Geophysical Research Abstracts
Vol. 21, EGU2019-6872, 2019
EGU General Assembly 2019
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Statistical investigations of flow structures in different regimes of the stable boundary layer

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For near-calm atmospheric boundary-layer flows in thermally stably stratified conditions, turbulence is observed to cease partially and the turbulent flux is dominated by infrequent localized mixing events. This situation represents a highly non-stationary state of the dynamics of turbulence where relationships between fluxes and the weak mean flow break down, resulting in failure of turbulence parameterisation schemes in weather and climate models. The infrequent mixing events are related to increased shear due to localised wind accelerations on the so-called submeso-scales (scales between the largest turbulent eddies and the smallest mesoscale motions traditionally specified at 2 km). The submeso motions can exhibit structures such as ramp-cliff convective patterns, waves or microfronts but are generally unknown. Here we propose a data-driven approach to study the statistical properties of flow structures occurring in classified dynamical regimes of the stably stratified atmospheric boundary layer.
A combination of methods originating from non-stationary timeseries analysis is applied to two datasets of near surface turbulence in order to gain insights on the non-stationary enhancement mechanism of intermittent turbulence in the stable atmospheric boundary layer. We identify regimes of SBL turbulence for which the range of timescales of turbulence and submeso motions, and hence their scale separation (or lack of separation) differs. Ubiquitous flow structures, or events, are extracted from the turbulence data in each flow regime. We relate flow regimes characterised by very stable stratification but different scale interaction properties to a signature of flow structures thought to be submeso motions.