

In-situ Measurements in polar firn with Borehole Optical Stratigraphy

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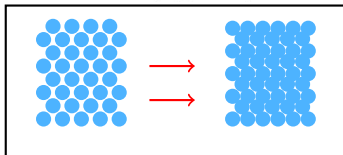
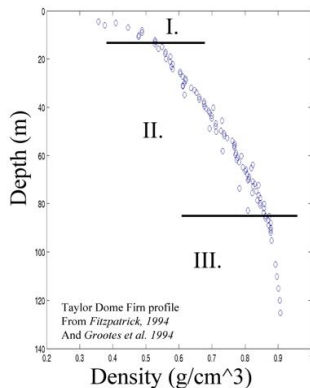
Dartmouth College
With contributions from many others

IDPO Community Workshop, Washington, DC
April 15, 2011

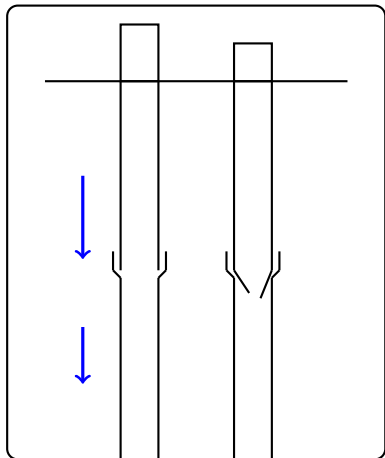
Understanding of firn processes is important...

Firn physical properties (ρ , grain size)...

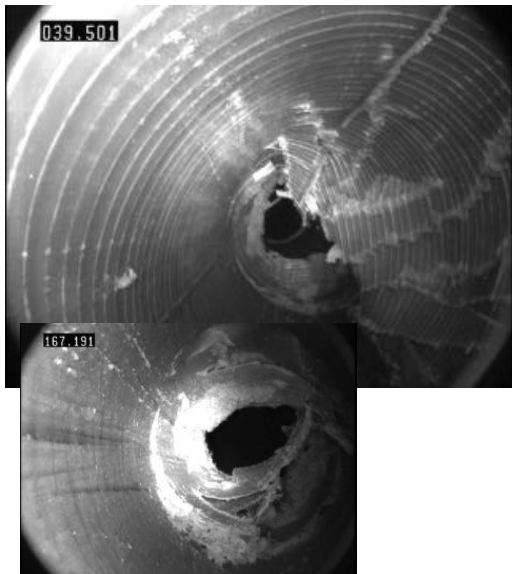
- Determine pore close-off and thus gas-age/ice-age difference
- Contain paleoclimate information
- Affect changes in surface elevation



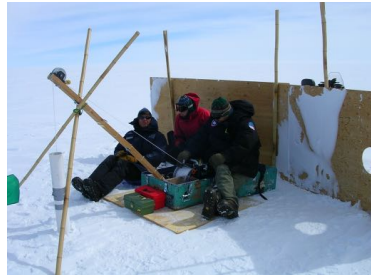
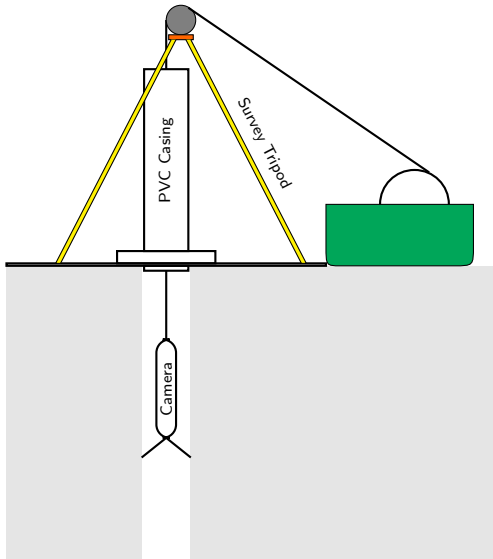
Firn densification matters



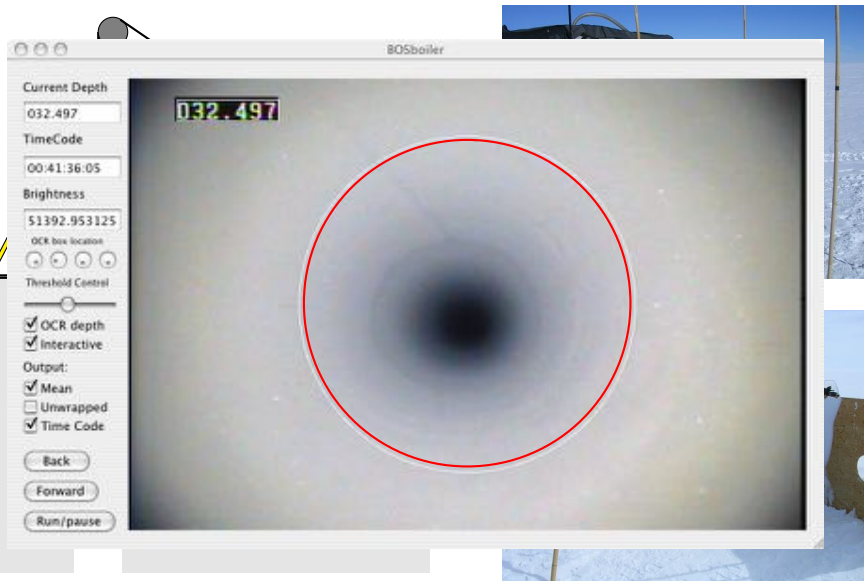
Damage to the GISP2 casing,
caused by firn compaction



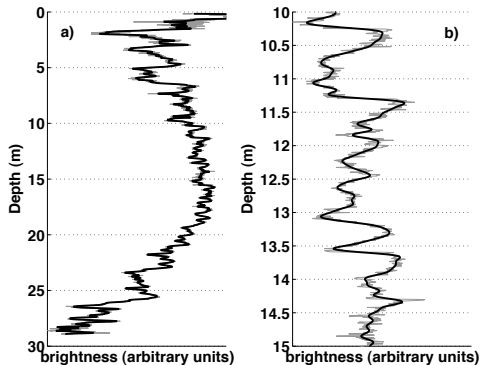
System Setup



System Setup

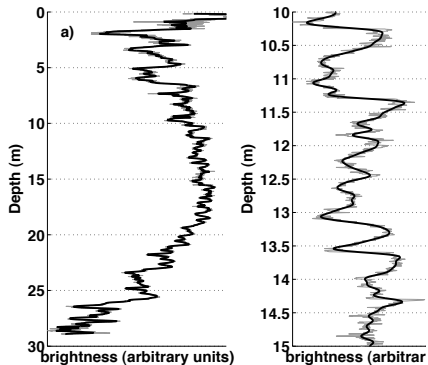


Borehole Optical Stratigraphy profile



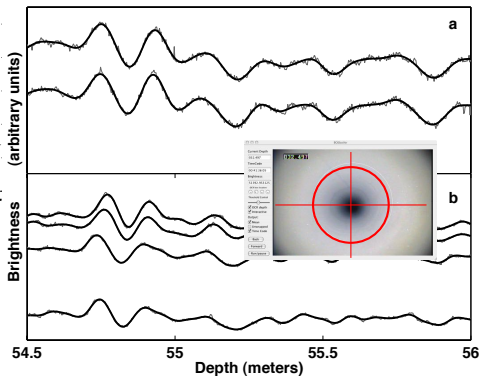
Variability on multiple scales...

Borehole Optical Stratigraphy profile

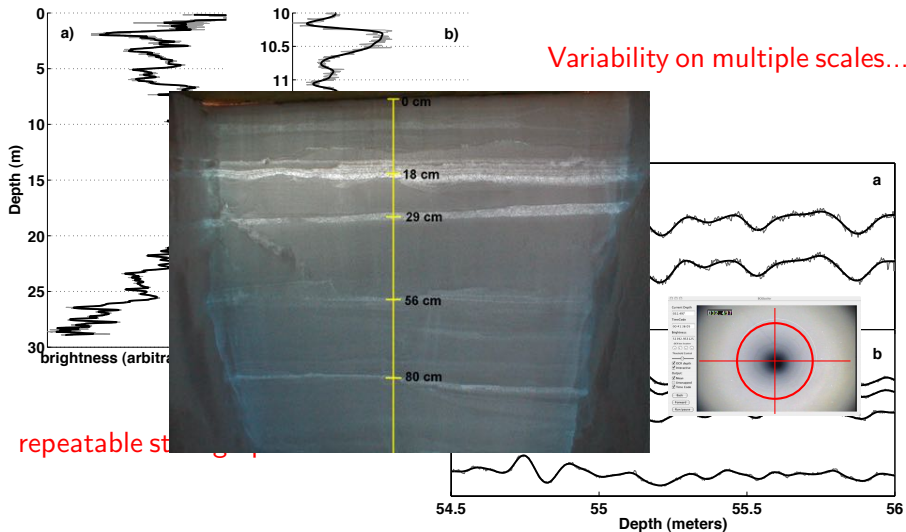


Variability on multiple scales...

repeatable stratigraphic features

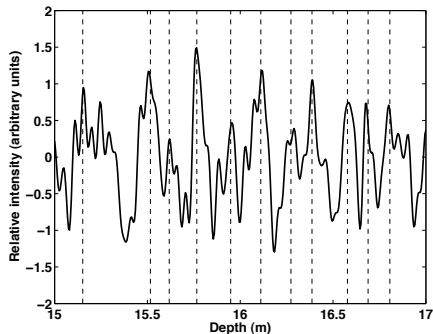


Borehole Optical Stratigraphy profile

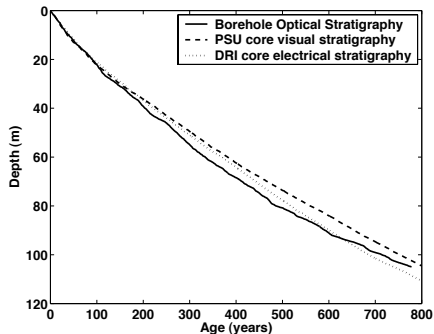


Annual Layers From BOS- Siple Dome

Example picks of annual layers

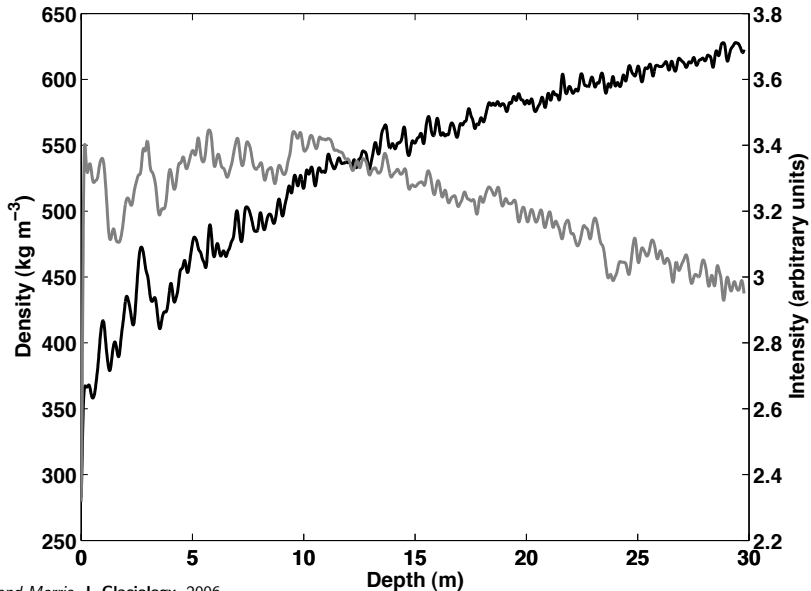


Resulting depth-age scale



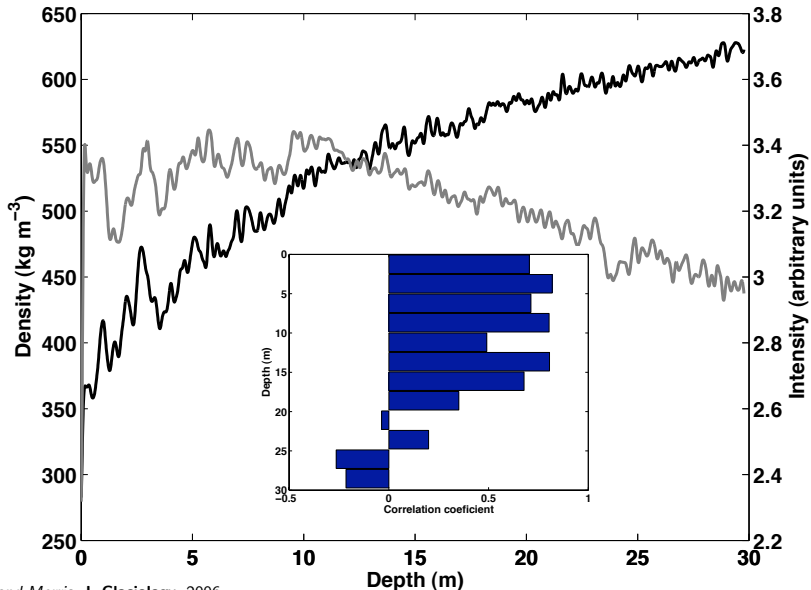
Hawley and others, **GRL**, 2003

Density from BOS?



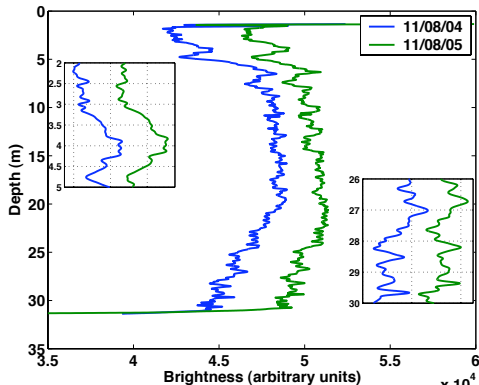
Hawley and Morris, J. Glaciology, 2006

Density from BOS?



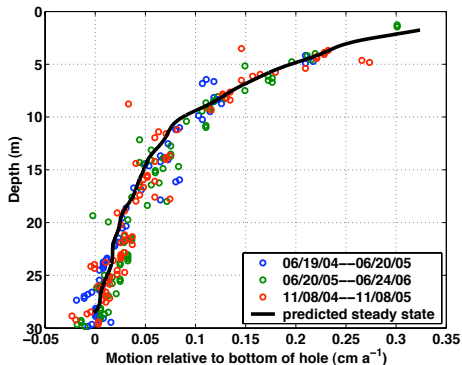
Hawley and Morris, J. Glaciology, 2006

Measuring firn compaction



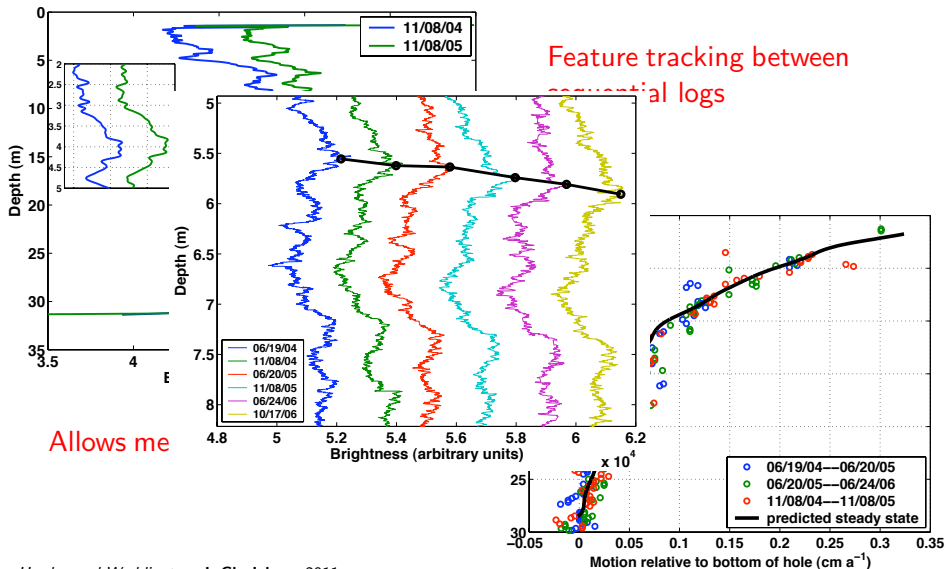
Allows measurement of compaction

Feature tracking between sequential logs



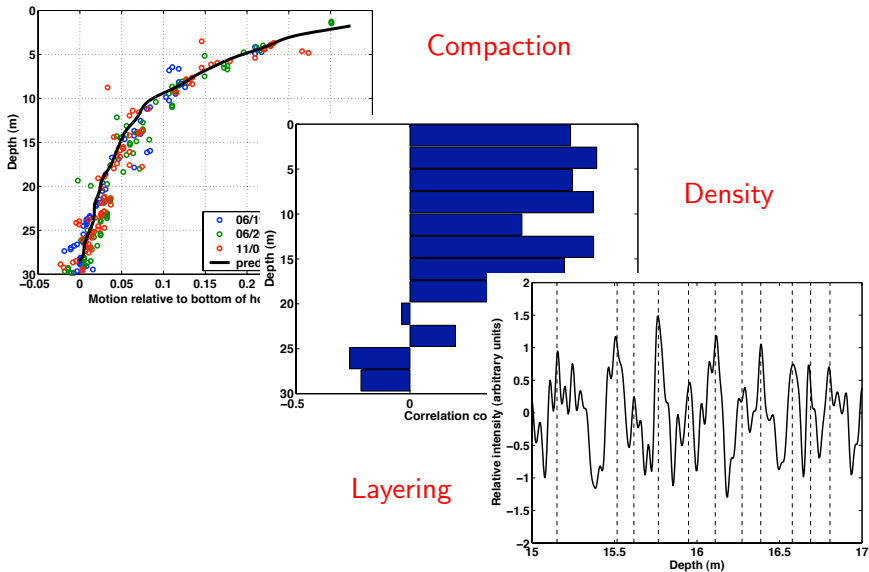
Hawley and Waddington, J. Glaciology, 2011

Measuring firn compaction



Hawley and Waddington, J. Glaciology, 2011

Key Results- Summary



Future directions

Going deeper $\Rightarrow$ Longer time series
 $\Rightarrow$ New logging tools

Multiple wavelengths $\Rightarrow$ grain size vs
density $\Rightarrow$ New logging tools

More holes $\Rightarrow$ Spatial Variability $\Rightarrow$
Light, fast drills



The drill matters



Kovacs non-coring auger

"Prairie Dog" coring drill

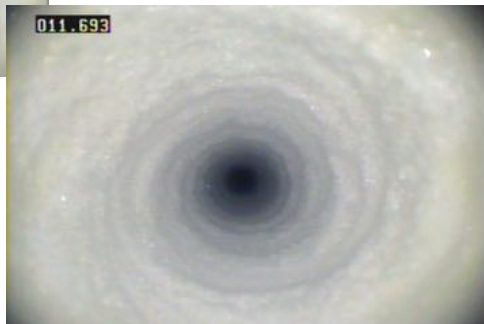


Kovacs auger

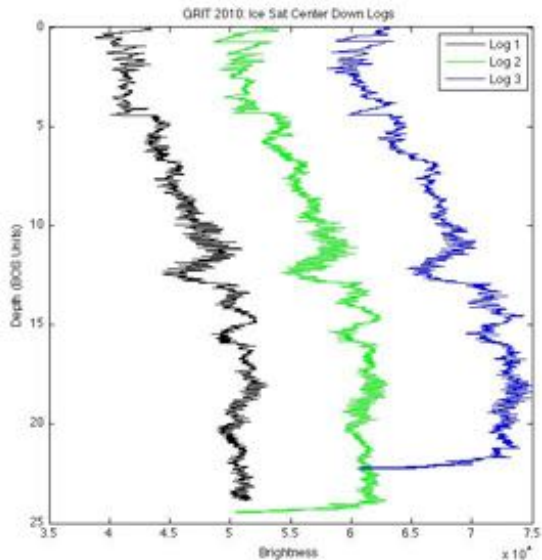


“Scallops” in the borehole walls from kovacs auger

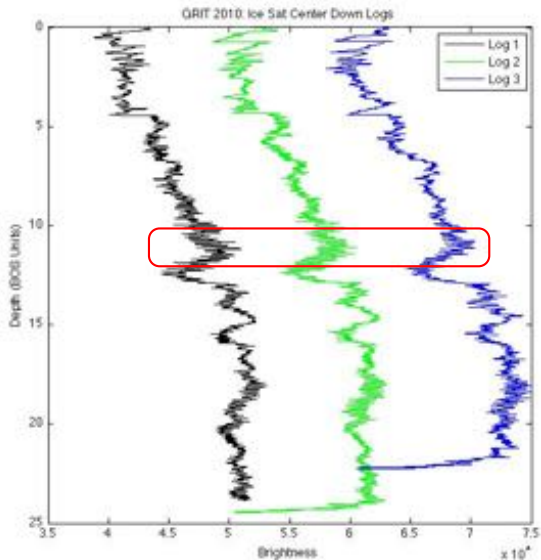
After “reaming”, scalloping is diminished



Auger effects as seen on the BOS log



Auger effects as seen on the BOS log

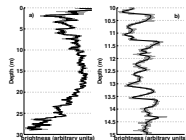


The longer-wavelength features appear to be unaffected by the Scalping.

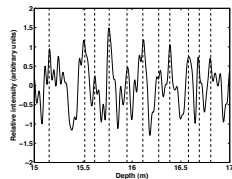
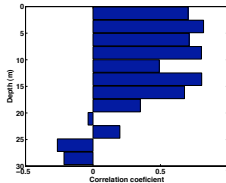
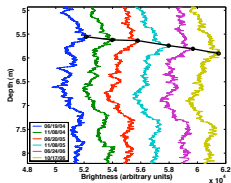
-but- "clean" holes are clearly preferable.

Summary & conclusions

BOS:



Key
Results:



Future
drills



Thanks!

Collaborators:

Ed Waddington, Richard Alley, Ken Taylor, Joe McConnell, Erich Osterberg, Zoe Courville

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