

2.10. Winter storms

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Winter storms arise in connection with intensive low-pressure systems. In Central Europe, the frequency of storm events rises in periods of high Atlantic cyclone activity. The frequency of intensive low-pressure systems over the North Atlantic has increased since the 1930s. Many simulation models predict an increase in cyclone activity in the eastern North Atlantic and over Western Europe as a result of climate change. In Western Europe, more intensive storms are cautiously regarded as a possible development. No predictions are available on future changes in föhn frequency.

Introduction

Extreme winter storms such as Lothar (December 1999) and Vivian (January 1990) are rare individual cases. Therefore it is not possible to make statistically reliable statements on changes in the frequency and intensity of these events. Trend predictions on whether the events will become more or less frequent are therefore very unreliable.

The intensity of a storm is defined in terms of the wind speed above the ground (at a height of 10 m). It is important to distinguish between the peak values in gusts (at one-second intervals) and average wind speeds (mostly at 10 minute intervals). In media reports, peak values are normally used. Furthermore, the insurance business uses the peak value to define the liability threshold, which lies at 75 km/h. The term 'storm' is in fact a misnomer and lies in contradiction to the arguments advanced below. The best known and oldest standard for classifying winds is probably the Beaufort scale. In this, however, average values are used. On the Beaufort scale, force 9 signifies a storm, and refers to average values from 75 km/h upwards. The term 'hurricane' (extreme event) corresponds to force 12 on the Beaufort scale, i.e. to average values upwards of 118 km/h, and these hardly ever occur in low-lying inland areas. To determine peak gust values from the average wind speeds, these must be increased by 30 to 80%.

Meteorological conditions

Winter storms arise in connection with intensive low-pressure systems (cf. Chapter 1.3). They arise in regions with large horizontal temperature differences, that is in areas intermediate between the warm subtropical and cold polar air. The western North Atlantic is an example of a region having a strong climatological temper-

ature difference between north and south. Here, numerous low-pressure systems arise that often drift towards north-western Europe. The path of the low-pressure areas rarely passes directly via Central Europe, so that it is mostly the cold fronts of these that reach Switzerland in the form of troughs. Under weather conditions characterised by a large pressure difference between the Azores and Iceland, the Atlantic west winds increase in intensity, and the frequency of low-pressure systems that finally reach Europe increases.

Extreme winter storms arise through the interaction of numerous processes (heavy north-



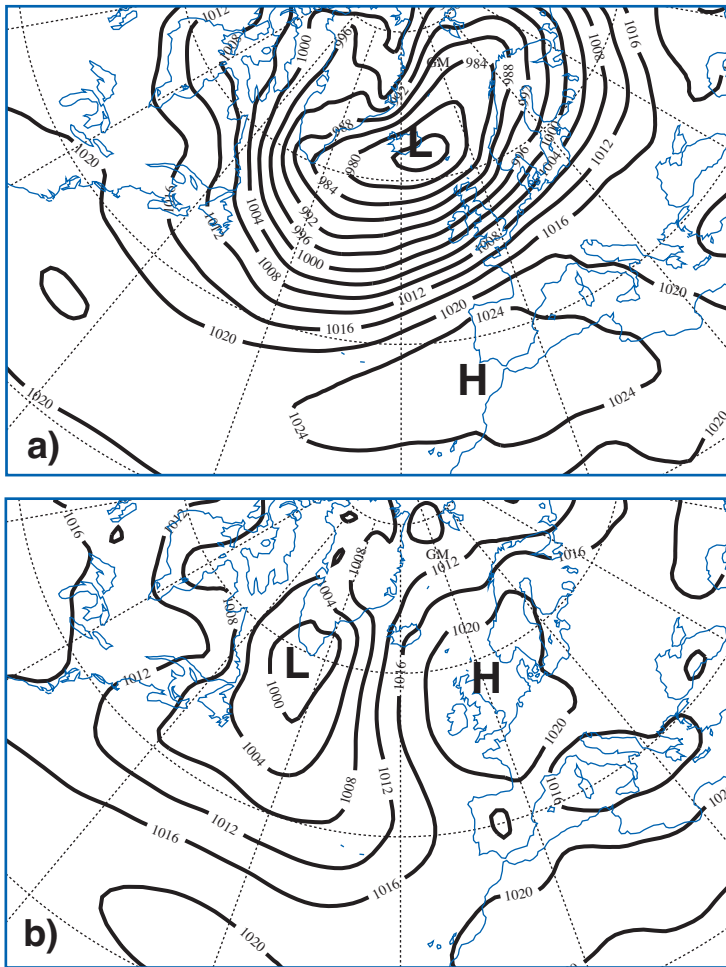


Fig. 46 Ground pressure distribution for (a) a month with a high positive NAO index (February 1990) and (b) a month with a heavily negative NAO index (January 1987). The distance between the isobars is 4 hPa. A positive NAO phase (in terms of the monthly average) is characterised by an intensive low-pressure area over Iceland and an extensive high-pressure area extending from the Azores over Spain. A negative NAO phase is characterised (in terms of the monthly average) by a high-pressure area over North-West Europe and a moderately intensive low-pressure area over the southern extremity of Greenland.

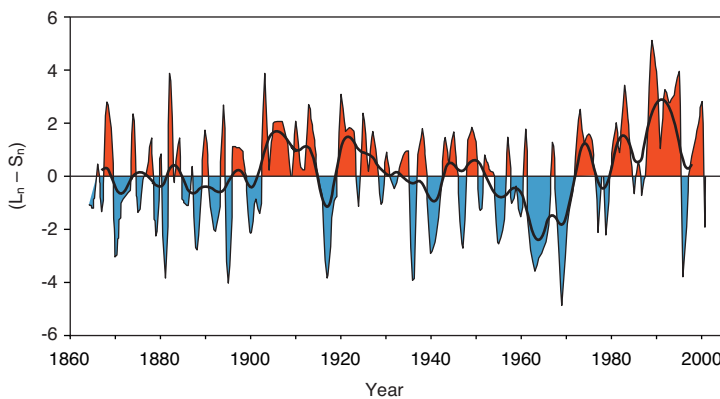


Fig. 47 Reconstruction of the NAO index since 1864. The NAO index designates the pressure difference between the Azores and Iceland.⁴ With a high NAO index, the pressure difference is large. Since the early 1970s, the NAO index has mostly been positive.

south temperature gradients; strong jet stream; perturbations at an altitude of approx. 9 km (position of the tropopause), and condensation of water vapour), each of which play a different part in individual cases. In the case of Lothar (December 1999), computer simulations show that the condensation of water vapour played a very important part in the generation and intensification of the weather system above the Atlantic¹ (cf. Fig. 10 and box *Lothar – a process analysis*).

Observed trend in the 20th century

In periods of high Atlantic cyclone activity, the frequency of storm events in Central Europe increases. The index of North Atlantic Oscillation NAO^{2,3} is an indicator of the degree of cyclone activity over the North Atlantic and Europe on a monthly basis. The NAO index specifies the difference in pressure at the ground between the Azores (or Portugal) and Iceland (Fig. 46).⁴ In periods with a high NAO index, the pressure difference is large.

Over the past 30 years, weather conditions over the North Atlantic and Europe in winter have been characterised by a high NAO index (Fig. 47). This also applies to the winters of 1989/90 and 1999/2000 when the Vivian and Lothar storms occurred. However, it has not proved possible to establish a connection between the NAO index and the frequency of heavy storms in Central Europe.

Statistical analyses of all (i.e. extreme and moderate) low-pressure systems in winter from 1958 to 1999 show that these have become somewhat more seldom over the North Atlantic. Their paths have shifted towards

the North.³ Over Central Europe, the shift is not significant. In distinction, the frequency of intensive low-pressure areas over the North Atlantic has increased since the early 1930s⁵ (Fig. 48). The paths of these have also shifted towards the North. Thus today, Switzerland increasingly lies at the southern fringe of the storm fields, and sometimes completely outside of these.⁶ Between 1880 and 1930, the number of days with high wind speeds in north-eastern Switzerland lay significantly higher than in more recent times (Fig. 49). It is also noteworthy that in the course of time, heavy storms in Switzerland have increasingly begun in December rather than in October/November. Seen from a global perspective, there are no significant trends in the intensity and frequency of non-tropical storms in connection with climate change.⁷

Future events in connection with climate change

Global climate change could affect the occurrence of conditions favouring extreme winter storms. Climate simulations are practically unanimous in predicting an increase in water vapour in the atmosphere, and this could increase the intensity and frequency of storm cyclones.

Many simulations of the global climate predict that cyclone activity in the eastern North Atlantic and over Western Europe will increase.^{8,9} The physical processes underlying this are, however, not yet clear.⁷ Thus the question must remain unanswered as to whether cyclone activity will increase as a result of increased frequency or intensity of low-pressure areas.

Forecasts on the frequency of heavy (and extreme) winter storms must be treated with caution. The global climate models often display relatively large deviations in predicting the paths of individual low-pressure areas.¹⁰

Furthermore, several of the significant processes in connection with relatively small and very intensive low-pressure areas (Lothar, Vivian) are probably not yet sufficiently well modelled. Thus, for example, the maximum wind speeds near the ground are heavily influenced by the local topography, and have to be estimated using very complex numerical methods.¹¹

Both from measurements and simulation results, more intensive storms are cautiously forecast as a possible development in central latitudes (e.g. Western Europe). On the other hand, most climate models predict greater warming in high than in lower latitudes. Should this be the case, the temperature differences, and thus the potential for the generation of intensive low-pressure areas, would decrease.

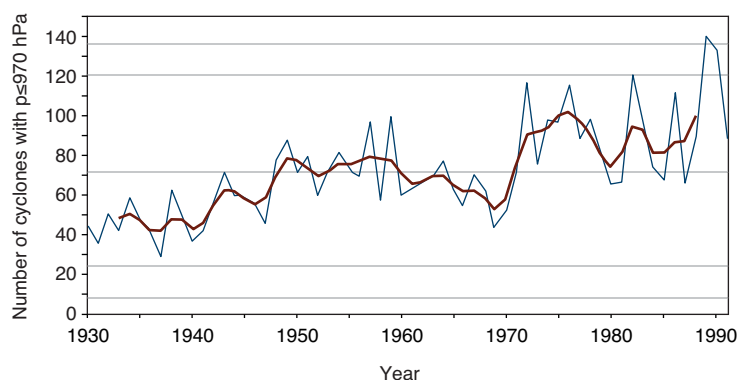


Fig. 48 Time series of the annual number of intensive low-pressure areas over the North Atlantic and Europe from 1930-1990. An intensive low-pressure area is one in which the minimum air pressure lies below 970 hPa.⁵ The figure shows a significant increase in the frequency of intensive low-pressure areas over the observation period.

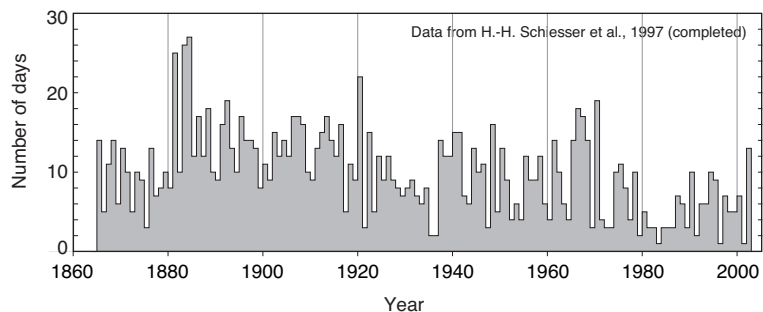


Fig. 49 Number of days with heavy winds (peak gusts of 90 km/h (50 knots) and more) during the winter months in the period 1864/65-2001/02 at the Zurich measurement station⁶ (missing values calculated). This station is regarded as representative of North-East Switzerland. Neighbouring stations were used for comparison purposes and for calculating missing data.

Föhn as a form of extreme wind

To the north of the Swiss Alps, in addition to the classical westwind storms, föhn storms add to the storm risk. This includes extreme events. The föhn storm of 7/8 November 1982 left behind it a path of destruction in Alpine forests.

Föhn is a very frequent phenomenon in the Alpine valleys. The peak wind speeds during föhn mostly lie below 100 km/h. However, an analysis of the yearly maxima shows that heavy storms repeatedly occur in north-south oriented valleys, which channel the föhn winds and give them additional momentum. At the measurement station in Altdorf, föhn gusts with maxima of 110 km/h and above occur almost every year. Every 10 years, 140 km/h are attained, and the estimated 50-year maximum lies just under 160 km/h. Similar values were determined for Vaduz, although these lie on average some 5 km/h lower than in Altdorf.

It is generally assumed that föhn storms with peak values of over 100 km/h occur in most föhn valleys. In rare cases, this may also affect areas that are not especially prone to föhn (e.g. Appenzellerland, Zugerberg, Obwalden, Bernese Oberland). At altitudes over approx. 2000 m, storm force is attained over the entire northern Alpine region under the influence of föhn. In exposed locations near the Alpine crest (e.g. at Gütsch near Andermatt), gusts as high as 200 km/h and more are attained.

Both due to the high wind loads generated and the danger of fire, the risk of föhn should not be taken lightly. Föhn winds may persist over long periods: not only can they start fires, but may also increase the intensity of fires already raging. Fire-fighting under föhn conditions is an extremely demanding duty.

At present, no predictions on future trends in föhn frequency as a result of global climate change are available. Although föhn is known to be closely associated with particular weather conditions and their regional characteristics, reliable predictions will not be possible until data on future trends in regional weather conditions are available.

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