

HyMeX PRELIMINARY ANALYSIS OF THE INTENSIVE OBSERVATION PERIOD EVENTS OCCURRED IN ITALY DURING THE HYMEX CAMPAIGN

R. Ferretti, E. Pichelli, S. Gentile, V. Colaiuda, I. Maiello⁽¹⁾, R. Rotunno⁽²⁾, N. Loggisci⁽³⁾, A. Montani, C. Marsigli⁽⁴⁾, A. Pucillo, A. Manzato⁽⁵⁾, M. E. Ferrario⁽⁶⁾, S. Gallino⁽⁷⁾, F. Pasi, G. Bartolini⁽⁸⁾, S. Davolio, G. Panegrossi, M.M. Miglietta⁽⁹⁾, D. Cimini⁽¹⁰⁾, A. Santacasa, D. Ronconi⁽¹¹⁾, S. Mariani, M. Casaioli⁽¹²⁾

⁽¹⁾ University of L'Aquila, Physics – CETEMPS, L'Aquila, Italy (rossella.ferretti@aquila.infn.it), ⁽²⁾ NCAR – National Center for Atmosphere Research, ⁽³⁾ ARPA Piemonte – Weather Forecasting Department, ⁽⁴⁾ ARPA Emilia Romagna – SIMC, ⁽⁵⁾ ARPA Friuli Venezia Giulia – OSMER, ⁽⁶⁾ ARPA Veneto, ⁽⁷⁾ ARPA Liguria, ⁽⁸⁾ LAMMA Toscana, ⁽⁹⁾ CNR ISAC, ⁽¹⁰⁾ CNR IMAA, ⁽¹¹⁾ CFA, Regione Abruzzo, ⁽¹²⁾ ISPRA, Rome

BACKGROUND

HyMeX – Hydrological cycle in the Mediterranean eXperiment is an international programme which aims at a better understanding and quantification of the hydrological cycle and related processes in the Mediterranean basin.

As a part of HyMeX, Special Observation Periods (SOPs) are dedicated to provide detailed and specific observations to study key processes leading to orographic precipitation (ORP), heavy precipitation events (HPEs), flash flood events (FFE), intense air-sea exchanges and dense water formation in three Target Areas (TAs): NW Mediterranean Sea, Adriatic Sea and SE Mediterranean Sea.

Informed by numerical weather forecasts and standard observations, Intensive Operation Periods (IOPs) are declared during each SOP. Specific observations in the TAs are provided by operational measurements (ground meteorological networks, soundings, and remote-sensing instruments), coupled with specific measurements during IOPs from several instruments, such as disdrometers, sodars, lidars, research radars, extra soundings.

An overview is presented here of the HyMeX IOPs in Italy during SOP1 (5 September–6 November, 2012). The hydrometeorological sites of interest were: Liguria-Tuscany (LT), northeastern Italy (NEI) and central Italy (CI).

TARGET AREAS & TEST-BED SITES

OBSERVATION STRATEGY

- LOP:** Long-term Observation Period to analyze seasonal-to-interannual variability
- EOP:** Enhanced Observation Period foreseen for both budget & process studies
- SOP:** Special Observation Periods to study key processes of the water cycle

Legend:
□ Hydrometeorological sites
● Long term ocean sites
★ Long term land surface sites

Timeline: 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020

Annotations:
- LOP (Long-term Observation Period)
- EOP (Enhanced Observation Period)
- SOP1 (Special Observation Period 1)
- SOP2 (Special Observation Period 2)

NEI HYDROMETEOROLOGICAL SITE

In this region, HPEs mainly occurred with upper level southwesterly flow ahead of advancing troughs with low-level moist southerly or southeasterly flow over the Adriatic Sea.

One of the most interesting HPEs for the NEI site occurred on **12-13 September 2012 (IOP2)**: a maximum of 97.0 mm in 24 hours – with 53.0 mm in only 1 hour (between 1300 and 1400 UTC) – was recorded at Crespano del Grappa in Veneto, whilst in Friuli Venezia Giulia (FVG) precipitation in 24 hours exceeded 100.0 mm as observed by rain gauges (Palazzolo station), with an estimate maximum of about 150.0 mm, derived by the Fossalon di Grado radar SRI combined with rain gauge data.

Short range forecasts reproduced pretty well the large scale and the mesoscale features responsible for the event. All the investigated Limited Area Models (LAMs) provided by the Italian MET community – available online at <http://sop.hymex.org/> – captured the convergence among the Low Level Jet confined close to the east coast of the northern Adriatic, the southwesterly flow across the Apennines, the east-northeasterly barrier flow just inshore the FVG coast. This convergence was responsible for the convective triggering.

However, the exact location and timing of both the convective cells that crossed the NEI area on the morning of 12 September were not correctly reproduced by LAMs: e.g., the 2.3-km MOLOCH-ISAC run reproduces pretty well the southern cell (panel c) but misses the northern one, which is the only one captured by the WRF-ISAC run (panel d).

Daily rainfall on 12 September in Veneto region (left panel) and Friuli-Venezia Giulia region (right panel).

Track of the ATR42 flight (Italy4) activated for IOP2

LIDAR along the flight track

Courtesy of SAFIRE team

CI HYDROMETEOROLOGICAL SITE

Among the HPEs and FFEs monitored in CI during SOP1, the event occurred on **15-16 October 2013 (IOP13)** is presented here as a typical situation of prefrontal precipitation. Also the LT and NEI areas were affected by this weather system (see lightning image). The precipitating events were associated with a wide upper level trough over France with a cold front moving and advecting low level moist air towards Corsica and Italy. The main convective activity was located in the pre-frontal warm air sector, in the narrow cold frontal rainband and behind, under the upper cold low (see the synoptic situation at 1800 UTC).

A maximum rainfall of 60 mm 24h⁻¹ was reached on 15 October. Almost all of the precipitation occurred in the late afternoon, with a remarkable maximum of rainfall rate of 35 mm h⁻¹ at 1800 UTC, whereas little precipitation amounts were recorded at night and in the morning.

Most of precipitation occurred on the western slope and on the Apennines, as observed by the disdrometers purposely installed at L'Aquila and Pescara (eastern slope) that recorded 9.8 mm and 5.0 mm, respectively.

Synoptic analysis and forecast at 1800 UTC on 15 October. Left panel: ECMWF 500-hPa GPH (green lines), 700-hPa temperature advection (red warm and blue cold), the MSG SEVIRI AirMass RGB composite EumetSat product and the enhanced IR 10.8 μm temperature, ranging between 200 K (red) and 240 K (blue) – Source: <http://www.eumettrain.org>. Right panel: 0.07° BOLAM-ISPRA forecast for 500-hPa GPH (blue contour lines), 300-hPa wind (> 10 m s⁻¹) and 1.5 PVU isosurface (color shaded area).

LINET lightning activity measured on 15 October.

Daily rainfall on 15 October: (a) observations from regional networks – Courtesy of DPC; (b)-(c) deterministic forecasts from 3-km WFR-ARF of CETEMPS and 2.5-km MOLOCH-ISPRA; (d)-(e) probabilistic forecasts from 2.8-km COSMO-H2-EPS of ARPA SIM (p>10.0 mm & p>50.0 mm).

For IOP13 deterministic and ensemble forecast were available: such richness of products eased the forecaster work. Further investigation are necessary to evaluate why two deterministic model chains sharing the same ECMWF initialization provided an overall good forecast but with some differences. Are these differences consequence of the different models used? Or are they due to the differences in the parent model design?

LT HYDROMETEOROLOGICAL SITE

The HPE presented here occurred over LT and NEI areas on **3-5 November 2012 (IOP19)**. A maximum precipitation of 317.0 mm in 3 days was observed in LT (see gauges and radar-satellite estimate). Events of this kind are generally well forecasted days in advance by LAMs. Also in this case, models performed quite well resulting of great help for weather forecasters. A *posteriori* analysis shows that LAMs' forecasts correctly simulate the precipitation structure with the two maxima over the two mountain ridges, even if more precipitation were forecast over the Apennines than on the Apuan: LAMs overestimate the forcing by the highest mountain ridge (Apennines) that turns in an underestimation of the Apuan rainfall maxima.

The main characteristics of such kind of ORP are:

- SW advection of warm and humid air plus orographic lifting (Apennines) → instability;
- topography-forced low-level convergence → local rainfall maxima, leading to FFEs;
- surface cold air in the Po valley (ground thermal inversion) intruding from the valleys (drainage gap flow) → winds nearly opposite to the gradient flow, producing local convergence.

Falcon flight track (bottom panel) and radar reflectivity (top panel) on 5 November.

Daily accumulated precipitation for 4 November forecast by (a) 3-km WRF-ARW of LaMMA (+24hrs forecast), (b) 2.3-km MOLOCH-ISAC (+24hrs forecast), (c) 3-km WRF-ARW of LaMMA (+48hrs forecast) and (d) 2.3-km MOLOCH-ISAC (+48hrs forecast).

Daily accumulated precipitation observed by rain gauges on 3 and 4 November.

Hourly accumulated precipitation retrieved by radar and MSG satellite on 3 November at 2200 LST and on 4 November at 2300 LST – Courtesy of DPC.

The SOP1 campaign required a huge effort in terms of coordination and logistics and it experienced an extraordinary monitoring activity (partially shown here, details are available at <http://sop.hymex.org>) as well as an outstanding number of implemented weather forecasting modeling chains. A national operational centre has been organized at the University of L'Aquila, coordinated by CETEMPS, with the aim of supporting the activity of the main HyMeX Operational Centre in Montpellier (France). The national operational centre represented an important opportunity for multidisciplinary activity, characterized by an almost unprecedented collaboration in an international framework among the Italian meteorological, hydrological and oceanographic scientific communities, from both modeling and observational fields.

The activities carried out during the field campaign and planned for the upcoming years represent an important opportunity of exploiting the synergy between a unique database of observations and model simulations in order to improve the knowledge and forecasting ability of high impact weather events. This poster represents just the first step towards a coordinated activity of the large Italian scientific and operational community in the field.