Current Status and Future Plan of JAXA Earth Observation Missions for Climate Studies and Operational Applications

Japan Aerospace Exploration Agency (JAXA)

with supports from M. Yamaji, M. Yoshida and JMA

AOMSUC-10@Melbourne, Australia
4-6 Dec. 2019
## Japanese Earth Observation Satellites

### Targets (JFY: Apr-Mar)

<table>
<thead>
<tr>
<th>Year</th>
<th>Mission Status</th>
<th>Mission Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>Completed</td>
<td>ALOS-2 / PALSAR-2 (Land and disaster monitoring)</td>
</tr>
<tr>
<td>2013</td>
<td>On orbit</td>
<td>ISS/CIRC</td>
</tr>
<tr>
<td>2014</td>
<td>Development</td>
<td>TRMM / PR 1997-2011 (Precipitation 3D structure)</td>
</tr>
<tr>
<td>2015</td>
<td>Completed</td>
<td>GPM / DPR (Precipitation 3D structure)</td>
</tr>
<tr>
<td>2016</td>
<td>Completed</td>
<td>GCOM-W / AMSR2 (Vegetation, aerosol, cloud, SST, ocean color)</td>
</tr>
<tr>
<td>2017</td>
<td>Completed</td>
<td>GCOM-C / SGLI (Cloud and aerosol 3D structure)</td>
</tr>
<tr>
<td>2018</td>
<td>Completed</td>
<td>GOAT-GW/AMSR3 (Cloud and aerosol 3D structure)</td>
</tr>
<tr>
<td>2019</td>
<td>Completed</td>
<td>GOSAT-2</td>
</tr>
<tr>
<td>2020</td>
<td>Pre-phase-A</td>
<td>GOSAT-3</td>
</tr>
<tr>
<td>2021</td>
<td>Pre-phase-A</td>
<td>Himawari 8/9</td>
</tr>
<tr>
<td>2022</td>
<td>Pre-phase-A</td>
<td>Himawari 10/11 planning</td>
</tr>
<tr>
<td>2023</td>
<td>Pre-phase-A</td>
<td>Himawari 10/11 planning</td>
</tr>
</tbody>
</table>

### Disasters & Resources
- **ADEOS-I/AVNIR**
- **ALOS/AVNIR2, PALSAR (2006-2011)**

### Climate System
#### Water Cycle
- **ADEOS-II/AMSR (2003)**
- **Aqua/AMSR-E (2002-2011)**

#### Climate change
- **ADEOS-I/OCTS (1996-1997)**
- **ADEOS-II/GLI (2003)**

### Greenhouse gases
- **GOSAT / FTS, CAI 2009~**
- **MTSAT-1R (Himawari-6)**
- **MTSAT-2 (Himawari-7)**
- **MTSAT-3 (Himawari-8)**
- **MTSAT-4 (Himawari-9)**
- **Himawari-10/11 planning**

### JMA geostationary meteorological satellites
- **MTSAT-1R (Himawari-6)**
- **MTSAT-2 (Himawari-7)**
- **MTSAT-3 (Himawari-8)**
- **MTSAT-4 (Himawari-9)**
- **Himawari-10 (standby)**
- **Himawari-11 (standby)**
Launch of Greenhouse gases Observing SATellite-2 (GOSAT-2)

GOSAT-2 launch on Oct. 29, 2018

TANSO-FTS-2
(1) Adding Carbon Monoxide (CO) measurement to identify CO₂ enhancement by combustion
(2) Wider pointing angles
(3) Fully customized observation pattern
(4) Cloud avoiding pointing

TANSO-FTS-2 first spectra
Dec. 13, 2018, Nagoya, Japan

TANSO-CAI-2
(1) 10 bands
(2) Multi-viewing capability improved aerosol detection

TANSO-CAI Nadir
GOSAT-2 CAI-2-forward
GOSAT-2 CAI-2-Backward
Iran
Dubai
Pakistan
Arabian Sea

GOSAT-2 CAI Nadir
TANSO-CAI-2 first light
(Nov. 5, 2018)
Data Release of Global Change Observation Mission – Climate (GCOM-C) in Dec. 2018

GCOM-C provides 29 data products from G-Portal

- Snow grain size
- Aerosol optical thickness
- Leaf area index
- PAR
- Chlorophyll-a conc.
- Land surface temperature
- SST
- Above ground biomass
- Water-cloud optical thickness
- Water-cloud effective radius

SGLI on GCOM-C has 250-m resolution and captured fine structures of ocean current and eddies.

2019/05/08

Sea Surface Temperature

Chlorophyll-a
The GOSAT-GW satellite will carry two missions, AMSR3 and TANSO-3.

- AMSR3, led by JAXA, will succeed AMSR series observations with new high-frequency channels (166 & 183 GHz) for solid precipitation retrievals and water vapor analysis in numerical weather prediction.
- Internal project approval review was completed in Nov. 2019, and became official project in Dec. 2019.

Orbit Specification

- 666 km altitude (same as GOSAT) and 13:30 LT in Ascending node (same as GCOM-W)

Mission Targets of AMSR3

- Understanding water cycle variation and impacts of climate change
- Improvements in numerical weather prediction, typhoon analysis, etc.
- Contributions to fisheries near coast
- Contribution to navigation support in polar oceans
Example of Collaborations (1): Aerosol Monitoring and Forecasts

- The high and nearly continuous AOT over land and ocean are estimated from Himawari-8/AHI
- Transports of aerosols are captured by utilizing frequent (10-min) observations by AHI
JMA-JAXA Collaboration Framework for Aerosol Forecasts

JAXA has provided the Himawari aerosol algorithm (L2, L3) to JMA, and JMA has implemented the algorithm to its operational system.

JMA plans to start data assimilation of the Himawari aerosol in its operational system in January 2020.

Data assimilation of aerosol by polar orbital satellites (e.g. GCOM-C/SGLI) will be the next target.
Example of Collaborations (2): Global Satellite Mapping of Precipitation

- **Global Precipitation Measurement Core satellite**
- **Dual-Frequency Precipitation Radar**
  - **Microwave Imager**
  - **GPM**

**Constellation satellites**

**Providing reference standard**

- **Cloud motion information by IR imager on Geostationary satellite**

**Precipitation Radar**

**Microwave Radiometer**

**IR Imager**

**Multi-satellite Rainfall Product**
- **Distribution**
  - website
  - CSV
  - netCDF
  - Binary
  - GeoTIFF
  - png

- **Hourly global rainfall data**
- **0.1x0.1deg. lat/lon**
- **Various version such as realtime for monitoring or long-term gauge-adjusted for climatological purposes**

Quoted by JMA website
Utilization of GSMaP in Asia-Oceania

In Asian region,

- Oceania: 2%
- Africa: 3%
- Europe: 7%
- Americas: 9%
- Japan: 32%
- Asia (including Middle East): 47%

5380 registered (data analysis) users from 128 countries as of Oct.2019. 79% of total registered users are originally from Asian region.

Various application fields using GSMaP in Asia

- Operational Weather Monitoring
- Disaster Report
- Agricultural Climate Monitoring

In Oceania region,

- Timeseries of PageView from Pacific Islands

Users from Pacific islands use website for monitoring

- Himawari
  - Higher-resolution Cloud
  - Directly observed Rainfall

@BMKG, Indonesia
Officers monitoring rainfall using GSMaP

@Disaster Management Centre, SriLanka
https://reliefweb.int/sites/reliefweb.int/files/resources/Situation_16_May_2016.pdf

@Solomon met service

Drought Anomaly in Thailand

@Disaster Management Centre, SriLanka
https://reliefweb.int/sites/reliefweb.int/files/resources/Situation_16_May_2016.pdf

@Solomon met service

Drought Anomaly in Thailand
Evaluation of uncertainties in rainfall analysis and prediction in GSMaP data

WMO’s Regional Specialized Meteorological Centre Tokyo for Nowcasting (RSMC Tokyo for Nowcasting) operated by JMA supplies National Meteorological and Hydrological Services (NMHSs) with graphical nowcasting products to help improve capacity for disaster risk reduction.

JAXA and JMA started collaboration toward the utilization of GSMaP data in the issuance of warnings by NMHSs in Asia and Pacific region through the RSMC Tokyo for Nowcasting.

JAXA & JMA’s Collaboration in Technical Development toward the Utilization of GSMaP

Phase I (2018-2019)

Evaluation of uncertainties in rainfall analysis and prediction in GSMaP data

Phase II (2020-2022)

Development of integrated regional QPE (Quantitative Precipitation Estimation) and QPF (Quantitative Precipitation Forecast)
GSMaP’s Contribution to WMO SEMDP
Space-based Weather and Climate Extremes Monitoring Demo. Project

- WMO Space-based Weather and Climate Extremes Monitoring (SWCEM) Demonstration Project (SEMDP), East Asia and Western Pacific Regional Subproject initiated in 2018 (Kuleshov et al. 2019, DOI:10.5772/intechopen.85824).
- JAXA participates to this subproject with the GSMaP, and provide the GSMaP_Gauge_NRT product with 19yr-climate normal.
- Targets are heavy rainfall and drought from 5-days up to a month.

WMO SEMDP
Kinck-off Workshop, Jan. 2018, BMKG, Jakarta, Indonesia

WMO SEMDP
Workshop, Nov. 2018, Kuala Lumpur, Malaysia

Case study over Indonesia on Dec2014

Satellite Detected Region of Extreme Heavy Rainfall based upon percentiles from past 19-yr data

GSMaP (v6) Gauge-NRT

Eleventh ASEAN Climate Outlook Forum and WMO SEMDP Workshop & Steering Group Meeting 23 October – 2 November 2018
Kuala Lumpur, Malaysia
Example of Collaborations (3): Multi-satellites and Models

Hourly animation of GSMaP accumulated rainfall by the Super Typhoon No.19 “HAGIBIS” from 00Z 5th Oct. to 23Z 13th Oct., 2019

Himawari-8/AHI VIS

3:50-59Z on 11 Oct. 2019

- AMSR2 can capture structure of rainfall, total precipitable water and wind speed under the typhoon clouds
Capturing the Damages Caused by the Typhoon by ALOS-2 and GCOM-C

Simulation of river discharge by 1-km resolution land surface/floodplain model. Flooding of Chikuma river was forecasted by the model.


Broken bank 3m res., HH pol.

https://www.eorc.jaxa.jp/water/
## JAXA’s Open and Free EO Data and Services

<table>
<thead>
<tr>
<th>Portal Name and URL</th>
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<tbody>
<tr>
<td><strong>G-Portal</strong></td>
</tr>
<tr>
<td>(Contacts: <a href="mailto:z-gportal-support@ml.jaxa.jp">z-gportal-support@ml.jaxa.jp</a>)</td>
</tr>
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<td><strong>GSMaP: Global Satellite Mapping of Precipitation</strong></td>
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<td>Provides hourly Global Rainfall Map in Near-Real-Time (GSMaP_NRT), available four hours after observation. (GPM-Core GMI, TRMM TMI, GCOM-W1 AMSR2, DMSP series SSMIS, NOAA series AMSU, MetOp series AMSU, and Geostationary IR) <a href="https://sharaku.eorc.jaxa.jp/GSMaP/">https://sharaku.eorc.jaxa.jp/GSMaP/</a></td>
</tr>
<tr>
<td>(Contacts: <a href="mailto:z-trmm_real@ml.jaxa.jp">z-trmm_real@ml.jaxa.jp</a>)</td>
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<td><strong>JAXA Himawari Monitor</strong></td>
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<td>Provides multi-satellite products from the Himawari Standard Data provided by the Japan Meteorological Agency (JMA) as well as the geophysical parameter data (Aerosol Optical Thickness, Sea Surface Temperature, Short Wave Radiation, Chlorophyll-a, Wild Fire, Photovoltaic Power, Cloud Optical Thickness and Cloud Type) produced by JAXA. <a href="https://www.eorc.jaxa.jp/ptree/">https://www.eorc.jaxa.jp/ptree/</a></td>
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<td>(Contacts: <a href="mailto:z-ptree@ml.jaxa.jp">z-ptree@ml.jaxa.jp</a>)</td>
</tr>
<tr>
<td><strong>GDAS: GOSAT Data Archive Service (Operated by National Institute for Environmental Studies (NIES))</strong></td>
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<td>(Contacts: <a href="mailto:gosat-support@nies.go.jp">gosat-support@nies.go.jp</a>)</td>
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