Geophysical Research Abstracts, Vol. 8, 04758, 2006
SRef-ID: 1607-7962/gra/EGU06-A-04758

Simulating rainfall in mountainous terrain with MM5 - the role of physics parametrizations

A. Pfeiffer, H. Garny, G. Zängl

Meteorological Institute, University of Munich, Germany (a.pfeiffer@lmu.de)

Simulation of precipitation is still one of the most challenging problems in numerical weather prediction. This is especially true in areas with complex orography like e.g. the European Alps. Previous simulations conducted within the GLOWA-Danube project indicated systematic model deficiencies (bias) in the eastern central Alps, where summertime precipitation tended to be substantially overestimated. To further investigate this issue, we conducted climate-mode MM5 simulations over Central Europe with a horizontal resolution of either 45 km or 15 km. The simulations were performed for the year 1997 and were driven with ERA40 data provided by the ECMWF. We investigated the role of different cumulus parametrizations and the impact of the implementation of numerical diffusion. Specifically we considered the Betts-Miller and Kain-Fritsch cumulus schemes. For diffusion we tested the standard MM5 implementation in which diffusion is computed along the terrain-following coordinate surfaces and the truly horizontal diffusion scheme implemented by Zängl (2002).

Our results reveal a great sensitivity to both the cumulus scheme, the diffusion implementation and the horizontal resolution. The Betts-Miller scheme tends to produce systematically more convective rain than the Kain-Fritsch scheme, and a cursory comparison with climatological rainfall fields indicates that the Betts-Miller scheme overestimates summertime convection while the Kain-Fritsch scheme produces more realistic results. Computing numerical diffusion along the terrain-following coordinate surfaces leads to a strong overestimation of precipitation over topography, which is mainly because the moisture diffusion induces a systematic upward transport of moisture over mountains. Particularly in summer, the modified diffusion scheme brings about a great improvement of the simulated precipitation field. Refining the horizontal resolution from 45 km to 15 km generally increases the amount of small-scale structures resolved in the model fields. Moreover, the average precipitation over the Alps

tends to increase, particularly in summer when using the Kain-Fritsch parametrization. The systematic errors related to the simple diffusion scheme are much more pronounced at 15 km resolution than at 45 km.