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Applying NWP-ensembles to identify different large scale setups for analyzing local extreme precipitation

Karianne Ødemark, Ole Einar Tveito, and Malte Müller
The Norwegian Meteorological Institute, Climate Services, Norway (karianneo@met.no)

When designing water management infrastructure, such as dams, an assessment of the theoretically maximum probable precipitation (PMP) is necessary. The currently applied approach in Norway is time consuming and the results are influenced by subjective judgements. The most recent World Meteorological Organization manual for estimation of PMP recommends to apply physically based atmospheric models, especially for areas where orographic precipitation is significant.

Ohara et al. (2011) studied probable maximum precipitation for a catchment in California and applied a regional scale high resolution physical atmospheric model, where the boundary and initial conditions where altered to maximize precipitation. How to best set up a model system for providing these estimates is a challenge, and any guidelines for this is currently not established.

This study applies a similar approach where instead of manipulating the initial and boundary conditions we make use of ensembles. We utilize a physical numerical model chain all the way from a global climate model down to catchment scale by downscaling the global model output with a regional forecast model. 30 years model run of present day climate from the EC-Earth model is used to find the most extreme precipitation event which in turn is perturbed to get an ensemble of 10 plausible extreme precipitation realizations. The 10 ensembles are then downscaled with the regional model AROME, Met-Norway's operational weather forecast model, to a resolution of 2.5 x 2.5 km.

This approach yields a maximization of precipitation over a selected area, in a physically consistent and balanced way. We look at maximized precipitation values aggregated over several days, and the relatively large differences between ensemble members on catchment scale caused by small differences on larger (synoptic) scale. Special focus is on the variations in the large scale moisture flow in the climate model, which serves as input values for AROME, and thus what is the state at the domain boundary for the regional model. The placement of moisture flux at the boundaries provides locally quite different precipitation values in the western area of Norway, as well as differences in the time evaluation of the precipitation event.

Ohara, N., Kavvas, M. L., Kure, S., Chen, Z. Q., lang, S., and Tan, E.(2011). "Physically based estimation of maximum precipitation over American River watershed, California." J. Hydrol Eng., 10.1061/ (ASCE)HE.1943-5584.0000324, 351-361.