Using microwave limb sounder data to validate model cloud ice fields

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Abstract

Upper–tropospheric ice clouds can strongly influence global climate through their effects on the radiation budget of the earth and the atmosphere. Present-day shortcomings in the representation of such cloud processes in global climate models (GCMs) introduce a major source of error for both weather and climate (e.g., monsoon, El Nino) forecasts due to lacking of availability of adequate high-quality ice cloud process observations. The NASA EOS Microwave Limb Sounder (MLS) observations provide a rich new data set to help address the above problems. In particular, MLS' vertical profiles of cloud ice, in concert with its collocated values of temperature and water vapor, represent a new and important observational capability. In this study, measurements from the EOS/MLS are used to examine the fidelity of the ECMWF integrated forecasting system in representing upper-tropospheric ice water content (IWC). Comparisons are made with ECMWF analyses and forecasts from 30R1 for the period August 2004 to July 2005. The ECMWF data are sampled along the MLS measurement tracks and have a lower-limit threshold applied to account for the MLS instrument/algorithm sensitivity. From the annual mean values at 147 hPa, the spatial agreement between MLS and sampled ECMWF analyses is reasonable, in particular over the oceans, but the analyses are biased high relative to MLS by about 10%. In contrast, over tropical landmasses, including the maritime continent region, ECMWF analyses are biased low relative to MLS by up to 50%. This underestimation grows in the forecasts, with a further ~40% reduction in IWC at 147 hPa across the tropics by day 10, and with greater reductions occurring over the warm pool region. Since the analyses biases reflect those in the forecast model, it is apparent that they are partly due to shortcomings intrinsic to the model physics. Preliminary comparisons of a common period of May-Jun 2006 for both 30R1 and 31R1 - in which the latter includes moist physics changes - shows improvements in regards to the representation of cloud ice and water vapor in he upper troposphere. These results demonstrate the potential usefulness of the MLS data set for evaluating global atmospheric model performance and guiding their development. These observations, combined with MLS's observations of temperature and water vapor as well as measurements from other NASA EOS "A-Train" platforms – including the CloudSat mission – provide an altogether new and innovative opportunity to understand upper-tropospheric hydrological processes as well as to assess and improve cloud processes in GCMs.