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Radiative impacts of precipitating hydrometeors on atmosphere circulation features in weather and climate models

Jui-Lin Li[†]; Richard Forbes; Duane Waliser; Tristan L'Ecuyer; A. Molod; J-D Chern; W-T Chen; M. Suarez
[†] Jet Propulsion Laboratory/CalTech, USA
Leading author: jli@jpl.nasa.gov

Climate models such as those used in the Intergovernmental Panel on Climate Change (IPCC) assessments such as those used in CMIP3 and CMIP5, often ignore radiative impacts of precipitating hydrometeors (e.g., rain, snow) due in part to the perception that the combination of their limited spatial and temporal extent and large particle radii are insufficient to have a tangible radiative impact on the atmosphere and because there has been limited observations on the amount of precipitating hydrometeor mass in the atmosphere. Because of this, the models ignore the radiative processes associated with falling hydrometeors and only consider the "suspended" water in the radiation calculations. The implications of this are that such models are likely achieving top of atmosphere (TOA) radiation balance through compensating errors and introducing atmospheric circulation, hydrometeors, precipitation and land/sea surface temperatures biases. By using the ice particle size distribution parameters estimated by the CloudSat retrieval algorithm, CloudSat retrievals of ice water content provide one of the first comprehensive means to estimate the amount of precipitating ice mass in the atmosphere and characterize its vertical structure. Using the radiation calculations associated with the 2B-FLXHR algorithm of cloudsat, the ECMWF Integrated Forecast System and the GEOS5 AGCM, we perform a number of sensitivity tests in order to examine the radiative and dynamical impacts of the exclusion/inclusion of the precipitating hydrometeors in the calculations on atmospheric radiative fluxes and heating rates. These results indicate some shortcomings in our representation of cloud-radiative processes that may be important to climate change considerations.