Graduate Seminar in Mathematics

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Turbulence modeling for the atmospheric boundary layer

Abstract:

Following Nansen's (1896) observation that the direction of drift of sea ice is about 20 to 40 degrees to the right of the geostrophic wind direction, Ekman (1902) formulated a model which is now called the Ekman boundary layer. Taylor (1915) used measurements with kite ascents from a ship in the North Atlantic to predict the near surface wind direction in the turbulent Ekman boundary layer. Although there is a large body of literature investigating atmospheric turbulence, unfortunately, the phenomena is poorly understand, particularly, when turbulence interacts with on- and off-shore structures in the atmospheric (Ekman) boundary layer. Researchers conjectured that a slight improvement in understanding turbulence may result in saving hundreds of billions of dollars per year.

In this research, we have developed a Large Eddy Simulation (LES) methodology for atmospheric turbulence, and employed a cluster of wavelets to cope with the computational challenge of intermittent turbulent spots in length scales between O(m) to O(km). This talk aims at an introductory outline for the proposed wavelet based technique and turbulence modelling. Some verification results will be presented for an idealized atmospheric boundary layer where the temperature of the air laps at 10 degrees (C) per kilometer. The results are compared with that of experiments, measurements, and reference numerical simulations. This primary investigation outlines a novel technology for addressing the challenges of turbulence in the atmospheric boundary layer.