Validating remote sensing evapotranspiration algorithms using global tower data

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Co-authorship strategy

The proposed research seeks to validate the MODIS evapotranspiration algorithm on a global scale. Site PIs with an interest in ET modelling and remote sensing will be invited to join as coauthors if they provide intellectual input to algorithm development & improvement, or assist in tower data interpretation.

Background

The validation of remote sensing data is a central concern of earth system science (Morisette et al., 2002). Research to date on MODIS validation at the tower scale is extensive, and relies heavily on tower flux datasets. For the case of FLUXNET data, this includes extensive analyses of the NEE and GPP algorithms using a subset of the Ameriflux dataset (Heinsch et al., 2006; Xiao et al., 2008; Yang et al., 2007), regional studies the MODIS ET algorithm using temperate, boreal and arctic datasets from subsets of the OzFlux and Ameriflux datasets (Cleugh et al., 2007; Mu et al., 2007; Mu et al., 2009; Yang et al., 2006), and meteorological applications with relevance to surface-atmosphere flux including surface VPD estimation (Hashimoto et al., 2008). The MODIS ET algorithms have yet to be tested against truly global tower-based ET observations, including measurements from forest, savanna, and desert ecosystems across the tropics.

Approach

The MODIS ET algorithm is an extension of work by Cleugh et al. (2007). The algorithm is a Penman-Monteith based scheme that uses vegetation indices to assist the surface resistance calculation. Mu et al. (2007) extended the original Cleugh et al. (2007) algorithm by adding VPD and minimum air temperature constraints on stomatal conductance, incorporating LAI as a canopy conductance scalar, using the enhanced vegetation index (EVI) instead of the normalized difference vegetation index (NDVI) to estimate vegetation cover fraction and LAI, and adding a soil evaporation subroutine. This revised algorithm was found to represent an improvement over the original algorithm using data from 19 Ameriflux towers.

It remains to be seen how the MODIS ET algorithm performs when compared to flux data from the tropics or other temperate, boreal and arctic/boreal ecosystem types (e.g. larch) that differ from the North American tower subset investigated to date. We will compare the MODIS ET algorithm against global FLUXNET data to identify potential errors and biases that may exist as a result of vegetation functioning in different biomes, and improve the algorithm as necessary.

In addition, we will perform initial investigations on the MODIS evaporation and transpiration algorithms against partitioned evaporation and transpiration from flux tower measurements. Some initial efforts to separate evaporation and transpiration from tower-based ET data have been undertaken (Oishi et al., 2008; Stoy et al., 2006) and show reasonable correspondence with stand-scaled sapflux data. A proposal that seeks to partition FLUXNET data into evaporation and transpiration is currently in review at NSF (PI: Stoy, CoPI: McGlynn & Richardson). Work on validating the MODIS transpiration and evaporation algorithms against these tower products will be undertaken if this grant is funded.

Any validation effort for ET must be cognizant of the energy balance closure issues with tower data, and the emerging knowledge that this may arise from larger atmospheric motions rather than sensor biases (Foken, 2008). We will undertake all efforts to minimize energy balance closure concerns via careful data screening and site selection.

References

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