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Effects of microphysical schemes on orographic precipitation and atmospheric water cycle in the WRF model

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Atmospheric processes that occur at spatial and temporal scales not resolved by global and regional climate models (GCMs and RCMs) are represented by means of physical parameterizations (or schemes), which are based on several assumptions and approximations. The drawback of using these simplified schemes is the risk of introducing errors in the models, especially when long simulations are performed. This study focuses on the microphysical schemes, the parameterizations responsible for determining the amount of atmospheric water vapour and the liquid and solid atmospheric water content. A correct estimation of cloud density/distribution and precipitation amounts is crucial for long-term climate simulations. Clouds and water vapour modify the radiative properties of the atmosphere, while precipitation affects soil moisture, temperature and albedo. Furthermore, microphysics parameterizations are important for the hydrological and energy budgets, especially for RCMs that employ mass-conserving formulations of the model equations.

The Weather Research and Forecasting (WRF) model, a modern numerical weather prediction (NWP) model, has been recently used for regional climate downscaling. WRF was originally designed for short-range NWP but not expressly for long-term climate simulations, and the success of the simulations strongly depends on the parameterizations used. There is therefore the need to test whether WRF physical schemes are suitable for climate prediction or not.

Our objective, rather than developing a new parameterization suitable for RCMs, is to make a comparative evaluation of the existing microphysical schemes available in WRF. To achieve this, we perform an idealized simulation in which a fixed set of physical schemes is chosen and a simple terrain model is adopted to eliminate the effects due to complex topography. This method lacks a direct verification with observations but allows to isolate the effects due solely to the microphysical schemes. With respect to other similar studies, we are able to characterize a larger number of microphysical schemes (13) using a relatively longer integration period ($\sim$2 months). The schemes are characterized in terms of variables of hydrological interest such as integrated water vapour, integrated total condensate, accumulated precipitation, accumulated evaporation and total water. The results of this study will contribute to the understanding of these parameterizations and to a more conscious use of WRF in regional climate simulations.