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CLIMATIC CHANGE AND THE NORDIC COUNTRIES, ESPECIALLY IN THE LIGHT OF MEAN TEMPERATURES FOR THE NORMAL PERIODS 1931–60 AND 1961–90

Abstract: All climatic models of climatic changes and scenarios suggest more pronounced warming at high latitudes, especially in winter, than at the global level, but no reliable signs of warming are discernable in northwestern Europe, least of all in its northern parts and in winter. In this article the mean temperatures during the normal periods 1931–60 and 1961–1990 are compared. The former period was warmer than the latter practically everywhere in the Nordic countries, and the negative difference was especially marked in Lapland (–0,8°C). However, there are differences between the seasons. Furthermore, long temperature time-series from some Nordic meteorological stations are examined. When the series are corrected, the apparent rise in temperature during the 20th century up to today becomes very small, in some cases non-existent.

Key words: climatic change, Nordic countries, normal periods, seasonal mean temperatures, temperature time-series.

1. Introduction

Annual global surface temperatures warmed by 0.57°C over the period 1861–1997, with the warming being slightly greater in the Southern Hemisphere than in the Northern Hemisphere. There have been two major warming periods in the 20th century (1925–1944 and 1978–1997), during which the warming has been greatest over the northern continents and in the winter and spring seasons (Jones et al. 1999).

The modelling of climatic changes and scenarios still involves grave deficiences, and regional predictions in particular are very unreliable. Such periods as the Little Ice Age (ca AD 1300–1800 or 1900) or the Medieval Warm period (ca 900–1300) may have been confined to specific regions and do not necessarily reflect global patterns (Mann et al. 1998). A general feature is that the predicted temperature rise becomes smaller as the climatic models become better developed.

In the following, possible changes in the Nordic countries (Denmark, Finland, Iceland, Norway and Sweden) are discussed by comparing the mean temperatures during the normal periods 1931–60 and 1961–90. Naturally, this represents only one aspect of the whole, but may give some interesting information. Furthermore, long temperature time-series from a few Nordic meteorological stations are examined.

2. Changes in Temperature between the Old and New Normal Periods

The following maps (Fig. 1–5) have been compiled on the basis of a number of sources: Lysgaard 1969; Frich 1990; Alexandersson et al. 1991; Førland et al. 1992; Heino 1994; Cappelen, Vaarby Laursen 1998.

Year: The annual mean temperatures during the normal period 1961-90 were lower than those during 1931-60 practically everywhere in the Nordic countries, and the difference was especially marked in Lapland, as much as –1.8°C (Fig. 1). The differences were smallest in the south and west, –0.2°C.

Winter: This season shows the greatest differences in temperature between the normal periods and again the greatest negative difference, almost –2°C is to be found in Lapland, the smallest ones in the south (Fig. 2). In Denmark the difference was only –0.1°C. In a small area in western Norway (Møre och Rømsdal fylke), there was no difference at all, or the difference was even positive, +0.2°C.

Spring: This is the only season which shows positive differences almost everywhere in the Nordic countries, in southeastern Finland as much as +0.6°C (Fig. 3). From here, the differences become smaller in all directions, in the north only 0.0 … +0.2°C, while in Denmark the difference was negative, –0.2°C. The difference in Iceland was –0.6°C.

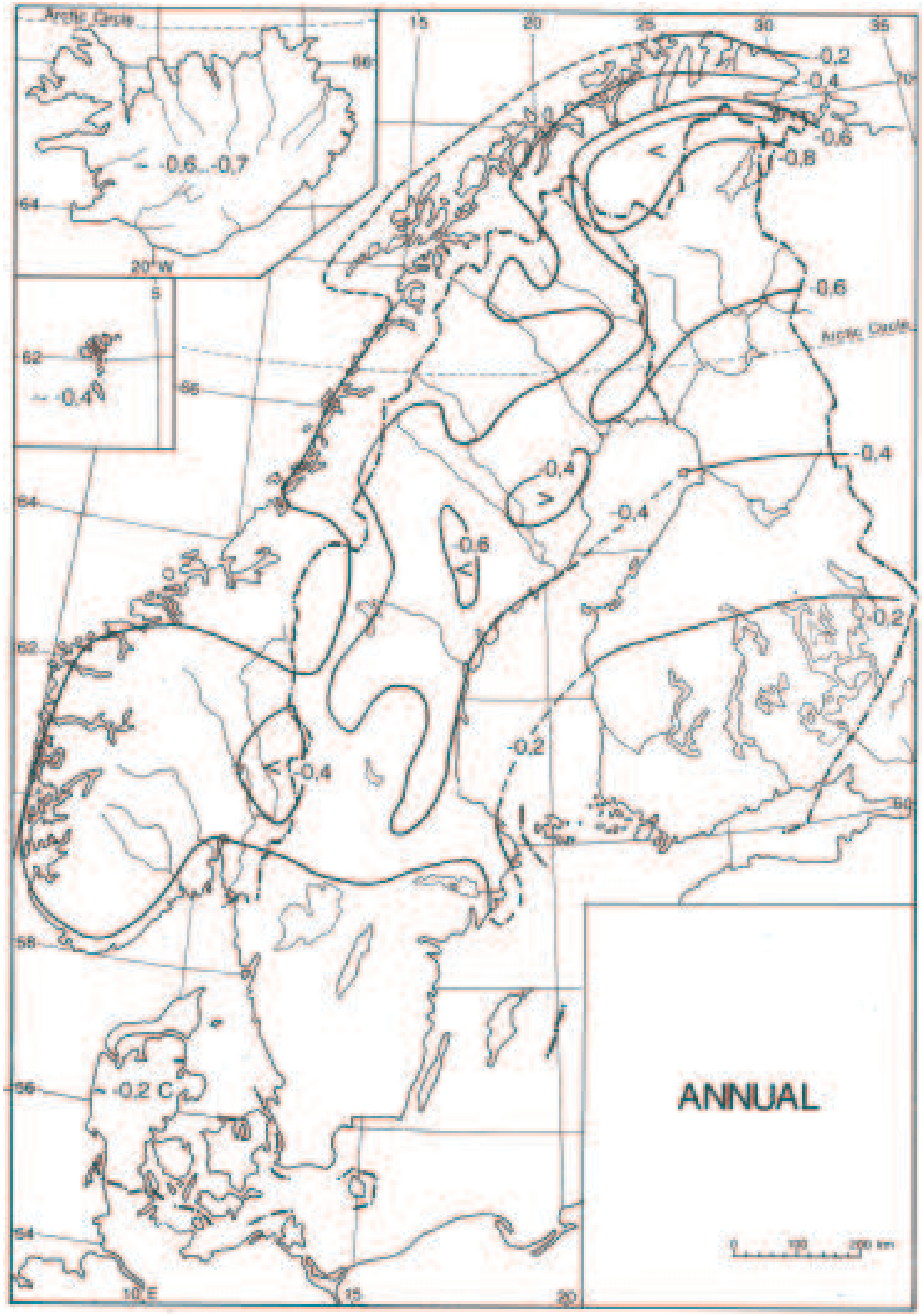
Summer: The summer become cooler everywhere, the temperature drop being extensively –0.2 … –0.4°C (Fig. 4). In the inner parts of Lapland and in Denmark the difference was –0.6°C.

Autumn: Again a temperature drop can be observed all over the Nordic countries (Fig. 5). The difference is smallest in the south, in Denmark only –0.1°C, and greatest in Lapland, even –0.8°C. The autumn temperature in Iceland dropped still more: –1.0 … –1.1°C. This map has a certain resemblance with the annual one: the temperature dropped most in the inner parts of northern Fennoscandia and in Iceland, less so in the south and west.

3. Long Instrumental Temperature Time-Series from Selected Locations

Some temperature series from selected locations in the Nordic countries are examined in the following. Moberg (1996) has studied the temperature series of

Fig. 1. Distribution of the differences in annual mean temperatures (°C) between the normal periods 1931–60 and 1961–90. Negative values indicate lower temperatures in 1931–60. – Sources: listed in the text.


Arctic Circle
-0.6..-0.7
-0.4
-0.2
-0.4
-0.6
-0.8
-0.6
Arctic Circle
-0.4
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ANNUAL
0 100 200 km

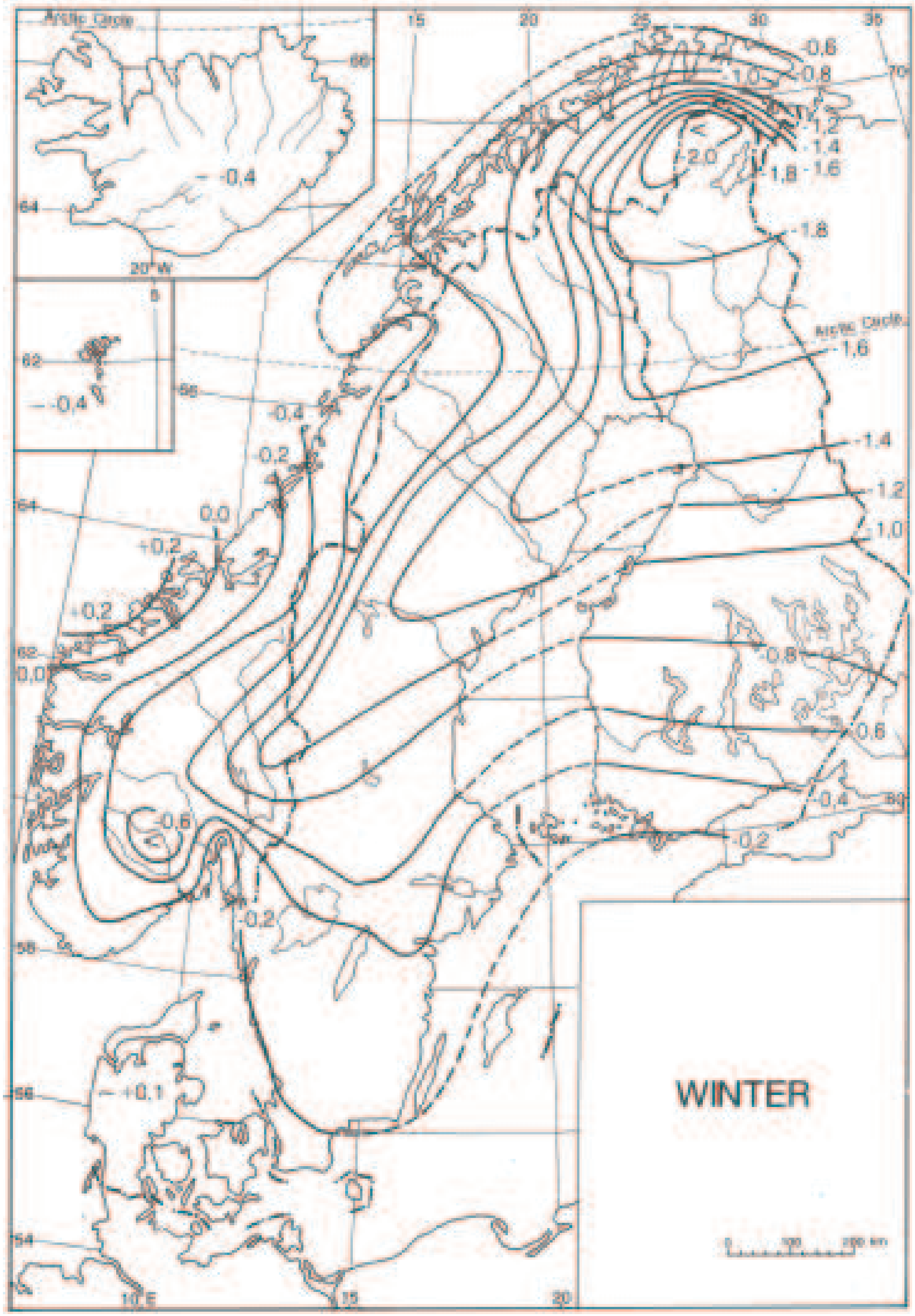

Fig. 2. Distribution of the differences in winter temperatures (December–February) between the normal periods 1931–60 and 1961–90. – Sources: listed in the text.

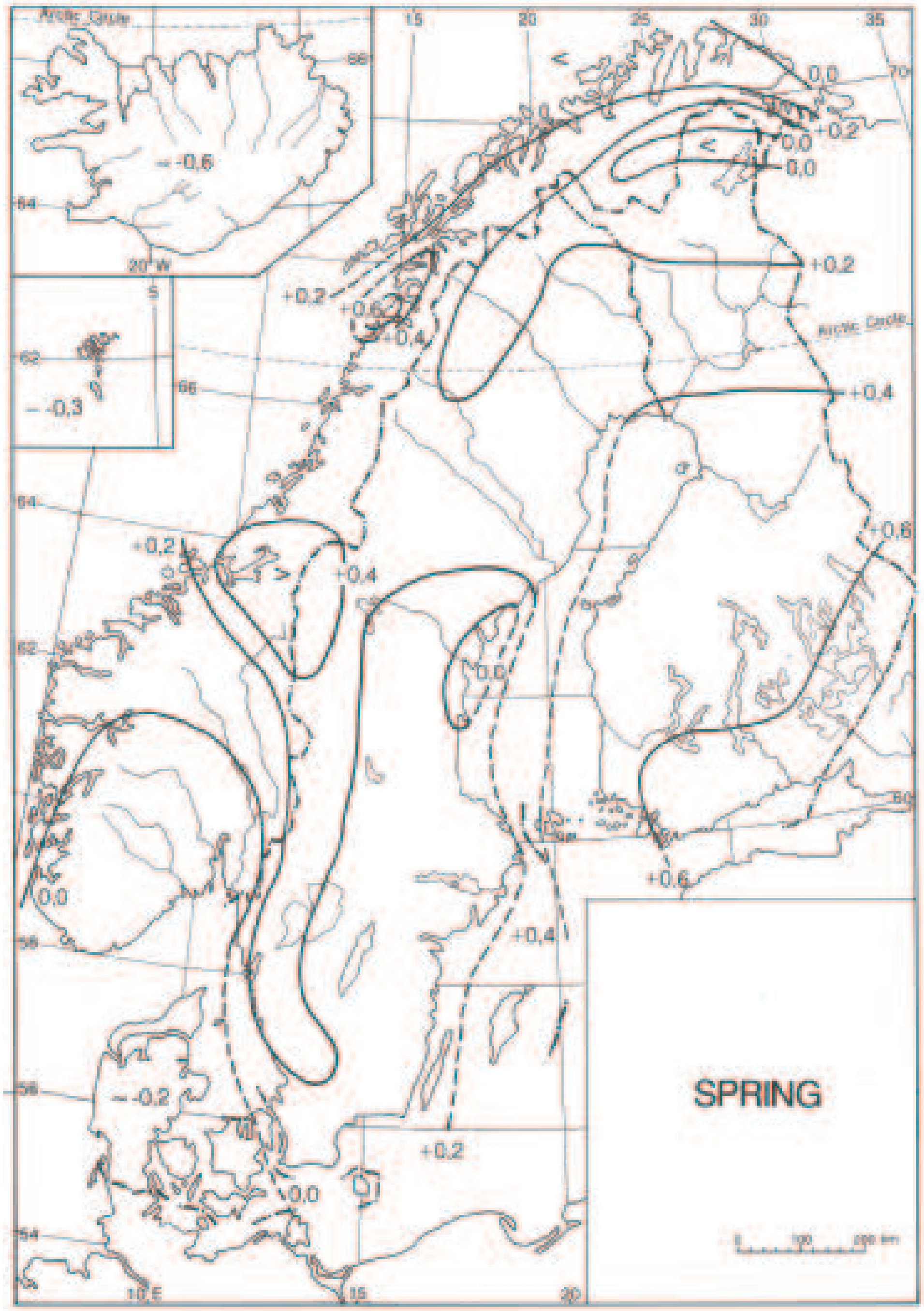

Fig. 3. Distribution of the differences in spring temperatures (March–May) between the normal periods 1931–60 and 1961–90. – Sources: listed in the text.

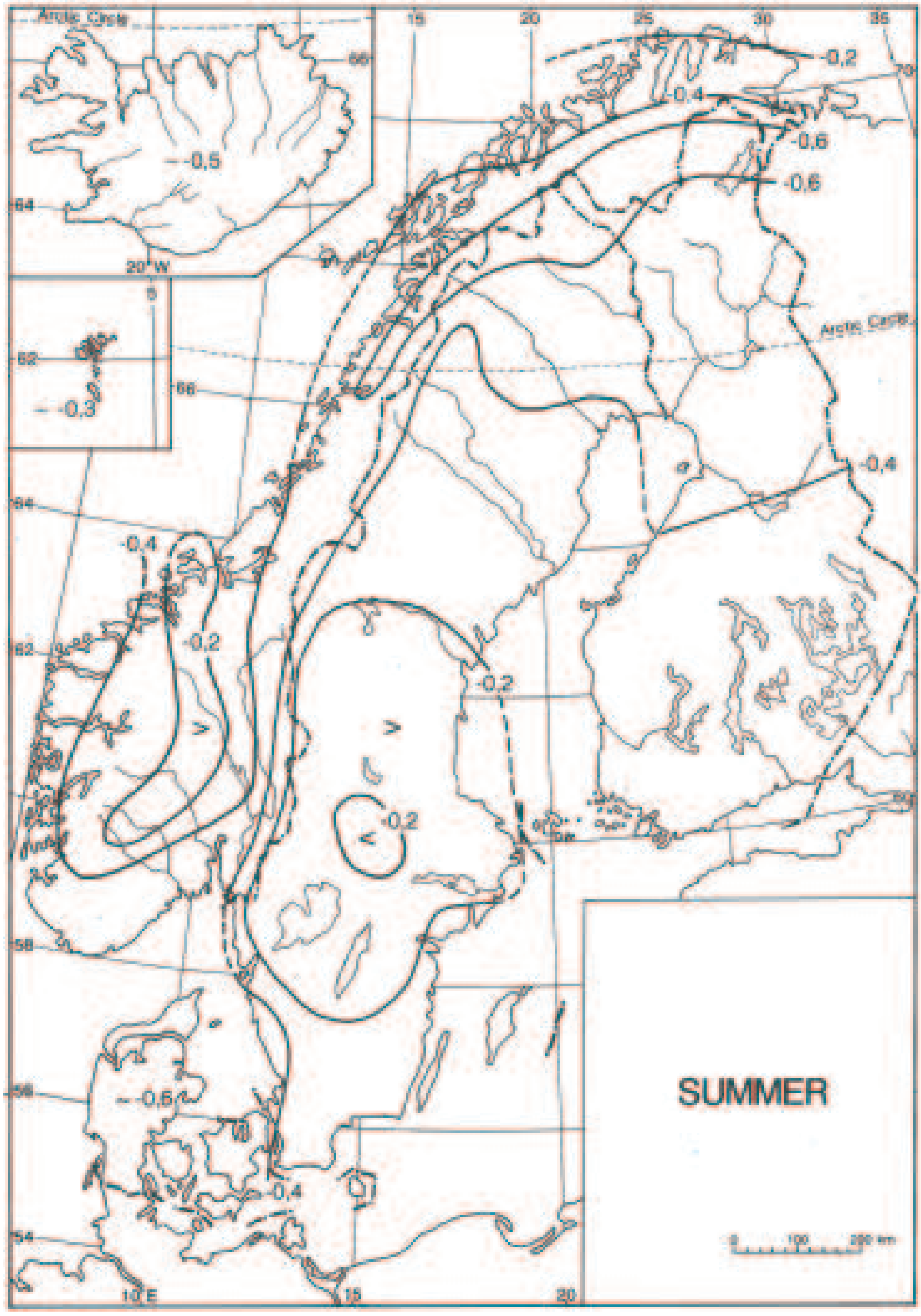

Fig. 4. Distribution of the differences in summer temperatures (June–August) between the normal periods 1931–60 and 1961–90. – Sources: listed in the text.

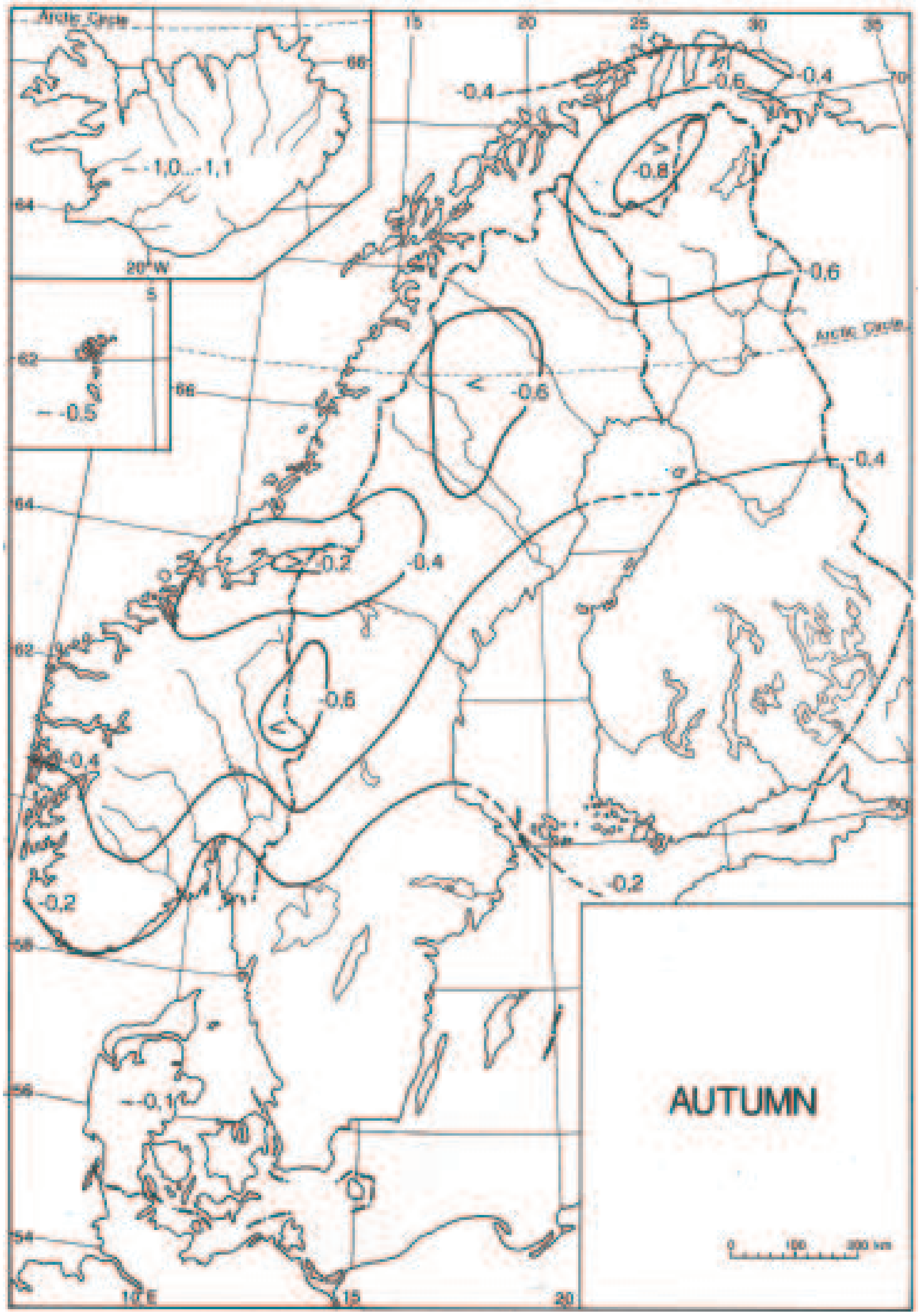

Fig. 5. Distribution of the differences in autumn temperatures (September–November) between the the normal periods 1931–60 and 1961–90. – Sources: listed in the text.

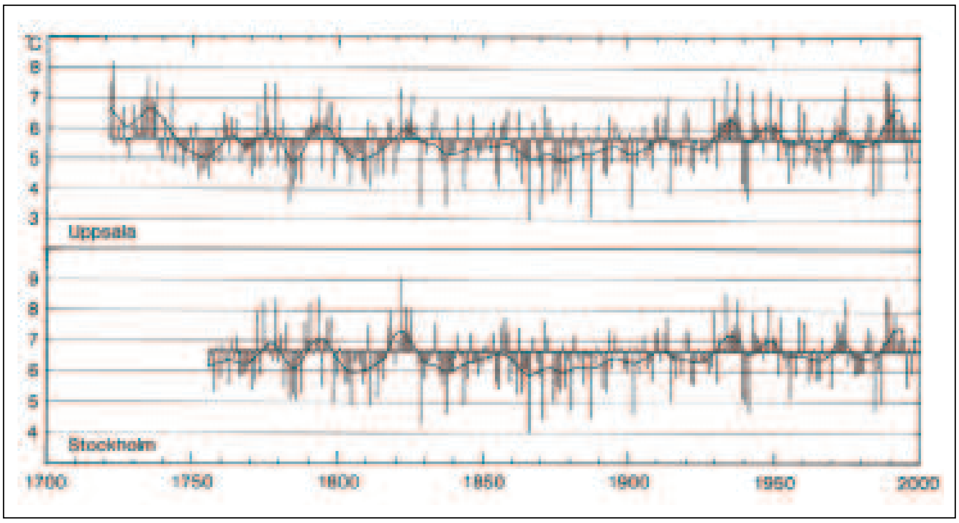

Fig. 6. Annual mean temperatures in Uppsala (1722–1999) and Stockholm (1756–1999). The reference level is the mean temperature for the normal period 1961–90. Low-frequency variations are indicated using a Gaussian low-pass filter with s=3, corresponding closely to 10-year moving averages. All temperatures are corrected (instruments/ averaging changes, urban warming, station relocations). – Source: Moberg 1996: Fig. 5 (redrawn); the years 1995–99 are added as corrected values (Swedish Meteorological and Hydrological Institute 2000, personal communication).

Stockholm and Uppsala (Fig. 6). He homogenized the series by abolishing as much as possible the non-homogenities which are the results of instrument and averaging changes, station relocations and urban effect. He was able to distinguish three periods with different patterns of variability in the annual mean temperatures. Large interdecadal fluctuations occurred from the warm 1720's and 1730's to the cold 1860's. A period with increasing annual temperatures and very little interdecadal variability occurred from the 1860's to the 1920's. The temperature rose abruptly and there were mild conditions around 1930. Since then temperature has fluctuated on an interdecadal time scale. A cooling trend can be observed 1940–1970 and a warming trend since ca 1985. The 1930's was the warmest decade in the Stockholm series, while in the Uppsala data, it was the next warmest after the 1730's. The 1990's was the next warmest in the Stockholm series, but the 1820's was, however, only 0.1°C cooler than the 1990's. The 1990's was the third warmest decade in the Uppsala data. After correcting the temperature records the warming during the 20th century seems to be only 0.1°C (Moberg 1992; Fig. 7). The difference between the curves depicting corrected and uncorrected values since 1920 depends mainly on the urbanisation effect.

Heino (1994) studied the annual mean temperature series in Helsinki from 1829 to 1992. Some features corresponding to those of the Stockholm and Uppsala series

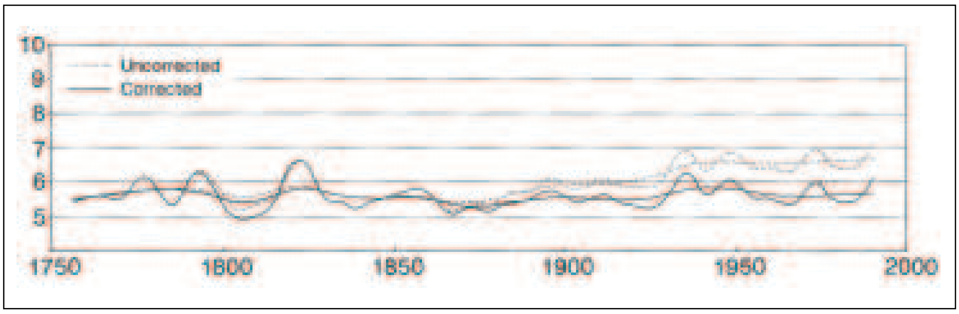

Fig. 7. Annual mean temperatures in Stockholm 1756–1990. The series are Gauss-filtrated (s=3, s=9). – Source: Moberg 1992: Fig. 7 (redrawn).

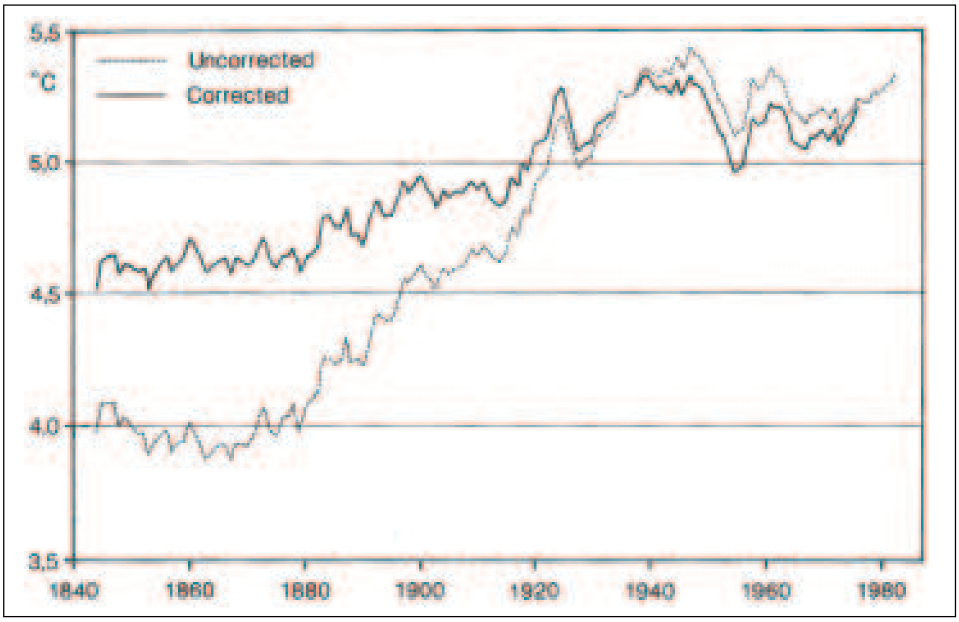

Fig. 8. 30-year moving averages of annual mean temperatures in the centre of Helsiki 1829–1999. – Source: Heino 1994: Fig. 3.8 (redrawn); the years 1993-99 are added as uncorrected values (Finnish Meteorological Institute 2000, personal communication).

can be observed (Fig. 8). For example, the period 1830–1900 seems to have been cold, followed by a clear warming in 1920–1940, then cooling until ca 1980, but the climate did not cool as much as it had warmed since the beginning of the century. Slight warming can be seen again since 1985. The warming from 1829 to 1992 is clearly reduced when the temperature records are corrected. During the 20th century the annual mean temperature rose 0.3 … 0.4°C.

Oulu represents a relatively northern location (65°N). A warming trend beginning in the 1920's and ending in 1940 can again be observed (Fig. 9). Then a cooling trend started and continued until 1970, with the climate cooling as much as it had warmed up since the beginning of the century. No general warming during the 20th century can be observed. In fact, the annual temperatures in Oulu are at the same level as at the end of the 19th century, at least according to uncorrected temperature values. No warming in the 1990's can be discerned.

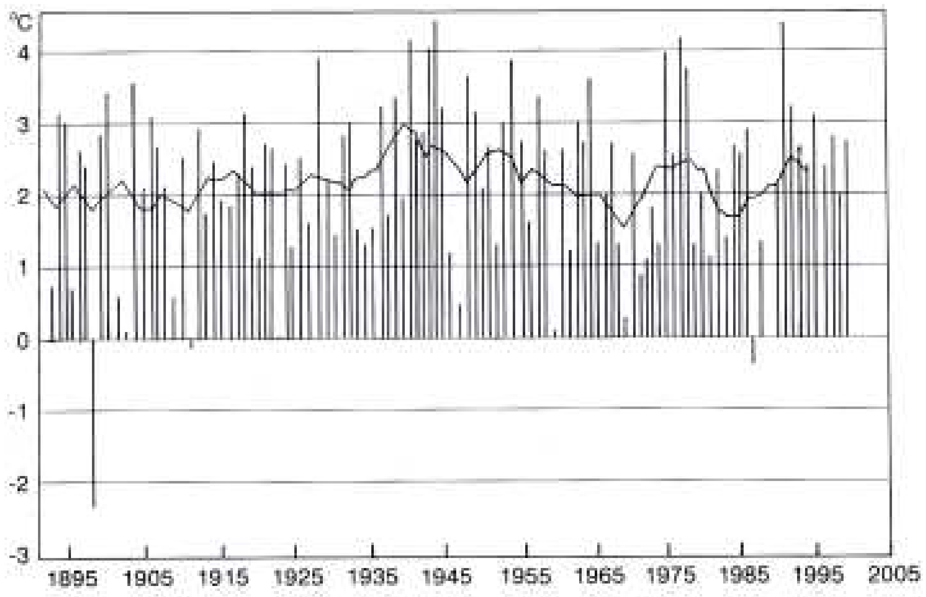

Fig. 9. Annual mean temperatures in Oulu (latitude 65°N) 1892–1999. The temperatures are uncorrected. The line shows 10-year moving averages – Wahlström et al. 1992: Fig. 23 (redrawn); the years 1992–1999 are added (Finnish Meteorological Institute 2000, personal communication).

Oslo's temperature series begins in 1850 (Fig. 10). Again there are some common features with Helsinki and Stockholm. The period 1850–1900 was cold, then a clear warming trend started in the 1920's, followed by a cooling trend from 1940 to 1970, then a short-term fluctuation of warming and cooling and a warming trend again since the end of 1980's. Taking the whole 20th century into consideration, it is however hard to say whether any long-term climate change has occurred, only fluctuations of about ten or some tens of years can be observed.

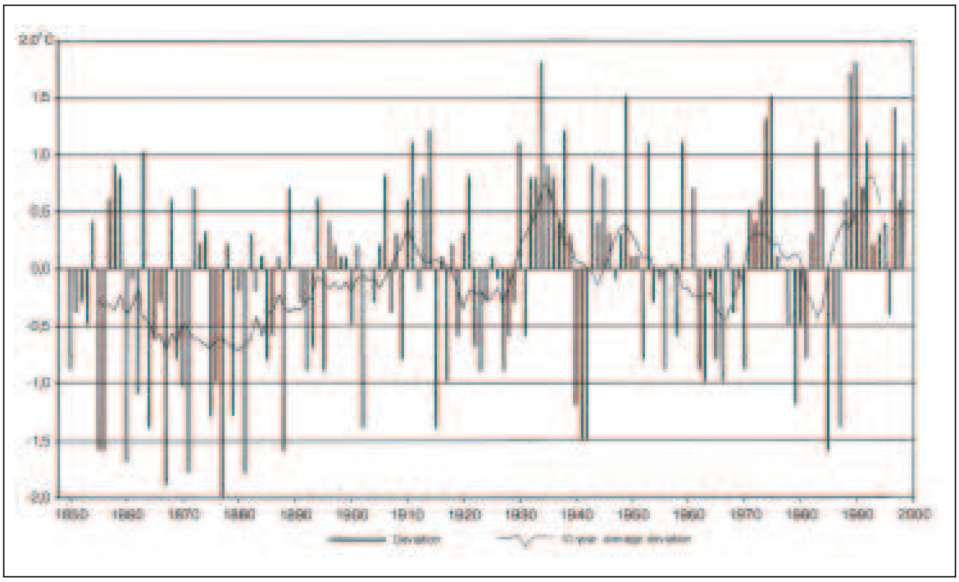

Fig. 10. Annual mean temperatures in Oslo 1850–1999 as deviation from normal temperature 1961–90. Temperatures during the period 1850–1994 are corrected, the period 1995–99 is added (Norwegian Metorological Institute 2000, personal communication) and it is uncorrected. – GRID-Arendal (1999; redrawn).

4. Discussion

It is clear that regional differences appear in the warming and cooling trends and they do not always represent global patterns. However, all climate models, even the most recent ones, project the climate as warming in the Nordic countries. One of the greatest problems with modelling is cloudiness. At present, many of the feedbacks between the clouds and the climatic system are poorly understood. The influence of clouds on the global heat budget is so immense that even a small mistake in cloud estimates affects more than a doubling of CO_2 concentration. There are as yet no climate models which are capable of taking into consideration the significance of clouds to a sufficient degree (MIT center 2000).

Some researchers have seen the global warming trend as a recovery from the Little Ice Age, especially in the 1920’s and 1930’s. The CO_2 concentration in the atmosphere increased very little during this period, and accordingly this climatic warming must have been natural, at least in the first place. It is not very convincing to argue that the present global warming is without any doubt completely of anthropogenic origin. Variations in CO_2 not only represent a forcing factor, but also occur as a result of climatic change (Fischer et al. 1999).

Friis-Christensen and Larsen (1991) found a high correlation between variations in the length of the sunspot cycle and changes in global mean temperatures over the past 100 years. This is suggestive of a direct link between solar forcing and climate, but variations in solar output energy over sunspot cycles are not sufficient to trigger the observed magnitude of climatic fluctuations by direct energy-balance considerations. If there is a cause-effect relation, some amplifying feedback mechanism must exist, and this mechanism has not yet been explained.

Accordingly, it could be external factors like solar activity which trigger climate changes, while it is the internal factors like changes in ocean currents and air circulation and the CO_2 balance between oceans and the atmosphere that are of major importance for the intensity and the regional distribution of the effects.

There are a variety of causalities behind climatic changes, functioning on different time scales. Where human interests are concerned, the scale of 10 to 100 years is of most importance. The warming trend in global surface mean temperatures is not exceptional in terms of climatic changes during the Holocene, but greater and more abrupt changes are known to have happened (Briffa et al. 1992; Boecker 1995; Bianchi, McCave 1999). It is justified to presume that there is an anthropogenic component in the global warming trend, but its separation from natural climatic change processes is very uncertain. It has not been possible to detect any sure and unambiguous signal separate from natural climatic changes (Santer et al. 1996).

Although all models suggest more pronounced warming at high latitudes than at the global level, no reliable signs of warming are discernable in northwestern Europe, particularly neither in its northern parts, nor in winter. It is an interesting question, whether there would have been a continuous cooling since 1940 in northwestern Europe, if there had not been any presumed enhanced greenhouse effect. The temperature time-series which have been studied show a slight warming trend since the end of the 1980's, but it is too early to say if this is just a short-term fluctuation. At any event, the temperature level was generally higher 60–70 years ago than it is today. A central factor in the climate of northwestern Europe is the behaviour of the Gulf Stream, which is extremely difficult to predict, and about which there is very little monitoring before 1990. It is not impossible that the Nordic countries would become colder if the Gulf Stream did not reach as far north as nowadays, which could happen if the surface water in the Arctic Sea becomes fresher as a consequence of melted ice (Holmén 1996).

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