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Sensitivity of extreme events to soil moisture-atmosphere interactions in the western Mediterranean

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In a warming climate an increase in the intensity and frequency of extreme events like floods, droughts and extreme heat is expected. The ability to predict such events is still a great challenge and exhibits many uncertainties in the weather forecast and climate predictions. In this respect the missing knowledge about soil moisture-atmosphere interactions and their representation in models is identified as one of the main sources of uncertainty. The soil moisture (SM) controls the partitioning of sensible and latent heat fluxes on the surface and thereby influences the boundary-layer stability and the precipitation formation.

The goal of this research work is to investigate the coupling between soil-moisture and precipitation and the related chain of processes for selected regions in the western Mediterranean. The role of local and remote soil moisture anomalies as well as the impact of realistic SM initialization on initiation and development of extreme events is assessed.

High-resolution simulations with the regional COSMO model and the climate version COSMO-CLM are conducted using a multiscale approach (days to years, $\sim$7km to 2.8km spatial resolution). Moreover, the Effective Drought Index (EDI) and the convective adjustment time-scale are calculated to select extreme dry and wet periods and time-spans with weak synoptic conditions favouring a possible SM-precipitation coupling. Observational data provided in the framework of the HYdrological cycle in the Mediterranean EXperiment (HyMeX) as well as satellite data such as precipitation from CMORPH, evapotranspiration from LSA-SAF and atmospheric moisture from MODIS are used for process understanding and model validation. The online trajectory module of COSMO is applied to identify moisture sources contributing to weather extremes. For the analysis of SM initialization sensitivity studies are performed with different SM initialization scenarios. Furthermore, a realistic SM initialization with state-of-art global high-resolution SM observations from the Soil Moisture Ocean Salinity mission (SMOS) is tested.