RADAR QPE ANALYSIS OF AN EXTREME RAINFALL EVENT IN THE REGION OF VENICE

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Introduction

Fig. 1: Veneto Region in Northeastern Italy

It is well-known that information on real-time distribution and short-term forecasting of precipitation is a crucial input for civil defence activities.
Several procedures are based on predefined threshold values related to recorded raingauge data. In this framework a question can arise: "Could weather radar play a role, to bring into account that it has a unique capability of monitoring precipitation with high spatial and temporal resolution?". The present study deals with such kind of considerations in connection with an extreme event occurred in the eastern area of the Veneto Region (Fig. 1). Furthermore some limits related to precipitation estimation by weather radar are considered, first of all attenuation suffered by C-band radar when strong rain occurs. It is well-known that dual polarisation can be a significant added value, but the present case was monitored by a couple of "conventional" radars from different spatial locations, i.e. different "points of view".

Overview of the 26th September 2007 event

The synoptics of 26 September 2007 was characterized by a surface low on the Gulf of Genoa and an upper trough advecting cold air from North Europe towards the Alps. This scenario led to strong instability conditions in the eastern area of Veneto Region.

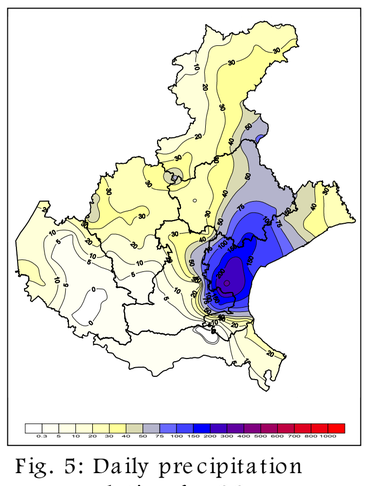
Fig. 5: Daily precipitation accumulation for 26 September 2007 for Veneto, based on the 161 raingauges ARPAV network

For many hours both low-topped supercellular (Fig. 2 and 3) and multicellular (Fig. 4) systems regenerated continuously on the area causing large amounts of rain accumulations.
Later in the morning the systems started to evolve moving eastwards and showing progressively decreasing rain rates.
The main points of the precipitation event were:

- low level convergence, with strong southeasterly winds on the sea and shoreline and moderate to strong northeasterly winds inland kept the system stationary;
- advection of very humid and warmer air from the sea that contributed to enhance instability;
- moderate shear supported the multicell organization of the convection;
- moderate medium troposphere winds (3000-5000m) supported continuous regeneration of cumulonimbus clouds in the same area (flanking line);
- divergence in the left-exit region of the jet stream at high levels enhanced the convergence in the low levels.

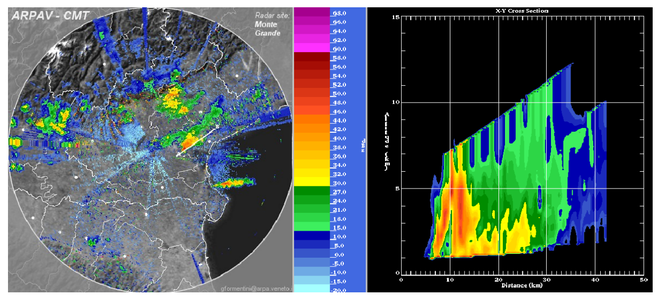

Fig. 2 and 3: Reflectivity of the Teolo radar PPI 0.8° for 00:40UTC and vertical section along A-B segment

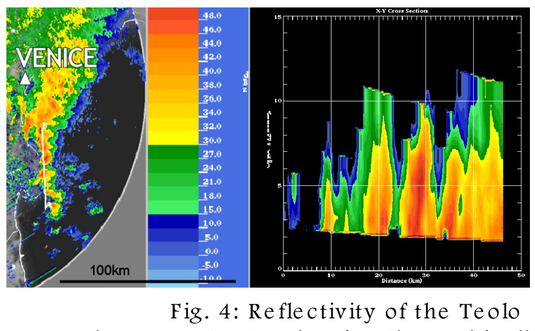

Fig. 4: Reflectivity of the Teolo radar at 08:50UTC showing the multicell structure

The main effects of the event were the very high rainfall rates and large amounts of precipitation accumulated in short time intervals on a localized area on the central-southern coastline of Veneto. It is close to Venice and densely populated so that many people experienced the effects of floods in urban areas. Fig. 5 shows the isolines of total daily precipitation measured for the day of 26 September 2007 by 161 ARPAV raingauges in Veneto, which were not corrected for strong wind that can lead to significant underestimation.

Radar data analysis

The precipitation area is characterized by good radar visibility (flat plane without beam blocking effects). Except for anaprop effect in the winter season, clearly not significant for present study, the QPE by radar are quite good.
A climatological study based on six months data set shows a mean radar to gauge ratio of 1.1 – 1.5 for this area.
Generally it is not a correct thing to apply climatological assessment factors to extreme events, however in this case "the results are not so bad" (see Figg. 6, 7, 8).
Single point radar values and a 3 x 3 km areal values were compared, confirming a good mean assessment factor (radar/raingauge ratio) during this event.
Fig. 6 shows 24h precipitation accumulation from radar against corresponding raingauges values. Systematic effects are not visible. In more detail, Fig. 7 shows hourly precipitation from radar and raingauges in the urban area of Mestre, where people experienced flooding. Best agreement is visible during the phases of weak precipitation while attenuation effects are noticeable with heaviest precipitations (in the interval 06-07 UTC). In this time interval the maximum 3kmx3km areal values compare better with gauge values than the corresponding single-pixel values. The same is observed for the Valle Averto rain gauge station (see Fig. 8).
A qualitative analysis of single radar and of composite images was carried on expecially to estimate the extent of attenuation due to heavy precipitation. For this aim it is important to point out that the Teolo radar and the Concordia Sagittaria radar are placed on the opposite sides of precipitation area (see white dots on Figure 9).
ARPAV-HDSS (Hydromet Decision Support System) algorithms were used to elaborate and composite the scans coming from the two radars. VPR correction was also used to extract precipitation at lower levels. The result was a ground precipitation field with a 1km x1km grid space, reported in Figure 9, where 24h precipitation accumulation output from HDSS is shown; nearest raingauges are superimposed as cross symbols. Both from single radars and from merged products, the positioning of reflectivity maximum did not coincide with raingauges (see dark area on Fig. 9). This means that probably the extreme event of 26 September 2007 was associated with localized rainfall values that were even higher than those recorded by the gauges.
A more detailed analysis of radar/gauge behaviour will be carried on in a future work.

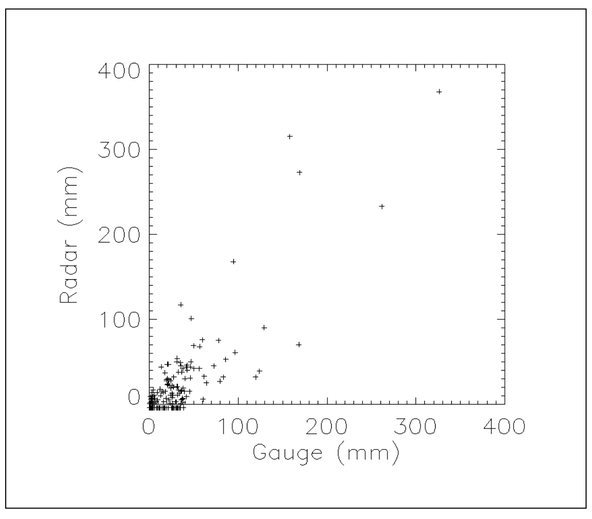

Fig. 6: Daily precipitation; radar against raingauges values

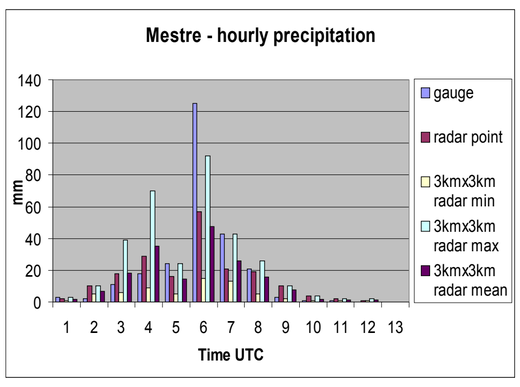

Fig. 7: Hourly precipitation in Mestre urban area

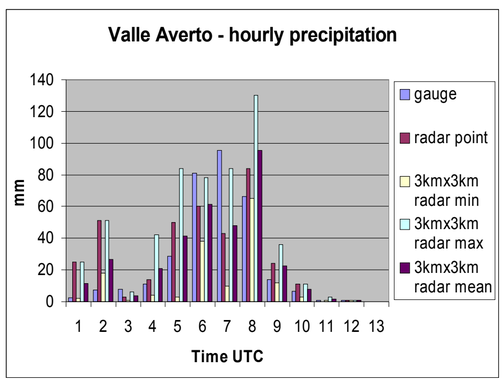

Fig. 8: Hourly precipitation in Valle Averto area.

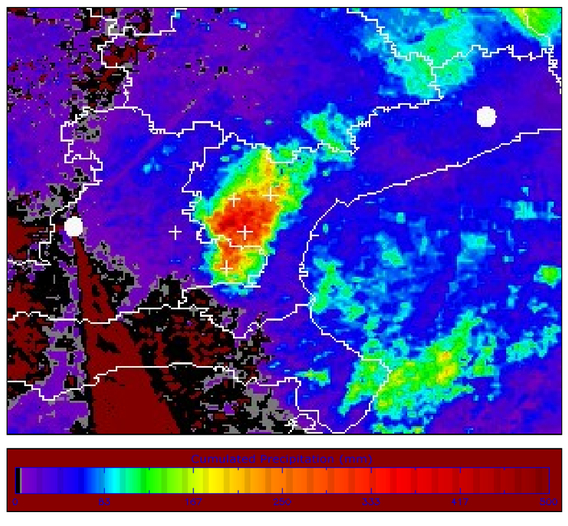
Fig. 9: 24h radar precipitation accumulation with the two radar positions (white dots) and the nearest raingauges (white crosses).

Conclusions

- Information on real-time distribution and short-term forecasting of precipitation is a crucial input for civil defence activities.
- C-band radars have the capability of monitoring precipitation with high spatial and temporal resolution.
- The present study shows the application of radar capability to an extreme event occurred in the area surrounding Venice on the 26 September 2007.
- Within a few hours 40% of the total annual precipitation amount was recorded.
- Raingauges measured maximum values of 260.4mm (Mestre rain station) and 324.6mm (Valle Averto rain station) in less than 12h.
- HDSS QPEsums showed to be able to deliver good areal precipitation estimation even during extreme rainfall.
- A first analysis of radar data suggests that precipitation amount fallen could be locally even larger than that recorded by raingauges.