ANALYSIS OF RECENT METEOROLOGICAL CONFIGURATIONS RESPONSIBLE FOR SUBSTANTIAL SNOWFALLS IN THE TRENTINE SECTOR OF THE ADIGE VALLEY BOTTOM (EASTERN ITALIAN ALPS)

Roberto Barbiero[1], Massimiliano Fazzini[2], Mauro Gaddo[1] and Carlo Bisci[3]

[1] PAT Trento – Ufficio Previsioni ed Organizzazione – Via Vannetti, 41 Trento
[2]Università di Ferrara – Dipartimento di Scienze della Terra
[3]Universita di Camerino - Dipartimento di Scienze della Terra

Abstract

This work aims at analyzing synoptic conditions favourable to snowfall with more than 10 cm of fresh snow cover along the bottom of the Trentine sector of the Adige Valley (Eastern Italian Alps). The mid portion of the Adige Valley features climatic-dynamic conditions leading almost every year to relevant snowfalls affecting the valley bottom too. All the events observed from 1976 to 2006 were analyzed using the data recorded at the Trento Roncafort (194 m a.s.l.), Trento Laste (312 m a.s.l.) and Rovereto (203 m a.s.l.) meteo-climatic stations. Through study and analysis of ground and 500 hPa geopotential meteo maps, satellite imagery, thermodynamic diagrams of the nearest sounding stations and records of nivo-meteorological stations, the synoptic types characterizing snowfalls were studied and classified; a clusterisation was made too. Analyses outlined that in the area snowfalls typically are of a "sliding" type and are mainly connected with a flux of southern wind. The two most recent substantial snowfalls confirm the results of the analyses carried out on thirty years of data.

Keywords: *Adige valley bottom, snowfall, continental anticyclone, south-western wind*

1. INTRODUCTION

Because of its geographic features, the Adige valley is of a great interest for climatologic study of valleys located to the South of the main Alpine divide. It is the most important Italian Alpine valley and its mainly North-South trend favours advection both of temperate-warm air to the North and of continental air toward the Mediterranean area. Therefore, this attempt to characterize synoptically relevant snowfalls along its valley bottom constitutes a valid indication of similar conditions at a regional scale within the whole Central-Eastern Italian Alps. The studied portion of the valley is some 30 km long, with altitudes ranging between ca. 200 and 300 m a.s.l. There, rather low winter temperatures (month averages ranging from 0°C to 2°C) lead to a high relative nivometric coefficient (around 20%): as a consequence, significant snowfalls are not rare. The time distribution of snowfalls (Tab. 1) shows a significantly high frequency during the '80s followed by an almost total lack during the '90s and an irregular enhancement in the last years, with particularly abundant and frequent events during the 2003-04 and 2005-06 winters.

2. DATA AND METHODS

Nivometric records for the last three decades, deriving from three stations (Fig. 1 and Tab. 1) belonging to the measuring network of the Autonomous Province of Trento and grouped in a rather small area (ca. 60 km^2), have been analyzed. The Trento Rocafort and Rovereto stations are located along the valley bottom at an altitude of ca. 200 m, while the Trento Laste one is located on the left side of the valley, along a steep slope, some 100 m above the thalweg. After the calculation of the entity of the snowfalls recorded by all the three stations, the synoptic situation that lead to those events were analyzed trying to cluster them basing on their similarity, in order to highlight any potential signal. During the 1976-2006 time span, in the study area 18 particularly intense snowfalls (more than 10 cm of snow cover) were individuated, mainly concentrated during December and January. In order to define the synoptic situations responsible for the events, NCEP reanalysis maps both for the pressure at ground level and the geopotential at 500 hPa were analyzed. Generally, for snowfalls lasting 48-72 hours the synoptic situation continuously changes: therefore, we referred to the situation at the moment of maximum intensity. Starting from 1991, the records of the radio-sounding station of Udine Rivolto (ca. 100 km to the East) were analyzed too.

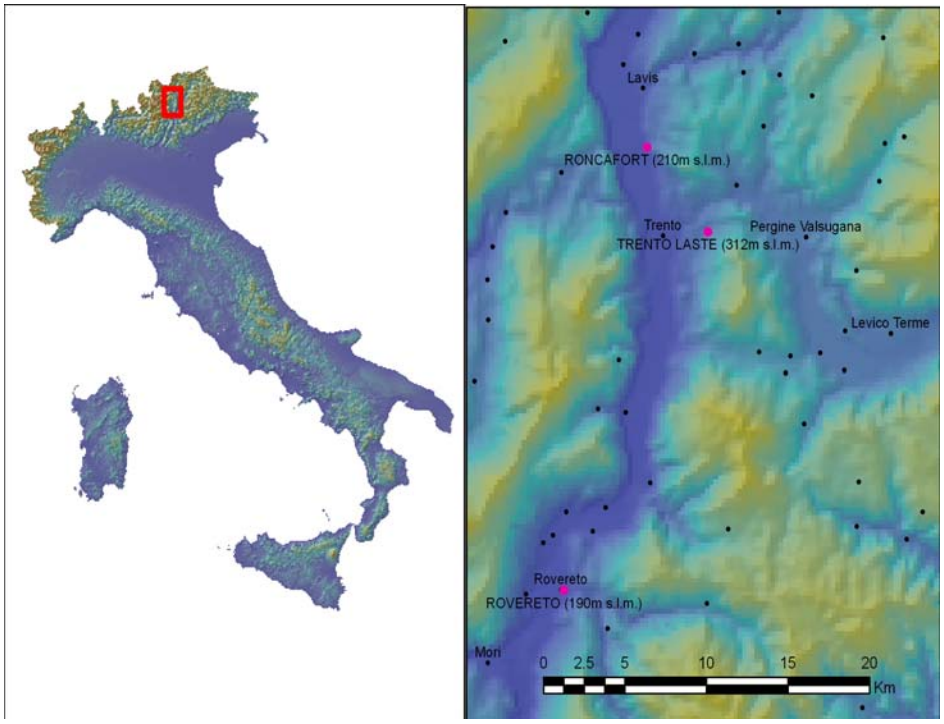

Figure 1 – Location of the study area and of the three recording stations.

EVENT DATE	Trento Laste - 312 m	Trento Roncafort 194 m	Rovereto 203 m
16 jan 1977	23 cm	26 cm	16 cm
12 jan 1978	23 cm	23 cm	14 cm
29 jan 1978	45 cm	36 cm	22 cm
10 jan 1979	23 cm	23 cm	14 cm
11-13 feb 1979	65 cm	59 cm	30 cm
20-22 dec 1979	29 cm	28 cm	29 cm
22-23 dec 1981	60 cm	40 cm	33 cm
17 dec 1983	20 cm	15 cm	11 cm
15-18 jan 1985	111 cm	81 cm	69 cm
28 jan 1985	26 cm	23 cm	23 cm
31 jan - 2 feb 1986	63 cm	41 cm	42 cm
26 jan 1988	20 cm	12 cm	15 cm
25 dec 1993	36 cm	21 cm	17 cm
2 jan 1994	18 cm	23 cm	10 cm
2 jan 1997	41 cm	35 cm	22 cm
11-mar-04	50 cm	34 cm	25 cm
2-3 dec 2005	31 cm	20 cm	20 cm
26-28 jan 2006	75 cm	65 cm	50 cm

Table 1 – Height of fresh snow for events accumulating more than 10 cm in all the three stations (1976 – 2006)

3. DISCUSSION

The analysis of synoptic frameworks evidenced that all the significant events were connected with South-Western or South-Eastern wind associated with the formation or the passage either of a depression on the Northern Mediterranean (Fig. 2) or of a deep cold depression located on the Northern Sea (fig. 3).

Each of the two most recent snowfalls was characterized by one of the above mentioned situations.

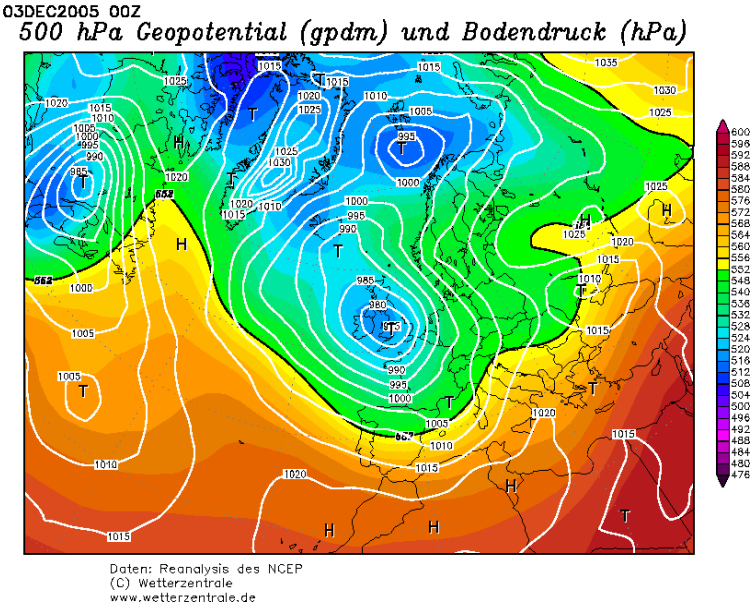

Figure 2 - Reanalysis map at the ground and geopotential of 500 hPa for December 3rd 2005 00:00 (NCEP)

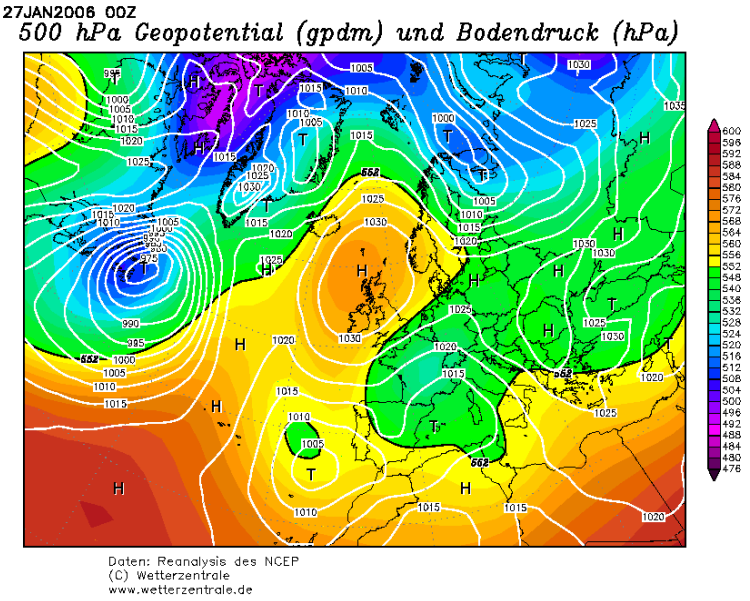

Figure 3 - Reanalysis map at the ground and geopotential of 500 hPa for January 27th 2006 00:00 (NCEP)

In December 2005, the snowfall was generated by a deep depression extended to the Western Mediterranean and with a minimum on Great Britain (Fig. 2), while in January 2006 it derived from a depressionary vortex with a minimum on the Northern Mediterranean bringing pseudo-unstable warm and humid air on the Eastern Alps (Fig. 3). In both cases, long lasting persistence of very cold high pressure in the study area was instrumental for the snowfalls along the valley bottom.

During the first event, an abundant snowfall affected from the evening of December 2nd to the following morning the majority of Northern Italy. In the Trentino area, 20 hours of continuous precipitation produced a fresh snow height ranging from 20 cm along the valley bottom to 60 cm at an altitude of ca. 1'500 m. Snow quantities were not exceptional but such to cause relevant problems to the population. During December 1st, a weak anticyclonic nose still allowed stable and clear conditions with low temperatures (3-4°C below the average of the period). The day after, an Atlantic perturbation, connected with a depression centred on Great Britain and extending down to Spain, reached the Alps thus producing South-Western wind over the Eastern Alps. In the morning, the sky was still clear and temperatures were low, with thermal inversion along the valley bottom.

During the afternoon, cloud cover rapidly increased bringing sparse snowfall that in a short while become diffuse. The perturbation crossed the Alps during the night bringing heavy snowfalls, with a very irregular lower limit of snow accumulation (from 200 to 1'000 m a.s.l.). The precipitation ended early in the afternoon, but along the valleys the sky remained covered by low clouds.

The second snowfall (Figs. 3 and 4) was diffused all over Northern Italy, with an average height of fresh snow of 50 cm along the valley bottom of the study area and a maximum of 120 cm to the south of the Province. During the days preceding the event, the Russian anticyclone (extended to the whole Northern Mediterranean) determined stability with very cold continental polar air: temperatures were lower than the average all over Central-Eastern Europe. A depressionary vortex slowly moved southward at high altitude. During the morning of January 26th, a closed minimum over Central Europe determined a significant worsening of the weather on Northern Italy, while the Azores anticyclone, strangely centred at over 50° of latitude, affected Great Britain and Scandinavia (conditions of negative NAO). In the following 24 hours (fig. 4), the high altitude minimum progressively reached France: therefore, warm and humid air progressively more intensely flowed on the Alps from the Mediterranean determining a warm front that brought abundant precipitation.

Only during the final part of the event warm advection determined a significant increase of temperatures leading to an increase of the lower limit of snowfalls.

Figure 4 - View of the Adige valley bottom after the January 26th-28th 2006 snowfall.

4. CONCLUSION

The study highlighted that substantial snowfalls along Alpine valley bottoms are of a "sliding" type and are almost exclusively associated with advection of Mediterranean warm-humid air caused either by the presence of depressions located on the Genoa Gulf or on the Northern Mediterranean, or by the transit of cold depressions located on the Northern Sea and slowly moving Eastward. It is also necessary to have had previously a thick layer of cold air, with a thick thermal inversion caused by long lasting persistence of anticyclonic noses of a continental origin with a thermal values of about –3°C at 850 hPa geopotential and with a strong thickness of thermic inversion (about 1000 meters) in the valley.