Geophysical Research Abstracts
Vol. 12, EGU2010-2479, 2010
EGU General Assembly 2010

Evaluation of clouds in the ECHAM5 GCM using the ’CALIPSO and CloudSat Satellite Simulator’

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The CloudSat and CALIPSO simulators are used in the evaluation of different cloud/boundary layer models in the ECHAM5 general circulation model (GCM). These include: the standard turbulent kinetic energy (TKE) based scheme, with Tiedtke’s representation of shallow convection (Brinkop and Roeckner, 1995); an Eddy Diffusivity Mass Flux (EDMF) scheme modified to better represent shallow convection (Neggers et al., 2009); as well as the standard scheme with a new convective trigger which dramatically alters the statistics of shallow convection (Roeckner, 2010*).

The CALIPSO lidar simulator shows the standard ECHAM5 scheme has a greater frequency of large scattering ratios at all levels of the model compared to the GCM orientated Calipso Cloud Product observational data set. This indicates the modeled clouds are optically thicker, which may be due to either a large number of ice particles or a larger particle size than those observed. Furthermore, low- and mid-level clouds in ECHAM5 are underestimated, in particular the (sub)tropical regions; while high altitude ice clouds are overestimated. The latter of which is confirmed by preliminary results from the CloudSat radar simulator. The radar simulator also reveals an overestimation in the precipitation frequency of ECHAM5 compared to the CloudSat 2B-GeoProf observations. Precipitation in ECHAM5 occurs more often, but at a lower intensity than those observed.

Evaluation of the other two boundary layer schemes are underway and a comparison of the three schemes will be presented.

References:
Brinkop, S. and Roeckner, E., 1995: Sensitivity of a general circulation model to parameterizations of cloud-turbulence interactions in the atmospheric boundary layer. Tellus, 47A, 197-220.
Neggers, R.A.J., M. Köhler, and A.C.M. Beljaars, 2009: A Dual Mass Flux Framework for Boundary Layer Convection. Part I: Transport., J. Atmos. Sci., 66, 1465–1487.
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