マルチセンサー衛星観測の複合利用による雲プロセスの定量化と気候モデル診断
Synergistic use of multisensor satellite observations for quantification of cloud processes and climate model diagnostics

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It is now recognized that key questions in climate sciences cannot be addressed with a single satellite observation alone. This recognition is an underlying motivation for emerging/existing multisensor satellite observations. One particular area of research to be advanced with such multisensor satellite observations is a characterization of physical processes in climate system, which still is a fundamental uncertainty in climate modeling. Cloud processes, among others, are one of the most uncertain components in state-of-the-art climate models and therefore are a particular target of studies that should be conducted with a synergistic use of multisensor satellite observations. In this presentation, I highlight our recent progress in combining multiple NASA satellites to obtain novel insight into cloud processes, which also has enabled a new “process-oriented” type of climate model diagnostics. In particular, we have developed methodologies for combining simultaneous measurements of cloud and precipitation provided by CloudSat and Aqua/MODIS. The methodologies exploit the unique measurement capability of the two sensors to construct the particular statistics that “fingerprint” the particle growth processes in warm clouds. Our recent investigation for land-ocean differences found in the statistics is also discussed in this presentation to identify a key role of updraft velocity in the warm rain formation. This points to a necessity for measuring updraft velocity from space in our future satellite mission. The observation-based statistics also serve as a reference for evaluating climate models in their representations of fundamental cloud processes. The methodologies developed have indeed been applied to a hierarchy of models, including global climate models and global/regional cloud-resolving models, to identify their key biases in representations of fundamental microphysical processes. Such a new process-based model constraint has also been contrasted against a traditional “performance-oriented” model evaluation based on historical trends of global mean temperature to expose their apparent dichotomy. This implies the presence of compensating errors at a fundamental process level in current climate models and underscores the necessity of further efforts for “process-oriented” model diagnostics with a synergistic use of upcoming multiple satellite observations.

