Geophysical Research Abstracts
Vol. 16, EGU2014-6058, 2014
EGU General Assembly 2014

The role of surface vs. root-zone soil moisture variability for soil moisture-temperature coupling

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Hot extremes have been shown to be induced by antecedent surface moisture deficits in several regions. While most previous studies on this topic relied on modeling results or precipitation-based surface moisture information (particularly the standardized precipitation index, SPI), we use here a new merged remote sensing (RS) soil moisture product that combines active and passive microwave sensors to investigate the relation between the number of hot days (NHD) and preceding soil moisture deficits. Along with analyses of temporal variabilities of surface vs. root-zone soil moisture, this sheds light on the role of different soil depths for soil moisture-temperature coupling.

The global patterns of soil moisture-NHD correlations from RS data and from SPI as used in previous studies are comparable. Nonetheless, the strength of the relationship appears underestimated with RS-based soil moisture compared to SPI-based estimates, particularly in regions of strong soil moisture-temperature coupling. This is mainly due to the fact that the temporal hydrological variability is less pronounced in the RS data than in the SPI estimates in these regions, and large dry/wet anomalies appear underestimated. Comparing temporal variabilities of surface and root-zone soil moisture in in-situ observations reveals a drop of surface-layer variability below that of root-zone when dry conditions are considered. This feature is a plausible explanation for the observed weaker relationship of RS-based soil moisture (representing the surface layer) with NHD as it leads to a gradual decoupling of the surface layer from temperature under dry conditions, while root-zone soil moisture sustains more of its temporal variability.