Current Status of the AMSR2 and the GCOM-W1 “SHIZUKU”

Misako Kachi and Keiji Imaoka

Earth Observation Research Center, Japan Aerospace Exploration Agency (JAXA),
Tsukuba, Japan
e-mail: kachi.misako @ jaxa.jp

ABSTRACT

The Global Change Observation Mission 1st - Water "SHIZUKU" (or GCOM-W1) was launched at 1:39 a.m. in 18 May 2012 (Japan Standard Time, JST) from the JAXA’s Tanegashima Space Center, Kagoshima, Japan. "SHIZUKU" completed its critical operations in 19 May as it was successfully inserted into the initial orbit, deployed the antenna of the Advanced Microwave Scanning Radiometer-2 (AMSR2,) and finished the AMSR2 initial run-up (4 rpm) and other essential events normally. AMSR2 has started scientific observation at 40 rpm since 3 July 2012, after insert the satellite into the “A-Train orbit” in 29 June 2012. Initial checkout of the satellite and the instrument has completed on August 10 without major problem.

AMSR2 is a successor of JAXA’s Advanced Microwave Scanning Radiometer for EOS (AMSR-E) on the NASA's Aqua satellite, which was launched in May 2002 and halted its observation in 4 October, 2011. Preliminary results of L2 geophysical parameters seem good condition, but validation activities have been conducted from now. During the initial calibration and validation period, JAXA will conduct the activities with PIs and collaborating agencies. AMSR2 standard products will be distributed to public for research and educational purposes though web site (https://gcom-w1.jaxa.jp/) after calibration/validation phase. Level 1 products (brightness temperature) have been released to public since 24 January 2013, and distribution of Level 2 products (geophysical parameters) are scheduled in May 2013.

1. INTRODUCTION

The Global Change Observation Mission (GCOM) is planned by the Japan Aerospace Exploration Agency (JAXA) for long-term continuous observation of the Earth’s environment. GCOM is a successor mission of the Advanced Earth Observing Satellite-II (ADEOS-II), launched on December 2002 but stopped its operation due to the satellite malfunction in 2003. JAXA developed two core sensors for ADEOS-II, the Advanced
Microwave Scanning Radiometer (AMSR) and the Global Imager (GLI). AMSR for the EOS (called AMSR-E) was also provided to NASA’s Aqua satellite launched on May 2002, but halted its scientific observation in 4 October 2011.

“GCOM” is not a name of single satellite mission, but consists of two medium-sized satellites, the GCOM-W (water) and the GCOM-C (climate), and three generations with one year overlap to ensure 10-15 years stable data records (Imaoka et al., 2010). The GCOM-W1 carries the Advanced Microwave Scanning Radiometer-2 (AMSR2), follow-on sensor of AMSR-E, and contributes to the observations related to global water and energy circulation, while the GCOM-C1 will carry the Second-Generation Global Imager (SGLI), which is follow-on sensor of the Global Imager (GLI) and scheduled to be launched in Japanese Fiscal Year of 2015. The GCOM-C1 will contribute to the surface and atmospheric measurements related to the carbon cycle and radiation budget.

2. OVERVIEW OF THE GCOM-1 SATELLITE

2.1. OVERVIEW OF THE GCOM-W1 SATELLITE

The GCOM-W1 (or Japanese nickname “SHIZUKU”, meaning “droplet”) satellite was launched from JAXA Tanegashima Space Center in 18 May 2012 (JST). The early orbit checkout of GCOM-W1 satellite and AMSR2 instrument was performed for about three months after the launch. Since it took about 45 days to insert the satellite into “A-Train” orbit, the checkout tasks were carried forward between intervals of orbit control events (Kasahara et al., 2012). The GCOM-W1 satellite has joined A-train orbit since 29 June. After GCOM-W1 was inserted into the planned position on the A-Train orbit, AMSR2 was spun up to 40 rpm, and then set to “science mode” to start observation in 3 July.

Initial checkout of the satellite and the instrument has completed in 10 August without major problem. The GCOM-W1 satellite was installed in front of the Aqua satellite to keep continuity of AMSR-E observations and provide synergy with the other A-Train instruments for new Earth science researches. Also, since AMSR2 will be a single instrument onboard, participating in the A-Train will enhance the synchronous measurement capability with other satellite instruments available in the constellation, such as MODIS/AIRS/AMSU on Aqua, CloudSat, and CALIPSO. Unfortunately, AMSR-E stopped its scientific observation at 40-rpm in 4 October 2011. AMSR-E has restarted observation at 2-rpm since December 2012 to implement cross-calibration with AMSR2.

2.2. THE ADVANCED MICROWAVE SCANNING RADIOMETER-2 (AMSR2)

Targets of the GCOM-W1 satellite are water-energy cycle, and will carry the AMSR2.
AMSR2 will continue AMSR-E observations of water vapor, cloud liquid water, precipitation, SST, sea surface wind speed, sea ice concentration, snow depth, and soil moisture (Table 1). Basic concept of AMSR2 is almost identical to that of AMSR-E: conical scanning system with large-size offset parabolic antenna, feed horn cluster to realize multi-frequency observation, external calibration with two temperature standards, and total-power radiometer systems. Figure 1 shows Level 1 products (brightness temperature) of each observation channel which are basis for geophysical parameters.

<table>
<thead>
<tr>
<th>Products</th>
<th>Areas</th>
<th>Resolution</th>
<th>Accuracy</th>
<th>Goal</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brightness temperature</td>
<td>Global</td>
<td>5-50km</td>
<td>±1.5K</td>
<td>±1.5K</td>
<td>±1.0K (systematic) ±0.3K (random)</td>
</tr>
<tr>
<td>Int. water vapor</td>
<td>Global, over ocean</td>
<td>15km</td>
<td>±3.5kg/m²</td>
<td>±3.5kg/m²</td>
<td>±2.0kg/m²</td>
</tr>
<tr>
<td>Int. cloud liquid water</td>
<td>Global, over ocean</td>
<td>15km</td>
<td>±0.10kg/m²</td>
<td>±0.05kg/m²</td>
<td>±0.02kg/m²</td>
</tr>
<tr>
<td>Precipitation</td>
<td>Global, except cold latitude</td>
<td>15km</td>
<td>Ocean ±50%</td>
<td>Ocean ±50%</td>
<td>Ocean ±20%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Land ±120%</td>
<td>Land ±120%</td>
<td>Land ±80%</td>
</tr>
<tr>
<td>Sea surface temperature</td>
<td>Global, over ocean</td>
<td>50km</td>
<td>±0.5°C</td>
<td>±0.5°C</td>
<td>±0.2°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-2 - 35°C</td>
</tr>
<tr>
<td>Sea surface wind speed</td>
<td>Global, over ocean</td>
<td>15km</td>
<td>±1.5m/s</td>
<td>±1.0m/s</td>
<td>±1.0m/s</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0 - 30m/s</td>
</tr>
<tr>
<td>Sea ice concentration</td>
<td>Polar region, over ocean</td>
<td>15km</td>
<td>±10%</td>
<td>±10%</td>
<td>±5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0 - 100%</td>
</tr>
<tr>
<td>Snow depth</td>
<td>Land</td>
<td>30km</td>
<td>±20cm</td>
<td>±20cm</td>
<td>±10cm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0 - 100cm</td>
</tr>
<tr>
<td>Soil moisture</td>
<td>Land</td>
<td>50km</td>
<td>±10%</td>
<td>±10%</td>
<td>±5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0 - 40%</td>
</tr>
</tbody>
</table>

Table 1. List of AMSR2 standard products and its target accuracies.

Figure 1. AMSR2 brightness temperature of all channels from 6.9 to 89 GHz for one orbit.
2.3. IMPROVEMENTS FROM AMSR-E

Following improvements of AMSR2 instrument were conducted based on experience in the AMSR-E mission; a) Deployable main reflector system with 2.0m diameter; b) Frequency channel set is identical to that of AMSR-E except additional 7.3GHz channel for radio frequency interference (RFI) mitigation; and c) Two-point external calibration with the improved a Hot-temperature noise Source (HTS). In addition, deep-space maneuver will be considered to check the consistency between main reflector and Cold Sky Mirror (CSM).

RFI signals at 7.3 GHz channels are more evident and outspread than those at 6.9 GHz channels (Figure 2). Over land, they are evident over Southeast Asia, Eastern Europe, Russia, and so forth. Also, frequency of occurrences of RFI are higher over ocean too. There are still many regions with small difference of brightness temperature between 6.9 and 7.3 GHz channels. Simple RFI identification will be tested by using this difference.

In addition to above improvements, observation width of AMSR2 is increased compared to AMSR-E. AMSR2 Level 1 (brightness temperature) products retain all scan points from Level 1A (observation counts) product, resulting in the increase of swath width. Nominal swath width (instrument assured) is still 1457.8 km same as that of AMSR-E, but effective swath width is wider than 1600 km after scan-bias correction.
3. EARLY RESULTS FROM AMSR2

3.1. LEVEL 1 PRODUCTS

Various inter-comparisons of AMSR2 are in progress during Calibration/Validation phase. AMSR2 brightness temperatures are compared with TRMM Microwave Imager (TMI) in simultaneous observation and AMSR-E in past period. Recently, simultaneous comparison with AMSR-E in 2-rpm observation is underway. Figure 3 is comparison of oceanic AMSR2 and AMSR-E brightness temperature by computing simulated TB by using RTTOV-10 with inputs from JMA’s global analysis and MGDSST (JMA’s merged, daily, global SST). Compute observation minus simulation (O-C) for both AMSR2 and AMSR-E TBs, and further create double difference (this roughly cancels out differences in year and season, but not perfect. In both Ascending and Descending orbits, AMSR2 TB tends to show higher value than that of AMSR-E.

![Figure 3. Oceanic TB of AMSR-E (Aug. 2011 for AMSR-E and 2012 for AMSR2)](image)

3.2. LEVEL 2 PRODUCTS

Figure 4 is AMSR2 rainfall observation of Typhoon No.11 in 2012 using the AMSR2 Precipitation Algorithm (Aonashi et al., 2009). AMSR2 will be introduced to the processing system of the JAXA Global Rainfall Watch, which is a near-real-time version of the Global Satellite Mapping of Precipitation (GSMaP) product (Kubota et al., 2007), after validation. AMSR2 rainfall algorithm will be base algorithm of GSMaP for the Global Precipitation Measurement (GPM) mission, which led by Japan and U.S., in coordination with international partners. The GCOM-W1 will play an important role within the GPM mission.

4. FUTURE PLAN

AMSR2 standard products are distributed through the GCOM-W1 Data Providing Service (https://gcom-w1.jaxa.jp/). Level 1 data distribution to general users has started
since 25 January 2013, and distribution of Level 2 and 3 products is scheduled in May 2013.

Still, there are many ongoing works during calibration/validation phase. Regarding RFI identification, simple identification will be tested for C-band by using difference of brightness temperature between 6.9 and 7.3GHz channels. And we plan to conduct systematic survey of RFI in 6.9/7.3, 10.65, and 18.7 GHz channels.

![Image](image_url)

Figure 4. AMSR2 rainfall of Typhoon No.11 "HAIKUI" at around 2:30 A.M. on August 7, 2012 (JST). Rainfall product is under validation.

5. REFERENCES


