WINDSAT SOIL MOISTURE AND VEGETATION WATER CONTENT OBSERVATIONS ASSOCIATED WITH THE 2003 EUROPEAN HEAT WAVE

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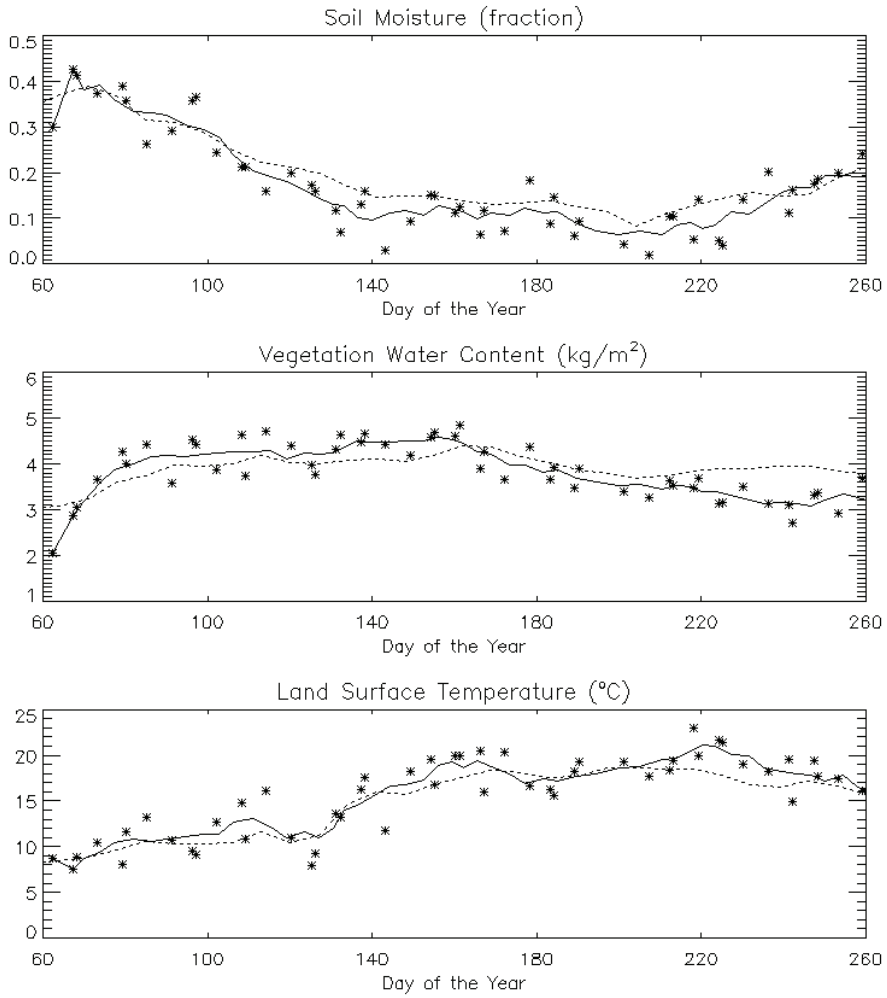
The 2003 European summer heat wave was an extreme climatic anomaly. Understanding its evolution and the underlying physical mechanisms are important for improving Europe climate seasonal forecast and developing early warning systems. Regional climate model experiments suggest that land-atmosphere coupling played an important role for the evolution of the heat wave. Extreme low soil moisture and severe vegetative stress conditions reduce the latent heat cooling and create a positive feedback effect for soil moisture-temperature interactions, which increases the heat wave duration and account for a majority of the number of hot days. However, limited ground observational data is available to corroborate the simulated dry soil conditions and ensuing soil moisture dynamics. Recently, we have developed a new remote sensing algorithm that retrieves the surface soil moisture, vegetation water content and land surface temperature simultaneously using passive microwave data from the WindSat instrument. A five-year climatology (2003 – 2007) and the associated 2003 anomaly were built for global land retrievals. Using these climatology and anomaly data, we find that WindSat soil moisture retrievals, as well as vegetation and land surface temperature retrievals, agree well with regional climate simulations in terms of the 2003 soil moisture evolution and anomaly. Furthermore, the analysis of simultaneous retrievals of the three investigated key land variables provide a description of the interplay between land surface temperature, soil moisture and vegetation water content, as well as the evolution that led to the extreme temperatures observed in August in the second phase of the 2003 heatwave.

The bottom panel in Figure below compares land surface temperature retrievals with their climatology. The dynamic range of the temperature is from 7^{o}C in the spring to 20^{o}C in the summer, which is reasonable given the WindSat early morning passes. As expected, the temperature was warmer than average throughout the spring, which is consistent with the early green-up demonstrated by the vegetation data from both MODIS and WindSat. There were three obvious positive temperature anomalies: the April anomaly around day 115, the June anomaly around day 160, and the July-August anomaly around day 220. All three anomalies can be attributed to synoptic-scale weather patterns, but they took place under different surface conditions. The April anomaly was under normal soil moisture level and high vegetation water content. For the June anomaly, the soil moisture level was low but has not yet reached extreme low values, while the vegetation water content was still near the climatology mean. The July-August anomaly took place when both soil moisture and vegetation water content have reached extreme dry levels, which is consistent with the assumption of the positive feedback mechanism between of soil moisture and temperature operating through the suppression of latent cooling interaction. Without sufficient latent cooling, the July-August heat wave became deadly. The

temperature extreme of 24°C is captured by satellite near day 218, which is about 6°C above its climatology mean.



Passive microwave remote sensing of land holds great potential for applications in a broad range of scientific and operational applications in hydrology, climate studies and agriculture. In order to realize such a potential, it is necessarily to examine the sensitivity of satellite retrievals to weather and climate phenomena. One example would be extreme climate events such as heat waves. Our study demonstrated that Windsat soil moisture and vegetation water retrievals qualitatively agree with recent studies of the 2003 European heat wave based on regional climate model simulations and MODIS NDVI measurements. In addition, the simultaneous observations of three key land parameters reveal the interplay among land surface temperature, soil moisture and vegetation water content, and provide a detailed description of the 2003 European heat wave.

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