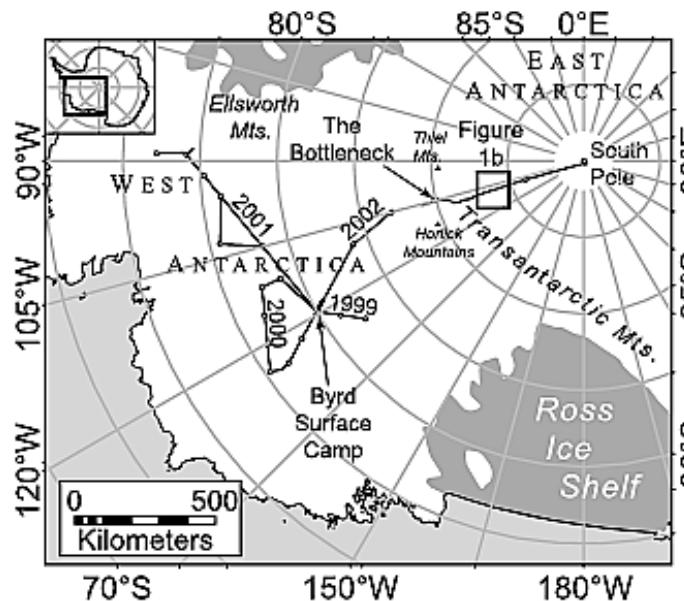


Part 1.

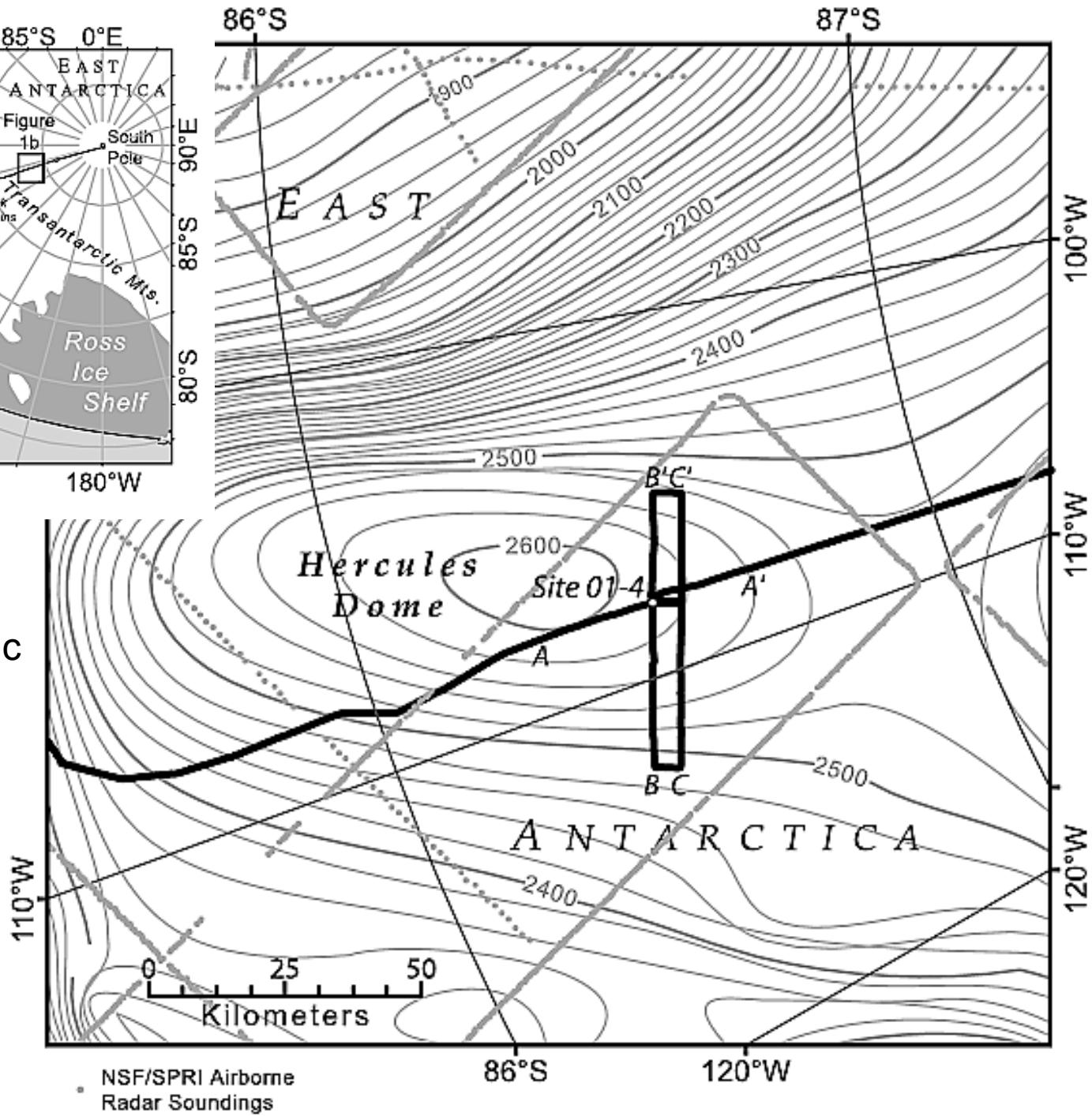
Why sites like South Pole and Herc Dome matter for understanding Antarctic climate variability

Eric J. Steig

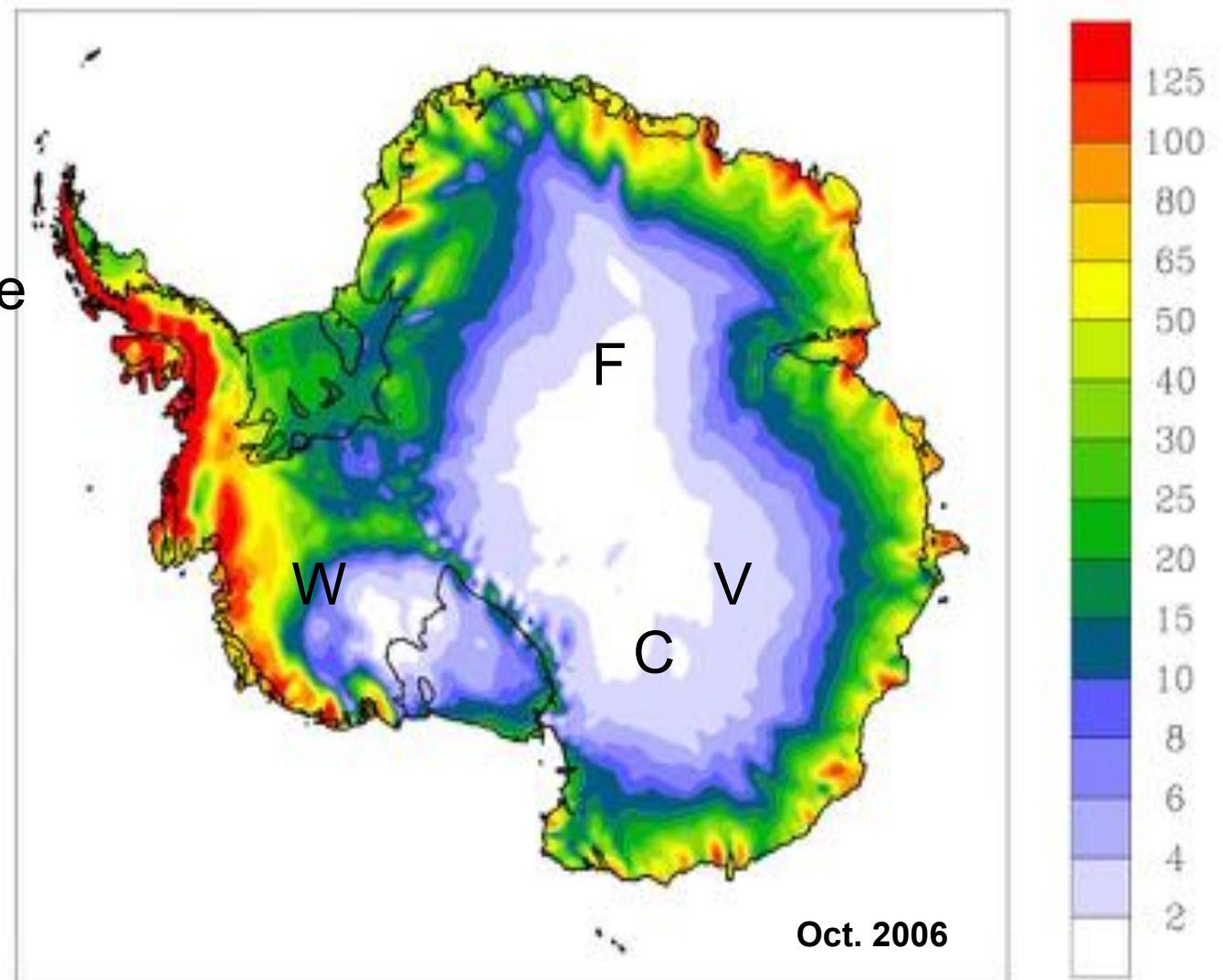
Quaternary Research Center and Department of Earth
and Space Sciences, University of Washington



Jacobel, Welch,
Steig, Schneider,
2005 reported basic
site characteristics
and a 300-year
isotope record



Hercules Dome
and South Pole:
blank spot on the
map of long ice
core records in
Antarctica

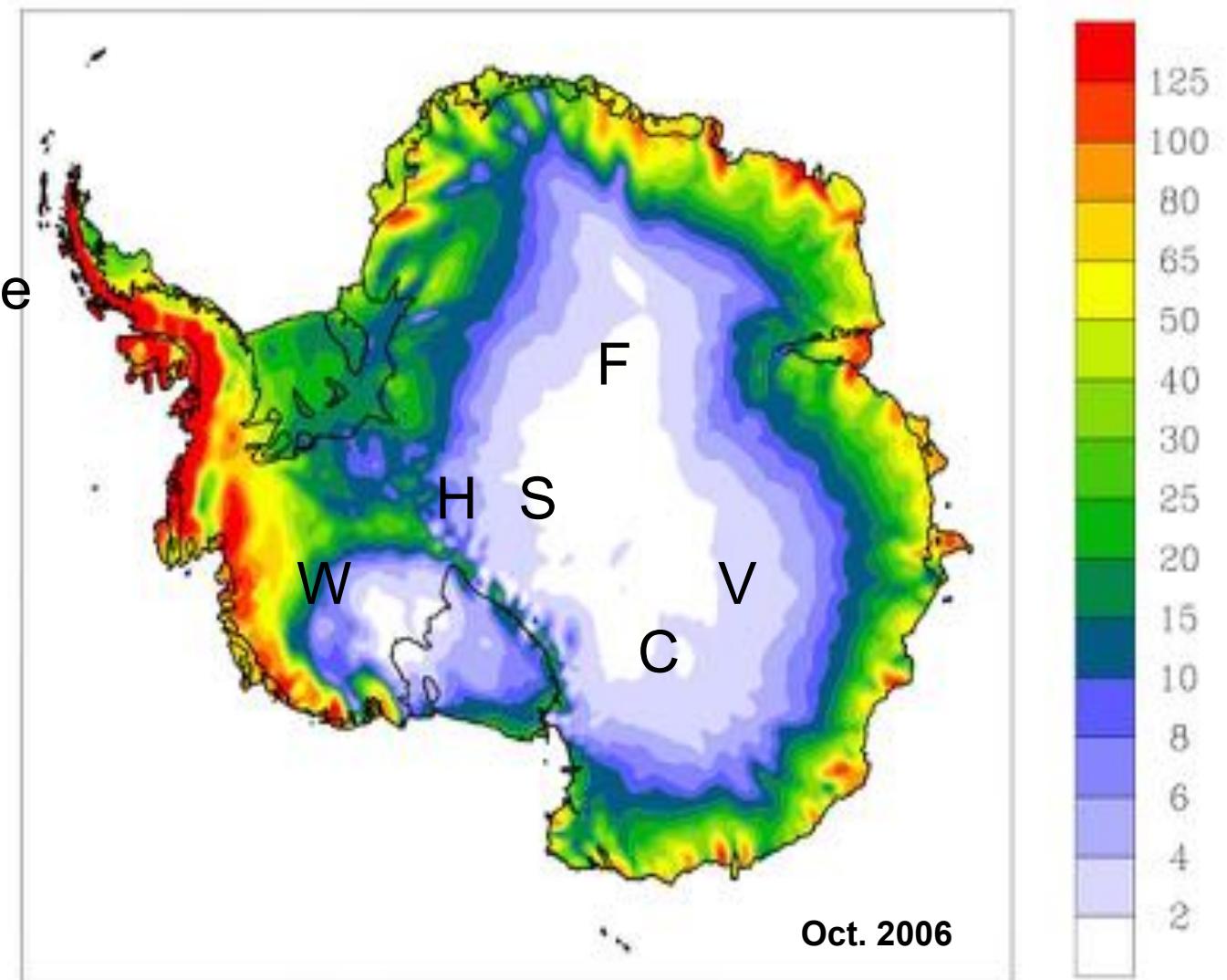


Nicholas et al, 2008

Hercules Dome
and South Pole:

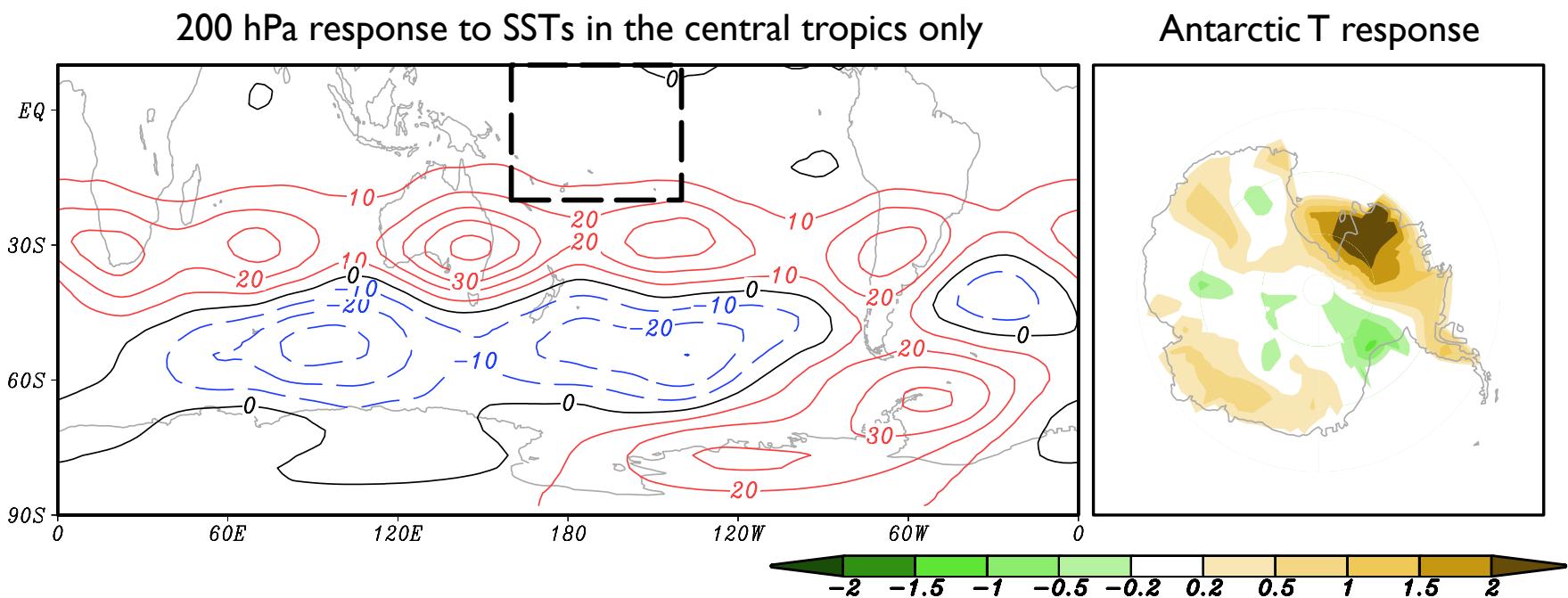
blank spot on the
map of long ice
core records in
Antarctica

“West Antarctic
accumulation,
East Antarctic
temperature”

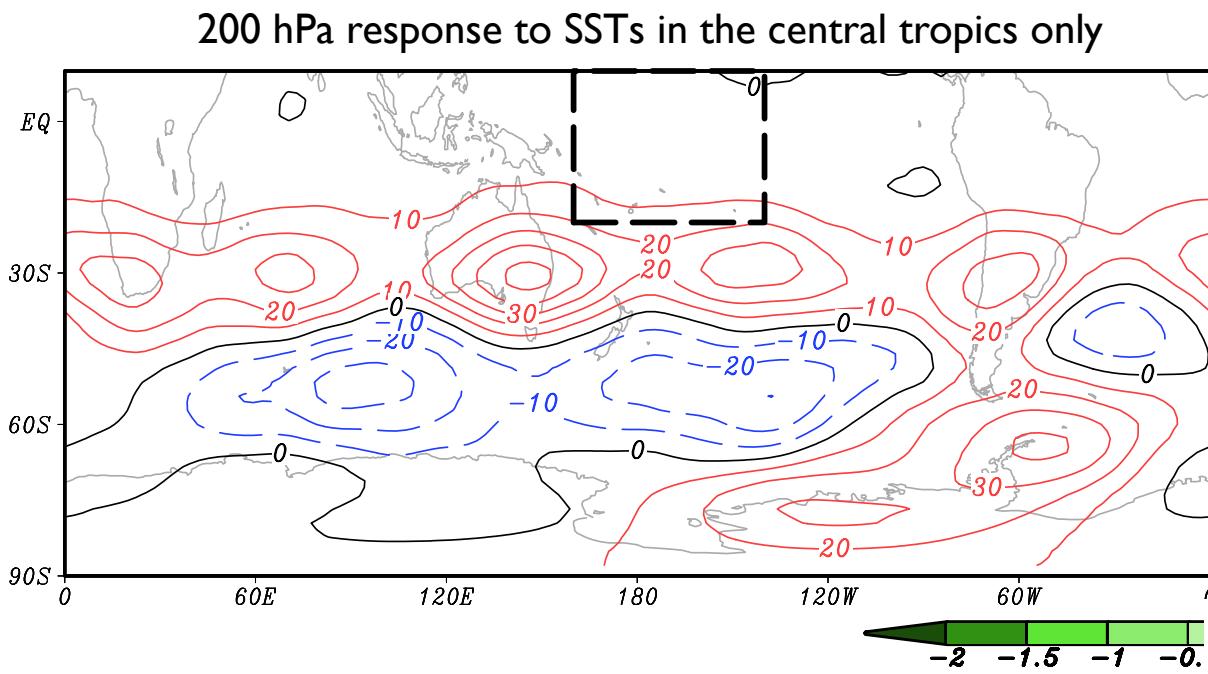


Nicholas et al, 2008

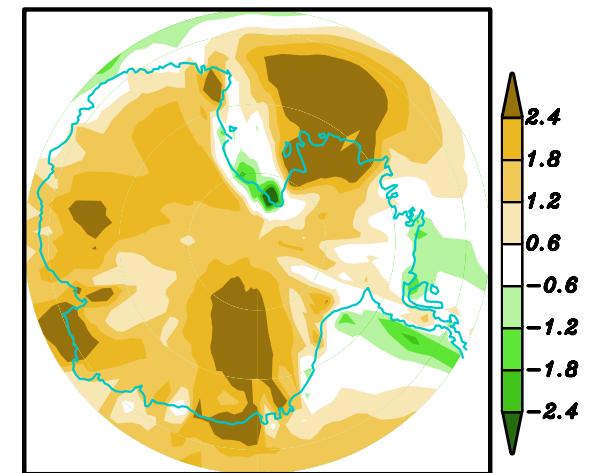
Climate variability comes in spatial patterns



Response to SST forcing in the central tropical Pacific

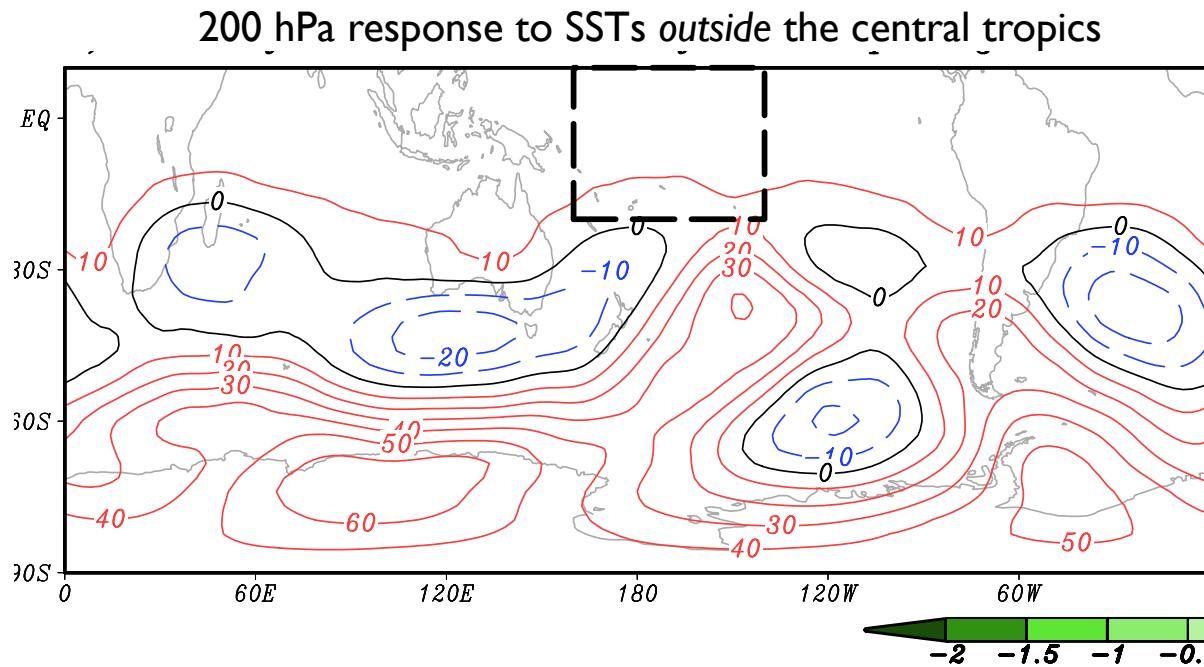


ECHAM 4.6 with climatological SST as boundary condition; observed SST in central tropical Pacific

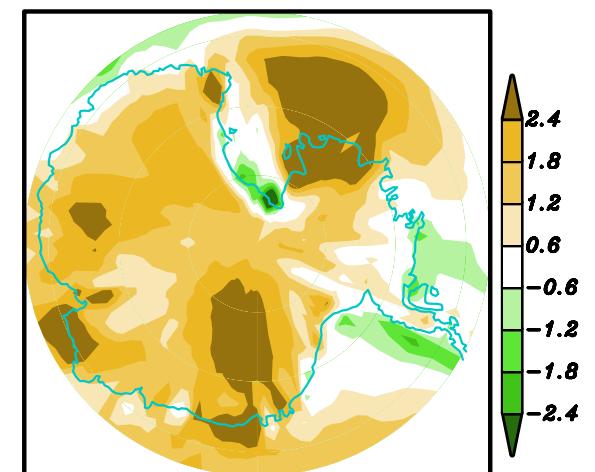


Ding et al., Nature Geoscience, 2011

Response to SST forcing excluding the central tropical Pacific



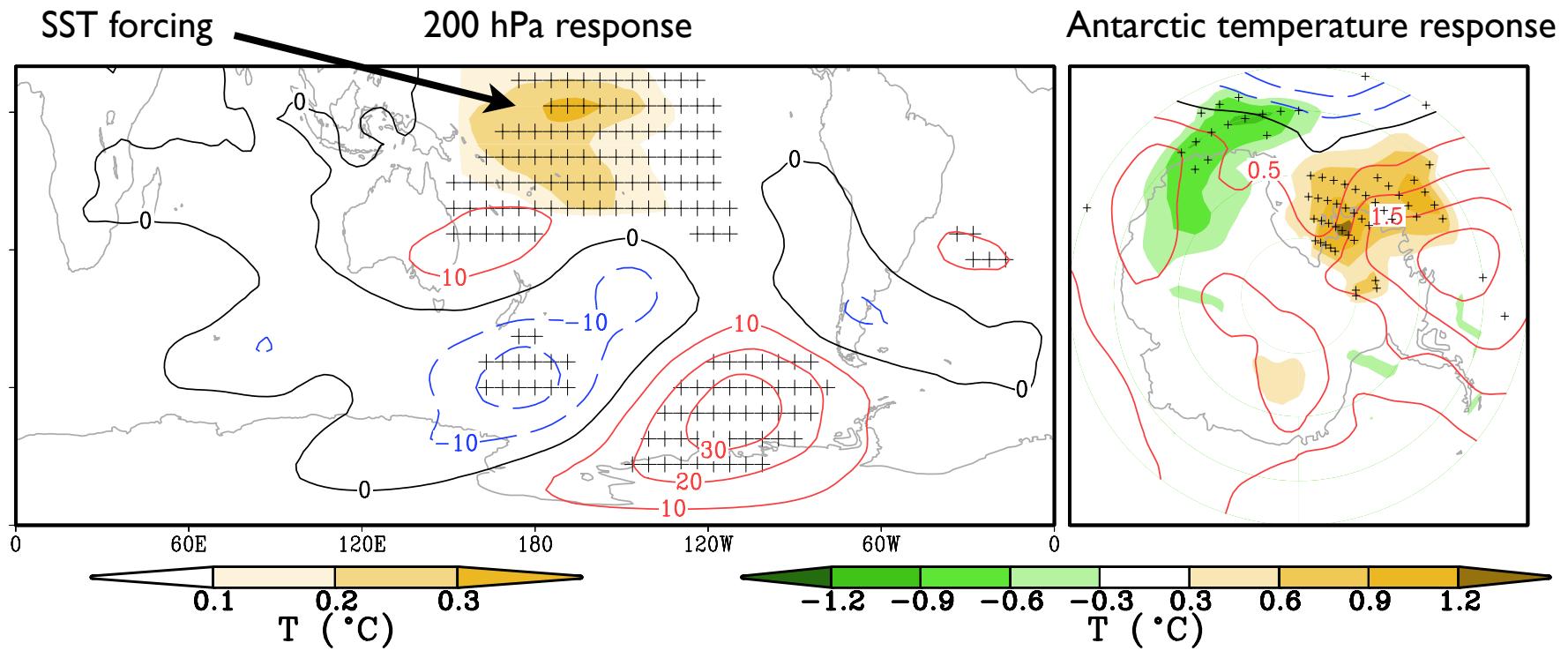
ECHAM 4.6 with observed SST as boundary condition; climatological



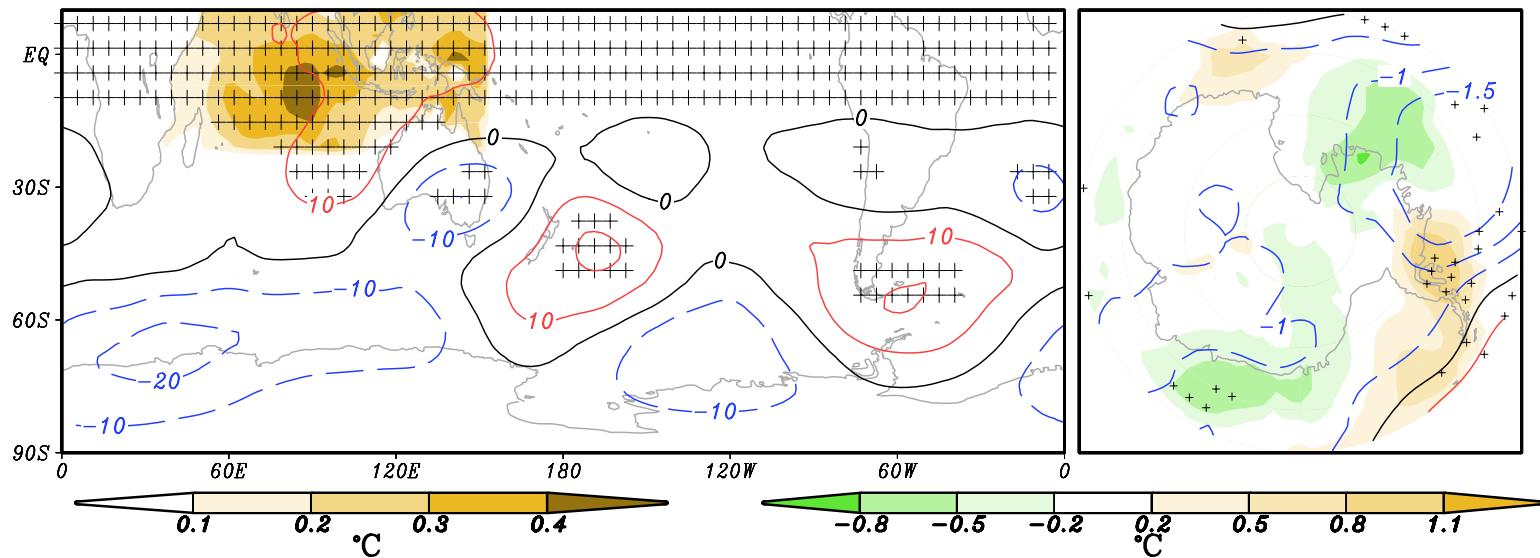
Ding et al., Nature Geoscience, 2011

Ensemble response to idealized 1σ anomalies in the central tropics

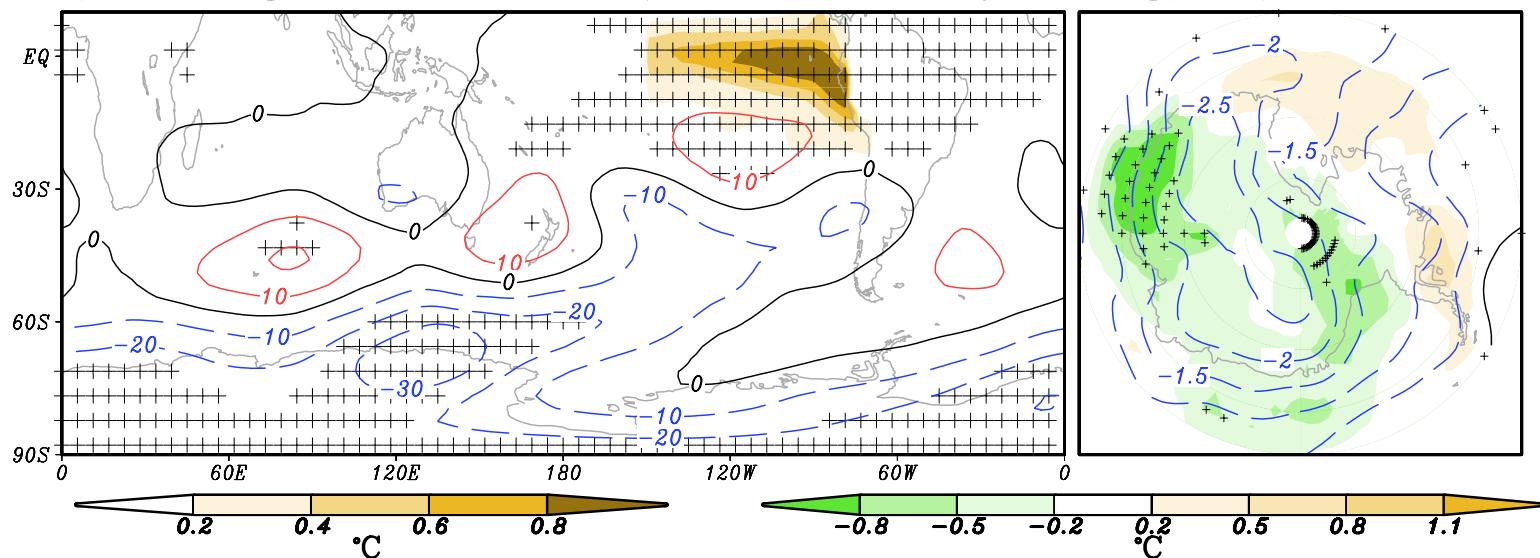
the central tropical Pacific is a key region for West Antarctica



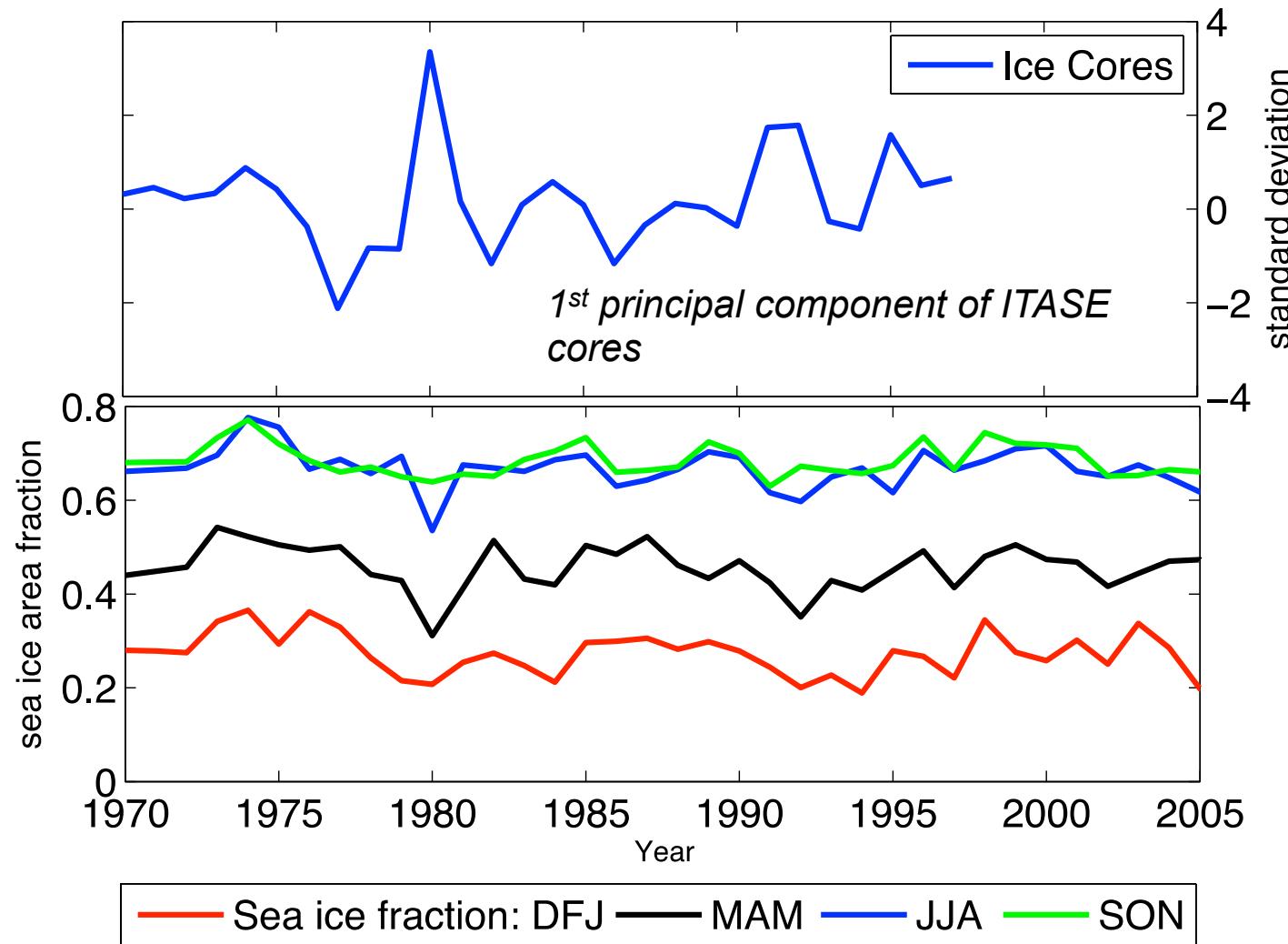
a) Model response to Indian Ocean SST (JJA Z200 and surface Temp/SLP)



b) Model response to ENSO SST (JJA Z200 and surface Temp/SLP)

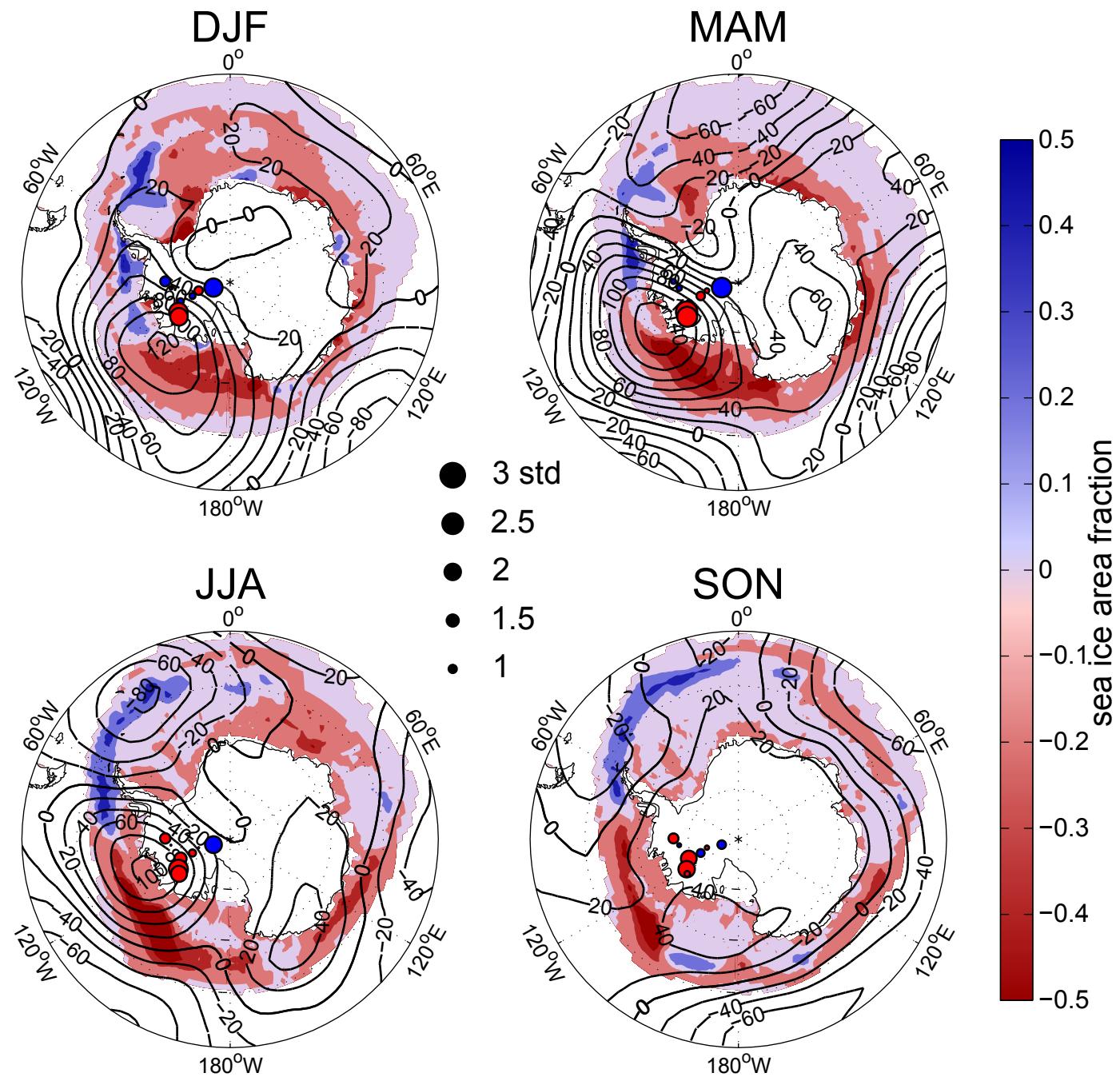


1980, an extreme climate anomaly: max. $\delta^{18}\text{O}$, min sea ice, max circulation anomalies

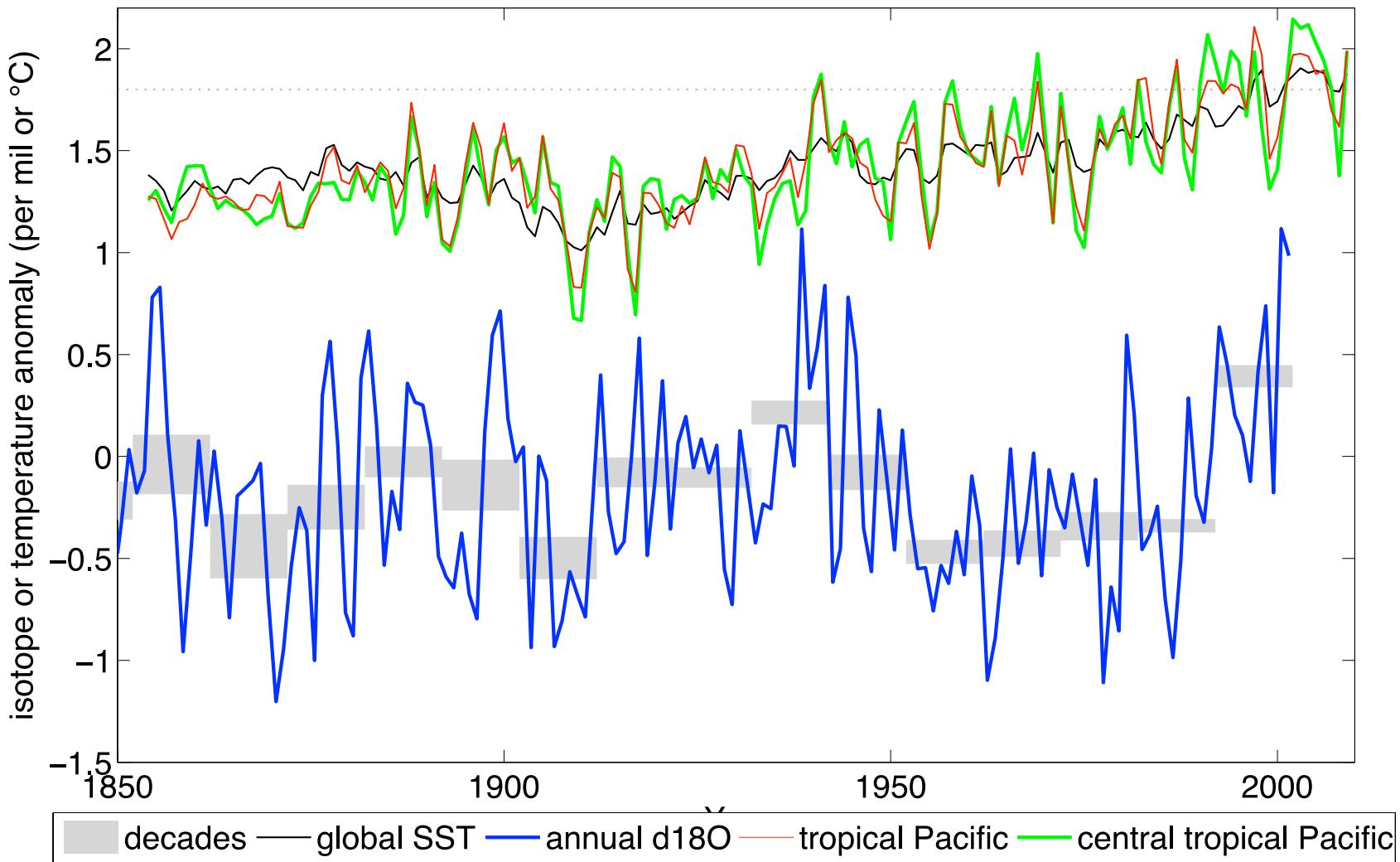


Küttel et al., in review

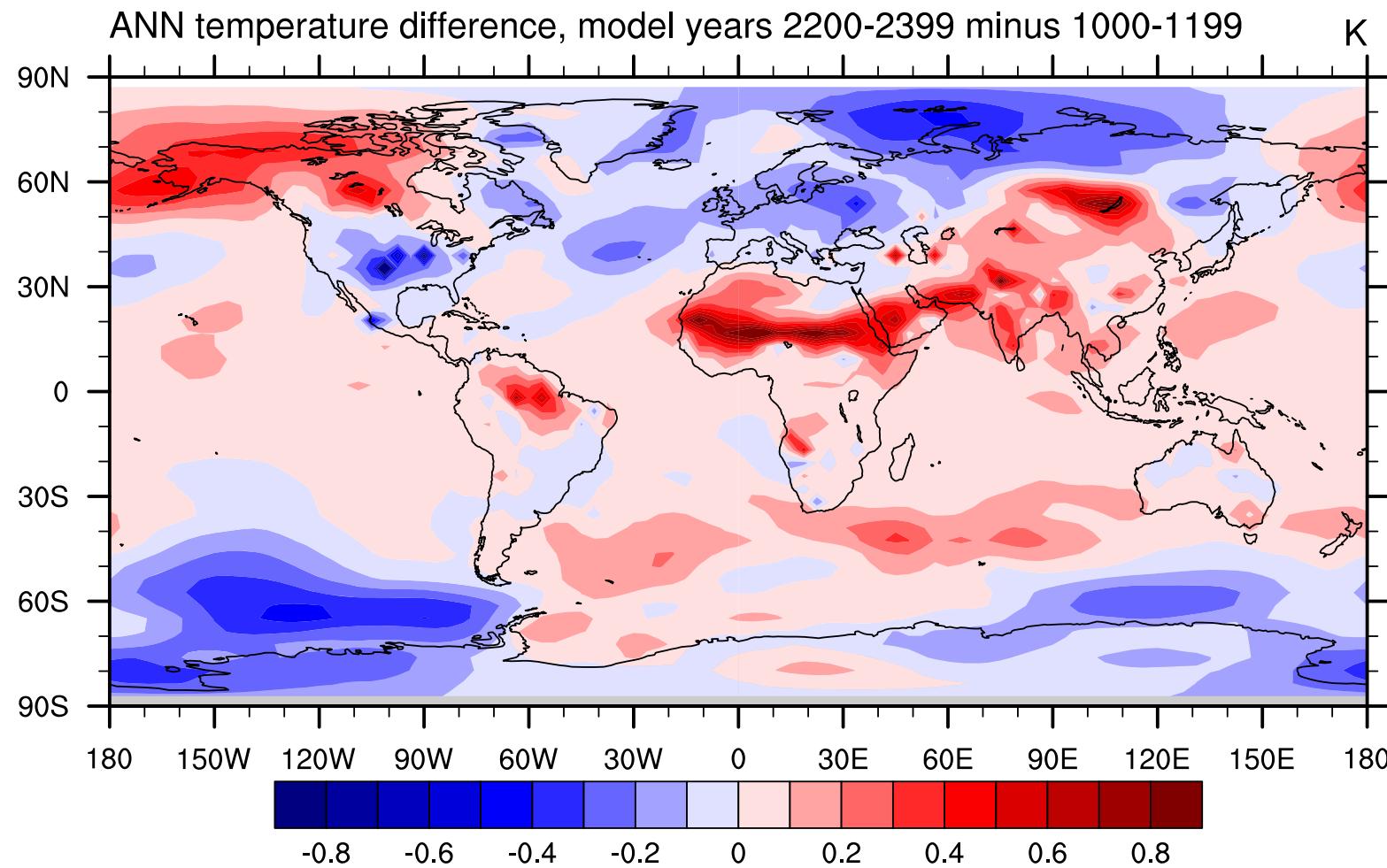
Spatial pattern of 1980 anomalies



SSTs and West Antarctic $\delta^{18}\text{O}$



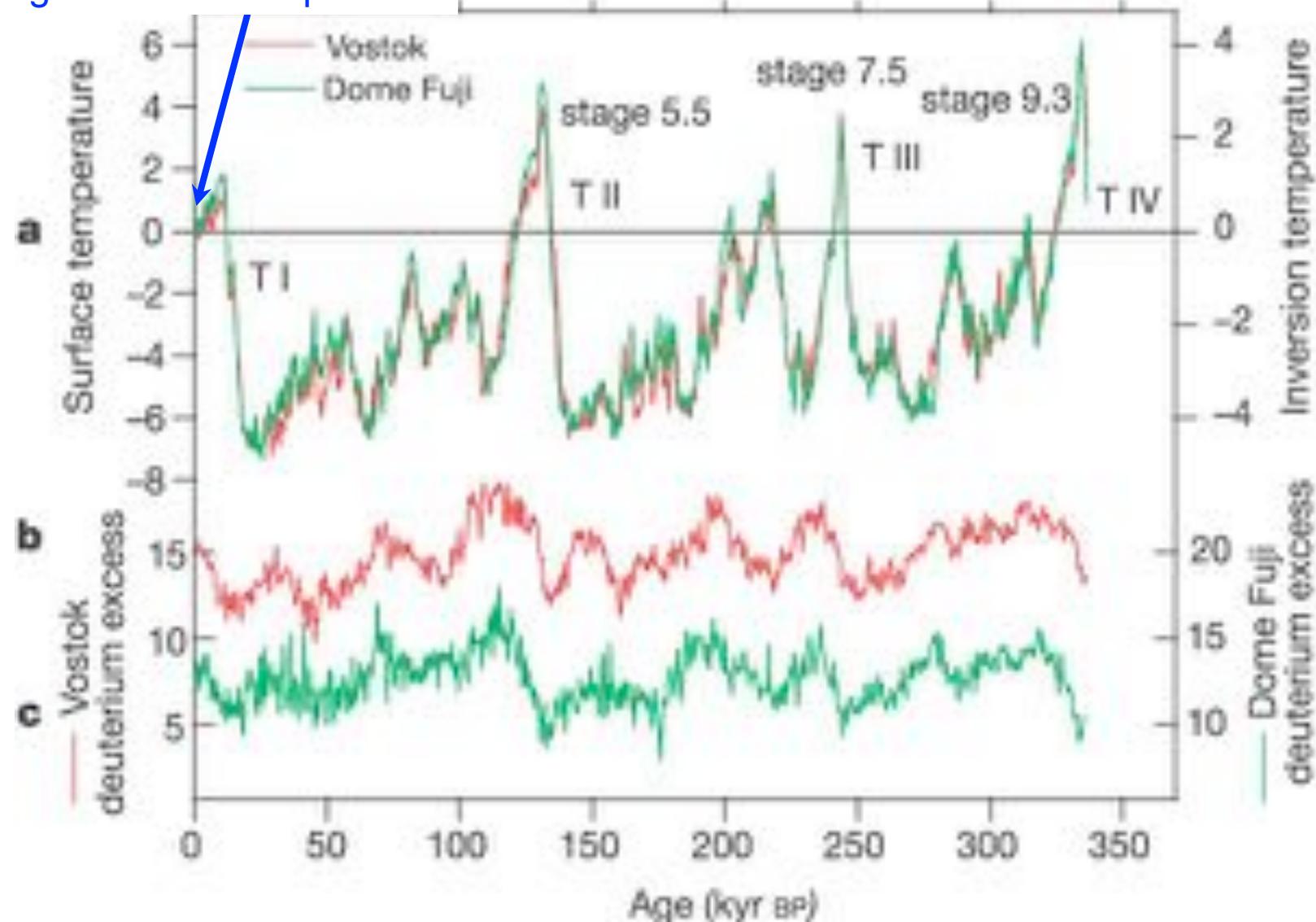
Even on long timescales, climate variability comes in patterns



Courtesy Bette Otto-Bleisner and David Schneider

Existing East Antarctic ice cores all look the same! What will South Pole look like?

Declining Holocene temperature



Summary

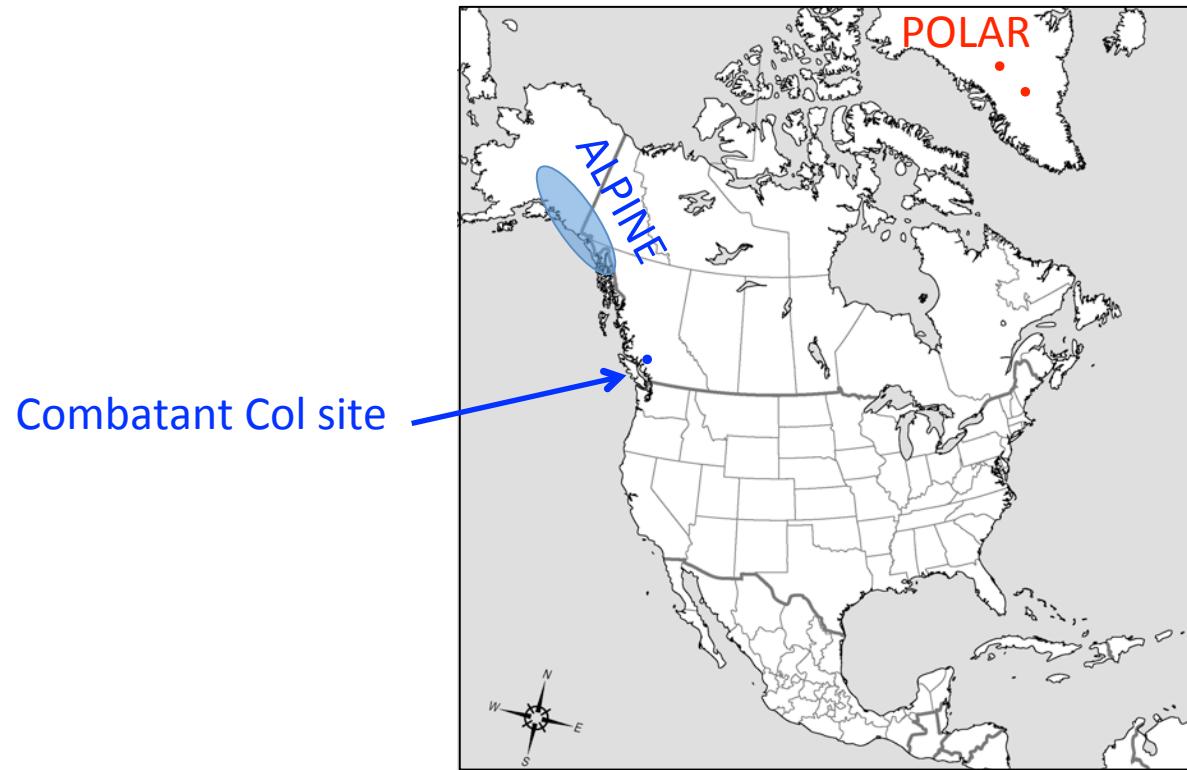
- The dominant influence on Antarctic climate is different in different locations. The response to the same forcing is different in different locations. This is true all timescales.
- ITASE cores are already out of date (2010 was the warmest summer on record at South Pole, for instance)
- South Pole and Hercules Dome are climatically distinct from other East Antarctic sites.
- WAIS Divide will not be the last word on WAIS – we need multiple cores to get the full spatial picture. There may be Eemian ice Herc Dome.

Alpine Ice Coring: Studies at Combatant Col

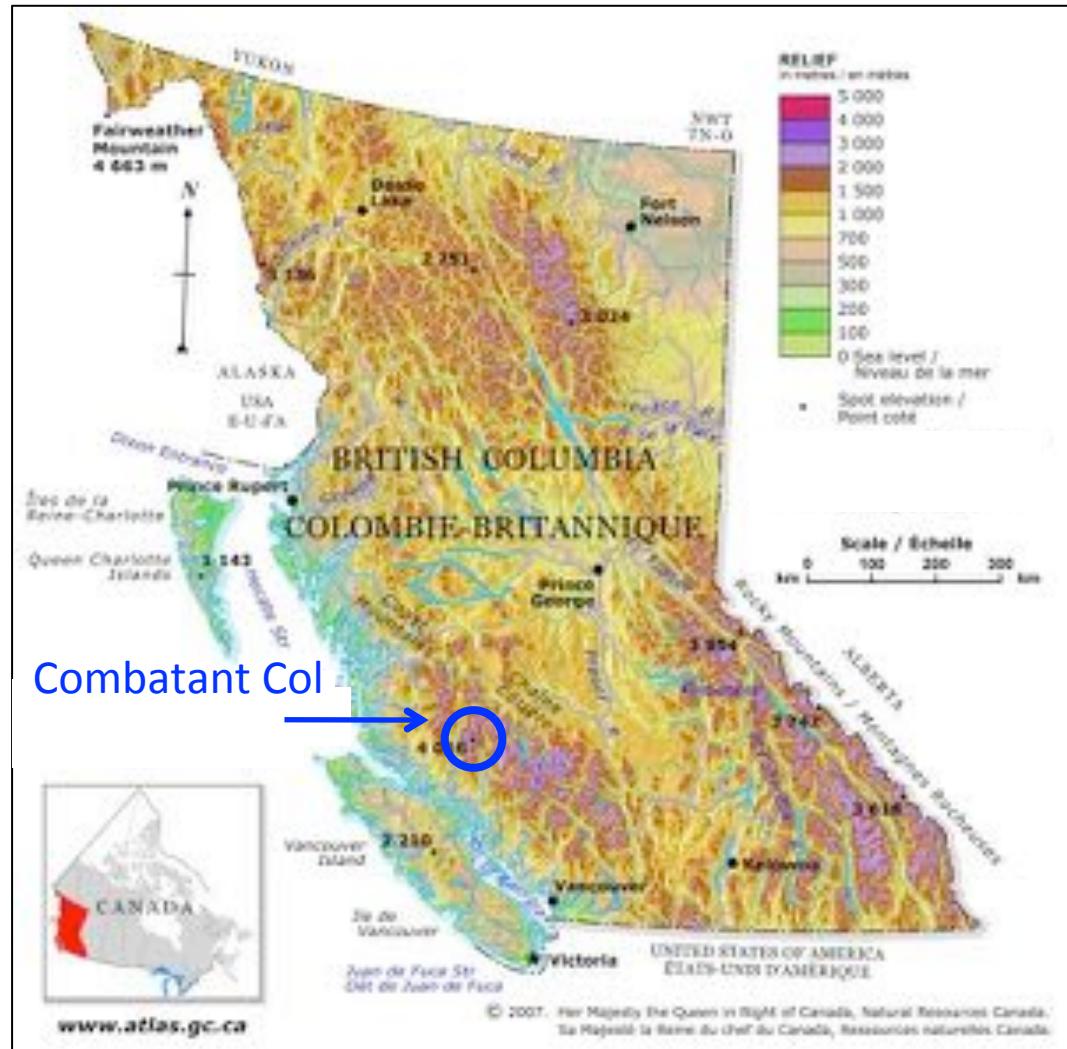
British Columbia, Canada

Peter D. Neff, Eric J. Steig, Douglas H. Clark, Joseph R. McConnell, Erin C. Pettit





COMBATANT COL SITE (51.39°N, 125.22°W), 3000m asl



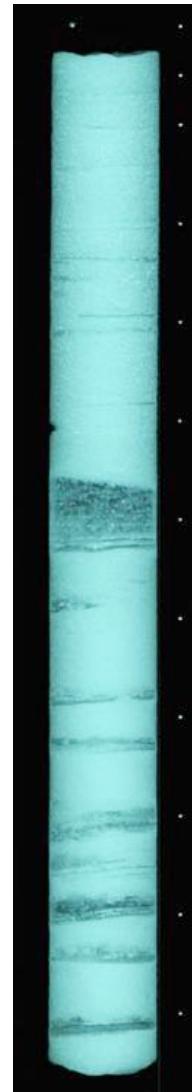


COMBATANT COL SITE (51.39°N , 125.22°W), 3000m asl

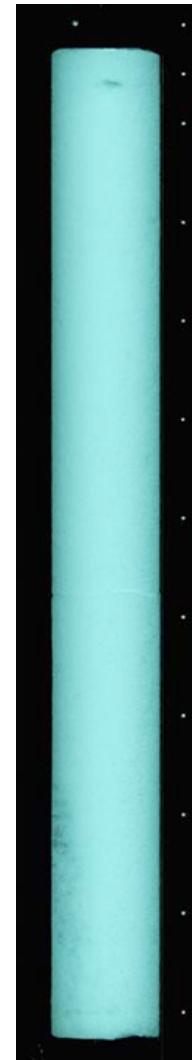
Surface snowmelt common

→ Not destructive, and useful as a summer indicator

Summer



Winter



COMBATANT COL SITE (51.39°N, 125.22°W), 3000m asl

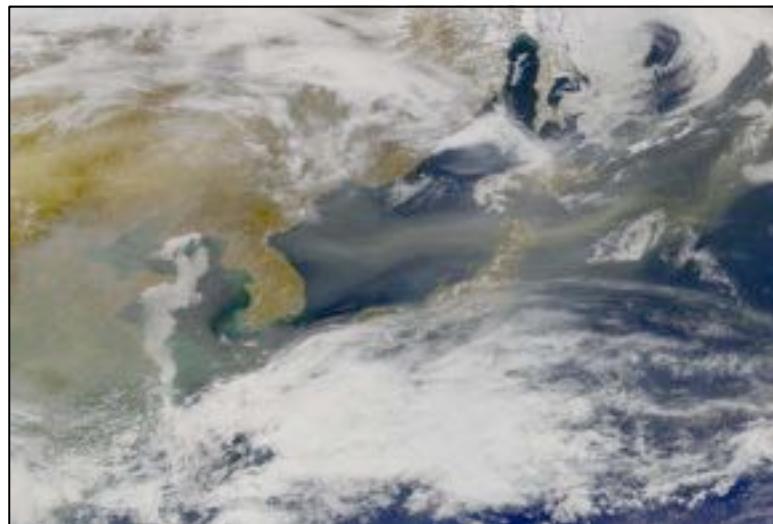
Surface snowmelt common

→ Not destructive, and useful as a summer indicator

Annual snow accumulation high, but...

→ Ice is deep (250-300 meters)

Dust peaks every Spring-Summer, from forest fires and Asian sources



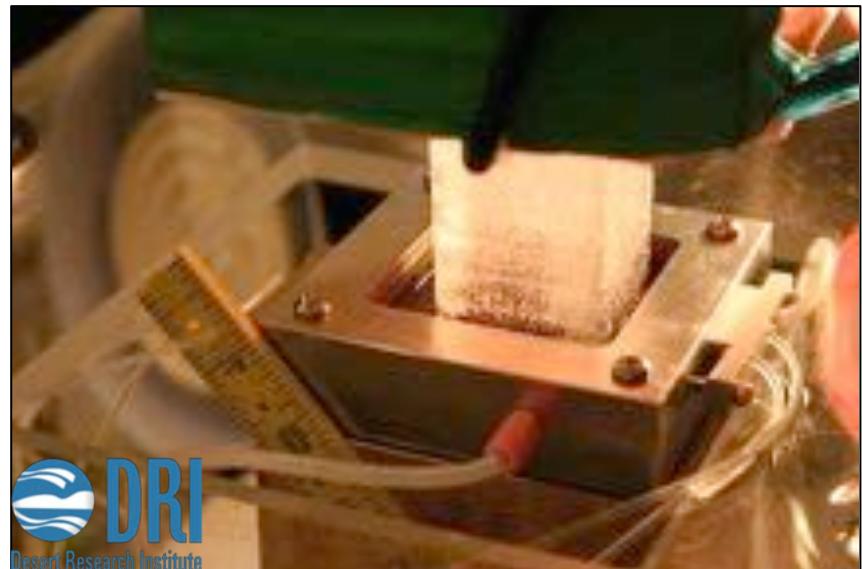
April 2001 event, NASA SeaWiFS

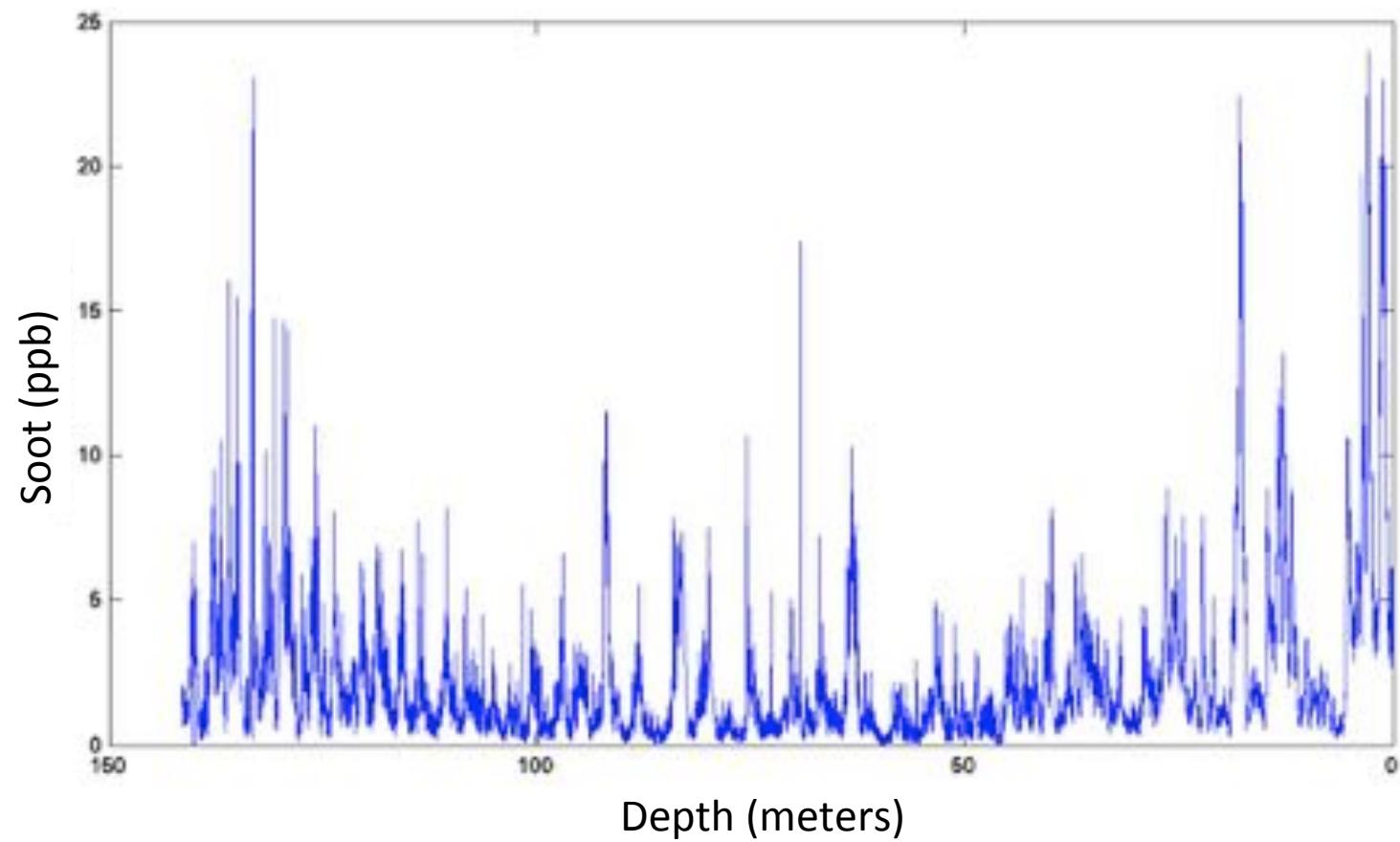
COMBATANT CHEMISTRY

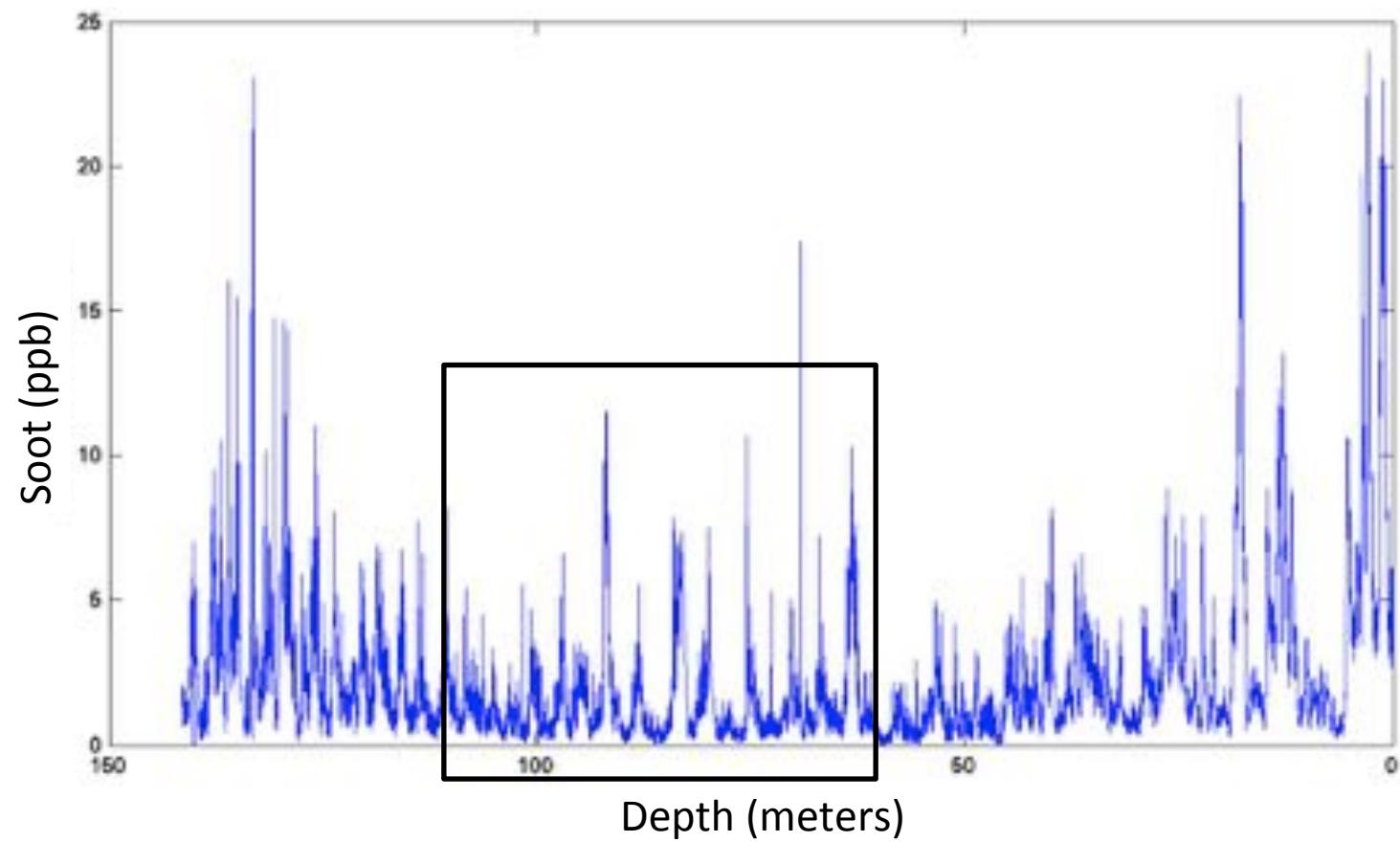
High resolution imaging for melt layer analysis

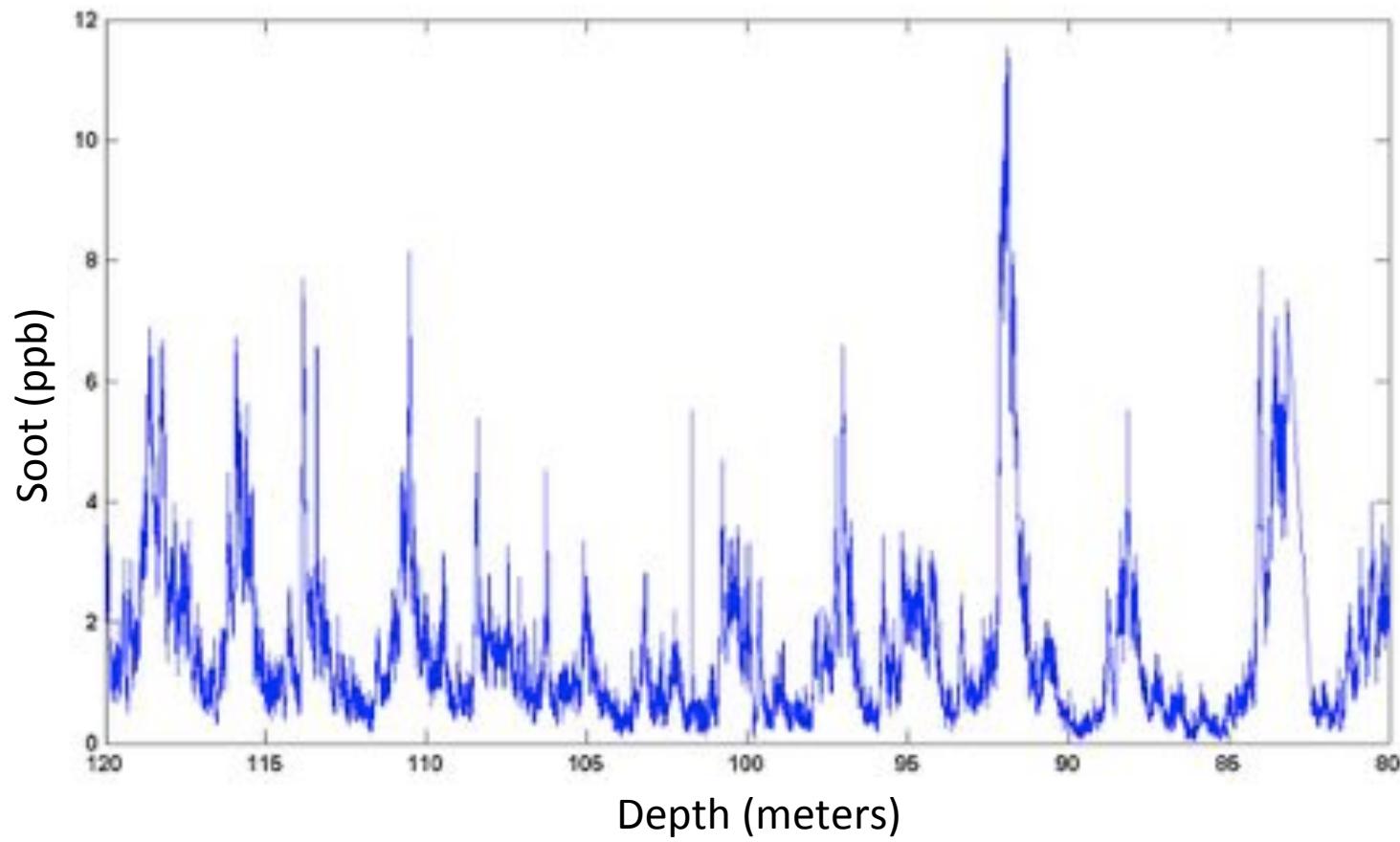
Ultra-trace continuous flow analysis of chemical species in water

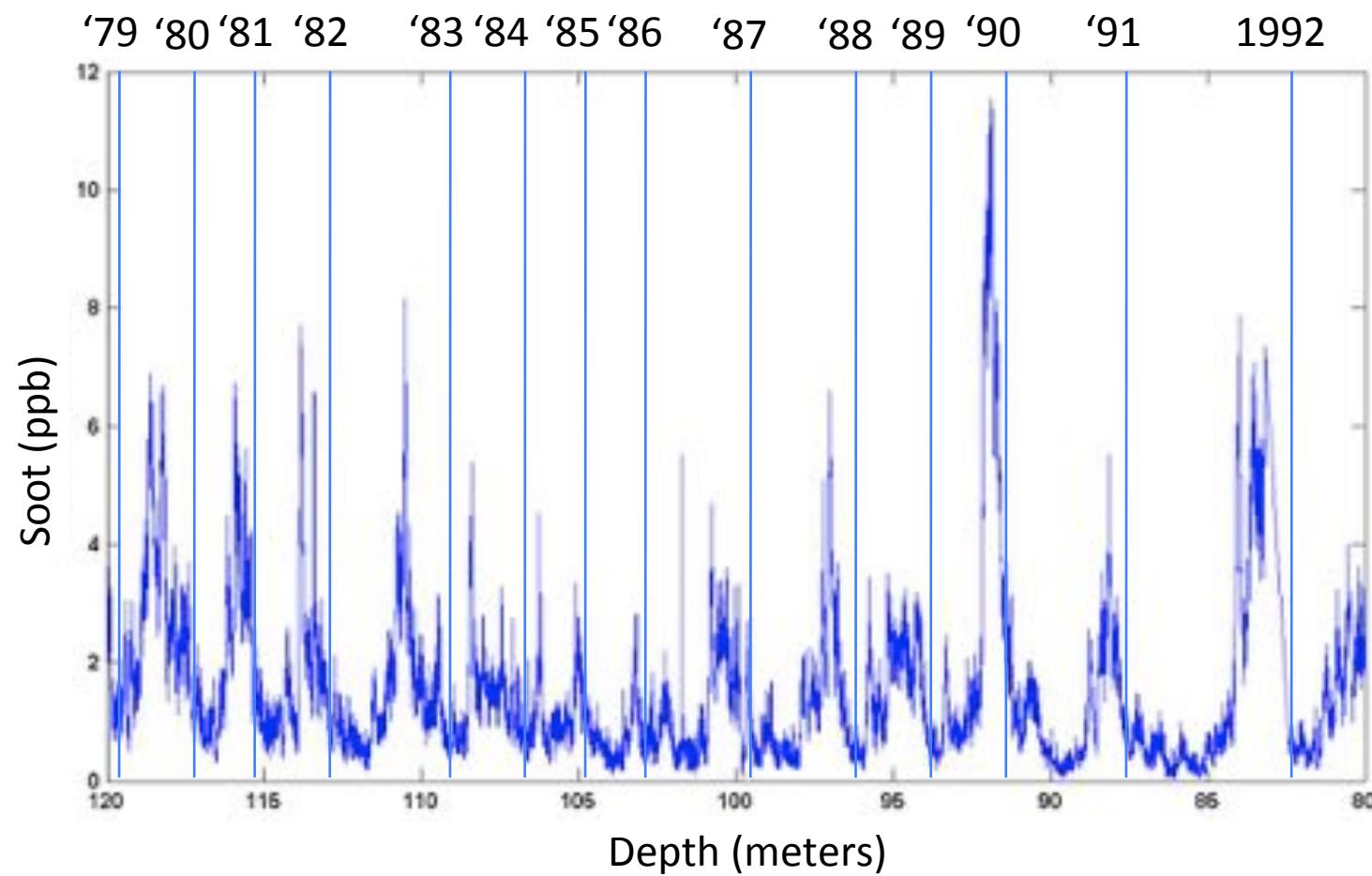
THIS MAKES THE DIFFERENCE AND
BRINGS **USEFUL** ALPINE ICE CORE
RECORDS TO THE TABLE

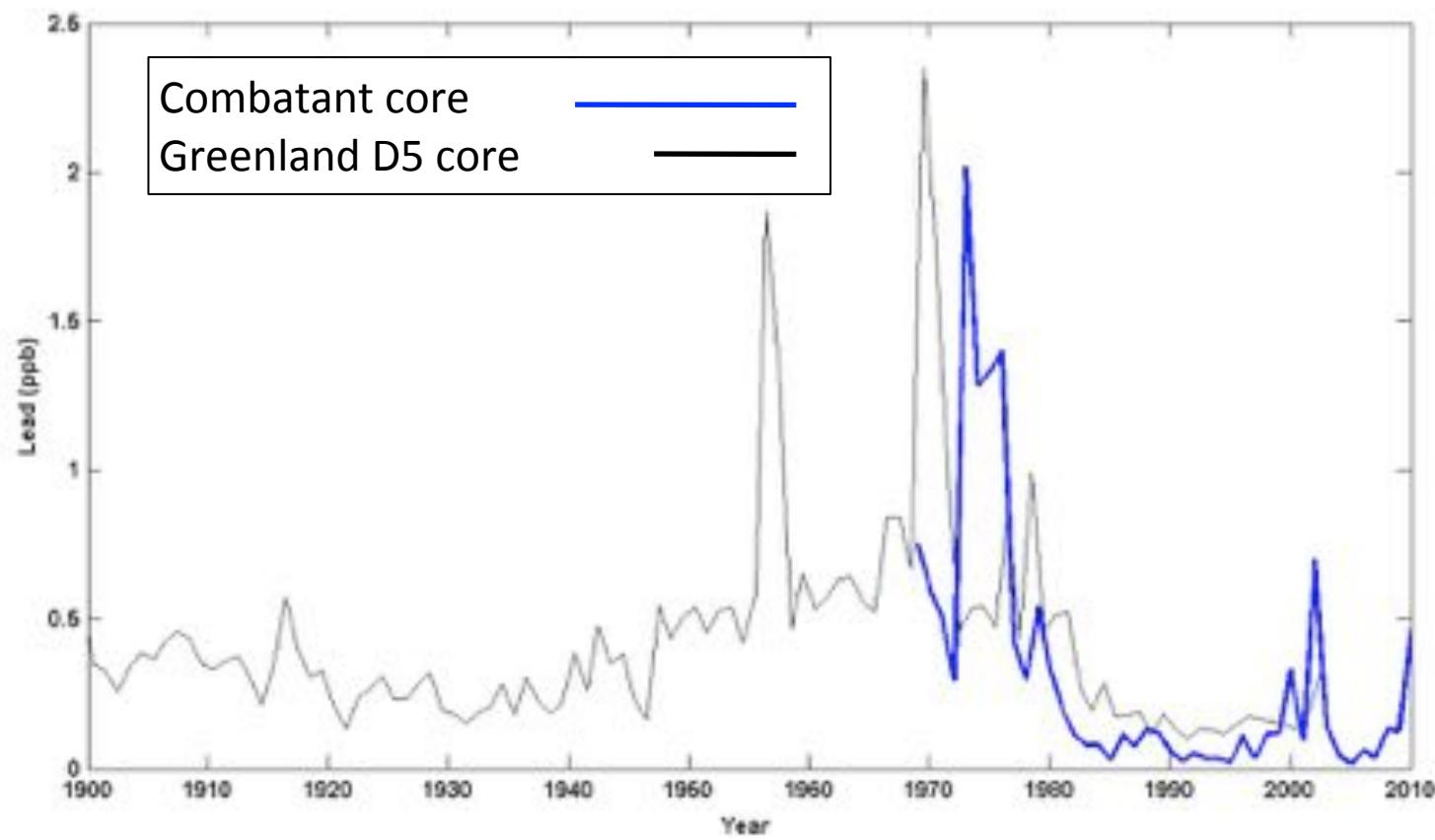




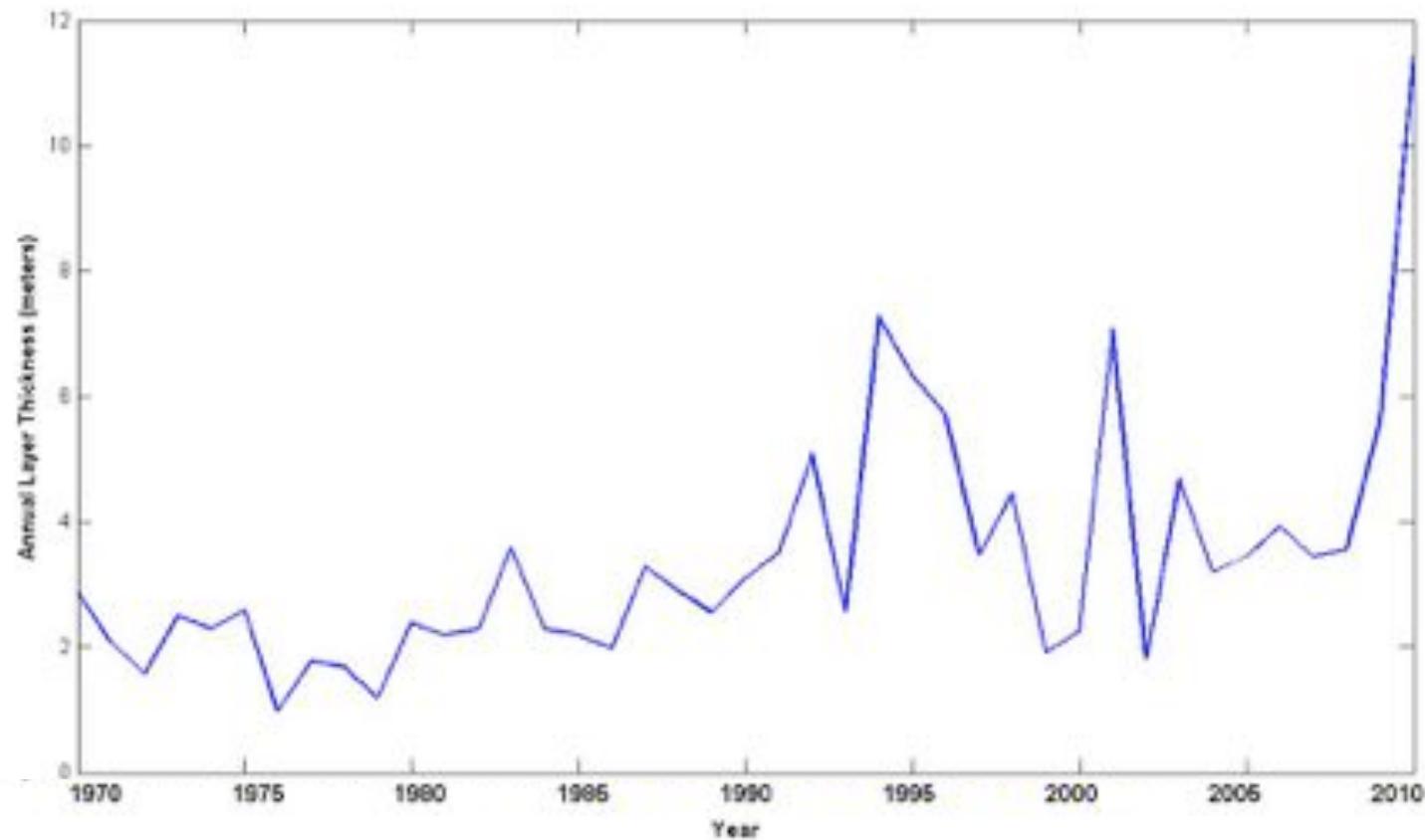








Accumulation history at Combatant Col



Problem: water prevented us from reaching bedrock

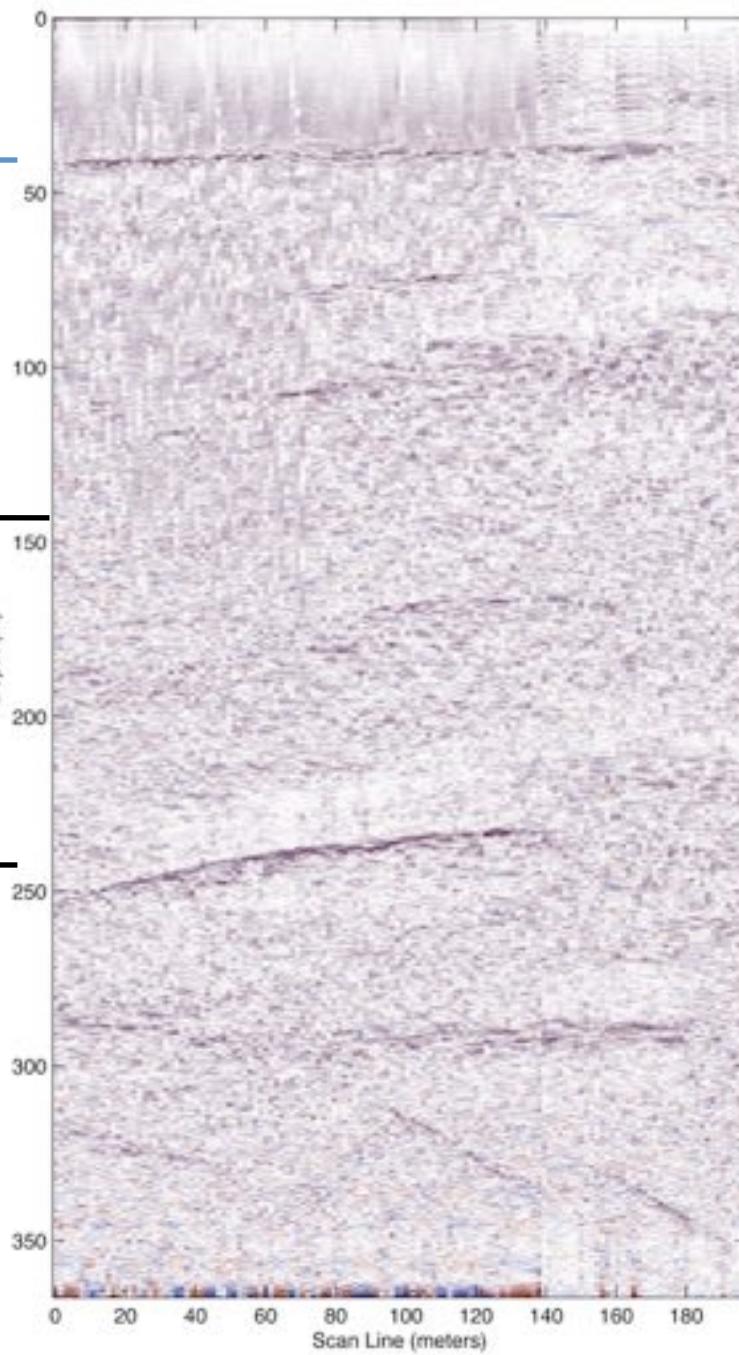
Cold ice

Temperate
ice

Limit of successful drilling

Bedrock

Depth (m)



Summary

- Temperate sites such as Mt. Waddington (Combatant Col), McGall Glacier (Alaska), Fremont Glacier (Wyoming), have more potential than once thought. High resolution chemistry shows annual layer is preserved.
- Drilling in these locations probably requires new technology