Evaluating the impact of precipitation radar observations from a geostationary satellite on typhoon forecasts

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Over the past two decades precipitation radars (PR) onboard low-earth orbiting satellites such as the Tropical Rainfall Measuring Mission (TRMM) and the Global Precipitation Measurement (GPM) Core Observatory have provided valuable measurements of the three-dimensional structure of precipitation, improving our understanding of the role of precipitation in the global climate system. Building upon this success, Japan Aerospace Exploration Agency (JAXA) is now exploring the feasibility and usefulness of a new PR satellite stationed in geostationary orbit (Okazaki et al 2019). Such an instrument would have much higher observation frequency of global precipitation compared to previous and existing instruments, bringing new insight into the distribution and variability of rainfall, as well as advances in numerical weather prediction (NWP) through data assimilation.

Okazaki et al (2019) previously showed that obtaining the three-dimensional structure of precipitation from a geostationary PR is feasible and that assimilation of observations within a NWP model has positive impact on typhoon forecasts. The study also demonstrated that observation quality and resolution depended on the size of beam width and beam span, with larger beam widths and coarser beam spans unable to observe weaker precipitation at lower altitudes due to heavy contamination from surface clutter. Owing to the limitations on antenna size that could be delivered for a satellite in geostationary orbit, the resolution of observations are expected to be several times coarser than those onboard low-earth orbiting satellites. Given this, is important to consider a range of resolutions and beam sampling spans and understand their impact on NWP, in order to provide better forward guidance pertaining to future satellite mission design and strategy.

In this study we perform an Observing Simulation System Experiment (OSSE) to investigate the impact of GPR observations with horizontal resolutions and beam sampling spans ranging between 5km and 30km on forecasts for a typhoon case (Typhoon Soudelor 2015). The results show that the assimilation of observations at higher resolution (5km) improved representation of the typhoon structure and intensity in the analysis and reduced intensity forecast error compared to assimilating observations at lower resolution (20km). This was due to the smaller beam width able to observe the higher intensity precipitation regions at lower altitudes. Representation of the typhoon structure and intensity forecasts was also improved for experiments where the beam sampling span was narrowed from 20km to 5km.

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