

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

Eric J. Steig

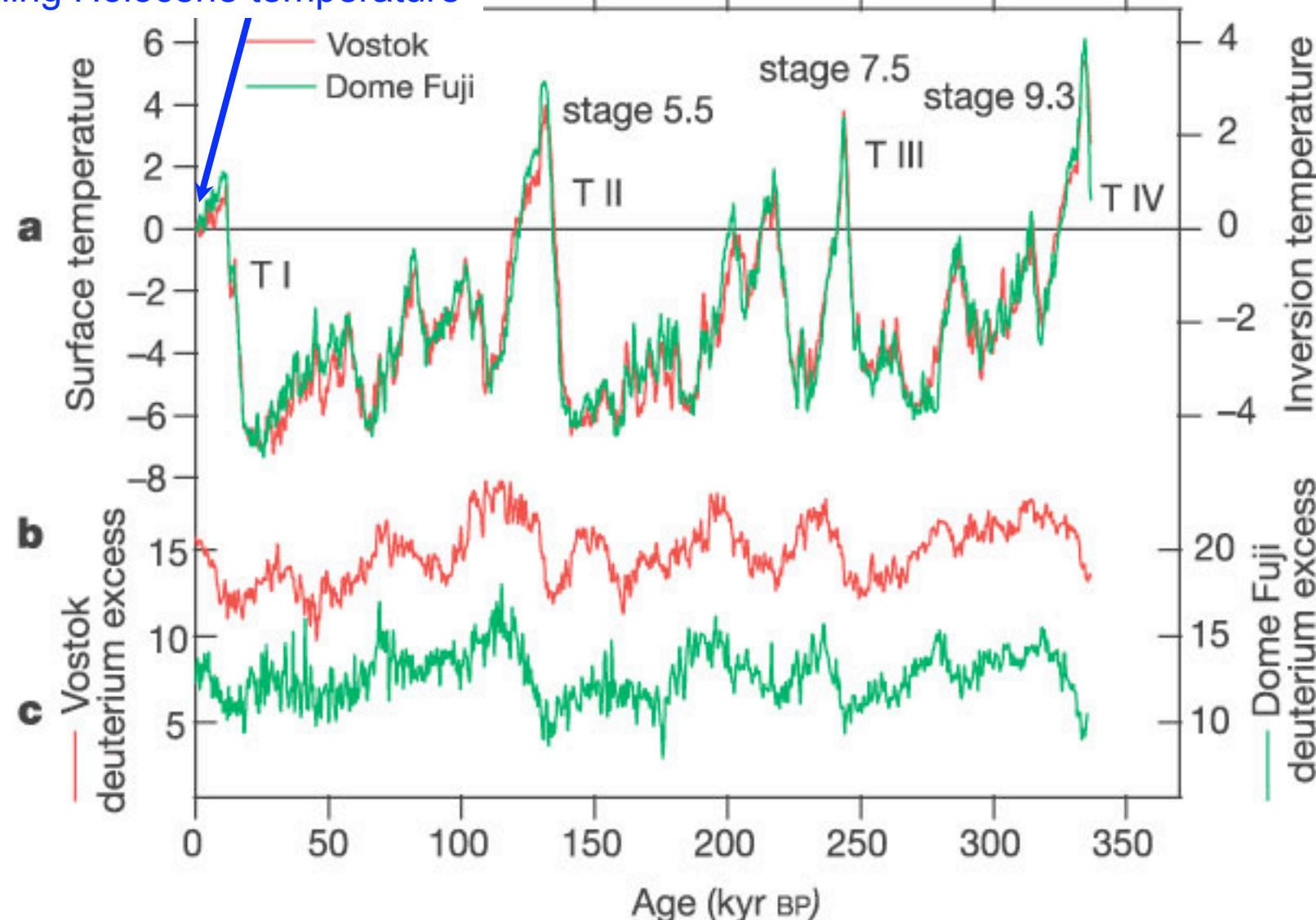
Quaternary Research Center and Department of Earth
and Space Sciences, University of Washington

Where to take DISC next?

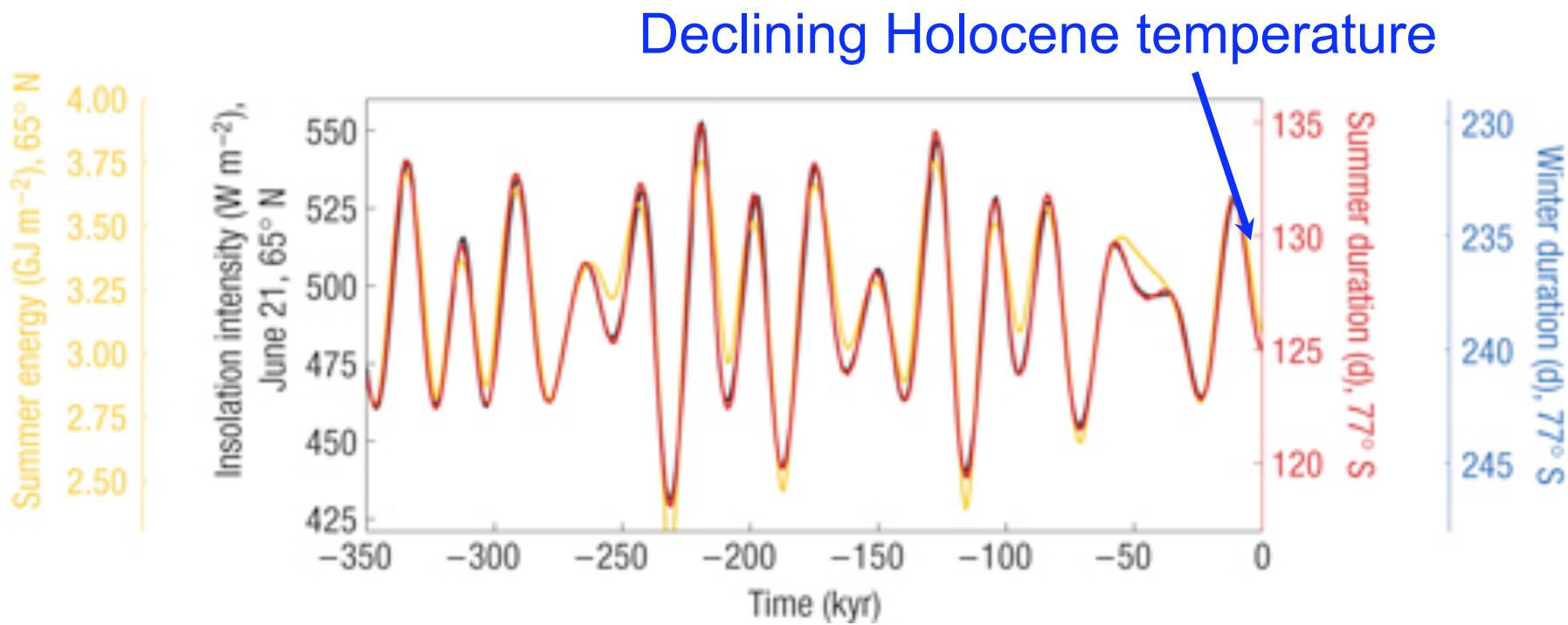
- a) Towards the Bellinghausen from WDC
- b) South Pole
- c) Hercules Dome
- d) Dome A or other ‘million-year ice’ site

All East Antarctic ice cores look like Vostok

Declining Holocene temperature

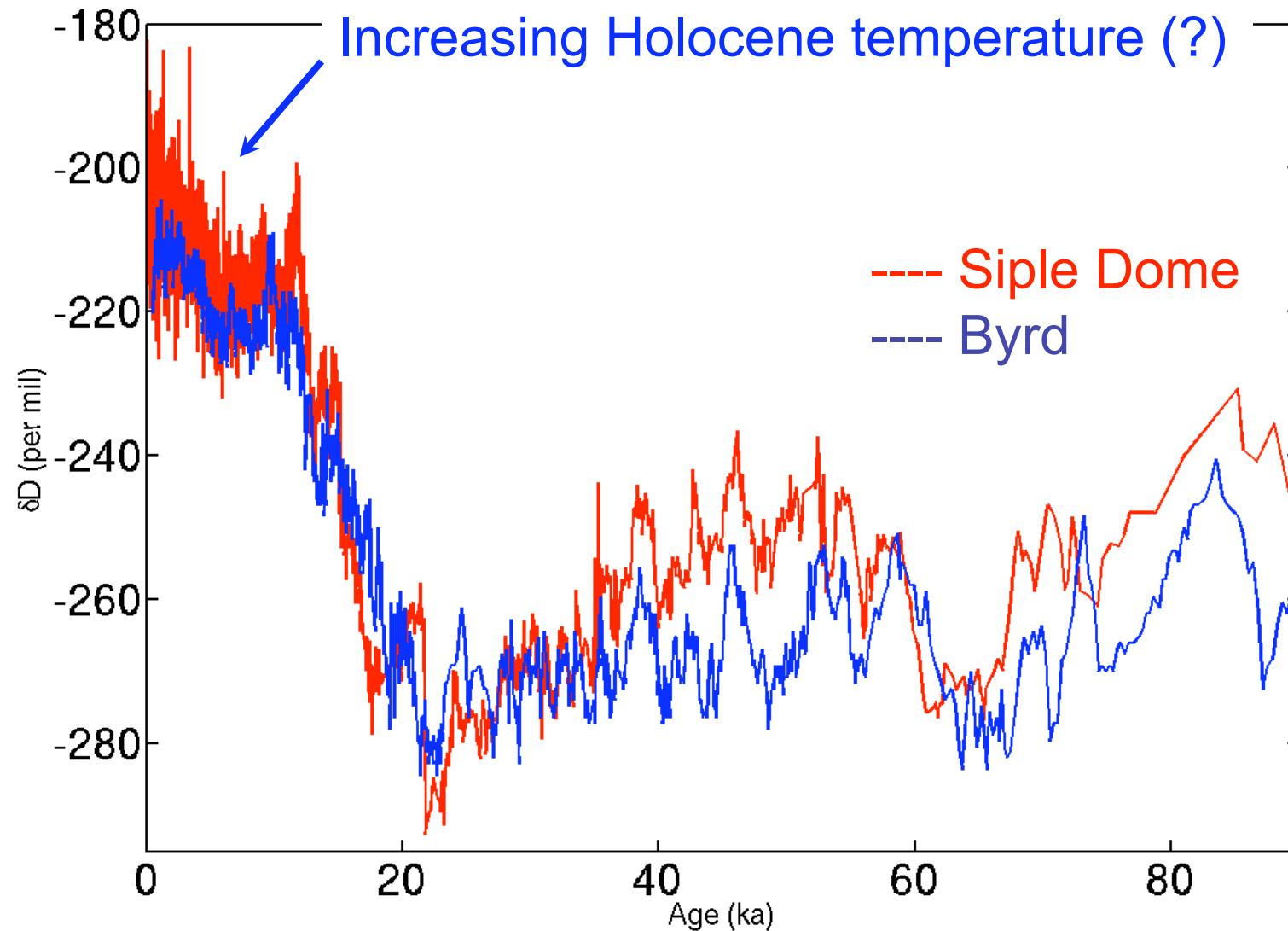


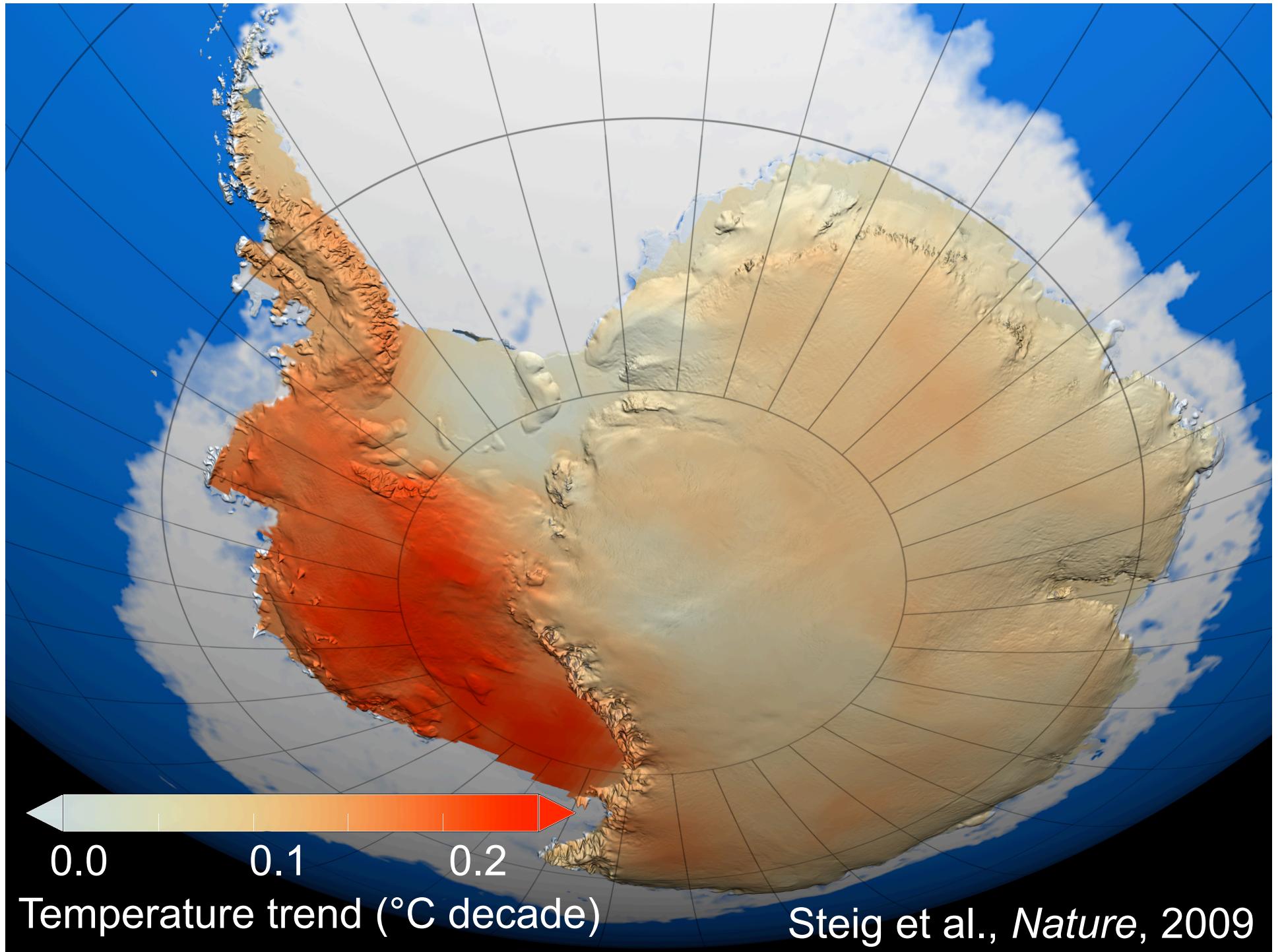
Antarctic temperature variations understood (it's all insolation)



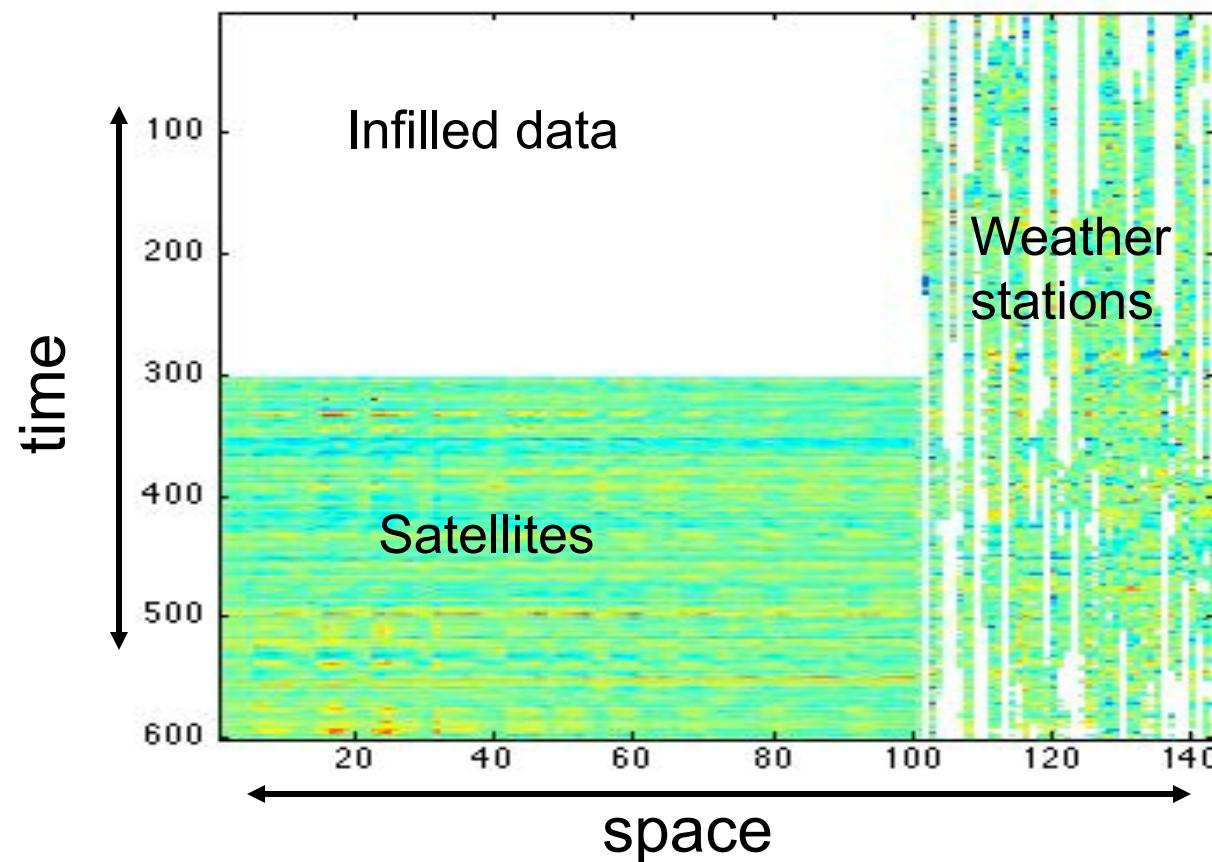
Huybers and Denton,
Nature Geoscience, 2008

West Antarctic isotope records

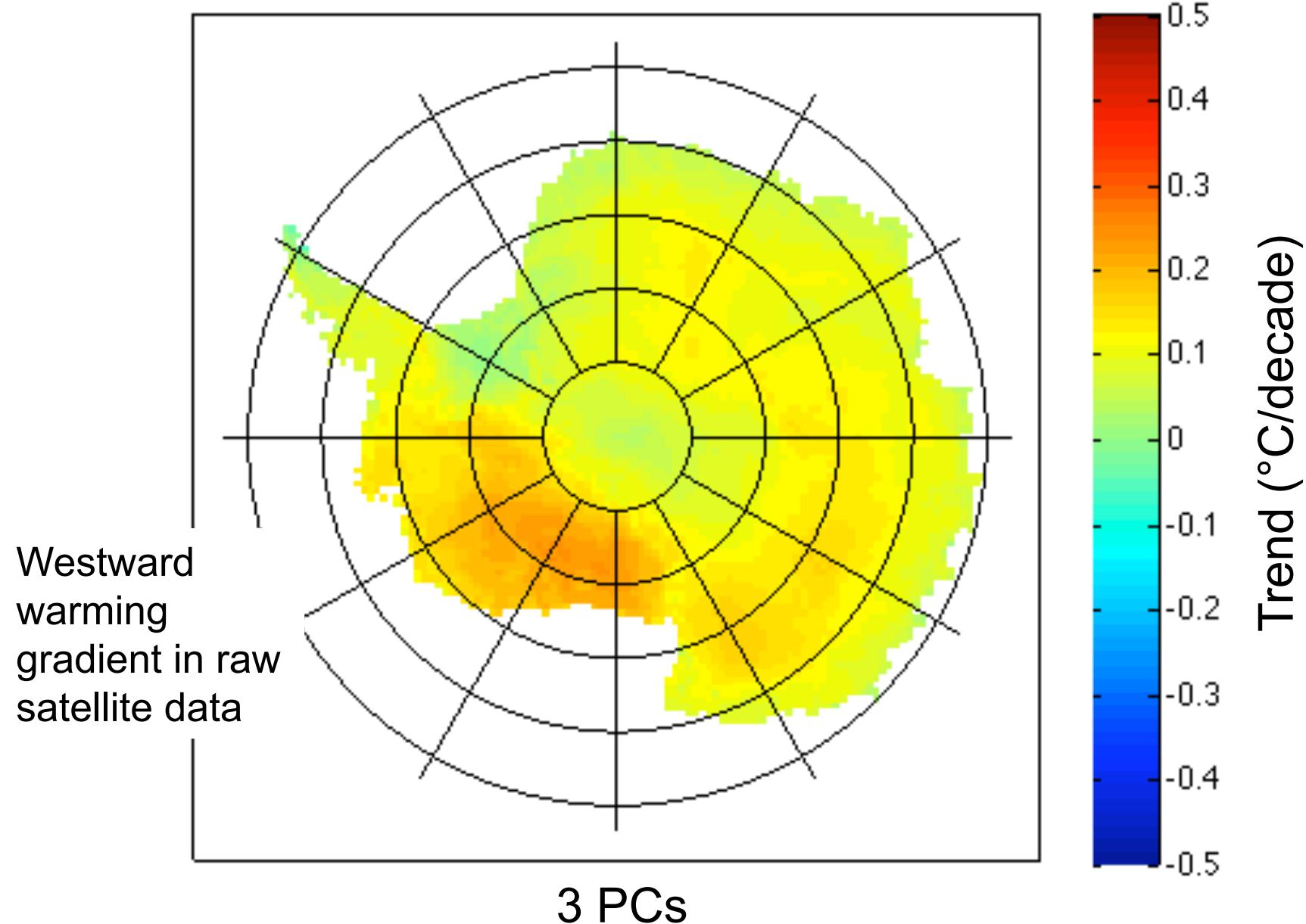




Reconstruction of Antarctic temperature

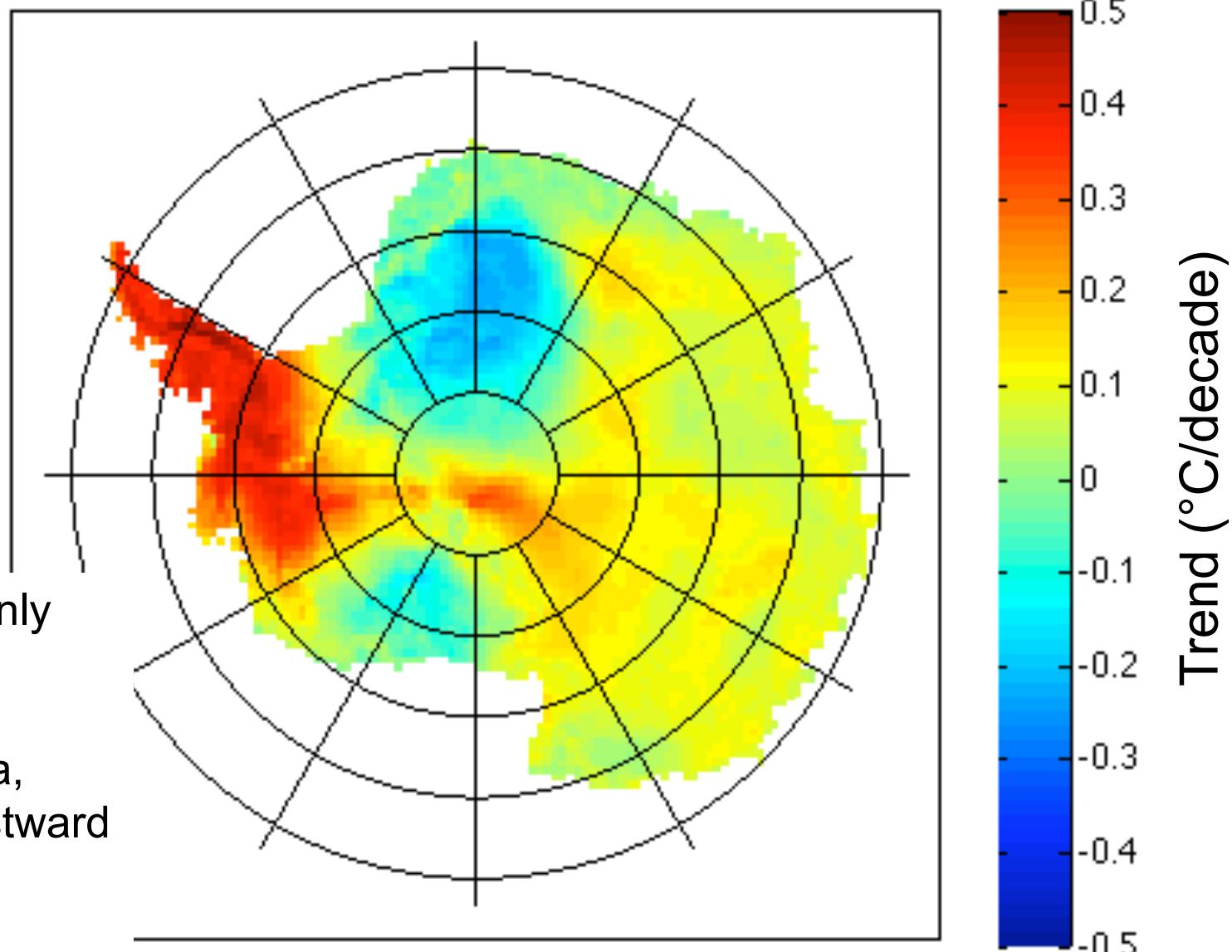


Satellite/station reconstruction



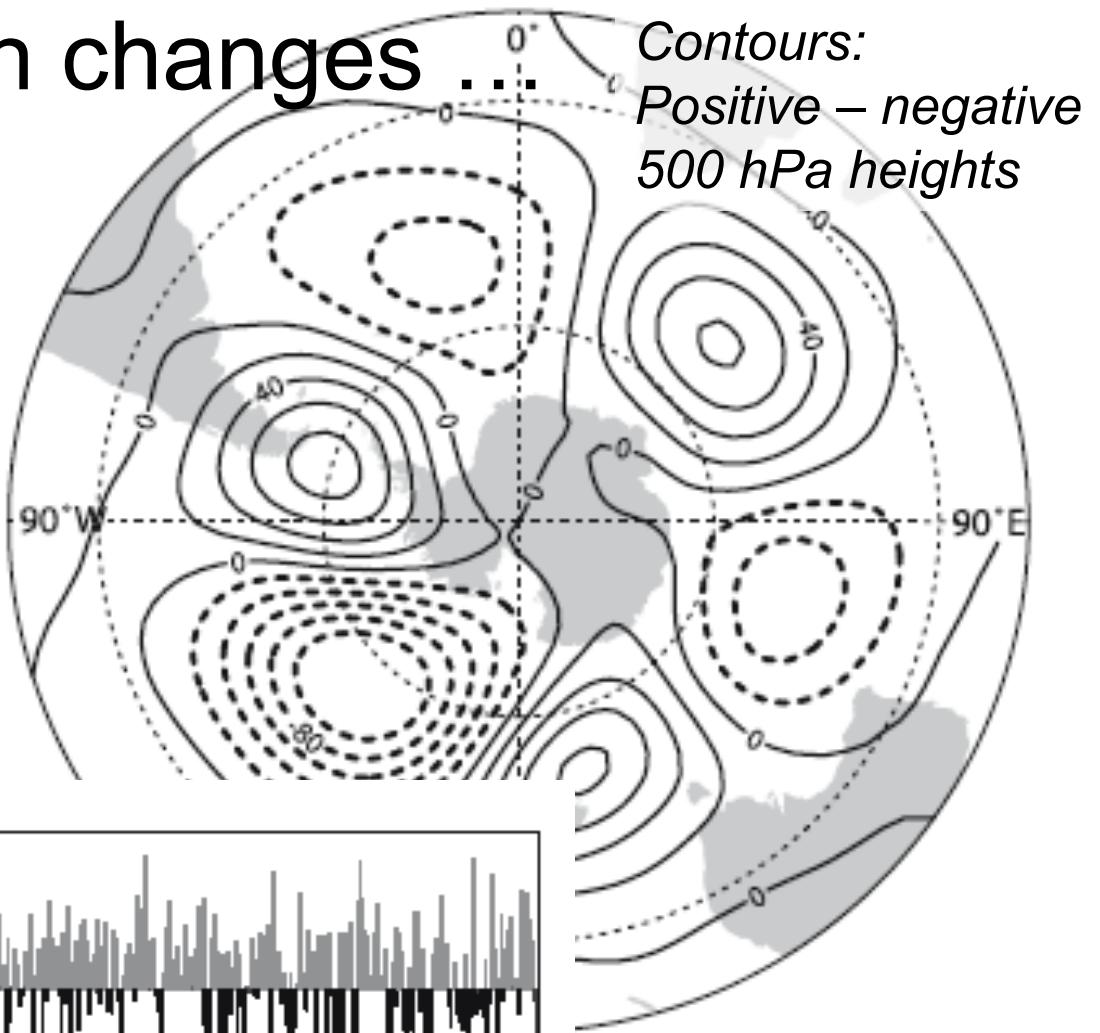
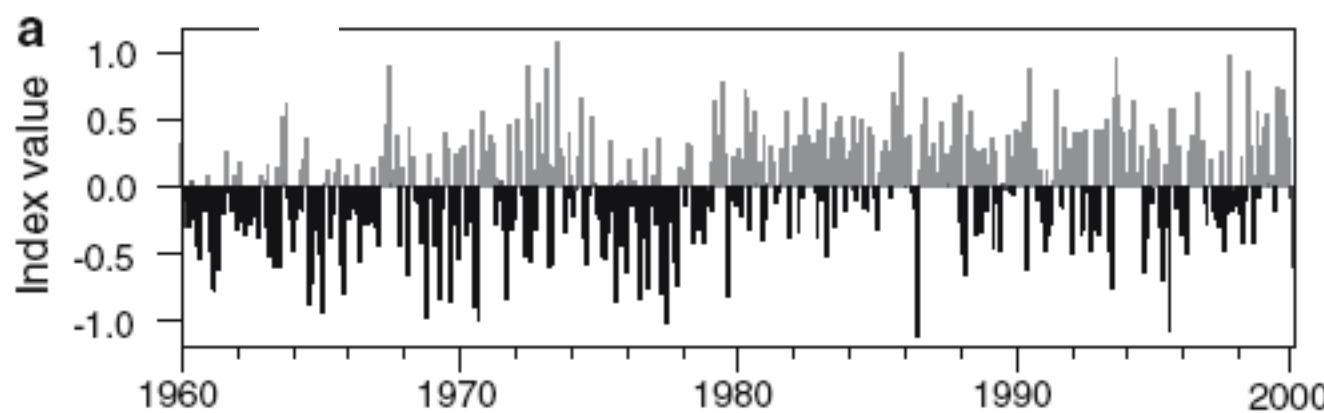
Station-only reconstruction

Station-only
estimate
shows
Peninsula,
north/eastward
warming
gradient



Recent West Antarctic warming reflects circulation changes ...

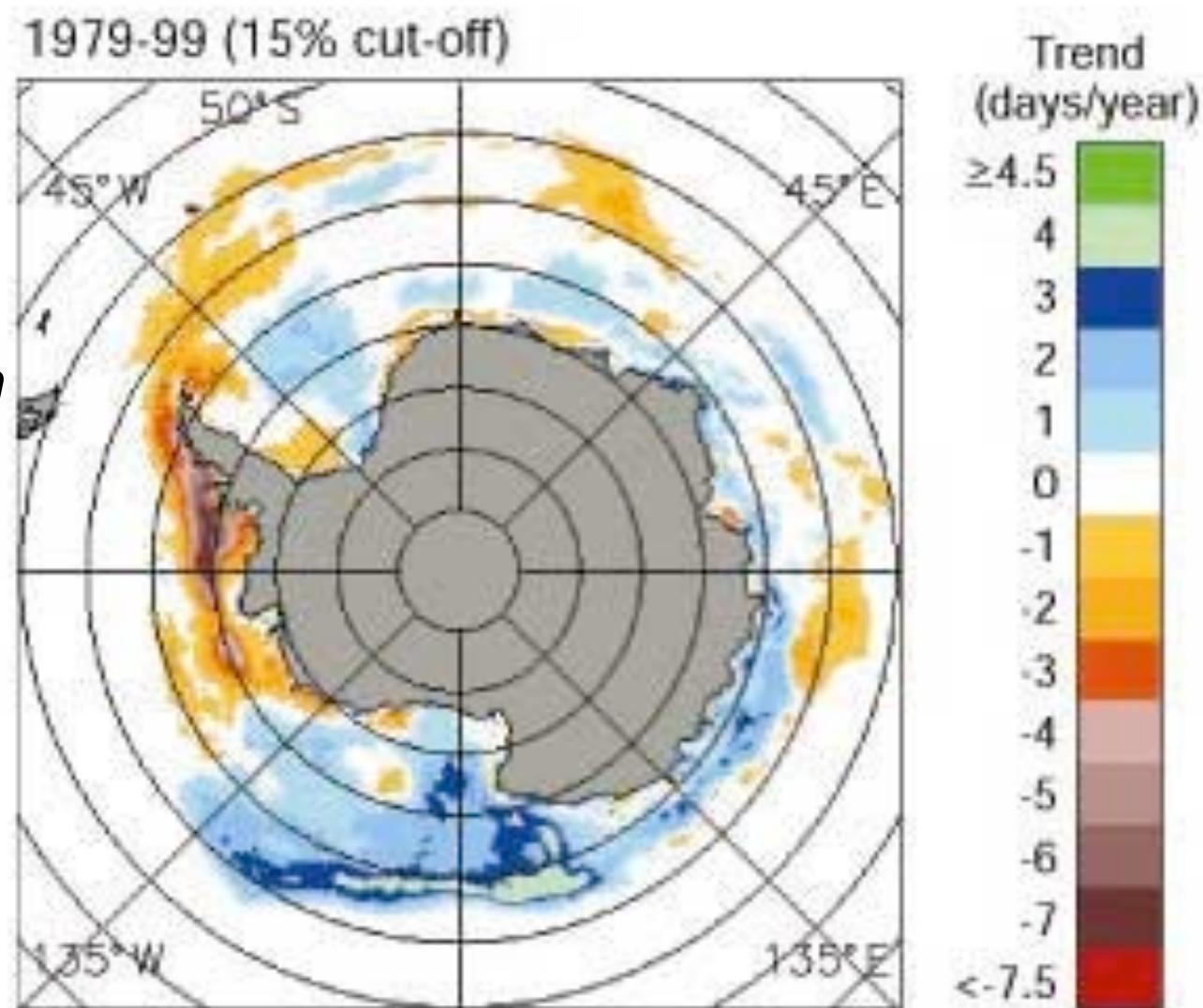
Trend in zonal wave-3 pattern: increased warm-air flow into West Antarctica



Raphael and Holland, 2006, Climate Dynamics

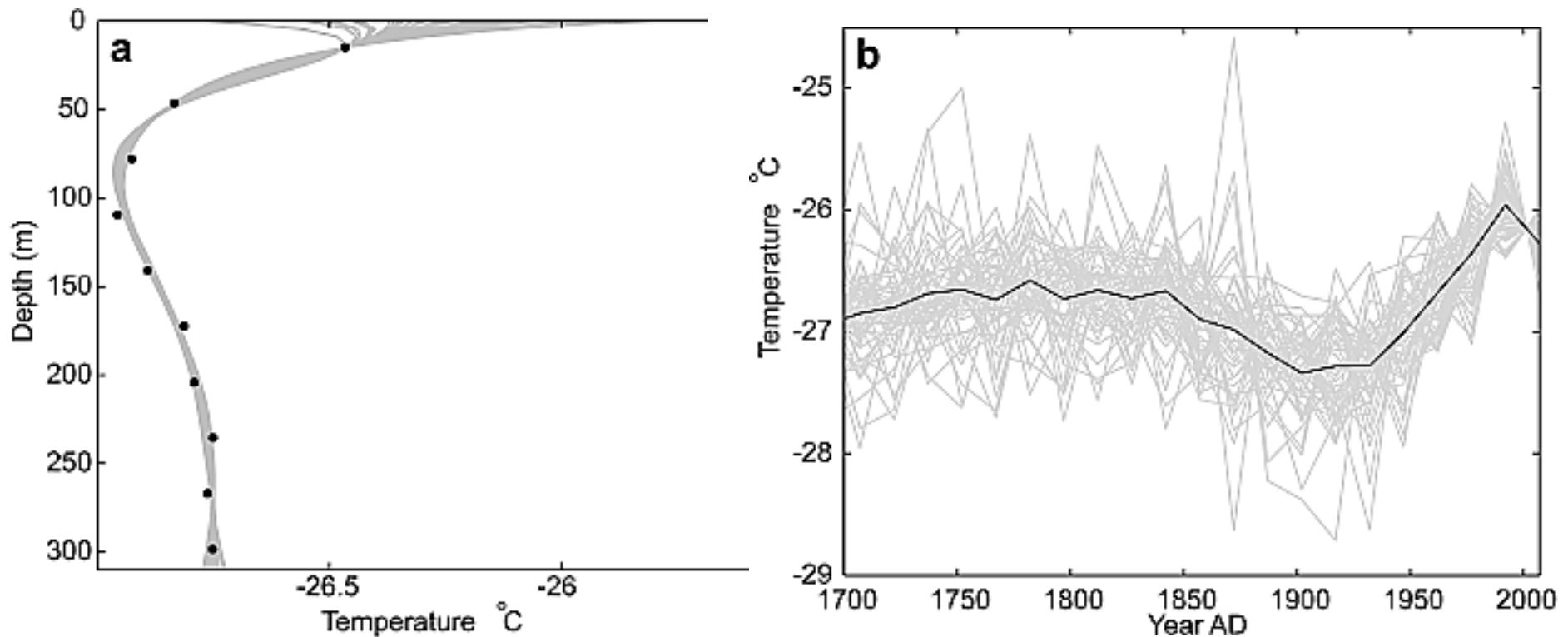
...and in sea ice (coupled to atmospheric circulation)

Trends in ice season length



West Antarctic temperature changes are occurring on long timescales.

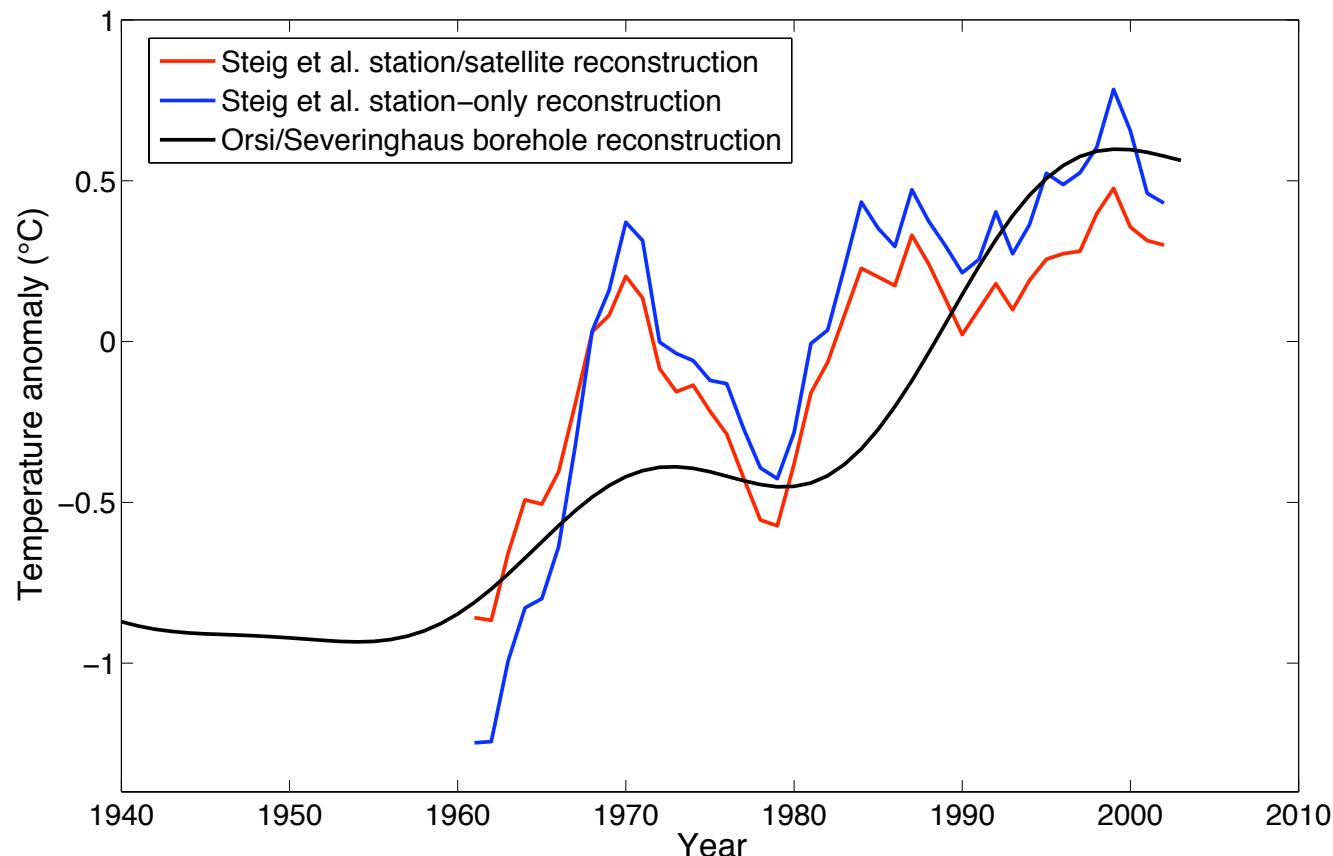
Borehole T reconstruction from Rutherford Ice Stream



*Barrett et al., 2009
Geophys. Res. Lett.*

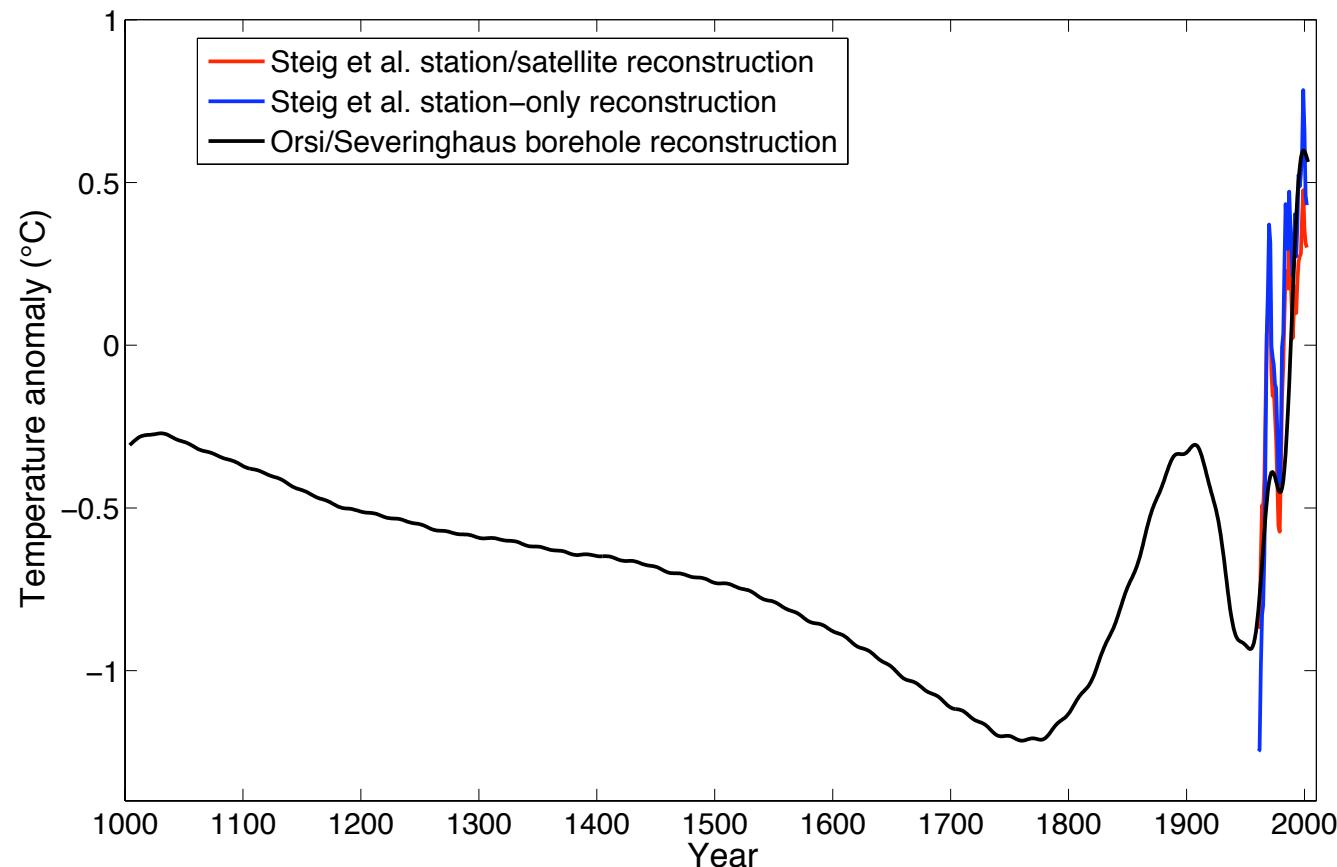
West Antarctic temperature changes are occurring on long timescales.

Borehole validation of WAIS Divide T reconstruction



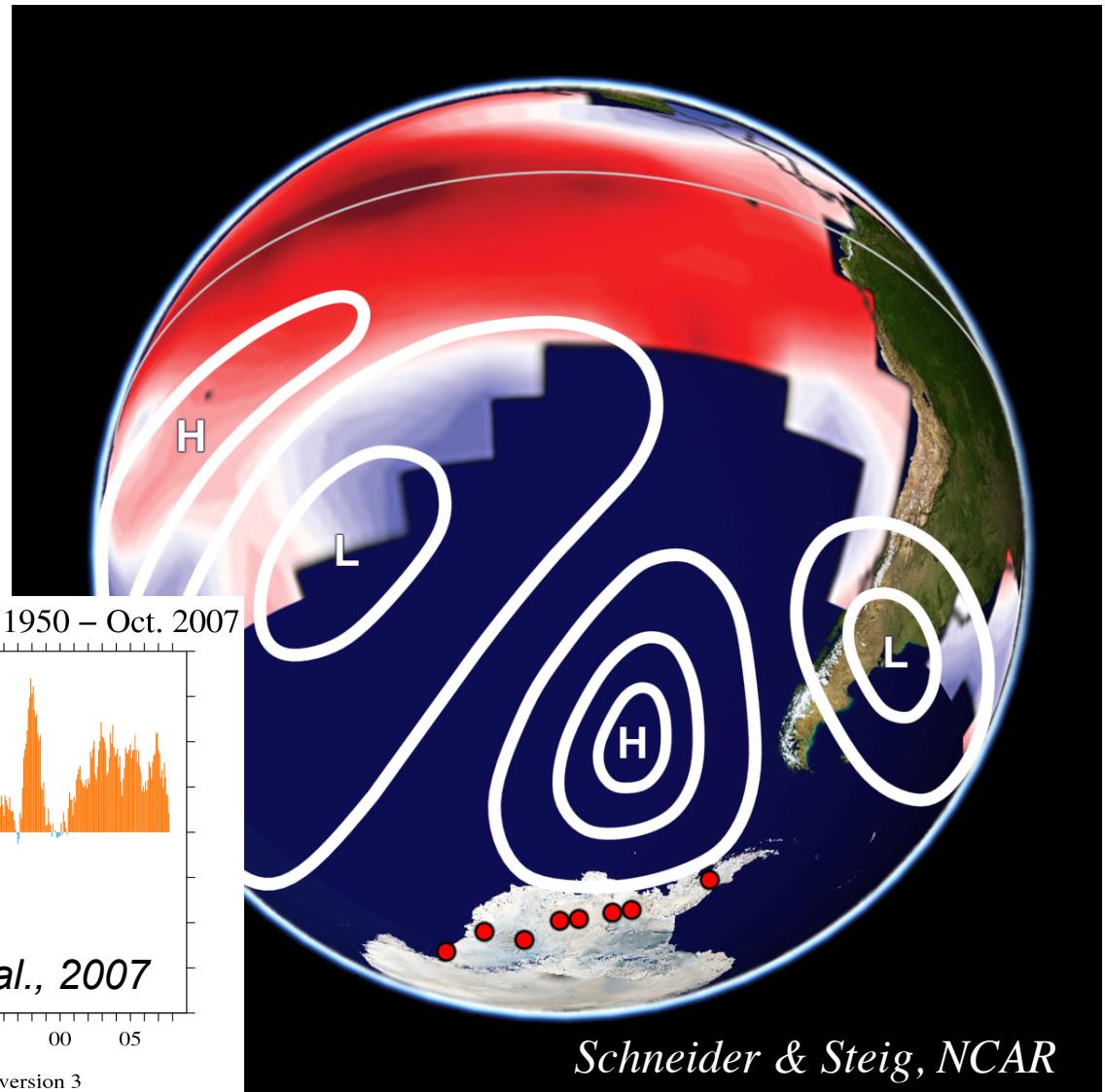
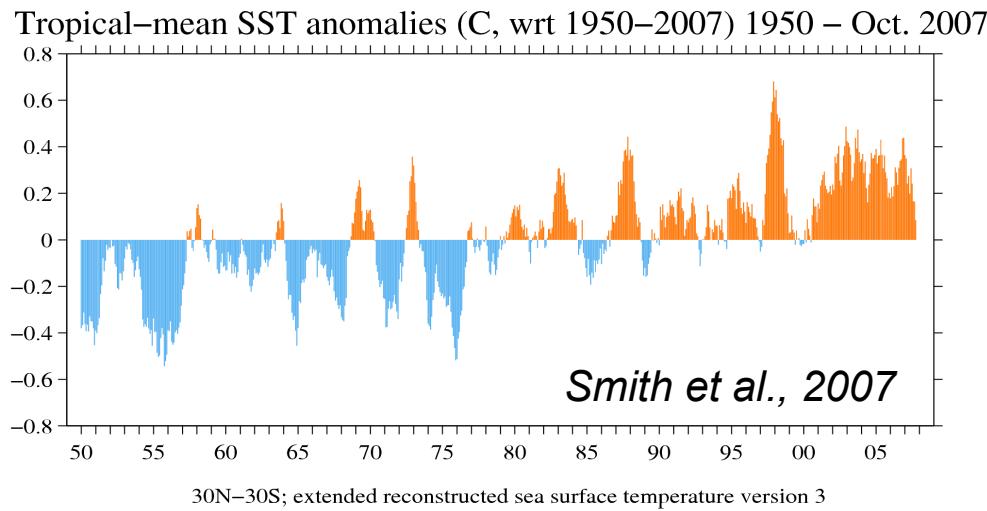
West Antarctic temperature changes are occurring on long timescales.

Borehole validation of WAIS Divide T reconstruction

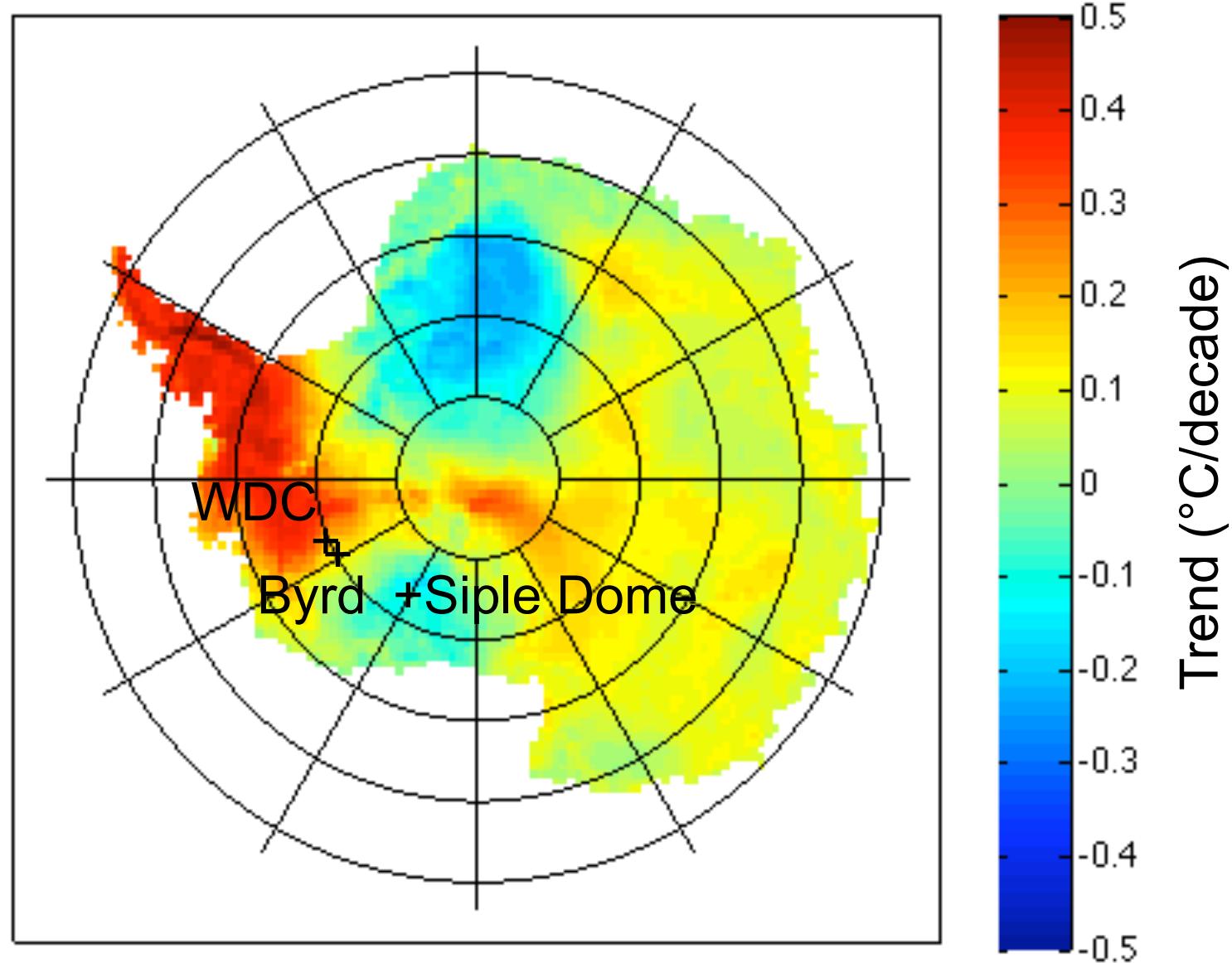


West Antarctic / tropical connection

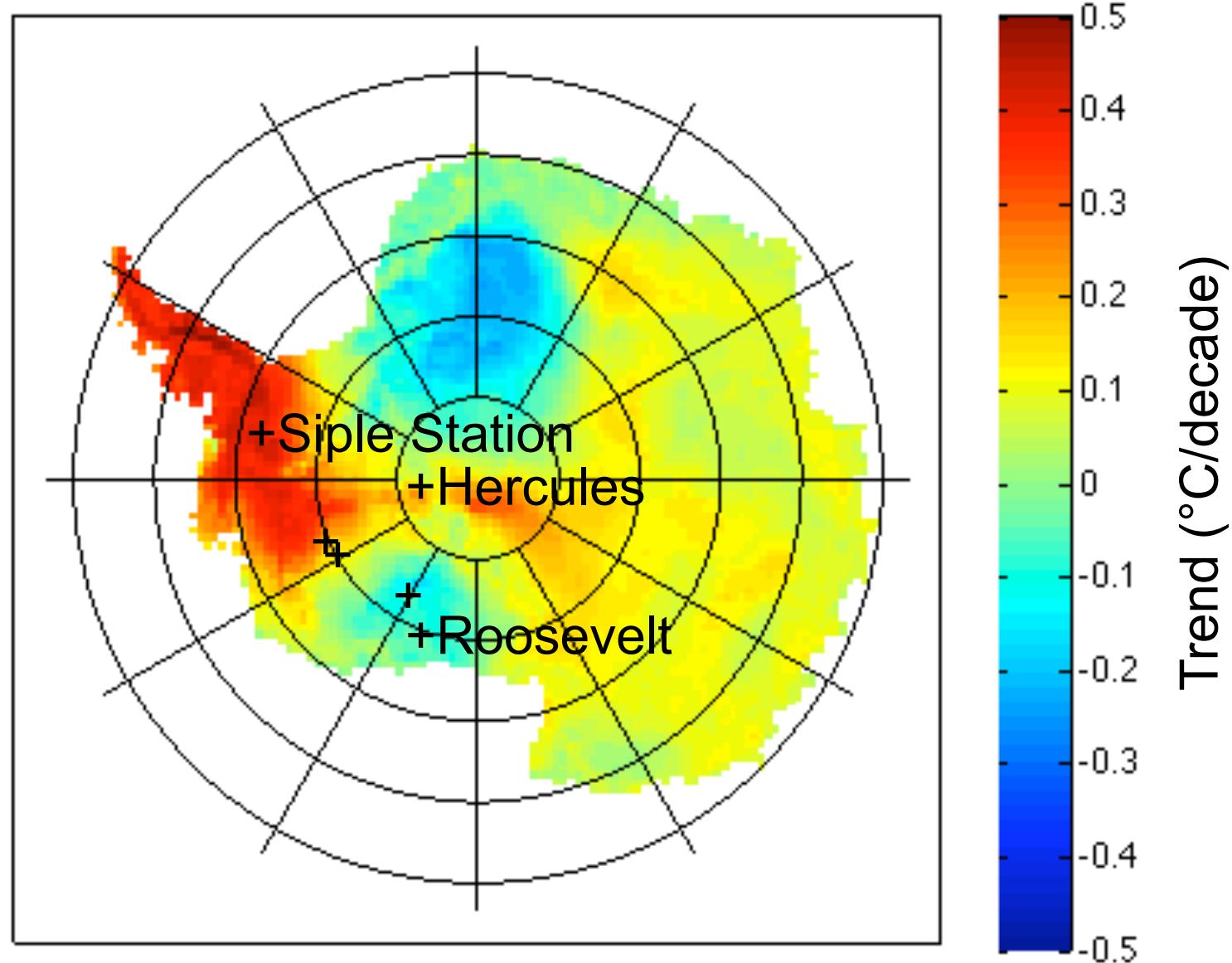
Tropical warming
enhances poleward
moisture transport to
coastal WAIS



If we want understand Antarctic climate, we need more ice core records from West Antarctica

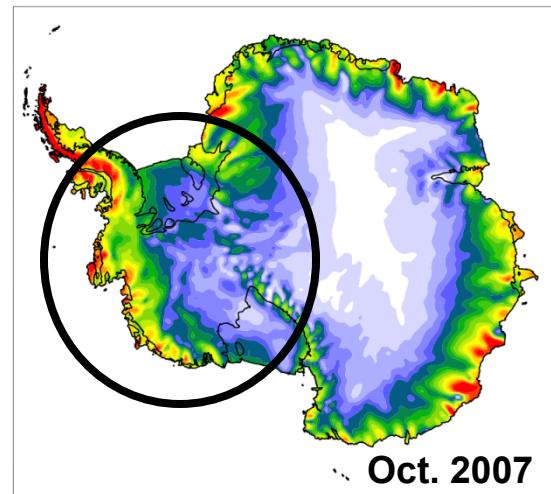
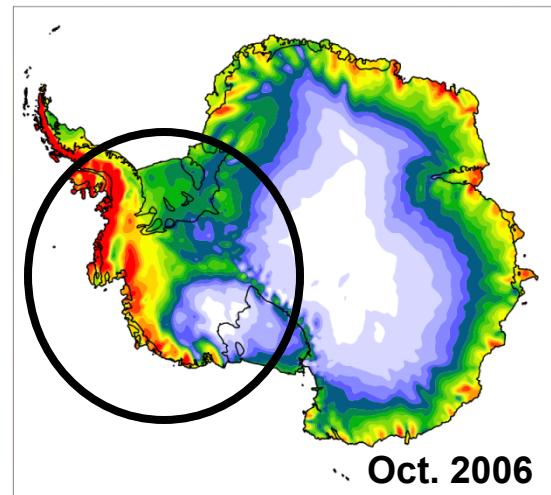


If we want understand Antarctic climate, we need more ice core records from West Antarctica



West Antarctic is a 'marine ice sheet' in more ways than one

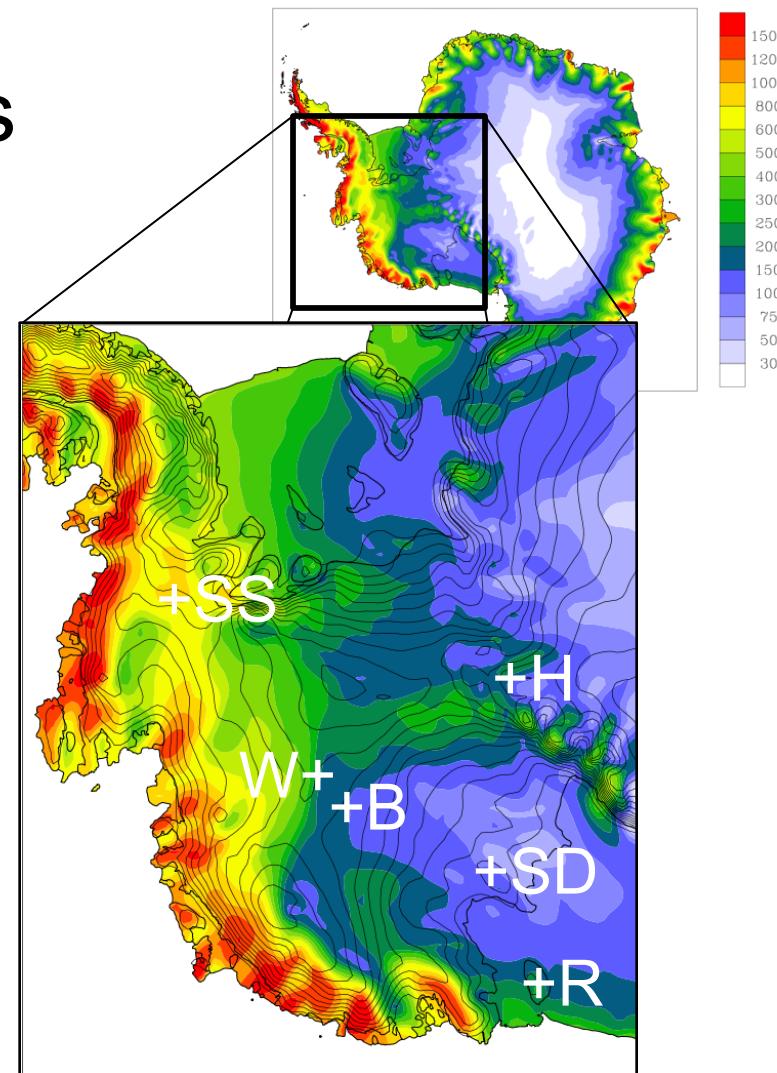
- The "marine signature" varies over time and depends strongly on the prevailing atmospheric circulation over the Southern Ocean



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...

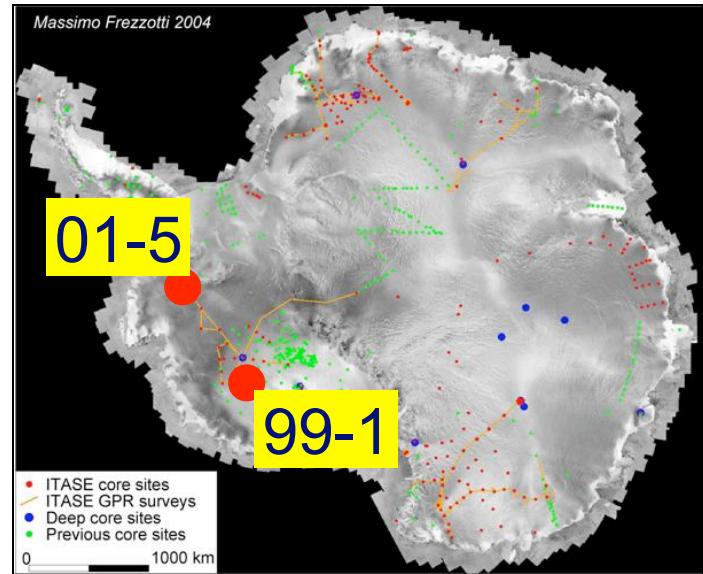
- We have *no* long term record from the ('marine-influenced') areas.
- WAIS Divide is close but may not be far north/east enough.



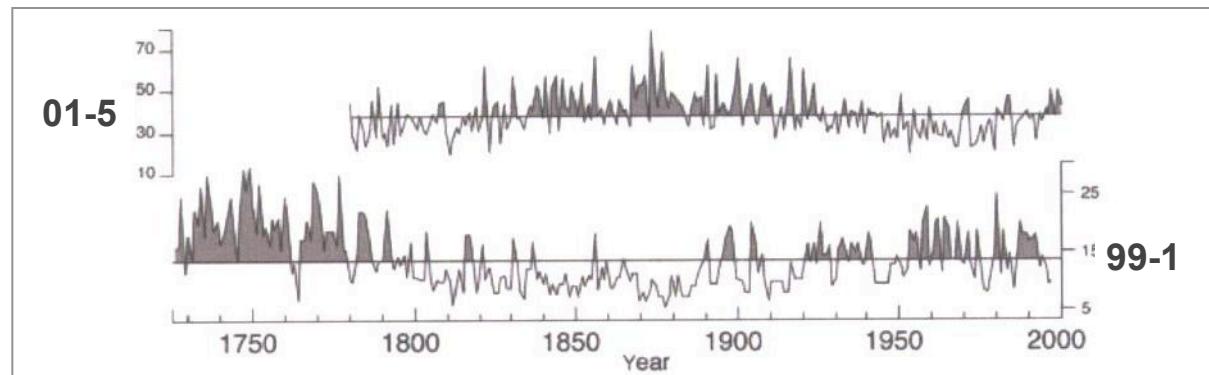
Mean annual precipitation in 2006-2007
from the AMPS forecast archive
[Nicolas et al., in preparation]

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



[Kaspari et al., 2004, *Ann. Glaciol.*]

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

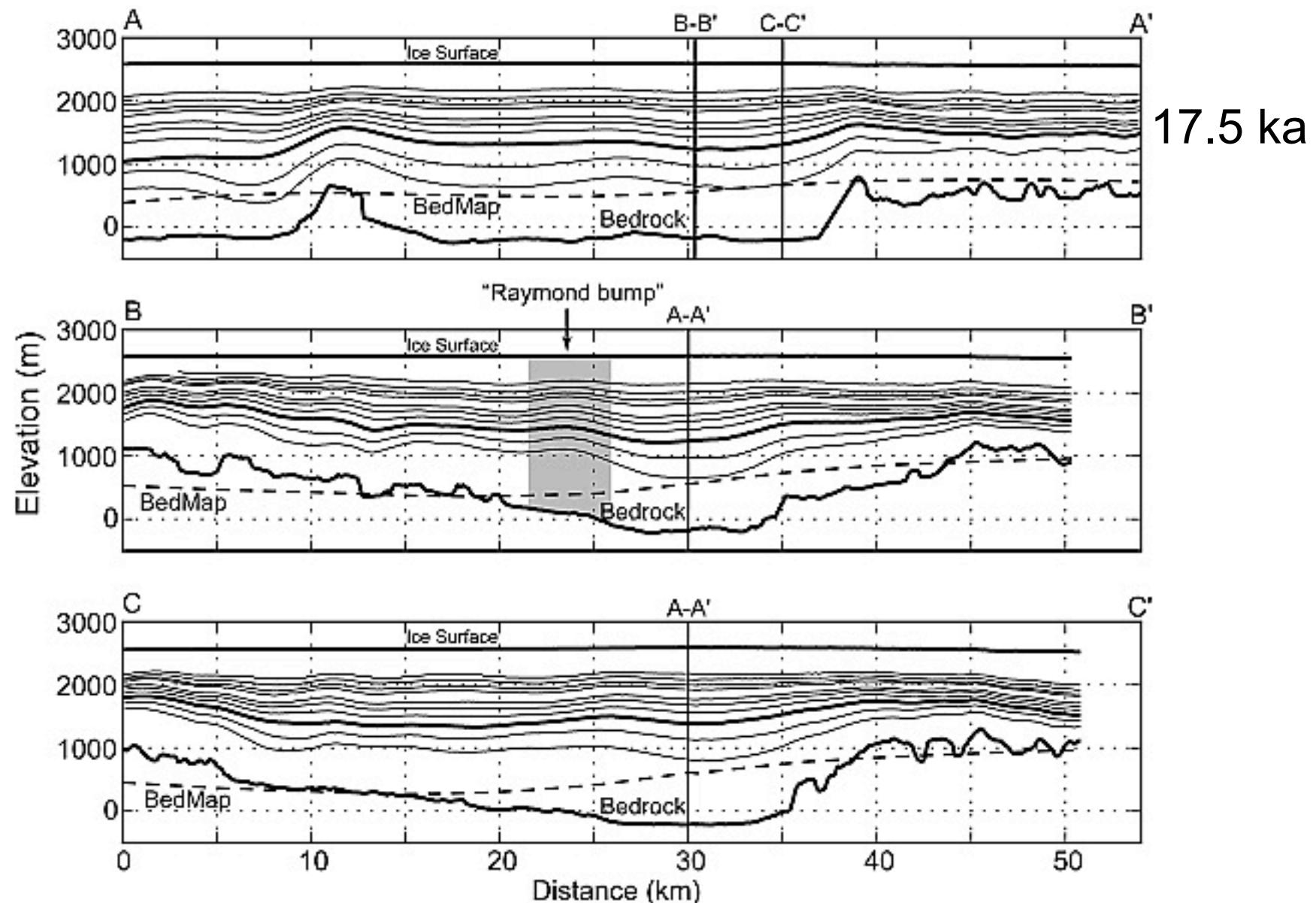


Where to take DISC next?

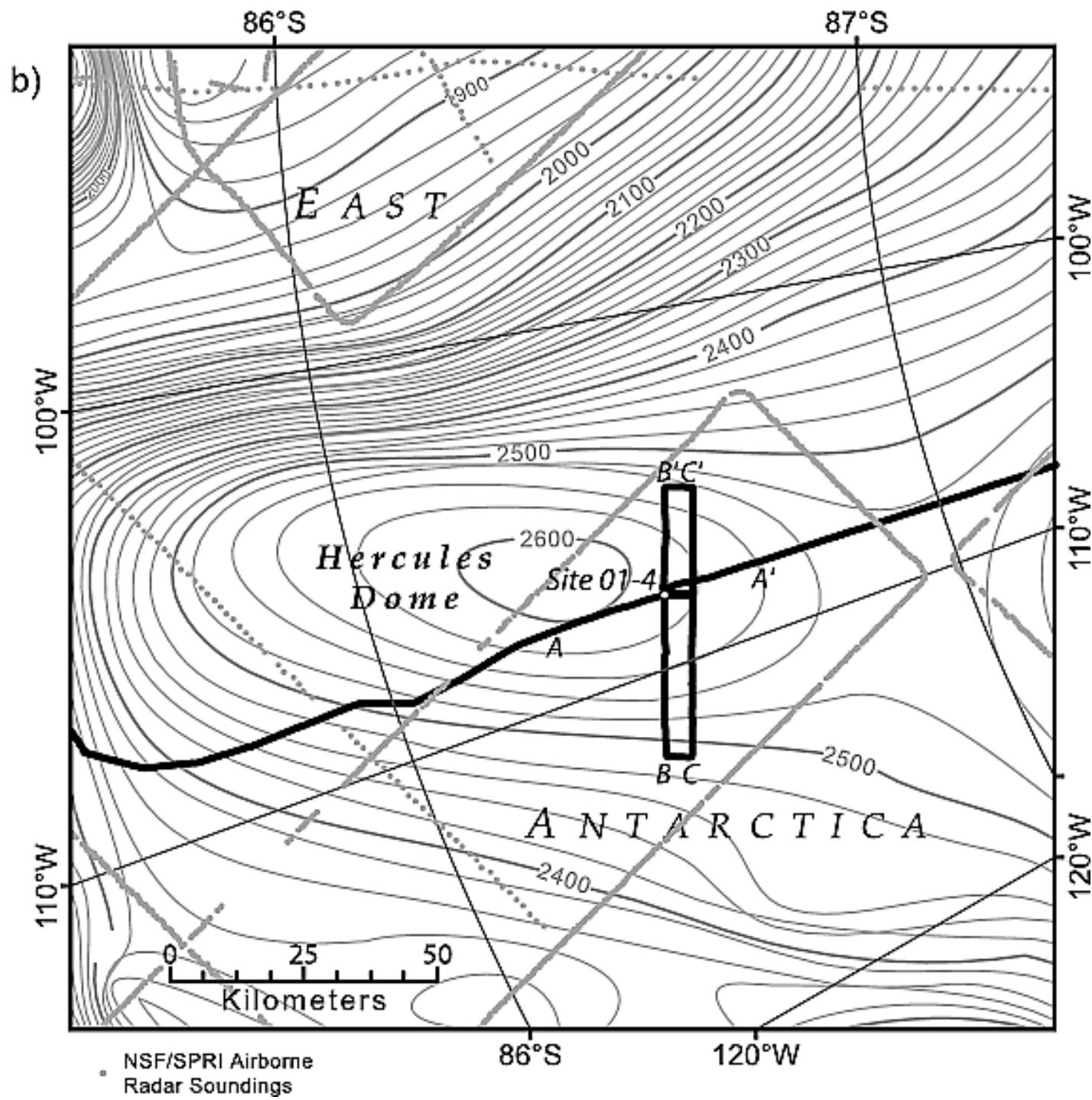
- a) Northeastward from WAIS Divide
(climate science!)
- b) South Pole (atmospheric chemistry,
logistical convenience)
- c) Hercules Dome (possibly addresses a
+b?)
- d) Dome A or other ‘million-year ice’ site
(old old ice!)

Thank you

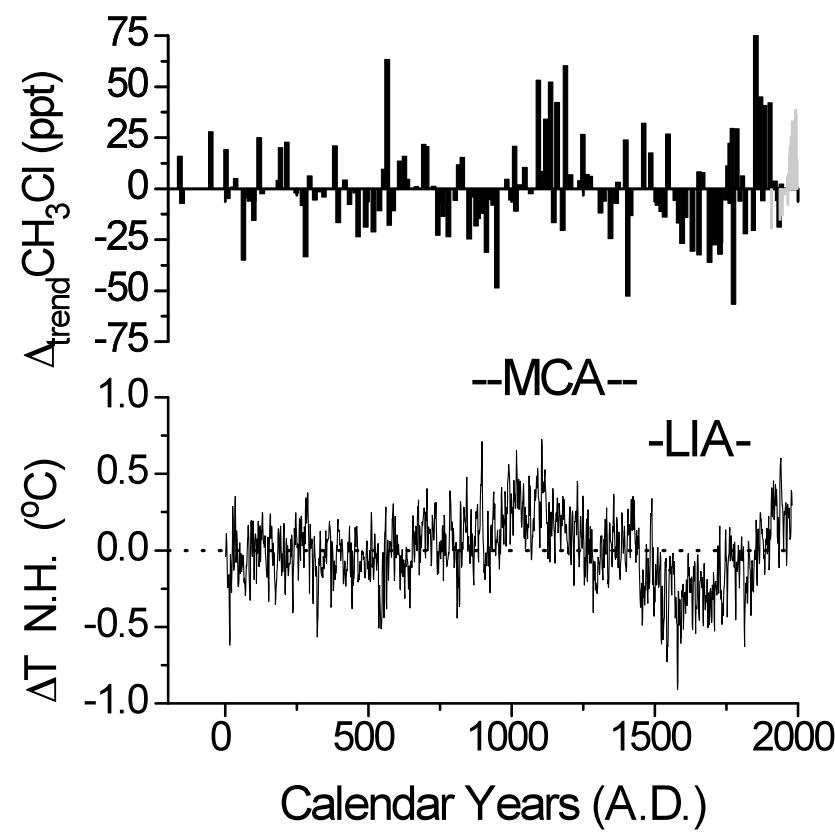
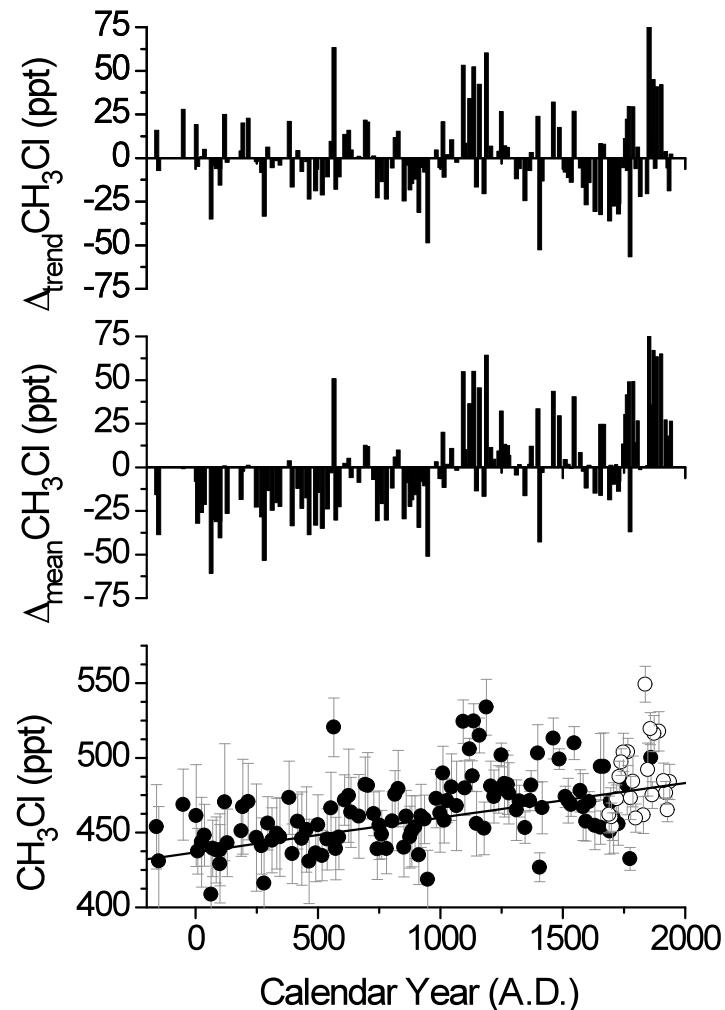
Radar at Herc Dome



Jacobel , Welch, Steig, Schneider, 2004

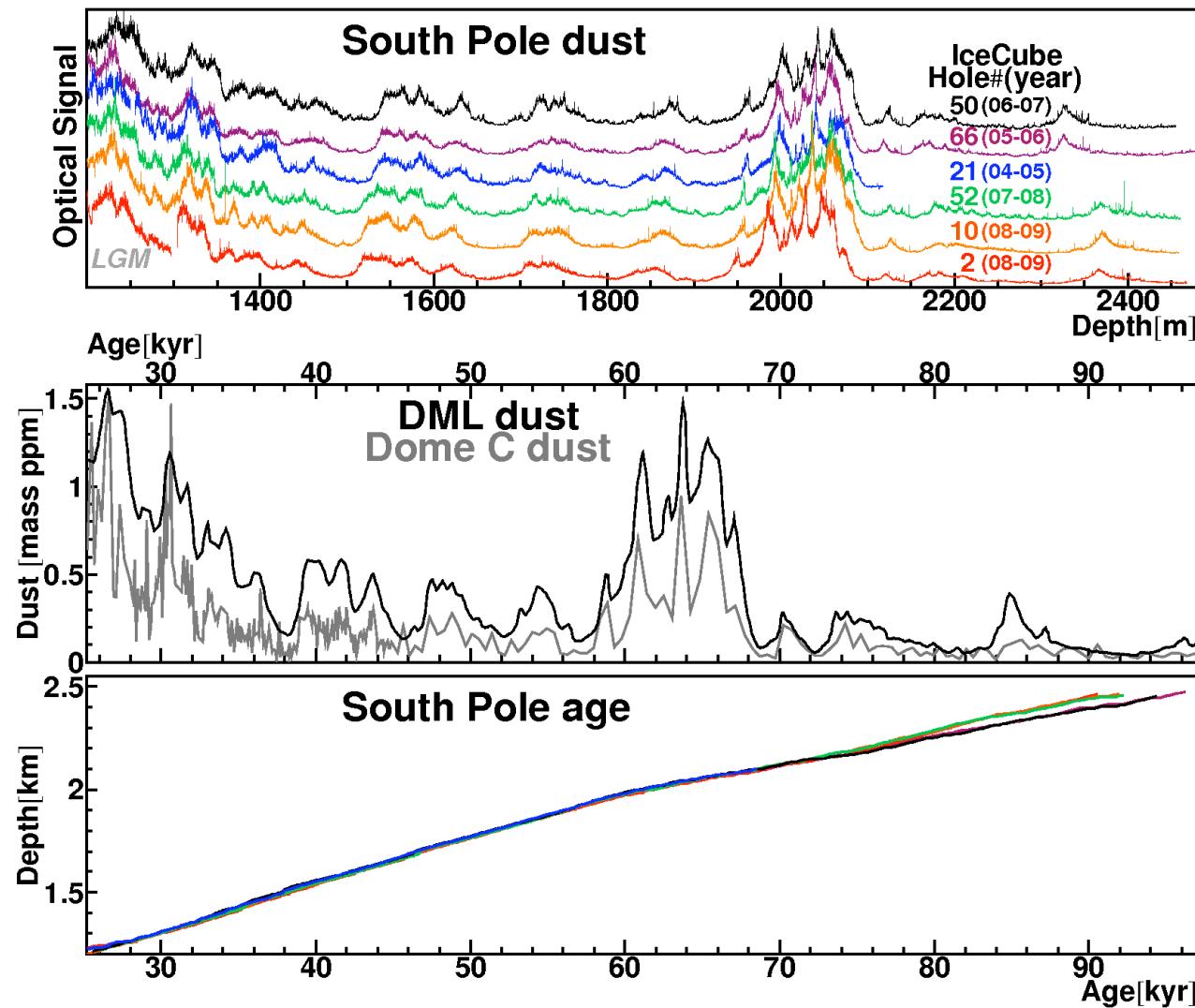


Ice core record of methyl chloride – a natural ozone-depleting Substance: evidence for climate-related variability at South Pole



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