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Combining satellite data and land model outputs to advance in the estimation of global land surface heat fluxes

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Land heat fluxes are one of the essential components of the water and energy cycles. Despite a large body of work, there is no systematic data analysis activity underway to produce a complete, phisically consistent, global, multi-decadal land heat flux data product. The GEWEX Radiation Panel (GRP) recently launched an activity, called LandFlux , to develop the needed capabilities to produce such data product. In this context, we have started to study the sensitivity of a suite of satellite observations to land surface turbulent fluxes and to investigate the possibility of estimating the fluxes from the satellite measurements. The satellite data were selected for their expected sensitivity to the surface properties that affect the fluxes, and includes: active microwave backscatter (ERS scatterometer), passive microwave emissivities (SSM/I), visible and near-infrared reflectances (AVHRR), and thermal infrared surface skin temperature (ISCCP) and the corresponding amplitude of its diurnal cycle. The fluxes calculated from some land surface models were adopted as estimates of land surface fluxes at a global scale: the GSWP-2 multi-model analysis and the NCEP/NCAR reanalysis were used, at a monthly time scale for the 1993-1995 period. To link the satellite observations to the fluxes, a statistical model based on a neural network is trained to find the global relationships between the fluxes and the satellite observations.

Comparing the fluxes predicted by the statistical model and the original land model fluxes shows that the satellite data can reproduce the fluxes with global RMS errors of less than 25 W/m2. Geographical and temporal patterns of the fluxes are realtively well captured. When there are large differences related to local departures from the global relationships, they can be used to reveal potential modelling problems. The original and estimated fluxes are also compared with climatological AmeriFlux tower flux measurements (2002-2006 annual averages), with similar correlations of Õ.7, but the comparison cannot be regarded as conclusive. It is outside of the relatively well modeled mid-latitude regions where the differences between the original and estimated fluxes are the largest, but lack of tower fluxes precludes a more extensive comparison.

This methodology is general and can also be applied to link other land model outputs and global satellite observations. However, it is tightly related to the model outputs and cannot be considered as a method to derive independent land surface products from satellite observations. Nevertheless, this statistical analysis can be an efficient tool to diagnose modelling difficulties or to combine satellite data and land models to produce global surface products maximizing their relational consistency.