EFFECTS OF OCEAN FRONTS ON THE ATMOSPHERIC RESPONSE IN THE MEDITERRANEAN

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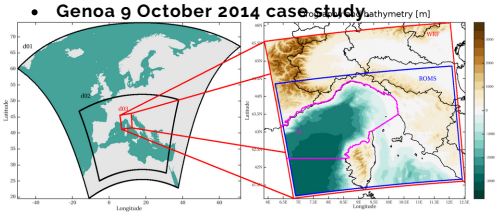
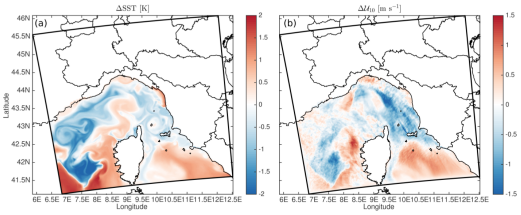
NUMERICAL APPROACH: A CASE STUDY

- **Atmosphere only and ocean-atmosphere numerical simulations with the Weather Research and Forecasting (WRF) model at convective-permitting resolution.**
- **Genoa 9 October 2014 case study.**



^ Numerical model domains: 12, 4, 1.4 km resolution.

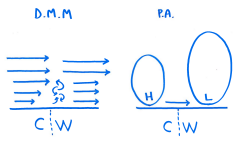
The SST is modified to study two mechanisms of surface wind control by the SST spatial structure.

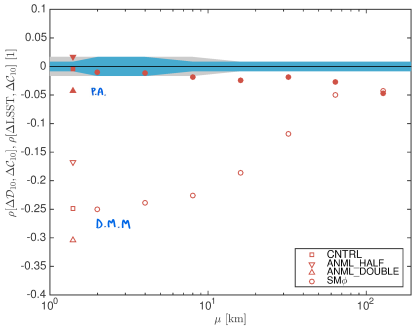


^ Maps of time average SST and surface wind magnitude anomaly (with respect to a homogeneous SST simulation).

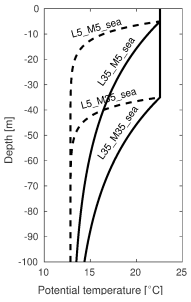
> Spatial correlation coefficients for the two mechanisms under study: surface convergence and downwind gradient for the DMM mechanism, and surface convergence and SST laplacian for the PA one.

> Schematic of the two mechanisms: Downward Momentum Mixing, DMM [Wallace et al., 1989; Hayes et al., 1989], and Pressure Adjustment, PA [Lindzen & Nigam, 1987].

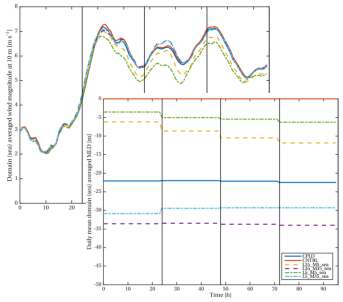




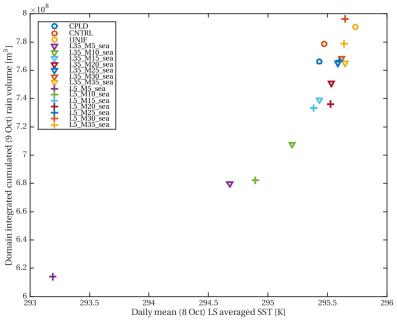
The vertical temperature initial conditions are set to analytical profiles to study the sensitivity of the rainfall to the ocean mixed layer depth (MLD) and stratification.



Some of the initial temperature profiles.



Time evolution domain averaged of the surface wind speed (rear) and the MLD (front).

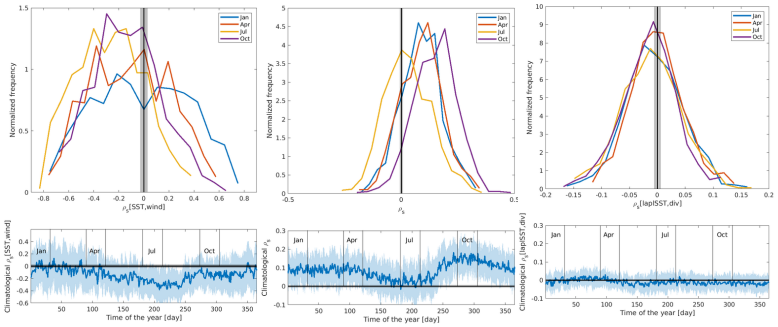


Daily rain on the 9/10/14 as a function of the daily mean SST on the 8/10/14 for all the simulations.

- **Surface wind is significantly affected by the SST structure through the DMM mechanism.**
- **Surface wind convergence can be enhanced over a SST front.**
- **For shallow initial MLD, the winds can cool down the SST so that the total rain significantly decreases.**
- **Find out more in Meroni et al. JGRA (2018) and in Meroni et al. PAAG (2018).**

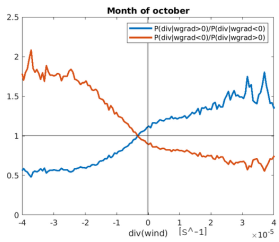
EVIDENCES IN OBSERVATIONS: A CLIMATOLOGICAL STUDY

The statistical significance of the action of the DMM mechanism is evaluated with 25 years of daily SST (NOAA daily Optimum Interpolation Sea Surface Temperature, OISST) and surface wind data (V2.0 Cross-Calibrated Multi-Platform, CCMP, analysis) in the Mediterranean, with 0.25° resolution.

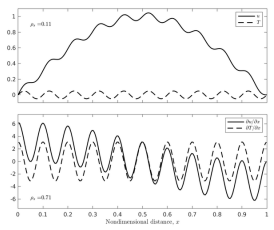


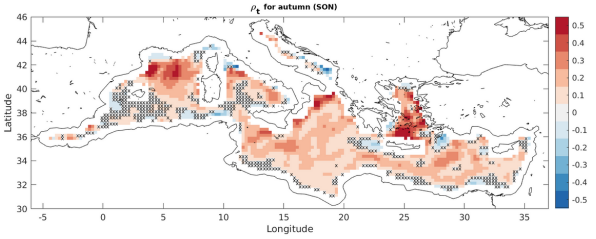
< Spatial correlation coefficient distributions and seasonal cycles for [SST, wind], [wind.grad(SST), div(wind)] and [lapl(SST),div(wind)] respectively.

Ratio of the div(wind) conditional pdfs.



Simple model to explain the role of the synoptic patters.





< Map of the temporal correlation coefficient between [wind.grad(SST), div(wind)] for the autumn season.

- **Surface wind convergence and SST fronts are significantly correlated over daily time scales**
- **In autumn, when the SST cools along the wind, it is twice more likely to produce a convergence line**
- **The large scale atmospheric dynamics masks the effect of SST on wind magnitude on daily time scales**
- **A proper representation of the SST at the 1-10 km scale is important for correct weather forecast**

Hayes S P, M J McPhaden & J M Wallace (1989), The influence of sea surface temperature on surface wind in the eastern equatorial Pacific, JCli, 2, 1500-1506.
Lindzen R S & R S Nigam (1987), On the role of the sea surface temperature gradients in forcing low level winds and convergence in the tropics, JAS, 44, 2418-2436.
Meroni A N, A Parodi & C Pasquero (2018), Role of SST patterns on surface winds modulation in a realistic midlatitudes heavy precipitation event, JGRA, doi: 10.1029/2018JD028276.
Meroni A N, L Renault, A Parodi & C Pasquero (2018), Role of the oceanic vertical thermal structure in the modulation of heavy precipitations over the Ligurian Sea, PAAG, doi:10.1007/s00024-018-2002-y.
Wallace J M, T P Mitchell & C Deser (1989), The influence of sea surface temperature on surface wind in the eastern equatorial Pacific: Seasonal and interannual variability, JCli, 2, 1492-1499.
OISST: https://www.ncdc.noaa.gov/oisst, CCMP https://www.remss.com/measurements/ccmp.