S1. Trajectories types for selected case studies synoptic patterns

The NW IP is affected by different synoptic weather systems (Gómez-Gesteira *et al.*, 2011). Several case studies will now be analysed in order to validate the Lagrangian classification for different synoptic conditions and to compare it with the Eulerian LWT for a given case. The corresponding circulation type for the NW IP (Lorenzo *et al.*, 2008) will be given for each case study. Furthermore we use the case studies to illustrate different ways how the information in the final catalogue can be presented.

S1.1. Cold front - 12/11/2002

The NW of the IP is often affected by the passage of cold fronts associated with the storm track in the North Atlantic Ocean and the passage of cyclones that strike directly the region (Trigo, 2005). Therefore, the study of a cold front system is first presented. On the 12th November 2002, a typical cold front associated to a low pressure system located west of the British Isles affected the NW IP (Figure S1). The corresponding LWT for that day was a 'W' type. Additional information can be obtained from the Lagrangian-based classification. For this day there are five main airstreams arriving to the region, their characterisation given in Figure S1. For example, besides the long range transport, some short range and medium range transport features are also found. All the air streams present on average a cyclonic path (CI), while the majority is only weakly curved (ZI): they are not strongly affected by meso- and synoptic-scale cyclones on their way to NW IP. With respect to the integrated changes in the specific humidity (MU) the signal is not so clear. There is one air stream with a decrease in humidity, two air streams with an increase in humidity, and two with small humidity changes. In summary, this day can be characterized by the string [Q+/Q0, Z-, C_{net}, L-SW], as determined from the predominant characteristics.

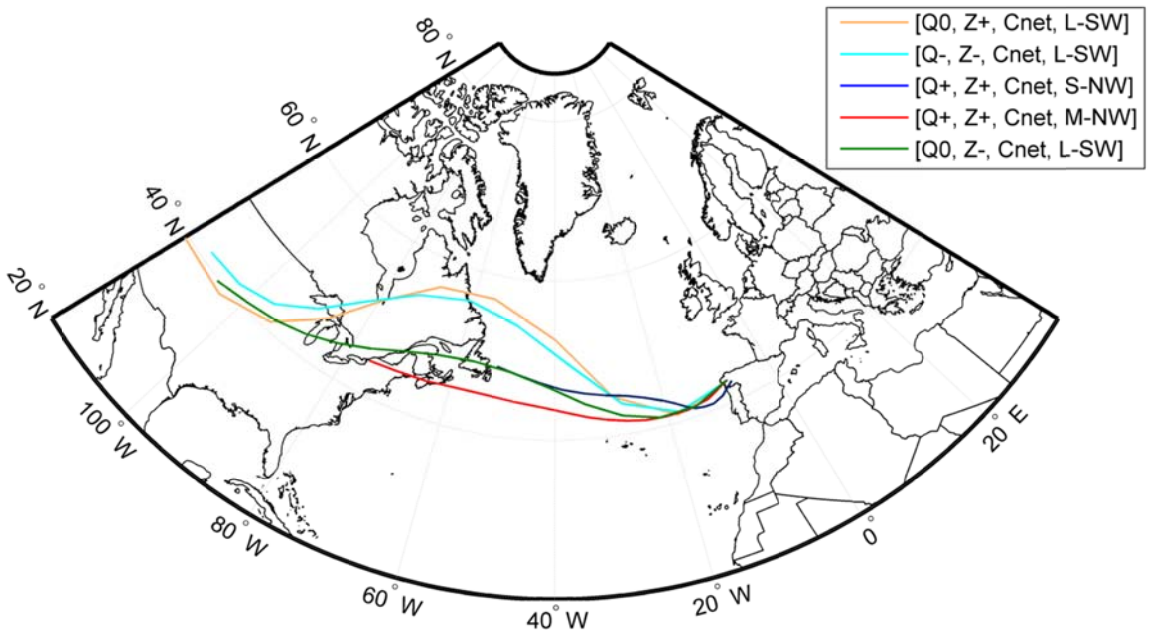


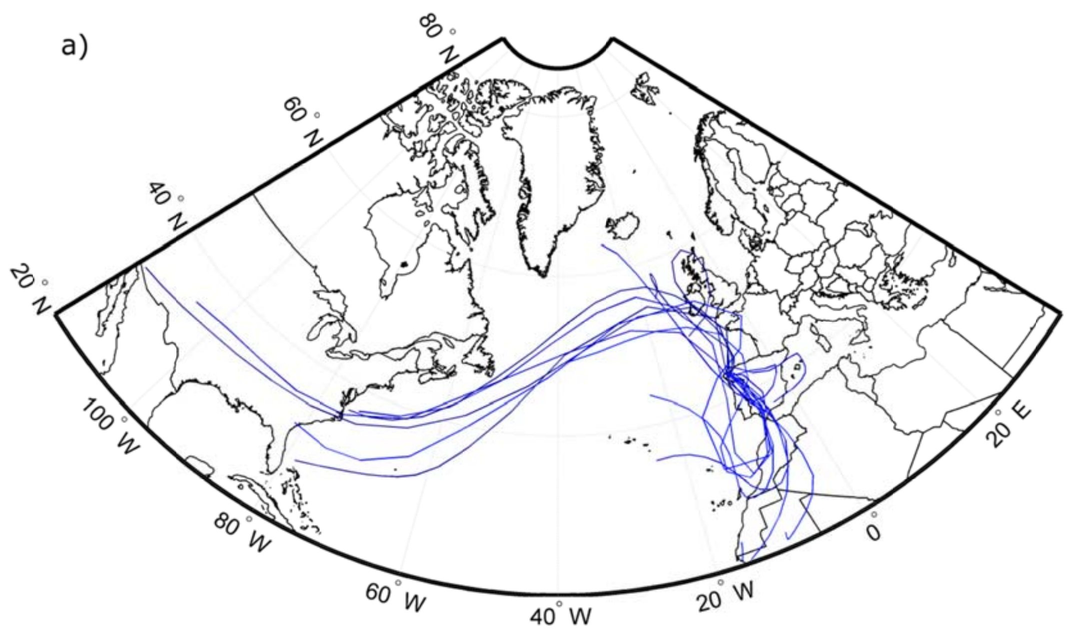
Figure S1. Air streams for the cold front case study (12/11/2002). Each color represents a different air stream – see legend.

S1.2. Cut off low system - 10/10/2001 to 12/10/2001

Cut off low systems (COLS) are very common in the Mediterranean region of the IP, but not as common in the NW IP (Nieto *et al*., 2005). In any case COLS are a very important synoptic weather system to be analysed since most of the time they are associated with reduced thermodynamic stability beneath, hence enhancing the convection in the region, and they do not necessarily have any signature in the SLP field (Nieto *et al*., 2005; Nieto *et al*., 2007; Ramos *et al*., 2011). This particular COL became stationary for three days in the IP between 10/10/2001 and 12/10/2001 (Nieto *et al*., 2008) and it did not have any particular signature at the surface level. The LWT for the three days are A, A and S, respectively. These circulation types are often associated with no precipitation (Lorenzo *et al*., 2008), which is not the case for the present case, since a total of 32 mm of precipitation was registered at the Lourizán station.

The total number of air streams for these three days are 15 which makes the pure listing of the characterising strings no longer a reasonable option and therefore a more graphical presentation needed. Figure S2a) presents the air streams for this case while in Figure S2b) the catalogue of the Lagrangian types for these 3 days. This catalogue (Figure S2b) must be carefully read from bottom to top. The air streams are identified and characterized independently for each day: e.g. air stream 2 at day 2 might be the 'natural continuation' of air stream 1 at day 1. Therefore, an abrupt change in the air stream characteristics from one day to the next is not necessarily physical relevant.

The new method is able to capture the cyclonic circulation at high levels of the atmosphere. This is clear in CI where the cyclonic classes (C_s and C_{net}) dominate. The air streams on these three days are typically strongly curved (Z+). With respect to humidity (MU) the most frequent class corresponds to small changes (positive or negative) followed by the class that corresponds to a decrease in humidity. These three days have the following characterization: [Q0, Z+, C_s, L-SW].



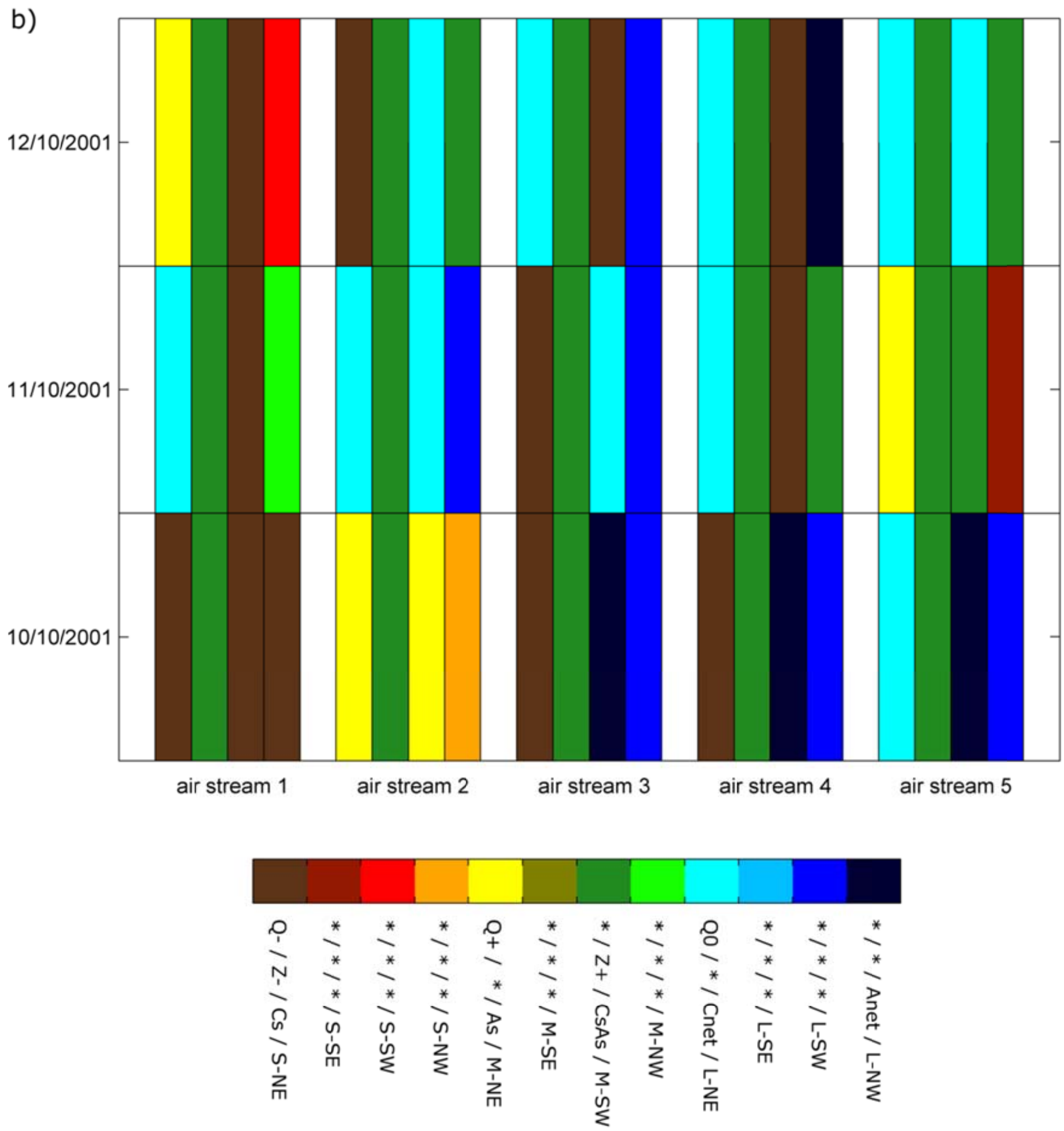
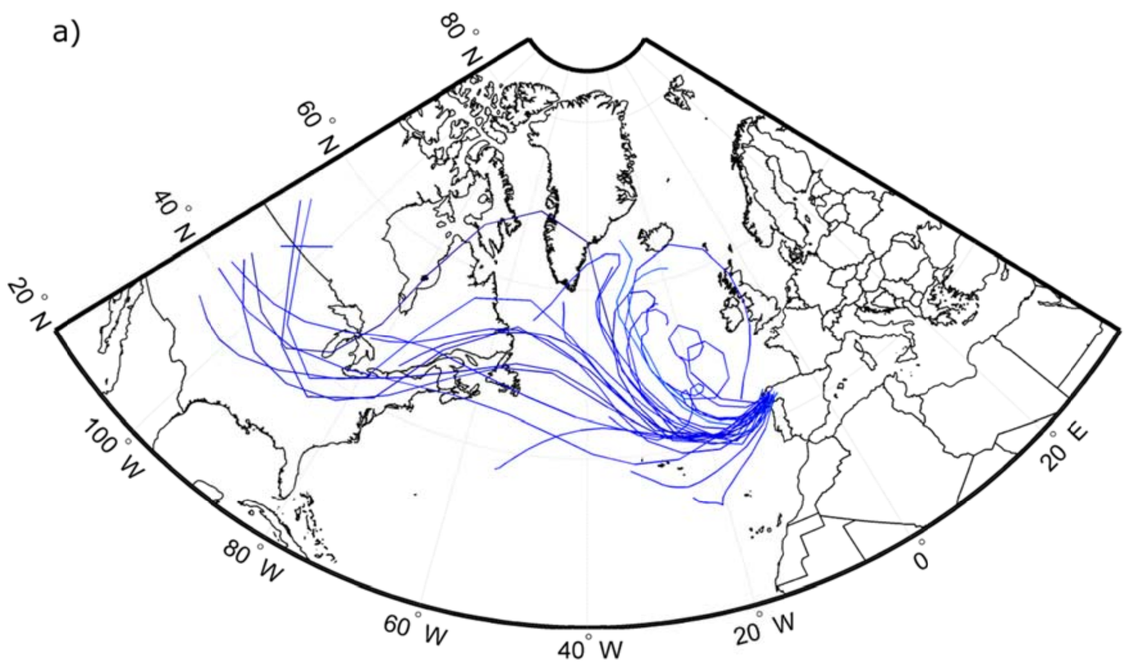


Figure S2. a) Air streams and b) characteristics of the trajectory types classification for the cut-off low system case study (10/10/2001 - 12/10/2001).

S1.3. 5-day averaged highest precipitation period - 17/10/2001 to 21/10/2001

Given that the NW IP is the region with highest annual precipitation in the IP (Herrera *et al.*, 2010; SIAM, 2002), the next case study focuses on the most intense precipitation period averaged during five days for the region (17/10/2001 to 21/10/2001) with an average amount of 41.9 mm. During these days the NW IP was under the influence of a stationary extra-tropical cyclone located in the NW IP with pressure centre values below 1000 hPa (not shown). The correspondent LWT for the five days respectively were CSW, SW, C, C, CSW, corresponding to types that often produce precipitation in NW IP.

Focusing on the Lagrangian types (Figure S3), results confirm a high cyclonic circulation in the region (C_s and C_{net}) with more of 80% of the air streams presenting strong curvature (Z+). Most of the air streams correspond to short or medium range transport. The string [Q-, Z+, C_s / C_{net}, M-NW] summarizes the features for this period.



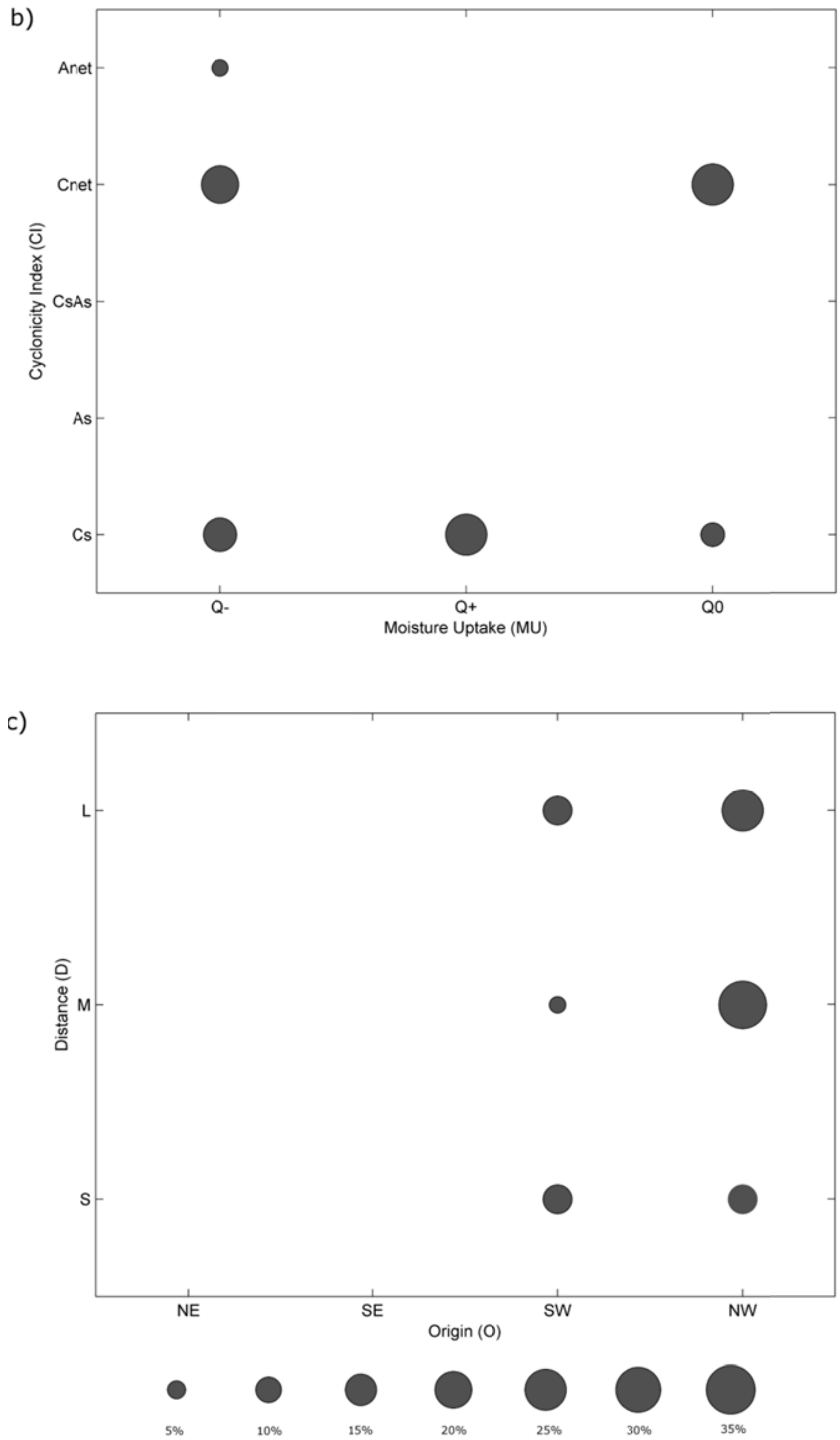


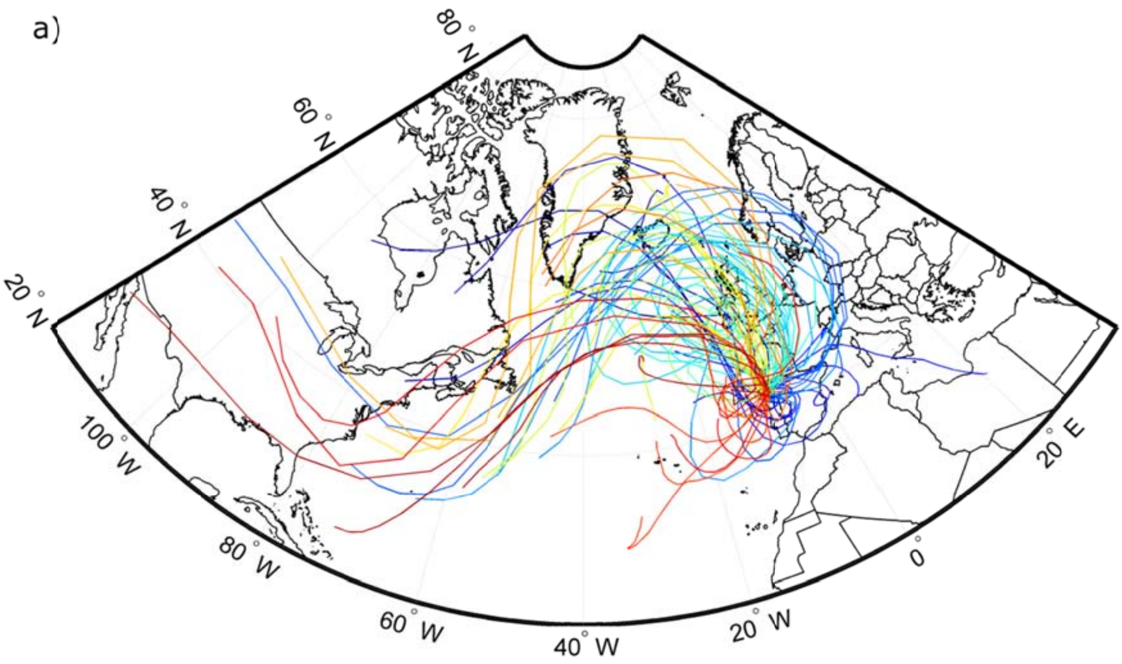
Figure S3. a) Air streams for the precipitation period case study (17/10/2001 to 21/10/2001). b) Scatter plot with frequencies of air streams characteri**z**ed by MU and CI. c) As in panel b), but for D and O.

S1.4. Blocking episode - 14/01/2000 to 29/01/2000)

Blocking events are characterised by a large-scale high pressure system with an anticyclonic circulation dominating the troposphere (Rex, 1950). In the target region the blocking events located over the North Atlantic are known to influence the local weather (Barriopedro *et al.*, 2006). The selected event from 14/1/2000 to 29/1/2000 was the most persistent blocking that occurred in the 12/1999 to 11/2004 period in the North Atlantic. Blocking is associated with anomalous weather conditions over long periods of time and large areas of the mid and high latitudes (Barriopedro *et al.*, 2010; García-Herrera *et al.*, 2007; Trigo *et al.*, 2004). The correspondent daily LWT for this period are shown in Table S1). Most common for this period are the A and S related types.

A closer look at the Lagrangian classification catalogue (Figure S4) reveals that most of the air streams present an anticyclonic path (A_s and A_{net}). In addition more than 3/4 of the air streams are strongly curved (ZI+), while the air streams with no change in humidity are the most common ones (Q0). In terms of integrated length (D), medium and long range transport dominates. This blocking event can be summarized as [Q0, Z+, A_s, M-NW].

a)



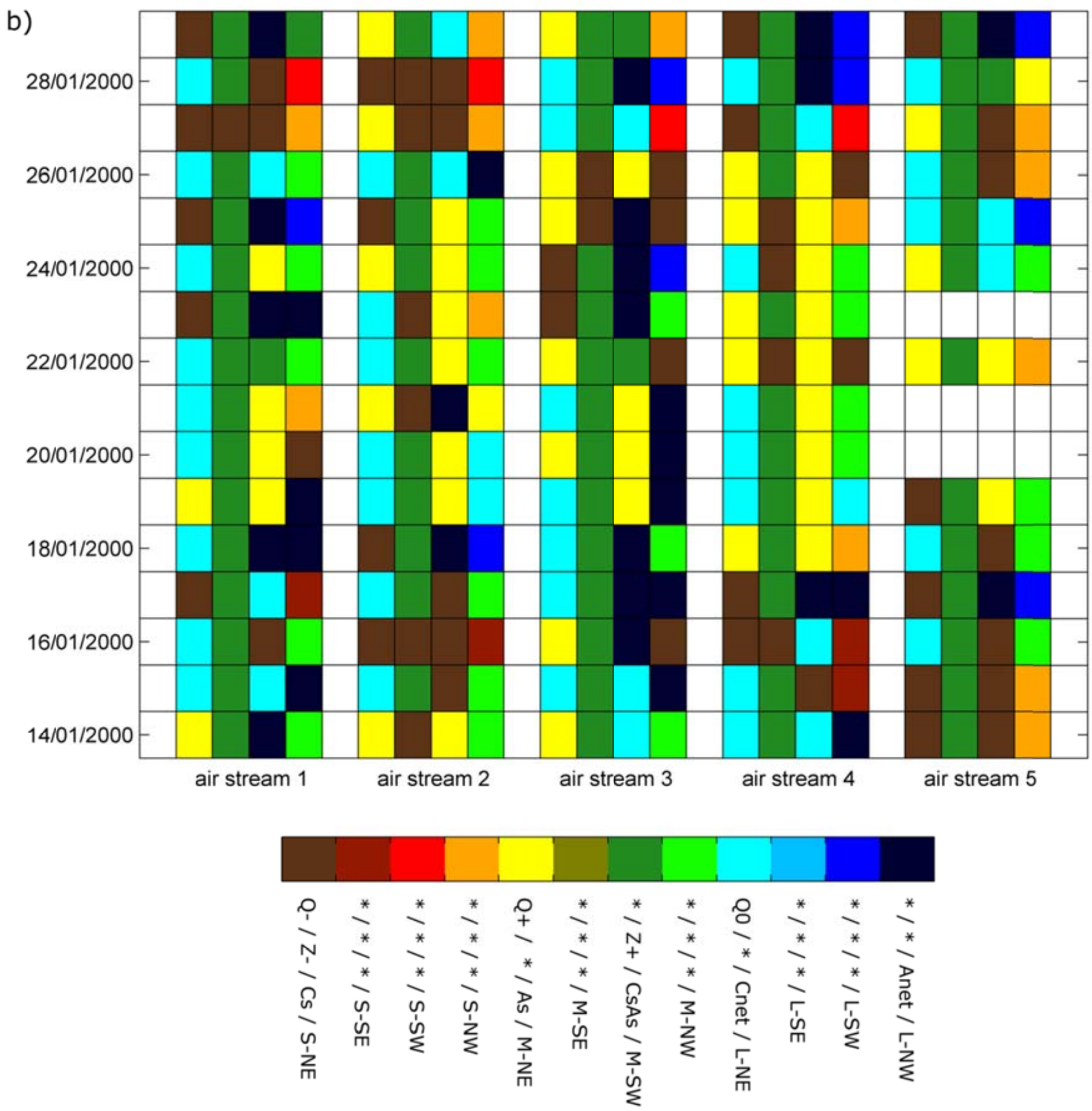


Figure S4. a) Air streams (each color represent a different day) and b) characteristics of the trajectory types classification for the blocking event case study (14/01/2000 to 29/01/2000).

Table S1 . Lamb weather types for each day of the Blocking case study (14/1/2000 - 29/1/2000).

Date	LWT
14/1/200	CNE
15/1/200	E
16/1/200	S
17/1/200	S
18/1/200	AS
19/1/200	S
20/1/200	AS
21/1/200	AE
22/1/200	ANE
23/1/200	ANE
24/1/200	ANE
25/1/200	S
26/1/200	SE
27/1/200	SE
28/1/200	A
29/1/200	AW

S2. Definition of each category of precipitation

Table S2. Definition of each category of precipitation for winter (DJF) and summer (JJA) seasons.

Period	Light	Moderate	Intense	Very intense
Winter	0mm < DP ≤ 3mm	3mm < DP ≤ 9mm	9mm < DP ≤ 21mm	DP > 21mm
Summer	0mm < DP ≤ 1.5mm	1.5mm < DP ≤ 4mm	4mm < DP ≤10mm	DP > 10mm

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