Geophysical Research Abstracts, Vol. 9, 05802, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-05802

Heat and momentum transfer within open canopies

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Within open canopies, flux-gradient relationship for heat shows larger dependence on local stability than that for momentum in unstable condition. Here, “open” canopy refers to sufficient spacing between vegetation elements to allow significant buoyancy flux in the subcanopy. To examine different behavior between momentum and heat transfer within canopy, we analyzed within-canopy eddy-correlation data from a mature ponderosa pine site in Central Oregon, USA. One is measured in the crown space (10m) and the other in the trunk space (3m).

Using the temperature variance equation, a relationship between air temperature gradient and turbulent heat flux is derived as a function of flux-variance relationship and the ratio of turbulent transport to production for temperature variance and we evaluated flux-variance relationship in terms of local stability within canopy in unstable condition. For conditional analysis and spectral analysis, we selected 12 runs which are representative in unstable and stable condition according to local stability parameter at 10m.

Analysis results show that flux-variance relationship for temperature follows well with stability dependence of Monin-Obukhov similarity when it is normalized by neutral value. Temperature variance production nearly balances dissipation at 10m, indicating a little turbulent transport of temperature variance. On the other hand, dissipation of turbulent kinetic energy is much larger than production. Conditional analysis indicates although sweep dominates ejection for both momentum and heat transfer within canopy, the influence of intermittent large flux on total flux is smaller in heat flux than momentum flux.