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Downscaling of heavy rainfall in the subtropics – challenges and limits

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Determination of temporal and spatial distribution of rainfall is of special interest for people living in subtropical semi-arid environments. In general, surface observations are scarce in these regions and the use of station data is strictly limited. The seldom but sometimes violent rainfall events in these regions are normally not displayed by GCM simulations. In addition, they are difficult to obtain from satellite measurements because of the high cirrus contamination in the subtropics enforcing the problems of calibration of rain rates obtained. It is, however, essential to determine precipitation amounts correctly in space and time, especially in these regions, to enable maximum use of water and avoid disasters (discharge of water from intense rainfall events causes several deaths each year in semi-arid and arid regions). Therefore, an attempt is made on downscaling a heavy rainfall event in a subtropical semi-arid region in southern Morocco.

Nested simulations are performed for the period 30.03.2002 to 02.04.2002, when an intense rainfall event occurred in southern Morocco. This event caused rainfall of 42mm at the station Ouarzazate and constitutes the largest rainfall event since beginning of measurements at this station in 1978. Further ground based measurements, covering a transect from the High Atlas Mountain tops to the border of the Saharan desert, are provided by the research project IMPETUS. Satellite observations are used to compare the simulated and detected location of the convective system causing the precipitation.

GME analyses, provided by the German Weather Service (DWD), are used to drive simulations with the Lokal Modell (LM) with 0.25˚ lat/lon resolution in an area covering the whole north-westerly part of Africa from the equator up to 35˚N and from 10˚E to 25˚W. In a first step, downscaling to 0.0625˚ lat/lon resolution is realised with the LM centred in the Atlas Mountains of 700 km by 700 km size. High resolution simulations (3 km x 3 km) are performed using the non-hydrostatic model FOOT3DK and are further refined to 1 km x 1 km resolution for a region at the desert border (29.5N – 30.5N, 5.5W – 6.5W).

We present resulting precipitation and related meteorological variables, simulated with different resolutions, validated against ground measurements. An additional focus is put upon deficiencies and limits of the dynamic downscaling approach for this case. Comparison of simulation results for different combinations of the convection parameterisations of the models (LM and FOOT3DK) are performed to obtain the best possible representation of measured rainfall amounts and near surface atmospheric parameters.