An Innovative Method of Using GPM Observation to Quantitatively Evaluate Cloud and Precipitation Properties Simulated by the DOE Climate Model over the Continental U.S.

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A method has been developed to use the Global Precipitation Measurement (GPM) satellite Ku-band radar (high resolution, instantaneous data) to evaluate a global climate model (coarse resolution, usually mean data). Due to differences in scales between observed and modeled data, fair comparison is difficult. This study uses a satellite simulator package developed under the framework of the Cloud Feedback Model Intercomparison Project (CFMIP), the CFMIP Observation Simulator Package (COSP) by calculating simulated Ku-band radar reflectivity from the DOE Energy Exascale Earth System Model (E3SM) outputs. COSP allows calculation of radar reflectivity for sub-columns, which can bring the modeled data to the similar spatial scale as GPM data. Discrepancies in spatial-temporal resolution between E3SM (1°, hourly output) and GPM (0.05°, instantaneous snapshot), as well as the fact that GPM has minimum detectable reflectivity threshold of 13 dBZ, require a series of data processing procedures to match the observational data set to the model output scale. Three-year (2014-2016) 3D cloud and precipitation fields simulated by E3SM over the Continental U.S. are examined from the perspectives of grid-scale horizontal spatial pattern, vertical structure, and subgrid variability. Through the direct comparison with the GPM observation, model agreement and biases overlooked in previous evaluation studies are revealed for the first time. For example, an agreement is found between E3SM and GPM in both magnitude and spatial distribution below 4 km altitude, but there is severe model underestimation in the upper levels. Moreover, the simulated echo top height is about 3 km lower than the observation, indicating the simulated deep convection is not “deep” enough. As for the subgrid variability, the bimodal distribution simulated by E3SM differs significantly from the lognormal distribution observed. More detailed evaluation results will be presented.

Keywords: E3SM evaluation, COSP radar simulator, 3D cloud structure, GPM Ku-band radar