# Radar Rainfall Estimations in the Campania Region (Southern Italy): Preliminary Findings.

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**Abstract**

Since no research on radar rainfall estimation was ever performed in Southern Italy, a research group was set up in order to produce and develop high resolution radar-rainfall data sets for the Campania Region. The group started its activity in the spring 1999 with a measurement campaign based on a meteorological radar located in the Italian Air Force base of Grazzanise (~ 20 km north of Naples) and a network of rain gauges located in a number of critical positions in Campania. The radar sensor is a Plessey 46 C with a RTX incoherent which supplies only horizontal reflectivity measurements. After a preliminary work phase aimed at removing or reducing noise from the radar images, a first implementation of the Marshall/Palmer relationship to the reflectivity data showed a reasonable agreement with the available rain gauge data. Further results on the spatial distributions of the rainfall cells are expected in the near future.

# 1. Introduction

The Mediterranean area is characterised by the following three main rainfall phenomena: short and intense small scale events, which typically take place at the end of summer or at the beginning of autumn, such as the well known Salerno flood in 1954 (Rossi and Villani, 1995); sub-sinoptic scale events, associated with frontal systems, which usually occur in late autumn (as for instance in Basento, 1929 and Calore and Volturno, 1949; see Rossi and Villani, 1995); small time and space scale events, normally taking place in the spring, such as the recent Sarno disaster (1998).

Since the density of the traditional measurement rain-gauge network is usually inadequate to monitor rainfall at small spatial scale, meteorological radar has a crucial role in integrating raingauge measurements and in forecasting events.

A multitask research group was formed in the spring 1999, in order to test the possibility of using a weather radar to monitor and forecast rainfall in Campania, with special emphasis given to areas where natural disasters are most likely to occur. This work focuses on the Sarno area, including the town of Sarno itself and the other locations involved in the recent disaster of May 1998 (area **A,** fig 1), and it is oriented to solving such technical problems such as ground clutter and other sources of noise, and to calibrating the reflectivity/rainfall (Z-R) relationship. A bi-dimensional convolution filter is used to smooth out the spikes which were present in the original images.

# 2. Data and Analysis Procedure

The horizontal reflectivity fields employed within this work were provided by a C-Band radar at the Italian Air Force airport of Grazzanise in the Campania Region. The technical characteristics of the radar are reported in table 1, while figure **1** presents the area under study.

The data were preliminarily corrected for two way attenuation, as proposed by COST 77, and particular care was also taken to eliminate the clutter effect from the signal.

Radar reflectivity measurements were mapped onto a Cartesian co-ordinate system with a grid spacing of 0.5 km x 0.5 km, each polar data point falling within a Cartesian pixel. The tables I and II shows the technical characteristics of the Radar Sensor

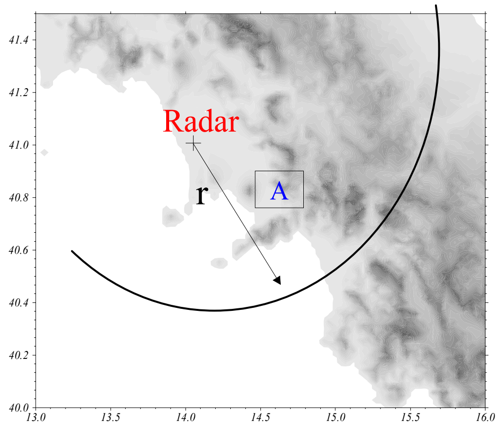


Figure 1*:* Radar location, coverage area (r = 128 Km) and area analysed (A).

| **ANTENNA FEATURES** | |
|---|---|
| Diameter | 244 cm |
| Beam amplitude | 1.5° |
| Rotation | 360° |
| Vertical excursion | -2 to 90 degrees |
| Rotation velocity | 0.1 to 6 r.p.m. |
| Elevation velocity | 10°/sec |

Table I

| **TRANSMITTER FEATURES** | *Magnetron* |
|---|---|
| C band | selectable from 5420 to 5825 MHz |
| Impulse | 2 µs |
| Power | 250 kVA |
| PRF | 300 Hz |
| Polarization | horizontal linearly polarised |
| range bin | 500 metres |
| maximum coverage | 250 km |

Table II

## 3. Observations and the first implementation of a Z-R relationship

As previously stated, the work is based on the Sarno area, so radar observations on area A (fig 1) were compared with raingauge network data available in the same zone. The altitude of the raingauge network used is shown in the following table:

| **RAINGAUGE** | *ALTITUDE* |
|---|---|
| 1-Sarno | 302 m |
| 2-Piani di Prato | 836 m |
| 3-Cetronico | 250 m |
| 4-Torriello | 900 m |
| 5-Quindici | 300 m |

The measurement radar campaign started in March 1999 and so far only a few significant events have been monitored. We refer here to events occurring on March 23, 1999 and May 20, 1999.

By analysing the reflectivity data it was shown that over the whole duration of the campaign the maximum value was never higher than 25-30 DbZ; i.e., if a typical Marshal-Palmer relationship is used, then rainfall intensities are within the 2-7 mm/h range.

According to the standard Z-R relationship

$$Z=aR^b$$

as proposed WMO (World Meteorological Organization), the following coefficients are used:

1) weak rain a=31, b=1.71
2) stratiform rain a=200, b=1.6 (Typical Marshal Palmer relationship)
3) convective rain, a=486, b=1.37

In figure 2 the preliminary calibration of the Z-R relationship with the raingauge measurements is shown. Since no convective events were observed during the measurement campaign we are only dealing with weak rainfall events, so the radar data were calibrated by making use of the first two relationships shown above.

We considered the mean of a 3 x 3 pixel square, where the central pixel covers the location of the raingauge. Since we are dealing with 0.5 km linear resolution in that area, the values are representative of a small area of 2.25 $km^2$. Working with typical **C**onstant **A**ltitude **P**lane **P**osition **I**ndicator (CAPPI) products, the layers at 500 m and 1000 m were used during this preliminary phase. In particular the CAPPI at 500 m was affected by some clutter disturbance which had to be removed while at the 1000 CAPPI layer no clutter disturbance was present.

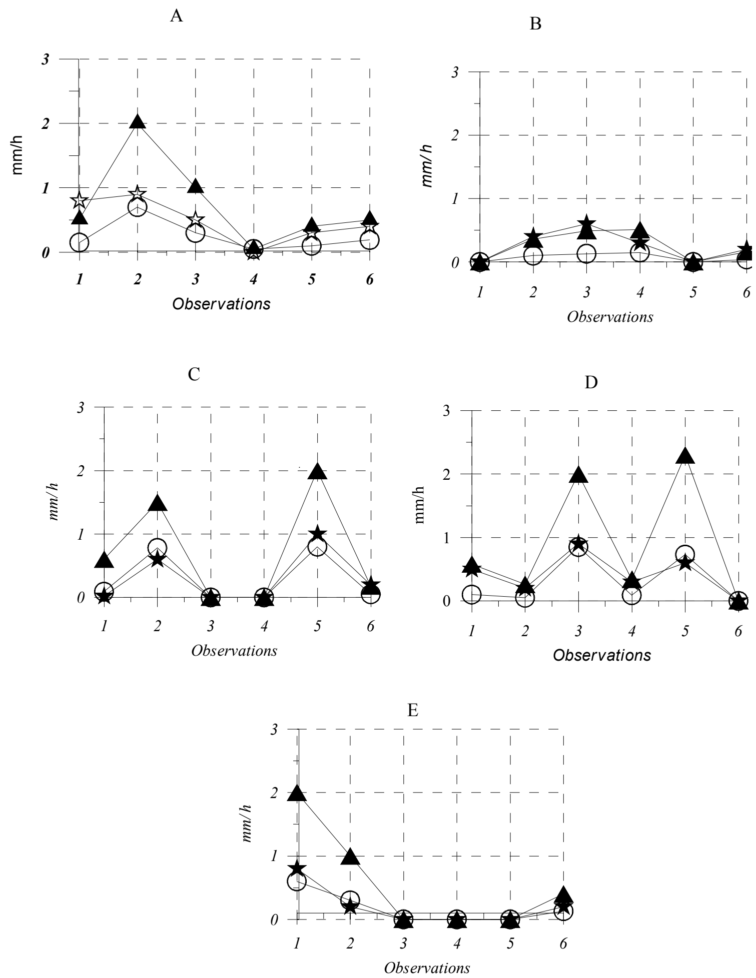


Figure **2:** Radar-Raingauge data compared: (A) Sarno, (B) Quindici, (C) Cetronico. (D) Piani di Prato, (E) Torriello. The observations refer to: (1) 23 March 13.20, (2) 23 March 14.20, (3) 20 May 0.20, (4) 20 May 1.20 (5) 20 May 2.20 (6) 20 May 3.20. Simbols caption: triangle (coefficients 1), circle (coefficients 2), star (rain-gauge measure)

The data from the Sarno, Quindici and Cetronico raingauges were used in connection to the 500 m layer, and the Torriello and Piani di Prato to the 1000 m. Neither upscaling nor downscaling procedures were used here when dealing with CAPPI data, which represent a 300 m thick layer. According to this preliminary data the standard Marshal-Palmer relationship seems to fit fairly well with radar observation in each single site considered.

## Conclusions

The study presented here is a work in progress and involves the participation of four institutions: Centro inter-Universitario Grandi RIschi (CUGRI), Istituto di Meteorologia e Oceanografia – Istituto Universitario Navale, Centro Nazionale di Climatologia e Meteorologia Aeronautica (CNCMA) and Ente Nazionale Assistenza al Volo (ENAV). The work follows the Sarno Disaster Contingency Unit previous activities, and it is aimed at studying rainfall over areas in the Campania Region where natural disasters are most likely to occur. During the preliminary phase the technical problems related to the radar were solved and a first implementation of Z-R relationship was shown to fit fairly well with the available raingauge observations.


## Acknowledgements

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