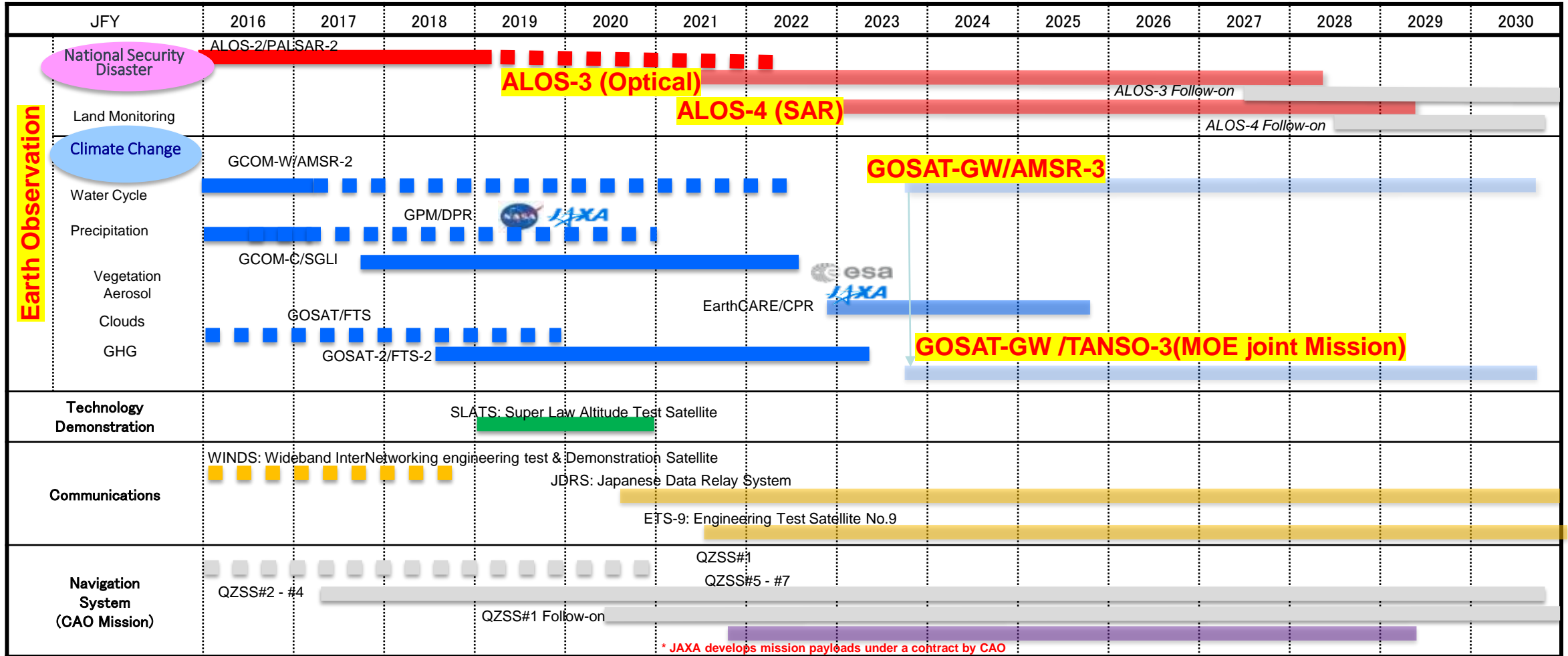


# JAXA's Earth Observation Program

HIRABAYASHI Takeshi  
Director of EROC, JAXA

# JAXA's Satellite Development and Operation Schedule



■ ■ ■ ■ Extended Life Period    ■ On Orbit    ■ Development    ■ Study

# Current JAXA Earth Observation Satellites

## Climate Change

**GCOM-C**

Launched:  
23 December 2017

Cloud/  
Aerosols/  
Vegetation

**GOSAT**

Launched: 2009

Greenhouse  
Gases

**GOSAT-2**

Launched:  
29 October 2018

**GCOM-W**

Launched: 2012

Water  
Cycling

**GPM**

DPR:  
Dual Frequency  
Radar

Launched: 2014

Precipitation



Courtesy of NASA

## Disaster Risk Management Land Monitoring

**ALOS-2**

Land Surface  
Disaster/Forest

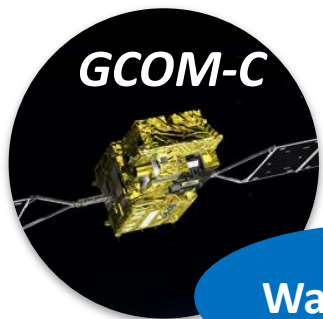
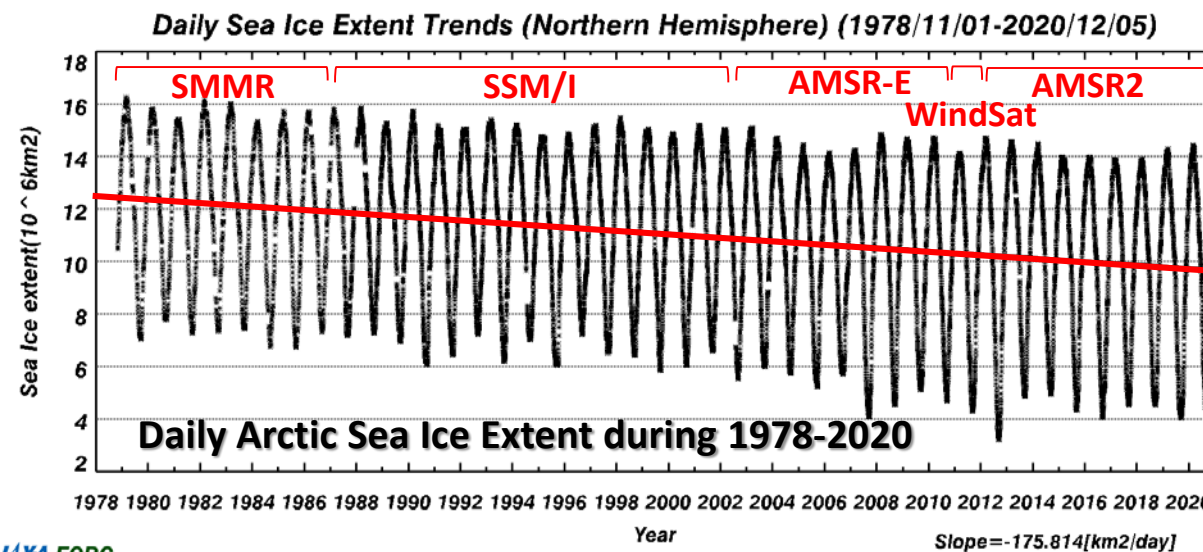
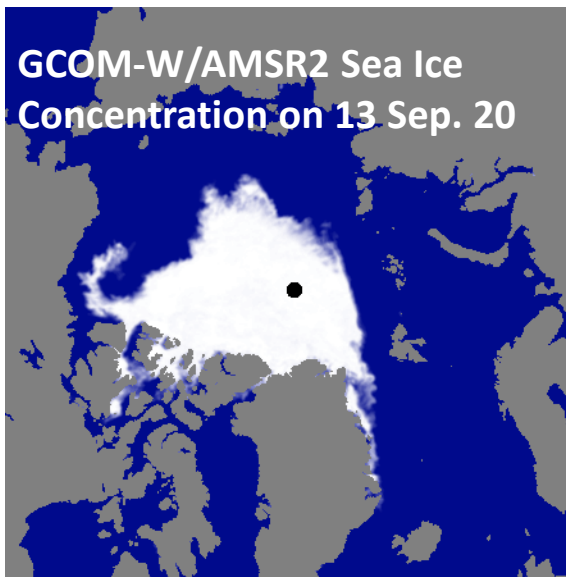
Launched: 2014

# Cryosphere Monitoring by GCOM-W & GCOM-C



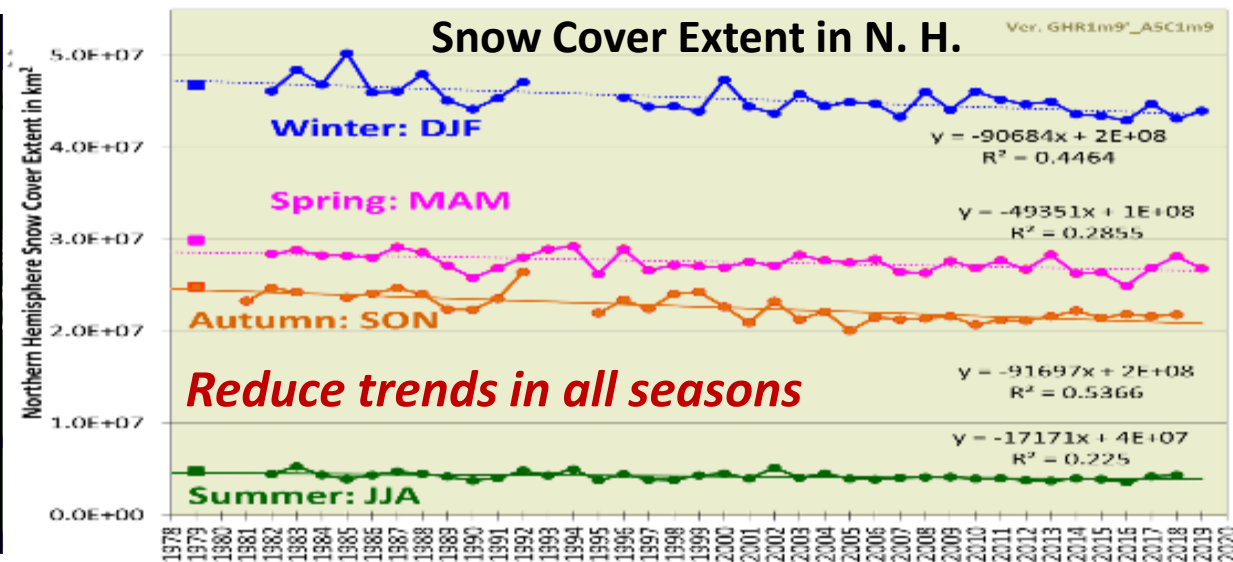
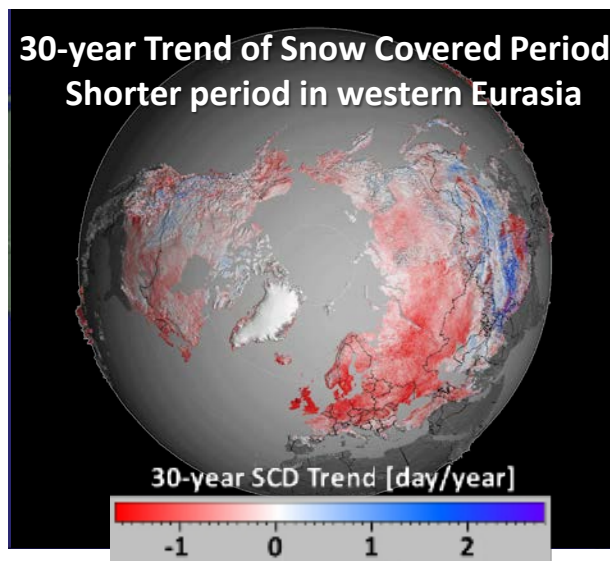
Water Cycle

Second minimum extent in the record in 2020, and thinning of sea ice thickness



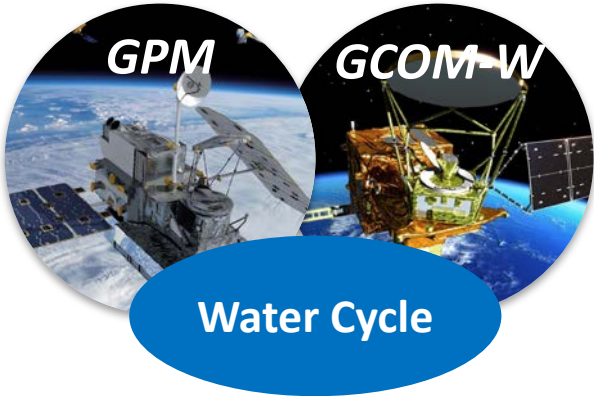
Water Cycle

Reduced snow area & shorter snow cover period in recent decades



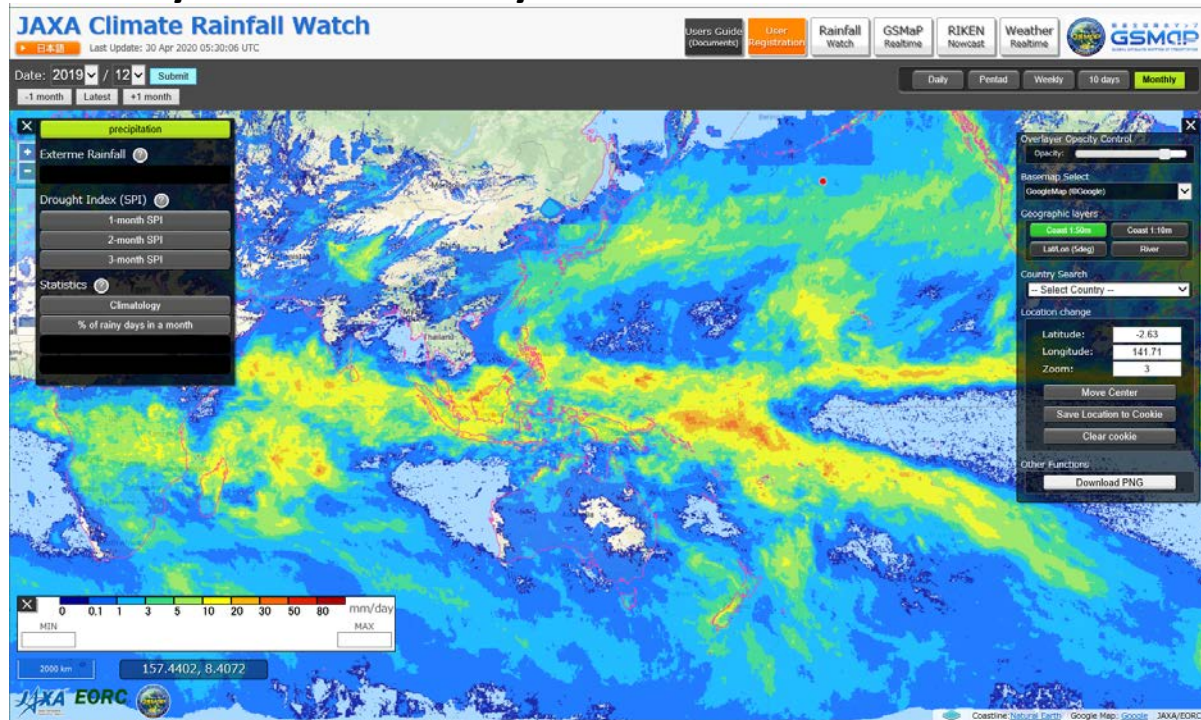
# Extreme Heavy Rainfall and Drought by GSMaP

## Global Satellite Mapping of Precipitation (GSMaP)

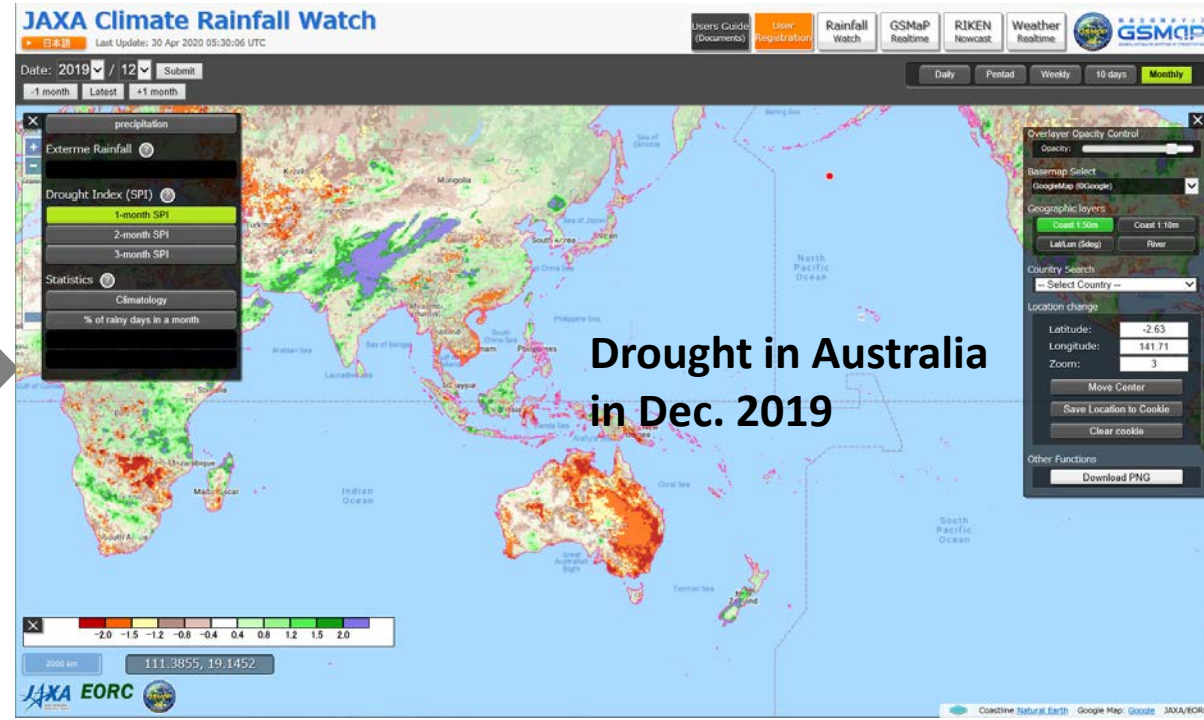


- "JAXA Climate Rainfall Watch", which provides information about extreme heavy rainfall and drought over the world, is now available.
  - Easily monitor global extreme weather and climate by displaying accumulated rainfall in some temporal scale (daily, pentad, weekly, 10-days and monthly), indices related to Extreme heavy rainfall (percentiles) and Drought index (SPI).

### Monthly mean Rainfall by GSMaP in Dec.



### Drought index in Dec. 2019



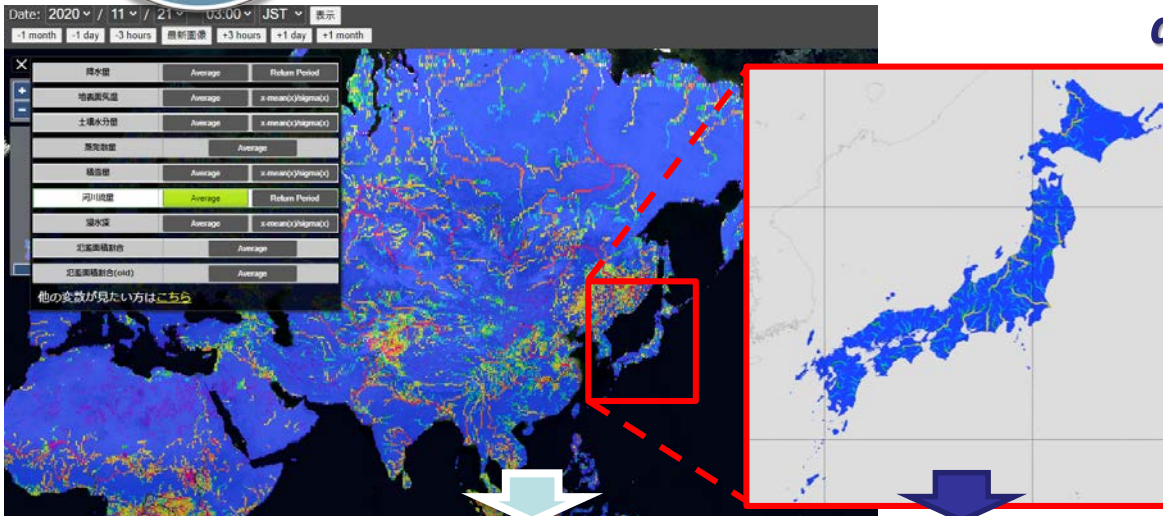


# Terrestrial Hydrological Simulation System "Today's Earth (TE)"



<https://www.eorc.jaxa.jp/water/>

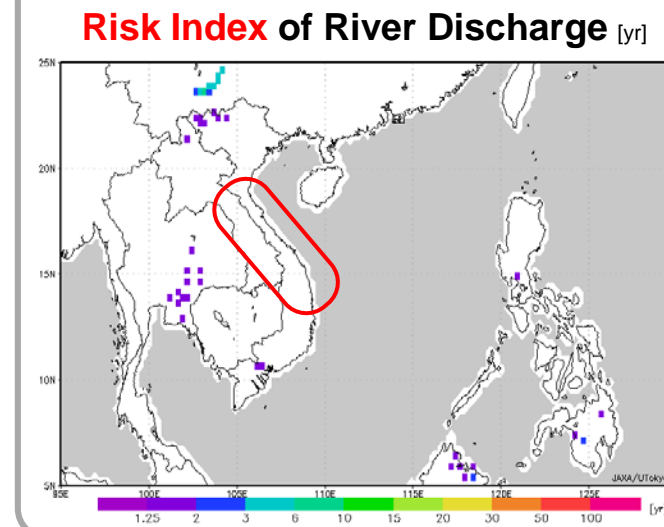
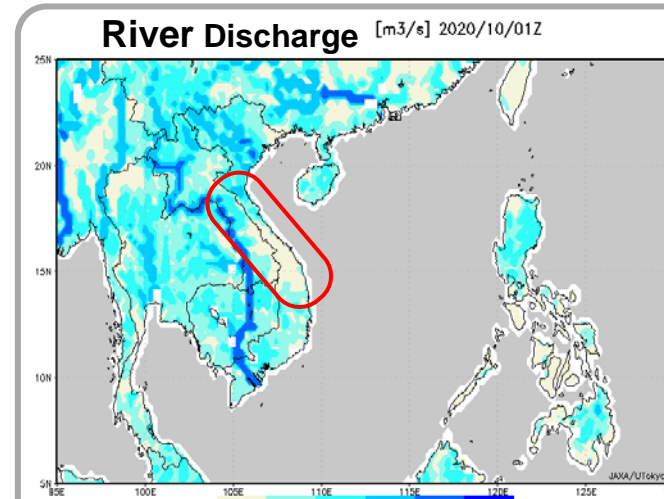
*Today's Earth (TE) is the global hydrological simulation system developed by JAXA & The University of Tokyo.*



**Global System  
[TE-Global]**

**Regional (Japan) System  
[TE-Japan]**

<b>Horizontal Resol.</b>	Land: 1/2 deg. River: 1/4 deg.	1/60 deg.
<b>Temporal Resol.</b>	3hourly	hourly
<b>Latency</b>	About 3days	<b>Realtime*</b> *Prediction data is also available only for research purpose.
<b>Satellite Data Used in the System (in prep.)</b>	GSMaP, Terra/Aqua MODIS, SRTM30, NOAA AVHRR, (AW3D, GCOM-C)	SRTM30, NOAA AVHRR, (GSMaP, Himawari-8, ALOS HRLC)
<b>Products</b>	<b>About 50 variables</b> (river discharge, soil moisture etc.) <b>and their risk indices</b>	



## TE-Global Estimates of Vietnam Flood (Oct. 2020)

- In mid to late October, 4 typhoons (Typhoons 15-18) made landfall in Vietnam from the South China Sea.
- TE-Global's river discharge estimates (top) represent a dynamic flow change brought by typhoons.
- By looking at the risk index (i.e. return periods) (bottom), users can extract the areas that were actually at high risk of flooding.

TE-Global's estimate of daily average river discharge in October 2020 (top) and its recurrence period (bottom) over time.

# A-decade-long GHG observation by GOSAT series

## Greenhouse gases Observing SATellite (GOSAT) & GOSAT-2



Carbon & Material Cycle

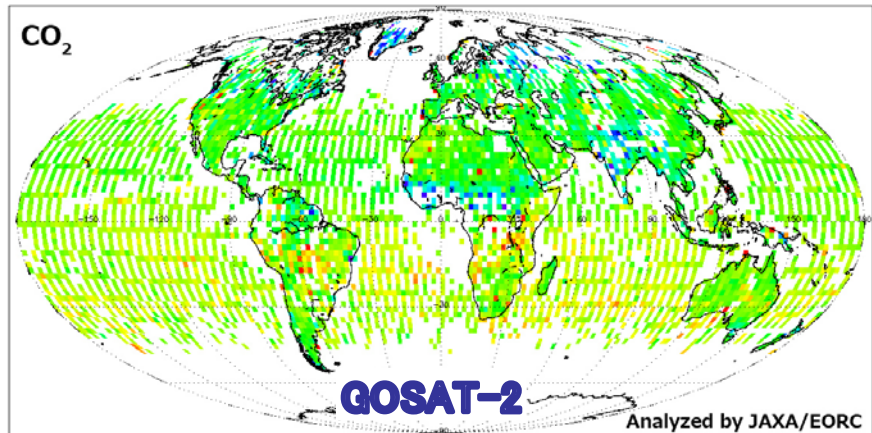
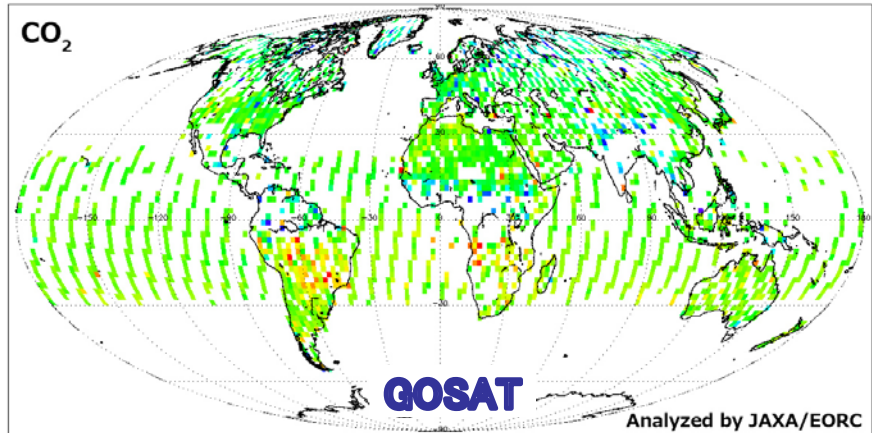


2009-Now

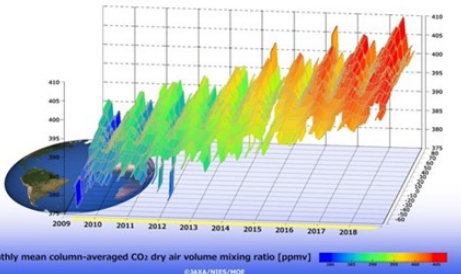
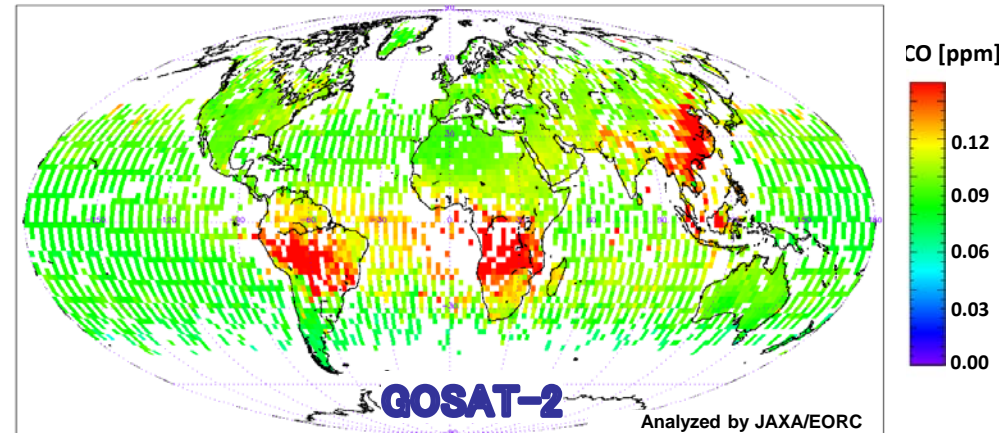
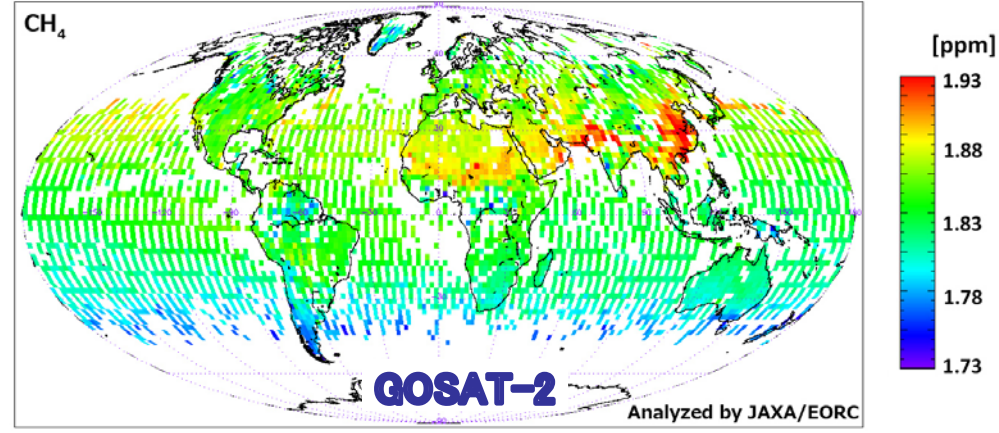


2018-Now

### CO<sub>2</sub> Observation



### CH<sub>4</sub> (upper) & CO (lower) Observation



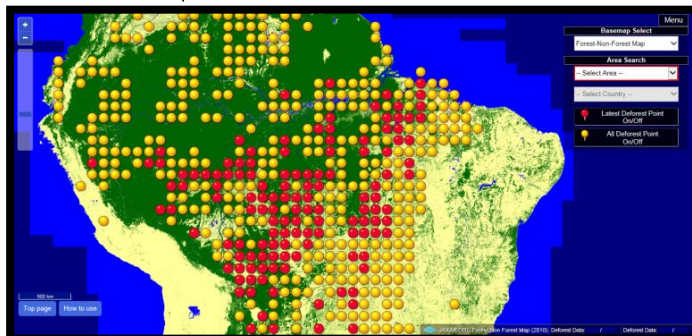
Global CO<sub>2</sub> concentrations observed by GOSAT and GOSAT-2, CH<sub>4</sub> and CO (September 2019)

# Global Forest Change Monitoring by L-band SARs

## JICA-JAXA Forest Early Warning System in the Tropics (JJ-FAST)



JJ-FAST website ([http://www.eorc.jaxa.jp/jjfast//jj\\_index.html](http://www.eorc.jaxa.jp/jjfast//jj_index.html))



Red indicates the latest Deforest Point  
Yellow indicates all Deforest Point

Data source	ALOS-2/PALSAR-2 (ScanSAR mode)
Target area	77 countries
Update	Every 1.5 months

Monitoring Tropical forests in **77** countries



## Goals



## Indicators

- 6.3.2 Proportion of bodies of water with good ambient water quality
- 6.6.1 Change in the extent of water-related ecosystems over time
- 11.3.1 Ratio of land consumption rate to population growth rate
- 14.3.1 Average marine acidity (pH) measured at agreed suite of representative sampling stations
- 15.2.1 Progress towards sustainable forest management
- 15.3.1 Proportion of land that is degraded over total land area



# Supporting SDG Goals (1/2)



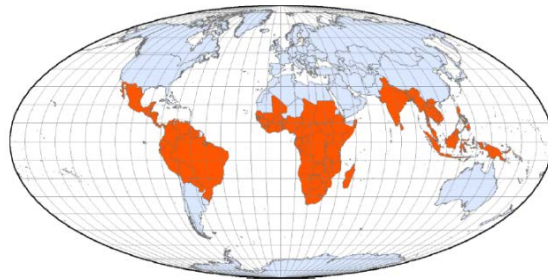
15 LIFE ON LAND



## Save Tropical Forest

Broad Ground Surface Observation by Radar Capable of Penetrating Clouds

Manage forest sustainably using satellite data of monitoring forest changes



Coverage Area: 77 Countries

JJ-FAST

Latest deforest point

Country: Brazil  
State: Pará  
Town: Paragominas  
Latitude: S3°25'12"  
Longitude: W47°35'46"  
Change Area: 127.5 [ha]  
Reliability: Medium

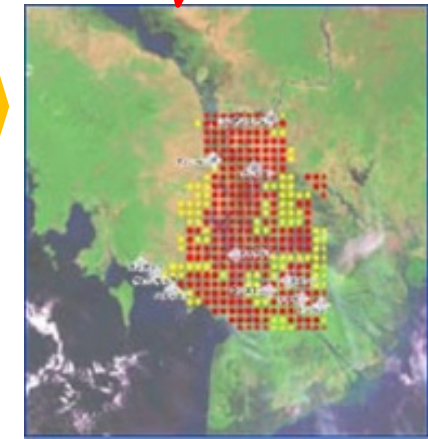
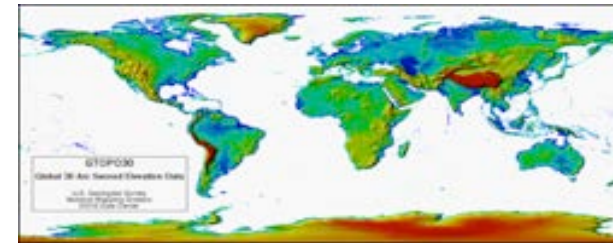
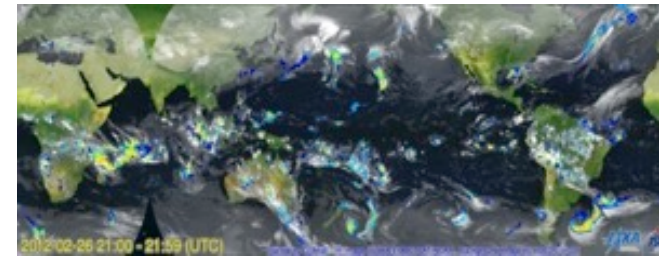
Partner:



## Reduce Flood Damage

Global satellites grasp the situation on water level of International cross-border rivers.

### Global Satellite Mapping of Precipitation (GSMaP)



Partners:

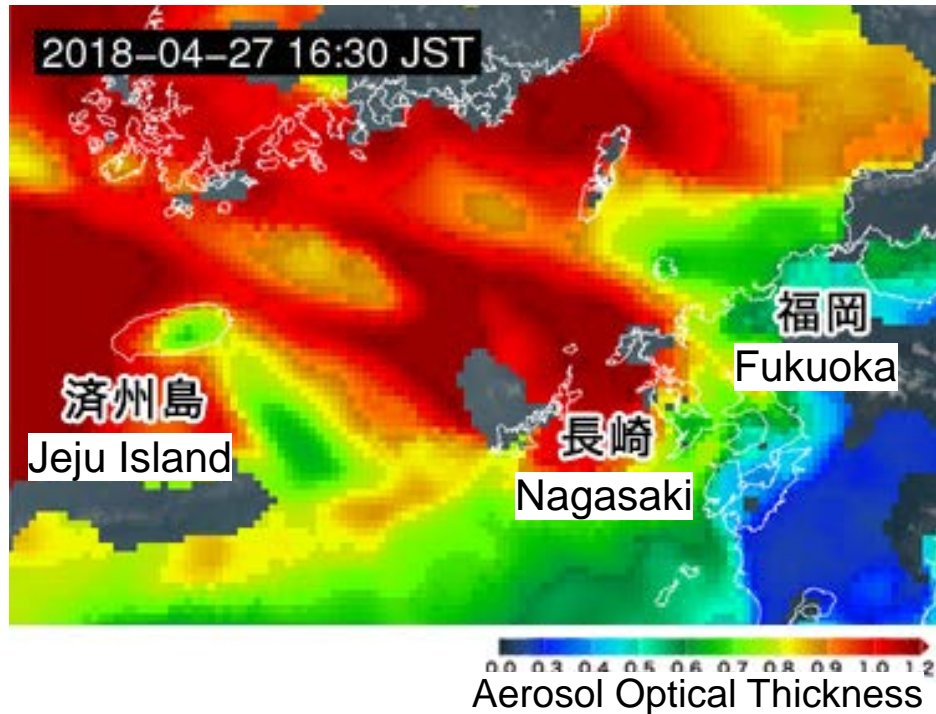


# Supporting SDG Goals (2/2)



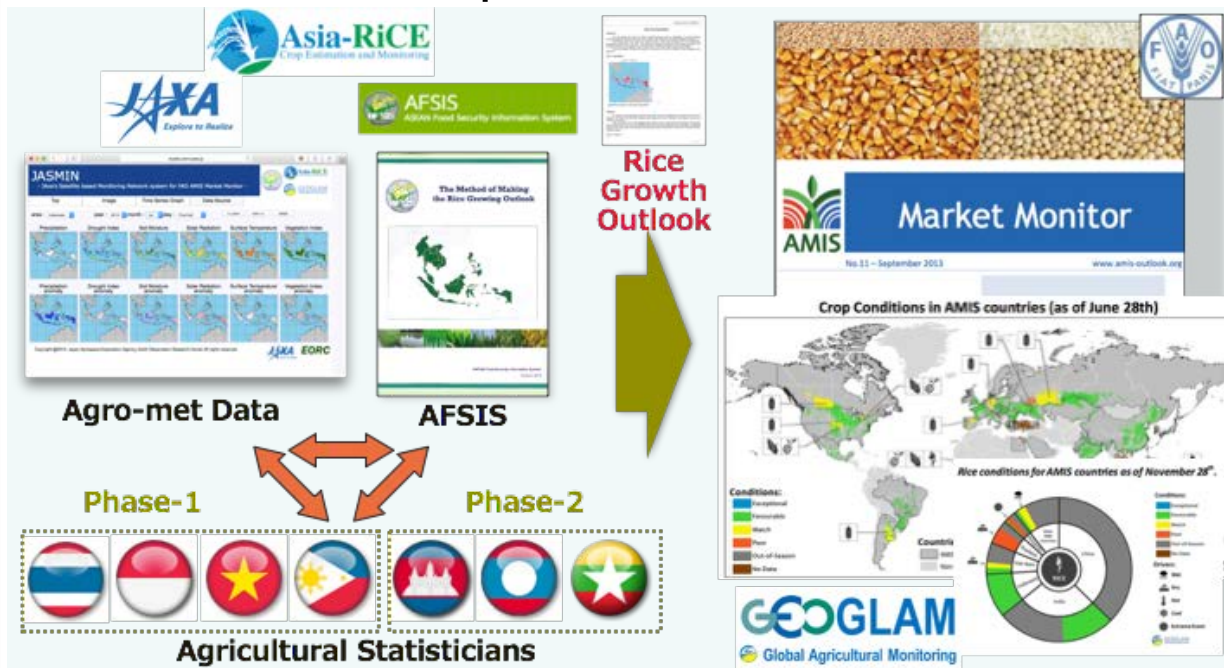
## Support Health from Atmospheric Pollution

Himawari and GCOM-C data enables to improve forecast on arrival of aerosols (Yellow dusts, PM2.5, etc.) in Asia-Oceania region.



## Rice Crop Monitoring for Early Warning

Rice crop condition and early warning of crop failure is reported based on agrometeorology information (precipitation, soil moisture, solar radiation, land surface temperature) monitored from space



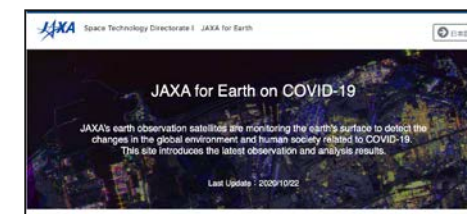
# JAXA-ESA-NASA cooperation in response to COVID-19



- Trilateral collaboration to analyze the changes in the global environment and socio-economic activities before and after the COVID-19 pandemic using EO satellite data from the three agencies
- Collaboration activities based on the Working Groups: Air quality, Climate, Economic activity, Water quality and Agriculture.
- Launched websites on June 25, 2020:
  - “**Earth Observing Dashboard**”: trilateral-collaboration results
  - “**JAXA for Earth on COVID-19**”: A special web page introducing analysis results of JAXA’s Earth observation data on COVID-19



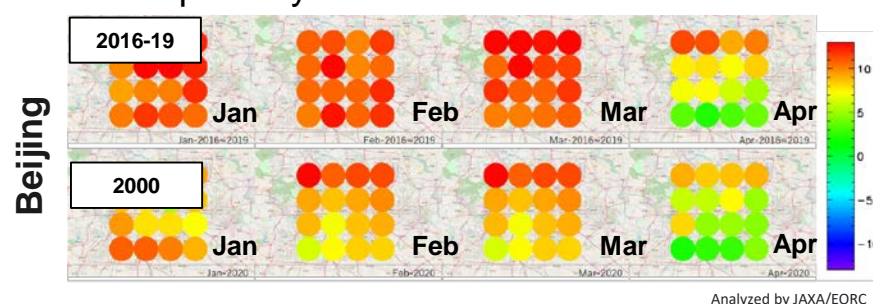
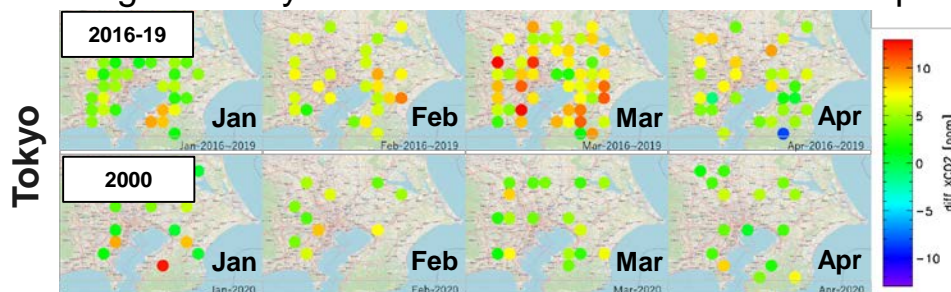
<https://eodashboard.org>



<https://earth.jaxa.jp/covid19/>

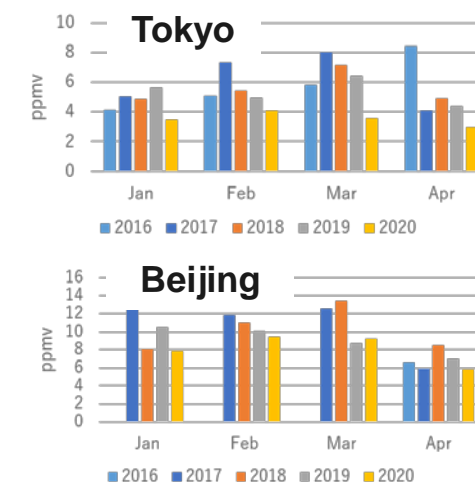
## City scale GHG monitoring by GOSAT

Average monthly abundances of CO<sub>2</sub> in the lower troposphere for the past 4 years and 2020



Analyzed by JAXA/EORC

The difference in CO<sub>2</sub> density in the upper and lower troposphere is **smaller** in 2020 compared to 2016-2019 in Tokyo.



# Future Earth Observation Missions in JAXA

2021(TBD)

2022(TBD)

2022

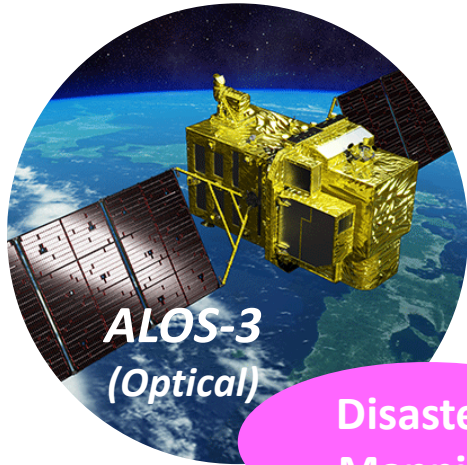
2023

ALOS-3

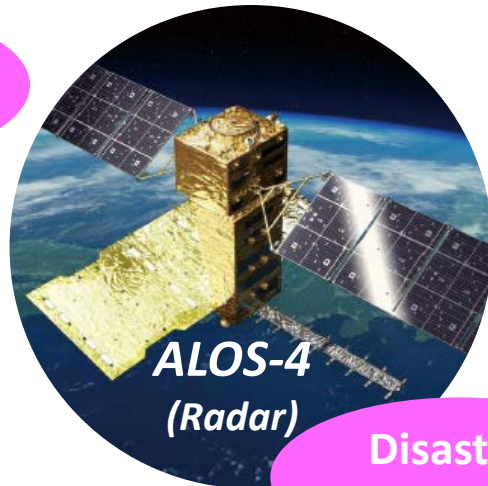
ALOS-4

EarthCARE

GOSAT-GW



Disaster/  
Mapping

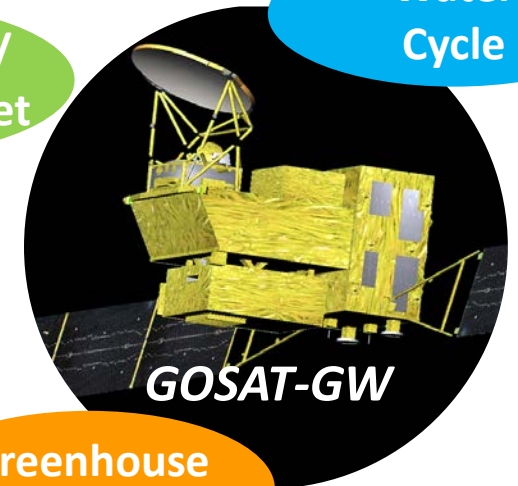


Disaster/  
Forest



(ESA-JAXA  
joint mission)

Cloud/Aerosol/  
Radiation Budget



Greenhouse  
gases

(MOE Mission)

(JAXA Mission)

Water  
Cycle

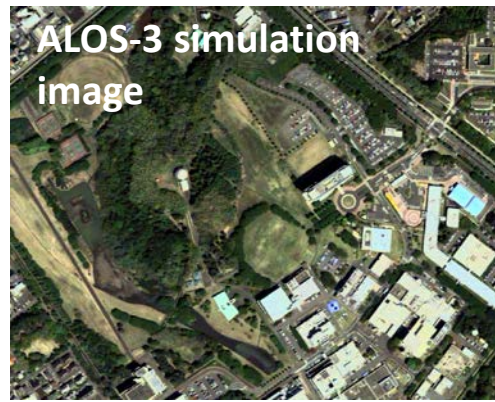
# Future ALOS series Missions: ALOS-3 Optical (2021) & ALOS-4 L-band SAR (2022)



To be launched  
in JFY2021

Disaster/  
Mapping

**ALOS-3  
(Optical)**



ALOS-3 simulation  
image



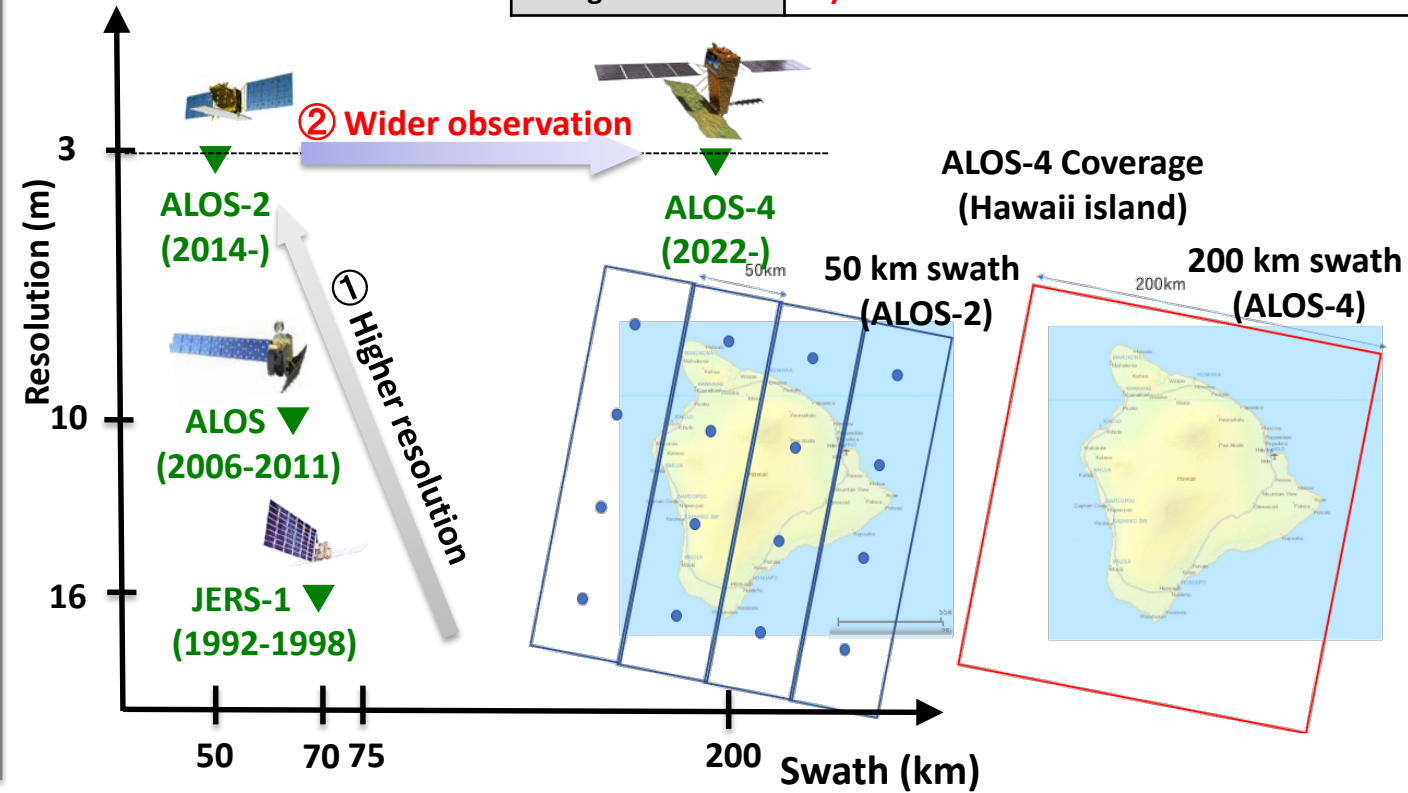
To be launched  
in JFY2022

Disaster/  
Forest

**ALOS-4  
(Radar)**

Orbit	Same orbit as ALOS-2 Altitude: 628 km at the equator Inclination angle: 97.9° Local sun time at Desc.: 12:00 +/- 15 min Revisit time: 14 day (15-3/14 rev/day)
Instruments	- <b>PALSAR-3</b> (Phased Array type L-band Synthetic Aperture Radar-3) - <b>SPAISE3</b> (SPace based AIS Experiment 3)
Satellite Mass	Approx. 3 tons at launch
Designed lifetime	<b>7 years</b>

Orbit	Sun-synchronous sub-recurrent Altitude: 669 km at the equator Local Sun Time at Desc: 10:30 am +/- 15 min Revisit time: 35 days (Sub-cycle 3 days)
Instruments	- Wide-swath and high-resolution optical imager - Dual-frequencies Infrared sensor (hosted payload)
Ground Sampling Distance (GSD)	- <b>Panchromatic band (Pa): 0.8 m</b> - <b>Multispectral band (Mu): 3.2 m (6 bands)</b>
Quantization	11 bit / pixel
Swath width	<b>70 km at nadir</b>
Mission data downlink	Direct: Ka and X-band; via. Data Relay Satellite
Satellite Mass	Approx. 3 tons at launch
Duty	10 mins / recurrent
Designed lifetime	<b>7 years</b>

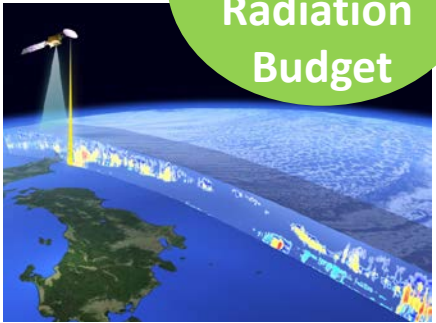


# Future Missions for Climate & Water: EarthCARE (2022) & GOSAT-GW (2023)



To be launched in JFY2022

Cloud/  
Aerosol/  
Radiation  
Budget



- Europe-Japan joint mission
- Targeting to measure three-dimensional global distributions of cloud and aerosol to contribute to precise understanding of climate change
- JAXA and NICT provides the world's first satellite-based cloud vertical motion by the Cloud Profiling Radar (CPR) with 94 GHz with Doppler Capability at 0.8 km spatial resolution.

<b>Orbit</b>	Sun-synchronous sub-recurrent orbit Altitude: approx. 400km Inclination angle: 97.05° Local Sun Time at Desc.: 14:00 Revisit time: 25 days
<b>Instruments</b>	- <b>Cloud Profiling Radar (CPR)</b> by NICT & JAXA - Atmospheric Lidar (ATLID) by ESA - Multi-Spectral Imager (MSI) by ESA - Broad-Band Radiometer (BBR) by ESA
<b>Mass</b>	Approx. 2.2 tons at launch
<b>Designed lifetime</b>	3 years

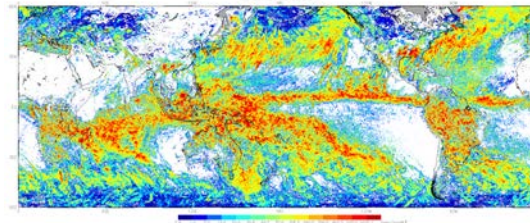


To be launched in JFY2023

Water  
Cycle

Green-  
house  
gases

AMSR3 for both snow & rain



- Carrying two instruments, AMSR3 and TANSO-3.
  - AMSR3 (JAXA) will succeed AMSR series observations adding new high frequency channels (166 & 183 GHz) for snow fall retrievals and water vapor analysis for numerical weather prediction.
  - TANSO-3 (led by Ministry of Environment in Japan) uses imaging spectrometer technology to measure CO<sub>2</sub>, CH<sub>4</sub> and NO<sub>2</sub> globally with medium and locally with high spatial resolution.

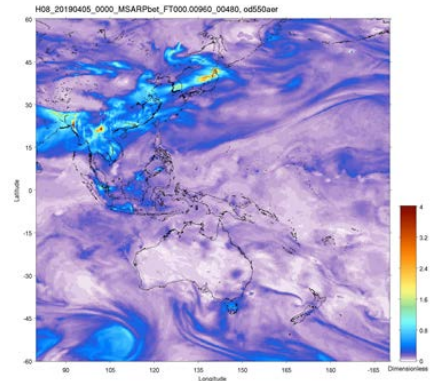
<b>Orbit</b>	Sun-synchronous sub-recurrent orbit Altitude: approx. 666km Inclination angle: 98.06° Local Sun Time at Desc.: 1:30 +/- 15 min Revisit time: 3 days
<b>Instruments</b>	- <b>Advanced Microwave Scanning Radiometer 3 (AMSR3)</b> - <b>Total Anthropogenic and Natural emissions mapping SpectrOmeter-3 (TANSO-3)</b> (for Ministry of Environment in Japan (MOE))
<b>Mass</b>	Approx. 2.6 tons at launch
<b>Designed lifetime</b>	<b>7 years</b>



# Satellite and Model Collaborations toward Earth Environment Predictions

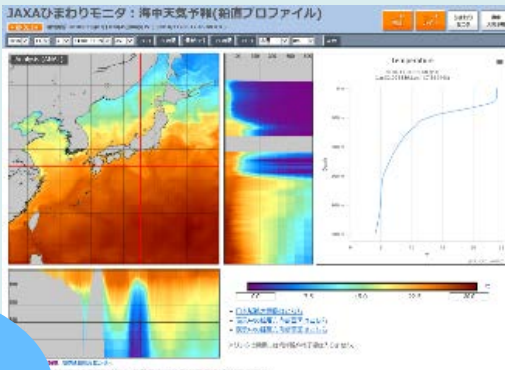
Alert for Public Health

with JMA, MRI, Kyushu Univ., NIES



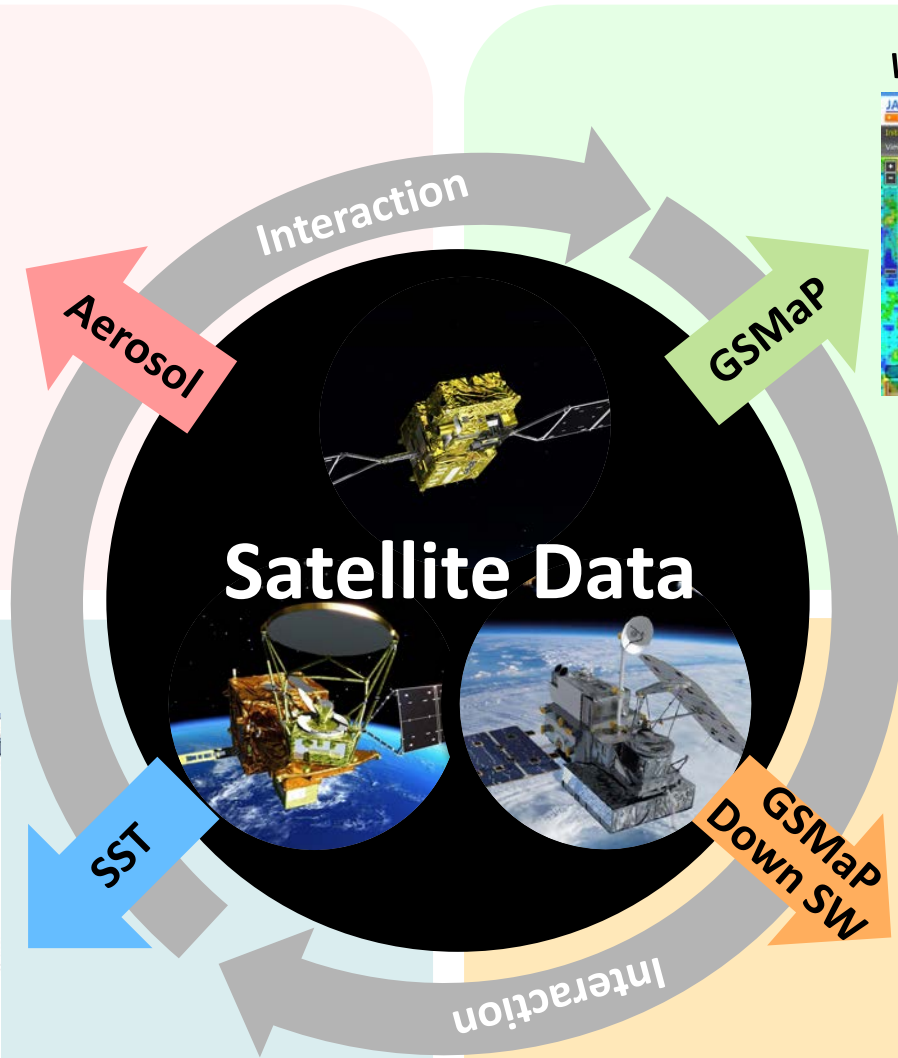
Aerosol Model

Ocean Model

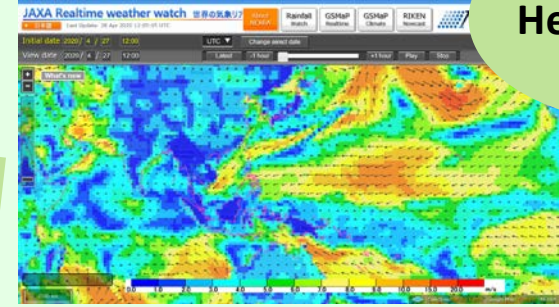


Fishery, Ocean Transport, Climate

with JAMSTEC, RIKEN, Nagoya Univ.



with U. Tokyo, RIKEN

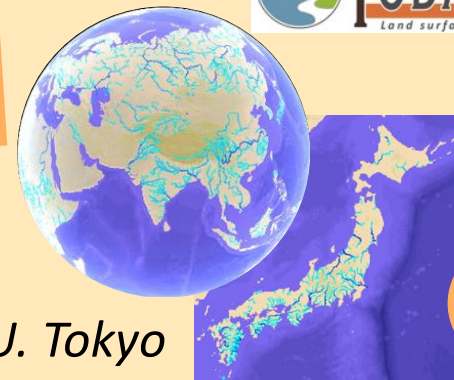


Severe Weather Heavy Rainfall, Flood



Atmospheric Model

Land/River Model



with U. Tokyo

Flood, Drought, Water-related Hazard





# Summary

- Contribution to water cycle and climate studies, disaster mitigation, and various operational applications, including weather forecast, fishery, and agriculture, is a big target of JAXA's Earth observation program.
- For this purpose, JAXA currently operates six EO satellites/missions on orbit, and will continue these contributions by launching ALOS-3, ALOS-4, ESA-JAXA joint EarthCARE and GOSAT-GW in the near future.
- We also collaborate with various model communities to utilize satellite data in their models to enhance predictions and contribute to science and society.
- We recognize calibration/validation activities, algorithm development, and application research are important to achieve our goals.

We expect PIs to create cutting-edge scientific achievements that can contribute to solving various social and global issues such as Natural Disaster, Global Warming, Climate Change, SDGs etc.

**For Our Sustainable Future**  
**Thank you for your attention.**



*Images of the Earth about 340,000 km from the center of the Earth took  
by the Hayabusa2 after the swing-by on December 4, 2015.*

*Australian continent on the upper right, and Antarctica on the lower right.*