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Site report: Japan - Tateno

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Summary and Purpose of Document

This document contains an overview of the Tateno, site status with respect to GRUAN to be discussed in this session, and comparison of Vaisala RS92-SGPJ with Meisei RS2-91.

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1. OVERVIEW OF TATENO

1.1 History

The Aerological Observatory, the Japan Meteorological Agency (JMA), was founded in 1920, and began upper wind observation in April 1921 (Table 1). Tateno (47646) is the station name of the Aerological Observatory, and is located at Tsukuba city (36°03' N, 140°08’ E, 31 m MSL), about 52 km northeast of Tokyo (Fig. 1).

Table 1 Chronological table of the Aerological Observatory.

Aug. 1920	The Aerological Observatory was founded.
Nov. 1920	Surface Observation started.
Apr. 1921	Upper wind observation started. A small balloon filled with hydrogen gas was launched and tracked using optical theodolites.
Dec. 1922	Lower atmosphere observation started using a kite and a tethered balloon (Use of kite was ended in February 1946).
Dec. 1924	Ooishi discovered the strong westerly winds* (Jet stream discovery)**.
Aug. 1925	Sounding-balloon observation started. A large balloon equipped with an aerometeorograph was launched. The balloon was recovered when it fell down, and then the records of atmospheric pressure, temperature, and humidity were read.
Sep. 1944	Radiosonde observation started.
Nov. 1948	Rawin observation (wind sounding) started (ended in March 2004)
Jul. 1955	Atmospheric ozone observation started with Dobson spectrophotometer.
Jul. 1957	Observation of solar and terrestrial radiation started.
Sep. 1959	Radioactivity-sonde observation started (ended in March 2006).
Mar. 1968	Ozonesonde observation started.
Mar. 1986	Automatic data processing system was introduced for aerological observation.
Aug. 1988	Surface ozone observation started.
Jan. 1990	Observation of solar spectral ultraviolet radiation started with Brewer spectrophotometer.
Feb. 1992	New ground facilities of aerological observation system type JMA-91 was introduced for aerological observation.
Oct. 1992	New radiosonde (type: RS2-91) was introduced for aerological observation.
Feb. 1993	The WMO International Radiosonde Comparison Phase IV was held at the Aerological Observatory.
Jan. 1994	Automatic Dobson ozone spectrophotometer was developed.
Feb. 1996	International Workshops on Ozone Observation in Asia and the Pacific Region (IWOAP) was held at the Aerological Observatory.
Aug. 1996	International Workshops on Ozone Observation in Asia and the Pacific Region (IWOAP-II) held at the observatory.
Jun. 1997	BSRN (Baseline Surface Radiation Network) report to World Radiation Centre started.
Jul. 1999	High altitude observation was started to obtain upper-air data up to 5 hPa.
Mar. 2003	WMO/GAW Regional Intercomparison of Dobson Spectrophotometer for Asia was held at the Aerological Observatory.
Mar. 2006	Dobson Regional Intercomparison for Asia in Tsukuba, Japan (DIC-T2006) was held at the Aerological Observatory.
Nov. 2009	Measurement of total column water vapour using ground-based GPS receiver started.
Dev. 2009	Observation of wind profile using Doppler lidar started. RS92-SGPJ type GPS sonde was introduced for aerological observation. ECC ozonesonde was introduced for ozonesonde observation.

* Ooishi, W., 1926: Raporto de la Aerologia Observatorio de Tateno (in Esperanto). Aerological Observatory Rep. 1, Central Meteorological Observatory, Japan, 213 pp.

** Lewis, J. M., 2003: Ooishi's observation: Viewed in the context of jet stream discovery. *Bull. Amer. Meteor. Soc*., **84**, 357-369.

1.2 Activities

The Aerological Observatory conducts surface observation, lower atmosphere observation (up to 1.5km) using a tethered balloon, upper atmosphere observation (up to about 30 km) using radiosondes, ozone observation, and radiation observation. In its role as a technical center for aerological observation in Japan, the Observatory has responsibilities to develop and improve methods and instrumentation for upper-air observation and to provide training for meteorological experts from JMA.

1.2.1 Surface Observation

Surface observation is carried out using JMA-95 surface meteorological observation equipment. Elements and equipment sensors are shown in Table 2.

Table 2 Elements and equipment sensors of surface observation at Tateno.

Element	Equipment Sensor
Atmospheric pressure	Electrostatic capacity barometer
Air temperature	Platinum resistance thermometer*
Humidity	Electrical capacitive hygrometer
Wind direction/speed	Wind vane/propeller anemometer*
Precipitation	Tripping bucket rain gauge*
Sunshine duration	Sunshine recorder on sun tracker *
Global solar radiation	Radiation pyranometer
Weather	Visual observation
Cloud amount/form	Visual observation
Visibility	Visual observation

*Shared with AMeDAS (the Automated Meteorological Data Acquisition System)

1.2.2 Observation of Surface Ozone

Instrument: UV Photometer Ebara Jitsugyo Co., Ltd. EG-2001F. Data Processing: 10-minute data are calculated with 20-second sampling data. Hourly data are calculated with 10-minute data.

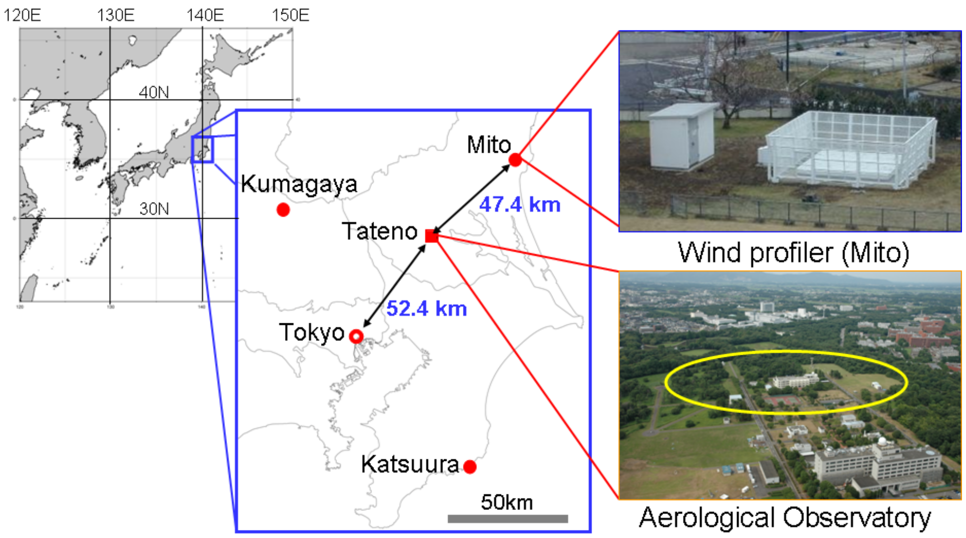

Fig. 1. Location of Tateno (36°03'N, 140°08'E, 31 m MSL).
Mito, Kumagaya, and Katsuura are wind profiler sites.

1.2.3 Observation of the Lower Atmosphere

A radiosonde attached to a tethered balloon is used to observe temperature, humidity, pressure, and wind direction/speed from the ground to approximately 1,500 meters height. The collected data are used to study the lower atmosphere.

1.2.4 Upper-air Observation

Upper-air observation using radiosondes are carried out twice a day at 00 UTC (09 LST) and 12 UTC (21 LST) that are internationally specified times (Table 2). The Meisei RS2-91 radiosonde with radio-direction wind finding system had been used at Tateno until November 2009, and it was replaced with the Vaisala RS92-SGPJ type GPS radiosonde in December 2009.

Upper-air observation using ozonesondes are carried out at 06 UTC (15 LST) on every Wednesday. The KC ozonesonde had been used until November 2009, and it was replaced with the ECC ozonesonde in December 2009.

Tateno is registered as a site of the GCOS Upper-air Network (GUAN) in 1995. According to the GCOS recommendation, high altitude radiosonde observations up to 5-hPa are carried out at 12 UTC (21 LST). The observation height coverages of radiosondes for 00 UTC and 12 UTC and of ozonesondes are shown in Fig. 2.

Table 2 Upper-air observation using radiosondes at Tateno.

Type	Element	Time	
Radiosonde	Atmospheric pressure, Air temperature, Humidity, Wind direction/speed	0900 LST, 2100 LST*	Balloon launched 30 minutes before observation time.
Ozonesonde	Ozone amount, Atmospheric pressure, Air temperature, Wind direction/speed	1500 LST* Wednesday	

In the event of severe weather conditions such as typhoons, radiosondes are also released at 0300 LST* or 1500 LST*.

* LST (UTC+9)

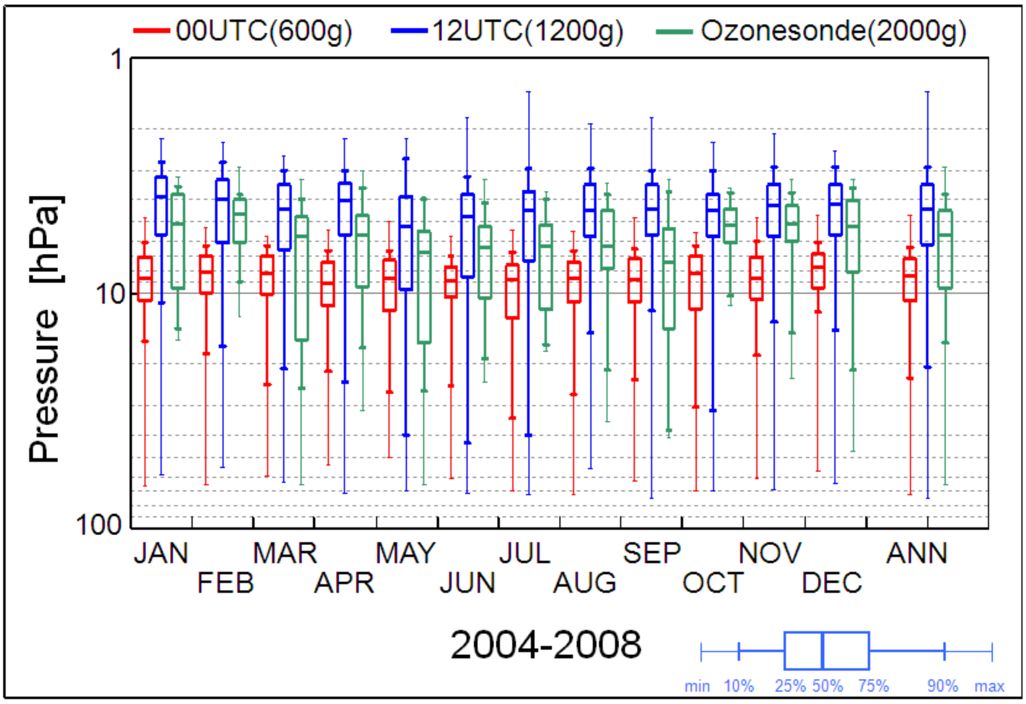

Fig. 2. Observation height coverages of radiosondes and ozonesondes at Tateno.

1.2.5 Ozone Observation

Observation of the total amount and vertical distribution of ozone in the atmosphere is carried out using Dobson ozone spectrophotometer. In addition, analysis of the observation results as well as improvement and development of the related equipment are performed.

1.2.6 Ultraviolet Radiation Observation

To accurately ascertain the amount of harmful ultraviolet radiation that reaches the ground, observation of global ultraviolet spectral irradiance is carried out using Brewer spectrophotometer, and global UV-B irradiance is monitored with ultraviolet pyranometers.

1.2.7 Radiation Observation

To investigate the mechanism of radiation in detail, observation and study of the following radiation components are carried out: global solar radiation, direct solar radiation, diffuse solar radiation, reflected solar radiation, downward long-wave radiation, upward long-wave radiation.

The Tateno site is one of the station of WCRP/GCOS Baseline Surface Radiation Network (BSRN) and has been providing accurate radiation data via the BSRN data archive to researchers since 1996.

More information is available on the website:
http://www.kousou-jma.go.jp/english/index.HTM.

2. SITE STATUS IN RESPECT TO GRUAN

1. Which of your existing radiosonde launches already meet the mandatory requirements (GCOS 121: once weekly best production quality radiosonde, once monthly stratospheric water vapour; recommended twice daily), and which additional launches need to be instigated or augmented?

Radiosonde observations with the Vaisala RS92-SGPJ type GPS radiosonde, high quality radiosonde, are carried out twice a day at 00 UTC (09 LST) and 12 UTC (21 LST), which are the standard times of synoptic upper-air observations. Although Tateno does not implement once monthly stratospheric water vapour, high altitude radiosonde observations at 12 UTC (21 LST) reach the 5 hPa level for more than 50 percent of the ascents.

2. Which ground based measurements can you provide in addition to the mandatory GPS total water vapour column (microwave, FTIR, lidar, …) and how can you use these additional observations to make sure that measurement uncertainty estimates will be consistent?

It is planned to compare radiosonde observations with GPS observations (Tateno) for total column water vapour, and with Doppler lidar (Tateno) and wind profiler (Mito, Kumagaya, and Katsuura) measurements for winds.

3. Do you have any limitations regarding the development of GRUAN launch protocols for routine and reference sonde launches (e.g. the use of autosonde launchers)?

The limitations are observation time at 00 UTC (09 LST) and 12 UTC (21 LST).

4. Do you have any limitations regarding the development of uniform GRUAN data processing schemes for remote sensing observations?

In general, remote sensing observation produces a large amount of data with high resolution in time and space. Table 4 shows vertical resolution and observing cycle of wind profiler (Mito) and Doppler lidar (Tateno). The characteristics of wind profiler and Doppler lidar are summarized in Table 5 and Table 6, respectively.

It is required for JMA to prepare a suitable system for archive and dissemination of a large amount of remote sensing data. In addition, to build confidence of the GRUAN data processing, it is necessary to examine quality control methods and conversion processes from signal data to meteorological variables.

Table 4 Vertical resolution and observing cycle of wind profiler at Mito and Doppler lidar at Tateno.

Remote sensing instruments	Vertical resolution	Observing cycle
Wind profiler (Mito)	300 m	10 min
Doppler lidar (Tateno)	73 m	8 s

Table 5 Characteristics of wind profiler.

Frequency	1357.5 MHz
Antenna	Active phased array, 4 m × 4 m
Peak Power	1.8 kW
Beam width	4 degree
Beam configuration	Vertical and 4 directions of elevation angle 75～80°.
Beam Scanning Time	5 directions per minute
Pulse Length	0.67, 1.33, 2.00*, 4.00 $\times 10^{-6}$ sec (*: operational mode)
Vertical resolution	100, 200, 300*, 600 m (*: operational mode)
Observation Interval	10 minutes
Height Range	400 m to 9.1 km* (*: operational mode)
Basic Data	Doppler moments every minutes
Distributed data	wind(u,v,w), S/N ratio, data quality flag every 10minutes

Table 6 Characteristics of Doppler lidar.

Wavelength	1.5～1.6 μm
Observation mode	Conical scanning (Elevation angle: 80 deg)
Pulse Length	2, 5*, 10 $\times 10^{-9}$ sec (*: operational mode)
Range resolution	30, 75*, 150 m (*: operational mode)
Range	30～600, 75～1500*, 150～3000 m (*: operational mode)
Number of range gate	20
Observation velocity	-30～30 m/s
Observation data	Wind (u, v, w)

5. What local analysis can you provide to assure that measurements uncertainties will be consistent across the network (Analysis of redundant observations either dual sonde launches or sonde + remote sensing observations)?

JMA can provide analysis results of dual radiosonde launches and remote sensing observations.

To confirm the performances and accuracies of the radiosondes, JMA is carrying out a series of comparison launches of the Meisei RS2-91 type radiosonde with the Vaisala RS92-SGPJ type GPS sonde at Tateno for four intensive observation periods (IOPs) of December 2009 (IOP-1), March 2010 (IOP-2), June 2010 (IOP-3) and September-October 2010 (IOP-4). The dual soundings are boarded on the same balloon. The sonde-observed wind and total column water vapour will be compared with remotely-sensed data, which are observed with the Doppler lidar (Tateno), GPS receiver (Tateno) and wind profiler (Mito).

6. For sonde observations: Can you provide all raw data for central archiving?

Basically, it is possible for JMA to provide all the raw data of sonde observations, though it is required to define raw data clearly. It is noted that raw data size per one observation to be processed with Vaisala DigiCORA III is about 10 MB.

7. For remote sensing observations: Will you be able to archive all raw data for possible future Reanalysis and reprocessing?

It is under discussion at JMA to archive all the raw data of Doppler lidar and GPS receiver at Tateno for a long time.

8. What help do you need from the Lead Centre / WG-ARO / GCOS Secretariat in moving forwards?

The Lead Centre and WG-ARO are requested to develop procedure for data quality control and analysis method of intercomparison observations.

In order to obtain necessary resources for full implementation of GRUAN activities, JMA requires information and materials to raise awareness on GRUAN. The GCOS Secretariat is requested to make further efforts to raise awareness on GRUAN and demonstrate benefits from GRUAN at every occasion.

9. Will you be able so host local intercomparison campaigns (yet to be scheduled)?

For hosting local intercomparison campaigns, there are several issues to be solved such as those related to the assignment of radio frequency bands for radiosonde observation, growing air-traffic control.

10. Are there any special infrastructure needs that should be addressed?

There are not such needs.

3. COMPARISON OF VAISALA RS92-SGPJ with MEISEI RS2-91

Concerning the transition to a new radiosonde model in routine use, JMA is carrying out a series of comparison launches of the Meisei RS2-91 type radiosonde with the Vaisala RS92-SGPJ type GPS sonde on the same balloon at Tateno.

Fig. 3 shows the annual variation of solar elevation angle at 00 UTC (09 LST), Tateno, during the period from November 2009 to October 2010. Dual soundings are planned to be carried out during four intensive observation periods (IOPs) to encompass entire annual cycle. The number of dual soundings is 15 in each observation time of 00 UTC (09 LST) and 12 UTC (21 LST) for each IOP. The sonde-observed wind and total column water vapour will be compared with remotely-sensed data, which are observed with the Doppler lidar (Tateno), wind profiler (Mito) and GPS receiver (Tateno).

During the IOP-1 from 3 December 2009 to 15 January 2010, thirty balloons were released successfully. Two balloon flights were launched each day, weather permitting, one was launched in the daytime and another was done in the nighttime. The flight configuration of dual sounding is indicated in Fig. 4, and the rise rate of the balloon is typically 6 meters per second. The measurements from the radiosondes were simultaneously obtained on the same balloon platform. The observation data, which are classified according to the elapse time after balloon release, are analyzed.

After completing these comparisons, the detailed observation data and the metadata will be sent to the GRUAN Lead Center according to the GRUAN data policy.

Fig. 3 The orange (▬) and green (▬) curves show variations in the solar elevation angle at 00 UTC (09 LST) and at meridian passage time, Tateno, during the period from November 2009 to October 2010, respectively. Blue dots (●) indicate the solar elevation angle at the beginning time of sounding, and red dots (●) at the finishing time.

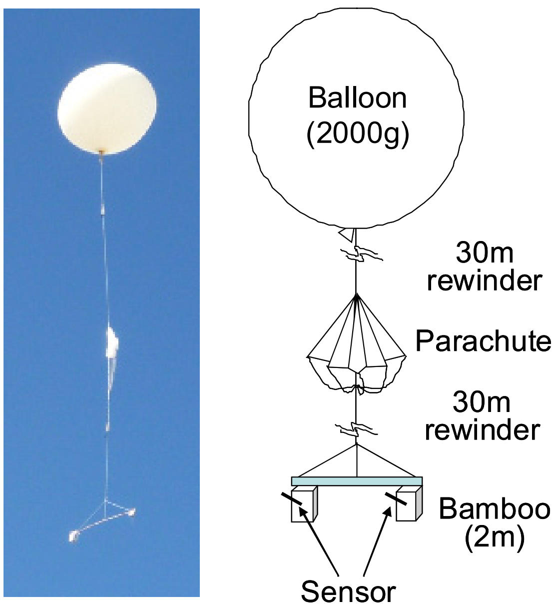

Fig. 4 Flight configuration of dual sounding.