Antarctic temperature change and its relevance to future ice core drilling efforts

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Where to take DISC next?

a) Towards the Bellinghausen from WDC

b) South Pole

c) Hercules Dome

d) Dome A or other ‘million-year ice’ site
All East Antarctic ice cores look like Vostok

Declining Holocene temperature

![Graph showing temperature changes over time with stages T I to T IV and temperature peaks at stage 5.5, stage 7.5, and stage 9.3.](image-url)
Antarctic temperature variations understood (it’s all insolation)

Declining Holocene temperature

Huybers and Denton, 
*Nature Geoscience*, 2008
West Antarctic isotope records

Increasing Holocene temperature (?)

--- Siple Dome

--- Byrd

$\delta$D (per mil)

Age (ka)
Temperature trend (°C decade)

Steig et al., *Nature*, 2009
Reconstruction of Antarctic temperature

- Infilled data
- Weather stations
- Satellites

Diagram showing the relationship between time and space with data collections from different sources.
Westward warming gradient in raw satellite data
Station-only reconstruction

- 6 PCs, satellite data detrended
- Trend (°C/decade)
- Station-only estimate shows Peninsula, north/eastward warming gradient

6 PCs, satellite data detrended
Recent West Antarctic warming reflects circulation changes ...

Trend in zonal wave-3 pattern: increased warm-air flow into West Antarctica

Contours:
Positive – negative 500 hPa heights

Index value

Raphael and Holland, 2006, Climate Dynamics
...and in sea ice (coupled to atmospheric circulation)

*Trends in ice season length*
West Antarctic temperature changes are occurring on long timescales.

Borehole T reconstruction from Rutherford Ice Stream

Barrett et al., 2009
West Antarctic temperature changes are occurring on long timescales.

Borehole validation of WAIS Divide T reconstruction
West Antarctic temperature changes are occurring on long timescales.

**Borehole validation of WAIS Divide T reconstruction**
West Antarctic / tropical connection

Tropical warming enhances poleward moisture transport to coastal WAIS

Smith et al., 2007


30N–30S; extended reconstructed sea surface temperature version 3

Schneider & Steig, NCAR
If we want to understand Antarctic climate, we need more ice core records from West Antarctica.
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West Antarctic is a ‘marine ice sheet’ in more ways than one

- The “marine signature” varies over time and depends strongly on the prevailing atmospheric circulation over the Southern Ocean

Monthly precipitation from AMPS in October 2006 (top) and October 2007 (bottom)
[Nicolas et al., in preparation]
The marine influence in West Antarctica extends only so far...

- We have no long term record from the ('marine-influenced') areas.

- WAIS Divide is close but may not be far north/east enough.

Mean annual precipitation in 2006-2007 from the AMPS forecast archive [Nicolas et al., in preparation]
East-West climatic contrast

- Anticorrelation between eastern and western West Antarctica visible in accumulation records from ITASE ice cores

Annual accumulation at ITASE 01-5 and 99-1 core sites

Summary

• Hemisphere-scale climate changes profoundly influence West Antarctica, and in a very different way from East Antarctica,

• Vostok is not a very good proxy for WAIS climate (and nor, perhaps, is WAIS Divide)

• The ‘marine-influenced’ sector of WAIS – towards the Peninsula – is the most strongly affected and will yield the most interesting new information
Where to take DISC next?

a) Northeastward from WAIS Divide (climate science!)

b) South Pole (atmospheric chemistry, logistical convenience)

c) Hercules Dome (possibly addresses a + b?)

d) Dome A or other ‘million-year ice’ site (old old ice!)
Thank you
Radar at Herc Dome

17.5 ka

Jacobel, Welch, Steig, Schneider, 2004
Ice core record of methyl chloride – a natural ozone-depleting Substance: evidence for climate-related variability at South Pole

Williams et al., GRL, 2007
Age-depth relationship at South Pole inferred from optical dust logging

Ryan Bay, personal communication
Price et al., GRL, 2000