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Climate simulation in mountain regions: why we need sub-km-scale resolution

Petra Seibert, Irene Schicker, Delia Arnold, Herbert Formayer, and Imran Nadeem

Institute of Meteorology (BOKU-Met), University of Natural Resources and Appl. Life Sciences, Vienna, Austria (petra.seibert@boku.ac.at)

Both the numerical weather prediction and climate modelling communities strive to continuosly increase the resolution of their atmospheric simulation models. It has been recognised that resolution is especially important in mountain regions. Usually, these improvements go by small steps, e.g. from 50 km grid distance to 15 km, then to 10 and maybe to 5 km. However, there are arguments that the benefit of the step 50 $\rightarrow$ 15 km is much larger than that from 15 $\rightarrow$ 5 km. Results at 5 km inside a mountain region like the Alps may even be more troublesome to use than those at 15 km, as valleys and ridges now start to be resolved, but are still far away from being represented with their true shape and depth/height. Furthermore, higher horizontal resolution means steeper model levels and that means more errors, as most models have not been developed for steep topography. Typical effects of such problems are wrong spatial distribution and/or amount of precipitation, and inability to properly reproduce the temperature regime inside valleys. Approaches where only some components are treated at high resolution are insufficient as this does not remove numerical errors and does not consider the dynamical linkage between the scales. With this in mind, we have started the project HIRMOD: High-resolution atmospheric modelling in complex terrain for future climate simulations in the context of the Austrian Climate Research Programme. It aims at working with MM5 and WRF at resolutions $<$ 1 km in episodes of different length in three regions of different orographic complexity (Tyrolean Alps, Black Forest, Vienna Basin) to optimise set-ups (domains, resolution, physical parameterisations). In addition, models shall be improved, e. g. for initial conditions and for using high-resolution topography and land-use data. For comparison with the model results, remote-sensing data shall be used in addition to station data.

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