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Attribution of soil moisture dynamics - Initial conditions vs. atmospheric forcing and the role of climate change

Rene Orth and Sonia I. Seneviratne
ETH Zürich, Zürich, Switzerland (rene.orth@env.ethz.ch)

The world's climate has started to change more quickly in recent decades and a stronger and faster shift is expected in the future. Even if the public perception is mostly limited to a widespread warming, climate change is a complex phenomenon impacting numerous variables of the climate system in different ways, also depending on time and location. Furthermore, extreme events may change more drastically than the mean climate. There is growing evidence that climate change is mostly man-made. However, it is still a matter of debate to which extent changes of the mean climate but also of particular (extreme) events are due to human impact. These questions are addressed by the growing science of climate attribution. Pointing out the anthropogenic influence on extreme events such as the 2010 Russian heatwave or the 2002 floods in Central Europe may help to support adaptation to climate change.

This study investigates soil moisture in Europe in the context of climate change, because of its role as a key variable of the land-climate system and its practical importance for instance to agriculture.
To derive soil moisture dynamics from 1984-2007 we use E-OBS forcing data together with SRB radiation data and employ an observation-based approach where soil moisture is computed from a water balance equation in which runoff (normalized with precipitation) and ET (normalized with net radiation) are simple functions of soil moisture. The constant runoff function is prescribed for the whole continent, and the ET function is calibrated using temperature data.
After performing a validation of the inferred soil moisture data we use it in order to analyze changes in the likelihood of droughts. Our results show increased drought risk especially in north-eastern Europe and the Mediterranean, whereby the probability of extreme droughts increases stronger as for mild dryness episodes. To assess the potential for drought forecasting we furthermore study the importance of the initial conditions versus the atmospheric forcing for monthly soil moisture variations. We find that initial soil moisture anomalies are overall more important than the forcing, even if less pronounced in summer. Especially in southern Europe we show high drought forecasting potential, whereas the forcing is more important in Central and North-eastern Europe.