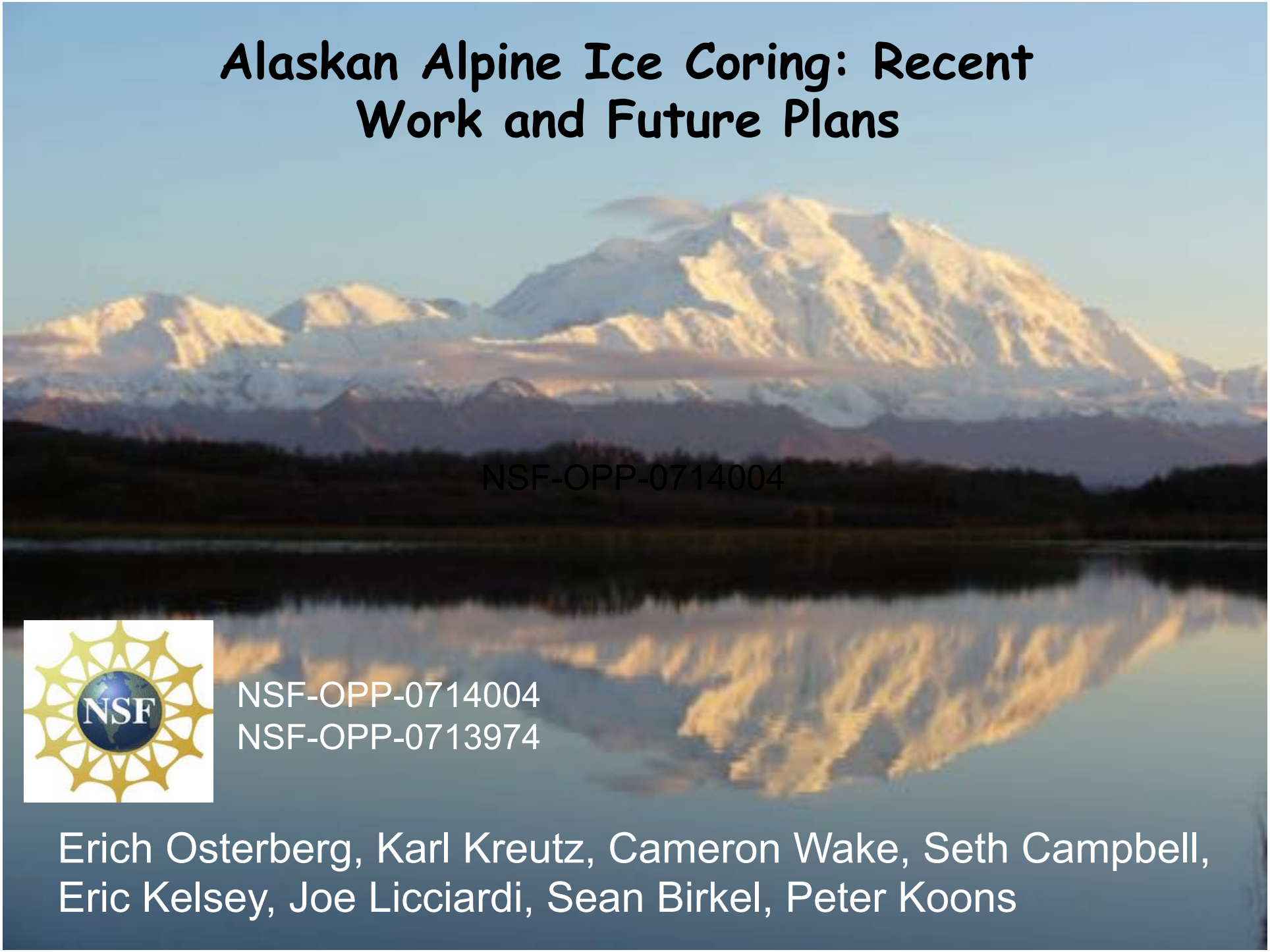
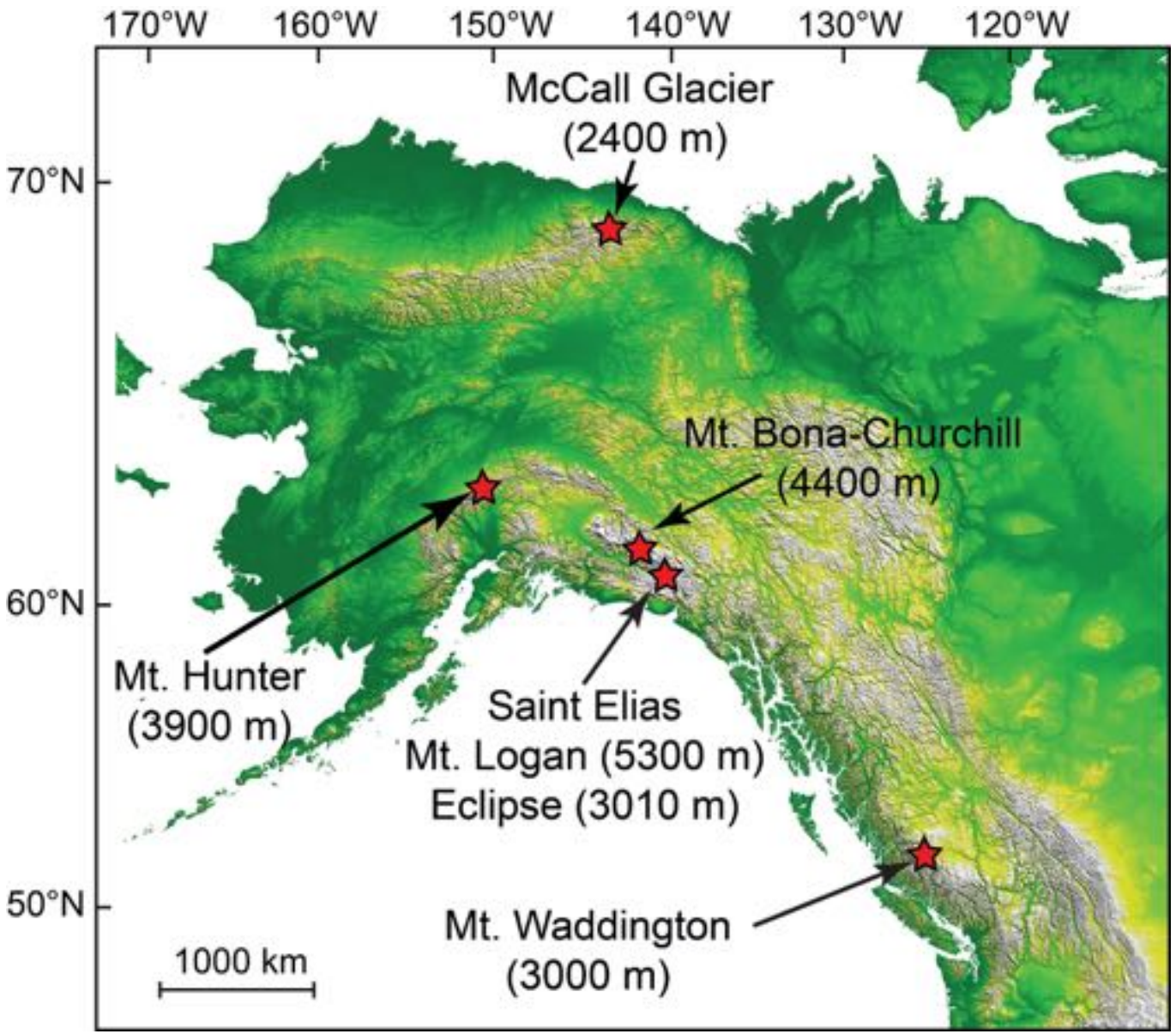
Alaskan Alpine Ice Coring: Recent Work and Future Plans



NSF-OPP-0714004
NSF-OPP-0713974

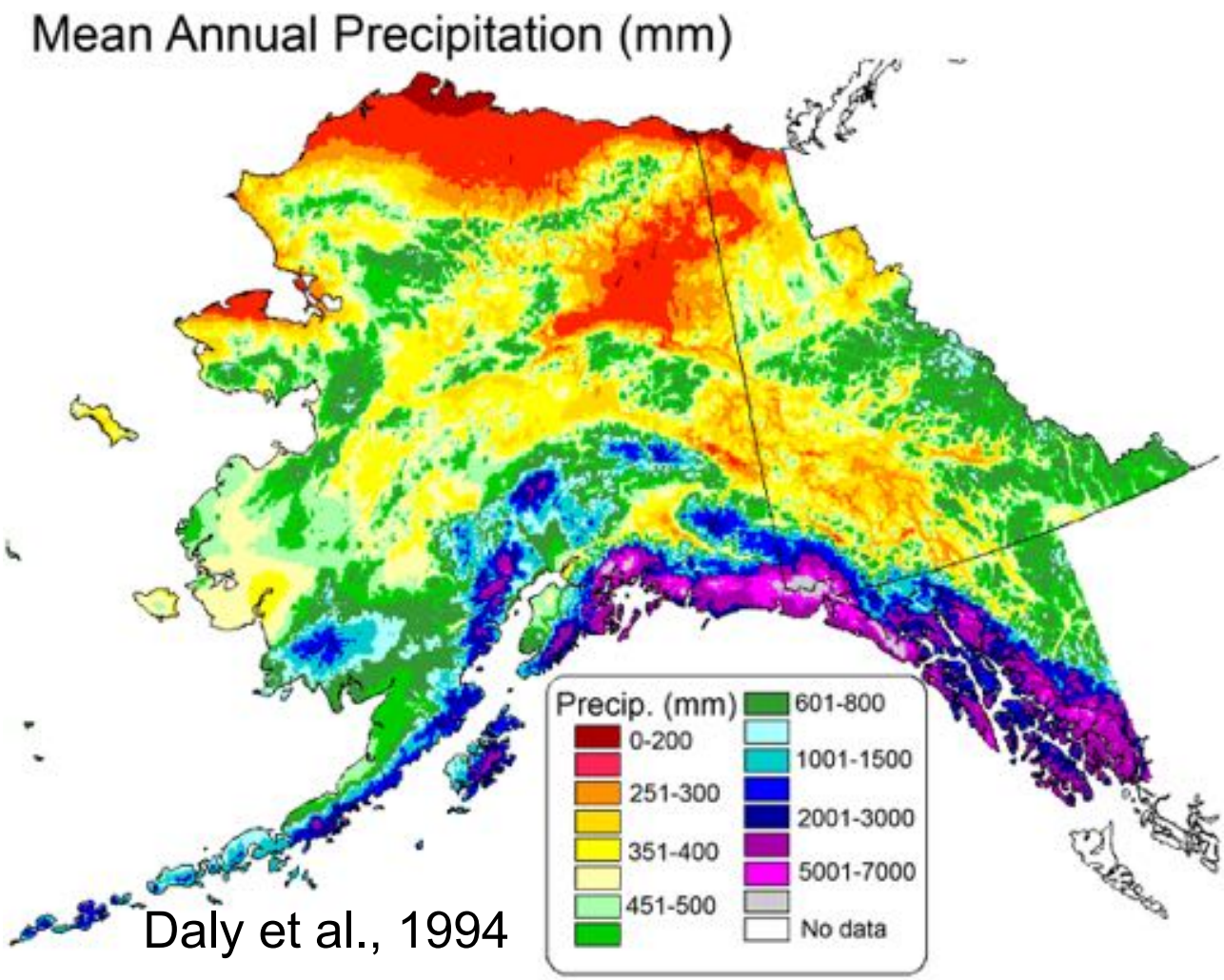
Erich Osterberg, Karl Kreutz, Cameron Wake, Seth Campbell, Eric Kelsey, Joe Licciardi, Sean Birkel, Peter Koons

North Pacific Ice Core Locations



Alaskan Ice Core Research Questions

PRISM 1 km data



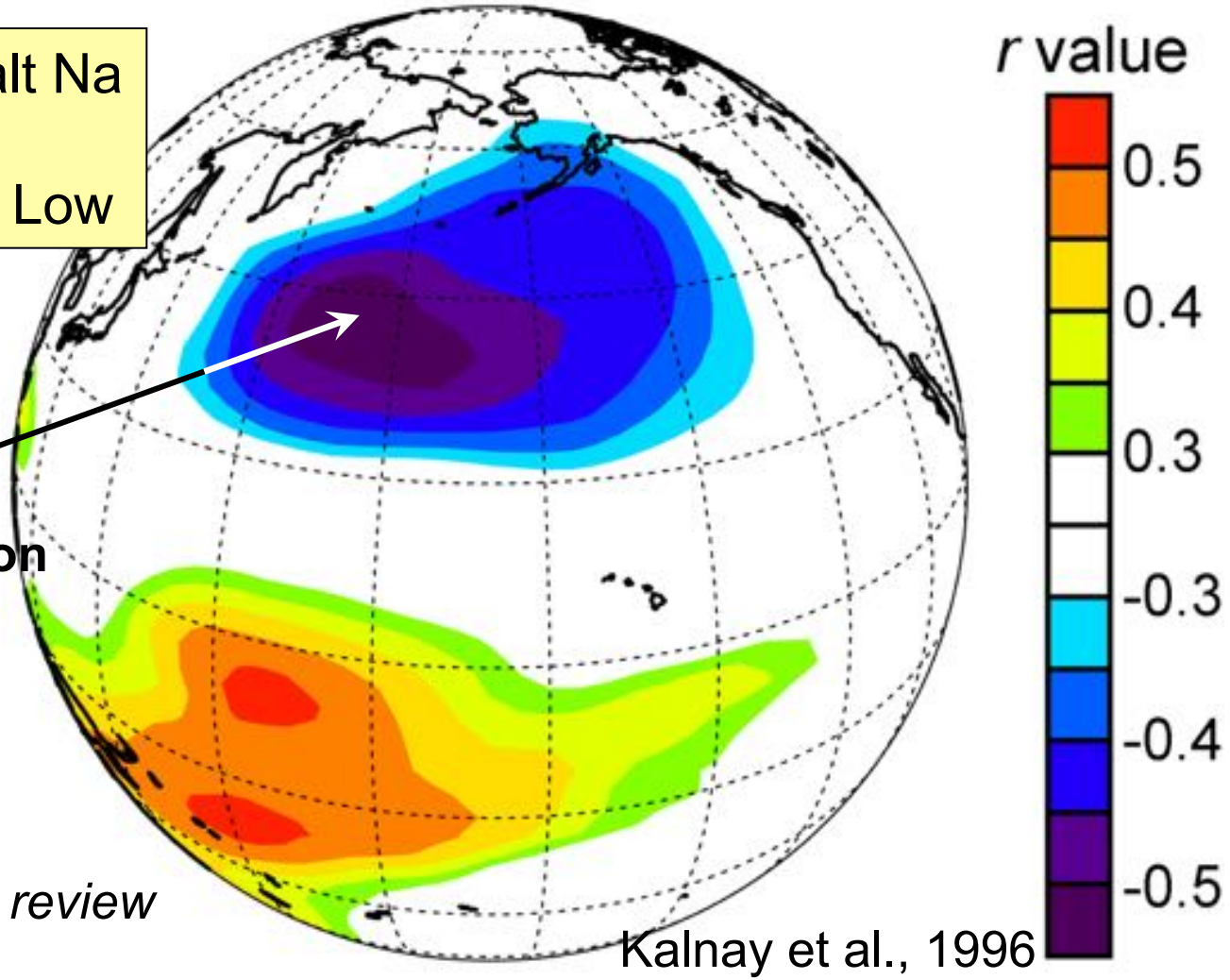
Daly et al., 1994

Denali AWS

2. How did the PDO, AO, and ENSO influence Alaskan paleoclimate, particularly during the LIA and MCA?

Mt. Logan Annual [Na^+]

Mt. Logan sea-salt Na correlated with stronger Aleutian Low



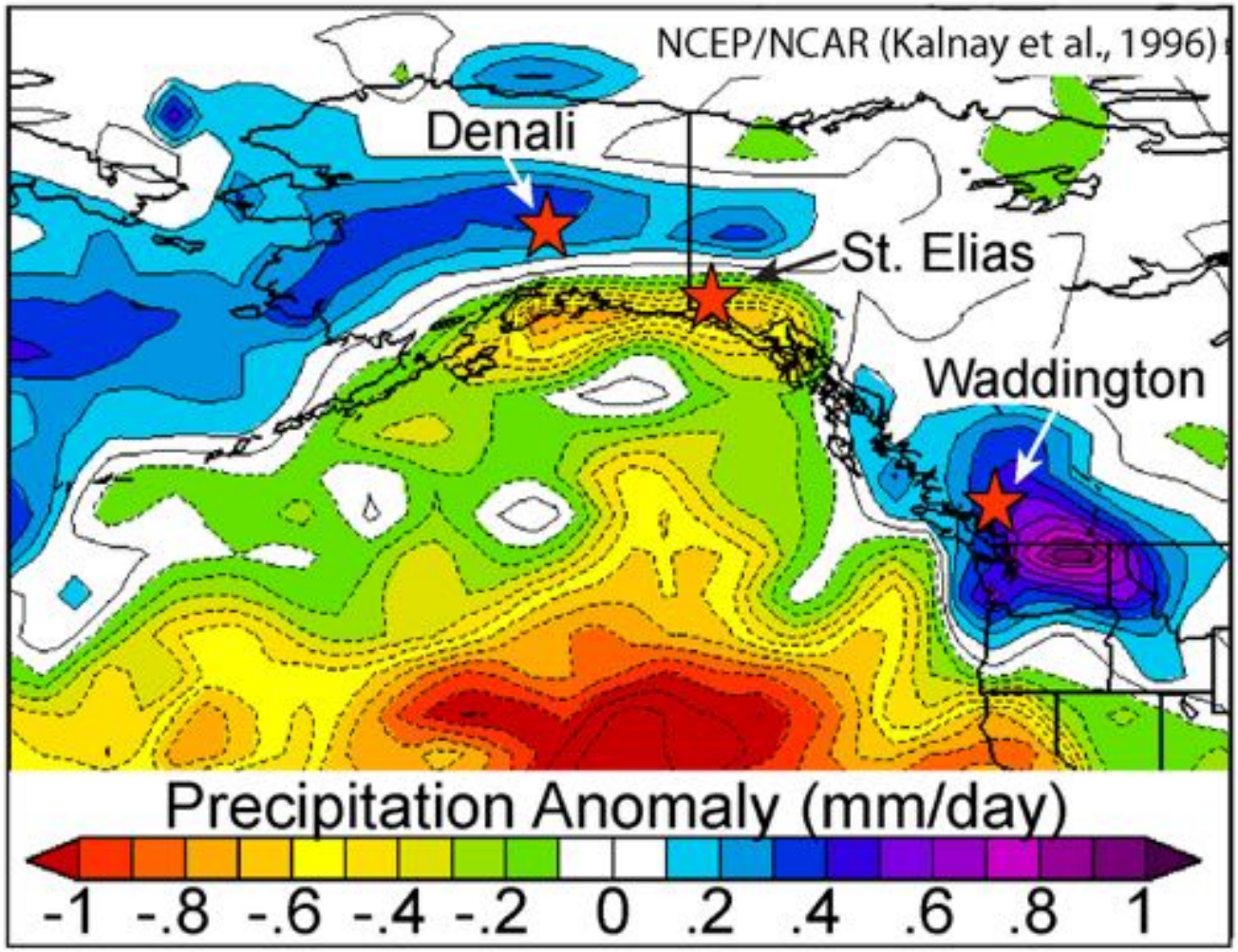
Best Correlation
r = -0.53
p < 0.001

Osterberg et al., in review

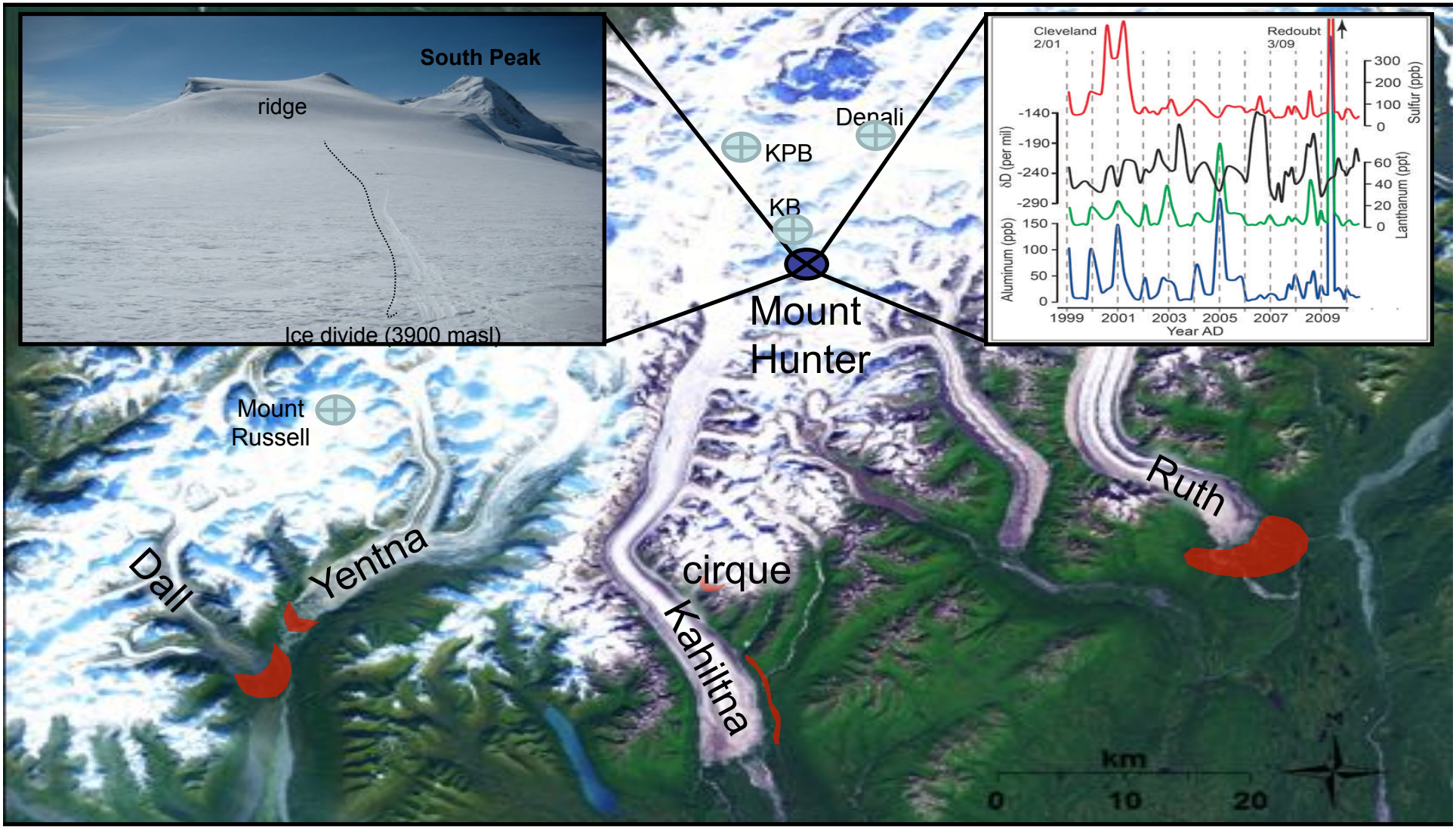
Kalnay et al., 1996

2. How did the PDO, AO, and ENSO influence Alaskan paleoclimate, particularly during the LIA and MCA?

Weak Aleutian Low Precipitation Anomaly



3. How did Alaskan glaciers respond to past warm and cold periods, and how sensitive are they to future warming?



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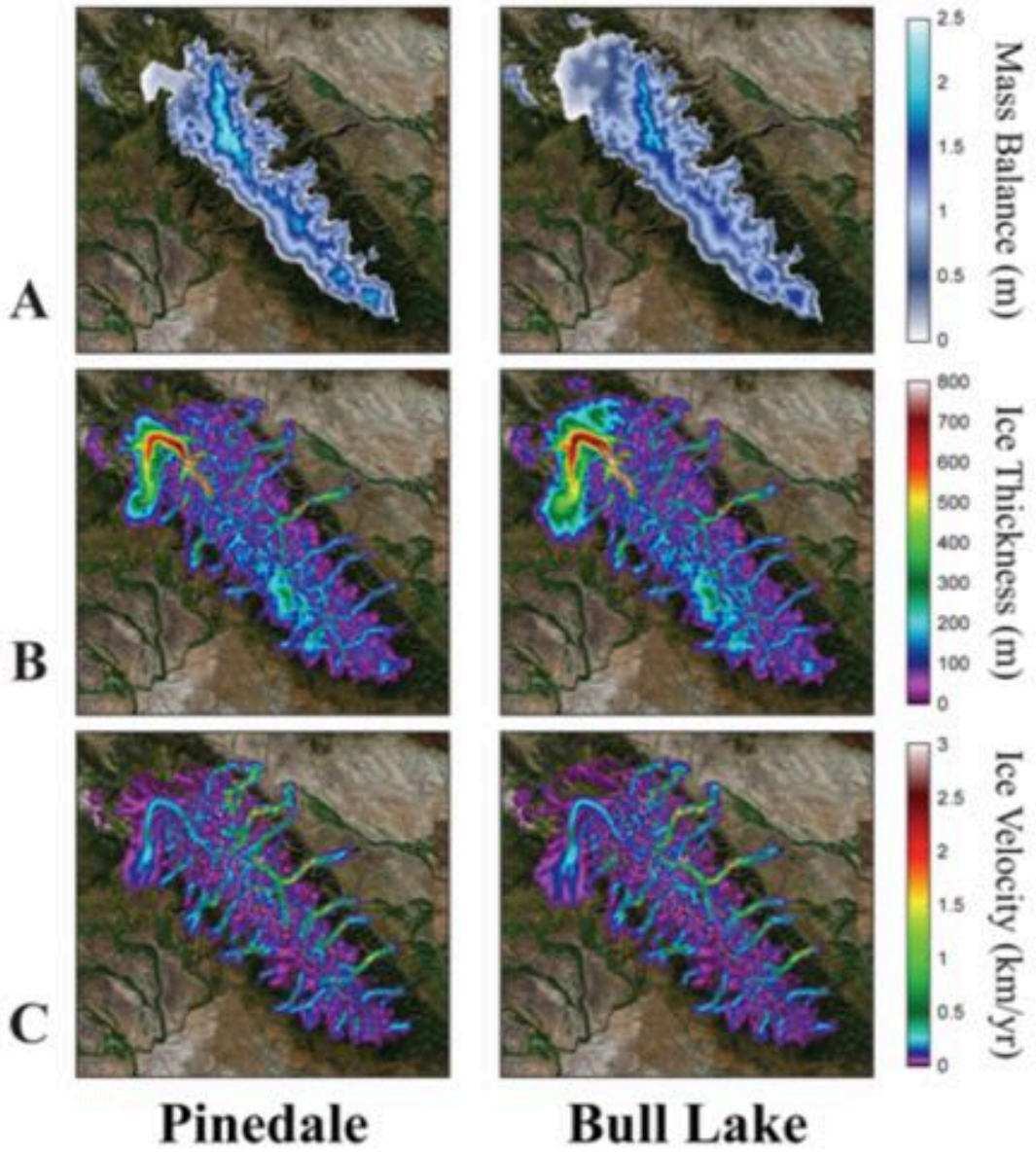
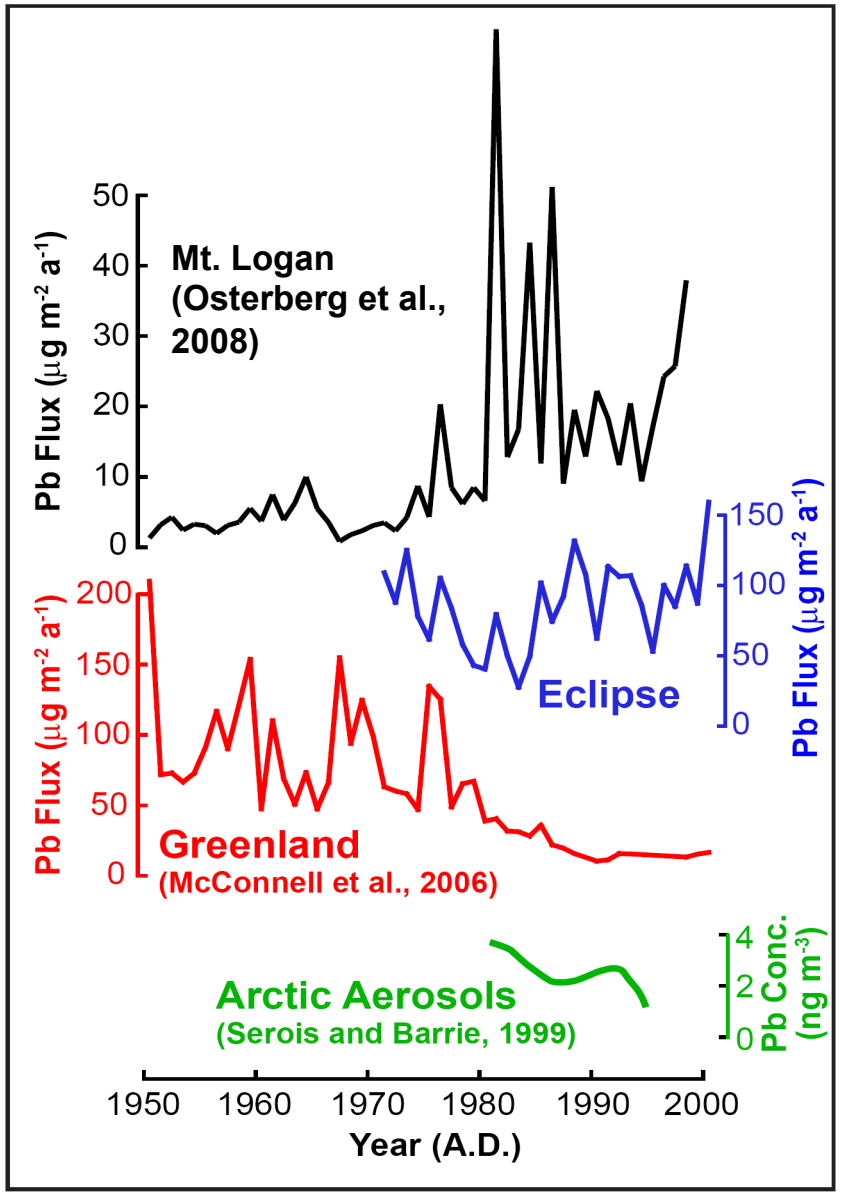
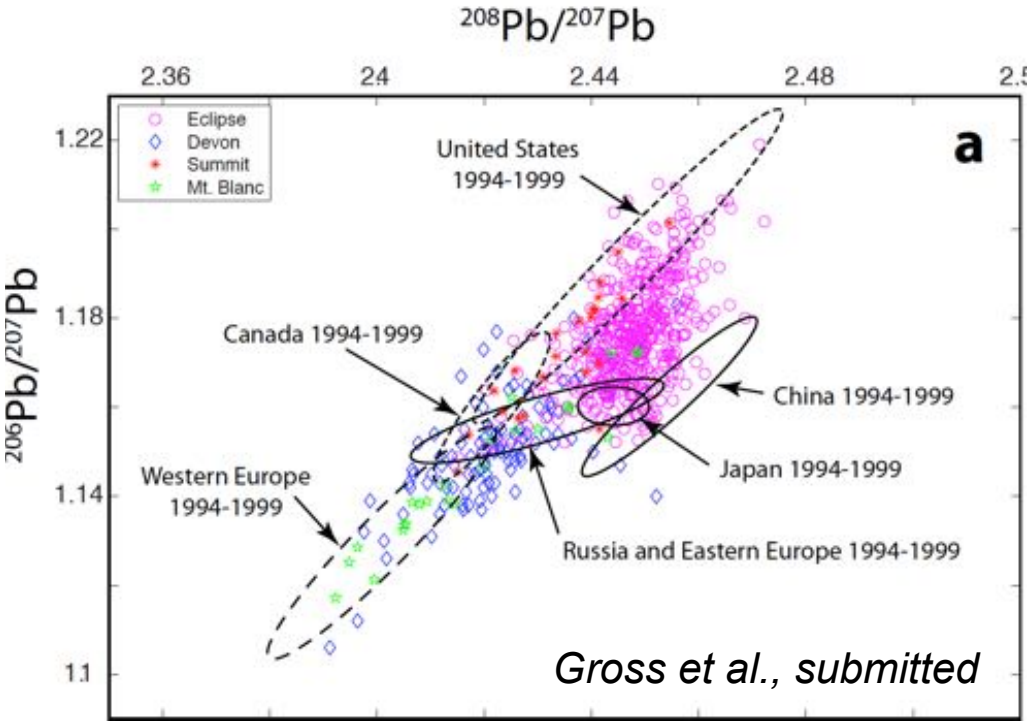


Birkel, 2010

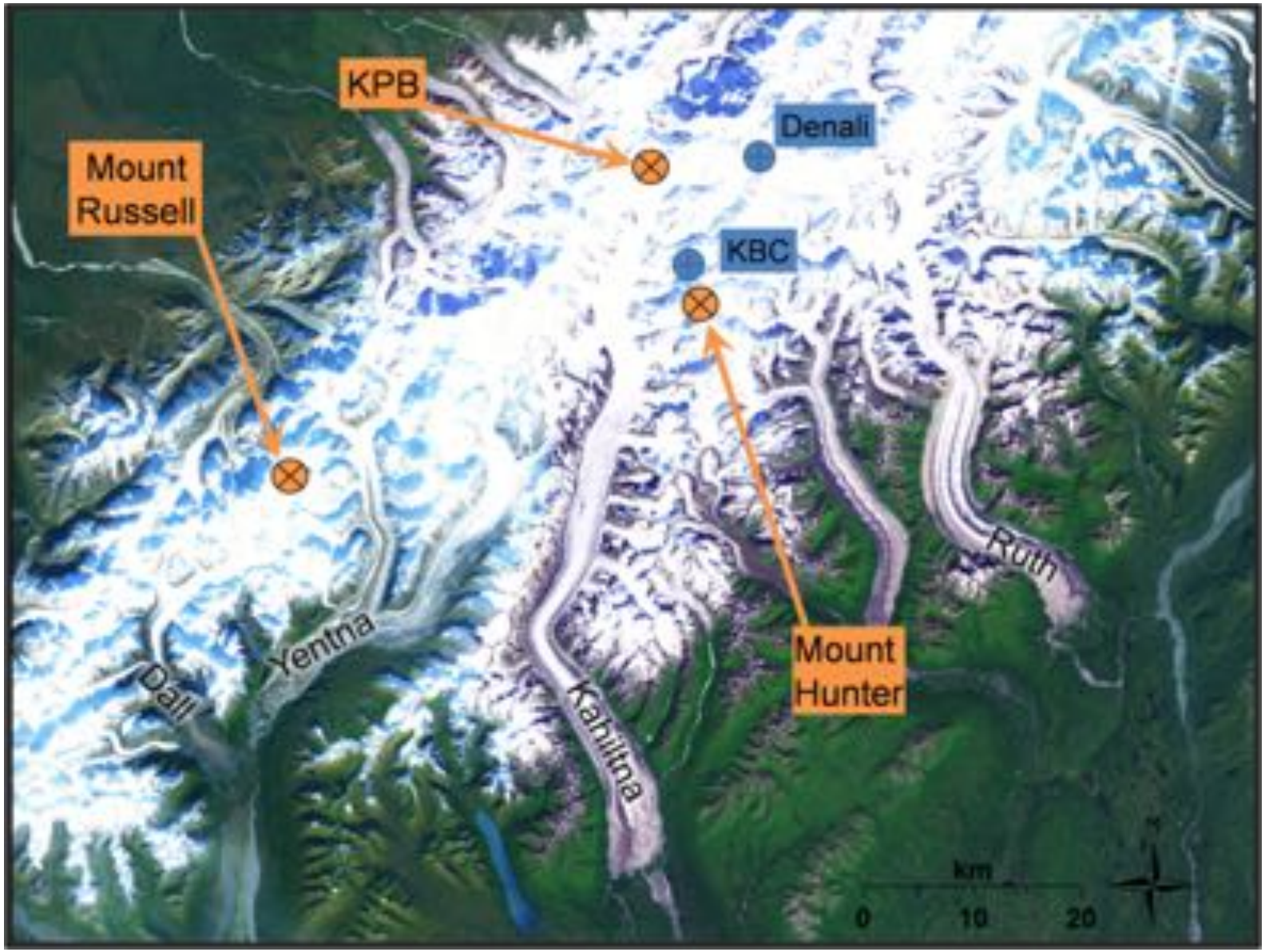
4. What are the sources and transport pathways of atmospheric dust and pollution?



Trans-Pacific pollution from the west, Arctic air pollution from the north



Denali Potential Drill Sites Evaluated, 2008-2011

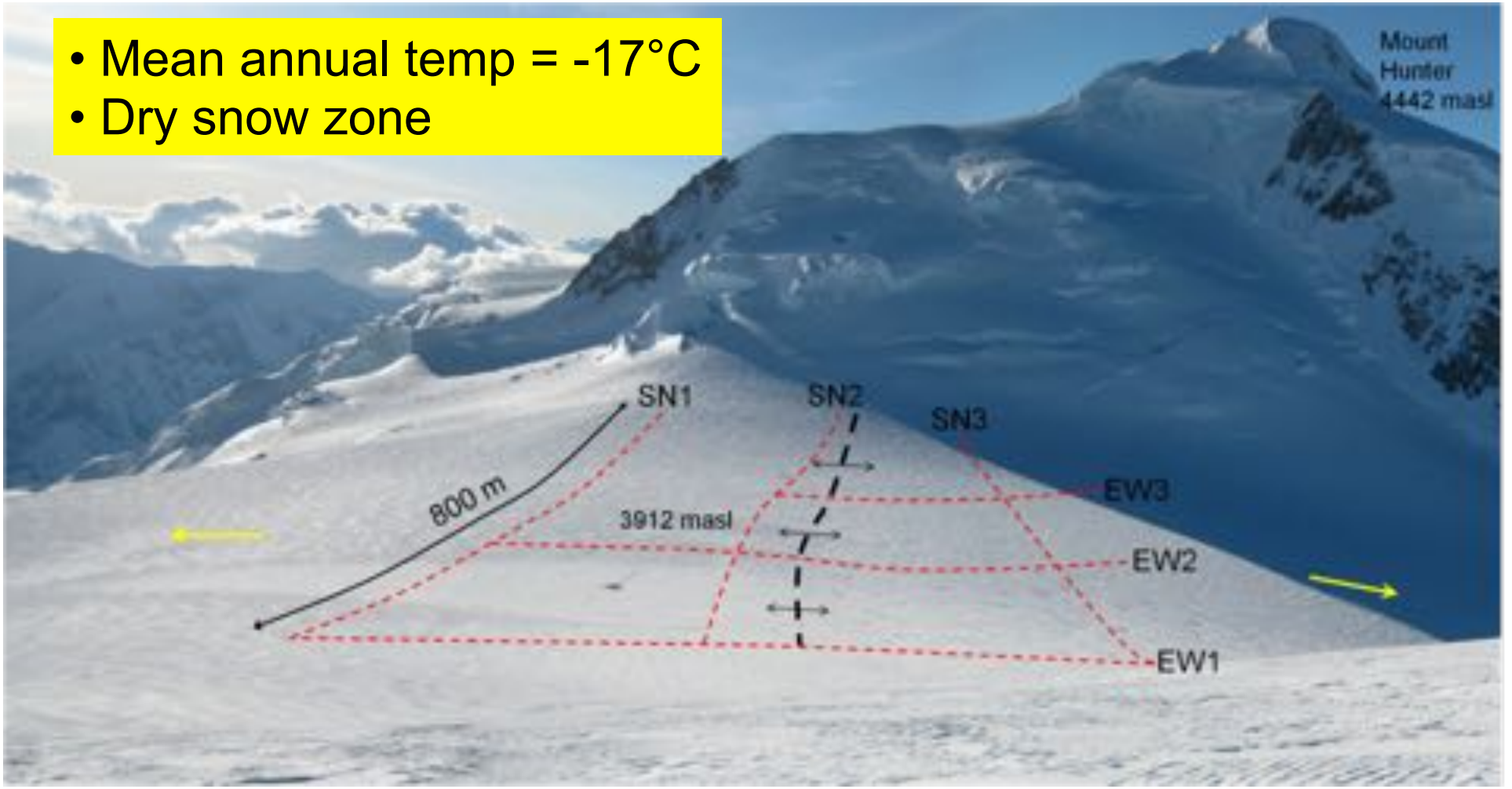


Recon. Field Methods; Pits and Hand Auger

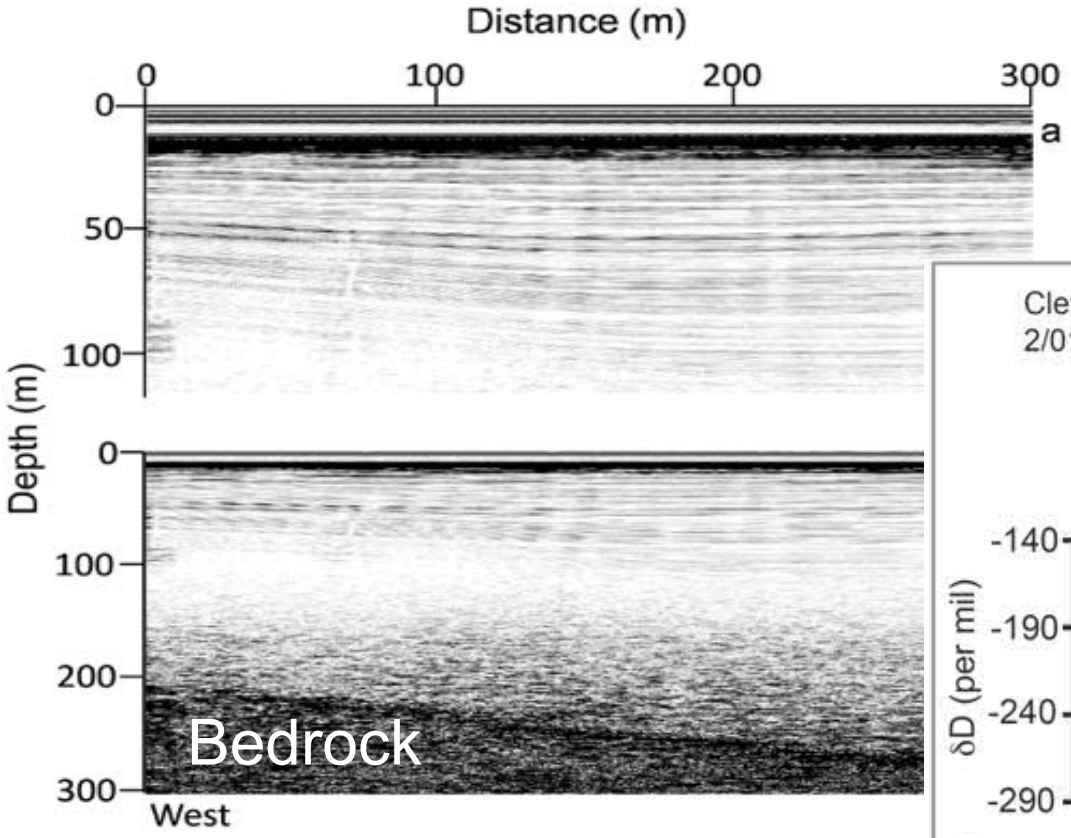
Drillsite reconnaissance requires use of lightweight, portable auger for 10-30 m cores

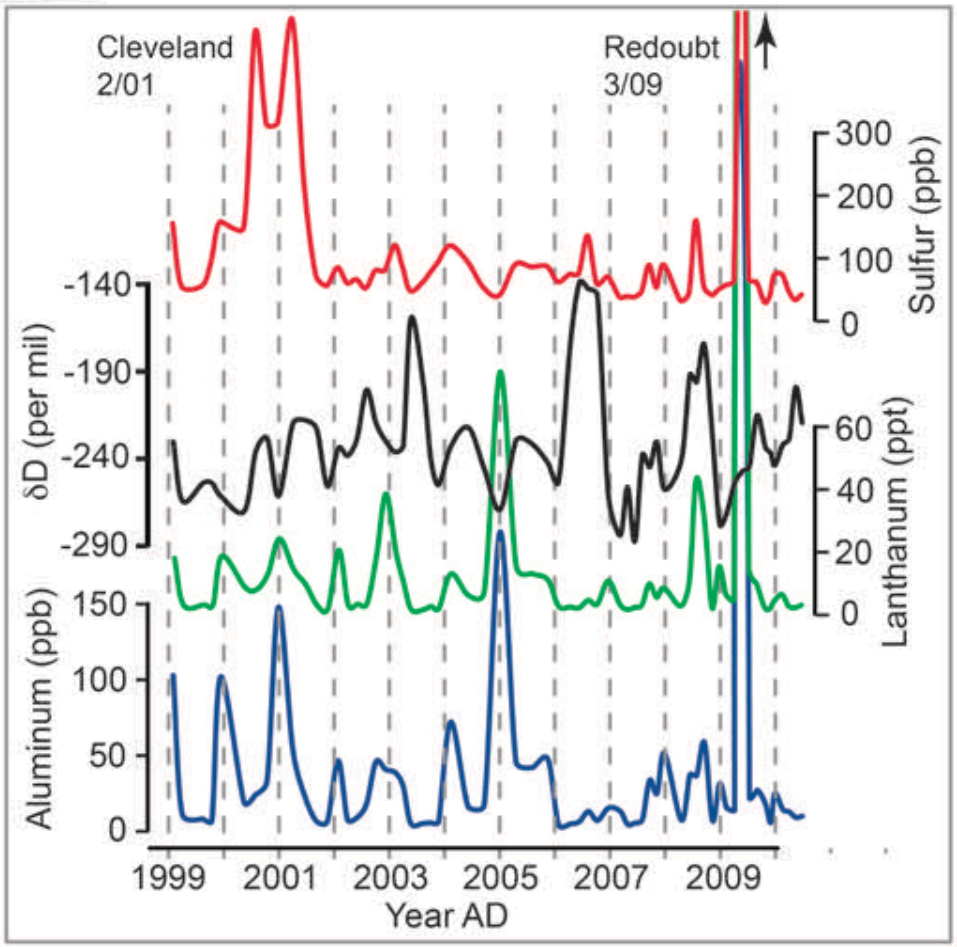
Potential 2012 Core to Bedrock: Mt. Hunter Plateau, 3900 m

- Mean annual temp = -17°C
- Dry snow zone



Mt. Hunter GPR and Chemistry



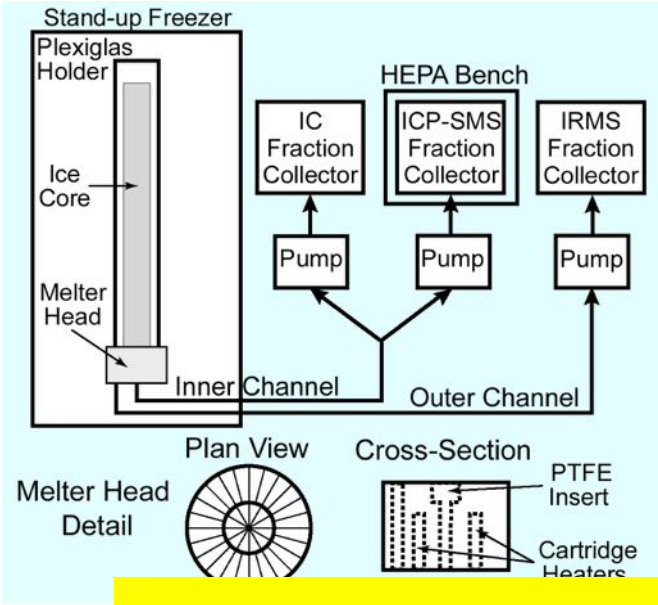


- 270-300 m of firn/ice
- ~0.7 m w.e. a^{-1} accum.
- >1000 year climate record

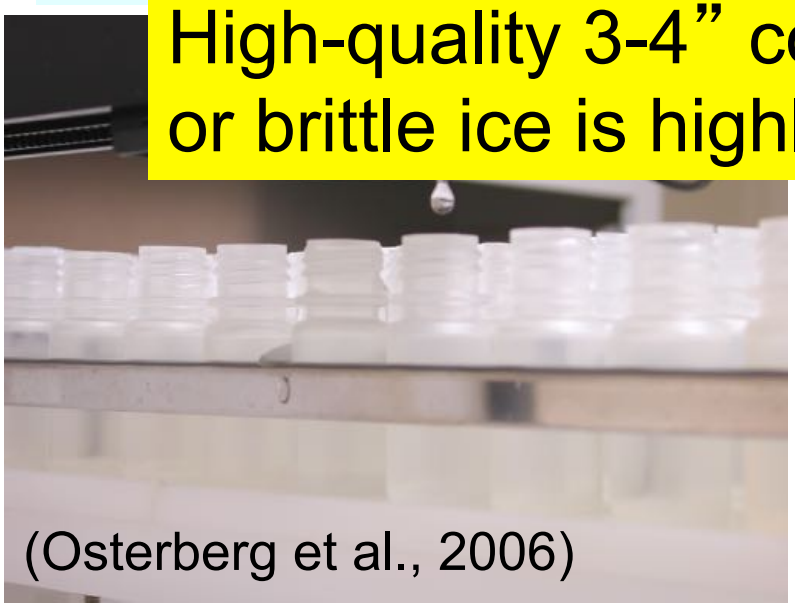
Logistical Constraints

- Drill must be portable by helicopter
- Turbine otter is sometimes available (Denali), but not always
- Drilling to bedrock (~300 m) completed by a small team (~5) in one field season

Continuous Ice Melting with Discrete Sampling



High-quality 3-4” core with minimal breaks or brittle ice is highly advantageous



(Osterberg et al., 2006)

Ice Core Chemical Analyses

Ice Core Chemistry Measurements:

- Sub-annual sampling for glaciochemistry
- Major Ion concentrations by IC, including Na^+, Cl^-, Ca^{2+}, Mg^{2+}, SO_4^{2-}, NO_3^-, MS^-
- dD and $d^{18}O$ ratios by IRMS
- 25+ Trace element concentrations by ICP-MS, including Al, Fe, Pb, Bi, As, U, REEs (Osterberg et al., 2006)
- Additional specialty measurements including Hg, Hg speciation, Pb isotopes, Os concentrations and isotopes, etc.

Development of "clean" hand auger and shallow (Eclipse-like) drill would be beneficial

PAPER www.rsc.org/jem | Journal of Environmental Monitoring

An ultra-clean firn core from the Devon Island Ice Cap, Nunavut, Canada, retrieved using a titanium drill specially designed for trace element studies

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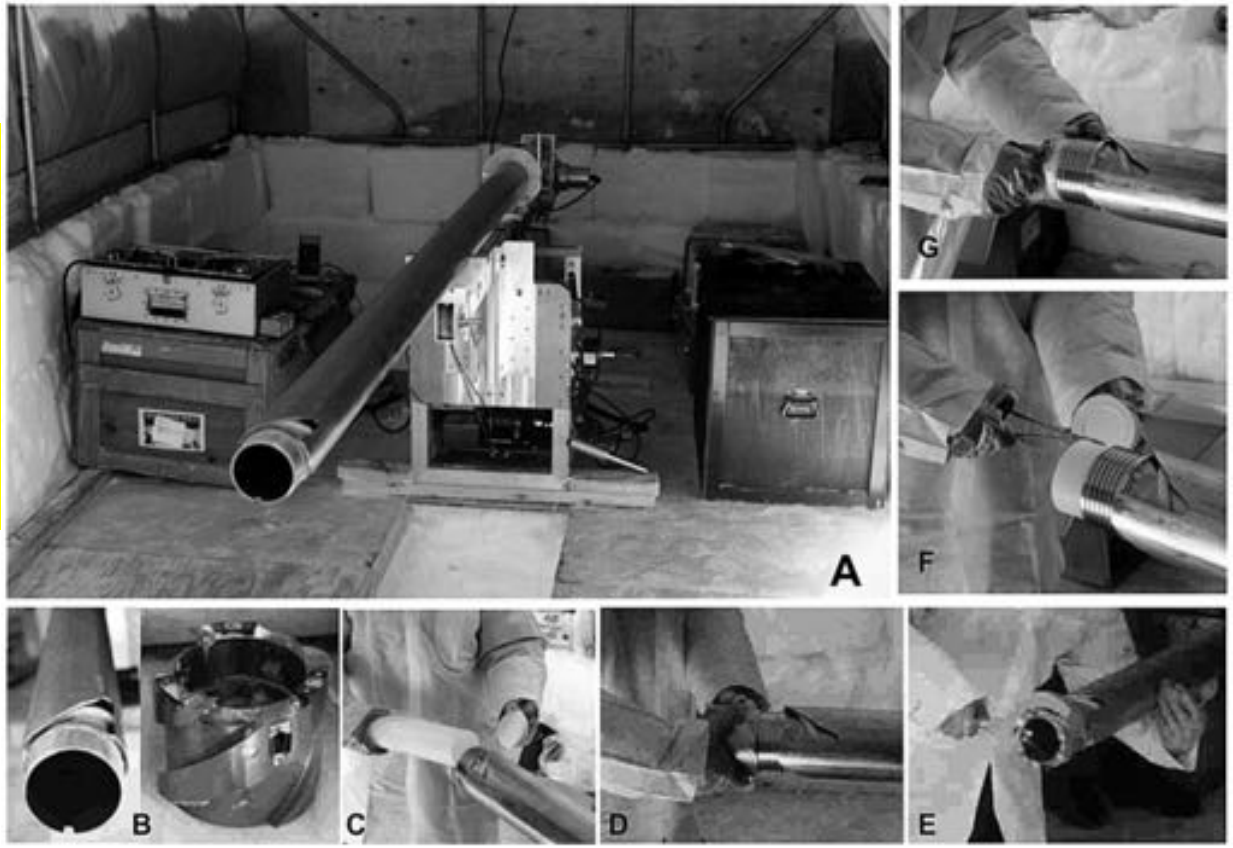
First published as an Advance Article on the web 20th February 2006
DOI: 10.1039/b515886a

"Clean Simon" Drill

- Ti barrel
- Carbide cutters
- HDPE Core sleeves

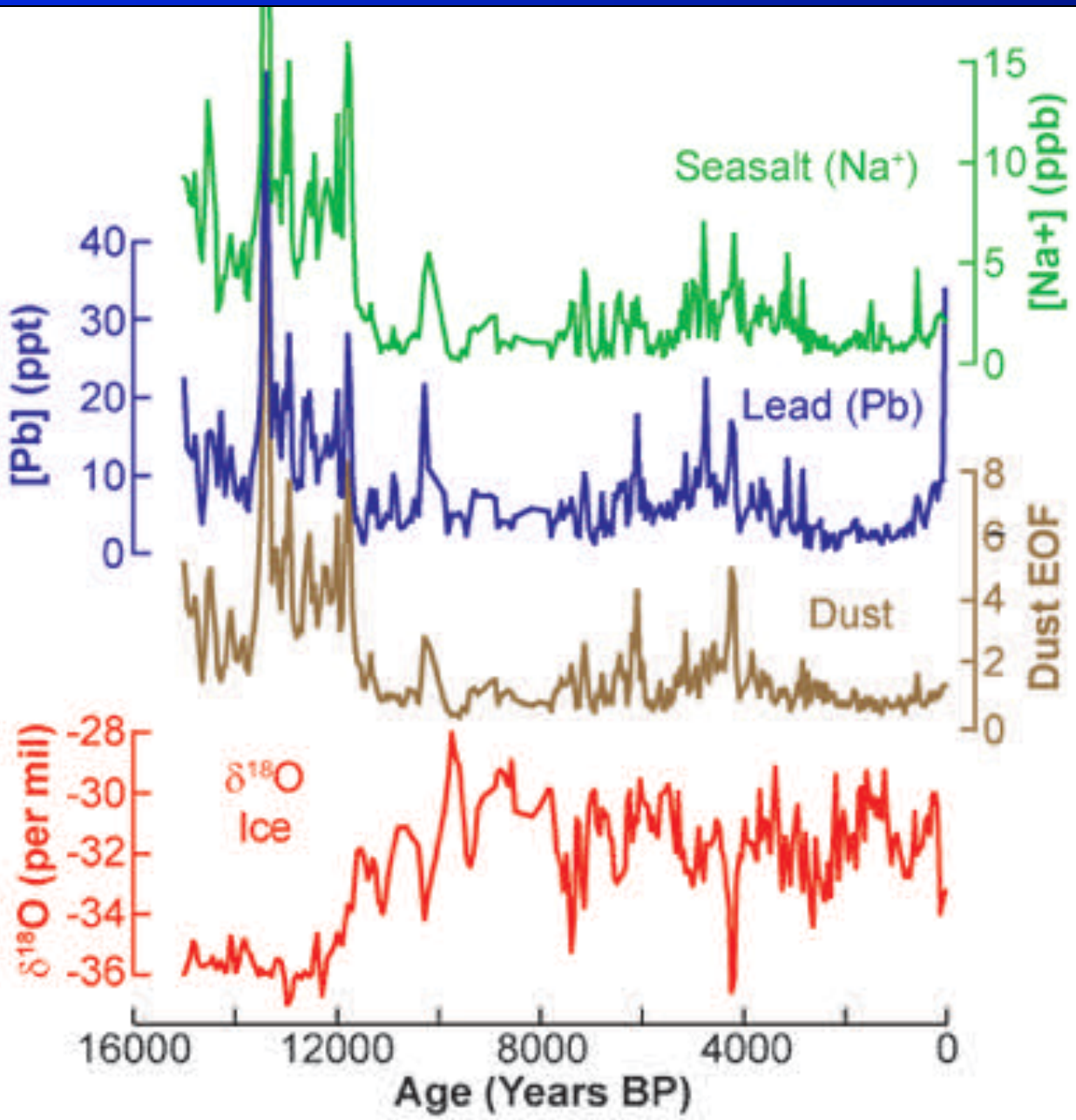


Long-Term Goal: Core from Denali Summit Plateau

Similar logistics as Mt. Hunter and Mt. Logan

Mt. Logan Summit Holocene Glaciochemistry

- Complete Holocene record
- Large "regime shifts" every 1-2 ka in Holocene
- Anti-correlation of precip $d^{18}O$ and aerosols (r = -0.35 to r = -0.46, $p<0.001$)



Summary

- Continued heavy use of portable auger for 10-30 m long reconnaissance cores
- Continued need for a drill capable of:
  - 3-4” diameter core
  - 300+ m depth in a dry (?) hole
  - Being transported by helicopter
  - Producing intact, high-quality core for continuous melters
  - Operable by a small team with perhaps a single driller
- New development of clean hand augers and Eclipse-like drill for trace element chemistry?