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Using dual temperature difference two source energy balance model and MODIS data to estimate surface energy fluxes at regional scales in northern latitudes

R. Guzinski (1), M. Anderson (2), W. Kustas (2), H. Nieto (1), and I. Sandholt (1)

(1) Department of Geography & Geology, University of Copenhagen, Copenhagen, Denmark (rag@geo.ku.dk), (2) USDA-ARS-Hydrology Laboratory, Beltsville, MD, USA

A Two Source Energy Balance (TSEB) thermal-based modeling scheme has previously been used to successfully estimate surface latent and sensible heat fluxes at regional to continental scales with the help of satellite surface radiometric temperature observations. The Dual Temperature Difference (DTD) model introduced a simple methodology to address the sensitivity of the thermal-based energy balance models to the absolute measurement of land surface temperature (LST), which when derived with the help of satellites can have errors of several degrees. The original DTD model formulation required an early morning LST observation (1 hour after local sunrise) when fluxes were minimal followed by another LST observations later in the morning or afternoon and so was limited in use to data provided by geostationary satellites having high temporal resolution. This, however, made it unsuitable for areas at higher latitudes, such as northern Eurasia and northern North America.

In this poster we present a number of modifications to the DTD model which allows it to exploit the day and night LST observations by the MODIS sensor aboard the Terra and Aqua polar orbiting satellites. Firstly, we look at whether taking the first LST observation around the time of Aqua's night overpass, when fluxes are small but not insignificant, would greatly affect the accuracy of the model. Secondly, we consider the issues directly related to using the MODIS sensor to measure the LST. This includes different view zenith angles of the day and night LST observations, the two observations possibly coming from the two different satellites and the accuracy of the instrument itself. We also evaluate two approaches for estimating α_{PT}, the Priestley-Taylor parameter used in the TSEB modeling scheme to estimate heat fluxes of the vegetation canopy, to improve the performance of the model in coniferous and deciduous forests. The first approach estimates α_{PT} based on tree height, while the second uses fraction of vegetation that is green, calculated from vegetation indices as a multiplier of a default α_{PT} value.

We run the modified DTD model with LST observations taken by the MODIS instrument and validate the output against field measurements in a number of different ecosystems in Denmark and USA obtaining good accuracy of the modeled sensible and latent heat fluxes. Finally we produce regional maps of energy fluxes over the area of a hydrological observatory in western Denmark, HOBE.