The 26th September 2007
Venice extreme convective rainfall event

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Agenzia Regionale per la Prevenzione e Protezione Ambientale del Veneto

Introduction

- ARPAV is the Regional Agency for Environmental Prevention and Protection of the Veneto , the region of Venice, in Northeastern Italy.
  The Meteorological Centre of Teolo (CMT) belonging to ARPAV is the operational regional meteorological service in Veneto.
- The multisensor network of ARPAV includes two meteorological C-band radars, Meteosat-9 satellite data, and a high-resolution surface network of automatic weather stations. Data analysis allowed to find interesting features of the storm environment.

Fig. 1: Veneto region in Europe

Synoptic situation

- A surface low formed in the very first hours of September the 26th on the Gulf of Genoa in northern Italy. Aloft a trough deepened advecting cold air from North Europe to South France towards the Alps
- Surface winds intensified during the night from southeast on the North Adriatic Sea and from northeast on the Veneto region inland

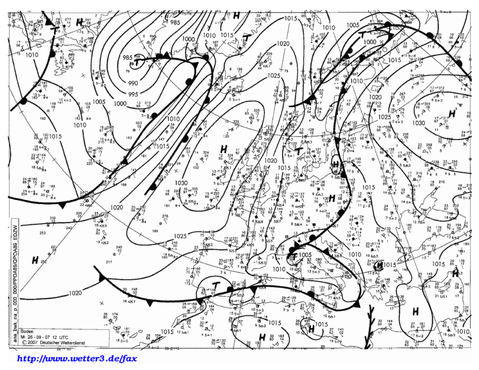


Fig. 2: Surface analysis

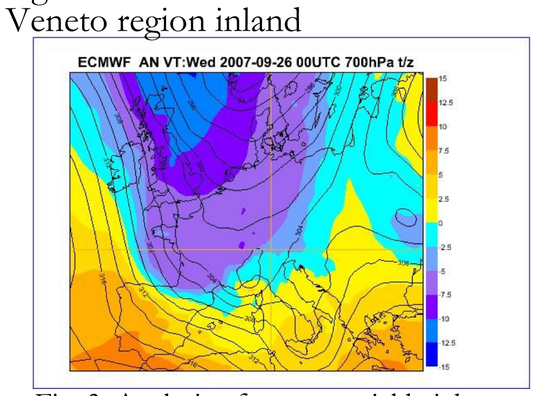
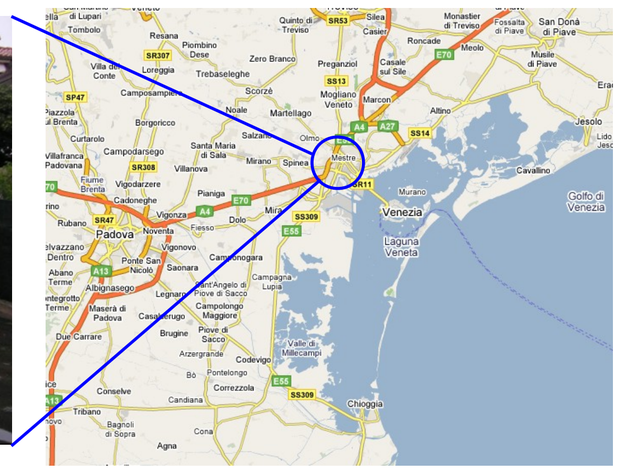


Fig. 3: Analysis of geopotential height and temperatures at 700hPa

Fig. 4: Floods in urban area



Motivation for the case study

- In the early and morning hours of the 26th September surrounding areas of Venice were hit by extreme rainfall caused by severe thunderstorms which developed close to the central-southern coastline of the north-eastern Italian region Veneto. The main effects of the event were the exceptionally high rainfall rates and large amounts of accumulated precipitation in short time intervals. Some different raingauges observed 250 mm in three hours and 300 mm in six hours, numbers close to the 40% of annual total rainfall (700-800 mm).
- The specific position of the area of interest close to the western Veneto radar site allows a detailed analysis of the convective event. The area invested by the thunderstorms is densely populated so that many people experienced the effects of floods in urban area.

Storm evolution

At first a low topped supercell (echo-top below the height of 6-7km) formed with the typical weak echo region and mini hook echo as nicely visible in the radar data (Fig. 5 and 6). The main effect of this low-topped supercell was the high precipitation rate.

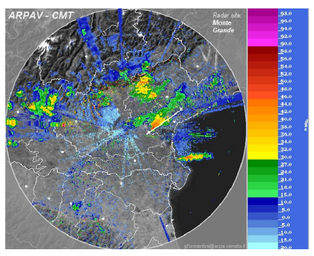


Fig. 5: reflectivity of the Teolo radar PPI 0.8° 00:40UTC 26th September 2007

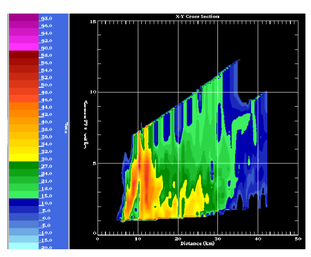


Fig. 6: Teolo's radar corresponding vertical cross section

At 3:50 the supercell dissipated moving westwards but the convergence between its outflow and the south-easterly winds over the north Adriatic Sea gave rise to a second low-topped supercell. Between 4-5UTC convection changed its characteristics from supercellular to multicellular.

A very strong convergence between northeastern relatively cold and warm and humid southeastern air formed close to the shoreline and became the focus point that triggered and drove the convection from this time onward (Fig. 7).

For many hours different cells originated, developed and dissipated much over the same geographical area. The main system took the form of a multicell convective system with very low translation velocity causing large amounts of rain accumulations. From 07UTC the system became a V-shape mesoscale convective system causing floods in the very densely populated Mestre-Venice metropolitan area (Fig. 8).

During the morning the multicell system started to evolve moving eastwards and showing progressively decreasing rain rates.

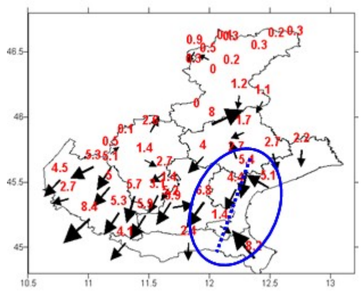


Fig. 7: Wind vectors (m/sec) from automatic surface stations valid for 05UTC. The blue dashed line denotes the low-level wind convergence

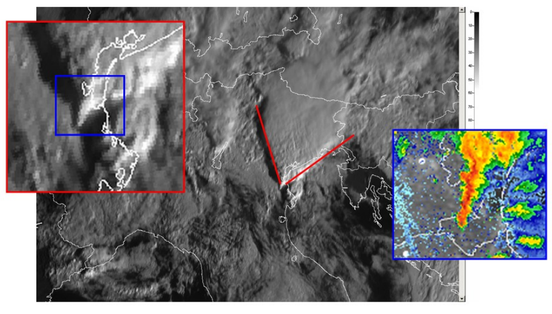


Fig. 8: HRV MSG satellite image with superimposed radar image at 07:00UTC

Precipitation measurements

The main effects of the event were the very high rainfall rates and large amounts of precipitation accumulated in short time intervals in a restricted area of the region invested by the thunderstorms. This area, on the central-southern coastline of Veneto, is close to Venice and densely populated so that many people experienced the effects of floods in urban area. Fig.9 shows the isolines of total daily precipitation measured for the day of 26 September 2007 by 161 ARPAV raingauges in Veneto.

The rainiest area is the central and southern part of Venice Province, close to the lagoon, where 5 rain gauges measured more than 160mm, with maximum values of 260.4mm (Mestre raingauge) and 324.6mm (Valle Averto raingauge).

The extreme behaviour of the 26 September event is described in the maps of Figs. 10-11-12, where a composite map of the maximum 30 minutes, 1 hour and 6 hours precipitation accumulation recorded at each station is shown. Note that the maximum did not necessarily happen in the same time.

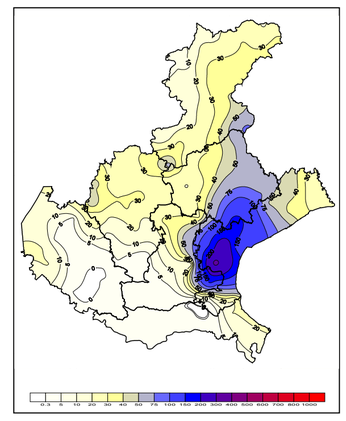


Fig. 9: Daily precipitation accumulation

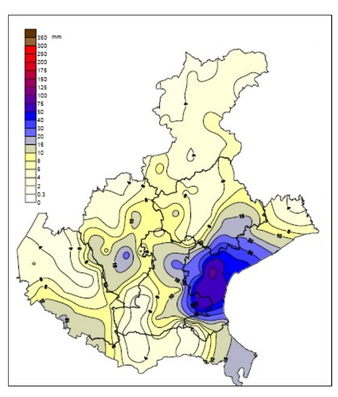


Fig. 10: Maximum 30 minutes precipitation accumulation

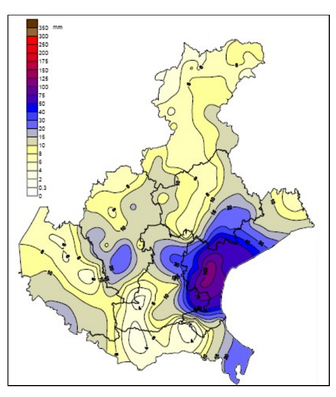


Fig. 11: Maximum 1 hour precipitation accumulation

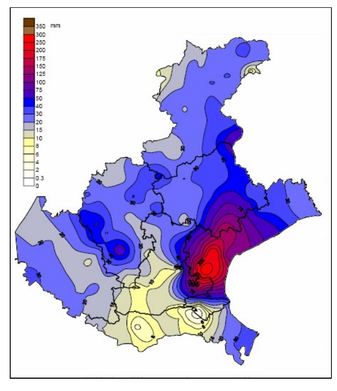


Fig. 12: Maximum 6 hours precipitation accumulation

The extremely high intensity of the events registered in this area are further evidenced by the comparison with the 100 years return time precipitation reference values. For two stations in the area the 1 to 12 hours maximum precipitation accumulation are two to three times higher than the reference values.

Conclusions

- The area surrounding Venice experienced an extremely strong precipitation event on the 26 September 2007.
- Within a few hours 40% of the total annual precipitation amount was recorded.
- Severe weather events frequently happen in September and October in the areas close to the Adriatic sea. The water basin with relative high temperatures plays a crucial role in the triggering and/or enhancement of convection.
- Key factors for the event have been studied thanks to the availability of a very detailed observing system (radar, satellite, dense network of automatic surface weather stations).
- To better understand the convective dynamics and its interplay with the mesoscale environment, further studies should be carried on, including numerical simulations with proper resolution and parametrisation.