



Critical Soil Moisture Content Estimated from Lysimeter Time Series for Different Soil, Vegetation and Weather conditions

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Evapotranspiration (ET) is a crucial terrestrial ecosystem process that links water, energy, and carbon cycles. ET can be limited by either energy or water availability. The transition between water- and energy-limited regimes is associated with the soil moisture content, and can be postulated as the soil moisture content reaching a threshold, denoted as critical soil moisture (θ_{crit}). Knowledge of θ_{crit} is important for improving land surface, hydrological and crop models and predicting hydroclimate extremes such as droughts and heatwaves. However, the quantification of θ_{crit} and the factors that impact θ_{crit} are still not well understood. Here we used precise lysimeter observations to quantify θ_{crit} by analyzing the relationship between soil moisture content and evaporative fraction (EF), as well as the relationship between soil moisture content and the actual ET/ potential ET ratio during drydowns. We estimated θ_{crit} not only at the surface layer using in situ soil moisture measurements at 10 cm depth, but also for the root zone using vertically integrated in situ soil moisture (0–50 cm) observations. We estimated θ_{crit} across various soil textures (e.g., sandy loam, silty loam, clay loam), vegetation types (grass, crop), as well as weather conditions from western and eastern Germany (spatial distances: 10 ~ 600 km). Especially, with some lysimeters that were taken from their original environment and translocated to other regions, we can identify the shift of θ_{crit} with the same soil and vegetation but under different weather conditions, which can provide implication on changes of θ_{crit} under global warming. We would expect a dependence of θ_{crit} on soil texture and weather condition. We found for example that at the same site with the same crop rotation on the lysimeters but different soils, the sandy loamy soil experienced a lower θ_{crit} (approximate 0.15 m³/m³) than the silty loamy soil (approximate 0.17 m³/m³), indicating that the higher content of sand would lead to the lower θ_{crit} . In addition, an increase in θ_{crit} was observed when the lysimeter was translocated from a site with a lower potential ET to a site with a higher potential ET.