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The magnitude of land surface persistence in absence of rainfall

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The sensitivity of evapotranspiration to soil moisture determines the persistence timescale of the land surface. Traditionally, this timescale has been derived from profile soil moisture observations leading to values in the range of 1–4 months. This timescale has been shown to increase with depth. It is however unclear from these studies what depth (or corresponding persistence timescale) is actually "felt" by the atmosphere. In absence of drainage and rainfall, this timescale can be derived directly from time series of flux observations, without the need for soil moisture observations. Here we investigate the sensitivity of evapotranspiration to soil moisture under water-limited conditions (the range where root zone soil moisture influences the partitioning surface fluxes). We study this sensitivity for different sites around the globe with different vegetation, climate and soil characteristics. In general, we find the corresponding timescales to be much smaller (2–4 weeks) than those derived from profile soil moisture observations. Possible explanations for these differences are a) persistence in rainfall forcing that is not considered in this study (possibly due to land surface-atmosphere interaction) and b) limited sensitivity of evapotranspiration to soil moisture in the "wet" soil moisture range and c) the inability of deeper soil moisture to affect energy flux partitioning at the land surface. Differences in rooting depth are likely to cause the largest differences in persistence timescales between the sites. We compared 3 observed drought events in a German lysimeter station with the corresponding GSWP2 simulations. While the observations for the different years give a consistent picture, there are large differences both between the individual GSWP2 models and between the different years.