OVERVIEW OF GCOM

IGARSS11
Vancouver, Canada
July 29, 2011
Haruhisa Shimoda, Hiroshi Murakami
Taikan Oki, Yoshiaki Honda,
Tamotsu Igarashi
EORC, JAXA
Background

• Minister of MEXT committed at Earth Observation Summit on Apr. 2004
  – Global Warming, Carbon Cycle
  – Climate Change, Water Cycle
  – Disaster mitigation

• Future Earth Observation system must reflect
  – Reliability
  – Continuity
  – User oriented

“Stable and continuous social infrastructure”

Contribution to GEOSS
Council for Science and Technology Policy (CSTP)

- 3rd Science and Technology Basic Plan
- Total budget of $240B in 5 years
- Strategic fields: Environment, Life science, Information/communication, Nanotechnology
- Ocean-Earth Observation Exploration System
- One of the 5 national critical technology
GEOSS 10 year implementation plan

**Earth System Model**
- Ocean
- Cryosphere
- Land
- Atmosphere
- Solid Earth
- Biosphere

**Prediction & Analysis**
- High speed computing & communication
- Visualization

**Policy decision support**
- Evaluation
- Decision support system

**9 Societal benefit areas**
- Disaster
- Health
- Biodiversity
- Agriculture
- Energy
- Climate
- Water
- Weather
- Ecosystem

**Assimilation**
- Interoperability criterion
- Observation
- Satellite observation
- Other data

**Earth observation system**
- In-situ observation
- Airborne observation
- Other data

**GCOS Essential Climate Variables (ECV)**
- Require continuous satellite products

Value optimization, Elimination of gap areas, Continuous feedback for human activity understanding
### JAXA’s Long-Term Plan of Earth Observation

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**Mission status**
- **On orbit**
- **Phase B~**
- **Phase A**
- **Extension**
JAXA Future Environment Missions

1. GCOM-C (2014): Long-term observation of the horizontal distribution of aerosol, cloud, and ecosystem CO$_2$ absorption and discharge
2. GCOM-W (2012): Long-term observation of water-cycle such as the snow/ice coverage, water vapor, and SST
3. GOSAT (Jan. 2009–): Observation of distribution and flux of the atmospheric greenhouse gases, CO$_2$ and CH$_4$
4. EarthCARE/CPR (2013): Observation of vertical structure of clouds and aerosols
5. GPM/DPR (Jul. 2013): Accurate and frequent observation of precipitation with active and passive sensors
6. ALOS (Jan. 2006–): Fine resolution mapping by optical and SAR instruments
GCOM Mission

- Continuation of ADEOS II
- Contribution to GEOSS
- Climate, Weather, Water, Ecosystem, Agriculture, etc. in GEOSS 9 areas
- Focus on Climate change / Global warming and Water cycle committed in Summit
- Contribution to operational fields like weather forecast, fisheries, etc.
- Long term continuous measurements
Scientific Targets

- Accurate estimation of aerosol radiative forcing
- Validation of climate models
- Accurate estimation of primary production
- Better understanding of coastal phenomena
- Better understanding of sea ice trend
GCOM Observation Targets

Radiation budget
- Cloud/aerosol changes and Radiative forcing
- Ice-albedo feedback

Major unknown factor in climate modeling

Carbon cycle
- Carbon cycle and vegetation production
- Carbon and heat pool and coastal environment

Sink and pool of CO₂ (major greenhouse gas)

Water and energy cycle in global scale
- Water cycle changes by global warming

Direct effect to human activities (severe weather, flood, water resources)

Water/Energy cycle
Operational Applications

- Input to NWP
- Extreme weather forecasting
- Fisheries
- Navigation
- Coastal management
- Crop yield estimation
- Monitoring forest decrease
- Monitoring volcano eruptions
- Monitoring forest fire
GCOM satellites

• GCOM-W1
  – AMSR2 (Advanced Microwave Scanning Radiometer 2)
  – Planned to be launched on Feb., 2012

• GCOM-C1
  – SGLI (Second generation Global Imager)
  – Planned to be launched in fiscal 2014

• Plan for the 2nd and 3rd generations
  – GCOM-W2 (in 2015),
    GCOM-W3 (in 2019)
  – GCOM-C2 (in 2018),
    GCOM-C3 (in 2022)
GCOM-W1

- **Orbit**
  - Sun synchronous orbit
  - Height: about 700km
  - Local time of ascending node: 13:30
- **Weight**: about 1.99t
- **Power**: about 3.9kW
- **Lifetime**: 5 years

**Data transmission**
- Global observation data are stored and transmitted every orbit period
- Observed data are transmitted to ground stations in real time
A-Train and GCOM-W1

- After invitation to A-Train constellation from NASA, JAXA and A-Train members studied the possibility of participation of GCOM-W1 to A-Train.
- Participation of GCOM-W1 to A-Train was approved by A-Train members last October. The position of GCOM-W1 is ahead of Aqua.
- Benefits of joining the A-train are:
  - Precise inter-calibration between AMSR-E and AMSR2; and
  - Synergy with A-Train instruments for new Earth science research.
Downlink

- Freq : 8245MHz
- Polarization : RHCP
- Modulation : OQPSK
- Data Rate : 10Mbps (20Msps)
- Coding : CCSDS, Reed-Solomon, convolution
- GCOM-W1/AMSR2 will contribute to long-term observation of global water and energy cycle.
- Continue AMSR-E observation (high spatial resolution, low-frequency channels, etc.).
- Construct reliable long-term dataset to contribute for understanding and monitoring of climate change.
- Contribute to operational use by providing continuous cloud-through SST, frequent and quantitative storm observation to maintain precipitation forecast accuracy.
Basic requirements for AMSR 2

• Minimum modifications from AMSR on ADEOS-II to reduce risks/cost and keep the earliest launch date.

• Several essential improvements.
  – Improvement of calibration system including warm load calibration target.
  – Consideration to C-band radio frequency interference (RFI).

• Combination with SeaWinds-type scatterometer is highly desired.
Basic requirements for AMSR 2

- **Antenna**: 2.0m, offset parabolic antenna
- **Channel sets**
  - Identical to AMSR-E (no O$_2$ band channels)
  - 6.925, 7.3, 10.65, 18.7, 23.8, 36.5, 89.0GHz
  - Dual polarization
- **Calibration**
  - Improvements of hot load etc.
  - Enhance pre-launch calibration testing
- **Orbit**
  - A-Train
- **Mission life**
  - 5 years
Improvement of hot load

- Adoption of temperature controlled reflector over hot load
- Minimize the effect of thermal interference
- Design results shows the maximum temperature difference less than 2K
- Brightness temperature accuracy will be around 0.1K
Prototyping and testing

Calibration Assembly

MPU testing board
Improvement of HTS (Hot Load)

(1) Temperature inside HTS is kept constant (= 20 degrees C) using heaters on 5 walls of HTS and TCP.
(2) Sunshields attached to HTS and TCP minimize the sun light reflection into HTS.
(3) TCP thermally isolates HTS from SU structure (much colder than HTS).

Maximum temperature difference inside HTS: less than 2K
Estimated brightness temperature accuracy:
- 0.2 K (Variable bias during orbit, season, design life)
- 0.1 K (Random due to quantization)
# Temperature Resolution

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<tr>
<th>Frequency</th>
<th>Resolution (target)</th>
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<tr>
<td>6.925</td>
<td>&lt;0.34 (0.3)</td>
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<tr>
<td>7.3</td>
<td>&lt;0.43</td>
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<tr>
<td>10.65</td>
<td>&lt;0.7 (0.6)</td>
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<td>18.7</td>
<td>&lt;0.7 (0.6)</td>
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<td>23.8</td>
<td>&lt;0.6 (0.55)</td>
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<tr>
<td>36.5</td>
<td>&lt;0.7 (0.65)</td>
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<tr>
<td>89.0</td>
<td>&lt;1.2 (1.1)</td>
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### Overview of AMSR2 instrument

- Deployable main reflector system with 2.0m diameter.
- Frequency channel set is identical to that of AMSR-E except 7.3GHz channel for RFI mitigation.
- Two-point external calibration with the improved HTS (hot-load).
- Deep-space maneuver will be considered to check the consistency between main reflector and CSM.

### GCOM-W1/AMSR2 characteristics

<table>
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<th>Orbit</th>
<th>Sun Synchronous with 699.6km altitude (over the equator)</th>
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<td>Launch</td>
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<td>Design-Life</td>
<td>5-years</td>
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<td>Local time</td>
<td>13:30 LTAN</td>
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<td>Swath width</td>
<td>1450km</td>
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<tr>
<td>Antenna</td>
<td>2.0m offset parabola</td>
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<td>Incidence angle</td>
<td>Nominal 55 degree</td>
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### AMSR2 Channel Set

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<tr>
<th>Center Freq. [GHz]</th>
<th>Bandwidth [MHz]</th>
<th>Polariization</th>
<th>Beam width [deg] (Ground res. [km])</th>
<th>Sampling interval [km]</th>
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<tr>
<td>6.925 / 7.3</td>
<td>350</td>
<td>V and H</td>
<td>1.8 (35 x 62)</td>
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<tr>
<td>10.65</td>
<td>100</td>
<td>V</td>
<td>1.7 (34 x 58)</td>
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<td>18.7</td>
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<td>23.8</td>
<td>400</td>
<td>V</td>
<td>0.65 (14 x 22)</td>
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<td>36.5</td>
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<td>H</td>
<td>0.75 (15 x 26)</td>
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<td>89.0</td>
<td>3000</td>
<td>H</td>
<td>0.35 (7 x 12)</td>
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<td>V</td>
<td>0.15 (3 x 5)</td>
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Cross Calibration with AMSR-E

- AMSR-E and AMSR2 will remain in A-train at least 1 year.
- Cross calibration will be conducted during this 1 year period.
- New calibration parameters of AMSR-E will be determined.
- The whole AMSR-E products will be reprocessed using this new parameters.
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<th>products</th>
<th>IFOV</th>
<th>std. accr.</th>
<th>dynamic range</th>
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<td>brightness temp.</td>
<td>5-50km</td>
<td>±1.5K</td>
<td>2.7-340K</td>
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<tr>
<td>total prec. water</td>
<td>15km</td>
<td>±3.5kg/m³</td>
<td>0-70kg/m³</td>
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<td>cloud liq. water</td>
<td>15km</td>
<td>±0.05kg/m²</td>
<td>0-1.0kg/m²</td>
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<tr>
<td>precipitation</td>
<td>15km</td>
<td>Ocean: 50%</td>
<td>0-20mm/h</td>
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<td>Land: ±120%</td>
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<td>SST</td>
<td>50km</td>
<td>±5 °C</td>
<td>-2-35°C</td>
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<td>sea surf. winds</td>
<td>15km</td>
<td>±1m/s</td>
<td>0-30m/s</td>
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<td>sea ice conc.</td>
<td>15km</td>
<td>±10%</td>
<td>0-100%</td>
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<tr>
<td>snow depth</td>
<td>30km</td>
<td>±20cm</td>
<td>0-100cm</td>
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<tr>
<td>soil moisture</td>
<td>50km</td>
<td>±10%</td>
<td>0-40%</td>
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Oceanic geophysical parameters by AMSR

Global Monthly Mean in April 2003

* AMSR 200304 Monthly TPW (kg/m²) Takeuchi Algorithm
* AMSR 200304 Monthly CLW (kg/m²) Wentz Algorithm
* AMSR 200304 Monthly SSW (m/s) Shibata Algorithm
* AMSR 200304 Monthly Precip. (mm) Liu Algorithm

- Total precipitable water
- Cloud liquid water
- Sea surface wind speed
- Precipitation
AMSR-E Soil Moisture

- C-band (7GHz) channels are currently best available frequency for retrieving global, long-term soil moisture content from satellite.
- Synergy with L-band radiometers (e.g., SMOS, SMAP) and high-resolution SAR instruments are desired.

Soil moisture standard product is being generated by using 10GHz as a primary frequency due to the radio frequency interference issue in 6.9GHz band.
Soil Moisture and Precipitation

AMSRE Soil Moisture
- L2, Descending
- Volumetric Soil Moisture [%]

Precipitation:
- Total amount of precipitation for 48 hours before AMSR-E observation.
- Data source: GSMaP MVK hourly (JST-CREST/GSMaP)

Provided by Dr. Fujii of JAXA/EORC.
Soil Moisture Observation

- AMSR-E soil moisture anomalies over south-eastern Australia (green rectangle) averaged Sep.-Oct. 2005 and 2006 are compared to wheat production.

2005

Soil Moisture (AMSR L2), September – October, 2005

2006

Soil Moisture (AMSR L2), September – October, 2006

Source: Australian Bureau of Agricultural and Resource Economics
Microwave and IR SST Combination

- C-band (6.9GHz) is indispensable frequency for retrieving SST and soil moisture. Microwave measurement can provide cloud-through frequent SST mapping.
- Microwave and IR observations complement each other in terms of spatial resolution and error sources. Importance and needs of Merged SST from microwave and IR are increasing.

SST images around east coast of Japan on April 10, 2003, observed by GLI (left) and AMSR (right). Difference of spatial resolution and cloud effect are clearly seen in the figures.

Image of the New Generation Sea Surface Temperature (NGSST) for Open Ocean on May 10, 2005. Provided by NGSST development group led by Professor Kawamura of Tohoku University.
SST anomaly in northern high latitudes

Monthly SST anomaly in northern high latitude oceans for July 2002 (left) and July 2007 (right).
Changes in AMSR-E sea ice

AMSР-E sea ice extent over northern polar region on August 20 of recent 6 years (2002-2007). Images were obtained from the Arctic Sea-Ice Monitor site maintained by the International Arctic Research Center (http://www.ijis.iarc.uaf.edu/en/index.htm).
Recent Status of Ice Extent

Sea Ice Extent: 8,314,219 km² (July 9, 2010)

Time series of AMSR-E sea ice extent over Arctic Oceans. Daily updates are available at the Arctic Sea-Ice Monitor site maintained by the International Arctic Research Center (http://www.ijis.iarc.uaf.edu/en/index.htm).
Global Rainfall Map in Near Real Time

- Displaying global rainfall map merging TRMM, AMSR-E and other satellite information
- Available 4-hr after observation
- Browse images, 24-hr animation, displaying by Google Earth
- 0.1-degree lat/lon grid, hourly products
- Data are also available via password protected ftp site
- Based on JST/CREST GSMaP algorithm

http://sharaku.eorc.jaxa.jp/GSMaP/
GSMaP_NRT Observed Cyclone Attack in Myanmar (May 2008)
GCOM-C Science Targets

Radiation budget of the atmosphere-surface system

Today's the most significant factor: atmospheric CO₂

Radiative forcing components

<table>
<thead>
<tr>
<th>RF Terms</th>
<th>RF values (W/m²)</th>
<th>Spatial scale</th>
<th>LOSU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long-lived greenhouse gases</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO₂</td>
<td>1.66 [1.46 to 1.83]</td>
<td>Global</td>
<td>High</td>
</tr>
<tr>
<td>N₂O</td>
<td>0.48 [0.43 to 0.53]</td>
<td>Global</td>
<td>High</td>
</tr>
<tr>
<td>CH₄</td>
<td>0.16 [0.14 to 0.18]</td>
<td>Global</td>
<td></td>
</tr>
<tr>
<td>Halocarbons</td>
<td>0.34 [0.31 to 0.37]</td>
<td>Global</td>
<td></td>
</tr>
<tr>
<td>Ozone</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stratospheric</td>
<td>-0.06 [-0.15 to 0.05]</td>
<td>Continental</td>
<td>Med-Low</td>
</tr>
<tr>
<td>Tropospheric</td>
<td>0.36 [0.25 to 0.65]</td>
<td>Global</td>
<td>Low</td>
</tr>
<tr>
<td>Stratospheric water vapour from CH₄</td>
<td>0.07 [0.02 to 0.12]</td>
<td>Global</td>
<td>Low</td>
</tr>
<tr>
<td>Surface albedo</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land use</td>
<td>-0.2 [-0.4 to 0.0]</td>
<td>Local to continental</td>
<td>Med-Low</td>
</tr>
<tr>
<td>Black carbon on snow</td>
<td>0.1 [0.0 to 0.2]</td>
<td>Local to continental</td>
<td>Low</td>
</tr>
<tr>
<td>Total Aerosol</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct effect</td>
<td>-0.5 [-0.9 to -0.1]</td>
<td>Continental</td>
<td>Med-Low</td>
</tr>
<tr>
<td>Cloud albedo effect</td>
<td>-8.7 [-1.8 to -0.3]</td>
<td>Continental</td>
<td>Low</td>
</tr>
<tr>
<td>Linear contrails</td>
<td>0.01 [0.003 to 0.003]</td>
<td>Continental</td>
<td>Low</td>
</tr>
<tr>
<td>Natural</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solar irradiance</td>
<td>0.12 [0.08 to 0.30]</td>
<td>Global</td>
<td>Low</td>
</tr>
<tr>
<td>Total net anthropogenic</td>
<td>1.6 [0.6 to 2.4]</td>
<td>Global</td>
<td>Low</td>
</tr>
</tbody>
</table>

Figure 2.4. Global average radiative forcing (RF) in 2005 (best estimates and 5 to 95% uncertainty ranges) with respect to 1750 for CO₂, CH₄, N₂O and other important agents and mechanisms, together with the typical geographical extent (spatial scale) of the forcing and the assessed level of scientific understanding (LOSU). Aerosols from explosive volcanic eruptions contribute an additional episodic cooling term for a few years following an eruption. The range for linear contrails does not include other possible effects of aviation on cloudiness. (WGs Figure SPM.2)

Monitoring and process investigation about cloud and aerosol by GCOM-C & EarthCARE

Evaluation of model outputs and process parameterization

Climate models present and future cloud and aerosol roles in the global warming scenarios

Today's the most significant uncertainty of radiative forcing is direct/indirect role of cloud-aerosol system
CGOM-C1

• Orbit
  – Sun synchronous orbit
  – Height: about 800km
  – Local time of descending node: 10:30
• Weight: about 2.1t
• Power: about 4kW
• Lifetime: 5 years
• Data transmission
  – Global observation data are stored and transmitted every orbit period
  – Observed data over Japanese islands are transmitted to JAXA ground station in real time
SGLI

- Wide spectrum coverage
- Near UV, VIS, NIR, SWIR, TIR
- Polarization measurements
- Multiple angle observation
- Multiple telescopes
VNR

• Composed of 3 telescopes to cover the total swath
• Each telescope covers 24 degree achieving 70 degree in total
Polarization

• Composed of 1 telescope for each channel
• IFOV is 55 degree
• Looking fore, nadir & aft
• One camera with tilt or two cameras?
<table>
<thead>
<tr>
<th>Ch.</th>
<th>central wavelength [nm]</th>
<th>IFOV [m]</th>
<th>$\Delta \lambda$ [nm]</th>
<th>$L_\lambda$ [W/m²/str/µm]</th>
<th>$L_{max.}$ [W/m²/str/µm]</th>
<th>S/N</th>
</tr>
</thead>
<tbody>
<tr>
<td>VN1</td>
<td>380</td>
<td>250</td>
<td>10</td>
<td>60</td>
<td>210</td>
<td>250</td>
</tr>
<tr>
<td>VN2</td>
<td>412</td>
<td>250</td>
<td>10</td>
<td>75</td>
<td>250</td>
<td>400</td>
</tr>
<tr>
<td>VN3</td>
<td>443</td>
<td>250</td>
<td>10</td>
<td>64</td>
<td>400</td>
<td>300</td>
</tr>
<tr>
<td>VN4</td>
<td>490</td>
<td>250</td>
<td>10</td>
<td>53</td>
<td>120</td>
<td>400</td>
</tr>
<tr>
<td>VN5</td>
<td>530</td>
<td>250</td>
<td>20</td>
<td>41</td>
<td>350</td>
<td>250</td>
</tr>
<tr>
<td>VN6</td>
<td>565</td>
<td>250</td>
<td>20</td>
<td>33</td>
<td>90</td>
<td>400</td>
</tr>
<tr>
<td>VN7</td>
<td>673.5</td>
<td>250</td>
<td>20</td>
<td>23</td>
<td>62</td>
<td>400</td>
</tr>
<tr>
<td>VN8</td>
<td>673.5</td>
<td>250</td>
<td>20</td>
<td>25</td>
<td>210</td>
<td>250</td>
</tr>
<tr>
<td>VN9</td>
<td>763</td>
<td>1000</td>
<td>12</td>
<td>40</td>
<td>350</td>
<td>400</td>
</tr>
<tr>
<td>VN10</td>
<td>868.5</td>
<td>250</td>
<td>20</td>
<td>8</td>
<td>30</td>
<td>400</td>
</tr>
<tr>
<td>VN11</td>
<td>868.5</td>
<td>250</td>
<td>20</td>
<td>30</td>
<td>300</td>
<td>200</td>
</tr>
</tbody>
</table>
## Polarization channels
(3 directions)

<table>
<thead>
<tr>
<th>Ch.</th>
<th>central wavelength [nm]</th>
<th>IFOV [m]</th>
<th>$\Delta \lambda$ [nm]</th>
<th>$L_{\lambda}$ [W/m²/str/μm]</th>
<th>$L_{\text{max}}$ [W/m²/str/μm]</th>
<th>S/N</th>
</tr>
</thead>
<tbody>
<tr>
<td>673-P1</td>
<td>673.5</td>
<td>1000</td>
<td>20</td>
<td>25</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>673-P2</td>
<td>673.5</td>
<td>1000</td>
<td>20</td>
<td>25</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>673-P3</td>
<td>673.5</td>
<td>1000</td>
<td>20</td>
<td>25</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>868-P1</td>
<td>868.5</td>
<td>1000</td>
<td>20</td>
<td>30</td>
<td>300</td>
<td>250</td>
</tr>
<tr>
<td>868-P2</td>
<td>868.5</td>
<td>1000</td>
<td>20</td>
<td>30</td>
<td>300</td>
<td>250</td>
</tr>
<tr>
<td>868-P3</td>
<td>868.5</td>
<td>1000</td>
<td>20</td>
<td>30</td>
<td>300</td>
<td>250</td>
</tr>
<tr>
<td>IRS Ch.</td>
<td>central wavelength [μm]</td>
<td>IFOV[m]</td>
<td>$\Delta \lambda$[μm]</td>
<td>$L_{\lambda}$[W/m^2/str/μm] or Tstd[K]</td>
<td>$L_{max}$[W/m^2/str/μm] or T_{max}[K]</td>
<td>S/N or NEdT@300[K]</td>
</tr>
<tr>
<td>---------</td>
<td>--------------------------</td>
<td>---------</td>
<td>---------------------</td>
<td>---------------------------------</td>
<td>---------------------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>SW1</td>
<td>1.05</td>
<td>1000</td>
<td>0.02</td>
<td>57</td>
<td>248</td>
<td>500</td>
</tr>
<tr>
<td>SW2</td>
<td>1.38</td>
<td>1000</td>
<td>0.02</td>
<td>8</td>
<td>103</td>
<td>150</td>
</tr>
<tr>
<td>SW3</td>
<td>1.63</td>
<td>250</td>
<td>0.2</td>
<td>3</td>
<td>50</td>
<td>57</td>
</tr>
<tr>
<td>SW4</td>
<td>2.21</td>
<td>1000</td>
<td>0.05</td>
<td>1.9</td>
<td>20</td>
<td>211</td>
</tr>
<tr>
<td>T1</td>
<td>10.8</td>
<td>500</td>
<td>0.7</td>
<td>300</td>
<td>340</td>
<td>0.2</td>
</tr>
<tr>
<td>T2</td>
<td>12.0</td>
<td>500</td>
<td>0.7</td>
<td>300</td>
<td>340</td>
<td>0.2</td>
</tr>
</tbody>
</table>
2. GCOM-C products and SGLI design
   - 2.8 SGLI design (VNR and IRS)

- SGLI system consists of two components: **SGLI-VNR** and **SGLI-IRS** to optimize optics for each wavelength range.
- SGLI-VNR consists of **11-channel non-polarimetric telescope** and **2-channel along-track slant polarimetric telescope** systems.

![Diagram of GCOM-C satellite with SGLI-VNR and SGLI-IRS components](image)

- **Total FOV**: 70 deg = 24 deg × 3 telescopes (-1150km@nadir)
- **FOV**: 55 deg (-1150 km @ ±45 deg along-track slant)

---

**Visible and Near-infrared Radiometer (SGLI-VNR)**

- **Solar calibration window**
- **Deep space window**
- **Earth view window**: FOV: 80-deg
- **Solar diffuser**
- **Non-polarization tree telescopes**
  - Each has the same 11 channels
- **Polarization two (670 nm and 865 nm) telescopes**
  - Each has tree polarization-angle filters

---

**InfraRed Scanner (SGLI-IRS)**

- **Optical bench**
- **Mechanical cooler**
- **Dichroic filter**
- **TIR detectors**
- **SWIR detector**
- **SWIR detector**
- **Scan mirror**
- **Ritchey-Chretien Optics**
- **TIR detector**
- **Secondary mirror**
- **Dichroic filter**

---

**Additional Notes**

- **Total FOV**: 70 deg = 24 deg × 3 telescopes (-1150 km @ nadir)
- **FOV**: 55 deg (-1150 km @ ±45 deg along-track slant)
2. GCOM-C products and SGLI design
- 2.1 mission target and product groups

GCOM-C observation targets

**Radiation budget**
- Atmosphere
  - Cloud and aerosol changes and Radiative forcing
- Cryosphere
  - Ice-albedo feedback in global warming

**Carbon cycle**
- Land
  - Carbon cycle and vegetation production
- Ocean
  - Carbon and heat pool and coastal environment

**Major observation targets of GCOM**
- Water vapor
- Precipitation
- Sea ice concentration
- Snow depth
- Snow surface Temp.
- Soil moisture
- Land cover
- Above-ground biomass
- Vegetation production
- Ocean color
- Sea surface Temp.
- Sea surface wind

GCOM-W
Water cycle change observation satellite
### Standard products (land)

<table>
<thead>
<tr>
<th>products</th>
<th>GSD</th>
<th>accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>radiance</td>
<td>250/1000m</td>
<td>5%, 0.5K</td>
</tr>
<tr>
<td>geom. corr. rad.</td>
<td>250m</td>
<td>0.5pixel</td>
</tr>
<tr>
<td>land surface refl.</td>
<td>250m</td>
<td>5%/10%*1</td>
</tr>
<tr>
<td>veg. index</td>
<td>250m</td>
<td>20%/15%*2</td>
</tr>
<tr>
<td>veg. roughness. index</td>
<td>1km</td>
<td>20%/15%*2</td>
</tr>
<tr>
<td>shadow index</td>
<td>1km</td>
<td>20%/15%*2</td>
</tr>
<tr>
<td>land surf. temp</td>
<td>500m</td>
<td>2.5K</td>
</tr>
<tr>
<td>fAPAR</td>
<td>250m</td>
<td>30%/20%*2</td>
</tr>
<tr>
<td>LAI</td>
<td>250m</td>
<td>30%</td>
</tr>
<tr>
<td>above ground biomass</td>
<td>1km</td>
<td>30%</td>
</tr>
</tbody>
</table>

*1 : >443nm / ≤443nm  
*2 : grass land / forest
<table>
<thead>
<tr>
<th>products</th>
<th>GSD</th>
<th>accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>net primary prod.</td>
<td>1km</td>
<td>TBD</td>
</tr>
<tr>
<td>veg. water stress index</td>
<td>500m</td>
<td>TBD</td>
</tr>
<tr>
<td>fire</td>
<td>500m</td>
<td>TBD</td>
</tr>
<tr>
<td>land cover class.</td>
<td>250m</td>
<td>TBD</td>
</tr>
<tr>
<td>land surface albedo</td>
<td>1km</td>
<td>TBD</td>
</tr>
<tr>
<td>products</td>
<td>GSD</td>
<td>accuracy</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>--------------</td>
<td>----------</td>
</tr>
<tr>
<td>cloud flag/type</td>
<td>1km</td>
<td></td>
</tr>
<tr>
<td>cloud type &amp; amount</td>
<td>1km/0.1°</td>
<td>15%</td>
</tr>
<tr>
<td>cloud top temp/altitude</td>
<td>1km/0.1°</td>
<td>3k/2km</td>
</tr>
<tr>
<td>opt. thick. of water cloud</td>
<td>1km/0.1°</td>
<td>100%</td>
</tr>
<tr>
<td>opt. thick. of cirrus</td>
<td>1km/0.1°</td>
<td>70%</td>
</tr>
<tr>
<td>aerosol over ocean</td>
<td>1km/0.1°</td>
<td>0.1</td>
</tr>
<tr>
<td>aerosol over land UV</td>
<td>1km/0.1°</td>
<td>0.15</td>
</tr>
<tr>
<td>aerosol over land pol.</td>
<td>1km/0.1°</td>
<td>0.15</td>
</tr>
</tbody>
</table>

Standard products (atmosphere)
<table>
<thead>
<tr>
<th>products</th>
<th>GSD</th>
<th>accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>geom. thickness of water clouds</td>
<td>1km/0.1°</td>
<td>N/A</td>
</tr>
<tr>
<td>land surface long wave radiant flux</td>
<td>1km/0.1°</td>
<td>N/A</td>
</tr>
<tr>
<td>land surface short wave radiant flux</td>
<td>1km/0.1°</td>
<td>N/A</td>
</tr>
</tbody>
</table>
## Standard products (ocean)

<table>
<thead>
<tr>
<th>products</th>
<th>GSD</th>
<th>accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>normalized water leav. rad.</td>
<td>250m/1km/4-9km *1</td>
<td>50%</td>
</tr>
<tr>
<td>atm. corr. parameter</td>
<td>250m/1km/4-9km</td>
<td>50%</td>
</tr>
<tr>
<td>PAR</td>
<td>250m/1km/4-9km</td>
<td>15%</td>
</tr>
<tr>
<td>chlorophyll-a</td>
<td>250m/1km/4-9km</td>
<td>-60-+150%</td>
</tr>
<tr>
<td>SS</td>
<td>250m/1km/4-9km</td>
<td>-60-+150%</td>
</tr>
<tr>
<td>CDOM</td>
<td>250m/1km/4-9km</td>
<td>-60-+150%</td>
</tr>
<tr>
<td>SST</td>
<td>500m/1km/4-9km</td>
<td>0.8K</td>
</tr>
</tbody>
</table>

*1 : 250m: coastal, 1km : open ocean, 4-9km : global
<table>
<thead>
<tr>
<th>products</th>
<th>GSD</th>
<th>accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>euphotic zone depth</td>
<td>250m/1km/4-9km</td>
<td>N/A</td>
</tr>
<tr>
<td>intrinsic opt. char. of seawater</td>
<td>250m/1km/4-9km</td>
<td>N/A</td>
</tr>
<tr>
<td>primary production</td>
<td>500m/1km/4-9km</td>
<td>N/A</td>
</tr>
<tr>
<td>phytoplankton type</td>
<td>250m/1km/4-9km</td>
<td>N/A</td>
</tr>
<tr>
<td>red tide</td>
<td>250m/1km/4-9km</td>
<td>N/A</td>
</tr>
<tr>
<td>sensor fusion ocean color</td>
<td>250m/1km</td>
<td>N/A</td>
</tr>
<tr>
<td>sensor fusion SST</td>
<td>500m/1km</td>
<td>N/A</td>
</tr>
<tr>
<td>products</td>
<td>GSD</td>
<td>accuracy</td>
</tr>
<tr>
<td>-----------------------------------------</td>
<td>----------------</td>
<td>----------</td>
</tr>
<tr>
<td>snow &amp; ice cover</td>
<td>250m/1km</td>
<td>7%</td>
</tr>
<tr>
<td>sea ice dist. in Okhotsk sea</td>
<td>250m</td>
<td>5%</td>
</tr>
<tr>
<td>snow/ice surface temp.</td>
<td>500m/1km</td>
<td>2K</td>
</tr>
<tr>
<td>snow particle size</td>
<td>250m/1km</td>
<td>50%</td>
</tr>
<tr>
<td>products</td>
<td>GSD</td>
<td>accuracy</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>---------</td>
<td>----------</td>
</tr>
<tr>
<td>snow/sea ice class.</td>
<td>1km</td>
<td>N/A</td>
</tr>
<tr>
<td>snow cover over mountains</td>
<td>250m</td>
<td>N/A</td>
</tr>
<tr>
<td>snow particle size of semi surface</td>
<td>1km</td>
<td>N/A</td>
</tr>
<tr>
<td>surface snow particle size</td>
<td>250m/1km</td>
<td>N/A</td>
</tr>
<tr>
<td>snow/ice surface albedo</td>
<td>1km</td>
<td>N/A</td>
</tr>
<tr>
<td>snow impurity</td>
<td>250m/1km</td>
<td>N/A</td>
</tr>
<tr>
<td>ice sheet roughness</td>
<td>1km</td>
<td>N/A</td>
</tr>
<tr>
<td>ice sheet edge monitor</td>
<td>250m</td>
<td>N/A</td>
</tr>
</tbody>
</table>
San Francisco

250m ocean

RGB:22/21/20, 2003.5.26
3. Examples of expected GCOM-C product
- 3.4 VNR 250m land and coastal observation

250m Ocean color chlorophyll-a and NDVI simulated using GLI 250m channels

(a) GLI 1km Osaka Bay
(1 Oct. 2003, CHL by LCI)

(b) GLI 250m Osaka Bay
(1 Oct. 2003, CHL by LCI)

SGLI 250m resolution will enable to detect more fine structure in the coastal area such as river outflow, regional blooms, and small current.
3. Examples of expected GCOM-C product
- 3.3 VNR 250m land cover classification

- SGLI’s 250m channels (11CHs from 380nm to 1640nm) and once/2-day observation and can improve the land cover classification.

Classification to 25 class (IGBP: International Geosphere-Biosphere Program) using GLI 39 scenes (2003/04~2003/10)
(provided by Dr. Nguyen Dinh Duong, VAST(Vietnamese Academy of Science and Technology)
3. Examples of expected GCOM-C product
- 3.5 Thermal infrared 500m land and coastal observation

- The 500m and 1000m spatial resolution thermal infrared images are simulated using ASTER data (original resolution is 90m) (Tokyo Bay in the night on August 4, 2003).

- SGLI 500m-resolution thermal infrared channels will enable detection of fine structures such as land and coastal surface temperature influenced by the city and the river flows.
Examples of expected GCOM-C product

- 6. Land aerosol by Near-UV and polarization

**Near-UV aerosol**

Global aerosol optical thickness in June 2003 using the GLI Near-UV (380nm) channel (NIR is used for the ocean area)

**Polarization aerosol**

Global aerosol optical thickness in June 2003 using POLDER-2 polarization reflectance

- Not only over the ocean, SGLI will estimate **land-area aerosols using near-UV (380nm) and polarization channels** which are more sensitive to atmosphere scattering rather than land surface reflection.

- Combination of aerosol absorption by Near-UV and fine-mode aerosol properties by polarization.
Examples of expected GCOM-C product
- 9. Marine resource monitoring and management

Chlorophyll-a concentration in the northwestern Pacific in June 2003 overlaid on fisheries of skipjack and tuna. The fisheries of skipjack and tuna, warm-water migratory fish, appear to be influenced by the Kuroshio warm current and its extensions offshore Sanriku.

GCOM-C/SGLI observes sea surface temperature, chlorophyll-a concentration and solar radiation (PAR) (indicate ocean current structure and marine ecosystem activity)

Monitoring

- Marine resources distribution
- Ocean primary production sustaining marine resources
- Marine environment change relevant to climate

Ocean ecosystem model

Fishery inquiry (left figure)

Prediction of future marine resources

Marine-resource management for continuous use (contribution to the policy design)

Cooperation with an operational organization and a numerical model research institution

25
Recent status of GCOM-W1

- Project status
  - GCOM-W1 was approved to move to development phase (by SAC on August 8, 2007).
  - PDR was finished in June, 2008.
  - AMSR2 CDR1 was finished on July, 2008.
  - AMSR2 deltaCDR was held on November.
  - System CDR was finished on Oct, 2009.
  - AMSR2 PQR was finished on Sep. 2010.
  - GCOM-W1 PQR was finished on June, 2011.
  - Current target launch date is Feb. 2012.
Recent status of GCOM-C1

- GCOM-C1 is under phase B.
- GCOM-C1 was approved to go to a project within JAXA on July, 2008.
- SGLI PDR was finished on Dec. 2009.
- GCOM-C1 PDR was finished on Oct. 2010.
Research Announcements

• First RA for GCOM-W1 was issued on Jan. 2008.
• 35 PIs were selected.
• First GCOM Symposium/Workshop was held on 13-15, Jan. 2009 in Yokohama.
• First GCOM-C1 RA was issued on January, 2009. 28 PIs were selected.
• PI workshop including GPM & EarthCare PIs was held on Dec., 2010.
• Second RA for GCOM W1 is under review.
International Cooperation

• Discussions on the cooperation with NPOESS is underway with NOAA

• JAXA is proposing a joint science activity with NASA

• Provision of a scatterometer on GCOM-W2 is under discussion with JPL and NOAA
New Scatterometer on GCOM-W2

- Dual Frequency Scatterometer (DFS)
- Ku band and C band
- around 2m aperture
- All weather monitoring
- All wind speed monitoring
AMSR3 on GCOM-W2

- Addition of scatterometer
- Addition of high frequency channels (150-190GHz) for solid precipitation and water vapor sounding
- Also, join the A-train at least 1 year
GCOM-W2 Overview

**Mission instruments**
- Advanced Microwave Scanning Radiometer 3 (AMSR3)
- Dual Frequency Scatterometer (DFS)

**Observation orbit**
Sun Synchronous Orbit (A-train orbit)
Altitude 699.6km, Inclination 98.186deg

**Local sun time**
13:30 (ascending)

**Dimensions**
5.6m(X), 17.6m(Y), 5.2m(Z)

**Spacecraft mass**
2515kg (BOL)

**Generation power**
4050W (EOL, two wings)

**Launch year and launcher**
January 2016 / H-IIA

**Design lifetime**
Five years
GCOM-W2 Configuration

AMSР3 sensor unit

DFS RF shield
DFS reflector

DFS horn

DFS electronics subassembly

Fairing envelope

DFS RWs

MWA-B

GCOM-W2 in H-IIA 4S fairing
Conclusions

- AMSR2 will have the highest calibration capability within microwave imager.
- AMSR-E products will be reprocessed after the cross calibration with AMSR2.
- Long term high accuracy microwave imager products will be obtained.
Basic Law on Space

- Basic Law on Space has passed the Parliament last June
- Strategic Headquarters has been established (Minister level)
- All the space activities will go under the Cabinet Office
- Restructuring of JAXA
- Increased budget?
Influence of Great East Japan Earthquake

- GCOM-W1 PFM received no damage.
- Testing facilities have some damage.
- Testing facilities are now reopened.
- Launcher also received some damage.
- The new launch date is later than 14, Feb. 2012.