

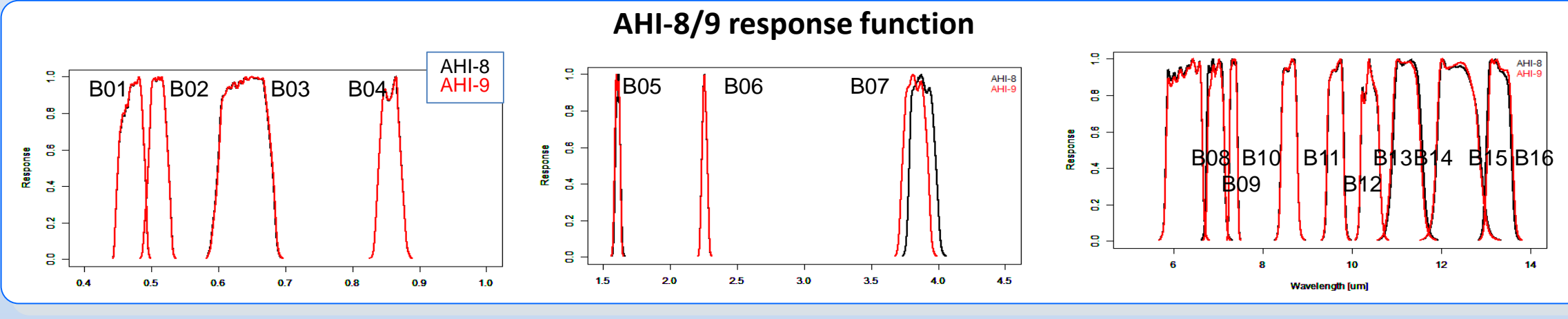
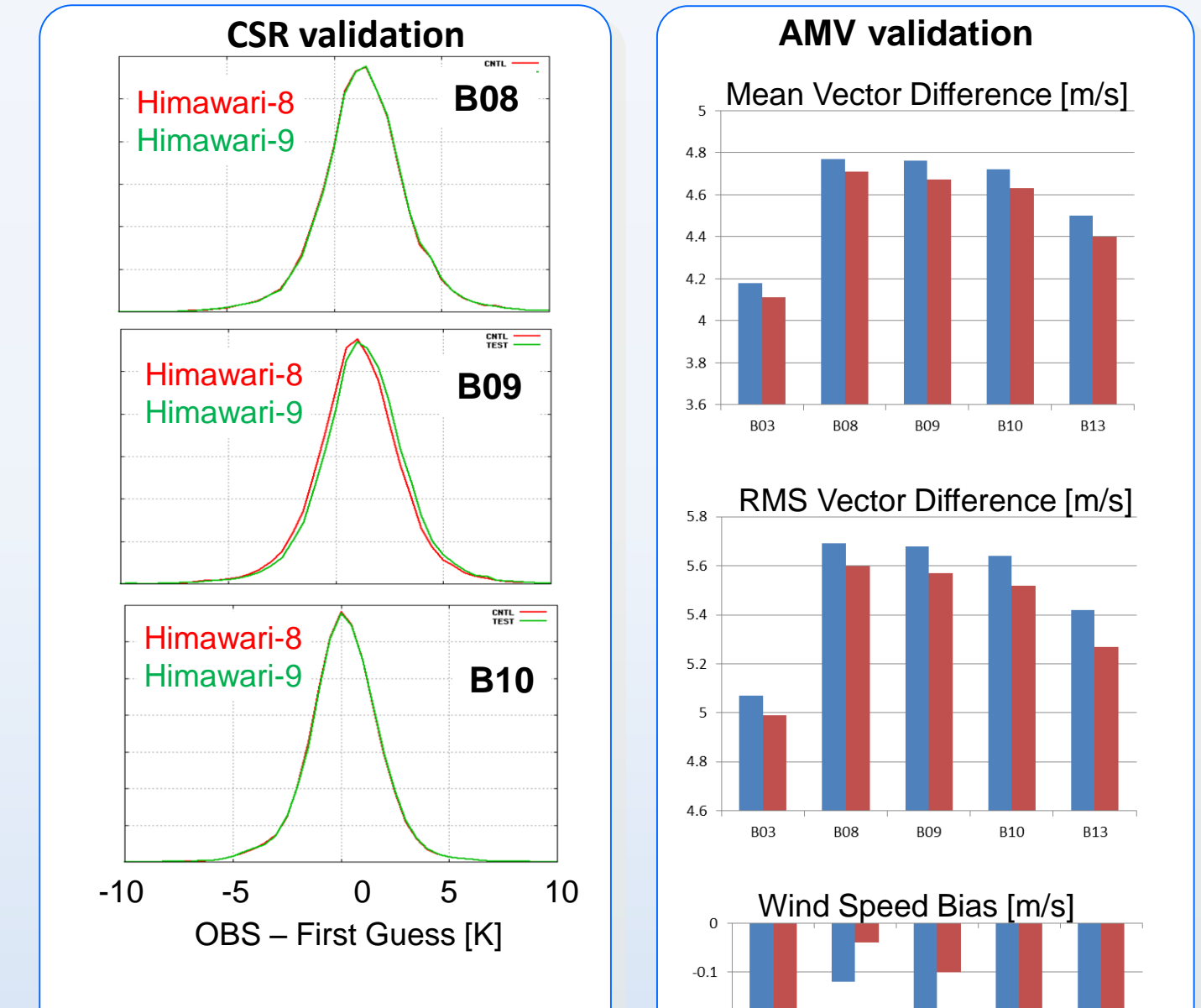
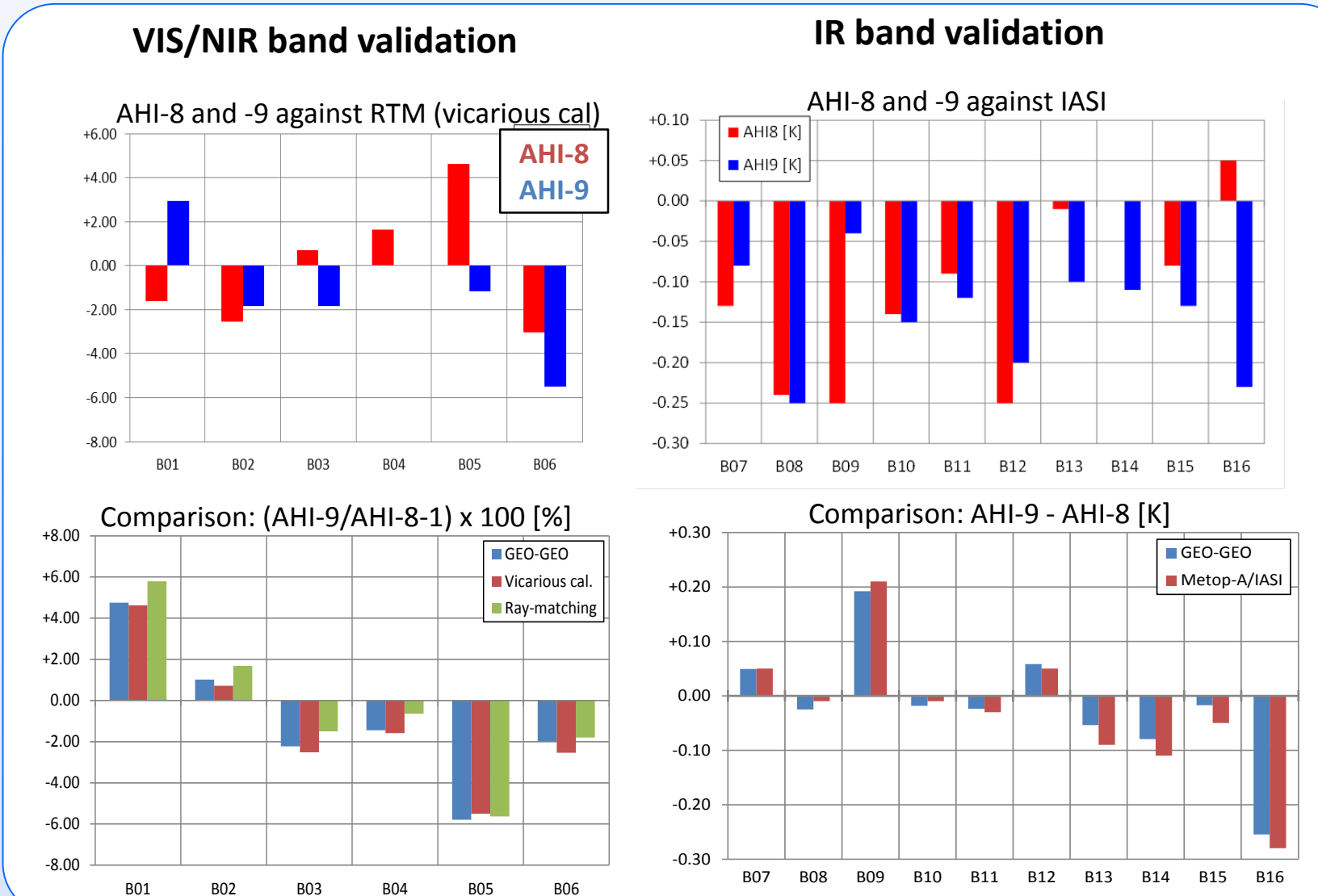
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1:JMA, 2:JAXA

## JMA

- **Himawari-8**: Launched on 7 Oct. 2014, started operation on 7 Jul. 2015
- **Himawari-9**: Launched on 2 Nov. 2016, under standby status since 10 Mar. 2017
- Comparison of Himawari-8 and -9

| 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                |

- Himawari-9 is in good agreement with Himawari-8 at most bands, but
  - 4-6 % brighter at band 1 and 6 % darker at band 5
  - 0.2 K warmer at band 9 and cooler at band 16 at the standard scene
- L2 product
  - **CSR** (clear-sky radiance)
    - Hourly products from 16x16 pixels (32x32km) at all IR bands (10 bands)
    - Very small difference between Himawari-8 and -9 but 0.2 K warmer in O-B at band 9 for Himawari-9
  - **AMV** (atmospheric motion vector)
    - Hourly products from 10 min interval images at bands 3,8,9,10, 3,(,7)
    - Rapid Scan AMVs (RS-AMVs)
    - Low Level-AMVs around typhoon for monitoring of ocean surface winds
    - High resolution Cloud Analysis Information (HCAI)
    - Aerosol Optical Depth (AOD) product for monitoring of Asian dust
- Recent development
  - 25 Jul. 2017: revise ground-base processing by updating VIS/NIR calibration coefficients (reduction of stripe and banding noise) and quantization noise handling
  - 21 Mar. 2017: Improve cloud top height retrieval in fundamental cloud products
  - 16 Nov. 2016: Improve band-to-band co-registration and image navigation performance
  - 9 Mar. 2016: reduce coherent noise, improve band-to-band co-registration and resampling processes



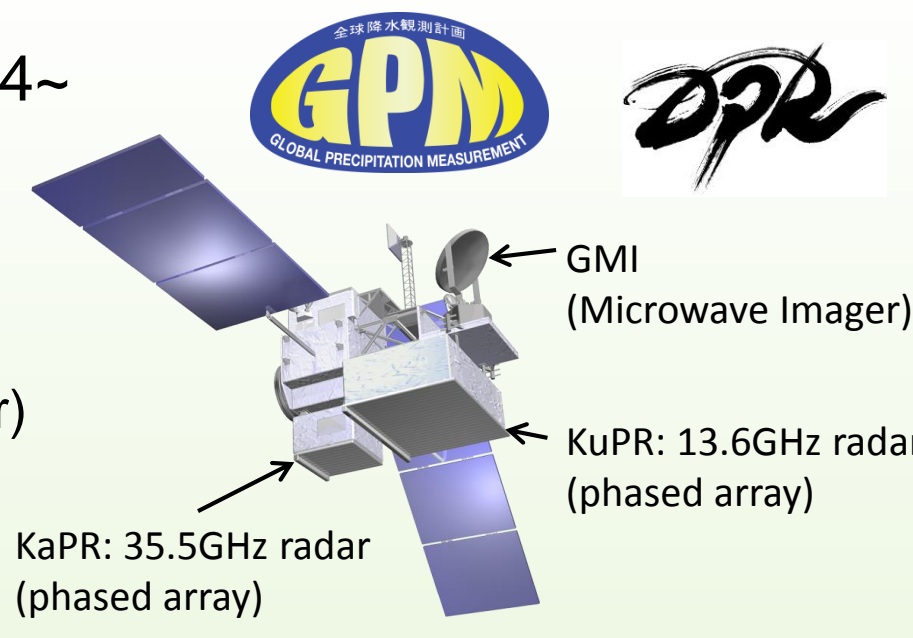
|           | B08 (6.2 μm) | B09 (6.9 μm) | B10 (7.3 μm) |
|-----------|--------------|--------------|--------------|
| Satellite | H-8          | H-9          | H-8          |
| Number    | 53079        | 52940        | 50074        |
| Mean [K]  | 1.40         | 1.42         | 1.07         |
| Stdev [K] | 2.04         | 2.04         | 2.06         |

More information is available on <http://www.jma-net.go.jp/msc/en>

## JAXA

### DPR on GPM (Global Precipitation Mission) Feb 2014~

- GPM (Global Precipitation Mission): an international mission consisting of the GPM core observatory and constellation satellites for high accurate and frequent global precipitation observation
  - Core observatory carries 2 instruments : **DPR** and **GMI** (GPM Microwave Imager)
  - **DPR** (Dual-frequency Precipitation Radar)
    - **KuPR** (13.6 GHz) and **KaPR** (35.5 GHz)
    - Highly sensitive precipitation measurement
    - No degradation in function and performance since the launch
- GPM algorithm development
  - L1/L2/L3 ver.5 (V05) released in May 2017
  - DPR/GMI combined L2 V05 released in May 2017
  - Spectral Latent Heating (SLH) V05 in July 2017
  - <https://www.gportal.jaxa.jp/gp/top.html>



|                          | GPM core                     |                     | TRMM                         |
|--------------------------|------------------------------|---------------------|------------------------------|
| Radar                    | KuPR                         | KaPR                | PR                           |
| Observation frequency    | 13.597 & 13.603 GHz          | 35.547 & 35.553 GHz | 13.796 & 13.802 GHz          |
| Swath width              | 245 km                       | 125 km              | 215 km                       |
| Horizontal resolution    | 5 km                         | 5 km                | 4.3 km                       |
| Range resolution         | 125 m                        | 125/250 m           | 250 m                        |
| Minimum Ze and rain rate | 18 dBZ / 0.3 mm/h            | 12 dBZ / 0.5 mm/h   | 18 dBZ / 0.7 mm/h            |
| Launch date (JST)        | 28 Feb. 2014                 |                     | 28 Nov. 1997                 |
| Orbit (inclination)      | Non-sun-synchronous (65 deg) |                     | Non-sun synchronous (35 deg) |
| Altitude                 | 407 km                       |                     | 350 km                       |

- **GSMaP** (Global Satellite Mapping of Precipitation)
  - Blended MW and IR precipitation hourly product at 0.1-degree resolution.
  - V04 was released in Jan 2017
  - GSMaP\_NOW: realtime product in Himawari region
  - GSMaP\_RNL: reanalysis version since Mar 2000
  - GSMaP\_RNC: nowcast developed by RIKEN/AICS
  - <http://sharaku.eorc.jaxa.jp/GSMaP>

### AMSR2 on GCOM-W1 May 2012~

- Long-term observation of water and energy circulation
- **GCOM-W** (Global Change Observation Mission - Water)
  - Sun-synchronous orbit at 700 km altitude, 98.186 degrees inclination and 13:30 LT of descending node
- **AMSR2** (Advanced Microwave Scanning Radiometer-2)
  - Conical scanning MW radiometer with dual polarization channels
  - Fine resolution compared to other passive MW imagers
  - DMSP/SSMIS: 31x41km@36GHz, GPM/GMI: 9x14km@36GHz, FY-3/MWRI: 18x30km@36GHz
  - Wide swath width : 1600 km
  - DMSP/SSMIS:1700km, GPM/GMI:885km, FY-3/MWRI:1400km
  - Can observe SST and soil moisture with 7-GHz channels
  - DMSP/SSMIS: 19-183GHz, GPM/GMI: 10-183GHz, FY-3/MWRI: 10-89GHz
  - <http://gcom-w1.jaxa.jp/index.html>
- AMSR2 follow-on mission
  - Research is underway on possible payload capability onto GOSAT-3 in corresponding to revision of the roadmap for the Japanese Basic Plan on Space policy
  - Highest priority for users is gapless transition from AMSR2

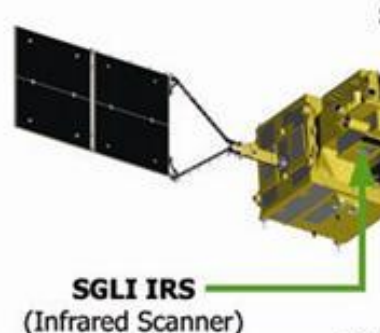


| Freq. [GHz] | Temp. res. | Beam width (-3dB res. at surface) |
|-------------|------------|-----------------------------------|
| 6.925/7.3   | < 0.34 K   | 1.8° (35km x 62km)                |
| 10.65       | < 0.70 K   | 1.2° (24km x 42km)                |
| 18.7        | < 0.70 K   | 0.65° (14km x 22km)               |
| 23.8        | < 0.60 K   | 0.75° (15km x 26km)               |
| 36.5        | < 0.70 K   | 0.35° (7km x 12km)                |
| 89.0 A/B    | < 1.20 K   | 0.15° (3km x 5km)                 |

| Product                  | Coverage                      | Resolution | Validation Result          |
|--------------------------|-------------------------------|------------|----------------------------|
| Brightness Temperature   | Global                        | 5-50km     | < 1.4 K                    |
| Total Precipitable Water | Global Ocean                  | 15km       | 1.5 kg/m²                  |
| Cloud Liquid Water       | Global Ocean                  | 15km       | 0.04 kg/m²                 |
| Precipitation            | Global (except high latitude) | 15km       | Ocean 48%<br>Land 86%      |
| Sea Surface Temperature  | Global Ocean                  | 50km       | 0.5 °C<br>< 0.2 °C (zonal) |
| Sea Surface Wind Speed   | Global Ocean                  | 15km       | 1.0 m/s                    |
| Sea Ice Concentration    | Ocean in high latitude        | 15km       | 9 %                        |
| Snow Depth               | Land                          | 30km       | 18 cm                      |
| Soil Moisture            | Land                          | 50km       | 4 %                        |

### SGLI on GCOM-C1 (23 Dec 2017)

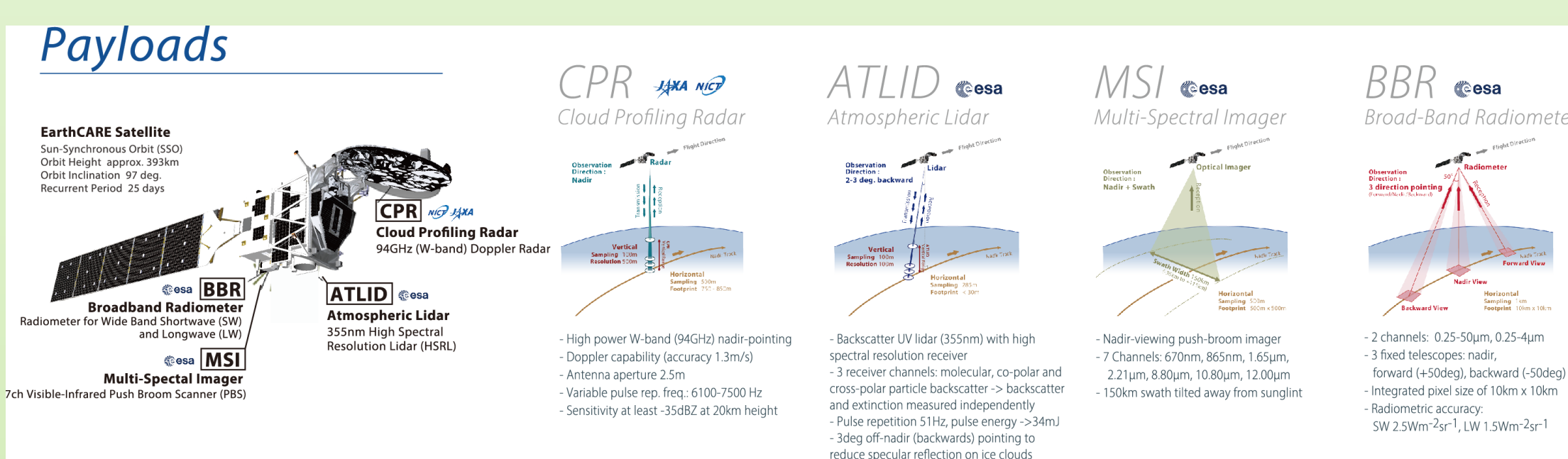
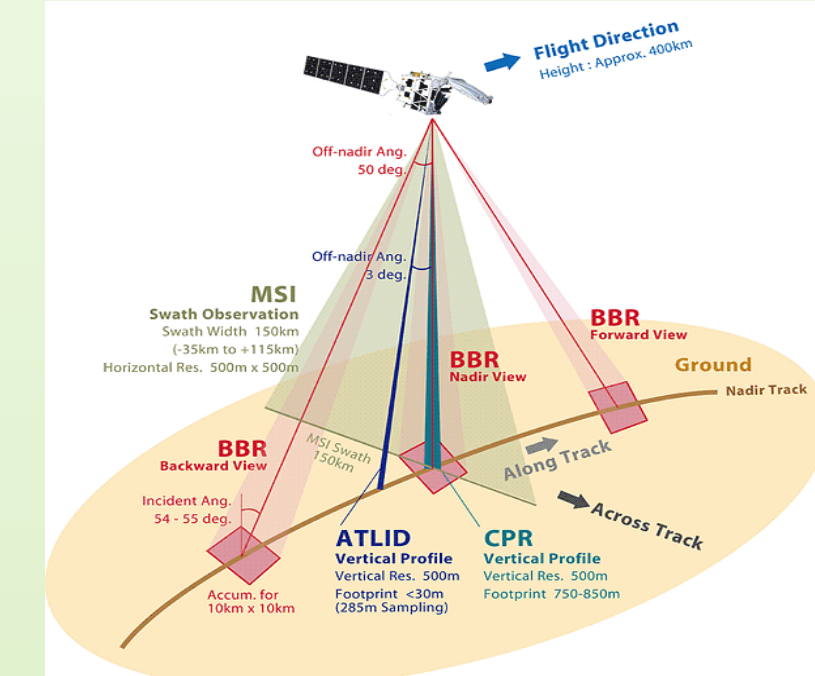
- Long-term observation of the aerosol, cloud, and ecosystem CO2 absorption and discharge
- **GCOM-C**: (Global Change Observation Mission - Climate)
  - Sun-synchronous orbit at 798 km altitude, 98.6 degrees inclination and 10:30 LT of descending node
- **SGLI** (Second Generation Global Imager)
  - SGLI-VNR (Vis and NIR Radiometer) and SGLI-IRS (IR Scanner)
  - Characterized by 250 m resolution (for vegetation, phytoplankton, sea ice), along-track slant view (biomass, land cover), and polarization (aerosol)
- All standard products (L1,L2,L3) will be distributed by S-FTP
  - released to the public one year after the launch
  - Free for both science and commercial purpose
  - [http://suzaku.eorc.jaxa.jp/GCOM\\_C/index.html](http://suzaku.eorc.jaxa.jp/GCOM_C/index.html)



| CH   | Wavelength |     | S/N Ratio | IFOV | Tilt  |      |       |   |
|------|------------|-----|-----------|------|-------|------|-------|---|
|      | μm         | nm  |           |      |       |      |       |   |
| VN1  | 380        | 10  | 60        | 210  | 250   | 1000 | 0     |   |
| VN2  | 412        | 10  | 75        | 250  | 400   | 250  | 1000  | 0 |
| VN3  | 443        | 10  | 64        | 400  | 300   | 250  | 1000  | 0 |
| VN4  | 490        | 10  | 53        | 120  | 400   | 250  | 1000  | 0 |
| VN5  | 530        | 20  | 41        | 350  | 250   | 250  | 1000  | 0 |
| VN6  | 565        | 20  | 33        | 300  | 400   | 250  | 1000  | 0 |
| VN7  | 673.5      | 20  | 23        | 62   | 400   | 250  | 1000  | 0 |
| VN8  | 673.5      | 20  | 25        | 210  | 250   | 250  | 1000  | 0 |
| VN9  | 763        | 12  | 40        | 350  | 1200* | 250  | 1000* | 0 |
| VN10 | 868.5      | 20  | 8         | 30   | 400*  | 250  | 1000  | 0 |
| VN11 | 868.5      | 20  | 30        | 300  | 200   | 250  | 1000  | 0 |
| POL1 | 673.5      | 20  | 25        | 250  | 250   | 1000 | 0.43  |   |
| POL2 | 868.5      | 20  | 30        | 300  | 250   | 1000 | 0.45  |   |
| SW1  | 1030       | 20  | 57        | 248  | 500   | 1000 | 0     |   |
| SW2  | 1380       | 20  | 8         | 103  | 150   | 1000 | 0     |   |
| SW3  | 1630       | 200 | 3         | 50   | 57    | 250  | 1000  | 0 |
| SW4  | 2210       | 50  | 1.9       | 20   | 211   | 1000 | 0     |   |
| TIR1 | 1080       | 0.7 | 300K      | 340K | 0.2K  | 250  | 1000  | 0 |
| TIR2 | 1200       | 0.7 | 300K      | 340K | 0.2K  | 250  | 1000  | 0 |

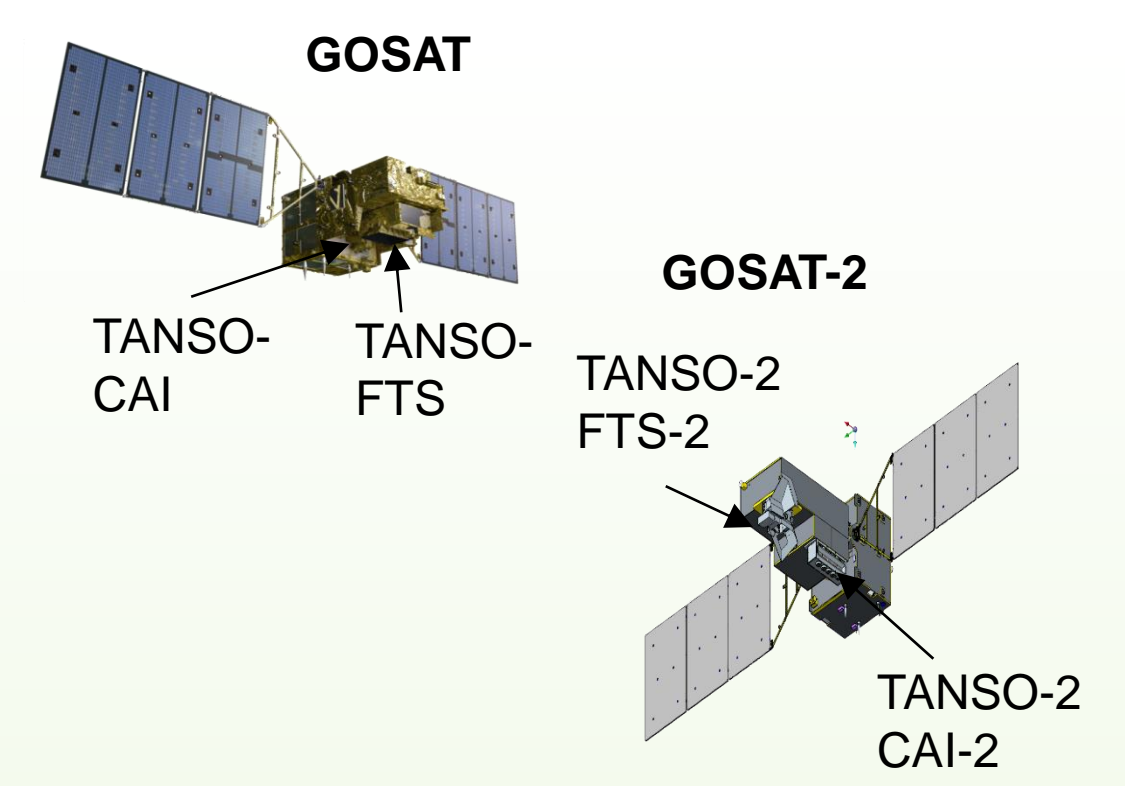
### CPR on EarthCARE (2019)

- EarthCARE: Joint mission of ESA and JAXA
- Evaluate the radiative interaction and forcing of cloud and aerosol, and reduce the uncertainties in global warming prediction by measuring 3D global structure of clouds and aerosols
- Sun-synchronous orbit at 400 km altitude, 97.05 degrees inclination and 14:00 LT of descending node
- 4 instruments: **CPR**, **ATLID**, **MSI**, and **BBR**
- **CPR** (Cloud Profiling Radar) : The world's first satellite-borne Doppler cloud radar
  - W-band (94GHz) radar to observe 3-dimensional distribution and physical characteristics of cloud and drizzle.
  - Approximately 6 times higher sensitivity than CloudSat/CPR
- In-cloud vertical motion by Doppler measurement function has the potential to contribute to the understanding of cloud and precipitation process



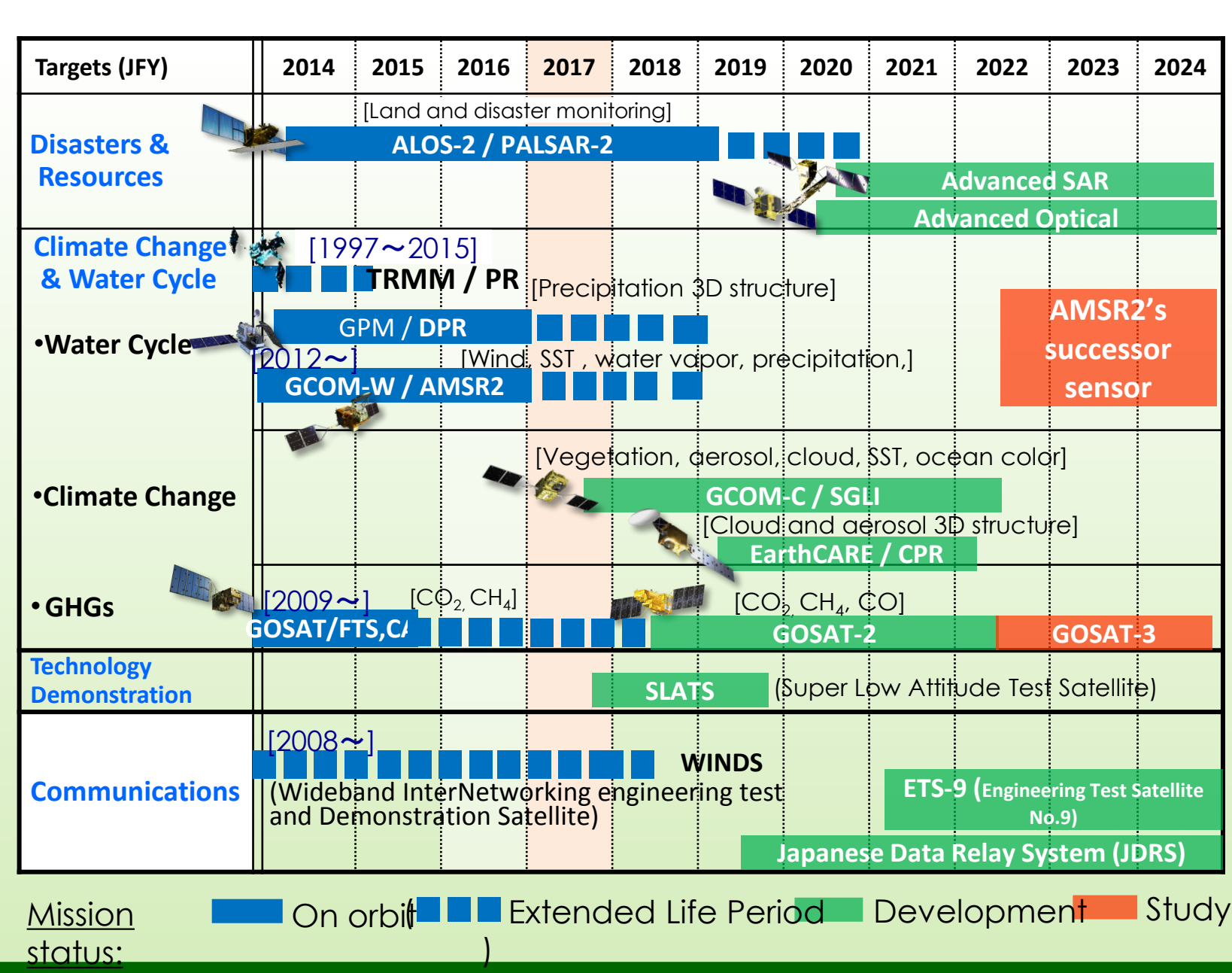
### GOSAT Jan 2009~

- GOSAT (Green house gases Observing SATellite)
  - The world's first spacecraft to measure the concentrations carbon dioxide (CO2) and methane (CH4)
  - 2 instruments: **TANSO** (Thermal And Near-infrared Sensor for carbon Observation)-**FTS** and **TANSO-CAI** (TANSO-Cloud and Aerosol Imager)
  - TANSO-FTS: 3 narrow NIR bands and 1 wide TIR band
  - Column averaged density of CO2 is mainly retrieved using 1.6 μm absorption
- GOSAT2 (2018)**
- Improve CO2 and CH4 observation accuracy, and reduce net flux estimation uncertainty
    - Enhance aerosol observation with FTS-2 band 1 and CAI-2
    - Enhance effective observation with intelligent pointing to avoid cloud contamination and expanding sunglint observation by CAI-2
  - Add CO measurement (band 3)
  - Evaluate vegetation activity with solar-induced chlorophyll fluorescence observation (band 1)
  - Intensive observation of megacities, plants, wildfires in forests and peatland



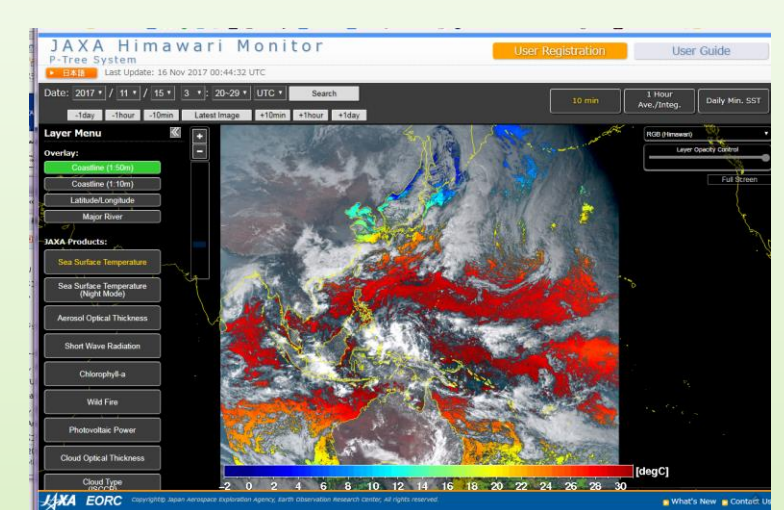
|                         | GOSAT                             | GOSAT-2                           |
|-------------------------|-----------------------------------|-----------------------------------|
| Main body Size(m) X*Y*Z | 3.7 x 1.8 x 2.0 (Wing Span 13.7m) | 5.8 x 2.0 x 2.1 (Wing Span 16.5m) |
| Total Mass              | 1750kg                            | 1800kg                            |
| Total Power             | 3.8 kW (EOL)                      | 5.0 kW (EOL)                      |
| Life Time               | 5 years                           | 5 years                           |
| Orbit                   | sun synchronous                   | sun synchronous                   |
| Local time              | 13:00+/-0:15                      | 13:00+/-0:15                      |
| Altitude                | 666km                             | 613km                             |
| Inclination             | 98deg                             | 98deg                             |
| Repeat                  | 3 days (44 revol.)                | 6 days (89 revol.)                |
| Launch Vehicle          | H-IIA                             | H-IIA                             |
| Schedule                | 23 Jan., 2009                     | 2018                              |

| Items                        | GOSAT TANSO FTS   | GOSAT-2 TANSO-2 FTS-2  |
|------------------------------|---|--|
| Measurement Gases            | CO2, CH4, O3, H2O   | CO2, CH4, O3, H2O, CO  |
| Footprint size (FOV)         | 10.5 kmf (15.8mrad)   | 9.7 kmf (15.8mrad)   |
| Spectral Ranges (mm): target | band 1: 0.75-0.77<br>band 2: 1.56-1.72<br>band 3: 1.92-2.08<br>band 4: 5.5-14.3 | band 1 : 0.75-0.77: O2, Chlorophyll fluorescence<br>band 2: 1.56-1.69 : CO2, CH4<br>band 3: 1.92-2.33 : CO2, CO<br>band 4: 5.5-8.4: CH4<br>band 5: 8.4-14.3: CO2, O3 |
| Observation Mesh             | 160km (5 points in the CT direction)  | 160km (5 points in the CT direction)   |
| Scan duration                | 4, 2, 1.1 seconds / interferogram   | 4 seconds / interferogram  |
| Sampling resolution          | 0.2cm <sup>-1</sup>   | 0.2cm <sup>-1</sup>  |
| Effective Aperture size      | Φ64mm   | Φ73mm  |
| Gain steps                   | 2   | 16   |
| Avoidance of the cloud       | -----   | Intelligent pointing   |



### JAXA Himawari-8 monitor Aug 2015~

- JAXA and JMA exchanged agreement to distribute Himawari-8 products through JAXA's web/ftp site for research and non-profit purposes in order to seek synergies between geostationary and Earth observation satellites.
- Algorithms for L2 products are developed based on GCOM-C/SGLI algorithms
  - Himawari-8's high-frequent observation and SGLI's high-resolution products will provide complementary information.
- JAXA is collaborating with model communities to conduct researches utilizing Himawari and JAXA satellite data
  - SST data assimilation into 3-km resolution local ocean model with JAMSTEC and Nagoya Univ.
  - Aerosol data assimilation into model with MRI, NIES, Kyushu Univ., and Tokyo Univ
- <http://www.eorc.jaxa.jp/ptree>



|            | Product name  | Grid size               | Interval      | Format |
|------------|---|-------------------------|---------------|--------|
| L1         | Reflectance (6 bands)   | 500m/1km/2km            | 10min(Full)   | HSD    |
|            | Brightness temperature (10 bands)                               | 2km                     | 2.5min(Japan) | NetCDF |
| Atmosphere | Aerosol properties  | 5km                     | 10min         |        |
|            | Cloud properties  | 5km                     | 10min         |        |
|            | Sea surface temperature   | 2km                     | 10min/1hr/1dy | NetCDF |
| Ocean      | Ocean color (Chlorophyll-a)                                     | 5km(full)<br>1km(Japan) | 1hr           |        |
|            | Land Wild fire  | -                       | 10min         | CSV    |
| Flux       | Photosynthetically active radiation (PAR) & Shortwave radiation | 5km(full)<br>1km(Japan) | 1hr           | NetCDF |
|            | Photovoltaic Power (image only)                                 | 1km/4km                 | 10min         | -      |