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An analytical study of the inland penetration of sea breezes in presence of complex topography

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An understanding of the inland penetration of sea breezes is of great interest because these winds can significantly modify local weather and climate, they can have an effect on air pollution transport and dispersion, on air quality, agriculture, aviation operations and safety, sports, and tourism and services, and energy (windmills). The aim of the current study is to estimate the inland propagation of sea breezes in the Iberian Peninsula (IP), in a terrain of complex topography with wide coastal plains, river valleys and the steep Prebetic mountain ranges (1000-1600 meters) located between 10 and 15 km inland. The study area corresponds to a portion of the south-eastern coast of the IP with focus on a concave land-water boundary: the Bay of Alicante on the Western Mediterranean basin. The surface meteorological observations used here consist of 30-minute average observations of horizontal wind speed (WS) and direction (WD) data, and other meteorological variables from a single reference station (RS) during a 6-yr study period (2000-2005). Meteorological data were also gathered from a high spatial-resolution surface network with 18 automatic weather monitoring stations. An automated selection technique successfully identified a total of 475 sea breeze episodes. The mean sea breeze extent is 97.7 km. Sea breezes were seen to move inland between 18.4 km (winter months) and 224.7 km (summer months). Sea breezes are mainly confined within the convective internal boundary layer (CIBL), and the dynamic is driven by the buoyancy gradients generated by differential diabatic sensible heat fluxes. As the CIBL grows in depth during the day over land, the sea breeze density current (SBG) depends and penetrates inland through damped inertia-gravity oscillations. In the present work we also present an analytical evaluation of the sea breeze inland

penetration as a stratified density current in a dissipative rotating system. Finally, we attempt to compare the horizontal extent of this local wind circulation obtained using different methodologies: (a) an analytical model which considers the barrier effect of mountains, and (b) a simple equation which provides a first order estimation of the distance that a particle travels if the vector wind is constant along its displacement without considering topography, which can have strong local effects.