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Downscaling an intense precipitation event in complex terrain: The importance of high grid resolution

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Floods due to intense rainfall are a major hazard to both people and infrastructure in western Norway. Here steep orography enhances precipitation and the complex terrain channels runoff into narrow valleys and small rivers. In this study we investigate a major rainfall and flood event in October 2014. We compare convection-permitting numerical simulations with measurements from rain gauges deployed in the impacted region. The main objective is to investigate the role grid resolution plays in the reproduction of intense rainfall in complex terrain. Our approach is to dynamically downscale the ERA-Interim reanalysis for this event with the Weather Research and Forecasting modelling system (WRF).

We find that WRF improves the representation of precipitation, in terms of both absolute value and spatial and temporal distribution, compared to the reanalysis. The largest improvement is found when we decrease the horizontal model grid spacing from 9 km to 3 km, at which point convection parameterization is turned off. Only minor additional improvements are obtained when downscaling further to 1 km. We believe that this is mainly related to the orography in the study area and its representation in the model. Realistic representation of gravity waves and the seeder-feeder effect seem to play crucial roles in reproducing the precipitation distribution correctly.

An analysis of associated wavelengths shows the importance of short length scales. Wavelengths not resolved on the 9 km grid seem important for the humidity distribution in the remaining simulations. On these scales our simulations show geographical differences in precipitation of up to 300 mm, accumulated over four days. Such large differences emphasize the need for inclusion of these wavelengths. The results clearly demonstrate the need for high-resolution dynamical downscaling in regions with complex terrain, but also suggest that there are limits to added value with increasing resolution.