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Large-scale model biases in the extratropical North Atlantic storm track and impacts on downstream precipitation

Marie Pontoppidan (1), Erik W. Kolstad (1), Stefan Sobolowski (1), Asgeir Sorteberg (2), Changhai Liu (3), and Roy Rasmussen (3)

(1) NORCE Norwegian Research Centre & Bjerknes Centre for Climate Research, Bergen, Norway (marie.pontoppidan@norceresearch.no), (2) University of Bergen & Bjerknes Centre for Climate Research, Bergen, Norway, (3) National Center for Atmospheric Research, Boulder, US

Current global climate models have circulation biases that the model community aim to reduce, for instance by high-resolution dynamical downscaling which enables better interaction between the high-resolution terrain and the atmosphere. Here we present results from a simulation where WRF was used to downscale both ERA-Interim and a bias-corrected version of the Norwegian climate model NorESM1-M with a grid spacing of 20 km. By varying the domain size, we investigated the influence of the quality of the driving data and the highly resolved topography over the contiguous US including the Rocky Mountains on the North Atlantic storm track and the precipitation in the exit region of the storm track. In our largest domains, including the Rocky Mountains, we found large-scale circulation and storm track biases similar to those seen in global models, and with spatial patterns independent of the choice of driving data. The biases in the smaller domains were more dependent on the quality of the driving data. Nevertheless, the biases had little effect on the simulated precipitation in Norway. Though the added value of downscaling was clear with respect to the global climate model and the reanalysis, all the downscaled simulations showed similar precipitation frequencies and intensities. The downscaled precipitation also compared better with ten selected observational stations. We posit that this is because the precipitation is so strongly governed by the strong local topographic forcing that a correct storm track is less critical for the precipitation distribution. However, a correct representation of the storm track is still considered important for other applications as shipping and wind energy.