Antarctic land-fast sea ice thickness: the role of platelet ice.

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1. Summary

Question:
What contribution does oceanic heat flux make to the seasonal land-fast sea ice thickness around Antarctica?

Known:

- Platelet ice is associated with a heat flux from the ice to the ocean.
- Platelet ice forms near ice shelves.
- Up to 50 % of landfast sea ice thickness near an ice shelf is platelet ice.

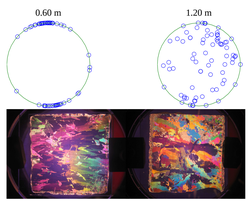
Attached platelet ice at the base of the sea ice cover.

Proposed work

- Use McMurdo Sound as a natural laboratory
- Measure interannual variability of platelet ice over a 5-year period.
- Make concurrent measurements of the upper ocean.

2. What is platelet ice?

- *Platelet ice*: ice crystals formed in supercooled water that rises from beneath ice shelves.
- *Loose platelet ice* can accumulate under the sea ice cover.
- *Incorporated platelet ice*: forms when the ice crystals become frozen into the sea ice.
- Incorporated platelet ice changes the sea ice structure.



aligned c-axes in columnar ice

random c-axes in incorporated platelet ice

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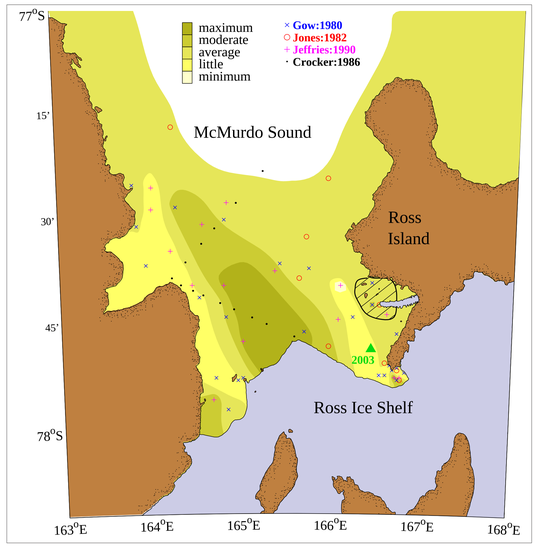
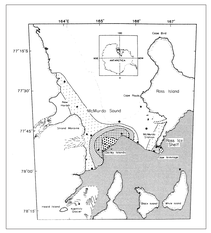
3. Platelet ice in McMurdo Sound



Map of relative abundance of platelet ice over McMurdo Sound, Antarctica based on historical data. Relative abundance was measured by dividing each data set into 5 bins of platelet layer thickness which were equal in magnitude for each year, but different between years. These were then graded from *minimum* to *maximum*. Average values are tabulated below.

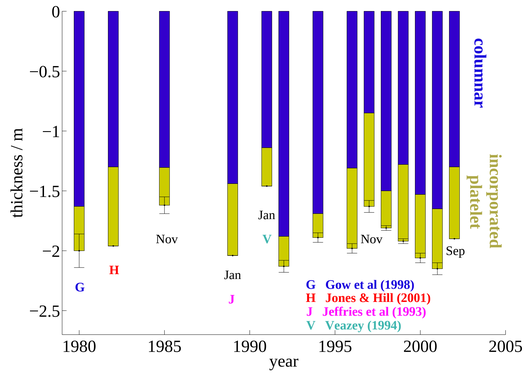
date	platelet thickness (m)	percentage of ice cover (%)	type	author
Oct-Nov 1980	0.26	13	incorp	*Gow et al.* (1998)
Oct-Nov 1982	0.80	42	incorp	*Jones and Hill* (2001)
Jan 1990	0.77	38	incorp	*Jeffries et al.* (1993)
Aug&Oct 1986	1.00	*NA*	loose	*Crocker* (1988)

Note the similarity to Barry's platelet abundance index for Nov 1984 (*Barry*, 1988), based on the amount of platelet ice in hyrdocast holes, on mooring lines and from diver observations.



Thus, in McMurdo Sound the absolute thickness of platelet ice appears to vary annually, but the spatial distribution is consistent from year to year.

4. Interannual variability in platelet ice



Time series of the structure of the first year sea ice in the hatched area marked on the map from 1980 to 2002. Data mainly from our field work and mainly taken in October (unless otherwise stated). There are no obvious trends over this time period. Unfortunately our data do not cover the period 2001 to 2005, when a large iceberg sat near the mouth of the Sound causing extensive multi-year ice.

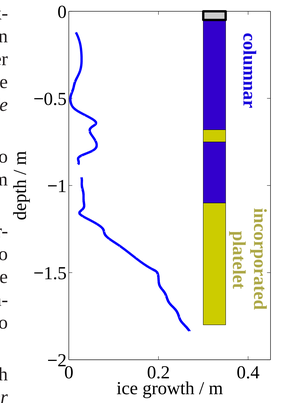
There are two major uncertainties in these data

- spatial and temporal variability may be intermingled;
- techniques used to assess platelet ice amount vary with time and researcher.

5. Contribution from the ocean

Contribution to total ice thickness by heat flux to the ocean was inferred during winter 2003 at the site marked on the map by green triangle (*Purdie et al.*, in press)

- 0.3 m ice growth was due to oceanic heat flux in the 1.8 m thick ice cover,
- approximately $\frac{1}{3}$ of the incorporated platelet ice is due to oceanic heat flux, with the remaining heat being conducted through the sea ice to the atmosphere,
- estimate of $\frac{1}{3}$ agrees with previous values (*Crocker and Wadhams*, 1989; *Trodahl et al.*, 2001; *Smith et al.*, 2001; *Smith*, 2001).



adapted from *Purdie et al.* (in press).

6. Implications and proposed future work

- 30 % of incorporated platelet ice layer is due to oceanic heat flux
- 40 % of total thickness is incorporated platelet ice
- therefore, close to an ice shelf, approximately 10 % of total ice thickness is due to heat flux to the ocean.

Although this will make a small contribution to sea ice thickness globally, its influence on the landfast ice thickness around Antarctica may be significant. Very few sea ice growth models account for platelet ice growth.

Our examination of historical data raises a number of questions which lead us to propose an experiment to measure the interannual variability of platelet ice:

1. There appears to be a factor of 3 change in the total amount of platelet ice in just 2 years. Is this a real effect or a measurement problem?
2. If real, why should there be more platelet ice in some years than others?
3. It is known that the presence of an iceberg had an important effect the extent and persistence of the sea ice cover in McMurdo Sound. What was its effect on the contribution of platelet ice?

7. Acknowledgements and References

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