Geophysical Research Abstracts
Vol. 12, EGU2010-13511, 2010
EGU General Assembly 2010

Sensitivity of the ECHAM6 Single Column Model to Vertical Resolution and Implementation of the Level Set Method

Suvarchal Kumar Cheedela (1), Bjorn Stevens (1), Heiko Schmidt (2), and Juan Pedro Mellado (3)

(1) Max-Planck Institut für Meteorologie, Atmosphere im Erdsystem, Hamburg, Germany (suvarchal.kumar@zmaw.de), (2) BTU Cottbus, Cottbus, Germany, (3) Institut für Technische Verbrennung, RWTH Aachen, Aachen, Germany

Simulating cloud-topped boundary layers has been a haunting task for general circulation models (GCM's) and has challenged our ability to study the role of low clouds in climate in detail. One of the most important, yet difficult to simulate, feature of cloud-topped boundary layers is the presence of large vertical gradients. Resolving such gradients is important because of their relevance to key processes that govern the evolution of the boundary layer. For instance, a typical stratocumulus cloud has a thickness on the order of hundreds of meters and a process such as cloud-top entrainment, that is key to the dynamics of stratocumulus-topped boundary layers, occurs across a very thin interface (on the order of tens of centimeters) with sharp gradients in temperature and humidity. Such sharp gradients are not well represented by current GCM's and evidently linked to the vertical resolution used by these models.

In an ongoing study we investigate the sensitivity of the ECHAM6 GCM to vertical resolution in a single column model (SCM) framework. The SCM is a 1D vertical column of a GCM that includes all parameterizations of diabatic processes and is run over a region of interest using prescribed large-scale advective fluxes estimated from observations. As such, the SCM conveniently decouples the large-scale flow from (diabatic) parameterizations and has a great advantage of its high computational speed.

Because simply increasing vertical resolution to improve the representation of vertical gradients remains difficult, even in climate models envisaged for the future (principally due to the associated high computational cost), we propose a novel alternative strategy of using level set method. Level Set Method here aims to capture effects of very high resolution such as cloud top interface in a lower vertical resolution models (current climate models). In this method the 2D interface is represented as a level set of a smoother field, computed as the distance from the interface. This field is coupled to entrainment at the interface (source/sink) and advected with the flow.

To constrain and assess the sensitivity and convergence of the ECHAM6 SCM simulations to vertical resolution, we use test cases for different (cloudy) boundary layer regimes, constructed from observations by the GEWEX Cloud System Studies (GCSS) Boundary Layer Group. A preliminary implementation of the level set method in SCM is presented and its performance is assessed by comparing to very high vertical resolution experiments for these GCSS cases.