# SNOWFALL ANALYSIS OVER PENINSULAR ITALY IN RELATIONSHIP TO THE DIFFERENT TYPES OF SYNOPTIC CIRCULATION: FIRST RESULTS

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**Abstract**: The time series of snow data for a sample of Italian meteorological stations have been analyzed taking into account, for the time series, an acceptable continuity and quality of meteorological data. The data set is that of the Italian Meteorological Service (UGM), and refer to the period 1982–2004. The Slovenian station of Kredarica, located in the Julian Alps, has been added for convenience.
The study is composed of two different parts:

- Climatologic analysis of the snow parameters during the last 20 years. In particular, the height of the fresh snow and the number of days with permanence of snow at the ground have been analyzed.
- Evidence of the synoptic situations in which snowfalls are observed with at least a thickness of 10 cm in at least a third of the total number of analyzed stations in Central, Southern and insular Italy

***Keywords:*** *Peninsular Italy, snow, wind, pressure*

## 1. INTRODUCTION

The aim of the analysis is to get a better knowledge of the distribution of the snow coverage all over Italy, especially in the Alps and Apennines, in the last twenty years.

The climatic analysis has been carried out separately for Alps, where in some stations the snow coverage is observed in all months of the year, and the remaining part of the national land, where in the summer period the snow coverage disappears.

The data set for the alpine zone refers to 14 stations; for the Apennines and the islands a set of 15 observatories has been considered.

The localities for the Italian Country are shown and Fig. 1; in Tab. 1 the amount of fresh snow height is reported together with the trend in the observed period. All stations are belonging to the synoptic/climatic network of the Italian Air Force Met. Service, except Kredarica kindly allowed by the Slovenian Meteorological and Hydrological Service

A special analysis has been carried out for the synoptic situations favorable to widespread snow precipitation. In this aim the situations in which the snow fall has been observed in at least a third of the localities, and the amount has been 10 cm or more. In the whole period 20 events have been selected, each one of 1-3 days long, during which snow precipitation affected a large part of the Italian Peninsula.

Among them, some situations can be considered exceptional, as for example the one which affected the whole of Italy between the end of January and the beginning of March 2005.

In this case, further than the classic climatic analysis of surface stations, also the data of the seven Italian and of the supplemental Ajaccio radio sounding stations have been taken into consideration. The statistic distributions of the prevailing direction of the wind (PWD), the average of the wind speed (AWS) and Temperature (°C) have been calculated at level station and at the 700 hPa geopotential height, in order to obtain a characterization of the related synoptic conditions.

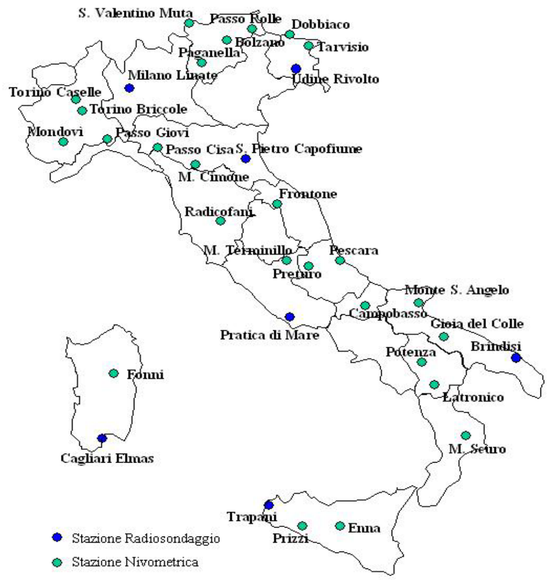



**Figure 1.** Locations of the surface meteorological stations (in green color), and of the radio soundings (blue color), used in the analysis

## 2. DATA ANALYSIS

A careful analysis of the average of the thickness of fresh snow that usually falls down, shows a difference in behavior in Alpine regions compared with the Apennines one.

Over the Alps the snow coverage shows a linear increasing with elevation, except Kredarica, with a rate of change of approximately 20 cm of snow every 100 meters increasing with elevation.

In the Apennines the stations on the mountain top have a very different behavior than valley stations; the difference in latitude is quite irrelevant. If we need to consider a rate of change, this is approximately 14 cm every 100 m. increasing with elevation (Fig. 2 and 3).

A further point to note is that in the Alpine regions a general trend in decreasing snow coverage is evident everywhere; in the Apennines the trend is negative just for stations situated above 1000 meters, while others localities show a positive trend.

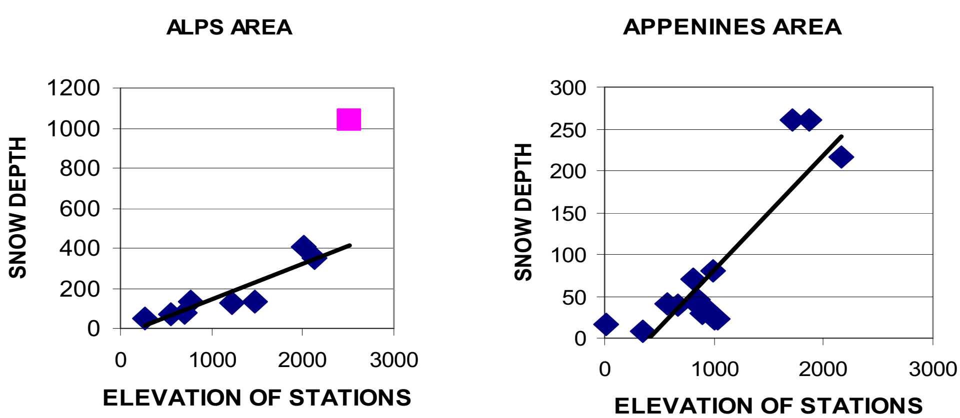
On the contrary, the number of days with snow precipitation shows only local trends, with a large variability in space even over short distances. However, there is no evidence of relevant trends, with a mean decrease in the Alpine area and a moderate increase in the Central and Southern Apennines. This could be related to the tendency for more extreme meteorological events, so that after warmer and dryer periods follow even long cold spells, with specially intense phenomena.

The analysis of the distribution of the different nivometric regimes (Biancotti et *al*, 1998, Fazzini et *al* 2003), shows a difference between stations situated at an elevation up to 1500 meters and stations situated over hills or in the valleys.

The first ones show two maxima in December and during the spring (March and April for the Alps, and February and March for Apennines). The valley stations distribution has just a maximum in January for the Alps and in February for the Apennines.

**Table 1.** Monthly and annual means of the height of fresh snow for the data set stations. YAV: year annual average; trend %: percentage trend; *: recent snow instrumentally registered (24 h).

| ALPINE STATIONS | ELEV | J | F | M | A | M | G | O | N | D | YAV | TREND % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | |
| KREDARICA- SLO* | 2515 | 111 | 115 | 159 | 172 | 86 | 33 | 64 | 141 | 141 | 1037 | -1,5 |
| PAGANELLA | 2124 | 35 | 47 | 55 | 60 | 20 | 3 | 22 | 53 | 53 | 349 | -1,9 |
| PASSO ROLLE | 2004 | 51 | 46 | 60 | 89 | 21 | 4 | 15 | 54 | 64 | 405 | -1,5 |
| S. VALENTINO MUTA | 1474 | 21 | 31 | 16 | 11 | 2 | | 1 | 18 | 29 | 130 | -2,7 |
| DOBBIACO | 1218 | 19 | 24 | 19 | 12 | 1 | | 2 | 19 | 27 | 124 | -2,2 |
| TARVISIO | 777 | 23 | 34 | 18 | 13 | 1 | | | 14 | 29 | 132 | -2,0 |
| TORINO BRICCOLE | 710 | 31 | 19 | 8 | 2 | 1 | | 0 | 4 | 10 | 74 | -1,8 |
| MONDOVI' | 556 | 26 | 16 | 9 | 2 | | | | 4 | 11 | 68 | 0,3 |
| BOLZANO | 265 | 13 | 12 | 3 | 1 | | | 1 | 4 | 18 | 52 | -2,5 |
| | | | | | | | | | | | | |
| **APENNINE STATIONS** | ELEV | J | F | M | A | M | G | O | N | D | YAV | TREND % |
| | | | | | | | | | | | | |
| MONTE CIMONE | 2165 | 39 | 37 | 30 | 41 | 7 | | 2 | 29 | 34 | 217 | -3,3 |
| MONTE TERMINILLO | 1875 | 39 | 70 | 56 | 45 | 2 | | | 3 | 44 | 260 | -1,5 |
| MONTE SCURO | 1714 | 54 | 59 | 50 | 28 | 4 | | | 7 | 59 | 261 | -0,1 |
| PRIZZI | 1035 | 5 | 6 | 6 | 1 | | | | 1 | 4 | 23 | -3,9 |
| ENNA | 1001 | 3 | 16 | 2 | | | | | | 2 | 23 | -11,1 |
| FONNI | 992 | 12 | 27 | 9 | 8 | | | | 1 | 23 | 80 | -8,0 |
| RADICOFANI | 918 | 5 | 17 | 6 | 2 | 1 | | | 1 | 5 | 36 | -0,4 |
| LATRONICO | 896 | 6 | 11 | 7 | 1 | | | | 1 | 3 | 29 | 5,9 |
| M.TE SANT'ANGELO | 847 | 16 | 12 | 8 | 1 | | | | 2 | 7 | 46 | 6,7 |
| POTENZA | 845 | 6 | 13 | 5 | 4 | | | 1 | 2 | 9 | 39 | 4,2 |
| CAMPOBASSO | 807 | 17 | 16 | 13 | 4 | | | 1 | 3 | 16 | 70 | 2,4 |
| PRETURO | 675 | 9 | 13 | 6 | 2 | | | | 1 | 9 | 39 | -7,7 |
| FRONTONE | 574 | 10 | 13 | 5 | 1 | | | | 4 | 7 | 41 | -0,5 |
| GIOIA DEL COLLE | 352 | 3 | 3 | 1 | 1 | | | | | 1 | 9 | 1,7 |
| PESCARA | 10 | 6 | 1 | 1 | 1 | | | 1 | 2 | 4 | 17 | -4,3 |




**Figures 2 and 3**. Average of the amount of fresh snow in the Alps and Apennines .

## 3. THE SYNOPTIC CORRELATION

From a synoptic point of view, it is well known that snow precipitations are more widespread and intense in case of a Southerly flow associated with a surface low pressure over the Gulf of Genoa or the

North-Westerly Po Valley, while the snowing conditions affecting the Adriatic side of the Peninsula from Romagna to Molise are produced by cold advections from the East, with a low over Southern Tyrrhenian Sea or the Jonian Sea.

Still not well known are the synoptic conditions producing widespread snow over Southern Italy and the Tyrrhenian side of the Apennines (typically characterized by a mild climate), and over the islands.

Analyzing 20 episodes in the last twenty years, it is evident that two periods are more interested from extreme situations: the one in 1985–86, and the other in the last 5 years.

The most snowy seasons occurred in 2002–2003 and 2004–2005, and this is a confirmation of a possible positive trend.

The analysis of sounding data shows that surface wind directions are North Easterly in the North of the Italian country, and South-Westerly in the South of the peninsula, according to a minimum on the Gulf of Genoa or the Po Valley.

Looking the situation at the 700 hPa data, we can note that wind direction is quite always from South-West or South-East, in agreement with the theory of a layer of very cold air near the land and a smooth South-Westerly flow aloft.

The surface pressure and geopotential at 700 hPa, confirm a minimum in Northern Italy.

**Table 2.** Means of some meteorological variables at the surface and the 700 hPa level; PWD: prevailing wind direction; MWS: mean wind speed

| | SURFACE | | | | | | 700 hPa | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SOUNDING AT | ELEV | PWD | PWD degr | MW S | T°c | P (Hpa) | PWD | PWD degr | MWS | T°c | Geop (mt) |
| | | | | | | | | | | | |
| MILANO LINATE | 121 | SE | 155 | 1,4 | -1,2 | 1001 | SE | 152 | 15 | -13 | 2913 |
| UDINE RIVOLTO | 97 | NE | 55 | 3 | -1,4 | 1003 | SW | 203 | 21 | -13 | 2903 |
| S.P. CAPOFIUME | 53 | NE | 60 | 4,7 | -1,1 | 1005 | SE | 136 | 27 | -16 | 2929 |
| AJACCIO | 11 | SE | 120 | 7,3 | 5,7 | 1012 | SE | 171 | 28 | -13 | 2925 |
| PRATICA DI MARE | 64 | NW | 315 | 3,5 | 2,8 | 1009 | NW | 293 | 21 | -11 | 2931 |
| BRINDISI | 5 | SW | 229 | 11,1 | 5,5 | 1011 | SW | 250 | 22 | -12 | 2927 |
| TRAPANI | 11 | SW | 218 | 11 | 8,4 | 1011 | SW | 220 | 26 | -10 | 2950 |
| CAGLIARI | 3 | SW | 246 | 7,5 | 6,5 | 1015 | NW | 279 | 27 | -11 | 2961 |

## 3. CONCLUSION

The climatic analysis of nivologic values has shown that, for the same elevation, sensible differences are observed in the spatial distribution, with mean snow amounts and snow persistence at the ground clearly larger in the Alps than in the Apennines. On the contrary, substantial differences are not observed in the number of snowy days in the different regions.

The trends of the same variables show a general small decrease of snow precipitation over the Alps, the Northern Apennines and Abruzzo, while evidence of contrasting trends are present over the Apennines, with an increase in the Southern part and an even sensible decrease over Sicily and Sardinia.

The synoptic situations producing relevant snow amounts in the Southern part of the Peninsula seem to be associated with an Easterly surface flow in the North, becoming North-Westerly over the Tyrrhenian slopes, and South-Westerly in the South, while in the upper levels a general southerly flow is prevalent.

## REFERENCES

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