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Mesoscale-turbulence interactions in the ABL dynamics: a 10-year study in Cabauw (Netherlands)

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The diurnal evolution of the Atmospheric Boundary Layer (ABL) in Cabauw (Netherlands) during the warmest months of the year is investigated by considering the role of local forcings and mesoscale. By local, we understand, the surface fluxes that drive the growing of the ABL in addition to the non-local entrained fluxes. We study potential disruptions occurring in spring and summer driven by the formation of sea-breeze (SB) flows in the form of density currents, due to the proximity of both The North Sea and the Markermeer-Ijsselmeer closed seas. This interactive system of surface, boundary layer and mesoscale may play a role in the transport of carbon dioxide and 222Rn, as well as some other scalars.

Our method is based on the analysis of a comprehensive 10-yr observational database (2001-2010), which gives the opportunity to understand the ABL dynamics from a robust perspective. One of the novelties is the integration of ABL height estimations from ceilometer backscatter data, using the The Haar Wavelet transform. Besides, several scalar and flux measurements are conducted along the vertical levels of the tower (2, 10, 20, 40, 80, 140, 200 m), proving an interesting snapshot of the lower atmosphere.

In order to identify the SB arrival, we apply a SB criteria selection algorithm. It is developed and adapted after a SB observational study in the Cantabrian Coast (Spain) to filter the SB events occurring in Cabauw. Results show the ability of the method to filter out clear frontal passages under fine-weather conditions. 8.4% of the total amount of days of the May-August period are selected as SB days. We classify those days intro three different ABL regimes according to the value of the sensible heat flux during the onset: convective, transition and stable regimes. First results show that the response of the ABL to the arrival of the SB flow is very distinct depending on the regime. SB direction is also proved to play a role in the transport of scalars: density currents arriving directly from the North Sea can produce abrupt increases of the CO_2 concentration, whereas the SB coming from the closed seas (N-NE) triggers a greater specific-humidity jump. Finally, we show that the evening SB events accelerate the ABL transition to stable nocturnal conditions.