The need for a rapid-access drill

IDPO Meeting, April 2011
Jeff Severinghaus
BIG QUESTIONS:

• Did WAIS collapse 130 kyr ago?
  Last interglacial sea level 7-9 m higher than present.

• Why did the ice ages cycle at 41 kyr periods >1 million years ago? Was it CO$_2$?
Hunting for the Oldest Ice:
A 1.5 million-year record of greenhouse gases and climate
SCIENTIFIC RATIONALE FOR 1.5 Myr ICE RECORD

Existing ice cores:

Marine record:

EPICA Dome C ice core, Lüthi et al. (2008); Lisiecki and Raymo (2005)
Scientific Rationale:

-test hypothesis that falling atmospheric CO$_2$ caused the “41k world” to turn into the “100k world”

-test hypothesis that 41k marine d$^{18}$O signature was caused by existence of land-based Antarctic ice sheet margins, which were sensitive to precession-band local insolation forcing (Raymo)

--- > testable prediction: Antarctic temperature proxies (dD$_{ice}$) should have strong local insolation signature in 41k world, despite absence of precession in deep sea
International Partnerships in Ice Core Sciences
“OldestIce” desired site characteristics

- accumulation rate < 2 cm a\(^{-1}\)
- ice thickness > 3500 m
- low heat flow at base (~50 mW m\(^{-2}\))
- surface temperature < -55 °C
- flat bottom topography
- slow ice velocity
Dome A summit

“Oldest Ice” Site

Aurora Basin
Figure 5. Estimated location of sites with oldest ice, based on knowledge as of 2005, courtesy of Philippe Huybrechts. Contours are age (in ka BP) at 98.5% depth (typically 50 m above the bed).
Figure 3. A map of the bedrock under the East Antarctic ice sheet (taken from the BEDMAP compilation (Lythe and Vaughan, 2001)). Apparently smooth regions are mainly areas with no data!
Figure 4. A map of the ice thickness over the East Antarctic plateau (taken from the BEDMAP compilation (Lythe and Vaughan, 2001)).
Glazed regions with very low snow accumulation (white areas)

Courtesy of Ted Scambos, NSIDC
Glazed regions with very low snow accumulation (white areas)

*Courtesy of Ted Scambos, NSIDC*
GRACE data
A radioechogram from the Gamburtsev Mountains in East Antarctica, showing internal layering within the 4680 m ice thickness at this site. The Center for Remote Sensing of Ice Sheets (CReSIS) processed and analyzed these radar data, which were obtained by the AGAP collaboration (http://www.ldeo.columbia.edu/~mstuding/AGAP/).
Radar Profile 15 km Down Hydrologic Potential from Melt Zone

Length of Bright Internal Layer 10 km
Conformal to
Anomalous Bright 
\[ \text{NOT Bed} \]

Anomalous Bright Internal Layer

Internal Layers

Valley
.6 km
Ice flow direction