Direct readout activity in MSC/JMA

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Introduction to MSC of JMA

- Meteorological Satellite Center (MSC) was established as an auxiliary organ of JMA on 1st April 1977.
- The mission of MSC is to observe meteorological and related phenomena from space using satellites, process observation data, and disseminate information and products derived from the data.
- Main activities of MSC of JMA:
  - Operation of the meteorological payloads of Himawari-8/-9
  - Derivation of imagery from Himawari-8/-9
  - Extraction of meteorological parameters
  - Collection and processing of DR data from LEO satellites

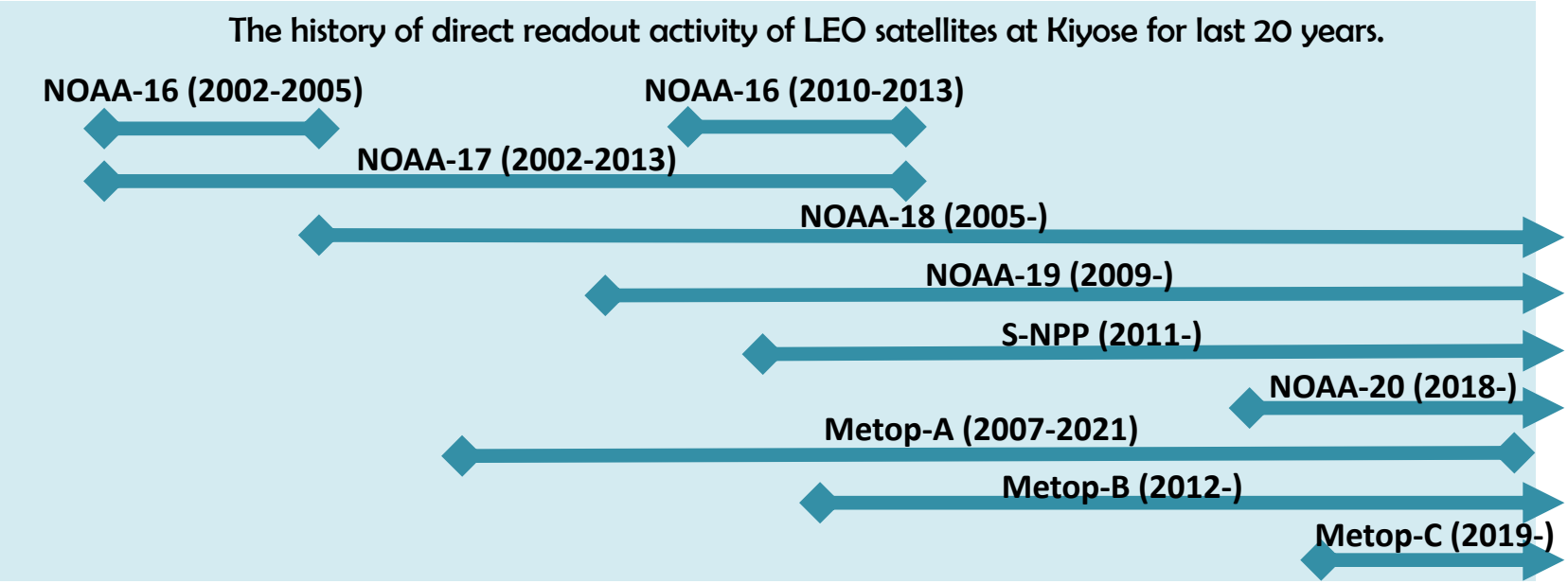
MSC in Spring

Himawari-8/9

DR antenna tower

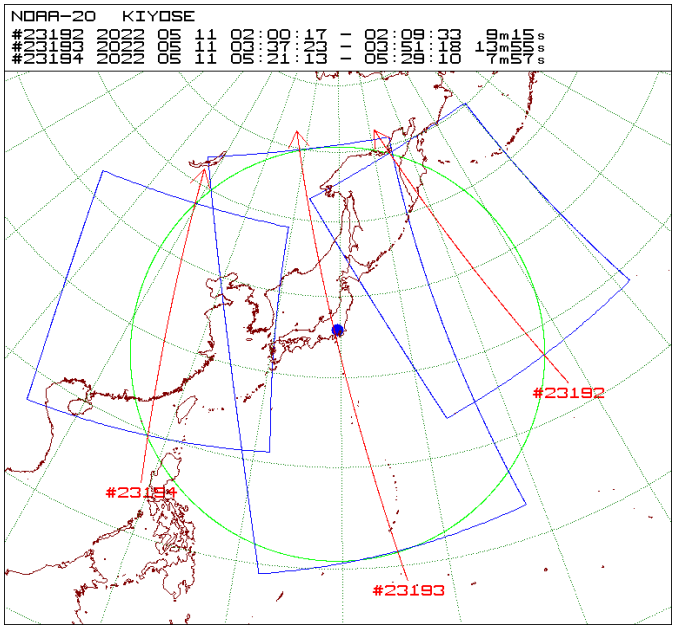
Overview of JMA's activities concerning DR from LEO satellites

- JMA has acquired Direct Readout (DR) data from LEO satellites since 1968 and utilized their products for early detection of extreme weather events such as typhoon and heavy precipitation.
- These low latency products also bring important benefit to numerical weather prediction (NWP) around the world including JMA's.
- JMA processes DR data acquired at Kiyose station (owned by JMA) and Syowa station (owned by a partner organization) and distributes products derived from it to Direct Broadcast Network (DBNet).



Kiyose station

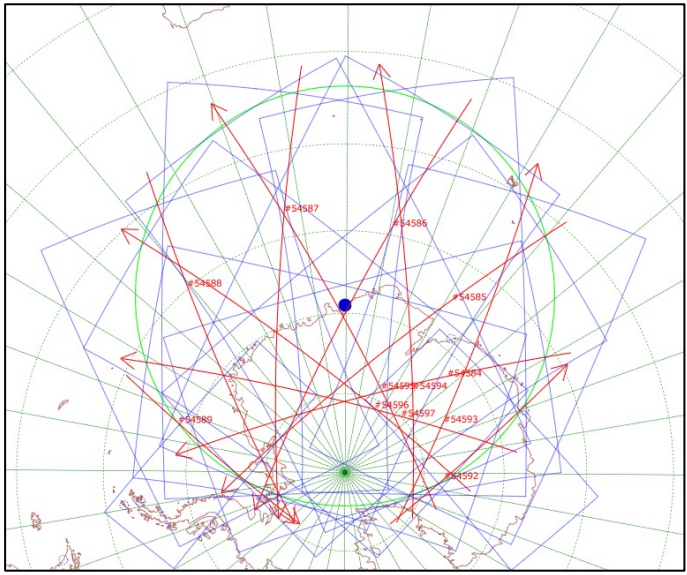
NOAA-20 Receivable Orbits



- Operator: JMA
- Location: 35.78N, 139.53E
- 1 antenna
  - Diameter: 3.6m
  - Program tracking for L-band
  - Conical scan tracking for X-band
  - Right-hand circular polarization
- Target satellites:
  - Metop-C, S-NPP, Metop-B, NOAA-19,NOAA-18,NOAA-20
- Upgrade for JPSS-2 and Metop-SG is planned next year.

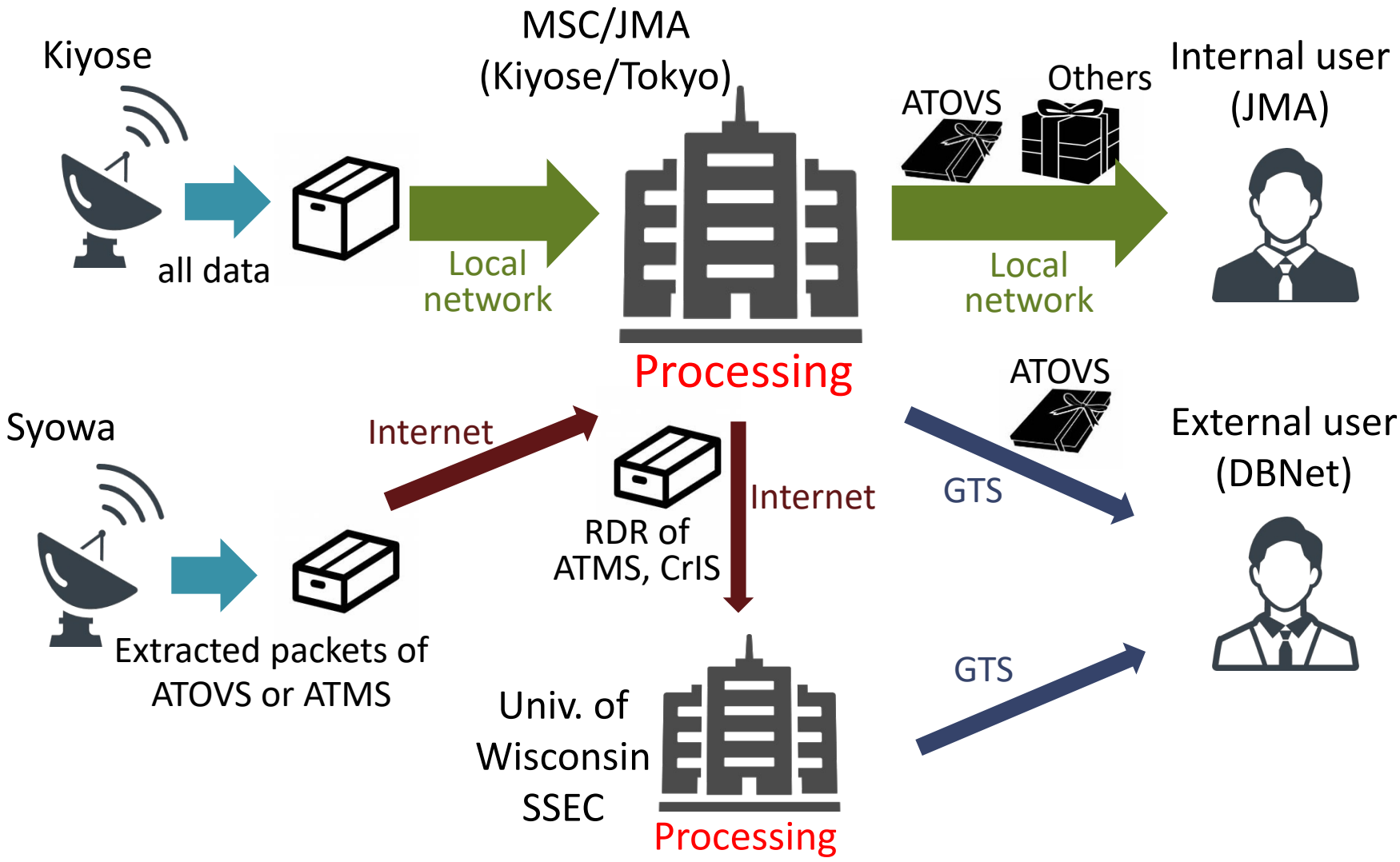
Syowa station

S-NPP, Receivable Orbits

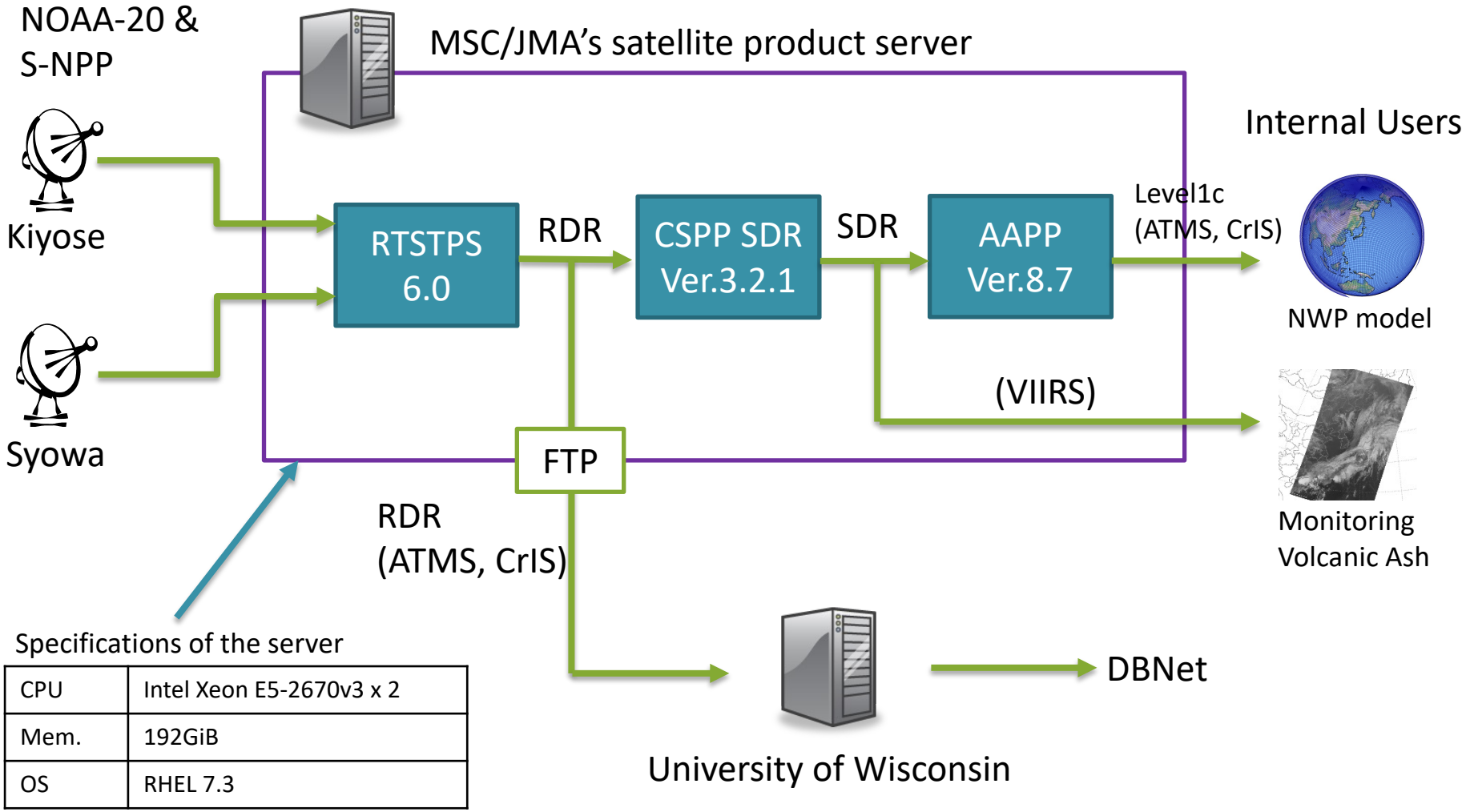


- Operator: National Institute of Polar Research (NIPR)
- Location: 69.00S, 39.58E
- 2 antennas (for L/S-bands and X-band)
  - Diameter: 1.2m for L/S-bands, 2.4m for X-band
  - Right-hand circular polarization
- Target satellites:
  - DMSP, NOAA-18/19, Metop-B/C for L/S-bands
  - S-NPP, NOAA-20, Aqua, Terra for X-band

Collection, Processing and Distribution



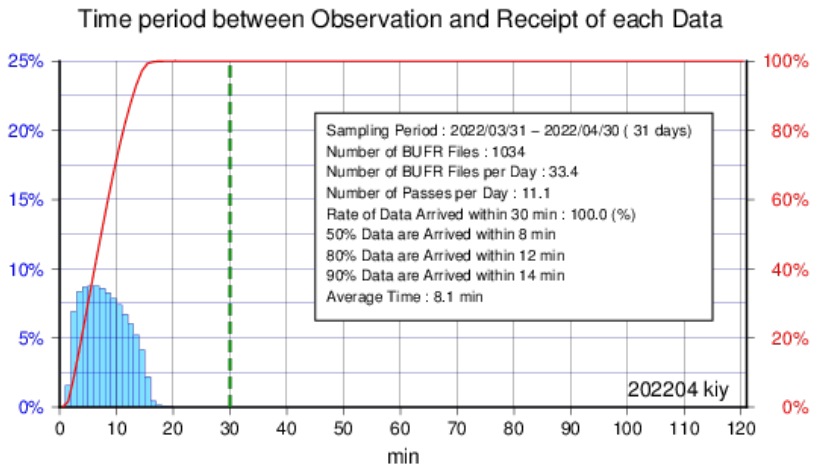
Use of CSPP Software in MSC/JMA

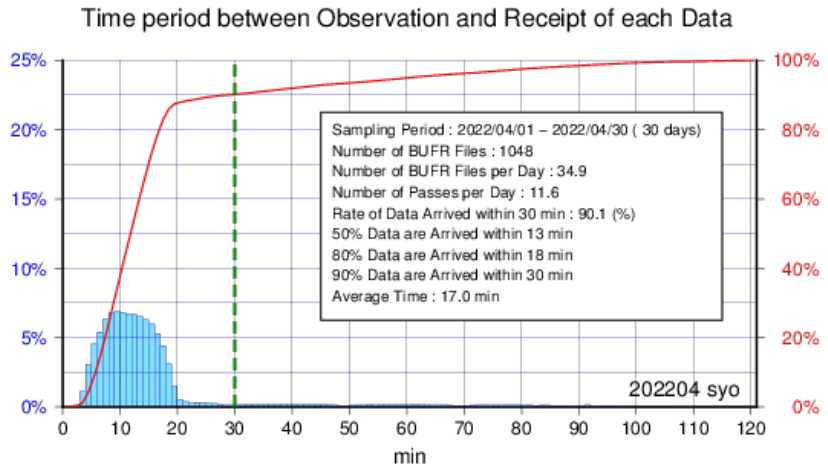


CPU	Intel Xeon E5-2670v3 x 2
Mem.	192GiB
OS	RHEL 7.3

Timeliness of Kiyose & Syowa data

- The time from observation to provision of DR data at Kiyose and Showa is generally within 20 minutes.
- This is fast enough for applications such as NWP, which requires rapid data provision.





Timeliness Plots of Kiyose (left) and Syowa (right). The bar chart is a histogram of the time taken from observation to delivery. The line chart shows the cumulative frequency.

Use of DR Data in JMA

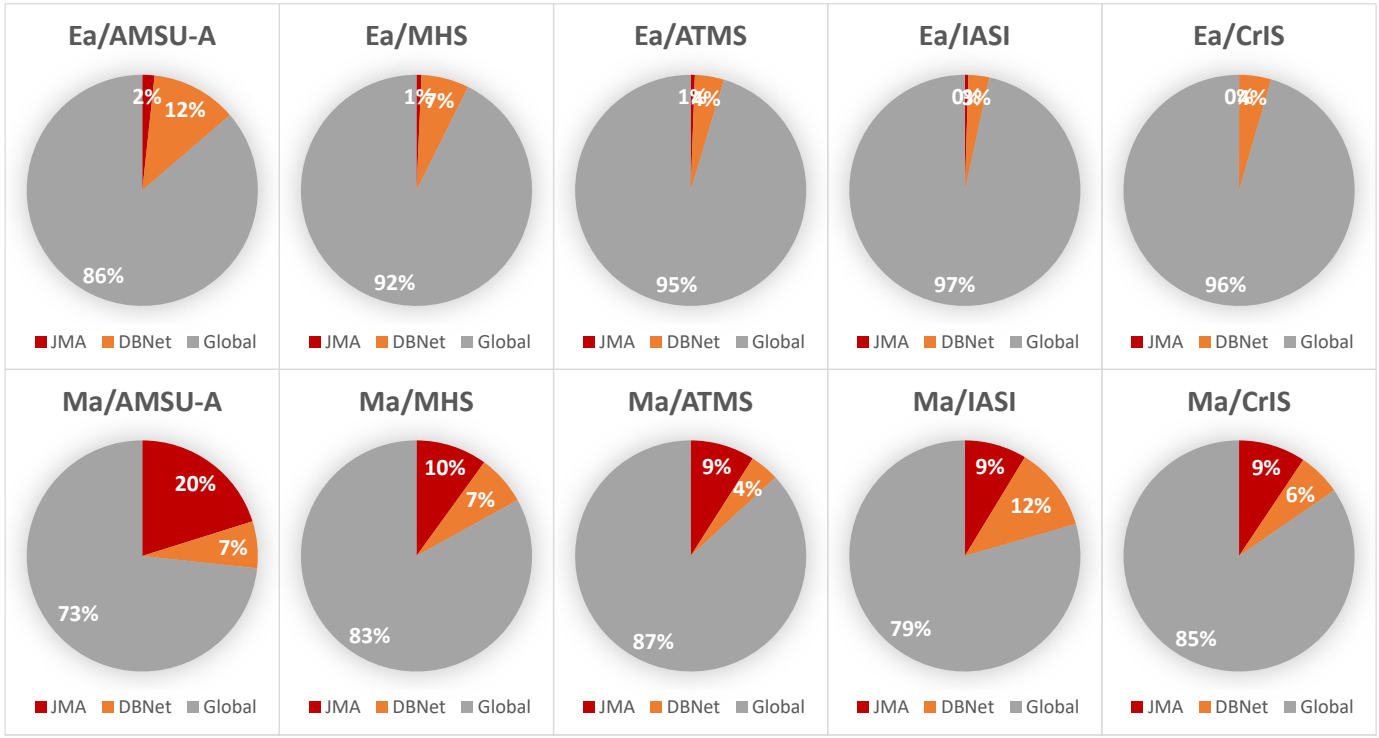
- JMA uses the DR data for a variety of applications.
  - Numerical Weather Prediction (NWP)
    - Toward Better Prediction for Stationary Linear Mesoscale Convective Systems
  - Volcanic Ash
  - Aerosol
  - Sea Surface Temperature (SST)
  - Sea Ice

Use of DR Data in JMA: NWP

2022/02/24-03/02

Global early analysis
(6 hourly)
data cut-off: 2 hr. 20min.

JMA Meso-scale analysis
(3 hourly)
data cut-off: 50 min.

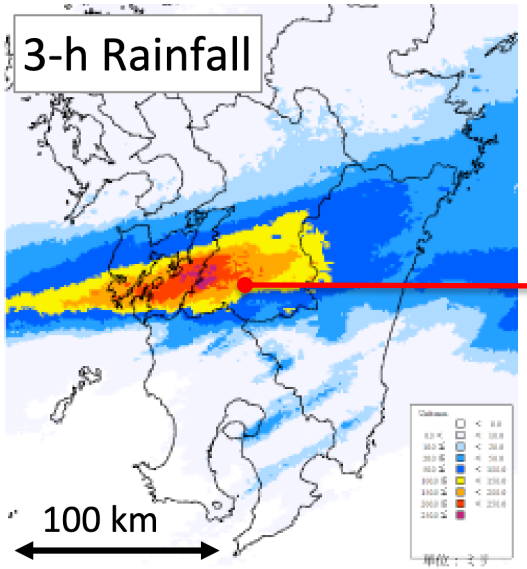


Ratio of available DR MW sounder data in the operational Global Analysis and Meso-scale (regional) analysis.

DR data is valuable for operational NWP system, especially for short data cut off time system.

Toward Better Prediction for Stationary Linear Mesoscale Convective Systems

- Torrential rain events during East Asian rainy season in recent years
  - Mainly caused by stationary linear mesoscale convective systems
- JMA has started the forecasts information for stationary linear mesoscale convective systems since June 1, 2022.
- To improve the prediction for the phenomenon, it is necessary to enhance the accuracy of water vapor observations.
- DR data is very important as it contributes to the improvement of NWP.



3-h accumulated radar/rain-gauge obs. (mm) at 0500 on 4th July 2020

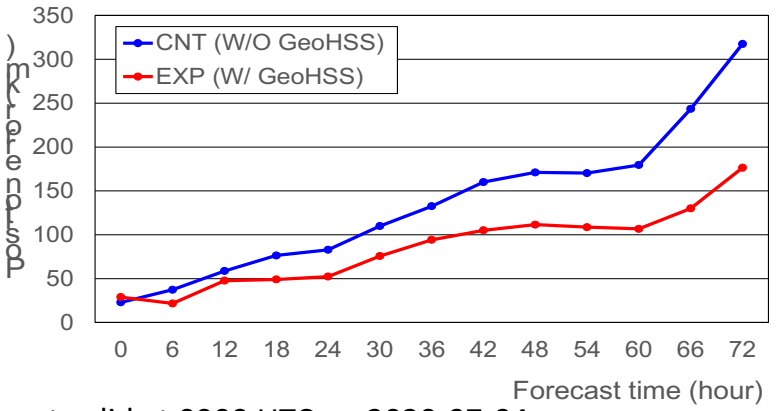
Houses submerged by the Kuma River on 4 July 2020 (MLIT)

Toward Better Prediction for Stationary Linear Mesoscale Convective Systems

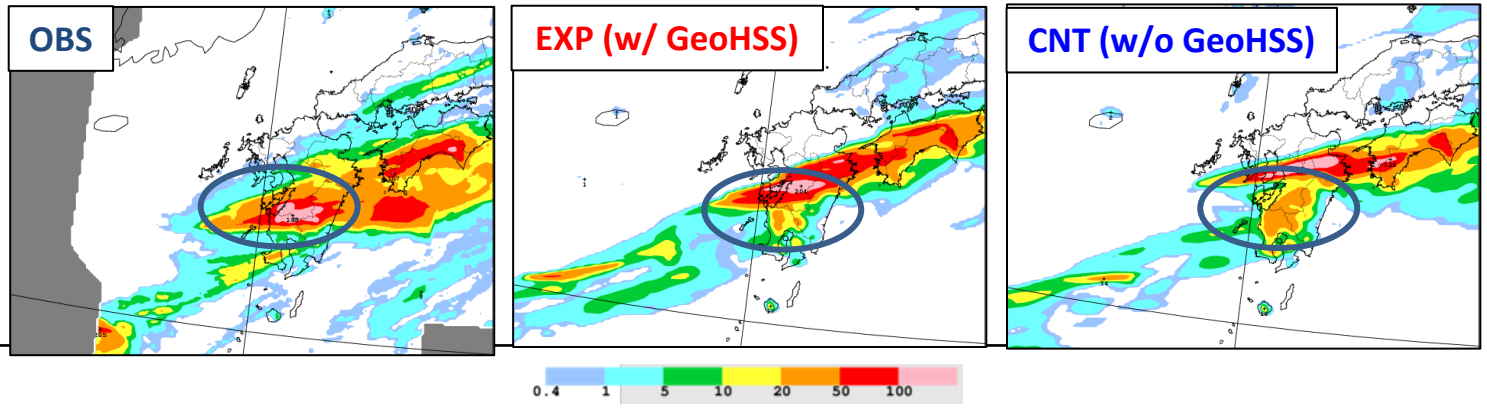
OSSE of GEO Hyperspectral IR Sounder

- Several experiments were implemented with Okamoto *et al.* (2020)
  - Operational DA configuration (incl. use of AIRS/CrIS/IASI in global model)
  - Hypothetical IRS on GEO at 140.7 E, hourly full-disk obs w/ 30 km spatial resolution from ERA5
- Global DA (upper figure)
  - ~140 km improvement in typhoon position for 3-d forecast (time of landing)
- Regional DA (bottom figures)
  - Better location of the heaviest rain area which caused devastating floods

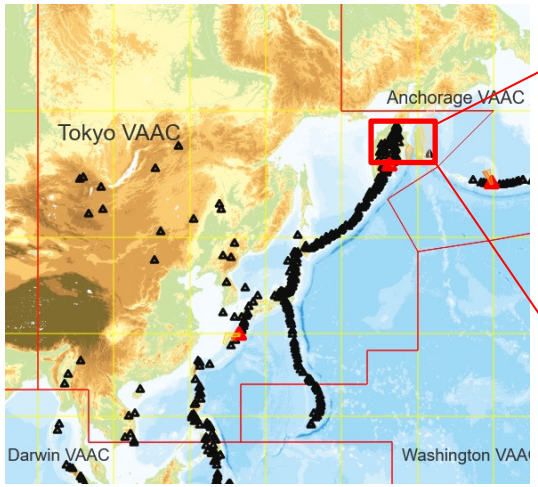
Averaged track forecast errors (4 typhoons) making landfall in Japan, 2018



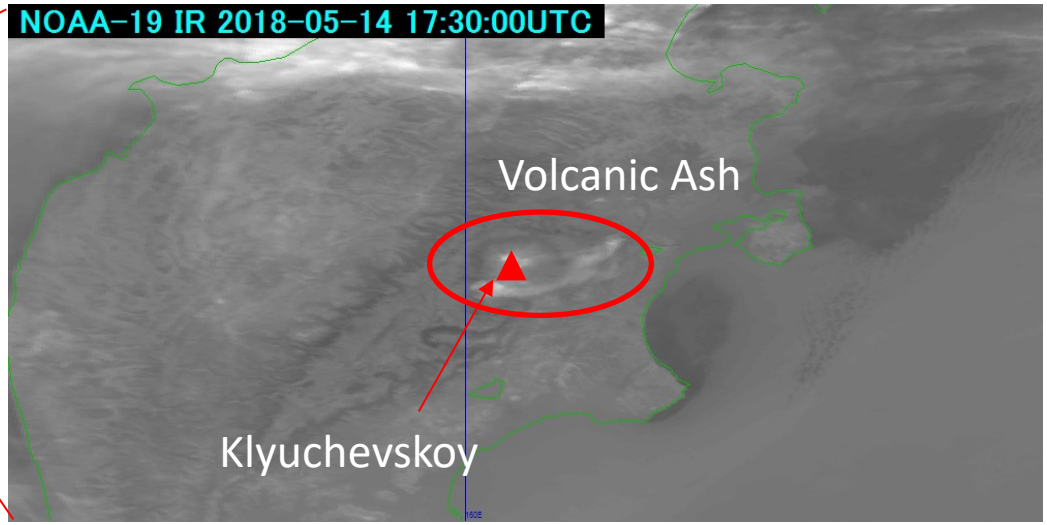
3-hour accumulated rainfall (mm), 12-h forecast valid at 0900 UTC on 2020-07-04



Use of DR Data in JMA: Volcanic Ash



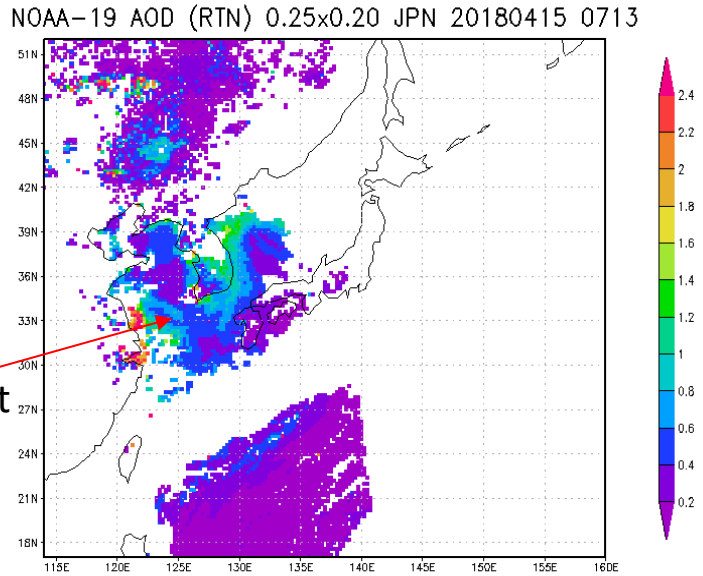
Area of Responsibility of Tokyo VAAC



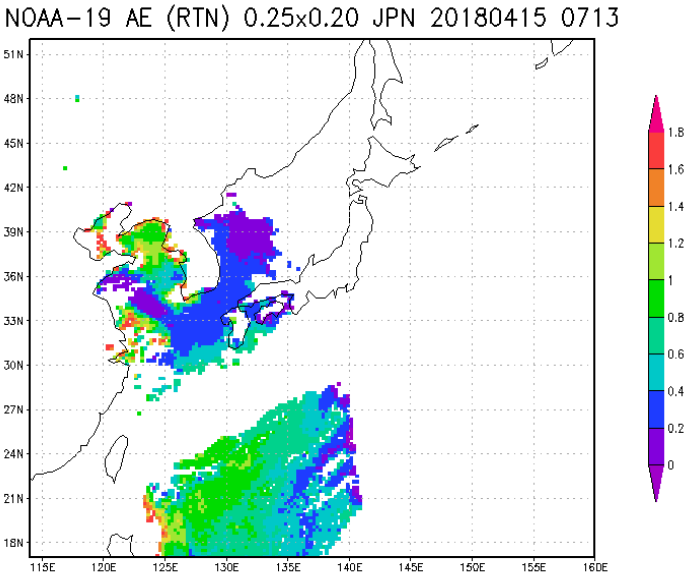
2018.05.14, NOAA-19, Infrared

- JMA operates Tokyo VAAC and provides Volcanic Ash Advisories (VAAs) in the East Asia, Northwest Pacific region and part of the Arctic Circle.
- Tokyo VAAC uses satellite data to monitor volcanic ash in the regions.
- DR data from LEO satellites are particularly useful for monitoring high-latitude regions, where GEO satellites have low resolution.

Use of DR Data in JMA: Aerosol



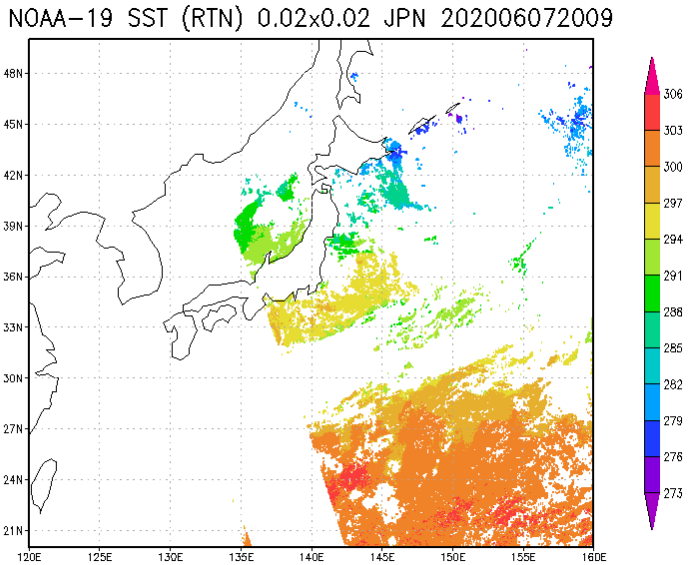
Aerosol Optical Depth



Angstrom Exponent

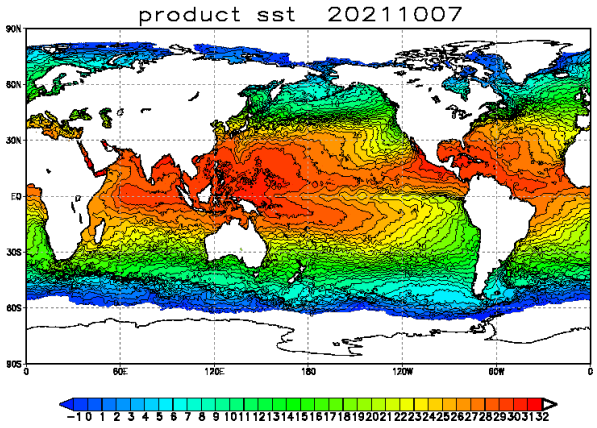
- JMA retrieves aerosol optical depth (AOD) and Angstrom exponent from the DR data.
- JMA uses these products to monitor the Aeolian dust.
- Aeolian dust is a kind of aerosol blown up from semi-arid areas of the Asian continent and transported by westerly winds to Japan.

Use of DR Data in JMA: SST



SST from DR data

ACSPO Level 3U	GAC Level 1B	Level 2
S-NPP/VIIRS (IR)	AVHRR/NOAA-19(IR)	AMSR2 (MW)
NOAA	NOAA	JAXA



Global SST analysis

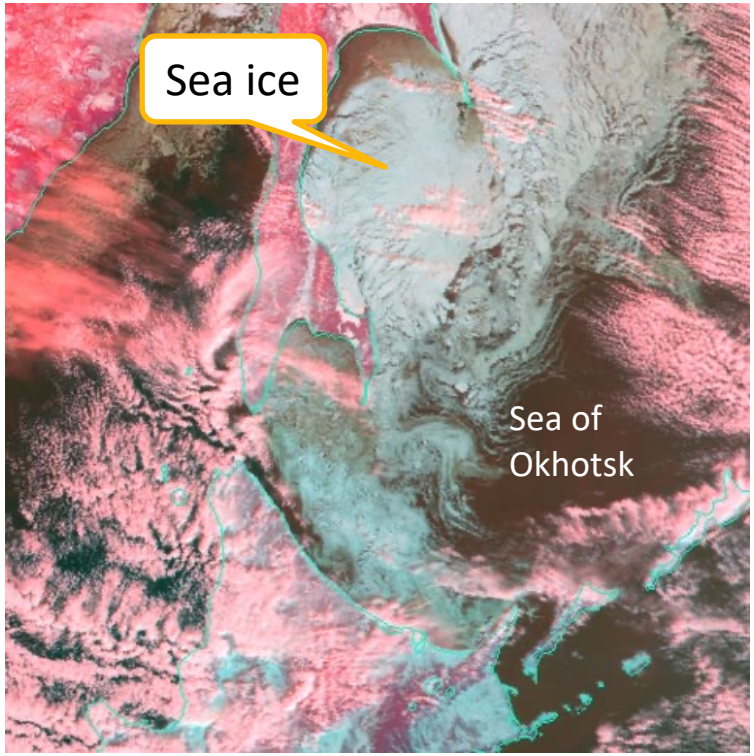
- JMA analyzes SSTs for use in fisheries, vessel operations, and boundary conditions for NWP models.
- DR data, as well as global data from LEO satellites, are used as input data for SST analysis.

Use of DR Data in JMA: Sea Ice

Sea ice in the sea of Okhotsk

The Sea of Okhotsk is the southernmost sea in the Northern Hemisphere where sea ice is observed across a wide area. Sea ice hinders marine output, damages fishing facilities and can obstruct shipping lanes, leading to accidents at sea.

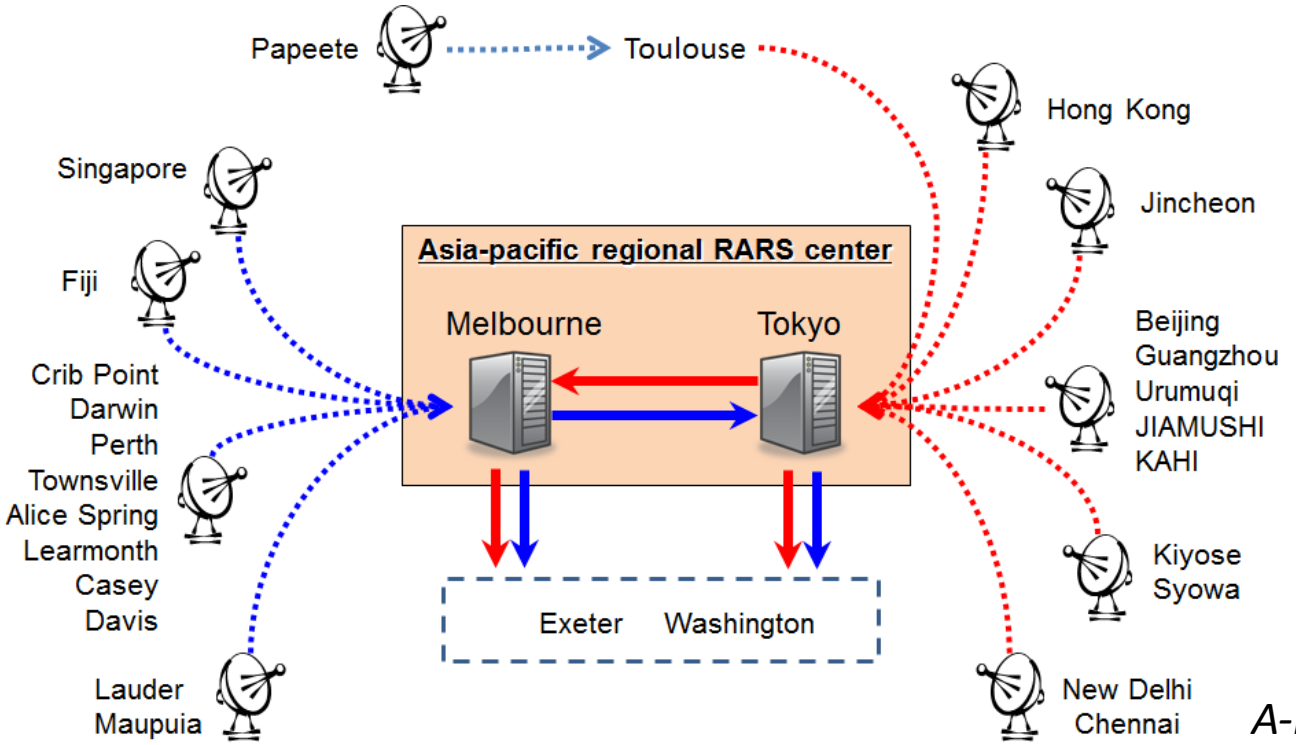
JMA uses DR data to monitor sea ice around Japan.



2016.02.26, Metop-B, AVHRR

DBNet activities

- Asia-Pacific (AP) RARS is one of Regional ATOVS Re-transmission Services of DBNet.
- JMA plays an important role in DBNet as a sub-regional network coordinator on AP RARS, which is responsible for coordination and management of activity of DBNet stations in the area.

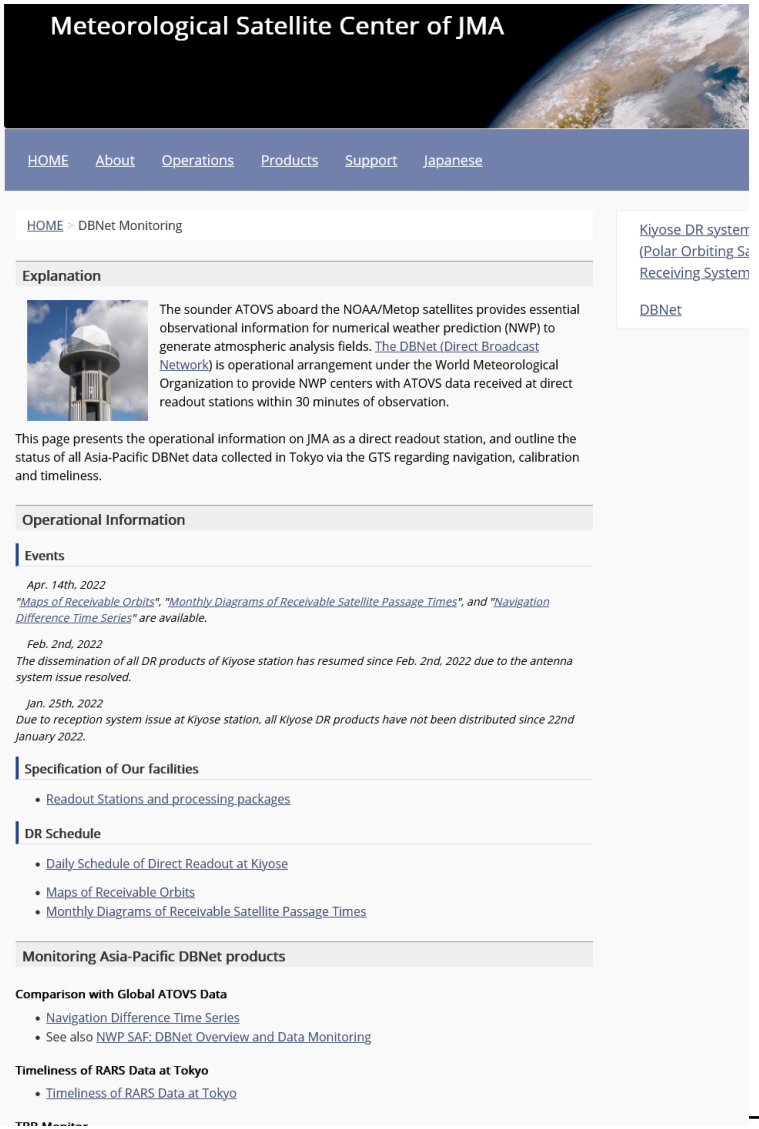


A-P RARS Network

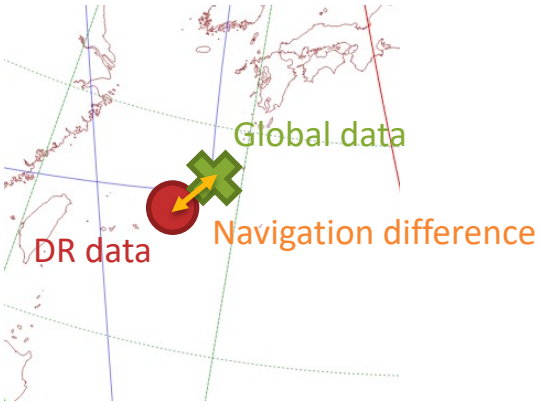
MSC/JMA AP-RARS Website

- DR Schedule
  - Daily Schedule of Direct Readout
  - Maps of Receivable Orbits
  - Monthly Diagrams of Receivable Satellite Passage Times
- Comparison with Global ATOVS Data
  - Navigation Difference Time Series
- Timeliness of RARS Data at Tokyo
- Specification of Direct Readout Stations

https://www.data.jma.go.jp/mscweb/en/DBNet/DBNet.html

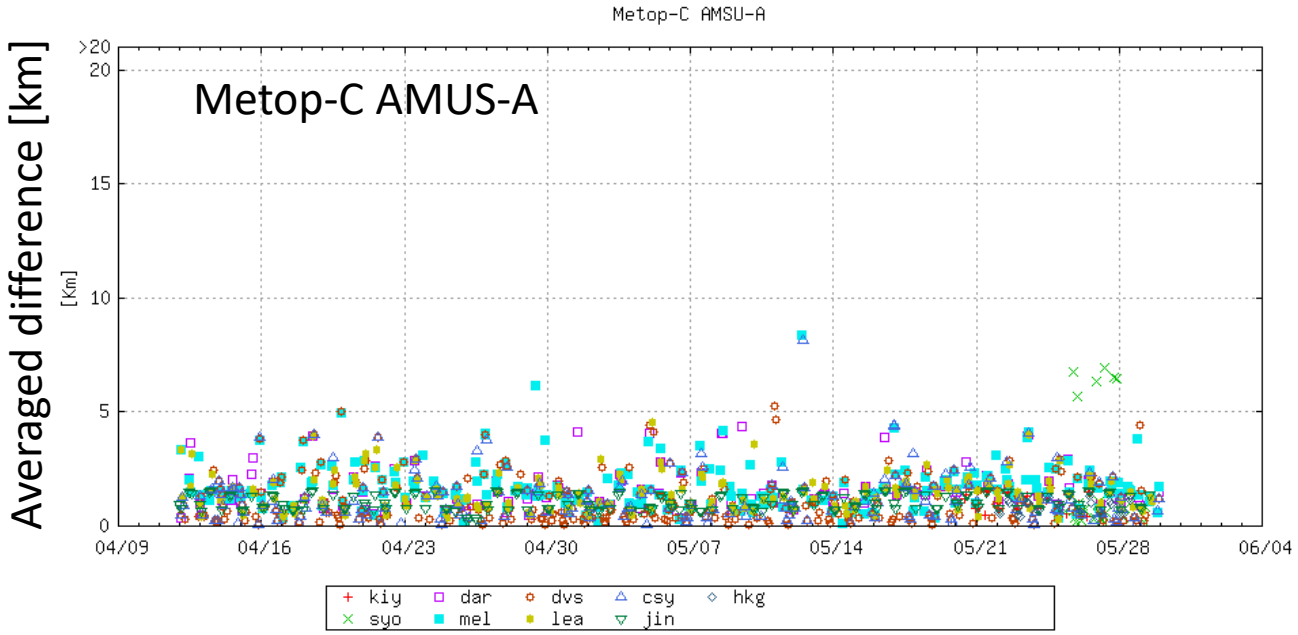


Navigation difference time series

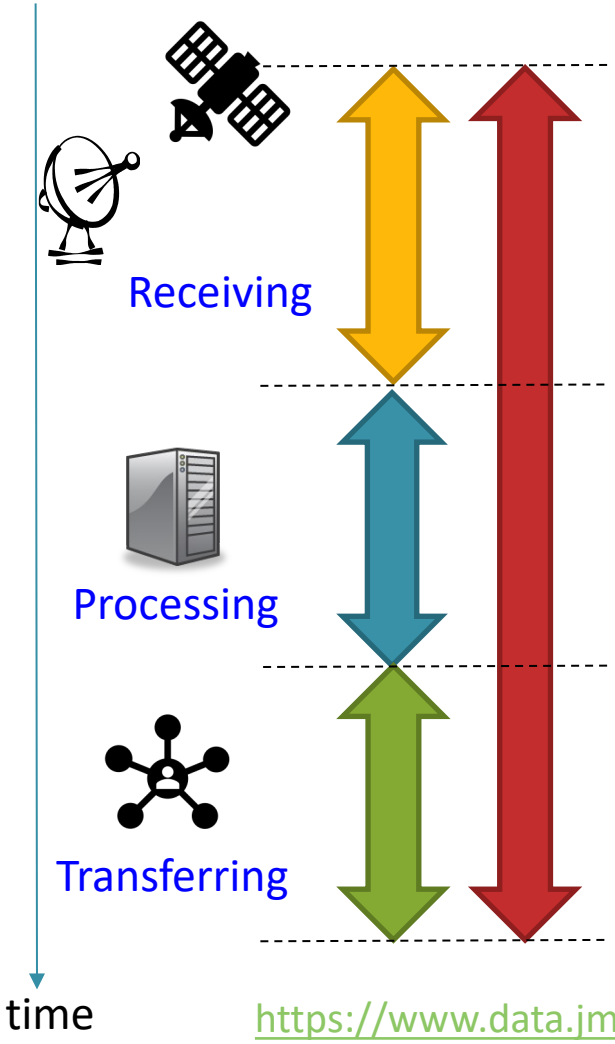


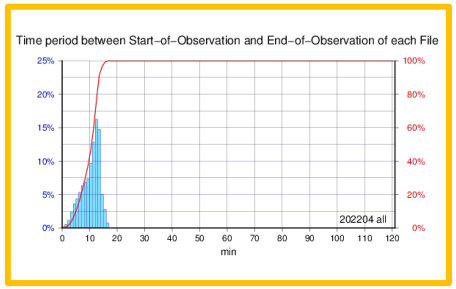
This content shows time series of the averaged navigation difference between global and DR data for each AP-RARS station.
This figure helps to identify alignment problems in DR data processing at an early stage.

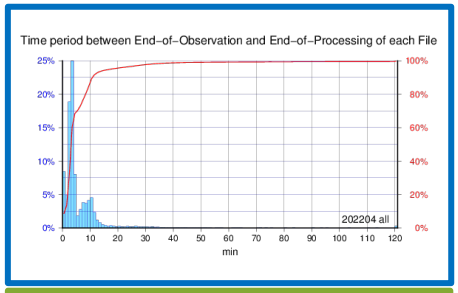
https://www.data.jma.go.jp/mscweb/data/DBNet/nav_ts_index.html

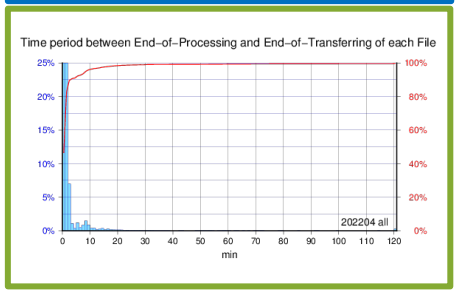


Timeliness monitor

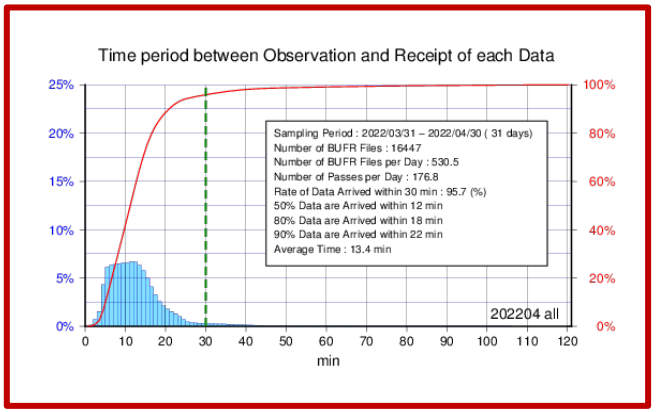








This content also aggregates the time it takes from observation to data delivery, as well as the time consumed at each stage of the process, to help the centers in AP RARS identify problems.



https://www.data.jma.go.jp/mscweb/data/DBNet/time_index.html

Plans for Next Generation LEO Satellites

- Both JMA (own Kiyose) and NIPR (own Syowa) have plans to receive JPSS-2 and Metop-SG DR data.
- JMA plans to replace the antenna of Kiyose station in January 2023 to receive coming new satellites including JPSS-2 and Metop-SG.
- NIPR intends to continue DR activity and has included JPSS-2 and Metop-SG DR one in their next six years plan.

Summary

- JMA has acquired DR data from LEO satellites for over fifty years.
- JMA uses CSPP SDR to process DR data.
  - We greatly appreciate the cooperation of SSEC/CIMSS.
- JMA uses DR data for a variety of applications.
- JMA plays an important role in DBNet as a sub-regional network coordinator on Asia-Pacific RARS.
- JMA has plans to receive JPSS-2 and Metop-SG.

Thank you for your attention!