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Opposite trends of sea-breeze speeds and gusts in Eastern Iberian Peninsula, 1961-2019

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Long-term trends of local winds such as sea breezes have been less addressed in climate research, despite their impacts on broad environmental and socioeconomic spheres, such as weather and climate, agriculture and hydrology, wind-power industry, air quality or even human health, among many others. In a warming climate, sea breezes could be affected by changes on air temperature, as these onshore winds are thermally-driven by gradients between the sea-land air, but also by ocean-atmosphere oscillations or changes in large-scale atmospheric circulation. In the last few decades, advances in wind trends studies evidenced a recovery in global wind stilling during the last 10 years, and differences in the sign-magnitude of wind speed trends were found at seasonal-scale, suggesting the hypothetical effect of the reinforcement of local wind circulations in the warm seasons.

In this study, we analyze for the first time the long-term trends, multidecadal variability and possible drivers of the sea-breeze speeds and gusts in Eastern Iberian Peninsula during the last 58 years (1961-2019), using homogenized wind speed and gusts data from 16 meteorological stations. To identify potential sea breeze episodes, we developed a robust automated method based on alternative criteria. Our results suggest a decoupling between the declining sea-breeze speeds and the strengthening of the maximum gusts for much of the 1961-2019 period at annual, seasonal and monthly scales, but differences based on locations were also found. Because sea breeze changes can be driven by multiple complex factors (i.e. land use changes, land-sea air temperature gradient, complex orography, etc.), the attribution of causes is challenging. To better understand the causes behind the opposite trends between sea-breeze speeds and gusts, we investigate the effect of e.g. the changes in large-scale atmospheric circulation or physical-local factors.