Atmos. Chem. Phys. Discuss., 11, C1832–C1834, 2011
www.atmos-chem-phys-discuss.net/11/C1832/2011/
© Author(s) 2011. This work is distributed under
the Creative Commons Attribute 3.0 License.

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Simulating deep convection with a shallow convection scheme" *by* C. Hohenegger and C. S. Bretherton

Anonymous Referee #3

Received and published: 14 April 2011

Title: Simulating deep convection with a shallow convection scheme Author(s): C. Hohenegger and C. S. Bretherton MS No.: acp-2010-948 MS Type: Research Article

General comments:

As stated in the abstract, the main hypothesis in this paper is that "differences between shallow and deep convection, regarding cloud-base properties as well as entrainment/detrainment rates, can be related to the evaporation of precipitation." If it is true that the differences between shallow and deep convection are related to the evaporation of precipitation, then the shallow scheme should do a good job of parameterizing deep convection that has no precipitation evaporation. This could be simulated in SAM by turning off precipitation evaporation in the microphysics. That might be a more direct test of the hypothesis.

The entrainment equations (3-8) with their 14 tuning parameters (some of which have three significant digits!) are so complicated that I am afraid that the essential physics of the problem has been obscured. This makes it easy to dismiss the agreement between the simulations and the observations as achievable with any entrainment model that has 14 free parameters. The paper would be improved by simplifying these equations.

The manuscript does not explain how the "chicken and egg" problem is solved in the convective parameterization. This is a parameterization that predicts rainfall, but requires the rainfall rate to predict it. How is this solved? Is the rain rate from the previous time step used? If so, the scheme would depend unphysically on the time step. Are the equations solved iteratively? If so, is the adjustment (to an equilibrium between rainfall and convective fluxes) assumed to be instantaneous? Since the objective is to look at the diurnal cycle, does this introduce timing problems?

Specific comments:

Eq 1: What is the theoretical justification for this expression?

Fig 3: The units on the color bar do not make sense. Are the units g/mˆ2/s/K?

Fig 3: Should "solid line" in the caption be "black line"? They are all solid lines.

Fig 3: If the "black line" is cloud fraction, why is it plotted on a temperature axis?

Fig 3: The green lines are very hard to see.

Eq 2b: Why parameterize the effect of convective downdrafts on the sub-cloud-layer MSE when the convective parameterization does not have a representation of convective downdrafts? This equation appears to be correcting a mismatch between MSE_cb and <MSE> that does not exist in the parameterization.

Eq 2b: Why such a complicated expression for such a simple-looking distribution? Is there a theoretical motivation for this? If no, why not use sigma = max(4e-4,aRRˆb), where a and b are constants?

Page 8398, Line 8: Figure 3a is used here to support the use of <MSE> for MSE_cb when the rain rate is essentially zero. But, in Figure 3a, the updrafts appear to have MSE that is 1-2 K larger than <MSE>. Is this difference not important?

Sec 3.2: If the vertical velocities of convective thermals in the sub-cloud layer are not changed by the cold pools, why would there be an enhancement of mass flux? In other words, why should the mass flux be calculated from the ratio of TKE to CIN if TKE is not representative of thermals' vertical velocity? Shouldn't the relevant ratio be wˆ2/CIN?

Sec 3.2: How is equation 2 used in UWSDpbl? This goes back to my earlier question about the relevance of equation 2 to a scheme that does not have precipitation-driven downdrafts.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 8385, 2011.