Assimilation of GCOM-W1/AMSR2 radiance data into JMA's NWP systems

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The Japan Meteorological Agency (JMA) develops and operates global and mesoscale numerical weather prediction (NWP) systems for weather forecasting. Japan suffers annually from heavy precipitation caused by typhoons and seasonal fronts, and the main source of this precipitation is moisture from oceans. Against such a background, the use of satellite observations (especially moisture-sensitive data such as microwave imager radiance data) is crucial in analysis conducted with JMA's NWP systems for the production of accurate initial conditions. Clear sky radiance data from microwave imagers are assimilated in JMA's global NWP system. In the Agency's mesoscale NWP system, clear sky radiance data and precipitation retrievals from microwave imagers are assimilated.

Although the temporal frequency of data from polar-orbiting satellites is insufficient for use in operational regional models, data from multiple satellites can be used to fill temporal and spatial gaps in data assimilation. Frequent analysis updates with multiple satellite observations can reflect rapidly changing humidity distribution to initial NWP fields. The Global Change Observation Mission 1st – Water (GCOM–W1)/Advanced Microwave Scanning Radiometer 2 (AMSR2) imager was launched in May 2012 by the Japan Aerospace Exploration Agency (JAXA) as a successor to the Advanced Microwave Scanning Radiometer for Earth Observing System (AMSR-E). AMSR2 has an afternoon orbit (known as the A-Train), and the equator crossing time in its ascending orbit is approximately 1:30 p.m. local time. AMSR2 radiance data have been assessed in JMA's NWP systems.

Although AMSR2 radiance data have large biases compared to AMSR-E data, most of the biases are considered to be constants in space and time and are without scene dependency. The quality of bias-corrected AMSR2 radiance data is comparable to that of data from AMSR-E and other microwave imagers. To investigate the related impact on analysis and forecasts in data assimilation experiments, AMSR2 radiance data were incorporated in addition to the currently used microwave imager data from the Defense Meteorological Satellite Program (DMSP)/Special Sensor Microwave Imager Sounder (SSMIS) F16, F17, F18, and Tropical Rainfall Measuring Mission (TRMM)/TRMM Microwave Imager (TMI).

Experiments with JMA's global NWP system demonstrated improvement in humidity fields. Figure 1 shows the results of verification for humidity analysis and forecast fields against radiosonde observations in the Southern Hemisphere. In experiments with JMA's mesoscale NWP system, increases in the analysis increment of humidity with AMSR2 radiance data assimilation were found. These resulted in significant improvement of precipitation forecasts

(Fig. 2). Based on these findings, AMSR2 radiance data were assimilated into JMA's NWP systems on 12 September 2013. Further work in the field will involve the inclusion of future microwave imager data (e.g., from the Global Precipitation Measurement (GPM) Microwave Imager) and the development of an all-sky radiance assimilation system in JMA'S systems.

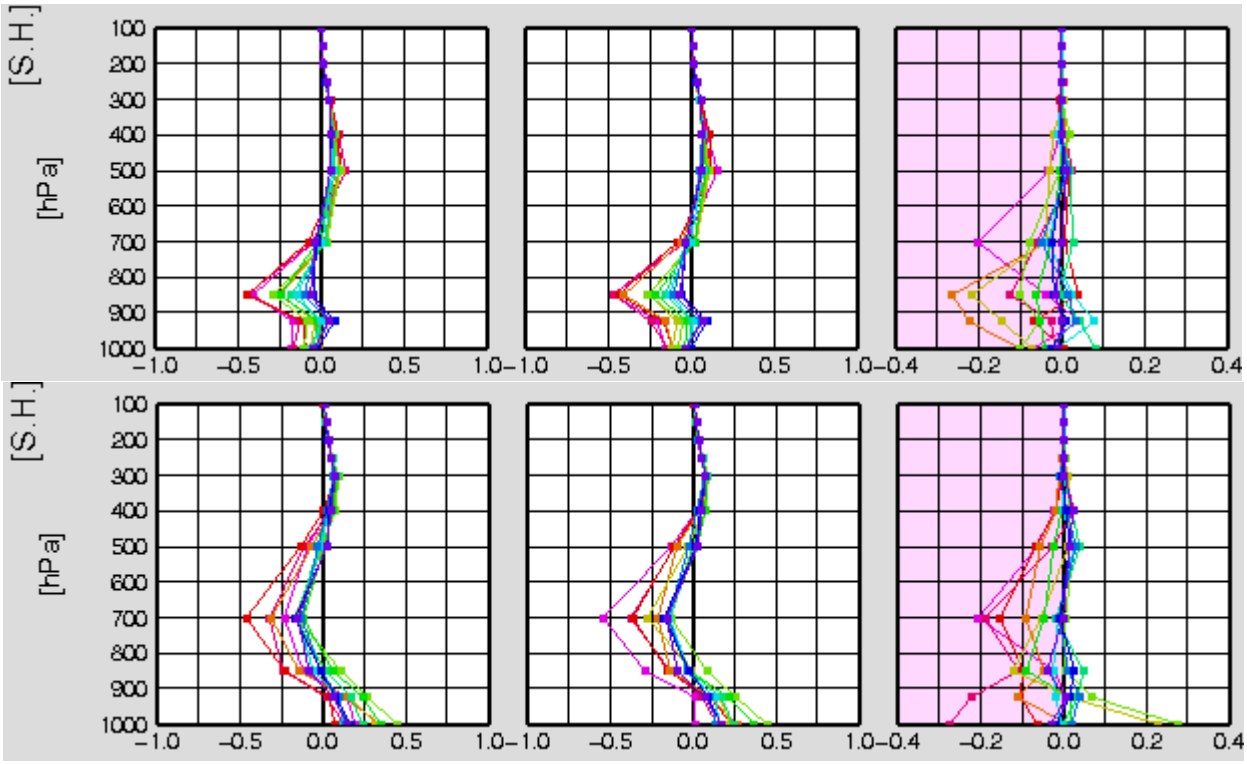

Fig. 1. Specific humidity field verification for the Southern Hemisphere against radiosonde observation for different forecast times (FT) [hours]. The upper panels show the results from experiments for August 2012 using JMA's global NWP system. The lower panels show the results for January 2013. The panels on the left show the bias error of the test run (with AMSR2) and the middle panels show that of the control run (without AMSR2). The panels on the right indicate root mean square error differences between the test run and the control run for forecast times. The unit is g/kg.

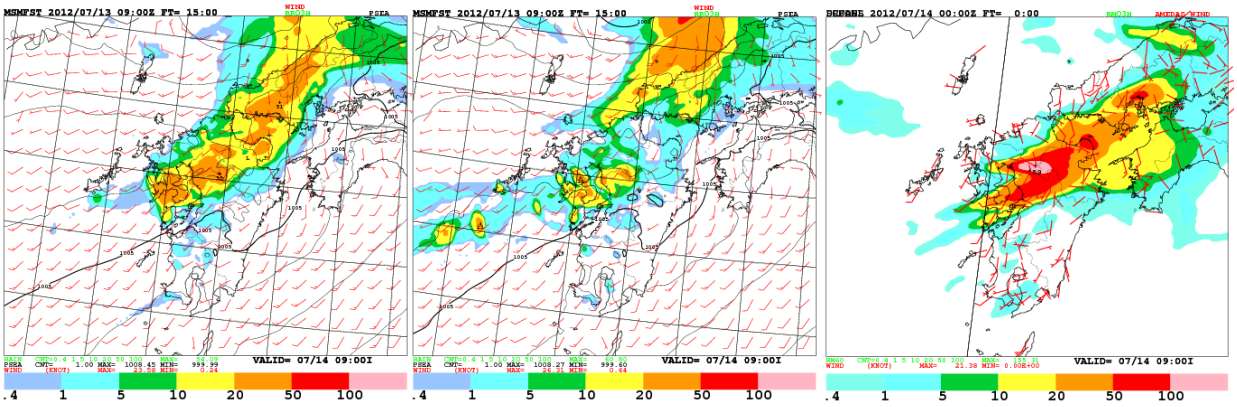

Fig. 2. Comparison of three-hour cumulative rainfall forecasts for 00 UTC on July 14 2012. The forecast period is 15 hours. The panel on the left shows the results of the test run (with AMSR2), the middle panel shows those of the control run (without AMSR2) and the panel on the right shows rainfall distribution estimated from radar observations and rain gauges. The unit is mm/3 hr.