Geophysical Research Abstracts
Vol. 16, EGU2014-3942-1, 2014
EGU General Assembly 2014

Deep convection triggering by boundary layer thermals: stochastic triggering parameterization for the LMDZ GCM

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This work presents a stochastic triggering parameterization for deep convection and its implementation in the latest standard version of the Laboratoire de Meteorologie Dynamique–Zoom (LMDZ) general circulation model: LMDZ5B.

Whereas the standard triggering formulation in LMDZ5B relies on the maximum vertical velocity within a mean bulk thermal, the new formulation presented here (i) considers a thermal size distribution instead of a bulk thermal, (ii) provides a statistical lifting energy at cloud base, (iii) proposes a three-step trigger (appearance of clouds, inhibition crossing, and exceeding of a cross-section threshold), and (iv) includes a stochastic component. Here the complete implementation is presented, with its coupling to the thermal model used to treat shallow convection in LMDZ5B. The parameterization is tested over various cases in a single-columnmodel framework. A sensitivity study to each parameter introduced is also carried out. The impact of the new triggering is then evaluated in the single-column version of LMDZ on several case studies and in full 3D simulations.

It is found that the new triggering (i) delays deep convection triggering, (ii) suppresses it over oceanic trade wind cumulus zones, (iii) increases the low-level cloudiness, and (iv) increases the convective variability. The scale-aware nature of this parameterization is also discussed. This study has been founded by the French Department of Education and Research and by the European FP7 Project EMBRACE (Earth system Model Bias Reduction and Assessing abrupt Climate Change).