GCOM-W1 now on the A-Train

GCOM-W1
Global Change Observation Mission-Water

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Mini-Workshop on A-Train Science, March 8th, 2013
The University of Tokyo, Tokyo, Japan
GCOM Science Target

- Monitor “Global Change” by continuous (>10yr) and consistent observations.
- Estimate model parameters with satellite observations and products.

GCOM observation

Satellite/sensor and algorithm development

Model prediction

Prediction results

Operational use for fishery, sea route, weather forecast, and climate monitoring

Understanding of the climate system and the climate change (global warming)

Policy design through prediction improvement

- **Radiation budget**
  - Surface albedo
  - Snow ice
  - Cloud/aerosol
  - SST/LST

- **Carbon cycle**
  - Vegetation cover
  - Primary production
  - Coastal environment

- **Water cycle**
  - Water vapor, cloud, precipitation
  - Soil moisture
  - Sea ice, snow
  - SST, wind

- **Improvement of parameterization**
  - about radiation budget and carbon cycle, etc. in climate prediction model.
  - Verification and improvement of prediction of the earth environment change including the water cycle by comparison with the satellite observation.

- **Input**
  - Air temperature prediction

- **Comparison**
  - Products or radiances with radiative transfer

- **Improve accuracy**

- **Future prediction**
  - Surface temperature
  - Sea level
  - Snow and sea ice area
  - Environmental change
  - Rain/drought distribution
  - Extreme weather frequency
  - Land cover

- **Frequent and long-term (>10yer) global observation system required for earth environment change monitoring and prediction**

- GCOM-W, GCOM-C

- **GCOM observation**

- **Data application**

- **Knowledge**

- **Cooperation with the climate model research institutions**
GCOM-W1 Status

16:39 UT, May 17th, 2012: GCOM-W1 was launched at Tanegashima-island. (1)

17:02 UT: Separated from H-IIA Rocket. (2)

17:05 UT: Deployed solar paddles. (3)

(1) Launch

(2) Separation from H-IIA

(3) Solar paddles deployment
GCOM-W1 Status

- 3:43 UT, May 18th, 2012: The antenna of AMSR2 was deployed. (4)
- 13:34 UT: AMSR2 started rotation in 4 rpm. (5)
- 17:00 UT: The Critical Operation Phase was finished.

(4) AMSR2 antenna deployment
(5) AMSR2 rotation in 4 rpm
図は、平成24年7月3日午前9時頃から同月4日午前9時頃（日本時間）にかけての約1日間に、「しずく」搭載のAMSR2が地球の全体を観測した擬似カラー合成画像で、89.0GHz垂直・水平偏波、23.8GHz垂直偏波の輝度温度を使用しています。

Figure is one-day color composite image of global Earth by the AMSR2 on-board the SHIZUKU on July 3, 2012 (UTC). Brightness temperatures of 89.0-GHz (both vertical and horizontal polarization) and 23.8-GHz (vertical polarization) channels were used.
# GCOM-W1 Data Products

## Standard Products

<table>
<thead>
<tr>
<th>Products</th>
<th>Areas</th>
<th>Res.</th>
<th>Accuracy</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Release</td>
<td>Standard</td>
</tr>
<tr>
<td>Brightness Temperature</td>
<td>Global</td>
<td>5-50km</td>
<td>±1.5K</td>
<td>±1.5K</td>
</tr>
<tr>
<td>Integrated water vapor</td>
<td>Global, over ocean</td>
<td>15km</td>
<td>±3.5kg/m²</td>
<td>±3.5kg/m²</td>
</tr>
<tr>
<td>Integrated cloud liquid water</td>
<td>Global, over ocean</td>
<td>15km</td>
<td>±0.10kg/ m²</td>
<td>±0.05kg/ m²</td>
</tr>
<tr>
<td>Precipitation</td>
<td>Global, except cold latitude</td>
<td>15km</td>
<td>Ocean ±50%</td>
<td>Ocean ±50%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Land ±120%</td>
<td>Land ±120%</td>
</tr>
<tr>
<td>Sea surface temperature</td>
<td>Global, over ocean</td>
<td>50km</td>
<td>±0.8°C</td>
<td>±0.5°C</td>
</tr>
<tr>
<td>Sea surface wind speed</td>
<td>Global, over ocean</td>
<td>15km</td>
<td>±1.5m s⁻¹</td>
<td>±1.0m s⁻¹</td>
</tr>
<tr>
<td>Sea ice concentration</td>
<td>Polar region, over ocean</td>
<td>15km</td>
<td>±10%</td>
<td>±10%</td>
</tr>
<tr>
<td>Snow depth</td>
<td>Land</td>
<td>30km</td>
<td>±20cm</td>
<td>±20cm</td>
</tr>
<tr>
<td>Soil moisture</td>
<td>Land</td>
<td>50km</td>
<td>±10%</td>
<td>±10%</td>
</tr>
</tbody>
</table>

## Research Products:
all-weather sea surface wind speed, sea ice moving vector, sea ice thickness, land hydrological assimilated products, etc.
Sea Surface Temperature

Sea Surface Wind Speed

Total Precipitable Water

Cloud Liquid Water

Monthly average (July 15 – August 14, 2012)
GCOM-W1 and A-Train

- **Continuity from AMSR-E on Aqua**
  - Stable observation from the same orbit and local observing time.
  - Direct cross-calibration with AMSR-E.

- **Atmosphere**
  - Snow fall detection by combining CloudSat and AMSR2.
  - Validation of cloud liquid water by MODIS, AMSR2, and CloudSat.
  - Aerosol-Cloud-Rain science by MODIS, CloudSat, AMSR2, and Aura.

- **Land**
  - Improvement of soil moisture retrieval by the help of MODIS NDVI.
  - Snow cover mapping by MODIS and AMSR2.
  - Land-atmosphere CO2 exchange by MODIS, AMSR2, and OCO-2.

- **Ocean**
  - Validation of AMSR2 sea ice concentration by using MODIS, thin ice detection by combining MODIS and AMSR2, and advanced sea ice research by adding the information of surface roughness from CALIPSO/CloudSat.
Status of Aqua/AMSR-E

✨ Instrument characteristics

❖ Multifrequency, dual polarization microwave radiometer system developed by JAXA.
❖ Sister instrument of AMSR on ADEOS-II.
❖ Large main reflector with diameter of 1.6m, which realizes higher spatial resolution.
❖ Channels at 6.9GHz for retrieving SST and soil moisture content.
❖ Afternoon (1:30pm) equatorial crossing time, where only AMSR-E is observing.

✨ Mission status

❖ After 9.5-years of observation onboard Aqua satellite, observation halted in October 2011 due to the increase of motor rotation torque.
❖ Discussions and efforts are being made for potential slow rotation for cross calibration.
Direct comparison with AMSR-E

- Orbits and frequency channel sets are almost identical: no corrections are needed for center frequency, incidence angle, and observing local time. It enables cross calibration in wide range of Tbs over land, ice, and ocean.
- AMSR-E observations resumed from December 4, 2012 with 2rpm rotation speed. Geolocation and Tbs are computed by modified software.
- Observation is sparse, but reasonable for global-scale comparison.
- Calibration improvement of 2rpm mode data is underway.
vs. AMSR-E 2rpm mode

Tb diff AMSR(2-E)

Obs. Tb[K]

Descending

06V

+10K

-10K

06H

10V

10H

18V

18H
vs. AMSR-E 2rpm mode

Tb diff AMSR(2-E)

23V

Descending

23H

+10K

-10K

Obs. Tb[K]

36V

36H

89BV

89BH
GCOM-W1 and A-Train

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Lookup Table based on MHS-CloudSat Matchups – 4.5 years data, North America

- EOF analysis to MHS data:
  - First 3 PCs – 88.6%, 8.2% and 2.1% of variances
  - PC3 had the best correlation Coeff to CloudSat reflectivity
- Lookup Table:
  - Project observed TBs to the first 3 PCs
  - In the 3-d EOF space, using MHS-CloudSat matchups, compute the probability of snowfall (CloudSat near-surface dBZₐ>-15)
  - Lookup tables for different MHS viewing angles
- Retrieve snowfall probability using the above lookup table; Use a Z-S relation, we can retrieve snowfall rate as well

40-65° N, 50-170° W
Land, T2m<0°C
Viewing angle ±10°
Use CloudSat to train passive microwave observations (done MHS, working on AMSR-E/AMSR2) for snowfall detection. This example shows that the trained passive microwave algorithm correctly identified snowfall area, and is potentially able to estimate snowfall intensity as well.
GCOM-W1 and A-Train

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Global Phenology Monitoring using Vegetation Optical Depth (VOD) from AMSR-E

- Microwave provides enhanced temporal fidelity, especially over cloud dominated regions.
- VOD provides synergistic canopy biomass & water content information relative to optical-IR greenness data.

MODIS LAI & AMSR-E VOD Correlation 2003-2008

- Strong VOD agreement with LAI, EVI & NDVI.

VOD & NDVI Phenology Metrics 2004-2007

- Temperature constrained ecoregions show earlier VOD start of season (SOS)
- Water constrained areas show VOD SOS delay relative to NDVI
- VOD lag increases with woody biomass cover

AMSR-E VOD, MODIS NDVI & Tower C-flux Seasonality

- VOD tracks canopy biomass change & seasonal shifts in land-atmosphere carbon fluxes.

Provided by Dr. John S. Kimball of the University of Montana
GCOM-W1 and A-Train

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Comparing AMSR2 sea ice concentration with MODIS visible/IR images

AMSР2海氷密接度とMODIS Band1の比較（2012年7月28日）

✓ AMSR2海氷分布はMODIS海氷分布と良く一致。
✓ 両センサはA-Train参加衛星に搭載されており、同時観測が可能。
GCOM-W1 and A-Train

Ocean (cont’d)

- Detailed analysis of SST stratification by using MODIS skin SST, AMSR2 subskin SST, and Argo/buoy/ship bulk SST, in comparison with AMSR2 wind, and MTSAT solar radiation with a 1-D simple ocean model.
- Air-sea exchange of CO2 by using MODIS Chl-a, AMSR2 SST and winds, and OCO-2 CO2.
- Studies on wind-wave field and surface roughness by combining AMSR2 wind with data from CALIPSO/CloudSat.
An example of statistical model for sea surface pCO2 derived from remotely-sensed SST, SSHA, Chl-a, and SSS

Liu et al. (20**)
Summary

GCOM-W1 and AMSR2 are in good shape.

GCOM-W1 “SHIZUKU”
- Launched on May 18, 2012 (JST).
- Joined A-Train constellation.
- Completed the initial checkout phase on August 10, 2012.

AMSR2
- Started continuous observation from July 3, 2012 (JST).
- Calibration and validation activities are ongoing.
- Preliminary products were already made available to PIs and collaborating agencies.
- Product release to public will be 8-months and 12-months after launch for brightness temperatures and geophysical parameters.
- Seeking various opportunities on the A-Train

Will participate in GPM constellation.
Thank You!