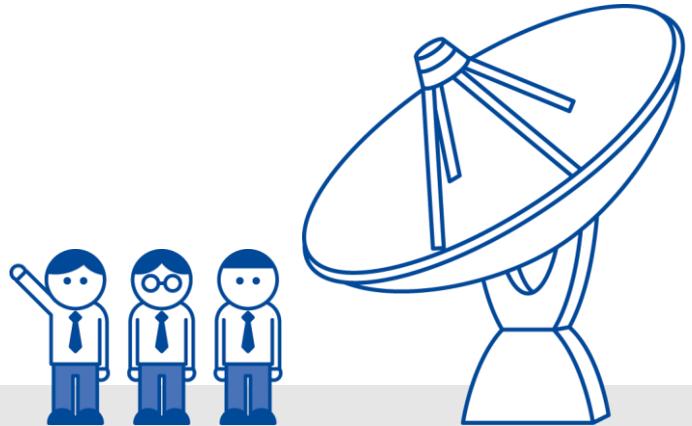


Solid-state Weather Radar made in JAPAN

Japan Meteorological Agency
Ministry of Land, Infrastructure, Transport and Tourism
Ministry of Internal Affairs and Communications





Worldwide prevalence of extreme weather events

A range of extreme weather events, including heat waves, blizzards, heavy rain and massive snowfall occur all over the world, bringing serious damage on a global scale.

To address this threat and mitigate related damage, there is a pressing need for highly accurate observation data indicating current conditions.





Advanced weather radar for a disaster-prone nation



Why is advanced weather radar development promoted in Japan?

Located in the Asian monsoon region, Japan is frequently hit by extreme natural disasters involving typhoons, heavy rain, flooding and landslides. Against such a background, there has been a need for meteorological observation data with finer resolution and greater precision to mitigate related damage. To meet this need, updates to introduce more advanced techniques for weather radar and other observation equipment have constantly been required since the first weather radar started operation in Japan in the 1950s. This situation has positioned Japanese solid-state weather radar as a pioneer in the global market.

Advanced solid-state weather radar for detailed observation

Early weather radar was capable of detecting only areas of rain, but has developed gradually in line with the needs of the times to enable observation of rain intensity, wind velocity and the shape of raindrops on a step-by-step basis. This has led to the recent establishment of weather radar with semiconductor transmitters replacing the previous electron tubes. Such units are ready for practical use, and are being installed for operational application in Japan by the Japan Meteorological Agency and other organizations.

Advantages of solid-state weather radar

High accuracy

Reduced running costs

Improved stability and maintainability

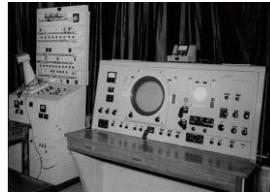
More effective use of radio waves

History of on-site weather radars in Japan



1954 – 1968

First operational weather radar



1950s – 1970s

Early weather radar monitoring equipment



1965 – 1999

Historical landmark: installation of the world's highest weather radar on top of Mt. Fuji



2016 –

Cutting-edge dual-polarization solid-state weather radar



High accuracy

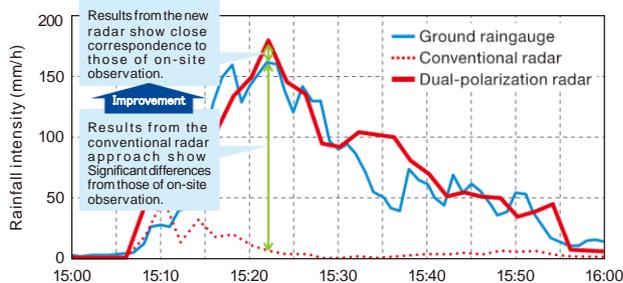
A combination of stable radio wave output and cutting-edge observation techniques based on dual polarization reduces observation time and increases data accuracy.



Increased precision

Comparison of radar-based and on-site raingauge observation

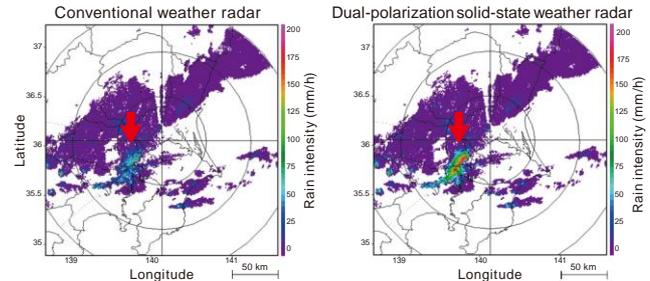
The figures below show rain intensity observed using new (dual-polarization solid-state)/conventional radar techniques and on-site raingauge observation. The new radar approach supports highly accurate observation.



[Dual-polarization radar]

- Dual-polarization radar enables highly accurate observation based on horizontally and vertically polarized waves.
- Stable radio wave output is essential for dual-polarization observation over a short time span.

Rain intensity observation using conventional and new radar technology



- Shaded areas show rain intensity observation results from each radar technique.
- Red arrows show locations of on-site raingauge observation.

Reduced running cost

Running costs can be drastically reduced by extending the life of transmitters and cutting power consumption.



Initial cost

Approx. the same
as electron tube
weather radar

Running cost (maintenance/part replacement)

Cost reduction

Running cost (power consumption)

Cost reduction

Reduced cost



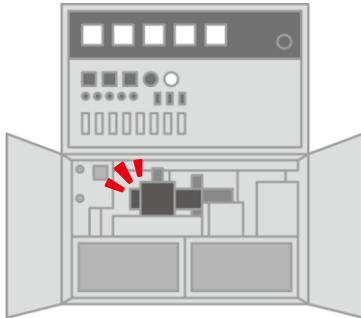
- Solid-state transmitters last over 10 years with fewer technical problems than electron tube transmitters, which require tube replacement every few years.
- Solid-state transmitters work without a high-voltage electricity supply.



Improved stability & maintainability



Solid-state transmitters continue operating even in the event of semiconductor device issues, and problem devices can be replaced without shutting down the whole radar system.



Electron tube transmitters

- Radar operation cannot continue in the event of electron tube malfunction.
- The system must be shut down for electron tube replacement.



Solid-state transmitters

- If a problem arises with a modular part, operation can be continued with reduced output.
- It is unnecessary to shut down the system during replacement, and adjustments can be easily made due to the low voltage used.
- Solid-state transmitters are around half the size of electron tube transmitters.

Improved continuity

More effective use of radio waves



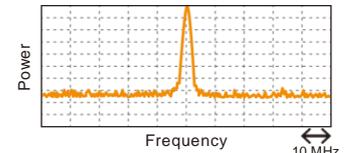
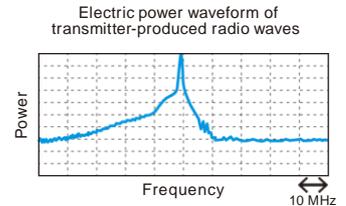
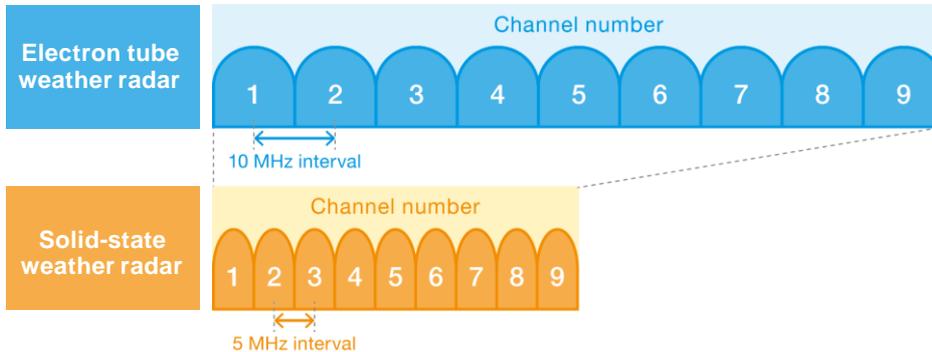
The narrow bandwidth of transmitted radio waves enables more effective use of radio wave resources.

Reduced channel interval

Example in Japan

Radio wave bandwidth allocated to each weather radar in the operation of multiple weather radars

- Using a solid-state transmitter makes it easy to shape the wave form.
- Consequently, the interval of the allocated bandwidth was halved to 5 MHz.



Introduction to operational use in Japan

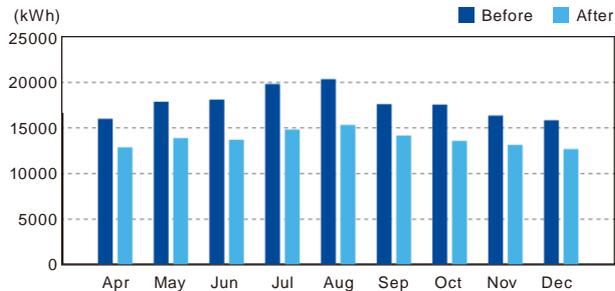
The Japan Meteorological Agency (JMA)

Trial observation with solid-state weather radar was started at JMA's Meteorological Research Institute in 2007, and the Agency upgraded its aviation weather radars with solid-state technology at Haneda, Narita and Kansai airports in 2016. The approach is also currently being deployed at other airports, and its adoption for the Agency's general-purpose weather radars is planned.



Haneda Airport Radar

Approx. 20% reduction in power consumption for the whole system compared to a Klystron



Water and Disaster Management Bureau, MLIT, Japan

In 2010, practical operation of dual-polarization solid-state radars was implemented for some X-band radars to support the management of river facilities by the Water and Disaster Management Bureau of Japan's Ministry of Land, Infrastructure, Transport and Tourism (MLIT). Some conventional C-band radars have been updated to dual-polarization solid-state types, and a united radar product based on the use of both bands entered practical operation in 2016.



Composite map of observation by X- and C-band radars

Radar product specifications

Observation interval	Spatial resolution	Transmission time
1 min	250 m	1 – 2 min

Countries adopting Solid-state Weather Radar made in JAPAN



- Australia
- Belgium
- Croatia
- Denmark
- India
- Indonesia
- Japan
- Myanmar
- Philippines
- Singapore
- USA

(As of January 2017)

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