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A review on regional convection permitting climate modeling

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With the increase of computational resources, it has recently become possible to perform climate model integrations where at least part the of convection is resolved. Since convection-permitting models (CPMs) are performing better than models where convection is parameterized, especially for high-impact weather like extreme precipitation, there is currently strong scientific progress in this research domain (Prein et al., 2015). Another advantage of CPMs, that have a horizontal grid spacing <4 km, is that they better resolve complex orography and land use. The regional climate model COSMO-CLM is frequently applied for CPM simulations, due to its non-hydrostatic dynamics and open international network of scientists. This presentation consists of an overview of the recent progress in CPM, with a focus on COSMO-CLM. It consists of three parts, namely the discussion of i) critical components of CPM, ii) the added value of CPM in the present-day climate and iii) the difference in climate sensitivity in CPM compared to coarser scale models. In terms of added value, the CPMs especially improve the representation of precipitation's, diurnal cycle, intensity and spatial distribution. However, an in depth-evaluation of cloud properties with CCLM over Belgium indicates a strong underestimation of the cloud fraction, causing an overestimation of high temperature extremes (Brisson et al., 2016). In terms of climate sensitivity, the CPMs indicate a stronger increase in flash floods, changes in hail storm characteristics, and reductions in the snowpack over mountains compared to coarser scale models. In conclusion, CPMs are a very promising tool for future climate research. However, additional efforts are necessary to overcome remaining deficiencies, like improving the cloud characteristics. This will be a challenging task due to compensating deficiencies that currently exist in 'state-of-the-art' models, yielding a good representation of average climate conditions. In the light of using CPMs to study climate change it is necessary that these deficiencies are addressed in future research. Coordinated modeling programs are crucially needed to advance parameterizations of unresolved physics and to assess the full potential of CPMs.

Brisson, E., K. Van Weverberg, M. Demuzere, A. Devis, S. Saeed, M. Stengel, N.P.M. van Lipzig, 2016. How well can a convection-permitting climate model reproduce 1 decadal statistics of precipitation, temperature and cloud characteristics? Clim. Dyn. (minor revisions).

Prein, Andreas F., Wolfgang Langhans, Giorgia Fosser, Andrew Ferrone, Nikolina Ban, Klaus Goergen, Michael Keller, Merja Tölle, Oliver Gutjahr, Frauke Feser, Erwan Brisson, Stefan Kollet, Juerg Schmidli, Nicole P. M. van Lipzig, Ruby Leung. (2015) A review on regional convection-permitting climate modeling: Demonstrations, prospects, and challenges. Reviews of Geophysics 53:10.1002/rog.v53.2, 323-361