Nikki Vercauteren (Freie Universität Berlin):

Learning and representing multiscale dynamics in the atmospheric boundary layer

Abstract:

Atmospheric boundary layers with thermally stable stratification are the least understood type of boundary layers due to suppressed turbulence and the presence of myriads of processes on multiple spatiotemporal scales that modulate the turbulence. Stable boundary layers (SBLs) are however the norm in Polar and winter alpine environments, and more generally at nighttime. Complex alpine terrain results in even more scale interactions due to orographic effects on small-scale atmospheric dynamics. In such environments, turbulence is typically unsteady and intermittent. Classical approaches to turbulence parameterization fail to reproduce turbulent dissipation in SBL context and this is a known source of errors in larger scale atmospheric models, including climate models.

In this presentation I will approach the question of intermittency of turbulence and its partial modulation by non-turbulent motions based on multiscale data analysis and statistical learning methods. The multitude of small-scale non-turbulent motions affecting the SBL is poorly understood, and even state-of-the-art Large Eddy Simulation (LES) tools cannot generate those sources of non-stationarity of turbulence. I will show how analyzing turbulence data based on statistically classified flow regimes helps unravel organizing principles in complex dynamics of near-surface SBL turbulent flows. I will suggest a novel framework to include stochastic inflow structures representing characteristics of classified field data in a LES tool. Such a framework will enable simulations of intermittent flows by LES, and will additionally serve as a computational method to study and derive new types of stochastic parameterizations for weather and climate models.