Atmosphere and Aerosols
by GOSAT-2 and other Satellites

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JAXA satellite programs

Earth Observation
- ADEOS
- TRMM/PR
- Aqua/AMSR-E

Climate Change/Water
- GPM/DPR
- GCOM-W
- GCOM-C
- EarthCARE/CPR

Aerosol
- 2016~

Global Warming
- 2009~
- 2003 (JAXA established)

GHG, Aerosol
- 2016~

Land Use
- 2016~

Disaster Monitoring
- 2016~

Next Gene. (optical)
- 2018~

Communications
- COMETS
- DRTS
- WINDS

Technology Development
- QZSS
- OICETS
- ETS-VII
- ETS-VIII

Positioning
- ETS-VI
① GCOM-C: Long-term observation of the horizontal distribution of aerosol, cloud, and ecosystem CO₂ absorption and discharge

② GCOM-W: Long-term observation of water cycle such as the snow/ice coverage, water vapor, and SST

③ GOSAT: Observation of distribution and flux of the atmospheric greenhouse gases, CO₂ and CH₄

④ EarthCARE/CPR: Observation of vertical structure of clouds and aerosols

⑤ GPM/DPR: Accurate and frequent observation of precipitation with active and passive sensors

⑥ ALOS, -2 Fine resolution mapping by SAR instruments
Greenhouse Gases Observing Satellite (GOSAT)

- Measure global distribution of GHGs, and understand how their emission is reduced.
- The only operation satellite for monitoring CO₂ and methane from space.

GOSAT “Ibuki” (Launched at Jan. 2009)

- FTS (Fourier Transform Spectrometer)
- CAI (Cloud and Aerosol Imager)

Measure global distribution of GHGs, and understand how their emission is reduced.

The only operation satellite for monitoring CO₂ and methane from space.

Change of monthly mean of CO₂ concentration in N. America and Australia

Animation of daily mean of CO₂ concentration (June 2009 - May 2011, at 800 m altitude)

Animation of daily mean of CH₄ concentration (June 2009 - May 2011, at 800 m altitude)

Dr. Yokota (NIES)
GOSAT-2: Successive greenhouse gas observation

Upgrade in GOSAT-2 mission

| Measurement precision | 0.5 ppm for CO₂ | 2ppm for CO₂ |
| Flux estimation       | 1000km for land | 2000km in sub-continental scale |
| Anthropogenic emission| CO to distinguish emission source |
| Ecosystem carbon exchange | Chlorophyll fluorescence to place constrains on GPP |
| Aerosol monitoring   | Aerosol size distribution and its property |

GOSAT achievement

<table>
<thead>
<tr>
<th>GOSAT target</th>
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<tr>
<td>4 ppm for CO₂</td>
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<tr>
<td>32 ppb for CH₄</td>
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Chlorophyll fluorescence has a potential to place constrain on GPP.

Figure 1. (a) Annual average (June 2009 through May 2010) of retrieved chlorophyll-a fluorescence at 755 nm on a $2^\circ \times 2^\circ$ grid. Only grid-boxes with more than 15 soundings constituting the average are displayed. (b) Latitudinal monthly averages of chlorophyll fluorescence from June 2009 through end of August 2010.
CO$_2$ and CO have a particular regional correlation affected by the anthropogenic activity. 

*Silva et al., GRL, 2013*
Aerosol property monitoring
Upgrading the aerosol observation bands of GOSAT-2

GOSAT aerosol observation

Beijing, 30 Aug 2009

R=670nm
G=870nm
B=380nm

Aerosol exponent (particle size index)

Aerosol optical thickness

Fukuda et al., JGR, 2013
GCOM-C: Climate

Push-broom Radiometer (VNR)
Polarization (along-track slant) radiometer (P)
Visible & Near infrared push-broom Radiometer (VNR)

shortwave & thermal InfraRed (T) Scanner (IRS)

**GCOM-C SGLI characteristics (Current baseline)**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Details</th>
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<tr>
<td><strong>Orbit</strong></td>
<td>Sun-synchronous (descending local time: 10:30), Altitude: 798km, Inclination: 98.6deg</td>
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<td><strong>Launch Date</strong></td>
<td>FY2016</td>
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<tr>
<td><strong>Mission Life</strong></td>
<td>5 years (3 satellites; total 13 years)</td>
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<td><strong>Scan</strong></td>
<td>Push-broom electric scan (VNR: VN &amp; P)</td>
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<td></td>
<td>Wisk-broom mechanical scan (IRS: SW &amp; T)</td>
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<tr>
<td><strong>Scan width</strong></td>
<td>1150km cross track (VNR: VN &amp; P)</td>
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<tr>
<td></td>
<td>1400km cross track (IRS: SW &amp; T)</td>
</tr>
<tr>
<td><strong>Digitalization</strong></td>
<td>12bit</td>
</tr>
<tr>
<td><strong>Polarization</strong></td>
<td>3 polarization angles for P</td>
</tr>
<tr>
<td><strong>Along track tilt</strong></td>
<td>Nadir for VN, SW and T, &amp; +/-45 deg for P</td>
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<tr>
<td><strong>On-board calibration</strong></td>
<td>VN: Solar diffuser, Internal lamp (LED, halogen), Lunar by pitch maneuvers (~once/month), and dark current by masked pixels and nighttime obs.</td>
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<tr>
<td></td>
<td>SW: Solar diffuser, Internal lamp, Lunar, and dark current by deep space window</td>
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<tr>
<td></td>
<td>T: Black body and dark current by deep space window</td>
</tr>
<tr>
<td></td>
<td>All: Electric calibration</td>
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Satellite under development...
Environmental monitoring by MODIS and MWRs derived geophysical parameters, as a preparatory activity for GCOM project.

Currently available parameters are RGB Images, Photosynthetically Active Radiation (PAR), Snow Cover Extent, Water Stress Trend, Wild Fire, Cloud Cover Rate. Recently introduced daily Water parameters, and Long-term Sea Ice Concentration.

Images, binary data, and trend curves for monthly/twice-a-month/daily statistics over globe and around Japan.

True color composite by MODIS Radiance

Optical thickness in 553μm channel
**EarthCARE: Earth Clouds, Aerosols and Radiation Explorer**

**EarthCARE major characteristics**
- **Launch schedule**: FY2017
- **Mission life**: 3 years
- **Total Mass**: 2,250kg (wet)
- **Orbit**: Sun-synchronous orbit around 400km

**Observation instruments**
- **CPR**: Cloud Profiling Rader (JAXA/NICT)
- **ATLID**: Atmospheric Lidar
- **MSI**: Multi-Spectral Imager
- **BBR**: Broadband Radiometer
- **Satellite & Launch**
Aerosol observation with imager and lidar

- Earth Clouds, Aerosol and Radiation Explorer
  - will be launched in FY2017.
  - is a collaborative mission between JAXA/NICT & ESA
- 4 sensors will be equipped;
  - CPR(radar), ATLID(lidar), MSI(Imager), BBR(radiometer)
- ATLID and MSI observe aerosols.

Schematic image of synergetic observation by 4 sensors.

Model simulation by Joint Simulator with NICAM-SPRINTARS (backscattering coefficient by ATLID)

Courtesy of Prof. M. Satoh and Dr. T. Hashino
Synergetic observation by JAXA’s satellites will contribute to

- Carbon exchange not only atmosphere but also ecosystem over land and ocean
- Aerosol global distributions and profile with size distribution and properties