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A multi-year drought scenario for western Europe

Claudia Gessner, Erich Fischer, Urs Beyerle, and Reto Knutti

Institute for Atmospheric and Climate Science, ETH Zurich, Universitätstrasse 16, 8092 Zurich, Switzerland

During the last decades, Europe has experienced intense dry and hot spells, which seriously impact socio-economic sectors and the ecosystem by shortages of water in the summer season. The occurrence of two exceptional consecutive dry summers 2018/2019 let a multi-year drought become a conceivable scenario. In order to implement adaptation strategies for such a natural hazard, stakeholders raise the questions, how dry and hot a worst-case drought scenario would turn out and how long it would take to fully recover from those climate anomalies?

We address these concerns through the generation of storylines, describing the driest plausible multi-year droughts over western Europe. By repeatedly resampling the occurrence of precipitation in the climate simulation, using 100-member ensembles, we inhibit rainfall and dehydrate the soils in western Europe. These storylines and a millennial climate control simulation are carried out with CESM1.2 under pre-industrial forcing.

In doing so, local precipitation is reduced by 80% and local soil moisture falls far below the 1st percentile of the climatology. Even compared to the present and future climate scenarios, still, the number of dry days is very rare in our drought storyline, i.e. we describe a hazardous but unlikely scenario. Moreover, these storylines are associated with the hottest spring, summer and fall temperatures, but also the coldest winter temperatures. Starting large ensembles from each summer of the multi-year drought scenario, i.e. under exceptional dry initial soil conditions, we find that summertime hot and dry spells have a twenty-fold chance to occur plus their persistence extents by about 1.5 days. After strong precipitation deficits in the summer months, the precipitation increases again. Nevertheless, the local soil moisture does not fully recover within the next year so that the following spring and summer season may be affected by re-occurring droughts, aggravating the damage through water deficits for the vegetation growth and the economy.