

# Heavy precipitation events in Italy: lessons from the HyMeX SOP1 campaign



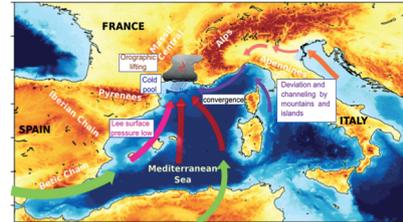
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## INTRODUCTION

The first Special Observation Period (SOP1) of HyMeX (Hydrological cycle in the Mediterranean eXperiment) was held in Fall 2012 and focused on the observation and real-time numerical simulation of heavy precipitation events (HPEs) and floods in the northwestern Mediterranean.

Nine of the twenty intensive observation periods (IOPs) involved the three Italian target areas, enabling unprecedented monitoring and analysis of intense precipitation systems over the three Italian target areas: north-east (NEI), Liguria and Tuscany (LT), and central Italy (CI).

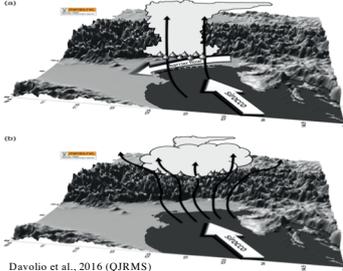
Main mesoscale processes responsible for HPE in the western Mediterranean region



Ducrocq et al., 2016 (QJRM)

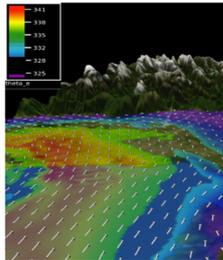
## NORTHEASTERN ITALY AND PO VALLEY

Sketch of the key mechanisms in the two different precipitation patterns over NEI, depending on the stability and wind (Froude number). (a) **Upstream event**: blocked low-level flow, barrier wind, convergence and deep convection development over the plain, upstream of the orography. (b) **Alpine event**: unblocked low-level flow, flow-over, orographic lifting and precipitation over the Alps with possible embedded convection.



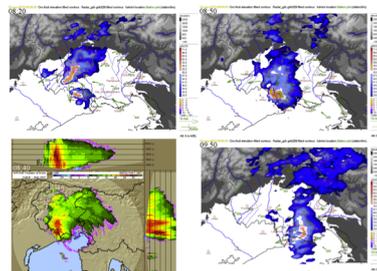
Davolio et al., 2016 (QJRM)

IOP2b: Moist tongue advected toward the eastern Po Valley before the supercell development. The curved shape is due to a shallow pressure low in NE Italy.



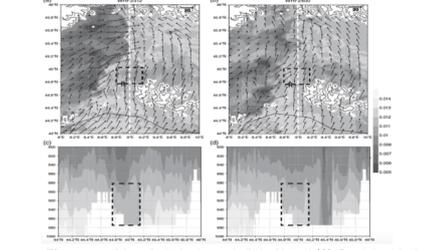
Miglietta et al., 2016 (QJRM)

IOP2b: Interaction between two convective cells and evolution into a small bow-echo-like structure during severe convection



Manzato et al., 2016 (Atmos. Res.)

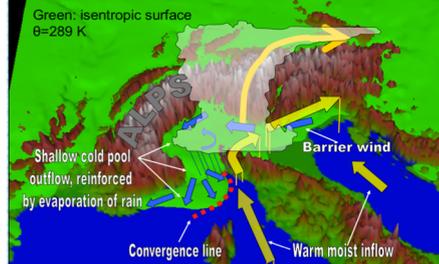
IOP6: Predictability of convection in the Po Valley critically depends on the intensity of the drying subsidence in environmental conditions close to the threshold between "flow-over" and "flow-around" regimes ( $\frac{h}{H} \sim 1$ ).



Pichelli et al., 2017 (QJRM)

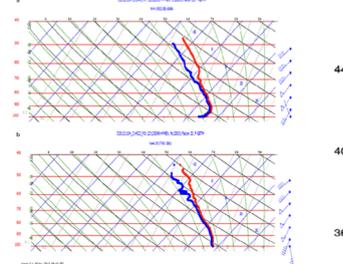
## LIGURIA AND TUSCANY

Sketch of the key mechanisms for localized HPE in Liguria due to quasi-stationary MCSs Convection triggering is due to the **convergence** of two main low-level currents: - a persistent low-level moist and conditionally unstable LLJ over the Tyrrhenian Sea; - outflow of cold and dense air spilling from the Po Valley through the lowest gaps of the Apennines and propagating as a density current over the Ligurian Sea



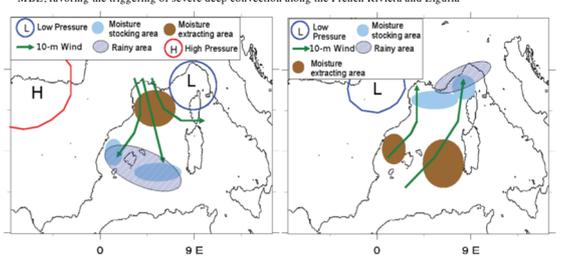
Following Buzzi et al., 2014 (NHES)

IOP19: Vertical profiles of two dropsondes in the Gulf of Genoa at 2140 UTC (DS1) and 2145 UTC (DS2), 4 Nov 2012. DS1 (top): a sharp low-level inversion, below 900 hPa, is produced by the N low-level flow advecting cooler air from the Po Valley. DS2 (bottom) intense S (SW aloft) wind was recorded.



Ferretti et al., 2014 (HESS)

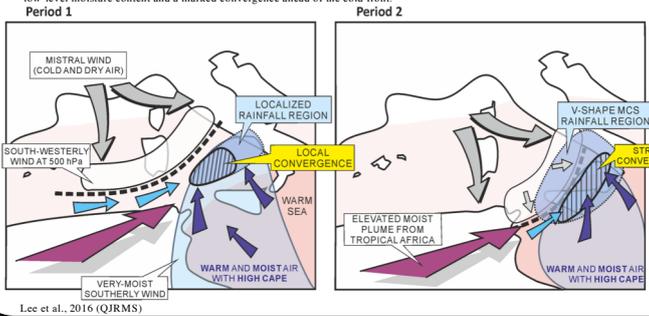
IOP13 showed the importance of air-sea exchange processes, even in area relatively far in the Mediterranean and few days in advance 1<sup>st</sup> phase (left): moisture and heat are extracted over the Gulf of Lion, mainly due to strong air-sea vertical gradients due to the drier/colder air (Mistral), and then advected southward, in the area where convective precipitation formed. 2<sup>nd</sup> phase: due to moderate SSW winds, moisture was extracted and transported to the French coast within the thin MBL, favoring the triggering of severe deep convection along the French Riviera and Liguria



Rinaud et al., 2016 (QJRM)

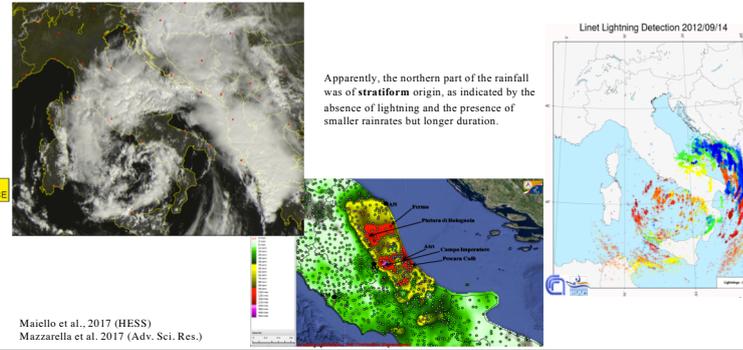
## CENTRAL ITALY

IOP13 (15 Oct 2012): Sketch of the key mechanisms responsible for the maintenance of deep convection leading to HPEs. (a) Period 1: low-level convergence over the Tyrrhenian Sea between SW ahead of the upper-level trough and S over the Strait of Sicily that advected warm and moist low-level air, an elevated moisture plume from the Tropics enriched the mid-level humidity. (b) Period 2: an MCS initiated by the orography over Algeria travelled toward Southern Italy. Convection was maintained by the large low-level moisture content and a marked convergence ahead of the cold front.



Lee et al., 2016 (QJRM)

IOP4 (14 Sep 2012): HPE over the eastern side of central Italy, affecting coastal and mountain areas, are associated with a cut-off low over the southern Tyrrhenian Sea, and enhanced by the moisture advection due to Bora flow over the Adriatic Sea.



Maiello et al., 2017 (HESS)

Mazzarella et al., 2017 (Adv. Sci. Res.)

## RESULTS

- 1) Improved understanding of the mechanisms responsible for HPEs
- 2) Analysis of the main findings emerged in the HyMeX campaign over Italy
- 3) Identification of the relevant mesoscale features and conceptual models over the three target areas

For additional information: MM Miglietta, S Davolio, Heavy precipitation events in Italy: lessons from the HyMeX SOP1 campaign, HESS, in preparation