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Surface energy balance closure – the role dispersive fluxes induced by submesoscale secondary circulations

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Quantitative knowledge of the surface energy balance is essential for the prediction of weather and climate. However, a multitude of studies from around the world indicates that the turbulent heat fluxes are generally underestimated using eddy-covariance measurements, and hence, the surface energy balance is not closed. This energy balance closure problem has been heavily covered in the literature for more than 25 years, and as a result, several instrumental and methodological aspects have been reconsidered and partially revised. Nevertheless, a non-negligible energy imbalance remains, and we demonstrate that a major portion of this imbalance can be explained by dispersive fluxes in the surface layer, which are associated with submesoscale secondary circulations. Such large-scale organized structures are a very common phenomenon in the convective boundary layer, and depending on static stability, they can either be roll-like or cell-like and occur even over homogeneous surfaces. Over heterogeneous surfaces, thermally-induced mesoscale circulations can occur in addition to those. Either way, the associated dispersive heat fluxes can inherently not be captured by single-tower measurements, since the ergodicity assumption is violated. As a consequence, energy transported non-turbulently will not be sensed by eddy-covariance systems and a bias towards lower energy fluxes will result. The objective of this research is to develop a model that can be used to correct single-tower eddy-covariance data. As a first step towards this goal, we will present a parametrisation for dispersive fluxes, which was developed based on an idealized high-resolution LES study for homogeneous surfaces, as a function of non-local scaling variables. Secondly, we explore how well this parametrisation works for a number of real-world eddy-covariance sites.