Republic of Korea

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

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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*

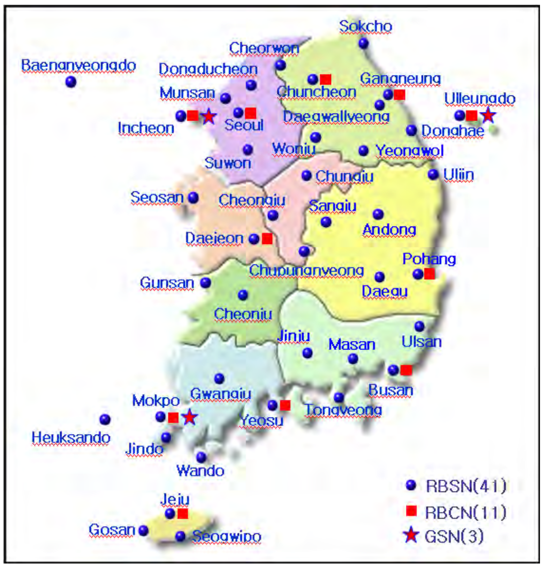
Table 1 Number of stations

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

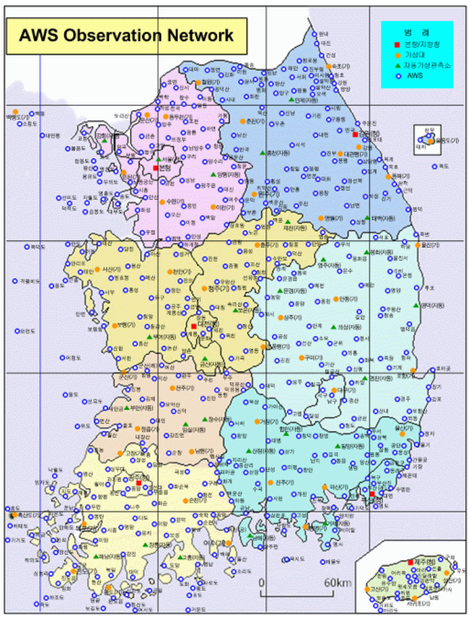
* An automatic weather station (AWS) is defined as a “meteorological station at which observations are made and transmitted automatically”.

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.

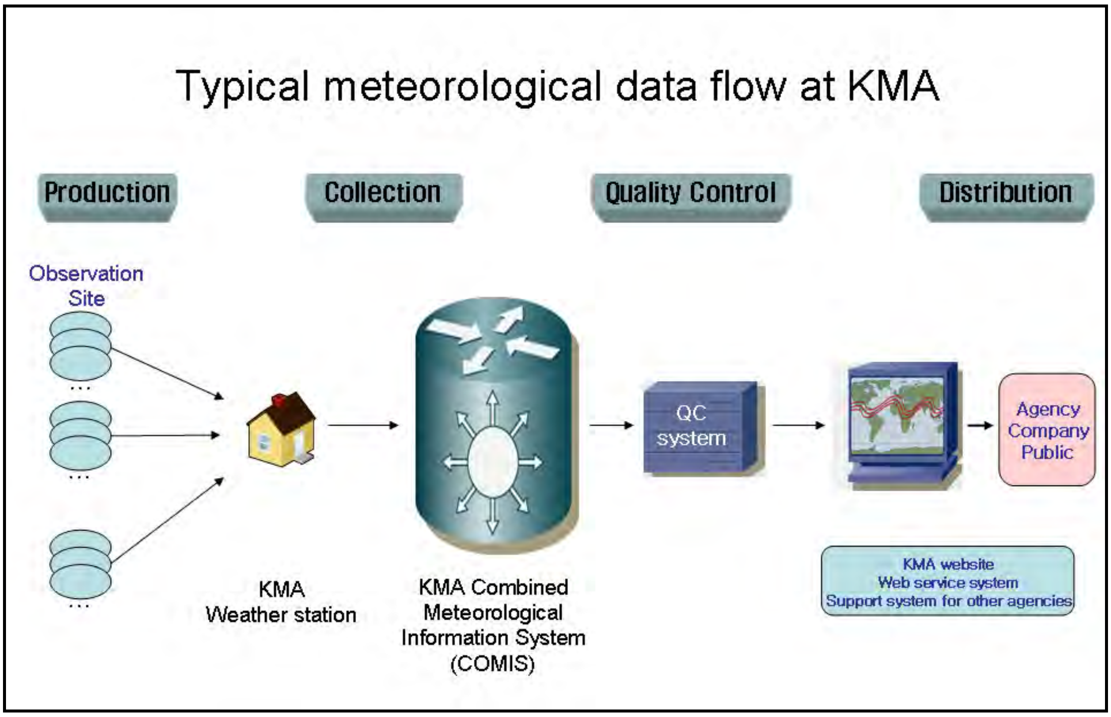


1.1.3 Time and frequency of observations

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.



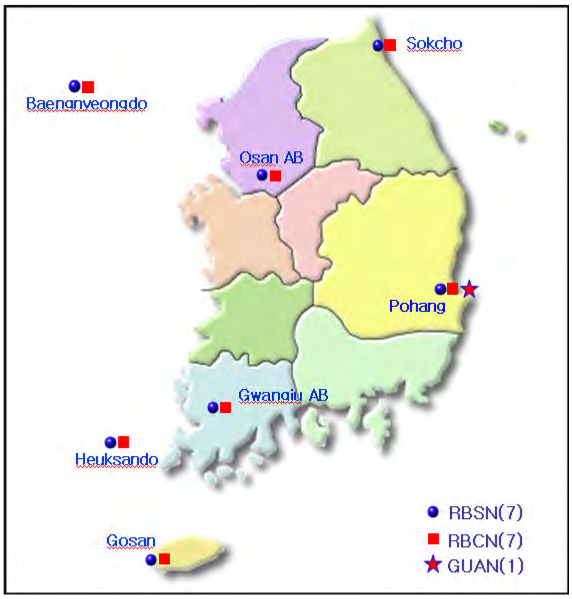
1.2 Upper-air observations

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

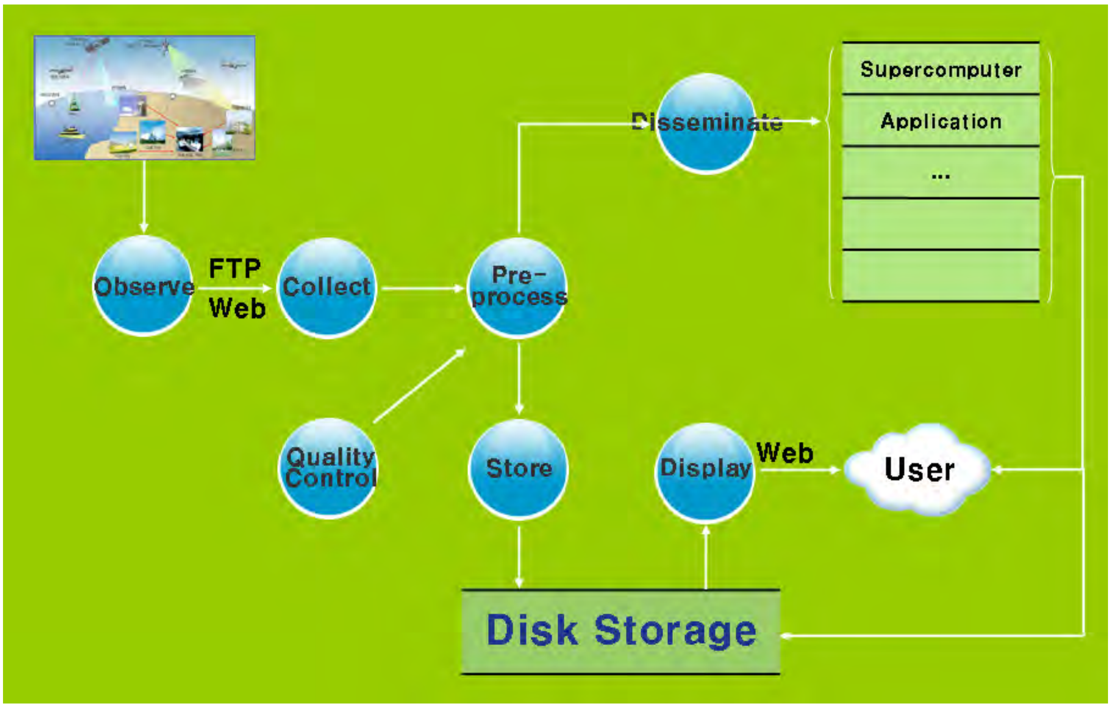


1.2.3 Time and frequency of observations

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.

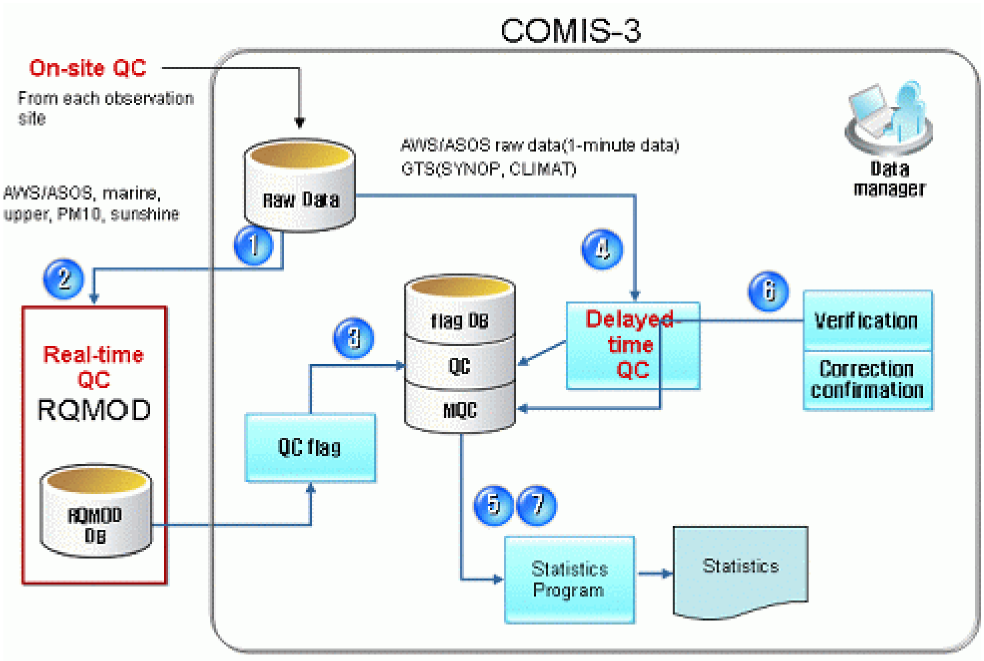
The KMA has established the standard meteorological observation sites at Chupungnyeong and Boseong. Chupunyeong, one of the KMA's synoptic observational stations, is located at the middle area of Korean Peninsula. It has been performing the synoptic observation since 1935, and was designated Korean Standard 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.

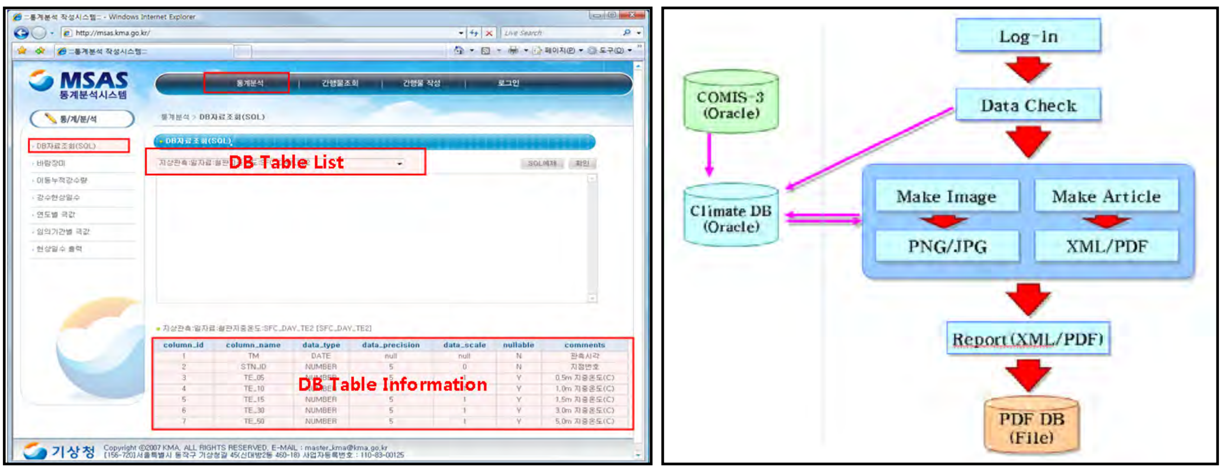
In Korea, there are many agencies and public institutions that have conducting the meteorological observations for their own purposes, such as for the transportation and the agriculture. Korean government hopes for an integrated implementation of their meteorological observation system by standardizing 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

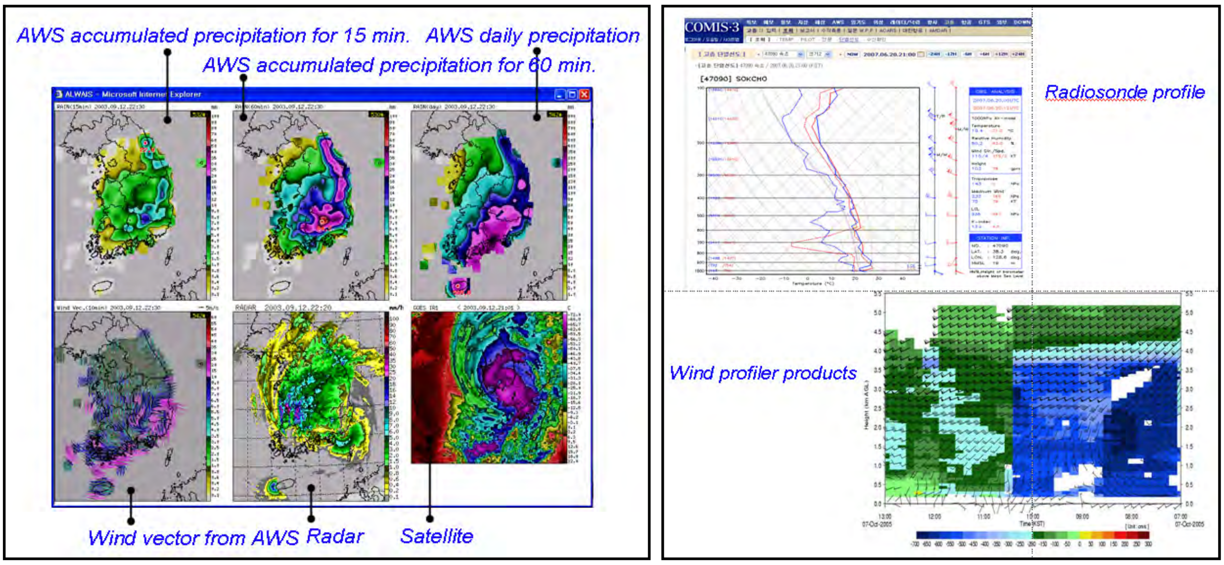
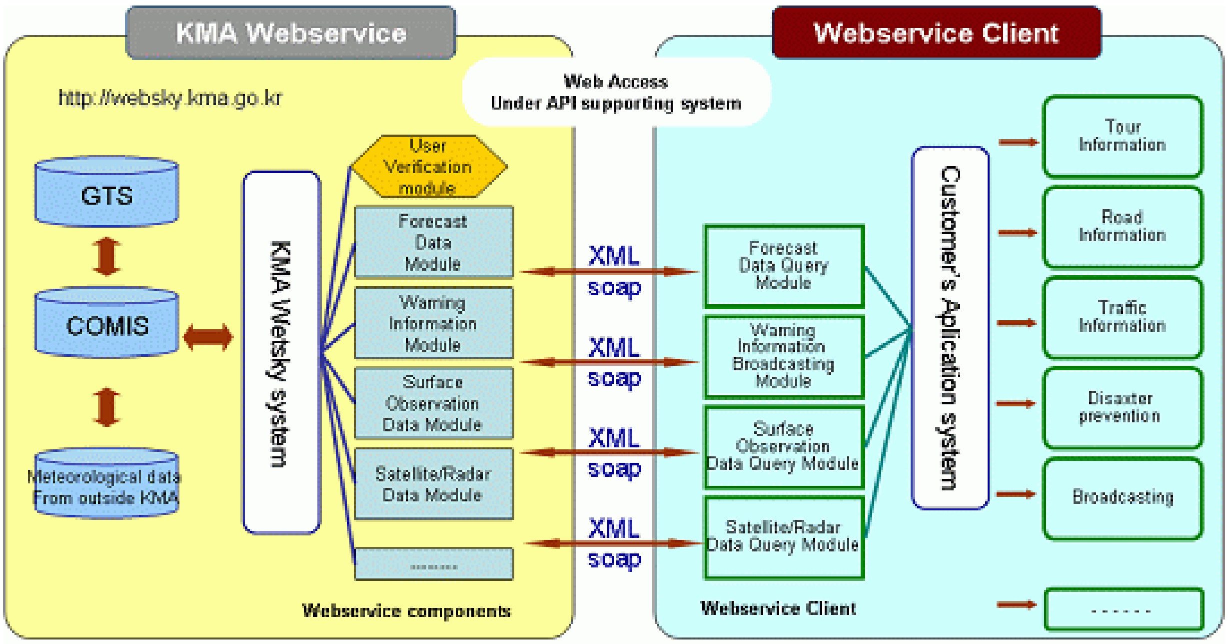


Illustration of the KMA's user-central data distribution system



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 ㎜	
	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)