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Integrative soil moisture monitoring in Switzerland for a better preparedness for projected drying trends

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Climate projections indicate an increasing risk of dry and hot episodes in Central Europe, including in Switzerland. However, models display a large spread in projections of changes in summer drying, highlighting the importance of related observations to evaluate climate models and constrain projections. Land hydrological variables play an essential role for these projections. This is particularly the case for soil moisture and land evaporation, which are directly affecting the development of droughts and heatwaves in both present and future.

The recent 2020 spring as well as 2015 and 2018 summer droughts in Switzerland have highlighted the importance of monitoring and assessing changes of soil moisture and land evaporation, which are strongly related to drought impacts on agriculture, forestry, and ecosystems. The country was affected by major drought and heatwave conditions in 2015 and 2018. While the meteorological conditions started to recover at the end of the summer, the soil moisture conditions (and runoff) continued to be anomalously low for most of the fall. This illustrates the decoupling between meteorological drought and soil moisture drought conditions related to the intrinsic memory of the soil.

The only Switzerland-wide soil moisture monitoring programme currently in place is the SwissSMEX (Swiss Soil Moisture Experiment) measurement network. It was initiated in 2008 and comprises 19 soil moisture measurement profiles at 17 different sites (grassland, forest and arable land). Since 2017, seven grassland SwissSMEX sites were complemented with land evaporation measurements from mini-lysimeters.

First, a quality assessment and inter-comparison of the in-situ soil moisture and land evaporation observations at 12 grassland sites revealed substantial discrepancies between different sensor types in terms of absolute values and data availability. A standard procedure for processing and interpreting the SwissSMEX data is thus being established. Second, analyses have been carried out comparing the SwissSMEX measurements with gridded remote-sensing and reanalysis products that provide near real time soil moisture data. In particular, the European Space Agency (ESA) Climate Change Initiative (CCI) surface soil moisture product (ESA-CCI soil moisture) as well as the new ECMWF reanalysis ERA5 are considered. The seasonal evolution of the soil moisture anomalies (with respect to the long-term mean) show for 2020 two pronounced phases of dryness. These are consistently represented in SwissSMEX in-situ observations and ERA5. Also the

other recent drought events of 2015 and 2018 show a similar temporal evolution in both datasets. The response of ESA-CCI surface soil moisture is less pronounced, more variable and also dependent on the measurement methodology, i.e., active or passive microwave remote sensing.

These first analyses provide useful insights in order to provide near-real time monitoring, enhance process understanding at the national scale and a better preparedness for future droughts.