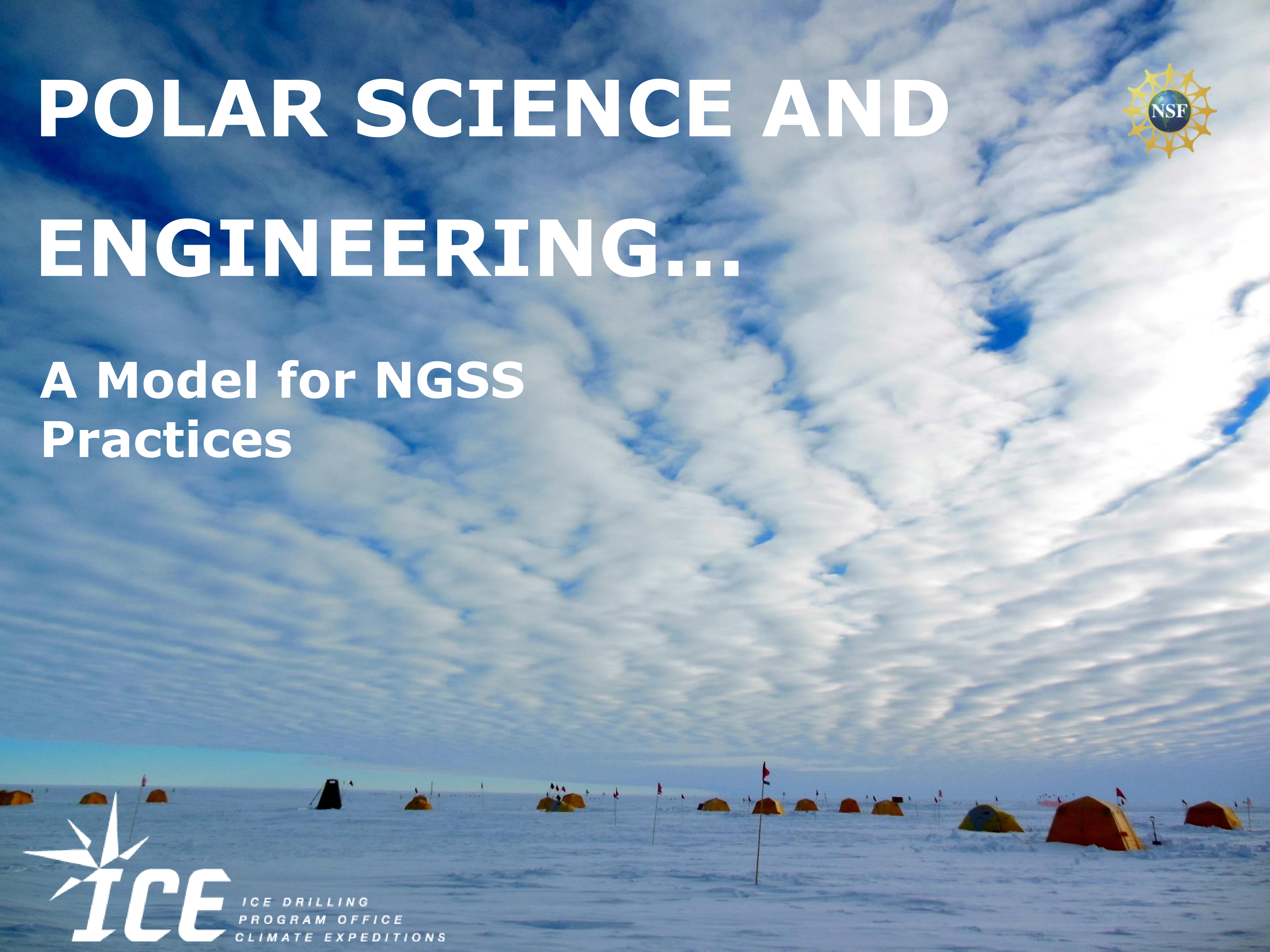
POLAR SCIENCE AND ENGINEERING…

A Model for NGSS Practices



ICE

ICE DRILLING
PROGRAM OFFICE
CLIMATE EXPEDITIONS

US Ice Drilling Program

NSF

IDPO IDDO

Strategic Planning for Science and Drilling Technologies

Morris for AGU 2013

Today's Focus: The "Practices"

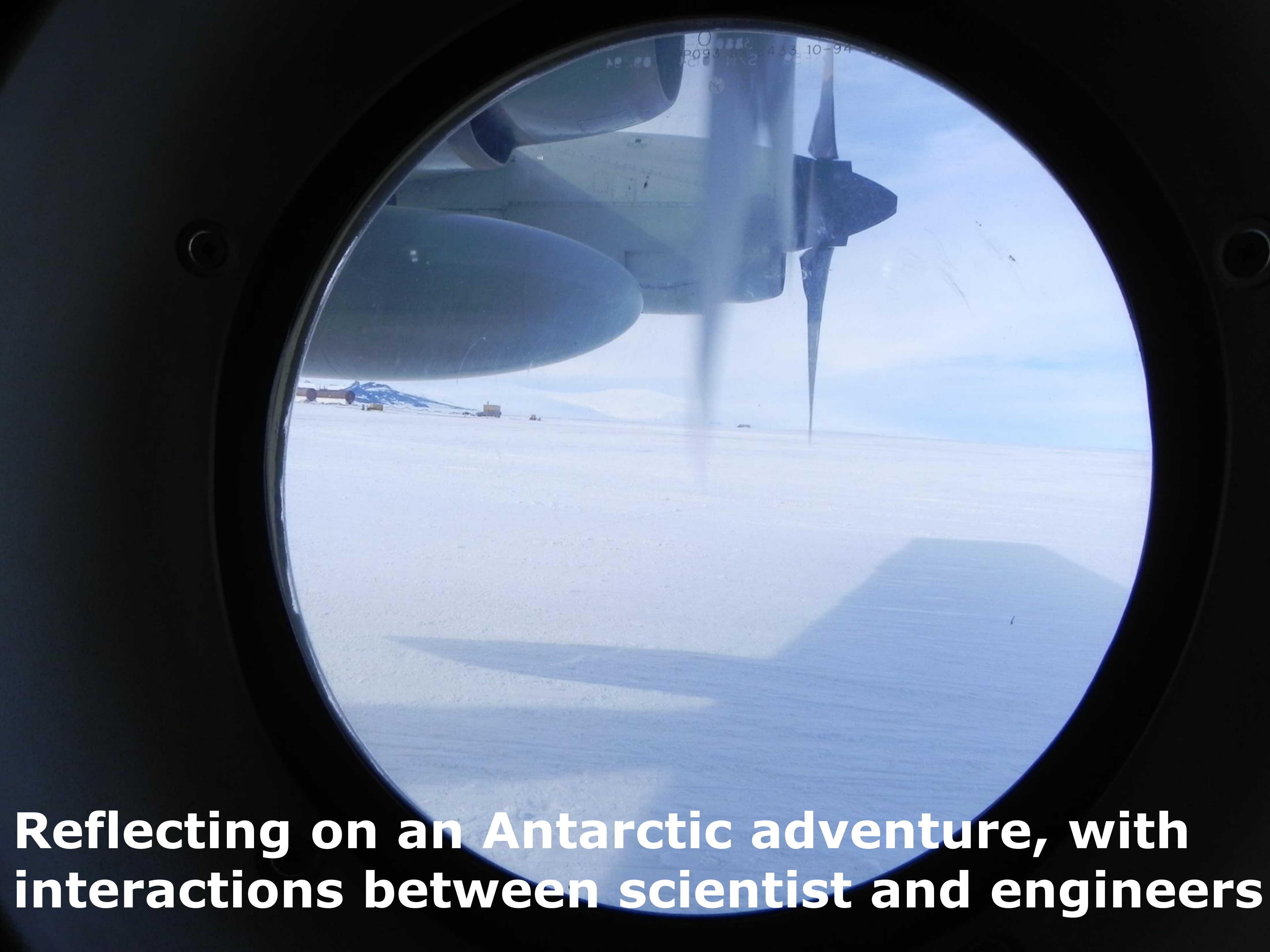
Processes of building and using Core Ideas to make sense of the natural and designed world.

Key Messages

- **Integration of engineering concepts and processes**
- **Parallel practices; different outcomes**
- **Emphasis on how scientists and engineers work together and communicate results**

Our Question:

How can we as educators effectively help students to distinguish these practices?



Reflecting on an Antarctic adventure, with interactions between scientist and engineers

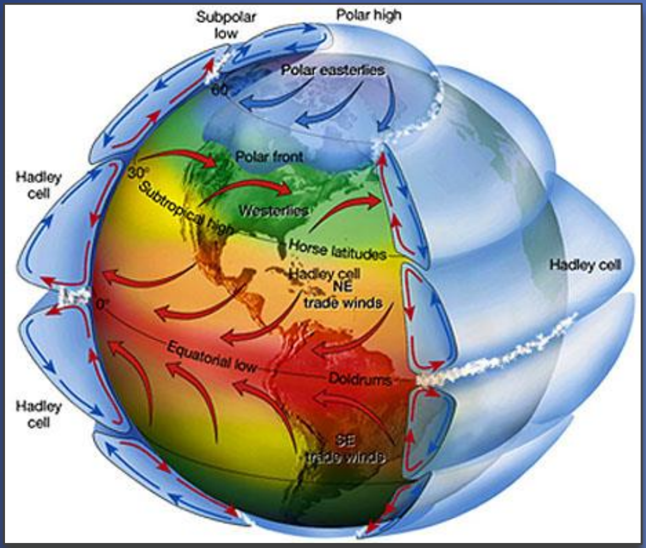
A key question being asked by scientists is,

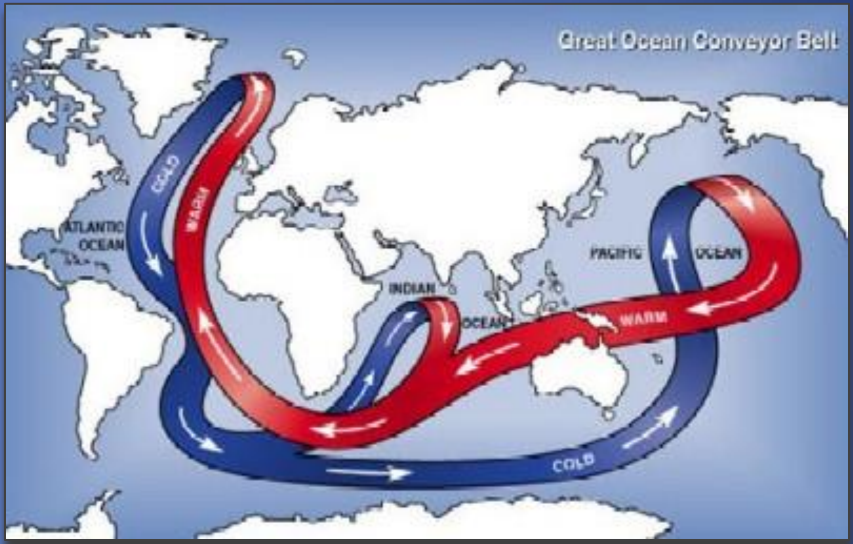
"How can we predict future

climate changes, and their impacts,

to empower decisions today "

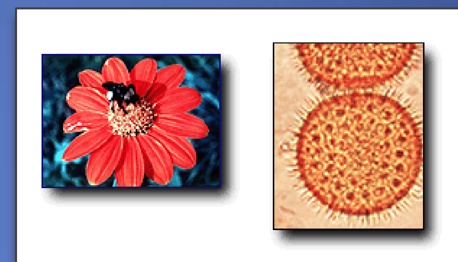
What we know:

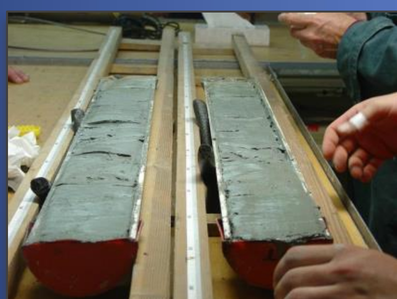




Earth's system of interacting systems influences long-term climate patterns

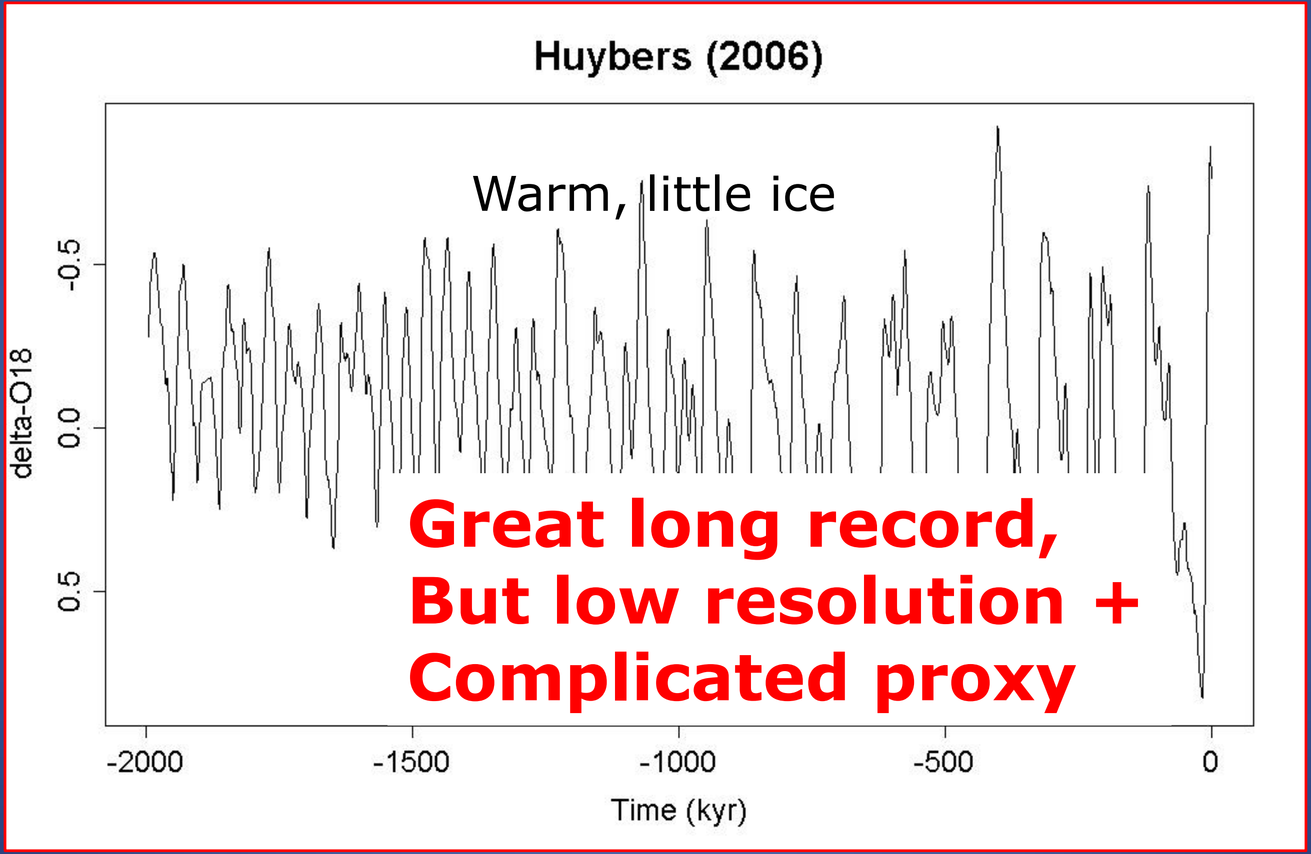
What we need to know: data from the past.





We started by looking at strategies others have used...

Sediment core record showing glacial cycles



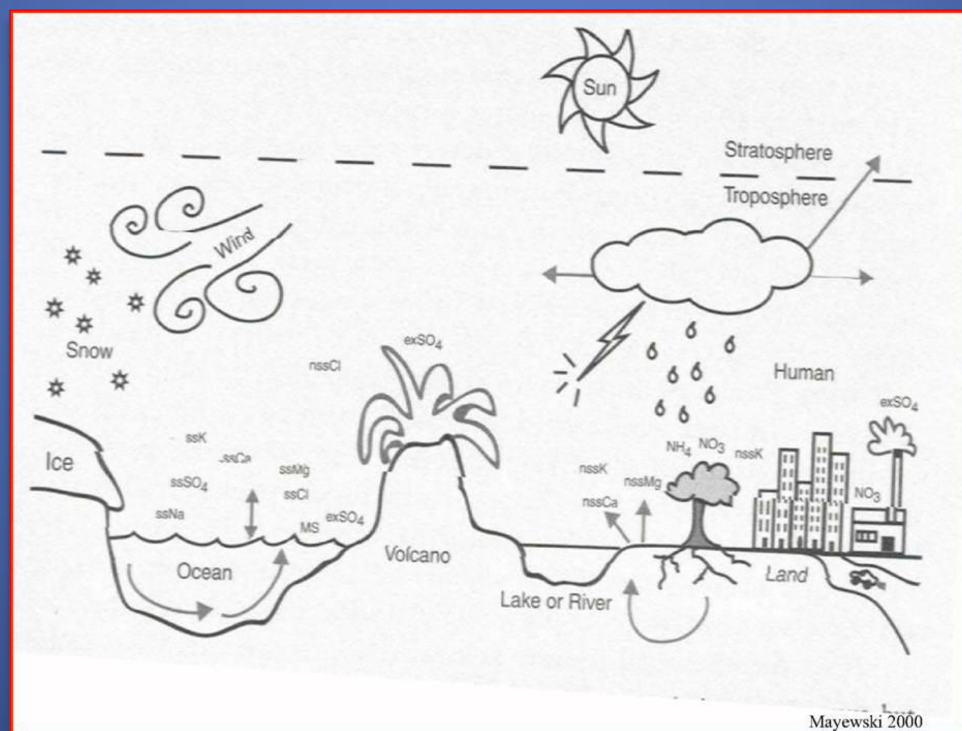
2 million years age

cold, lots of ice

Today

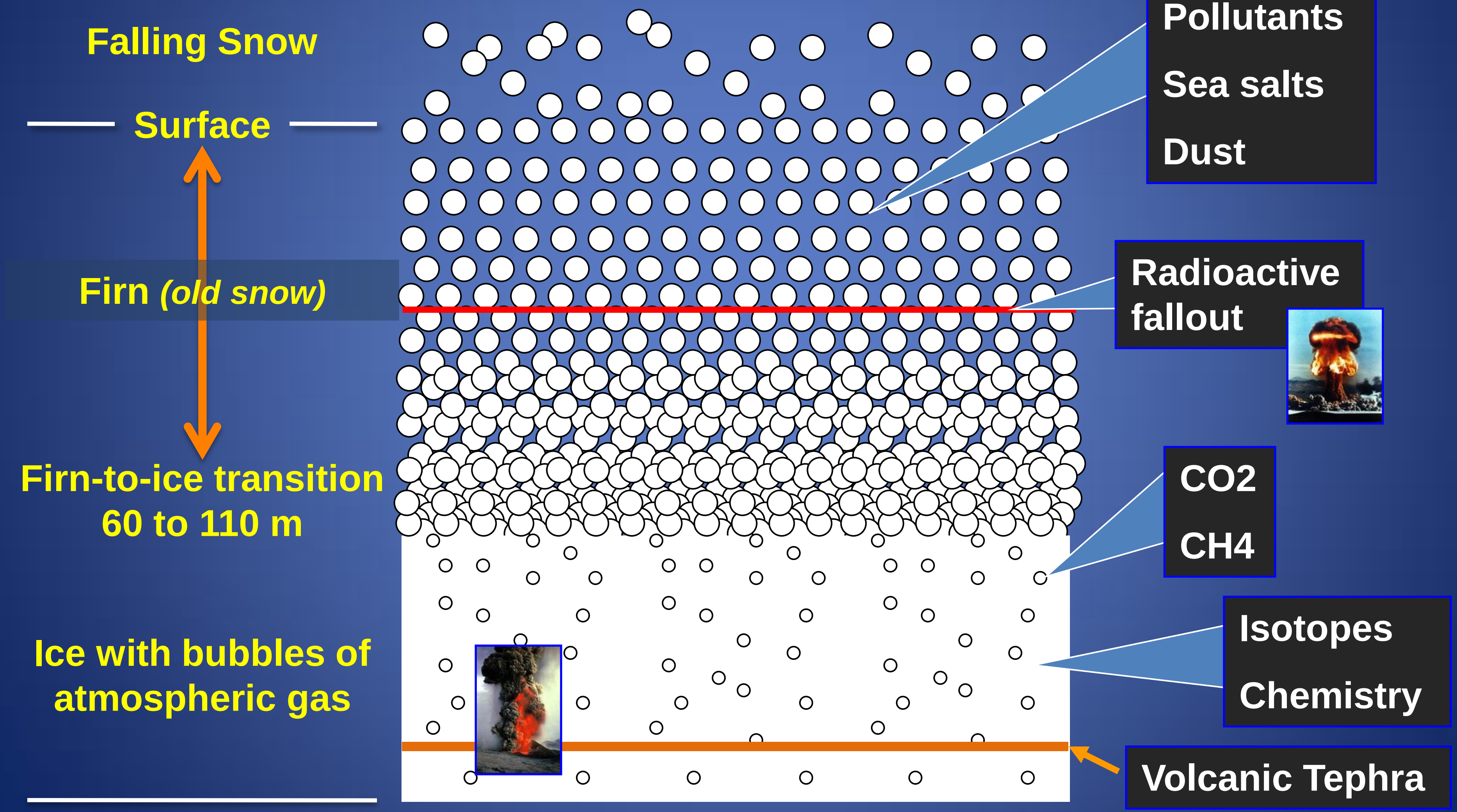
The moving atmosphere carries environmental evidence to the polar ice sheets

north



south

The evidence becomes archived in ice sheets



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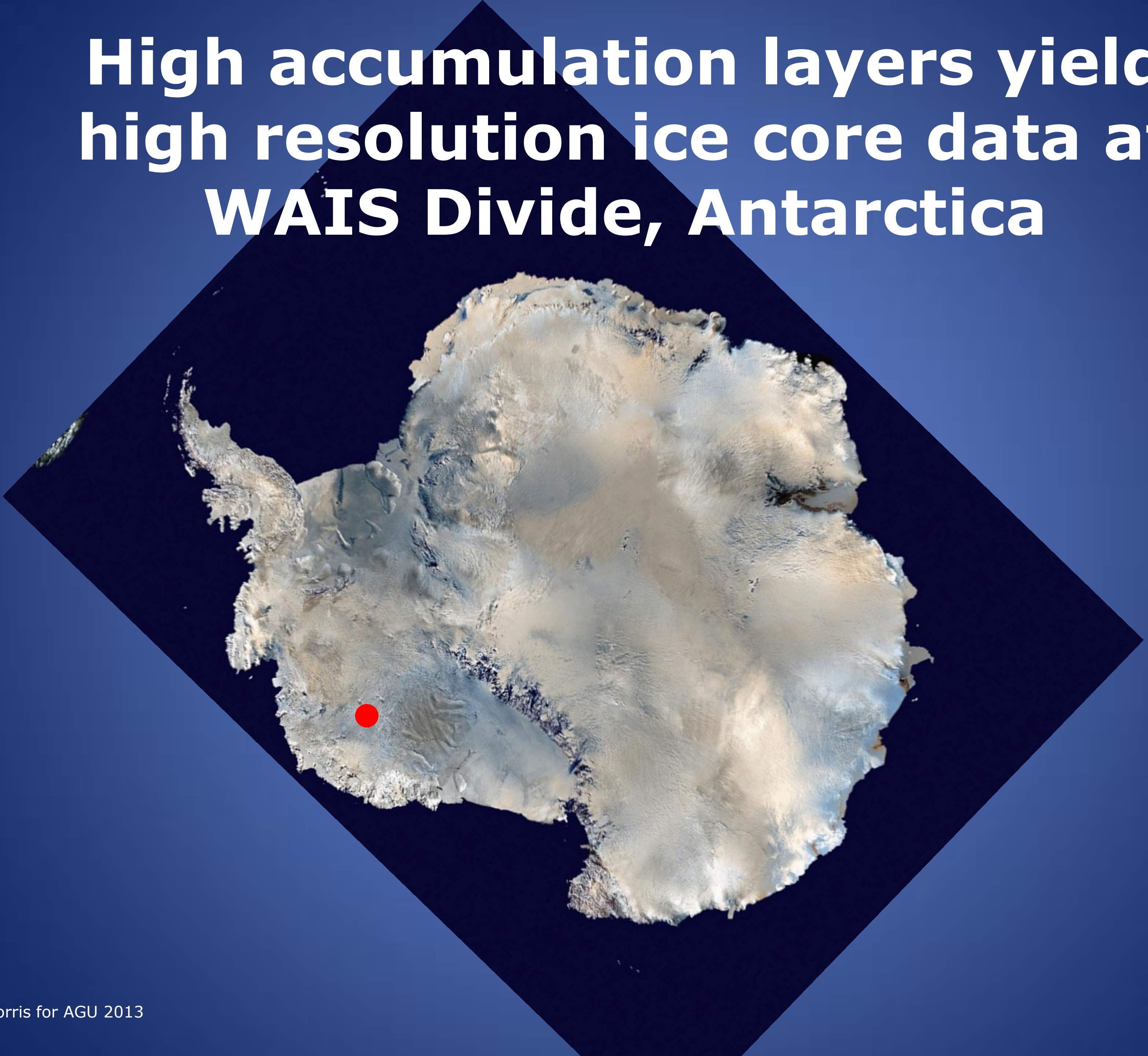
High accumulation layers yield high resolution ice core data at WAIS Divide, Antarctica



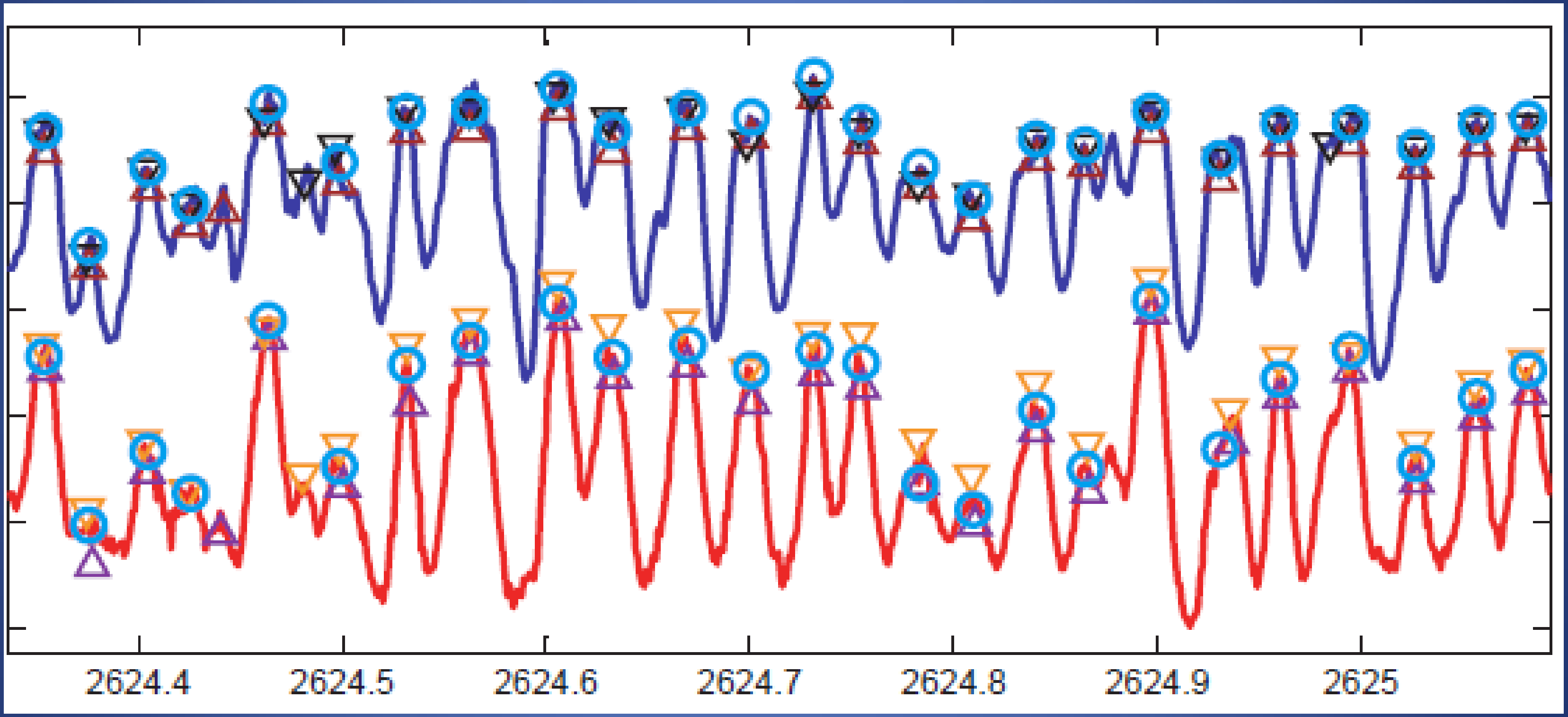
Drilled to 3400 m deep
(more than two miles)

DISC Drill

Recent Core From WAIS

Precisely Dated

Annual resolution to 30,000 years



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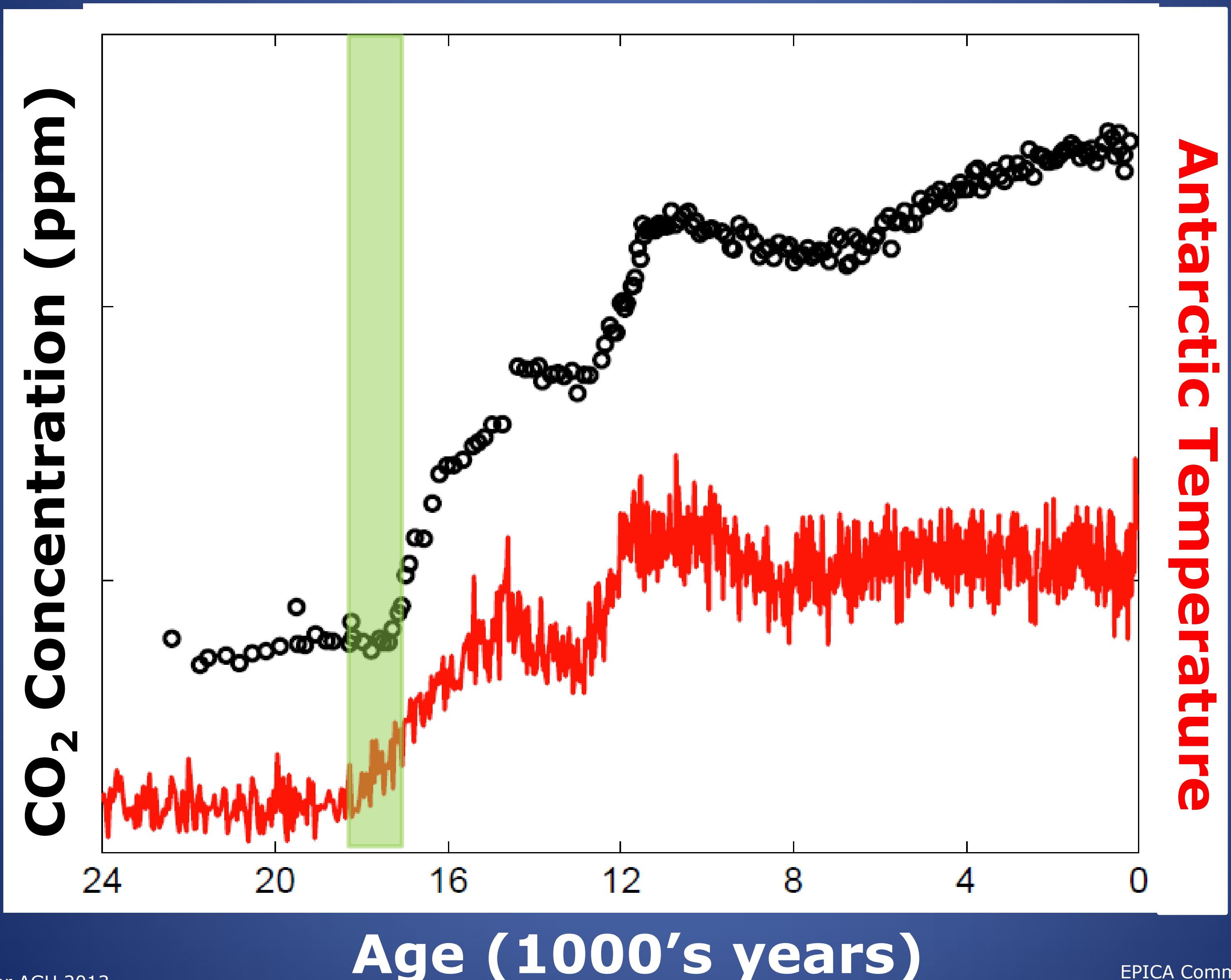
Data from T.J. Fudge

CO_2 and temp, rising together 18 K yrs ago



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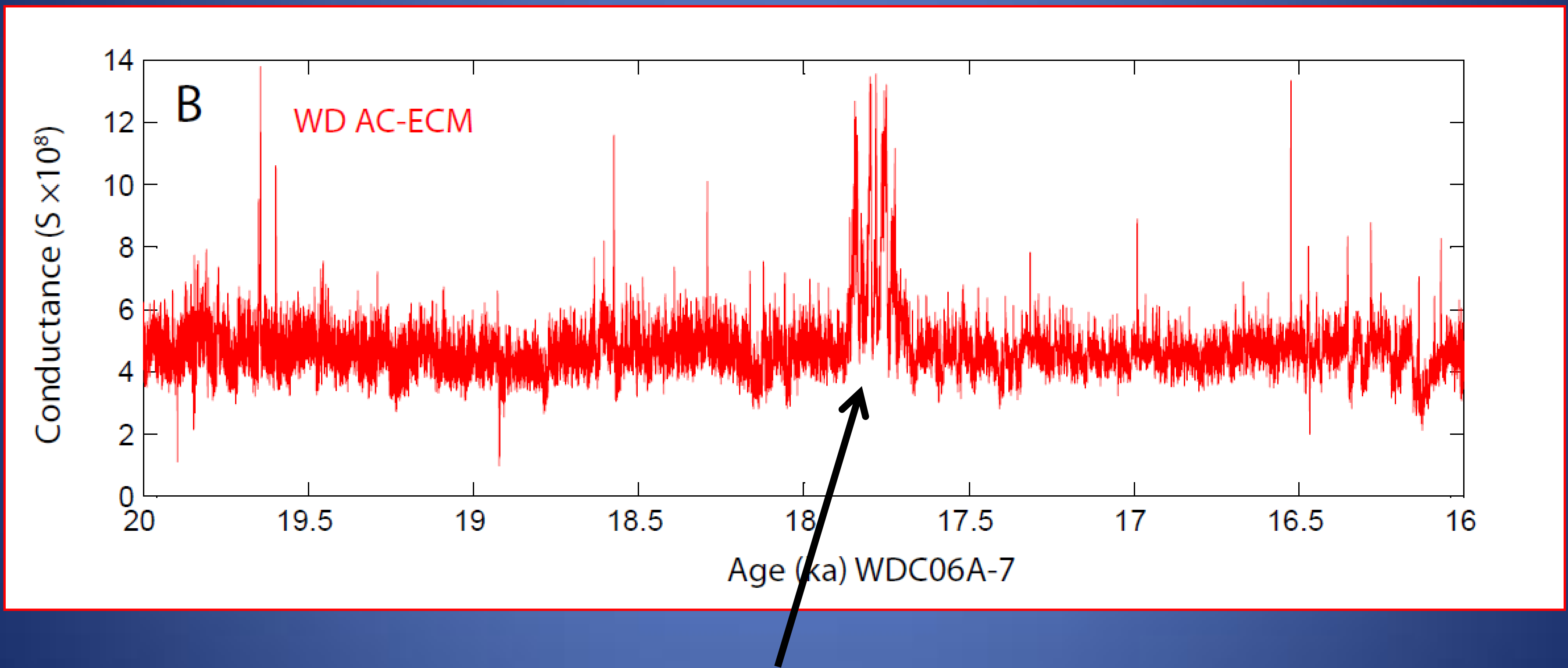
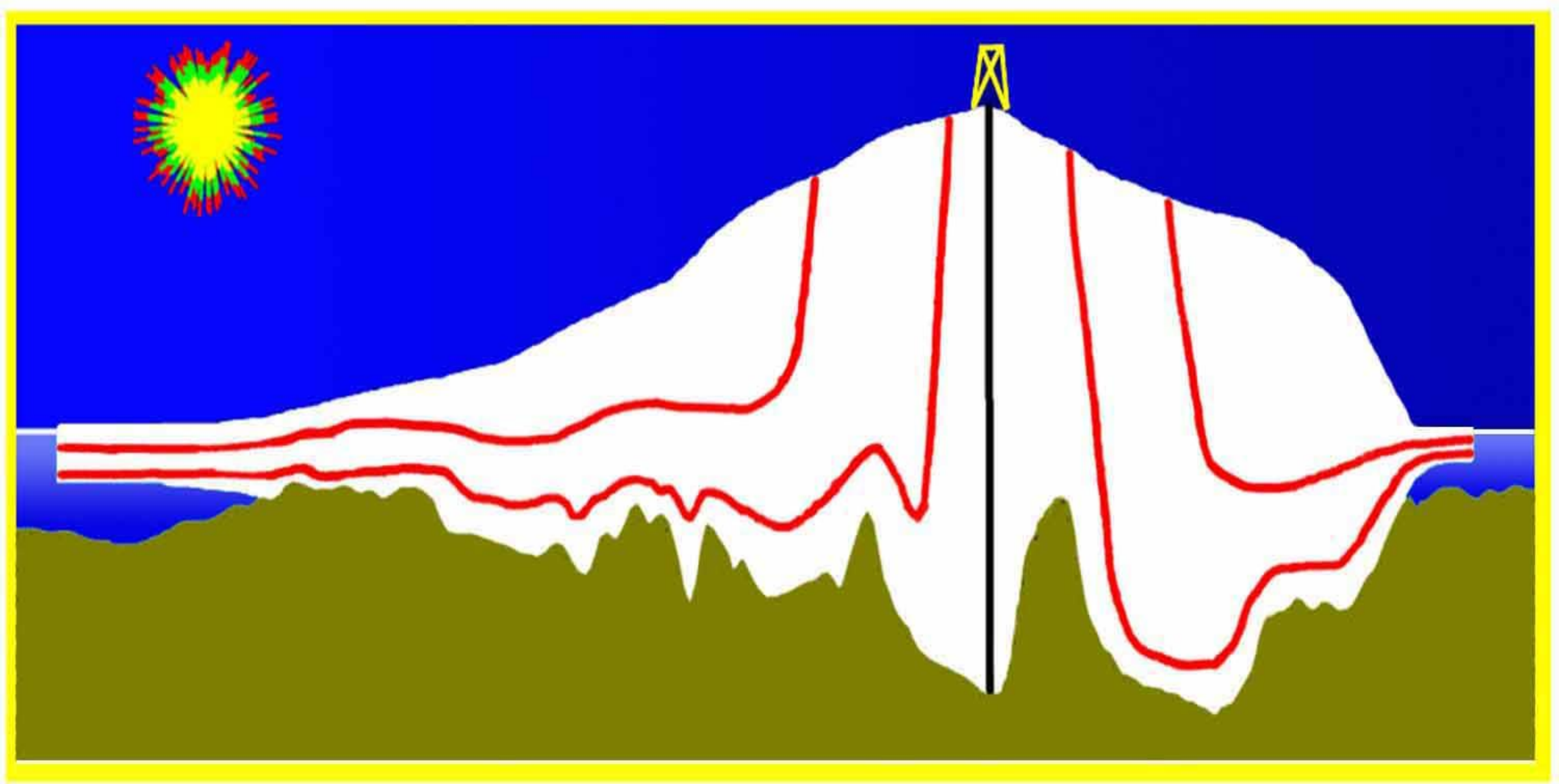
EPICA Community, 2008

Scientist: A really interesting period- I need more ice!

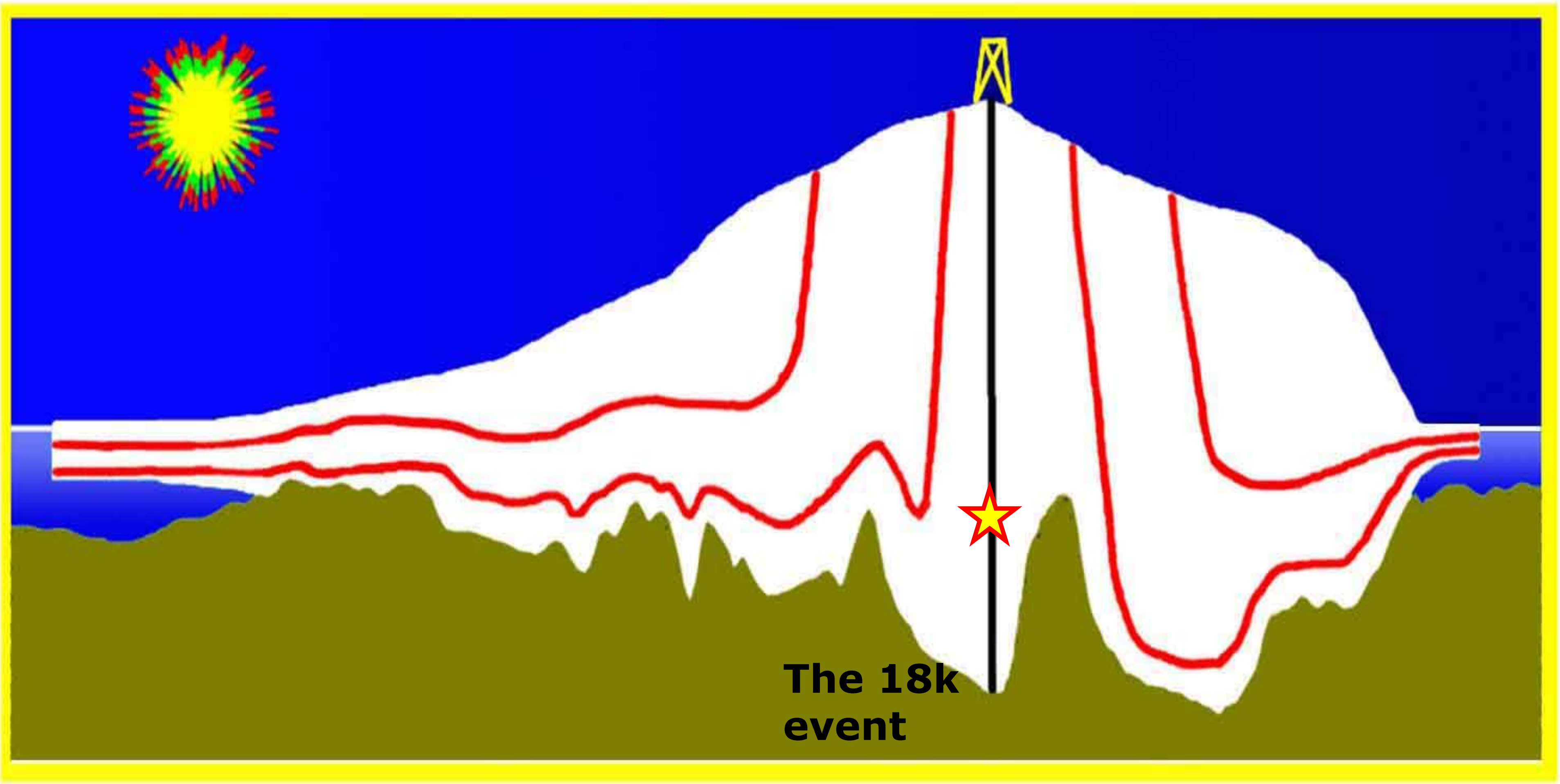


More ice core data is needed from this really funky event

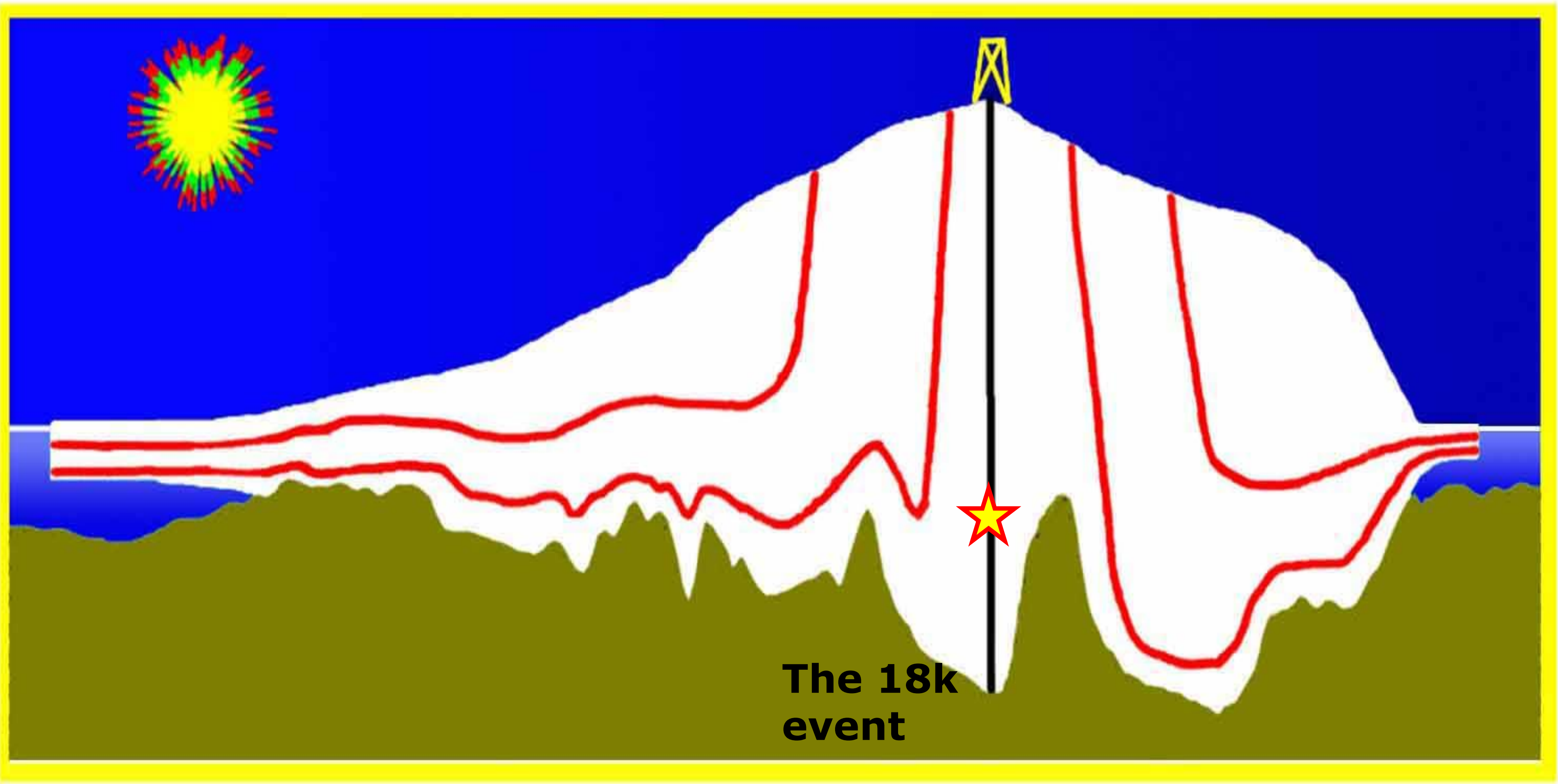
Scientist: Can we drill another core?



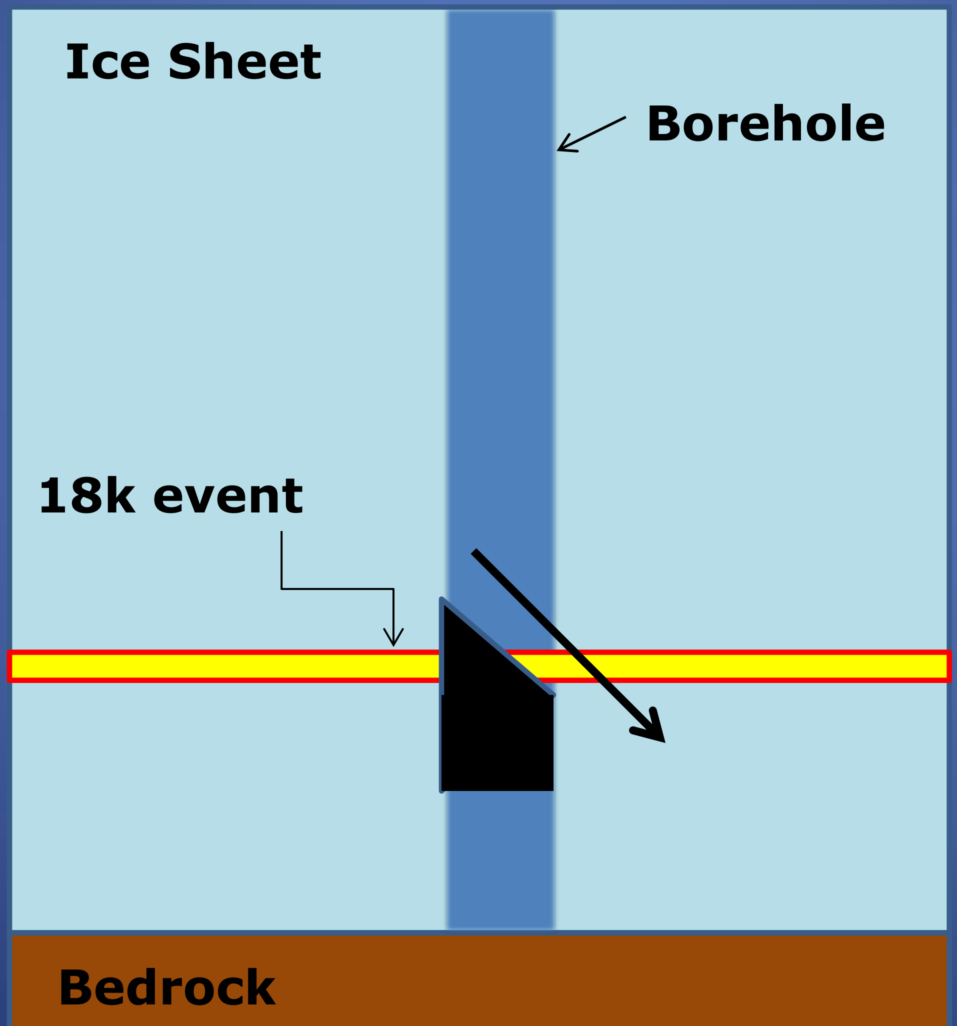
Engineer: Sure, but it took 4 seasons and $$ to get to that depth !



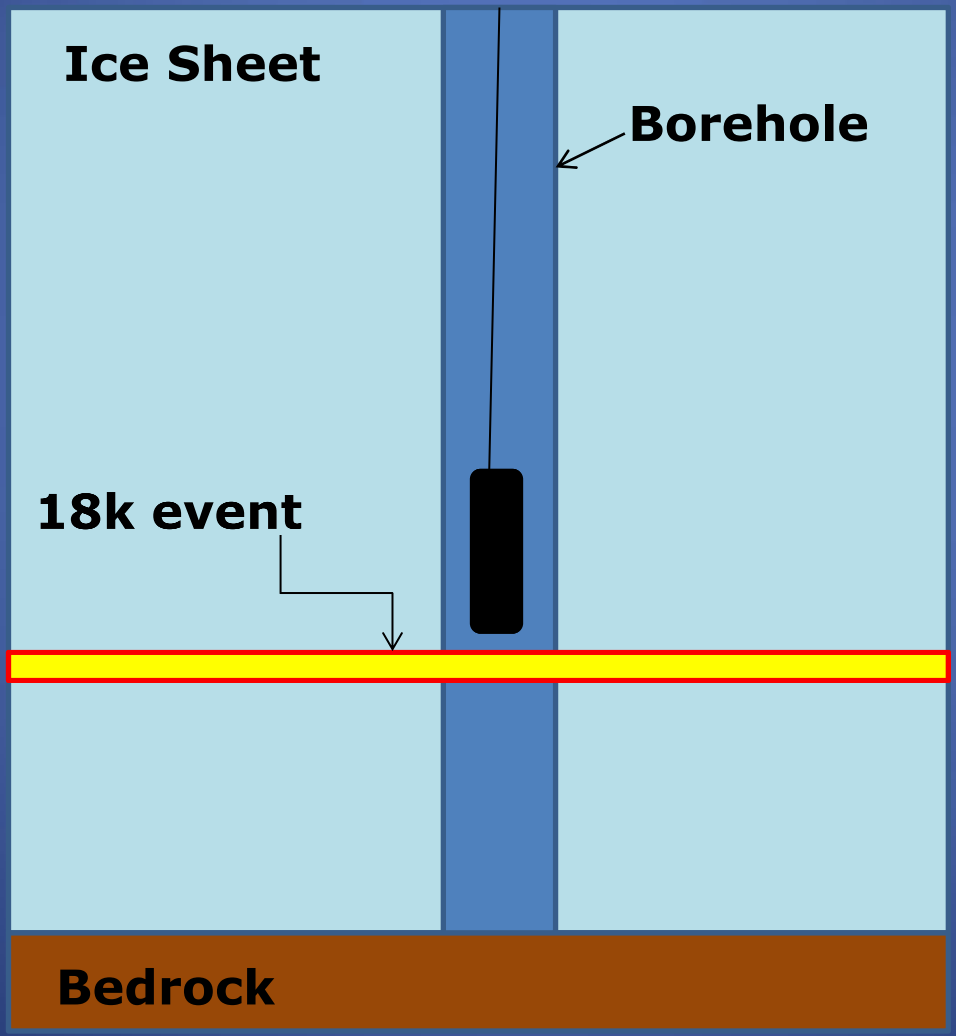
Engineer: What about drilling out the side of the hole instead?



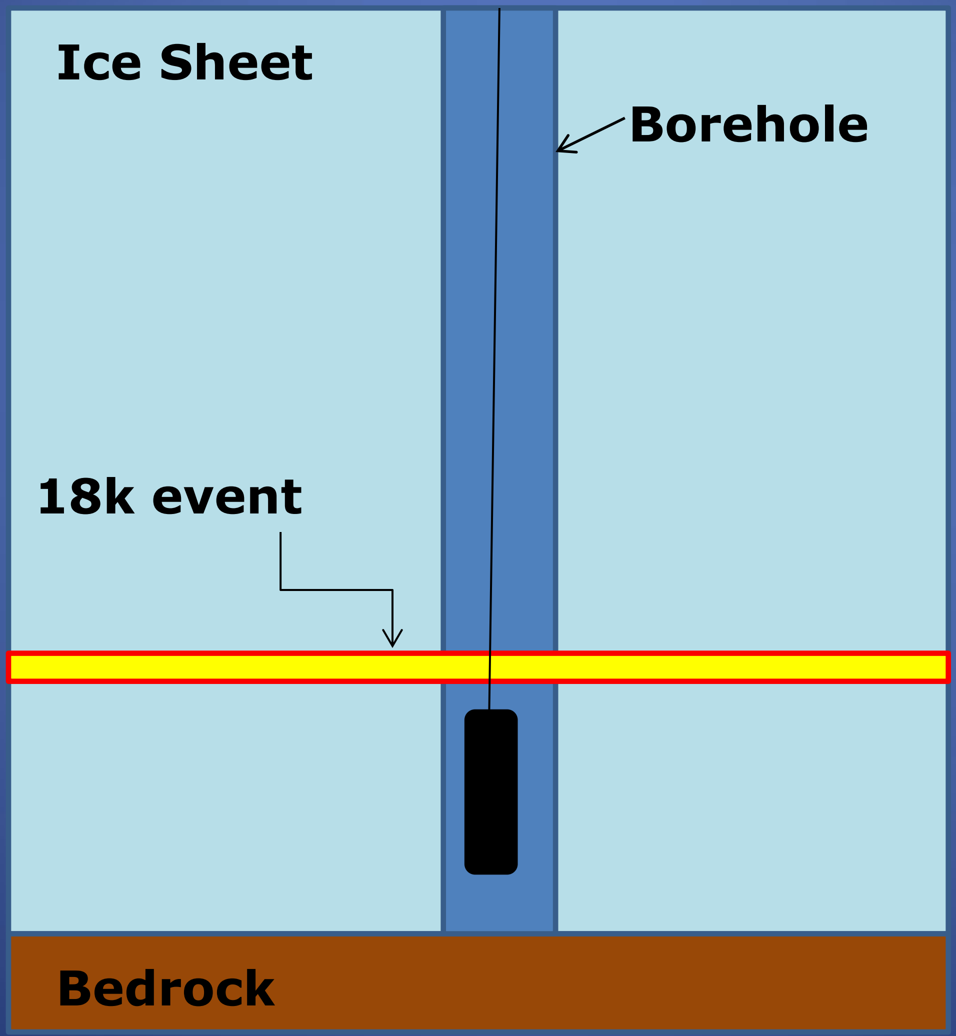
We can block the hole to deviate out the side. That's worked before-



Scientist: No, I need to measure stuff down the entire borehole length



Instruments will need to get past the 18K event depth…



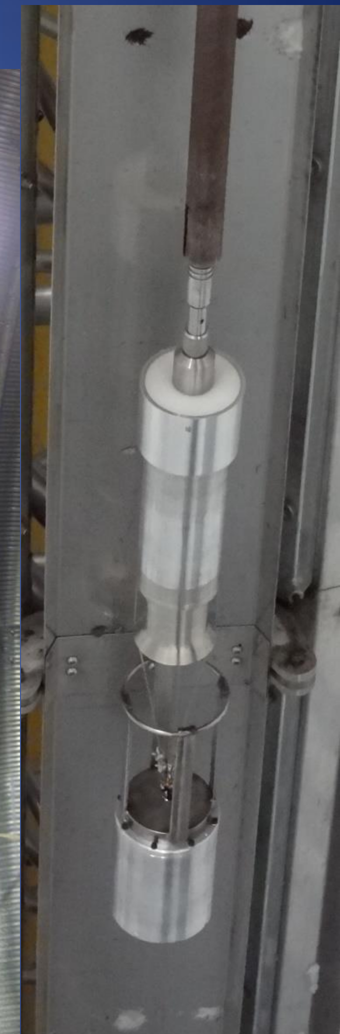
Sample Borehole "Logging" Tools

Temperature

Optical

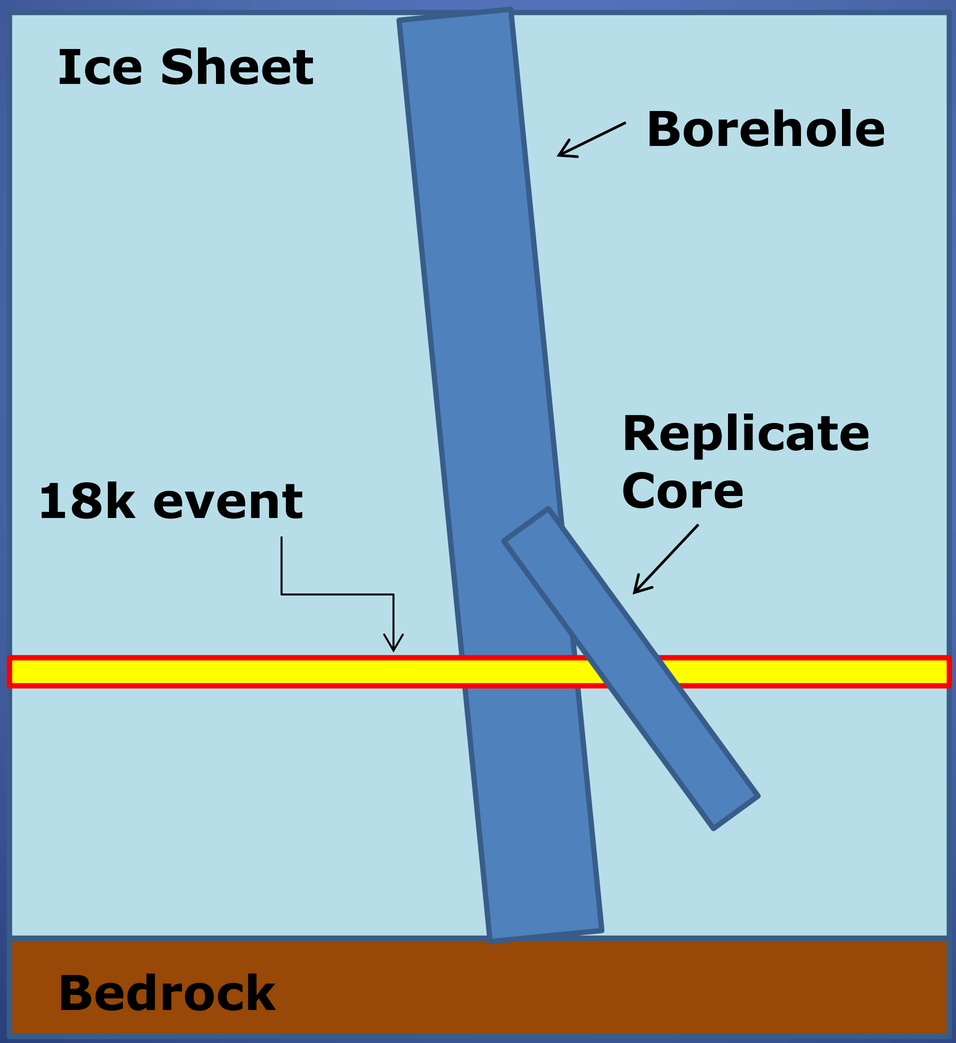
Sonic Velocity

Seismic

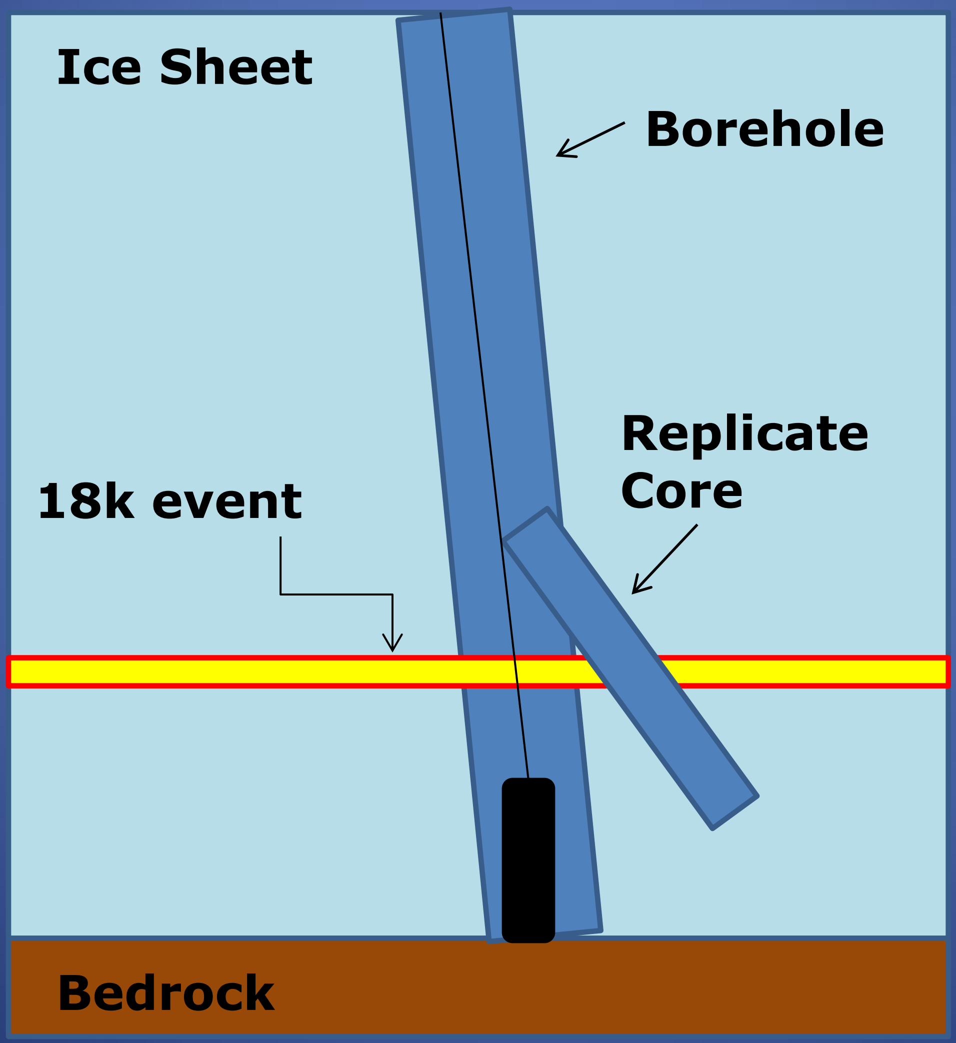


Acoustic

Engineer: So what about going out the uphill side of the borehole so gravity pulling the tools into deviations is not a factor?



Tools with still pass by the replicate hole, - Yikes, this has never been done before!



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Science Goal: cores parallel to the main hole to duplicate results from depths of great interest-

Engineer: That’s going to require a whole new kind of drill !!

Audience:

What kind of questions would you want to ask to define the drill the scientists need?

DISC Drill Modifications Done

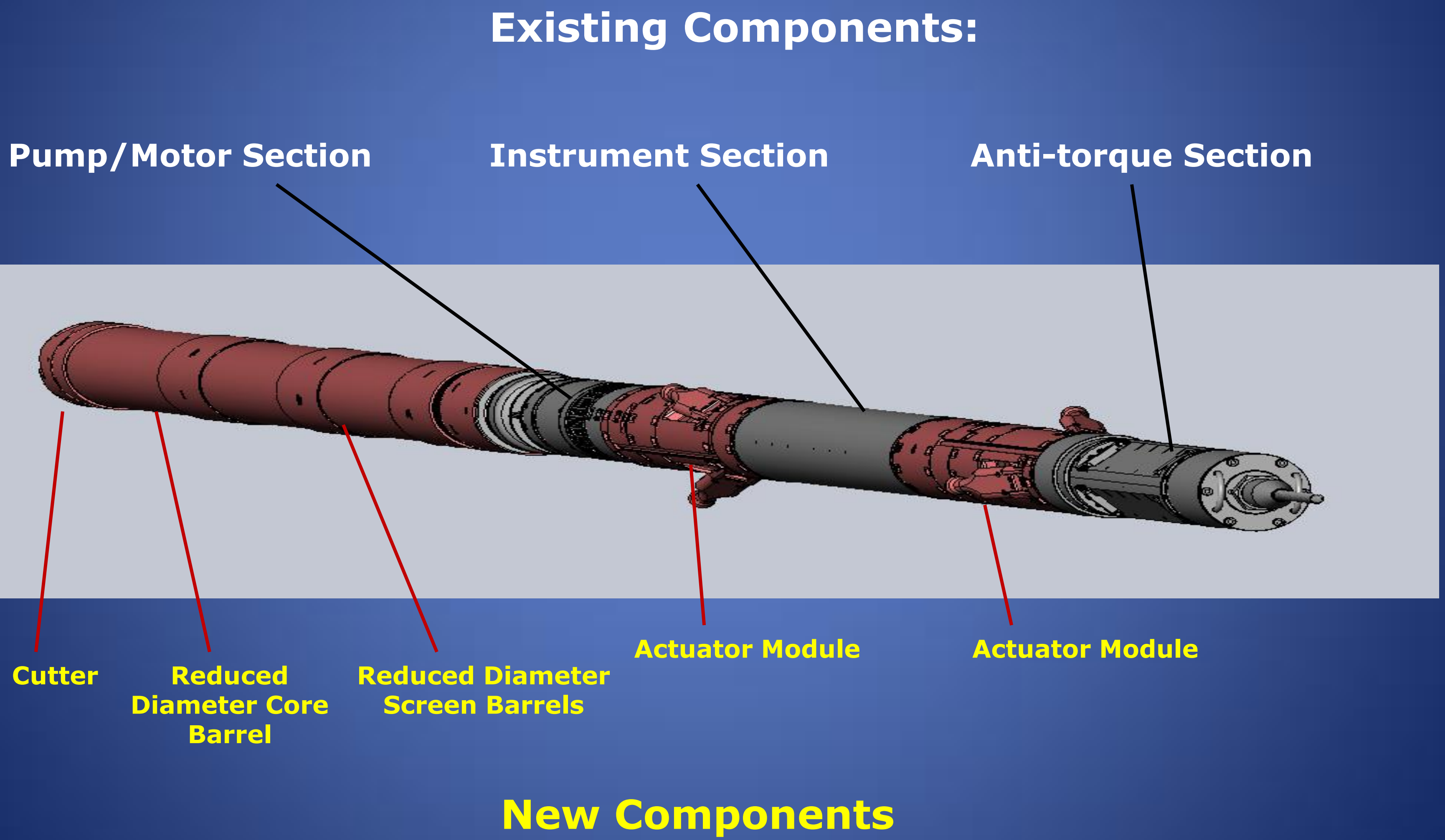
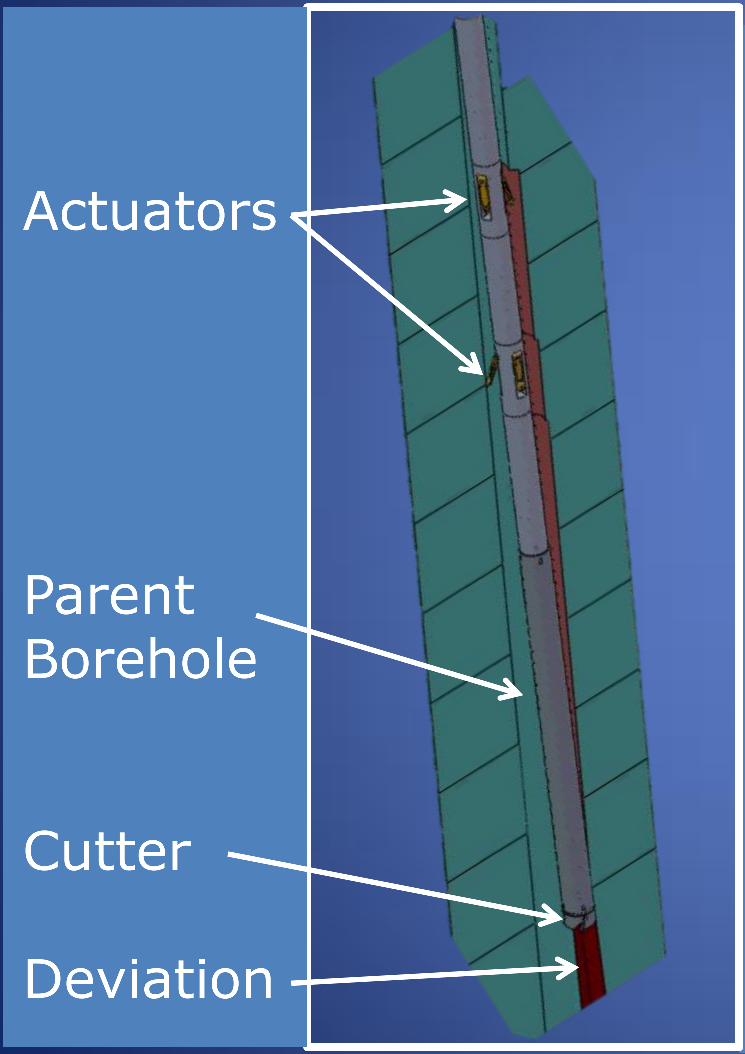


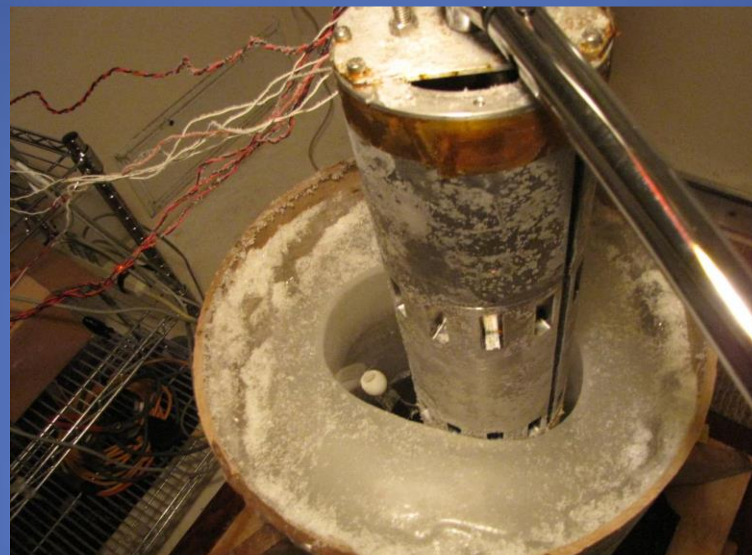
Diagram Brainstorming Deviation

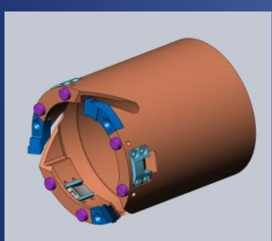


- Actuators Force Cutters to High-side of Parent Hole.
- Direction and Magnitude of Force via Surface Command
- Real-time Adjustments On-Board Controller
- Ascend/Descend to Deviate Over ~25m.

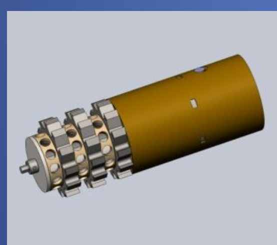
Prototype Testing Accomplished

Actuator

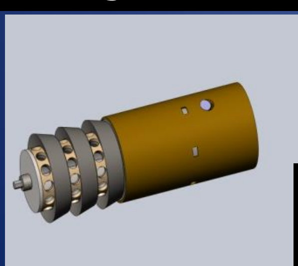




Coring Head

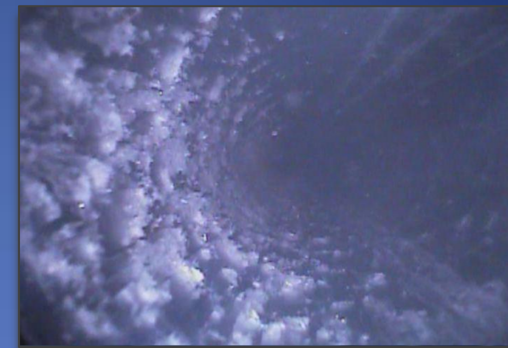


Milling Head

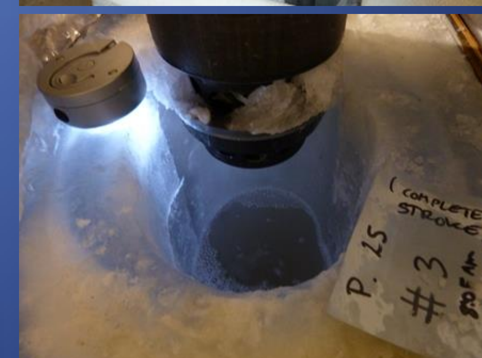


Broaching Head

2011-12 Field Test: Problems identified



Summer 2012 - evaluation and redesign



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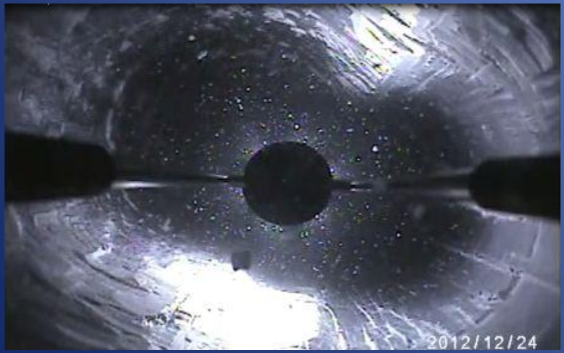
2012-13 season
A Huge Success!

5 deviations were completed from at four different depths

- **All goals were met**
- **284m of core were recovered**
- **First time an ice borehole has been deviated on the high side!**



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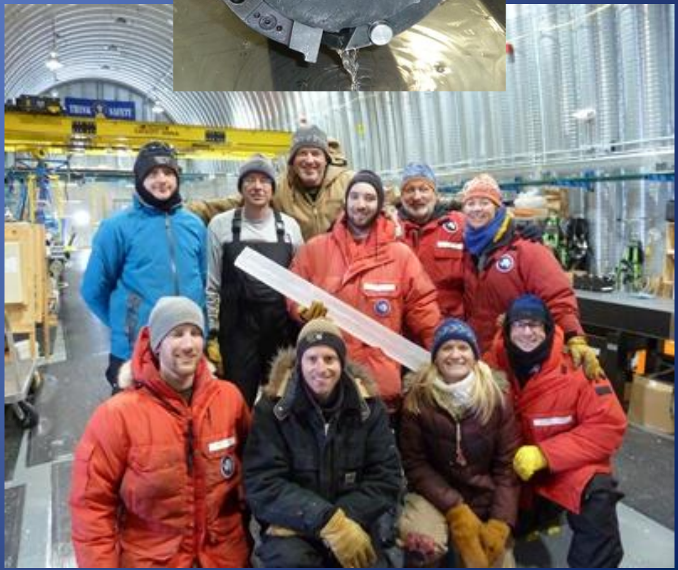
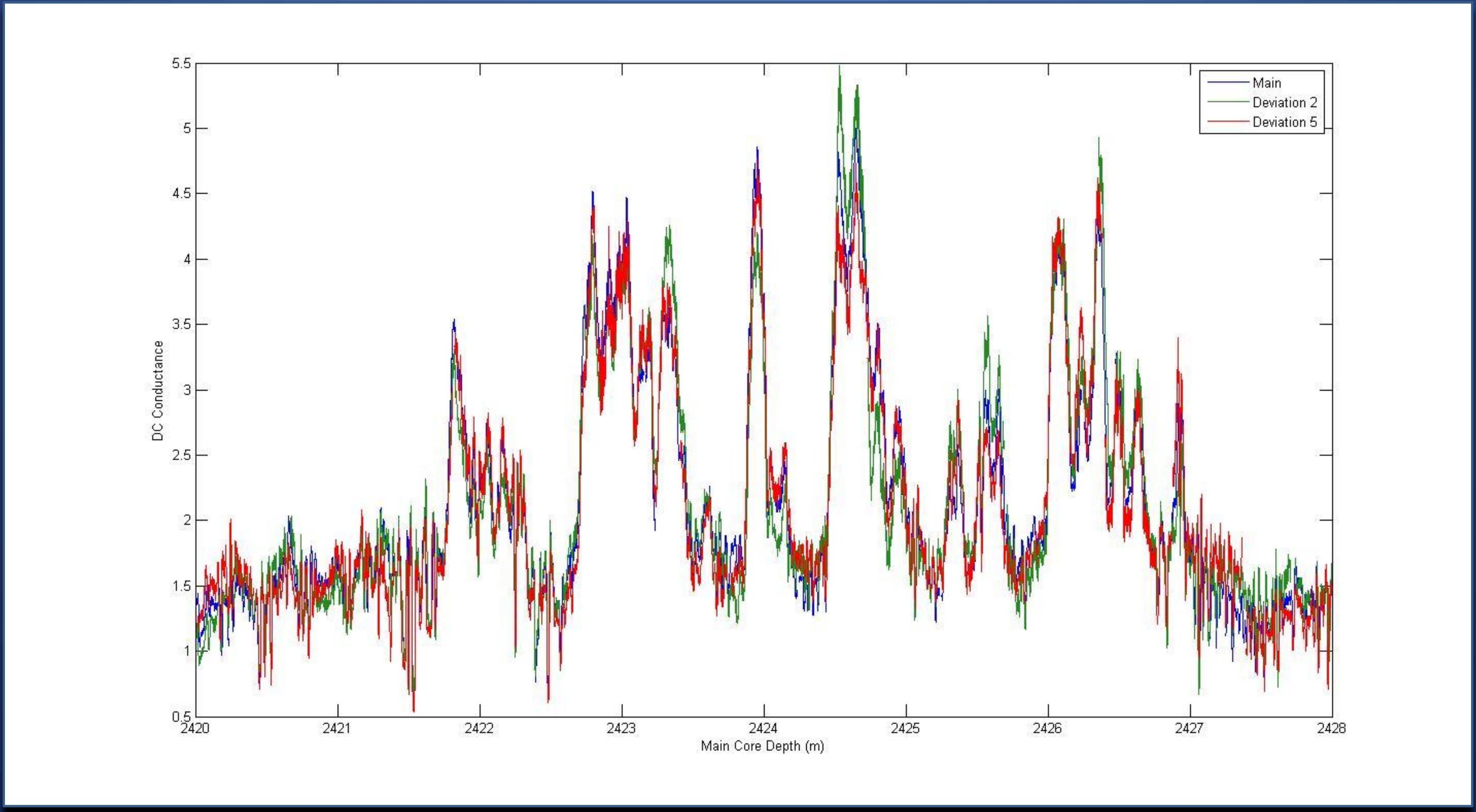


The 18k event was recovered not once, but twice: Stay tuned for analysis of the event!



Audience Question:

What processes or actions did you observe the scientist and/or engineer using?

NGSS Practices-how’d we do?

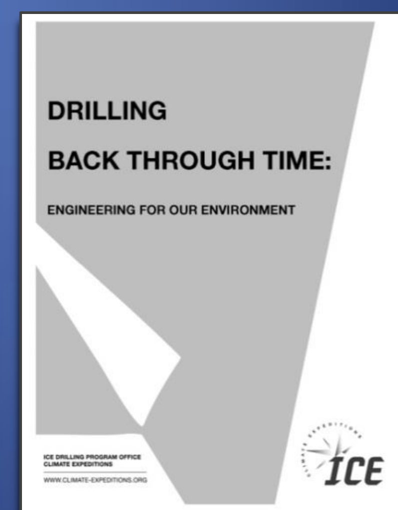
1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Activity: Drilling Back Through Time

1) Prepare your students

2) View the movie

www.youtube.com/user/USIceDrillingVideos



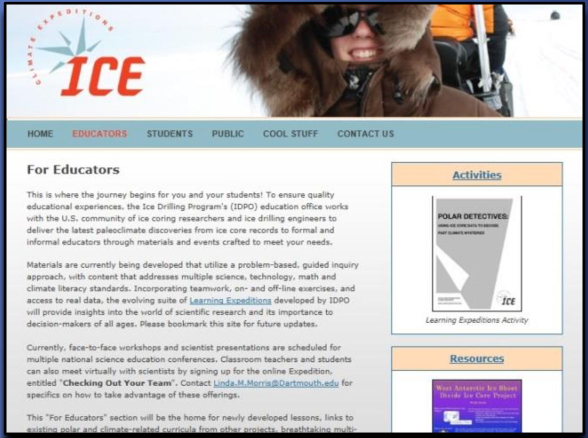
3) Check off each step as you hear it modeled by a scientist or engineer

Resources

Activity:

- http://www.climate-expeditions.org/educators/ Drilling-Back-Through-Time.pdf

US Ice Drilling Program



- www.icedrill.org
- www.climate-expeditions.org
- Linda.m.morris@dartmouth.edu

NSTA Webinar (will be archived)

- February 27, 2014:
  Jihong Cole-Dai, Jay Johnson, Linda Morris
  "Polar Science and Engineering"