4.02

JMA and JAXA

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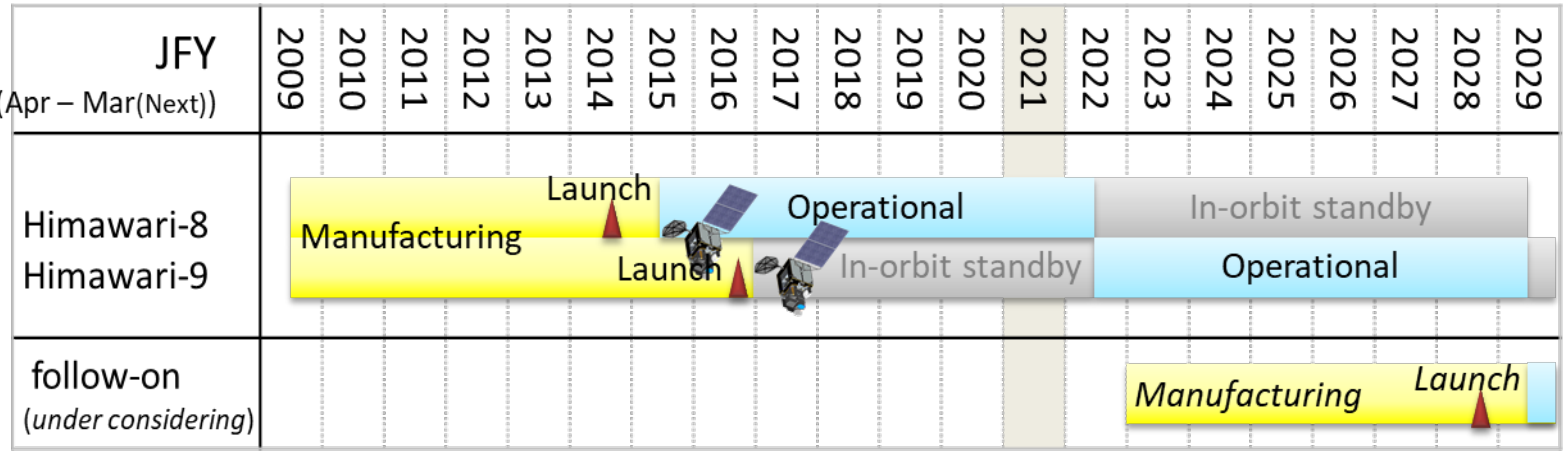
ITSC-XXIII: Virtual Meeting, 24 - 30 June 2021

JMA: Japan Meteorological Agency



- JMA operates GEO meteorological satellites; Himawari -8/9
- Himawari-8: Operational since July 7, 2015
- Himawari-9: Standby for backup since March 10, 2017
  - Switch over from H-8 to H-9 in JFY 2022
- JMA is *considering* the next GEO satellite program:
  - "By *JFY2023* Japan will start manufacturing the Geostationary Meteorological Satellites that will be the successors to Himawari-8/9, aiming to *put them into operation in around JFY2029*"

Japan's "Basic Plan on Space Policy" (June 2020)

Himawari-8,9/AHI Channel Set		
Band	Central Wavelength [μm]	Spatial Resolution
1	0.43 - 0.48	1km
2	0.50 - 0.52	1km
3	0.63 - 0.66	0.5km
4	0.85 - 0.87	1km
5	1.60 - 1.62	2km
6	2.25 - 2.27	2km
7	3.74 - 3.96	2km
8	6.06 - 6.43	2km
9	6.89 - 7.01	2km
10	7.26 - 7.43	2km
11	8.44 - 8.76	2km
12	9.54 - 9.72	2km
13	10.3 - 10.6	2km
14	11.1- 11.3	2km
15	12.2 - 12.5	2km
16	13.2 - 13.4	2km

Recent status of Himawari-8

気象庁 Japan Meteorological Agency

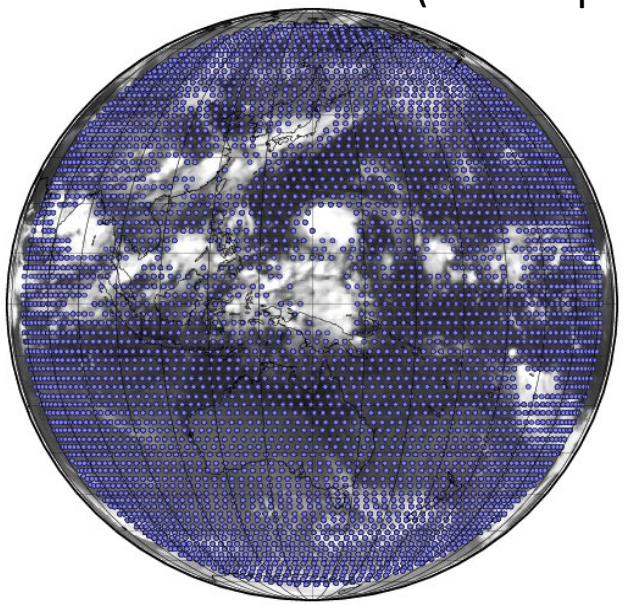
- Recently updated products
  - Sea Surface Temperatures (SSTs), Aerosol optical depth (AOD), Rapidly Developing Cumulus Area (RDCA), AMV reprocessing
    - SST: higher resolution and frequency (0.02 deg, 10min)
    - AOD products operationally assimilated in a global aerosol data assimilation for the aeolian dust forecast since Jan. 2020
- Observation quality
  - Navigation: error < 600m at the sub-sat point
  - Calibration: 5% for VNIR bands (1-6), < 0.3 K for IR bands (7-16)
- HimawariRequest (Jan 2018)
  - Allow users to request Target Area Obs of 1000 x 1000 km every 2.5 min
  - 122 international requests since the commencements
    - e.g. tropical cyclones in the South Pacific, extreme weather and bushfires in Australia, and volcanic activity in Indonesia
  - https://www.jma.go.jp/jma/jma-eng/satellite/HimawariRequest.html

Himawari-8/9 follow-on

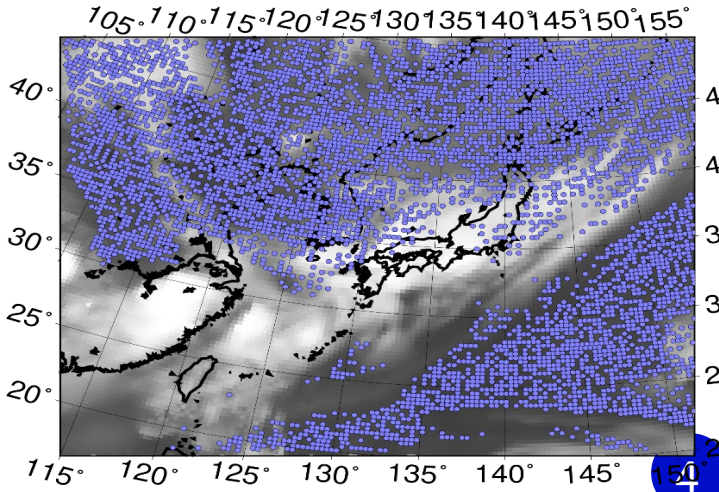
気象庁 Japan Meteorological Agency

- Plan to launch in JFY2028 and start operation in JFY2029
- Hyper Spectral infrared Sounder (HSS) as one of the potential payloads (GeoHSS)
- Observing system simulation experiment (OSSE)
  - Assume MTG/IRS at the location of Himawari-8
  - Assimilate clear-sky radiances in global DA system and T/Rh profiles in regional DA system, following the operational settings
  - GeoHSS improved forecasts of large scale field, typhoon track and heavy rainfall
    - Reduced frequency with full disc scanning of 3h, from 1h, still brought positive impacts despite its smaller magnitude
  - Also, used for developing a retrieval of temperature and humidity profile

Ch. 3 (14.260 μm)

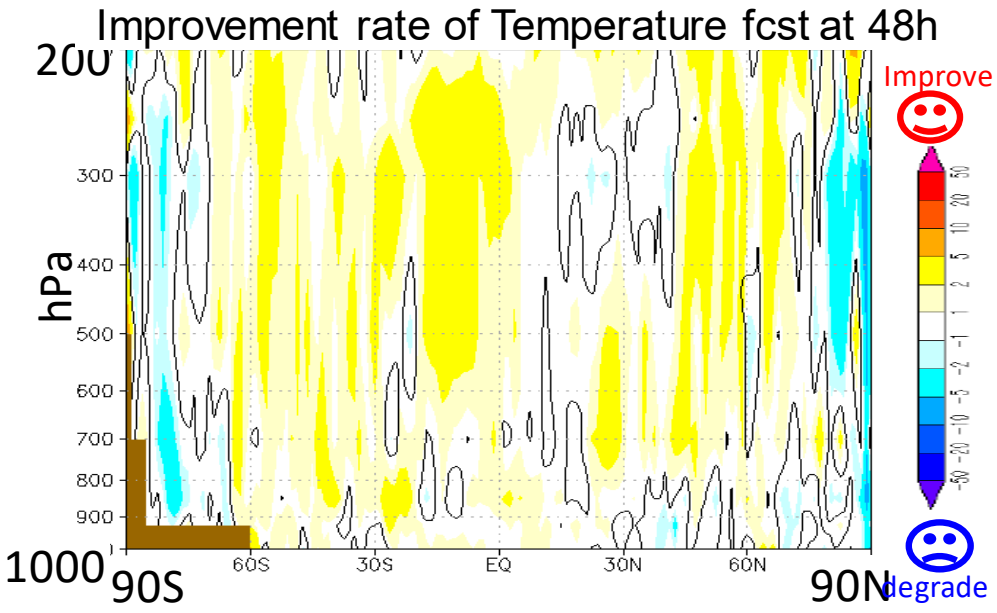


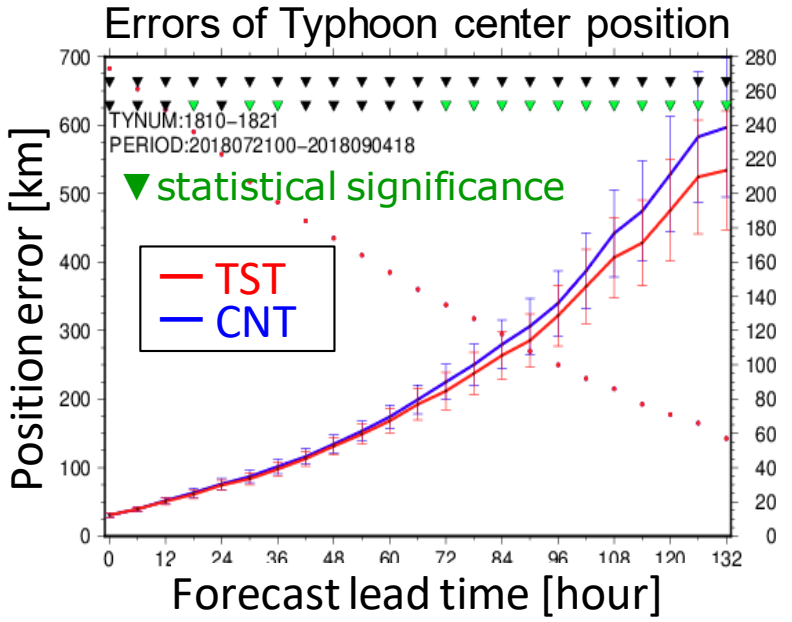
150～250 hPa



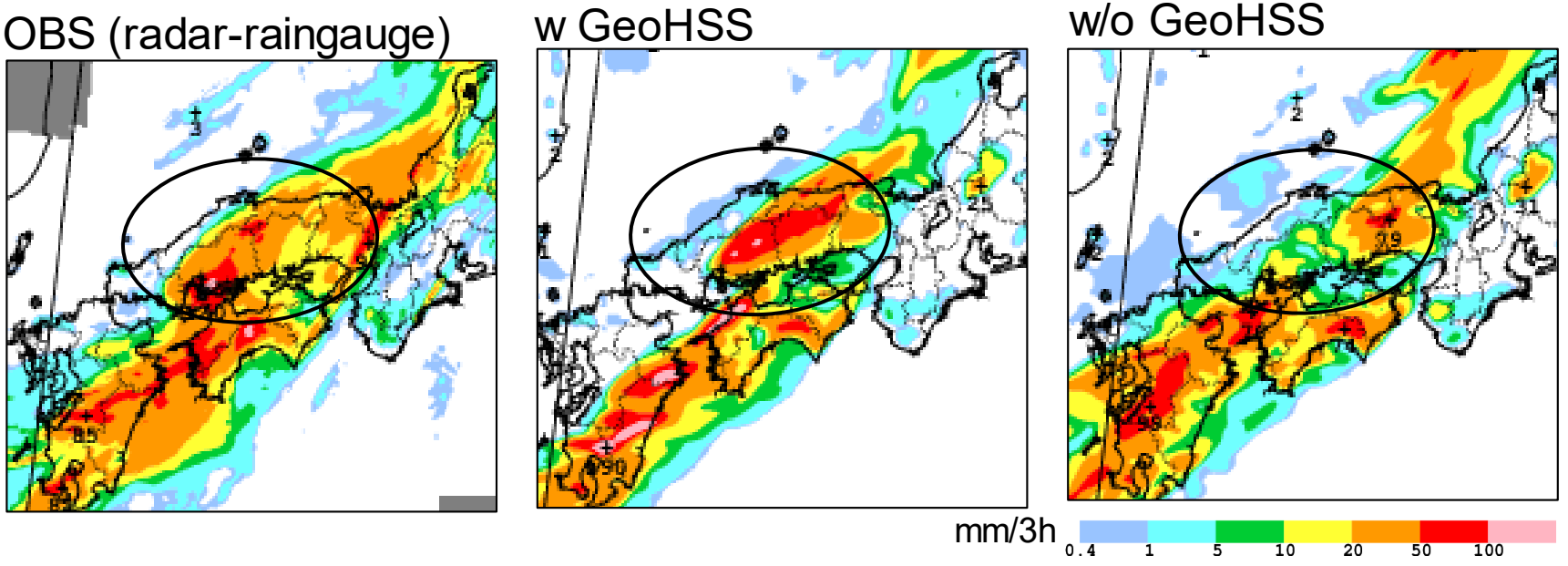
Impact of GeoHSS

- GeoHSS in Global DA
  - improved T (Q) at all the vertical layers and latitudes except polar regions
  - significantly improved the track forecast





- GeoHSS in Regional DA
  - improved heavy rainfall forecast in western Japan

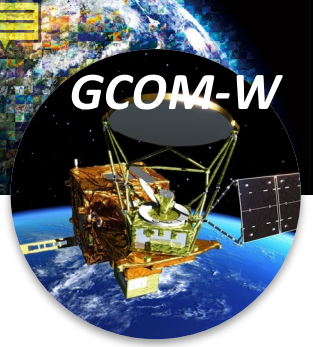


Okamoto et al. 2020, sola

JAXA: Japan Aerospace Exploration Agency

- Current operation
  - GPM-Core/DPR (NASA-JAXA): Dual-freq Precipitation Radar (KuPR + KaPR), Feb. 2014~
  - GOSAT/TANSO, GOSAT-2/TANSO-2 : FTS for GHGs (CO2, CH4, CO), Jan 2009~, Oct. 2018~
  - GCOM-W/AMSR2 : Microwave imager (16ch), May 2012~
  - GCOM-C/SGLI: Multi-ch optical imager for monitoring radiation budget and carbon cycle, Dec. 2017~
  - ALOS-2/PALSAR-2 : L-band SAR for monitoring environment, disaster and resource, May 2014~
- Plans
  - ALOS-3 : Advanced optical imager, follow-on of ALOS/AVNIR2 (JFY 2021)
  - ALOS-4 : Advanced L-band SAR, follow-on of ALOS-2/PALSAR-2 (JFY 2022)
  - EarthCARE/CPR (ESA-JAXA) : Doppler cloud radar (JFY 2022)
  - GOSAT-GW (JFY 2023)
    - TANSO-3: grating spectrometer for GHGs (CO2, CH4, NO2)
    - AMSR-3: Microwave imager including 183 GHz ch (21ch)

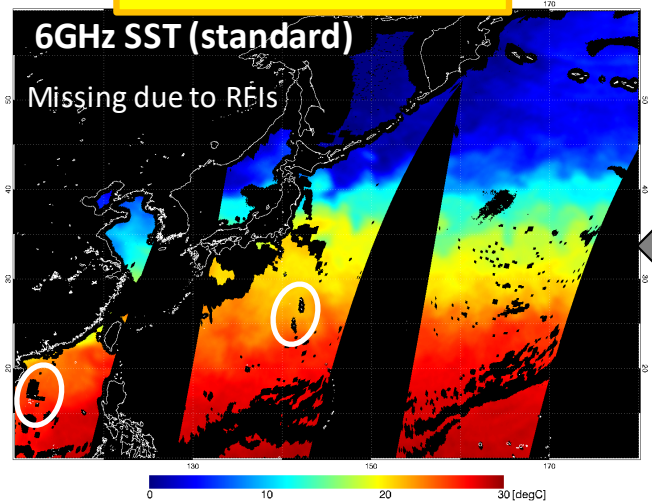
New AMSR2 Research Products
Global Change Observation Mission - Water (GCOM-W)



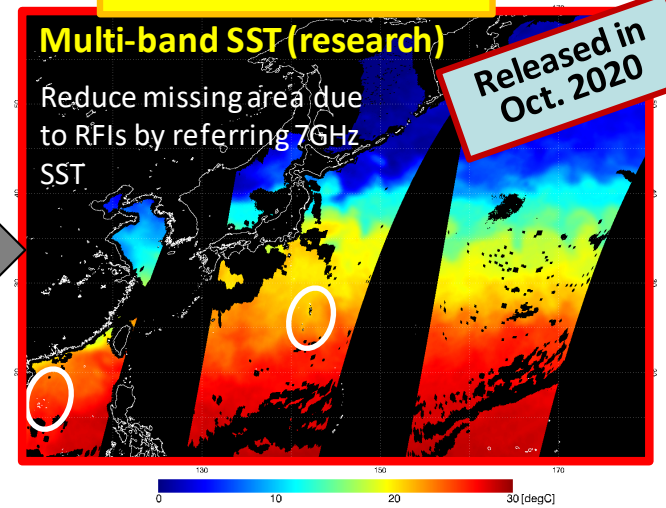
JAXA/GCOM-W observation:

- ✓ Observation started since 3 Jul. 2012
- ✓ Finest spatial resolution among MWIs
- ✓ Near-real-time distribution (2-3 hr latency)
- ✓ 9 standardd products (TB, TPW, CLW, rainfall, SST, SSW, SIC, snow depth, soil moisture)
- ✓ **Ver.4 products for SST & Sea Surface Wind Speed have been released in Oct. 2020**
- ✓ **Research Products are available via** https://suzaku.eorc.jaxa.jp/GCOM_W/research/resdist.html

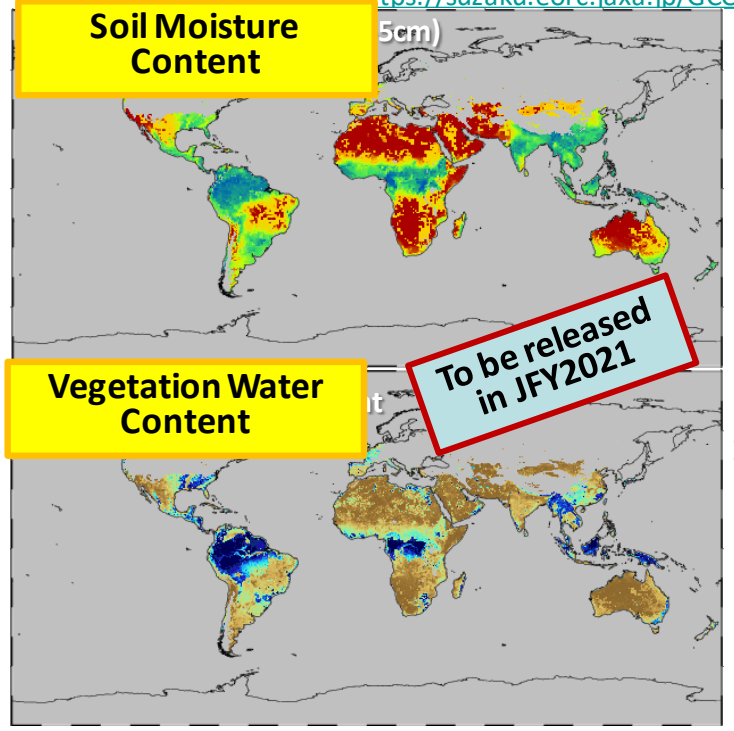
Standard SST



New Research SST



Soil Moisture Content

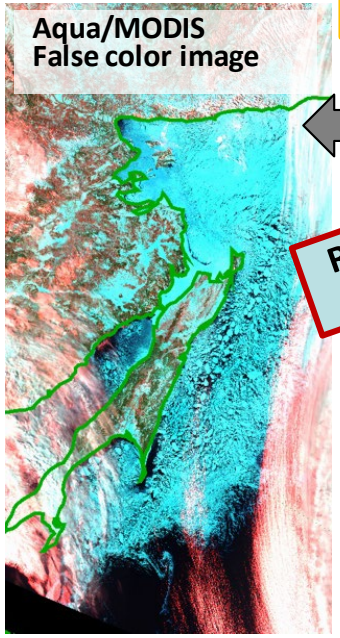


Vegetation Water Content

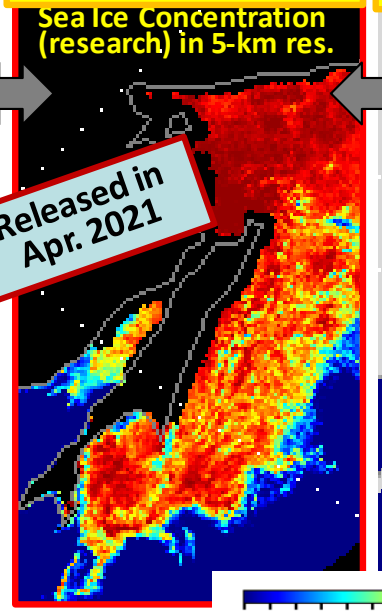
* See Sawada *et al.* (2017), Sawada (2020), etc.

New Research Product "Soil Moisture and Vegetation Water Content based on the Land Data Assimilation Methodology" using ECHLA* is in preparation

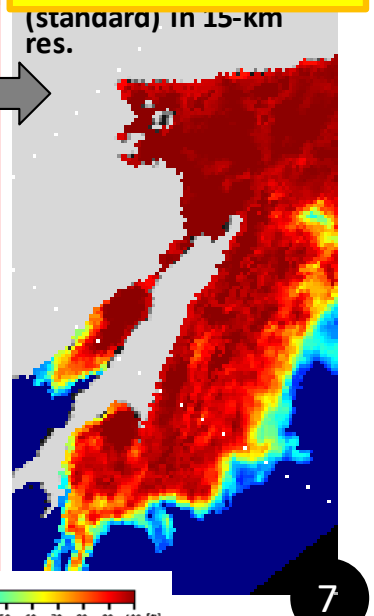
Sea ice concentration (SIC) product with enhanced resolution using 89GHz TB (5-km) was recently released. Standard SIC mainly uses 18 & 36GHz, so spatial resolution is 15-km.



High Res. SIC



Standard SIC



A-decade-long GHG observation by GOSAT series

Greenhouse gases Observing SATellite (GOSAT) & GOSAT-2

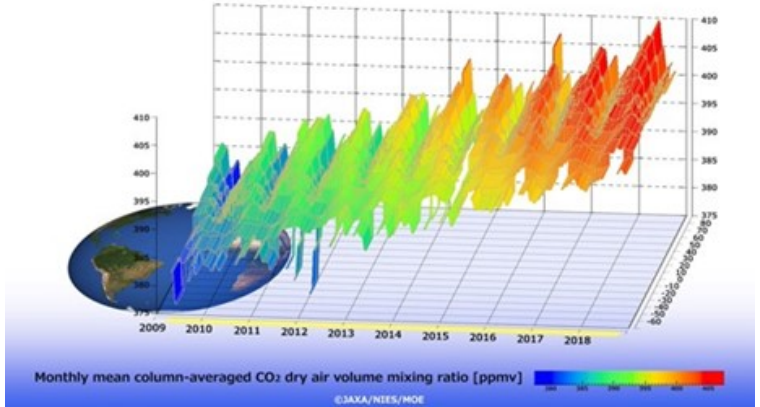
Carbon & Material Cycle

TANSO-FTS

TANSO-FTS-2

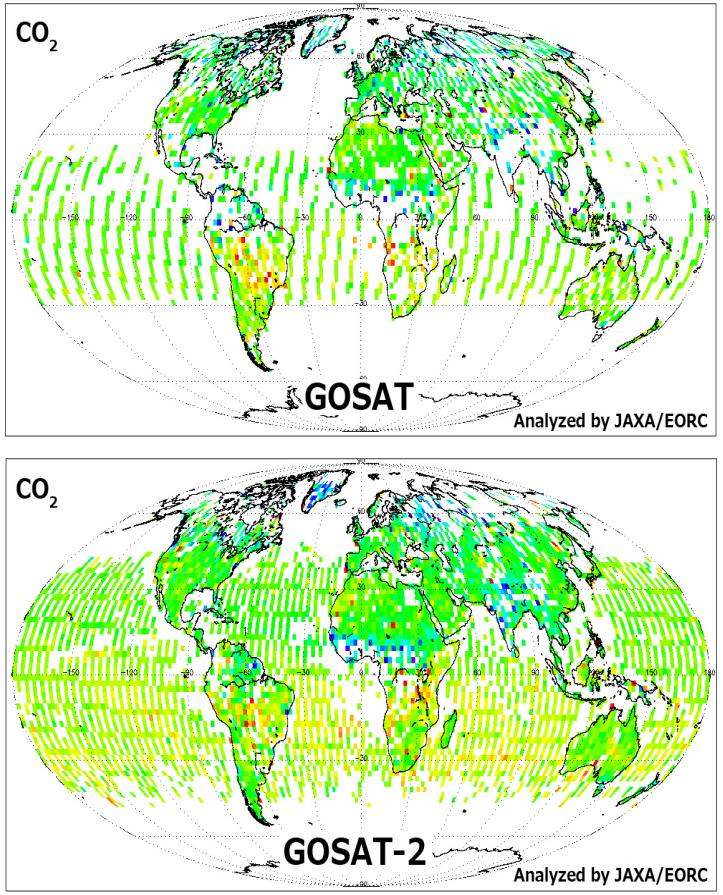
TANSO-FTS-2

- Increase bands (3 to 5) : add CO measurement (band3) to identify CO2 enhancement by combustion
- spectral resolution: 0.2 cm^{-1}
- Fully customized obs pattern
- Cloud avoiding pointing

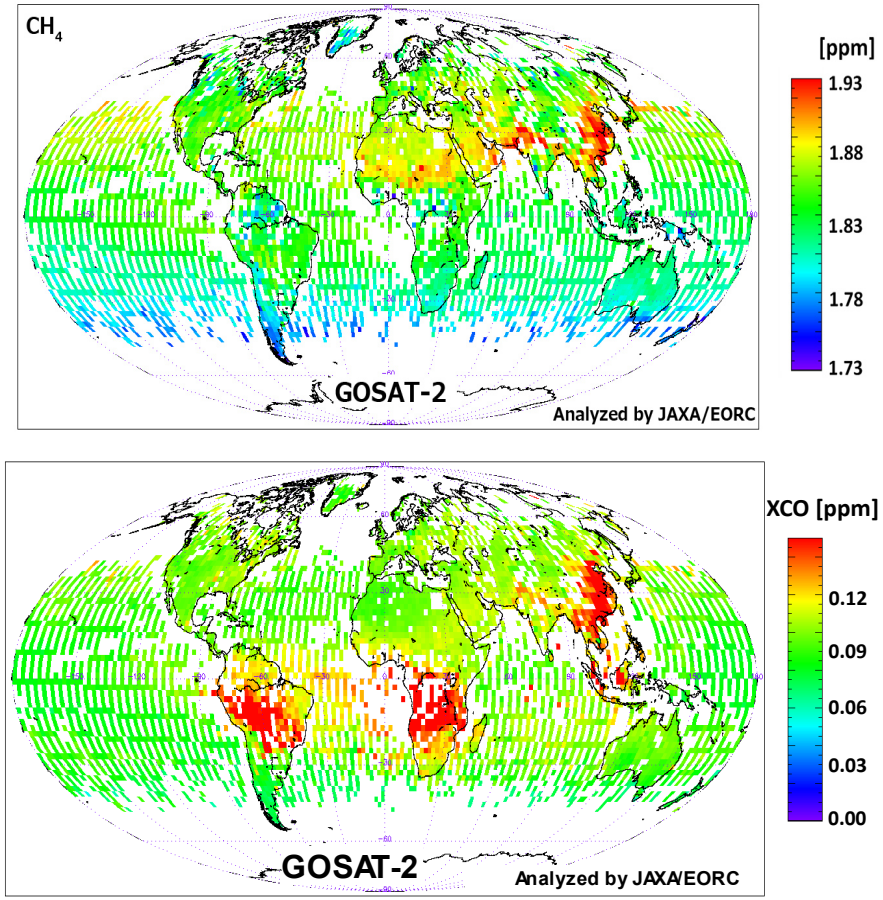


Monthly mean column averaged CO2 mixing ratio

CO_2 Observation

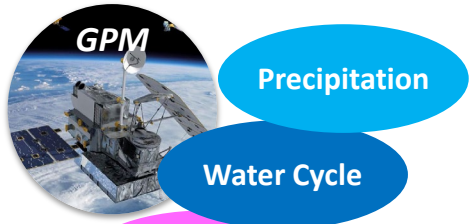


CH_4 (upper) & CO (lower) Observation



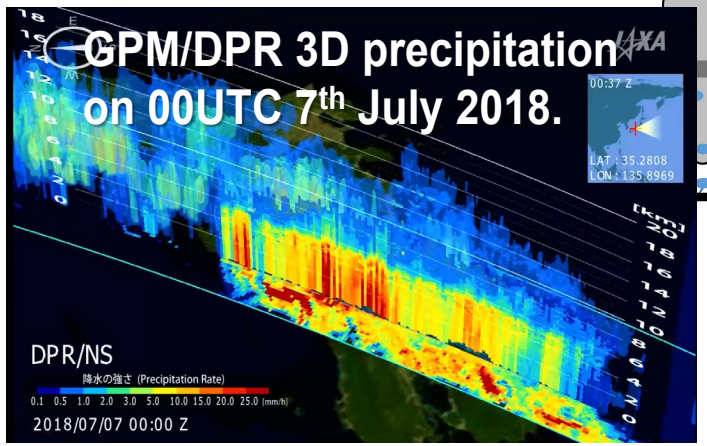
Global CO_2 concentrations observed by GOSAT and GOSAT-2, CH_4 and CO (September 2019)

Global Drop Size Distribution and its seasonal variations
Global Precipitation Mission/Dual-frequency Precipitation Radar (GPM/DPR)

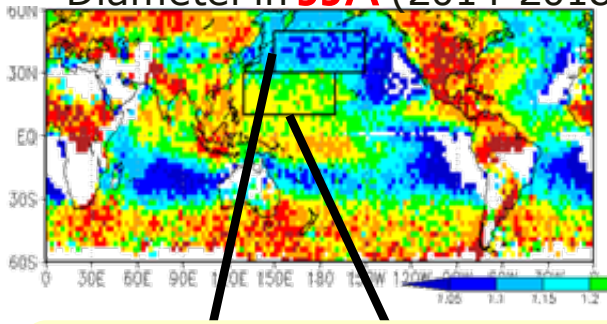


全球降水観測計画 GPM GLOBAL PRECIPITATION MEASUREMENT

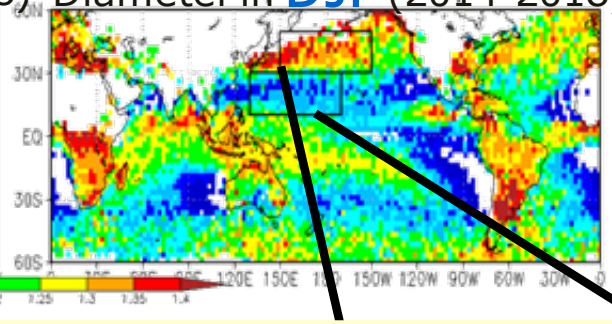
DPR Dual-frequency Precipitation Radar



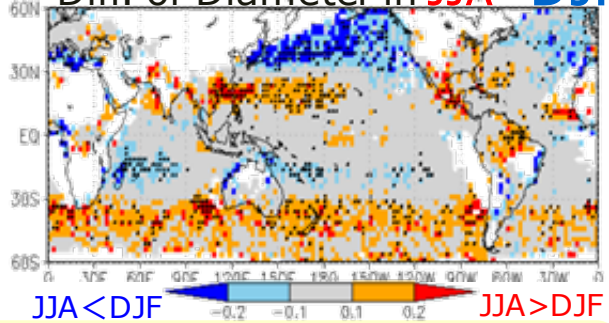
Diameter in JJA (2014-2018)



Diameter in DJF (2014-2018)



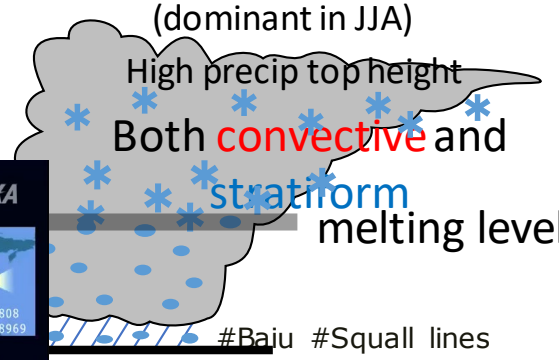
Diff. of Diameter in JJA - DJF



Diameter data in DPR-L2 product show statistically significant seasonal variations, which can be related to the changes in dominant precipitation systems.

Different Types of Organized Precipitation System

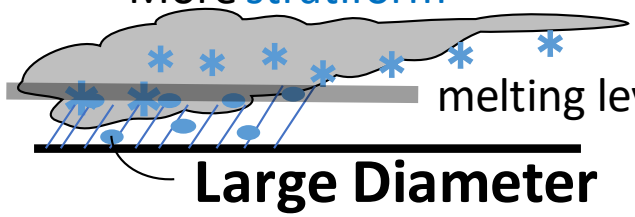
(dominant in JJA)



#Baiu #Squall lines
#tropical storms\

Extratropical Frontal System

(dominant over mid-latitudes in DJF)

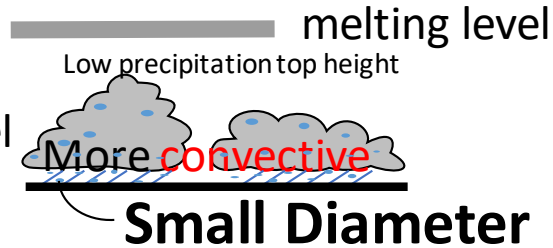


Large Diameter

#with ice particles in upper level

Shallow Convective System

(dominant over subtropics in DJF)



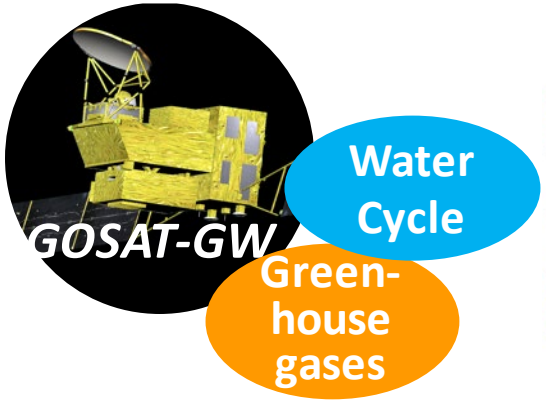
Small Diameter

#Trade wind convections

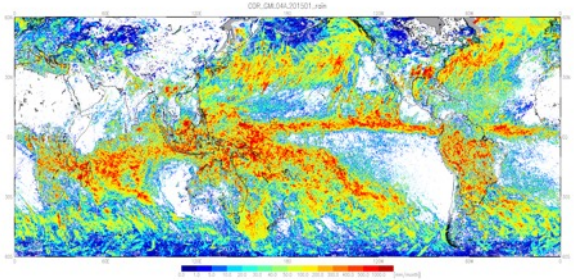
M. Yamaji, H. G. Takahashi, T. Kubota, R. Oki, A. Hamada, and Y. N. Takayabu, 2020: 4-year Climatology of Global Drop Size Distribution and its Seasonal Variability Observed by Spaceborne Dual-frequency Precipitation Radar, *J. Meteor. Soc. Japan*, Vol. 98, Issue 4, Pages 755-773. https://doi.org/10.2151/jmsj.2020-038

Future Missions for Climate and Water

Global Observing SATellite for Greenhouse gases and Water cycle (GOSAT-GW)

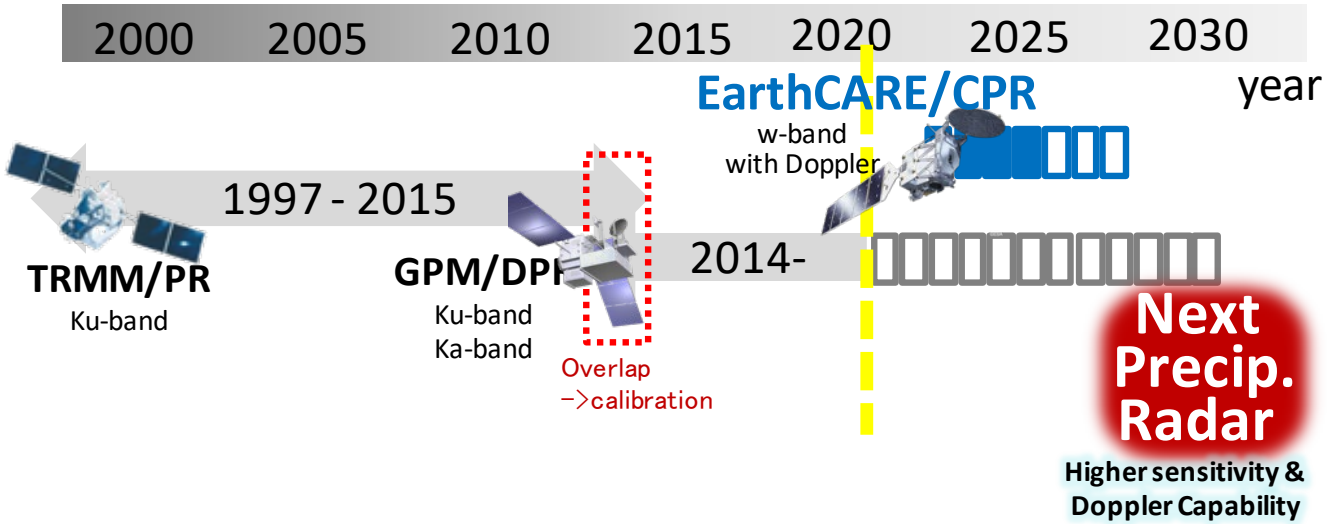


AMSR3 for both snow & rain



- ***GOSAT-GW is being developed and to be launched in Japanese Fiscal Year (JFY) of 2023.***
- ***GOSAT-GW will carry:***
  - *GCOM-W follow-on instrument (Advanced Microwave Scanning Radiometer 3; **AMSR3**)*
  - *GOSAT-2 follow-on instrument (Total Anthropogenic and Natural emissions mapping SpectrOmeter-3; **TANSO-3**),*

Spaceborne cloud and precipitation radars



Cloud Profiling Radar (CPR) for EarthCARE with ESA

- *JAXA and NICT provides the world's first W-band Doppler radar (CPR) on the EarthCARE to be launched in JFY2022, which observes clouds, aerosols, and radiation on a global scale.*

Next generation precipitation radar

- *Feasibility study for follow-on mission is now ongoing in JAXA, and discussed with NASA for collaboration.*
- *The mission definition review is planned to be held in Aug2021 (TBD).*

GOSAT-GW/AMSR3

AMSR3 Sensor Characteristics

Sensor type	Conical scanning total power microwave radiometer
Antenna	Off-set parabolic antenna (ϕ2.0m aperture)
Swath width	**> 1530km**
Quantization	12 bit
Incidence angle	55 deg. except 89G-B, 166G, 183G
X-polarization	< -20dB
Beam efficiency	> 90%
Range	2.7-340K
Sampling interval	5-10km
Data rate	87.4 kbps (average)
Life time	**7 years**

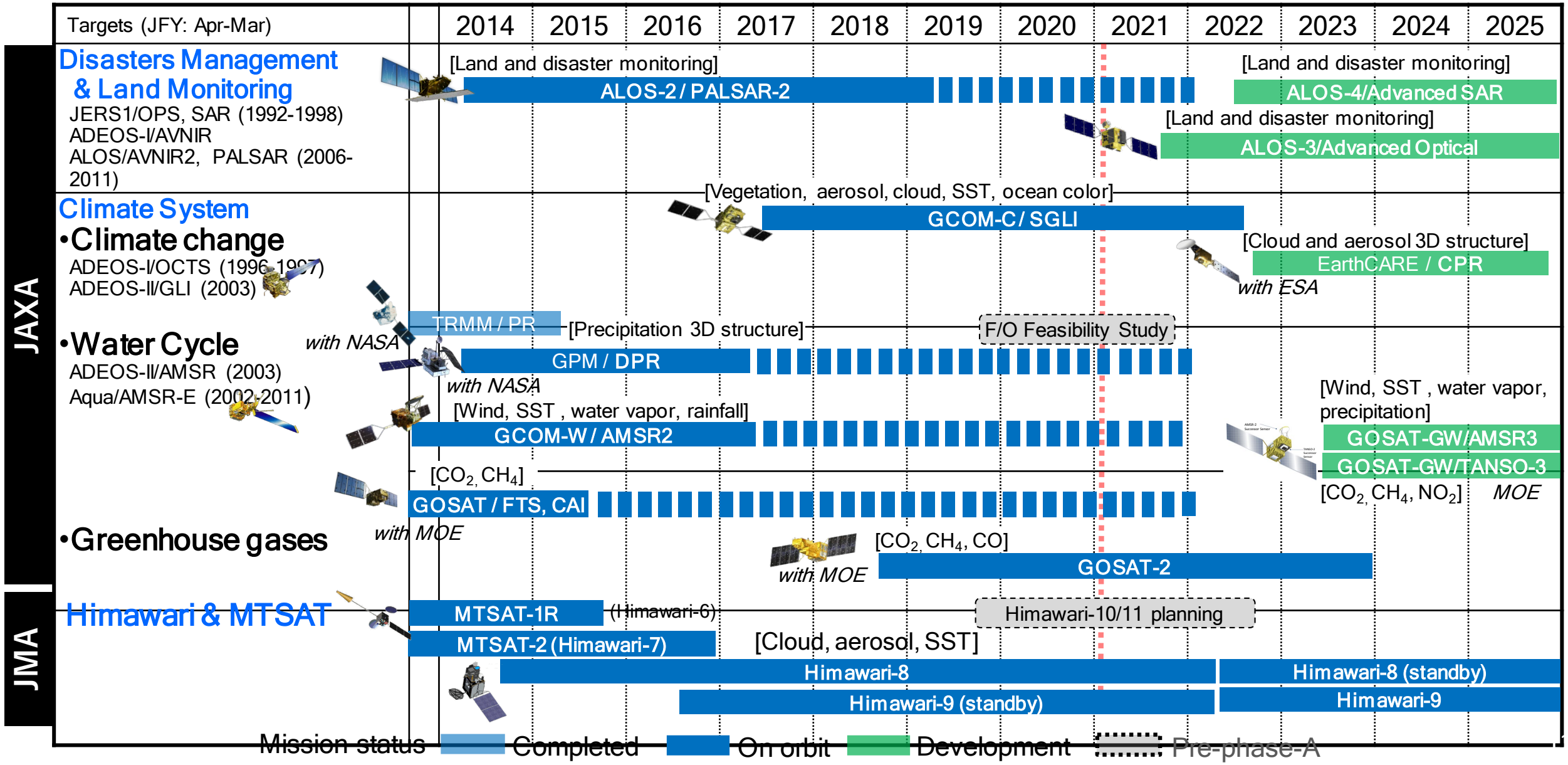
Red: Changes from AMSR2 including additional CHs

Changed the specification of Ka-band passband to reduce the future risk of RF interference from 5-G mobile communication system

AMSR3 Channel Sets

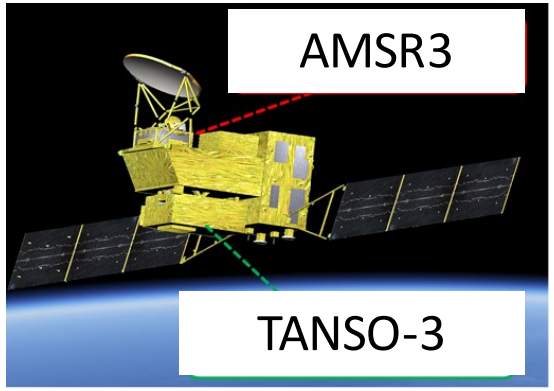
Center frequency [GHz]	Polarization	Band width [MHz]	NEDT (1σ)	Beam width (spatial resolution)
6.925 7.3	H/V	350	< 0.34 K	1.8° (34km x 58km)
10.25	**H/V**	**500**	**< 0.34 K**	**1.2° (22km x 39km)**
10.65	H/V	100	< 0.70 K	1.2° (22km x 39km)
18.7	H/V	200	< 0.70 K	0.65° (12km x 21km)
23.8	H/V	400	< 0.60 K	0.75° (14km x 24km)
36.42	H/V	**840**	< 0.70 K **(TBD)**	0.35° (7km x 11km)
89.0 A/B	H/V	3000	< 1.20 K	0.15° (3km x 5km)
165.5	**V**	**4000**	**< 1.50 K**	**0.30° (4km × 9km)**
183.31±7	**V**	**2000 × 2**	**< 1.50 K**	**0.27° (4km × 8km)**
183.31±3	**V**	**2000 × 2**	**< 1.50 K**	**0.27° (4km × 8km)**

Japanese Earth Observation Satellites



AMSR3 on GOSAT-GW: Global Observation SATellite for Greenhouse gases and Water cycle

- GOSAT-GW will carry two instruments, AMSR3 and TANSO-3.
  - AMSR3, led by JAXA, will succeed AMSR series observations adding new high-frequency channels for solid precipitation retrievals and water vapor analysis in NWP.
  - TANSO-3, led by Japanese Ministry of the Environment (MOE) and National Institute of Environment Studies (NIES) , will improve observation capability of greenhouse gases from GOSAT-2/TANSO-2.
  - Target launch is JFY2023 (Apr. 2023 - Mar. 2024)
- Current Status
  - Dec. 2019: Started GOSAT-GW Project
  - Aug. 2020: Completed AMSR3 PDR
  - Dec. 2020: Completed TANSO-3 PDR
  - Mar. 2021: Completed Preliminary Design Review (PDR) of GOSAT-GW Satellite System
  - Being coordinated major characteristics and performances of new G-band and conducted manufacture and test of engineering models of AMSR3 component (ex. G-band antenna sub-system, Receivers)



GOSAT-GW Satellite Specifications

Orbit	**Type**	Sun-synchronous, Sub-recurrent orbit
	Altitude	**666km, recurrent cycle 3days** (same as GOSAT)
	MLTAN	13:30±15min (same as GCOM-W)
Mass		2.6 ton (Including propellant)
Power		> 5.3 kW
Design life		**> 7 years**
Launch vehicle		H-IIA rocket
Mission data downlink rate		Direct transmission with X-band: 400 Mbps Direct transmission with S-band: 1 Mbps (Only for AMSR3)
Instrument		TANSO-3 (for GHG) AMSR3 (for Water Cycle)

List of AMSR3 Products

Standard Product
Brightness Temperature (6-183GHz) (L1B)
Resampled Brightness Temperature (6-183GHz) (L1R)
Total Precipitable Water (over ocean & land)
Integrated Cloud Liquid Water Content (over ocean)
Precipitation (liquid & solid)
Sea Surface Temperature (6GHz & 4-frequency)
Sea Surface Wind Speed
All Weather Sea Surface Wind Speed
Sea Ice Concentration
High-resolution Sea Ice Concentration
Soil Moisture Content
Snow Depth (snow depth & SWE)

Research Product
FOV-center Matched Brightness Temperature (L1C)
High-resolution Brightness Temperature (L1H)
High-resolution Sea Surface Temperature (20km res.)
Sea Ice Motion Vector (Level 3)
Land Surface Temperature
Vegetation Water Content
Thin Ice Detection
Soil Moisture Content & Vegetation Water Content by Land Data Assimilation (Level 4)
Climate Data Record (CDR) for each parameter (Level 3)

(as of Mar 2021)

Further products, including sea ice thickness, are being considered as research product candidates in future.

Red indicates differences from AMSR2

File format will be “HDF5-compatible” NetCDF4.

EASE-GRID2 projection product will be introduced to Level 3 products along with equal-latitude-longitude and polar-stereo grids.