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Comparing Spatial Distributions of Ice Water Path for Satellite data sets and Global Climate Models

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Modeled monthly mean cloud ice from the climate models used in the IPCC AR4 show large differences, especially in the tropics. The most valuable source of information that can be used to constrain the models is global satellite data, but these data sets must have a temporal range long enough to capture the inter-annual variability of Ice Water Path (IWP).
A clear distinction between ice categories in satellite retrievals, as desired from a model point of view is currently impossible, but long-term satellite data sets may still be used to indicate the climatic spatial distribution of IWP, useful for evaluating the spatial distribution of modeled cloud-ice.
We evaluated satellite data sets from CloudSat, PATMOS-x, ISCCP, MODIS and MSPPS in terms of monthly mean IWP in order to determine a satellite data set that can be used to evaluate the climate models. IWP data from CloudSat cloud profiling radar provides the most advanced data set on clouds. As CloudSat data is too short to evaluate the model data directly, it was mainly used to evaluate IWP from the other satellite data sets.
ISCCP and MSPPS were shown to have low IWP values by comparison. ISCCP shows particularly low values in the tropics, while MSPPS has particularly low values outside the tropics. MODIS and PATMOS-x were in closest agreement with CloudSat in terms of magnitude and spatial distribution, with MODIS being the best of the two. As PATMOS-x has a temporal range of over 25 years, it was chosen as the reference data set for the model evaluation.
In general there are large discrepancies between the individual climate models and all of the models have at least some problems in the spatial distribution of cloud-ice. Many of the models have distributions strongly deviating from that seen in satellite observations. Comparisons consistently showed that MPI-ECHAM is the GCM from IPCC AR4 closest to satellite observations.