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Experimental and numerical study of vertical pro[U+FB01]les in a weakly unstable Marine Boundary Layer

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Experimental time series of vertical profiles of wind, temperature and humidity profiles in the Marine Atmospheric Boundary Layer MABL, especially from the bottom to the top, are seldom and sparse. Measurements are not usually available because of technical and ?nancial di?culties of establishing o?shore towers or platforms suitable for air-sea interaction research. Since the improvement and evaluation of microscale and meso-scale models need observations, the few available datasets are valuable for this task especially from experiments already evaluated in peer reviewed literature. In this presentation, we consider a case study of the diurnal evolution of the vertical pro?les of wind, temperature and humidity from an experimental campaign in the MABL over inner Danish waters reported in [1].

We modeled the case study of weakly unstable MABL combining large-scale information from the Weather Research&Forecasting Model (WRF) simulations and Large-Eddy Simulations (LES) at a resolution (40mx40mx18m) and compared to experimental vertical profiles. Results are in agreement with the experimental evidence that the mixed-layer height over the sea does not generally exhibit the daily variation typical of the mixed layer over land, being nearly constant over a 24-hour cycle. However, for a selected case study of one day in the summer period, the mixed layer height increases in the morning but then rapidly collapses in the early afternoon. We show that only considering the decrease of the turbulent heat ?uxes at the sea surface can not explain the observed behaviour of the mixed layer height. Numerical simulation from WRF qualitatively points to the role of a large scale subsidence: this is further quanti?ed by LES that also correctly reproduce the experimental observations of the vertical pro?les of temperature and humidity but agree less with the observed wind profiles. However, LES allow a detailed description of the statistical behavior of turbulence collapse observed in the MABL.

References

[1] Anna Maria Sempreviva and Sven-Erik Gryning: Mixing Height Over Water And Its Role On The Correlation Between Temperature And Humidity Fluctuations In The Unstable Surface Layer. Boundary Layer Meteorology, 97, 273-291 (2000)