Assimilation of Passive and Active Sensors on Satellite to Improve Tropical Cyclone Forecasts

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Assimilating satellite observations have been playing significant roles in improving Numerical Weather Prediction (NWP) analyses and forecasts including tropical cyclones (TCs). Radiance observations from passive infrared and microwave imagers and sounders show biggest positive impacts on forecast skills in most operational centers. However, the satellite observations have not yet been fully exploited in data assimilation system. For example, radiances are mostly assimilated in clear-sky conditions. Active sensors such as space-based radars and lidars are not assimilated in most centers. In order to further improve TC and other severe weather forecasts, more exploitation of satellite observations is necessary. We have been working on developing assimilation of radiances in all-sky conditions. Although all of all-sky radiances could not be assimilated at the current stage of development partially due to the limited predictability of NWP and radiative transfer models, much better availability in TC regions and other cloudy/rainy conditions improved TC and accompanied precipitation forecasts than clear-sky radiance assimilation did. We also investigated impact of GPM-Core/DPR reflectivity together with GPM-Core/GMI radiances. Single assimilation experiments for TC showed that the synergetic use of DPR and GMI most improved TC track forecast by combining DPR capability of analyzing detailed hydrometeors and GMI capability of correcting broad hydrometeor and moisture. Assimilation of space-based Doppler wind lidars (DWLs) was also studied using Observing Simulation System Experiment (OSSE). Simulated winds of DWLs showed positive impacts on forecasts of TC track and wind especially in the tropics if appropriate quality control and observation errors were used in the data assimilation system.