AMSR INSTRUMENTS ON GCOM-W1/2: CONCEPTS AND APPLICATIONS

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1. INTRODUCTION

The Advanced Microwave Scanning Radiometer-2 (AMSR2) will be launched as a single mission instrument onboard on the first satellite of the Water Series of Global Change Observation Mission (GCOM-W1).

2 AMSR2

AMSR2 is multi-frequency, total-power microwave radiometer system with dual polarization channels for all frequency bands. The instrument is a successor of AMSR on the Advanced Earth Observing Satellite-II (ADEOS-II) and AMSR for the Earth Observing System (AMSR-E) on NASA's Aqua satellite. The frequency bands include 6.925, 7.3, 10.65, 18.7, 23.8, 36.5, and 89.0 GHz. The 6.925-GHz band is not primarily allocated for Earth observation, but is defined as the primary band for ground-to-ground and ground-to-satellite radio communications. Due to this, we frequently find radio-frequency interference (RFI) signals in 6.925-GHz brightness temperatures observed by AMSR-E, particularly over land. The 7.3-GHz channels were added to help mitigate RFI influences based on limited observational evidence such as aircraft measurements. Since the 6.925-GHz channels have been successful and promising for retrieving sea surface temperature (SST) over the ocean, we will keep those channels unchanged. RFI identification methods will be investigated by comparing brightness temperatures from those two frequency bands. The instrument employs a conical scanning mechanism at a rotation speed of 40 rpm to observe the Earth's surface with a constant incidence angle of 55 degrees. Multiple feed horns are clustered to realize multi-frequency simultaneous observation. To compensate for gain variation, a two-point calibration is performed on every scan by using the high temperature noise source (HTS, temperature-controlled warm calibration target) and the cold-sky mirror (CSM) to introduce the deep space temperature. The 2.0m diameter antenna, which is larger than that of AMSR-E, provides better spatial resolution at the same orbital altitude of about 700km. Although we have had experience with the 2.0m-diameter dish itself for AMSR on ADEOS-II, a deployable antenna system with such a large aperture has been a new engineering development.

Standard products of GCOM-W1 based on AMSR2 data are currently defined. All the eight standard products are: integrated water vapor, integrated cloud liquid water, sea surface temperature, sea surface wind speed, and sea ice concentration over ocean, snow depth and soil moisture content over land, and precipitation over the globe except for high latitude. The validities of these geophysical parameters have been proven by AMSR-E experience. However, there is a room for improvement in each geophysical parameter, particularly for land products. For example, the vegetation effect, which is one of the problems in the soil moisture retrieval using 6.925-GHz channels, should be more intensively assessed, and its error should be quantitatively identified. Cross validation and synergy with 1.4-GHz radiometer measurements, such as by the Soil Moisture and Ocean Salinity (SMOS) mission and the Soil Moisture Active and Passive (SMAP) mission, will be useful. Several research products are under discussion, including integrated water vapor over land and sea ice, solid precipitation in cold latitudes, and sea ice thickness.

3. Integrated Product from GCOM-W1

Data assimilation is being recognized as a powerful tool for interpolating intermittent satellite data. Assimilated results can be defined as research products. Data assimilation system under GCOM mission has not yet defined, however, JAXA/EORC established a research group on water cycle (W-RG) as one of the cross-cutting research groups over several satellite oriented missions under EORC, and the W-RG has started developing offline simulation system on water cycles over global land, which will be a basis for real-time data assimilation in the future. The pilot system simulates energy and water balances over global domain using Iso-MATSIRO, an extended version of MATSIRO (Minimal Advanced Treatments of Surface Interaction and Runoff) land surface model (LSM), driven by atmospheric forcing from satellite observations and assimilated data products. In addition to water balance components such as evapotranspiration, runoff, and soil moisture, river discharge is also calculated using Total Runoff Integrating Pathways (TRIP). Currently, the system is just an offline simulation, using forecast data from the Japan Meteorological Agency (JMA) and satellite data as external forcing. The pilot system is based on the "Today's Earth" from IIS, The Univ. of Tokyo, and the system is under improvement at EORC for combined use of satellite and Gridded Point Value (GPV) data, which includes objective analysis and forecasts by JMA’s operational Global-Scale Model.

Over the ocean, the evaporation and then the latent heat flux are estimated from microwave radiometer data, and the Japanese Ocean Flux data sets with Use of Remote sensing Observations (J-OFURO) is one of the activities conducted to compile the momentum flux and the four components of heat flux derived from remote-sensing observations. Although the use of multiple datasets from various satellites is indispensable, the importance of the instantaneous measurement of geophysical parameters was reported to compute accurate latent heat flux. AMSR2 will simultaneously provide SST, scalar sea surface wind speed, and columnar water vapor content, all of which are necessary to compute the latent heat flux. Recent studies have proposed the cross validation of the fresh water flux using both geophysical parameters from microwave radiometer and microwave scatterometer ocean vector winds. Although GCOM-W1 will not be capable of observing ocean surface vector winds, the future possibility of installing a scatterometer on GCOM-W2 is under discussion. Simultaneous active and passive microwave measurements will enhance the water cycle observation capability of the GCOM-W series.

Development of the GCOM-W1 system is going smoothly. Critical design review of AMSR2 was completed in January 2009, and flight model manufacturing is now underway. Thermal environment testing of the satellite system was over at the Tsukuba Space Center using the structural thermal model, and the critical design review of the satellite system was completed in July 2009. The additional review will be performed in early 2010 for remaining items. Participation of GCOM-W1 in the A-Train constellation is now being coordinated. This is beneficial both to the inter-sensor calibration between AMSR-E and AMSR2, and synergistic use of the multiple instruments available in the A-Train. Current target launch year of GCOM-W1 is in Japanese fiscal year 2011.

Bibliography:

Taikan Oki:

Prof. Taikan Oki received his Ph.D in Civil Engineering at The University of Tokyo in 1993. He stayed as a Visiting Scientist at NASA/GSFC, USA 1995-97, and he was also assigned at the Council for Science and Technology Policy, Cabinet Office of Japan as a Deputy Director for Environment and Energy from January 2005 through December 2006, to support policy making, prioritization and evaluation of measures of science and technology in Japan. He served as one of lead authors for the WGII/Chapter 3 "Freshwater resources and their management" of the IPCC Fourth Assessment Report. He has got many awards including the Japan Academy Medal and JSPS Award. His research interests within the field of atmospheric hydrology and global water resources engineering including world water resources assessment and the virtual water trade, impacts of climate change on hydrological extremes, and water resources managements in Asian Monsoon region.

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Keiji Imaoka received the B.S. degree in physics in 1990 and the M.S. degree in astrophysics in 1992, both from Nagoya University, Japan.

He joined the National Space Development Agency of Japan (NASDA), Tokyo, Japan, in 1992. Between 1992 and 1995, he worked at the Earth Observation Center, where he participated in prelaunch calibration and validation of ADEOS. He has been with Earth Observation Research Center of NASDA (merged into the Japan Aerospace Exploration Agency, or JAXA, in 2003) since 1995 and is working on AMSR science data processing and calibration and validation. From 1998 to 1999, he visited the National Aeronautics and Space Administration's Marshall Space Flight Center, Huntsville, AL, where he worked on data analysis of passive microwave radiometers.

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Misako Kachi received bachelor's degree in Earth and planetary physics in 1993 from the Hokkaido University and M.S. in Earth and planetary science in 1995 from the University of Tokyo, Japan.

She joined in the National Space Development Agency of Japan (NASDA) in 1996. From 2003 to 2005, she was with the Japanese Ministry of Education, Culture, Sports, Science and Technology as a secretariat member for the ad-hoc Group on Earth Observations and the Earth Observation Summits. In 2005, she joined Earth Observation Research Center, Japan Aerospace Exploration Agency. She is a member of Meteorological Society of Japan. Her research interest includes microwave remote sensing and its application to other research/operational fields.