Akademie der Wissenschaften und der Literatur

Paläoklimaforschung
Palaeoclimate Research Volume 23

Special Issue: ESF Project
"European Palaeoclimate and Man" 15

Editor: Burkhard Frenzel
Associate Editor: Mirjam M. Weiß

Documentary climatic evidence for 1750–1850 and the fourteenth century

Edited by Erik Wishman, Burkhard Frenzel & Mirjam M. Weiß

52 figures, 4 photos and 18 tables

1998

European Science Foundation
Strasbourg

Akademie der Wissenschaften
und der Literatur · Mainz

Gustav Fischer Verlag · Stuttgart · Jena · Lübeck · Ulm · 1998

Der vorliegende Sonderband wurde mit Mitteln der European Science Foundation (Straßburg) und der Akademie der Wissenschaften und der Literatur (Mainz) gefördert. Die Verantwortung für den Inhalt dieser Veröffentlichung liegt bei den Autoren.

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Technische Redaktion: Mirjam M. Weiß, Hohenheim/ESF
Bibliographische Bearbeitung: Mirjam M. Weiß, Hohenheim/ESF

Die Deutsche Bibliothek – CIP-Einheitsaufnahme

Documentary climatic evidence for 1750–1850 and the fourteenth century : 18 tables / ed. by Erik Wishman ... – Stuttgart ; Jena ; Lübeck ; Ulm : G. Fischer, 1998
(Palaeoclimate research ; Vol. 23 : ESF project "European palaeoclimate and man" ; Special issue 15)
ISBN 3-437-25396-4

Druck: Rheinhessische Druckwerkstätte, Alzey. Printed in Germany.
Gedruckt auf säurefreiem, chlorfrei gebleichtem Papier.

ISBN 3-437-25396-4
ISSN 0930-4673

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The most severe winters of the fourteenth century in Central Europe compared to some analogues in the more recent past

Christian Pfister, Gabriela Schwarz-Zanetti, Felix Hochstrasser & Milène Wegmann

Summary

Conditions in the seven most severe winters in fourteenth century Europe were reconstructed from a systematic compilation of verified documentary proxy evidence. The data were displayed in terms of seasonal charts and compared to more recent analogues documented with instrumental evidence. It is concluded that in four winters (1305/06, 1322/23, 1354/55 and 1363/64) the duration and intensity of the cold was equivalent to the most severe winters of the last 300 years (e.g. 1739/40, 1788/89, 1941/42 and 1962/63) that were strongly influenced by pressure reversals over Iceland and blocking action with domination of northerly or northeasterly flow and cold air advection over Europe.

Zusammenfassung

Die klimatischen Bedingungen der sieben strengsten Winter des 14. Jahrhunderts sind auf der Basis von Daten aus kritisch geprüften Schriftquellen rekonstruiert worden. Die räumliche Verteilung der Daten ist in kartographischer Form dargestellt und mit Analogfällen aus der jüngeren Vergangenheit verglichen worden, die mit Instrumentendaten dokumentiert sind. Daraus wurde geschlossen, daß die Dauer und Intensität der Kälte in den vier strengen Wintern 1305/06, 1322/23, 1354/55 und 1363/64 an die Bedingungen in den kältesten Wintern der letzten Jahrhunderte, wie z.B. 1739/40, 1788/89, 1941/42 und 1962/63, heranreichte, in denen blockierende Hochdruckgebiete für längere Zeit kalte Luft aus Norden und Nordosten nach Mitteleuropa führten.

1. Introduction

In this paper the most severe winters of the fourteenth century are reconstructed and compared to analogues in the early instrumental and modern instrumental periods. In this way it is attempted to assess the severity of those anomalies as well as the prevailing atmospheric pressure situations over Europe.

Documentary data are the most important and certainly the most accurate evidence for reconstructing weather conditions in winter for the preinstrumental period. In his classic monograph LAMB (1977) brought together a very wide range of evidence which describes

conditions in the cold season. Subsequently, the validity of his reconstructions was weakened to a significant degree by recent work (e.g. INGRAM *et al.*, 1981; ALEXANDRE, 1987). The historian Pierre Alexandre made the first major critical compilation of documentary data for the Middle Ages distinguishing between contemporary and non contemporary sources. Unfortunately, he relied on short source abstracts instead of quoting the relevant passages in his texts in their entire length. Moreover, he did not produce a real substitute for Lamb's winter severity index. BRÁZDIL (1994a, 1994b; BRÁZDIL & DOBROVOLNY, 1993) has worked in this direction for the Czech lands, and SADOWSKI (1991) for Poland. Other long term records were compiled for the Netherlands and Western Europe by A. VAN ENGELEN (this volume) and PFISTER et al. (1996).

2. Sources and data

Meteorological information for the Middle Ages is mostly contained in narrative or literary sources. The most important kinds are chronicles and annals which, however, overlap to a considerable extent. Annals usually consist of short, dry notes in strict annual succession. The entries are varied and concern politics, the life of the religious communities or meteorological phenomena. Annals are trustworthy with carefully made chronologies. On the other hand they are extremely brief and attempt nothing more than to give an unconnected enumeration of facts. For instance, meteorological anomalies are described by such terms as 'cold winter' or 'dry summer' which makes an interpretation very difficult (MCCORMICK, 1975).

Chronicles include a variety of narratives in form of extended histories which provide a great deal of detailed information. These rather lengthy descriptions written mostly in Latin may include proxy information such as references to the timing of vegetation, to floods or to low water tables, to the duration of snow-cover and to the freezing of water bodies. Likewise, they provide descriptions of hazards and their impact upon human societies in quite a detailed manner. For this reason chronicles are more valuable for the reconstruction of past meteorological situations than annals. Chronicles are seldom original for the whole length of their narrative. Most chroniclers began their work at the Creation, but many of them hastened through their accounts of the origins of the world in order to concentrate more fully upon the history of their times. Obviously, chroniclers had to copy the histories for the period prior to their lifetime, and this was done without mentioning the sources. The concept of intellectual property was unknown to the Middle Ages (TAYLOR, 1965; QUIRIN, 1991).

Annals and chronicles focus upon extreme, extraordinary weather situations. Sometimes the main intervals of a winter are characterized in a few words or a chronicler just refers to a short cold spell that caused damage to the vines. Occasionally we even get an idea of the 'normal' climate of the time. For instance, the anonymous writer of the chronicle of Klosterneuburg near Vienna classifies the winter of 1343/44 as mild, because he never saw ice on the Danube. This suggests that the occurrence of (drifting?) ice on this river was an 'ordinary' feature at that time.

With the weather diary kept by William Merle at Oxford from January, 1337 to January 8, (16th N.S.) 1344 a new, very valuable type of source begins in the fourteenth century (SYMONS, 1891). The information contained in these non instrumental weather diaries can be quantified by counting the frequencies of events such as rain, snow, etc.. Another diary was kept from August, 1399 to the end of 1405 at an unknown place, probably in Basel (THORNDIKE, 1966; SCHWARZ-ZANETTI & SCHWARZ-ZANETTI, 1992).

This paper mainly draws from the important collection of the Monumenta Germaniae Historica (MGH) from which all the passages relating to climate were made machine readable recently. The MGH were the first collection of medieval sources critical in method and conceived according to a deliberate and comprehensive plan. Its first volume was published in 1826. The critical method of text edition was then followed by scholars in other European countries. The geographical framework of MGH was the medieval German Empire automatically including Switzerland, the Netherlands and Belgium east of the Scheldt (VAN CAENEGEM, 1978).

For the present work most of the evidence for Northern Italy, for France and for the Benelux-Countries is taken from the critical compilation of ALEXANDRE (1987). Data from Danish sources were provided by Knud Frydendahl and Rudolf Brazdil supplemented some observations from the Czech lands. A systematical analysis of all data contained in the MGH for the Medieval period is being attempted (PFISTER *et al.*, in prep.).

The data are stored in the Euro-Climhist data-base in Bern. This data-base allows all kinds of documentary and natural proxy data to be integrated into a coherent data synthesis at the European level. For the medieval period the entire evidence contained in the work of ALEXANDRE (1987) was made machine readable. As far as the MGH are concerned the entire volume of evidence relating to climate were fully transcribed in the original language and sometimes translated into English in the form of a short abstract. It is thought that the Euro- Climhist data-base might be used in three different ways (PFISTER *et al.*, 1994):

1. As a means to investigate the causes of climatic variations on two fundamental time scales: decadal and century.
2. As a means to investigate the relationship between climatic variability and changes in the frequency and severity of anomalies.
3. As a tool to assess the impact of climatic changes upon pre-industrial economies and societies both in the short and in the long term.

In total, 2133 data were compiled for winters in the fourteenth century. The bulk of the material refers to Western and Central Europe, 13% to Italy (Northern), 5% to Poland and 5% to Denmark/Norway (Fig. 1).

The distribution on individual winters is very uneven. Severe anomalies received the most attention. This also refers to the mentioning of frozen water bodies or long duration of snow cover (Fig. 2). For two winters (1330, 1334) there are no records at all.

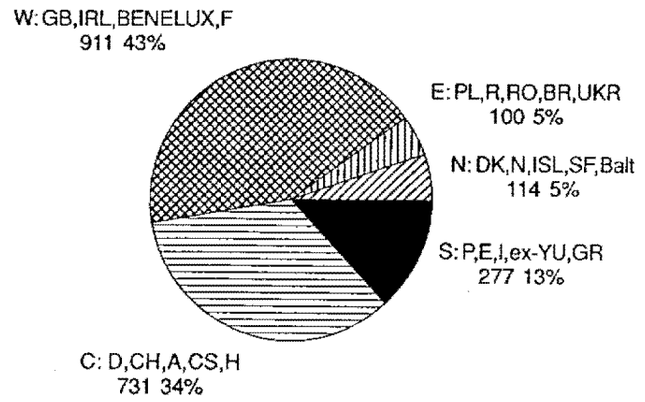

Fig. 1 Regional composition of Euro-Climhist data-base for winters in the fourteenth century. Total available records: 2133

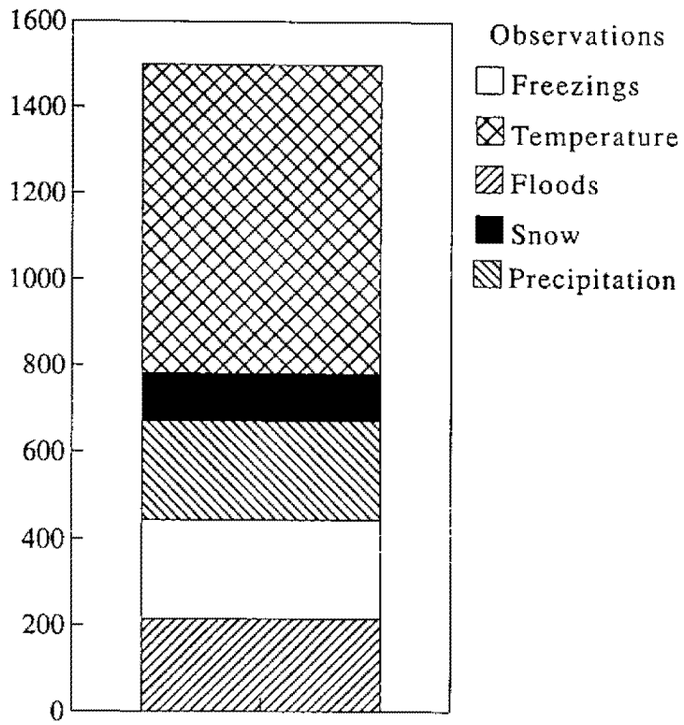

Fig. 2 Typological composition of data in Euro-Climhist for winters in the fourteenth century. Total records for these types: 1499

3. Problems of data verification

The student who attempts reconstructing climatic situations in the medieval period from chronicles and annals should be familiar with certain properties of these types of sources. It has become commonplace over the last decade or so to emphasize the importance of dealing with observations, which were laid down shortly after the event and which are precisely dated. In the case of medieval sources the time of composition is derived from the lifetime of the author, if this is known. Sometimes some personal remarks of an author are very helpful in this respect, e.g. if ecclesiastics refer to the time of their ordination or to missions they had to perform for the Church. However, this kind of information is lacking quite often. Chronicles may survive in a number of copies which are deposited in libraries or private collections scattered all over Europe. We cannot just focus on one of these examples unless its relationship with the others has been established. The mutual relationship of these writings is very difficult to unravel (VAN CAENEGEM, 1978). It should be assessed which is the oldest of the manuscripts - the archetype - that served as a model for subsequent copies and which of these copies were used in their turn as a model for copies of a second generation. Though there may be no autograph copy, textual examination will usually establish the relationship of one manuscript to another. The textual differences between the existing versions are compared in the philological procedure of critical text edition. In this way, a kind of genealogical tree is established which is called filiation. A good illustration of this procedure is given in QUIRIN (1991: 160-162).

To decide whether a chronicle is, in fact, contemporary with the events which it describes requires a detailed textual examination. It has been mentioned already that chroniclers copied from other writings, and the task of tracing a chronicle's sources may be one of the greatest difficulty (TAYLOR, 1965: 22). In most cases, the historian cannot get beyond the supposition that a chronicle was written about a certain time, or between two definite dates. Though handwriting may assist in this matter, it cannot be more than an approximate guide, and it is rarely that a scholar can, on palaeographic grounds, assign a manuscript to a particular year or indeed to a period of less than fifty years. Often, authorship is unknown or is, at best, a matter of inference. In those cases where the chronicler's name is known, few details concerning his life may be available. Because of imperfect knowledge, error and bias, the chronicler's narrative must, whenever possible, be cross-checked and supplemented by other sources (TAYLOR, 1965).

4. Dating

In most cases the sources do not specify which style was used for dating the events they describe (QUIRIN, 1991: 144). Several styles were in use at the time. The most common was the so called Christmas style, in which the new year began at Christmas. In another style which was also quite frequent, the new year began on March 25th (CAMUFFO & ENZI, 1992). Although through ignorance or carelessness chroniclers might occasionally misre-

present certain incidents, the majority of writers struggled for accuracy (TAYLOR, 1965: 5). By far the most errors in copying texts are made by attributing an event to the wrong year. It has been established that the error is frequently one year early or late. In his critical catalogue of climatic events ALEXANDRE (1987: 596-623) lists 300 inconsistencies of this kind. Even events which fall into the lifetime of a chronicler may be misdated one year early or late, if the text was composed considerable time after an event took place.

For assessing conditions in winter an additional difficulty arises from the fact that the change of the year falls into this season. Most sources give just one year to date an event. Thus it must be derived from the context or from other sources, whether the 'old' or the 'new' year is meant. A cautious interpretation is particularly needed in those cases, where severe winters occur in two consecutive years.

To sum it up: for the Medieval period we have to deal with evidence which is not strictly contemporary in the sense, that the events were recorded shortly after their occurrence. Most of the surviving reports may have been copied once or several times, and as a consequence the year to which an event is attributed may be only approximate in some cases. Does it mean that we should refrain from the analysis of documentary data for the Middle Ages altogether?

In the following we will look at procedures which are available to assess the validity and reliability of documentary information from this period despite the shortcomings mentioned.

Firstly, reconstructions should be based whenever possible on critical editions of chronicles. Norms for editing and understanding the sources of medieval history became first generally accepted in nineteenth century Germany.

Secondly, the worst errors which may occur in a reconstruction are related to a wrong dating. If a severe anomaly is reported in two subsequent years in two different sources, just because one of the reports is one year late, the interpretation of the entire record will be severely biased. As a consequence the interpretation should be always based upon the assumption, that severe anomalies did not occur in two subsequent years unless this can be proved by the record. For instance if this is explicitly mentioned in a source or if this fact can be established from independent proxy data from historical or natural archives. It is specified, for example, in a Danish chronicle, that the winter 1322 and the subsequent winter were so severe that horsemen and coaches could travel on the frozen sea[1].

Thirdly, reconstructions have to be meteorologically meaningful, i.e. consistent with the physical laws of the atmosphere. This can be checked from a chart which displays the spatial picture of the observations available for a particular month or season (see chapter 4).

[1] Magnus Matthiae, Regum Danice Terra, 2RII, p. 120

Many observers were well aware that their individual feelings of cold and warm were subjective. In order to demonstrate the anomalous character of a season, they often referred to observed signs in the physical or biological world. Temperature indicators in severe winters were mainly drawn from the observed freezing of water bodies and / or from an extended duration of the snowcover. For extremely warm winters signs of vegetation activity and the absence of frost were reported.

5. The most severe winters of the fourteenth century

In the following the most severe winters of the fourteenth century are discussed in somewhat more detail. For some of them the information is presented in the form of charts which were set up within Euro-Climhist (Figs. 3-5). This approach which was described in an earlier paper (PFISTER *et al.*, 1994) allows the consistency of the data to be checked and provides a rough idea of the probable state of climate. The severe winters of the fourteenth century are then compared to analogues which are documented with instrumental evidence.

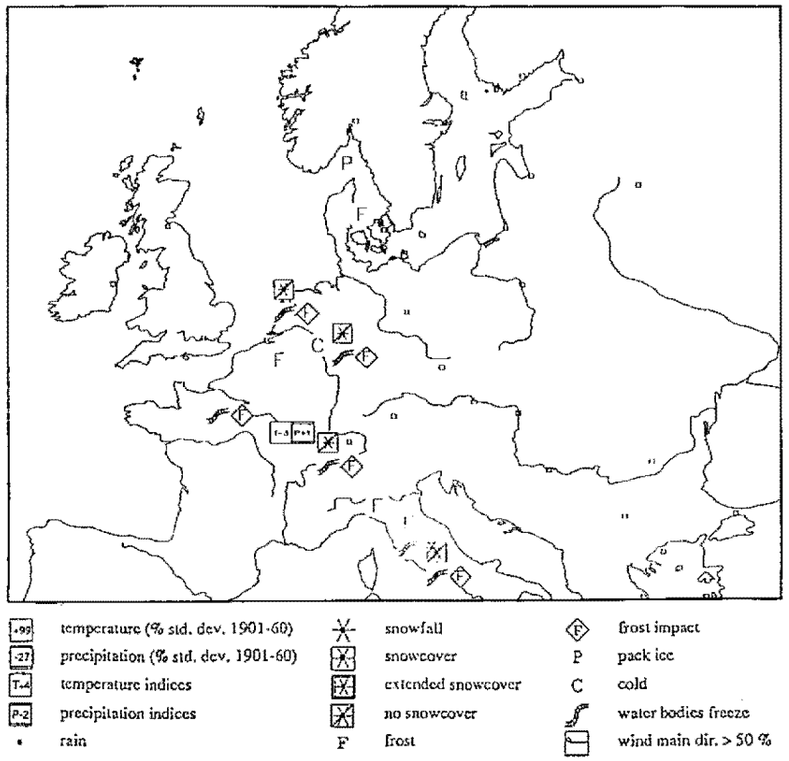

Fig. 3 The climatic situation in Central Europe in the winter of 1305/06

During the winter 1305/06 the whole sea region between all the Danish and Swedish areas and islands was changed into strong ice bridges. For the Baltic Sea this situation corresponds to the highest degree of winter severity which is documented with instrumental evidence (SEINÄ & PALOSUO, 1993). Large rivers such as the Rhine near Cologne[2], the Po[3] in Northern Italy, and the Seine near Paris[4] were frozen.

In 1318/19 a long period of severe frost lasting from early December to late February is reported from Italian sources (Parma, Reggio Emilia). It damaged the vines and the fig trees and caused major rivers such as the Po[5] to be frozen. According to a non contemporary source the Lake of the Four Cantons (Switzerland) was covered with ice in its lower part, as it used to be during the Great Winters in later phases of the Little Ice Age[6].

1322/23 needs to be mentioned among the Great Winters in the region of the Baltic. Several chronicles report that the ice between the Danish islands and the mainland froze to such an extent that it could be crossed on horse back for a period of six weeks. One source even reports that "Ships got stuck in the sea-ice between Sweden and Norway and those sank when the frost was over"[7]. This suggests that at least the sea north of Jutland must have been frozen which would be equivalent to the highest degree of winter severity set up by the Finnish Ice Service from the freezing of the Baltic. An extended freezing of this kind was observed several times since 1720, e.g. in 1739/40, 1788/89, 1829/30, 1870/71, 1887/88 and 1941/42 (SEINÄ & PALOSUO, 1993). Considering the destruction of ships by ice between Sweden and Norway in 1322/23, the sea ice in this winter may have extended to the Skagerrak area. Or, to suggest another interpretation, some ice may have broken off from this main pack and drifted into the North Sea. It is not the only time that the occurrence of sea-ice is reported in the North Sea. In February, 1684, the appearance of pack-ice in the English Channel is described by Richard Freebody of Lydd (Kent) in a letter to his nephew (LAMB, 1982).

2 ECKARTS, G. (ed.) (1870): Chronicon Brunwilarense. In Fontes Rerum Rhenanensium, 2, ..., p. 256

3 "Item eodem tempore et mense Ianuario [1306] per 13 dies continuos fuit arduum et immensum frigus, magis quam aliquis recordaretur, ita quod flumina omnia vales fovee indiferenter et in omnibus partibus Lombardiae congelaverunt, et flumen Paudi [Po] in pluribus partibus congelavit seu congelarum fuit taliter, quod super glaciem multe persone transiverunt et naves vi transire poterant". JAFFE, P. & PERTZ, G. H. (eds.) (1863): 4Annales Parmenses, MGSS 18, Hannover, p. 723

4 BELLAGUET, L. (ed.) (1852): Chronique de Religieux de St. Denis. In: Collection de documents inédits quoted after ALEXANDRE, P. (1987), p. 442

5 "In Festo Sancti Nicolai coepit esse tantum gelu, quod Padus gelavit: quare homines & bestiae transiebant super eum, nec poteramus comedere panem, nisi primo poneretur ad ignem & duravit usque ad XXV. diem Februarii". MURATORI, L. A. (ed.) (1731): Chronicon Regiense. Rer. Italic. SS T 18, col. 30

6 ARNET, X. (1896): Das Gefrieren der Seen in der Zentralschweiz 1890/91. In: Mitt. Natf. Ges. Luzern 1, p. 62

7 "Den vinter var der staerk frost fra Andreasmesse [Nov 30] og den varede til midt i fasten [March 6]. Skibene sad fast i havet midt melle Sverige og Norge, og en del gik til grunde, da froste vorsvand" (Detmar I, p. 214)

The winter 1325/26 was dry in England[8] and in Italy; in Parma and Ferrara the period of frost began in December[9]. On the Dutch coast the sea in the estuaries was covered with thick ice[10]. The Rhine near Constance[11] froze as well as the Seine. The latter river thawed around January 6 and then froze again. In some places around Paris the snow-cover persisted until the end of March[12]. In Bohemia the vines and the fruit trees were damaged by the frost[13].

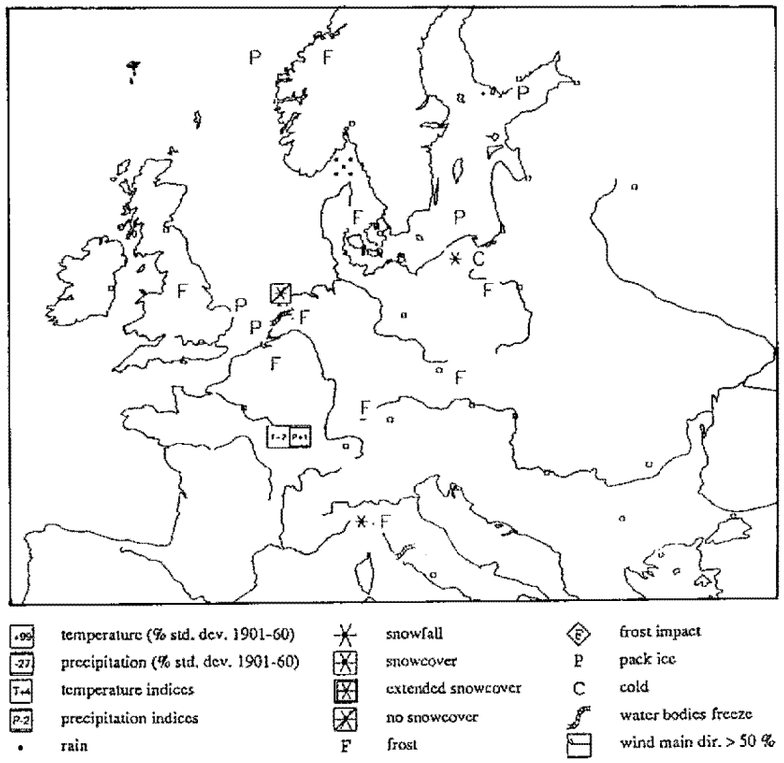

Fig. 4 The climatic situation in Central Europe in the winter of 1322/23

8 TITOW, I. Z. (1960), p. 389

9 JAFFE, P. & PERTZ, G. H. (eds.) (1893): Annales Parmenses maiores. MGSS 18, Hannover, pp. 664-790

10 PIJNACKER HORDIJK, C. (ed.) (1904): Guillaum d'Egmond. Chronicon, Series III, Vol. 20, quoted after ALEXANDRE, P., (1987), p. 448

11 MONE, F. J. (ed.) (1848): Nota Petrishusensis, Quellen zur badischen Geschichte 1, p. 220, quoted after ALEXANDRE, P. (1987), p. 448

12 Anonymus, Notes de St. Denis, quoted in ALEXANDRE, P. (1987), p. 447

13 EMLER, J. (ed.) (1884): Peter von Zittau, Chronicon, Fontes rer. Bohem. 4, quoted after ALEXANDRE, P. (1987), p. 448

In 1354/55 it snowed in the region of Florence in December. In the following months the weather remained sunny and clear with a bitter frost. The snow-cover remained on the ground for more than three months, the Arno[14] and Po rivers remained ice-bound for several months[15]. In Germany the Rhine near Cologne froze around January 21 and much ice was seen around Frankfurt at that time[16].

The winter 1363/64 is documented in about 30 first class sources. The period of severe frost began in early December and lasted until the end of March - even at the Northern shores of the Mediterranean. In Fosses in Belgium (altitude 200 m asl.) the snowcover remained on the ground for a hundred days. In Poland the winter caused the death of many

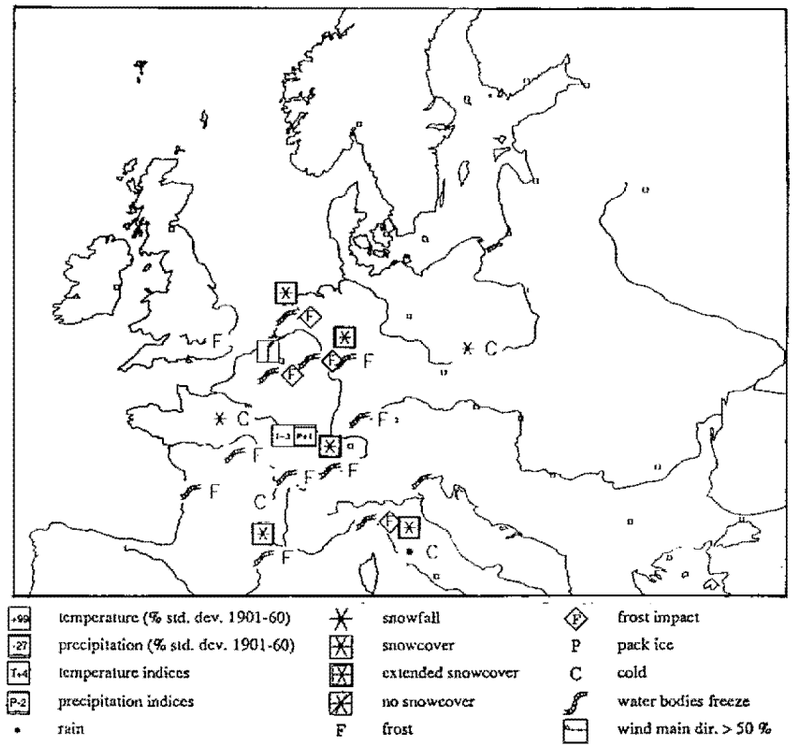

Fig. 5 The climatic situation in Central Europe in the winter of 1363/64

[14] RACHELI, A. (ed.) (1858): Croniche di Giovanni Matteo e Filippo Villani, Vol. 2, Trieste, pp. 7-387, quoted after ALEXANDRE, P. (1987), p. 448

[15] BARBIERI, L. (ed.) (1858): Giovanni Cornazani, Chronica. In: Monumenta historica ad provincias Parmensem et Plaventinam pertinensia, Vol. 10, Torino, p. 355-392, quoted in ALEXANDRE, P. (1987), p. 484

[16] FRONING, R. (ed.) (1864): Werner von Bonn. Chronica. Annalen eines Anonymus. In: Quellen zur Frankfurter Geschichte, hg. von H. Grotefend. Bd. 1, Frankfurt

wild mammals and birds[17]. The major lakes and rivers of mainland Europe were frozen, including the Rhone at its estuary in the Mediterranean, the Venetian Lagoon[18] and the shores of the Atlantic near Bordeaux. The Rhine near Mainz was ice covered for about 70 days and in Cologne a market was held on the river. A non contemporary Swiss chronicler mentions a freezing of the lake of Brienz in the Bernese Oberland. This would be the only occurrence of a freezing which is known for this deep lake. Even in the most severe winters of subsequent centuries such as 1476/77, 1572/73, 1694/95, 1708/09 and 1829/30[19] no freezing is reported in the sources. Thus, in southern Central Europe the cold spell in 1363/64 may well have been the longest and the most severe in this millennium.

In the winter of 1398/99 the snow in the Maastricht area accumulated to such an extent that roofs crumbled under its weight. For a period of three weeks in January and February the waterways were frozen. The Rhine at Mainz was ice bound for eight days in February (VAN ENGELEN, 1994). One could walk across the Great Belt from Lübeck to Denmark and to Sweden[20]. This suggests that this winter was colder in the Baltic area than in southern Central Europe.

6. Analogue cases documented with instrumental measurements

In order to obtain a yardstick for the thermic interpretation of these anomalies, some severe winters are presented for the eighteenth century in a first paragraph. In this period the course of the large rivers of Europe were, as yet, not much altered, but on the other hand instrumental data were already being made.

The effects of extreme cold in January, 1709 for Europe were compiled by SALMELLI (1986). For France the cold wave and its impact are impressively described by LACHIVER (1991). As in the severe winters of the fourteenth century, the Seine, the Po and the Rhine were frozen. The cold is documented with thermometrical observations from different places: in central England and De Bilt (Netherlands), temperatures were 250% of a standard deviation below the 1901-60 average; the value for Berlin was as low as 430%. (Euro-Climhist). The conjuncture was similar in 1740. A freezing of the Po is reported from Casale Monferrato (Savoy) (DE MORANI, 1795) and for the Rhine from Mainz and from Mannheim (BUISMAN, 1984), in both cases the ice cover was strong enough to carry loaded carts. Many Swiss lakes and most Dutch canals were frozen. The entire Baltic Sea was ice-bound (SEINÄ & PALOSUO, 1993). Temperatures in this winter were 383% (Central England) and 238% (De Bilt) standard deviations below the 1901-60 average (Euro-Climhist).

[17] WACHTER, F., Sigismundi Roisczii Chronica (1051-1470) quoted in MALEWICZ, H. M. (1980)

[18] SCHWITZER, B. (ed.) (1880): Chronica Monasterii Montis S Mariae. Tirolische Geschichtsquellen, Vol. 2, quoted by ALEXANDRE, P. (1987), p. 495. This freezing is not mentioned in the series compiled by CAMUFFO, L. D. (1992)

[19] Johann Gottlieb Schrämli, F. (n.d.), Chronik der Naturbegebenheiten, Manuscript, Stadtbibliothek Thun (Switzerland) SBT 3127/II

[20] Peter Olsens danske konge-krönike, S.R.D., 137; Pk 44, laeg B

1788/89 is the third winter that needs to be mentioned for its resemblance to the Great Winters of the fourteenth century. In Lombardy the snow-cover remained on the ground for three months, and the rivers froze in Northern Italy (DE MORANI, 1795). The ice on the Rhine and on the Danube was thick enough to carry heavy cargoes (BUISMAN, 1984) and people walked on the Lake of Constance and on the Lake of Zurich (PFISTER, 1992). Again, the entire Baltic Sea was ice-bound (SEINÄ & PALOSUO, 1993). At most stations which are documented with thermometrical measurements the intensity of the cold was between 200% and 300% of a standard deviation compared to 1901-1960 (Fig. 6).

In the following, two more recent analogues will be presented in order to display the monthly pressure fields that are often associated with Great Winters.

January and February 1942: the main centre of action was a strong anticyclone over Scandinavia and Russia with depression tracks across the Mediterranean. Cold continental air flowed southwestward into Central Europe. Over the entire winter the intensity of cold was between 200% and 300% of a standard deviation compared to 1901-1960 in Central and

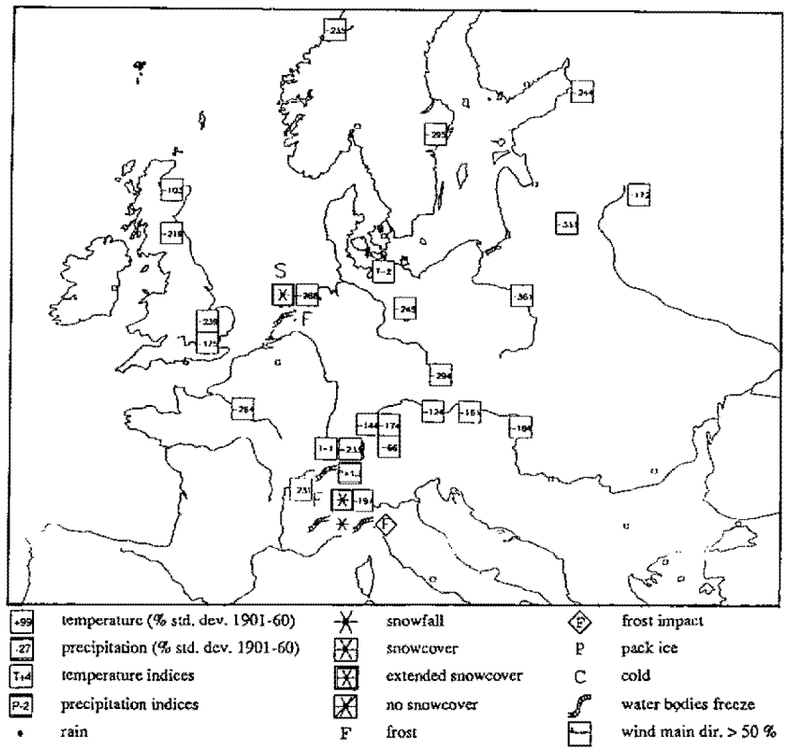

Fig. 6 The climatic situation in Europe in the winter of 1788/89

Eastern Europe. Iceland was dominated by warm air advection from the south-west (HESS & BREZOWKSI, 1993). Again, the entire Baltic Sea was ice-bound (SEINÄ & PALOSUO, 1993), but the main thrust of the cold was farther east, where Hitler's armies fought against the Russians. On the other hand, the cold was less pronounced in southern Central Europe. For instance, Lake of Zurich was not completely ice bound (PFISTER, 1984).

December 1962: The strong negative anomalies, especially in Central and Eastern Europe were caused on the one hand by northerly currents, on the other, by anticyclonic situations resulting in fog formation and/or large energy losses in the long winter nights.

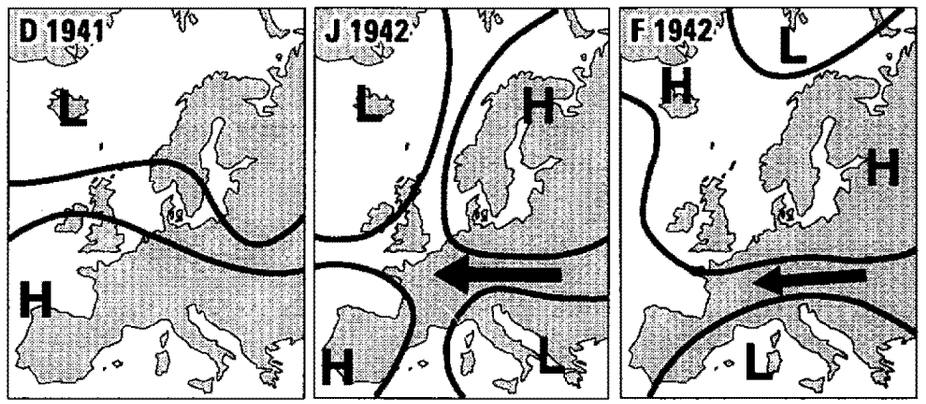

Fig. 7 The synoptic situation in Europe in the winter of 1941/42. Solid arrows: cold air advection, hatched arrows: moderate air advection

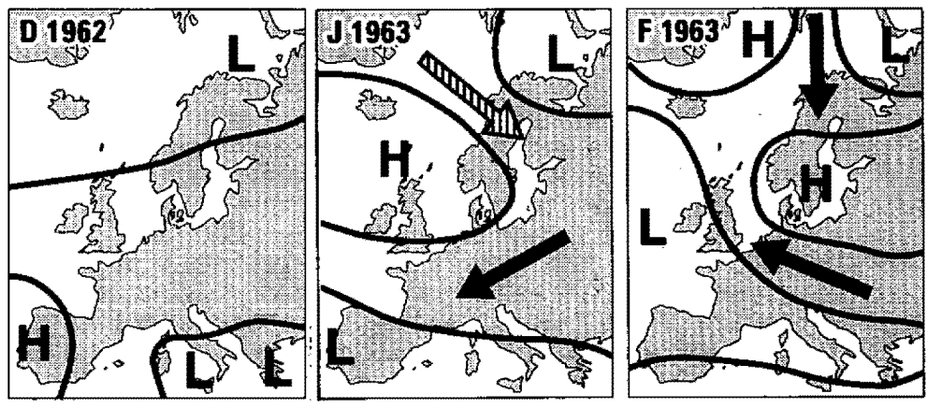

Fig. 8 The synoptic situation in Europe in the winter of 1962/63. Hatched arrows: moderate air advection

January 1963: An anticyclone situated over Iceland and Scotland blocked the Westerlies. Cold flows from the north and east caused strong negative temperature anomalies in Central Europe.

February 1963: Southeasterly and northerly currents caused predominantly cold weather over Central Europe and the British Isles (HESS & BREZOWKSI, 1993). Over the entire winter temperatures were below 300% of a standard deviation 1901-1960 in southern Central Europe, somewhat less in the northern and western parts of the continent. The Rhine and the Zuidersee were ice bound (BUISMAN, 1984), the ice cover on the Lake of Zurich and on the Lake of Constance was strong enough to carry airplanes (PFISTER, 1984).

7. Discussion and Conclusions

It is well known that the atmospheric circulation over western Europe is remarkably influenced by the North Atlantic Oscillation (NAO) (WANNER, 1994). This refers to a large-scale alternation of atmospheric mass between the areas of Iceland and the Azores (LAMB & PEPPLER, 1987). MOSES & KILADIS (1987) stated that the strong winter reversals in the monthly pressure field with high pressure over Iceland represent an extreme mode of the NAO. They show that these reversals are correlated with low winter temperatures over Europe, as was the case in 1941/42 (Fig. 7) and 1962/63 (Fig. 8). Recently it was demonstrated that these situations are also typical of the severe winters in the Late Maunder Minimum period at the end of the seventeenth century (WANNER *et al.*, 1995). These examples suggest that the severe winters in the fourteenth century were equally influenced by pressure reversals over Iceland and blocking actions with a domination of northerly flow and cold air advection. Several authors emphasize that these features of meridional cold air outbreaks over western and central Europe are typical elements of climatic fluctuations during the Holocene or even the whole Pleistocene (VAN LOON & ROGERS, 1978) and they speak about Litle Ice Age (LIA) type events (MOSES & KILADIS, 1987).

Considering the ongoing debate on the onset of the Little Ice Age, this result is likely to support the view that this major cold phase of our millennium had already begun in the fourteenth century. More research is needed in order to obtain a more precise knowledge of winter temperatures in the 'Medieval Warm Period' and in more recent centuries.

Acknowledgments

This research was supported by Swiss National Science Foundation, Priority Programme Environment (No. 5001, 34888). Acknowledgements are due to Rudolf Brazdil, Brno (Czech Republic), to Knud Frydendahl and Povl Frich, Danish Meteorological Institute, Copenhagen, to Aryan van Engelen, KNMI, De Bilt, and to Anita Bokwa, Geographical Institute, University of Kraków (Poland) for providing additional data. Heikki Vesajoki, University of Joensuu (Finland), for providing helpful hints and a translation from Finnish. John Kington, Climatic Research Unit, University of East Anglia has improved the style and helped with the interpretation of weather charts. Andreas Brodbeck (Geographical Institute, Bern) has drawn the charts. Gudrun Kleinlogel (Research Group for Regional and Environmental History, Bern) has done the main programming work.

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