Characterisation of snowfall events in the northern Iberian Peninsula and the synoptic classification of heavy episodes (1988-2018).

F. de Pablo Dávila[a*] , L.J. Rivas Soriano[a] , M. Mora García[b] , A. González Zamora[a]

(a) *Departamento de Física Fundamental, Universidad de Salamanca, Salamanca, Spain*

(b) *Agencia Estatal de Meteorología, (AEMet), Valladolid, Spain.*

* Corresponding author address:

Dr. Fernando de Pablo
Departamento de Física Fundamental
Facultad de Ciencias. Universidad de Salamanca
Pl. de la Merced s/n
37008 Salamanca (Spain)

e-mail: fpd123@usal.es
ORCID: 0000-0003-4859-4613

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Abstract

Historic snowfall events in the northern Iberian Peninsula recorded between 1988 and 2018 are presented and analysed. This study makes use of data collected over a course of 31 years from 105 observation stations. These weather reports describe the temporal and spatial characteristics of five Spanish provinces facing the Cantabrian Sea. The average number of snow events observed per year (as recorded by all 105 stations) was 133, where a maximum of 421 snow events was recorded in 2010 and a minimum of 24 events were recorded in 2002. In addition, the monthly distribution of snow events per day had a maximum of 630 events, (February), with a mean monthly value of 170 snow events. Other features like the distribution of snow events depending on the altitude of each province studied and the corresponding spatial patterns are also shown. Furthermore, the circulation patterns responsible for heavy snowfall in the region were also examined. To carry out this study, we considered the daily patterns at 1200 UTC of the geopotential height at 500 and 850 hPa pressure levels and sea-level pressure and temperature at 500 and 850 hPa respectively. The synoptic situations were classified based on a principal component analysis coupled with a K-means clustering, and four groups associated with heavy snowfall events were subsequently identified. The analysis of the daily synoptic patterns showed that a trough was present over the Iberian Peninsula, or close by, and a low appeared over the Mediterranean Sea or Central Europe. The low-level flow was from the north (N) or northeast (NE) in ~ 85% of the cases and the temperature at 850 hPa pressure level was lower than -3ºC in ~ 70% of the cases.

Keywords: snowfall, spatio-temporal variations, synoptic situations, northern Iberian Peninsula

1. INTRODUCTION

Snow is an important mid-latitude meteorological issue owing to its impact on the climate and social and economic activities. On a global scale, more than one third of the irrigation water in the world is from snowmelt (Steppuhn, 1981) and changes in the amount of snowfall may lead to floods occurring in spring (Berghuijs et al., 2014). Since snow has a high albedo value and low thermal conductivity, it modifies the surface–atmosphere energy budget (Robock, 1980; Robinson and Kukla, 1985) and influences weather conditions. At the same time, it modifies the climate system, mainly by lowering air temperature (Wagner, 1973; Dewey, 1977; Walsh et al., 1982) and by changing air circulation, cloudiness, and precipitation (Johnson et al., 1984; Namias, 1985; Cohen, 2001). Snow cover decreases the low-level air temperature, increases moisture distribution, and changes atmospheric circulation (Barnett et al., 1989; Groisman et al., 1994; Ke et al., 2009). Snow also stores water and isolates the ground, playing a role in agriculture and hydropower (Kocak, 2017). Moreover, episodes of intense snowfall, generating deep snow cover, may cause traffic and communication problems.

Brown (2000) reported that ~49% of the Northern Hemisphere is covered with snow during the winter season. However, in the southern part of the lowlands of western Europe this phenomenon is less frequent. Nevertheless, snowfall during the winter season, or during the winter–spring transition, plays a very important role from a climatological point of view (Wibig and Głowickim, 2002). Snow in Southern Europe presents high intra- and inter-annual variability, where there is an alternation between cold periods with snow cover and mild periods without snow (Falarz, 2004). Climate projections indicate a decrease in the seasonal snow cover in Europe (Adaptation in Europe, 2013; Climate Change, Impacts and Vulnerability in Europe, 2012) and in the number of days with precipitation greater than 10 cm (Räisänen, 2008; Kjellström et al., 2011; Räisänen and Eklund, 2012). Therefore, the study of synoptic conditions of snowfall in southern Europe is important.

Studies addressing both snowfall and snow cover have mostly been conducted on cold and mountainous areas. For instance, Satyawali et al., (2009), Valt et al., (2010), Soncini and Bocchiola, (2001), Scherrer et al., (2013) analyse the snow climate of the Alps, and Ikeda et al., (2009) has studied the snow climate of the Japanese Alps. Snow cover has been studied in Tibet (Gao et al., 2012), the Loess Plateau in China (Jin et al., 2015), the Atlas region (Boudhar et al., 2010) and the Kashmir Valley in India (Mishra and Rafiq, 2017). Within Europe, most studies have been on the Artic (Wang at al., 2005; Park et al., 2011) and Northern and Central regions (Bednorz, 2004; Bulgyna et al., 2009; Henderson and Leathers, 2010; Szwed et al., 2017), including the characteristics and classification of synoptic patterns associated with heavy snowfall (Babolcsai and Hirsch, 2006; Bednorz, 2011, 2013; Dafis et al., 2016). By contrast, studies examining the snow within the western region of Southern Europe are less frequent and are mostly associated with mountainous areas. For example, Esteban et al., (2005) describes the synoptic patterns of SLP and other atmospheric levels that cause heavy snowfall events in Andorra. Herrero et al., (2009) examine the southern slopes of the Sierra Nevada Mountains (Spain), reporting on the relevance of snowfall occurring in this area. In addition, García-Sellés et al., (2010) study the events of several avalanches occurring in the Eastern Pyrenees (north-eastern Iberian Peninsula) and their correlation with the North Atlantic Oscillation (NAO) and the Western Mediterranean Oscillation (WeMO). On the other hand, Núñez et al., (2016) analyse the long-term temporal and spatial characteristics of snowfall over the Valencian Community (central Mediterranean coast of the Iberian Peninsula).

The present study focuses on the northern part of the Iberian Peninsula (the coastal area adjoining the Cantabrian Sea), an area where not much information has been collected regarding snowfall and its associated characteristics. To address this, we have analysed data on the climatological (long-term spatial and temporal) characteristics of snow during a period of 31 years. The main synoptic patterns associated with episodes of heavy snowfall at low and mean levels of the troposphere have also been considered.

2. STUDY AREA AND DATA

The spatial domain included in this study is shown in Figure 1. It is located on the northern Iberian Peninsula, extending over a total area of 29,994 km^2 (between 42º 20′ N and 43º 45′ N latitude and between 7º 38´W and 1º 37´W longitude), and includes five Spanish provinces facing the Cantabrian Sea (Guipúzcoa, Vizcaya, Cantabria, Asturias, and Lugo). The complex orography appears variable across the study area and the eastern section is located between the Cantabrian mountain range and the Pyrenees (provinces of Guipúzcoa -mean altitude 370 m.a.s.l and Vizcaya -mean altitude 290 m.a.s.l). The climatic characteristics are typically maritime, with mild winters and summers and abundant precipitation throughout the year, especially during autumn and early winter. The average temperature varies between 8.1ºC (winter) and 18.2ºC (summer). The central part of the study area (provinces of Cantabria and Asturias) is occupied by the Picos de Europa mountain range (peaks higher than 2,600 m.a.s.l), close to the shoreline, and a narrow strip that exists between the mountain and the sea (40% of this area is higher than 700 m altitude). The climate in this area is also maritime, with mild winters and summers (average temperature 14ºC) and is humid (precipitation ~ 800-1200 mm in the coast increasing to ~ 2,400 mm in the mountains). Between November and March, snow is frequent in the Picos de Europa and the snow cover persists all year long above 2,500 m.a.s.l. Finally, the westernmost part of the study area (province of Lugo) is a zone of highlands (mean altitude 450m.a.s.l) with an average temperature and precipitation of 13.6ºC and 600-700 mm respectively (Font, 2000).

The World Meteorological Organization (WMO) state that data should be collected over a period of at least 30 years in order to accurately analyse events such as climate change. Therefore, data recorded between 1988 and 2018 was retrieved from the database of the Spanish State Meteorological Agency (AEMet). This agency is comprised of observatories with work staff, automatic stations and meteorological collaborators, and all data collected are checked through a process of quality control. In this study, a "snow event" is defined as an observation of snow at one observation station throughout the day, while a day was considered to be a “snow day” if snowfall had been observed at one or more of the observation stations included in the database. Therefore, one snow day may include many snow events, depending on the spatial extension of the snowfall. Within the study area, there were 537 rain gauges showing data for at least 1 day of precipitation during the time frame considered. All of the rain gauges were taken into account when determining which days could be considered as snow days. However, only those with 25 or more years of complete data from 1988 to 2018 (105 observation stations, Fig. 1a) were used to calculate average values. The observation stations selected were distributed over a wide range of altitudes (Fig. 1b), but most (71%) were situated below the altitude of 400 m.a.s.l.

Moreover, the daily patterns at 1200 UTC of geopotential height and temperature at the 500 and 850 hPa pressure level and sea-level pressure were taken into account. These patterns were obtained from the NCEP/NCAR Reanalysis database (Kalnay et al., 1996) in the geographic window (30ºN-60ºN) and (50ºW-20ºE). The synoptic patterns associated with heavy snowfall in the Cantabrian sea area were also classified in this study. Heavy snow events were determined using criteria similar to that used by Núñez et al. (2016) which stipulated that 1) a minimum of three observation stations had reported an accumulated daily precipitation greater than 10 mm in 24h and 2) that snowfall had been observed. The aim was to ensure that the snowfall episodes being considered were in fact relevant. As regards we selected the station which had recorded the greatest amount of snowfall, and which fulfilled the above conditions. As a result, a sample of 31 events was gathered, one for each day of the month (Table 2).

3. CLIMATOLOGICAL RESULTS

Figure 2a shows the number of snow events per year, as recorded by the 105 stations selected. It seem clear that the number of observed snow events could be considered as an estimate of the spatial extent of snowfall (the more stations observe snow, the greater the spatial extent). The average number of snow events was calculated to be 133, although there was a large amount of variability. The maximum number of events with snow was 421 during 2010 and the minimum was 24 in 2002. Figure 2b shows the monthly distribution of snow events. As expected, this distribution peaked during the cold season, where a maximum of 630 events were recorded in February. By contrast, there was no snow events recorded from July to September (except for two days). As shown in Figure 3a, the stations selected were distributed over a wide range of altitudes, where most were located at low altitudes (approximately 71% were positioned below an altitude of 400 m.a.s.l and 20% were located between 400 and 800 m.a.s.l). Only 9% of the observation stations were located at altitudes higher than 800 m.a.s.l.

Table 1 shows the monthly distribution of the minimum altitude at which snow was observed. Snowfall during the coldest time of the year, during December to March, was observed around sea level, while the altitude increased as the year progressed towards the summer months.

Figure 3b shows that the number of snow events is directly related to the altitude at which the observation stations were distributed (Fig. 3a). Most of the rain gauges were located between 200 and 400 m (25.4%) and between 800 and 900 m (25.4%), the altitudes at which the maximum number of snow events were recorded. By contrast, the minimum number of snow events recorded corresponded to altitude extremes: <200m and >1000m. The number of snow events for each province within the study area is shown in the Figure 4. As expected, the maximum number corresponded to the mountainous regions, where 43.6% and 34.7% of the total number of snow events were observed in Cantabria and Asturias respectively. Conversely, Lugo and Vizcaya were the regions with the lowest number of snow events, being 5.3% and 1.7% of the total number respectively.

The spatial pattern of the average number of snow days occurring annually is shown in the Figure 5. The maximum values were ~ 10 days per year in La Población de Yuso (altitude 840 m.a.s.l) located within the province of Cantabria near the border of Castile and Leon, and ~ 9 days per year in the village of Cubillos de Ebro (altitude 765 m.a.s.l) also located south of Cantabria. In general, the maximum number of snow days (between 5 and 10 days) occurred in the mountainous area situated south of Cantabria and Asturias. On the other hand, there were some areas located near the coastline where the temperatures tended to be higher. In these cases, snow was observed less than once a year.

Snow has the greatest impact on social and economic activities when covering the ground surface. On spatial average, the number of days with the ground covered by snow was 0.3 per year. The temperature at the 850 hPa pressure level was generally found to be between -1ºC and -4ºC during these days. The spatial distribution of the average number of days with snow covering the surface is shown in the Figure 6. As expected, the distribution was related to the orographic pattern, since the higher the altitude the greater the number of snow days. Two of the areas are particularly worth noting: the south of Cantabria and Asturias, which is a mountainous area with an altitude greater than 900 m and where snowfall is frequently found; and the lowlands, with an altitude lower than 500 m and where snowfall is much more infrequent.

4. SYNOPTIC PATTERNS ASSOCIATED WITH HEAVY SNOWFALL

The analysis of the daily synoptic patterns of geopotential height at the 500 hPa pressure level and mean sea-level pressure showed that a trough had been present over the Iberian Peninsula, or close by, and a low had appeared over the Mediterranean Sea or Central Europe. There was one exception in this general rule, since one case a long wave trough was located west of the Iberian Peninsula. The low-level flow was from N or NE in ~ 85% of the cases. Furthermore, the cold thermal profile in the troposphere is also worth noting. The temperature at the 850 hPa pressure level was lower than -3ºC in ~ 70% of all cases. The methodological approach used in this study consisted of applying Principal Component Analysis (PCA) coupled with Cluster Analysis (CA) as other authors have done (Richman, 1986; Yarnal, 1993). To apply these statistical techniques in a spatial domain it is necessary to use a continuous variable that gives the main dynamic and thermal structures. So, two indices were selected (one associated with the synoptic situation at the 500 hPa pressure level, and other associated with the surface wind direction) in the sample of the 31 selected days. As Huth et al., (2008) indicate, the use of PCA in the classification of synoptic patterns is twofold. In our analysis, PCA is used prior to CA, so it cannot be considered a classification tool because the posterior CA accomplishes this aim. The PCA is only used as an intermediate tool for the data dimension reduction.

The PCA was applied to the covariance matrix of these indices, and the resulting empirical orthogonal functions/patterns (EOF) were of unit variance and, also, were not rotated. It should be noted that there is a little correlation between the two parameters (r = 0.3), and they can therefore be considered to be lineally independent. Accordingly, only one principal component was retained, which explained 66.9% of the total variance. Later, CA is applied to the factor scores resulting from the PCA. The clustering algorithm used is the non-hierarchical K-means method. For this algorithm the number of the groups is required beforehand. This can be decided by taking into account the results of a procedure called “jump method”. This procedure is calculated from a hierarchical clustering algorithm and using the Ward Method as an agglomeration technique. The coefficient given in the agglomeration schedule is really the within-cluster sum of squares at each step. The number of groups is estimated detecting the greater distortion between the coefficients in two consecutive steps. Finally, the K-means method is used without iterative steps. These approaches have been widely applied in atmospheric studies and are described in detail in many text books (e.g. Wilks, 2006). The application of all this procedure gave 4 groups with their respective final cluster center (which represents for each case, the final cluster assignment made from the Euclidean distance between the case and the cluster center used to classify the case). We take as the characteristic pattern of the each cluster, the case closest to each final cluster center.

4.1. Group I (Cases: 8, 10, 11, 12, 20, 22 and 30)

Seven members belong to this group (Figure 7) and the case closest to cluster center corresponds to 20 (see Table 2). A 500 hPa trough over the Iberian Peninsula was identified. The pattern at sea level showed an anticyclone over the Atlantic Ocean and a low over Central Europe. Temperature was -31 ºC at the level of 500 hPa and -1 ºC at the level of 850 hPa, values that are considered to be not particularly cold. This situation was similar to that found for group II, but in this case the low-level flow was from the north and the air mass was found to be warmer, owing to its maritime travel. As a result, the level of snowfall reported in the mountainous areas of the provinces of Asturias and Cantabria was greater (Figure 7d).

4.2. Group II (Cases: 1, 3, 4, 5, 6, 7, 13, 15, 16, 21, 23, 24, 26, 27, 28, 29 and 31)

This group (Figure 8) had the most frequent synoptic patterns of snowfall in the Cantabrian Sea area (It contains 17 members and the case closest to cluster center corresponds to 1). Snowfall associated with this group tended to affect a large proportion of the area studied, including the mountainous (Asturias and Cantabria) and low altitude (Guipúzcoa) zones. It is worth mentioning that in this group snowfall was observed near the sea level (Figure 8d). A trough over Central Europe, Iberian Peninsula, and the western Mediterranean at 500 hPa characterized the average synoptic situation. At sea level, an anticyclone was located over the Atlantic Ocean and a deep low was centred over the western part of the Mediterranean Sea. The temperature found in this area was -35ºC at the level of 500 hPa and -7 ºC at the level of 850 hPa, which was associated with strong north-easterly flow at low levels from Central Europe. The air mass was in contact with the water surface before reaching the study area, where the lower layers became moistened and heated and the air tended to become unstable.

4.3. Group III (Cases: 2, 9,14, 17, 19 and 25)

This six-member group (Figure 9) with case 14 assigned as the cluster center, presented a low over the Iberian Peninsula at the 500 hPa pressure level. An anticyclone characterizes the pattern at the sea level over North Europe and a low over the Iberian

Peninsula and the western Mediterranean Sea. The temperature was around -30ºC at the level of 500 hPa and -3 ºC at the level of 850 hPa, highlighting the continental cold air with a clear NE flow at low levels over the study area. Most of snowfall was reported for the province of Asturias (Figure 9d).

4.4. Group IV (Case: 18)

This last atmospheric pattern was infrequent (only one case in the period studied), but is interesting because it is quite different from the other groups. A trough over the Atlantic Ocean at middle levels and an Atlantic low at sea level characterizes the pattern. This situation generated strong westerly flow and was usually related to cold fronts and precipitation bands over the study area. The temperature was -26ºC at the level of 500 hPa and +1 ºC at the level of 850 hPa, and probably reflects the situation prior to the snowfall generated by the marked cold front. This only event was reported for the provinces of Asturias and Cantabria (Figure 10(d)).

5. DISCUSSION AND CONCLUSIONS

The characteristics of snow over the northern Iberian Peninsula (the Cantabrian area) have been studied using data collected over a 31-year period (1988-2018) from a set of 105 observation stations. The number of snow events per year was highly variable, ranging from 24 (year 2002) to 421 snowfall events (year 2010), and with an average value of 133 events. As expected, this distribution peaked during the cold season (from October to May) with a seasonal average value of 255 snow events. The maximum of 630 snow events was observed in February. By contrast, there was no snow from July to September, except for two events during the period studied. During the cold season temperature at the 850 hPa and 500 hPa pressure levels were low (≤ -3 and -30 respectively) and, consequently, snow level was also low.

As expected, the spatial distribution of snow was related to the orography, since the highest numbers of snow events and snow days were observed in highlands and mountains, where the probability of being above the snow level is greater. Most of the weather gauge stations were located at low altitudes (approximately 71% of all stations are below an altitude of 400 m.a.s.l and 20% are located between 400 and 800 m.a.s.l), with a few of the stations (9%) located at altitudes higher than 800 m.a.s.l. The minimum altitude where snow was reported was analysed and is directly related to the altitude at which the observation stations are distributed. Most of the rain gauges are located between 200 and 400 m (25.4%) and between 800 and 900 m (25.4%), where the maximum number of snow events occurred. Likewise, the minimum number of snow events corresponds to altitude extremes: <200m and > 1000m. This fact is due to the small areal located at altitudes above 1000 m and, consequently, the number of observation stations reporting snow will be low and the number of snow events will be low. Conversely, the maximum number of snow days (~ 10 days per year) was found within the mountainous regions of the study area. As expected, these results are lower than those reported in colder areas, such as Poland, where the mean number of snow days ranged between 29.6 and 65.8 (Szwed et al., 2017). Moreover, our results are also lower than the mean number of snow days found in the mountainous regions of the Spanish Mediterranean area, where more than 30 days were reported (Núñez et al., 2016). This fact is probably due to the mountainous area being smaller. The mean number of snow days in the lowlands was < 0.5, which is similar to the values reported by Nuñez et al. (2016) for the Mediterranean coast of Spain. The ground was covered by snow for only 0.3 days per year on average, but in the mountainous areas the ground was covered more than 5 days per year.

The synoptic patterns associated with heavy snowfall were also analysed in this study. The daily patterns at 1200 UTC of geopotential height at the 500 and 850 hPa pressure levels, sea level pressure and temperature at 500 and 850 hPa were considered. The synoptic situations were classified based on a Principal Component Analysis (PCA) coupled with K-mean clustering and the characteristic patterns of each group are represented by the patterns of the cluster centers obtained for four groups. The synoptic patterns associated with heavy snowfall show that a trough was present over the Iberian Peninsula, or close by, and a low appeared over the Mediterranean Sea or Central Europe, which are similar to the circulation patterns related to heavy snowfall found by Esteban et al. (2005) in Andorra (Pyreness) The low-level flow from N or NE in ~ 85% of cases and the temperature at the 850 hPa pressure level was lower than -3ºC in ~ 70% of the cases, showing cold air advection from northern latitudes, which is also seen in other studies of occurrence of snowfall in southern Europe, as in Greece (Dafis et al., 2016).These results are in agreement with those reported by Bednorz (2011, 2013) who studied snow in Polish-German and Central European lowlands. This author found negative anomalies of sea level pressure and a pressure level 500 hPa over Central Europe during intense snowfalls, which were associated with a Mediterranean cyclone and low pressure systems in the Baltic regions. The synoptic patterns found in this study are associated with precipitation and low temperature, which is related to the negative NAO phase. The relationship between NAO and snow has been reported in Europe (Falarz, 2007; Szwed et al., 2017). However, the number of positive and negative monthly values of the normalized NAO index corresponding to the 31 cases analyzed in this study is similar (16 negative and 15 positive)

The results obtained could help to evaluate the impact of possible future changes, as atmospheric circulation changes, on snowfall over the study area.

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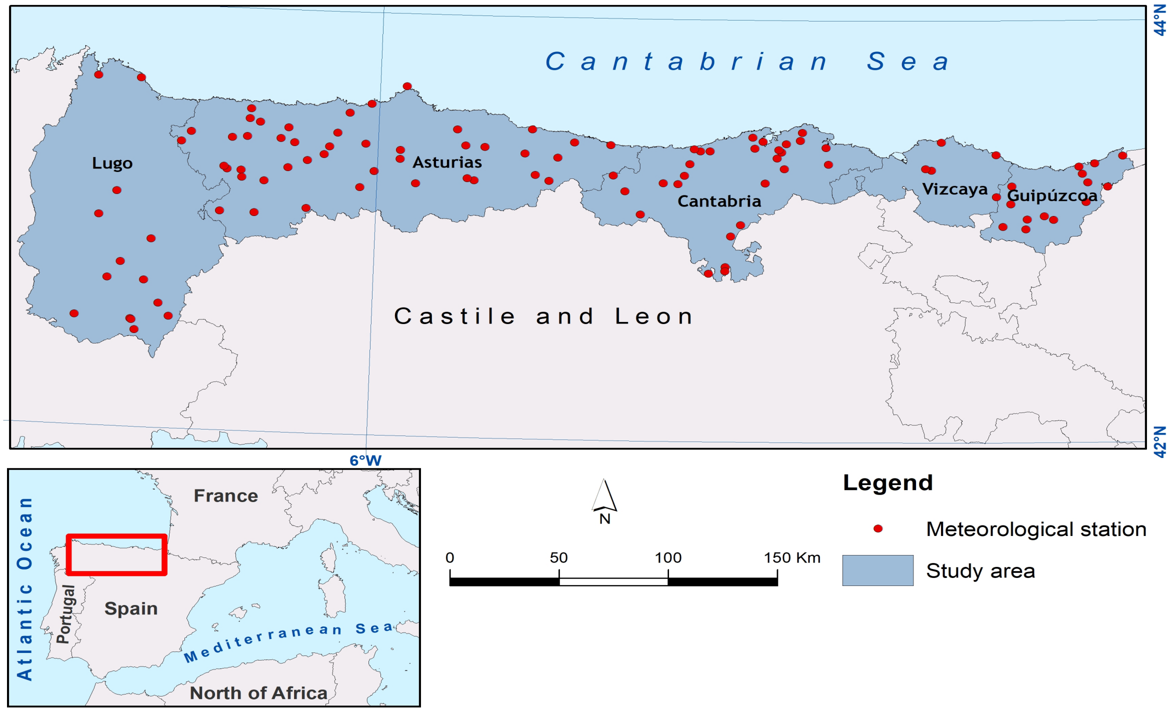
(a)



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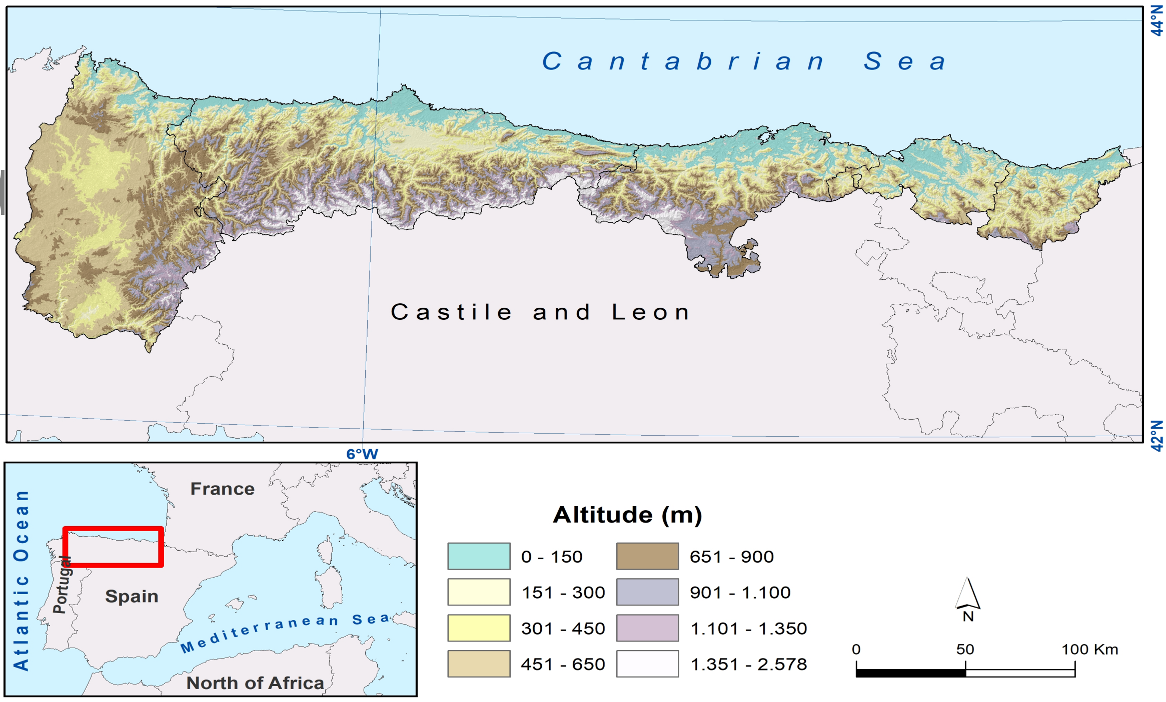

Figure 1. (a) Study area and location of the observation stations used in this study and (b) the geographical characteristics of the zone.

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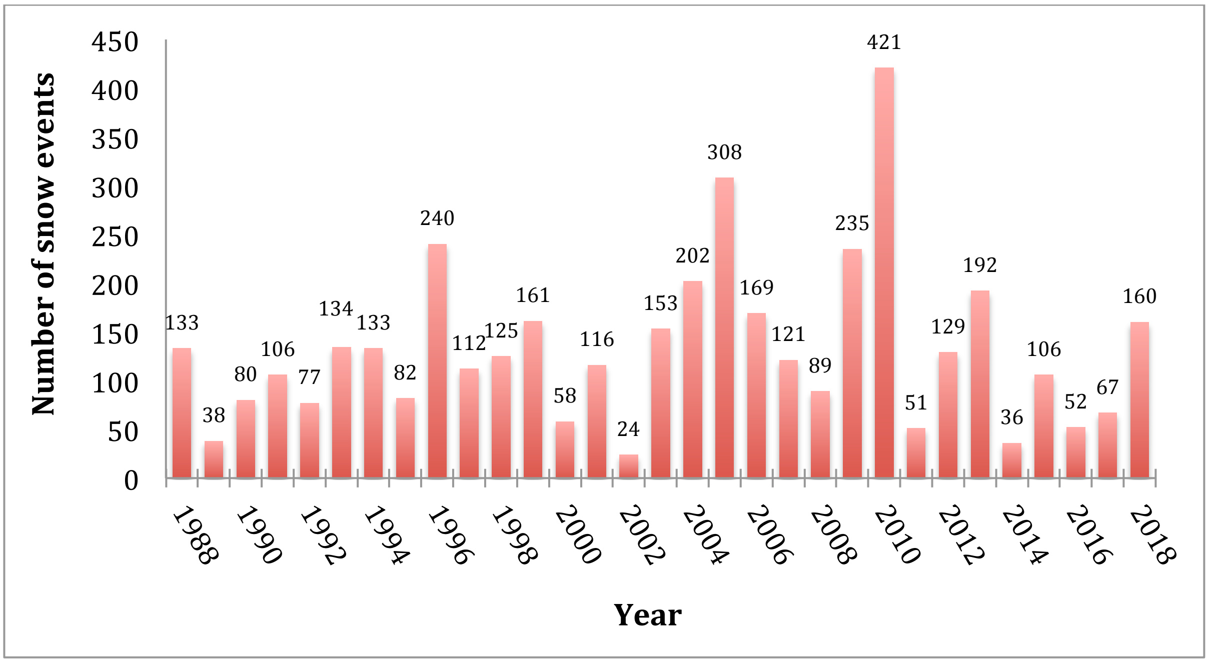
(a)



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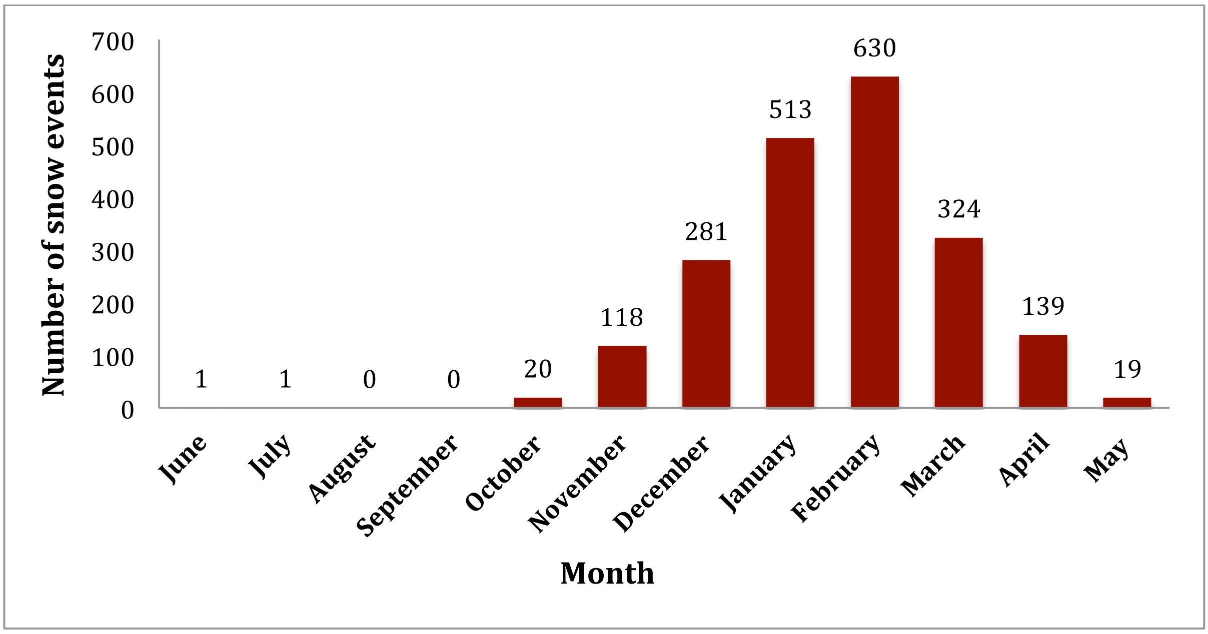

Figure 2. (a) Annual number of snow events and (b) number of snow events per month.

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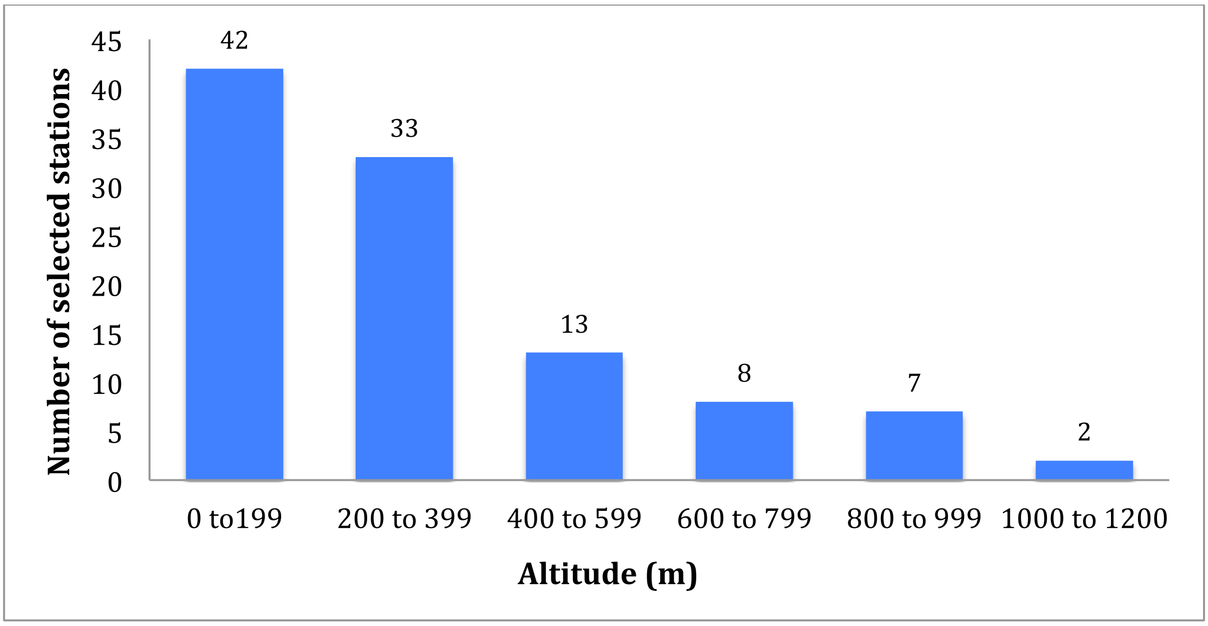
(a)



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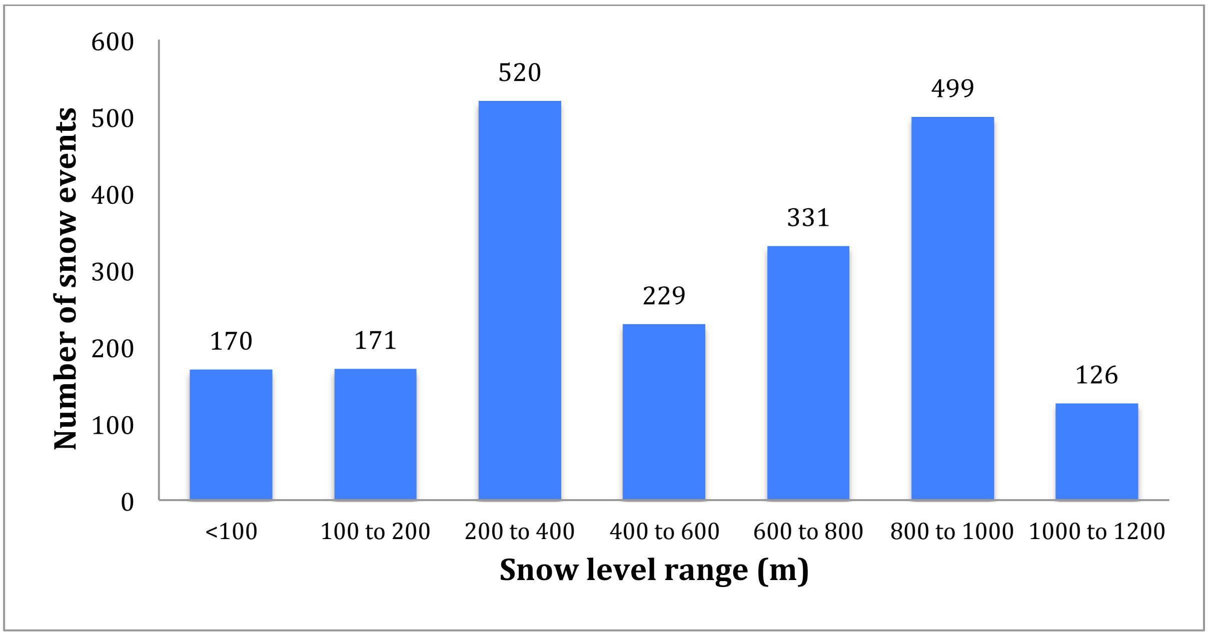

Figure 3. (a) Distribution of the observation stations at different altitudes and (b) Number of snow events vs minimum altitude where snow was observed.

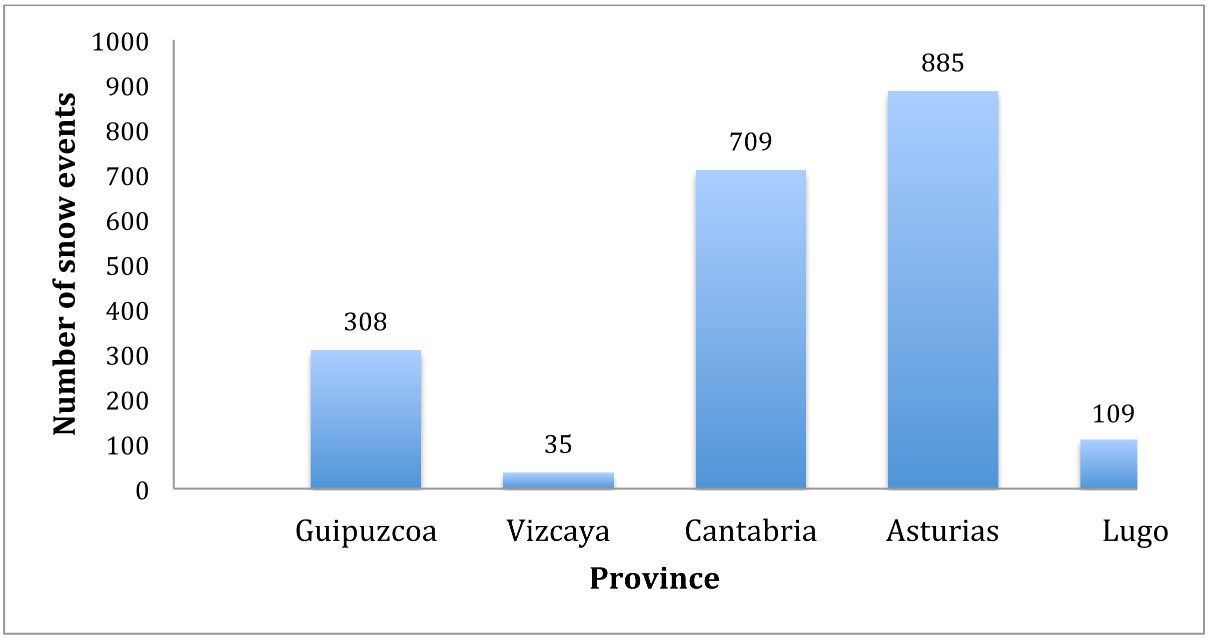

Figure 4. Number of snow events per province of the studied domain.

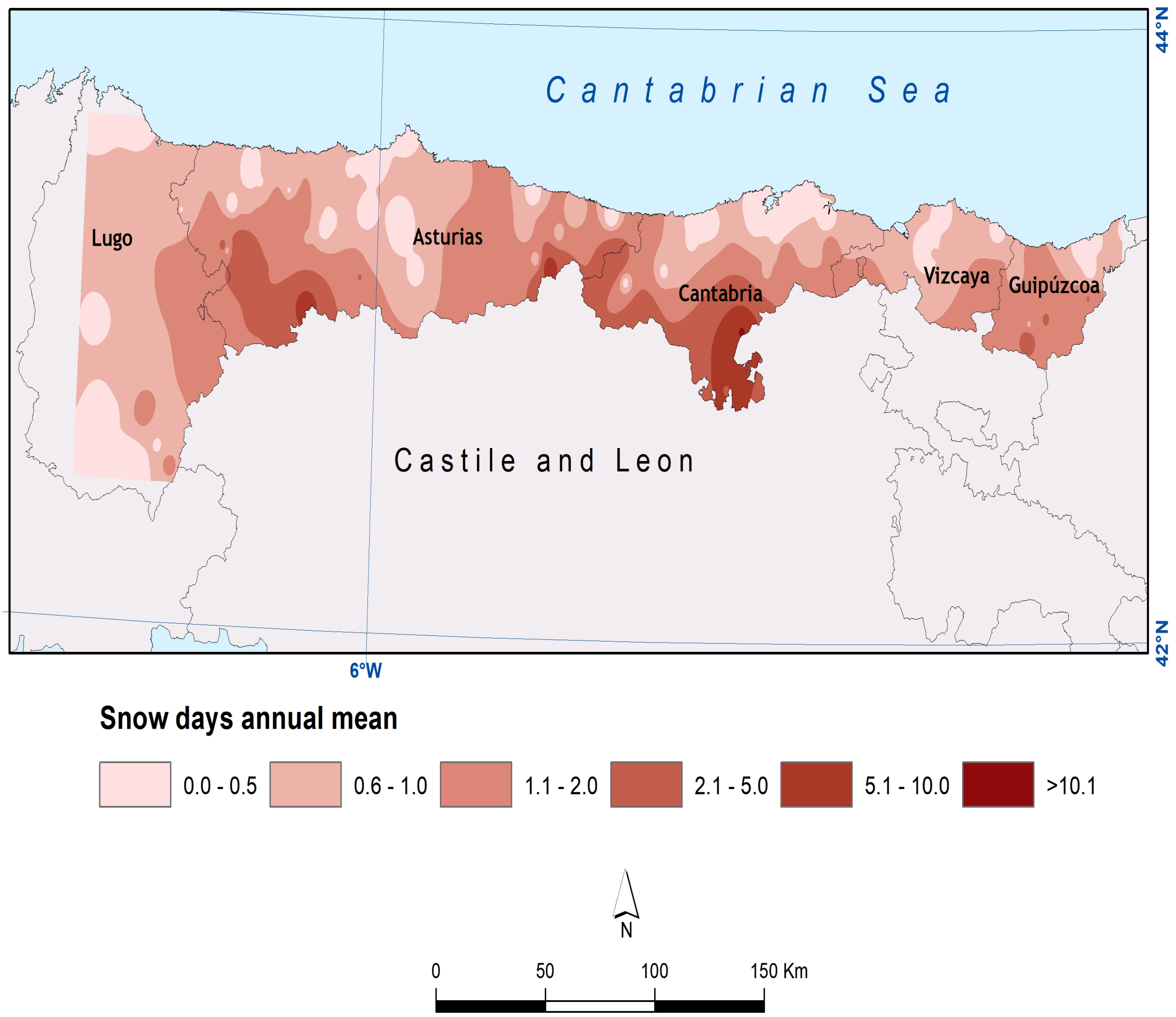

Figure 5. Spatial pattern of the annual average number of snowfall days.

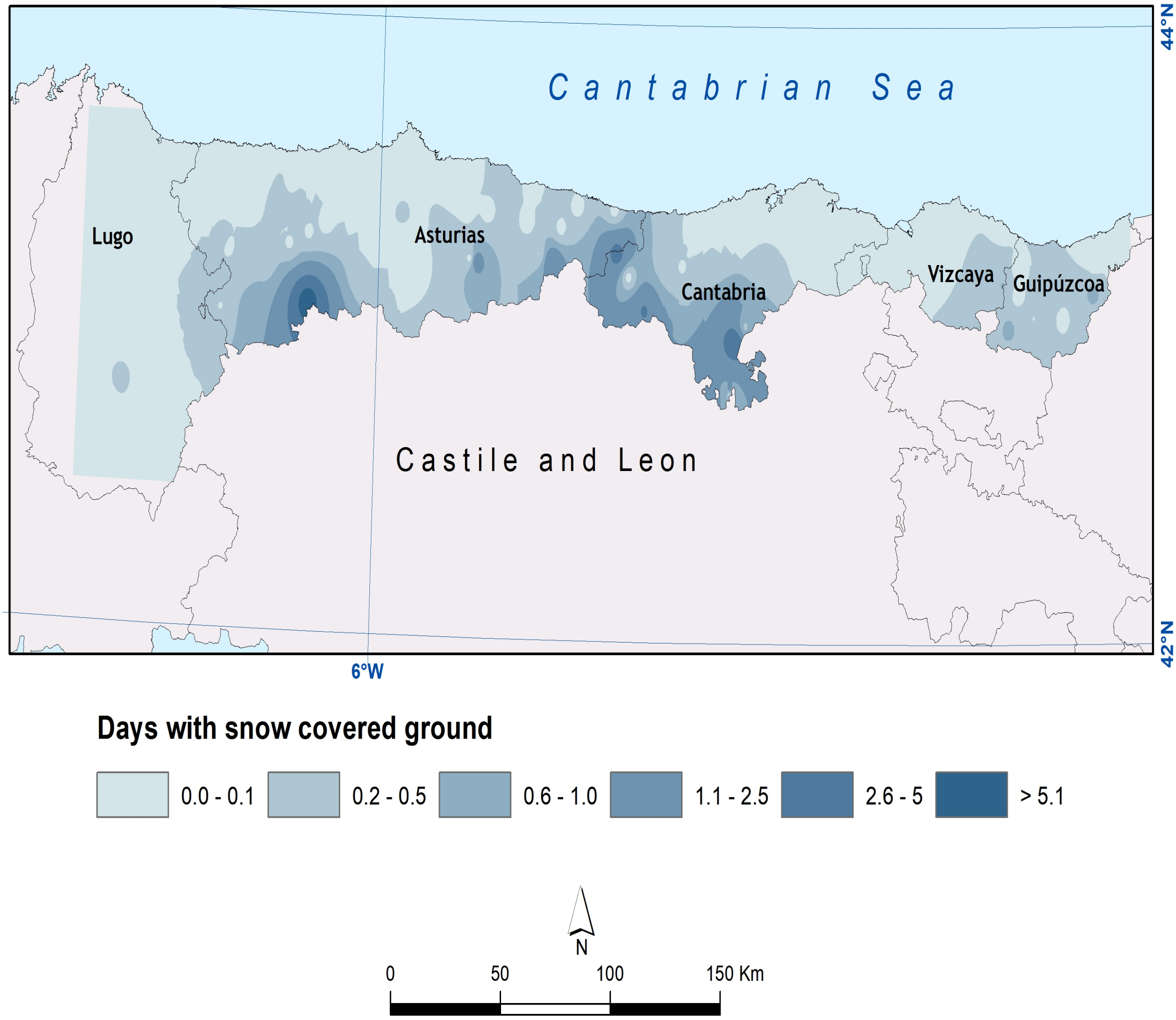

Figure 6. Spatial pattern of the mean number of days with snow covering the ground surface.

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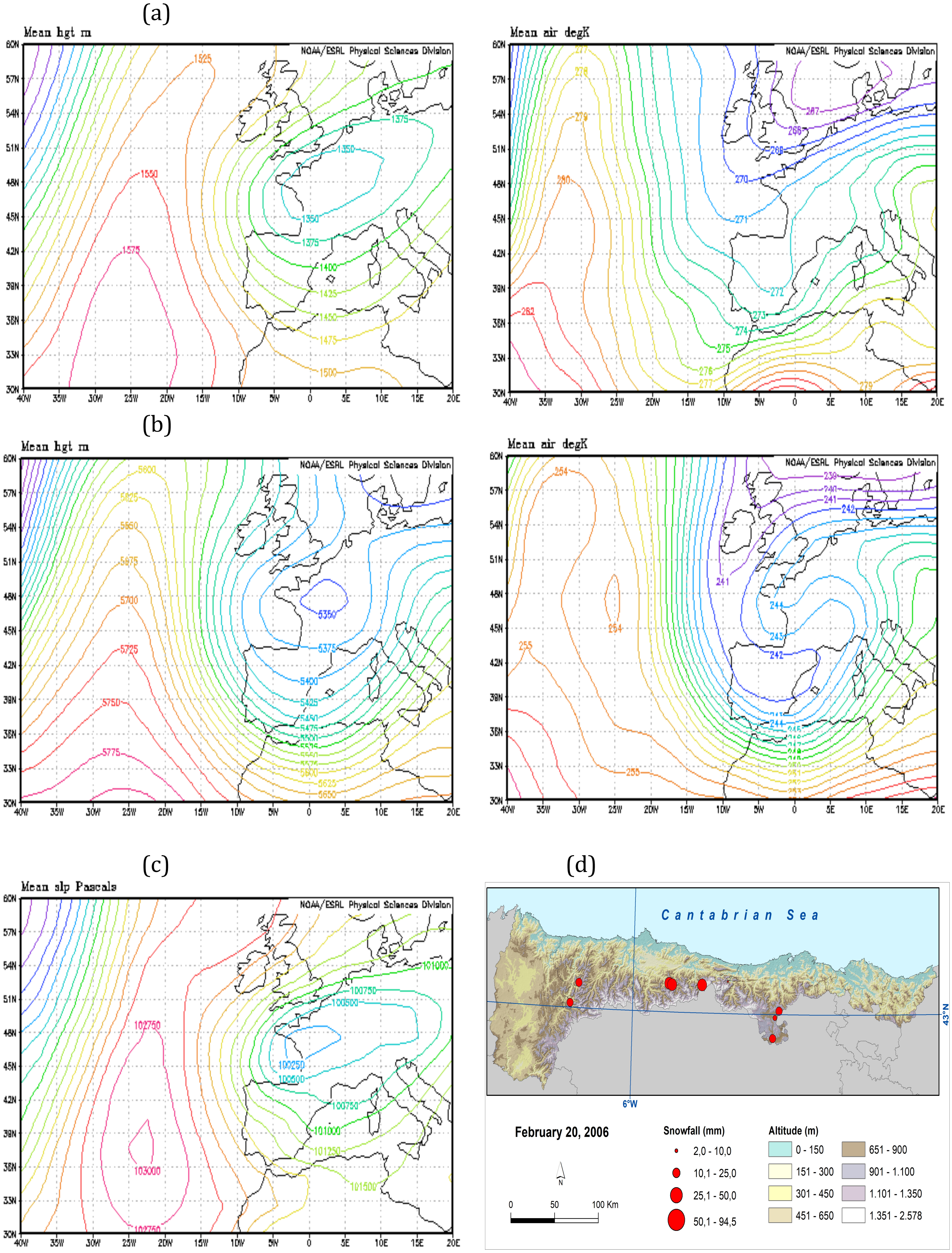

Figure 7. Average patterns for group I: (a) geopotential height (m) and temperature (K) at the 850 hPa pressure level; (b) geopotential height (m) and temperature (K) at the 500 hPa pressure level; (c) mean sea-level pressure (Pa) and (d) geographical distribution of snowfall associated with the day closest to the cluster center.

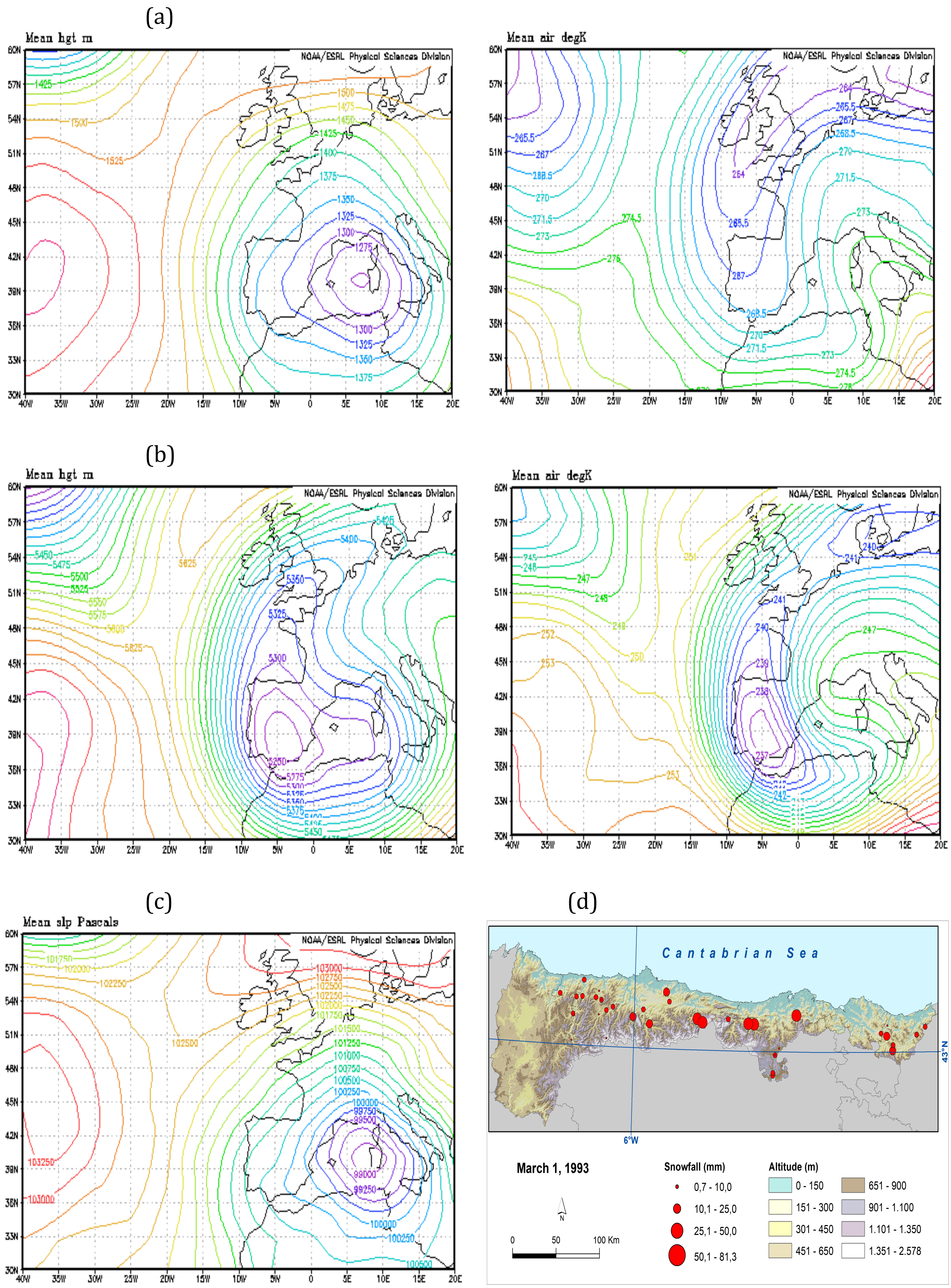

Figure 8. As Figure 7 for group II.

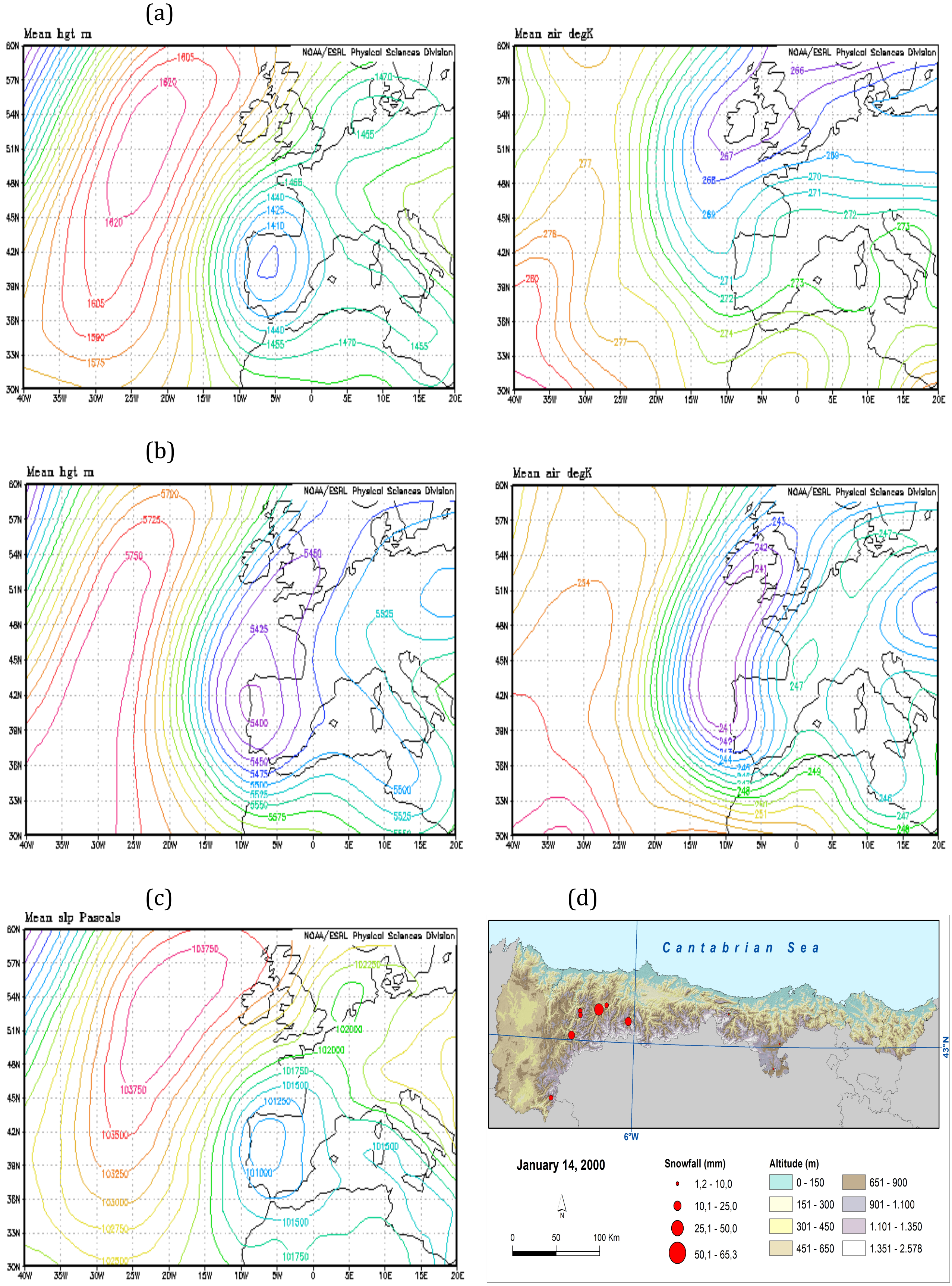

Figure 9. As Figure 7 for group III.

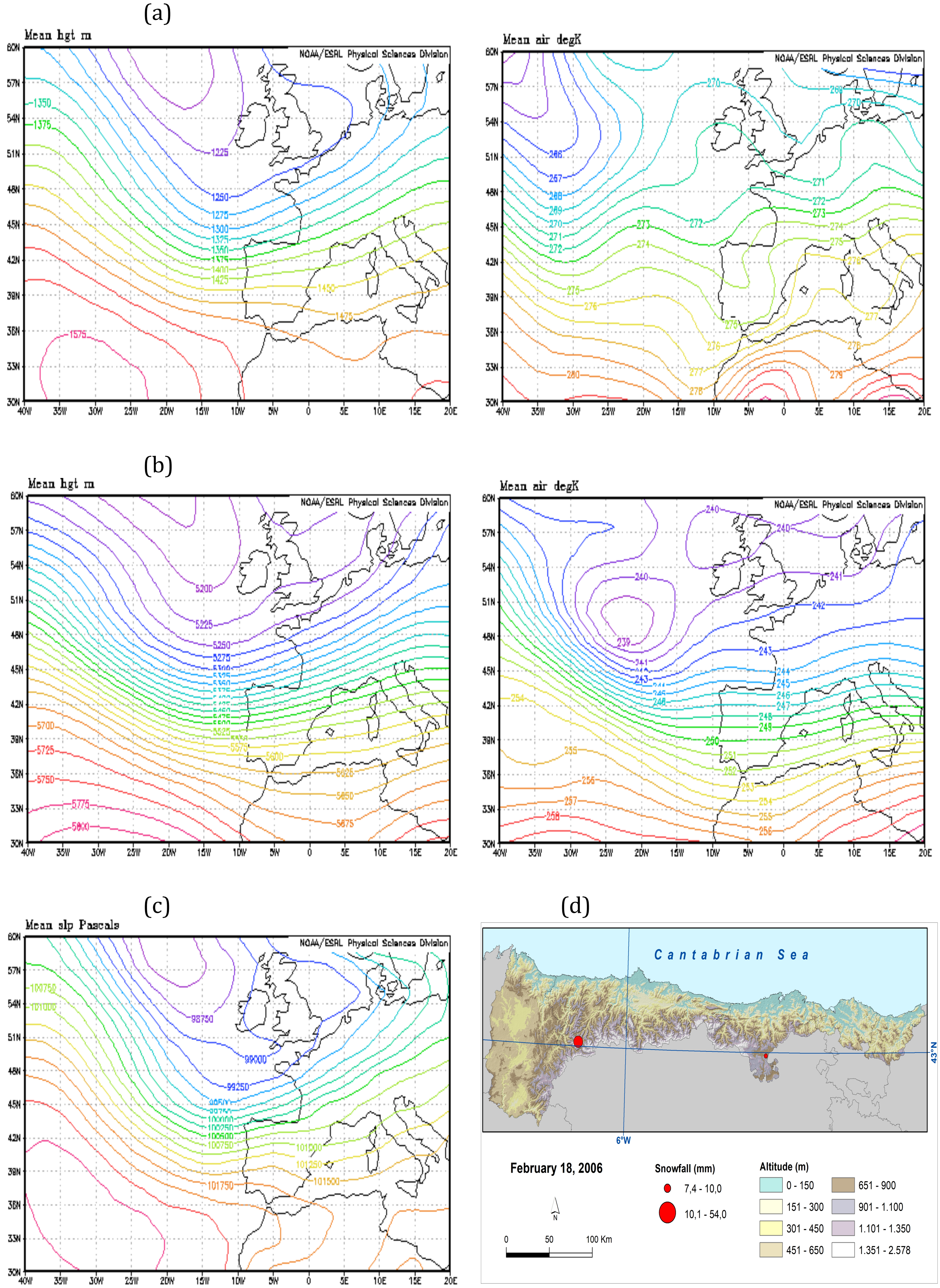

Figure 10. As Figure 7 for group IV.

Table 1. Minimum snow level (m) per month.

Month	**Minimum snow level**
January	Sea level
February	4 m
March	4 m
April	90 m
May	40 m
June	270 m
July	400 m
August	No snow days
September	No snow days
October	40 m
November	15 m
December	4 m

Table 2. Days representing the episodes of heavy snowfall selected, the group assigned, the temperature at the 850 hPa pressure level and surface wind.

Year	**Month**	**Day**	**Location**	**Altitude (m)**	**Rainfall (mm)**	**Group**	**T_{850} (ºC)**	**$V_{surf.}$**
1993	3	1	TERAN	260	81.3	2	-7	NE
1997	1	2	PONTICIELLA	360	58.7	3	-3	NE
1997	1	3	ONETA	330	68.8	2	-3	NE
2015	2	4	ENTRAGO-LA RECUSA	450	63.3	2	-5	NE
2015	2	5	LA POBLACION DE YUSO	840	59.5	2	-4	NE
1996	12	6	AMIEVA (RESTAÑO)	730	60.3	2	-3	NE
2015	2	7	VALDEPRADO (PESAGUER)	820	113.6	2	-4	NE
2013	2	8	BUSTAMANTE PANTANO	840	47.3	1	-1	N
1990	12	9	BARGAEDO	280	74.7	3	-4	NW
1990	12	10	SALCEDO DE ALLANDE	670	72.2	1	-1	N
1998	3	11	LA POBLACION DE YUSO	840	44.6	1	-1	N
1991	4	12	AMIEVA (RESTAÑO)	730	48.3	1	0	N
2013	3	13	BARGAEDO	280	59.7	2	-6	NE
2000	1	14	ARGANZA	340	65.3	3	-3	NE
1999	12	15	LA POBLACION DE YUSO	840	70.7	2	-6	NE
1999	12	16	OTERO DEL MONTE	940	70.6	2	-5	NE
1996	11	17	AMIEVA (RESTAÑO)	730	45.5	3	-1	NW
2006	2	18	CANGAS DE NARCEA	670	54.0	4	1	SW
1991	11	19	GENESTOSO	1170	69.4	3	-1	NW
2006	2	20	RIOSECO-DEPURADORA	370	94.5	1	-1	N
1996	2	21	RIOSECO-DEPURADORA	370	57.7	2	-4	NE
1991	3	22	TRESVISO	900	80.0	1	0	N
2016	11	23	AMIEVA (RESTAÑO)	730	53.9	2	-2	NE
1991	3	24	AMIEVA (RESTAÑO)	730	80.0	2	-4	NE
2007	1	25	SALCEDO DE ALLANDE	670	69.0	3	-6	ENE
2004	12	26	LA POBLACION DE YUSO	840	68.9	2	-5	NE
1993	2	27	LEGAZPIA (BARRENDIOL)	501	77.3	2	-4	NE
2001	1	28	LA POBLACION DE YUSO	840	98.0	2	-2	NE
2004	2	29	ARRIARAN (PRESA)	255	62.5	2	-6	NE
1998	4	30	GENESTOSO	1170	56.4	1	0	N
2016	3	31	SALCEDO DE ALLANDE	670	39.5	2	-4	NE