Geophysical Research Abstracts
Vol. 19, EGU2017-3730, 2017
EGU General Assembly 2017

Quantifying spatio–temporal variations of soil moisture control on surface energy balance and near-surface air temperature

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Soil moisture plays a crucial role for the energy partitioning at the Earth's surface. Changing shares of latent and sensible heat fluxes, caused by soil moisture variations, can affect both near-surface air temperature and precipitation. Here, we use a simple framework for the dependence of evaporative fraction (the ratio of latent heat flux over net radiation) on soil moisture to analyze spatial and temporal variations of land–atmosphere coupling and its effect on near-surface air temperature. Using three different data sources (two re-analysis datasets and one observation-based data combination), three key parameters for the relation between soil moisture and evaporative fraction are estimated: 1) the frequency of occurrence of different soil moisture regimes, 2) the sensitivity of evaporative fraction to soil moisture in the transitional soil moisture regime, and 3) the critical soil moisture value which separates soil moisture- and energy-limited evapotranspiration regimes. Large parts of the global land area enter the transitional regime during at least some months of the year. Based on the identification of transitional regimes, the effect of changes in soil moisture on near-surface air temperature can be analyzed. Typical soil moisture variations can impact air temperature by several kelvin. The results emphasize the role of soil moisture for atmosphere and climate and constitute a useful benchmark for the evaluation of the respective relationships in Earth System Models.