The JMA Mascot

Harerun

Harerun is designed with elements of sun, cloud and rainfall. It holds a green baton in prayer for a disaster-free, peaceful world.
The Japan Meteorological Agency (JMA) has provided services to protect people and their property from disasters by monitoring and predicting natural events for over a century since it was established in 1875.

JMA is committed to its activities for the protection of life and property as well as support for resilient and productive everyday living based on the mission and vision outlined below.

Mission:
To contribute to the promotion of public welfare by preventing disasters, securing traffic safety, and promoting the prosperity of industries, and to offer international cooperation concerning meteorological services, by ensuring the sound development of meteorological services.

Vision:
To provide meteorological services supporting safe, resilient and productive everyday living.

- Enhance technological development under public-private-academic partnerships and international coordination incorporating state-of-the-art science and technology.
- Promote the application of meteorological information and data as part of the soft infrastructure necessary for various aspects of everyday living.
Enhancement of Local Disaster Mitigation

JMA supports disaster mitigation activities of local governments and local branches of relevant Ministries as outlined here.

Preparation for Disasters

JMA runs practical drills for local government staff and promotes awareness of public safety to enable individual situation-dependent decisions for appropriate action.

Support for Disaster Response

In emergency situations, JMA provides information on disaster risk in press conferences. It also directly outlines weather conditions and forecasts to Ministries and local governments by telephone and JMA Emergency Task Team (JETT) to support related efforts in disaster mitigation.

Post-Disaster Review

JMA reviews its disaster response activities taken during past emergency situations together with local governments, to further improve its activities in everyday and emergency situations.

Forecaster in Your Town

To support the above initiatives, JMA deploys specialized local forecasting teams Forecaster in Your Town within LMOs with the aim of establishing close relations between JMA and local government staff.

Toward Enhanced Application of Weather Information and Data

As meteorological conditions significantly affect daily life and economic activity, JMA provides weather information and data to improve socio-economic productivity in Japan.

Data Provision to the Private Sector & Licensing for Forecast Services

Japan’s private sector plays a vital role providing individual and commercial weather information services. In this context, JMA provides the private sector with a wealth of related information via the Japan Meteorological Business Support Center (JMBSC; a general incorporated foundation designated by the JMA Director-General) and also conducts licensing for independent forecast services to control the quality of such services.

Development of the Market for Weather Business

Toward Enhanced Application of Weather Information and Data

- Analysis of industrial big data and weather ones to get business insight
- Multi-sector dialogue
- Efforts for provision of fit-for-purpose weather data

Specific Activities

The Weather Business Consortium (WXBC) of public, private and academic sectors (established in March 2017)
- Seminars and other events to promote expertise on weather data and related commercial application
- Provision of opportunities for service providers to engage with users

Service upgrade and productivity improvement with weather data in various sectors
Meteorological Observation Networks
For Better Monitoring of Atmospheric Phenomena

Satellite Observation
Satellite observation is indispensable for obtaining a clear picture of typhoons over ocean areas and other global atmospheric conditions. The Eastern Asia, Western Pacific, and Oceania regions are covered by JMA’s Himawari geostationary meteorological satellites (himawari is the Japanese word for sunflower), whose 10-minute interval observations from 35,800 km above the equator produce data on the distributions of clouds, moisture and volcanic ash, upper-air winds and sea surface temperatures. JMA and a variety of National Meteorological and Hydrological Services (NMHSs) make extensive use of Himawari data in daily operations.

Radar Observation
JMA operates 20 Doppler radars for observation of precipitation intensity and upper-air wind fields. The Tokyo radar was recently upgraded to include a dual polarization function allowing for more accurate precipitation monitoring.

Surface Weather Observation
A total of 160 JMA weather stations, including Local Meteorological Offices, across the country routinely collect data on variables such as surface pressure, temperature, humidity, wind, precipitation, sunshine duration, snow depth, visibility and current weather conditions. As many as 1,300 AMeDAS (Automated Meteorological Data Acquisition System) stations automatically observe precipitation, temperature, wind and sunshine duration. Around 320 of these also observe snow depth.

Upper-air Observation
To clarify meteorological conditions and three-dimensional atmospheric activity, upper-air monitoring is performed via radiosonde and wind profiler observation networks.

Radiosonde
Radiosondes measure pressure, temperature, humidity and wind in the atmosphere at altitudes of up to 30 km from the surface twice daily.

Wind profiler
Wind profilers measure wind in the upper atmosphere at altitudes of up to about 12 km every 10 minutes.

JMA operates an array of networks involving surface-based observation and the use of meteorological satellites to monitor the atmosphere around the clock. After a process of stringent quality control, the results are made available to the public and related users. The data produced are essential in clarifying atmospheric conditions, and are used for daily weather forecasts, severe weather monitoring, typhoon analysis and climate change monitoring.
Weather Analysis and Prediction
For Appropriate Forecasts and Warnings

Numerical Weather Prediction (NWP)
Weather prediction is numerically conducted on a supercomputer using models initialized with observation data.

Weather Forecasting
Weather forecasts, Emergency Warnings, Warnings and Advisories are issued mainly for natural disaster preparedness and mitigation based on observation data from around the world and NWP products.

Monitoring
Forecasters monitor changes in weather conditions such as torrential rain, tornadoes and thunderstorms to enable the issuance of appropriate weather information that will help mitigate the effects of natural disasters.

Utilization of Data from Other Organizations
JMA also collects data gathered by other national and local organizations in Japan as well as National Meteorological and Hydrological Services (NMHSs) and relevant organizations around the world.

Provision of Disaster Mitigation Information
JMA issues disaster mitigation information to residents, via TV, radio and other media, and directly to disaster management authorities and local governments to help mitigate disaster-related damage. Prefectural governments, NTT (Nippon Telegraphs and Telephone Corporation) and J-ALERT ensure the provision of information to municipal governments directly involved in local disaster mitigation. Alerts are provided online and through other channels.

Typical channels for notification
- JMA website (https://www.jma.go.jp/jma/indexe.html), social media
- Prefectural governments, National Police Agency, NTT (Nippon Telegraph and Telephone Corporation)
- Fire and Disaster Management Agency
- Water and Disaster Management Bureau, MEXT
- Electrical Power Companies
- Municipal Governments
- General Public
- Public, Agencies etc.
- Service Units
- Japan Coast Guard
- Japan Civil Aviation Bureau
- Marine Vessels

Access 11-language information on disaster mitigation:
jma.go.jp/jma/daigaku
Twitter: Warnings are also available here. #kōshinmei/yamaE (Shimodoaka)
jma.go.jp/koenravou
For more information, visit the JMA webpage in English:
jma.go.jp/jma/indexe.html
**Monitoring of the Global Environment**

For a Better Understanding of Our Earth

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### Monitoring of the Global Environment

#### Observation
- Weather conditions/phenomena
- Greenhouse gases
- Ozone layer and ultraviolet radiation
- Oceanographic conditions/phenomena
- Aerosol and solar radiation

#### Information
- Global warming projection
- Extreme climate events
- Ozone layer and ultraviolet radiation
- Marine Diagnosis Reports
- Global analysis of greenhouse gases

#### Analysis and Prediction

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### Monitoring of the Climate

JMA carries out observation and monitoring related to environmental issues such as global warming and ozone layer depletion as well as prediction of global warming, and makes the results public. The Agency also provides information on oceanic phenomena such as El Niño, which significantly affects extreme climate events around the world.

#### Monitoring of Global Warming

![Monitoring of global warming](image)

#### An El Niño event

![An El Niño event](image)

### Monitoring of the Atmospheric Environment

JMA observes elements of the atmospheric environment such as greenhouse gases at several stations. Its Minamitorishima location is one of the most important monitoring spots in the world because it is located more than 2,000 km from the continent and is therefore relatively unaffected by local anthropogenic emissions.

#### Overview of Minamitorishima

![Overview of Minamitorishima](image)

#### Greenhouse gas observation at Minamitorishima

![Greenhouse gas observation at Minamitorishima](image)

### Monitoring of Oceans

JMA conducts oceanographic observation (water temperature, salinity, carbon dioxide, etc.) using two research vessels and operates profiling floats to monitor the long-term variability of the marine environment and global warming.

#### Seawater collection and carbon dioxide analysis

![Seawater collection and carbon dioxide analysis](image)

#### On-board analysis

![On-board analysis](image)

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JMA monitors extreme climate events around the world and related phenomena such as El Niño and La Niña. The Agency also runs and develops a global general circulation model to calculate variables such as wind and sea currents for seasonal climate outlooks and future climate projection (see pages 21 and 22).
Monitoring of Earthquakes, Tsunamis and Volcanic Activity

For the Provision of Timely Information

Japan is one of the world’s most earthquake- and volcano-prone countries, and has suffered repeated damage from such disasters as well as tsunamis. To reduce damage caused by earthquakes, tsunamis and volcanic eruptions and to protect life and property, JMA monitors real-time data from seismometers, tsunami observation facilities and instruments installed near active volcanoes around the clock and issues a range of disaster mitigation information.

### Earthquake

- **Earthquake Early Warning**
  - Automatically issued in the event of a large earthquake → p.21

### Tsunami Warning/Advisory

- **Tsunami Warning/Advisory**
  - Example of a Tsunami Warning/Advisory
  - Example of Seismic Intensity Information

### Monitoring of Earthquakes

JMA collects real-time data from around 1,800 seismometers and 4,400 seismic intensity meters deployed throughout Japan to support the monitoring of earthquakes around the clock.

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### Earthquake Analysis, Forecasts and Monitoring of Tsunamis

JMA analyzes earthquakes and issues warnings/advisories if there is a threat of a tsunami. The Agency also monitors tsunami situations using sea level data gathered from 410 coastal tide gauges and offshore tsunami meters. Values observed at seismic intensity sites throughout Japan are also issued as earthquake information to support initial urgent action for disaster mitigation by disaster management authorities.

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### Monitoring of Nankai Trough Earthquakes

In line with increasing expectations of a megathrust earthquake along the Nankai Trough, JMA observes seismic activity over the whole area and crustal deformation around the trough in conjunction with related organizations to enable 24-hour monitoring. In the event of anomalies, JMA convenes the Nankai Trough Earthquake Assessment Committee for discussions on the expected potential for an earthquake and issues Nankai Trough Earthquake Extra Information.

- **Monitoring of Nankai Trough Earthquakes**
  - In line with increasing expectations of a megathrust earthquake along the Nankai Trough, JMA observes seismic activity over the whole area and crustal deformation around the trough in conjunction with related organizations to enable 24-hour monitoring. In the event of anomalies, JMA convenes the Nankai Trough Earthquake Assessment Committee for discussions on the expected potential for an earthquake and issues Nankai Trough Earthquake Extra Information.

### Monitoring of Volcanic Activity and Issuance of Volcanic Warnings

Among Japan’s 111 active volcanoes, 50 selected by the Coordinating Committee for Prediction of Volcanic Eruptions are continuously monitored using seismometers, GNSS and other tools. When unusual phenomena are observed, JMA reinforces its monitoring efforts and implements mobile observation if necessary. The Agency also issues Volcanic Warnings (see page 20) specifying target areas for caution based on the results of observation, monitoring and evaluations.

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Examples

Above: Tsunami Information (Tsunami Observations)
Bottom left: Information on Seismic Intensity at individual sites
Bottom right: Estimated Seismic Intensity Distribution Map

Operation Room – earthquake analysis work
Meteorological Information for Aviation and Maritime Safety

For Aviation Safety
Aircraft are affected by weather conditions from take-off to landing. To support safe and efficient aviation, JMA provides meteorological information on aerodromes and airspace to aeronautical operators, including airlines and air traffic service units of the Japan Civil Aviation Bureau (JCAB) under the Ministry of Land, Infrastructure, Transport and Tourism (MLIT).

- Monitoring at Airports
  - Issuance of forecasts and warnings
  - Observation (wind direction, wind speed, etc.)

- Monitoring of Airspace
  - Monitoring and forecasting of turbulence and thunderstorms
  - Monitoring and forecasting of volcanic ash clouds

- Provision to JCAB and Airlines

- For Maritime Safety
Maritime navigation must be safe even when typhoons or developing low-pressure systems approach, and this must be balanced with punctuality and economic effectiveness.

- Forecast weather maps and forecast wave height maps

JMA provides aviation stakeholders and maritime operators with specialized information to meet their specific needs.

Research
Observation with Cutting-edge Weather Radar
JMA’s Meteorological Research Institute conducts research and development using phased-array radar as a next-generation remote sensing technology. Figure 1 shows related results from observation of a well-developed thunderstorm system that caused significant hail in Tokyo on July 18, 2017. This innovative radar (Figure 2) is expected to support improved prediction of severe weather events.

Focus
Correspondence between JMA Information and Alert Levels
To support intuitive understanding of action to be taken in response to disaster prevention information provided by JMA and other organizations, five Alert Levels are specified.

- If Alert Level 4 equivalent information (Evacuation required) or Alert Level 3 equivalent information (Evacuation of elderly people required) is in effect, residents should refer to Real-time Risk Maps, river level information and other data to make individual decisions on evacuation regardless of municipal recommendations.
- If moving to an evacuation site may be hazardous, take all possible steps for self-protection such as moving to a higher floor or away from steep inclines.

Focus
New Information on Snow
To mitigate recent issues caused by record snowfall resulting in large-scale traffic jams and general paralysis in Japan, JMA began providing Snow Depth Analysis maps (covering snow depth) and Snowfall Amount Analysis maps (covering cumulative snowfall) in November 2019 in addition to AMeDAS observation data.

- Under the service, up-to-date snow information is displayed on maps showing roads, railways and other routes on the Snow Analysis page of the JMA website.
- The data are intended to support route selection, avoidance of traffic blockages and sightseeing plans.

Meteorological Information is imperative for the safe operation of aircraft and marine vessels. JMA provides aviation stakeholders and maritime operators with specialized information to meet their specific needs.

To support safety and efficiency, JMA issues marine warnings, forecasts and other information including sea surface temperature balanced with punctuality and economic effectiveness.

Maritime navigation must be safe even when typhoons or developing low-pressure systems approach, and this must be
Radar Observation

Radar observation is indispensable in weather monitoring and forecasting. Most countries today operate weather radars, and capacity development for related techniques is a common challenge for National Meteorological and Hydrological Services (NMHSs) in maximizing radar performance. JMA’s long history of weather radar operation stretches back to the technology’s introduction in 1954. Since then, the Agency has worked to improve radar observation quality by introducing new technologies, including the adoption of solid-state weather radar in recent years. The Weather Radar Seminar 2019 was held by JMA in Tokyo in November 2019 as a platform for sharing expertise in radar meteorology. Discussions included application to disaster risk reduction and state-of-the-art technology in radar observation in the presence of key staff in the planning, installation and operation of weather radar at NMHSs. The seminar was attended by 14 representatives from six NMHSs, as well as domestic manufacturers of systems for weather radar, lidar and related technologies.

JMA also works to further the use of weather radar in Southeast Asia as part of its activities under the UNESCAP/WMO Typhoon Committee project, by which JMA also works to further the use of weather radar in Southeast Asia as part of its activities under the UNESCAP/WMO Typhoon Committee project, by which JMA’s RIC Tsukuba has performed this role for Asia since 1998. JMA developed the RIC Tsukuba Package as a comprehensive support approach to assist regional Members in calibrating their national meteorological standards and to advise Members on instrument performance, maintenance, availability of relevant guidance materials, and other matters.


Instrument Maintenance and Calibration

WMO Regional Instrument Centre (RIC) Tsukuba

 Globally uniform, high-quality meteorological data are needed to enable accurate weather forecasting and appropriate monitoring of climate change. Regular calibration and maintenance of meteorological instruments are very important for accurate meteorological observation. To address this need, WMO recommended the establishment of a Regional Instrument Centre (RIC) for each region of the world. JMA’s RIC Tsukuba has performed this role for Asia since 1998. JMA developed the RIC Tsukuba Package as a comprehensive support approach to assist regional Members in calibrating their national meteorological standards and to advise Members on instrument performance, maintenance, availability of relevant guidance materials, and other matters.

“RIC Tsukuba Package

(x) Preliminary Survey on calibration capacity
(b) Preparation of standard instruments and/or inspection equipment
(c) Training (in Japan and on site)
(d) Follow up activities
NMHS
Technical cooperation in a manner both efficient and effective
Ensuring traceability of meteorological instruments, quality improvement of surface observation

These RIC activities are expected to help Members improve their meteorological observation data.”

Technical Cooperation

Meteorological capacity building in developing countries is essential both for the reinforcement of local weather services and for global disaster risk reduction. JMA has provided technical support to NMHSs for decades. In particular, more than 300 meteorologists from NMHSs worldwide have attended meteorological training courses run by the Japan International Cooperation Agency (JICA) and JMA since 1973. During these annual three-month courses, a variety of JMA experts give presentations and provide hands-on training. Dedicated JICA coordinators also provide trainees with everyday living support during their stays in Japan and assist their understanding of the training. JMA provides various forms of technical support in cooperation with JICA and other national authorities as part of Japanese Government aid programs in the meteorological field.

“Taking the course is a privilege, which makes trainees all the more responsible for winning public trust and providing vital and accurate meteorological information. They must think how to proactively use the expertise they gain from the course to benefit society.”

SONE Eri
Coordinator for JICA training course “Reinforcement of Meteorological Services”

Satellite

Himawari-series geostationary satellites

JMA’s Himawari series of geostationary weather satellites now has a history of over four decades. The latest units in the series – the Himawari-8/9 satellites – are capable of frequent and flexible observation with 16 spectral bands, providing full-disk Earth images every 10 minutes and regional images even more regularly. Himawari-8/9 data are distributed internationally via the HimawariCloud Internet service and the HimawariCast broadcasting service using a communication satellite, and are utilized by countries across the Asia-Pacific region and elsewhere.

HimawariRequest

In January 2018, JMA launched the HimawariRequest service, which enables National Meteorological and Hydrological Services (NMHSs) to request 1,000 x 1,000 km regional observation every 2.5 minutes by Himawari-8/9. The service supports intensive monitoring of extreme events such as tropical cyclones. As of January 2020, 17 NMHSs had joined the service and 28 request-based observations had been conducted.

RSMC Tokyo for Nowcasting

Himawari-8/9 also supports the Regional Specialized Meteorological Center (RSMC) Tokyo for Nowcasting, which JMA launched in December 2018. The Center’s website provides NMHSs in the Asia-Pacific region with graphical nowcasting products to support disaster risk reduction. The service currently offers Heavy Rainfall Potential (HRP) and High-resolution Cloud Analysis Information (HCAl) as Himawari-8/9 products.

“HimawariRequest is intended to serve NMHSs well.”

“HRP product on the RSMC Tokyo for Nowcasting website

Since the atmosphere has no national borders, international cooperation and coordination is essential for the development of worldwide meteorological activities. JMA devotes consistent efforts to international cooperation through multilateral and bilateral channels alike, and has established procedures to engage in cooperative activities with many National Meteorological and Hydrological Services (NMHSs) and international organizations.
International Cooperation

Numerical Weather Prediction

Numerical prediction for weather and climate characteristics is a highly critical skill in producing analysis and prediction of meteorological conditions based on various observations. The worldwide Global Data-processing and Forecasting Systems (GDPFS) network is a three-level organization of World Meteorological Centres (WMCs), Regional Specialized Meteorological Centres (RSMCs) and National Meteorological Centres (NCMs) that enables WMO Members to share scientific and technological advances.

JMA is recognized as one of the world’s most advanced numerical weather and climate prediction centers, and serves as both a WMC and an RSMC in global numerical prediction. To assist Members in enhancing forecasting, warning and climate services, the Agency provides a range of products based on its operational global numerical weather and climate prediction models as well as conducting various types of training. JMA is also designated as an RSMC for nuclear environmental emergency response, providing dispersion predictions in response to requests from the International Atomic Energy Agency (IAEA).


Disaster Mitigation

RSMC Tokyo – Typhoon Center

JMA’s Tokyo – Typhoon Center analyzes and forecasts tropical cyclones (TCs) over the western North Pacific (0 – 60°N, 100 – 180°E) in its role as a Regional Specialized Meteorological Center (RSMC) – one of six such facilities tasked with TC forecasting within the framework of the WMO World Weather Watch Program. The Center issues vital information on TCs, such as analysis results and forecasts, to support the disaster risk reduction activities of NMMHSs of ESCAP/WMO Typhoon Committee Members. Its activities include monitoring of data exchanges among Members, issuance of publications such as annual reports and technical reviews, and provision of on-the-job training at JMA Headquarters and other NMMHSs.

In 2019, JMA hosted the High-level Dialogues on Tropical Cyclones followed by the Commemoration Ceremony of the 30th anniversary of the RSMC Tokyo – Typhoon Center. The dialogues were attended by 12 Members of the ESCAP/WMO Typhoon Committee and representatives from all six RSMCs conducting tropical cyclone forecasting, and were marked by the adoption of the Statement of the High-level Dialogues on Tropical Cyclones, Tokyo, Japan 2019 (a.k.a. the Tokyo Statement), which includes the 10-year Vision to Protect Life and Property from Tropical Cyclones. In line with the Tokyo Statement, the RSMC Tokyo – Typhoon Center will continue supporting and working with NMMHSs to realize a tropical cyclone resilient society.

Tokyo Climate Center (TCC)

The Tokyo Climate Center (TCC), a WMO Regional Climate Centre (RCC) for Regional Association II (RA II; Asia) (RCC Tokyo) and a Global Producing Centre for Long-range Forecasts (GPC-LRF Tokyo) assist operational climate services provided by NMMHSs in the Asia Pacific region. Its main activities include the online provision of climate data, products and tools to NMMHSs and assistance with related capacity development.

As a part of its capacity development activities, TCC holds annual training seminars on the application of its climate monitoring and prediction products for NMMHS officials. A total of 176 experts from NMMHSs of 27 nations/territories have attended since 2008 (as of March 2020). The Center has also dispatched experts to NMMHSs to discuss collaboration, technical transfer and training every year since 2006. These activities represent TCC’s ongoing efforts to assist and improve climate services in the region.

Climate

WMO Information System (WIS)/Global Information System Centre (GISC) Tokyo

JMA operates the Global Information System Centre (GISC) Tokyo as part of the WMO Information System (WIS; WMO’s coordinated global telecommunication/data management infrastructure). GISCs are elements of the WIS core network, which builds on the Global Telecommunication System (GTS), interacting via high-speed dedicated networks to collect and distribute information for global provision. They also play major roles in data management, including coordination for reliable and efficient data communication and data catalogue updates.

GISC Tokyo is actively involved in all aspects of WIS operation and development, particularly in activities for capacity development regarding operational meteorological data exchanges at NMMHSs in Southeast Asia and elsewhere. In order to facilitate such activities, GISC Tokyo creates valuable opportunities through various training workshops and collaboration events. These efforts to provide the benefits of WIS to NMMHSs around the world undoubtedly help to make a difference in the WMO community.

“…We remain committed to the improvement of information sharing and management services for all day-to-day missions of meteorological service providers.”

Hands-on training seminar, 2019

“…Toward better management of risks relating to climate variability and change, there is a growing need for climate outlook and analysis information in user-oriented and fit-for-purpose contexts. To this end, TCC works to support NMMHSs in their production of nationally tailored climate products in close alignment with WMO initiatives.”
International Cooperation

Atmospheric Environment

Under the WMO Global Atmosphere Watch (GAW) programme, JMA provides international center services as described below and contributes to worldwide monitoring of the global environment.

World Data Centre for Greenhouse Gases (WDCCG)
The World Data Centre for Greenhouse Gases (WDCCG) is a World Data Centre (WDC) serving to collect, archive and provide information on atmospheric greenhouse gases. It has been operated by JMA since October 1990.

“We’re honored to have the chance to create such an important data archive and produce information from observation data provided by so many contributors worldwide.”

OHHUBO Saki, SHIMAMURA Shou
World Data Center for Greenhouse Gases
Global Environment and Marine Department

World Calibration Centre (WCC) for methane in Asia and the South-West Pacific
The World Calibration Centre (WCC) for methane (CH4) in Asia and the South-West Pacific was established in 2002 to ensure the traceability of GAW network measurements to the WMO primary standard through comparison campaigns and performance audits at GAW sites.

"Reference gas inter-comparison is essential in unifying observation standards, and is conducted in collaboration with the relevant institutions.”

KAWASAKI Teruo
World Calibration Centre for methane in Asia and the South-West Pacific
Global Environment and Marine Department

Tsunamis

Northwest Pacific Tsunami Advisory Center (NWPTAC)
Since 2005, JMA has monitored earthquakes and tsunamis in and around the Northwest Pacific region in its Northwest Pacific Tsunami Advisory Center (NWPTAC) role. When an earthquake with a magnitude of 6.5 or greater occurs in and around the region, NWPTAC forecasts possible tsunamis in its Area of Service (AoS) and provides Northwest Pacific Tsunami Advisory (NWPTA) to potentially affected countries. NWPTA reports the origin time, hypocenter and magnitude of the earthquake as well as estimated tsunami arrival times and heights for individual coastal Forecast Points (FPs). Actual tsunami arrival times and heights are also included in NWPTA as available. This information supports recipient country decisions on the issuance of local domestic tsunami warnings and evacuation recommendations.

NWPTAC’s provision of interim tsunami advisories for the South China Sea region began in 2006. It was terminated in November 2019 when South China Sea Tsunami Advisory Center (SCSTAC) of China entered full operation. NWPTAC now supports the tsunami disaster mitigation systems of Pacific countries in collaboration with the Pacific Tsunami Warning Center (PTWC) of the US, which covers the Pacific region, and SCSTAC, which covers the South China Sea region.

“Tsunamis

Atmospheric Environment

China Sea Tsunami Advisory Center (SCSTAC) of China entered full country decisions on the issuance of local domestic tsunami warnings and included in NWPTA as available. This information supports recipient as well as estimated tsunami arrival times and heights for individual coastal Tsunami Advisory (NWPTA) to potentially affected countries. NWPTA tsunamis in its Area of Service (AoS) and provides Northwest Pacific Center (NWPTAC) role. When an earthquake with a magnitude of 6.5 or the Northwest Pacific region in its Northwest Pacific Tsunami Advisory (NWPTA) to potentially affected countries. NWPTA tsunamis in its Area of Service (AoS) and provides Northwest Pacific Center (NWPTAC) role. When an earthquake with a magnitude of 6.5 or

JMA is also actively involved in international programs organized by the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific and Cultural Organization (UNESCO), the International Civil Aviation Organization (ICAO) and others.

Volcanic Ash

ICAO Volcanic Ash Advisory Center (VAAC) Tokyo
The world’s airspace is covered by nine Volcanic Ash Advisory Centers (VAACs) tasked with helping to prevent potentially disastrous ash-related aviation issues such as aircraft engine failure. Within the framework of the International Airways Volcano Watch (established by the International Civil Aviation Organization (ICAO) in conjunction with WMO), these centers monitor volcanic eruptions and provide information on the extent and movement of ash clouds as well as outlooks for their regions of coverage.

JMA operates VAAC Tokyo, which covers East Asia, the Northwest Pacific region and part of the Arctic Circle. This VAAC detects volcanic eruptions and ash clouds using satellite imagery as well as information from state volcano observatories run by JMA and other countries in the region. It calculates the expected extent and height of ash clouds using a transport model and issues Volcanic Ash Advisories to aviation-related organizations.

Aviation Weather

The CSI scheme– joint efforts for harmonized en-route weather services
As the volume of global air traffic increases, inconsistencies in en-route hazardous weather information among multiple Flight Information Regions (FIRs) have become a significant concern within the International Civil Aviation Organization (ICAO) framework, especially in the Asia-Pacific Region. Against such a background, JMA, together with aeronautical meteorological service providers in Lao PDR, Myanmar, the Philippines, Thailand and Vietnam, began a demonstration project for collaborative SIGMET issuance in 2015 toward the joint development of coordination procedures for seamless information provision. In March 2018, JMA and the five South-East Asian countries established the Collaborative SIGMET Issuance (CSI) scheme and its procedures were incorporated into these countries’ regular operations in April 2018. This multilateral cooperation scheme enables forecasters to interact via the JMA-hosted web platform providing Himawari-8 real-time imagery and a wide range of supporting weather information from JMA. Harmonized en-route weather information resulting from this collaboration will be extended within the region to further enhance the safety, efficiency and sustainability of aviation in the area.

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"From my involvement in VAAC activities, I really understand the importance of global harmonization based on international cooperation in providing the information that users need.”

JAMAMURA Yuichi
Assistant Scientific Officer, Volcanology Division, Seismology and Volcanology Department

The success of the CSI scheme is a fruit of all members’ close and continuous collaboration, which I believe is a leading global example of international cooperation.”

RYUZAKI Jun
Senior Coordinator for International Aeronautical Meteorology
Aeronautical Meteorology Division
(Chairperson of the ICAO Asia/Pacific Meteorology Sub Group)

Aviation Weather

"The success of the CSI scheme is a fruit of all members’ close and continuous collaboration, which I believe is a leading global example of international cooperation.”

RYUZAKI Jun
Senior Coordinator for International Aeronautical Meteorology
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The CSI scheme– joint efforts for harmonized en-route weather services
As the volume of global air traffic increases, inconsistencies in en-route hazardous weather information among multiple Flight Information Regions (FIRs) have become a significant concern within the International Civil Aviation Organization (ICAO) framework, especially in the Asia-Pacific Region. Against such a background, JMA, together with aeronautical meteorological service providers in Lao PDR, Myanmar, the Philippines, Thailand and Vietnam, began a demonstration project for collaborative SIGMET issuance in 2015 toward the joint development of coordination procedures for seamless information provision. In March 2018, JMA and the five South-East Asian countries established the Collaborative SIGMET Issuance (CSI) scheme and its procedures were incorporated into these countries’ regular operations in April 2018. This multilateral cooperation scheme enables forecasters to interact via the JMA-hosted web platform providing Himawari-8 real-time imagery and a wide range of supporting weather information from JMA. Harmonized en-route weather information resulting from this collaboration will be extended within the region to further enhance the safety, efficiency and sustainability of aviation in the area.

"From my involvement in VAAC activities, I really understand the importance of global harmonization based on international cooperation in providing the information that users need.”

JAMAMURA Yuichi
Assistant Scientific Officer, Volcanology Division, Seismology and Volcanology Department

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JMA Information Services

For Weather Disaster Mitigation

Information for Severe Weather Preparedness

JMA issues a variety of messages as detailed below in response to current and forecast weather conditions so that appropriate measures can be taken to mitigate possible issues such as damage from storms/wind and damage brought by such hazards as debris flow and slope failure caused by tropical or extra-tropical cyclones and fronts.

Emergency Warnings/Warnings/Advisories

JMA issues Emergency Warnings, Warnings and Advisories in line with the significance of possible disasters associated with meteorological phenomena so that disaster management authorities and residents can take appropriate mitigation measures.

<table>
<thead>
<tr>
<th>Emergency Warnings</th>
<th>Storm, Snow-storm, Heavy rain, Heavy snow, Storm surge and High waves Issued if there is significant likelihood that a serious disaster will be caused by a natural phenomenon of a scale far exceeding the warning criteria.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warnings</td>
<td>Storm, Snow-storm, Heavy rain, Heavy snow, Storm surge, High waves and Flood Issued if there is a chance of a serious disaster caused by weather conditions that meet the relevant warning criteria.</td>
</tr>
<tr>
<td>Advisories</td>
<td>Gale and snow, Gale, Heavy rain, Heavy snow, Dense fog, Thunderstorm, Dry air, Avalanche, Ice/snow accumulation, Frost, Low temperature, Snow-melting, Storm surge, High waves and Flood Issued if there is potential for the development of serious adverse conditions that meet the advisory criteria but remain below the warning criteria.</td>
</tr>
</tbody>
</table>

Real-time Risk Maps show where the risk of disasters is rising in association with heavy rain to supplement meteorological information such as Heavy rain/Flood Warnings.

Bulletins

Bulletins are issued to alert public to weather conditions before Warnings and Advisories are issued and to supplement the Warnings.

Real-time Risk Maps

These show landslide, inundation and flood risk for individual kilometer grids on an ascending five-level color scale (white to purple) every ten minutes.

Probability of Warnings

JMA provides probability information on the risk of severe weather phenomena expected to exceed the warning criteria within the next five days. Probability is expressed as “High” or “Mid.”

Bulletins on Exceptionally Heavy Downpours

Bulletins on Exceptionally Heavy Downpours are issued when a downpour with a scale seen only once every few years has been observed or analysed in the last hour.

Flood Warnings and Advisories for designated rivers

JMA issues Flood Warnings and Advisories for designated rivers with information on water levels or flow rates in collaboration with national and prefectural river authorities.

Landslide Alert Information

In association with the issuance of Heavy Rain Warnings, information on debris flow, slope failure and other hazards is issued jointly by LMDs and civil engineering bureaus of prefectural governments when damage from such hazards caused by heavy rain is considered likely within the next few hours.

Hazardous Wind Watch

Hazardous Wind Watch alerts supplement Thunderstorm Advisories to warn of a high probability of hazardous winds such as tornadoes and downbursts.

Radar/Rainage-Analyzed Precipitation and Very Short Range Forecasting of Precipitation

Radar/Rainage-Analyzed Precipitation data show the distribution of one-hour precipitation. Very Short-Range Forecast of Precipitation reports are issued to provide forecasts of hourly precipitation amounts for the next six hours.

Nowcast (Precipitation, Thunder and Tornadoes)

Nowcasts provide forecasts of precipitation intensity, thunder activity and the probability of hazardous winds such as tornadoes and downbursts up to four hours ahead.

Tropical Cyclone Information

JMA monitors tropical cyclone (TC) activity over the western North Pacific and issues TC advisories every three hours to provide relevant information, including the results of analysis and forecasts regarding location, intensity and movement up to 24 hours ahead. The Agency also issues five-day forecasts every six hours. If damage is expected from TCs approaching Japan, analysis data are provided every hour and 50-kt wind probability data are issued every six hours.

Daily Forecasts

Daily forecasts provide information on weather, winds, coastal ocean waves, maximum/minimum temperatures and probabilities of precipitation covering periods up to two days ahead. They include Distribution Forecasts and Three-hourly Forecasts.

One-week Forecasts

One-week Forecasts provide information on weather, precipitation probability, maximum/minimum temperatures and reliability, and cover the period up to seven days ahead.

Two-week Temperature Forecasts and Early Warning Information on Extreme Weather

Two-week Temperature Forecasts provide information on five-day averaged maximum and minimum temperatures for the second week ahead. If very high/low temperatures or very heavy snowfall on the Sea of Japan side of Japan are expected during this period, Early Warning Information on Extreme Weather is issued.

Seasonal Forecasts

Seasonal Forecasts provide climate outlooks on variables such as average temperature, precipitation amounts, sunshine duration and snowfall for the next one-to-six months. These are expressed in general terms of above-normal, normal or below-normal probability due to the scientific difficulty of deterministic prediction for the forecast period.

Information on climate, atmospheric environment and ocean conditions

JMA issues information on climate, atmospheric environment and ocean conditions. This includes data on extreme climate events worldwide, ultraviolet radiation, Aeolian dust (Kosa), the ozone hole and ocean currents/temperatures.

Reports on global warming and extreme climate events
Information on Earthquakes, Tsunami and Volcanoes

JMA Information Services
For Earthquake, Tsunami and Volcanic Disaster Mitigation

Information on Earthquakes, Tsunami and Volcanoes

Tsunami Warnings/Advisories and Tsunami Information

- **Tsunami Warnings/Advisories**
  - JMA estimates the potential for tsunami generation in the wake of earthquakes. If disastrous waves are expected in coastal regions, Tsunami Warnings/Advisories are issued.
  - **Tsunami Information**
    - When a Tsunami Warning/Advisory is issued, JMA also issues Tsunami Information with details such as estimated arrival times/heights and the recorded tsunami date.

Earthquake Early Warnings (EEWs)

- These provide advance notice of estimated seismic intensities and expected arrival times of principal motion just after an earthquake. If seismic intensities and expected arrival times exceed the threshold at a specified location, EEWs are issued.

Tsunami Warnings/Advisories

- **Tsunami height is estimated to exceed 3 meters.**
- **Tsunami height is estimated to be 1 - 3 meters.**
- **Tsunami height is estimated to be 0.2 - 1 meter.**

Eruption Notice

- **Eruption Notice**
  - JMA issues Eruption Notice to provide immediate brief information on volcanic eruptions for climbers, residents and other people nearby to adopt appropriate protective action.
  - The Notice is issued when a volcano for which no Volcanic Warning is in effect erupts, and in the event of an eruption that may affect locations outside the current target area.

Volcanic Ash Fall Forecasts (VAFFs)

- **Volcanic Ash Fall Forecasts (VAFFs)**
  - JMA issues Scheduled, Preliminary and Detailed Volcanic Ash Fall Forecasts to provide information on ash fall amounts and potential areas of lapilli fall. Ash fall thickness is expressed as heavy (≥ 1 mm), moderate (0.1 - 1 mm) or low (< 0.1 mm).

Volcanic Warnings and Alert Levels

- **Volcanic Warnings and Alert Levels**
  - JMA issues Volcanic Warnings when extremely hazardous volcanic phenomena or expansion of affected areas is expected. The information includes Volcanic Alert Levels highlighting target areas and action to be taken in five categories.

Extra Information

- **Extra Information**
  - JMA issues Extra Information to highlight target areas and action to be taken in five categories.

Details of Volcanic Activity

- **Details of Volcanic Activity**
  - JMA issues Details of Volcanic Activity to highlight the current status of volcanic activity. JMA also issues Details of Volcanic Activity (Extra) information when volcanic activity is elevated and the Volcanic Alert Level may need to be raised, although there is no need to do so at the time.

Seismic Intensity Information

- This specifies the time of earthquake occurrence and identifies regions where seismic intensities of 3 or greater have been observed.

Information on Seismic Intensity at Individual Locations

- This specifies hypocenters/magnitudes and identifies individual locations where seismic intensities of 1 or greater have been observed.

Estimated Seismic Intensity Distribution Map

- These specify areas where intensities of 4 or greater have been estimated using seismic intensity observation data. The Map is issued when maximum seismic intensity is 5 or greater.

Long-Period Ground Motion (LPGM) and related classes

- **Long-Period Ground Motion (LPGM)**
  - (a four-category metric indicating the strength of shaking in high-rise buildings) provides much more focused information for this purpose than regular seismic intensity data. JMA also publishes online data on observed long-period ground motion and information such as related classes and seismic waveforms.

Focus: Long-Period Ground Motion (LPGM) and related classes

- Long-Period Ground Motion (LPGM, where “period” refers to the duration of one back-and-forth shake cycle) associated with large earthquakes can cause strong shaking lasting 10 minutes or more in high-rise buildings. The phenomenon propagates over great distances, potentially resulting in persistent shaking hundreds of kilometers from the epicenter. It may cause furniture and fixtures to topple, fall or shift significantly.

JMA is responsible for issuing warnings and information on earthquakes, tsunamis and volcanoes. As such bulletins are critical for the protection of life, a standard operating procedure and warning categories are set in advance to ensure prompt issuance.

**Nankai Trough Earthquake Extra Information**

- If anomalies are detected along the Nankai Trough, Nankai Trough Earthquake Extra Information is issued with a keyword below in the line with the relationship with a major seismic event...

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Keywords | Condition
---|---
Under analysis | When analysis is underway to determine whether anomalies relate to a Nankai Trough Earthquake
Megathrust earthquake alert | When an earthquake with a magnitude of 8.0 or more is considered to have occurred at the plate boundary in the hypocenter area along the Nankai Trough
Megathrust earthquake attention | When an earthquake with a magnitude of 7.0 or more or an anomalous slow slip is considered to have occurred along the Nankai Trough (except in correspondence with a megathrust earthquake alert)
Analysis complete | When the results of analyses indicate that the anomalies are not classified into other megathrust earthquake alerts or megathrust earthquake attention output.
After the above announcements, Nankai Trough Earthquake Information may also be issued to supplement Nankai Trough Earthquake Extra Information.

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**Tsunami Information**

- When a Tsunami Warning/Advisory is issued, JMA also issues Tsunami Information with details such as estimated arrival times/heights and the recorded tsunami date.

**Volcanic Information**

- When an earthquake occurs, JMA promptly issues this earthquake Early Warnings (EEWs) and Tsunami Warnings/Advisories if a tsunami is expected. When a tsunami occurs, JMA promptly issues this Tsunami Warnings/Advisories and Tsunami Information.

**Earthquake Early Warnings (EEWs)**

- These provide advance notice of estimated seismic intensities and expected arrival times of principal motion just after an earthquake. If seismic intensities and expected arrival times exceed the threshold at a specified location, EEWs are issued.

**Seismic Intensity Information**

- This specifies the time of earthquake occurrence and identifies regions where seismic intensities of 3 or greater have been observed.

**Information on Seismic Intensity at Individual Locations**

- This specifies hypocenters/magnitudes and identifies individual locations where seismic intensities of 1 or greater have been observed.

**Estimated Seismic Intensity Distribution Map**

- These specify areas where intensities of 4 or greater have been estimated using seismic intensity observation data. The Map is issued when maximum seismic intensity is 5 or greater.
Organizational Structure

As of 31 March 2020

Headquarters
- Director-General
- Deputy Director-General

Field Offices
- Regional Headquarters (5)
- Local Meteorological Offices (50)
- Weather Stations (2)
- Aviation Weather Service Centers (5)
- Aviation Weather Stations (3)

Auxiliary Organs
- Meteorological Research Institute
- Meteorological Satellite Center
- Astronomical Observatory
- Magnetic Observatory
- Meteorological College

History

<table>
<thead>
<tr>
<th>Year</th>
<th>Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>1872</td>
<td>First observation station established in Hakodate.</td>
</tr>
<tr>
<td>1875</td>
<td>Tokyo Meteorological Observatory (TMO), the predecessor of JMA, established within the Ministry of the Interior.</td>
</tr>
<tr>
<td>1883</td>
<td>First weather map issued.</td>
</tr>
<tr>
<td>1884</td>
<td>First national weather forecast issued.</td>
</tr>
<tr>
<td>1884</td>
<td>Nationwide seismic intensity observation begun.</td>
</tr>
<tr>
<td>1887</td>
<td>TMO renamed as the Central Meteorological Observatory (CMO).</td>
</tr>
<tr>
<td>1921</td>
<td>Oceanographic and marine meteorological observation begun.</td>
</tr>
<tr>
<td>1930</td>
<td>Aviation weather service begun.</td>
</tr>
<tr>
<td>1935</td>
<td>Snow Warning System established.</td>
</tr>
<tr>
<td>1941</td>
<td>Tsunami warning organization for the Sanriku coast established.</td>
</tr>
<tr>
<td>1942</td>
<td>Long-range Forecast Service begun.</td>
</tr>
<tr>
<td>1953</td>
<td>Meteorological Service Act brought into force.</td>
</tr>
<tr>
<td>1953</td>
<td>Japan joins the World Meteorological Organization (WMO).</td>
</tr>
<tr>
<td>1956</td>
<td>JMA becomes a member of the World Meteorological Organization (WMO).</td>
</tr>
<tr>
<td>1957</td>
<td>JMA becomes a member of the International Telecommunication Union (ITU).</td>
</tr>
<tr>
<td>1959</td>
<td>JMA becomes a member of the International Telecommunication Union (ITU).</td>
</tr>
<tr>
<td>1965</td>
<td>Provision of Volcanic Information begun.</td>
</tr>
<tr>
<td>1978</td>
<td>Automated Meteorological Data Acquisition System (AMeDAS) established.</td>
</tr>
<tr>
<td>1979</td>
<td>GMS (JMA’s first geostationary meteorological satellite) launched.</td>
</tr>
<tr>
<td>2018</td>
<td>Provision of Real-time Risk Maps on inundation and flooding begun.</td>
</tr>
<tr>
<td>2020</td>
<td>Issuance of Nankai Trough Earthquake Information begun.</td>
</tr>
<tr>
<td>2015</td>
<td>Himawari-8 geostationary meteorological satellite operation begun.</td>
</tr>
<tr>
<td>2015</td>
<td>Issuance of Eruption notice begun.</td>
</tr>
</tbody>
</table>

JMA Main Offices

JMA operates the Sapporo, Sendai, Tokyo, Osaka, Fukuoka, and Okinawa Regional Headquarters to observe and monitor weather and earthquakes and to issue forecasts, warnings and bulletins for these regions. The Regional Headquarters give direction to Local Meteorological Offices for the issuance and provision of information and comments on prefectural and sub-focal regions. The Agency operates Aviation Weather Service Centers at major airports to support the safe flow of air traffic.

JMA also operates the Meteorological Research Institute, the Meteorological Satellite Center, the Aerological Observatory, the Magnetic Observatory and the Meteorological College as locations for research and training to support meteorological services.