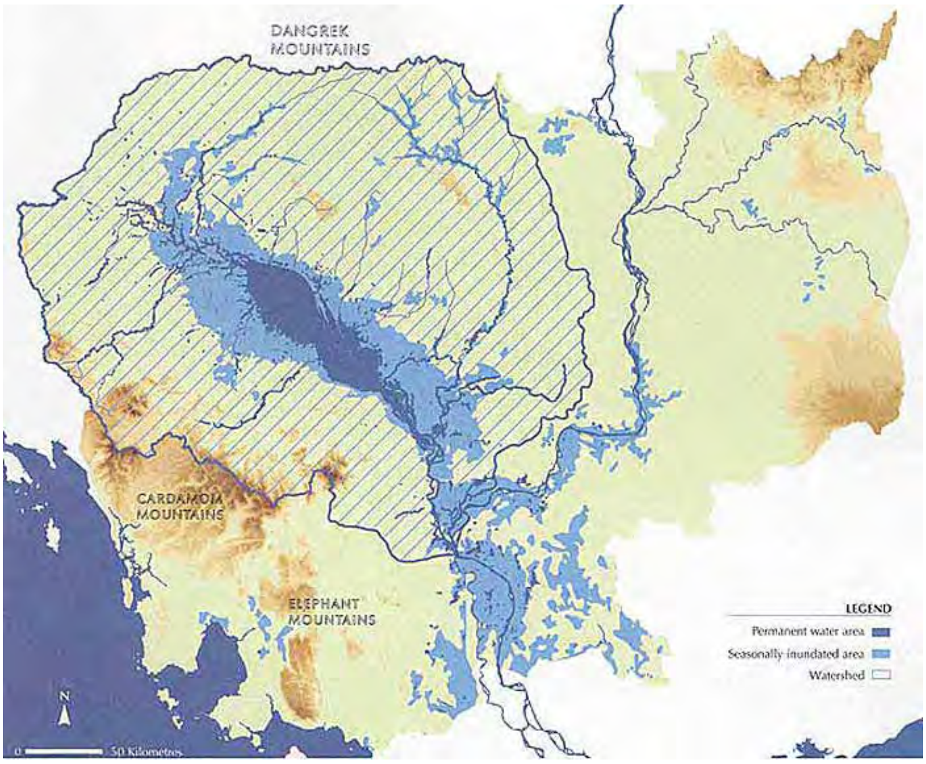
Summary and Purpose of Document

This document contains an overview of the surface and upper-air observations in Japan, with respect to instruments, quality assurance / quality control, training, statistics and applications.

Ministry of Water Resources and Meteorology

Department of Meteorology

Report on
The Status of Weather Observation in Cambodia
July, 2010.



Content

1- Background of Cambodia Weather Observation

Cambodia Weather Observation was beginning since 1894.
Cambodia joined the World Meteorological Organization in 1955.
Between1972-1975, Cambodia carried out of the project under UNDP-Funded.
From 1975-79, Cambodia was in the political instable of the Khmer Rouse (Democratic Kampuchea), Weather Observation Network and Service were abandoned and all Equipment were destroyed.

After 1979, weather Observation Service was re-established with the technical and equipment support from Soviet Union and Viet Nam, that was established 5 synoptic stations and 33 rainfall stations.

From 1992-1995, Weather Observation Network and Service were re-habilitated through the project of Danida-Financed Program and implemented by Lutheran World Service. During these years Cambodia Weather Observation was still in a basic of operational system due to the limited of funds.

During the period of the year 2001-2003, Cambodia Weather Observation was improved through the project of JICA; the project installed weather sensor 6 stations and conducted of the site of job training to the staff.

From 2005-2006, under the project of JICA, Global Telecommunication System (GTS) was installed. During 2007-2008, JICA funded project on the Urgent Rehabilitation and Improvement of Civil Aviation Meteorology, the GTS was improved, and MTSAT was installed.

In March 2010, Department of Meteorology was moved to the new place, GTS was re-installed and connected link to Bangkok again on June 14, 2010, and MTSAT was re-installed on July 15, 2010 that was under technical supported and assistant of WMO Volunteer.

2- Observation Network

Cambodia observes only on the Surface and we are not yet to observe on upper air.

2-1 Surface Observation:

2-1-1 Synoptic Station:

Weather Observation Network in Cambodia consists of:

- 20 synoptic stations including of 9 automatic stations (AWS) was broken and 20 synoptic stations are operational with manned observational equipment.
- 200 manual rainfall stations.

Weather Observation Stations in Cambodia

BN	SN	CCCC	Place Name	Lat	Long	WMO	Tx	AWS	Remark
48	962		Battambang	13.6N	103.26E	P	00Z	JICA	Manual
48	963		Pailin	12.51N	103.33E				Manual
48	964		Prah Vihear	13.48E					Manual
48	965		KampongThom					MRC	Manual
48	966		Siemreap	13.22N		P	00Z	JICA	AWS & Manual, to be moved
48	968		Pursat	12.31N				MRC	Manual
48	969		BanteayMeanchey						Manual
48	970		KraTie						Manual
48	971		Mondol Kiri						Manual
48	972		StungTreng	13.31N	105.58E			JICA	Manual
48	973		Ratanak Kiri						Manual
48	983		Kampong Som	10.38N	103.29E	P		JICA	Manual
48	985		Kampot	10.37N	104.13E	P	00Z		Manual
48	986		Koh Kong	11.37N	103.00E				Manual
48	991	VDPP	PhnomPenh	11.33N	104.51	P	00Z	JICA	Manual, to be moved
48	993		Takeo						Manual
48	995		KampongCham	12.00N	105.27E	P	00Z		Manual
48	997		PreyVeng			P	00Z	JICA	Manual
48	998		SvayRieng	11.05N	105.48E			JICA	Manual
48			Odor Meanchey	14.11N	103.30E				Manual

2-1-2 Map of Observation station in Cambodia

2-1-3 Time and Frequency of Observations:

Cambodia conducts operational weather observation for 4 times per day in the main standard times at:

- 00 UTC
- 06 UTC
- 12 UTC
- 18 UCT

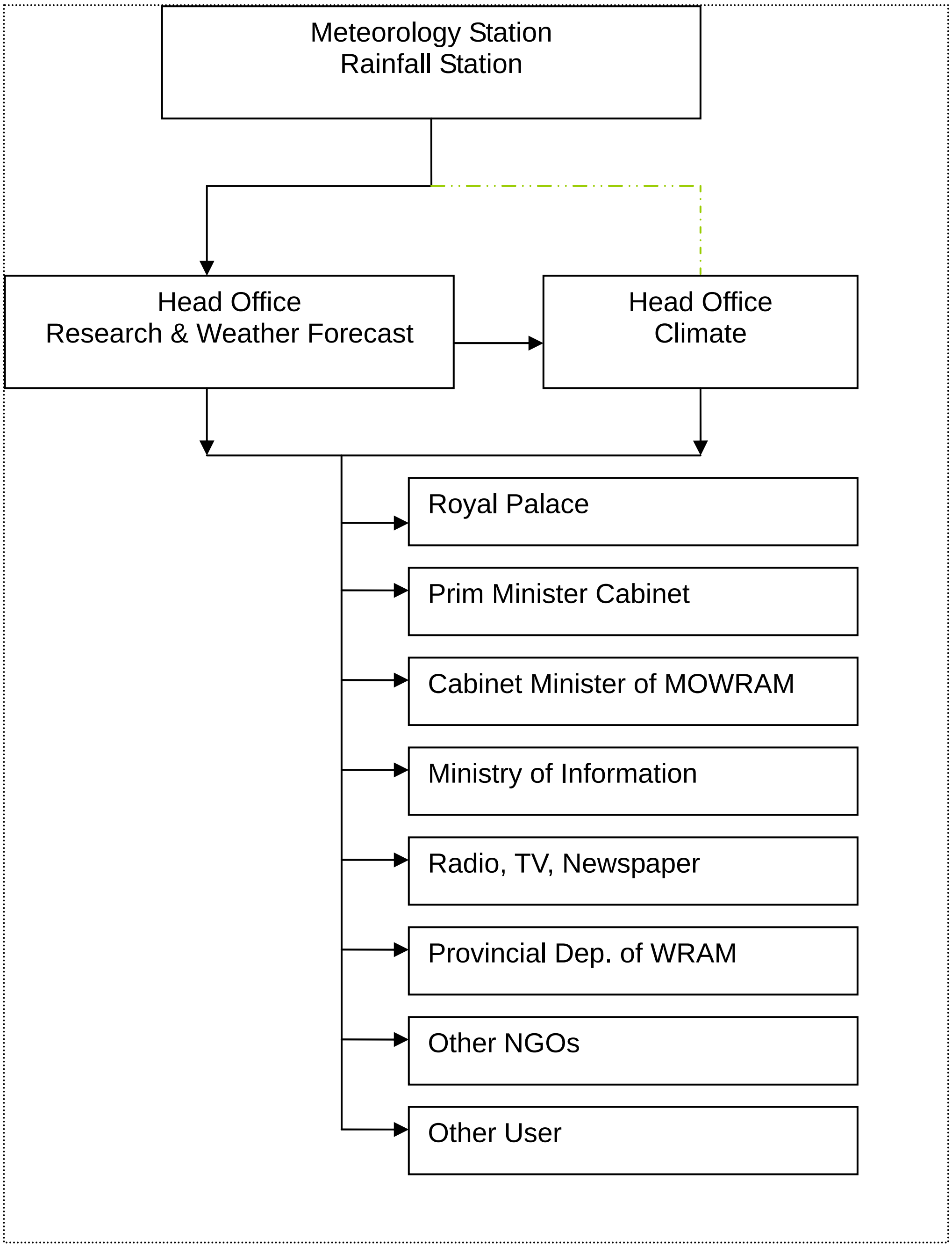
2-1-4 Data flow to users and archives

Data collection from manned station is recorded in the observation log, and transmitted to Department of Meteorology in Phnom Penh by Telephone and by Fax (HF SSB). The data is transfer first to the Head office of Research and Weather Forecast for using in forecasting, and after the data is transmitted to the Head office of Climate for climatologically use.

Rainfall data collection is carried out by local observation officer. Rainfall data are recorded in a log book that provided by Department of Meteorology, Actually, the rainfall data transmitting to Department of Meteorology only from 34 stations.

The data are analyzed and stored by the Head Office of Climate. The data production is provided to many users such as: Royal Palace, Prim minister Cabinet, Cabinet Ministry of Water Resources and Meteorology, Ministry of Information, Provincial Department of Water Resources and Meteorology, Radio, TV, Newspaper, Other NGO, and Other User.

Structure of Data Flow and Archive Chart



3- Sitting and Metadata

Surface Observation data in Cambodia is including:

- Air temperature
- Surface wind,
- Solar radiation,
- Evaporation,
- Cloud amount and type,
- Atmospheric pressure,
- Precipitation, amount and intensity,
- Humidity, and
- Visibility

4- Instruments, Sensor, Maintenance

The installation and maintenance of the instruments is responded by Head Office of Equipment Management. The officers of Head Office of Equipment Management are able to repair only manned instrument. Actually, instruments are repaired when the data at station are reported as error and being installed when it is broken.

5- Quality Assurance/Quality Control (real time, non-real time)

Global Telecommunication System (GTS) in Cambodia is frequency error in the connection system between Phnom Penh and Bang Kok.

The data transmitting to GTS is conducted only at 00 UTC, it is non-real time and not address to the framework of Global Observing System (GOS), it is done by the data are not provided from the local station, Technical Capacity is limited and Low cost resolution.

20 Synoptic station are provided the real data only Phnom Penh and Siem Reap, and 18 Synoptic stations provided only one or two data such as Air temperature and Surface wind, all these done its lack of instrument.

6- Training

The National Weather Center provides the job-training to the staff of the Local observation stations on operation and maintenance of the weather observation station the weather observation by providing as lecture and practice.

7- Statistics issues and Applications

- Produce surface weather map and Upper Air charts,

8- Current issues and future plan

- Build technical capacity to the staff
- Reinstall Automatic Station
- Install Upper Air Weather Observation
- Improve telecommunication service
- Improve observation data management

China

JMA/WMO Workshop on Quality Management in Surface, Climate and Upper-air Observations in RA II (Asia)	Doc. Country
Tokyo, Japan 27-30 July 2010	(.VII.2010)

QUALITY MANAGEMENT IN SURFACE, CLIMATE AND UPPER-AIR OBSERVATIONS IN CHINA

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Summary and Purpose of Document

This paper has attended the characters of China surface, climate and up-air stations which are exchanging data in RA II, including the number of stations, distribution map, instruments upgrade and maintenance, quality control etc. The total number of surface observation stations for exchange in China is 220, the number of up-air stations is 83. Since 2002, the instrument has been upgraded gradually, and now all these stations are AWS. Atmospheric Observing System Operations and Monitoring (ASOM) has been built up for the instruments tracing and maintaining. The operational quality control of meteorological data in China can be divided into real-time and non-real-time quality control in terms of effectiveness for a given period of time. Real-time QC is for the real-time data, non-real-time QC is for the storage and archived data. Many forms of data product have been used in a lot of fields like education, medicine, and agriculture etc.

QUALITY MANAGEMENT
IN SURFACE, CLIMATE AND UPPER-AIR OBSERVATIONS IN CHINA

Zhang Hongzheng[1] Meng Zhaolin[2]
[1] National Meteorological Information Centre of CMA, Beijing
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July 2010

1. Introduction

In China, operational meteorological observation network comprises observing facilities on land, at sea, in the air and in outer space. The observation network is used in weather, climate and professional meteorology observation services.

This paper will introduce conventional meteorological surface and upper-air observing networks, the number of stations within RBSN, RBCN, GSN/GUAN and the distribution map. Also discuss the Instruments and sensors' upgrade and maintenance , and quality management of observation data etc.

2. Observation Networks

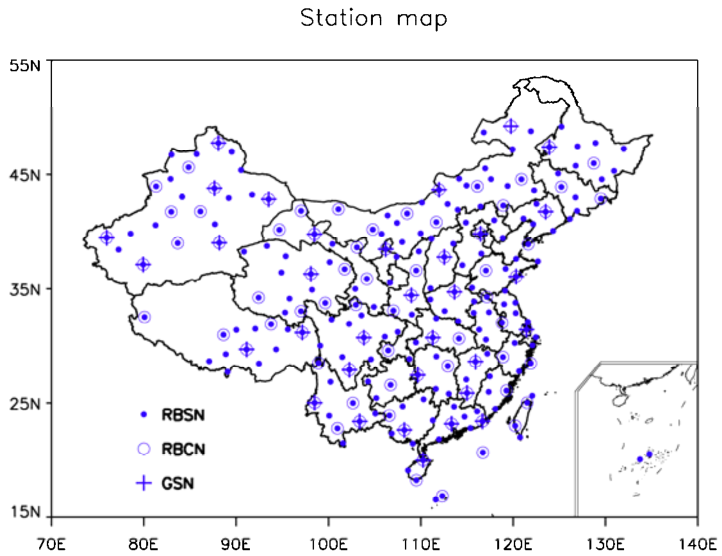
2.1 Surface observation network

The total number of surface observation stations for exchange through the Regional Basic Synoptic Network (RBSN) is 219, and the number of surface stations for exchange through the Regional Basic Climatological Network (RBCN) is 82, out of which 81 (with only exception of the station with the index number 50527) also function as RBSN stations at the same time. The number of surface stations from China participating in the Global Climate Observing System (GCOS) Network (GSN) is 33, which are all RBCN observation stations. All these stations are Automatic Weather Stations (AWS), but such elements as cloud and weather phenomena still rely on manual observations. A list of the stations is given in Table 1; and for their distribution, please see Figure 1.

Table 1 Number of China's surface stations

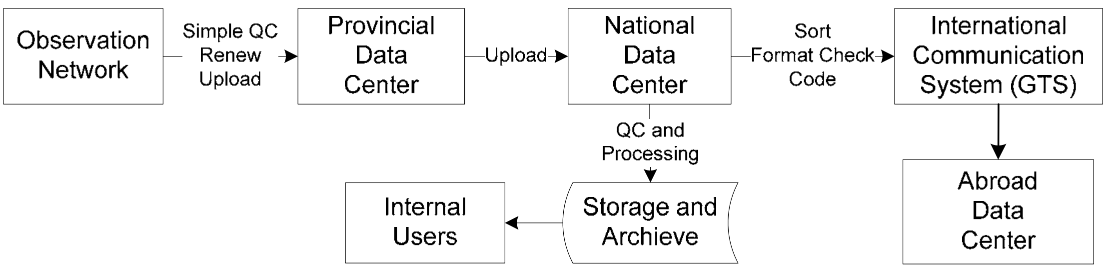
	RBSN	RBCN	GSN	Manned stations	AWS
Number	219	82	33	/	220

Figure 1 Distribution of China's surface stations



The transmission frequency of China's SYNOP reports for exchange via RBSN is 4 times per day, i.e. at 00, 06, 12, 18 UTC respectively. Normally each transmission will be completed 30 minutes after each synoptic observation hour. China's surface CLIMAT messages for exchange through RBCN are transmitted once a month, i.e. the message transmission is made at 06 UTC on the 4th day of each month. The work flows for transmitting both SYNOP and CLIMAT reports are identical, i.e. real-time data acquisition by observing station network, logging in AWS data files immediately after automatic quality control, automatic coding, human interventions by adding manual observations of such elements as weather phenomena and clouds, transmission to a provincial data centre, retransmission to the National Meteorological Data Centre, report sorting at the National Meteorological Data Centre, format checking, and dissemination via GTS to other relevant international centers. All observational data and reports transmitted to the National Data Centre shall be archived. A flow diagram is given in Figure 2.

Figure 2 Flow diagram for data transmission



2.2 Upper-air observation network

The total number of China's upper-air sounding stations for exchange through the Regional Basic Synoptic Network (RBSN) is 82; the number of upper-air stations that participate in regional exchange via the Regional Basic Climatological Network (RBCN) is 43, in which 42 (except station number 50527) are functioning as RBSN stations as well. The total number of the China's upper-air stations that have been included in the Global Climate Observing System (GCOS) Network (GUAN) is 7, which are all RBCN stations. All these stations are automatic ones. The number of upper-air sounding stations in China is listed in Table 2, and their distribution is shown in Figure 3.

Table 2 Number of China's upper-air sounding stations

	RBSN	RBCN	GUAN	Manned stations	Automated system stations
Number	82	43	7	/	83

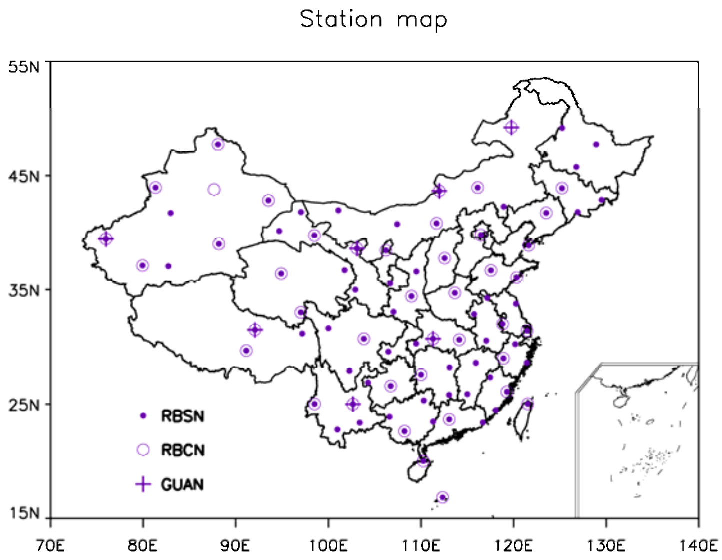


Figure 3 Distribution of China's upper-air sounding stations

The transmission frequency of China's TEMP reports for exchange through RBSN is twice per day, i.e. at 00 and 12 UTC respectively. Under normal conditions, each observation will be coded and transmitted within 30 minutes after a synoptic hour. The CLIMAT TEMP messages for exchange through RBCN are transmitted once a month, i.e. at 06 UTC on the 4th day of every month. The transmission procedure is identical to that for transmission of SYNOP reports.

3. Instruments and sensors' upgrade and maintenance
3.1 upgrade

In the past few years, all national surface station has installed the AWS by the CMA. The observations contain parameters such as wind direction and speed, temperature (atmospheric, ground and grass), atmospheric pressure and humidity; amount of precipitation; radiation automatically. But the weather phenomena, amounts, types and height of clouds, visibility are still observed by human as supplement. The observing data quality is needed to improve. The technique of the cloud, visibility and weather phenomena observation automatically is planned to develop.

Since 1950's, the instruments of up-air sounding has renew 2 times. First, type 49 had been replaced by type 59-701. Second, L band electronic radiosonde and windfinding radar sounding system as a new generation sounding system to replace the old sounding system (Type 59-701 Mechanical Radiosonde and Secondary Windfinding Radar). By 2010, April, almost all up-air stations have been replaced by L band sounding system.

3.2 Maintenance

A near real-time monitoring system of China meteorological observation network has been built up, named as Atmospheric Observing System Operations and Monitoring (ASOM). It monitors national surface observation system and upper-air sounding system. ASOM contains several subsystems, including equipments operation monitoring, observation data monitoring, equipment maintenance management, logistic management and observation site management.

3.2.1 Equipments operation monitoring

Based on parameters and certain model, equipment operation monitoring will show some indexes by processing and judging operational status, such as normal, alarm and so on, and it will display these statuses in many ways. Real-time monitoring can directly show the equipment status by overlapping on the Chinese electrical map with some special flags with a updating period of 1 hour for AWS. Historical monitoring figures can show the equipment operational status in any time or any period with time series. Station synthetically displaying can gather figures, parameters and alarm information, which is benefit for analyzing both equipment status and products quality.

3.2.2 Equipment maintenance management

Equipment maintenance management can realize life management and it can also offer supporting platform to improve maintenance level by archived the life time of the equipment from registration. It contains equipments maintain management, equipments repairing, maintenance and repairing experiences and knowledge management and things. In this subsystem, the uniform equipment ID is taken the module function chain, the equipment's maintaining and repairing status can be traced by the ID. When the equipment is down, all processes are filled in the form, and the different people from different sections will fill the same form in one accident. The national and the province center can collector these repairing experiences to form the knowledge database and sharing it so as to convenient for the following equipments maintenance and repairing work.

3.2.3 Logistic management

Logistical management realizes the meteorological equipments, meteorological apparatuses' lifetime tracing and management using the uniform equipment's ID number. Logistic management includes calibration and license modules. Calibration module establishes a database for supervising instrument calibration valid periods, which has alarm, and statistics function. Logistics management realized plan, stock, supply and storage in the internet. On the basis of operation and consumption, it can form stock plan and submit report by corresponding approval procedure then carry out stock in the internet and issue storage status at the same time. License module has realized declaration, experimentation, approval and search information management and has standardized management flow. Technology rules, regulations, criterions, database and information searching platform were established.

It will also generators some evaluation results, such as the consumption of the different equipments, the number of the stock and warehousing in one time and the top 10 purchase and so on.

3.2.4 Observation site management

Observation site management includes the management of the people, all equipments and the whole site environment in China meteorological observing network. It supplies this foundation information for the other subsystems. It has some basic information about stations, equipment types, numbers, observation items and update information about the sensors.

4. Quality Control

The operational quality control of meteorological data in China can be divided into real-time and non-real-time quality control in terms of effectiveness for a given period of time. In the whole process from data collection to data sending, storing and archiving (see Figure 2), real-time quality control should ensure the timeliness of data. Simple quality control methods can be used to achieve automated processing without manual intervention. Non-real-time quality control is targeted at monthly data or accumulated real-time data reported by stations. It uses more comprehensive quality control techniques, which is mainly based on computers and supplemented by manual intervention, combines both manual intervention and computers.

4.1 Real-time quality control

Real-time quality control is first made at the station level. The data will be sent, via provincial data center, to National Data Center. In this process, at the provincial level, real-time quality control is not made for data uploaded from stations to National Data Center. At the national level, real-time quality control is made so that these data are provided to domestic users and sent to overseas data centers through international communication system GTS after sorting, coding, and format checking.

4.1.1 Real-time quality control at the station level

Observing stations collect data in a real-time manner, and check the data against climatic extreme and element allowance range (B-QC), check element continuity (E-QC) and element consistency. Then, the results of these checks are written into AWS data collection files. In the process of data quality control, it is necessary to identify whether quality control is made on sampling instantaneous value and instantaneous meteorological value, as well as the results of quality control. This identification is used to qualitatively describe data confidence. The specifications of the identification are given in Table 1.

Table 3 Data quality control identifiers

ID code	Description
0	"Right": the data does not exceed a given limit.
1	"Doubtful": not credible.
2	"Wrong": erroneous data that exceeds a given limit.
3	"Inconsistent": one or more parameters are inconsistent; the relationship between different elements does not meet the required standards.
4	"Checked": Raw data that are identified as doubtful, wrong or inconsistent and that are reconfirmed as right using other verification procedures.
8	"Missing": Data are missing.
9	"Not checked": the variable has not been checked for quality control purpose.
N	No sensors. No data.
Note: If instantaneous meteorological values lack measurement data due to collectors or telecommunication, directly give "missing" when the terminal commands a data output, and the corresponding quality control is identified as "8". If data are available, which are judged as wrong by the quality control, and when the terminal commands a data output, their values are still given, and the corresponding quality control is identified as "2", but the erroneous data can not participate in subsequent computing or accounting.	

4.1.2 National real-time quality control

4.1.2.1 Ground

The quality of data for regular observation messages in national real-time ground observation data is controlled. Elements under quality check include air pressure, temperature, dew point temperature, wind direction and speed, and precipitation. Quality control includes:

(1) Limiting value or allowable values of climate

First of all, elements are checked against the limiting value or allowable values of climate according to Table 4. If the value of an element exceeds the limit or allowable values of climate, then it is wrong. The quality control code is set to be 2;

Table 4　Limiting values of climate of elements

Element	Climatic limiting values or allowable values of elements
Air pressure	1100 hpa——400 hpa
Air temperature	60℃—— -60℃
Dew point temperature	50℃—— -70℃
Precipitation	0－600mm
Wind direction	0－50 m/s
Wind speed	0-360 degrees

(2) Extreme value check at station

Determine whether air pressure, air temperature, wind speed and precipitation at the station go beyond the scope of each corresponding extreme value of the station. If yes, the data are doubtful, and the quality control code is set to be 1.

(3) Internal consistency check

Determine the consistency of related elements like sea level pressure and the station pressure, temperature and dew point temperature, wind speed and direction, and 1, 3, 6, 12 and 24-hour precipitation.

For example, the dew point temperature is equal or lower than temperature. When this relationship is not met, the two elements are doubtful, and the quality control code is set to be 1. The internal relationship of temperature should be 24-hour minimum temperature ≤ temperature ≤24-hour maximum temperature. When this relationship is not met, the two elements are doubtful, and the quality control code is set to be 1. Precipitation of different periods should meet the following relationship: 1-hour ≤ 3-hour ≤ 6-hour ≤ 12-hour ≤ 24-hourprecipitation, otherwise, precipitation during a relevant period is doubtful, and the quality control code is set to be 1.

4.1.2.2 Upper air

The quality of standard layer (US, UL, UP, UG) of the upper-air observational data will be checked, whose elements mainly include air pressure, geopotential height of the standard layer, temperature, dew point temperature, wind direction and wind speed. The quality control includes:

(1) The allowable value check

For example: in case of 0°≤wind direction≤360°, if it is found wrong in the checking, individual elements will be recorded as wrong, with corresponding quality code set to be 2.

(2) The climatological threshold value check

From the perspective of climatology, those climatological threshold values that can not appear (including values that couldn’t be measured by current measurement techniques) are called climatological threshold values for various elements. Those data beyond climatological threshold values for various elements is wrong (i.e. MQC=2).

(3) Internal consistency check

Checking whether certain physical relationship is met by different elements or items of the station is called internal consistency check. Upper-air data refers to multi-layer data extending vertically in the space. The consistency of related elements in the same layer is checked only in the quality control scheme, not involving in elements of many layers. For example, for the air temperature and dew point temperature, if the air temperature is lower than the dew point temperature in the same layer, then at least one item of the air temperature and dew point temperature is wrong, with the quality control code set to be 1 respectively for the two elements.

Through the aforementioned real-time quality control, statistics is taken for quality check results of international exchange stations from Jan. to Jun. 2010, with erroneous data accounting for 0.01% of the total data. The percentage of various types of errors is shown in Table 5.

Table 5 error type and percentage of quality control of real-time data

Error type	**Percentage**
Equipment failure	44.44%
Operation failure	37.04%
Unexplained	18.52%

4.2 Message format check

Once the real-time observational data from observation network is uploaded to the National Data Centre, the format of the message will be checked. The checking includes integrity of the bulletin (mainly checking the starting line, end line, correctness of the bulletin length), header (checking the bulletin header format, the correctness of time group), bulletin content (checking the bulletin formats of various kinds of data according to the WMO *Manual on Codes* (WMO-No.306). For ground report FM12, upper-air report FM35, ground monthly report FM71, upper-air monthly report FM75, etc., the format of each set of data and each report will be checked. After format checking, the correct data will be sorted and coded, and sent to overseas data centre by GTS.

4.3 Non-real-time quality control

For monthly report or accumulated real-time data from stations, more comprehensive quality control techniques are applied to non-real-time quality control, which is mainly based on computer and supplemented by manual intervention, and combines both manual intervention and computer. At present, an operational flow consisting of a three-level quality control system has been established for monthly and annual reports from ground AWSs and manual stations. The operational flow of the three-level quality control system is given in Figure 4, which includes station QC, provincial QC and national QC. The station QC means that stations make quality inspection and preliminary examination of data using station-level quality control software and submit those qualified data to provincial data processing center. Provincial QC means that the said data files are collected from stations within the province during specified time of each month. The data file will undergo quality inspection and man-computer interactive examination with provincial quality control software, while the information on quality inspection will be fed back to stations. The data will be submitted to National Meteorological Information Center after it is confirmed to be qualified through re-inspection. National QC means that data files are collected from provinces during specified time of each month. With national quality control software, rolling format examination and quality inspection will be conducted for the data files, while data check and processing will be made with human-computer interactive interface. Meanwhile, information on final quality control will be fed back to provinces, which will be kept in the archives of the Data Office of the National

Meteorological Information Center after it is confirmed to be qualified.

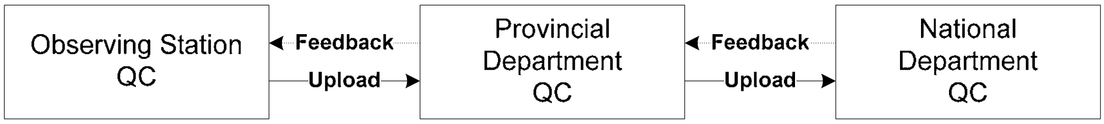


Figure 4 Flow chart of three-level quality control system

In the three-level quality control system, quality control is the core of the system as a whole. National and provincial QC processes are shown in Figure 5. The QC process at the station level is similar to Figure 6 but without spatial consistency check. In Figure 6, all links from format check to consistency check are automatically controlled by software.

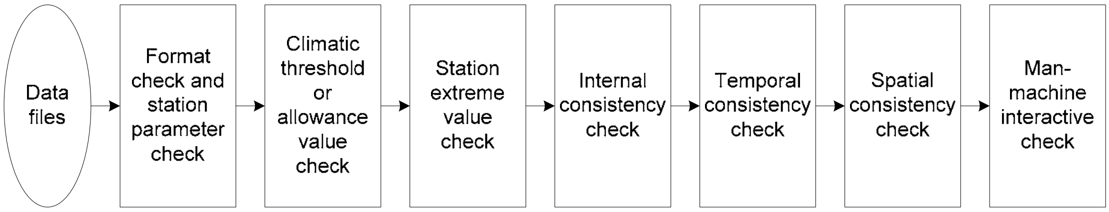


Figure 5 The flow chart of QC process

Fully automated quality control cannot solve all problems of data quality. For some special cases or problems, manual check is used as a supplement to make judgment. Manual check can be done at any level of quality control, which is the man-machine interactive quality control carried out on suspicious or erroneous data after automatic control mentioned above. According to data comparison, graphical analysis, inquiry stations, neighborhood stations comparison and manual analysis judgments, it is ultimately determined whether to modify or revise data, and determines quality control code corresponding to element value.

Following the quality control process, each data must be marked with quality-control flag, quality-related information has to be archived for reference of data processors and users. In monthly report, intervals have been set for storing information on data quality which contains quality-control codes and data amendments.

Quality control code representing quality status of observational data, according to the operational process, can be divided into three levels: station level, provincial and national level. Quality control code is represented by an integer of three digits, with one digit standing for national level, tens digit for provincial level, and hundred's digit for station level. The meaning of quality control code at all levels is as follows:

0：Data correct

1：Data suspicious

2：Data error

3：Data with corrected value

4：Data has been corrected

8：Lack Measured Data

9：Data without quality control

In the quality control process, it is allowed to correct doubtful data and data lacking measurement. Data correction includes data revising and data modification. Data revising refers to doubtful data or lacking of measured original observational data, a kind of data calculated and estimated through a given statistical method. This data does not replace the original data in observational data, only recording its revised data in data correction information. Data modification means that the original observational data is wrong, confirming the correct data after inquiries, which replaces the original data in observational data, while recording its modification status in data correction information. The corrected quality control codes are 3 or 4.

5. Training Activities

Training centers have been established in both national and provincial meteorological departments, which bear the responsibility for training employees at all levels of meteorological departments on basic meteorological knowledge, station network maintenance, forecasting operation, observation and detection technology, quality control technology. What's more, an integrated observing training/practice base was established to carry out online distance training. Through training, the operational personnel would deeply understand practice of meteorological observations and detection, master methods and operational requirements of meteorological observations and detection, and grasp basic principles of quality inspection and automatic quality control software operation. This will improve the operational capacity of meteorological technical personnel at all levels, ensure the quality of uploaded data, so as to meet the requirements for meteorological data in operational service and scientific researches.

6. Data Statistics and Application

6.1 The Climate standard value

WMO recommends that all the countries collate and prepare statistics for climate data taking 30 years as the standard, so as to facilitate WMO to issue a global climate standard value and to provide services for the national governments. Many member countries of WMO including China also stipulate that the climate standard value will be updated every ten years, in order to describe the average pattern of climate in 30 years, which is also regarded as the reference object for current climate condition. Meanwhile, climate standard value can be used to divide regional climate, providing extensive support to such areas as basic residential environment, agriculture, natural vegetation, energy utilization, transportation, tourism and environment research. China’s 30-year (i.e. 1951-1980, 1961-1990, and 1971-2000) meteorological data have been collated and compiled for three times (Figure 9). At present, preparations are underway to collate and compile the fourth 30-year (i.e. 1981-2010) meteorological data.

6.2 Data homogenization

Regarding data homogenization, studies on homogeneous verification and correction for data from surface and upper-air sounding stations nationwide are being carried out. Homogeneous verification for daily and monthly series of temperature, precipitation and upper-air temperature has been preliminary completed (see Figure 6).

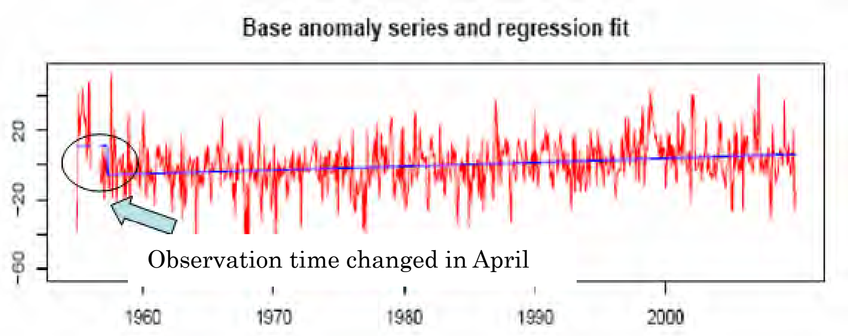


Figure 6　Verification of data homogenization

6.3 Application of meteorological data to various sectors

As meteorology is related to all aspects of national economy and scientific research, there are extensive and urgent needs for meteorological data. Meteorological data are applied to many sectors such as education, scientific research, government, agriculture, forestry, water conservancy, military, pharmacy, ocean, railway, public security, media and environment protection. Figure 7 presents a distribution chart of user groups based on statistics by sectors. Evidently, major user groups are from scientific institutions, colleges and universities followed by meteorological sectors, while the rest users are from earth science, agricultural science, bio-science, water engineering, and medicine and health sectors. All of them are professional staff involving in national scientific and technological projects, such as 863, 973 and the Natural Science Foundation, etc.

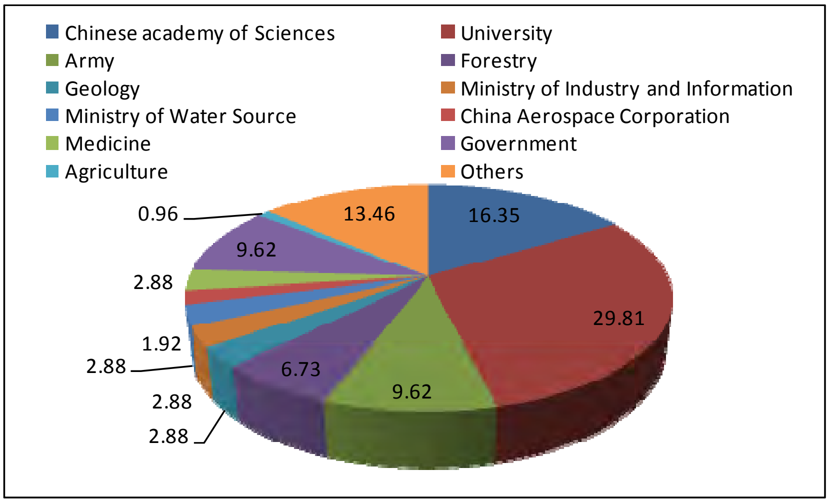


Figure 7　Sectors applying meteorological data

7. Existing problems and future plan

The improvement of observation data quality is needed. Although the electronic radiosonde in use has obviously been improved compared to mechanical ones, the stability and accuracy should further be increased to meet the requirements of climate observation. The high accuracy sensor of the pressure, temperature and humidity is planned to develop.

Quality control schemes need to be improved, and quality control is not used effectively for all observing elements. For example, quality control schemes are not developed for significant level, surface layer and L-band minute-level data for upper-air sounding data. Therefore, more efforts should be made to develop quality control schemes and put them into operation.

Metadata are limited, and a large amount of metadata are still archived in different stations, leading to uncertainties in judgment of data breakpoints, since it is hard to identify whether breakpoints are caused by natural variability or by other factors such as observing methods, changing of instruments. In this regard, cooperation should be enhanced with stations to collect metadata as much and soon as possible.

It is necessary to improve capabilities of data observers and recorders, allowing them to comprehensively and scientifically understand physical meaning and algorithm of observing elements, strengthening, meanwhile, operational practices to reduce or avoid data quality problems caused by human factors as far as possible.

Acknowledgments:
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Hong Kong, China

JMA/WMO Workshop on Quality Management in Surface, Climate and Upper-air Observations in RA II (Asia)

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Country Report of Hong Kong, China

(Submitted by H Y Mok, Hong Kong Observatory)

Summary and Purpose of Document

This country report describes the operation of the meteorological and climatological monitoring network of Hong Kong, China being operated by the Hong Kong Observatory. Besides operational details, the quality assurance programme being used for data quality assurance is also described.

1. Observation networks

1.1 Surface observations

1.1.1 Number of stations: RBSN, RBCN, GSN, manned stations and AWS*

Table 1 summarizes the number of RBSN, RBCN and GSN stations as well as the number of manned stations and automatic weather stations (AWS) being operated in the territory of Hong Kong by the Hong Kong Observatory for surface observations.

Table 1 Number of stations for surface observations (as at 31 December 2009)

	RBSN	RBCN	GSN	Manned stations	AWS *
number	1	1	0	19	73

* An automatic weather station (AWS) is defined as a "meteorological station at which observations are made and transmitted automatically".

1.1.2 Station map

Figure 1 shows the locations of the RBSN, RBCN and GSN stations as well as the manned stations and AWS being operated in the territory of Hong Kong by the Hong Kong Observatory.

1.1.3 Time and frequency of observations

At the synoptic land station in Hong Kong, surface synoptic observations are made and reported at hourly intervals. At the manned rainfall stations, measurements are taken once a day. AWS data are transmitted to the Hong Kong Observatory at one-minute intervals.

1.1.4 Data flow to users and archives

The surface observation data are transmitted in real time from the outstations to the Hong Kong Observatory Headquarters via leased line and/or radio link. The data are then processed and quality checked (details in Section 4) automatically. Both the data and the quality checked information are archived in a database system which serves different downstream users and applications. Security measures such as user access privilege are implemented to safeguard the database. Data are also archived on magnetic tapes for long term storage.

1.2 Upper-air observations

1.2.1 Number of stations: RBSN, RBCN, GUAN, manned stations and automated system stations

There is one upper-air station in Hong Kong. It is automatic and its location is also shown in Figure 1. The upper-air station is also one of the RBSN, RBCN and GUAN stations.

1.2.2 Time and frequency of observations

Regular upper-air soundings are made two times a day at 00 UTC and 12 UTC at the upper-air station.

1.2.3 Data flow to users and archives

The upper-air observation data are transmitted in real time from the upper-air station to the Hong Kong Observatory Headquarters via leased line. The data are then processed and quality checked (details in Section 4) automatically. Both the data and the quality checked information are archived in a database system which serves different downstream users and applications. Security measures such as user access privilege are implemented to safeguard the database. Data are also archived on magnetic tapes for long term storage.

2. Siting and metadata

The siting of weather stations for surface observation generally follows the guidelines given in the WMO “Guide to Meteorological Instruments and Methods of Observation, WMO-No. 8 (CIMO Guide)”. For metadata, the Hong Kong Observatory compiles annually a publication to provide users with comprehensive information of how, where, when and what surface observations are made at weather stations in Hong Kong. The metadata format and layout adopted in the publication generally follow the guidelines and recommendations suggested in the WMO "Guidelines on Climate Metadata and Homogenization, WMO-TD No. 1186”. The historical records of measuring instruments at each station and the station location, including latitude, longitude and altitude, are given in the publication.

3. Instruments, sensors, upgrade, maintenance, instrument intercomparisons and traceability

In recent years, several Heat Stress Measurement Systems (system measuring the Wet Bulb Globe Temperature (WBGT)) have been installed at some automatic weather stations in the urban and rural areas. A network of weather camera has also been implemented to assist forecasters in the monitoring of weather conditions, visibility and sea conditions, and to provide the public and special users with real-time weather photos.

To maintain high data availability, backup instruments using independent data transmission paths are installed at strategic AWSs to provide data redundancy.

The Observatory implements calibration procedures for meteorological sensors to ensure that the measurement results are traceable to the System International (SI) standard. Solar radiation instruments are calibrated using a PMO-6 absolute radiometer, which itself is kept traceable to the WRR through intercomparisons with the regional standard kept by the Japan Meteorological Agency every 5 years. Sunshine duration and UV-Index radiometers are calibrated at factory every 2 years.

From December 2007 to January 2008, the Observatory carried out a comparison of the Hong Kong Standard Barometer with the Japan Meteorological Agency’s Primary Standard Barometer through the use of travelling standards. In 2009, the Observatory upgraded its pressure standard from a Kew-pattern mercury barometer (WMO Class C barometer) to a high-accuracy digital barometer (WMO Class B barometer).

4. Quality assurance / quality control (real-time, non-real time)

The Hong Kong Observatory has implemented quality assurance procedures to carry out quality check and control of observational data both on a real-time and non-real-time basis.

The AWS data received by the central data acquisition system at the Hong Kong Observatory Headquarters are passed to an Integrated Meteorological Data Quality Assurance System (System) for real-time data quality check and control. The System is highly automatic. Through various real-time QC procedures including range test, trend (jump) test and consistency test, the System carries out quality assurance for each data received from the AWS by assigning a quality assurance flag to the data, filtering out erroneous data from the AWS, and alerting maintenance staff to action via automatic email. Operation of the AWSs can also be monitored via a webpage which displays the status of the AWS network in real-time. The automatic alerting feature enables early detection and diagnosis of faults as well as enhancing data availability. Apart from monitoring the operation of the AWS, the quality assurance flags also serve as an indication of quality, facilitating reference by users in future studies. The quality check and control procedures generally follow the “Guide on the Global

Data-Processing System WMO No.305."

Non-real-time checking of all observation data collected will also be conducted with the help of the quality check results of the System. Except spatial check of rainfall data and double-check of those erroneous data flagged by the System, non-real-time quality check, including range check and consistency check, are also conducted automatically using in-house developed computer programmes.

5. Training

A formal training course covering surface observations and related codes is conducted for relevant new recruits. The course lasts about 10 weeks.

6. Statistics and applications

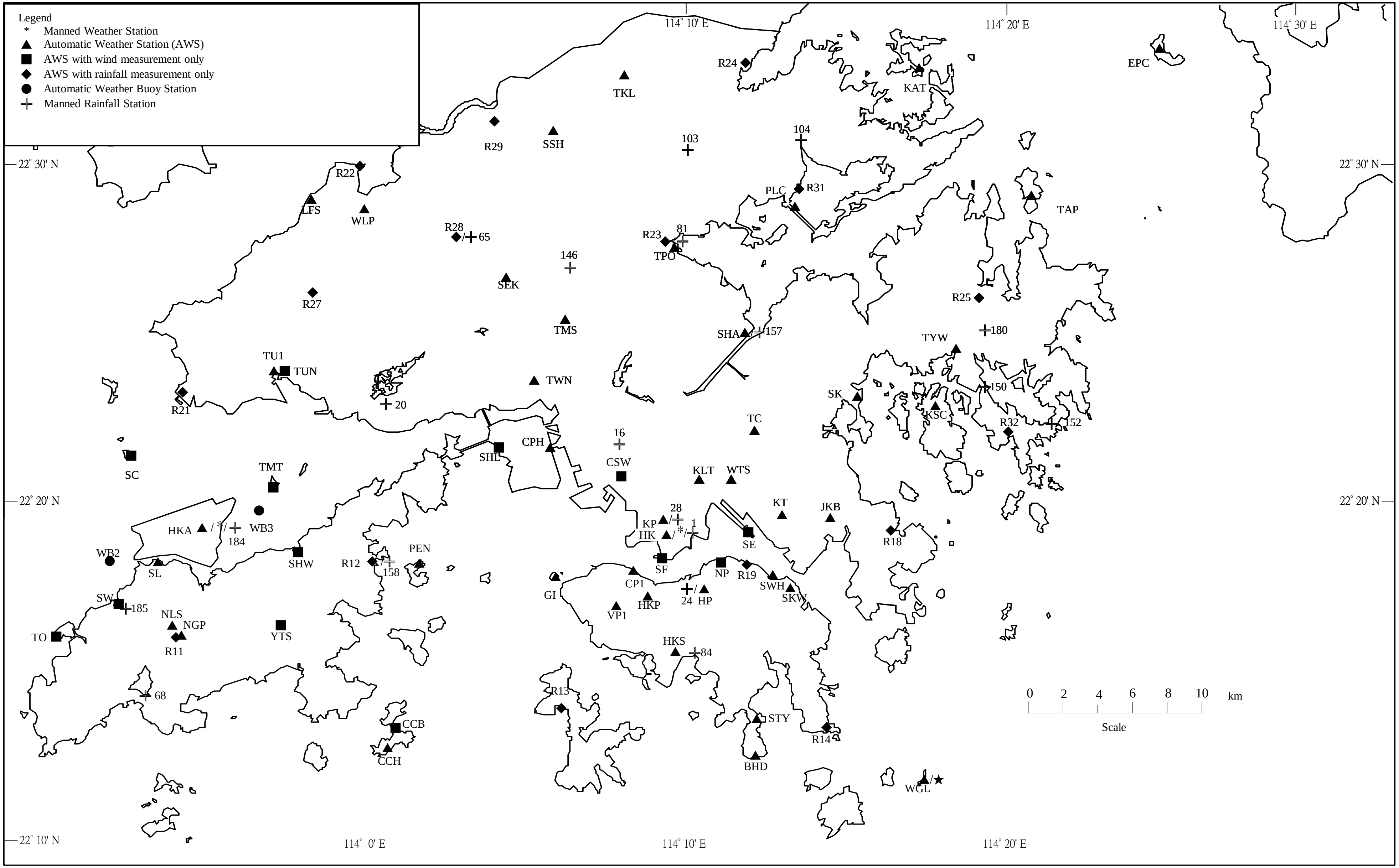
Climatological statistics such as mean, total, mean maximum, mean minimum values of major weather elements are computed on monthly and annual basis for the publications of monthly and yearly weather summaries. The PDF versions of the summaries are also available on the Hong Kong Observatory's website. Climatological normals, extremes and ranking order information of some weather events are also compiled and available on the Hong Kong Observatory's website.

Apart from supporting the weather forecasting and warning operation of the Hong Kong Observatory, these observational data and statistical information are also provided to other government departments and private sectors such as shipping, aviation, engineering, industries, judicial proceeding, recreational activities and the public to meet their different needs. Based on these observational data and statistical information, a series of climatological studies including urban and regional climate, long term climate trends, frequency of occurrence of extreme weather events, and relationship between weather and health have been conducted.

7. Current issues and future plan

Meteorological observations at Hong Kong by the Hong Kong Observatory started in 1885. Part of the historical data, especially those collected before the 1950's, are still kept in paper format. Actions are being taken to digitize those historical data for permanent archive and facilitate climate analysis.

The increase in the number of meteorological observation stations in recent years has generated burden on the maintenance of high quality climatological data. Actions are being taken to develop a sophisticated climate data management system for better climate data management and more efficient climatological services.



Note: A station code is assigned to each station.
For surface observations, HKA is RBSN station and KP is the RBCN station.
For upper-air obervations, KP is RBSN, RBCN and GUAN station.

Figure 1 Locations of surface and upper-air stations in Hong Kong as at 31 December 2009

India

JMA/WMO Workshop on Quality Management in Surface, Climate and Upper-air Observations in RA II (Asia)

Tokyo, Japan
27-30 July 2010

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COUNTRY REPORT

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Summary and Purpose of Document

The document is submitted as per the requirement stipulated in the invitation letter for JMA/WMO WORKSHOP ON QUALITY MANAGEMENT IN SURFACE, CLIMATE AND UPPER-AIR OBSERVATIONS IN RA II (ASIA)

The document describes the status of Meteorological Observation in India including quality control, instrumentation, training and other related aspect thereof.

A GUIDE TO WRITING A COUNTRY REPORT AND PRESENTATION

1. Observation networks

1.1 Surface observations

1.1.1 Number of stations: RBSN, RBCN, GSN, manned stations and AWS

Table 1 Number of stations

	RBSN	RBCN	GSN	Manned stations	AWS	ARG
number	82	44	20	528	425 *	324 #

* Further addition in progress. Total planned : 675
** Further addition in progress. Total Planned :1350

1.1.2 Station map

Maps showing locations of the RBSN, RBCN and GSN station : Fig. 1 to 3
Maps showing locations of the manned station and AWS : Fig 4 & 5

1.1.3 Time and frequency of observations

All surface stations included in the regional basic synoptic network take surface observations at the four main standard times of observation, i.e. 0000, 0600, 1200 and 1800 UTC, and at the four intermediate standard times of observation, i.e. 0300, 0900, 1500 and 2100 UTC.

1.1.4 Data flow to users and archives

Illustrated in Fig 9

1.2 Upper-air observations

1.2.1 Number of stations: RBSN, RBCN, GUAN, manned stations and automated system stations

	RBSN	RBCN	GUAN	Manned stations	Automated system stations
number	-	20	-	39	-

1.2.2 Station map

Map showing locations of the RBCN upper-air stations : Fig.6
Map showing locations of all upper-air and Pilot balloon stations : Fig. 7 & 8

1.2.3 Time and frequency of observations

- upper air observations are made and reported at 0000 UTC and 1200 UTC.
- Pilot balloon observations are made and reported at -
  - 0000 UTC and 1200 UTC where Radiosonde observation not taken
  - 0600 UTC and 1800 UTC where Radiosonde observation are taken

1.2.4 Data flow to users and archives

Illustrated in Fig 9

2. Siting and metadata

- Outdoor instruments are installed on a level piece of ground, approximately 10 m x10 metres, covered with short grass or a surface representative of the locality, and surrounded by open fencing. Within the enclosure, a bare patch of ground about two metres by two metres is reserved for observations of the state of the ground and of soil temperature at depths of equal or less than 20 centimetres.
- There should be no steeply sloping ground in the vicinity and the site should not be in a ditch. The site should be well away from trees, buildings, walls or other obstructions. The distance of any such obstacle (including fencing) from the raingauge should not be less than twice the height of the object above the rim of the gauge, and preferably four times the height.
- Metadata consists of station name, latitude, longitude, altitude, height (above ground) of pressure and wind measuring instrument, details of obstruction if any,

3. Instruments, sensors, upgrade, maintenance, instrument intercomparisons and traceability

- India belongs to that select group of countries who manufacture their own upper air and surface instruments. This is done by the meteorological department through in-house production facilities
- All instruments at surface stations are checked and compared once a year with portable standard that are traceable to national standards. National standards are also regularly compared and calibrated against international /WMO standards.
- The maintenance of modern electronic instruments is a matter of concern. Availability of spare part is restricted to its manufacturer and sometime too costly. Lack of skilled manpower for maintenance is another difficulty towards upgrade to modernization/ automation.

4. Quality assurance / quality control (real-time, non-real time)

- Manual QC is applied at manned synoptic station by comparing with long term normals (Averages) at observer's intelligence. QC algorithms for AWS is under development
- SYNOP/TEMP messages are checked for proper WMO format at communication centres before forwarding to users. Any message found erratic is flagged for manual correction.
- Suitable software of 10 day moving averages is run for checking errors in meteorological parameters. Doubtful values are flagged for manual correction.
- Hydrostatic quality checks is performed on upper air data at processing centres.

5. Training

- The Central Training Institute (CTI) of the India Meteorological Department (IMD) is situated at a pleasant location at Pashan in Pune. IMD also has training centres at New Delhi for Upper Air Instrumentation.
- Facilities for meteorological training at Pune and New Delhi have been recognized by the WMO to function as RMTC in all the four main

disciplines namely, General Meteorology, Meteorological instrumentation, Telecommunication and Agro-meteorology.

- The training institute (CTI) has been continuously upgrading, keeping pace with technological advancement, its training capabilities, composition, objectives, contents, etc, in catering to personnel covering all levels from Class I to Class IV.

6. Statistics and applications

Application for surface and upper-air observations:

- Weather forecasting
- Climatology
- Agromet advisory
- Civil aviation
- Marine navigation
- Cyclone warning
- Hydrology and flood forcasting
- Environmental monitoring
- Supply of data to various users on demand

7. Current issues and future plan

Current issues:

- Non-availability of quality monitoring mechanism for AWS and ARG data from large number of stations.
- Poor quality of radiosonde data due to poor accuracy (repeatability) of baroswitch (pressure sensor)

Future plans:

- Development of algorithms and software for automatic quality monitoring of AWS and ARG data.
- Development of indigenous GPS radiosonde

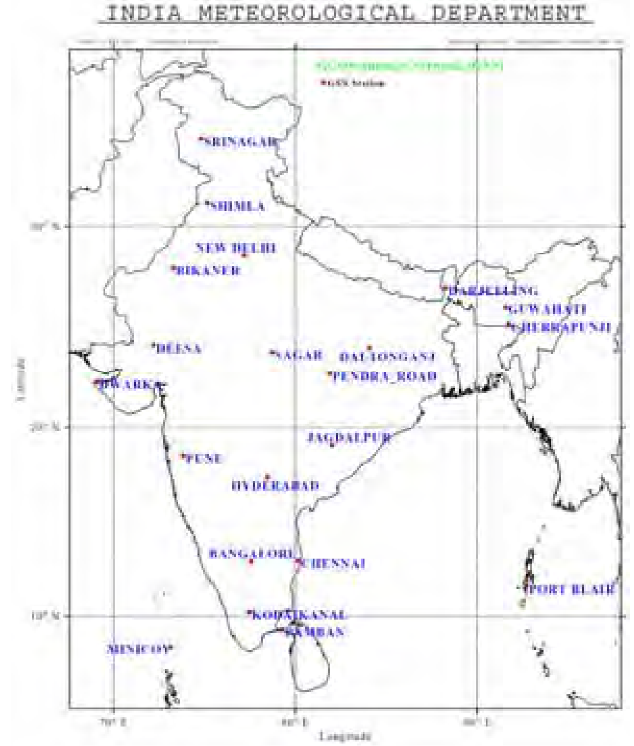

Fig.1 GSN- Surface stations

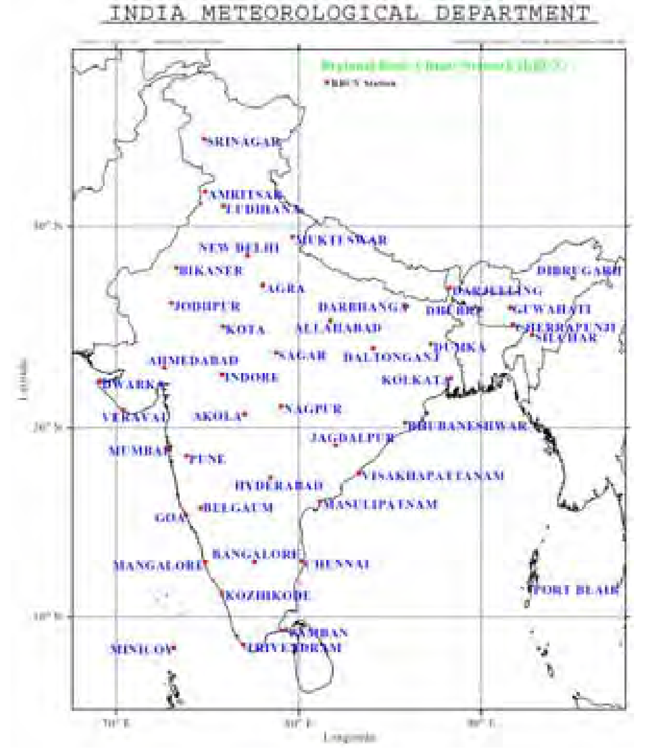

Fig 2 RBCN-Surface stations

Fig 3 RBSN-Surface stations

Fig. 4 Manned surface stations

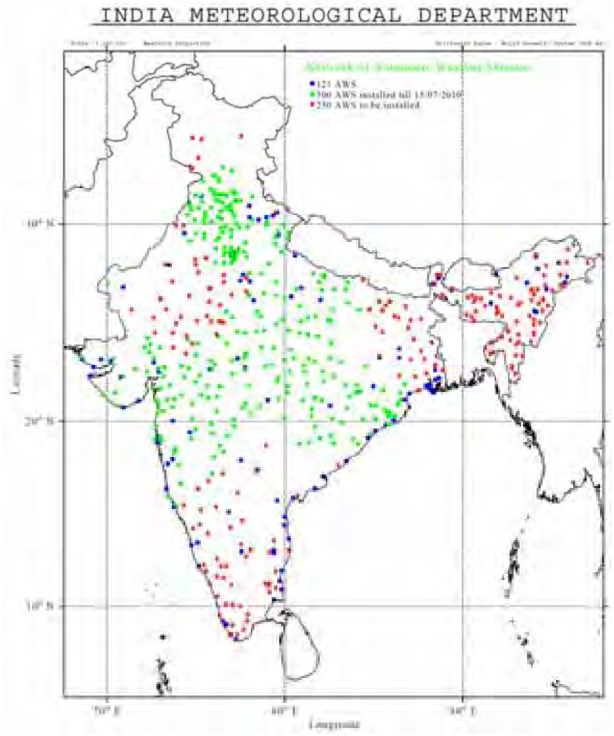

Fig 5 AWS netwirk

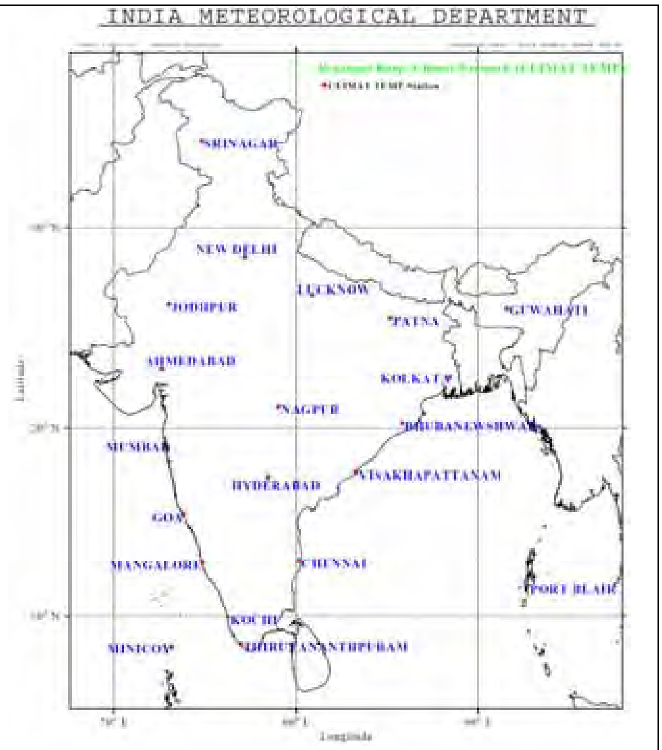

Fig 6 RBCN-Upper-air stations

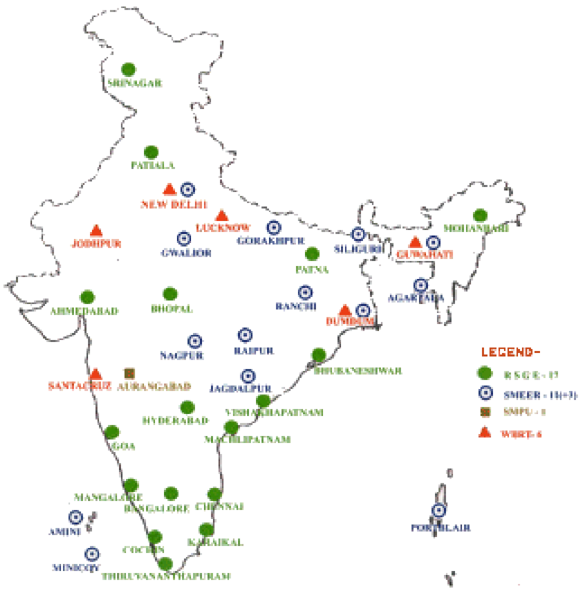

Fig 7. Upper Air Stations

Fig 8. Pilot Balloon Stations

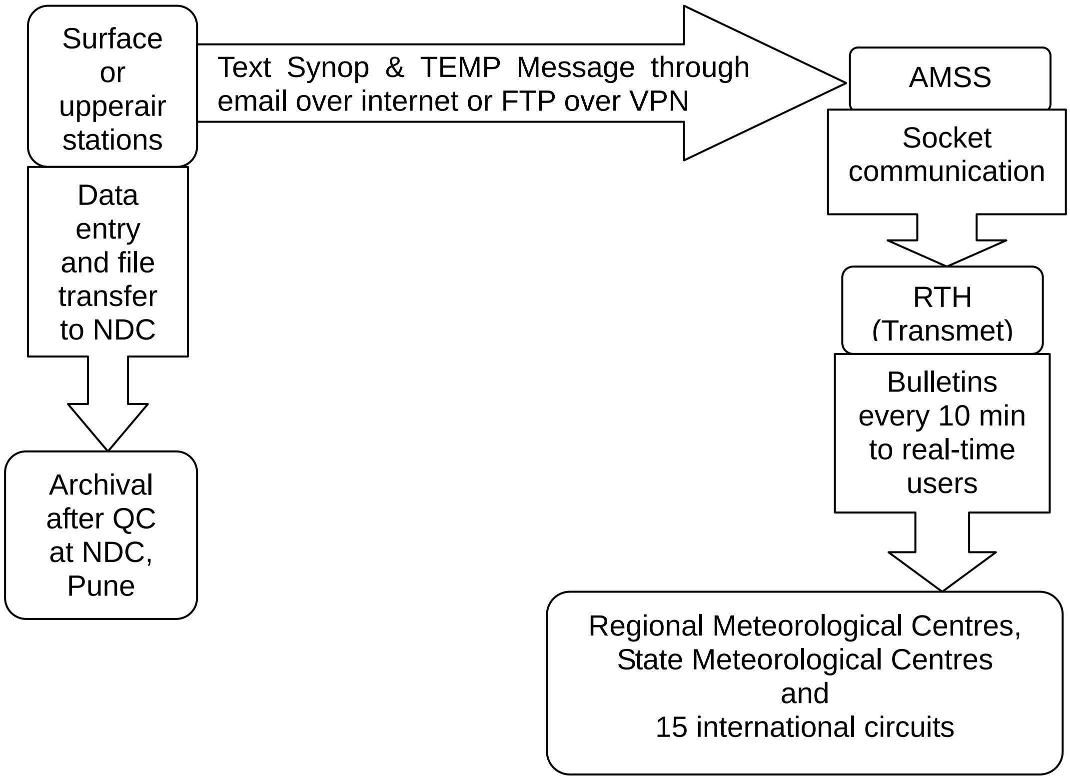

Fig 9 Surface and Upper-air Data flow to users and archives

JMA/WMO Workshop on Quality Management in Surface, Climate and Upper-air Observations in RA II (Asia)

Tokyo, Japan
27 – 30 July 2010

Doc.
Japan

(10.VII.2010)

Country Report for Japan

(Submitted by Kenji Akaeda, Japan Meteorological Agency)

Summary and Purpose of Document

This document contains an overview of surface and upper-air observations in Japan with respect to instruments, quality assurance/quality control, training, statistics and applications.

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1. Observation networks

1.1 Surface observation

1.1.1 Number of stations: RBSN, RBCN, GSN, manned stations and AWS*

Japan has 156 meteorological observatories that perform observations of air pressure/temperature, wind, precipitation, visibility, weather and other elements to meet the general requirements of meteorological stations. Sixty-eight of these are observer-staffed weather stations, while the others are unmanned stations equipped with fully automatic instrumentation including visibility sensors. All these observatories are integrated into Japan's AWS network, known as AMeDAS (the Automated Meteorological Data Acquisition System), which consists of more than 1,100 local observation stations all over the country. All AMeDAS stations measure precipitation, and approximately 690 of them also measure air temperature, wind and sunshine duration.

Fifty-two meteorological observatories (not including Syowa Station in Antarctica), both staffed and unstaffed, have been appointed as RBSN stations, whose data are utilized for international exchange. These stations have stably provided data of the accuracy level stipulated in the CIMO Guide (WMO-No. 8) for years. Accordingly, they have also been registered as RBCN stations and submit CLIMAT reports every month.

In consideration of observational record length, site environment and station density, 13 stations have been registered as GSN stations.

Table 1. Number of stations

	RBSN	RBCN	GSN	Manned	AWS *
Number	52	52	13	68	1,209

1.1.2 Station map

Figure 1 shows the locations of the RBSN, RBCN and GSN stations, and Figure 2 shows the locations of manned stations and AWSs in Japan.

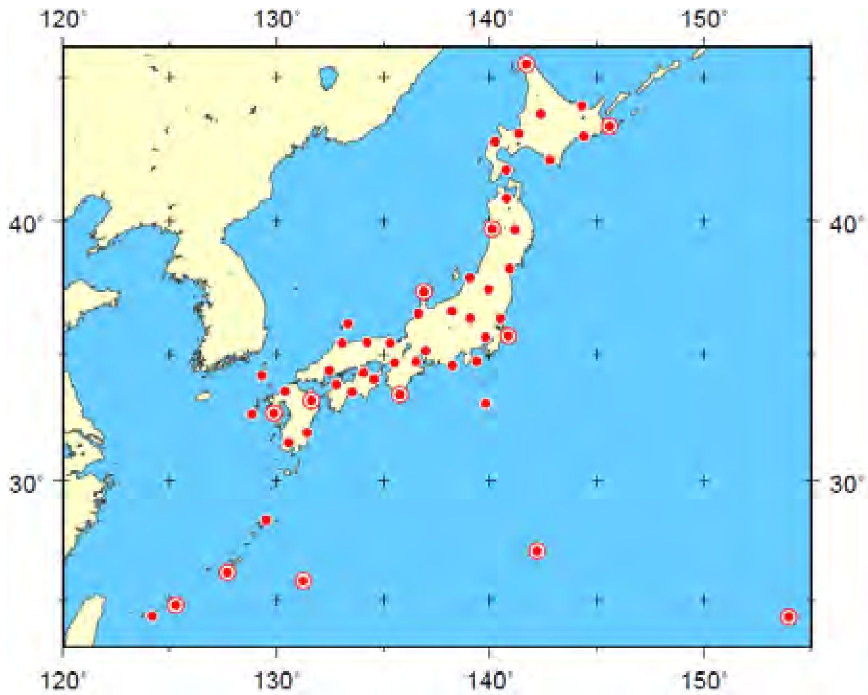

Figure 1. RBSN, RBCN and GSN stations in Japan
Solid circles: RBSN/RBCN stations; double solid circles: GSN stations (also RBSN/RBCN stations)

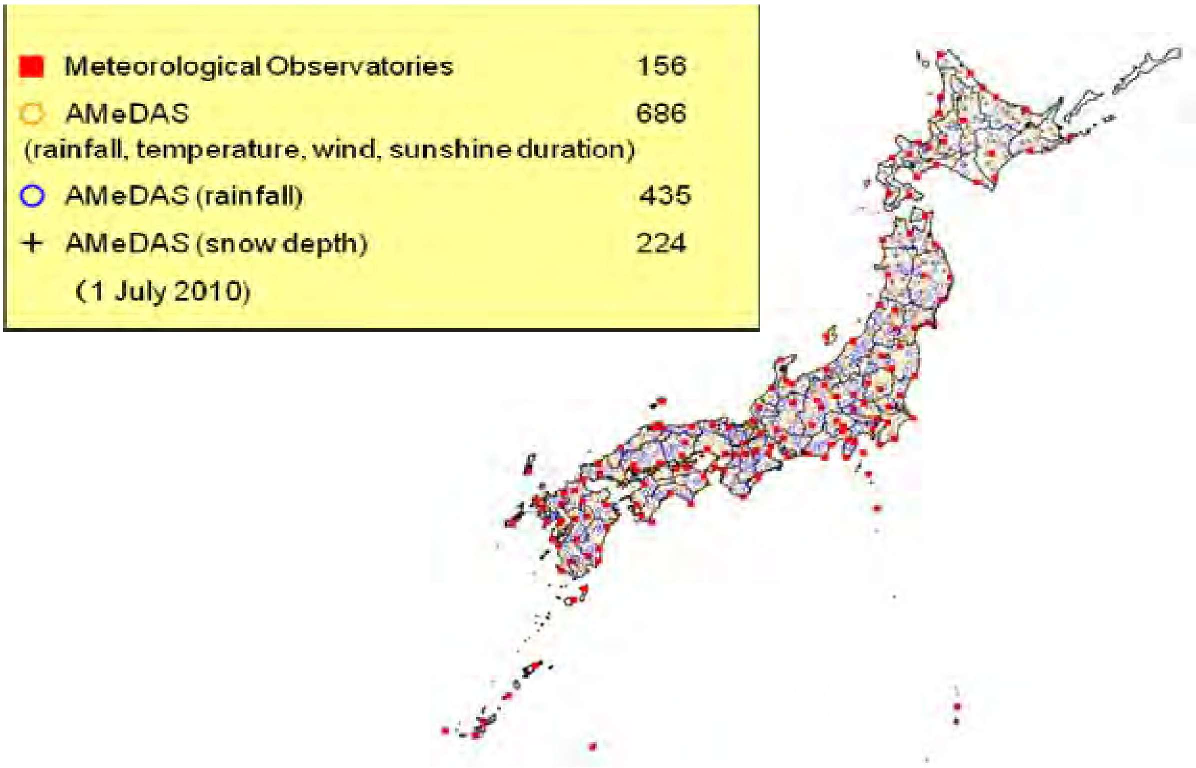

Figure 2. Meteorological observatories and AMeDAS stations (AWSs) in Japan

1.1.3 Timing and frequency of observations

Observations at almost all meteorological observatories (154 stations) are made and transmitted to the data-processing center at JMA's headquarters every 10 seconds, with a 10-minute frequency for observations at other AWSs.

1.1.4 Data flow to users and archives

All JMA observational data are transmitted to JMA's headquarters, processed and quality-controlled in computing systems (see Figure 3). The data are utilized in weather and climate monitoring, statistical analysis and other prediction tasks, thereby benefitting the public in terms of disaster mitigation, transportation safety and improvements in life and industry.

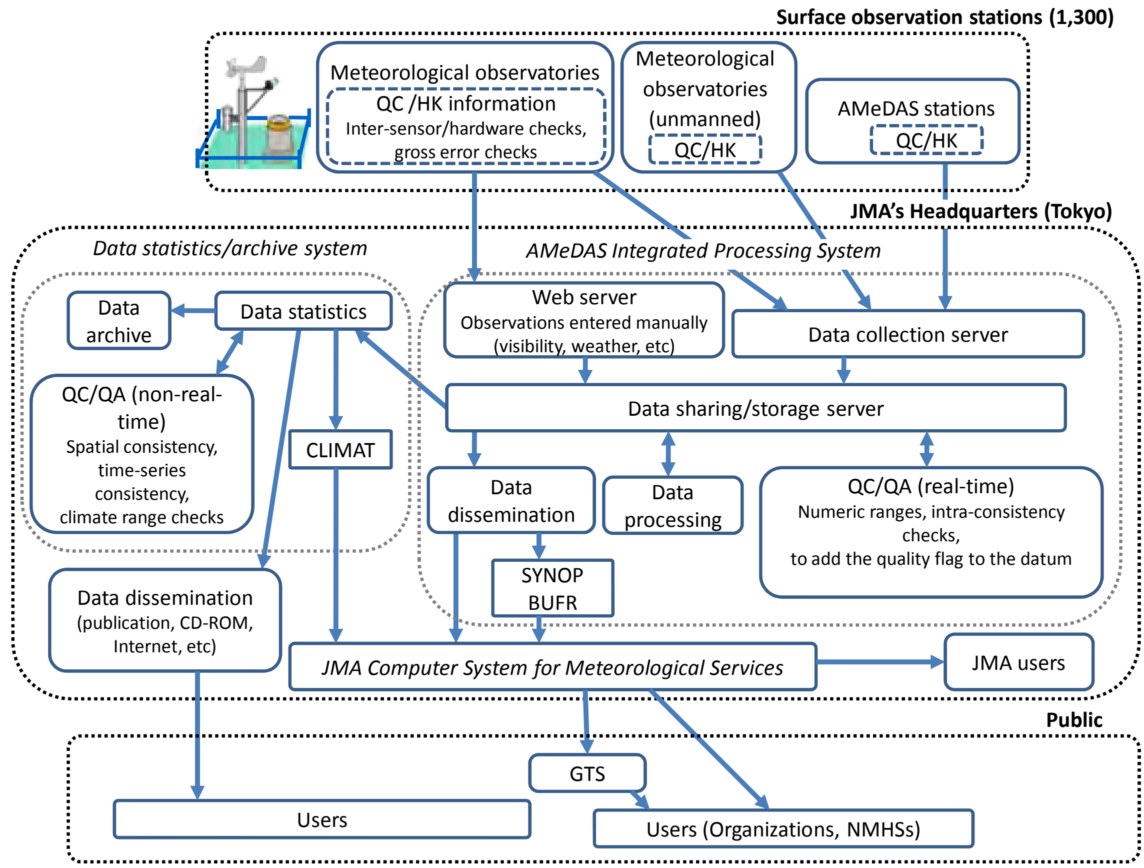

Figure 3. Flow of surface observation data to users and archives

1.2 Upper-air observation

1.2.1 Number of stations: RBSN, RBCN, GUAN, manned stations and automated system stations

Table 2. Number of stations

	RBSN	RBCN	GUAN	Manned	Automated
Number	16*	16*	6*	8*	8

*Syowa Station (Antarctica) is not included.

1.2.2 Station map

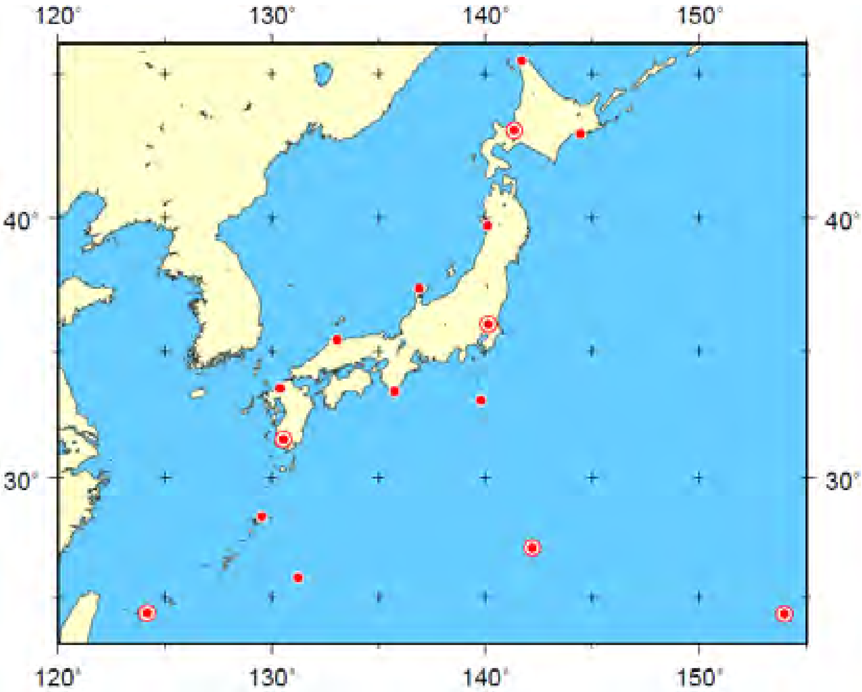

Figure 4. RBSN, RBCN and GUAN stations for upper-air observation in Japan. Solid circles: RBSN/RBCN stations; double solid circles: GUAN stations (including RBSN/RBCN stations)

1.2.3 Timing and frequency of observations

Observations are made and reported twice a day at 00 and 12 UTC at 16 stations in Japan and at Syowa Station in Antarctica. In the event of severe weather conditions such as typhoons, radiosondes are also launched at 06 UTC and/or 18 UTC.

When data are not obtained below 150 hPa in an observation, the observation has to be made again from the beginning.

1.2.4 Flow of data to users and archives

Figure 5 shows the flow of upper-air observation data to users and archives.

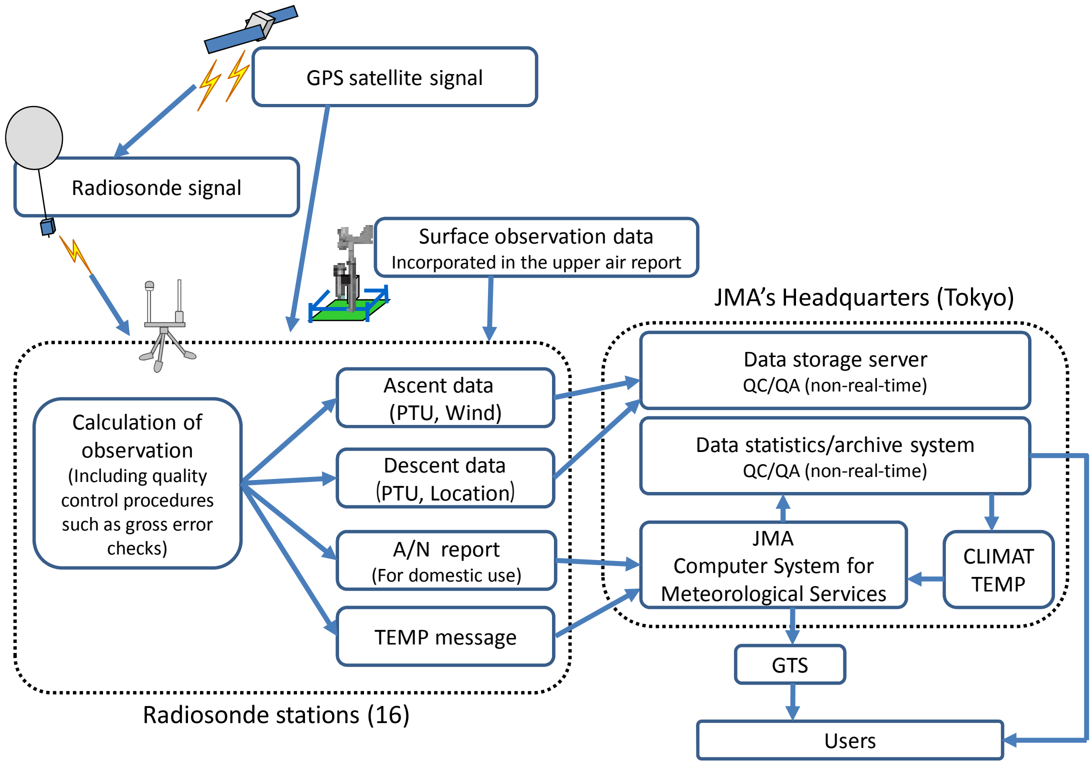

Figure 5. Flow of upper-air observation data to users and archives

2. Siting and metadata

Siting and exposure criteria for surface observation stations have been designed in accordance with WMO recommendations. The specifications are as follows:

a) Outdoor instruments should be installed on a level area of ground covered with short grass, preferably more than 20 m in width or length, and approximately 600 m^2 in area.

b) Sites as described in a) should be located well away from buildings, i.e., a distance equivalent to more than three times the building height or 10 meters.

c) The angular height of nearby buildings as seen from the center of the site should be 18 degrees or less.

No matter how carefully instruments are positioned according to the above criteria, measurement uncertainties caused by fluctuations in site conditions are unavoidable. It is therefore important to document metadata that describe the conditions in which data have been recorded. We conducted surveys to ascertain which metadata factors significantly influence measurements when it comes to monitoring the current status of sites and possible changes in siting environments such as plans for new construction in the neighborhood. It was concluded that operational periods, geographical data (such as latitude, longitude and elevation), site size, instrument mounting height and exposure, and site maps and photos showing the surroundings constituted critical metadata items for identifying site conditions. All these kinds of metadata have been documented and updated by local staff, gathered and stored by the management section at JMA's headquarters, and shared by all JMA staff through the Agency's intranet.

3. Instruments, sensors, upgrading, maintenance, instrument intercomparison and traceability

3.1 Surface observation

Upgrading of weather observation equipment at local meteorological observatories is being planned. The current equipment (JMA-95, used since 1995) consists of a set of sensors connected to data collection and transmission units, automatically sending data to computing systems at JMA's headquarters. The new equipment (JMA-10, to be installed from 2010 to 2014) includes measurement devices for air pressure/temperature, humidity, wind, precipitation, snow depth and sunshine duration/radiation, and at unmanned stations exclusively, visibility and present/past weather. As seen in Table 4, the equipment is expected to meet or exceed the measurement accuracy requirements of international standards such as those recommended in WMO's CIMO Guide (WMO-No. 8), featuring sensors using the same observation methods as JMA-95 except for those measuring snow depth and sunshine duration.

In designing the new equipment, improvement of strength and durability, increased efficiency in maintenance and operation, and adaptation to versatile low-cost devices and technologies have been particularly considered. By way of example, installation of independent input/output modulation for individual CPU sensors and improvements to system software for checking, monitoring and quality control can be expected.

Table 3. Performance specifications of JMA-10 and JMA-95 sensors

	WMO/CIMO achievable measurement uncertainty	**JMA-10**		**JMA-95**	
		Performance specification	Sensor	Performance specification	Sensor
Pressure	±0.3 hPa	±0.2 h Pa	Capacitive barometer	±0.2 hPa	Capacitive barometer
Temperature	±0.2°C	±0.15°C	Platinum resistance thermometer	±0.15°C	Platinum resistance thermometer
Humidity	±3%	±3%	Capacitive hygrometer	±5%	Capacitive hygrometer
Wind speed	– 5.0 m/s ±0.5 m/s 5.0 m/s – ±10%	– 10.0 m/s ±0.3 m/s 10.0 m/s – ±3%	Combined wind vane and propeller anemometer	– 10.0 m/s ±0.3 m/s 10.0 m/s – ±3%	Combined wind vane and propeller anemometer
Wind direction	±5°	±3%		±3%	
Precipitation	The larger of ±5% or 0.1 mm	±3%	Tipping-bucket gauge	±3%	Tipping-bucket gauge
Snow depth	– 20 cm ±1 cm 20 cm – ±5% *	±1 cm	Snow depth meter (laser sensing)	±2 cm	Snow depth meter (ultrasonic/ laser sensing)
Sunshine radiation	– 8 MJm^{-2} ±0.4 MJm^{-2} 8 MJm^{-2} – ±5% (based on daily totals)	±3%	Electric pyranometer	±3%	Electric pyranometer
Sunshine duration	The larger of 0.1 h or 2% (based on daily totals)	120 Wm^{-2} ±10% (based on the threshold value)	Sunshine duration meter (rotation type)	120 Wm^{-2} ±10% (based on the threshold value)	Sunshine duration meter (sun tracking)
Visibility	The larger of 20 m or 20%	– 10,000 m ±10% 10,000 m – ±15%	Forward scatter meter	– 10,000 m ±10% 10,000 m – ±20%	Forward scatter meter

*Required measurement uncertainty

3.2 Upper-air observation

The upper-air observation system was renewed in fiscal 2009. Meisei Radiosonde RS2-91 and Meisei GPS Radiosonde RS-01GM were replaced by Vaisala GPS Radiosonde RS92-SGP and Meisei GPS Radiosonde RS-06G, respectively, thereby achieving complete updating of the existing radiosonde network with GPS radiosondes.

Comparisons of observations by the new and old types of sonde at the Aerological Observatory in Tsukuba have been analyzed to ensure data continuity before and after the renewal. As RS-01GM uses the same sensors and conversion formulas as RS2-91, RS-06G is compared with RS2-91 instead of RS-01 GM. The comparison periods are as follows:

a) From September 28th to October 14th, 2009 (20 comparisons)
b) From December 3rd, 2009 to January 15th, 2010 (30 comparisons)
c) From March 1st to 19th, 2010 (30 comparisons)
d) From May 24th to July 9th, 2010 (30 comparisons)
e) A total of 30 comparisons are also scheduled for September 2010.

4. Quality assurance/quality control (real-time, non-real-time)

4.1 Instrumental AQC in real time

JMA's weather observation equipment (JMA-95) has a management system of self-checking and automatic quality checking (AQC) to facilitate its maintenance. Processing tasks such as invalidation of erroneous data are performed according to instrumental housekeeping parameters.

In upper-air observation, the signal receiver on the ground invalidates erroneous data in signal processing and conversion to physical values.

4.2 AQC in real time in the observation system

The AMeDAS Integrated Processing System (AIPS) implements real-time AQC for observation values acquired from stations via telecommunication lines. AQC tasks such as gross-error checking and logical checking are performed on values covering ten seconds, one minute and ten minutes. Quality flags of "Normal," "Serious (Warning level),""Minor (Advisory level)" or "Invalid" are added to the values.

4.3 AQC in non-real time in the processing systems

After sending SYNOP reports to GTS lines and domestic BUFR reports to the external telecommunication lines, the processing systems in JMA-HQ implement non-real-time AQC.

The various types of AQC are as followings:

a) Spatial checking: Data from the station are compared with those from surrounding stations. A multiple regression relationship for the past and a simple magnitude relationship are used. This type of AQC is also applied to rainfall data from external agencies.
b) Sequential checking: Checking is performed to detect when identical values (temperature, wind direction, wind speed) are observed over a number of hours.
c) Extreme value checking: Checking is performed to detect when values above past extreme levels are observed.

In upper-air observation, AQC in non-real time is performed to detect when values at the standard pressure level are observed with an anomaly of above 2 σ.

Observatory officials correct observation values according to AQC results returned from AIPS and processing systems.

4.4 Correction of erroneous data

Observatory officials correct observation values according to AQC results returned from AIPS and processing systems.

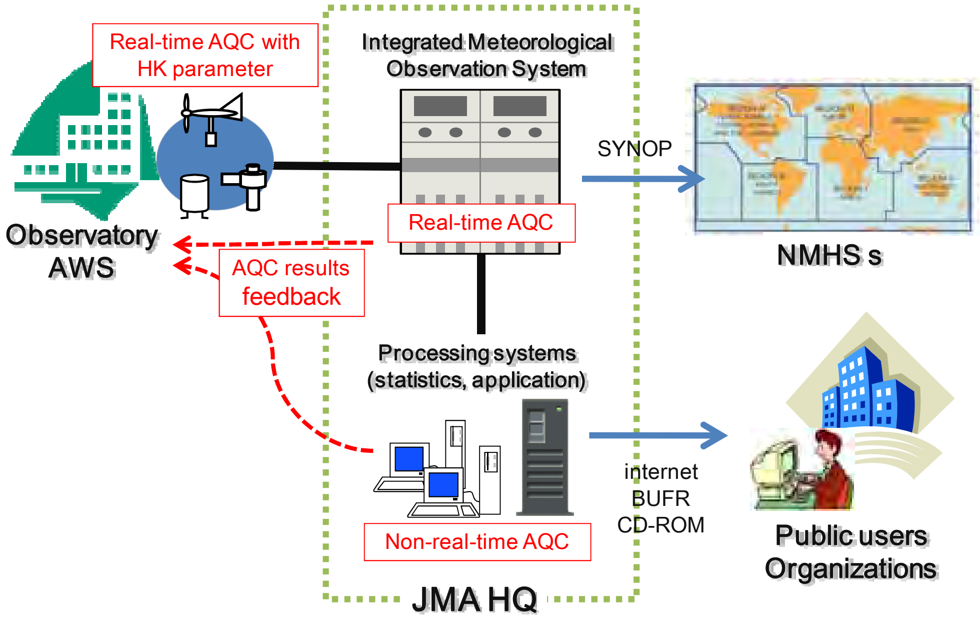

Figure 6. Flow-chart of QC for surface observation data

5. Training

5.1 Surface observation

Maintenance staff from local district observatories attend an annual 15-day training program, which aims to provide them with the knowledge and skills needed for instrumentation maintenance and nurture their expertise toward future leadership in the field. In addition, a three-day program is also held annually at local district observatories. The program provides instructions to local observatory maintenance staff on how to take immediate remedial action in response to instrumentation problems during operation. In these programs, trainees learn about inspections and maintenance through demonstration and practice using actual instruments, sensors and equipment, and also attend lectures on the mechanics of the instruments.

5.2 Upper-air observation

For staff at manned stations where radiosondes are launched by hand, a four-day training program is provided annually at the Aerological Observatory in Tsukuba. A representative from each observatory attends the program to learn the basics of upper-air observation and keep abreast of new knowledge and techniques.

The training program for staff at automated stations is quite different from the above. It is a one-day program for operators who are responsible for physically loading the balloon train (including the radiosonde) into the tray of the carousel in observations. When an annual routine inspection is conducted, the manufacturer and JMA headquarters staff together give instructions to the local staff on the practice of loading balloons and how to respond to mechanical problems.

6. Statistics and applications

JMA has prepared and updated its original guide to statistical procedures in past decades. The guide describes in detail how to deal with data inhomogeneities including those stemming from changes in observational site locations and changes in the instrumentation used to make observations, as well as basic statistical procedures. Quality flags for statistics are also defined according to the quality flags of the observational data and the number of available observational data over the reference period.

All observational data and data statistically processed over the past 100 years are archived together with their associated quality flags. Metadata concerning instrumentation, locations, etc. for each observational site since the commencement of observation are also archived.

Observations made and quality-controlled by AIPS are processed every 10 minutes for the prompt output of a variety of statistics such as daily maximum and minimum temperatures and any updates on daily/monthly extremes. These statistical data and information are made available on JMA's website on a real-time basis (limited data and information are also available on its English site).

7. Current issues and future plans

7.1 Surface observation

Changes in site environments due to urbanization or other factors can affect the quality of observational data, possibly to the extent of making it difficult to meet the requirements for long-term sustainable climate monitoring. JMA is currently developing tools to assess the effects of changes in surroundings and trying to clarify suitable environmental conditions to serve individual purposes for different types of data usage.

7.2 Upper-air observation

The new GPS radiosonde system has made it possible to obtain data during descent as well as ascent. The feasibility of using descent data as reference data in the future will be examined.

JMA/WMO Workshop on Quality Management in Surface, Climate and Upper-air Observations in RA II (Asia)

Tokyo, Japan
27-30 July 2010

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KAZHYDROMET – NATIONAL HYDROMETEOROLOGICAL SERVICE OF REPUBLIC KAZAKHSTAN

(submitted by Zainuldinova Dinara,RSE Kazhydroment)

Summary and Purpose of Document

This document contains an overview of the surface and upper-air observations and Radar observation in kazakhstan.

KAZHYDROMET-
NATIONAL HYDROMETEOROLOGICAL SERVICE
OF REPUBLIC KAZAKHSTAN

ASTANA, 2010

The ministry of preservation of the environment of Republic Kazakhstan The republican State Enterprise «Kazhydromet»

Main objective of activity of RSE “Kazhydromet " is maintenance with the information on weather, a climate and a state of environment, notifications about the dangerous and spontaneous meteorological, agrometeorological, hydrological phenomena and extremely high levels of environmental contamination, maintenance of high level of hydrometeorological and ecological safety of the country.

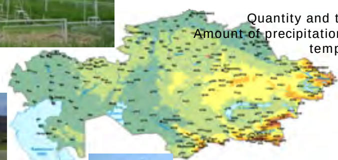
Primary goals of RSE “Kazhydromet ":
1. Working out and drawing up of all kinds of hydrometeorological forecasts;
2. Carrying out of regular hydrometeorological and ecological supervision;
3. Preventions of possibility of occurrence of the spontaneous hydrometeorological phenomena;
4. Conducting of Republican fund of the data on hydrometeorology and environmental contamination;
5. Hydrometeorological maintenance of branches of economy of Republic Kazakhstan. 2

THE INTERNATIONAL COOPERATION

The basic directions:
- The world Meteorological Organization (WMO)
- Regional Associations II (Asia) and VI (Europe) WMO
- Interstate Council about Hydrometeorology (ICH)
- Bilateral and multilateral Agreements in the field of hydrometeorology
- The international courses, trainings, educational seminars

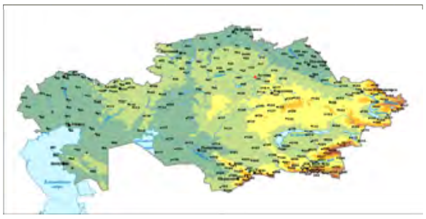
Observant network of Kazhydromet

Meteorological station
Makes supervision over temperature and humidity of air,
Direction and in the speed of a wind, atmospheric pressure,
Meteorological visibility range,
the height of the bottom border of clouds,
Condition of weather,
The atmospheric phenomena,
The dangerous and spontaneous phenomena,
Quantity and the form of clouds,
Amount of precipitation, condition and in temperature spreading
Soil surfaces.



CONDUCTING METEOROLOGICAL MONITORING

The land meteorological network of Republic Kazakhstan includes 259 meteorological stations.



On structure meteorological stations are subdivided on:
- stations of the international exchange (65 MS);
- stations of a global network of supervision over a climate (16 MS);
- reference climatic stations (33 MS);
- stations of an interstate hydrometeorological network of commonwealth of the independent states (159 MS).

ACTINOMETRICAL OBSERVATION

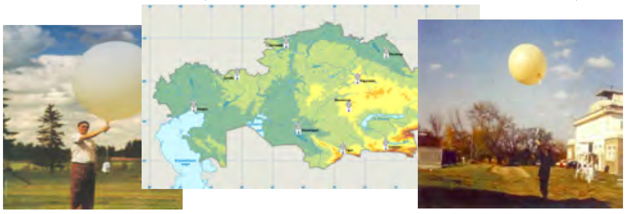
At 12 meteorological stations are spent actinometrical observation – observation over intensity of the straight line disseminated, total solar radiation, and also over effective radiation, radiating balance.

OZONOMETRICAL OBSERVATION

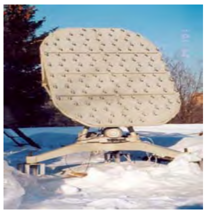
Observation over the general maintenance of ozone in atmosphere are spent at 5 stations – Almaty, Aral sea, Atyrau, Karaganda, Semipalatinsk.

Upper-air Observations

One of the major directions of activity of hydrometeorological service are the aerological observation intended for data acquisition about the basic meteorological sizes of atmosphere (temperature, pressure, relative humidity of air, a direction and speed of a wind) at standard and special levels to heights of 30-40 km. The aerological information from 8 stations is used for studying of atmospheric processes, weather forecasts, and also service of consumers.



RADAR MARL-A

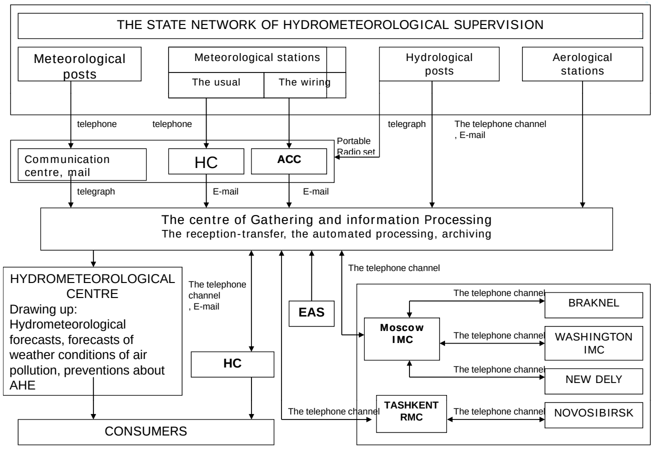


Microelectronic aerological radar (MARL-A)
It is intended for work as a part of small-sized system of network aerological sounding and carries out following functions:
Tracking angular co-ordinates and range of the radiosonde let out in free flight;
Reception of the telemetering information from a radiosonde about meteorological data of atmosphere (temperature, humidity) in a flight point;
Calculation of speed and wind direction;
Formation of standard meteorological telegrams.
Into structure MARL enter as actually radar equipment (in drawing - without radio transparent shelter), and the operating COMPUTER and the software of secondary processing of the information.

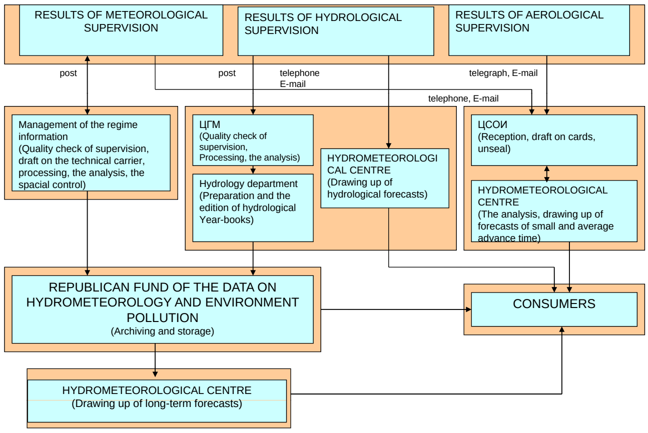
RADIOSOUNDING OF ATMOSPHERE AC-1

System "AC-1" (automatic centre) is intended for temperature-wind or wind radio sounding of atmosphere with automatic data processing and delivery of aerological telegrams.

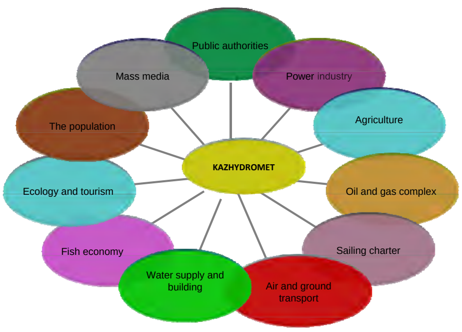
GATHERING-TRANSFER OF THE OPERATIVE HYDROMETEOROLOGICAL INFORMATION



GATHERING AND PROCESSING OF THE REGIME HYDROMETEOROLOGICAL INFORMATION



Consumers of the hydrometeorological information



Thanks for attention

Lao People's Democratic Republic

JMA/WMO Workshop on Quality Management in Surface, Climate and Upper-air Observations in RA II (Asia)	Doc. Japan
Tokyo, Japan 27-30 July 2010	(10.VII.2010)

Status of Meteorological Network, Observations and Data Management In Lao P D R

(by Singthong Pathoummady, Department of Meteorology and Hydrology)

Summary and Purpose of Document

This document aims to report on the meteorological network in Lao PDR and relating operational weather observation tasks. Data archiving and data quality is also discussed. As a matter of fact Laos started operational weather observation since the year 1950 in some large cities and was registered as a member of WMO in 1955. Unfortunately under the least developed country status, there has not been much improvement or development in the field of meteorology during the past decades. The establishment of meteorological stations has been slightly increased and extended in most of large cities in the last 10 years. All instruments are analogue and manual types as a result these furnished all manned stations. These existing deteriorated instruments have no means to get calibration due to lack of standard calibrating tools. This situation lead to poor data quality even though data are preliminary checked manually prior to be archived in forms of hard copies and digital recorded devices.

1. Observation networks

1.1 Surface observations

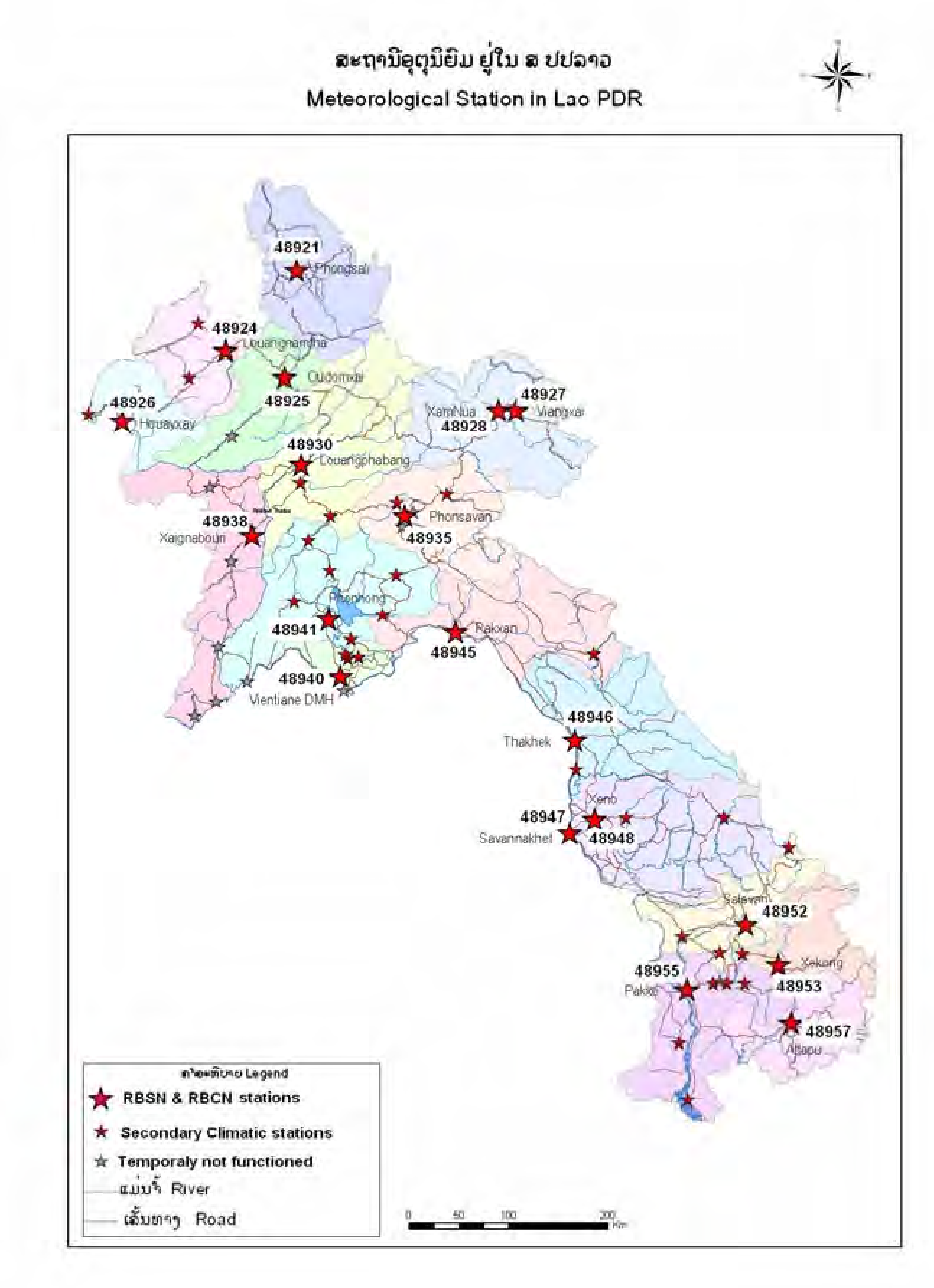
1.1.1 Number of stations: RBSN, RBCN, GSN, manned stations and AWS*

Table 1 Number of stations

	RBSN	RBCN	GSN	Manned stations	AWS *
number	**19**	**4**	**0**		**0**

Note: There are 29 secondary climatic stations which make a total of 48 stations, including 4 RBCN

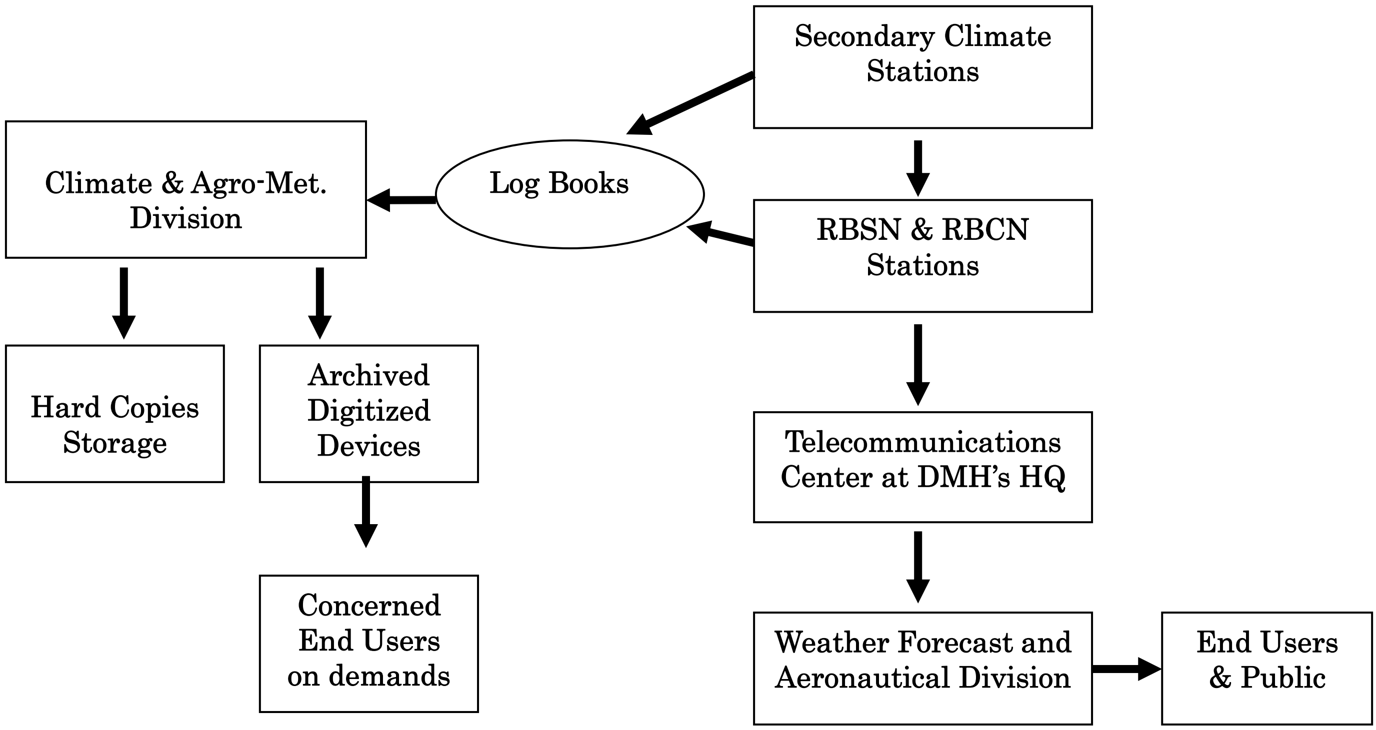
1.1.2 Station map



1.1.3 Time and frequency of observations

- 4 stations carried out 8 times observations namely : 48940 , 48947 , 48930 and 48955 at 00UTC, 03UTC, 06UTC , 09UTC, 12UTC,15UTC,18UTC ,and 21UTC
- Others make 4– 5 observations (day time only): 00UTC, 03UTC,06UTC,09UTC,12UTC

1.1.4 Data flow to users and archives



1.2 Upper-air observations

1.2.1 Number of stations: RBSN, RBCN, GUAN, manned stations and automated system stations

	RBSN	RBCN	GUAN	Manned stations	Automated system stations
number	0	0	0	0	0

1.2.2 Station map

1.2.3 Time and frequency of observations

1.2.4 Data flow to users and archives

Upper-air observation data flow to users and archives is expected to be described with an illustration.

2. Siting and metadata

List of meteorological stations : The highlighted blue stations are RBSN & RBCN

No.	WMO ID	Station name	District	Village	Latitude N	Longitude E	Altitude
1	**48940**	**Vientiane DMH**	Sikhottabong	Akat	17° 57′	102° 34′	171
2	48944	Thangone	Xaithani	Thangone	18° 17′	102° 38′	185
3		Veunkham	Xaithani	Chaleunsay	18° 11′	102° 37′	178
4	48942	Naphok	Xaithani	NAFRI	18° 09′	102° 44′	170
5	**48921**	**Phongsali**	Phongsali	Phongsali	21° 42′	102° 05′	1300
6	**48924**	**Louangnamtha**	LouangNamtha	LouangNamtha	21° 03′	101° 28′	557
7	48922	Meuang Sing	Sing	Siliheuang	21° 11′	101° 09′	643
8	48923	Viangphoukha	Viangphoukha	Phouka	20° 41′	101° 04′	671
9	**48925**	**Oudomxai**	Xai	Phoulay	20° 41′	102° 00′	648
10	**48926**	**Houayxay**	Houayxay	Airport	20° 16′	100° 24′	401
11	48929	Thonpheung	Thonpheung	Khoneluang	20° 19′	100° 09′	371
12	**48930**	**Louangphabang**	Louangphabang		19° 53′	102° 08′	560
13		XiangNgeum	Xiang-Ngeun	HouaiKhoat	19° 45′	102° 10′	304
14	48931	Phoukhoun	Phoukhoun	Phoukhoun	19° 26′	102° 26′	1317
15	**48928**	**XamNua**	Xam-Nua		20° 25′	104° 04′	1000
16	**48927**	**Viangxai**	Viangxai	Phonbeng	20° 25′	104° 14′	913
17	**48938**	**Xaignabouri**	Xaignabouli	Xaignabouri	19° 14′	101° 44′	292
18	**48935**	**Phonsavan**	Pek	Thonghaihin	19° 28′	103° 08′	1094
19	48936	Meuang Kham	Kham	Longpeeo	19° 39′	103° 34′	587
20	48932	Meuang Phoukout	Phoukout		19° 34′	103° 05′	1114
21	**48941**	**Phonhong**	Phonhong	Nalongkhoon	18° 28′	102° 24′	179
22	48943	Napheng	Thoulakhom	Thourakhom	18° 16′	102° 56′	172
23		Kasi	Kasi	Kasikhammueang	19° 24′	102° 29′	360
24	48939	Vangviang	Vangviang	Vangviang	18° 55′	102° 27′	298
25		Meuang Fuang	Fuang	Fuang	18° 39′	102° 26′	243
26	48934	Longxan	Hom	PhonhNgam	18° 32′	102° 57′	254
27	48933	Xaisomboun	Xaisomboun	Namcha	18° 59′	102° 56′	460
28	**48945**	**Pakxan**	Pakxan		18° 24′	103° 40′	155
29	48950	Lak 20	Khamkeut	Somsanouk	18° 11′	104° 51′	540
30	**48946**	**Thakhek**	Thakhek	Chompheth	17° 23′	104° 49′	151
31		Nongbok	Nongbok	Song Muang Tai	17° 09′	104° 49′	147
32	**48947**	**Savannakhet**	Kaysone Phonmvihane	Xai Oudom	16° 33′	104° 45′	144
33	**48948**	**Xeno**	Outhoumphon	Outhomphon	16° 40′	105° 00′	185
34		Donghen	Atsaphangthong	Donghen	16° 42′	105° 16′	158
35	48949	Xepon	Xepon	Xepon	16° 43′	106° 12′	170
36	**48952**	**Salavan**	Salavan	Laksong	15° 41′	106° 26′	168
37	48951	Khongxedon	Khongxedon	Khong	15° 36′	105° 48′	156
38		Laongam	Lao-Ngam	Laoneam	15° 28′	106° 10′	540
39		Samouay	Samouay	Samouay	16° 25′	106° 49′	400
40	**48953**	**Xekong**	Lamam	Phiamai	15° 20′	106° 41′	143
41	48954	Thateng	Thateng	Thateng	15° 27′	106° 22′	816
42	**48955**	**Pakxe**	Pakxe	Pakxe	15° 07′	105° 47′	104
43	48956	Pakxong	Pakxong	Pakxong	15° 14′	106° 20′	1200
44		Nikhom 34	Pakxong	Houei Vai	15° 10′	106° 24′	1120
45		Itou	Pakxong	Itou Lak35	15° 10′	106° 35′	890
46	48958	Soukhouma	Soukhouma	Soukhouma	14° 39′	105° 47′	90
47	48959	Meuang Khong	Khong		14° 07′	105° 50′	76
48	**48957**	**Attapu**	Samakkhixai		14° 48′	106° 50′	103

Metadata = Most of parameters are daily mean, monthly and yearly mean, extreme Absolute (Max, Min) , Average, Normal

3. Instruments, sensors, upgrade, maintenance, instrument intercomparisons and traceability

All existing instruments are analogue system. All stations are manned stations. Installation, checking of status and maintenance by DMH HQ's staff. No calibration nor intercomparisons were conducted. Recent improvement of six synoptic stations by JICA TCP.

4. Quality assurance / quality control (real-time, non-real time)

1). Quality Assurance : DMH does not have QA system (mechanism). Data are manually keyed into message switching PC, then send in to GTS RTH Bangkok. Simply the operators are taking care of possible errors or mistakes.

2). Quality Control : This is primary manually checked for possible man made mistakes basing on staff experiences , then staff key in to CLICOM software format. For hydrological data , the HYMOS software is used

5. Training

DMH conducted its in-house Training Course on surface observation, but only technician operational Observer level. The trainees have to completed High School or year 12. This is not a regular training to be opened every year, but depending on needs of new staff and availability of fundings.

6. Statistics and applications

Statistics .are utilized for climate analysis, to serve for agricultural purposes, disaster risk analysis, as well as for requested projects

7. Current issues and future plan

DMH has set up its implementation plan for data management improvement firstly by the TCP , support by JICA experts for technology transfer and the WMO-World Bank-UNISDR Project to support Southeast Asia member countries. Secondly under the capacity building framework alongside with the implementation of Mekong-Integrated Water Resources Management Programme (M-IWRMP). Within the strategic plan 2011 – 2015, DMH has to take part in providing data over projected basins with data quality assured and controlled. This will be achieved by technical Assistance of International Experts and financial support by potential donors including Japan. Thirdly DMH will participate the activities of MRCS, especially the capacity building on Hydro-Met Data Quality assurance and Quality Control under the Information and Knowledge Management Programme (IKMP) and the HYCOS project.

Mongolia

JMA/WMO Workshop on Quality Management in Surface, Climate and Upper-air Observations in RA II (Asia)

Tokyo, Japan
27-30 July 2010

Doc.
Japan

(10.VII.2010)

Observation network of Mongolia

(Submitted by Norov BATTUR,
National Agency for Meteorology and Environment Monitoring of Mongolia)

Summary and Purpose of Document

This document contains an overview of the surface observations in Mongolia, with respect to instruments, training.

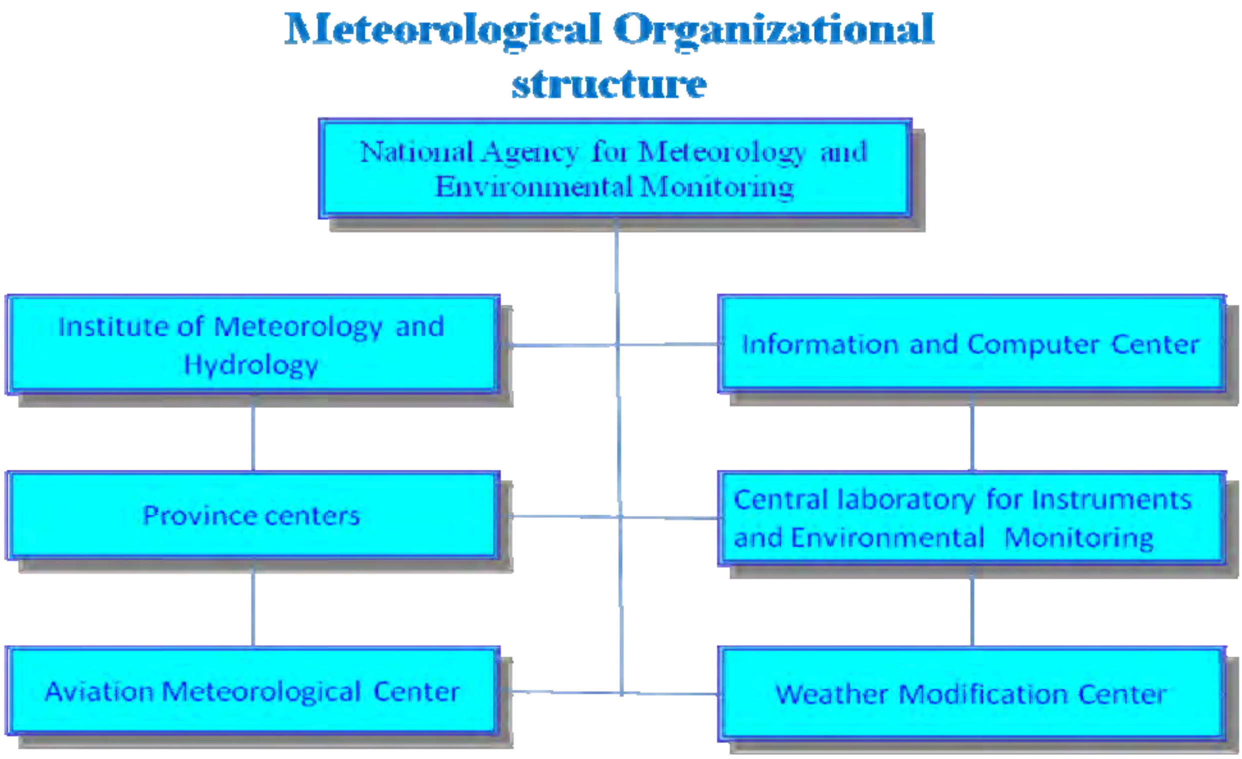
Observation network of Mongolia

Battur. N / MONGOLIA /

Meteorological and Hydrological Services of Mongolia are functioning officially since 1936 when the first meteorological observation stations were established in the country. But several meteorological observations stations operated since 1986 in capital city in Ulaanbaatar, and some other administrative centers of Mongolia.
Mongolia has joined to the World Meteorological Organization in 1963.

The National Agency for Meteorology and Environment Monitoring /NAMEM/, is the government's implementing agency.

The agency provides information of weather forecasting, hydro-meteorology and environmental changes to governmental and private organizations, coordinates all hydro-meteorological observation networks of Mongolia.



Currently there are 130 meteorological stations, 186 meteorological posts, 3 upper-air stations in observation network of NAMEM.

Figure.1. Location of meteorological stations

The observed variables in all meteorological stations: Air temperature, surface soil temperature, atmospheric pressure, humidity, velocity and direction of wind, precipitation /amount and intensity/, cloud amount and type, visibility, weather /present and past/, snow depth and density.

In addition to these variables mentioned above, some meteorological stations observe solar radiation, sunshine duration, deep soil temperature, soil moisture, evaporation.

There are 70 manned stations in meteorological observation network. We supply instruments to all observation stations and purchase mostly observation instruments from Russian and China.

Our Agency is intending to install automatic meteorological station at all observation stations, but we have difficulty is financial problems. Therefore, this plan greatly depends on Mongolian economics and finance.

Present, about 60 automatic meteorological stations operated since 2000 in our meteorological observation network, 30 of the stations have been set up in 2008. Types of automatic meteorological stations in our observation network: MAWS301, SK4100, CAMS630, QLI50.

Table 1. number of stations

	RBSN	RBCN	GSN	Manned stations	AWS
1	130	130	-	70	60

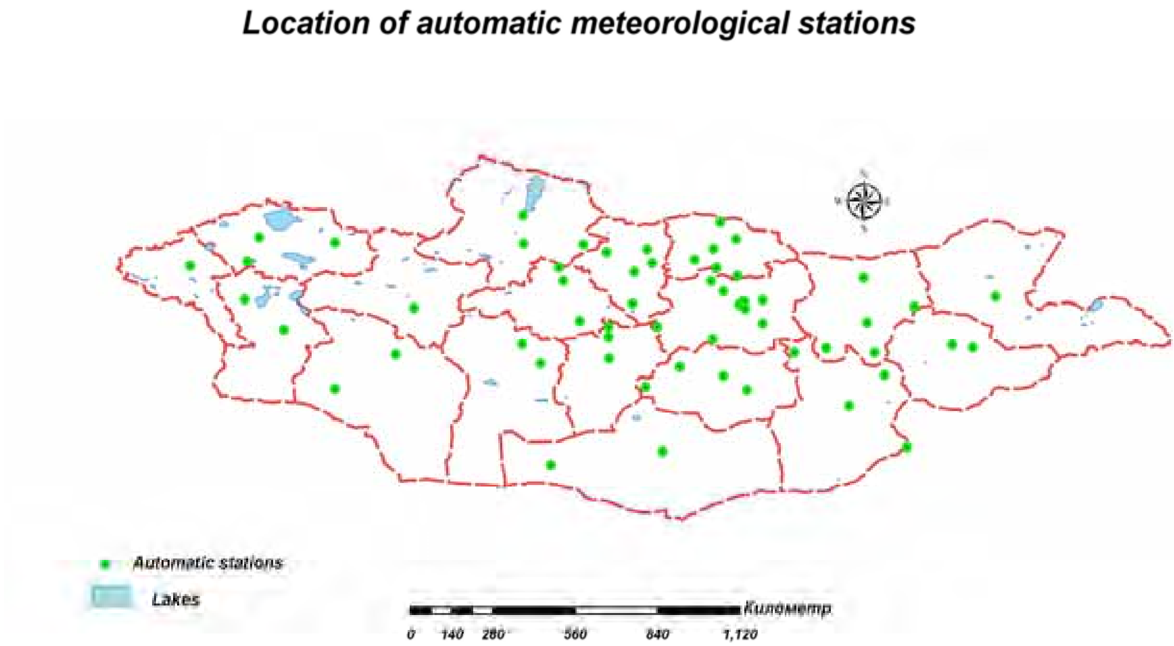


Figure.2. Location of automatic meteorological stations

All meteorological stations are making synoptic and climate observations 8 times per day. Local meteorologists and technicians use mobile, internet, VSAT to transfer observation data.

National Meteorological Telecommunication Network has two GTS lines with WMO Regional Meteorological Centers in Novosibirsk, Russia and Beijing, China and twenty local lines with local centers through VSAT.

Above given, there are a lot of manned station in meteorological observation network since it's necessary to check observation data. Therefore, Local meteorologists check first observation data in province meteorological center.

Climate section in the Institute of the Hydrology and Meteorology make last control of observation data along specific instruction and transfer checked data to center of data base.

It's different series of observation data in ever station and have over 70 years observation data in the oldest stations . All observation data are stored in data base center of NAMEM.

About training

NAMEM is responsible for training activities for meteorologists and technicians of observation network. We organize special trainings for different fields such as meteorology, agro-meteorology, hydrology and environmental monitoring. The used types of training: lecture, discussion, practice, e-learning.

Figure.3. Lecture rooms of the Training center.

Some observers of the observation network are not graduated from special college for this observation. So every year we organize short training / 1 month/ course for them and they obtained a certificate. Also last few years we have installed several types of automatic meteorological stations. So we need specialized technicians and engineers.

In the future we would like to extend our training activities to cooperate other international and regional training centers. It will be very important to improve their skills and knowledge for our meteorologists and engineers.

There is a need to improve meteorological observation networks of the country. Our main goal is:

- improve skills of meteorologists and technicians
- Improve quality of observational data.
- Improve quality technologies and techniques.

JMA/WMO Workshop on Quality Management in Surface, Climate and Upper-air Observations in RA II (Asia)

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(10.VII.2010)

Perspective of Department of Hydrology and Meteorology (DHM) in Nepal

(Submitted by Rajendra P. Shrestha, Meteorological Forecasting Division)

Summary and Purpose of Document

Department of Hydrology and Meteorology has a mandate from Government of Nepal to monitor all the hydrological and meteorological activities in Nepal. The scope of work includes the monitoring of river hydrology, climate, agrometeorology, sediment, air quality, water quality, limnology, snow hydrology, glaciology, and wind and solar energy. General and aviation weather forecasts are the regular services provided by DHM. DHM is also look network of all type of observation station. As a member of the World Meteorological Organization (WMO), DHM contributes to the global exchange of meteorological data on a regular basis.

Introduction

Government of Nepal started hydrological and meteorological activities in an organized way in 1962. The activities were initiated as a section under the Department of Electricity. The section was subsequently transferred to the Department of Irrigation and was ultimately upgraded to Department status in 1988.

The Department of Hydrology and Meteorology (DHM) is an organization under the Ministry of Environment, Government of Nepal. The department with headquarters in Kathmandu has three basin offices: Karnali Basin Office in Surkhet, Narayani Basin Office in Pokhara and Kosi Basin Office in Dharan.

DHM actively participates in the programs of relevant international organizations, such as, the UNESCO's International Hydrological Program (IHP) and WMO's Operational Hydrology Program (OHP). In the past, DHM has hosted several regional and international workshops, symposia, seminars and meetings on different aspects of meteorology, hydrology, sediment, and snow hydrology. The department is also a focal point for the Intergovernmental Panel on Climate Change (IPCC) and for the meteorological activities of the South Asian Association for Regional Co-operation (SAARC). The International Civil Aviation Organization (ICAO) has recognized DHM as an authority to provide meteorological services for international flights.

The Principal Activities of DHM

Collect and disseminate hydrological and meteorological information for water resources, agriculture, energy, and other development activities.
Collect and disseminate hydrological and meteorological information for water resources, agriculture, energy, and other development activities.
Issue hydrological and meteorological forecasts for public, mountaineering expedition, civil aviation, and for the mitigation of natural disasters.
Conduct special studies required for the policy makers and for the development of hydrological and meteorological sciences in the region.
Promote relationship with national and international organizations in the field of hydrology and meteorology.

Organizational Setup

The Director General heads DHM. The present Organizational Chart has four divisions headed by Deputy Director Generals: Hydrology Division, Climatology Division, Meteorological Forecasting Division and Co-ordination Division.

Hydrology Division has four major sections: River Hydrology Section, Flood Forecasting Section, Snow and Glacier Hydrology Section and Sediment and Water Quality Section. Similarly, the sections under the Climatology Division include: Climatology Section, Agrometeorology Section, and Wind and Solar Energy Section & Data Section.

The Meteorological Forecasting Division has three main units: the Communication Unit, Aviation Unit, and General Weather Forecast Unit.

Co-ordination Division is primarily responsible for developing policies and co-coordinating all the departmental activities including financial and administrative matters. Along with the three basin offices, the Co-ordination Division provides support to the following sections: Data Management Section, Planning Section, Instrument Section, and Training Section.

Hydrology Division

Hydrology division is responsible for collecting hydrological (river, lake, flood, snow and glacier) data, studying and analyzing them, publishing analyzed data and report, and run and manage hydrological project across the country. There are different sections under Hydrology division. They are

River Hydrology Section This section is responsible for following activities:

Nation wide study and analyze water level and discharge of different rivers and lakes.
Hydrological data collected from the basin offices is processed, corrected and validated.
Management and supervision of current meter calibration.
Publication of hydrological data.
Providing guidelines for abovementioned jobs.
Snow and Glacier Hydrology Section
Responsible for monitoring snow and Glacier Lake, river etc. of High- Mountain by establishing monitoring stations.
Publication of collected and analyzed snow and snow hydrology related data.
Estimation of snowmelt from high mountain region.
Providing guidelines for abovementioned jobs.
Sediment and Water Quality Section
Responsible for monitoring sediment in different rivers.
Regular monitoring of existing sediment stations and analyzes the data collected from them.
Publication of collected and analyzed sediment data.
Providing guidelines for abovementioned jobs.
Flood Forecasting Section
Collection and processing of rainfall, water level and discharge data from different flood station during flood season from radio set.
Preparation of forecasting models from analyzing the abovementioned data.
River water level will be forecasted according to these models.
Establish different flood stations and manage them.
Preparing guidelines for flood forecasting and running models.

Climatology Division

Meteorology division is responsible for collecting meteorological (rainfall, lake, flood, snow and glacier) data, studying and analyzing them, publishing analyzed data and report, and run and manage hydrological project across the country.

Climatology Section

According to geographical Different aspects of agriculture, water resource, environment change etc.
Study and investigation about climate change.
Collection and publication of air pollution data.
Preparation of climatic atlas of Nepal.Agromet Section
Preparation of crop calendar of different weather to help agriculture. Wind and Solar Energy Section
Technical and Human Resources

DHM maintains nation-wide networks of 337 precipitation stations, 154 hydrometric stations, 20 sediment stations, 68 climatic stations, 22 agrometeorological stations, 9 synoptic stations and 6 Aero-synoptic stations. Data are made available to users through published reports, bulletins, and computer media outputs such as hard copies or diskettes. DHM publishes data on an annual basis. Most of the sections under DHM are equipped with personal computer systems connected through a network. The computers are not only used for database management but also for hydrological and meteorological modelling and analyses. Hydrological and meteorological studies are produced as reports every year. Recent publications include the reports on low flow analyses, flood risk assessment and integrated database developments.

DHM is equipped with several data collection facilities based on different technologies, such as, wireless communication, meteor burst, radiosonde, Satellite Distribution Information System (SADIS), Weather Fax, and satellite picture receiving system. Wireless system connects Kathmandu to 54 stations spread over Nepal for climatic and hydrological data whereas the Global Telecommunication System (GTS) links DHM to the global meteorological community. DHM employs a staff of 238 personnel. Eighty-four staff are employed at field offices, 48 at basin offices, and 130 at the headquarters. Sixty professional staff and 143 technicians serving the department are supported by 34 administrative staff.

Objective

Collect and disseminate hydrological and meteorological information for water resources, agriculture, energy, and other development activities.

Issue hydrological and meteorological forecasts for public, mountaineering expedition, civil aviation, and for the mitigation of natural disasters.
Conduct special studies required for the policy makers and for the development of hydrological and meteorological sciences in the region.
Promote relationship with national and international organizations in the field of hydrology and meteorology.
Function

The Department of Hydrology and Meteorology (DHM) is a central governing organization under the Ministry of Environment, Science and Technology. The major functions of the department are as follows:

Collect and disseminate hydrological and meteorological information for water resources, agriculture, energy and other development activities.
Issue hydrological and meteorological forecasts for public, mountaineering expedition, civil aviation and for the mitigation of natural disasters.
Conduct special studies required for the policy makers and for the development of hydrological and meteorological sciences in the region.
Promote relationship with national and international organizations in the field of hydrology and meteorology.
International Relation

DHM actively participates in the programs of relevant international organizations, such as, the UNESCO's International Hydrological Program (IHP) and WMO's Operational Hydrology Program (OHP). In the past, DHM has hosted several regional and international workshops, symposia, seminars and meetings on different aspects of meteorology, hydrology, sediment, and snow hydrology. The department is also a focal point for the Intergovernmental Panel on Climate Change (IPCC) and for the meteorological activities of the South Asian Association for Regional Co-operation (SAARC). The International Civil Aviation Organization (ICAO) has recognized DHM as an authority to provide meteorological services for international flights.

Observation network

Surface Observation

Number of station: RBSN, RBCN, GSN, manned station and AWS

	RBSN	RBCN	GSN	Manned Station	AWS
Number	15	68	2	83	15

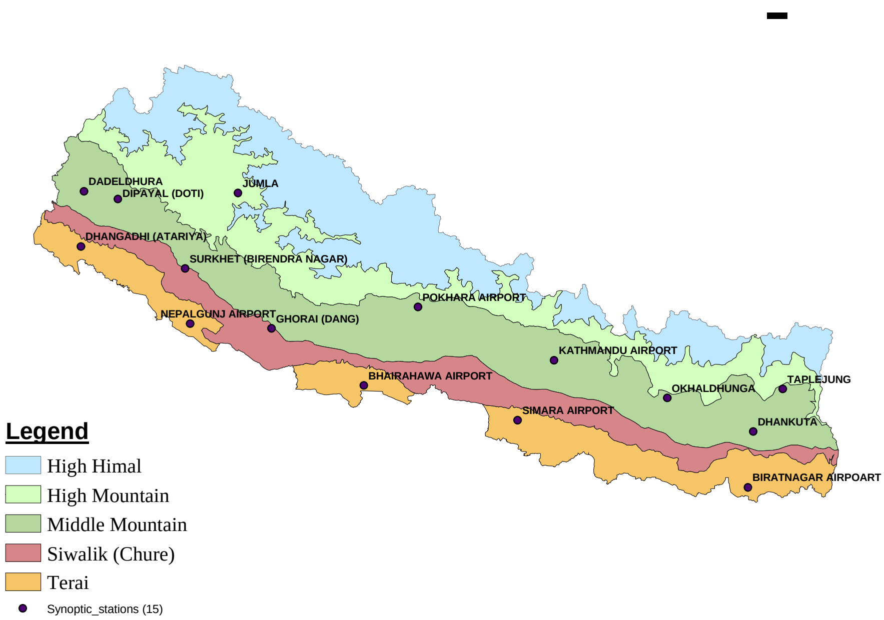

Fig: 1 Synoptic Station

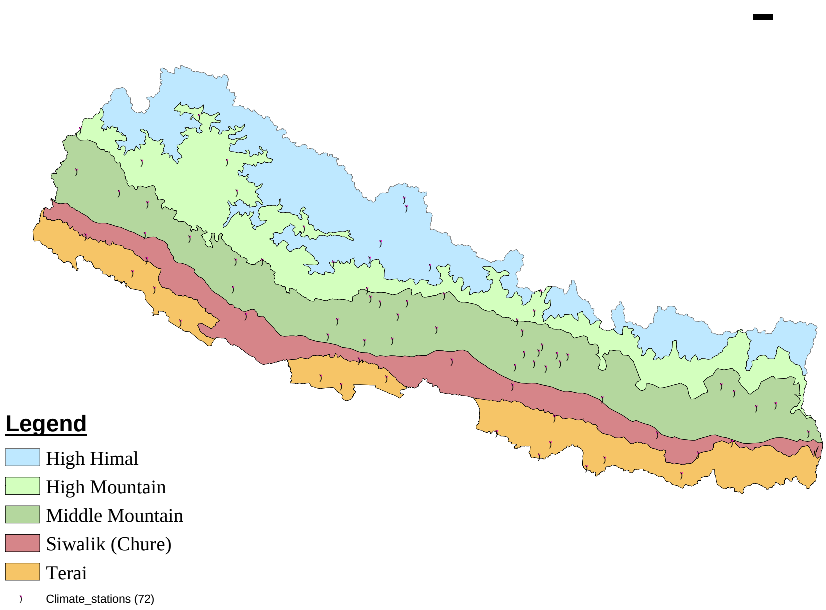

Fig: 2 Climatological Stations

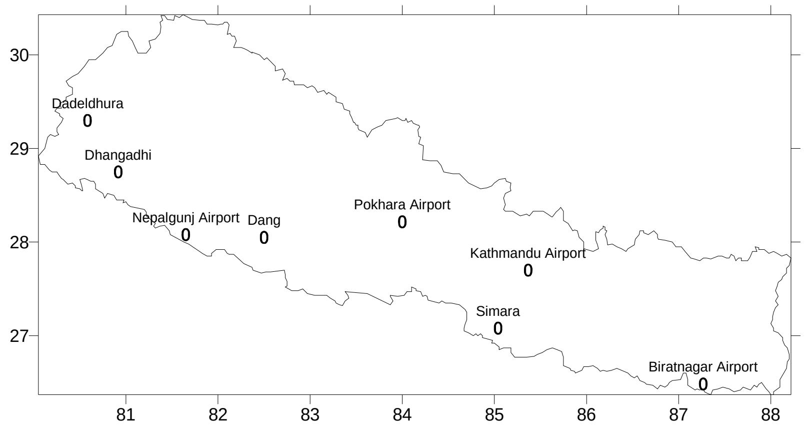

Fig: 3 Existing AWS Station

Time and Frequency of Observations

Synoptic observations at Kathmandu (capital) are made 8 times per day and 5 times per day in the rest of the stations. All observations are taken in WMO Standard time.

Data flow to users and archives

All synoptic observation data are transmitted to Meteorological Forecasting Division via Code Division Multiple access (CDMA) as well as HF Transceiver system (SSB) (Conventional) to analyze and weather forecasting. Data receiving from all stations are archived electronically and hard copy too. Necessary data are given for users on request. Temperature and rainfall data has also been posted in website.

Siting and Meta data:

Location of stations (Latitude, Longitude and Altitude) is routinely checked every year.

Instruments, Sensors, upgrade, maintenance instruments intercomparison and traceability:

Regular inspection of observing stations and maintenance of instruments are conducting, Apart from this, when problems are reported then maintenance would be conducted.

Quality assurance/quality control:

All data are checked for logical and statistical error at data processing centre as well as in real time.

Training:

There is no routinely training program although refreshing courses and training classes for new comers are conducted if necessary. During last five years we have conducted two training classes.

Future Plan:

- Installation of AWS in all synoptic stations during this year 2010 under SAARC_STORM project.
- One Doppler Weather Radar probably next year
- Two GPS Sonde Stations

- 16 telemetry rainfall stations will be installed in model basin.

Proposed Automatic weather station for storm project

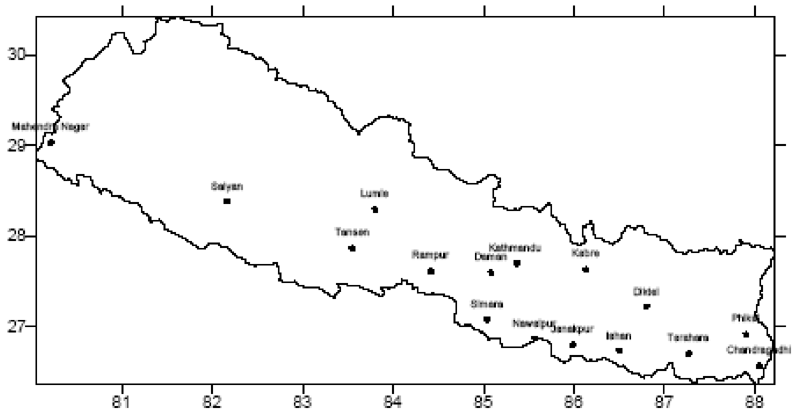

Fig. 1: Proposed locations of the AWS to be installed in Nepal under the SAARC STORM Programme.

Fig: 3

Proposed locations for the installation of AWS Network

S.N.	Name of station	Latitude	Longitude	Elevation (m)
1	Chandragadhi	26.57	88.05	120
2	Phikal	26.92	87.90	
3	Tarahara	26.70	87.27	
4	Diktel	27.22	86.80	
5	lahan	26.73	86.50	138
6	Janakpur	26.80	85.98	93
7	Kabre	27.63	86.13	1755
8	Nawalpur	26.87	85.57	
9	Kathmandu	27.70	85.37	1320
10	Daman	27.60	85.08	2314
11	Simara	27.08	85.04	
12	Rampur	27.62	84.42	256
13	Lumle	28.30	83.80	1652
14	Tansen	27.87	83.55	1067
15	Salyan	28.38	82.17	1457
16	Mahendra Nagar	29.03	80.22	

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SURFACE, CLIMATE AND UPPERAIR OBSERVATIONS SYSTEN IN PAKISTAN

(submitted by MUHAMMAD TOUSEEF ALAM, Pakistan Meteorological Department)

Summary and Purpose of Document

The purpose of this document to illustrate the existing surface and upper air observational network of Pakistan Meteorological Department. It also explains the type of observing station and timing of the observation. A brief about techniques and procedures being adopted for the QC applied at different levels, at the observing station,in the data processing centre, communication centre, data archive/dissemination centre has been given. Meteorological and observational training being imparted has also been included.

COUNTRY REPORT

ON

SURFACE, CLIMATE AND UPPER-AIR OBSERVATIONS SYSTEN IN PAKISTAN

BY

MUHAMMAD TOUSEEF ALAM
Pakistan Meteorological Department

JMA/WMO WORKSHOP ON QUALITY MANAGEMENT IN SURFACE, CLIMATE AND UPPER-AIR OBSERVATIONS IN RA II (ASIA)

Tokyo, Japan
27-30 July 2010

Summary and Purpose of Document

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1. Observation networks

1.1 Surface observations

1.1.1 Number of stations: RBSN, RBCN, GSN, manned stations and AWS*

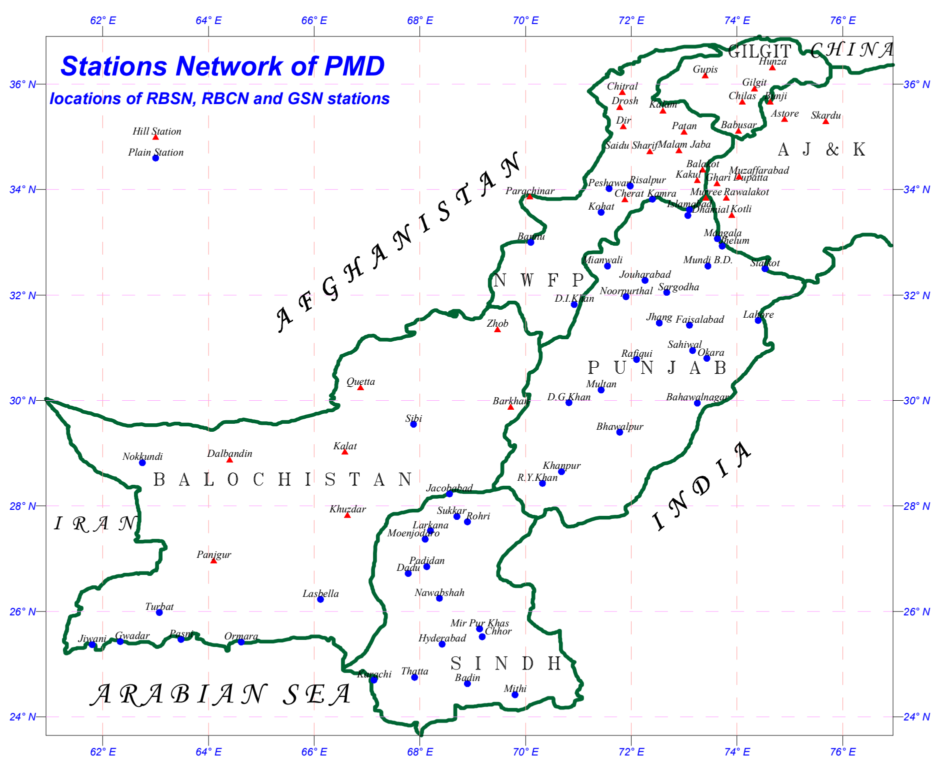
Table 1 Number of stations

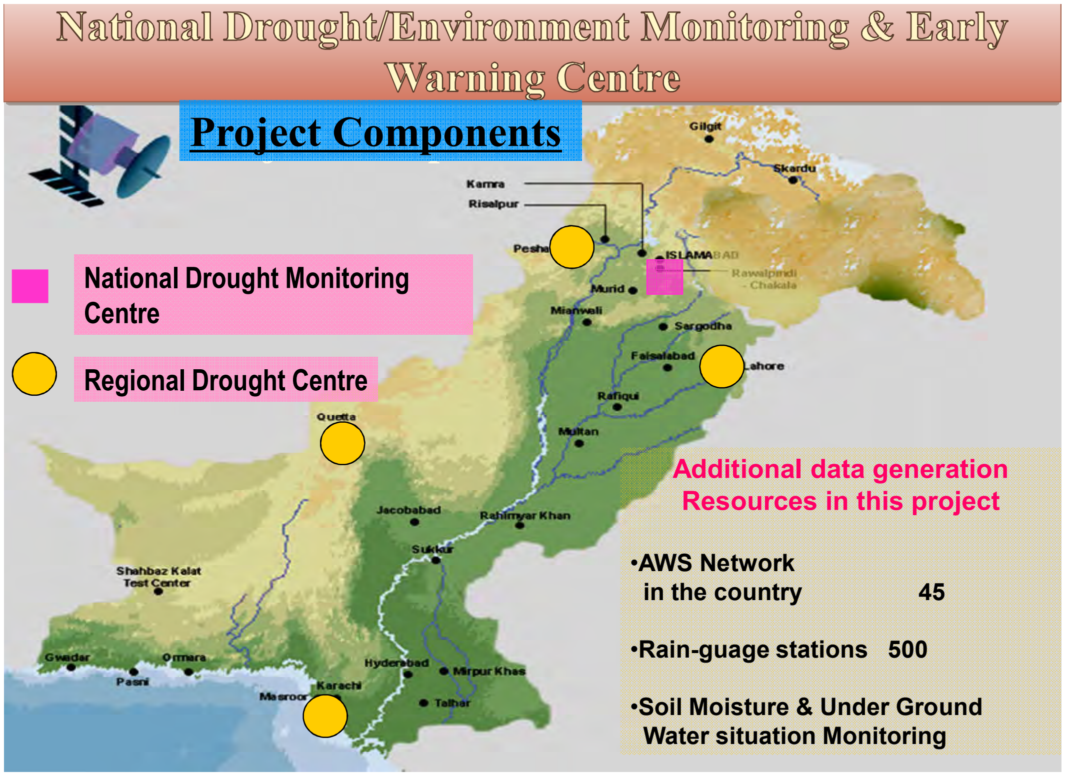
	RBSN	RBCN	GSN	Manned stations	AWS *
number	92	55	6	-	50

* An automatic weather station (AWS) is defined as a "meteorological station at which observations are made and transmitted automatically".

1.1.2 Station map

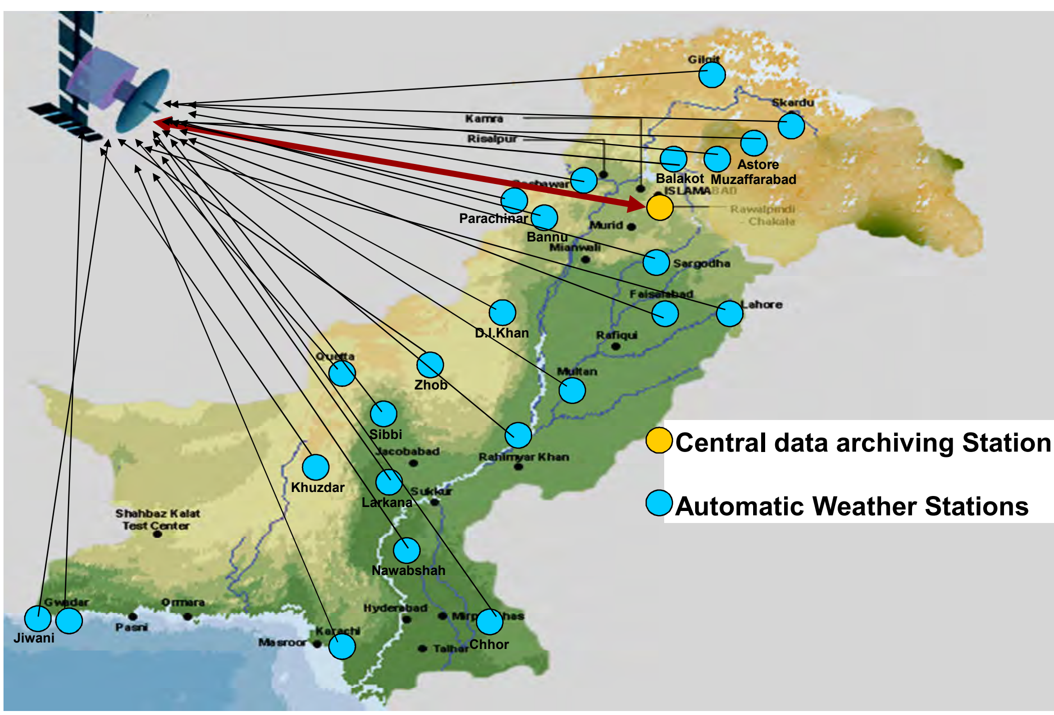
Map showing locations of the PMD RBSN, RBCN and GSN stations



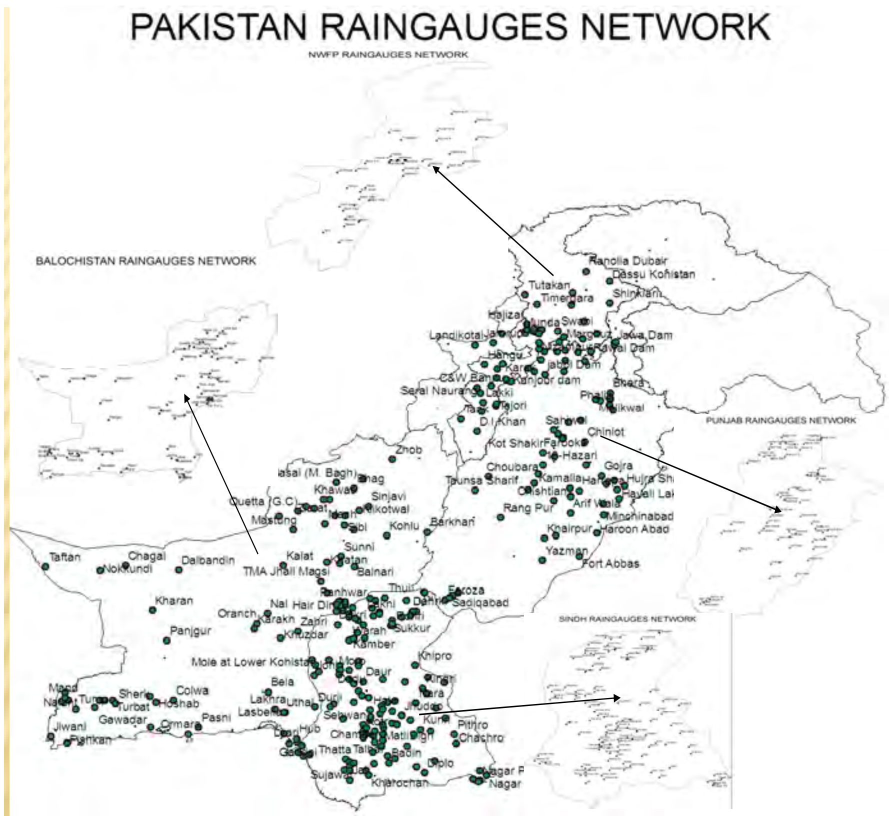


Map showing locations of PMD AWS

Automation of Meteorological Observing Network



Map showing locations of PMD Rain gauges (500) Network



1.1.3 Time and frequency of observations

00 UTC	03 UTC	06 UTC	09 UTC
12 UTC	15 UTC	18 UTC	21 UTC

1.1.4 Data flow to users and archives

Surface observation data flow to users and archives is expected to be described with an illustration.

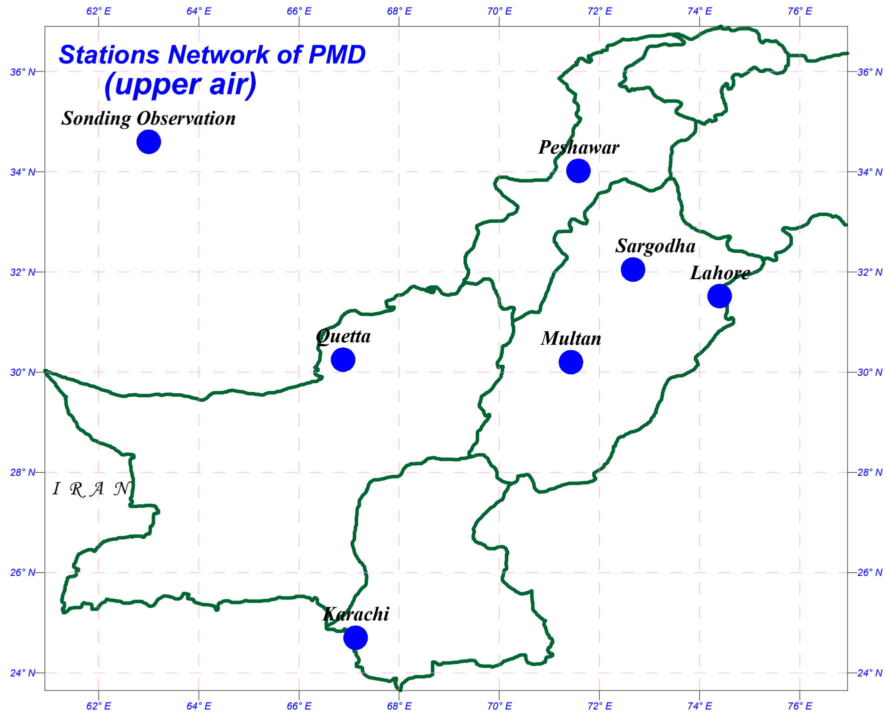
1.2 Upper-air observations

1.2.1 Number of stations: RBSN, RBCN, GUAN, manned stations and automated system stations

	RBSN	RBCN	GUAN	Manned stations	Automated system stations
number	6	3	0	-	-

1.2.2 Station map

A map showing locations of the RBSN, RBCN and GUAN stations for upper-air observations are expected.



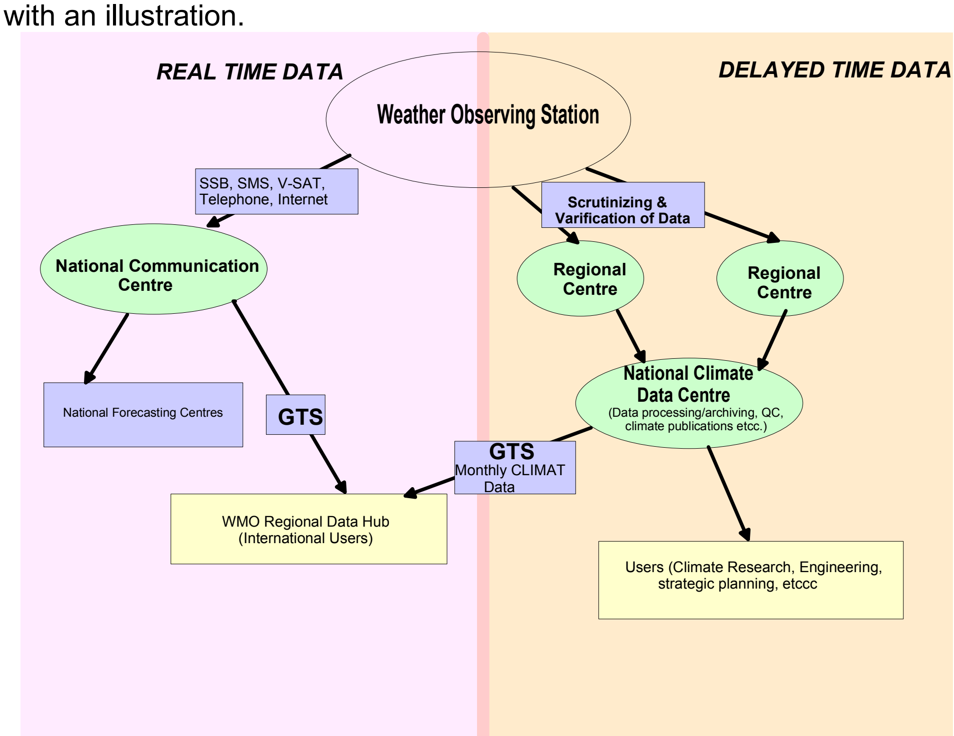
1.2.3 Time and frequency of observations

One (1) time per day:

00 UTC

1.2.4 Data flow to users and archives

Upper-air observation data flow to users and archives is expected to be described with an illustration.



2 Siting and metadata

Example of metadata:

STATION NAME	KARACHI (AIRPORT)
WMO NO	41780
ICAO ID	OPKC
ESTABLISHED	1928
LATITUDE	24° 54' N
LONGITUDE	67° 08' E
HEIGHT OF BAROMETER CISTERN AMSL	0073 ft (0022 m)
HEIGHT OF STEVENSON SCREEN AMSL/AG	0069 ft (0021 m) , 1.2 m
HEIGHT OF ANEMOMETER ABOVE GROUND	0023 ft (0007 m)
ELEVATION	21 m
TYPE OF STATION	HILLY/PLAIN

3 Instruments, sensors, upgrade, maintenance, instrument intercomparisons and traceability

Due to financial constants often problems arises in terms of instruments/sensors , up gradation or replacement. Repair, maintenance intercomparisons of instruments and sensor are being carried out by trained PMD personnel at stations or at regional centers.

4 Quality assurance / quality control (real-time, non-real time)

At the observing station, officer in-charge compares and checks the data thoroughly before dissemination to National Meteorological Communication Centre. Moreover, this data is further scrutinized at Data Processing Centre, If respective Director of Regional Center feels any fault occurred in the equipment(s) then they send inspector to find out the cause of error(s) in the equipment(s) and inspector removes the defect(s) on the spot (if any)

QC result generally communicated via various means of communication(s) Viz, phone, fax, email, SSB, VSAT etc. Fault/error may be rectified by verbal instruction to the officer in-charge of the observatory, otherwise inspector of the respective RC visited the observatory and he takes the remedial and necessary action

5 Training

Pakistan Meteorological Department (P.M.D) offers professional training courses in various branches of Meteorology, Geophysics and allied sciences at the Institute of Meteorology and Geophysics (I.M.G), Karachi. The courses are of various levels and are designed for the new comer to meteorology as well as for those who have acquired sufficient experience in the field and require higher training. The syllabi of courses provided at the Institute have been prepared mainly according to the pattern recommended by the **World Meteorological Organization (W.M.O.)**. The courses aim to provide both theoretical and practical background to a student and to equip him fully for the job one is to take up after completion of the training. Lectures by specialists are also arranged from time to time. Revision of necessary topics in Physics and Mathematics is included in the regular courses. The Institute has its own library and a good collection of textbooks are available for the benefit of the students. New books and publications are added from time to time. The Institute also has well equipped computer laboratory.

6 Statistics and applications

Description of statistics and application for surface and upper-air observations:

- Aeronautical Forecast and Warning services for Aviation.
- Flood Forecast and Warning Service.
- Farmer's Weather Bulletins and Warning Services
- Public Utility and Advisory Services in various fields of :
  - Planning and Development
  - Town Planning
  - Construction: Road, Bridges, Aerodrome, Power Plant, Air-conditioning etc.
  - Provision of Meteorological/Geophysical data for Court cases, Insurance Claims, Enquiry Reports, and District Gazetteers etc.
- Marine Met. Forecast and Warning Services.
- Air Pollution Monitoring services.
- Research activities in the following disciplines:
  - Meteorology
  - Climatology
  - Hydrology
  - Oceanography
  - Atmospheric Physics
  - Environmental Pollution
  - Geophysics
  - Agricultural Meteorology

7 Current issues and future plan

- Expansion of more data observing network
- Up gradation of existing observing stations.
- Installation of more AWS
- Increase in the more observational hours (24 observations per day)

Republic of Korea

JMA/WMO Workshop on Quality Management in Surface, Climate and Upper-air Observations in RA II (Asia)	Doc. Country
Tokyo, Japan 27-30 July 2010	(.VII.2010)

Planning and Situation of the Meteorological Observation in The Republic of Korea

(Hyuk Je Lee, Korean Meteorological Administration)

Summary and Purpose of Document

The Korea Meteorological Administration (KMA) has an extremely dense network of the surface and upper-air observation. This high density has been dictated by Korea's complex topographic and meteorological gradients. The KMA has devoted substantial efforts to the standardization of meteorological observation. However, there are actually some issues for improving the observational ability and the data quality. This report will describe briefly the planning and situation of the surface and upper-air observation in Korea.

---

1. Observation networks

1.1 Surface observations

1.1.1 Number of stations: RBSN, RBCN, GSN, manned stations and AWS*

Table 1 Number of stations

	RBSN	RBCN	GSN	Manned stations	AWS *
number	41	11	3	86	483

* An automatic weather station (AWS) is defined as a “meteorological station at which observations are made and transmitted automatically”.

1.1.2 Station map

A map showing locations of the RBSN, RBCN and GSN stations.

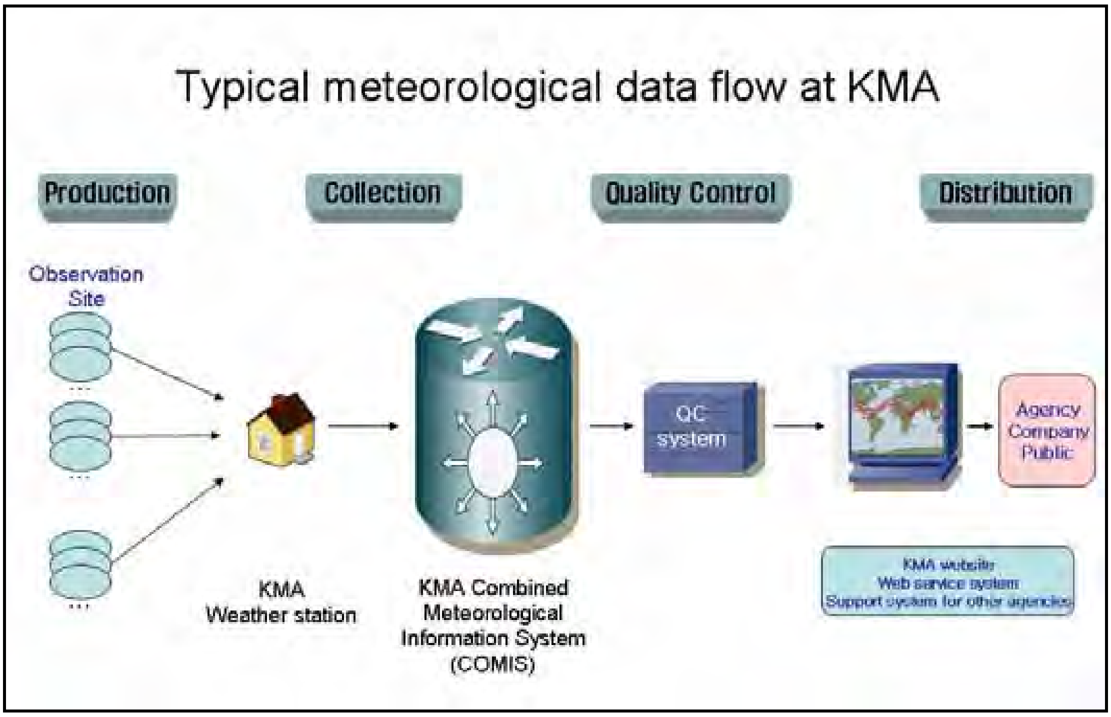
A map showing locations of the manned stations and AWSs.

1.1.3 Time and frequency of observations

The time and frequency of surface observations is made 24 times per day on the hour, and surface observation data is reported to Global Telecommunication System (GTS) 8 times per day. The frequency of the AWS observation is 1 minute.

1.1.4 Data flow to users and archives

The automatic observation data is transferred to the KMA weather stations. All data (auto + manual) are collected to the integrated data system named COMIS (Combined Meteorological Information System) at the KMA headquarters. The KMA's Real-time Quality control system for Meteorological Observation Data (RQMOD) would process the data for improving the data quality in real time, and then the data is published and recorded.



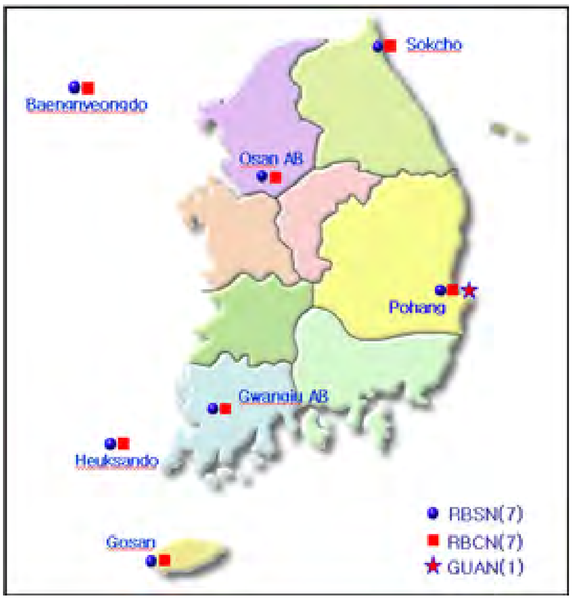
1.2 Upper-air observations

1.2.1 Number of stations: RBSN, RBCN, GUAN, manned stations and automated system stations

	RBSN	RBCN	GUAN	Manned stations	Automated system stations
number	7	7	1	7	0

1.2.2 Station map

A map showing locations of the RBSN, RBCN and GUAN stations for upper-air observations

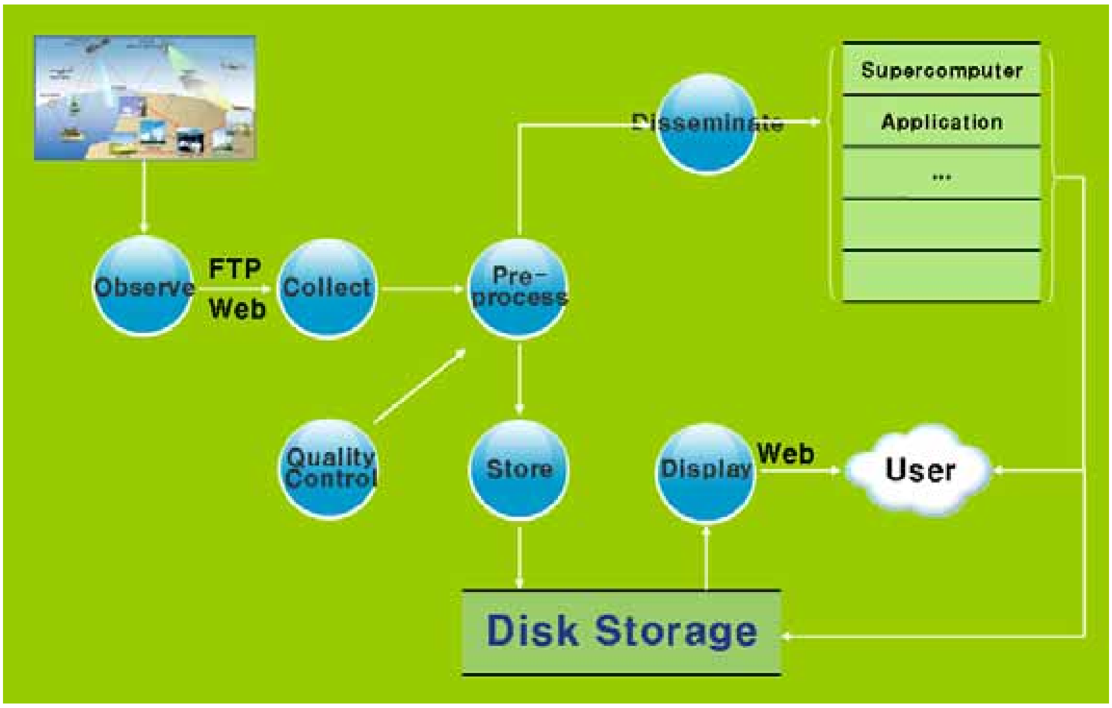


1.2.3 Time and frequency of observations

The time and frequency of upper-air observations is made twice per day at 0000 UTC and 1200UTC, and upper-air observation data is reported to the GTS twice per day at the same time.

1.2.4 Data flow to users and archives

The upper-air observation is performed at the KMA weather stations. The data of upper-air observation is transferred to the COMIS at the KMA headquarters. And then Quality Control (QC) must be applied to the data through the RQMOD. Finally, the data is stored and provided for users.



2. Siting and metadata

Siting of the synoptic observational stations that the KMA has been operating follows the standards of WMO (WMO-NO. 8). As for AWSs, however, they need some efforts to meet the requirements. In the urban areas, some of AWSs are located on rooftops.

The KMA has operated the metadata system (National Meteorological Observation Environment Information System) since 2005. It tracks close to 100 fields for each observational station including AWS. These include latitudes, longitudes, contact information, climatological extremes, observation equipment, sensor serial numbers, site and observational history, surroundings and panoramic photographs, etc. The metadata system also tracks dates of sensor installations and calibrations. It allows the generation of statistics and dynamic maps via various queries.

The KMA's National Meteorological Observation Environment Information System

3. Instruments, sensors, upgrade, maintenance, instrument intercomparisons and traceability

There are three distinct types of the KMA automatic weather observational stations. These include: (1) Automated Surface Observing System (ASOS) stations; (2) Automatic Weather System (AWS) stations, and (3) Agriculture Automated Observation Systems (AAOS). The distinct measurements made at each type of KMA automatic weather observational stations are detailed in Appendix 1. All AAOS stations are collocated with ASOS sites.

The KMA has a checklist for the annual preventative maintenance visit that is made to each station (see Appendix 2). Sensors are checked for cleanliness and proper operation. On-site intercomparisons are performed once per year for AWS air temperature, rain, and wind sensors. The KMA owns a set of 44 Fluke portable temperature calibrators. This test equipment verifies that the air temperature thermistor is accurate to ±0.5°C. If the thermistor fails the test, the KMA staffer performing the intercomparison will adjust the settings on the logger to bring the thermistor within specification.

To check the accuracy of the wind sensors in the field, the KMA staff person attaches a reference anemometer to the tower boom to ensure ±5% accuracy over a 3-min period.

The wind direction is tested by placing it on a template and checking accuracy at 45° increments. The wind direction must be within ±5°. Moisture is applied to the rain detector to ensure that it successfully indicates the presence of "rain". The aspirator is audibly checked to ensure that the fan is running. During the final check, the rain gauge is tested to ensure it reports with ±5% accuracy.

The KMA is planning to improve the surface observation and the accuracy of data. The contents of the plan are as follows;

- Substitution of the observational equipment type
  · Precipitation : Bucket gauge → weighing gauge
  · Wetness : Heating type → Poister type
  · Aspirator : Double pan type → Double circulation type (including tachometer)
  · Wind direction/speed : Propeller and Photo chopper type → Heated ultrasonic type
  · Tower : Triangular steel type → One-pole type (mechanical type)
- Automation of the manual observation
  · Visibility, Present weather : Eye measurement → Forward scattering type
  · Cloud height/amount : Eye measurement → Laser type
  · Evaporation : Pan evaporation → Calculation with other variables

For doing these, the KMA is performing the following instrument intercomparisons and also planning to conduct other experiments

- Analysis of the effectiveness of the fence for precipitation gauge
  · Intercomparison of Pit gauge with others (3 types)
- Analysis of solar radiation/duration
  · Intercomparison of the reference with others (22 sites)
- Demonstration operating of weighing gauges
  · Intercomparison of Pit gauge (Pluvio) with DFIR (OTT)
    * DFIR : Double Fence Intercomparison reference

The KMA also expects to participate in the international instrument intercomparisons continuously. For the upper-air observation, the KMA will start to establish a few more stations and plan to observe the vertical profile with autosonde in the near future. The KMA is conducting the upper-air observation with GPS radiosondes, wind profilers, and microwave radiometer profilers. KMA will join the 8th WMO radiosonde intercomparison held in China in July 2010.

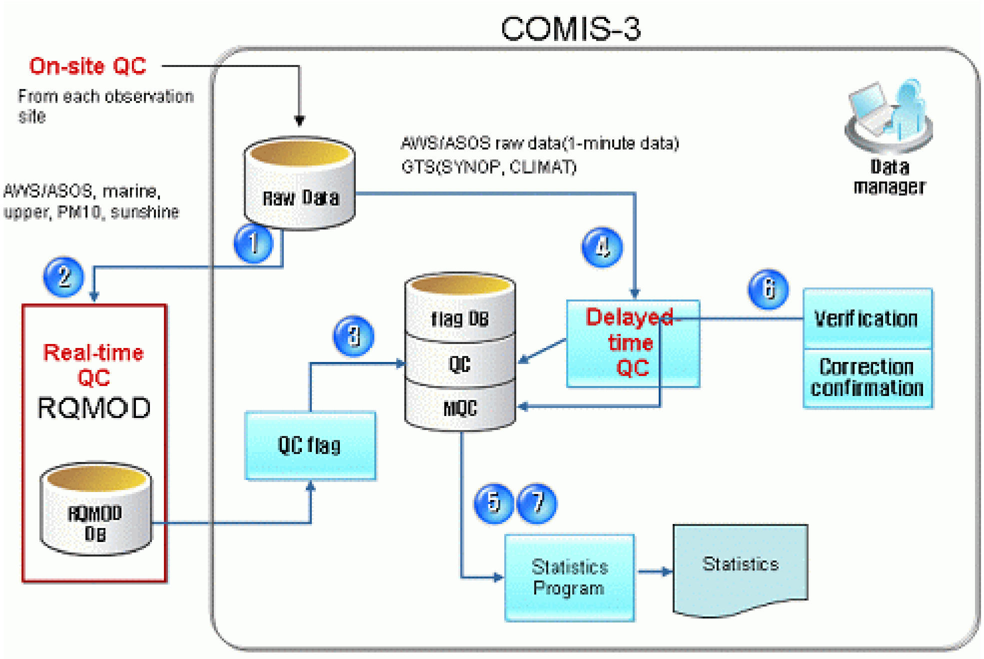
The KMA has established the standard meteorological observation sites at Chupungnyeong and Boseong. Chupunyeong, one of the KMA's synoptic observational stations, is located at the middle area of Korean Peninsula. It has been performing the synoptic observation since 1935, and was designated Korean Standard Weather Observatory for senor performance testing and intercomparison observation by the KMA in 2008. As part of its endeavor of Korea to participate in WMO Integrated Global Observing Systems (WIGOS) activities, the KMA has been creating an observing site at Boseong since 2008 in cooperation with the local government. The purpose of the site is to enhance standardization of meteorological observation. It aims at becoming one of best practices of standardization of meteorological observation for the WMO Member countries, and evolving into a global standardized weather station.

4. Quality assurance / quality control (real-time, non-real time)

The KMA is applying QC for the surface observational data at different levels. Firstly, real-time Automatic QC (AQC) is performed at AWS data logger on-site. It is simple QC provided by the manufacture. It inspects the errors of power, sensor, and communication system, and provides the errors for the maintenance staffs who manage the equipment.

Secondly, after collecting the data to the COMIS, the KMA performs a number of automated quality assurance tests. The RQMOD runs in real-time. Quality testing consists of physical limit test, step check (maximum variation), step check (standard deviation), persistency check, internal consistency check, median filter check, climatological limit/range test, spatial consistency (temperature, precipitation) check and the like. Thirdly, real-time Manual QC (MQC) is conducted on-site by workers at each weather station. They manually inspect data in real-time and report the results to the KMA headquarters. Lastly, some staff members at the KMA headquarters double check the observation records from each site and evaluate the data quality for each station. For the upper-air observation, real-time AQC and non real-time MQC are performed at the KMA headquarters.

The KMA's Data Quality Control System



Such a system facilitates timely quality control of the observational data, and hence acquisition and utilization of reliable data. The data that has passed quality control is provided to users as the basis for immediate apprehension of meteorological conditions and as the NWP data. When the quality assurance detects a problem, it is notified to observational stations by phone, short message services (SMS), and email immediately. Then the person in charge of the site checks on the reason of the problem and makes a process to solve it, like calling to the maintenance company. At the same time, the data that fails QC test must not be made public. However, once archived, if a user requests all data, the archives shared include the QC results associated with each and every datum.

5. Training

The KMA has training courses for observers and maintenance personnel for the surface and upper-air observations. When the new employees start working for the KMA, they receive the skill, working and theory educations for overall observations in an orientation course for about a month. For the junior staffs, there is a training course for the meteorological observation and observational instrument to improve the executive ability of them once a year for about a week. The senior staffs receive the synoptic and upper-air observational technical education once a year for about a week.

In addition to this, there are some special training courses, which are the upper-air sounding training course and the AWS operating technical training course. Also, the staffs are educated on the QA/QC for the data processing. When new instrument is installed, the contractor should conduct factory and on-site training for some of the KMA staffs concerning all contents required for the operation and maintenance of the new observational instrument system.

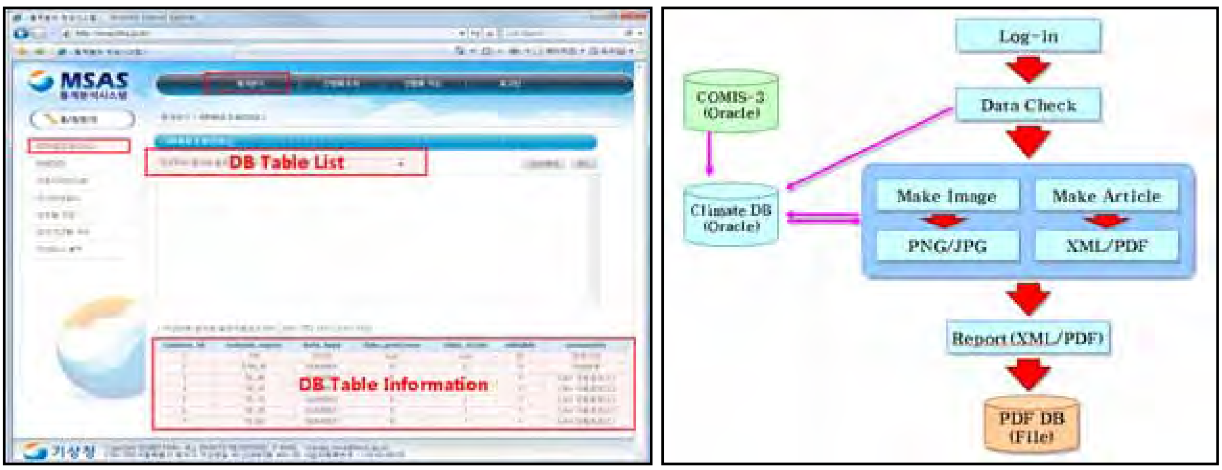
In Korea, there are many agencies and public institutions that have conducting the meteorological observations for their own purposes, such as for the transportation and the agriculture. Korean government hopes for an integrated implementation of their meteorological observation system by standardizing meteorological observing facilities including the KMA, intensifying QC, and encouraging co-use of the observational data. With these facts in mind, the KMA instituted a framework for standardization and has launched organized efforts for its systematic implementation. The Meteorological Observation Standardization Law (MOSL) has as its goal the precision in meteorological observation on the basis of WMO. It was instituted so as to provide users with valuable meteorological data, through efficient operation of meteorological equipment and improvement of the observational environment and data quality. That is why Korea was designated as a demonstration country in RAII for WIGOS. The KMA is doing the WIGOS demonstration project and supporting the education for the people who are working for the meteorological observation of other agencies and public institutions, as well as providing practical observational skills and techniques. The KMA also hosts workshops periodically to gather the opinions and provide the training for the meteorological observation standardization.

6. Statistics and applications

After the QA/QC of the observational data, the data should go through the statistic analysis process. The KMA is operating the Meteorological Statistic Analysis System (MSAS). In the system, the KMA can make inquires about DB data retrieval using Structured Query Language (SQL), windrose, accumulated precipitation (moving), precipitation date, annual extreme value for weather element, extreme value for weather element and number of days of weather phenomenon. Monthly weather report, monthly report of AWS data, and annual climatological report would be made for publication through the system.

The steps of this process are (1) Checking the observational data, (2) Making the statistic data, (3) Making the image and article, (4) Making the PDF file for contents, (5) Making publication, (6) Publishing and searching.

DB data retrieval in MSAS and the process of making publication



The surface observational data is used for the real-time monitoring of severe weather for the weather forecaster, the calibration for the radar precipitation, improving Z-R relationship, the ground validation of satellite data, and enhancing the understanding of severe precipitation systems. The upper-air observational data is assimilated into the regional numerical model with 10 km resolution. It improves the prediction accuracy of heavy rain, heavy snow and typhoon track.

The KMA publishes its observational products to interested users in graphic or text form. The KMA also provides web services that enable active sharing of data with related agencies, alongside data transmission via FTP. In addition to its main website at http://www.kma.go.kr for the general public, KMA provides a user-specific website at http://metsky.kma.go.kr with in-depth meteorological products such as observational data, weather charts, satellite/radar data, special reports, and earthquake information for disaster prevention authorities, agencies in charge of hydrology, maritime affairs, fire rescue, and the media.

Surface and upper-air observational data application

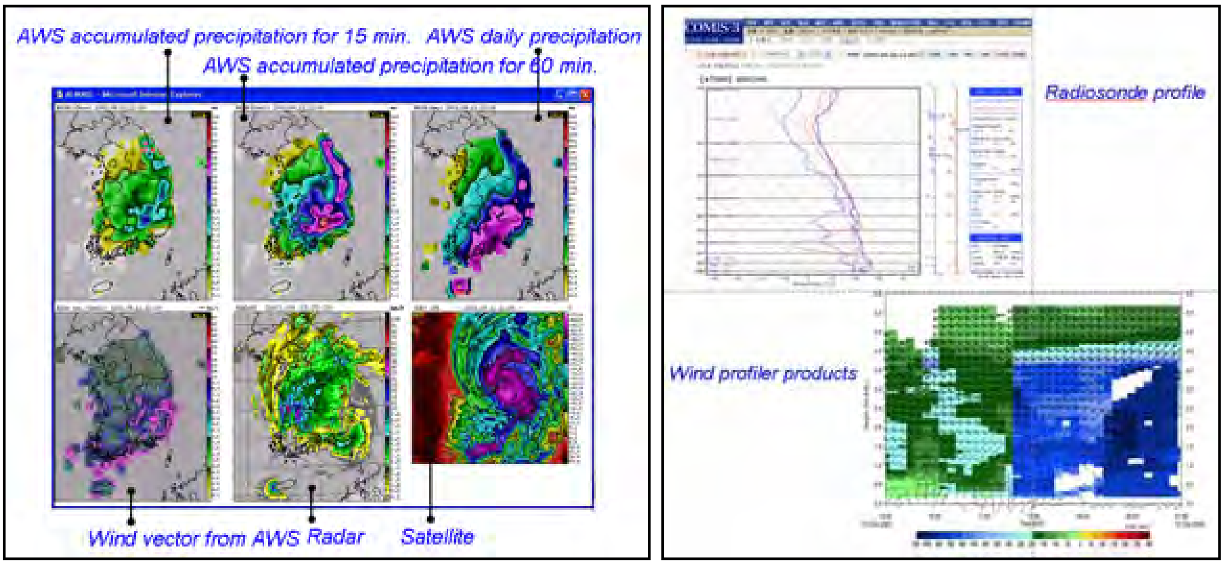
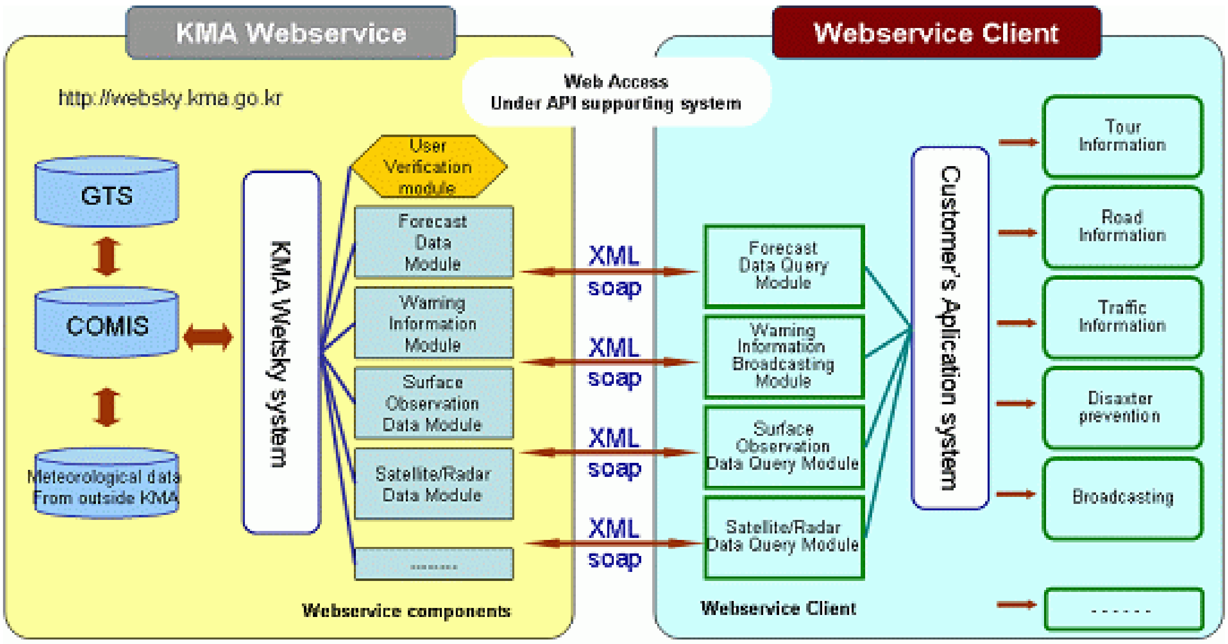


Illustration of the KMA's user-central data distribution system



7. Current issues and future plan

One of the important issues in the KMA is the problem of the continuity of observational data regarding the environmental change of observational stations due to the urbanization. It is related to relocate the observational stations that have the environment getting worse to other appropriate location.
Another is the replacement of observational instrument with different types according to the improvement of observational technique. For example, the KMA is planning to replace the bucket precipitation gauge and the propeller-type anemometer with the weighing gauge and the ultrasonic-type anemometer respectively, as the above-mentioned in chapter 4. In this connection, the KMA also has in mind to automate the manual observation including the eye measurement for some observational elements. The introduction of visibility and ceilometer gives a good example of it.
To handle and resolve the issues, the KMA is trying to establish the standard meteorological observation sites for the weather sensor performance testing and field experiments, and performing parallel observations using various atmospheric profilers and rainfall micro-radar for the upper-air and in-situ observational equipment for the synoptic weather. And these efforts would like to contribute to the standardization of observing conditions and quality management of observational data and WIGOS project.

Appendix 1: Measurments at KMA automatic weather observational stations

Variable	Automatic Surface Observing System (ASOS)	Automatic Weather System (AWS)	Agriculture Automated Observation Systems (AAOS)
Air Temperature		O	O (1.5 and 4.0 m)
Cloud Height	Manually Observed		
Cloud Amount	Manually Observed		
Dew Point	Derived from air temperature and relative humidity		Derived at 0.5, 1.5, and 4.0 m
Grass Temperature	O		O
Illumination			O
Pan Evaporation	Manually Observed		
Present Weather	Manually Observed		
Pressure	O		
Rainfall	O	O	O
Relative Humidity	O		O (0.5, 1.5 and 4.0 m)
Skin Temperature			
Soil Moisture			O (0.1, 0.2, 0.3, and 0.5 m)
Soil Temperature	O (0.0, 0.05, 0.1, 0.2, 0.3, 0.5, 1.0, 1.5, 3.0, 5.0 m)		O (0.0, 0.05, 0.1, 0.2, 0.3, 0.5, and 1.0 m)
Snow Depth	At 40 sites		
Solar Duration	O		
Solar Radiation	At 22 sites		Global and reflected radiation
Visibility	Manually Observed		
Wetness (Rain Detection)	O	O	
Wind Direction	O	O	O (1.5 and 4.0 m)
Wind Speed and Gust	O	O	O (1.5 and 4.0 m)

Appendix 2: KMA Maintenance Checklists

Check List for ASOS Preventive Maintenance

☐ Station ID : Data-logger Serial No. : Maintenance type: Routine/On demand

part	element	check points	Result (good○, bad×)	remark
sensor	Wind direction	Checking appearance status & A ball bearing		
	Wind speed	Checking appearance status & A ball bearing		
	Temperature	Checking sensor cleanliness & changing status of temperature data		
	Humidity	Checking sensor cleanliness & changing status of humidity data		
	Shelter	checking cleaning, painting and fixing of shelter		
		Checking fan operating (replace a fan per half-yearly)		
	Pressure	Checking and removing foreign substances on sensor		
		Checking sensor cleanliness & changing status of pressure data		
	Solar radiation /Sunshine duration	Checking cleanliness and condensation on sensor dome and maintaining level		
		Checking status of a moisture absorbent		
		Checking the number of rotations(in sunshine duration sensor(36 second per one time)		
	Precipitation (0.1, 0.5mm)	Checking maintaining level of precipitation sensor		
		Checking sensor cleanliness of precipitation sensor		
		Checking a point of contact in rid switch		
		Test by Measuring cylinder 20 mm	Less than ±1 mm	
	Rain detector	Checking working status		
		Checking surface corrosion & cleanliness of a sensor		
Data-logger	Data-logger	Checking working status Of Keypad		
		Checking Data display status		
acquisition computer	computer	Checking status of data acquisition & working		
power	Battery	Measuring input voltage(~13 V)	DCV	
		Measuring battery voltage after cut off AC power(12.5~13V)	DCV	
	Power	Measuring input voltage of AC power(~220V)	ACV	
		Checking working status of earth leakage breaker		
	Power supply	Measuring DC voltage(5V, 12V, -12V)	V/ V/ V	
		Checking generation of heat		
		Checking power supply working after cut off AC power		
Additional facilities	Data Monitoring Display	Checking display status of data		
		Checking data change		
	tower, wire, earthing	Checking fixation & corrosion status of additional facilities Measuring earthing resistance(per half-yearly		
		Checking data, power & communication lines		
Lightning protector	Lightning protector	Checking status of serge protector for power line		
		Checking status of serge protector for data line		
The others				

Certifying the checking results.

Date:

Inspector info: company name position name (sign)

Confirmer: agency name position name (sign)

Russian Federation

JMA/WMO Workshop on Quality Management in Surface, Climate and Upper-air Observations in RA II (Asia)

Tokyo, Japan
27-30 July 2010

Doc.
Country

(.VII.2010)

Upper-Air observations in the Russian Federation

(Submitted by Alexander Kats, Central Aerological Observatory)

Summary and Purpose of Document

To present the current state, achievements and problems of upper-air observations in the Russian Federation

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A GUIDE TO WRITING A COUNTRY REPORT AND PRESENTATION

Participants from RA II Members are kindly requested to provide written reports (about 8 pages) concerning the following key themes. In addition, participants are expected to give their presentations for specific subjects at the workshop (choose one of subjects, i.e., siting and metadata, sensors/Instruments, QA/QC, training,).

The following items are expected to be described in the country report.

1. Observation networks

~~1.1 Surface observations~~

~~1.1.1 Number of stations: RBSN, RBCN, GSN, manned stations and AWS*~~

~~Table 1 Number of stations~~

	~~RBSN~~	~~RBCN~~	~~GSN~~	~~Manned stations~~	~~AWS *~~
~~number~~					

~~An automatic weather station (AWS) is defined as a “meteorological station at which observations are made and transmitted automatically”.~~

~~1.1.2 Station map~~

~~A map showing locations of the RBSN, RBCN and GSN station is expected.~~
~~A map showing locations of the manned station and AWS is also expected.~~

~~1.1.3 Time and frequency of observations~~

~~A description of time and frequency of surface observations is expected.~~

Reference: 2.3.2.11 At synoptic land stations the frequency of surface synoptic observations should be made and reported eight times per day at the main and intermediate standard times in extratropical areas and four times per day at the main standard times in the tropics. (WMO-No. 544)

~~1.1.4 Data flow to users and archives~~

~~Surface observation data flow to users and archives is expected to be described with an illustration.~~

1.2 Upper-air observations

1.2.1 Number of stations: RBSN, RBCN, GUAN, manned stations and automated system stations

According to the official RBSN and RBCN lists (ftp://ftp.wmo.int/wmo-ddbs/RBSN_JUNE2010.xls and ftp://ftp.wmo.int/wmo-ddbs/RBCN_JUNE2010.xls) the Russian Federation has 68 RBSN, 39 RBCN and 10 GUAN upper-air stations in RA II. However, included into RBCN 25954 station at the moment is out of operation[4]:

	RBSN	RBCN	GUAN	Manned stations[5]	Automated system stations
RA II	68	38+1[4]	10	80	None
RA VI	25+1[6]	10+1[6]	1+1[6]	31	None

[4] RA II RBCN upper-station 25954 is mothballed and its revitalization remains so far unclear due to heavy damage in earthquake.
[5] In operation
[6] One RA VI upper-air station 27459, included to RBSN, RBCN and GUAN, is temporarily mothballed till 4th Qr. of 2010.

Total	93+1	49+1	11+1	111	None

Totally, observational program of the Russian continental upper-air network at the moment assumes operation of 111 upper-air stations. This amount doesn't take into account 27459 station (RA VI, silent since August 2009), which is about to resume observations by the end of 2010. Three more mothballed stations in RAII are about to resume their operations by the end of 2010 as well due to installation of new ground systems owing to National Hydrometeorological Modernization Project (see later). Thus we expect our upper-air network to grow up to 115 stations by the end of 2010.

From those 111 stations, operational by June 2010, 106 have to send their data to GTS, but in the 2nd Qr. of 2010 two of them (1 RA II + 1 RA VI) were silent at all due to problems with hydrogen production, one more station in RA II was silent in June due to ground system failure. More details about the fulfillment of the program of observations are brought below,

As well, apart from continental network Russian Federation operates 2 Antarctic upper-stations (they both belong to RBSN, RBCN and GRUAN) and since 2007 organizes expeditionary upper-air observations on the Drifting station "North Pole" expeditions in Arctic. The latter one as well as resuming operation of several polar upper-air stations resulted from efforts undertaken by the Russian Federation during preparation to and implementation of the International Polar Year.

1.2.2 Station map

Figure 1 provides an overall view of the Russian upper-air network, it shows operating (pink), mothballed (light-blue) and closed after 1990 (crosses) upper-air stations.

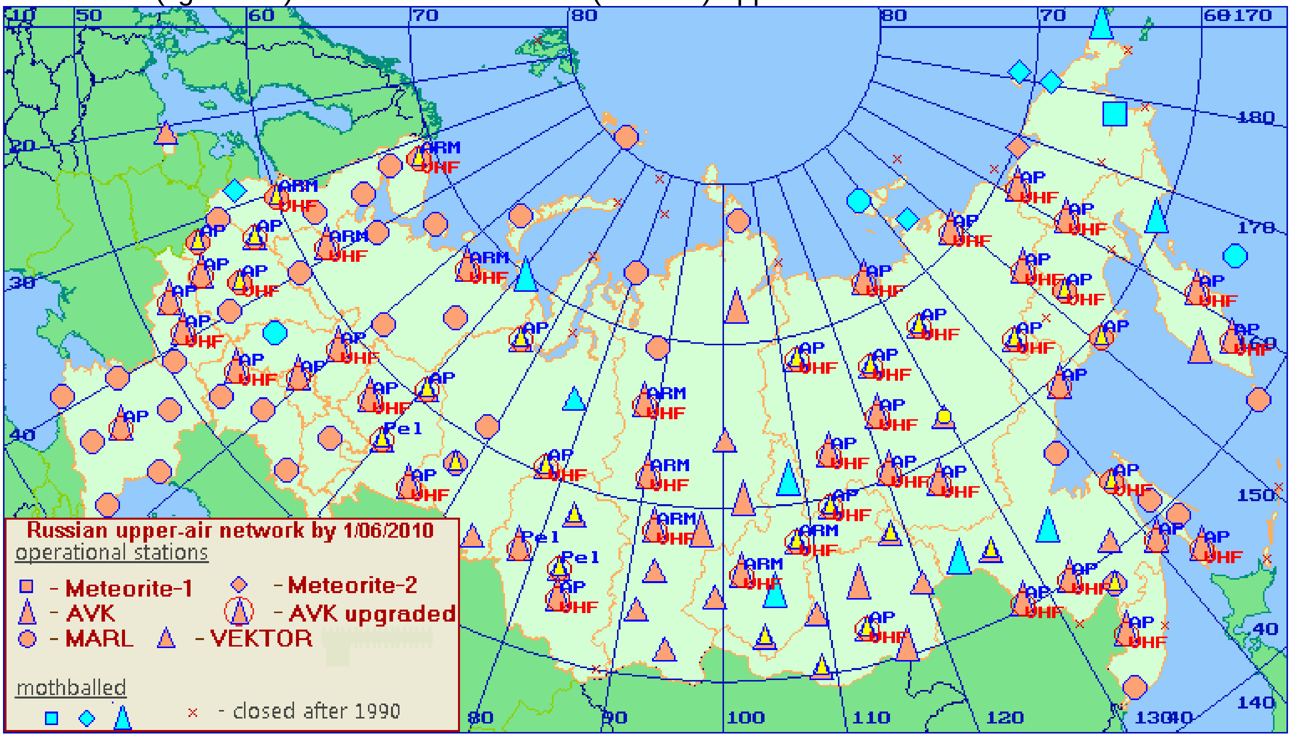


Fig **1.** The Russian Federation upper-air network.

Note variety of ground systems indicated by the legend. It's may be worth to notice here that typical Russian radiosonde system consists of secondary radar and a radiosonde, equipped with transponder; pressure is derived from temperature, humidity and radar height by integration of hydrostatic equation. At the moment there are three major types of radars in operation (with some of them having more than one modification). Each of them is able to operate MRZ-3 like radiosonde of four domestic manufacturers.

Following maps present the RBSN, RBCN and GUAN upper-air stations of the Russian Federation (mothballed stations are shown with orange symbols):

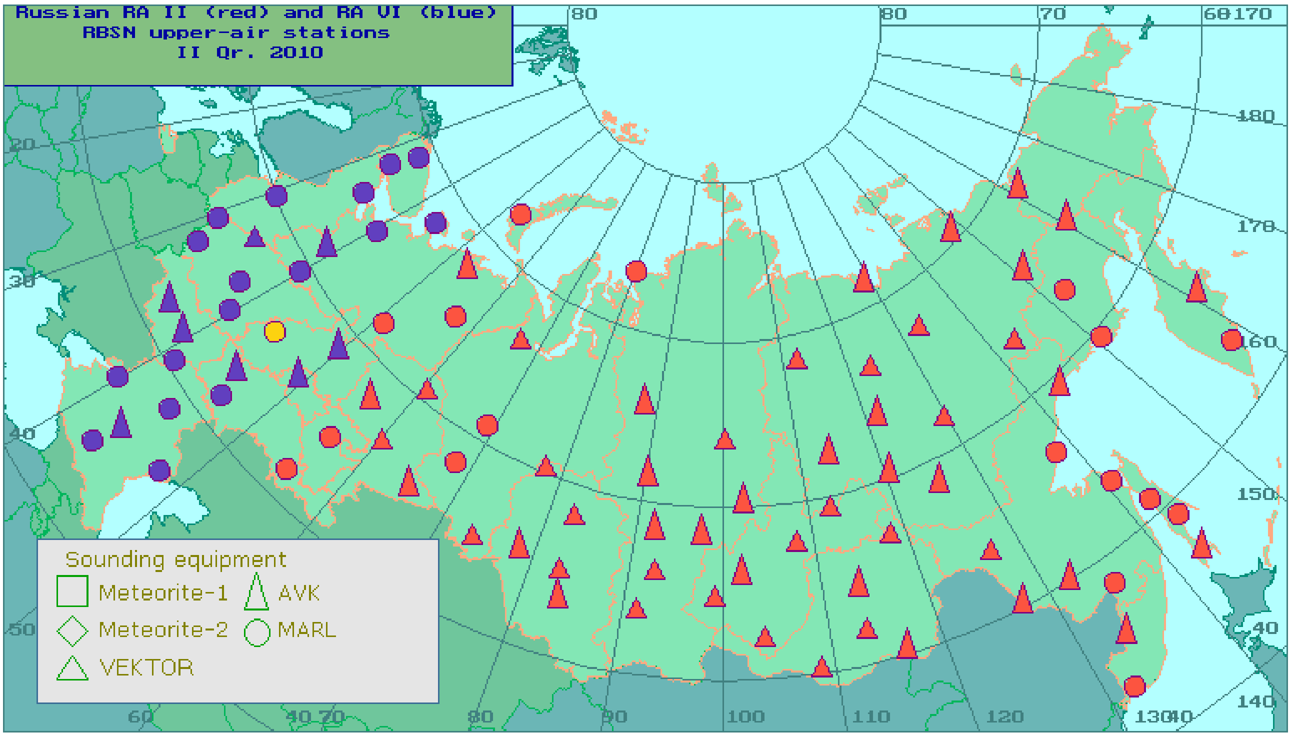


Fig **2.** The Russian Federation RBSN upper-air stations.

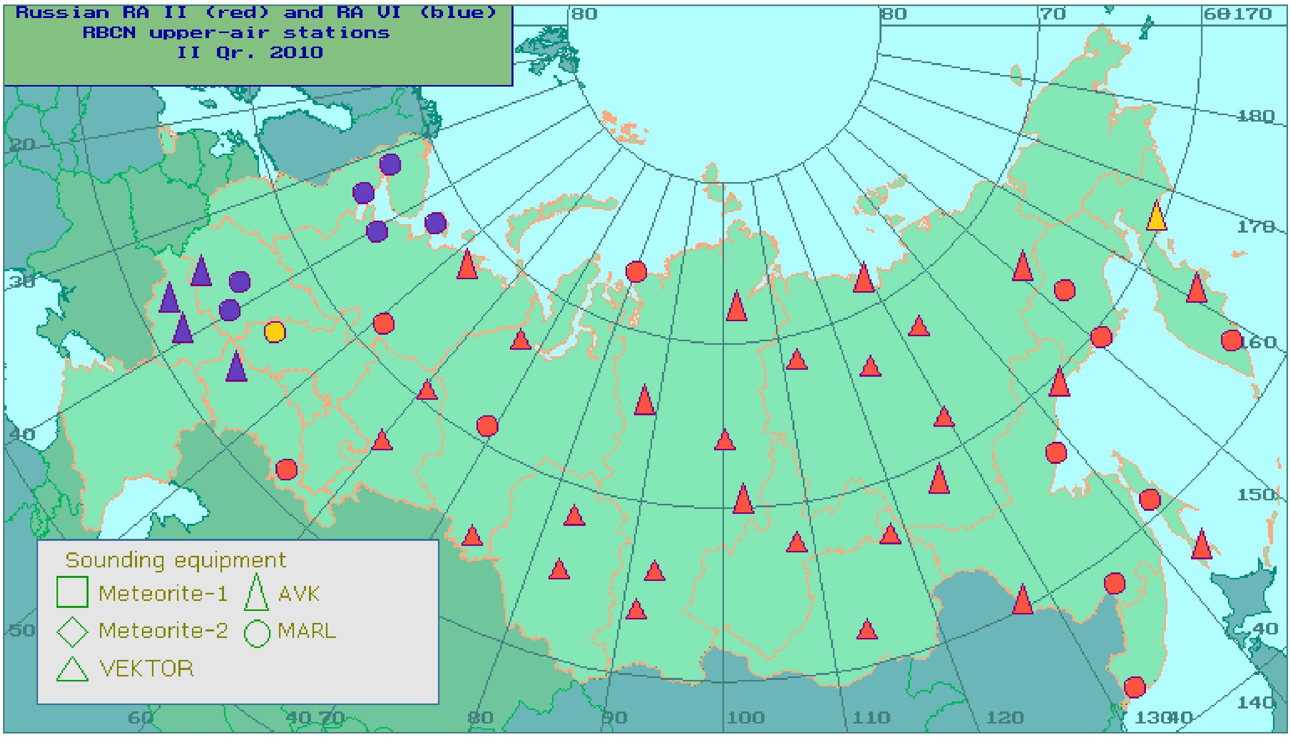


Fig **3.** The Russian Federation RBCN upper-air stations.

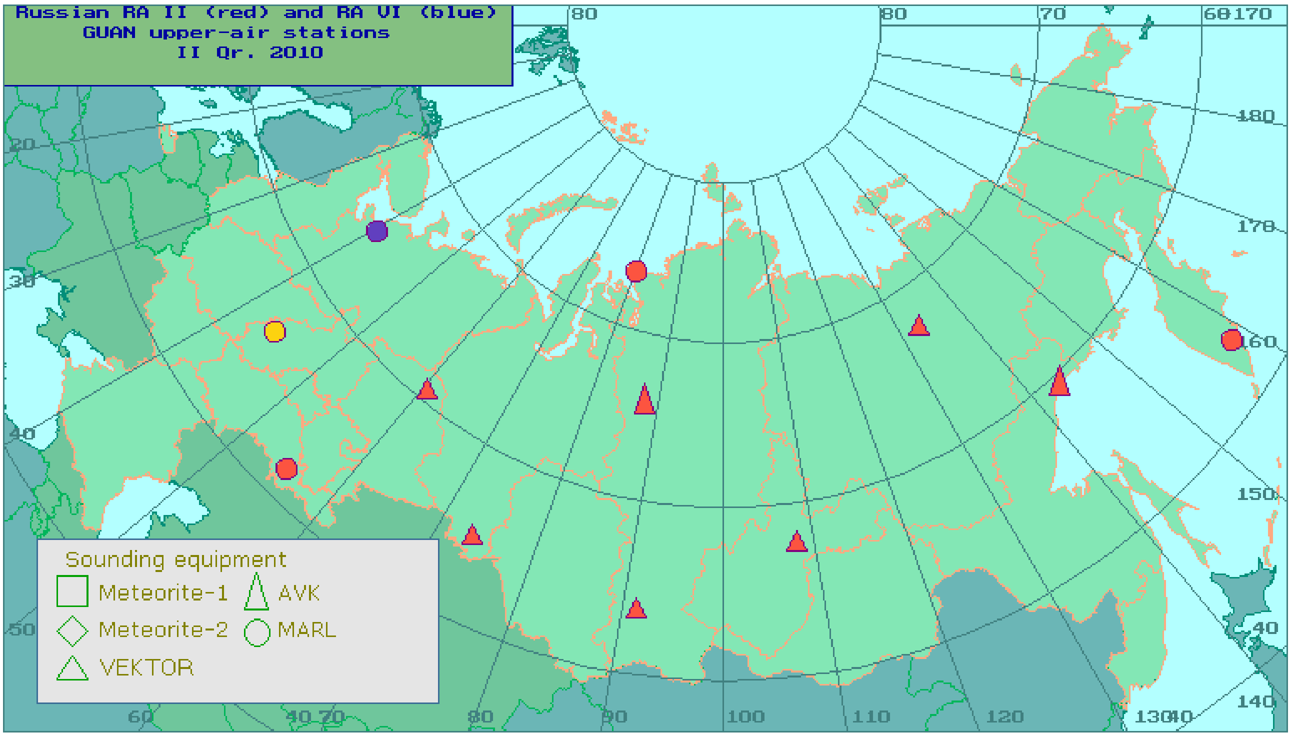


Fig **4.** The Russian Federation GUAN upper-air stations.

1.2.3 Time and frequency of observations

Figure 5 presents observational program of The Russian Federation upper-air network. All except two (in RA II) upper-air stations in the Russian Federation make their observations according to the rigid schedule twice per day, at 00 and 12 UTC. According to the national practice, the actual release of a radiosonde is carried out half an hour prior to nominal synoptic time, i.e. 23:30 and 11:30 UTC.

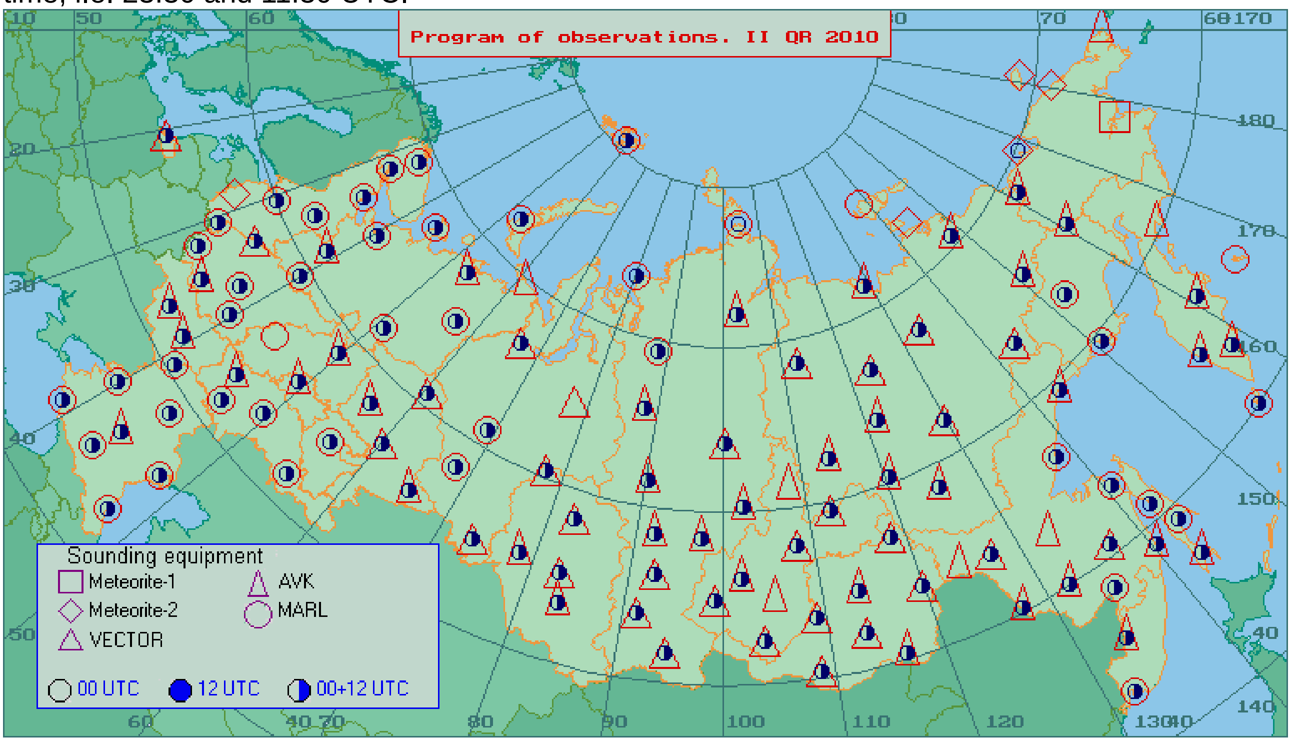


Fig **5.** The Russian Federation upper-air network observational program.

Actual fulfillment of observational program (for 00 and 12 UTC) is presented on Figure 6. Average percentage for the Russian Federation in the 2nd Quarter of 2010 is 95% (for 00 and 12 UTC and for both time). Total amount of observations within this period was 19031, i.e. 209.2

daily ascents. The main reasons of non-fulfillment of the plan are ground equipment failures and shortage of chemicals for hydrogen production (logistics issues).

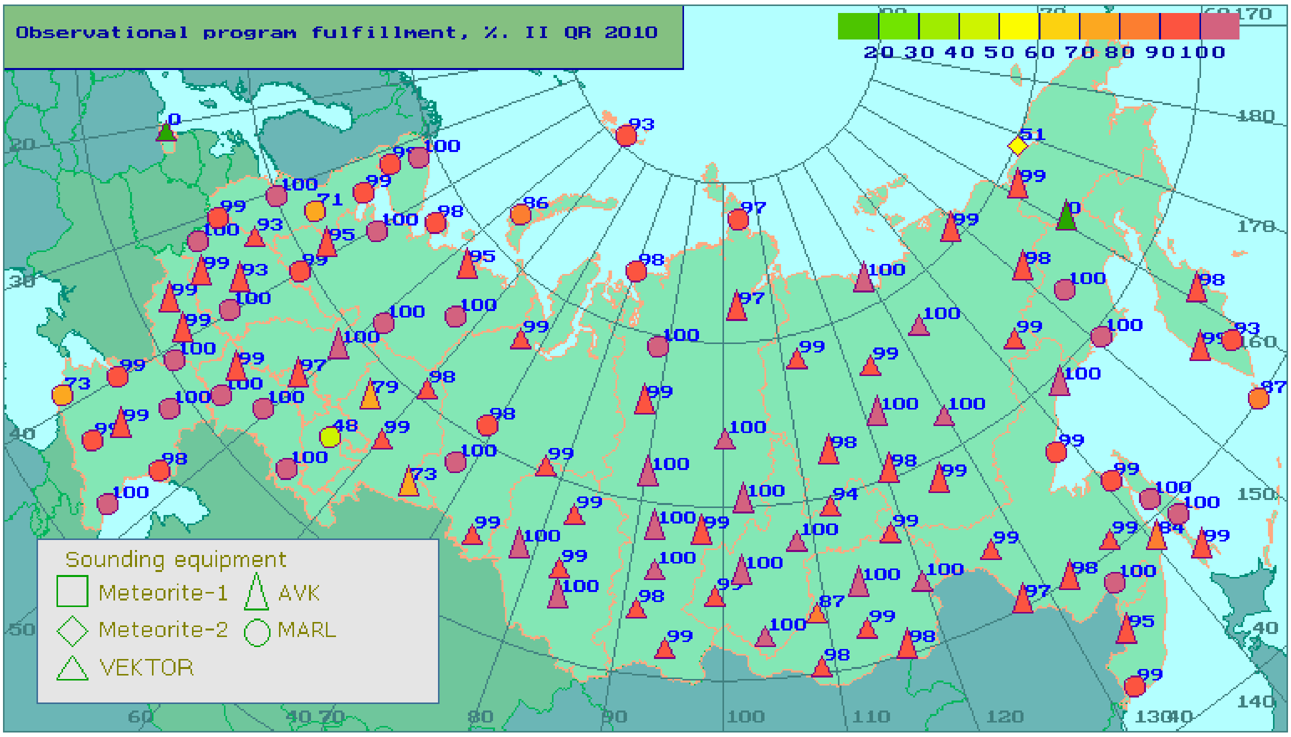


Fig **6.** The Russian Federation upper-air network observational program fulfillment.

As well the Russian Federation upper-air network took part in the experiment related to adaptive observation strategy: 37 upper-air stations of 11 Regional Roshydromet Administrations took part in the Winter T-PARC THORPEX field campaign during 07.01.2009 - 28.02.2009 and made totally 603 irregular adaptive ascents within 33 periods of intensive observations (IOPs).In each IOP an individually selected subset of the participating stations has been performing additional 06 and 18 UTC ascents following special DTS Observation requests.

Requests were sent by Senior Duty Meteorologist of NCEP NOAA Central Operations to WMC/RTH Moscow by e-mail ~30 hours prior to additional ascent 06 UTC and were promptly disseminated to upper-air stations via Roshydromet telecommunication network. Results of additional observation were transmitted operationally to the WMO GTS as conventional FM35 TEMP messages.

Upper-air network is a multi-purpose and expensive observing system. Its optimizing (unless reducing amount of sites would be justified by availability of alternative observing platforms) is very challenging task due to very high dimension and lot of imposed constrains. For many practical reasons a redesign with changing site locations seems almost unrealistic. Adaptive observation strategies, or targeting, are expected to be a solution by improving forecast skill and minimizing operational expenditures.

The experiment has proved the ability of the operational upper-air stations to perform adaptive observations on condition that proper logistics and procurement are provided. Nonetheless they require much more sophisticated organization and logistics. Therefore unless full launch automation isn't implemented, labor component of expenditures remains significant and benefit from targeted observations must be clearly demonstrated.

1.2.4 Data flow to users and archives

The backbone of upper-air observation data flow is the telecommunication network of Roshydromet. Roughly streams of operational upper-air observation data look like on Figure 7. Beside of providing operational data to WMO GTS, WMC/RTH, two RTH and each regional/provincial communication centre provides data to local users such as Hydrometeorological centre of Russia (WMC "Moscow"), regional hydrometeorological centers and other organizations supplying end-users with various products. Russian Research Institute for Hydrometeorological Information – World Data Center (RIHMI-WDC) in Obninsk, which is responsible for the maintaining of the Russian State Fund of data on hydrometeorology and monitoring of environment, as well has its own communication centre and receives all routine operational upper-air data (TEMP FM 35 and PILOT FM 32) in near real time. The system works rather fine and fluently in relation to traditional TEMPs and PILOTs but makes an obstacle for the further development.

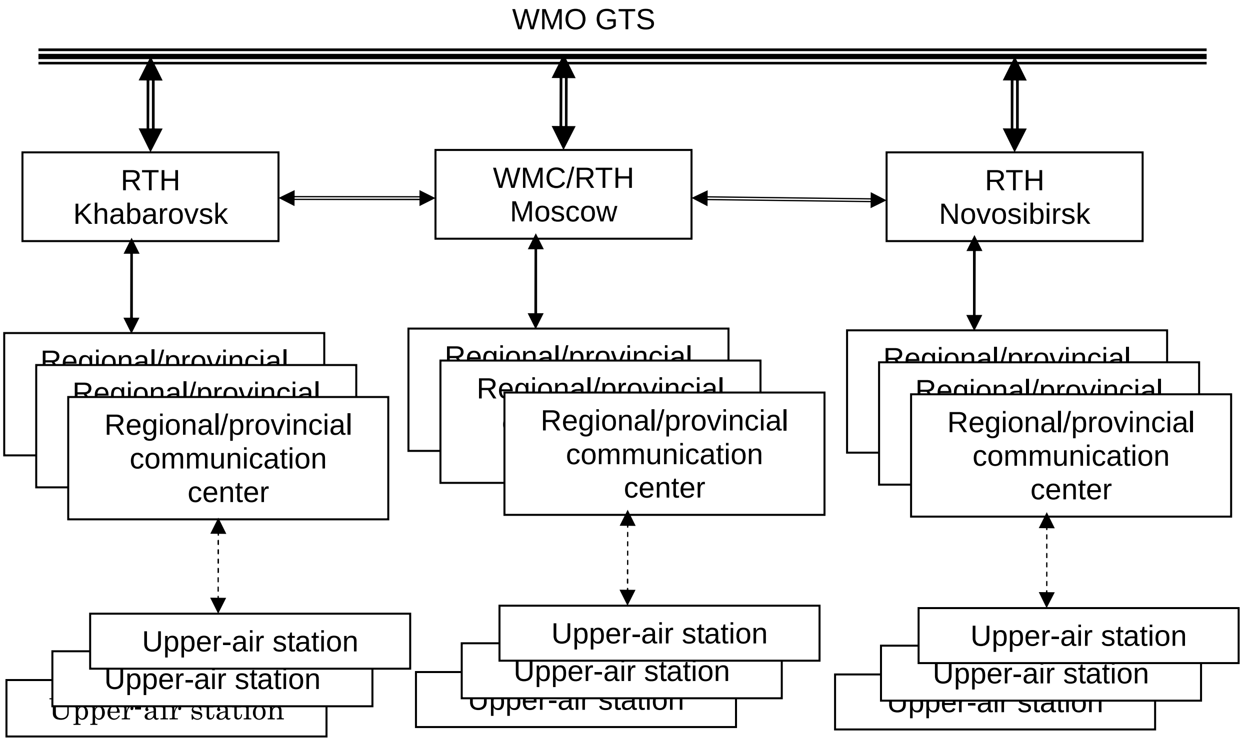


Fig **7.** Upper-air observation operational data flow.

The main shortcoming is the “last mile” bottle-neck – many stations still submit their observations using teletypes equipment. This prevents on many sites a migration to TDCF data representation which provides lot of advantages to data users as well as network operators. Now it’s the major challenge in maintaining data flow. One of possible solutions is using CREX upper-air data representation with same content as in TAC TEMPs and PILOTs where sending binary BUFR messages is impossible due to technical limitations. Another issue is inevitable introduction of typing errors.

Except one all stations have automatic data processing and from latter ones only 5 have no ability to save raw data and processed results on external storage, thus there is a potential possibility to obtain and transmit operationally high-resolution upper-air data using e.g. B/C 25 WMO TDCF template. However, until recently only limited size printouts were collected and these hardcopies were archived on monthly basis in the Regional hydrometeorological administrations. Of course, they have very limited value for the further processing. Therefore, since 2010 it was started quarterly “off-line” collection in CAO and RIHMI of all files, produced by PC-based automatic, to make a basis to create a national high-resolution upper-air data archive. Some positive experience in this respect was received in Winter T-PARC experiment with retrospective processing of collected for each IOP raw data files resulted in obtaining detailed upper-air profiles with vertical resolution about 100 m.

2. Siting and metadata

Although upper-air observations are generally less affected by an environmental change a site selection is not arbitrary. Apart from basic principles, there are specific requirements to Russian upper-air sites resulted from usage a radar like necessity to have low takeoff angles (clear horizon); when station is located near a settlement it's desirable for a radiosonde to move off from apartment buildings after release. As well, a place for radiosonde release should be selected so that under prevailing winds a radiosonde moves off from radar after release.

Upper-air instrumentation is quite volatile and WMO Code Table is not able to take into account all changes in radiosonde design, software upgrades, equipment modernization etc. Since 1998 till 2006 it was lot of equipment modernization and data-processing software upgrades on the Russian upper-air network, respective metadata information was collected but still is not published.

The optimal solution seems to be a keeping as much as possible metadata information (radiosonde serial ID, balloon type, free lift, software and firmware versions, angle adjustments and so on and so on) along with each sounding data archive.

3. Instruments, sensors, upgrade, maintenance, instrument intercomparisons and traceability

In 1989 AVK radar with MRZ-3 radiosonde successfully took part in the 3rd WMO Radiosonde systems intercomparison and was recognized as meeting WMO requirements to upper-air data performance requirements.

Since the end of 80-s AVK radar remained a backbone of the Russian upper-air network. With design service time as long as 10 years many of them are still in operation (either as the only one or as reserve ground system) due to numerous modernization like replacing non-durable electro vacuum devices in receivers by solid-state microwave modules to ensure better telemetry reception and radiosonde tracking, replacing built-in firmwared minicomputer with PC-based data acquisition and processing system and some others less significant (There were several versions of hardware and software modifications from several manufacturers and it took lot of efforts to document all this variety and provide required support).

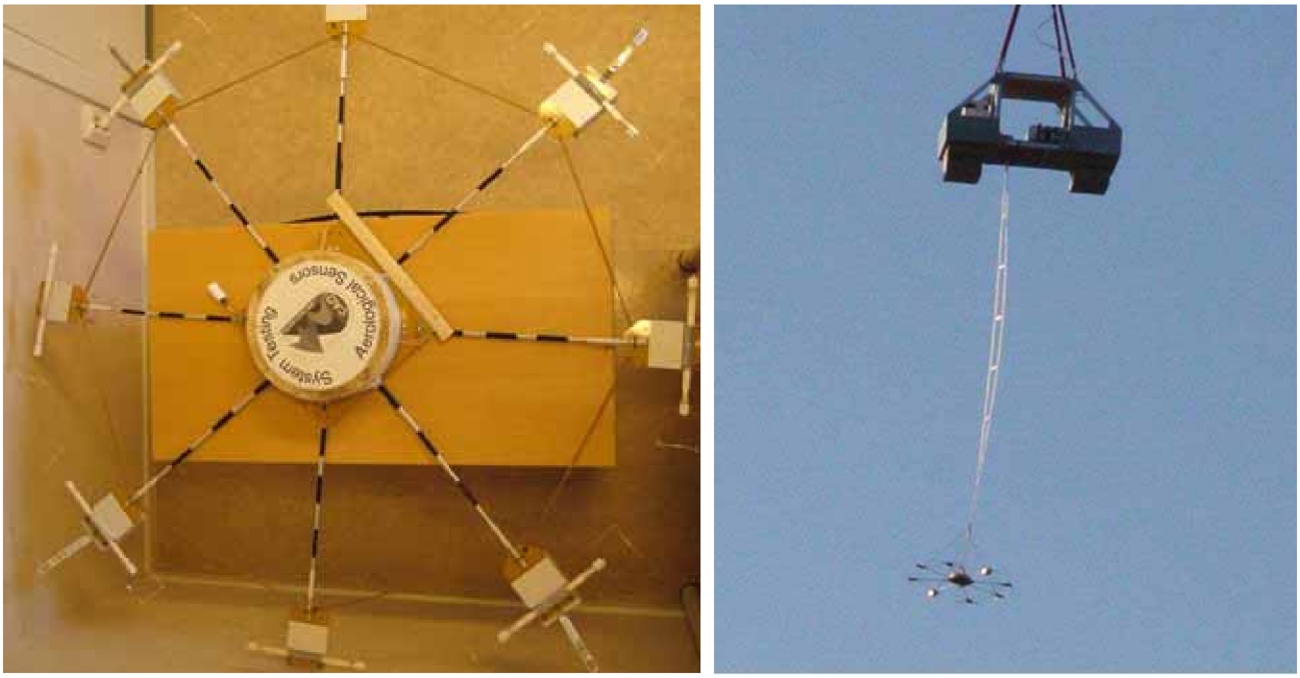
MRZ-3 now is not the only radiosonde in use, there are several alternative types with telemetry compatible to MRZ-3, same temperature and alternative humidity sensors. Although the type of thermistor, which serves as sensitive element of the temperature sensors, remains the same, it's known that earlier used anti-radiation enamel is out of production. For temperature sensors from different manufacturers a calibration may differ as well as slight variations in the design of sensor mounting and anti-radiation coating may affect thermal equilibrium. Therefore, radiation correction may require modification. So, both temperature and humidity sensors again require intercomparison. Its worth to mention that around 1995-2005 it was in use an alternative radiosonde RF95 with temperature and humidity sensors of world-recognized Vaisala RS80 radiosonde. However, at the moment production of RS80 was ceased and new generation of Russian radiosonde with sensors of Vaisala RS92 radiosonde is not ready yet.

For investigation of compatibility of radiosonde temperature sensors from various Russian radiosonde manufacturers in free atmosphere it was developed a lightweight platform (see Figure 8) to be deployed as an autonomous piggy-back payload to high-altitude stratospheric balloons during various international research programs. It allows simultaneous registration of up to 16 thermistors during ascent, drift and descent of a balloon. As well, it can carry out a pair or two of Vaisala RS80 and RS92 radiosonde sensor. 5 test flight were undertaken during experiments with stratospheric balloons of 2009-2010 performed by CNES, France, in Swedish Space Corporation ESRANGE Space Center in Kiruna, Sweden. Totally 76 temperature sensors from two manufacturers (38 pcs from each one) were tested, the very first results will be presented on WMO TECO-2010 in Helsinki. It is considered a possibility to use the platform for intercomparison of humidity sensors.

Since around 2005 a new generation domestic upper-air radars MARL and Vektor became available. Owing to National Hydrometeorological Modernization Project, co-sponsored by International Bank for Reconstruction and Development and the Government of Russian Federation as well as to preparation to IPY new radars were installed at more than 60 stations (6 mothballed stations resumed their operations). Improved procurement resulted in increase in observational program fulfillment and soundings height. Not everything went smooth but the tendency is apparently positive. Major remaining issues regarding upper-air ground system are following:

1.1 Maintenance of worn-out AVK radars and further replacing them with new generation radars to make upper-air observations sustainable;

1.2 compatibility and skill of new radars data-processing software;
1.3 uncertain reliability of one of new upper-air radar.



a) b)

Fig **8.** System for Testing Aerological Sensors - on the ground (a) and in a flight (b).

Most of the Russian upper-air stations use chemical method for producing hydrogen and it's desirable to replace them with electrolytic generator for many reasons. 12 new domestic electrolytic generators were delivered to the network however their reliability and safety were found to be insufficient and manufacturer was requested to remedy defects.

4. Quality assurance / quality control (real-time, non-real time)

Upper-air QC and quality management in the Russian Federation is a multi-tier system of near real-time observation error checks and medium- and long-range QC and performance monitoring:

At upper-air stations:
- operational quality control during flight until message reporting**;**
- next-day re-check;
- cross-check by station engineer-aerolog.

At Regional administrations – spot-check of observations raw and processed data, connecting upper-air stations and lead centre (verification of rejected data), periodical site inspections.

At Hydrometeorological centre of Russia (WMC "Moscow") – operational upper-air data QC within regular data assimilation cycles.

At Russian Research Institute for Hydrometeorological Information – World Data Center (RIHMI-WDC) in Obninsk – QC of archived upper-air data.

At Central aerological observatory – monthly and long-term upper-air network performance monitoring based on products from Hydrometeorological centre of Russia. The main function of Central aerological observatory in the QC/QM system is providing feedback to upper-air stations and requesting remedial actions: periodical inspections of upper-air observations in the Regional administrations, maintenance requests, site inspections, requests to radiosondes, ground equipment and software manufacturers, guidelines and consultations.

At the Roshydromet level: the yearly best stations national contest based on reports from the Regional administrations and Central aerological observatory.

Most sources of operational information used for national upper-air network performance monitoring in Central aerological observatory were recently upgraded and now include:

- 00 and 12 UTC de-coded radiosounding results from parts A, B, C and D of TEMP messages, there were added sections 3, 4 and 7;

- results of upper-air data complex quality control for data on standard pressure levels and significant points, performed operationally by the Hydrometeorological Centre of Russia data assimilation system;
- geopotential, temperature and wind first-guess (FG) fields, based on 6-h forecast, for all standard pressure levels from 1000 to 30 hPa and pressure at sea level, interpolated to the station's locations;
- time of arriving parts A, B, C and D of TEMP and PILOT messages to the Hydrometeorological Centre of Russia;
- NIL messages (the messages from Russian and some other stations use extended NIL code for providing additional information on reasons of absence for each missed radiosonde observation, such as routine maintenance, lack of consumables, failure of ground equipment, absence of energy, severe weather conditions, ATC ascent ban, communication problems etc).

All above information is received by FTP-protocol with dedicated software.

Some information is still collected off-line: quarterly statistics of radiosonde pre-flight and in-flight failures, monthly statistics of ascent heights (with separation of cases with balloon burst and all other cases). It is compiled on stations (in most cases so far manually) and regional administrations and is sent to CAO by e-mail.

Different aspects of upper-air network performance under monitoring include fulfillment of program of observations, reasons of stations downtime, completeness and quality of observations. Developed software allows generation in operational mode different kinds of monthly, quarterly and annual reports for stations, regional administrations and member states of the Intergovernmental Council for Hydrometeorology of the Commonwealth of Independent States, e.g.:

- detailed monthly list of soundings and reasons of observations absence;
- statistics of program of observations fulfillment for 00 and 12 UTC and both terms;
- statistics of soundings heights;
- reasons of failure of observations statistics;
- rejected data statistics;
- (OB-FG) geopotential and wind statistics and their distributions and lists of suspected stations for geopotential and wind observations (according to WMO No.485).

Some of results are presented on the monthly, quarterly and yearly web reports at http://cao-ntcr.mipt.ru/monitor (English version available at http://cao-ntcr.mipt.ru/monitor/monitorrese.htm) in tabular forms, as diagrams (see Figure 9) and maps (see Figure 6).

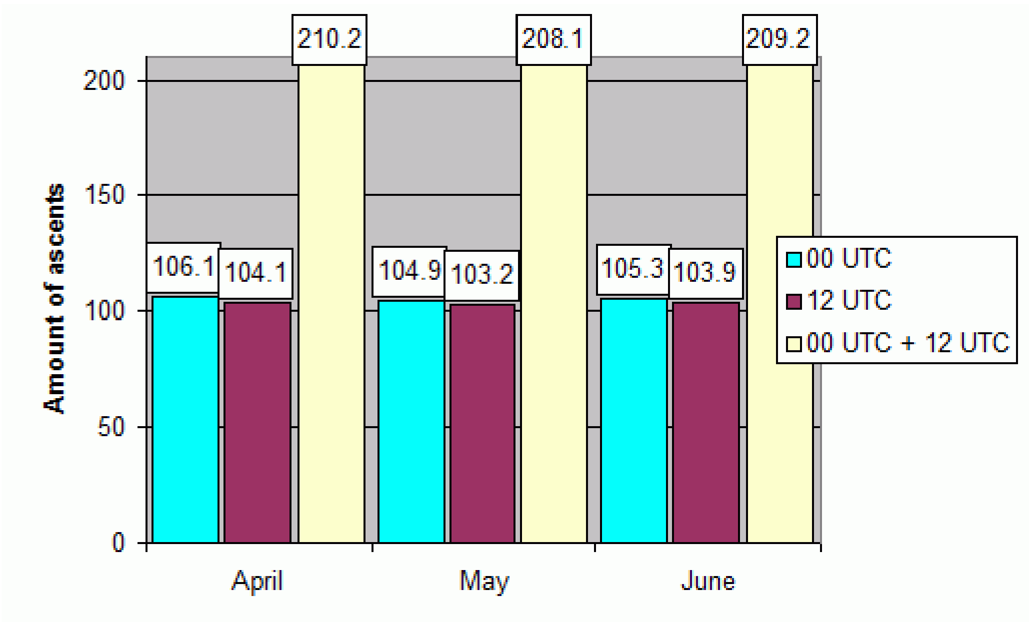


Fig **9.** Daily amount of ascents on the Russian Federation upper-air network. II Qr. 2010.

5. Training

There are an institute and several technical schools providing higher and high hydrometeorological education.

Due to lack of resources for trainees travel and accommodation training activity is mainly limited to episodic courses related to new equipment introduction. Last Roshydromet workshop on upper-air observation issues took place in 2004.

Web-conferencing is studied as a potential platform for discussions and training. The problem for communication is the amount of time zones in the Russian Federation, so a platform to choose must provide possibilities both for online and offline conversation.

6. Statistics and applications

RIHMI-WDC in Obninsk has the Aerological department dealing with all aspects of upper-air data processing. It has two thoroughly checked data sets of global upper-air data: the AEROSTAB data (uper-air observations obtained through communication channels) and the Comprehensive Aerological Reference Data Set (CARDS), developed in cooperation with NCDC in Asheville. Various derived products for boundary layer and free atmosphere are available: long term monthly means, variability and extremes, auto- and cross-correlations, trends and so on.

7. Current issues and future plan

Remaining major issues are: Out-of-repair ground systems at some stations, unstable performance of some new ground systems, unstable reliability of radiosondes, staff recruitment and motivation, manual input of upper-air messages to teletypes on many stations, sometimes lack of chemicals and power supply, radio interference (esp. with cellular networks) issues.

Problems for quality monitoring result from heterogeneity of the network (various ground systems and radiosondes could be in use at the particular station simultaneously). Now we realized separate monitoring of different ground systems (i.e. separate OB-FG statistics for a new and alternative ground systems) and are about to present to the public the first results for July. In plans there is also separate monitoring for various radiosonde type that will provide as a tool for feedback to procurement policy.

There is also a need to present our new ground systems to comprehensive intercomparison with world-wide modern upper-air systems.

Sri Lanka

JMA/WMO Workshop on Quality Management in Surface, Climate and Upper-air Observations in RA II (Asia)	Doc. Country
Tokyo, Japan 27-30 July 2010	(.VII.2010)

Meteorological Observations and Instrumental Systems for Meteorological services in Sri Lanka

(Submitted by M.D. Dayananda,   Department of Meteorology,   Sri   Lanka)

Summary and Purpose of Document

This document contains an overview of the surface and upper-air observations in Sri Lanka, with respect to instruments, Data Network, quality assurance / quality control, training, and applications.

1. Indroduction

1.1 *General Introduction About Sri Lanka:*

Sri Lanka is an island in the North Indian ocean, just south-east of the southern tip of the Indian sub continent, having an arial extent of 65,610 square kilometers. The highlands, mostly above 300 meters, occupy the south central part of Sri Lanka with numerous peaks (Pidurutalagala -2524 m, Kirigalpotte - 2396 m), high plateaus and basins and are surrounded by an extensive lowland area. There are twenty-five (25) Administration Districts in the Country with 246 sub-divisions. The population in Sri Lanka is about 20 million and the ethnic division of the population is: Sinhalese 74%, Tamil 18%, Moor 7%, Burgher, Malay, and Vedda 1%. Major languages are: Sinhala 74% (official and national), Tamil 18% (national), other 8%. English is commonly used in government and spoken competently by about 10% of people. Population density of Sri Lanka is 792 per square miles.

1.2 *Meteorological Characteristics*:

Due to its location within the tropics between 5^o 55' to 9^o 51' North latitude and between 79^o 42' to 81^o 53' East longitude, and in the Asiatic monsoon region, the climate of the island could be characterized as both tropical as well as monsoonal. Topographical features mentioned above influence strongly on spatial variation of climate in the island. The mean annual rainfall varies from under 1000mm in the southeastern and northwestern parts to over 5000mm in the western slopes of the central highlands. The mean annual temperature varies from 27^0C in the coastal lowlands to 16^0C at Nuwara Eliya, in the central highlands (1900m above mean sea level). This relatively unique feature manifesting as sunny beaches to rain forests inland is a tourist attraction.

The island is seasonally affected by two regional scale wind regimes. The Southwest monsoon is from May to September and the Northeast monsoon from December to February. The intermonsoon periods, the transition periods between the two monsoons are, from March to April and from October to November. The rainfall during these intermonsoon periods is mainly due to convective thunderstorm activity.

It is characteristic to have long spells of dry days over most parts of the country except in the north and east during January and February, with ground frost appearing in the central hills where vegetables are grown. During the months of November to December, depressions forming in the Bay of Bengal (and Arabian Sea) tend to intensify into cyclonic storms and move closer to Sri Lanka bringing much rain and wind; but chances of land fall along east coast are very low; only 13 out of some 1,300 storms since 1891. Devastation due to cyclones thus does not top the list of natural disasters. However gust of strong winds during the southwest monsoon period cause damage to houses and other building structures in the southwest quarter of the island. Another phenomenon that increasingly threats the life and property is lightning. Torrential rains too cause floods displacing people and, also in the other extreme, prolonged dry spells sometimes affect agriculture adversely. Landslides in the hill country are also on the increase as a natural calamity, during the recent years.

2. Organization

2.1 Present Situation

The Directorate of Meteorology consists of The Director General of Meteorology as the Head with two Directors and five Deputy Directors: all are former Meteorologists except Dututy Director administration. Most divisions are under a Meteorologist-in-Charge with NMC and International Airport Meteorological Office having four additional Meteorologists each as Forecasters, for round the clock service. In the Department Head Office there are ten (10) main Branches (Divisions) viz., National Meteorological Centre (NMC), Agro-meteorology, Computer, Radar, Instrument, Rainfall, Climate , Data Divisions and Establishment & finance Divisions.

3. The current Status of Meteorological Instrument and Observational System
3.1 Meteorological Observation Network
3.1.1 Surface observations

Department of Meteorology, Sri Lanka maintains 20 meteorological stations scattered throughout the Island, manned by trained meteorological observers. In addition to the department headquarters in Colombo, 19 outstation meteorological offices are operated.:

Surface observations at main standard time of observation (i.e 0000, 0600, 1200 and 1800 UTC) and at the intermediate time of observation (i.e. 0300, 0900, 1500 and 2100 UTC) are done at :

1). Anuradhapura (080 20' N 800 23'E)
2). Batticaloa (00 0' N 00 0' E)
*3).Colombo (060 54' N 790 52' E)
4).Galle (060 02' N 800 13' E)
*5).Hambantota (060 07' N 810 08' E)
6).Katugastota (070 20' N 800 38' E)
7).Katunayake (070 10' N 790 53' E)
*8).Nuwara Eliya (060 58' N 800 46' E)
*9).Puttalam (070 02' N 790 50' E)
10). Ratmalana (060 49' N 790 53' E)
11). Ratnapura (060 41' N 800 24' E)
12).Trincomalee. (00 0' N 00 0' E)

The following stations are done surface observations at 0300, 0600, 0900, 1200 and 1500 UTC.

1). Badulla (060 59' N 810 03' E)
2). Bandarawela (060 49' N 800 58' E)
3). Jaffna (00 0' N 00 0' E)
*4). Kurunegala (070 28' N 800 22' E)
5). Maha Illupallama (080 07' N 800 28' E)
6). Mannar. (00 0' N 00 0' E)
7). Pottuvil. (00 0' N 00 0' E)
8). Vauniya (00 0' N 00 0' E)

* indicate RBCN. See the Table-1 and Fig. 1.

Table -1 Number of stations

	RBSN	RBCN	GSN	Manned stations	AWS *
number	20	05	20	20	33

- **Automatic Weather Stations (AWS)**
  Under the JICA granted project (" the project for Improvement of Meteorological and Disaster Information Network ") Department has being received 38 AWS systems and 33 AWS's already installed and these data is being used for

forecasting purposes and mitigation of disaster due to heavy rainfall even-though they are in experimental stage. National forecasting centre receive these data in every 10 minute period of time. The remaining 05 AWS system will be installed within this year.

3.1.1 Upper Air Observations

Upper air observations are done at Hambantota in the extreme south, Puttalam in the west and Colombo in the southwest coast and Polonnaruwa(new station, still this station data not send to GTS). See the Table-2 and Fig.-2.
Radar and Radiosonde Observations (upper air observation which give wind, temperature and pressure data up to about 20,000 metres or more) are done only at Colombo.

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Table - 2 Number of stations

	RBSN	RBCN	GSN	Manned stations	Automated system stations
number	03	03	01	03	0

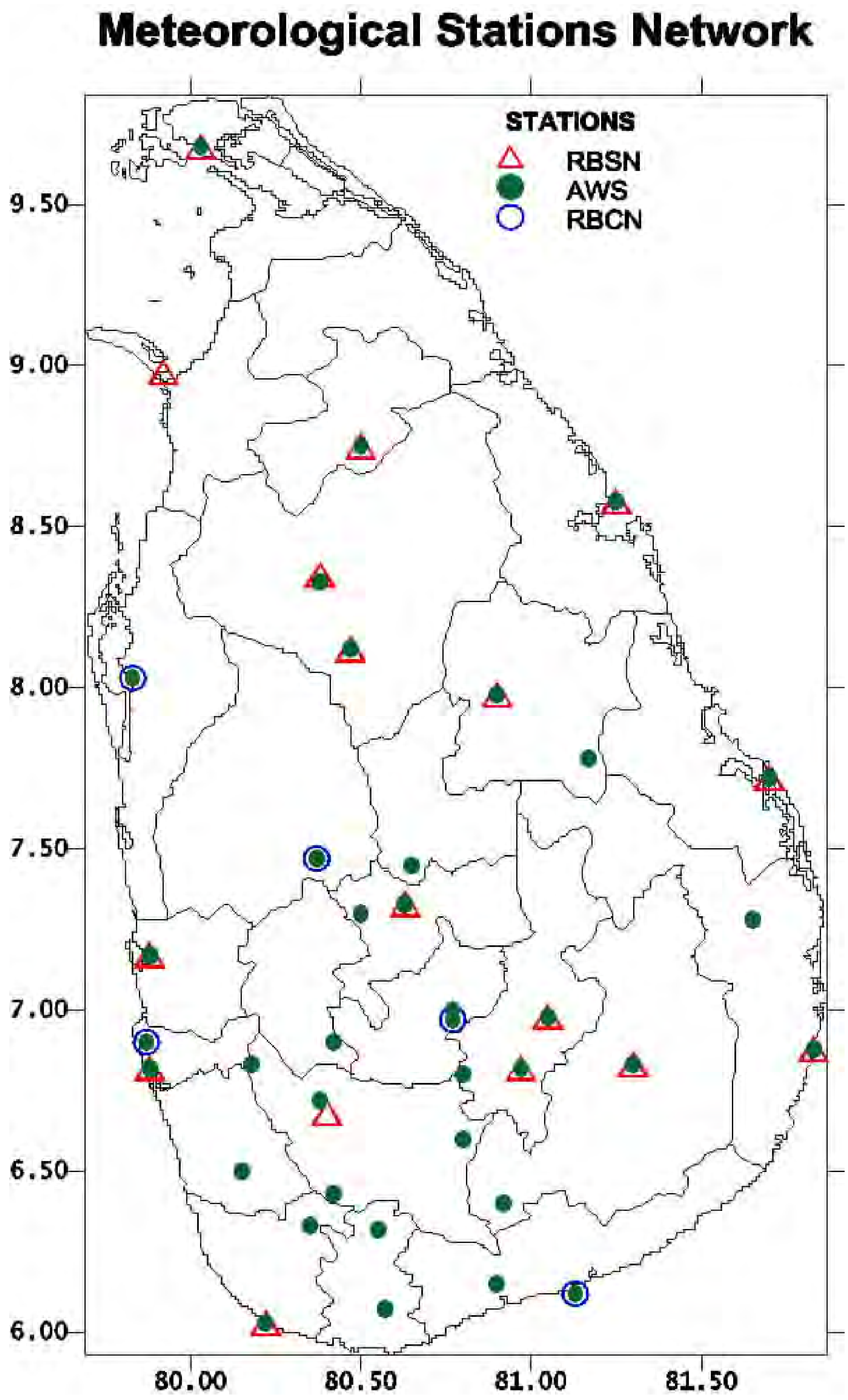


Fig. 1 Map showing locations of the RBSN, RBCN, GSN, manned and AWS stations.

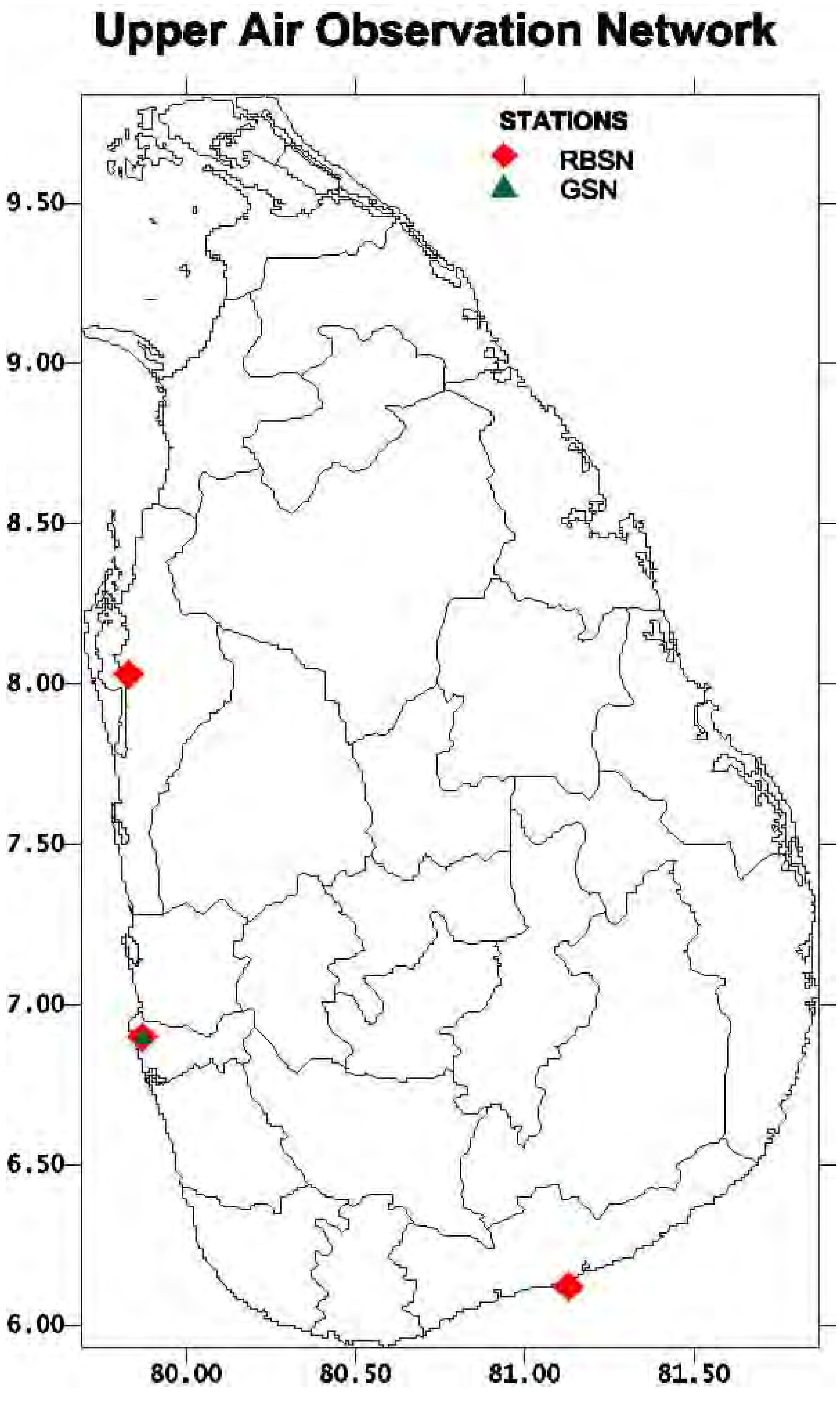


Fig. 2 Map showing locations of the Upper Air Observation Network

3.2 *Agrometeorological Station Network*

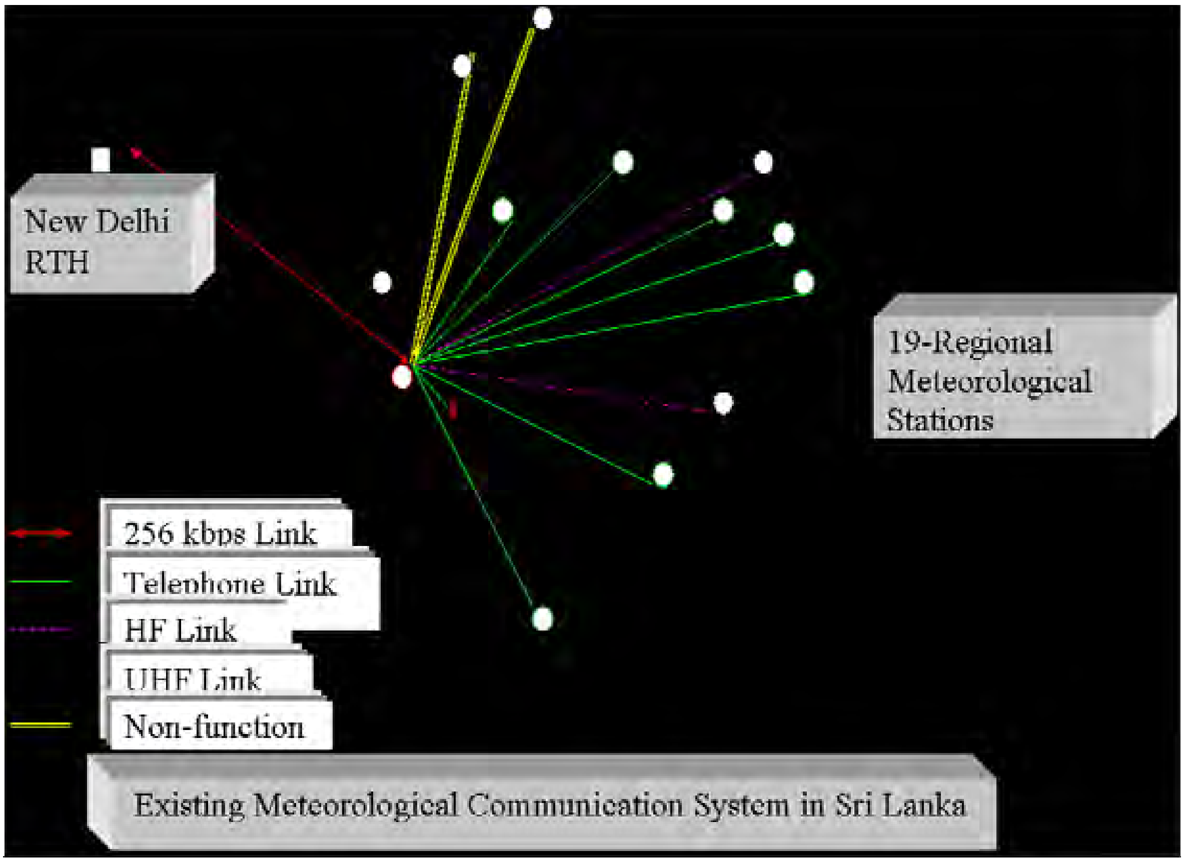
Agrometeorological stations are maintained in different parts of the island in collaboration with other government institutions such as the Agriculture Department, Tea Research Institute, Rubber Research Institute, Coconut Research Institute, Mahaweli Authority etc.

3.3 *Raingauge Station Network*

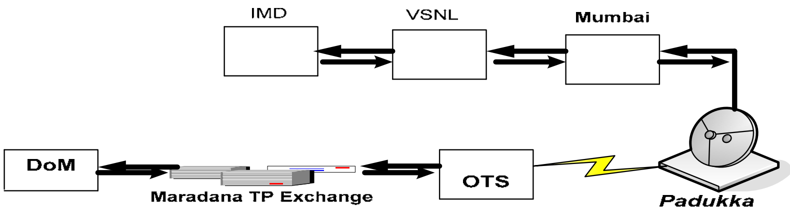
Nearly 400 rainguage stations scattered over the island are maintained with the co-operation of various other govt institutions and many individuals who have volunteered to do the observations. Daily rainfall data from these stations are received at the end of the month. In addition, rainfall data are collected daily from about 80 of these stations by phone for weather forecasting purposes.

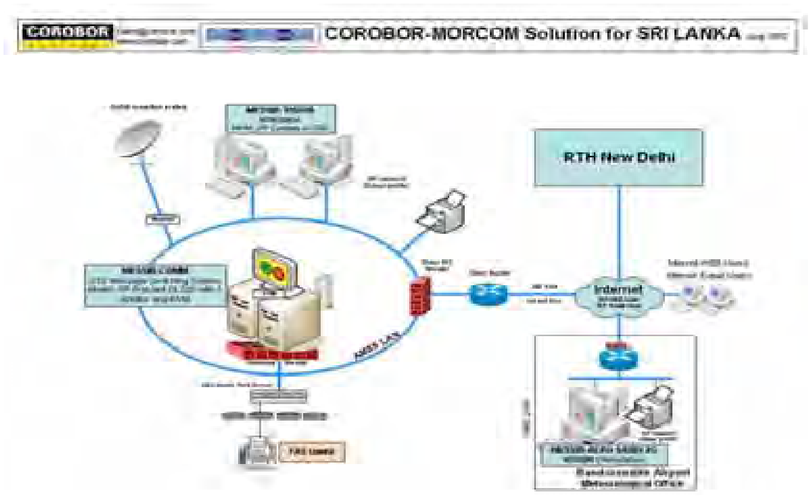
4. Data Flow to Users and Archives

Regional weather observations are received at the NMC via the Regional Telecommunication Centre at New Delhi over the dedicated telecommunication circuit established for this purpose. Computer Division archives all the data under CLICOM Project. Monthly and annual climatological means are calculated for various parameters. Presently data are stored in CDs and the computer hard disk.



4.1 Quality controll





4.1 Quality controlling of data

Quality controlling of data is done subjectively at the observatory, NMC, Data branch and at the Climate branch. Following checking are carried out .

Check for coding errors
Check for physical reasonableness of observation
Check against it's neighbours, spatial and temporal consistency
Check against self recording charts

5. Utilization of Meteorological Observation and Instruments

The NMC is responsible for the collection and processing of Meteorological Data received from field offices, and outside via GTS. Synoptic and Upper Air data are plotted and analyzed manually every six hourly (local data 3 hourly).

The weather forecasts are issued using subjective methods by looking at the analyzed charts (synoptic & upper air), satellite images etc, by experienced meteorologists. The quality of the forecast certainly depends on the skill and the experience of the meteorologists. This Division is manned 24 hours by a Meteorologist for Weather Forecasting. All queries on current and forecast weather are dealt by this Division. One Meteorological (field) station serves for the International Aviation while another serves for the Domestic.

Issue of weather warnings during Bad Weather periods is done by the NMC for general

public and by the Airport Meteorological Office for Aviation. Agro-meteorology Division collects data from the relevant stations and is to be examined and quality controlled by Observers. These data are then condensed as weekly values and used to calculate long-term means. Every type of data is supplied to Researchers and other interested parties such as Industrialists.
.
Instrument Branch attends to defects and deficiencies in instrumentation and also calibration. These services are extended to Agro-meteorological Stations too whenever possible.

Rainfall Branch looks after deficiencies at rain gauge stations and keep records of timely reception of data monthly and checking for authenticity. Data and Climate Branches examine and quality control Meteorological data received from all the Meteorological Stations. Astronomical information to the general public, such as phases of moon, sunrise, sunset, eclipses, etc., are also provided by the Climate Division.

The first step in the planning and designing of development projects like irrigation schemes, hydropower generation projects etc., is a feasibility study, which involves*, inter alia*, an analysis of climatological data. The Department of Meteorology plays an important role in these studies by supplying meteorological data, which have been systematically recorded over many years.

Data are also sought for the designing of building, towers, factories, roadways, establishment of agricultural farms, designing of drainage systems, disaster mitigation studies, research studies etc. This responsibility is shared among the Data, Climate and Agro-meteorology Divisions.

Meteorological Office at the International airport , Katunayake is responsible for all aeronautical met services. Half hourly METAR are done and necessary TAF, SIGMET are issued according to the ICAO regulations. WAFS products down loaded from SADIS are also provided with manually prepared windtemp and sigwx charts. Training courses on aeronautical Meteorology are also conducted for the airline personnel. .

6. Training

Nearly once a year training programme is organized at the Head Office for observers for upgrade their knowledge and skill about the observations and to give proper knowledge to handle and maintenance of conventional and AWS instruments.

7. Current issues and future plans

Most of the sensors (specially wind sensors) of the present AWS system (donated by Japanies Government - under JICA project) are malfunctioned very frequently. But the department is not having expertise to rectify this problem. Due to the system is under warranty period, suppler is helping to replace these sensors.

Therefore department is needed external expertise assistance for maintenance of the system.

Department is does not having proper archiving system, in future it is essential establish a proper system for data archiving.

Organizing of Instrumentation training programme regionally will be used full for calibration of instruments and verification of data.

The Quality managment system in Sri Lanka is not in WMO standard as such the Department of Meteorology is seeking the ways to improve the QMS. Firstly we are going to establish a quality core team with a quality Manager. This core group will prepare the required document. In the meantime discussion are going on with Aeronautical authorities to implement QMS for the Meteorological office at the Airport. Quality inspector will be nominated.

JMA/WMO Workshop on Quality Management in Surface, Climate and Upper-air Observations in RA II (Asia)

Tokyo, Japan
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METEORLOGICAL OBSERVATIONS IN THAILAND

(Submitted by Songkran Agsorn, Ph.D., Director, Weather Observation Bureau, Meteorological Department, Bangkok, Thailand.)

Summary and Purpose of Document

This report reviews the present status of meteorological observing stations in Thailand. A total of 122 weather stations are employed throughout Thailand, mostly surface weather. Some stations are assigned for WMO-RBSN, RBCN, GSN and GUAN stations. Almost all surface stations are operated 8 synoptic times daily. Mixed standard manual and modern automatic weather instruments are used. Coded messages are sent from the observing stations manually. Data quality assurance/control is performed both real-time (on message programing) and non-real-time (by manually audits). Observers are directed to refreshing courses, training or seminar periodically.

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1. Observation networks

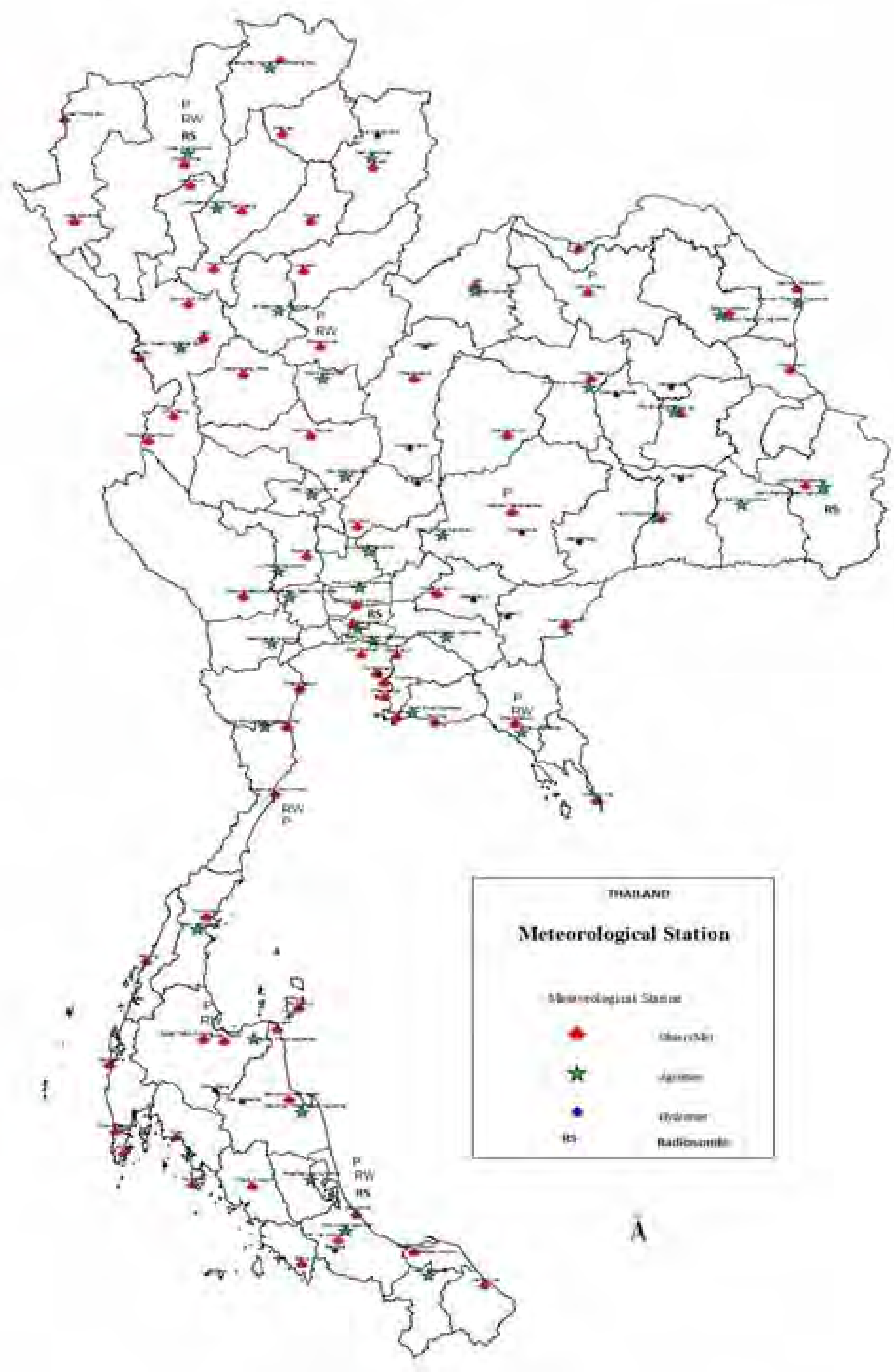
1.1 Surface observations

1.1.1 Number of stations: RBSN, RBCN, GSN, manned stations and AWS

Table 1. Number of stations

	RSBN	GSN	Manned Stations	AWS*
Number	87	6	122	----

1.1.2 Site Map



1.1.3 Time and frequency of observations

8 synoptic times daily: 00UTC, O3UTC, 06UTC, 09UTC, 12UTC, 15UTC, 18UTC, 21UTC

1.1.4 Data flow to users and archives

Data are recorded manually at the station in a log-book and on PC to be sent as WMO-coded messages to the headquarter in Bangkok to further distributed via GTS and kept as archive at the climatological data section. Real-time automatic weather reports are available to the forecasters and public (via web) and separately archived.

1.2 Upper-air observations

1.2.1 Number of stations: RBSN, RBCN, GSN, manned stations and AWS

Table 2. Number of Upper-air stations

	RBCN	GUAN	Manned Stations	Automated System
Number	2(4)	2(4)	2(4)	

1.2.2 Station Map

See 1.1.2

1.2.3 Time and frequency of observations

1.2.4 Data flow to users and archives

The same as 1.1.4

2. Siting and metadata

Most observation stations were sited in rural areas at the beginning. The advance of the development of town moves the stations into the areas now more populated and obstructed by building nearby. The station details now include location and altitude. Work are moving to gather more standardized station information or meta-data. Phetburi (48465) weather station is used as a pilot station to collect the information both spatial and temporal.

3. Instruments, sensors, upgrade, maintenance, instrument intercomparisons and traceability

All stations are equipped with standard meteorological instruments, eg. wet-bulb dry-bulb glass thermometers, wind anemometers, Class-A evaporation pans, rain gauges. Agro-meteorological stations include soil thermometers. The 87 stations are equipped with limited function automatic weather sensors. Data collected at the 87 stations are sent via telecommunication lines to the headquarter in Bangkok for real-time reports for weather forecasters and separate archives. But, the meteorological observers at each stations send out coded messages to the telecommunication hub in Bangkok for GTS distribution. The standard instruments are maintained by in-house technical personnel. The automatic weather stations' maintenance is outsourced to suppliers. In-house calibration are done by the meteorological instrument division. Pressure wind, and temperature can be traced to Regional Instrument Center, Japan. Currently both standard (manual) and automated measurement data are collected for intercomparisons. Upper-air sondes are calibrated before sending up, according to manufacturer's instruction.

4. Quality assurance/quality control (real-time, non-real-time)

Data quality assurance is first done on a computer program to send the coded messages by observers in real-time. Non-real-time qualty control is processed by central officials inspecting the observation reports send monthly and comparing with stored electronic messages from the stations and kept at the central computers.

5. Training

Periodic refreshing training and seminars for the observers are done about 3-4 times a year. Correspondence between stations and the Observation Standard Sections have been continuously done in wake of misunderstanding of observation procedures or the new or changed WMO codes or procedures. New observers have to pass one-year program study of meteorological personnel offered by the department.

6. Statistics and applications

Surface observations are used first-hand by the weather forecasters. They are also shown to the public in the official web-site of the Meteorological Department. Archived data, now computerized, are given out to the public for further applications. Upper-air data are used in the same way as the surface data; fewer upper-air data are requested by the public. Most upper-air data requested are used with environmental applications.

7. Current issues and future plan

This coming fiscal year, the department intends to procure the three more radiosonde ground stations to be used at Phuket Airport (48565), Songkhla (48568) and Ubon Rachatani (48407) replaced the unusable Vailla ground stations that do not work with the newer sondes.

APPENDIX

Country (Area) THAILAND / THAILANDE

GSN

IndexNbr	Station Name	Latitude	Longitude	Elevation (m)
48303	CHIANG RAI	19 58N	99 53E	393
48400	NAKHON SAWAN	15 48N	100 10E	35
48462	ARANYAPRATHET	13 42N	102 35E	49
48500	PRACHUAP KHIRIKHAN	11 50N	99 50E	5
48517	CHUMPHON	10 29N	99 11E	6
48568	SONGKHLA	07 12N	100 36E	7

GUAN

IndexNbr	Station Name	Latitude	Longitude	Elevation (m)
48327	CHIANG MAI	18 47N	98 58E	314
48453	BANGNA AGROMET	13 40N	100 36E	3

*UBON-PHUKET-SONGKHLA MAKE OBSERVATIONS.

Uzbekistan

JMA/WMO Workshop on Quality Management in Surface, Climate and Upper-air Observations in RA II (Asia)

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Observational hydrometeorological network in Uzbekistan: Status , data acquisition and control

(submitted by Aleksandr Merkushkin, Uzhydromet, Uzbekistan)

Summary and Purpose of Document

The document given had been compiled in correspondence with requirement the ongoing pilot project to enhance the availability and quality management support for national meteorological and hydrological services in surface, climate and upper-air observations. The purpose of this document is to give brief information on status of existing observational ground hydrometeorological network in Uzbekistan as well as to outline the main principle of data acquisition and data control provided. Also the some issues related to improvement of existing data collecting, monitor and data dissimilation infrastructure are briefly discussed.

1. Observation networks

Critical water management within the five central Asian republics (CAR) of the former Soviet Union requires access to reliable climate and hydrological data. Under the Soviet Union an extensive network of manual climate stations was operated within the region. This network provided some of the essential climate data required for water resource management and forecasting. The network included stations throughout most of the region including remote stations within critical precipitation accumulation areas.

A significant reduction in capacity of the CAR governments to provide this vital data has followed the collapse of the Soviet Union. Many of the remote stations in significantly accumulated areas have been abandoned or are staff by minimally qualified observers. The snow survey program has been significantly reduced. Most remaining climate stations are concentrated outside of significant snow and precipitation accumulation areas. Quality control and maintenance procedures are difficult to enforce. The legacy radio, telephone and Teletype communication network is obsolete.

Four principle period might be distinguished on the way of evolving observational hydrometeorological network in Uzbekistan.

The first period is related to Tashkent's astronomical and physical observatory establishment at 1870's.

Then the primary meteorological and hydrological network had been deployed and hydrometric department was established. Under umbrella of department given the hydrometric and meteorological services were united.

The second period had been lasting from 1918 till 1945. During this period the centralized weather service had been established and some particular researches related to national economic interests had been initiated. Observational network was deployed including marginal and high-mountain sites and status of the operational observational stations was considerably raisen.

During the third time period that lasted from 1945 till 1991 the hydromeorological network in Central Asia was significantly affected with technical progress fruits like new equipment and coming of the computers. The favourable economical and financial conditions were pushing incentives to observational network extension. The maximum population of the hydrometeorological station was namely related to the end of this period.

The long-term degradation of observational hydrometeorological network is characteristic for the forth period. The stable degradation of hydrometeorological network had run at the end of 1990's and being resulted in the collapse of the former socio-economical and political system is still ongoing. Spite of objective hassles on the way of observational network prevention Uzbekistan has overcome the situation with minimal losses in respect to other Central Asia countries (see table below)

Table 1

The dynamic of population the meteorological stations in Central Asia for the last decades

Country	**Number of meteorological stations**		
	1985	**1996**	**2004**
Kyrgyzstan	**95**	**62**	**31**
Tajikistan	**64**	**51**	**47**
Turkmenistan	**51**	**51**	**48**
Uzbekistan	**91**	**75**	**78**

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t is remarkable that only Uzhydromet is the authorized body to collect, process and disseminate data have been gathering by its observational network in Uzbekistan so far. As well Uzhydromet accepts and bears the responsibilities on quality and timing of data service available.

The observational networks of Uzhydromets consist of 79 meteorological stations and 130 hydrological water gages and stations. Also it includes 84 surface water quality control gages.

Data come from 21 meteorological stations are included to the international data exchange cycle for World Weather Centres needs.

Nowadays the big project on development of Doppler radar facilities for such airports as Tashkent, Samarkand and Nukus is underway.

1.1 Surface observation (including AWS)

1.1.1 Number of station:RBSN,RBCN,GSN,manned stations and AWS

	RBSN	RBCN	GSN	Manned stations	AWS stations
number	**78**	**78**		**78***	**7***

*Seven AWS installed at operational climate stations that were staffed by NHS observers.

The territorial allocation of the both manned and automated weather observational networks is given on the Fig.1 and Fig.2 correspondingly.

1.1.2 Station map

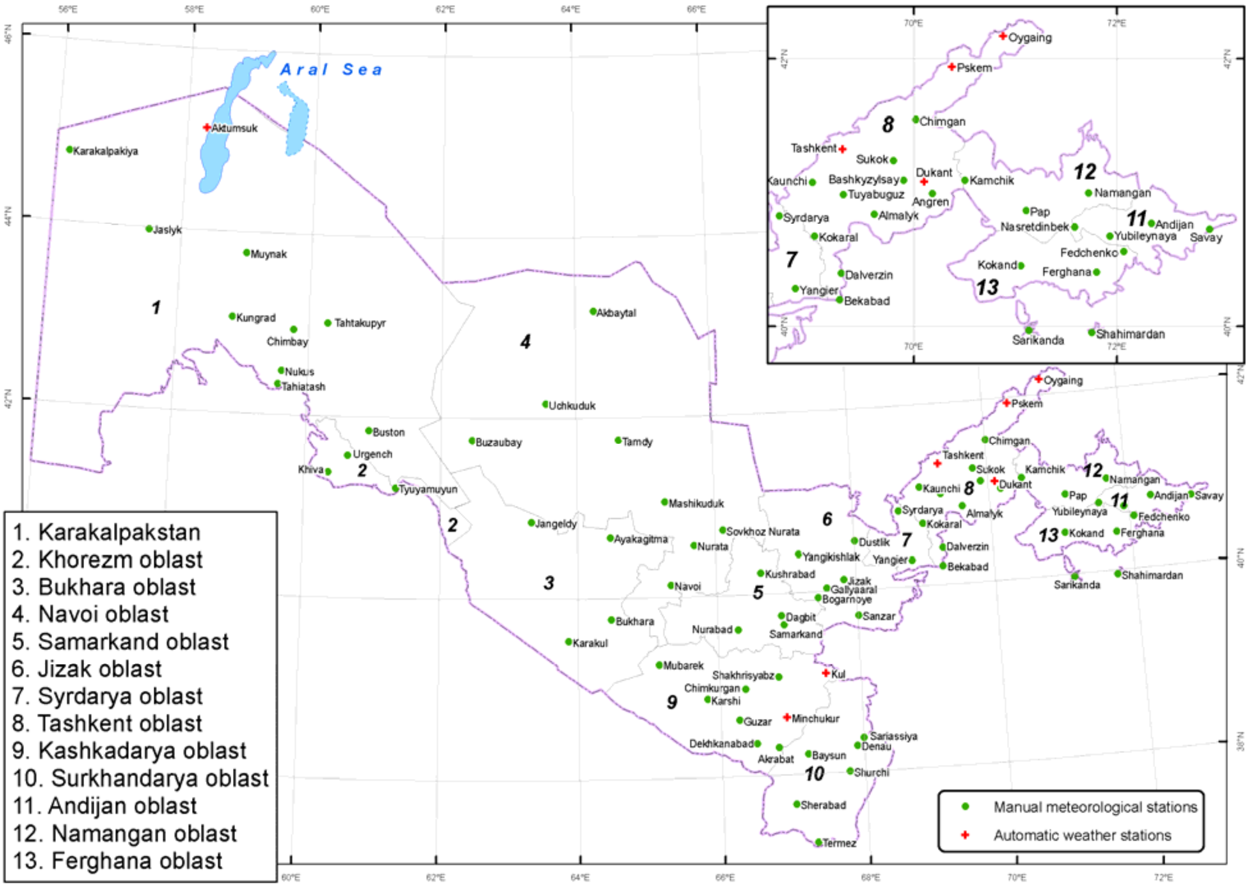

Fig.1 Scheme of observational meteorological network of Uzbekistan

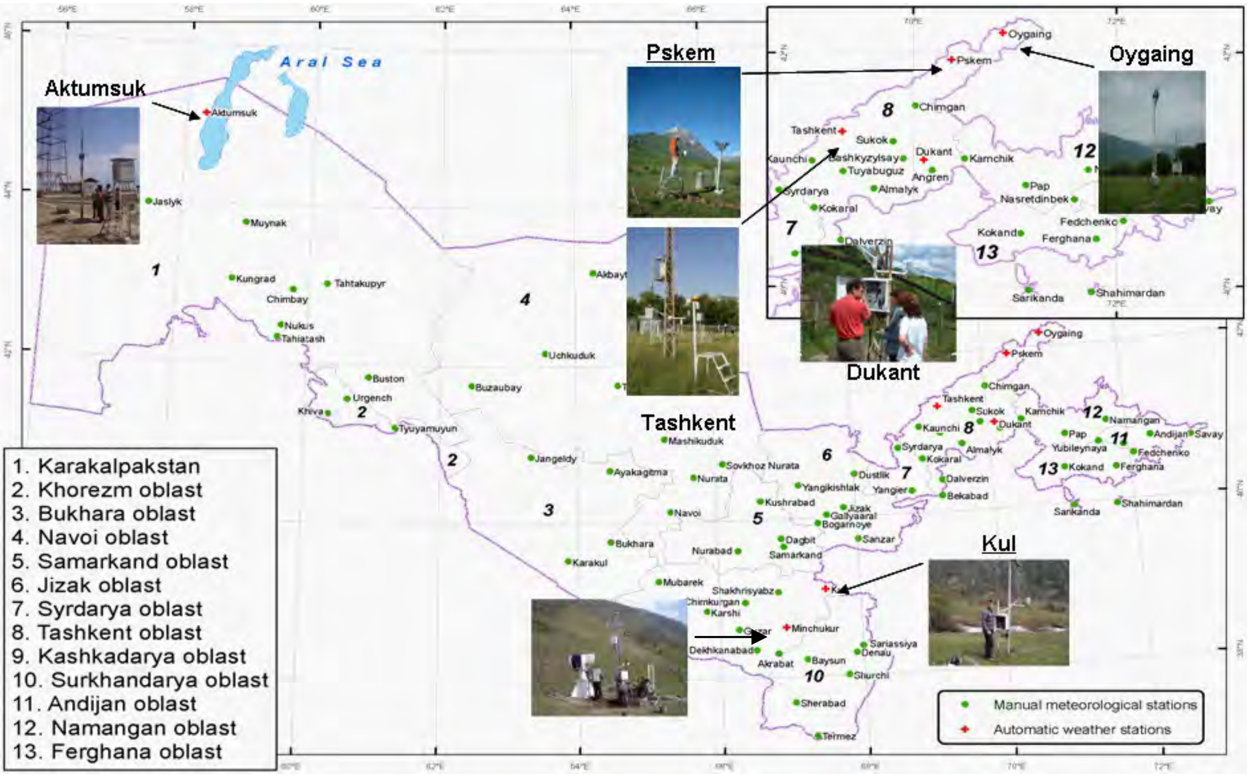

Fig.2 Scheme of observational automated weather stations network of Uzbekistan

1.1.3 Time and frequency of observations

Per WMO description on time and frequency of surface observation stated at cf. *2.3.2.11* .(WMO-No. 544) meteorological data are acquired on the regular 3 hours regular basis (8 times per 24 hours) over the all observational meteorological network in Uzbekistan
The meteorological observations in Uzbekistan are conducted in accordance with the following observations timetable:

☒ 00 UTC	□ 01 UTC	□ 02 UTC	☒03 UTC	□ 04 UTC	□ 05 UTC
☒ 06 UTC	□ 07 UTC	□ 08 UTC	☒09 UTC	□ 10 UTC	□ 11 UTC
☒ 12 UTC	□ 13 UTC	□ 14 UTC	☒15 UTC	□ 16 UTC	□ 17 UTC
☒ 18 UTC	□ 19 UTC	□ 20 UTC	☒21 UTC	□ 22 UTC	□ 23 UTC

1.1.4 Data flow to users and archives

Meteorological data are acquired on the regular 3 hours regular basis (8 times per 24 hours) over the all observational meteorological network in Uzbekistan.
Data come to Uzhydromet from observational network via short waves radio channels through the local centres of communication (so-called Bush CommCentres). Bush CommCentres send data to CommCentre where data pass preliminary data control and data processing. These data are stored with data storage CommCenter resources no longer then 3 days. Final data processed are stored as hard copies of tables (TMC-84) and monthly meteorological report in which the main meteorological characteristics are compiled .
CommCenter provides the communication link to informational resources for end users of meteorological information and maintains the operational status of communication facilities.
Servers and software of CommCentre provide data routing, preliminary data quality control and data storing.
Operative Weather Service and the Hydrometeorological Data Support Service provide wide spectrum of services the hydrometeorological data provision for end users.
There are agreed list of governmental bodies and organizations that are provided with free meteorological data. Users that are out of that list are provided with paid data.

On the inter-state level there occurs sharing by hydrometeorological information between NHMS of the region. 75 hydrological stations,water gages and 280 meteorological stations are included into the process of inter-state operational data exchange . 3 meteorological stations (Tashkent? Tamdy and Chimbay) are included into Global Observation System network that data are transmitted via CLIMAT cable to the GOS on the monthly basis.
Per WMO request the NHMS of Uzbekistan had run data transmitting for 9 more stations to the GOS. Nowadays data for 12 stations are available not for WMO only but for all world informational centres since January1, 2001.

2. Siting and metadata

Existing observational meteorological network is spatially imbalanced. The highest density of stations population is dated to territories with elevations in 0-1500 m.a.s.l. interval .Figure 3 shows the distribution of the numbers of meteorological stations by elevation intervals. From that it is obvious that there is insufficient coverage with meteorological observations high-mountain and the runoff forming zones.

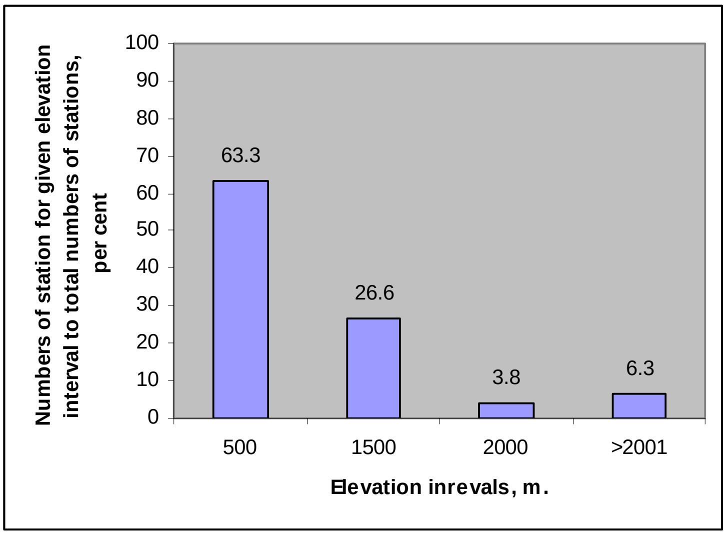

Fig.3 Distribution of the numbers of meteorological stations by elevation intervals.

As it was mentioned above the data processed are stored as hard copies of tables (TMC-84) and monthly meteorological report in which the following meteorological characteristics are compiled :

Content of TMC-84

3 hours data observations	
1	Air temperature, soil temperature, dew point temperature
2	Partial pressure of aqueous vapor
3	Relative humidity
4	Aqueous vapor saturation deficit
5	Atmospheric pressure
6	Rate of visibility and cloudness
7	Type of weather
8	Wind speed/direction
9	Precipitation (measured at 03 and 15 MGT)
Daily data	
1	Air temperature: average,max, min, min of dew point
2	Soil temperature: average, max, min
3	Partial pressure of aqueous vapor

4	Relative humidity :average, min
5	Aqueous vapor saturation deficit: average, max
6	Atmospheric pressure
7	Wind speed:average, max
8	Totalized precipitation
9	Snow depth
10	Solar radiance duration (data on 20 stations available)
11	Soil temperature profile (data on 14 stations available)
12	Ice crust deposits
13	Type and duration of precipitation

Meteorological monthly and yearly books content

№	Type of observations
1	Air and soil temperature (average,max, min)
2	Humidity (relative, absolute)
3	Visibility&cloudness
4	Wind speed (average, max gust)
5	Wind direction due to 16 compass points
6	Wind direction due to 8 compass points
	Atmospheric pressure
7	Precipitation
8	Precipitation measured on the water gage stations (it is published in the meteorological monthly book)
9	Daily and by 10 days period totalized precipitation (it is published in the meteorological monthly book)
10	Атмосферные явления, число дней, количество часов Atmospheric events (number of days/hours)
12	Pluviograph records (data from 10 stations)
16	Hazardous phenomena
17	Snow depth and snow condition
18	Solar radiance duration (data on 20 stations available)
19	Soil temperature profile (data on 14 stations available)
25	Ice crust deposits (it is published in the meteorological monthly book)

3. Instruments, sensors, upgrade, maintenance, instrument intercomparisons and traceability

As part of the effort to strengthen trans-boundary water resources management within the region, the US Agency for International Development's (USAID) Natural Resources Management Program (NRMP) funded a pilot automated climate data collection network. Sixteen automated weather stations (AWS) were installed within Tajikistan, Kyrgyzstan, Kazakhstan, Uzbekistan and Turkmenistan during the period from February 2002 to September 2003. Similar equipment is deployed throughout the world. Ease of use, low operational cost, suitability for remote unmanned operation, proven reliable collection of high quality data and capability to electronically store and transfer data are the primary reasons for utilizing automated climate monitoring instrumentation. Most of these stations use the USAID sponsored meteor burst radio communications to provide real time data telemetry and acquisition.
Two basic types of automated weather stations (AWS) were deployed within the five central Asian republics. Thirteen of the stations were designed to provide a complete array of typical climate parameters used for water resources management. These stations provide measurements needed for precipitation and evaporation estimation. In addition, the stations provide climate information typically provided for World Meteorological Organization synoptic observations. In addition, three of the stations were designed to also provide continuous monitoring of frozen precipitation. The stations were modeled after the SNOTEL monitoring

network located in the western United States and provide accumulated precipitation and snow water equivalent measurements in addition to the climate parameters provided by the other stations. Table 1 is a summary of the instrumentation that was installed at the stations.

Table 2
Measured meteorological parameters and deployed sensors for NRMP automatic weather stations.

Meteorological Parameter	Sensor	Manufacture Reported Operating Range and Accuracy	Notes:
Data logger and Control Module	Campbell Scientific CR10X	-55..+85°C ±0.1 of Full Scale Range @ (-25 to 50 °C)	
Air Tem-perature	Vaisala HMP45D w/ Pt 100 IEC 751 enclosed in RM Young 41003 Multi-Plate Radiation Shield	-40..+60°C ±0.2 °C @ 20 °C ±0.5 °C maximum within Range	Additional error is introduced due to heating of radiation shield and is dependent on wind speed and radiation intensity
Relative Humidity	Vaisala HMP45D w/ HUMICAP® 180	0..100% ±1% against factory references ±3% field calibration	Maximum error occurs between 90% and 100%
Atmo-spheric Pressure	Vaisala PTB100 Analog Barometer	600.. 1060 mb ±0.5 mb @ +20°C ±6 mb maximum within -40.. +60 °C Range	Measures absolute pressure and uses equation to calculate pressure at sea-level
Wind Speed and Direction	RM Young 05103	Wind Speed 0..60 m/s Gust survival 100 m/s ±0.3 m/s Wind Direction 0..355° ±3°	
Solar Radiation	Kipp & Zonen CM3	0..2000 W/m^2 ±10% for daily sums	Second Class thermopile type pyranometer Standard ISO 9060.
	LiCOR LI200X	0..3000 W/m^2 ±5% maximum absolute error in natural daylight ±3% typical	High stability silicon photovoltaic detector. Comparable to a first class thermopile pyranometer.
Preci-pitation (Rainfall)	Texas Electronics 525M Tipping Bucket Rain Gauge	0.1 mm resolution 1.0% < 25 mm/hr +0..-3% 25..50 mm/hr +0..-5% 50..75 mm/hr	Not suitable for measurement of snow. Heated tipping bucket rain gauges are not recommended by WMO.
Prec-ipitation (Accumulated)	Storage Gauge w/ Druck 1230 Submersible Pressure Transducer	7m H_2O 2 cm H_2O resolution	Requires annual recharge of antifreeze. Pressure transducers are subject to mechanical non-linear drift.
Snow Water Equivalent	3 meter Hypalon® Snow Pillow w/ Druck 1230 Pressure Transducer	7m H_2O 2 cm H_2O resolution	Extremely sensitive to placement. May be under representative because of snow bridging.
Ground Tempe-rature	CSI T-107/8 Thermistor	T-107: -35°..+50°C ±0.4°C for range of –24°..48°C T-108: -5°..+95°C ±0.3°C for range of –3°..90°C	Sensitive to solar radiation heating when sensor exposed to sunlight

Over the last years of this pilot program the AWS stations have demonstrated the capacity to provide reliable and consistent climate observations. The devices have required minimal maintenance while providing high quality regular observations. It is not recommended that

automated monitoring replace historical manual climate observation stations. However, automated stations can provide a cost effective and sustainable means for establishing a more comprehensive climate-monitoring program in the Central Asian Republics.
Electronic sensors evaluate the same physical phenomenon using different physical properties. For example, a liquid thermometer determines temperature by measuring the change in liquid volume where a Platinum Resistance Thermometer measures the change in electrical resistance. Sensor measurement time constants are different and the interaction of the sensor to site placement and enclosures will be different. Traditional calibration methods may not be suitable for calibration of electronic sensors. Field evaluation and calibration techniques are available for assessment of the operation of the sensor, but require a higher level of technical skill to perform than the more traditional sensors. Periodic calibration may require sophisticated offsite or lab evaluation. Electronic sensors require the inclusion of an analog to digital converter that may introduce additional error. Periodic maintenance and data quality evaluation will still need to be followed in order to assure the quality of the AWS data. Automatic operational alarms and periodic data quality review procedures must be implemented in order to assure the timely repair of equipment failure. Emergency maintenance trips may be warranted as review of the data indicates abnormal station operation.

Because of the recognized differences, AWS instrumentation is not typically considered for replacement of manual instrumentation for historical climate stations. Simultaneous operation can help define some of the differences in the change of station, but simple correlation will not be sufficient for defining all of the differences due to the inherent noise in climatic data.
Differences were evaluated between the simultaneously and automated collected data. Hourly data was compiled and compared at various time intervals for the four stations.
In general, climate observations of the automated equipment over the approximately two-year operation agreed very well with the manual observations. Differences in the mean temperatures for the three-hour temperature ranged from 0.030 to 0.220 °C. Differences between the temperature extremes ranged from 0.049 to 0.595 °C. Relative humidity differences ranged from 1.2% to 0.5%. Atmospheric pressure ranged between 0.482 to 0.936 millibars. Except for temperature there appears to be no bias in the observations.

Over the last two years of this pilot program the AWS stations have demonstrated the capacity to provide reliable and consistent climate observations. The devices have required minimal maintenance while providing high quality regular observations.
The results of comparative statistical analysis say that:

1. Only daily averaged measurements by sensors look like as confident in terms of statistically proven homogeneity in respect to manual data series.
2. Data come from sensors with 3 hours resolution cannot be merged to the manual data series as being a replenishment of that data series without adequate data processing because the risk of heterogeneity.
3. Variance sensor data-manual data can be minimized via mitigation the ambient influences.

4. Quality assurance / quality control (real-time, non-real time)

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Per WMO requirements to data control Within the framework of the Global Observing System (GOS). (WMO-No. 544) the following successive data control are applied in operative Uzhydromet practice:

- **In situ level** (before data transmitting to Communication Centre) : Observer's preliminary data control doing per experience and logical considerations.
- **Communication centre level** (before bulletin is formed and transmitted to GTS) : The data preprocessing of data received to check the compliance data coded with coding rules per WMO's telegrams coding requirements.
- **Synoptic Operational Service level** (within 1 hour after bulletin has been formed and transmitted to GTS) : Synoptic operational shift staff collates data after mapping and makes any amendments if need per its experience, logical current considerations and via immediate

feedback to observational network. Any reliable amendments are sent to GTS as delayed compliments to bulletin sent earlier.

- **Data processing centre level**: Comprehensive data control and analysis doing before meteorological data monthly books publishing.For data processing the program modules of PERSONA-mis and PERSONA-IB are used.

5. Training

Two programs addressed to improvement the national meteorological service via installation three Doppler locators at main airports of Uzbekistan and to facilitate access to high resolution satellite images (purchase and installation of the High Resolution Picture Terminal for receiving satellite images processed by TERRA/MODIS) funded by government of Uzbekistan serial training programs are expected.

6. Statistics and applications

The major objectives of Uzhydromet are the development and improvement of the state system of hydrometeorological observations, hydrometeorological provision of the sectors of economy, scientific research activities, improvement of short-term and long-term weather forecasts, water availability of rivers, climate change.

The main meteorological characteristics measured or calculated are listed under item 2. Climate data as a product of processing the meteorological data that can mostly be derived from the available set of meteorological data. Post processed climate data had been published in the “Scientific applied climate handbook” and are available as only hard copies.

Operative data come from observational hydrometeorlogical network are mainly used for:

- Provision of the state management bodies and branches of economy with the information on the condition of natural environment and climate, current and anticipated changes in hydrometeorological conditions.
- Issuing the short-term (next day, with three-six days lead time weather forecasts)and long-term weather forecasts.
- Data Input provision for climate scenarios design and modeling
- Warning on the anticipated risk of hydrometeorlogical disasters
- Compiling the “Weather reviews” and “Ecological bulletins”
- Publications, scientific researches and engineering.

7. Current issues and future plan

The following issues as the main existing barriers on the way to full value use of data could be mentioned:

- **Insufficient representativeness of existing observational ground network from of both spatial and informational view points.** From that it is obvious that there is insufficient coverage with meteorological observations the runoff forming zones.

- **Data series gaps by different reasons like measuring instruments breakage, observer’s faults, radio communications jams, electricity outages etc**.
- There are some gaps in the hydrometeorological data series that break homogeneity and continuity of data series. Those gaps can be explained by different reasons. Mainly they appear as results of observers negligence, measuring instruments breakage and radio communication faults. The suspicious data that have the mentioned above nature just filtered out from proved data series during data processing procedure but they are not restored.

- **Data available as only hard copied.** Data are storing as hard copies hinder the process of data preparation , process and control. It is really tiresome and laborious routine to transfer data from hard copies to electronic data storages. But it is to be proceeded anyway.

- **Insufficient data base design and existing data bases dissociation**.The process of unification the data base storage formats that would enable easy reciprocal data conversion has not been completed. Mainly existing data bases are stored as operational files for DOS only. Moreover existing data bases need to be fused into integrated informational platform. These archaic data storage is not able to support fast and efficient data exchange for operational hydrometeorological service current needs.
- **Insufficient automated stations network development**. Ongoing world wide progressive use of automated observational networks proves the beauties of this option of data acquisition and control . Rate of coverage the informational needs with data come from AMS is characteristic of readiness to meet advanced data acquisition and control requirements. There are only 7 sites equipped with AMS within observational hydrometeorological network of Uzhydromet that have't been included into CAR ComCentres data exchange contour yet.
- **High resolution picture terminal receiving facilities to receive process and disseminate high resolution digital satellite data unavailable.** To provide large scaled effective and reliable monitoring on glaciation change the high resolution satellite picture receiving facilities are to developed and installed. Uzhydromet has such facilities allow to gather information come from NOAA 18 with the best resolution as 1 km only. Such resolution doesn't enable recognition of natural objects with dimension equal or less than 1 km. At the same time such dimension is characteristic for the main number of glaciers in the region. Other recourses with resolution 250 m and higher were available on the irregular basis only.
- **Radio sounding upper air stations unavailable.** Upper air measurement got gradually stop after USSR collapse. There are no radio sounding upper air station now. That's why the informational shortage on vertical profile of the main meteorological parameters negatively affect to processes of data ingestion by dynamic modeling of upper air processes. Such data provision helps to improve and calibrate the developed models.

Proposed steps forward to improve the current status data acquisition and data control system

- Enhancing the spatial and informative capacities of the observational network.

- Data transfer from hard copies to the electronic data storages.

- Complete data statistical analysis to get reliable relationships to restore the existing data gaps .

- Improvement of existing data bases and ensure the integrated informational platform preconditions.

- Provision of the activities addressed to the rehabilitation of the operational status of the automated meteorological stations network and including them to the CAR ComCentres data exchange contour.

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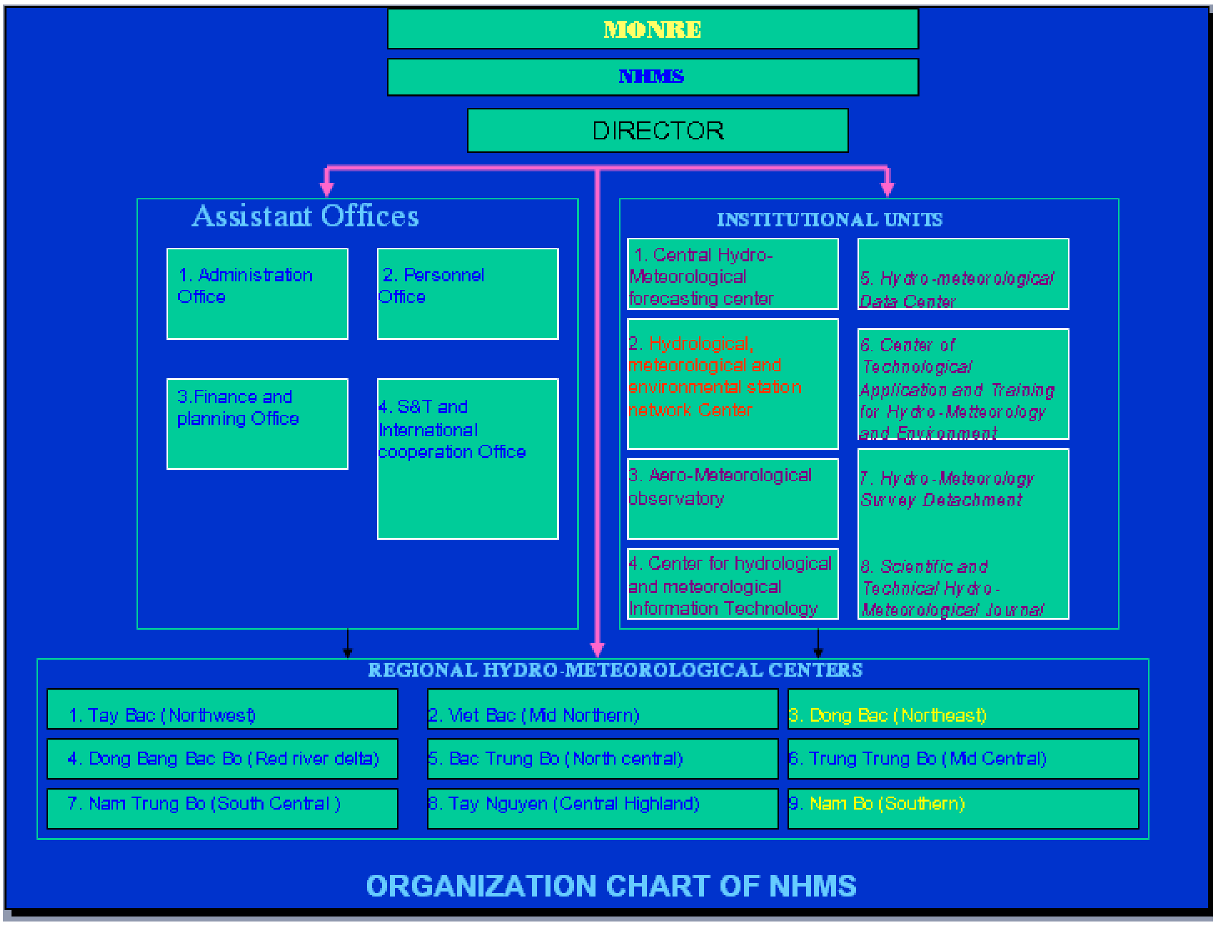
CURRENT STATUS AND FUTURE PLAN OF SURFACE, CLIMATE AND UPPER-AIR OBSERVATIONS OF NATIONAL HYDRO-METEOROLOGICAL SERVICE OF VIET NAM

(Submitted by: Nguyen Dinh Luong,National hydro-Meteorological Service of Viet Nam)

Summary and Purpose of Document

This report introduces National Hydro-Meteorological Service of Viet Nam, its activities and organisation. Current status and future plan related to surface, climate and upper-air observations of Viet Nam are also presented.

The National Hydro-meteorological Service of Viet Nam (NHMS) is a body under the Ministry of Natural Resources and Environment of Viet Nam. The main responsibility of NHMS is to manage and operate network of meteorological, hydrological and environmental stations, conduct hydro-meteorological forecast and other services related to these field of operation for socio-economic development of the country.



1. Observation networks

1.1 Surface observation

In total, there are 174 surface meteorological stations in operation in the whole territory of Viet Nam. All stations are manned stations. In the past, some stations were equipped with automatic instruments but all of them are out of work at the present.

1.1.1 Number of stations: RBSN, RBCN, GSN, manned stations and AWS*

Table 1: Number of stations

	RBSN	RBCN	GSN	Manned stations	AWS *
number	174	174	25	174	0

*An automatic weather station (AWS) is defined as a“meteorological station at which observations are made and transmitted automatically”.

1.1.2 Station map

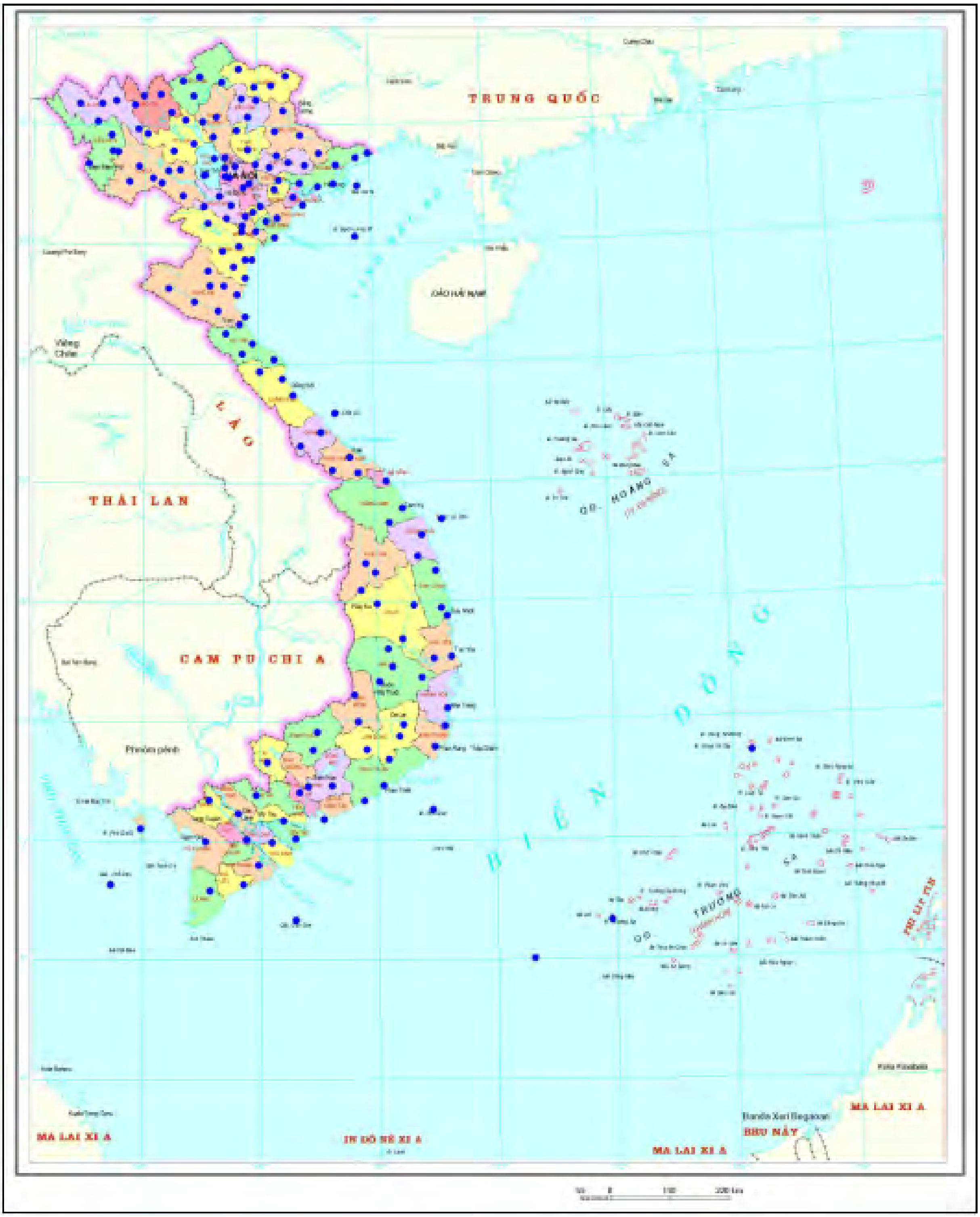


Figure 1: Map of Meteorological stations of Viet Nam

Figure 2: Global Synoptic Network of Viet Nam

1.1.3 Time and frequency of observations

From these 174 stations, 43 stations conduct and report 8 observations per day at 01h, 04h, 07h, 10h, 13h, 16h, 19h, 22h by local time (18h, 21h, 00h, 03h, 06h, 09h, 12h, 15h by UTC respectively) and other 131 stations do 4 observations and reports per day at 01h, 07h, 13h, 19h by local time (18h, 00h, 06h, 12h by UTC).

For the stations affected by typhoon, during typhoon time the observation of wind speed and direction, rain will be conducted and reported at least every hour. Except that, during typhoon time forecasting bureau can request stations in the typhoon affected area to do observation and report every 30 minutes.

1.1.4 Data flow to users and archives

Data collected at the stations will be transmitted to the forecasting center in near real time by telephone or ICOM (for the stations where there is no telephone line). Hard copy of collected data will be sent to the regional centers for primary processing and checking. In the next step, after primary processing and checking at regional level, all data will be sent to the National Center for final processing and checking before archiving. At the present, all data are archived only in hard copy form (paper).

The users can get data in regional centers or in central data archive center.

1.2 Upper-air observation

1.2.1 Number of stations: RBSN, RBCN, GUAN, manned stations and automated system stations

Table 2 Number of stations

	RBSN	RBCN	GUAN	Manned stations	Automated system stations
number	13	13	13	13	

1.2.2 Station map

Figure 3: location Map of the upper-air stations.

1.2.3 Time and frequency of observations

At the present, from 13 upper-air stations, 3 stations carry out observation and report at 07h and 19h of local time (00 UTC and 12 UTC respectively), one station - at 13h of local time (06 UTC) and others at 00 UTC.

1.2.4 Data flow to users and archives

Upper-air observation data collected at the stations will be transmitted to the forecasting center in near real time by telephone or internet. Hard copy of collected data will be sent to the regional centers for primary processing and checking. In the next step, after primary processing and checking at regional level, all data will be sent to the National Center for final processing and checking before archiving. At the present, all data are archived only in hard copy form (paper).

The users can get data in regional centers or in central data archive center.

2. Siting and metadata

Technical documentation (station book) is created for all stations. There are two hard copies of technical documentation for each station, one for station and one for network management center.

The content of technical documentation consists:

- Siting specifications: location map, longitude, latitude, pictures (at least from two sides), elevation above sea level, horizontal visibility.
- Station history and duty.
- Instruction how to go to the station.
- Description of landscape around the station in radius of 300m, 3000m, and 8000-10000m. Record all changes in landscape around the station.
- Description of garden and location of observing instruments in the garden.
- Description of horizon line at the station.
- Station staff: number of staff, education, staff change.
- Instrument: number of instruments in use and spare, technical specifications, calibration time.

Every supervision visit to the station will be recorded in this book with comments and recommendations of head of supervision team or expert.

3. Instruments, sensors, upgrade, maintenance, instrument intercomparisons and traceability

In recent years, observing instrument and equipments used in the network are improved and upgraded. Under NHMS of Viet Nam there are 3 calibration laboratories (one central and two regional) that are located in the North, Central and South part of the country. The regional laboratory is responsible for calibration of temperature, humidity and air pressure sensors and simple maintenance and repairing work. Central laboratory is responsible for calibration of wind, rain and other sensors that request experts of high skill and modern equipment.

According to the cooperation program with China Meteorological Administration (CMA), every two years Vietnamese experts bring air pressure standard to China for conducting instrument intercomparisons.

4. Quality assurance / quality control (real-time, non-real time)

After each observation head of the station have to perform checking of collected data before coding and transmitting to the forecasting center and on the Global Telecommunication System.

Every station is provided with technical instruction and guide book and operators at the station have to strictly follow all procedure related to observation and data processing in this book.

Experts from regional centers regularly perform visits to the stations for looking at operation of instruments, complying of technical regulation and guide and other issues related to the operation of the station that can affect data quality.

By the regulation on station management and operation, each station will be visited by experts from NHMS one time per three years.

Quality control of observational data will be performed at two levels: regional and national prior to forwarding for archiving.

5. Training

The most of operators at the stations get their education in Colleges of Natural Resource and Environment (There are two of them in Viet Nam that belong to the Ministry of Natural Resources and Environment of Viet Nam).

NHMS of Viet Nam organises training activity for station operators when new technical instruction and guide is issued or changed.

Every 5 years, NHMS organises 7-10 day training course for chief of stations where they can get newest knowledge related to the station management and operation.

In addition, operators at the stations can get on the work training when experts from national and regional centers have visits to the station.

6. Statistics and applications

Observation and collected data is used for forecasting, scientific research and in many fields of national economic activities.

At the present, no any publication of observation and collected data is carried out. All users can come to the data archive center or to the regional centers for getting observation and collected data. At these centers they can make their request and experts from these centers will provide them with requested data.

7. Current issues and future plan

At the present the number of stations is not enough to meet the need of national socio-economic development. All stations are manned. The most of observation Instruments and equipments are rather old and underdeveloped. The needs of network expand and modernisation is very big.

Recently, in June 2010 Prime Minister of Viet Nam has approved Development Strategy of Hydro-Meteorological Field to the year of 2020 and Modernisation Project for Hydro-meteorological Forecasting and Observation Network for the period from 2010 to 2012.

The main objectives of these strategy and Project are as follow:

- To the year of 2015 the number of stations is increased in 50% and 75% 0f them are automatic. All observation data is automatically processed and transmitted to the centers, 75% of observation and collected data are archived in digital form.
- To the year of 2020 the density of stations can be compared with which of developed countries and 90% of them are automatic. All observation and collected data are archived in digital form.