



WATER CYCLE SEMINAR

Evaluation of the Multi-Scale Modeling Framework using data from the Atmospheric Radiation Measurement Program

by

Mikhail Ovtchinnikov

Pacific Northwest National Laboratory, Richland, WA
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One of the goals of the Atmospheric Radiation Measurement (ARM) program is to provide long-term observations for evaluation of cloud and radiation treatment in global climate models (GCM). Unfortunately, the traditional parametric approach of diagnosing cloud and radiation properties from large-scale model fields is not well suited for comparison with observed time series at selected locations, largely because of GCM's poor spatial and temporal resolution. A recently emerging approach called the multi-scale modeling framework (MMF) has shown the promise to bridge the scale gap. Pioneered by Grabowski of NCAR and advanced by Khairoutdinov and Randall of CSU, the MMF consists of a two-dimensional cloud system resolving model (CSRM) embedded into each grid column of the Community Atmospheric Model (CAM), thereby computing cloud properties at scales that are more consistent with observations. In this presentation, we will present a comparison of data from ARM sites at the Southern Great Plains (SGP) in Oklahoma and in the Tropical Western Pacific (TWP) region, with output from both CAM and MMF.

Two sets of one year long simulations are considered: one using climatological sea surface temperatures (SST) and another using 1999 SST. Each set includes a run with MMF as well as CAM run with traditional or standard cloud and radiation treatment. Time series of cloud fraction, precipitation intensity, and downwelling solar radiation flux at the surface are statistically analyzed. For the TWP region, nearly all parameters of frequency distributions of these variables from the MMF runs are shown to be more consistent with observation than those from the CAM runs. For the SGP area, the improvements are marginal.

Different temporal and spatial averaging in the simulations and observations imposes limitations on the comparisons and these scale effects will be discussed. Output from the CAM run represents statistics for the large-scale grid, which, in our case, has the horizontal cross section of roughly 300 km x 300 km. In contrast, the CSRM domain is 4 km x 256 km and consists of a row of 64 columns, 4 km x 4 km each. One of the benefits of the MMF approach is that for each CAM grid column the statistics can be collected for CSRM domain-averaged as well as CSRM column cloud and radiation properties. The CSRM column statistics are representative of scales that are closer to the scales of observations and therefore allow for more direct comparisons. Benefits and limitations of these comparisons will be outlined.