Everybody's comments, Week 2, Jan22nd

From Roo Nicholson
Lit Eval for 1.23.2007. Glaciers

Holocene glacier variability: three case studies using an intermediate-complexity climate model
Weber, S.L and J. Oerlemans
The Holocene 13, 3 (2003)

This paper couples a glacier model with the intermediate climate model ECBilt to model the mass balance of three glaciers over the past 10,000 years. The three glaciers are located in Scandanavia, The European Alps and Northern Pakistan, in climates varying from maritime to continental. The model is forced with insolation changes only.

I don't know much about these models…

The intermediate complexity model was used to allow for longer integrations. The authors point out a few weaknesses in the model's ability to simulate modern climate. One of these was a warm and wet bias in mid to high latitudes. Tropical variability is reportedly underestimated (does that mean there isn't enough ENSO like stuff?) Jet and storm track are said to be well represented.

The glacier model used is a flow-line representation that takes into account the width and slopes of the valley surrounding the flowline. The modeled glaciers have parameterized flow speeds and geometry can vary (e.g. the glacier can widen when reaching an open valley). The mass balance for the glacier is largely determined by using a 'Seasonal Sensitivity Characteristic' (SSC) This means that for each month, a glacier is assigned a sensitivity to changes in both temperature and precipitation. The parameters are determined by local meteorological conditions such as length of the melt season. Choices for these parameters seem like they'd be very important to the result. Doesn't say much about how they were assigned

Authors' conclusions

Nigardsbreen – Norway
Summers were warmer 10 kyr ago because of higher insolation. As insolation decreased, length of the glacier increased, reaching a maximum at the present day. Precip not important here.

Rhonegletcher – alps
Length increases until a max is reached 4-5 kyr ago, after which length decreases until present day. The decrease is primarily due to decreased precipitation in more recent

times in the model. Authors discount this precip change as unreasonable (no explaination why)

Abramov – Pakistan
This glacier reached a maximum at 6 kyr and then decreased in length through the present day. Abromov punctuated by balance between warmer temperatures and more precipitation from 10 kyr to 7 kyr. Precip effect dominates and creates maximum length, following decreasing precip results in decreasing length from 6 kyr to present.

My interperetation:
Only one of three glaciers shows the straightforward interpretation (more sun in summer = little glaciers), even in this ideal model (e.g. only insolation forcing). Precipitation plays an important role for the other two, yet is poorly characterized (pretty much no significant changes in annual water budget).
A bit of confusion with the insolation-monsoon connection. There is a big lag between max insolation and max precipitation (from the model). An insolation strengthen monsoon should correlate temp and precip well. Perhaps it's an issue of exactly which month of insolation is important. If only July-August insolation is important to the monsoon cycle, then maybe the signals would line up much better.

Finally, it seems like you ought to be very careful when taking paleo-glacial extent records and interpreting them as temperature changes. E.g. in central Asia, you would think warmer temperatures 10-6 kyr would result in smaller glaciers, but increased precip may have actually meant bigger glaciers.

Some of the figs:

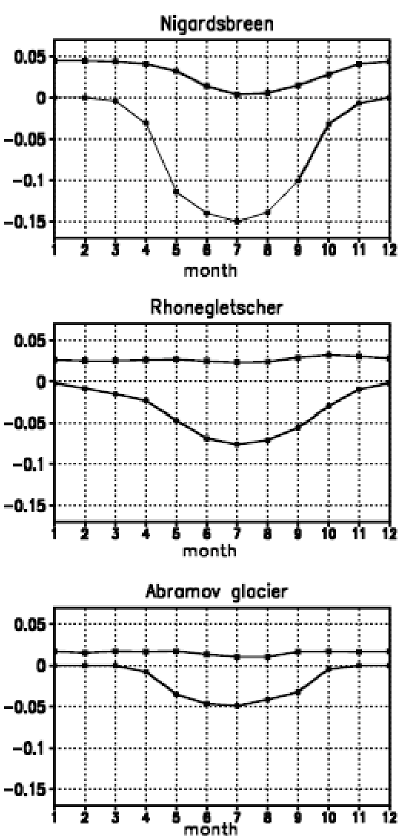
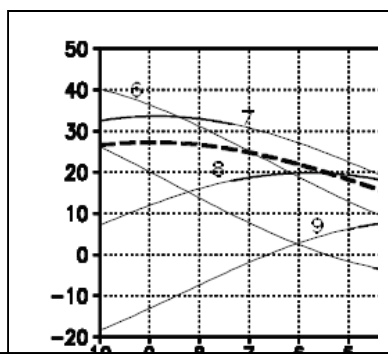


Figure 2 The seasonal sensitivity characteristic (SSC; see text) for Nigardsbreen, Rhonegletscher and Abramov glacier: temperature coefficients (in mwe/°C) of the SSC denoted by circles and precipitation



40-60 N Insolation by month

SSC's

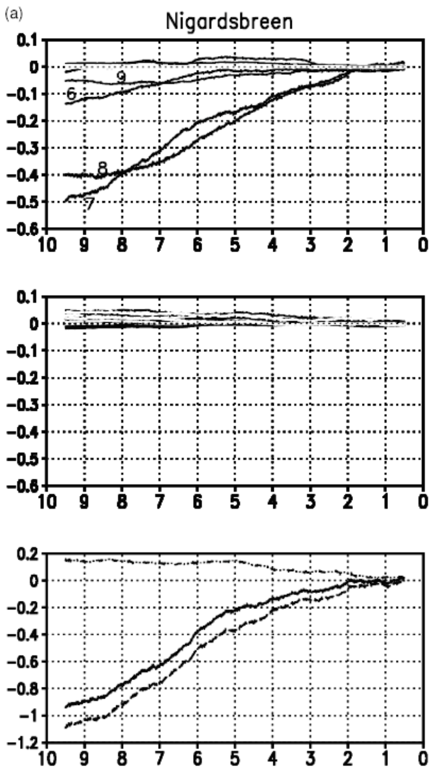


Figure 6 The impact as simulated by ECBilt of long-term monthly temperature anomalies (upper panel) and precipitation anomalies (middle panel) on the annual-mean mass-balance of (a) Nigardsbreen, (b) Rhonegletscher and (c) Abramov glacier as a function of time (in kyr before present). The impact is defined in the text. The lower panel gives the total temperature contribution ΔB^T (dashed) and precipitation contribution ΔB^P (dot-dashed) to the long-term annual mass-balance ΔB (solid line) (all units: mwe).

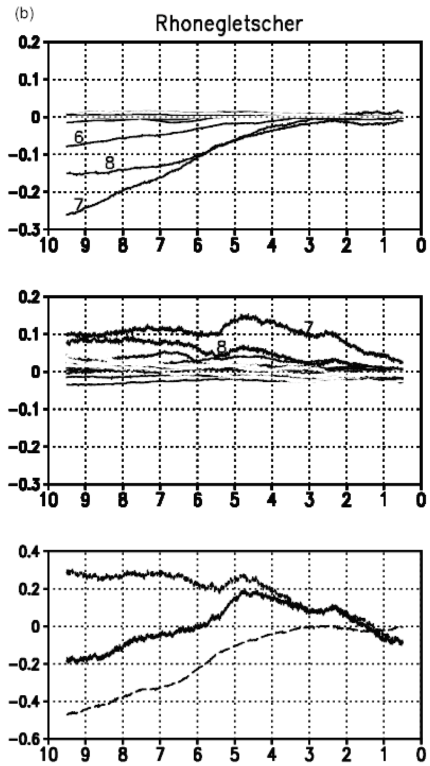


Figure 6 Continued.

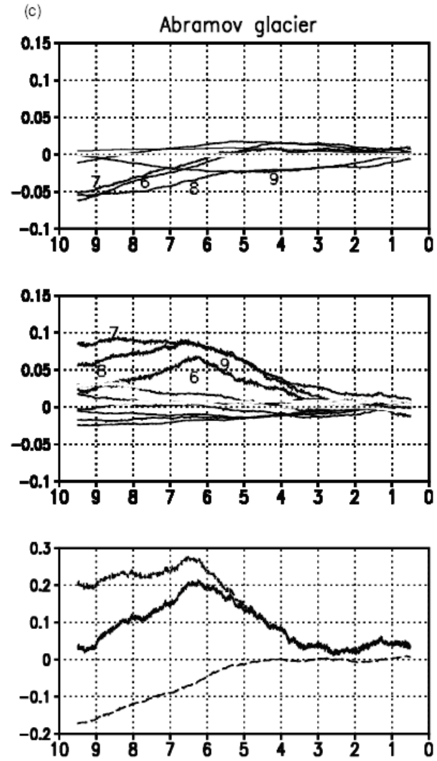
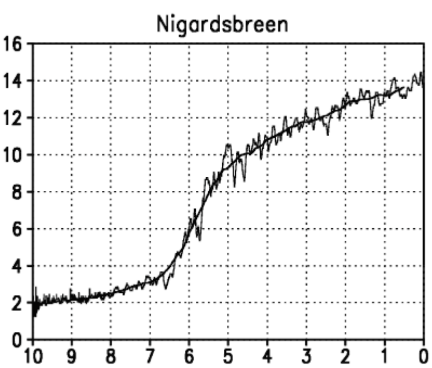
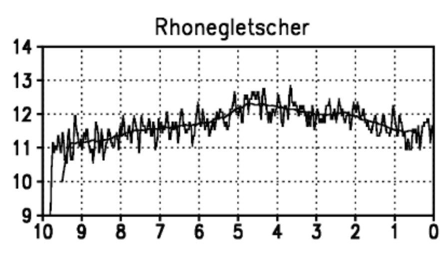


Figure 6 Continued.

($\beta = 2.2$ km/mwe) and for Abramov glacier this is $\rho = 0.93$ with $q = 100$ ($\beta = 3.7$ km/mwe). For Nigardsbreen, $\rho = 0.89$ with $q = 80$ ($\beta = 7.6$ km/mwe), using the segment 7–0 kyr BP only. The memory of this glacier is found to be smaller in the first millennia of the Holocene. Therefore, use of the entire record

Temperature and Precip contributions to mass balance





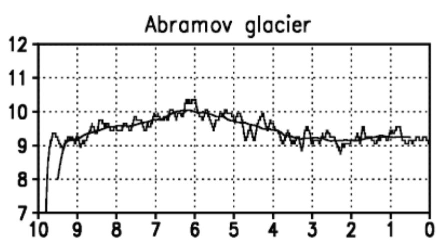


Figure 7 The glacier length (in km) as simulated by ECBilt for the three glaciers Nigardsbreen, Rhonegletscher and Abramov glacier as a function of time (in kyr before present). The long-term trends, as given by the 999-year running mean, are also shown.

Glacier length records

From David Smoliak

The Holocene Express - Winter 2007
Week 2 : The Cryosphere
Brian Smoliak

Masson et. al. (2000). Holocene Climate Variability in Antarctica Based on 11 Ice-Core Isotopic Records. Quaternary Research **54**, 348-358.

Commentary:

Masson et. al. utilizes 11 Antarctic Ice-Core records to diagnose changes in temperature and ice-sheet elevation throughout the Holocene. The Ice-Cores represent Antarctica's geography well, sampling locations along the coastline as well as in the continent's interior. The paper's stated results cite the confirmation of the following points:

- A widespread Antarctic optimum between 11.5 and 9 kyr.
- A specific regional optimum in the Ross Sea sector between 7 and 5 kyr.
- 9 aperiodic millennial-scale oscillations.
- A positive trend in ice elevation throughout the Holocene (50m).
- High frequency variability in the multidecadal mode.

Elevation trends are captured by the first component of a singular spectrum analysis (SSA). Millennial-scale variability is reconstructed from the second and third components of the SSA.

The paper uses the so-called 'Isotopic Paleothermometer' proxy method to detect changes in the annual mean surface temperature via fluctuations in the isotopic composition of precipitation falling at the core site. The records are exceedingly representative of eastern Antarctica, and do a sufficient job of depicting the continent as a whole. They are robust in terms of their temporal and spatial breadth, and use methods and assumptions that are in line with well-evidenced earlier studies. The basis for climate interpretation can be summarized as follows: Stemming from the modern surface isotopic relationship of 6.5‰ dD/°C (calculated using the various records), a deuterium shift of 10‰ is supposed to reflect a change of 1.5°C in surface temperature. The authors justify their usage of the current spatial isotopic-temperature relationship with the admission of two assumptions: (1) The annual mean condensation temperature covaries with the annual mean surface temperature. This requires no change in precipitation seasonality and no change in the surface temperature inversion. (2) Evaporation over ocean source regions remains unchanged. This requires a constant SST and constant $^{18}O_{SW}$ levels.

The authors believe that these assumptions hold, given some corrections to account for the increase in ocean surface isotopic composition in the early Holocene. Numerous papers are cited in support of the assumptions, and perhaps Eric can provide insights, as two of his papers are among those referenced (not to mention his co-authorship). The authors tend to avoid extended discussion of caveats, simply mentioning the difficulty in quantifying climate changes associated with deposition and/or post deposition processes. Most striking to me is the statement that the classic uncertainty level is modeling studies of this nature is 30%. This seems large, but also reveals my ignorance with respect to paleoclimate modeling. I'm currently going through a bout of scientific angst pertaining to uncertainty and our ability to make sound assertions. Perhaps this seminar will help alleviate some of it.

The records all indicate significant stability of the Antarctic climate (10‰ isotopic variations) as compared with the amplitude of glacial-interglacial changes (40‰). In addition to the influence of temperature, changes in ice-sheet elevation had a notable effect on isotopic levels (9.7‰/100m). Long-term trend deviations from modern values were extracted from each core isotopic profile. Error in the elevation data was roughly 10% for each record. Early Holocene optimums are illustrated in all of the records, and are said to have occurred at the same time as the NH summer insolation optimum (11 kyr ago). This is explained in terms of a reduced northern Atlantic thermohaline circulation. When the glacial period ended, the North Atlantic circulation resumes, progressively removing heat from high latitudes. Temperature and elevation trends--negative and positive, respectively--deduced from the ice-core data support this general interpretation.

Little discussion of millennial-scale and high-frequency variability is provided here, but more extensive attention is paid to the topics within the paper. The fundamental conclusions with respect to these notions are: (1) All records show several stages of significant periodicity in the multidecadal to centennial model. These changes cannot be attributed to low frequency variability in insolation or greenhouse gases. Instead short term forcing of internal oscillations by solar or volcanic activity is suggested as motivating the aforementioned periodicity; (2) The mid-Holocene optimum is related to a repetition of warm events between 8 and 5 kyr ago; (3) Relative to the 5 kyr cooling trend observed over Antarctica, a series of significant warm-cold fluctuations are observed within the last 2 kyr. These changes are hypothesized to have been associated with environmental changes over Antarctica.

Two notable suggestions for future work are given at the conclusion of the paper. First, the task of identifying common volcanic events throughout the records is vital for boosting the accuracy of Holocene isotopic records. And secondly, obtaining isotopic records from the Antarctic Peninsula would be of great interest for comparison with other high-resolution data records.

To conclude my comments, I would say that it is difficult for me to say whether or not these records support or deny what we would expect from insolation forcing. I presume that they support most of the data, insofar as the authors mention solar variability influencing the periodicity of oscillations. However, without a clear understanding of what exactly our "insolation expectations" are, I have to withhold comment. Further discussion will aid in the answering of this question.

From Angie Pendergrass:

Fleming, K., and K. Lambeck, 2004."Constraints on the Greenland Ice Sheet since the Last Glacial Maximum from sea-level observations and glacial-rebound models." *Quaternary Science Reviews*, Volume 23, p 1053-1077.

This paper uses various models of the Greenland Ice Sheet to reproduce sea level.

It seems that sea level rise is a good proxy of ice sheet volume, as long as the effect of all of the other ice sheets is known, as well as the thermal expansion of the oceans, and apparently the isostatic effects. But local marine limits are estimated to get an idea of sea level, and determining the change due in sea level due to the Greenland Ice Sheet still requires many steps, probably losing any reliable information along the way.

The age model was based on radiocarbon age of fossils at local marine limit is used to determine when the sea level was at various locations. However, most of these marine limits don't have suitable fossil data, so lower, younger data is used and interpolated (introducing error).

This paper develops a model that uses ice sheet extent observations and glacial-isostatic adjustment models to reproduce sea-level history of Greenland from local marine limits. This places constraints on the amount of ice on the Greenland Ice Sheet over the period. Some limitations are that it relies on correct ice margin definitions and modifies only ice thickness. Also, the temporal and spatial sampling distribution is poor. Another issue is that sea levels lower than today's sometimes cannot be reproduced because their evidence is currently underwater. Other times they can be reproduced, which is apparently due to the uplift of the continent when the weight of ice sheets is lifted.

The authors claim that their model shows ice thickness changed by around 500 m near the coast to a maximum of over 1500 m since the last glacial maximum. Also, they investigate the readvance of the Greenland Ice Sheet expansion that is not captured by their model due to its limitation of monotony. The ice sheet's trend has been towards a decrease in the volume of the Greenland Ice Sheet in general during the Holocene.

It is unclear how the model relates to our expectations of the insolation forcing response, mostly because the model cannot account for the readvance of the ice sheet due to the enhanced atmospheric circulation since it is monotonic. However, the authors did attempt to account for this.

From Clark Kirkman:
Clark Kirkman IV
PCC 586
Paper write-up 1
1/22/07

Curran et al., 2006, Ice Core Evidence for Antarctic Sea Ice Decline Since the 1950s, Science, vol. 302, pp. 1203-1206.

This paper discusses the use of methanesulphonic acid (MSA) as a proxy for the annual maximum sea ice extent in the Antarctic. The source of the data is the Law Dome ice core near the Indian Ocean coast at around 110 degrees east. Maritime processes (such as sea ice) influence this location and for various reasons (I'm going to believe them) the ice core record was well preserved. The length of the core is about 80,000 years, though this paper only deals with the section that has been analyzed for MSA, the last 160 years or so. The rest of the core could potentially provide information about the maximum sea ice extent throughout the Holocene and beyond once analyzed.

MSA is solely produced by biological activity in the oceans. In the Southern Ocean in particular, most MSA is produced by sea ice algae, which I assume grows on sea ice. The authors note that the greatest MSA production occurs when sea ice melts, and that more total area melting is equal to a larger MSA production (and hence transport to the Law Dome). This allows a relationship between MSA and maximum sea ice extent, since most sea ice in the Antarctic is seasonal. This explanation seems reasonable, though one must be careful, as the same relationship may not hold in other locations in the Arctic or the Antarctic. The authors note that others have found the opposite relationship between MSA and maximum sea ice extent at other locations in both hemispheres.

The ice core has a seasonally resolved MSA record though the authors use the yearly average MSA content for their analysis. Using microwave satellite data from 1974-1995, the authors correlate the maximum sea ice extent for all of the Antarctic with MSA from the Law Dome ice core and find that 23% of the variance in annual maximum sea ice extent is explained by the MSA in the ice core. Dividing the Antarctic into 10 degree longitude bins, the authors find that these two variables are significantly correlated for +/- 30 degrees longitude around the dome (~ 1/3 of variance explained). The value of this correlation would be much improved if the authors sub-sampled their data and found the same significant correlations, as they did not a priori specify where they expected the maximum sea ice extent to relate well to MSA in the ice core. Their timeseries of MSA is short, however, so this would probably be difficult.

The authors analyzed the Law Dome MSA and found a decreasing trend (and an implied maximum sea ice extent reduction) for the last 50 years or so with large decadal variability (no trend from 1840-1950). They believe that variations in the Antarctic Circumpolar may be partly responsible for this variability (limiting sea ice extent), but that solar forcing could also be a factor.

My take on this proxy is that the actual relationship between MSA and sea ice extent needs to be more closely examined, if not in general, then for each potential ice core examined. The conflicting relationships between the two variables found by different studies unsettles me. For this ice core, I believe the decrease in maximum sea ice extent for the last 50 years given the calibration with satellite data over the last 30 years. To get a real picture of the maximum sea ice extent throughout the holocene using MSA as a proxy, more cores are needed given the locality of correlations between the two variables, as well as a solid understanding of the relationship for each ice core. Moreover, given that at most 1/3 of the variance in the ice extent can be explained by MSA in this ice core, multiple proxies may be needed to get a clear picture of the maximum sea ice extent.

From Katie Fagan

Moller, H. S. et al. 2006. Late-Holocene environment and climatic changes in Ameralik Fjord, southwest Greenland: evidence from the sedimentary record. The Holocene 16 (5), 685 – 695

This paper examined a 348 cm long gravity core from a fjord in southwest Greenland which dated back to 4.4 ka BP. The core was analyzed for grain size (fine grains from glacial sources, large grains rafted on sea ice), magnetic susceptibility (gives information on provenance of sediment), the intensity of Fe (influence of terrestrial material) and Ca (marine production and biogenic calcium input), total carbon content (marine production vs terrestrial input), benthic foraminifera (West Greenland Current (WGC) bottom water conditions), and diatoms (presence of sea ice). The core was dated using the ^{14}C of benthic forams and an age model which used the median ^{14}C values and linear interpolation. The data appear to have been carefully collected, of good quality, and appropriately related to climate. I am unfamiliar with ^{14}C dating and producing age models and am not sure if linear interpolation is the best way to produce an age model. There are four measured ages over 4400 years, maybe this is closely spaced enough for linear interpolation but it seems to me that a few more data points might have been ideal. The proxies are all straightforwardly connected to climate and seem to be reliable.

The authors interpret the data to say that from 4.4 – 3.2 ka BP the climate was relatively stable, warm, and possibly windy with strong meltwater discharge from inland glaciers, high marine biological activity, and limited sea-ice cover. The period from 3.2 ka BP to the present however is characterized by a general atmospheric cooling and perhaps a reduction of wind with decreased terrestrial sediment deposition, increased presence of sea ice, and a lessened influence of WGC bottom water which resulted in low benthic marine production.

I agree with the general trend presented by the authors of a warmer climate from 4.4 – 3.2 ka BP and a general cooling from 3.2 ka BP to the present. The proxies for temperature conditions seem to agree well with each other and seem straightforward. It also appears (and noted by the authors) that the climate conditions were more stable in the earlier period and much more variable in the later period. The WGC bottom water appeared to have a constant influence in the earlier period and much more variable influence during the later period as shown by the benthic foram data. Terrestrial sediment input while lower during the later period, also appears to have been much more variable. A reason for why the more recent cooler climate would be more variable was not suggested by the authors and I'm afraid I do not have a reason to offer either.

The authors show a plot of Northern Hemisphere (60º) June insolation over the time period of the study. This plot shows a gradual decrease in insolation over the study period which does fit the general story presented of a warmed climate followed by a more recent cooler climate.

From Andy Chiodi:

Literature Write-up for week 2 ESS 586A Winter 2007

Paper: Holocene Sea-Ice Variations and Paleoenvironmental Change, Nothernmost Ellesmere Island, N.W.T., Canada, Arctic and Alpine Research, V15, No. 1, 1983

The authors of this paper collected drift wood samples embedded in the land along Clements Markham Inlet on the northern coast of Ellesmere Island. This inlet is open to the Arctic Ocean in summer and is exposed to drift wood that is flushed into the Arctic by one of the several rivers which run into it. By carbon dating the sediment layers between the present sea level and the marine limit (about 80m at this site), the authors generate an emergence curve. That is, a plot of present height to age of seabed. Driftwood is then collected on site and dated according to the emergence curve. The relative abundance of driftwood at each age/height level is then interpreted as a proxy for the local sea-ice conditions. The main result of this paper, is that drift wood was judged to be plentiful around 6500 ya and then became scarce from about 4200 ya to sometime within the last 1000 years. This is interpreted as evidence of the presence of substantially more land-fast sea ice in the period between 4200 ya and sometime within the last 100 years.

Although it seems straight forward enough to record the height of driftwood that may be seen along an embankment, the quality of this record as a proxy for sea-ice conditions seems somewhat uncertain. To be accurate, this method requires that not much happens to drift wood over the Holocene once it is embedded in the shore. Uncertainty over this, and the relatively low number of pieces collected (on the order of 100 total) makes it difficult to put a lot of faith in the results of any single site.

The age model for the emergence curve seems reasonable (carbon dating of the marine sediment layers) but looses resolution in the last 1000 years. Placing each drift wood sample on the emergence curve requires some subjectivity. For example, much of the drift wood that was dated did not fall on the emergence curve. In these cases, it was assumed that these pieces fell from a higher level. This makes the interpretation difficult.

In this case the authors interpret a lack of drift wood as an indication of land-fast sea-ice which, presumably, blocked the inlet in all seasons. To their credit, the authors point out that a scarcity of drift wood has also been judged to indicate relatively ice-free conditions in the arctic (the idea in this case is that the drift wood sinks in the open ocean before it embeds in the shore). Not knowing the history of the drift wood collected makes it difficult to assess the accuracy of the authors' interpretation. All things considered It does seem that a case can be made that sea-ice blocked the inlet sometime within the last 1000 years to 4200 ya. Given the coarseness of the data, it is difficult to compare this record to expectations based on solar forcing, although the lack of summer ice around 6500 ya seems consistent with increased summertime solar radiation then.

Andy Chiodi

From Gerard Roe

Glacier Holocene paper:-

Holocene Glacier fluctuations in South America and Antarctica
Clapperton and Sugden, 1988, QSR, 7, 185-198

South America (Chile, Argentina, Peru, Equador, Bolivia)

Their description:-

Most glaciers retreated at 8000BP (coincident with global warmth!). Neoglacial advances 5000-4000BP, 3000-2000BP, 1300-1000BP, 15^{th} to 19^{th} centuries. Smaller advances possible 8400BP, 7500BP, and 6300BP. They argue for four neoglacial advances throughout the continent. Their claim is that by-and-large these match periods of northern hemisphere advances, so global climate response.

The data:-

mostly radiocarbon dating of things stuck in moraines. Large piedmont lobe glaciers, which are very sensitive to climate. Tidewater glaciers in Patagonia, which march to their own tune.

Quality of record: (1/5)

Not clear glaciers can be interpreted so cleanly. Glaciers combines reponse to precip and temperature, their geometry affects the sensitivity to climate. Need to have a quantification in order to know what it means.

Evidence of mean change from glacial climate (3/5)

Glaciers appear to be less extensive now (shocked!), although actually not talked about in too much depth.

Evidence of trend: (0/5)

Not given/addressed, save for Antarctica

Evidence of variability: (2/5)

each individual advance is treated as a climate change, neglecting the internal dynamics of large glaciers.

My interpretation:

Cannot rule out internal glacier variability on these time timescales. These are large glaciers that will have long dynamic time scales. I don't believe the global connections. Without quantification, hard to know what any of it means.

Does this challenge understanding of climate? (0/5)
Not on its own. Would need to combine with model predictions of temperature/precip response in order to know whether the magnitude of changes are unexpected (both trend and variability).

Antarctica story:

East Antarctica: Not much. Some local glaciers in McMurdo sound (East Antarctica) are more extensive now than 18kbp, reached maximum extent sometime in the Holocene.

West Antarctica: Ice shelf collapse around 6500BP. (from barnacles! – not interpreted)
Sub Antarctic/South Georgia: withdrawn close to present limits by 9700BP, advances since, but different in different islands (carbon dating from whale, seals, whalers)

From Matt Kuharic and Sandy Tudhope

Corals and Holocene Sea-Level Rise

1. Quality of record:
Corals can be used effectively to create a high quality record of sea level change through the Holocene. Specifically, submerged coral can be drilled, dated, and the paleo sea-level can be inferred from the depth of the sample. The main correction needed is to account for any tectonic uplift or subsidence. Bard et al. (1996) present coral data from Tahiti that, combined with previous work done in Barbados (Fairbank et al., 1989, Bard et al., 1990) and New Guinea (Chappell and Polach., 1991, Edwards et al., 1993) clearly illustrate the story of sea-level rise through the Holocene. Dating of this record is extremely well constrained; $^{230}Th/^{234}U$ and ^{14}C ages are well correlated on all these records and can be quite precise. For example, Bard et al. (1996) report that the 2£m precision of the $^{230}Th/^{234}U$ ages is 30-60 years between 8,000 and 14,000 cal. Yr BP

2 and 3. Interpretations:
Prior to the Holocene, around 14 kyr there is evidence of a melt water pulse that lead to rapid sea level rise (on the order of 20 meters in hundreds of years). Beginning in the early Holocene (~12 kyr ago), at about -65 meters below current sea level, the coral records indicate an ~ 15mm/yr sea-level rise. Despite the seeming smoothness of the sea level rise data, some changes in sea level rates are quite possible within the resolution of the data. From ~ 7 kyr to present there has been a much more gradual and modest sea-level rise. (only a few meters increase over the last 7,000 years). Interestingly, while the authors indicate the possible existence of an additional melt water pulse around 11.5 and 11 kyr, this is not especially well supported by the data and uncertainties in the record (or it may be a relatively small pulse compared to the 14 kyr event.
4. Expectations:
This data indicates a gradual, consistent change of sea level through the Holocene in the two distinct time frames outlined above. This may indicate a more stable climate than might be expected due to the insolation forcing during the same period.
References:
Bard et al., *Nature* 382, 241-244, 1996.
Bard, E., Hamelin, B. and Fairbanks, R.G. *Nature* 349, 147-149, 1990.
Chappel, J. and Polach, H. *Nature* 349, 147-149, 1991.
Edwards, R.L. et al. *Science* 260, 962-968, 1993.
Fairbanks, R.G. *Nature* 342, 637-647, 1989.

Holocene Express PCC 586A Winter 2007
Summary Paul Hezel

Kilimanjaro Ice Core Records: Evidence of Holocene Climate Change in Tropical Africa
Lonnie G. Thompson, Ellen Mosley-Thompson, Mary E. Davis, Keith A. Henderson, Henry H. Brecher, Victor S. Zagorodnov, Tracy A. Mashiotta, Ping-Nan Lin, Vladimir N. Mikhalenko, Douglas R. Hardy, and Jürg Beer (18 October 2002)
Science **298** (5593), 589. [DOI: 10.1126/science.1073198]
http://www.sciencemag.org/cgi/content/abstract/298/5593/589

Description:
Proxy is essentially 3 ~50 m and 2 ~20 m cores from ice fields of Kilimanjaro. Record back to about 11 kya, and were dated according to a linear interpolation of time horizons (including dust, Eniwetok Atoll radiation fallout, radiocarbon dates) in

the ice layers. Some dates were also matched by solar minima. No direct correlation of dO18 values to climatic variables is given.

Authors interpretation:
Authors claim good correlation with other documentation of regional climate changes over the Holocene, including changes in lake levels, solar minima, as well as trends to changes in tropical temperature recorded in Huascaran dO18 and dust levels.

3 abrupt climate changes in the region at ~8.3, ~5.2, and ~4 kya documented and compared to other records.

My interpretation:
No clear trend in the dO18 record is obvious, though perhaps there is an overall decrease (more negative) in the dO18 levels especially after the 4kya dry period. There is no conclusion given as to magnitude of the changes of dO18, except by comparison to other documented events (lake levels, etc). Variabili8ty shows a range of about 8 per mil.

I do concur with the climate events as outlined, though there are some obvious pitfalls regarding the way the ages were interpolated within the cores.

Insolation forcing
Maunder, Sporer and Wolf minima were documented. For the Maunder, dO18 values seem to lag, Sporer is unclear, and Wolf also seems to lag as well. The variability is such that only the Maunder stands out – and so I am a bit skeptical that the other two really appear in the record.