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Characterization of Sea Breeze Events in the Northwestern Mediterranean based on Observational Data

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The sea breeze is a mesoscale wind circulation that occurs in coastal regions when the air over land heats up more rapidly than the sea surface. This study focuses on the characterization of the sea breeze in a northwestern Mediterranean region, Catalonia, with the aim of analysing its characteristics, spatiall distribution and its behaviour along the coast and its inland progression. This phenomenon is particularly relevant during the summer, both for wildfire management and for its influence on pollutant dispersion, and is an important thermal regulator which could have an important impact in the climate change context

To carry out this analysis, observational data from 98 surface stations of the Automatic Weather Stations Network (XEMA) of the Meteorological Service of Catalonia were used, covering the period from 2010 to 2023. The ERA5 dataset is also used to establish the synoptic conditions where sea breeze could have been developed. The study is focused on the months from April to October, which coincide with the warmest part of the year, when this event is most frequent.To identify the days on which the sea breeze circulation occurs, several filters are applied in synoptic wind conditions and in surface variables, based on previous literature,, resulting in a total of 672 sea breeze days. Based on this selection, the sea breeze cycle and evolution was analyzed in two-hour intervals, and the Catalan territory was classified spatially using the k-means clustering technique.

Results show that the region became divided into four main areas: the coastal and pre-coastal zones in the north; the coastal and pre-coastal areas ofcenter and south Catalonia; the Ebro valley lands; and the Central Depression. The Pyrenees and Pre-Pyrenees exhibit a different behavior from the rest of the regions, being strongly influenced by local valley circulations. In general terms, the sea breeze in coastal areas typically begins from the south or southeast and evolves toward a southwesterly direction by the end of the day. In contrast, the Central Depression experiences a marked easterly flow from late evening well into the early morning.