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

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Country Report for Japan

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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.

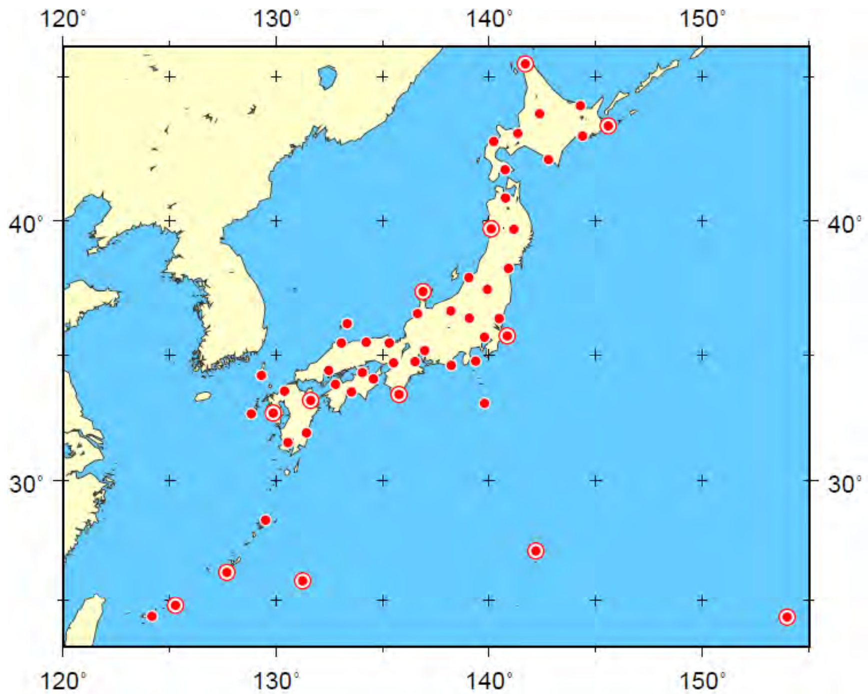

Figure 1. RBSN, RBCN and GSN stations in Japan
Solid circles: RBSN/RBCN stations; double solid circles: GSN stations (also RBSN/RBCN stations)

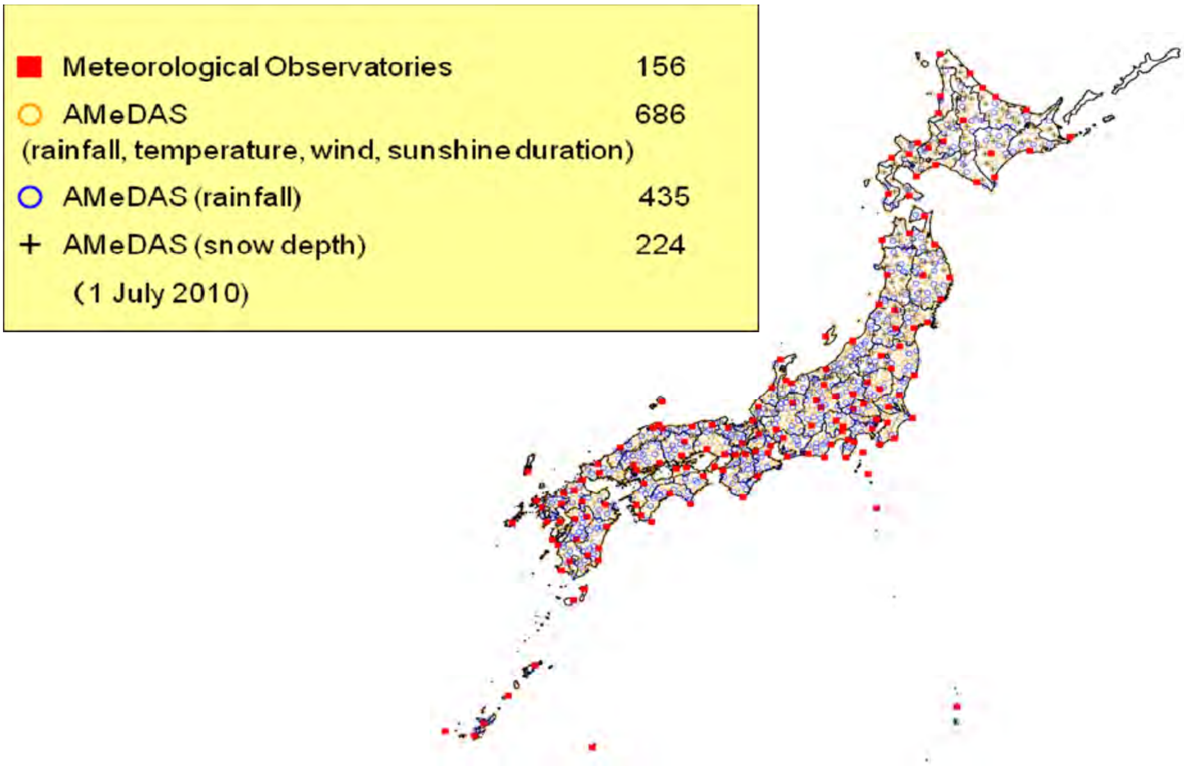

Figure 2. Meteorological observatories and AMeDAS stations (AWSs) in Japan

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.

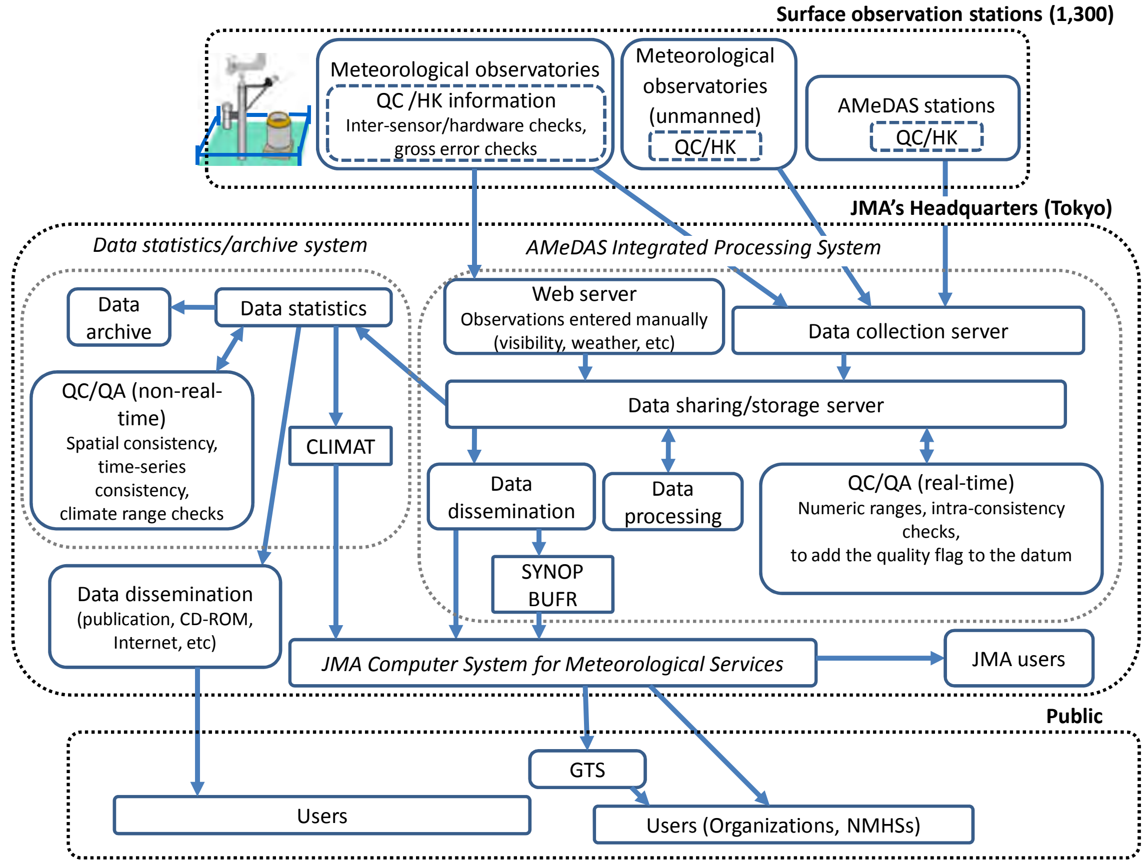

Figure 3. Flow of surface observation data to users and archives

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

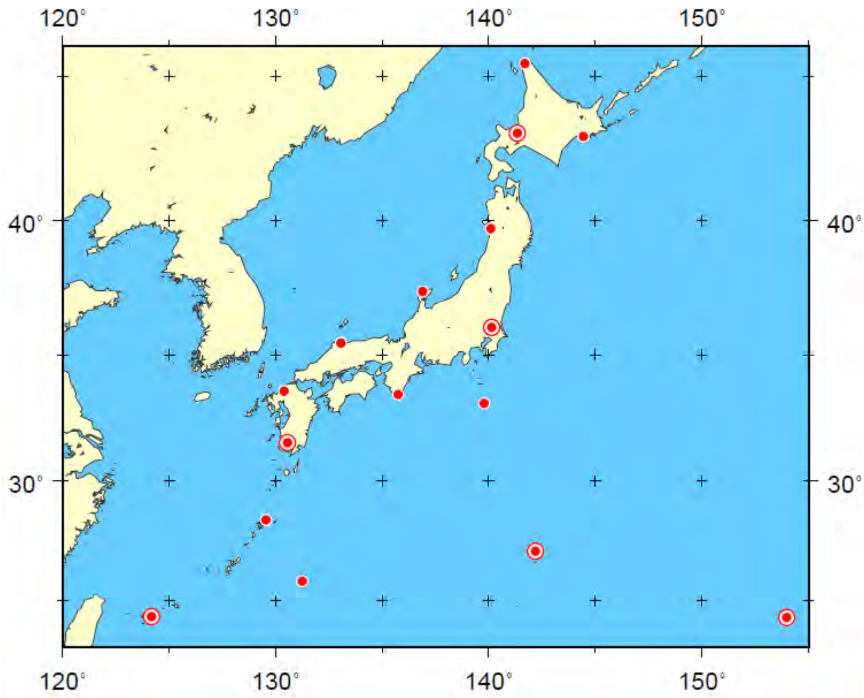

Figure 4. RBSN, RBCN and GUAN stations for upper-air observation in Japan. Solid circles: RBSN/RBCN stations; double solid circles: GUAN stations (including RBSN/RBCN stations)

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.

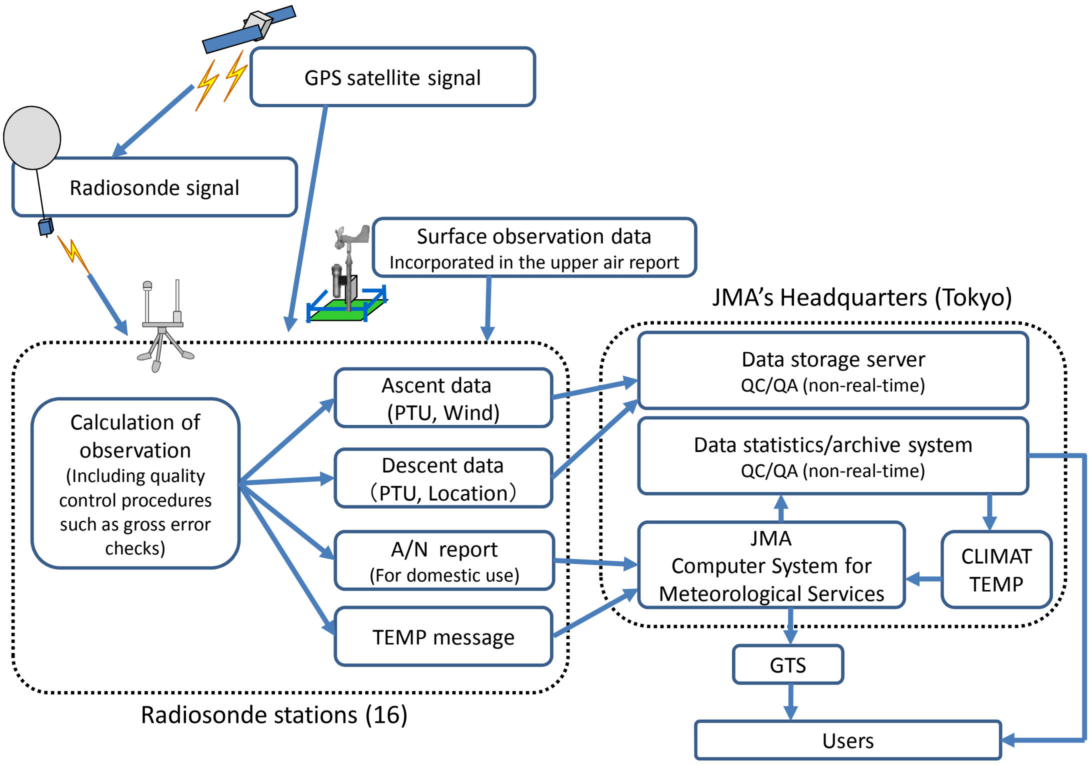

Figure 5. Flow of upper-air observation data to users and archives

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.

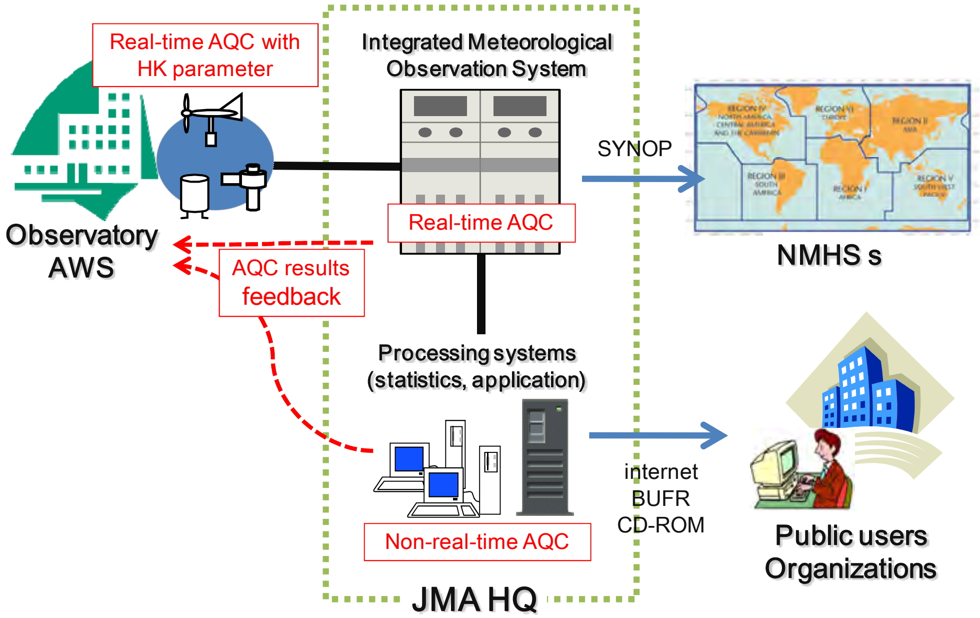

Figure 6. Flow-chart of QC for surface observation data

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.