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Interaction of turbulence and horizontal meandering in a low-wind stable boundary layer

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Turbulence structure in the very stable boundary layer (SBL) is characterized by complex interactions between the static stability of the air and non-turbulent processes that govern the mechanical generation of turbulence. Submeso motions, on scales from meters to few kilometres, can complicate the turbulence behaviour and can modulate the turbulent fluxes through the production of intermittent mixing events related to localized flow acceleration. Submeso motions can take a variety of forms including gravity waves, density currents, drainage flows. An important fraction of them is represented by horizontal meandering modes, particularly when the large-scale flow is weak; however their characteristics and their impact on turbulent transport are yet poorly studied and understood.

The aim of this work is the investigation of the characteristics of horizontal meandering motions and of their role in the turbulence productions in a very SBL, through the analysis of wind velocity components and temperature collected above an Antarctic Ice sheet during an Austral Summer. For the analysis two different methodologies have been used: the first, specifically implemented for identifying meandering motions, based on the evaluation of Eulerian auto-correlation functions (EAFs); and the second based on a Morlet continuous wavelet transform. Such combined approach enables a clear identification of periods interested by horizontal meandering motions and the determination of their characteristic time scales.
The selected periods are further analysed by using a complementary wavelet approach based on the multi-resolution flux decomposition (MRD) useful for detecting the scales of motions responsible for the shear generation of turbulence and for the flux variability. The use of the MRD methodology allows us to gain more insight on understanding the mechanism of turbulence generation by submeso motions on different time-scales and their role in influencing the turbulent transport in very stable low-wind conditions.
The analysis of the selected periods though the combination of the different methodologies of analysis allows the understanding of the conditions that trigger the meandering activation; finally, the comparison of data collected at three different measurement levels allows the study of the flow coupling at different heights within a very SBL.