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Trade-offs in flux disaggregation

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Airborne flux measurements can be applied to quantify the surface-atmosphere exchange over heterogeneous land surfaces. While often applied to infer area-averaged fluxes, it is also possible to infer component fluxes emanating from different surface patches via flux dis-aggregation strategies. Here, we emulate flux dis-aggregation strategies by conducting an ensemble of virtual flight measurements within a set of large-eddy simulations over idealized surface heterogeneities. The resulting patch surface fluxes are compared with the known patch surface fluxes in the simulation. To calculate fluxes along the flight leg, we applied the traditional eddy-covariance and a wavelet method.

We show that the resulting patch surface fluxes are captured best when fluxes along the flight leg are calculated with the wavelet method, where the dis-aggregation error is almost invariant of the segment length used for flux calculation. For the eddy-covariance method, however, the error strongly depends on the segment length, with largest random and systematic errors for shorter segments. Among our simulation set-ups, an optimal segment length for flux calculation is determined to be 3-4 km for the eddy-covariance method, while with the wavelet method even shorter segment lengths of a few hundreds of meters can be chosen, which enables sufficient isolation of signals from surface patches and the resolution of small-scale surface heterogeneity.