Observing Simulation System Experiment for Future Small Precipitation Radar Constellation: Impact on GSMaP Accuracy

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Satellite observation is a unique and effective tool to cover a large area homogeneously in a short time. Its advantage is obvious when it observes geophysical parameters varying both in temporally and horizontally, like precipitation. One of the important global precipitation observation missions from space is the Global Precipitation Measurement (GPM) Mission, which is composed of the GPM core satellite and multi constellation satellites carrying passive microwave (PMW) instruments. GPM core satellite carries the Dual-frequency Precipitation Radar (DPR) and GPM Microwave Imager (GMI). DPR consists of the Ku-band Precipitation Radar (KuPR) and the Ka-band Precipitation Radar (KaPR), aiming to observe global precipitation with high accuracy under the GPM mission. GPM core satellite carries both active and passive sensors and is in non-sun-synchronous orbit, therefore, GPM core satellite can be a calibrator of PMW sensors onboard multi constellation satellites in sun-synchronous orbit. The constellation satellites can contribute to extending coverage and increasing frequency. Thus, GPM mission achieves high accurate and high frequent global precipitation measurement.

The Japan Aerospace Exploration Agency (JAXA) has developed the multi-satellite precipitation product called Global Satellite Mapping of Precipitation (GSMaP) with the GPM core and constellation satellites. GSMaP has been developed by using combined data from PMW sensors in low Earth orbit and infrared (IR) radiometers in geostationary Earth orbit, and provides hourly global (60˚S - 60˚N) precipitation map by 0.1 x 0.1 degrees latitude/longitude. As advanced knowledge given by previous studies have been implemented to the algorithms, the accuracy of GSMaP has been improved. Such kind of precipitation product with high spatiotemporal frequency leads to wider applications over societal benefit areas, such as weather forecasts, flood predictions, agricultural monitoring and so on. Especially over the tropical Asian countries, GSMaP has been used as an infrastructure in operational agencies for meteorology and disaster management. Hence, it is strongly desired to keep the GSMaP maintained and improved by updating the algorithms.

As one of the future precipitation observation missions discussed in JAXA, there is a concept of small spaceborne precipitation radar (PR) constellation in the Tropics. The PR can obtain quantitative precipitation measurements over the land as well as over the ocean. It is well-known that there are still large uncertainties of rainfall estimates over the land using the PMW because over-land PMW algorithms basically use only scattering signals due to high and variable emissivity of the land surface. Current GPM/DPR dataset is used as a database to calculate look-up tables for retrieving rainfall from PMW sensors, because the observation frequency is insufficient to retrieve rainfall directly from DPR. If the future PR constellation is realized, the frequency of the PR data with high accuracy can increase, which leads to improve the quality of the GSMaP.

The aim of this study is to quantify the contribution of the future PR constellation to the improvement of future GSMaP. We perform an Observing System Simulation Experiment (OSSE) for the future PR constellation. Also the pseudo PR data obtained from the experiment is input to the actual GSMaP processing system to evaluate the impact on the accuracy of GSMaP.

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