Veðurstofa Íslands
Report

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(editors)

Climatic and Environmental History of Northern Europe and the North Atlantic Region over the past 1000 years

In honour of Knud Frydendahl and Erik Wishman

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North European Group of Historical Climatology

Climatic and Environmental History of Northern Europe and the North Atlantic Region over the past 1000 years, Reykjavík August 4 and 5 1997

A symposium organised by **Astrid Ogilvie**, INSTAAR, University of Colorado and **Trausti Jónsson**, Veðurstofa Íslands (Icelandic Meteorological Office).
The organisers are grateful to **Gísli Pálsson**, University of Iceland, **Jón Haukur Ingimundarson**, Bucknell University for their co-operation and collaboration. **Ingibjörg Jónsdóttir**, INSTAAR and Veðurstofa Íslands has provided invaluable assistance. The symposium is sponsored in part by the U.S. National Science Foundation (NSF).

Agenda:

Monday 4 August

Morning Session: Chairperson: **Gaston Demarée**
8.30: Bus from Hotel Cabin to Oddi

9.00-9.30: **Astrid Ogilvie**, INSTAAR, University of Colorado and CRU, Norwich and **Trausti Jónsson**, The Icelandic Meteorological Office: Introduction, welcome, some practical details.
9.30-10.00: **Tom McGovern**, Hunter College, City University of New York: Connections with NABO.
10.00-10.30: **Jean Grove**: "The 'Little Ice Age' around the North Atlantic."

10.30-11.00: Coffee

11.00-11.30: **A.T. (Dick) Grove**: Possible connections between Little Ice Age climates and geomorphological events in Mediterranean Europe.
11.30-12.00: **Paul Buckland, Pat Wagner and Jon Sadler**: University of Sheffield: "Does the fossil insect provide a signal for the 'Little Ice Age'?"

12.00-2.00: Lunch

Afternoon Session: Chairperson: **Paul Buckland**
2.00-2.30: **Lisa Barlow**, INSTAAR, University of Colorado: "The 'Little Ice Age' time period in Central Greenland ice cores; variability is the key."
2.30-3.00: **Andrew Dugmore**, Department of Geography, University of Edinburgh and **Martin Kirkbride** Dept. of Geography, University of Dundee: "Neoglaciation in Iceland: Exploring the limitations of the geomorphological evidence for the 'Little Ice Age'".

3.00-3.30: Coffee Break

3.30-4.00: **Maria Wastl, Hans Stötter**, Geographical Institute, University of Munich, **Chris Caseldine**, Department of Geography, University of Exeter: "The termination of the Little Ice Age in Northern Iceland."
4.00-4.30: **Gaston Demarée**, Royal Meteorological Institute of Belgium, and **Astrid Ogilvie**, INSTAAR, University of Colorado and CRU, Norwich: "On some early instrumental meteorological observations in Greenland and Labrador."
4.30-5.00: **Gaston Demarée**, Royal Meteorological Institute of Belgium and **Astrid Ogilvie**, INSTAAR, University of Colorado and CRU, Norwich: "Further evidence on the geographical spreading and ecological impact of the "great dry fog" due to the Skaftáreldar, A.D. 1783 or '*Bons Baisers d'Islande*'"

5.00-6.30: An informal ice-breaker party at "Oddi". Dinner in Reykjavik on your own (we will advise you on the possibilities).
6.30:Bus to hotel and/or downtown.

Tuesday 5 August

8.30: Bus from Hotel Cabin to Oddi

Morning Session: Chairperson: **Chris Caseldine**
9.00-9.30: **Peter Jönsson, Lars Bärring, Christine** Achberger and **Marie Ekström**, Department of Physical Geography, Lund University: "Reconstruction of the monthly mean pressure in Lund, southern Sweden, 1780-1995."
9.30-10.00:**Per Øyvind Nordli**: "A composite series of summer temperatures (1813- 1996) based on barley harvest data and instrumental observations."
10.00-10.30: **Andres Tarand**: "Tallin Time Series and Changing Air temperature in North Europe."

10.30-11.00: Coffee

11.00-11.30: **Tadeusz Niedzwiedz**, Cathedral of Climatology, Silesian University, Sosnowiec, and Institute of Meteorology and Water Management, Krakow: "Long-term atmospheric circulation indices variability in the northern part of Atlantic Region (above the Spitsbergen as an example)."
11.30-12.00: **Laryn Micaela Smith, Anne E. Jennings, John T. Andrews** and **James Syvitski**, INSTAAR, University of Colorado: "Environmental change during the last 1000 years in the Kangerlussuaq region, East Greenland, 68N."

12.00-2.00: Lunch

Afternoon Session: Chairperson: **Peter Jönsson**
2.00-2.30: **Geraint Coles**, Department of Archaeology, University of Edinburgh: (Provisional Only): "Palaeoecological evidence for the Little Ice Age in the Isle of Lewis, Scotland."
2.30-2.45: **Astrid Ogilvie**, INSTAAR, University of Colorado and CRU, Norwich: "What do the documentary sources tell us about a possible 'Little Ice Age' in Iceland?"
2.45-3.15: **Páll Bergthórsson**, former Director of The Icelandic Meteorological Office: Global Climate Forecasts based on CO2 and Spitzbergen temperatures.

3.15-3.40: Coffee

3.40-4.00: **Trausti Jónsson**, The Icelandic Meteorological Office: "Early Instrumental Observations in Iceland. Typical for the Little Ice Age?"
4.00-4.30: **Ingibörg Jónsdóttir:** "Sea ice off the coasts of Iceland A.D. 1850-1950. Sources of information."
4.30-5.00: The future of the group. General discussion and close.

5.00: Bus from Oddi to Hotel Cabin
7.15: Bus from Hotel Cabin to Restaurant
7.30 Conference Dinner. Restaurant Lækjarbrekka.

North European group of historical climatology
Veðurfarssöguhópur Norður-Evrópu

Little Ice Age Symposium Aug. 4 and 5 1997
Participants:

Guests of honour:

Knud Frydendahl,	Formerly at Danish Met. Institute, Denmark
Erik Wishman	Formerly at Archeological Museum, Stavanger, Norway

Other:

Tom Amorosi	Hunter College, Univ. of New York, USA
John Andrews	INSTAAR, Univ. of Colorado, USA
Lisa Barlow	INSTAAR, Univ. of Colorado , USA
Páll Bergþórsson	Former Director of Icel. Met. Office, Iceland
Nancy Bertler	Geographical Institute, Univ. of München, Germany
Paul Buckland	University of Sheffield, U.K.
Chris Caseldine	Dep. of Geography, Univ. of Exeter, UK
Geraint Coles	Dep. of Archaeology, Univ. of Edinburgh, UK
Gaston R. Demarée	Royal Met. Inst. of Belgium
Andy Dugmore	Dep. of Geography, Univ. of Edinburgh, UK
Jón Eiríksson	University of Iceland
Áslaug Geirsdóttir	University of Iceland
Thomas Geist	Geograpical Institute, Univ. of München, Germany
Dick Grove	University of Cambridge, UK
Jean Grove	University of Cambridge, UK
Grétar Guðbergsson	Institute of Agricultural Science, Iceland
Hjalti J. Guðmundsson	University of Edinburgh, Scotland, UK
Jórunn Harðardóttir	University of Colorado, USA
Haukur Jóhannesson	Institute of Natural History, Iceland
Helga Ívarsdóttir	Icelandic Met. Office, Iceland
Þór E. Jakobsson	Icelandic Met. Office, Iceland
Ingibjörg Jónsdóttir	Icelandic Met. Office, INSTAAR
Trausti Jónsson	Icelandic Met. Office, Iceland
Peter Jönsson	Dep. of Physical Geogr., Lund University
Jörmundur Ingi	
Tom McGovern	Hunter College, Univ. of New York, USA
Tim Malthus	University of Edinburgh, UK
Anthony Newton	University of Edinburgh, UK
Kurt Nicolussi	University of Innsbruck, Austria
Tadeusz Niedwiedz	Cathedral of Climatol. Silesian Univ. Krakow, Poland
Øyvind Nordli	Norwegian Meteorol. Institute, Norway
Astrid Ogilvie	INSTAAR, Univ. of Col. and CRU, Norwich
Ólafur Rögnvaldsson	
Micaela Smith	INSTAAR, Univ. of Colorado, USA
Matthildur B. Stefánsdóttir	
Árný Erla Sveinbjörnsdóttir	University of Iceland
Hans Stötter	Geographical Institute, Univ. of München, Germany
Andres Tarrand	The Estonian parliament
Þórhallur Vilmundarson	Professor, Univ. of Iceland
Maria Wastl	Geographical Institute, Univ. of München, Germany

25.08.1997

Tallinn time series and changing air temperatures in North Europe

Andres Tarand

Introduction.

Air temperature is a distinctive index in climate change research due to its integrated substance of reflecting climate formation and duration of direct measurements. The use of proxy data to reconstruct climate in pre-instrumental times leads mostly to derivation of air temperature and precipitation indices. However, the variety of errors in measurement and changing conditions of observation location as well as nature of proxy data makes obtaining precise and comparable data for longer periods rather difficult. This paper deals with the reconstruction of Tallinn air temperature time series for A.D. 1500-1997 in the context of other North European observation results.

Modern observation data.

In Tallinn we can consider the air temperature observations as modern ones from the year 1850 as the standardisation of measurements was introduced in 1849. From that year onwards the following means for homogenisation of time series are carried out:

-reducing the different observation times to 24-hours mean temperature by observed air temperature.

-filling the gaps in observations by the method of the smallest dispersion with possible variety of weather stations in the vicinity (combination of 8 stations in Estonia used).

-adding location correction to eliminate mesoscale impact of the Baltic Sea and urban effect on the bases of parallel observations in stations network and on special investigations. All corrections are provided on the level of monthly mean air temperature. As the scope was to follow up climate change, all corrections are true to the period in average but not for individual months.

Early observations

In Tallinn the first instrumental observations were recorded in 1774. Since that time, and up to 1805 only seasonal or monthly averages by Old Style are available. Recalculation to the New Style has been impossible as the search in archives has not produced results. The period 1805-1849 is covered mostly with parallel observations at different points in Tallinn, provided often with well-checked thermometer. To fill the gaps the observation results from Stockholm, St. Petersburg, Riga, Porvoo, Loviisa and Rakvere are used. However, as we try to prove with some proxy data, the measurements of this time were not fully correct anywhere, especially not in summer. To some extent further corrections are possible knowing the detailed history of observations in each station. Anyway, one can be sure that during all seasons the results of early measurements could be only increased but not decreased compared with real air temperature of the time.

Proxy data

We have three main proxy indices of air temperature before instrumental observation period in Estonia (and for the wider region):

-mean winter (December-March) air temperature on ice-break dates in Tallinn Port (well correlated with maximum ice-extent on the Baltic Sea).

- average ice-break dates on rivers in North Estonia as the beginning of spring (the Daugava, Neva and some Finnish rivers also used).
- average air temperature of spring-summer (April-July). Reconstruction of air temperature is based on first rye-harvesting date and corresponding to that degree days.

It is possible to calculate also mean temperature of August and November but for September and October the author has not yet found a suitable method to do it. To avoid location dependent differences all data are reduced to Tallinn.

The longest time series is that of average winter air temperature (without gaps up to the year 1600 and for 33-year periods to 1500).

Description of results

Some results of air temperature reconstruction for Tallinn have been published earlier by the author. Now, with the running Estonian Climate Change Country Study of UNEP, the completed and controlled time series could be presented. The statistical elaboration of data allows to show long-term trends and acceleration of warming in recent decades. Comparison with other North European time-series of air temperature (St. Petersburg, Helskinki, Riga, Stockholm, Oslo, Utsira, Bergen) is generally possible but for the reasons discussed above it needs more comprehensive critical analysis.

The Little Ice Age and its geomorphological consequences in Mediterranean Europe

Dick Grove

Historical and geomorphological studies of Mediterranean landscapes often point to rapid sedimentation in river valleys and deltas in late medieval and early modern times and attribute it to soil erosion. The soil erosion is claimed to be the result of population growth, agricultural expansion and deforestation. The evidence for the timing of clearance, and its effectiveness in promoting erosion is rarely demonstrated. Rural population growth was generally fastest somewhat later than the sedimentation, from the mid 18th to the end of the 19th century. I would argue that human activity is only part of the explanation. Climatic extremes, especially a greater frequency of deluges possibly associated with Little Ice Age ice advances, may have been more important than is usually recognized.

What do the documentary sources tell us about a possible 'Little Ice Age' in Iceland?

Astrid Ogilvie

The main documentary evidence for variations in climate and sea-ice incidence from Iceland for the seventeenth and eighteenth centuries are the annals written by individuals, certain diaries, and travellers accounts, as well as reports written by government officials (bréf sysslumanna). These sources will be discussed briefly. The evidence they contain will also be considered. It is interesting to note that there appears to have been a relatively ice-free period during the years ca. 1630 to 1680. This coincides with a period when independent documentary evidence shows that mainly mild temperatures predominated. This is in contrast to the marked coldness of the seventeenth century in Europe. Indeed, this century has often been regarded as the height of the so-called "Little Ice Age" (Lamb, 1979; Grove, 1989). For Iceland, there seems little doubt regarding the reality of this mild period with little ice. It is interesting also that, during these decades of apparent mild climate, an enlightened individual, Gísli Magnússon (1621-1696) managed to grow barley and a number of other plants on his farm at Fljótshlid in the south (Ólason, 1942). Barley had been grown during early settlement times but this practice subsequently ceased, possibly as a result of a colder climate (Thórarinsson, 1956). It should be noted, however, that there are more data available for the period after ca. 1780. There is thus a small chance that the lack of ice in the seventeenth century may be partly an artefact of reduced reporting frequency. Homogenizing the full climate and sea-ice record will help to establish this. Preliminary data suggest that, for the period 1600 to 1850, the decades with most ice present were the 1780s, early 1800s and the 1830s. The 1840s saw a return to a regime with very little sea ice (Ogilvie and Jónsdóttir, 1996). From about 1850 to around 1900, the incidence of sea ice off Iceland was apparently relatively heavy (Jónsdóttir and Ogilvie, 1997). It is already clear that, in comparison with the entire period AD 1600 to 1900, sea ice off Iceland occurred less frequently in the twentieth century. This latter period will be discussed by Ingibjörg Jónsdóttir.

On some early instrumental meteorological observations in Greenland and Labrador.

Gaston R. Demarée and Astrid E.J. Ogilvie

Since the mid eighteenth century regular instrumental meteorological observations have been carried out by missionaries of the Moravian Brethren (Unitas Fratrum) working among the Inuit population of both Greenland and Labrador. Some of these observations have been used in early meteorological works like Cotte, Kirwan and Dove, but seem to be known only by few in present times.

The practice of carrying out meteorological observations was carried out alongside the missionary activities of the Moravian Brethren, also called *Herrnhuters* according to the locality where they settled in the early eighteenth century. The observations are carried out under standard conditions by observers trained in natural sciences at their theological seminaries and pedagogical schools.

Extracts of these meteorological records were published in local newspapers and scientific journals in the core region of the Herrnhuters in eastern Germany. A further search in archives and libraries revealed a wealth of documents and material.

This paper places the above-mentioned meteorological observation in their historical and climatological context. It is believed that these meteorological records are a valuable tool in the climate reconstruction of the North Atlantic

The ‘Little Ice Age’ around the North Atlantic

Jean Grove

The "Little Ice Age" was the most recent period during which glaciers extended globally and oscillated about forward positions. It is frequently taken as having occurred during the last three centuries, and ending somewhere between 1850 and 1890, but Porter pointed out in 1881 that the Little Ice Age "may have begun at least three centuries earlier in the North Atlantic region than is generally inferred".

The glacial fluctuations of the last millennium have been traced in the greatest detail in the Swiss Alps, where the Little Ice Age is now seen as starting with advances around 1280-1290, and reaching an initial culmination in the 14th century. Evidence from Canada, Greenland, Iceland, Spitsbergen and Scandinavia will be compared with that from Switzerland. Such comparisons have been greatly facilitated by improved methods of calibrating radiocarbon dates to calendar dates and by increasing availability of evidence revealed during the current retreat phase.

The 'Little Ice Age' time period in central Greenland ice-cores: variability is the key.

Lisa K. Barlow

The search for a 'Little Ice Age' signal in Greenland ice core isotopic signals began with Dansgaard et al.'s 1975 paper, which suggested a 250 year lead in the climate signal of Greenland to match the European 'Little Ice Age'. Climate dynamics of the North Atlantic Region suggest that one would not necessarily expect like responses in temperature between Greenland and Northern Europe, especially for particularly anomalous years. More recent concepts of the 'Little Ice Age' suggest a variable climate as opposed to a centuries-long low temperature time period, and document the role of climate variability on agricultural losses and associated famines. The isotopically lowest signal on the century time scale in central Greenland ice cores in the last 1000 years is in the 1300s. Focusing on the GISP2 ice core, there is a second isotopically low time period in the late 1600s, and a third in the latter part of the 1700s. Lowest accumulation is in the 1700s. The GISP2 isotopic signal shows greater variability in the 1500's. Greater variability in both GISP2 isotopic and accumulation signals is evident in the 1700s, with isotopic variability beginning around AD 1675.

Environmental change during the last 1000 years in the Kangerlussuaq region, East Greenland, 68N

L. Micaela Smith, Anne E. Jennings, John T. Andrews, and James Syvitski

Sediment cores from two fjords in Kangerlussuaq, East Greenland, record changes in glaciological and oceanographic conditions over the past 1000 years. Nine cores were collected in 1991 and 1993 from Kangerlussuaq, and Nansen Fjords to study how changes in environmental and climatic conditions affect sedimentation. Although the two fjords are within 100 km of each other, they differ in terms of glaciology, hydrography, morphology, and bedrock lithology. As a result of these differences, the two fjord represent distinct depositional settings which respond differently to similar regional climate forcings.

The two main modes of sediment deposition in the fjords are rain-out of sediment through the water column (primary mode) and sediment gravity flows (secondary mode). The sediment originates in ice and either melts out directly at the glacier terminus or from icebergs drifting within the fjord. Sediment gravity flows, either turbidites or debris flows, act to rework and remobilize sediment down the fjord basins. The change in the thickness of the sediment gravity flow deposits is indicative of a change in the glacier position.

Kangerlussuaq is a long, narrow (75 km by 10 km) fjord with water depths reaching ca. 900 m in the deepest area of the basin. There is an active tidewater glacier at the fjord head that drains the Greenland ice sheet, and numerous local ice caps reaching tidewater along the sidewalls. At the terminus of the fjord head glacier, there is a sikkusaq region, a melange of sea ice and icebergs, that is defined by a morainal sill (Syvitski et al., 1996). The sediments within Kangerlussuaq Fjord are comprised of repeating packages of rain-out deposits and sediment gravity flow deposits. Sediment accumulation is primarily through rain-out from icebergs, although sediment gravity flows are common. It is hypothesized that the moraine at the fjord head is a Little Ice Age feature (Syvitski et al., 1996). Changes in the occurrence and thickness of sediment gravity flow deposits support this hypothesis. The thickness of the turbidites decrease upcore. It is hypothesized that this change is caused by ice being advanced farther than its present limit into the fjord basin as it built the moraine. A large amount of sediment was supplied to the basin, and thick turbidity currents were generated. As the ice retreated, the sediment supply and the thickness of the turbidite deposits decreased. Based on a radiocarbon date at the base of the core, the age of the change in the thickness of the turbidite deposits, correlative to the age ofglacier retreat from the LIA moraine, is ca 1650 AD.

Nansen Fjord is wide and short (40 km by 20 km), with an active tidewater glacier at its head that drains a local ice cap. The basin deepens to 450 m near the sill and shallows toward the head of the fjord. A semi-permanent sikkusaq exists at the tidewater margin. Sediments within Nansen Fjord are mostly deposited through sediment rain-out, with only minor deposits of sediment gravity flows. Correlation of foraminiferal assemblage data with sediment lithology indicates that changes in sediment lithology are controlled by changes in the oceanographic conditions of the fjord; these oceanographic changes relate to changes in climate. Nansen Fjord was relatively cool (similar totoday) from 1630 AD to the present, with marked periods of severe cold ca 1630 AD, 1740 AD, and 1830 AD (Jennings and Weiner, 1996). These cold intervals correlate to similar cold periods interpreted from Icelandic sea ice extent records (Oglivie, 1984), but are out of phase with the Greenland Crte ice-core record.

Jennings, A.E., and Weiner, N.J., 1996. Environmental changes in eastern Greenland during the last 1300 years: evidence from foraminifera and lithofacies changes in Nansen Fjord, 68N. The Holocene, 6(2),: 179-191.

Oglivie, A.E.J., 1984. The past climate and sea-ice record from Iceland, Part I: Data to A.D. 1780. Climatic Change, 6,: 131-152.

Syvitski, J.P.M., Andrews, J.T., and Dowdeswell, J.A., 1996. Sediment deposition in an iceberg-dominated glacimarine environment, East Greenland: basin fill implications. Global and Planetary Change, 12,1-4: 251-270.

Reconstruction of the monthly mean pressure in Lund, southern Sweden, 1780-1995.

Peter Jönsson, Lars Bärring, Christine Achberger and Marie Ekström.

As a part of the ADVICE-project (Annual to Decadal Variations In Climate in Europe), the Lund (55°42'N, 13°12'E) pressure series have been included in the construction of a Mean Sea Level Pressure grid for the European continent and the North Atlantic during the EIP (Early Instrumental Period; AD 1780-1860). This grid will serve as a tool for analysing the pre-industrial atmospheric circulation variations. About 90 000 entries of pressure (three daily observations) has been digitised from hand-written sources. Internal consistency (linking the EIP part of the series to the modern part) of the Lund pressure series was obtained by unit conversions, corrections to sea level, 0 °C, and to standard gravity with the aid of the station history. Comparisons have further been made with the modern grid (provided by UKMO; 1873-1995) and by inter-comparisons with acknowledged homogeneouos stations, like Copenhagen (1842-1995) and Edinburgh (1780-1995); a procedure in which distinct breaks in the compared mean differences were adjusted for. This final Lund homogenised series is, together with Barcelona, the longest one with a three daily observation frequency. Regional time series analyses of variations in cyclone activity, storminess and blocking over the last 215 years are made possible by pressure data with such a high time resolution.

Long-term atmospheric circulation indices variability in the northern part of Atlantic Region (above the Spitsbergen as an example)

Tadeusz Niedzwiedz

The author presents the variability of different circulation indices above the Spitsbergen for the period of 1951-1996. They were used to estimate the changes of atmospheric circulation over the Spitsbergen area. For that purpose some synthesis in the materials dealing with the frequencies of 21 different circulation types had to be done. Good results can be obtained using the simple circulation indices P, M, S, C, as proposed by R. Murray i R.P.W. Lewis (1966), while the author of this study introduces some minor modifications. The indices are used to get an easy estimate of atmospheric circulation for a whole month, season or year. Those indices are expressed by the abstract numbers which are the sum of the points assigned to the particular circulation types occurring in a given month. Westerly index W is counted by summation of scores (points) as follows:

types W +2, NW and SW +1, E -2, SE and NE -1).

It is easy to see that the high values of this index occur at a distinct predominance of air advection from the West while the negative ones point to a great frequency of easterly air flow. The remaining non-advective directions and situations received no points. Index of southerly circulation - S is calculated according to the following scoring of circulation types: type S +2, types SW and SE +1, types NW and NE -1, and type N -2. Hence, high positive values of the index point to a intensive advection of air masses from the South, while negative ones point to the advection from the North. Index of cyclonicity - C is calculated by (using) summation of scores allocated as follows: cyclonic situations +1, anticyclonic patterns -1. Positive values of the index inform about the prevalence of cyclonic situations over anticyclonic ones.

The earliest series of air temperature for Spitsbergen were reconstructed for the period of 1912-1997 at Isfjord Radio for January.

Circulation forms over Spitsbergen have been fluctuated in the long-term period. During the analysed period 1951-1996 the great changes have been observed in all seasons and the annual values of the indices: W, S and C. Generally the positive trends were observed, except only one example for index S in Autumn. Recently more intensive cyclonicity level was observed in winter and spring, and weaker in summer and autumn.

The periods with weakness of westerly and southerly air flow and lowering of cyclone frequency were characterized by deepest decrease of January temperatures. There was observed the significant influence of circulation patterns on temperature of January at Spitsbergen. The best correlation between the mean January temperature at Isfjord Radio and circulation indices exists for the S and W index. Correlation coefficients are very high, 0.6 and 0.4 respectively, with the significance level of 0.1%. The best results in the reconstruction of the mean January temperature gives the multiply regression model.

Great similarities between the January temperature fluctuations and course of circulation indices is presented on diagrams. Analyze of the long-term data (1912-1992) from Isfjord Radio shows the significant increase of temperature from the beginning of the century to the decade of 1930. The period of lowest temperatures were observed round the 1965. During the last decade of 1980 the period of a little warming is observed again.

Early instrumental observations in Iceland: Typical for the Little ice age?

Trausti Jónsson

Analysis of early instrumental observations in Iceland is in progress. This analysis is conducted as a part of the EU-environment funded project ADVICE. Temperature and pressure variations in Iceland back to about 1830 are now fairly well known but a lot of work remains until it will be possible to extend these series back to the late 1770's in a reliable and consistent way. A number of series from this period have been digitized and analysis has started. Some of the results are presented here.

Three broad methods are in use for checking the quality of old weather records:

1. Comparison between "concurrent" observations within a reasonable radius
2. Comparison between the statistical behavior of the "old" obs. and modern ones
3. Internal consistency of the "old" series of observations.
4. Checks against "proxy" data.

Preliminary results:

1. The series are usually consistent but a number of corrections must be employed so they can be compared to "modern" observations. In most cases these corrections are rather straightforward, but there are also enigmatic facts to deal with.
2. The seasonal amplitude of temperatures seems to be somewhat larger than in modern times. This is mainly because of colder winters. There are, however, in some cases grave difficulties regarding the summer measurements, due to the exposure of the instruments.
3. The difference between northern and southern Iceland seems to be greater than in modern times, especially in the winter and spring. This is consistent with a greater extent of the sea-ice.
4. There are "bad" years and "good" years and it is relatively easy from the data to extract information on the relative year-to-year temperatures.
5. Very cold polar outbreaks seem to be much more common during the whole first 110 years of the instrumental record (1780-1892) than later.

A composite series of summer temperatures (1813 - 1996) based on barley harvest data and instrumental observations.

Per Öyvind Nordli

Farmers' diaries containing barley harvest data exist from the village Kjøremsgrendi in the Dovre area (Northern Gudbrandsdalen, Southern Norway) for the period 1813 - 1874. From the same area a series of instrumental observations is also available since 1864, called the Kjøremsgrendi series which is tested and judged to be homogeneous. Linear regression analysis during the overlapping period (1865-1874) shows that the first harvest day and the mean summer temperature May - August are well correlated ($r = 0.97$). Linear regression analysis is used to reconstruct summer temperature before 1865 so as to form a composite time series of summer temperature from 1813 to 1996.

This series is compared to the Norwegian classical 19th century instrumental series from Trondheim, Bergen and Oslo and the Swedish series from Uppsala and Stockholm. This comparison reveals some biases of the difference between the instrumental Trondheim and Oslo series during the period 1813 to about 1860, the Trondheim series being the warmer one relative to the whole length of the series. The Kjøremsgrendi composite series does not support the high summer temperature at Trondheim during this early period. It is therefore likely that the bias of the Trondheim series is caused by overheating of the thermometer due to bad exposure.

In order to test this proxy data method, harvest data from three other diaries have been correlated to mean summer temperature data from near by instrumental observations. Also these diaries correlate reasonably well to the instrumental series showing correlation coefficients of 0.78, 0.89 and 0.91. The residuals of the regression analysis reveal that the uncertainties of summer temperature calculated by this method during one decade is about 0.1 - 0.2_C, which is less than the errors of the thermometers used in the first half of the 19th century. Provided that the harvest data are homogeneous (unchanged corn field and type of barley), they are a very useful tool for checking and eventually adjusting early instrumental records. Moreover, farmers' diaries might be used to extrapolate instrumental observations to pre-instrumental time. This requires however that the diary origins from the same climatic region as an available series of instrumental observations and that there exists an overlapping period for the two data sets.

Global Climate Forecasts based on carbon dioxide and Spitzbergen temperature

Páll Bergþórsson

The running ten year mean air temperature of Spitzbergen over the past 100 years shows extreme and prolonged oscillations, with a difference of 4°C between the warmest and the coldest decade. The air temperature variations in the northern hemisphere are an order of magnitude less and they are lagging about 5-7 years behind the Spitzbergen variations. In the southern hemisphere the temperature amplitude is still less but the time lag after Spitzbergen is greater.

The main explanation of this phenomenon seems to be looked for in the huge ocean circulation from Spitzbergen to Greenland, Newfoundland, Norway and back to Spitzbergen in approximately 14 years. This is the circulation of the so-called great salinity anomaly studied by Dickson et al. It reminds of the El Nino phenomenon but the episodes are longer by an order of magnitude. The climate impact of the Spitzbergen circulation are longer of an order of magnitude. The climate impact of the Spitzbergen oscillations is therefore far greater. Only two parameters, the carbon dioxide and the exponentially smoothed Spitzbergen temperature, make it thus possible to forecast 7 years' mean temperature of the northern and southern hemisphere with a correlation coefficients of 0.94 and 0.98 respectively, and with a root-mean-square-error of about 0.05°C. Another important conclusion is that this confirms the greenhouse warming which in all probability has been going on persistently over the past century, hardly disturbed by anything but the Spitzbergen oscillations.

Does the fossil insect provide a signal for the 'Little Ice Age'?

Paul Buckland, Pat E.Wagner and Jon P. Sadler

The remains of insects, particularly of Coleoptera (beetles) and Diptera (true flies) present some of the most frequent identifiable animal fossils in Quaternary sediments. The abundance of species which have close ecological and thermal requirements and the extent of modern knowledge of both their distribution and habitats gives them great potential in reconstructing past environments (*cf.* Elias 1994). In the last 25 years, their use in both natural and archaeological contexts has been particularly developed in the British Isles, although there are increasing numbers of studies from sites in Scandinavia, Iceland, Greenland and North America. It is unfortunate, however, that no single natural succession brings a sequence of faunas through the post-medieval period to the present day. Therefore climatic inferences based upon changing insect distribution rely upon samples from scattered partial sequences usually taken for other reasons. Two recent critical reviews of the British evidence, by Osborne (1997) and Wagner (1997), come to opposing conclusions, the former accepting major declines, principally in the diversity of the dung fauna, as climatically induced, and the latter preferring an anthropogenic impact explanation. Much of the problem lies in the ability to define a presence and the inability to confirm an absence. A particularly good example is provided by the small Hemipteran (true bug) *Ischnodemus sabuleti*. Associated with the widespread Canary reed grass, in the early years of this century, it was confined to a few localities on the south coast of England around Folkestone. It has since spread virtually throughout England and it is tempting to relate this to the documented warming through this century. The fossil record shows that it lived in north Lincolnshire *ca.* 1000 BC (Buckland 1981), but there is presently no record for the intervening period and its decline may have taken place at any time thereafter. Kenward (in Addyman *et al.* 1976) has argued that the frequent occurrence of the bug *Heterogaster urticae* in medieval York supports a model of a medieval warm period followed by a decline in temperatures, which have yet to return to comparable levels. The species currently extends northwards at least to south Derbyshire, less than 100 km south of York, where it may be quite frequent in stands of nettles. Whilst other dramatic changes in the York insect faunas are more likely to reflect the changes nature of our urban centres, it is difficult to explain change in a species whose host remains ubiquitous without recourse to climatic change.

Girling (1976) has argued that the extinction of the water beetle *Gyrinus colymbus* from England since the medieval period reflects LIA cooling and Osborne (1974) has maintained the same for the marsh-dwelling *Airaphilus elongatus* since the Roman period, yet both exploit habitats liable to man-induced changes, particularly pollution of inland waters. Similarly Hellqvist and Lemdahl's (1996) use of the Mutual Climatic Range (MCR) model to fix climatic parameters around faunas from medieval Uppsala is open to criticism because of the limited nature of the faunas and the slight nature of the change in climate inferred compared with the scale of human impact on the landscapes of south Sweden.

Atlantic islands offer a slightly clearer opportunity in that once extinguished a species has little change of re-establishing itself. In southern Iceland, east of Markarfljót, the small water beetle *Hydraena britteni* is a common fossil in deposits into the fifteenth century, after which it disappears (Buckland *et al.* 1983). Using MCR retrodictively, it is possible to come up with a potential fauna for Iceland given present climatic constraints; a 1°C decline overall would be sufficient to remove this species from the fauna. This could imply that the LIA was the coldest part of the Holocene at least in this part of Iceland. As a cautionary tale, however, a similar game, played in Greenland, with the small ladybird *Nephus redtenbacheri*, only known from a few captures in the far south but a not infrequent fossil in Norse farms in the Western Settlement (Buckland *et al.* 1996), has foundered on finds from pitfall traps set around the recently excavated farm site at GUS.

The answer to the question, "is there a LIA insect signal?" is yes probably, but we have yet to thoroughly disentangle it from the much great signal imposed by human activity and destruction of habitat.

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Neoglaciation in Iceland: Exploring the limitations of the geomorphological evidence for the 'Little Ice Age'.

Andrew Dugmore and Martin Kirkbride

There is evidence for glaciers fluctuating beyond present limits at times throughout the late half of the Holocene and including the medieval period. Of particular interest are the timing and extent of fluctuation during the last 500 years. Numerous examples exist of ice limits dated to the last two advances, but the record of historical-age moraines before 1800 A.D. is rather sparse. To what extent is this pattern a reflection of glacial history, and to what extent is this a function of current knowledge or the limitations of the environmental record? The evidence of older fluctuations will tend to be masked by later events, and of the most relevant dating techniques, lichenometry has a restricted application in the south and tephrochronology is limited by the timing and extent of recent volcanic fallout. Where detailed work has been undertaken there is evidence of recent maxima in the 18th century A.D. So within the limitations of the environmental record it is possible that more 18th century glacial advances could be identified, reducing apparent differences with glacier records from the Alps and Northwestern Europe.

Sea ice off the coast of Iceland A.D. 1850-1950. Sources of information

Ingibjörg Jónsdóttir

The project describes the sea-ice conditions off the coasts of Iceland in the period from A.D. 1850-1950 and produces indices that indicate the severity and persistence of ice in Icelandic Waters. The sea-ice indices will then be compared to different environmental data, such as air temperature, atmospheric pressure and sea surface temperature. The impacts that the ice had on peoples lives in Iceland are also considered.

Sea ice is usually not formed around Iceland but is occasionally brought up towards the coasts by the East-Greenland Current. Great variations in the extent of ice are believed to be due to differences in the amount of ice and Arctic Water in the East-Greenland Current, atmospheric pressure fields in the North Atlantic Region, and the oceanographic conditions in the sea around Iceland.

This talk focuses mainly on the quality and quantity of different sources of information used to establish the sea-ice history.

Many researchers have worked on the Icelandic sea-ice history in the past. However, they do not always agree on the amount, distribution or persistence of ice around Iceland. In order to establish a long consistent sea-ice data record, it is thus necessary to work only with high quality sources, preferably primary data. When evaluating the sources quality, it is a rule of thumb that the closer a source is to an event in time and space, the more likely it is to be correct. However, many other things, discussed in more detail in the talk, have to be considered as well.
Even though ice reconnaissance flights became possible in the latter part of the period, they were not common. Therefore, most of the information stem from observations onboard ships or from coastal stations. The main primary sources used in this project are ship's logbooks and farmers diaries. It is very important to be able to compare these two different sides of the sea-ice occurrences, from land versus from the sea. Other sources used to establish the sea-ice history are reports, mainly from the Danish Meteorological Institute, various books, newspapers and letters.
Many of the sources used for this sea ice project could be used for different environmental tasks. Most of the diaries describe weather in general, vegetation and harvest, fisheries, day to day live, as well as single events such as earthquakes or snow avalanches.

Further evidence on the geographical spreading and ecological impact of the 'great dry fog' due to the Skaftáreldar, A.D. 1783 or *Bons Baisers d'Islande*

Gaston R. Demarée and Astrid E.J. Ogilvie

In this presentation we discuss:
a) The geographical spreading of the "Great Dry Fog" due to the Skaftáreldar in 1783.
b) The ecological and climatic impact of that event.
In particular, regions for which little or no evidence for the presence of the great dry fog was known, are presented. This includes the Iberian peninsula, Asia Minor, Northern Africa and the Labrador coast. The material is based upon a screening of western European newspapers, scientific journals, contemporary weather journals etc. The "Great Dry Fog" of the year 1783 is placed within the context of the meteorological knowledge of that time.

The Termination of the 'Little Ice Age' in Northern Iceland

Maria Wastl, Hans Stötter and Chris Caseldine

Paleoecological evidence for the 'Little Ice Age' in the Isle of Lewis, Scotland

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