Role of moist and dry air advection in the development of Mediterranean tropical-like cyclones (medicanes)

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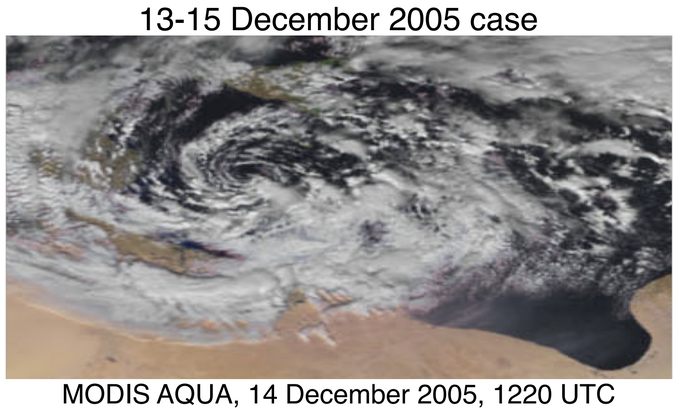
OBJECTIVES

- Analyze how local evaporation and/or long-range transport of moist air masses influence the environment where the Mediterranean cyclones form.
- Explore the effect of the long-range transport of dry air masses on the inner core of the medicanes (i.e., the dry intrusion from lower stratosphere/upper troposphere).

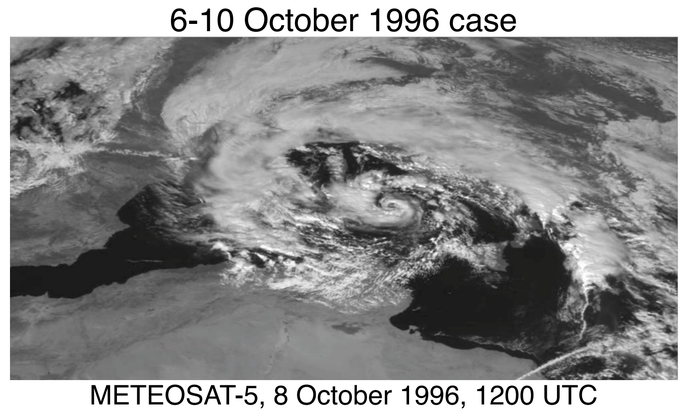
CASE STUDIES

13-15 December 2005 case



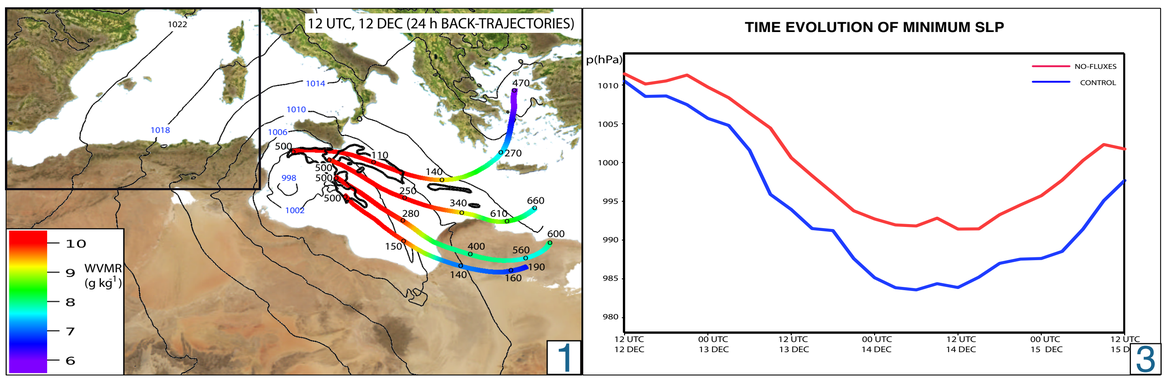
MODIS AQUA, 14 December 2005, 1220 UTC

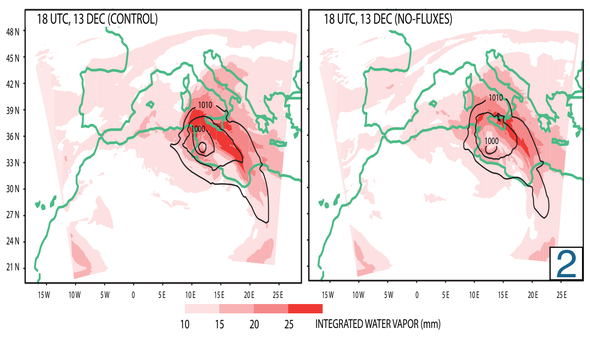
6-10 October 1996 case



METEOSAT-5, 8 October 1996, 1200 UTC

SENSITIVITY TO HEAT FLUXES

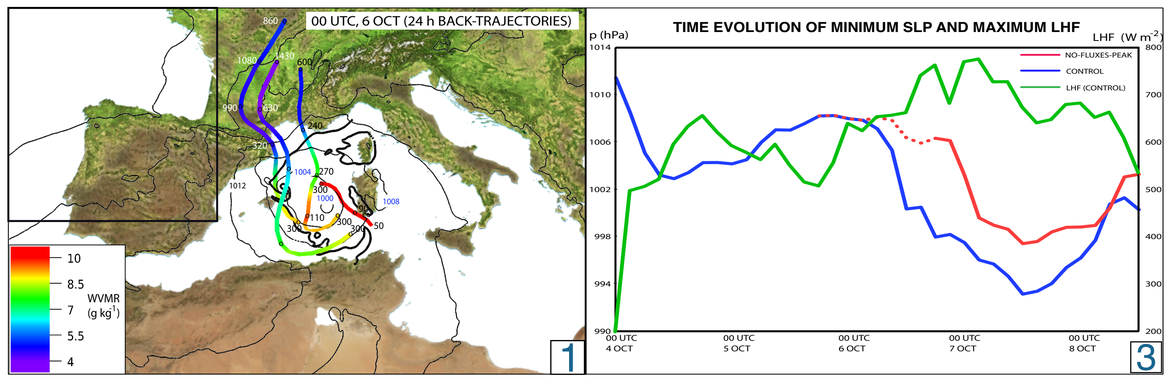


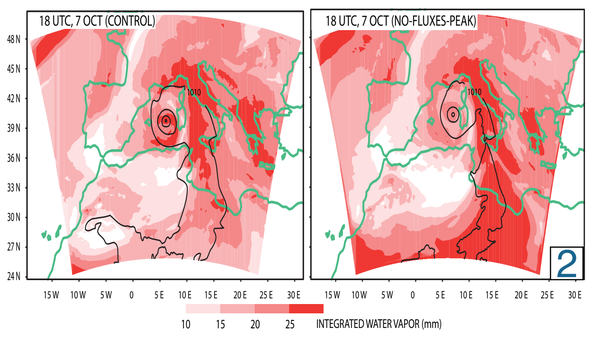


1 Air parcels from Balcans and eastern Mediterranean gain humidity from local evaporation.

2 No-Fluxes sensitivity test shows a remarkable reduction of WV in the cyclogenetic area.

3 The lower amount of humidity in the sensitivity test limits the intensification of the cyclone and the intensification rate.



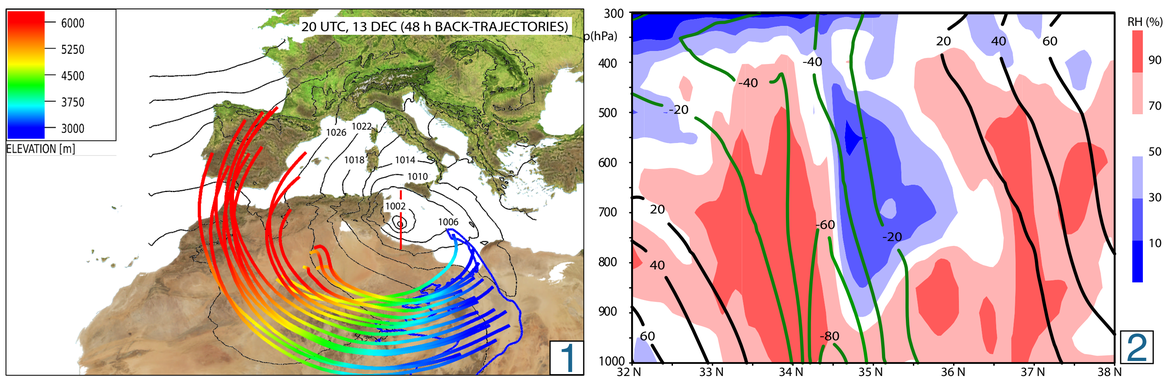


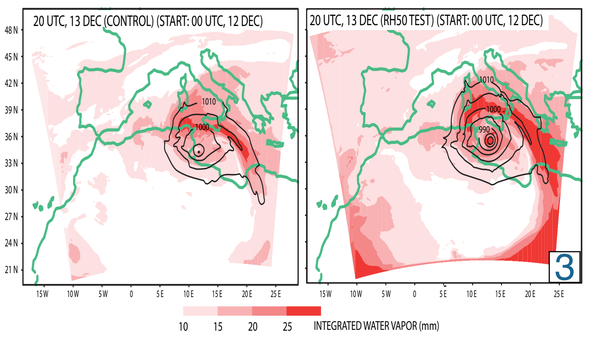
1 The outbreak of Tramontane and Cierzo winds triggers intense sea-surface fluxes around the Balearic Islands.

2 Sensitivity test without sea-surface fluxes intensification shows formation of drier air around the SLP minimum.

3 Cyclone in the sensitivity test recovers only a part of SLP minimum respect the control run, after it benefits of intense sea surface fluxes.

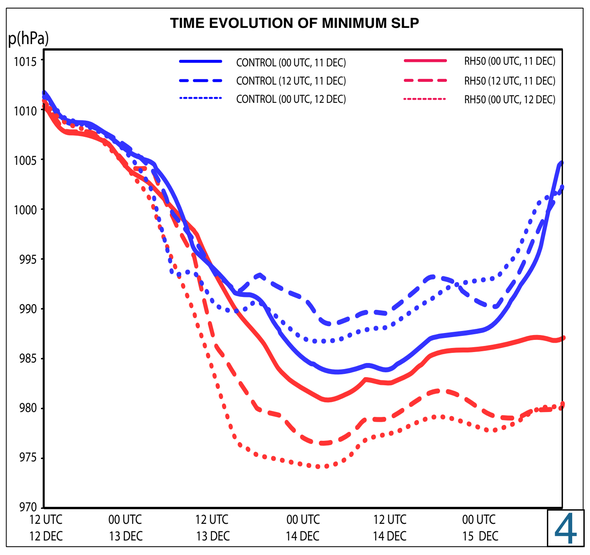
EFFECT OF THE DRY AIR INTRUSIONS





1 Back-trajectories ending at 3000 m show a slantwise-descending airstream behind the cyclone, associated with a long-range transport of upper-troposhere dry air.

2 Dry-air intrusion is apparent in the vertical cross section of RH. The dry air moving to lower levels inhibits deep convection near the center and it is confined to the outer bands.

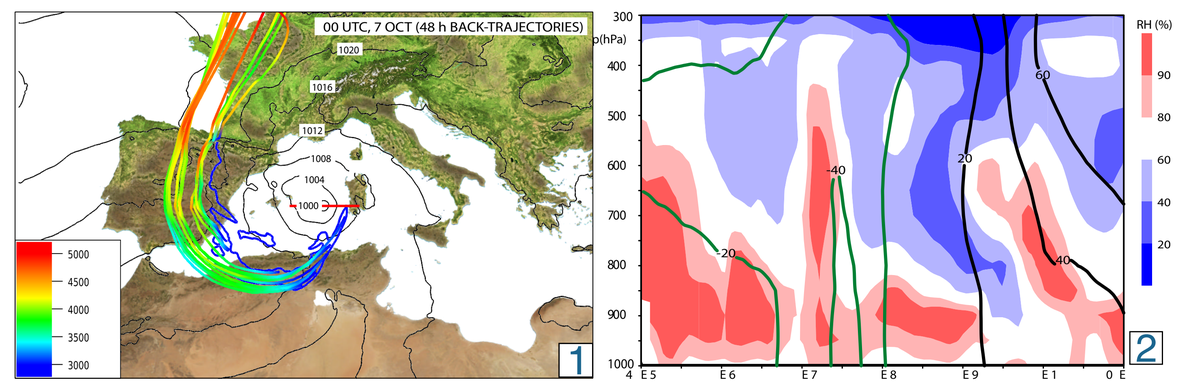


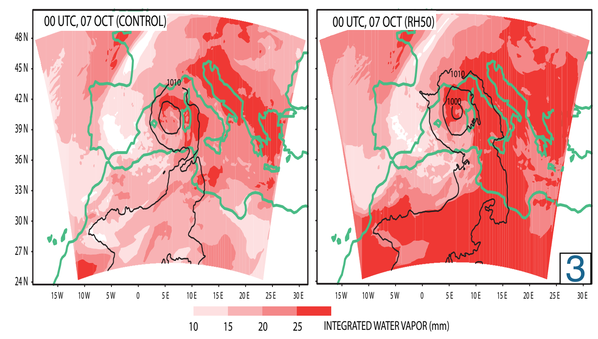
METHOD

A time-lagged ensemble of subsequent simulations each postponed by 12 hours is been used with every initial and boundary conditions modified with the constraint of minimum value of RH=50% (the most prominent effect is in the high troposphere).

3 The sensitivity test shows a deeper cyclone with more humid atmosphere than in the control run (runs starting at 00 UTC, 12 December 2005) .

4 Evolution of minimum SLP for each pair of control and RH50 tests shows that intense and longer-lasting vortices form in the sensitivity test.





1-2 Similar considerations can be done for the October 1996 case. The descending of dry air is similar but shallower. Dry air intrusion is clearly visible in the vertical cross section across the cyclone center.

3 The complex orography of western Mediterranean makes the interpretation of the results of RH50 tests less clear. Cyclone in the RH50 test show a faster development to TC-like structure with a more defined warm core.

CONCLUSIONS

- The importance of the heat fluxes from the surface appears fundamental to create a favorable environment for the development and intensification of medicanes, but there is a case-to-case dependence: in December 2005 case it is the humidity due to evaporation before formation that plays a key role, while in October 1996 case are the stronger fluxes induced by the outbreak of Mistral and Tramontane that determine an increase in humidity.
- The effect of dry air intrusions (i.e., air with lower moist entropy) from the upper troposphere into the cyclone inner core prevents this type of cyclone from developing more intense convection. In general, the increase in humidity at high altitude allows a more rapid intensification and a longer duration of the cyclone's life.

REFERENCES

For additional informations: Miglietta et al. (2021), *Q. J. Roy. Met. Soc.*, https://doi.org/10.1002/qj.3951 —— Miglietta and Rotunno (2019), Q. J. Roy. Met. Soc., https://doi.org/10.1002/qj.3503 —— Fita and Flounas (2018) for December 2005 case —— Reale and Atlas (2001), Mazza et al. (2017) for October 1996 case