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Multiscale analysis of stratified boundary layer velocity profiles in the limit of low wind condition.

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The lower atmospheric boundary layer in thermally stably stratified conditions is characterised by intermittent turbulence. This intermittency is partially triggered by the activity of so-called submeso motions in a complex way. This study analyses fluctuations of wind velocity profiles relative to a logarithmically shaped background mean scale velocity profile. The purpose is to disentangle submeso and turbulent scales in the data so as to investigate the relationship between the intensity of submeso motions and the patchiness of the turbulence.

The data analysis is performed on high-resolution nocturnal turbulence measurements that were collected during the FLOSSII field program with a 30-meter high tower. To investigate scale interactions, we use discrete wavelet transform on the wind data to separate the scales of fluctuations. The idea is to find a scale of the mean wind at which the logarithmic wind profile is clearly defined. At that averaging scale, the largest velocity is at the top measurement point. This velocity is used to scale the turbulent intensity and the sub-mesoscale wind velocity and thereby define non-dimensional ratios to compare the relative activity of submeso and turbulent scales.

We find that for this field program, the scale of the mean wind for which a logarithmic profile is clearly satisfied corresponds to averaging over 2 to 3 hours. Faster time scales correspond to localised accelerations creating inflexions in the logarithmic profile. The variety of scales between the mean wind scale and the turbulent scale are separated in two groups. The larger ones having periods from 3 to 1 hour and the submeso motions having periods from 1 hour to 5 min. The results demonstrate how the activity of these two groups of scales is becoming closely related to the intermittent behaviour of the turbulent intensity in the limit of low mean wind condition. Intermittent turbulence occurs when the variability of submeso and jet scales are of the same order as the mean scale.

This study brings new insights into the identification of scales originating in the spectral grey zone of surface-layer atmospheric turbulence.