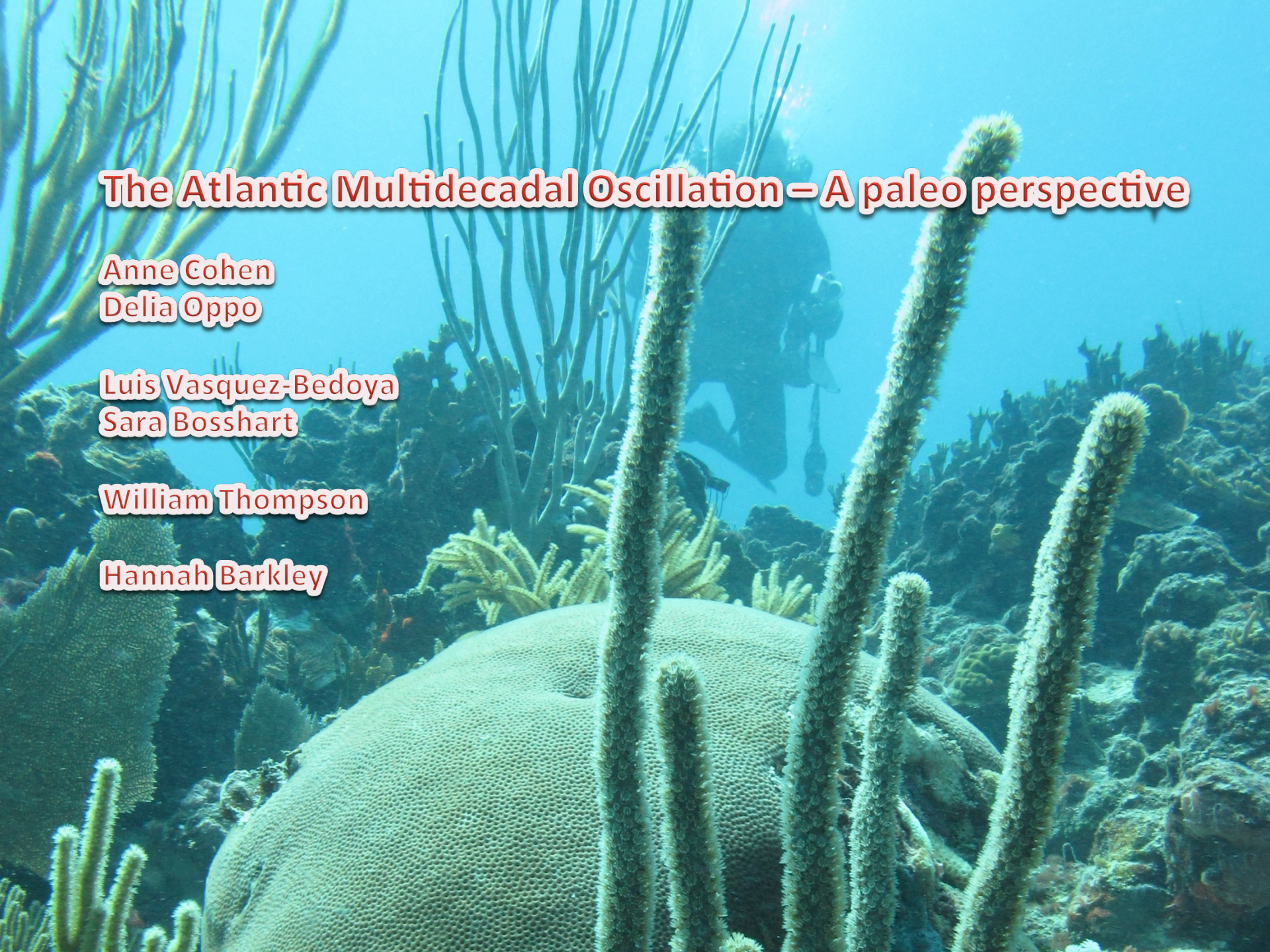


The Atlantic Multidecadal Oscillation – A paleo perspective

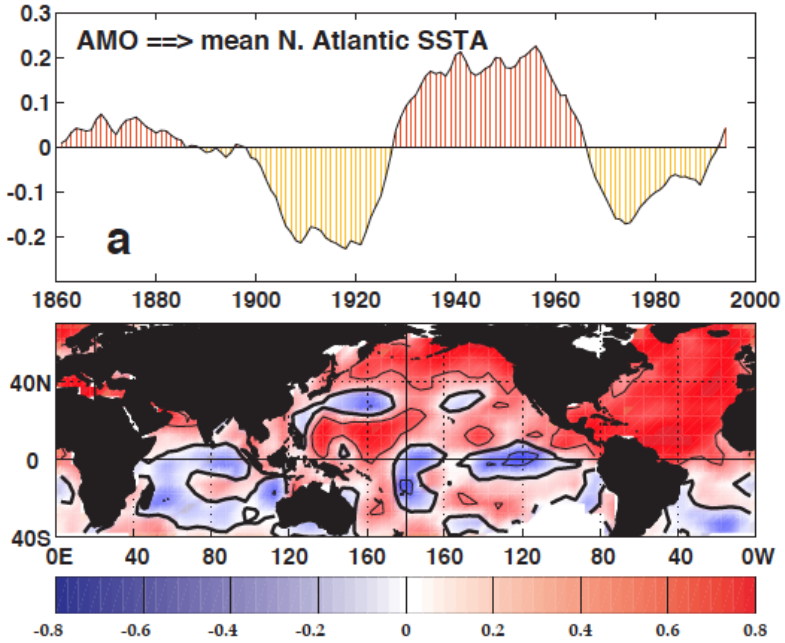
Anne Cohen
Delia Oppo

Luis Vasquez-Bedoya
Sara Bosshart

William Thompson

Hannah Barkley

The Atlantic Multidecadal Oscillation



Enfield et al. 2001

1. Detrended, 10yr running mean of N. Atlantic SST
2. 65-70 yr period suggested by observations (~ 2 cycles)
3. Temporarily dampens or enhances rate of warming
4. Strong climate connections (Atlantic hurricanes, regional rainfall anomalies)

Questions that Paleo archives can help address:

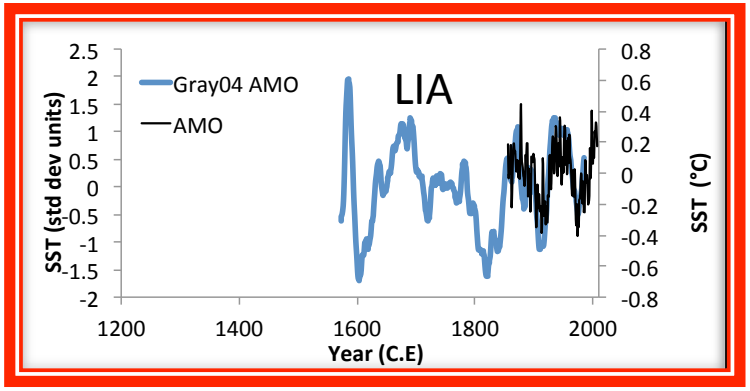
1. Is Atlantic multidecadal variability persistent?

2. Has the amplitude and frequency of AMV varied?
   Due to human activity?
   In relationship with background climate?

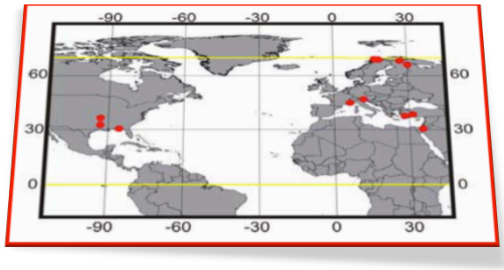
3. Does the evidence of pre-industrial AMV present a coherent picture of that variability?

4. Is AMV associated with AMOC variability?

AMO Reconstructions



- Tree ring records screened for correlations to N. Atlantic SST
- (12 records r>|0.25|)

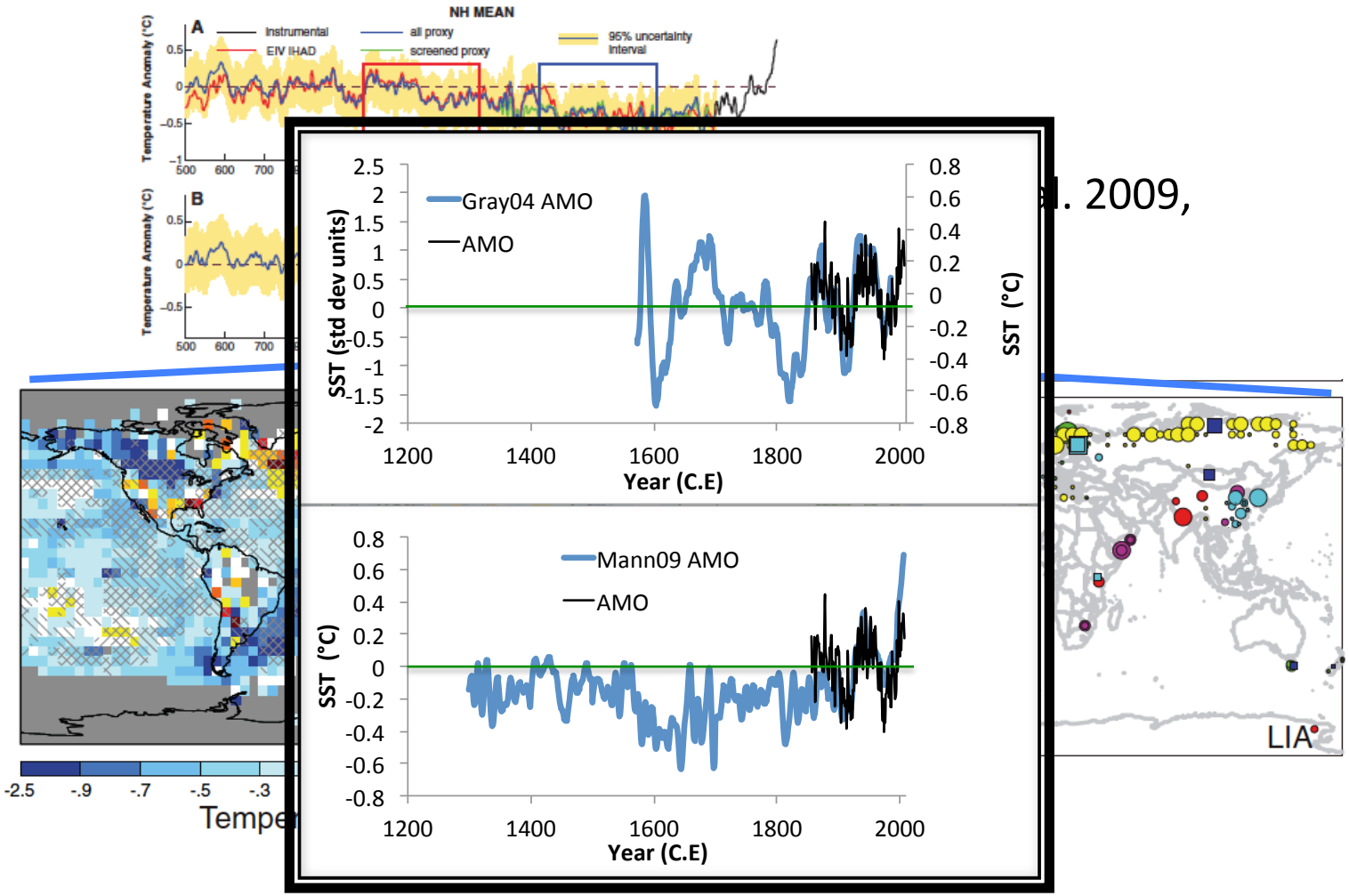


$$North\ Atlantic\ SSTA = -0.0607 - 0.0566\ PC1 + 0.0703\ PC2 + 0.0528\ PC4 - 0.0679\ PC5 \qquad (1)$$

r=0.64

r=0.81 (10-yr smoothed)

Assumes persistent connection between N. Atl. SST & tree ring response



. 2009,

Two Atlantic (marine) records passed screening criteria – 100m sclerosponge Sr/Ca, Chesapeake Bay salinity reconstruction (SST from same site did not pass)

Assumes persistent links between N. Atlantic SST and environmental response

Advantages of corals:

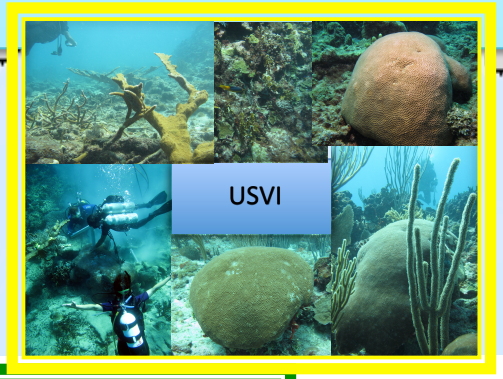
Occur throughout tropics and in some subtropical locations.

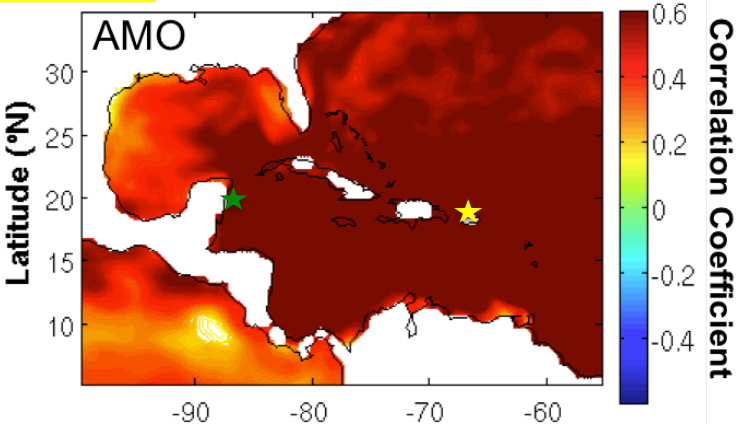
Usually annually banded

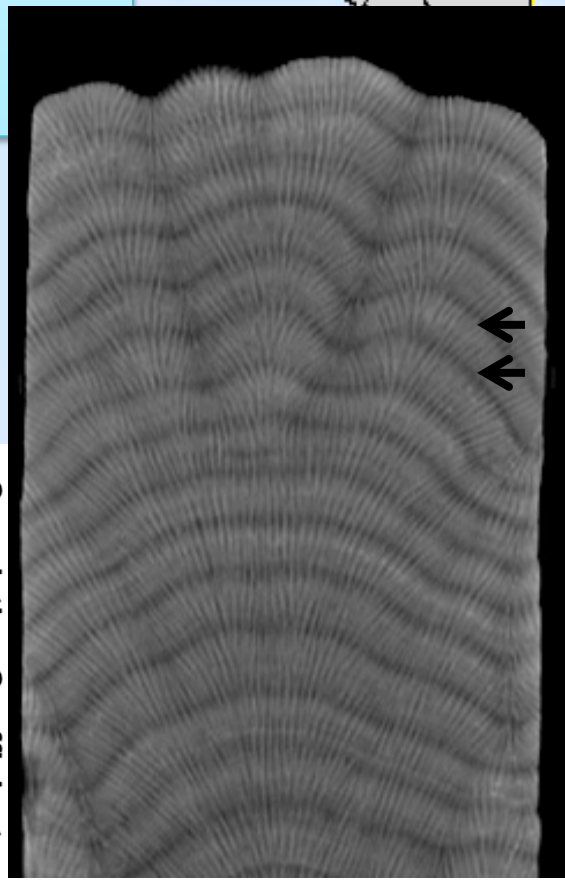
Long-lived

Fossil corals

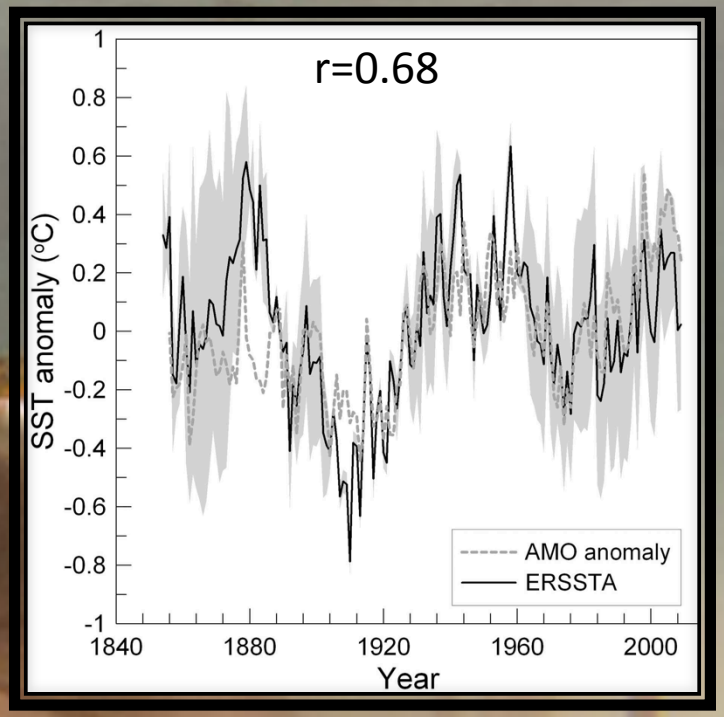
Coral growth rate and geochemistry sensitive to environment

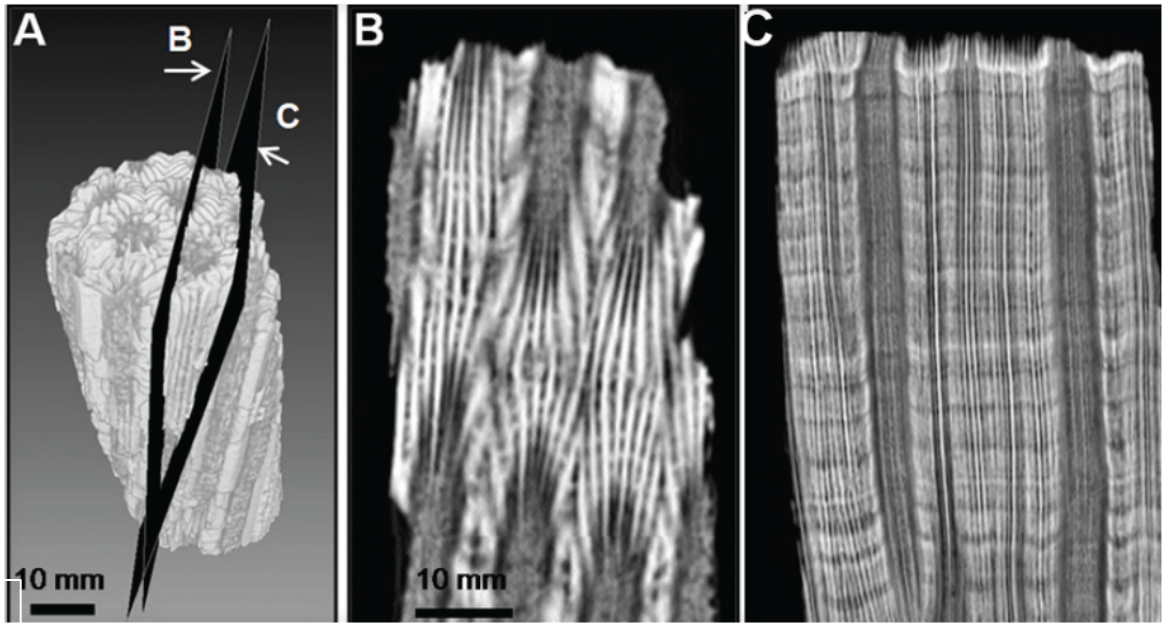






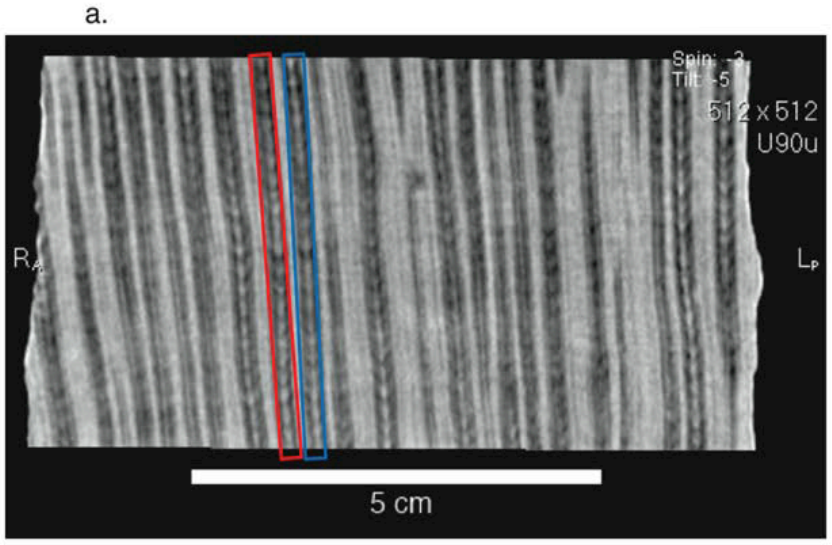
Instrumental SST variability correlated to AMO at Yucatan coral site

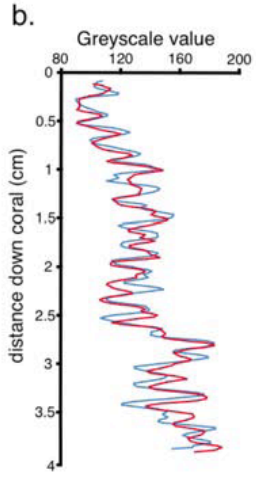




Coral growth quantified from CAT scans

Figure 7. Quantification of annual coral growth by 3D CT scanning. (**A**) 3D CT scan reconstruction of the skeleton. (**B**) A slice cut subparallel to the upward growth axis (**C**) A slice cut parallel to the upward growth axis, reveals clear annual growth bands. [*adapted from Cantin et al., 2010*]

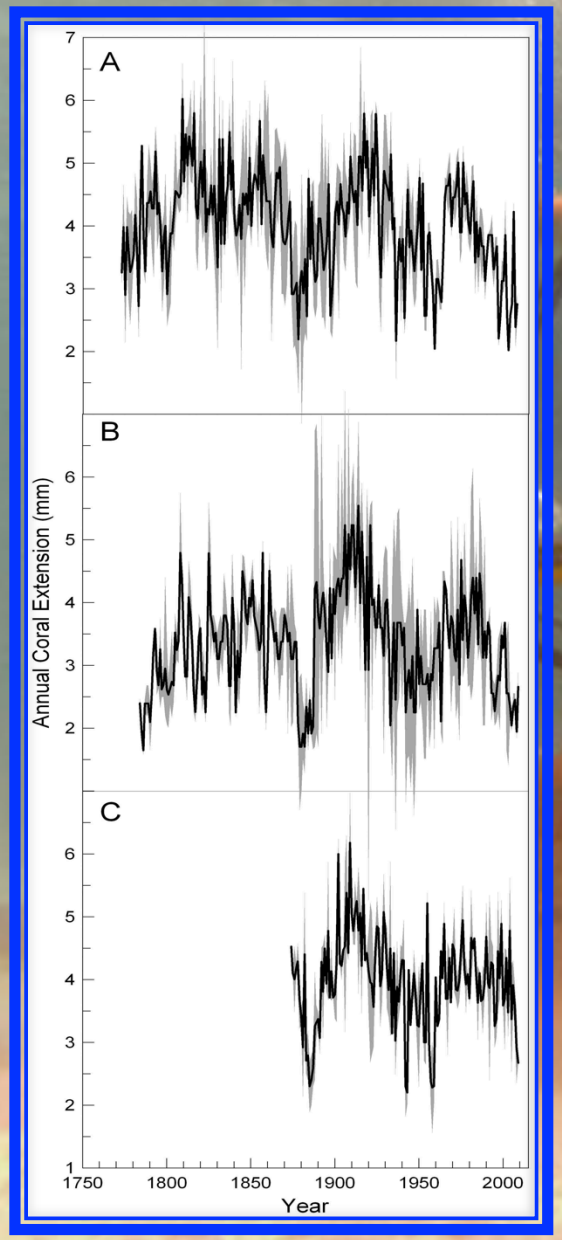


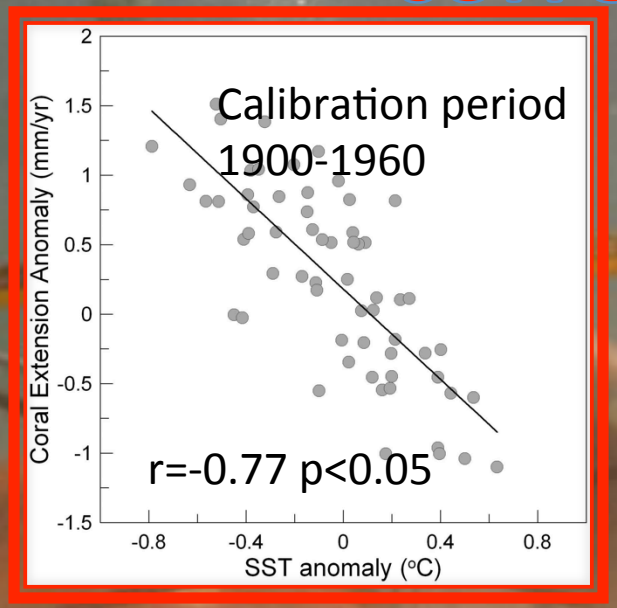


(A. Cohen lab)

Three corals have similar growth histories – longest to 1773 C.E.

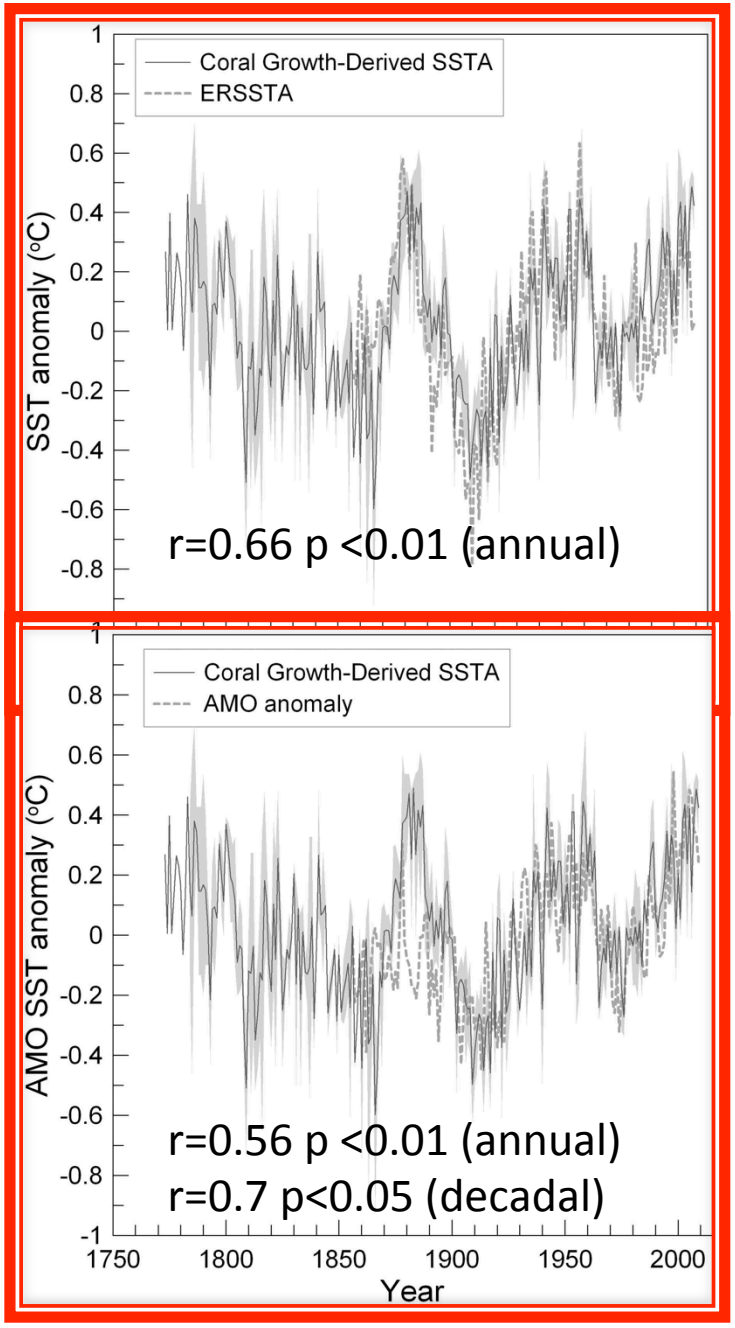
Coral growth and temperature inversely correlated



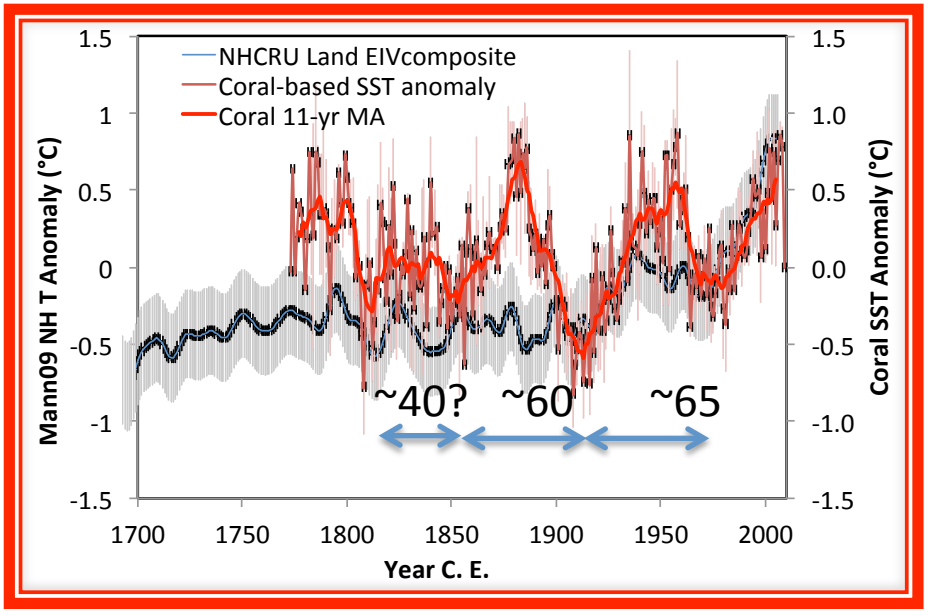


Verification periods:
r=-0.56 and -0.55 (p<0.01)

Vásquez-Bedoya, L. F., A. L. Cohen*, D. W. Oppo, and P. Blanchon (2012), Corals record persistent multidecadal SST variability in the Atlantic Warm Pool since 1775 AD, Paleoceanography, 27, PA3231, doi: 10.1029/2012PA002313

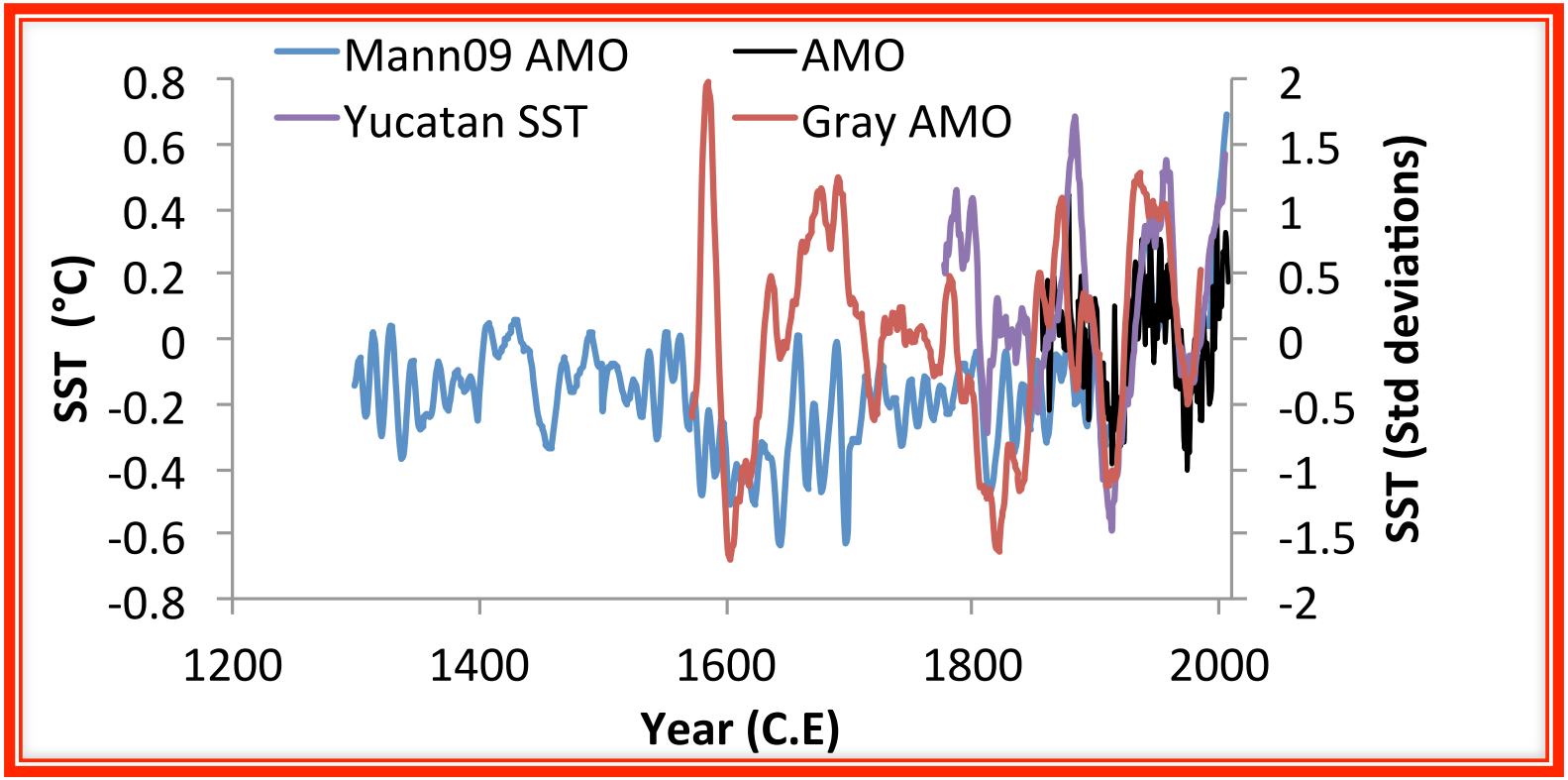


Coral record extends SST record ~ 80 years

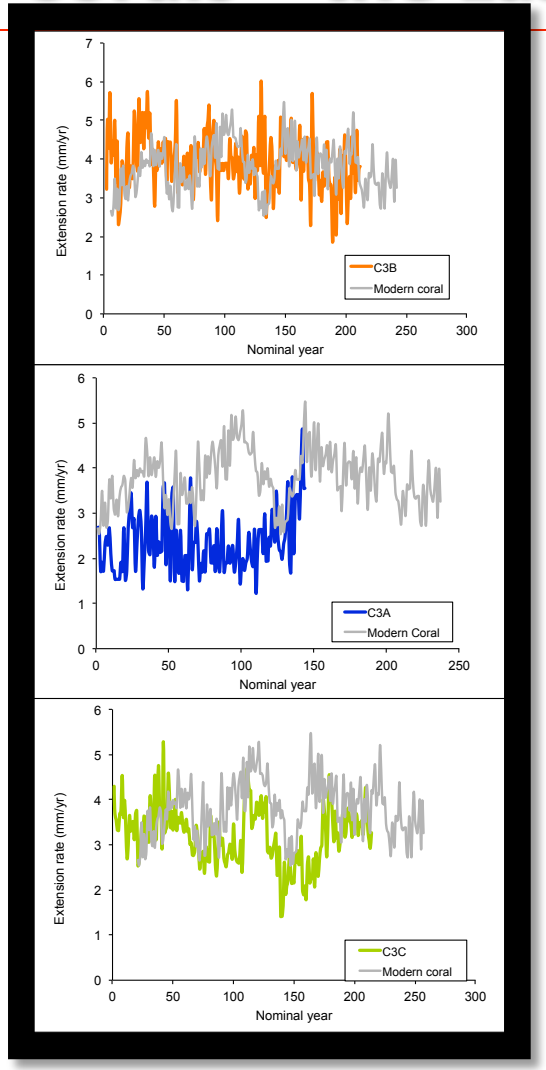


Spectral peak – 45-70 years

General similarities but important differences between AMO reconstructions



Multidecadal Variability in Yucatan Fossil Corals – the Last Interglacial (122,000 yr ago)

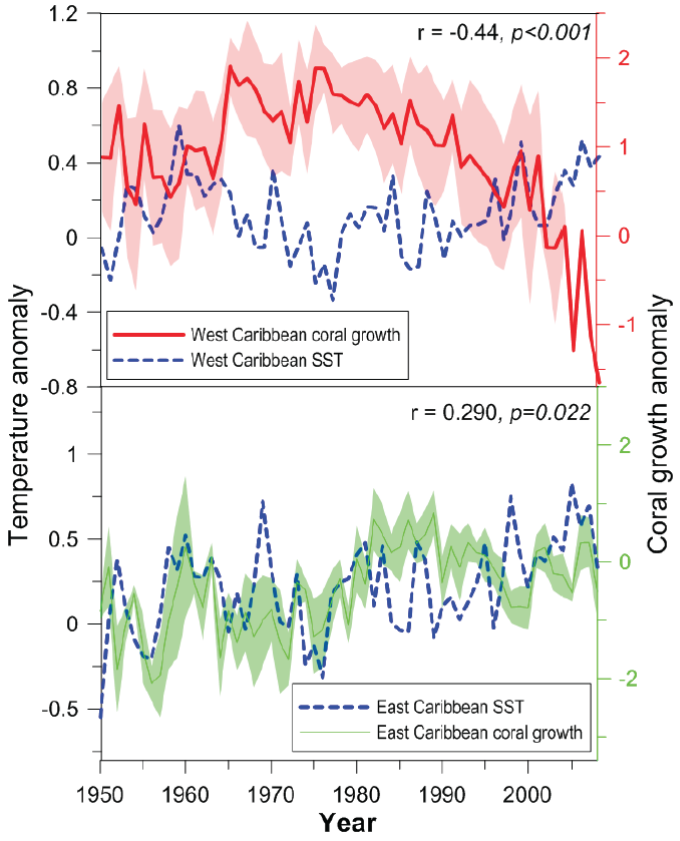


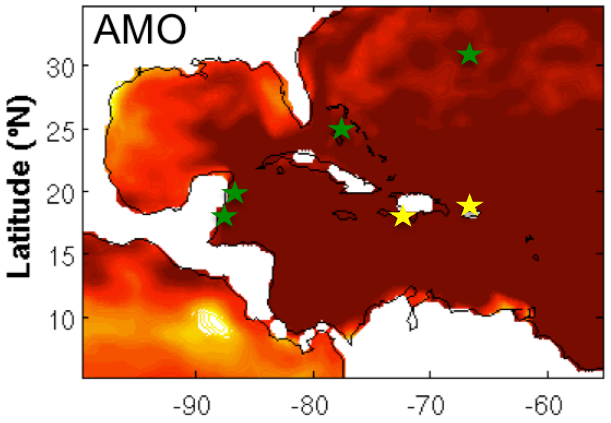
Corals from reef 2m above modern sea level
2 of 3 coral cores have growth rate variability
similar to modern coral (spectral peak 50-70yrs)
3rd coral has >50 years with little variability

Implies tropical AMV is natural
Variations in amplitude and period are natural

Ph. D Thesis L. Vasquez-Bedoya (et al., in prep.)
U/Th Dates –W. Thompson

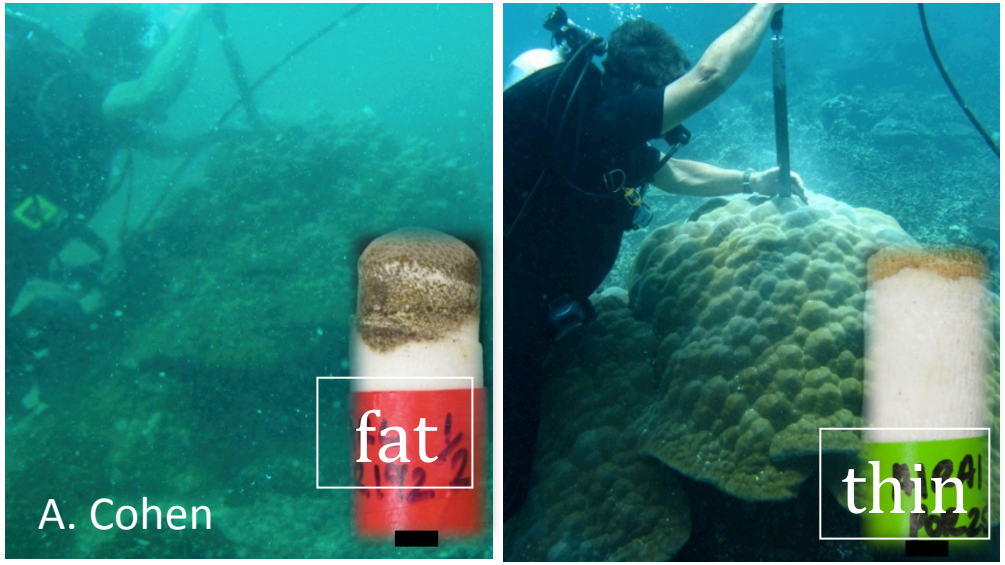
Coral growth in eastern Caribbean is weakly positively correlated to SST

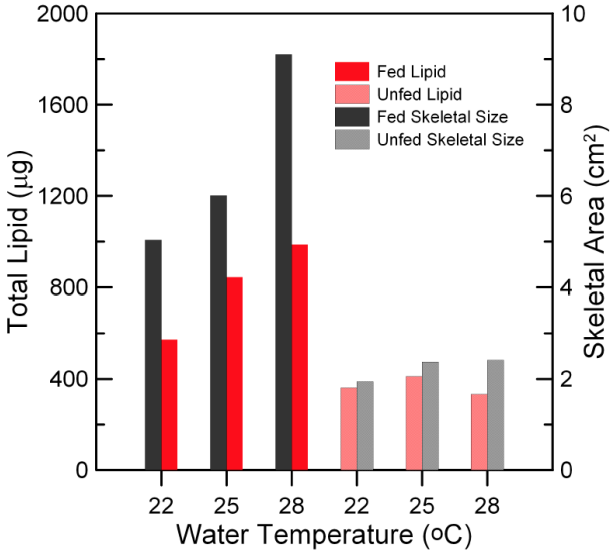




Digging Deeper Into Coral Growth – SST Connection

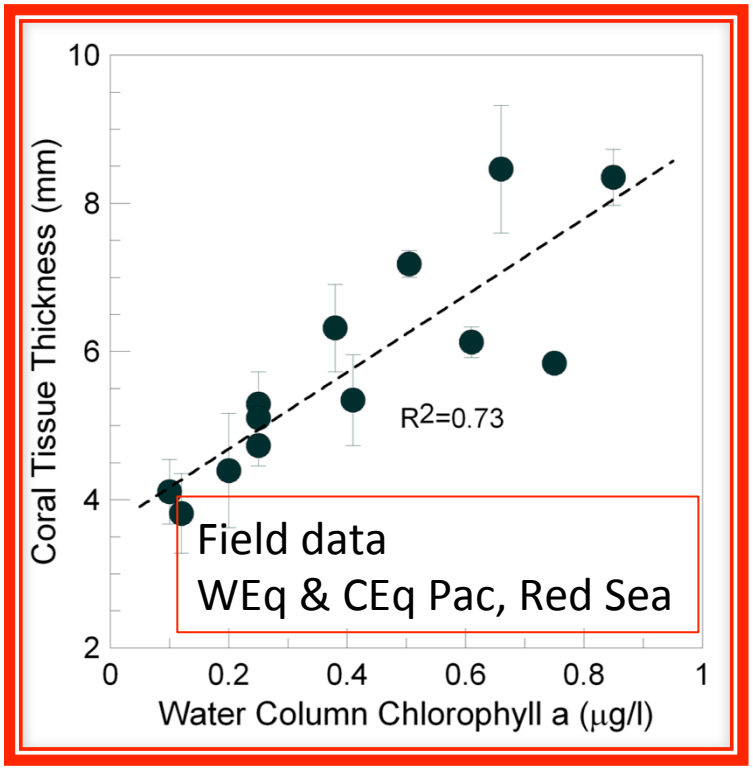
Well nourished corals have fat tissue layers

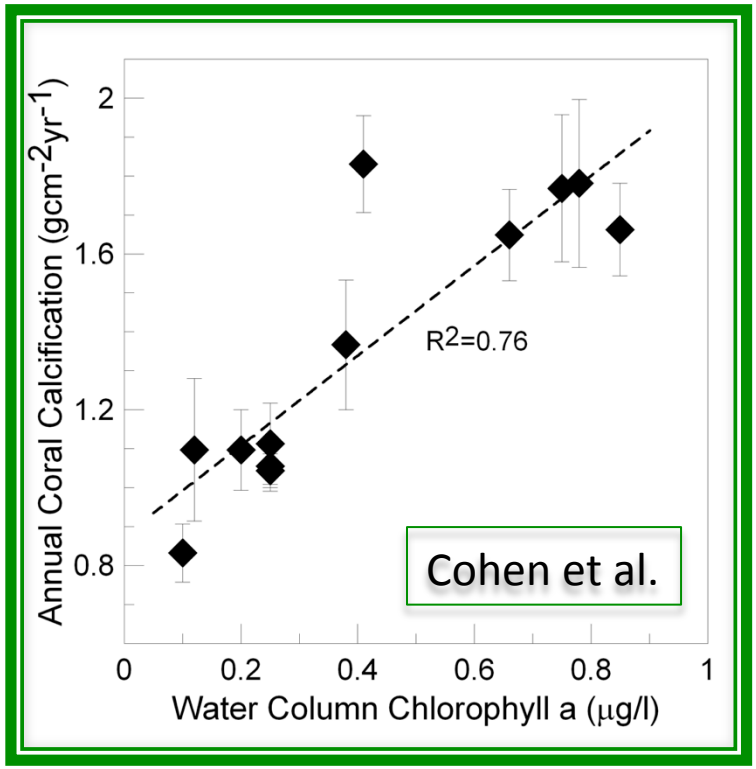




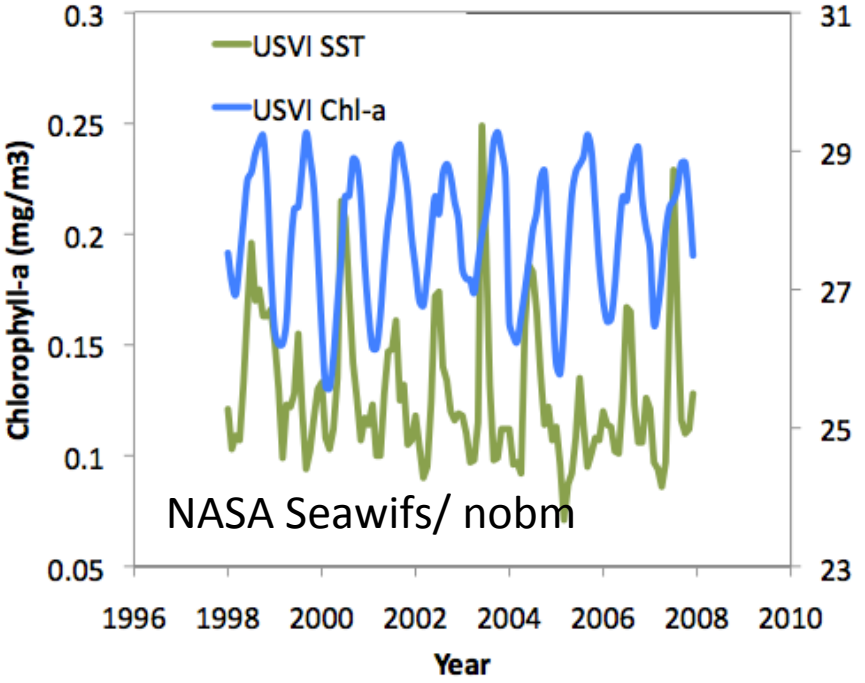
Barkley, Cohen, de Putron unpub.

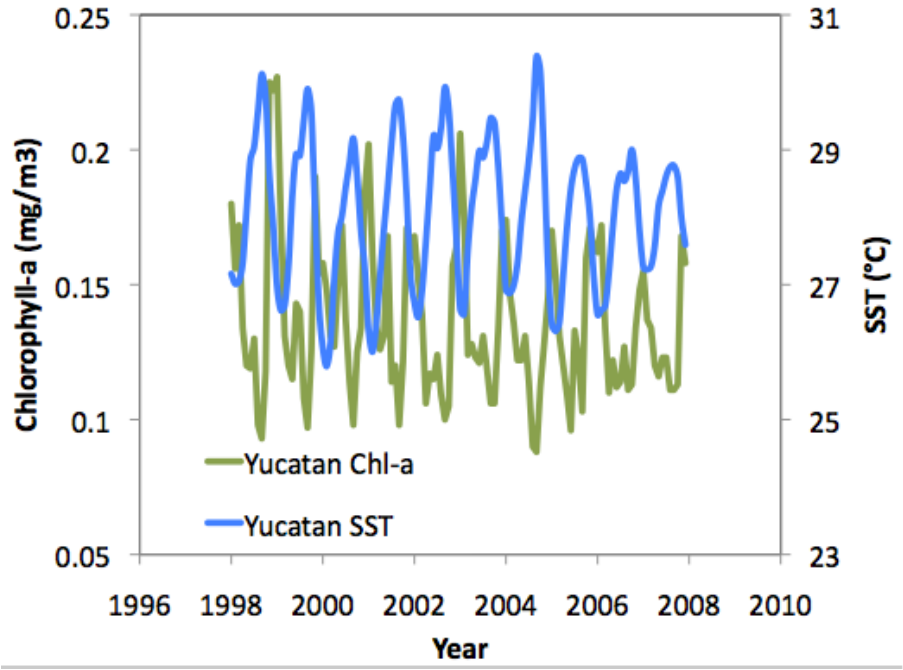
Coral growth correlated to chlorphyll-a





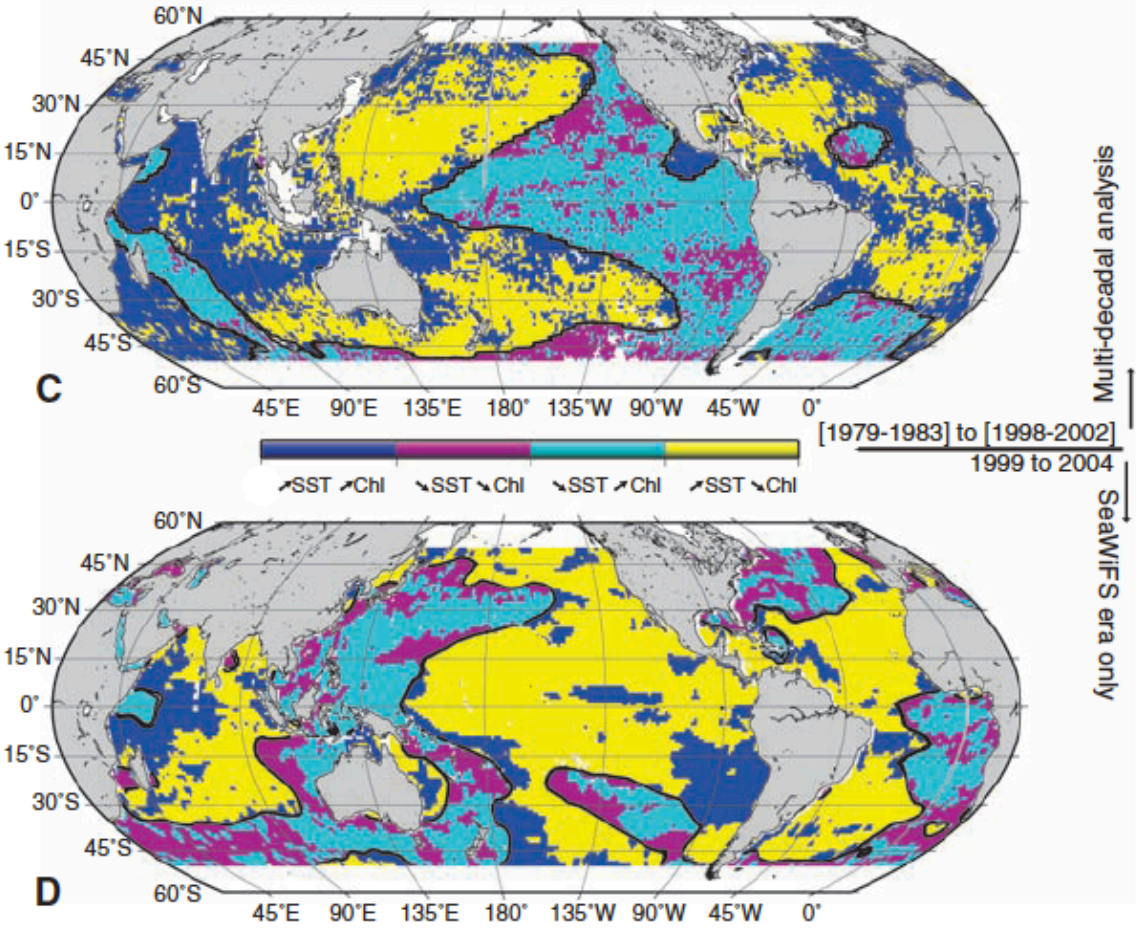
Different seasonality of chlorophyll peaks at USVI and Yucatan …





may explain different relationships between coral growth and SST

Evidence of different long-term behavior in E and W Caribbean



Martinez et al. 2009 (link Atlantic trends to AMO influence on stratification)

Conclusions:

1. Atlantic Multidecadal Variability is **Natural**
2. Variations in frequency and amplitude are **Natural**
3. **Many outstanding questions**

Ongoing and Future Work:

Continuing reconstructions where SST and nutrients are inversely correlated on seasonal basis – using reanalysis products and models to evaluate longer-term link

Extracting other paleo-oceanographic information from regions where controls on coral growth rates are more complicated