Reducing Canada's vulnerability to climate change

Sea Ice & Ice Core Records, Developing A Transfer Function

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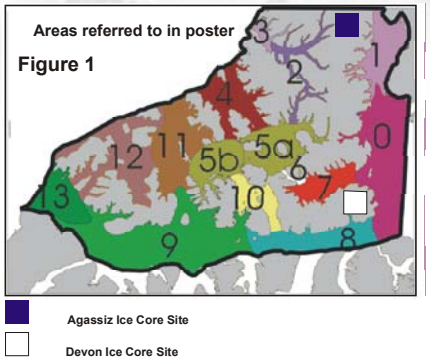


The purpose at this stage of the sub-project is to:

1: Use existing data at the Geological Survey of Canada and the Canadian Ice Service to update studies done earlier e.g. Koerner (1977), Jeffers et al, (2001), Atkinson et al (in review 2001).
2: Re-examine the relationships between sea ice distribution and ice core variables.
3: Use those relationships to develop better transfer functions for the application of existing, and future, ice cores records to sea ice paleo-history.

This work to be done with special reference to the NorthWest Passage.

Previous work

1: had shown a significant relationship between glacier mass balance (the volume a glacier loses or gains each year)and the amount of melting at the top of the ice cap (Koerner, 1977). This was then applied to the record of ice layering in an ice core (Figure 2).

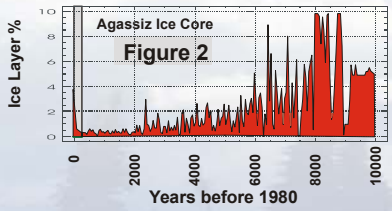
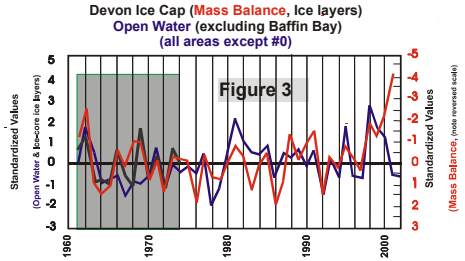


Figure 2 shows one such record from Agassiz Ice Cap and indicates that, because the present ice cap mass balance is slightly negative, the first half of the Holocene period (0-11,000 years ago), must have seen considerable ice cap melt and volume loss.

2: Next, it was found that both the ice-core ice layer and mass balance records showed a significant relationship with the maximum amount of open water in the Queen Elizabeth Islands (where the area and sub-regions are defined in figure 1).



The shaded area shows that part of the record for which we have used the Ice-core ice layer record.

Present work is showing that the relationship between the mass balance and sea ice has become weaker in the late 1990's (e.g. 2001). This shows the need to update the ice layer record from surface sampling and new ice cores from Devon Ice Cap. This task is presently underway. However, Figure 4 shows there is still a strong relationship between an ice cap's mass balance and the sea ice conditions away from Baffin Bay. This is largely because both mass balance and sea ice are strongly influenced by summer climate
rather than that of winter. It is also becoming clear from recent work that Baffin Bay and the North Water (regions #0, 7&8 Figure 1) do not behave in the same fashion to climatic change as the rest of the Queen Elizabeth Islands.

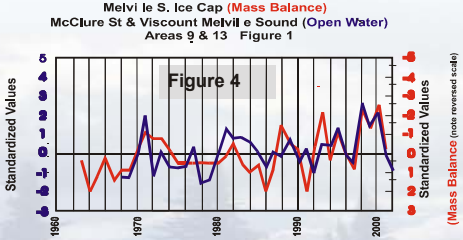
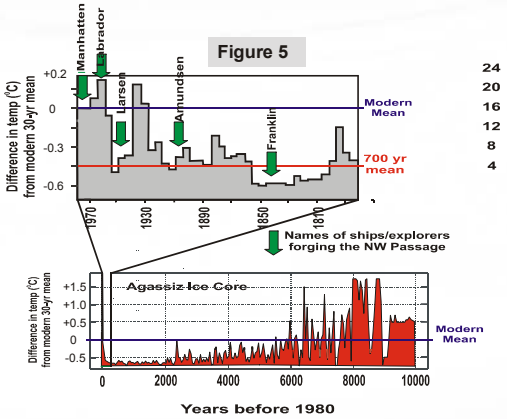
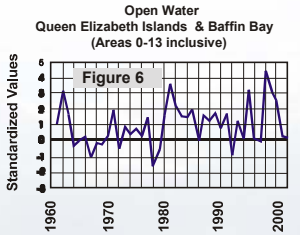


Figure 5 (below) shows the application of the Ice-core ice-layer record to past sea ice conditions. In this case (Koerner, 1977) the history of the exploration of the NW passage was shown to have been influenced by climate. Early exploration occurred during the coldest period of the last 10,000 years when summer temperatures were at least 0.50C colder than the mean for the last 30 years.





Update of work so far has shown, that while there is a strong trend for increased melting since the mid-1980's on Canadian ice caps there is in the sea ice record, a jump rather than a trend, to more open water beginning in the early 1980s (Figure 6)..

Progress and future work:

A previous update of the original Koerner (1977) sea ice/glacier balance record (Atkinson et al, 2001) has been further up-dated from 1998-2002. It leaves the way clear for the main task: that of updating the ice layer record in ice cores drilled in 1997,1998 and 1999. This task is presently in hand.

References: **1977, Koerner R.M.** :Devon Island ice cap: core stratigraphy and paleoclimate; Science, v.196, p.15-18.
2001: Jeffers, S., T.A. Agnew, B.T. Alt, R. De Abreu, and S. McCourt. Investigating the anomalous sea ice conditions in the Canadian High Arctic (Queen Elizabeth Islands) during the summer of 1998. Annals of Glaciology, 33, 507-512.
2004: Atkinson, D.E. .and 19 others, Canadian cryospheric response to an anomalous warm summer. *in review*