"Biology has become the scientific basis for medicine, but cognitive psychology has **not** become the scientific basis for education."

–Nora Newcombe,
developmental psychologist

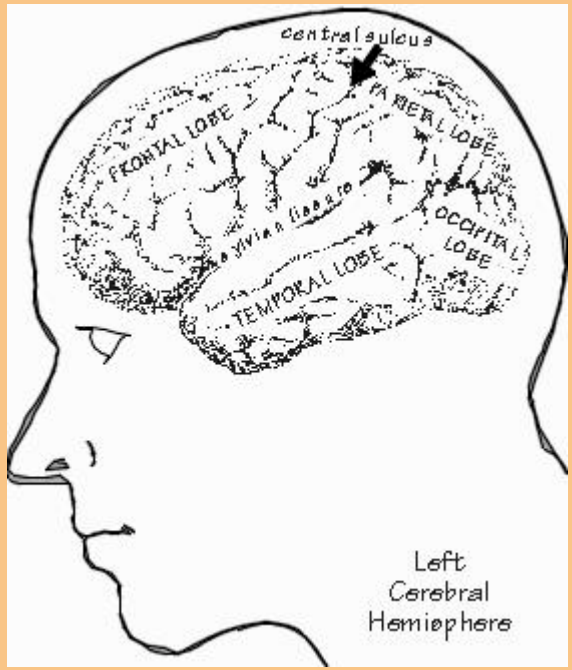


image from "Conversations with Neil's Brain"
http://www.williamcalvin.com/bk7/bk7.htm

were you here last year? {yes or no}	what's my thesis about?
what should every voter know about statistics?	what sparked your interest in earth science?

first, some questions for you!

more specifically:

- I'm experimenting with **teaching techniques**:

  testing whether the "one minute paper" at the end of my talk last year helped anyone remember what I said about my dissertation…

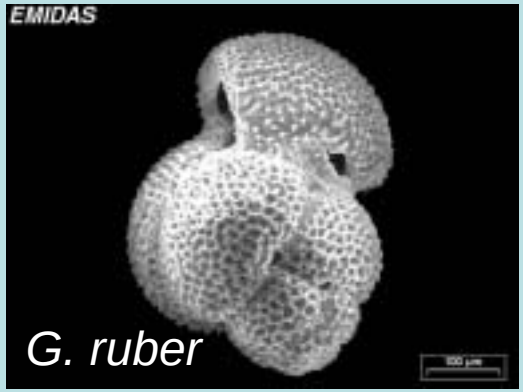
- I'm trying to incorporate **"active learning"** into what I will be teaching next month

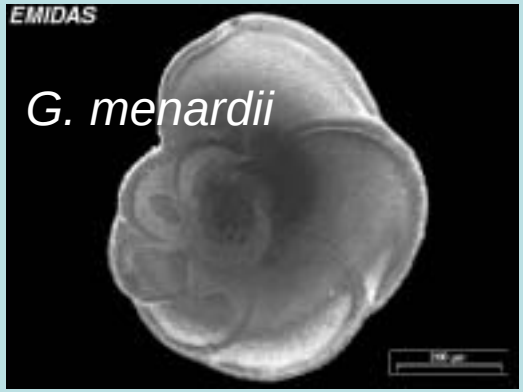
- to prime a brief (~5 minute) **discussion** at the end of my presentation, on:

  "effective strategies for teaching introductory earth science classes"

…now, my dissertation presentation:

Reconstructing tropical Atlantic paleoclimate from Mg/Ca and oxygen isotopes of planktonic foraminifera





E. Christa Farmer

Lamont-Doherty Earth Observatory
of Columbia University
and Hofstra University

why do we care?

- to understand natural variability of climate system
- to investigate mechanisms of past climate change on timescales longer than decades
- to understand future possible climate “surprises”:

  what happens when the “conveyor belt” deep ocean circulation slows?

20th Century Fox

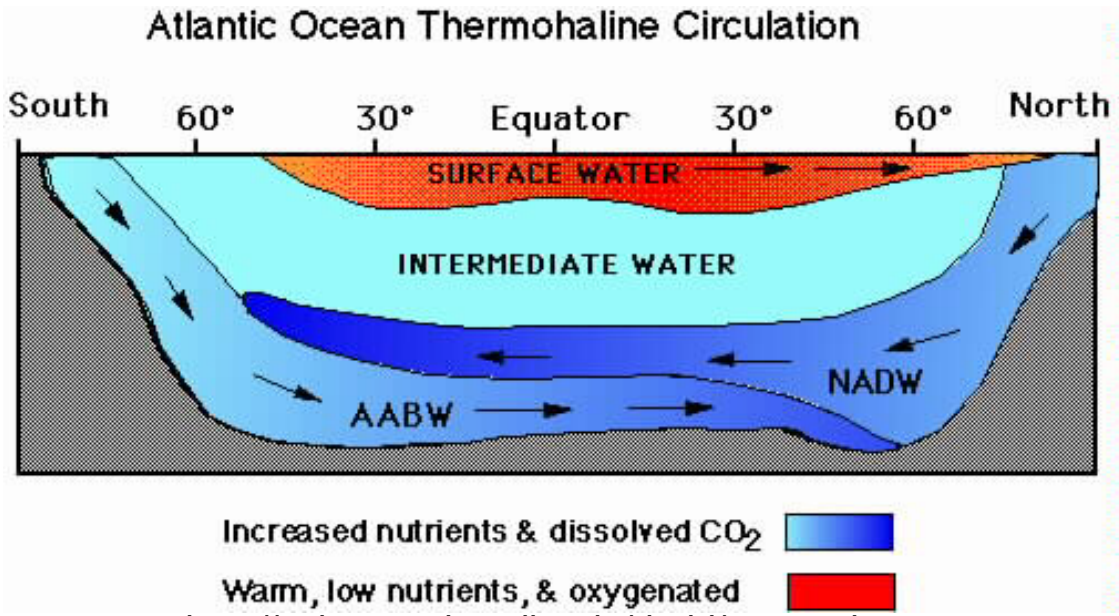
…or: how accurate was

The Day After Tomorrow??

http://web.clas.ufl.edu/users/mrosenme/Oceanography/Lectures/thermohaline_circulation.htm

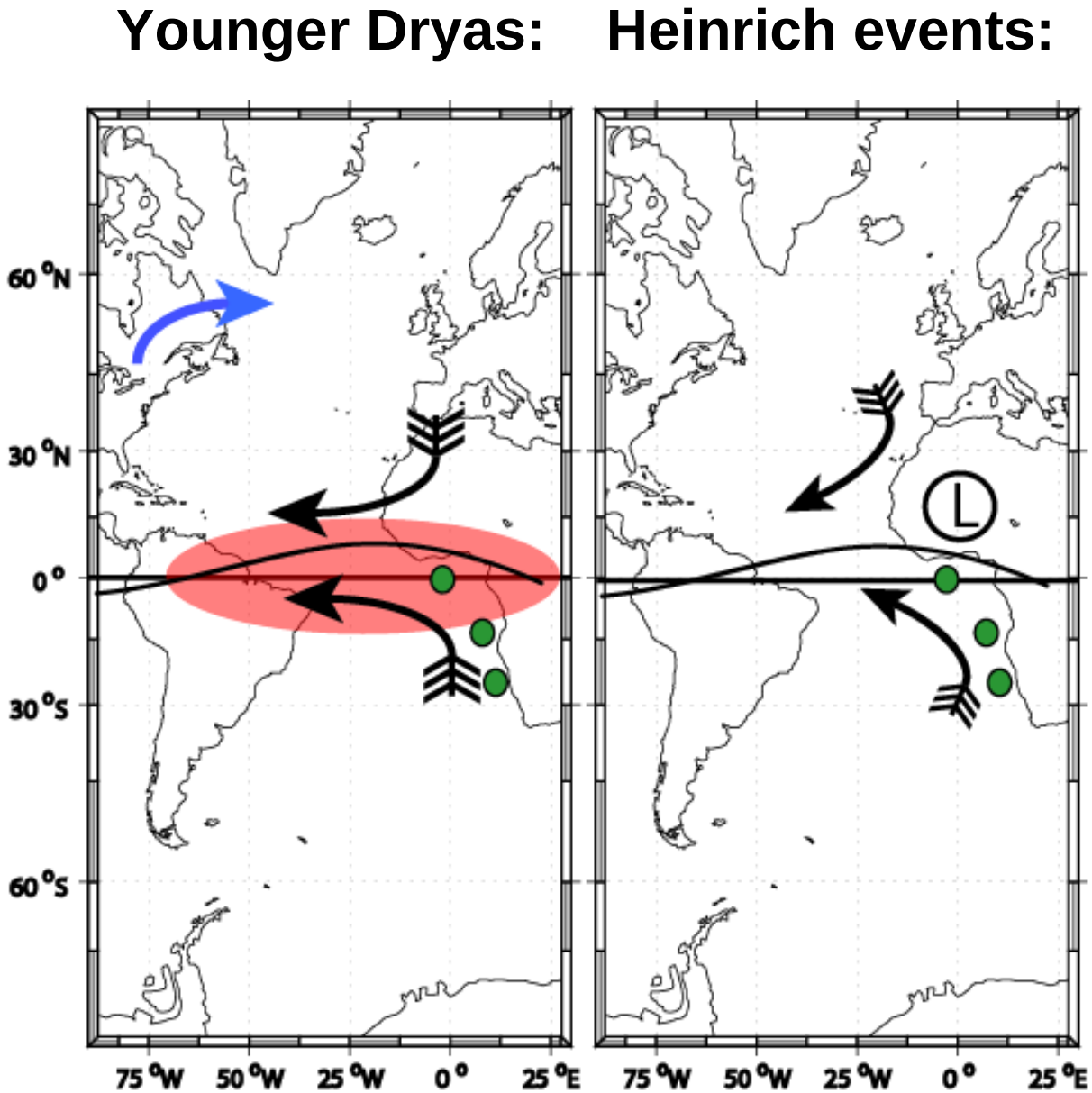
ocean circulation:

- "conveyor belt" (gross generalization of net transport but gives the idea)
- cold, salty water sinks in polar regions, gets enriched in nutrients from sinking organic matter everywhere
- heat transport across the equator in Atlantic warms northern regions, cools southern
- evidence of less NADW formation during glacial period, YD



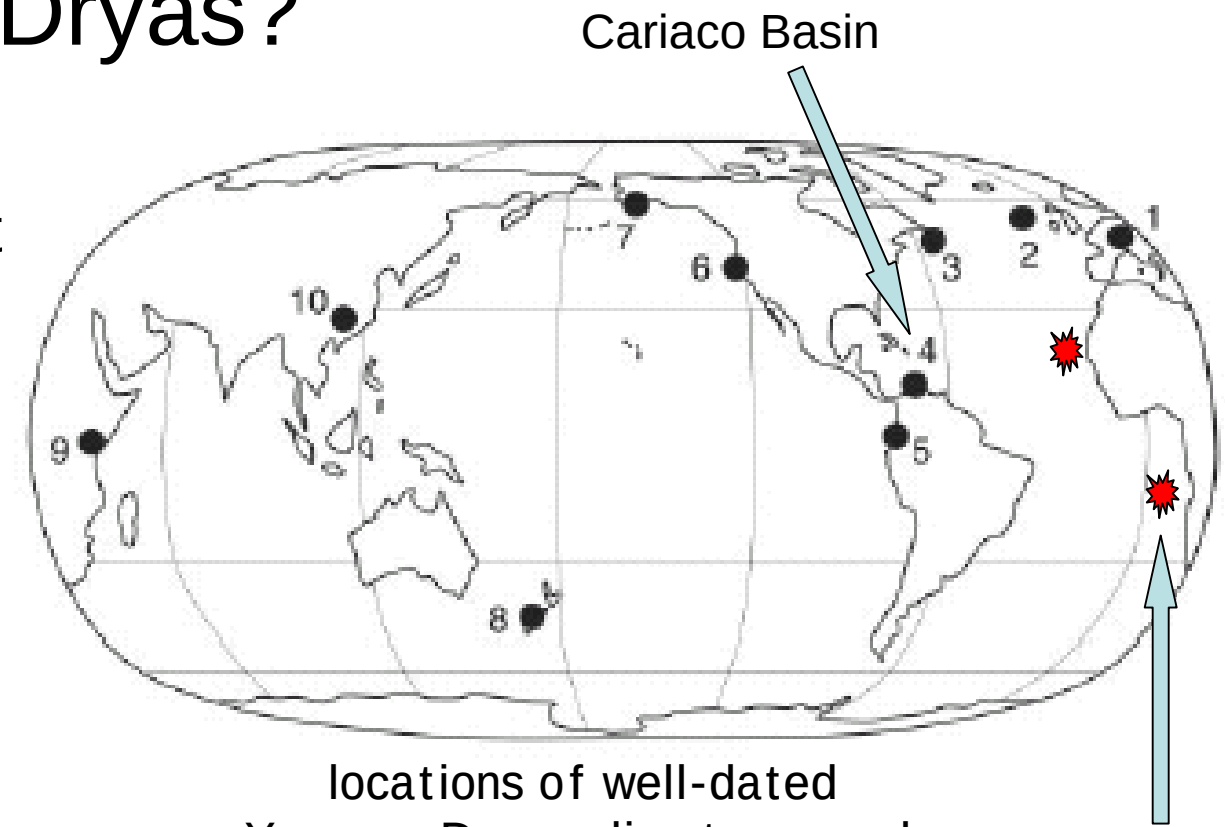
http://seis.natsci.csulb.edu/rbehl/NADW.htm

proposed different mechanisms for abrupt millennial-scale climate change:

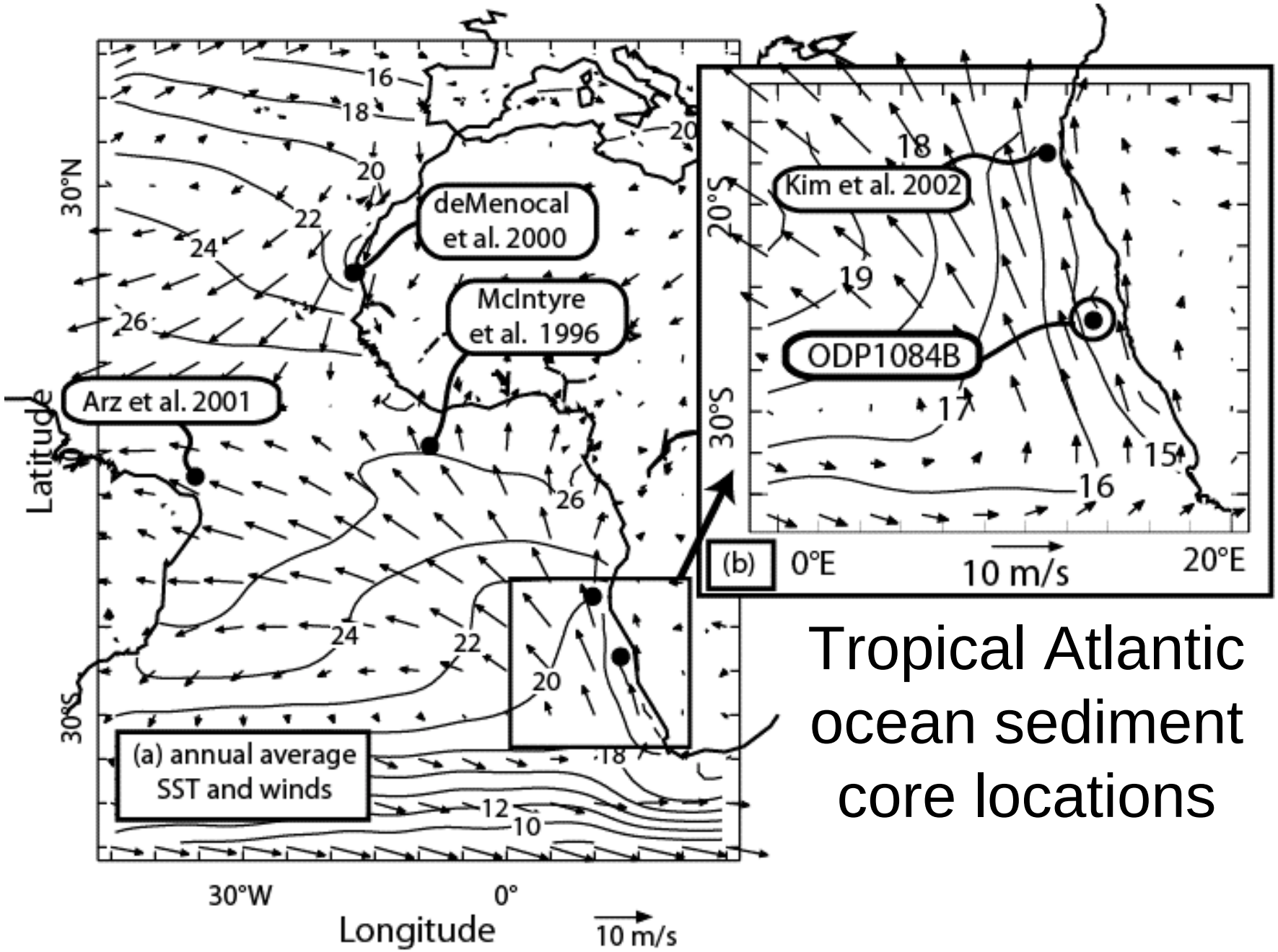


how global was the Younger Dryas?

- seems to be everywhere but Antarctica?
- but need more data from Southern Hemisphere...



locations of well-dated Younger Dryas climate records (Broecker, 2003)



Tropical Atlantic ocean sediment core locations

getting the samples:

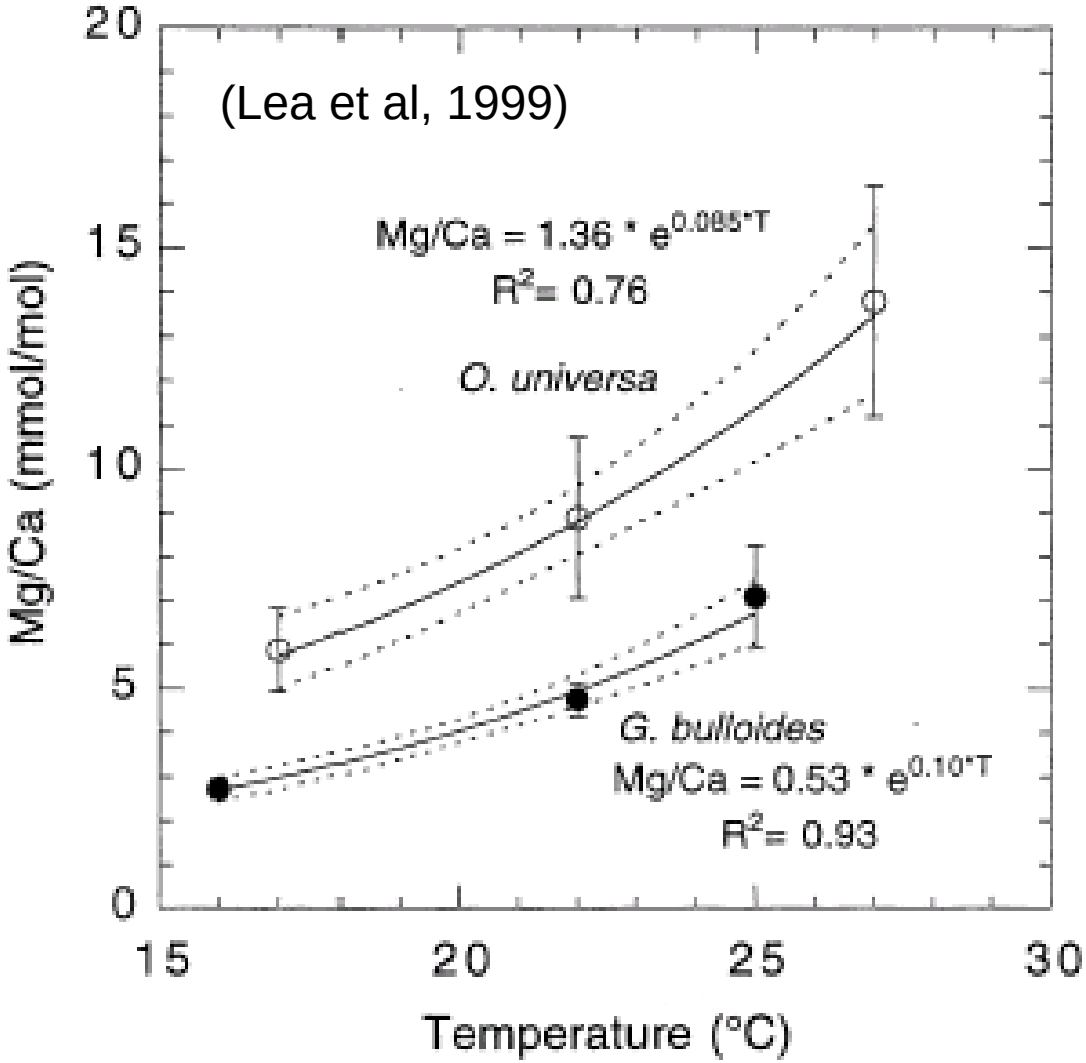
Mg/Ca temperature proxy:

G. bulloides, planktonic foraminifera:

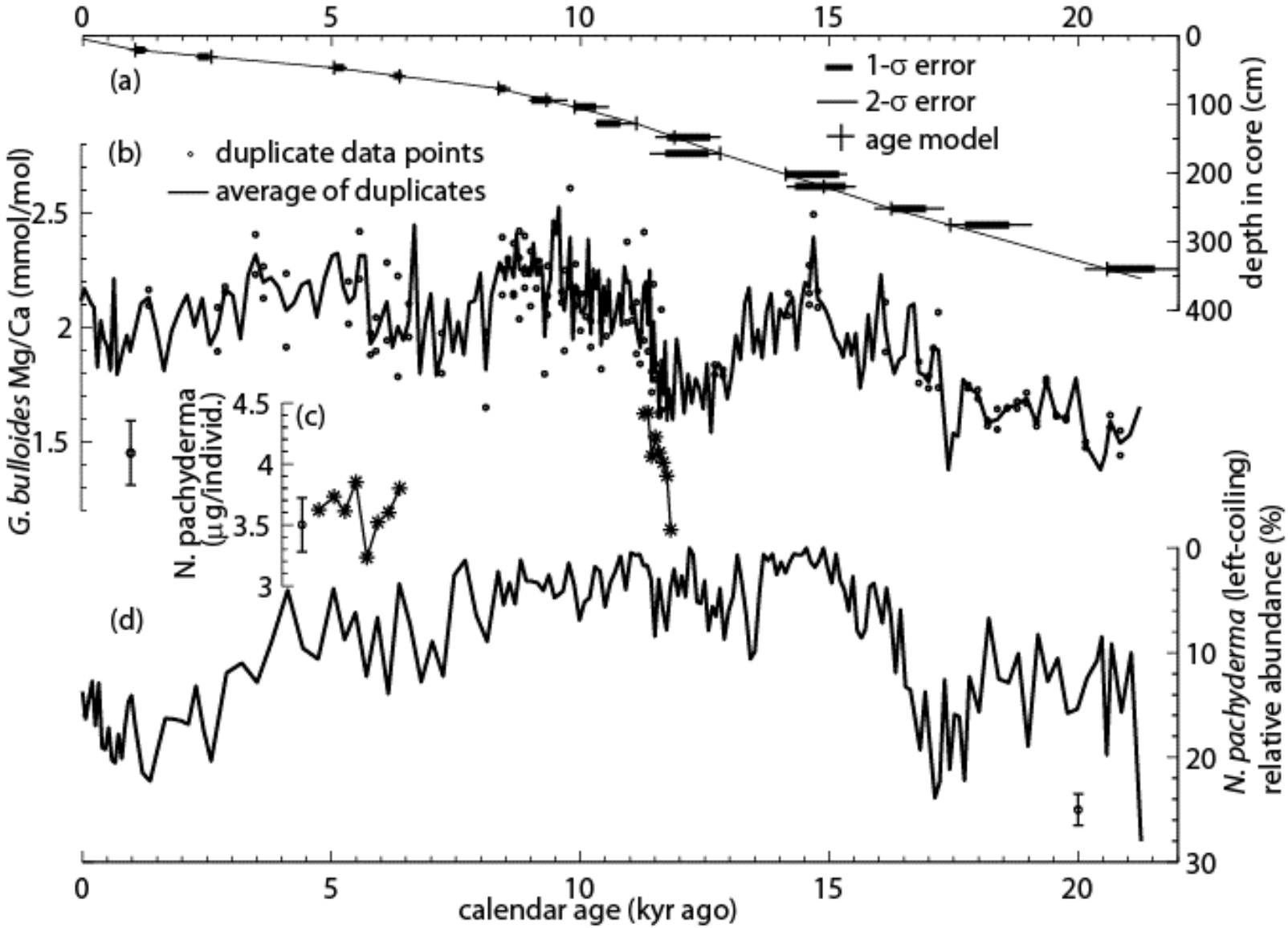
- mixed-layer dweller
- transitional to polar locations and upwelling environments; here, on edge of permanent upwelling zone
- $CaCO_3$ skeleton provides temperature, global ice volume, faunal abundance, and other proxy information

Mg/Ca:

- Lea et al. 1999: culture experiments
- [Mg]/[Ca] of *G. bulloides* depends on temperature

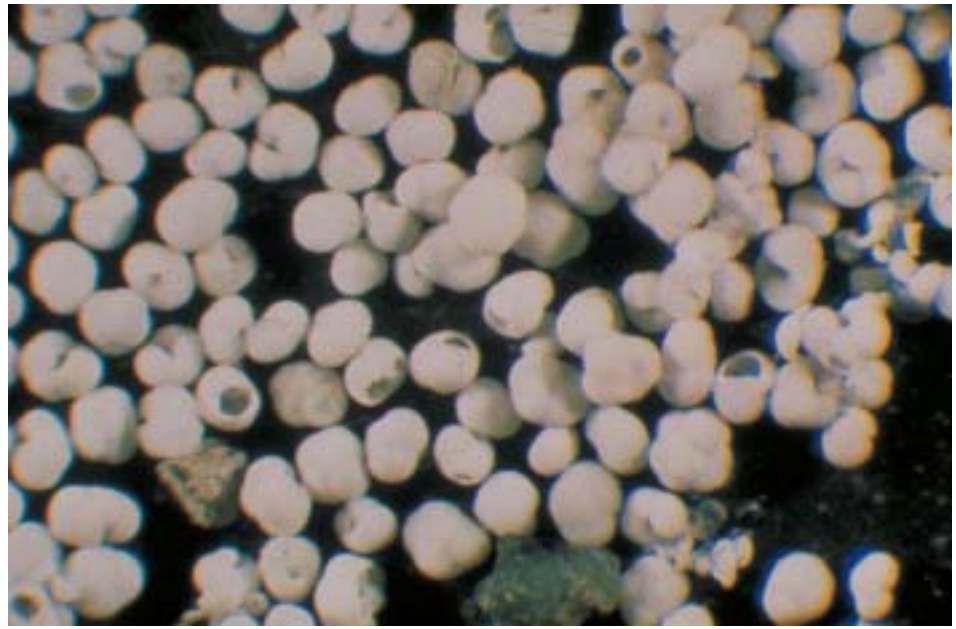


ODP1084B age model, Mg/Ca, dissolution, and faunal abundance data:

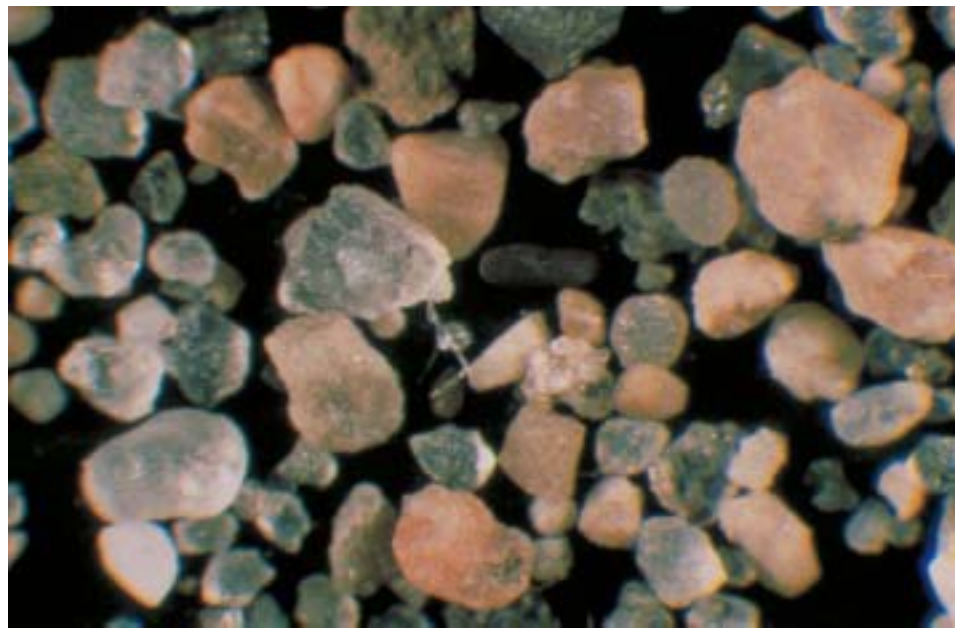


Heinrich events:

- micrograph detailing sand-size fraction in core HU87033-009:



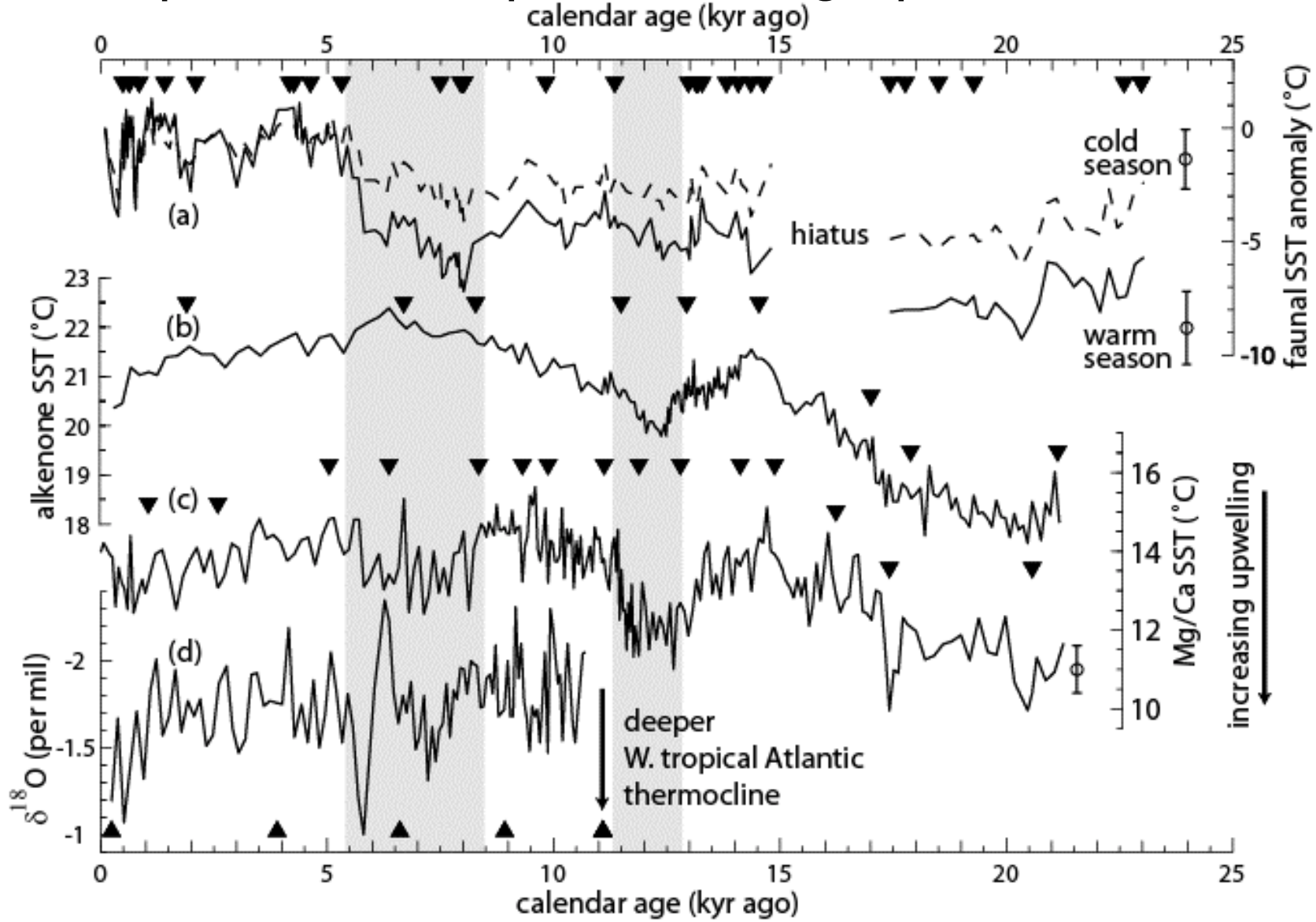
- Micrograph detailing sand-size fraction from same core at 670-672 cm depth, within H-2:

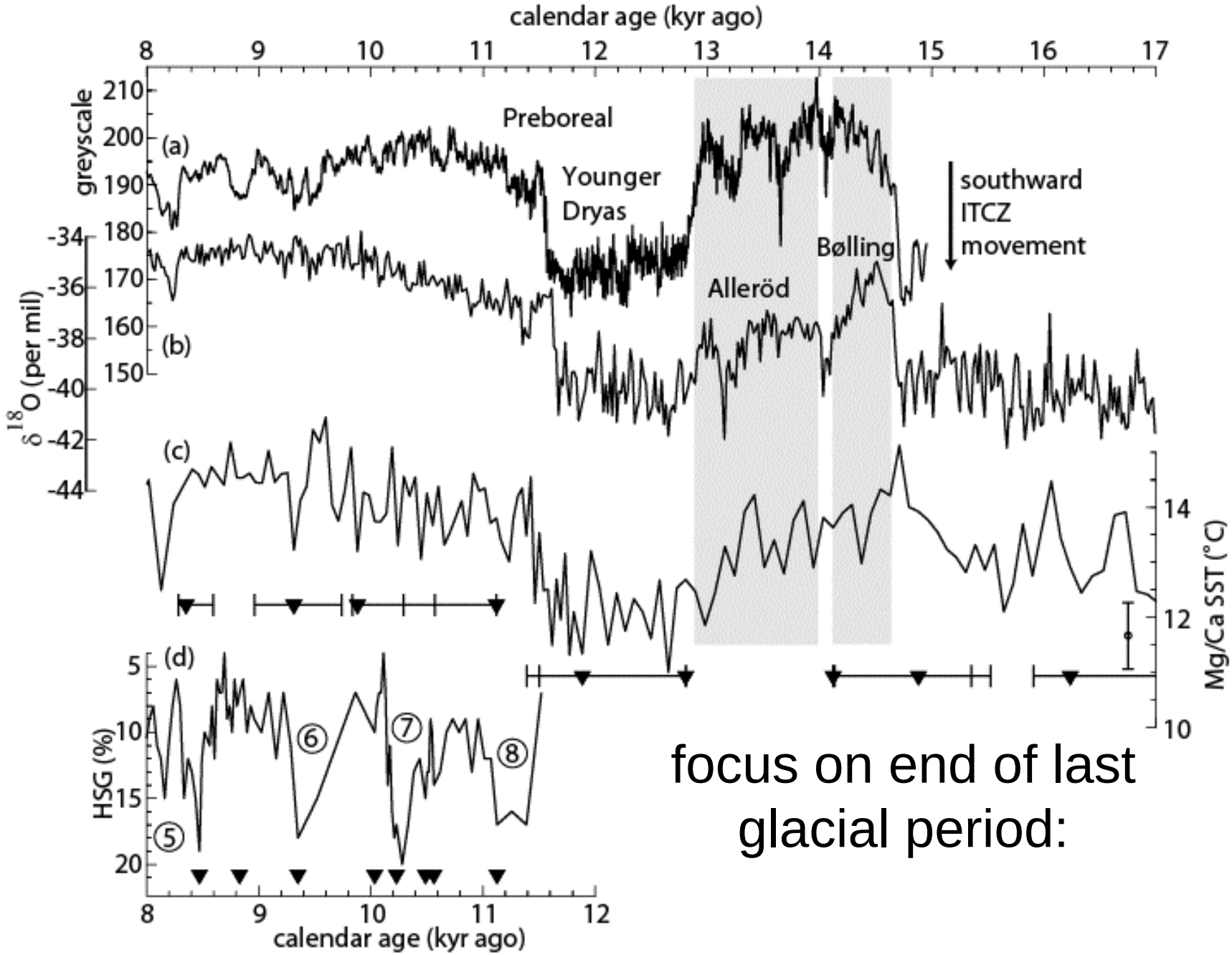


terrestrial material too large to be carried out into open ocean by currents– must be ice!

http://www.ngdc.noaa.gov/paleo/slides/slideset/19/index.html

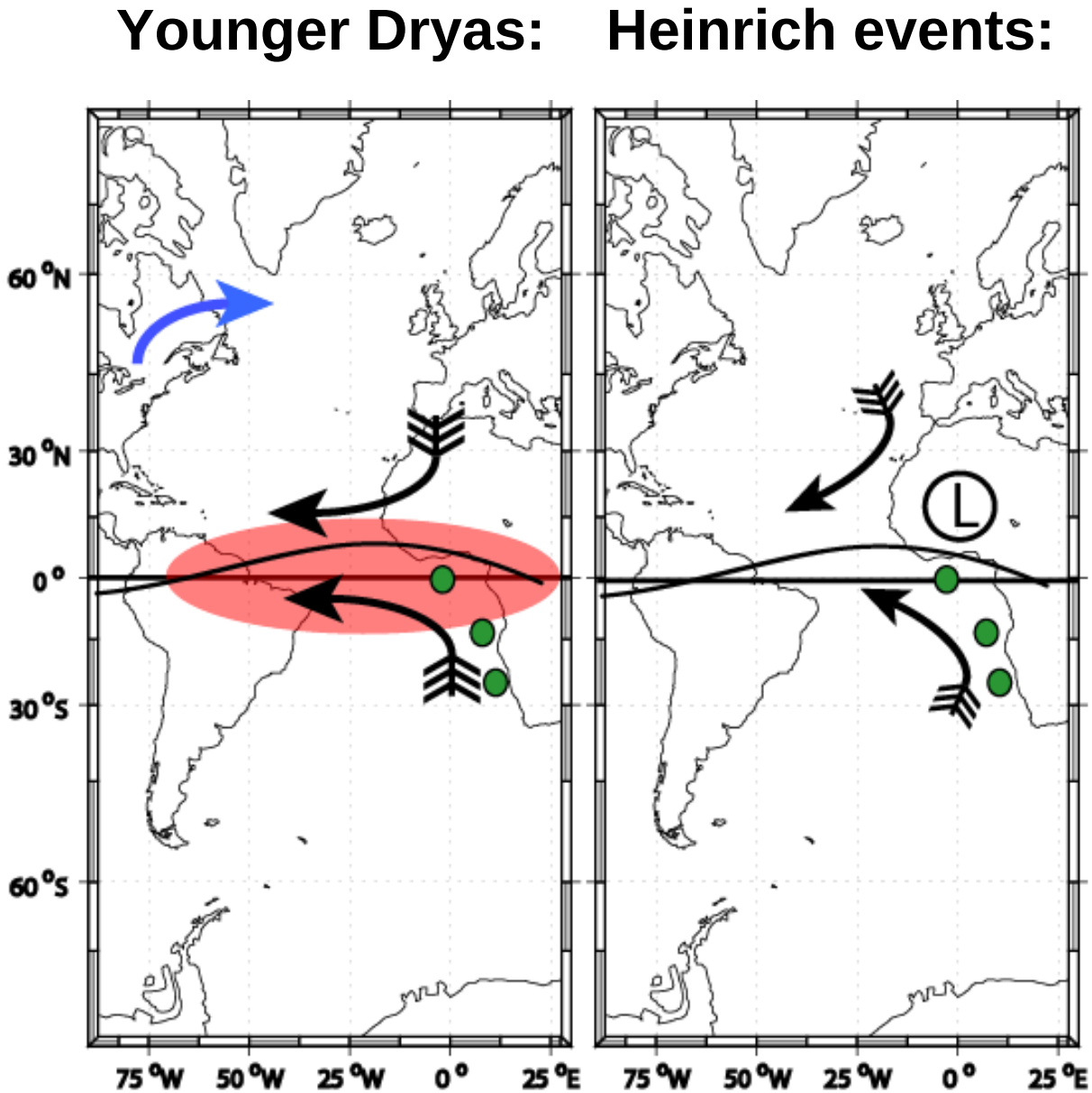
comparison of ODP1084B Mg/Ca data to other tropical Atlantic paleoceanographic records:





focus on end of last glacial period:

proposed different mechanisms for abrupt millennial-scale climate change:



…and now, for something completely different:

A brief discussion on "effective strategies for teaching introductory earth science"

were you here last year? {yes or no}	what's my thesis about?
what should every voter know about statistics?	what sparked your interest in earth science?

first, some questions for you!

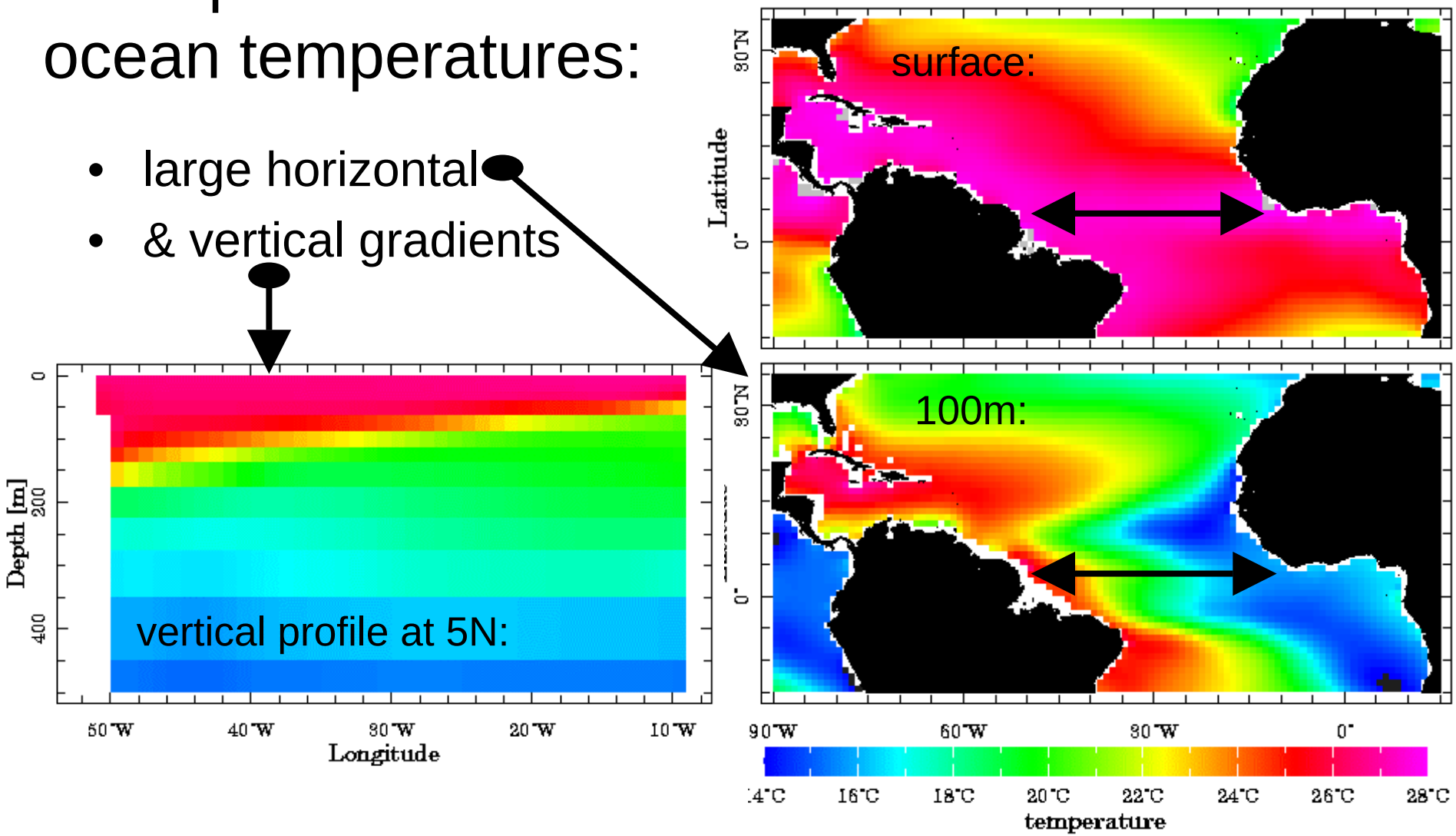
my questions for discussion:

- what should college non-science majors know about statistics & earth science? (…*future voters*…)
  - all of us probably had scientific majors
  - most students in my classes this fall will not (%??)

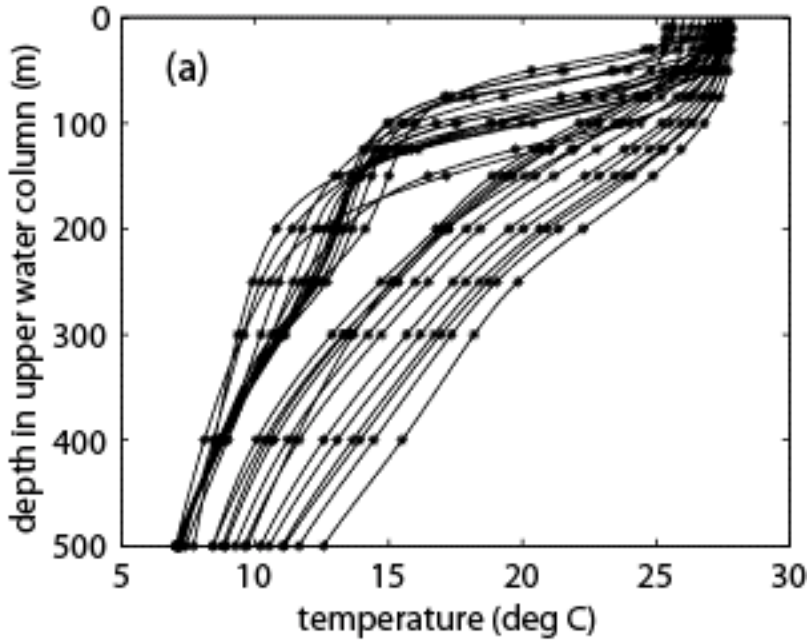
- what is the most effective way to learn how to study earth science?
  - has anyone here given or assigned a poster as part of a semester-long class?
  - can I incorporate activities into my classroom that result in publishable research?

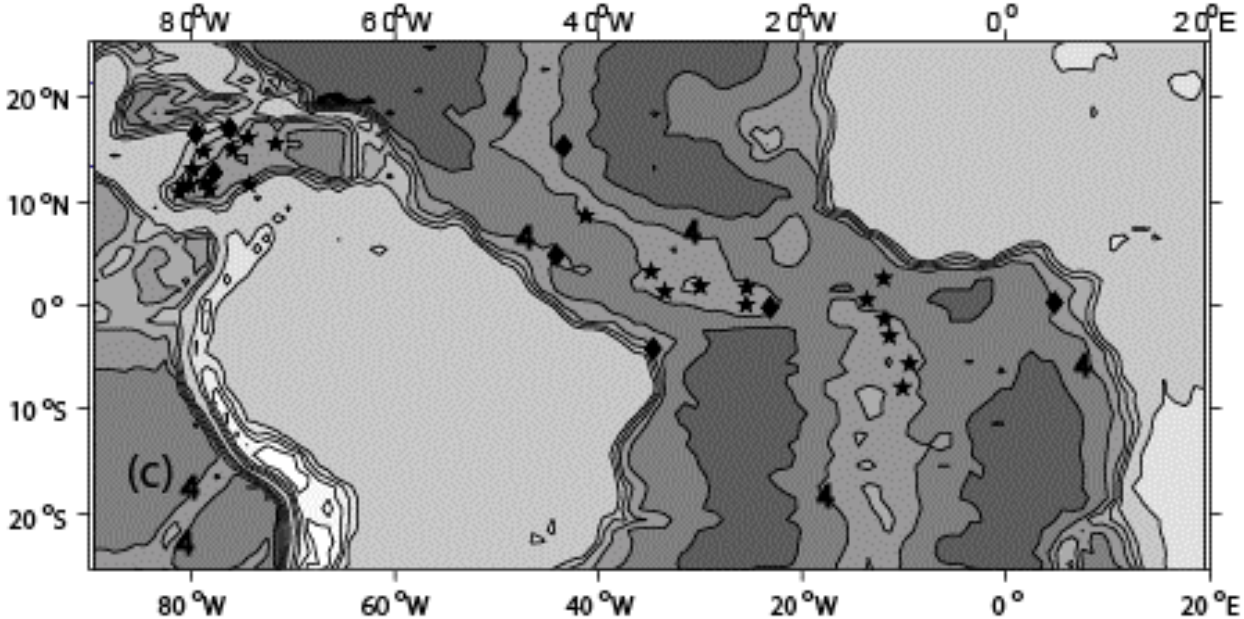
Tropical Atlantic ocean temperatures:

- large horizontal
- & vertical gradients

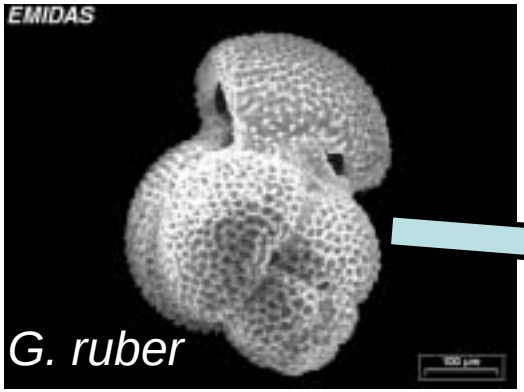


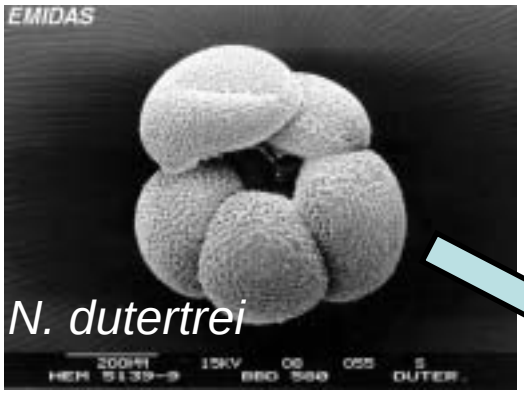
Transect of tropical Atlantic coretops for calibration of new subsurface temperature proxy:

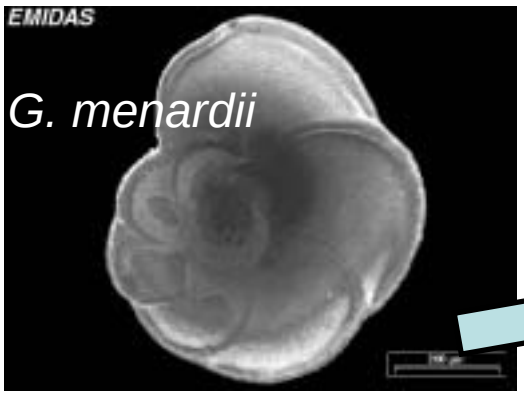


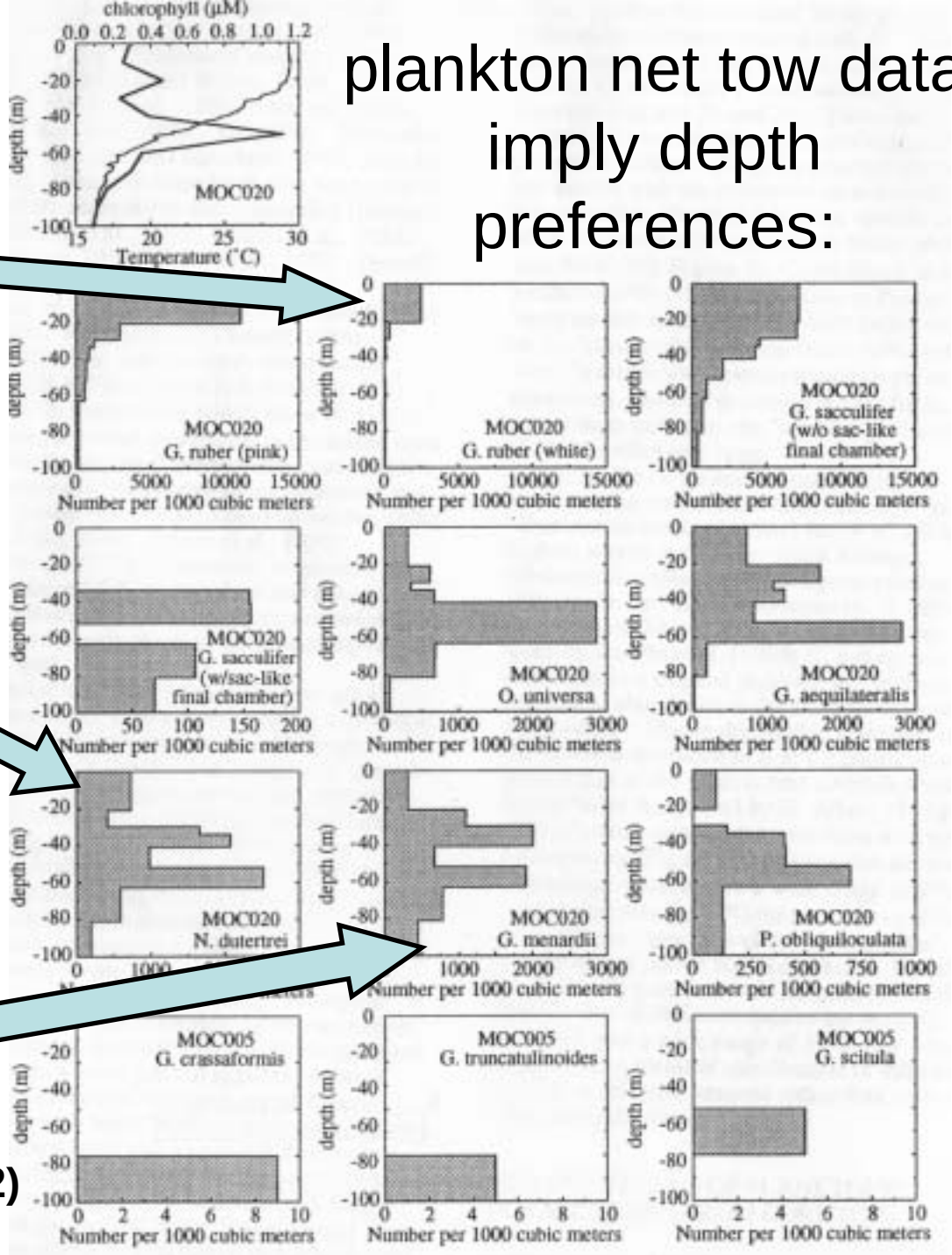


plankton net tow data imply depth preferences:



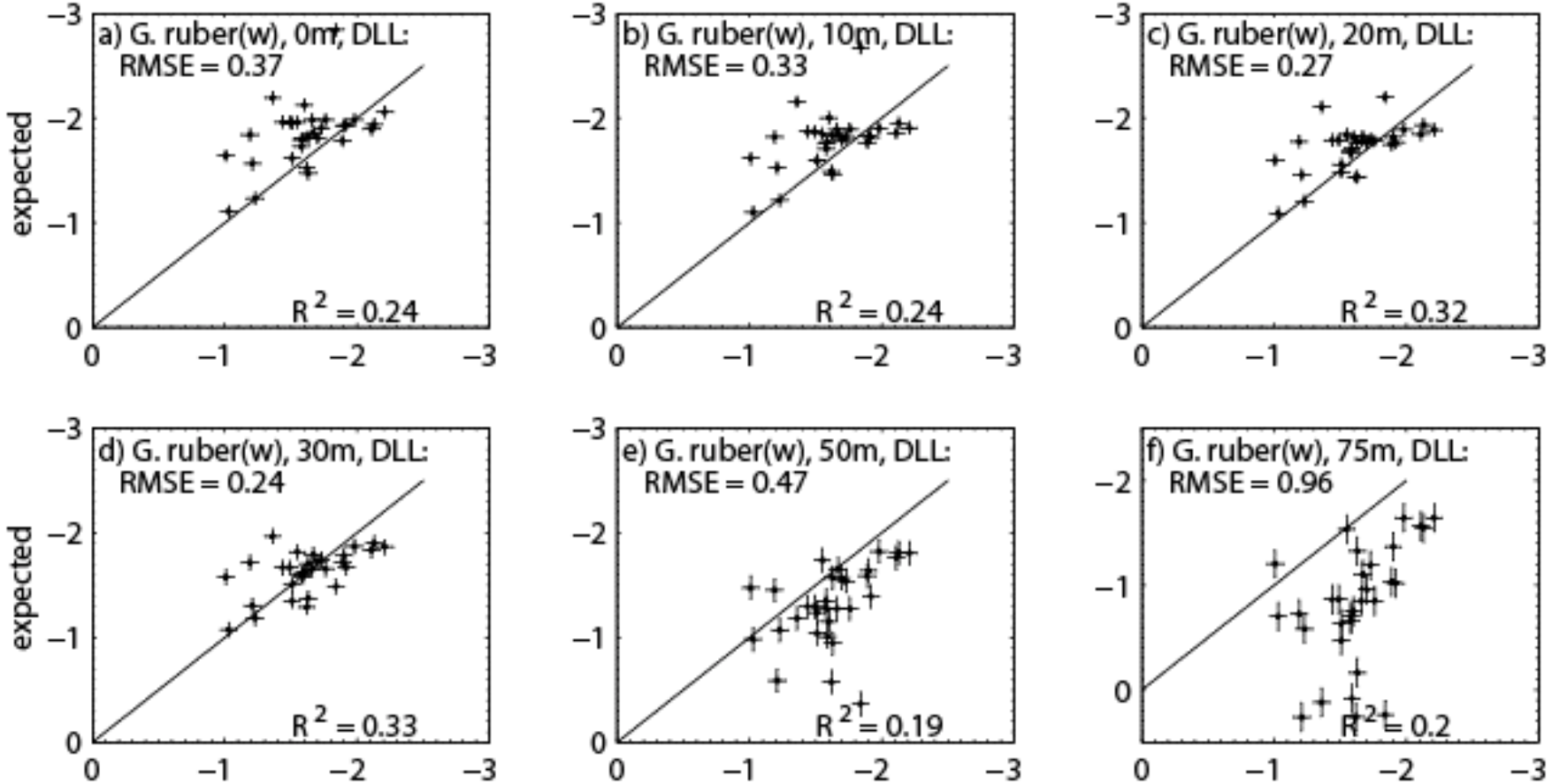






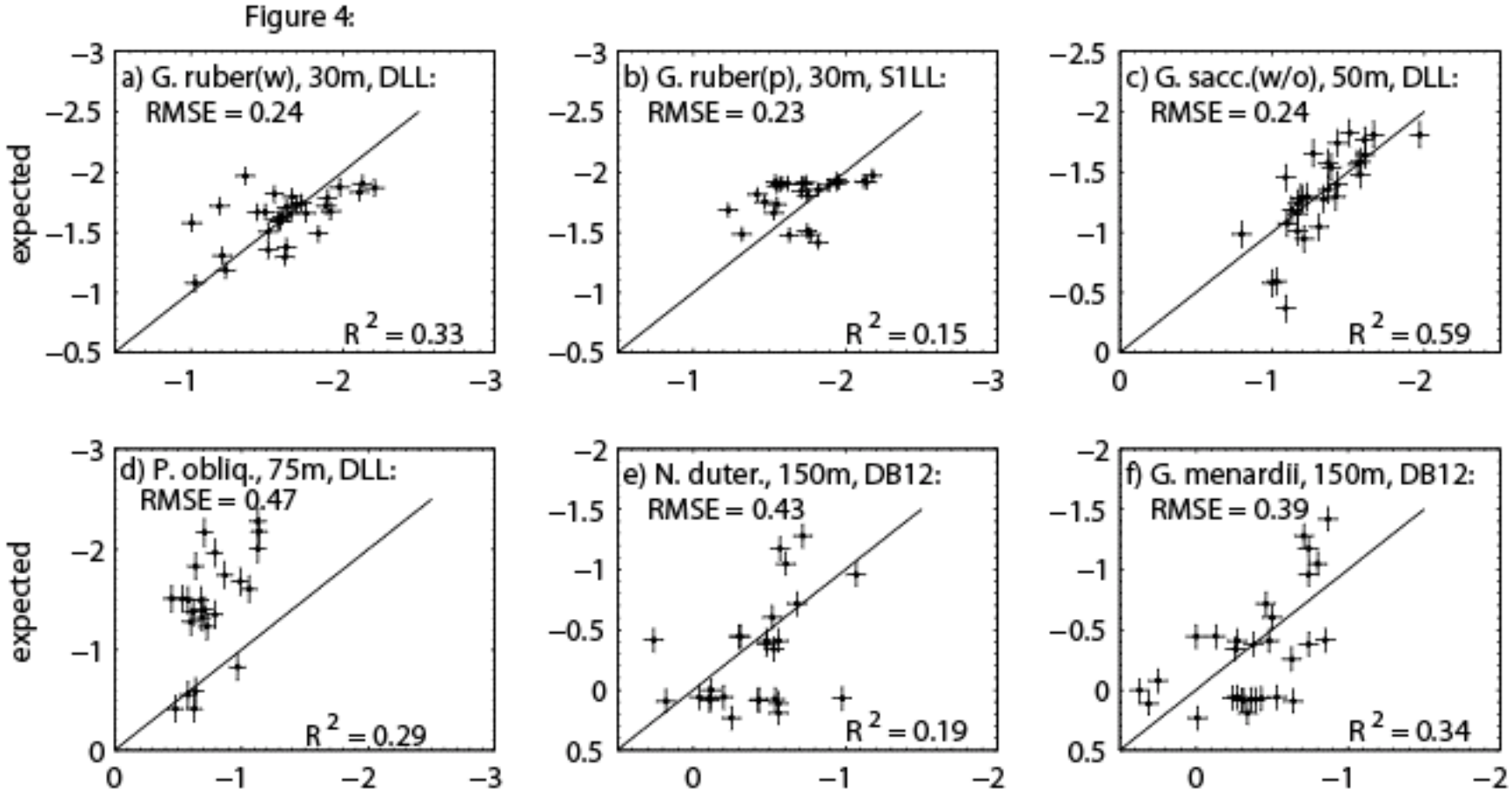
(Ravelo & Fairbanks 1992)

oxygen isotope ratios confirm suspected planktonic foraminifera depth preferences:



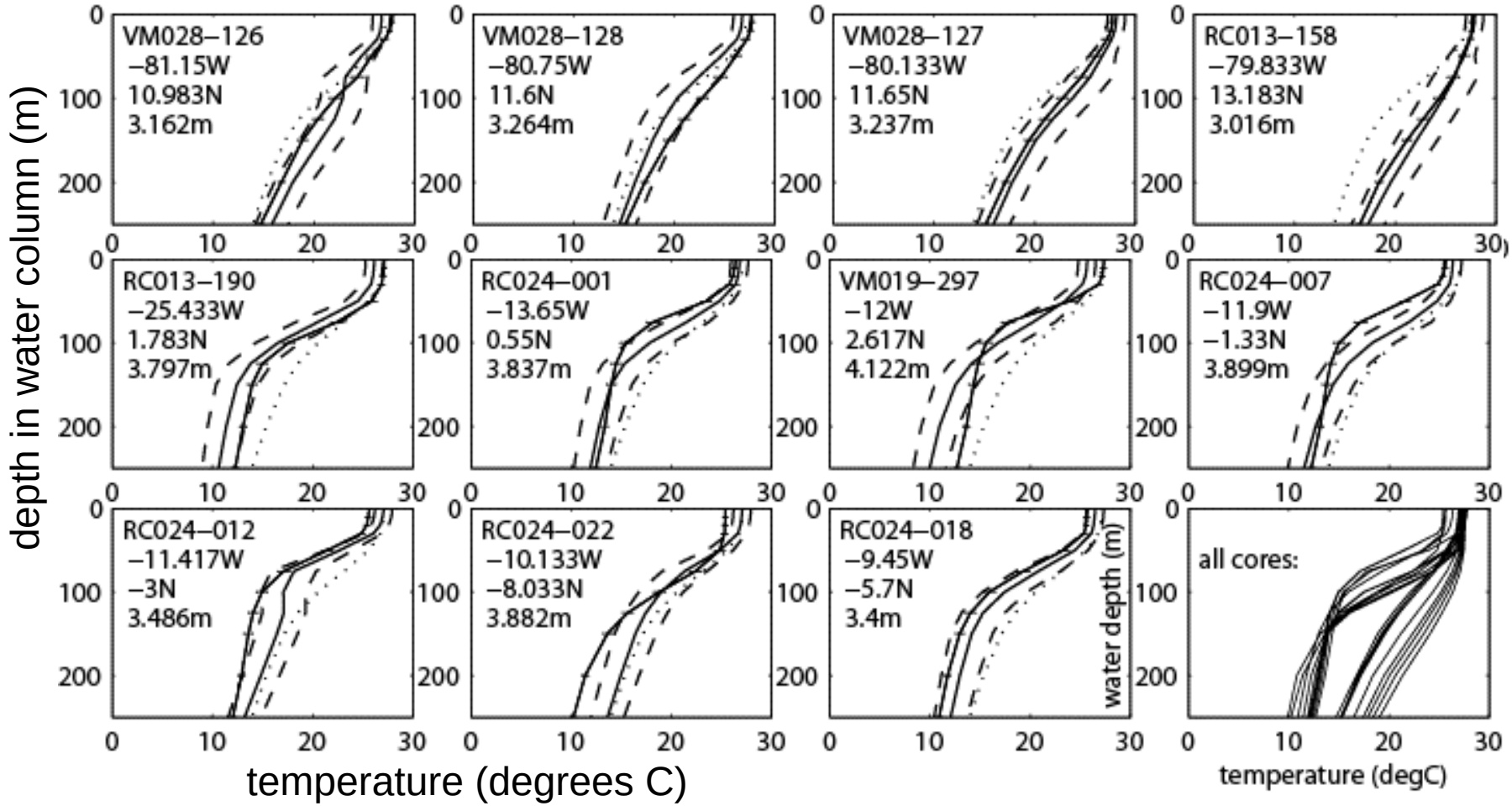
$\delta^{18}O$ (oxygen isotope ratio, per mil PDB)

… for all species:

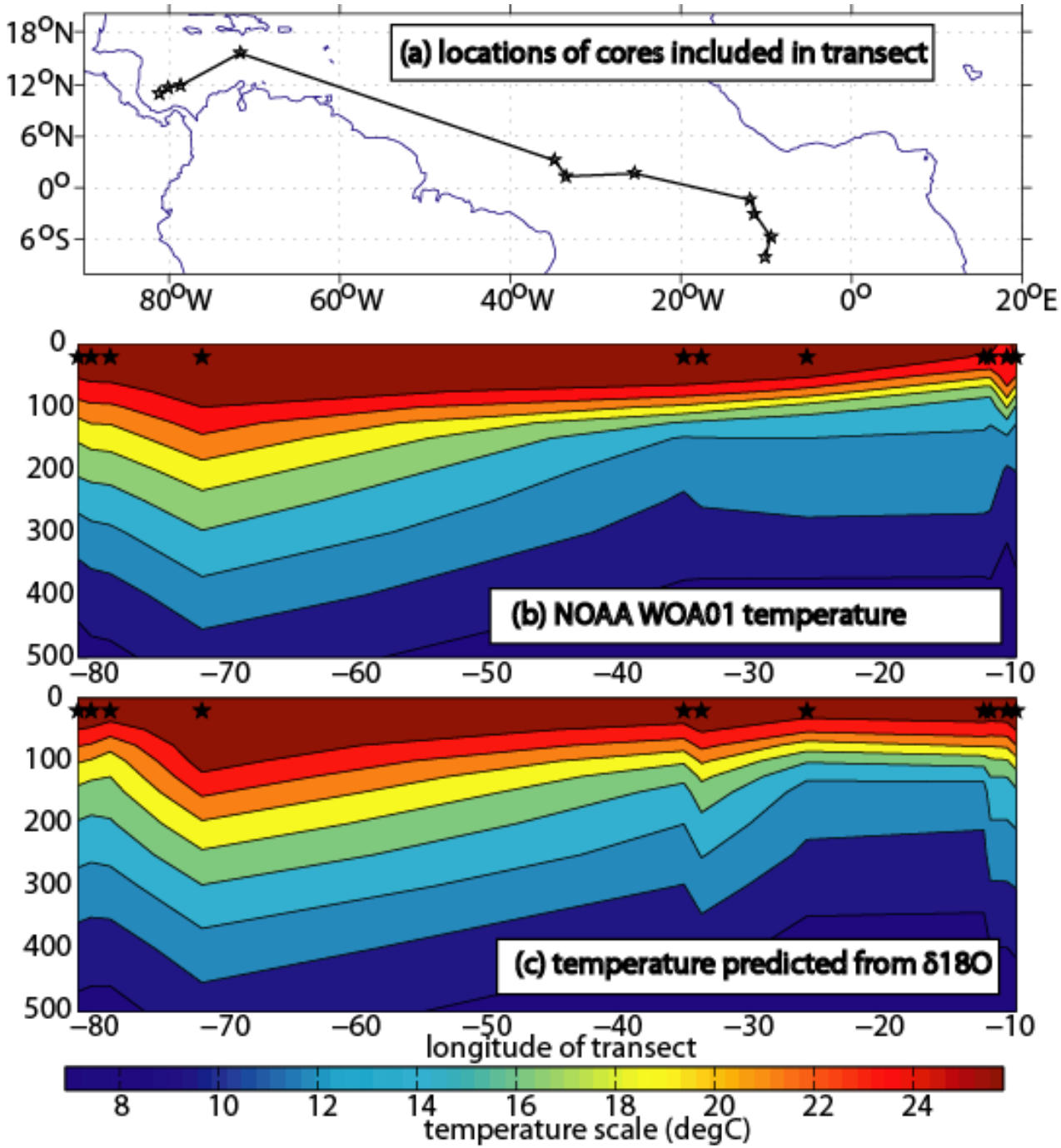


$\delta^{18}O$ (oxygen isotope ratio, per mil PDB)

multiple regressions give reasonable "predictions" of subsurface temperatures:



overall:
can use oxygen isotopes in planktonic foraminifera to measure past changes in thermocline depth across the tropical Atlantic

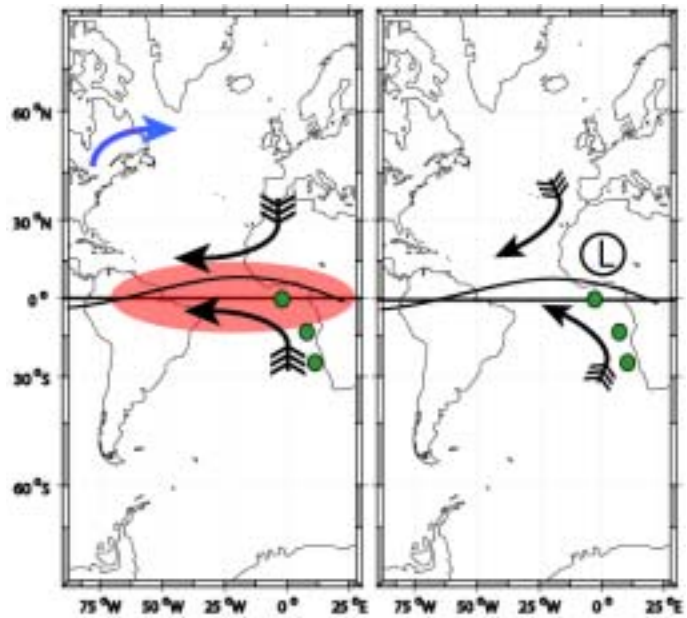


Two main conclusions of my dissertation:

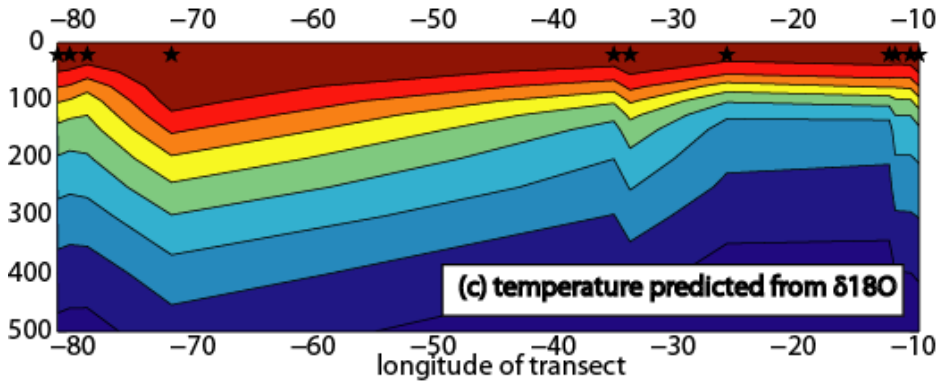
(1) trade winds seem to have changed consistently across the Tropical Atlantic at the end of the last glacial period, suggesting different mechanisms for two types of rapid climate change

(Younger Dryas

& Heinrich events)



(2) oxygen isotopes from multiple species of planktonic foraminifera can be used to estimate past changes in upper ocean temperatures




Thank you!!