Automated Meteorological Data Acquisition System (AMeDAS) in Japan and field experiments to determine the effects of its observation environment

Hideyuki Yato[1], Yukihiro Nomura[1], Kenshi Umehara[2], Akiko Hosomichi[2]
Saeko Kawano[2], Hideaki Mouri[3] and Satoshi Hagiya[2]
[1] Japan Meteorological Agency, Tokyo, Japan
[2]RIC-Tsukuba, Japan Meteorological Agency, Tsukuba, Japan
[3]Meteorological Research Institute, Japan Meteorological Agency, Tsukuba, Japan

JMA conducts collective surface observation using Automatic Weather Stations (AWSs) within the Automated Meteorological Data Acquisition System (AMeDAS), which observes precipitation, air temperature, wind direction/speed and sunshine duration with high temporal and spatial resolution. The system plays an important role in mitigating weather-related disaster risk.

JMA began operating AMeDAS, which currently incorporates as many as 1,300 AWSs an average of 17 km apart nationwide, on 1st November 1974. All stations observe precipitation, and around 840 also observe air temperature, wind direction/speed and sunshine duration. Snow depth is additionally observed at around 320 manned and unmanned stations in snowy districts (Figs. 1 and 2).

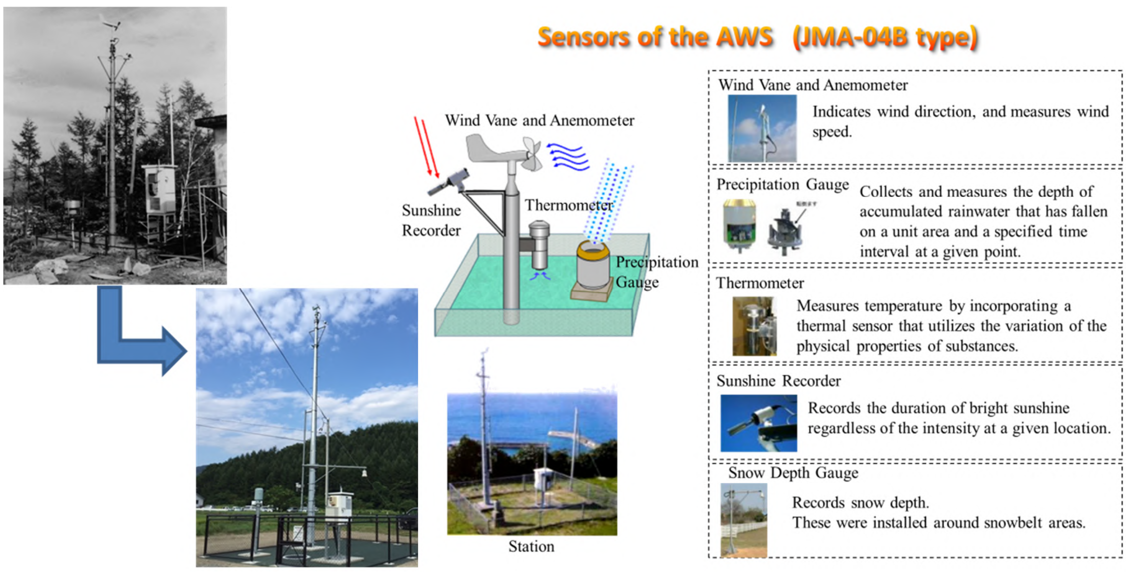


Figure 1 Past and present AWSs and AWS sensors (JMA-04B type)

E-mail: ric-tsukuba@met.kishou.go.jp
URL(JMA): http://www.jma.go.jp/jma/indexe.html
URL(RIC-Tsukuba): http://www.jma.go.jp/jma/jma-eng/jma-center/ric/RIC_HP.html

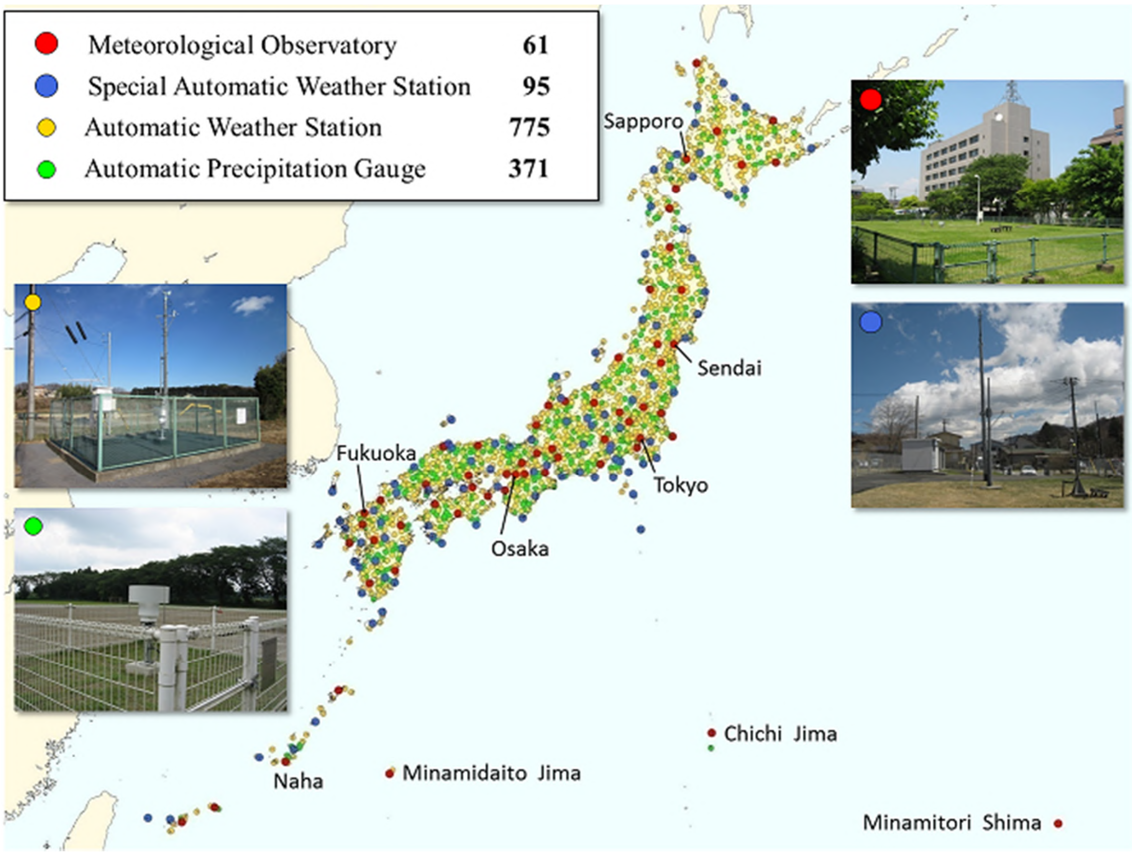


Figure 2　JMA surface observation stations

The AMeDAS Center System collects AWS data every minute or every 10 minutes, producing observation information for the corresponding periods. Automatic quality control (AQC) is applied to remove any abnormal values (Figs. 3 and 4), and AMeDAS then provides the quality-checked data to JMA meteorological observatories, private-sector operators, the media, the general public and other users. The data are also posted on the JMA website (http://www.jma.go.jp/en/amedas/).

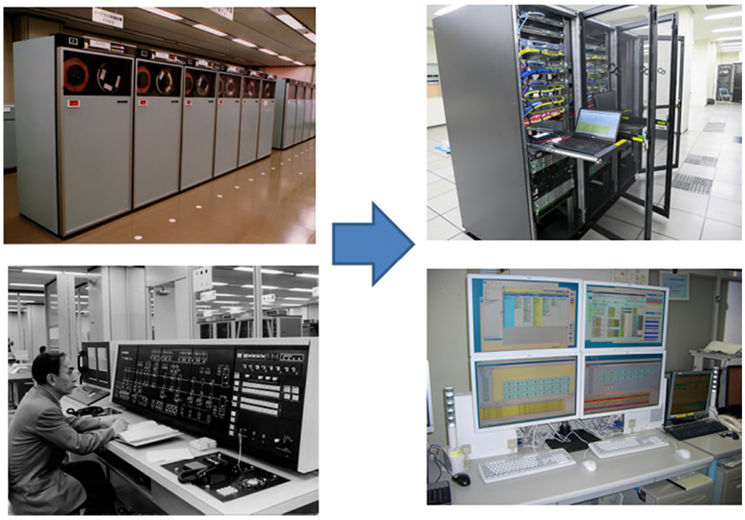


Figure 3　AMeDAS Center System past (left) and present (right)

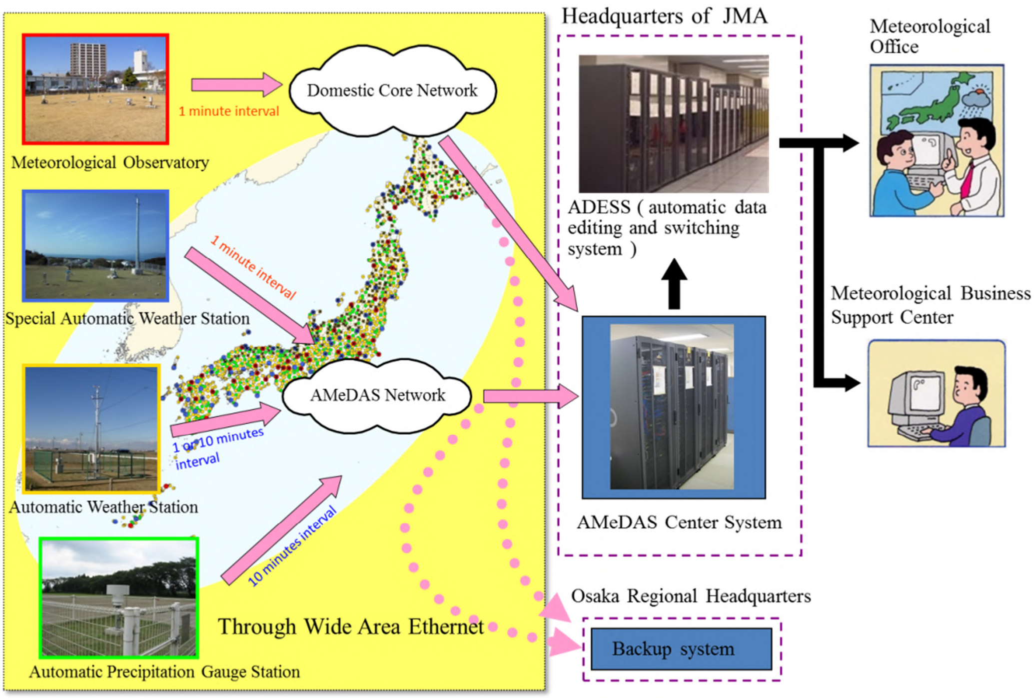


Figure 4　JMA's AMeDAS network

Example of AMeDAS quality control

(1) When the AMeDAS Center System finds unexpected data (such as records of sunshine at nighttime) during AQC, it appends the information with a "dubious value" label for user reference and notifies the relevant AWS observers of the issue.

(2) The relevant AWS observers handle the matter in line with a predetermined response flow, first checking the data/situation and removing erroneous information as necessary. AWS observation equipment is also checked in the event of suspected errors (Fig. 5).

As a result, JMA maintains high accuracy and quality in its data provision.

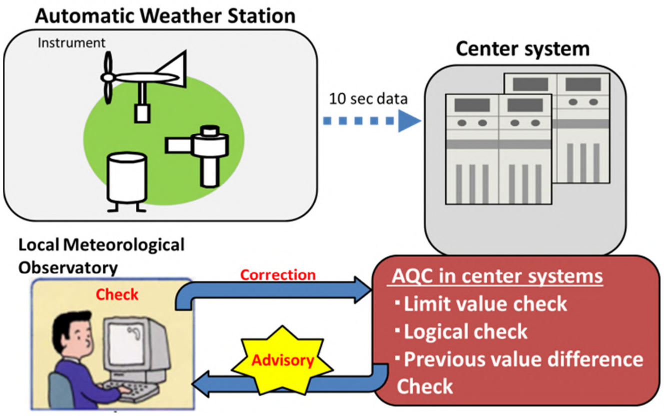


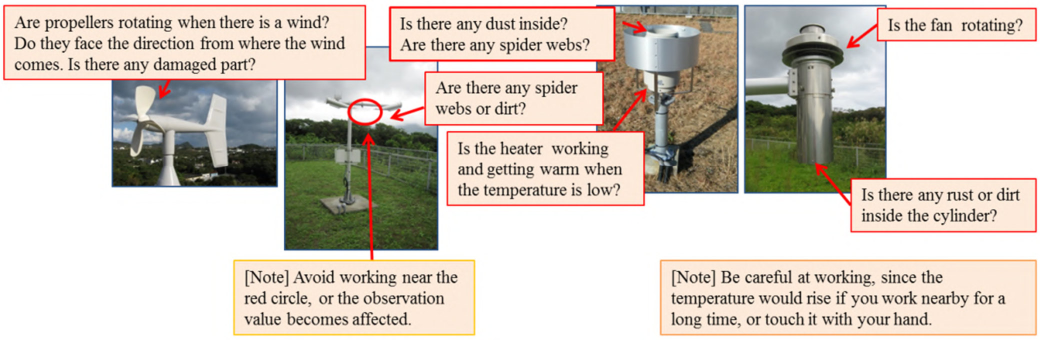
Figure 5　Center System automatic quality control (AQC)

In addition to the implementation of AQC by systems such as AMeDAS, it is also important to periodically check and calibrate meteorological instruments and perform observation environment maintenance (e.g., cutting grass) to ensure stable observation data quality (Figs. 6 and 7).

Maintenance of Surface Observation System

Target facilities

Precipitation gauge, rain sensor, shelter, snow depth gauge, visibility meter, wind vane and anemometer, sunshine recorder (rotation type) , station office, fence, observation field [grass height, trees], solar panel, power/telephone line [disconnection, flexure, etc.]), indoor housing, etc.



Details of work

- ✓ Visual confirmation
  Presence/absence of damage, rust, dirt, spider webs, dust, fallen leaves
- ✓ Confirmation by touching with hands
  Confirm the slack of attaching screw and the operating condition of heater
- ✓ Operation check and works
  Removal of dust, fallen leaves and spider webs, cleaning of glass surface, rotation (propeller…), reset, OFF/ON of power

Issues and efforts in maintenance

In addition to periodical checks, extra and infrequent checks may be required.

Although it is necessary to mow vegetation in all stations, many costs are required to tend to the site frequently.

A camera was installed in the observation field so that we could decide on an effective schedule for maintaining the site by periodically checking the situation.

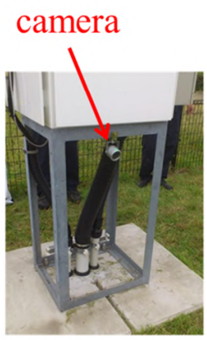


Figure 6 AWS equipment/environment maintenance

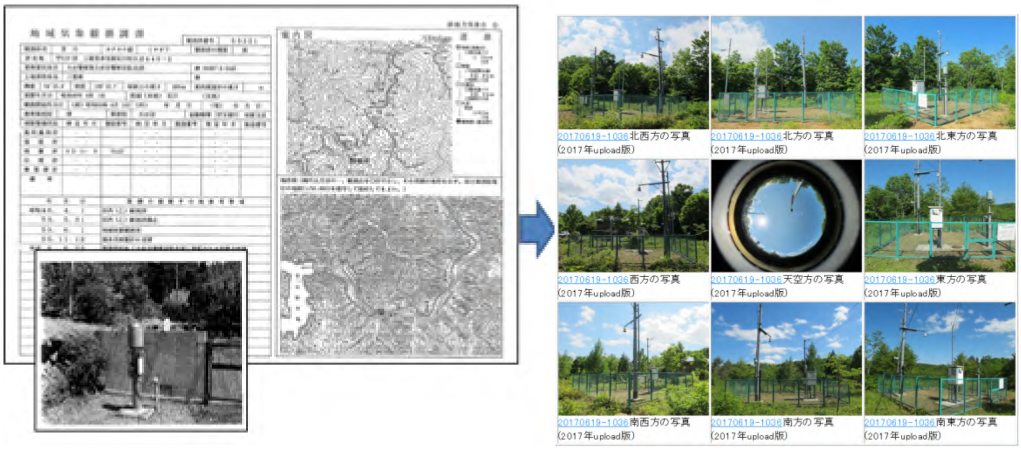


Figure 7 Siting environment records (previous paper-based approach (left) replaced with online system (right))

Despite efforts to maintain suitable environments for meteorological observation, data collected have been affected in recent years by changes relating to rapid urbanization and other factors. As a result, JMA now sets fences and hedges around parts of AWSs to minimize the influence of warm air from artificial ground heat sources. However, such barriers may help to lift warm air to thermometer height, thereby affecting observation temperatures. Accordingly, JMA conducted field and laboratory experiments to determine how fences affect temperature data in order to identify the characteristics of ideal observation environments.

In the field experiment, 5.5 × 5.5-m test areas surrounded by 1-mm^2-mesh boundary fences with heights of 1.0 and 0.5 m were set on a large lawn at the JMA's Regional Instrument Centre (RIC) Tsukuba (Figs. 8 and 9). Thermometers placed with anemometers at a height of 1.5 m in the center of these areas showed slightly higher diurnal temperatures (0.3 − 0.4°C on average) than in non-fenced areas.

In the laboratory experiment, 1/10-scale models of the test areas were set in a JMA Meteorological Research Institute wind tunnel to enable visualization of wind flow patterns (Fig. 10). The results indicated that wind-related turbulence caused by fences may impact temperature observation, as wind blew over the fence and was lifted to thermometer height.

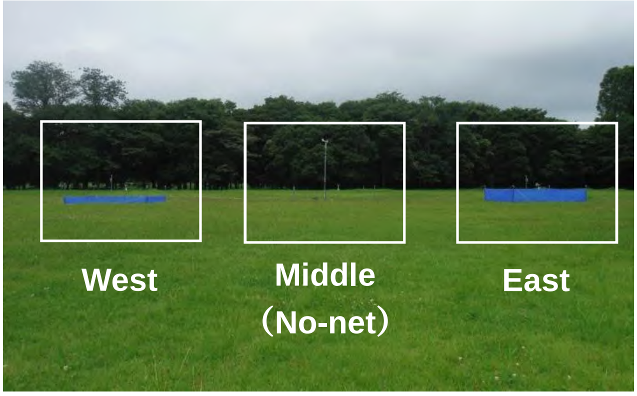


Figure 8 The three fields on the large lawn at RIC Tsukuba

Figure 9 Observational field enclosed in a four-face net with a height of 1 m

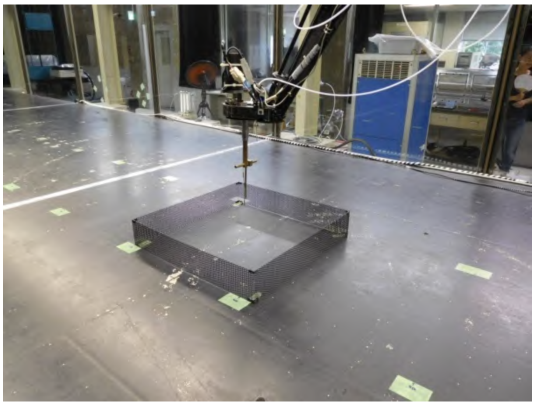


Figure 10 1/10-scale model of a fenced observation field on the wind tunnel floor

The results of these experiments and related analysis are expected to help clarify uncertainties caused by boundary fences near stations, and will also facilitate the collection of continuous quality-assured observation data from AWSs in conjunction with regular instrument maintenance and calibration.