EMS Annual Meeting Abstracts
Vol. 18, EMS2021-167, 2021, updated on 26 May 2022
https://doi.org/10.5194/ems2021-167
EMS Annual Meeting 2021


# Energy cascade for highly anisotropic turbulence in the Stable Boundary Layer

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The broad variety of phenomena occurring on multiple scales under stably stratified conditions and their complex interactions make it difficult to get a full description of the Stable Boundary Layer (SBL). Near-surface turbulence may be intermittent and highly anisotropic even at small scales. By studying the invariants of the anisotropy Reynolds stress tensor, it is possible to analyse the eddy kinetic energy distribution over the three components of the flow. Recent analyses of SBL turbulence data highlighted a prevalence of one-component limiting state of anisotropy. The causes of this particular limiting state are not fully understood, but there is evidence that submeso activity influences turbulence topology.

This open question motivated the present work, that addresses the issue from the point of view of space dimensionality. In large-scale atmospheric and oceanic dynamics it is well known that turbulent motions may transfer energy both to the large and to the small scales, according to density stratification and rotation. These two properties act as constraints on the flow, giving it a 2D structure, and leading turbulence to be more complex than the homogeneous and isotropic case. For a SBL in low-wind speed conditions, atmospheric stratification might be very strong and we investigate if some of the peculiar characteristics of this regime might be related to a quasi-2D dynamics, with the occurrence of an inverse energy cascade, typical of 2D-like turbulence.

Energy exchanges across larger and smaller scales are studied by analysing the direction of the momentum flux with different methods, including a coarse-graining approach based on Large Eddy Simulation (LES) theory. The SnoHATS dataset was used to this purpose, where two vertically-separated horizontal arrays of sonic anemometers over the Plaine Morte Glacier (Switzerland) allowed the computation of the full three-dimensional velocity gradient. In order to fully characterize the energy exchanges according to different states of turbulence anisotropy, energy conversion processes between eddy kinetic and potential energy have also been considered and analysed at different heights. To this purpose, the dataset FLOSSII was used, providing turbulence measurements up to 30 m above a flat grass surface, often covered by snow.

Results seem to suggest that turbulent kinetic energy in the SBL is distributed mainly in one component more as a consequence of wave-turbulence interactions than of development of 2D-like turbulence. This gives insights on mechanisms driving turbulence anisotropy that might be used to improve turbulence parameterizations in the SBL.