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How can we quantify sub-grid land surface heterogeneity effects on mesoscale fluxes on climate model scales?

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The dynamical effect of land surface heterogeneity on heat fluxes in the boundary layer is investigated using numerical simulations with a non-hydrostatic model over a wide range of grid resolutions. It is commonly assumed that mesoscale or dynamical fluxes associated with mesoscale and convective circulations simulated by a high-resolution model (sub-grid (SG) model) on the sub-grid scale of a climate model (large-scale (LS) model) represent additional processes in the ABL, which are not considered by the turbulence scheme of the LS-model, and which can be parameterized using the SG-model. The present study investigates the usefulness of this methodology for small-scale and large-scale idealized heterogeneities using a SG-model resolving mesoscale or even microscale circulations to compute the mesoscale fluxes on the scale of the LS-model. It is shown that the dynamical transports as derived from the SG-model should not be used to correct the parameterized turbulent fluxes of the LS-model. The reason is that the sub-grid circulations simulated by the SG-model interact with the fields of wind and scalars in the ABL, which results in reduced turbulent fluxes in the ABL. Thus the methodology of previous studies to use mesoscale/dynamical fluxes for the correction of flux profiles simulated by climate models seems to be questionable.