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On the opposing roles of air temperature and wind speed variability in flux estimation over partially vegetated landscapes

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In semi-arid regions the evapotranspiration rates depend on both the spatial distribution of the vegetation and the soil moisture, for a given radiation regime. Remote sensing can provide high resolution spatially distributed estimation of land surface states. However, data on the near surface air properties are not readily available at the same resolution and are often taken as spatially uniform over a greater region. Concern for how this scale mismatch might lead to erroneous flux estimations motivates this effort. This paper examines the relative roles of variability in the two dominant atmospheric states, wind speed and air temperature, on the variability of the surface fluxes. The study is conducted with a Large Eddy Simulation model of the Atmospheric Boundary Layer, where the boundary conditions are given by a surface energy balance model based on remotely sensed land surface data. Simulations have been performed for the late morning hours of two clear-sky summer days during the SGP97 experiment with different wetness conditions over an area characterized by a high contrast in surface temperature, canopy cover, and roughness between vegetated and dry bare soil areas. Spatial variability in canopy density affects both the air temperature Ta, through the energy partitioning, and the wind speed U, via the roughness, leading to local variations at 5 m above the ground of the order of 1 K and 1 m/s, respectively. Simulations show that the Ta variability tends to decrease the sensible heat flux H (-30 W/m2) over bare soil areas and to increase it (+30 W/m2) over dense vegetation, thus reducing the total variability of the surface fluxes relative to those that would be

estimated for spatially constant Ta, as observed in previous studies. The variability in U tends to increase H over bare soil (+50 W/m2), while having negligible effects over the vegetation, thus increasing the spatial variance of surface fluxes. However, when considered together, the combined effect is limited (< 10 W/m2), due to a partial canceling of effects. Consequently, for operational applications, such effects on regional flux estimation are typically minor. An interesting implication for ignoring atmospheric variability over the bare soil locations, with marked water limitation, is a significant local error (>50%) in the estimation of the evaporative fraction EF. Finally, simple method to reduce the error of surface observations in not representative locations is presented.