Geophysical Research Abstracts,
Vol. 11, EGU2009-3889, 2009
EGU General Assembly 2009

Scale-dependency of surface fluxes in an atmospheric mesoscale model: Effect of spatial heterogeneity in atmospheric conditions

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We examined the nonlinear effect of spatial heterogeneity in atmospheric conditions on the simulation of surface fluxes in the mesoscale model, MM5 by testing their scale-invariance from a tower footprint to regional scales. The test domain was a homogeneous shortgrass prarie in the central part of the Tibetan Plateau with an eddy-covariance flux tower at the center. We found that the spatial variability resulting from changing distribution of cloulds and precipitation in the model domain affected radiative forcing at the ground surface, thereby altering the partitioning of surface fluxes. Consequently, due to increasing spatial variability in atmospheric conditions, the results of MM5 did not produce convergent estimates of surface fluxes with increasing grid sizes. Our finding demonstrates that an atmospheric model can underestimate surface fluxes in regional scale not necessarily due to intrinsic model inaccuracy (e.g., inaccurate parameterization) but due to scale-dependent nonlinear effect of spatial variability in atmospheric conditions.