Geophysical Research Abstracts
Vol. 17, EGU2015-268-1, 2015
EGU General Assembly 2015

An observational and numerical study of the sea breeze in the eastern Cantabrian coast (Spain)

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The sea breeze and its characteristics are well studied in the Mediterranean coast of the Iberian Peninsula, but not so in the Cantabrian coast, perhaps due to a lower prevalence of stable synoptic conditions during the summer period. However, it was found that the sea breeze was one of the main drivers of pollution episodes in the industrialised metropolitan area of Bilbao. In addition, an accurate prediction of this mesoscale phenomenon is fundamental for forecasting hot spells with predominant southerly gradient winds, especially in the eastern half of the Cantabrian Sea, during which can be recorded up to 40 ºC close to the shore.
In this work, an automated method is used for selecting sea breeze days [1], based in 6 filters that evaluate the observed synoptic and surface conditions in the Eastern Cantabrian, provided by the Basque and Spanish meteorological agencies. The main objective is to make an observational and numerical analysis of this phenomenon in the aforementioned region, focusing on the predictability of the Sea Breeze Index (SBI) [2] and the evolution of turbulent parameters such as the Turbulent Kinetic Energy (TKE). Numerical simulations are performed using the mesoscale model Weather Research and Forecast (WRF).
The selection method fails filtering a non-sea-breeze day owing to a shift hint in the wind direction, which is predominantly southerly making temperature reach around 40 ºC in one of the meteorological stations. This day is simulated both with and without updating the Sea Surface Temperature (SST). The latter simulation leads to a more unrealistic situation.
Furthermore, the Planetary Boundary Layer (PBL) height evolution given by the model is compared for a sea breeze and a non-sea-breeze day, concluding that the establishment of a maritime flux results in a lower diffusive capacity in the lower atmosphere, which would lead to a higher concentration of pollutants close to the surface. It is also found that the cause of the establishment of the sea breeze is the sharp decline in the value of the simulated SBI, not the value itself. Nonetheless, the complex coastline and topography cause evident spatial differences in this region, which are well represented in the outputs of the model as well as in the observed surface variables.

[1] Borne, K. & Chen, D. (1998). A method for finding sea breeze days under stable synoptic conditions and its application to the Swedish west coast. Int. J. Climatol., 18, 901-914.

[2] Simpson, J. E. (1994). Sea Breeze and Local Winds. Cambridge University Press, 234pp.