EGU21-5208
https://doi.org/10.5194/egusphere-egu21-5208
EGU General Assembly 2021

Climatic effects of mesoscale sea frontal structures in the Mediterranean Sea

Fabien Desbiolles[1,2], **Agostino Meroni**[3,4], Maria Alberi[1], Mostafa E. Hamouda[1,5], Michele Giurato[1], Francesco Ragone[1,6], and Claudia Pasquero[1,7]

[1]University Milano-Bicocca, Department of Earth and Environmental Sciences, Italy (fabien.desbiolles@unimib.it)
[2]OGS, Trieste, Italy
[3]Department of Civil and Environmental Engineering, Politecnico di Milano, Milan, Italy
[4]CIMA Research Foundation, Savona, Italy
[5]Astronomy and Meteorology Department, Faculty of Science, Cairo University, Cairo, Egypt
[6]Laboratoire de Physique, ENS de Lyon, Université Claude Bernard, Lyon, France
[7]Institute of Atmospheric Sciences and Climate, Consiglio Nazionale delle Ricerche (ISAC-CNR), Turin, Italy

Sea Surface Temperature (SST) is known to affect the marine atmospheric boundary layer (MABL) at scales smaller than O(1000 km) via different mechanisms. In particular, the oceanic thermal forcing induces modification in the wind speed, its divergence and its curl by the action of the Downward Momentum Mixing (DMM) mechanism and the Pressure Adjustment (PA) one.

By analyzing 25 years of observations of surface wind speed and SST in the Mediterranean, it is found that the probability of observing surface wind convergence is significantly higher over a thermal oceanic front crossed from the warm to the cold side, in agreement with the DMM mechanism. Physically, this is due to a deceleration of the surface wind over the cold side of the SST front because of the increased atmospheric stability over the cold water. The strongest response in terms of surface convergence is found when atmospheric fronts (already characterized by strong surface convergence) cross SST gradients from the warm to the cold side.

Using 25 years of ERA5 reanalysis data, it is also found that the wind divergence variability within the MABL (until about 925 hPa) is partially driven by mesoscale SST patterns via their effect on the boundary layer stability. This results in a cloud cover and rainfall response: when a wind blows from warm-to-cold (cold-to-warm) ocean patterns, a converging (diverging) cell is enhanced, increasing (decreasing) low-cloud cover and favouring rainfall. Specifically, strong warm-to-cold fronts (the upper 25th percentile) are associated with a mean increase of cloud cover of 10±5% and a mean increase in the probability of a rain event of 15±6%, with respect to the average values.

The cloud and rainfall dependence on SST fronts is more pronounced in fall than in the rest of the year, probably due to the stronger SST gradients present at the end of the summer season. The effects on cloud cover, in particular, are a preferential way through which mesoscale SST structures can impact the radiation budget and, thus, the Earth climate.