Geophysical Research Abstracts
Vol. 12, EGU2010-3662, 2010
EGU General Assembly 2010

Simulating deep convection with a shallow convection scheme

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Atmospheric convection profoundly affects the global energy and water balance of our planet by the release of latent heat and the transport of momentum, heat and moisture. However, adequately simulating convection and its effects both over the tropics and mid-latitude continental areas remains a challenge for global climate models. This study uses large-eddy simulations (LES) and single column model experiments to assess the suitability and performance of a shallow convection scheme in simulating deep convection. Cases of mid-latitude summertime continental convection (from the Southern Great Plain ARM measurement facility) and of tropical oceanic convection (from the KWAJEX measurement campaign) are considered.
Without any modification the shallow convection scheme provides a better precipitation diurnal cycle but strongly underestimates the precipitation amounts as compared to a deep convection scheme (Zhang-McFarlane scheme) and to the LES. By additionally tying the mixing rates and the cumulus base mass flux to precipitation evaporation as suggested by the LES results, it is nevertheless found that the scheme outperforms the Zhang-McFarlane parameterization: Precipitation amounts and diurnal cycle are better captured both for KWAJEX and ARM, while biases in the temperature and humidity profiles are generally reduced. The main advantage of this approach lies in the fact that the same scheme can be used to simulate shallow and deep convection and their transitional forms.