Gulf of Mexico Corals as Monitors of Environmental Change

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Objectives

- Part I – Interdecadal climate variability
  - Reconstruction of PNA pattern using corals at the Flower Garden Banks National Marine Sanctuary
- Part II – Carbon cycling
  - Air-sea interaction and pre to post-bomb transition
  - Interfacing with numerical modeling

Interdecadal Climate Variability

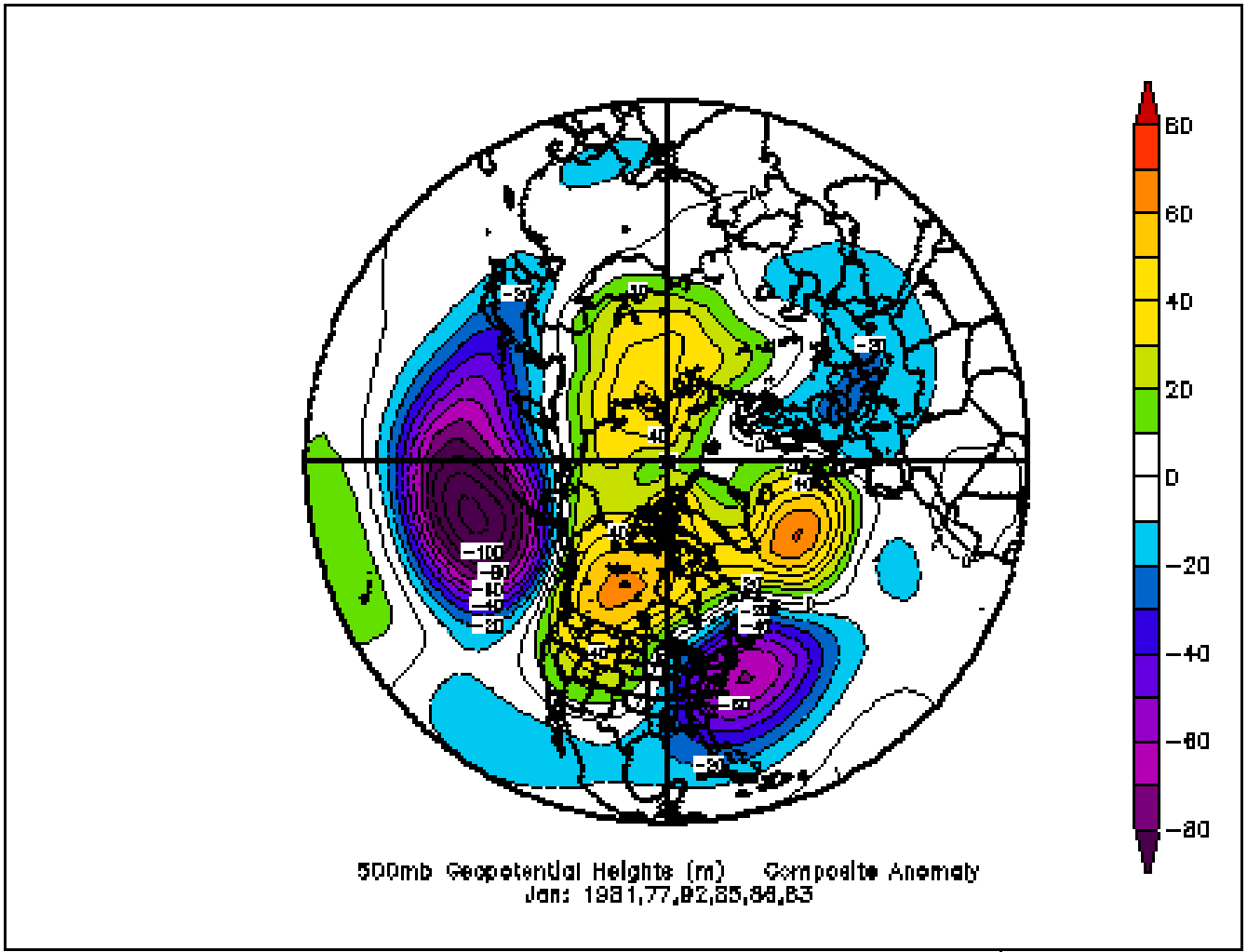
- Impact of climate variations on tropical Pacific and North Atlantic well known
- Less well known but equally significant extratropical climate variations occur
- Flower Garden Banks (FGB) are uniquely situated to monitor extratropical climate
- Information about past extratropical climate (and possibly tropical climate) is preserved in skeletons of corals at FGB

Pacific/North American (PNA) Pattern

- Synchronous changes in the strength of the high and low atmospheric pressure centers over the North Pacific and North America
- Most pronounced during winter months
- Tremendous effect on winter climate in the Northern Hemisphere

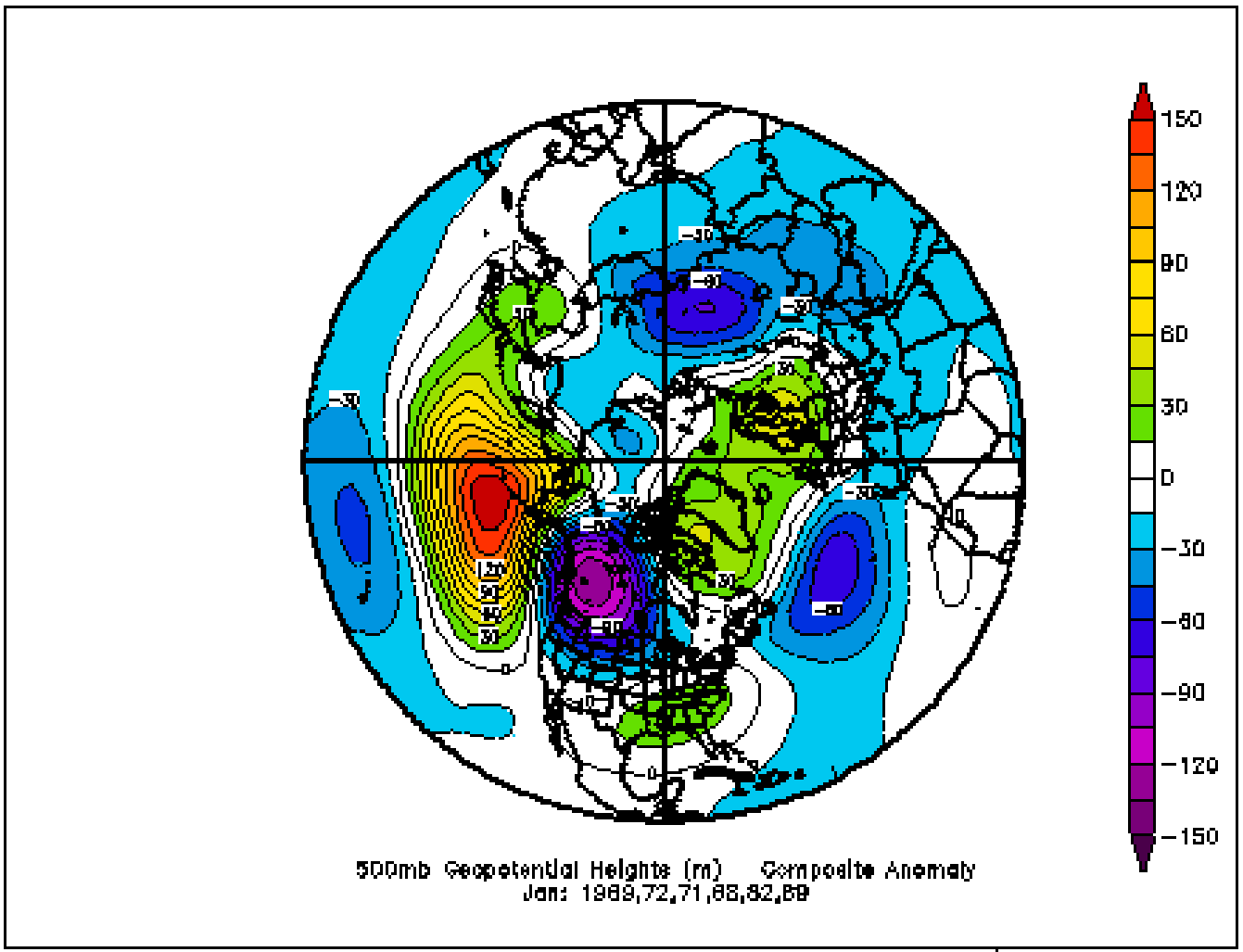
PNA Positive Phase

- Warmer and drier in the NW, colder in the SE



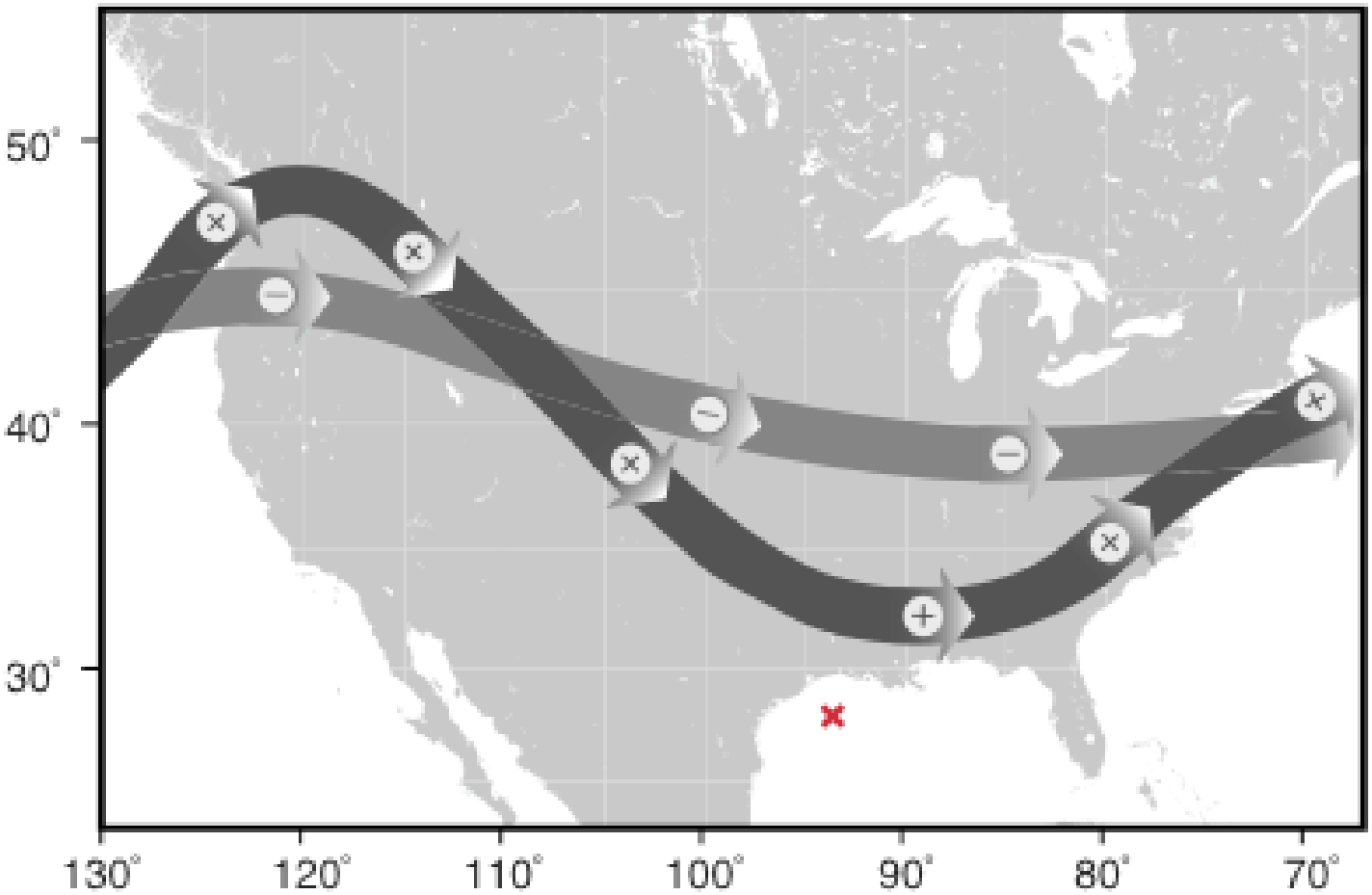
PNA Negative Phase

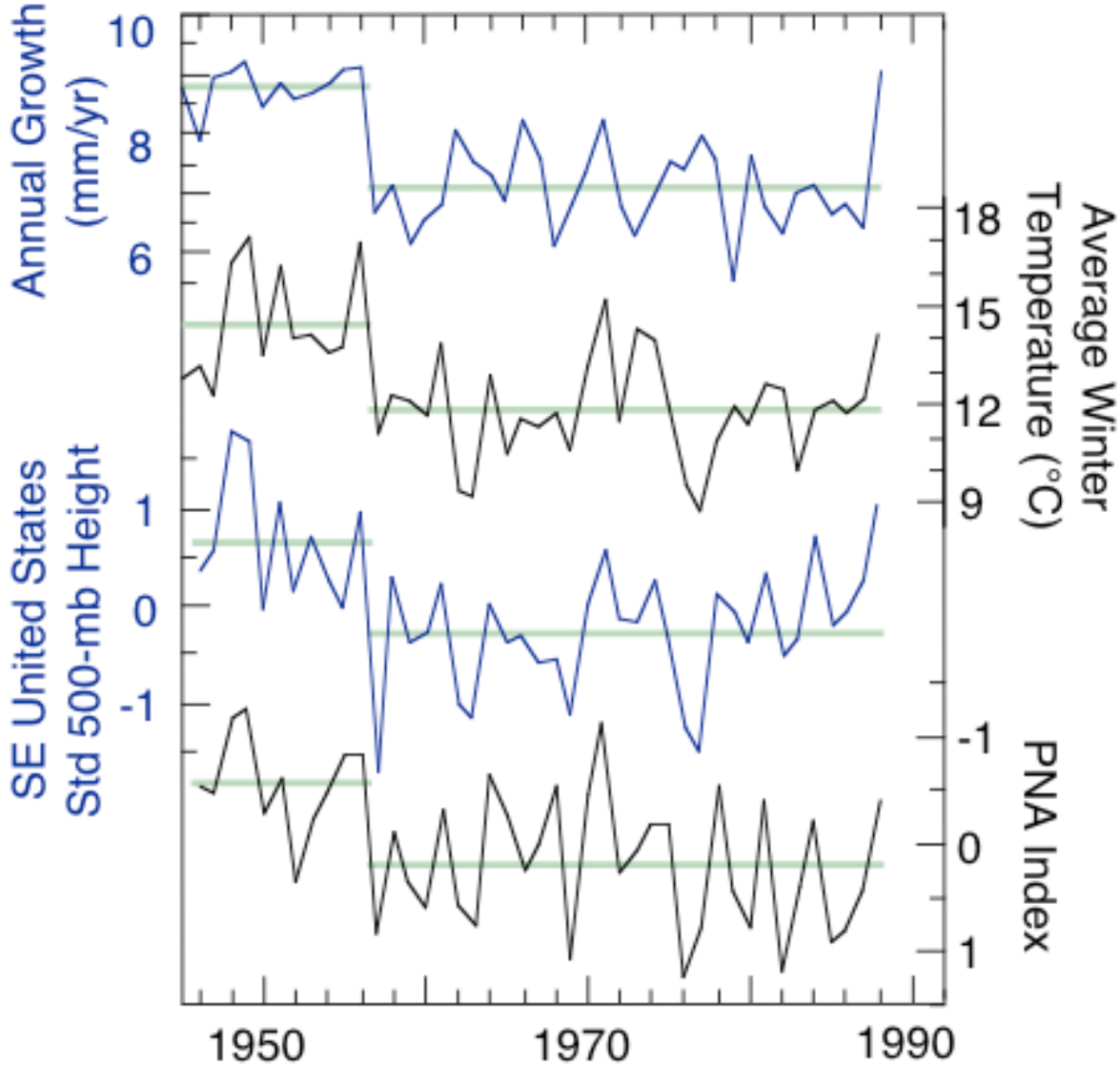
- Cooler and wetter in the NW, warmer in the SE



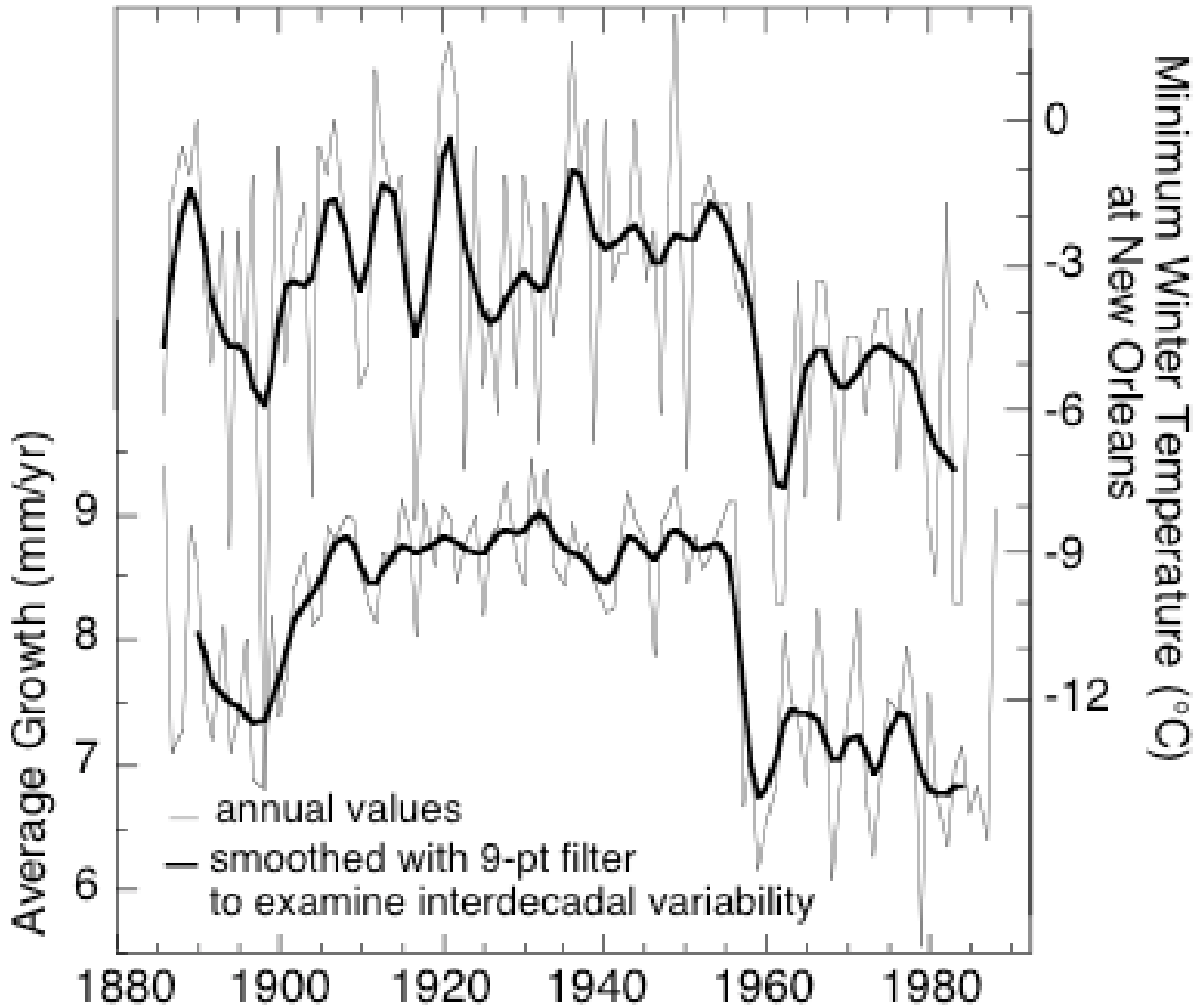
The Jet Stream

FGB ideally located





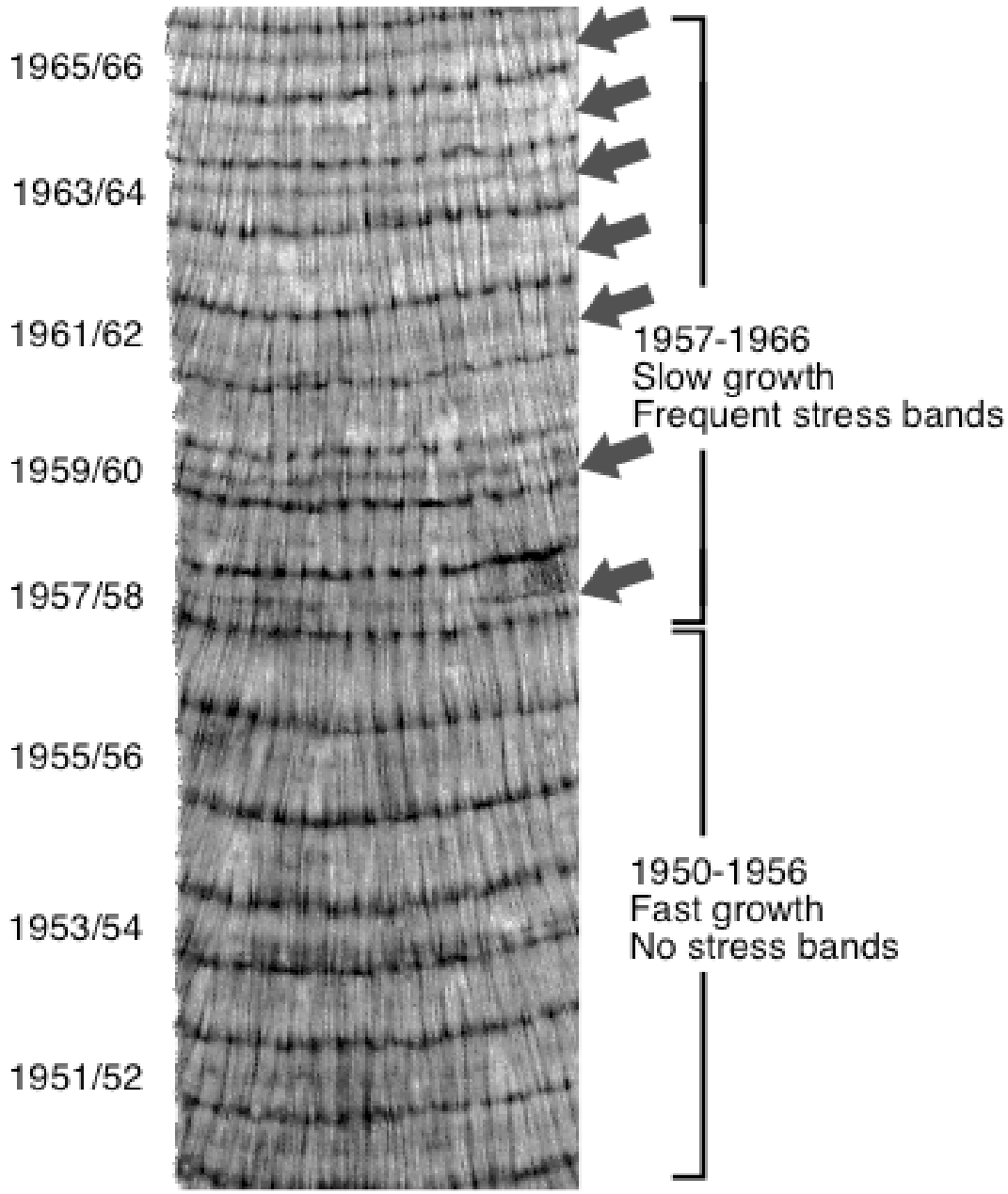
(Slowey and Crowley, 1995)



(Slowey and Crowley, 1995)

Why corals?

- Strong correlation between coral growth and water temperature
- Certain corals (e.g. *Montastrea* and *Siderastrea*) form distinct seasonal density bands
- Isotopic composition ($^{18}O/^{16}O$) of calcium carbonate coral skeletons reflects the temperature and oxygen isotopic concentration of the water
- Mg/Ca and Sr/Ca ratios of coral skeletons provide independent records of temperature
- $\Delta^{14}C$ of skeletons provide radiocarbon records of Gulf of Mexico


1965/66
1963/64
1961/62
1959/60
1957/58
1955/56
1953/54
1951/52
1957-1966
Slow growth
Frequent stress bands
1950-1956
Fast growth
No stress bands

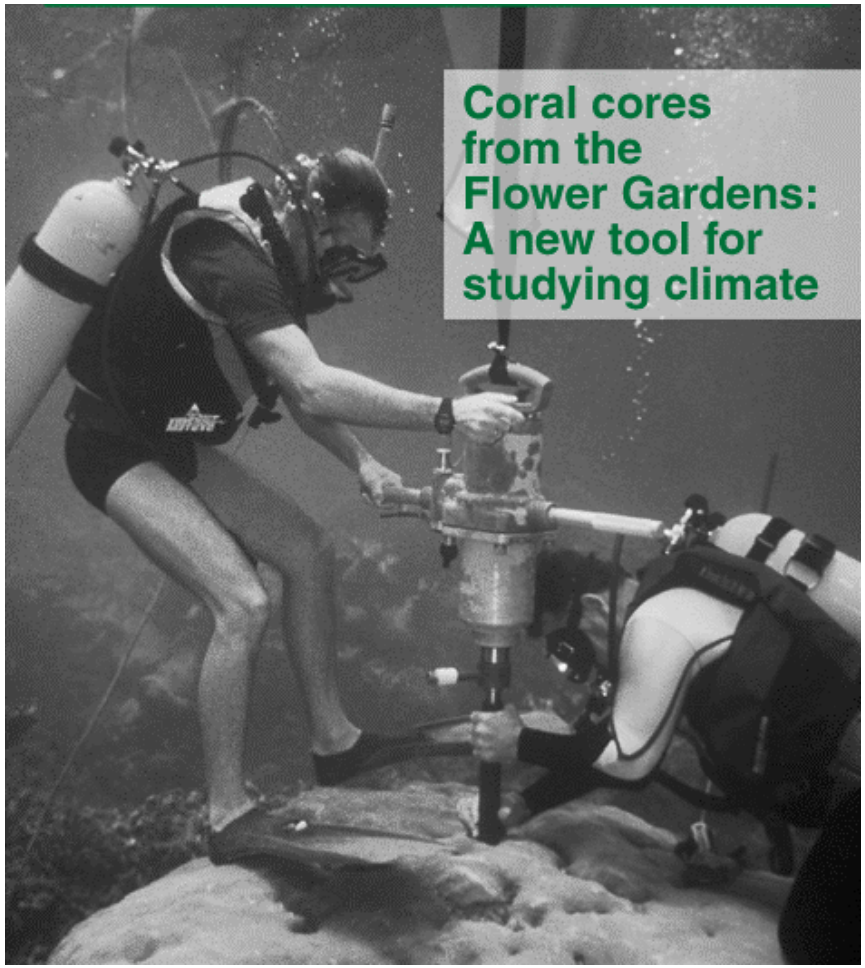
Strategy – Part I

- Construct long proxy records of environmental conditions
  - Collect several ~2 meter cores of *Montastrea* and *Siderastrea* corals
  - Cut slab and x-ray cores
  - Count and measure annual and winter stress density bands
  - Analyze $^{18}O/^{16}O$, Mg/Ca and Sr/Ca ratios of calcium carbonate samples removed from one core, constructing records with monthly resolution (≥12 samples/year)
  - Compare *in situ* temperature data with coral density, growth, and chemical composition ($^{18}O/^{16}O$, Mg/Ca and Sr/Ca ratios)
  - Construct histories of coral growth, local temperature and PNA pattern variations

Coral Species

Siderastrea siderea

Montastrea annularis


Coral cores
from the
Flower Gardens:
A new tool for
studying climate

Greg Boland

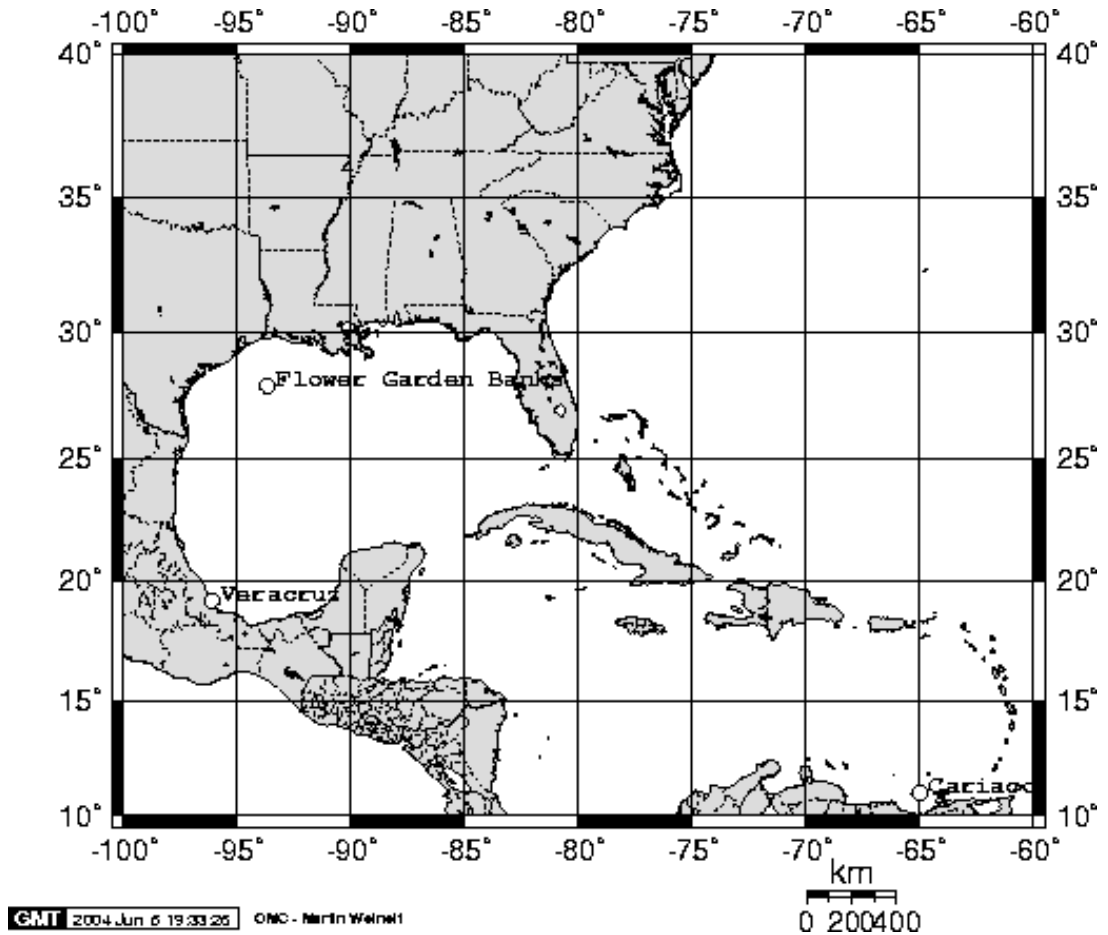
Strategy – Part II

- Carbon Cycling and air-sea interaction in the Gulf of Mexico
  - Use coral cores from three Caribbean/Gulf of Mexico sites
  - Sample annually running every other year from ~1875-1980
  - Air-sea CO_2 exchange
  - Use results in 1-D model

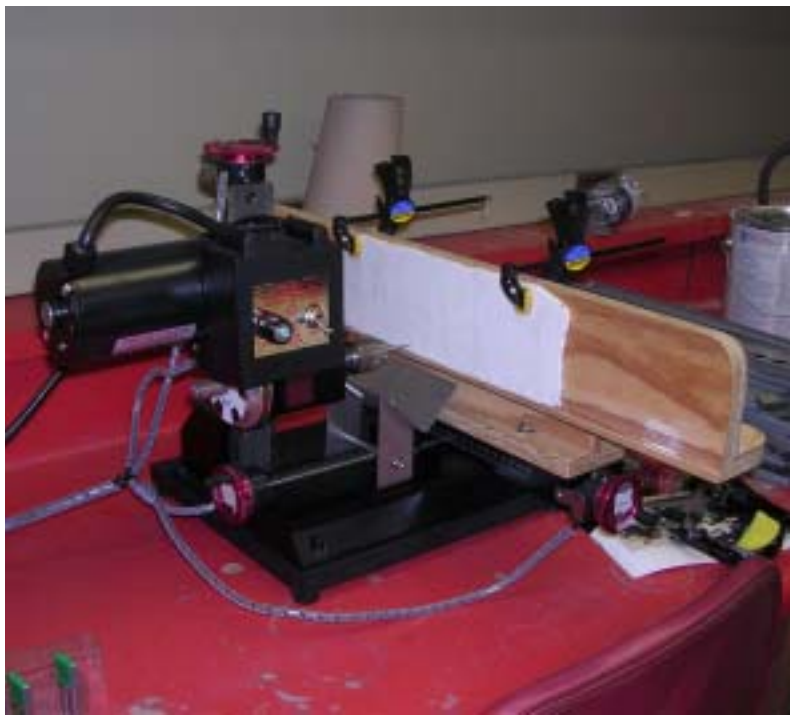
$\Delta\ ^{14}C$ in Corals

Corals from three sites:

- Flower Garden Banks
- Veracruz, Mexico
- Cariaco Basin, Venezuela

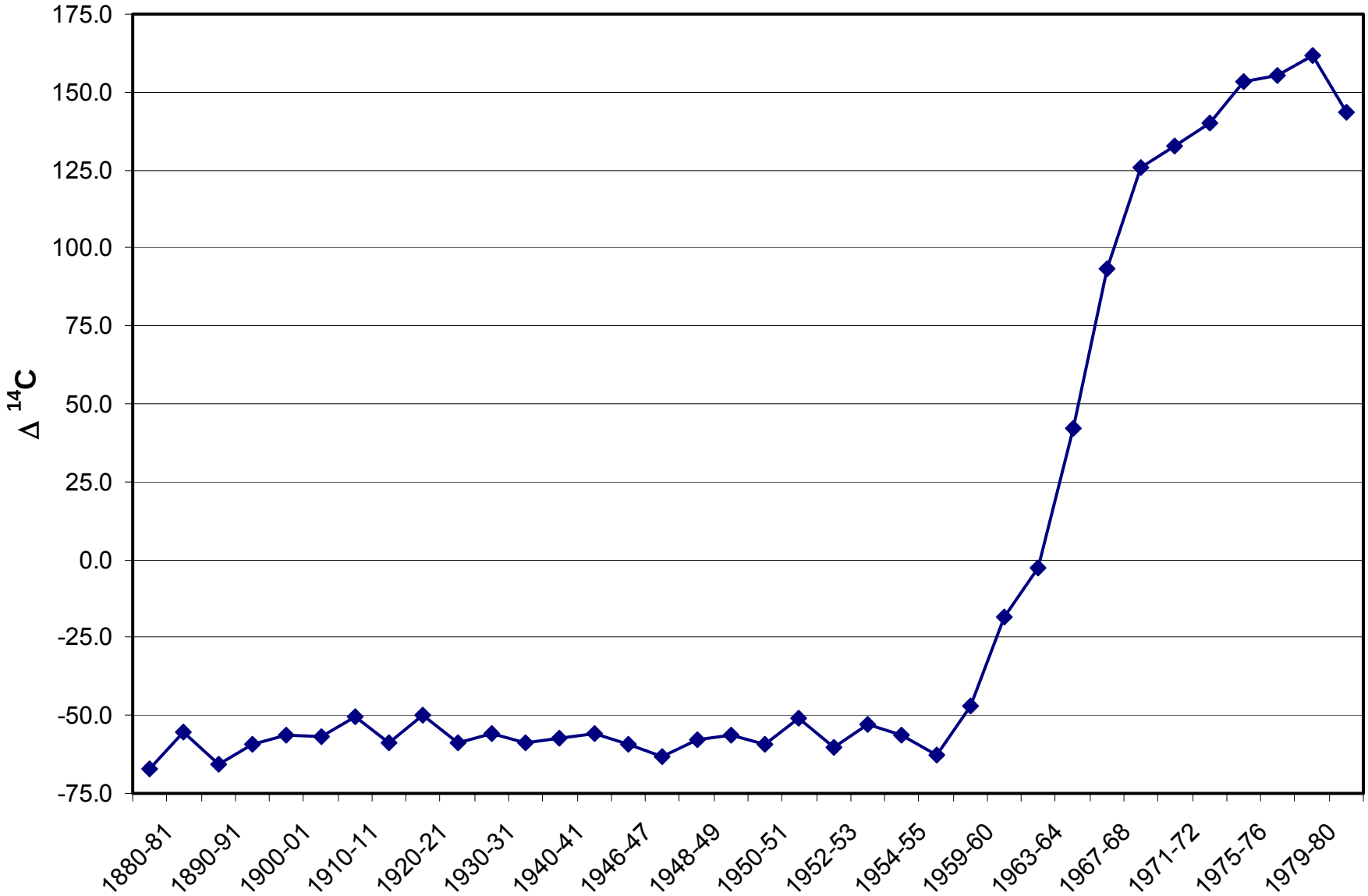


Sampling the corals



Center for Accelerator Mass Spectrometry – Lawrence Livermore National Lab (CAMS-LLNL)

Preliminary ^{14}C Data from Veracruz



Acknowledgments

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