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20-year simulations over the Nordic region with a convection-permitting climate model – benefits and added value of kilometer-scale resolution

Petter Lind (1), David Lindstedt (1), Danijel Belušić (1), Fuxing Wang (1), Erik Kjellström (1), Andreas Dobler (2), Oskar Landgren (2), Erika Toivonen (3), Joni-Pekka Pietikäinen (3), Rasmus Anker Pedersen (4), Ruth Mottram (4), and Dominic Matte (4)

(1) Swedish Meteorological and Hydrological Institute, Norrköping, Sweden (petter.lind@smhi.se), (2) Norwegian Meteorological Institute, Oslo, Norway, (3) Finnish Meteorological Institute, Helsinki, Finland, (4) Danish Meteorological Institute, Copenhagen, Denmark

Projected future climate changes in northern Europe are among the largest in the world, driven to a large extent by the strong positive feedback involving reduction of snow and ice as the climate warms. At the same time, northern Europe is in many respects a complex region with steep topography (the Scandinavian mountains), long coast-lines and a large number of lakes. Climatologically, the region is situated between different dominant climate regimes; the mild maritime North Atlantic and its storm track in the west and the dry Eurasian continental regime in the east. The large temperature contrasts between seasons are accompanied by low temperatures and widespread snow climate in winter and heat waves and intense convective rainfall in summer. Due to this complexity, uncertainties in future climate responses are in part related to the inability of coarser climate models to represent fine scale surface properties, land-sea contrasts as well as small scale atmospheric processes that frequently occur in these environments such as convection and local wind systems. For example, the intensities of precipitation extremes are expected to increase as climate warms. However, there are indications that the rate of change may be stronger in models with kilometer-scale resolution compared to coarser climate models, the former generally representing convective processes more accurately. Furthermore, there has been an increased need for more detailed information from impact researchers, stakeholders and policy makers, for example for urban planning. However, so far there has been a scale gap between climate information provided by climate models and the needs of end users. In response to these challenges the Harmonie-Climate regional climate model (HCLIM-AROME) has been run at 3 km grid spacing over the Nordic region with boundary conditions from the global reanalysis product ERA-Interim covering years from 1997 to 2017. In this study we validate the performance of HCLIM-AROME with particular focus to quantify the added value. The high model grid resolution combined with the extensive simulated time period which enables assessment on climatological time scales makes this study one of very few for this region.