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Evaporative Fraction estimated from surface observations of humidity using a simple boundary layer model.

Annu Panwar (1), Guido Salvucci (2), Maik Renner (1), and Axel Kleidon (1)

(1) Max Planck Institute for Biogeochemistry, Biosphere Theory and Modelling, Jena, Germany (apanwar@bgc-jena.mpg.de), (2) Boston University, Earth and Environment, Boston, MA, United States of America

Surface evaporation and the specific humidity of the atmosphere are two connected aspects of land-atmosphere interaction. Recent research (Gentine et al., 2016) demonstrates that evaporative fraction can be estimated by fitting the temperature and humidity predictions of slab models of the convective boundary layer to measured diurnal cycles of temperature and humidity. Here we extend this approach to a more advanced boundary layer model (Vila et al., 2015) that includes transport from the sub-cloud layer to the cloud layer, which represents an important drying term for the convective boundary layer. We also explore the utility of assuming that a diurnal equilibrium condition exists for specific humidity, wherein a similar magnitude of humidity exists at the beginning and collapse of the boundary layer growth. Under this condition, the net flux of moisture from the surface layer is balanced by the convective flux at the top of the mixed layer. This condition has been demonstrated to hold approximately when averaged over 3 to 5 days (Salvucci et al., 2017, AGU Fall Meeting) at a series of Ameriflux sites. Here we explore this condition by comparing the particular evaporative fraction for which the diurnal specific humidity demonstrates diurnal equilibrium with observations from sites in the Southern Great Plains. The surface variables of the model are initialized using FLUXNET dataset and the boundary layer variables from radiosondes and Atmospheric Emitted Radiance Interferometer data. To further validate the model, its output of diurnal air temperature for the evaporative fraction at equilibrium humidity is compared to observed air temperature. Our results show that the evaporative fractions estimated by this method are in good agreement with the measured evaporative fraction, which is significant for understanding the association of evaporative conditions to boundary layer processes and humidity budget.