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Simulations of precipitation in a future climate scenario at various horizontal resolutions. Part I - Scandinavia

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Precipitation is simulated over selected areas in W-Norway, Central Sweden, Denmark and S-Finland at different resolutions. The simulations are carried out with the WRF model with microphysics parameterized by the WSM3 scheme. The simulations are forced by a global simulation by Arpege model , run by the Bergen group (BCCR) on a T159c3 irregular grid. The simulated period is 1 September 2020 to 31 August 2021. The scenario chosen is the SRES A1B. Values of sea surface temperature (SST) are calculated as ERA40 SSTs plus smoothed SST anomalies from ECHAM5/MPI-OM, corrected for drift.

The highest horizontal resolution (3 km) gives the greatest stratiform precipitation and maximum number of extremes. However, the sensitivity of accumulated precipitation to horizontal resolution is only moderate, except in the Norway region, where the 3 km domain gives about 50% greater precipitation than the 9 km domain. The large increase of precipitation in the mountainous regions of Norway is expected. This increase is related to direct forcing of ascending motion above the mountains that is not resolved at the coarse resolutions. The precipitation extremes that appear at the fine resolutions (9 and particularly 3 km) are much more pronounced in Norway than elsewhere. This difference must be associated with strong winds and rising motion over the mountains. In spite of mountains being present inside the Swedish domain, the total impact of increased resolution is much less in that region, than at the West coast of Norway. This difference is presumably related to the height and the spatial scale of the mountains.

In spite of the land being relatively flat both in the Denmark and the Finland regions, simulated stratiform precipitation increases with resolution. The sensitivity in Denmark is very limited, but the signal is more clear in Finland. There is a precipitation maximum aligned with the coast of Southern Finland. This maximum becomes more pronounced when resolution is increased, indicating that increased resolution may enhance coastal convergence and that this effect may be important in climate context. A similar feature can be detected in the Denmark domain.