Geophysical Research Abstracts
Vol. 14, EGU2012-6422, 2012
EGU General Assembly 2012

Monitoring transfer processes in the soil-plant-atmosphere continuum across scales using Distributed Temperature Sensing

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Distributed Temperature Sensing (DTS) is presented as a novel experimental technique to monitor soil temperature, moisture and heat flux from the meter to kilometer scale. In DTS, fiber optic cables are used to measure temperature at a resolution of ∼1m in cables up to 5km in length. Two strategies, Active and Passive DTS, can determine the soil thermal properties and moisture content. In Active DTS, a heat pulse is applied to the protective armor on the cable and the temperature response in the cable is monitored. This response depends on the thermal properties of the surrounding soil, variations in which are largely dependent on its moisture content. In Passive DTS, a profile of temperature measurements at different depths monitors soil temperature dynamics in response to the daily net radiation cycle. Amplitude and phase differences between the temperatures at different depths are dictated by the thermal properties of the soil. Amplitude analysis, an inversion approach or data assimilation can be used to infer the soil thermal properties (or moisture content) and heat fluxes.

Results will be presented from two distinct field installations. Data collected from April to July 2011 at the SMAP Marena Oklahoma In-Situ Sensor Testbed (MOISST) were used to monitored soil temperature and moisture variations in a tallgrass prairie. Results are compared to continuous measurements from point sensors at three locations at the site, as well as distributed point measurements and large-area measurements from the new COSMOS sensor. From March to September 2011, cables were buried at a grass site in Delft, the Netherlands to measure soil moisture and heat flux. Results are validated with soil moisture, thermal property and energy balance measurements. Results from the two installations will be used to explain the technology, discuss the merits and challenges of using this approach, and to demonstrate its value as a tool to monitor transfer process in the soil-plant-atmosphere continuum from the meter to the kilometer scale.