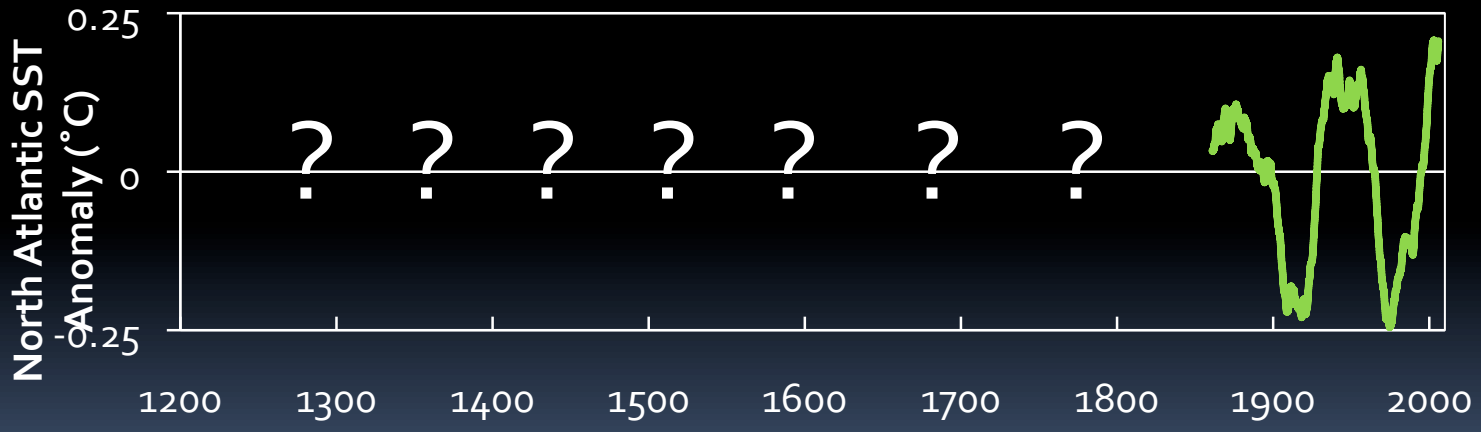
Chesapeake Biological Laboratory
University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE

A PALEOCLIMATE PERSPECTIVE ON ATLANTIC MULTIDECADAL VARIABILITY

The View from the Tropics

K.Halimeda Kilbourne

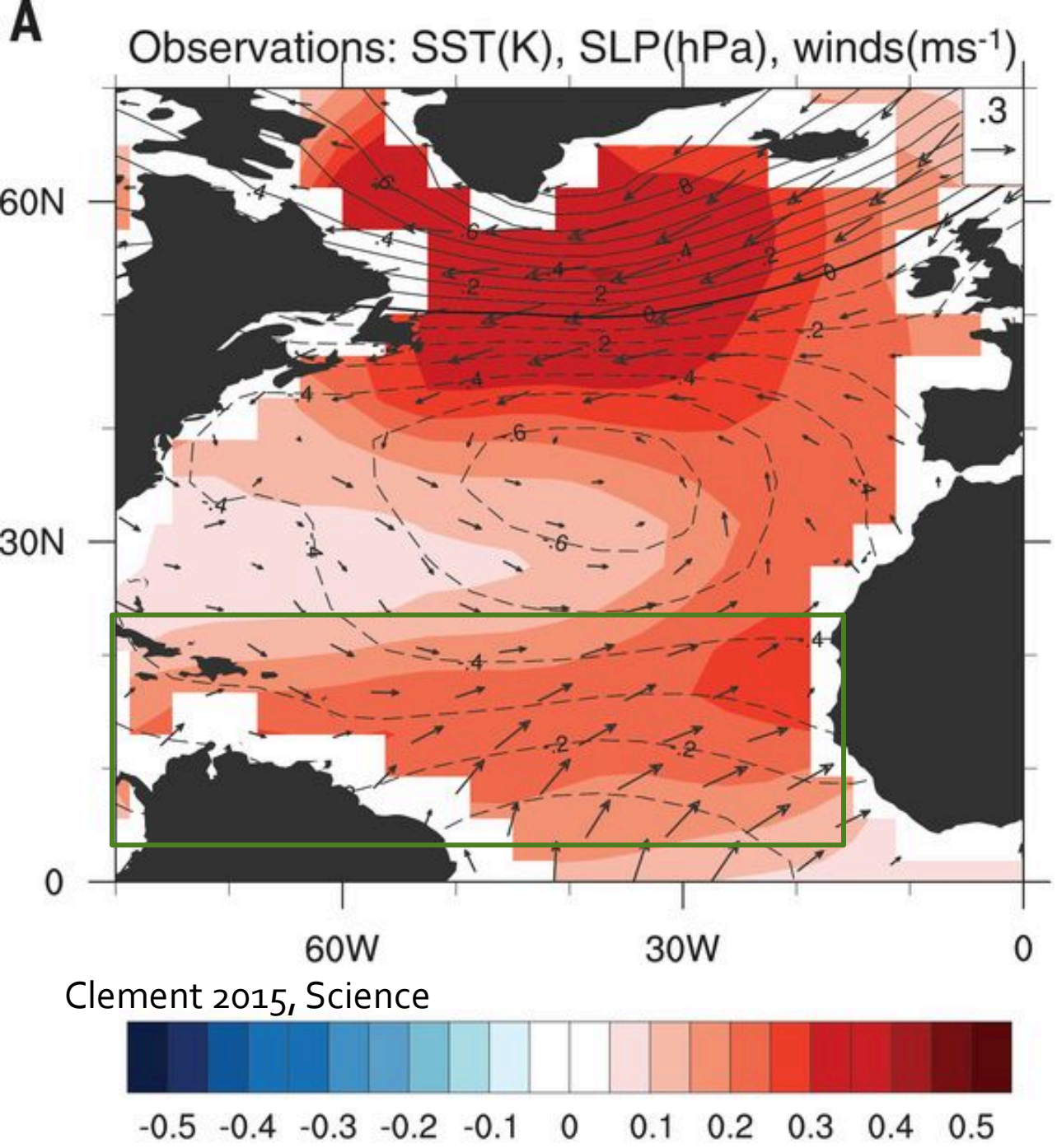
Is there a concentration of variance at multidecadal bands in the climate of the Atlantic region above the expected red noise background?



Summary of Paleo Literature of AMV

(Kilbourne et al., 2014, Journal of Marine Science)

- Consensus view: significant multidecadal variability back to mid 1700s
- Prior to mid 1700's
  - Intermittent
  - Persistent
- Apples and Oranges
  - Local signals vs. regional
  - Different variables examined
- Recommendation: avoid proxy reconstructions based on teleconnected variables – keep to the proximal proxy driver(s)



Clement 2015, Science

Tropical Reconstruction

- 1 of 2 Centers of Action

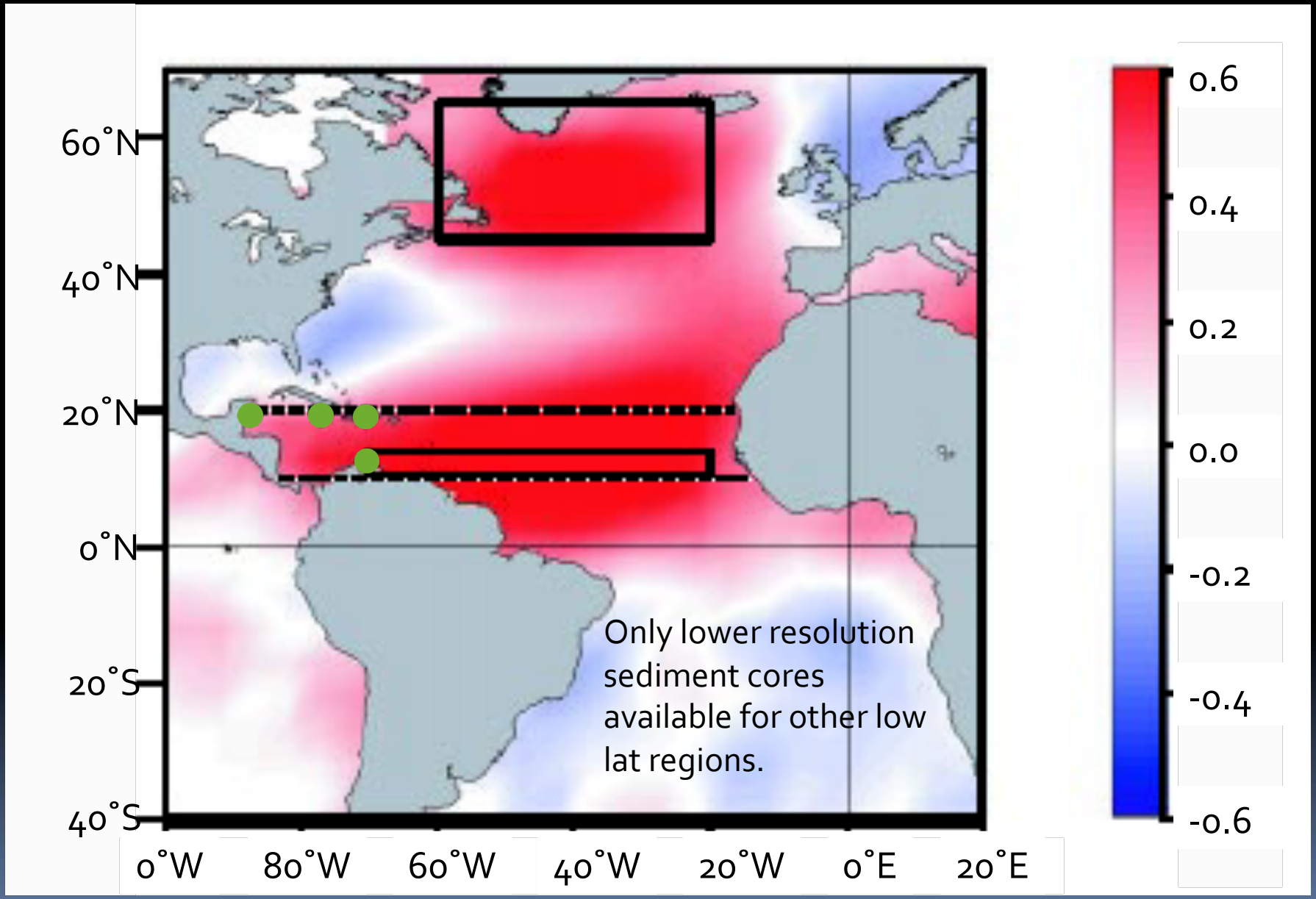
Related to

- Hurricanes and
- Precip Anomalies

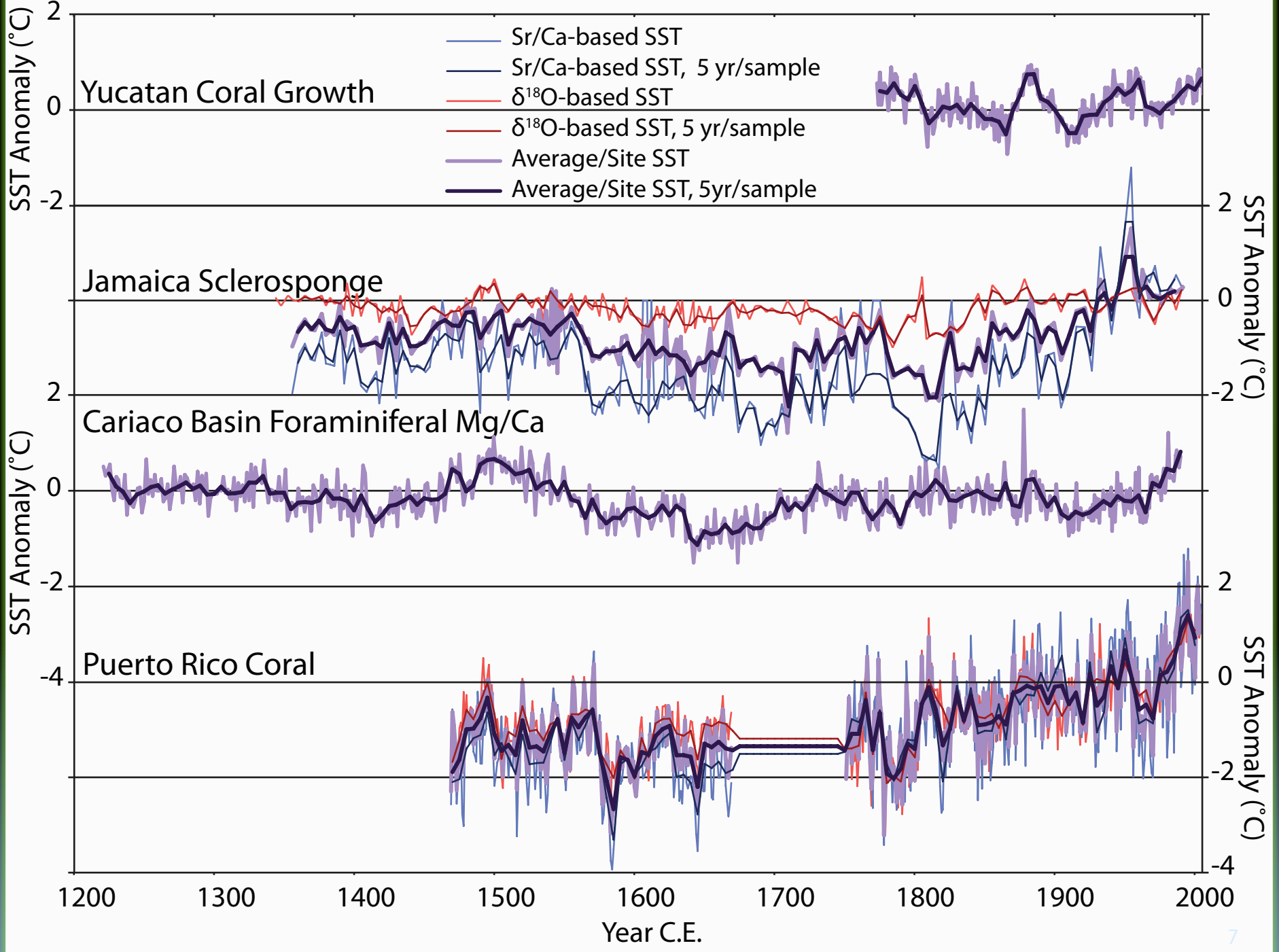
- Look at specific variable: SST

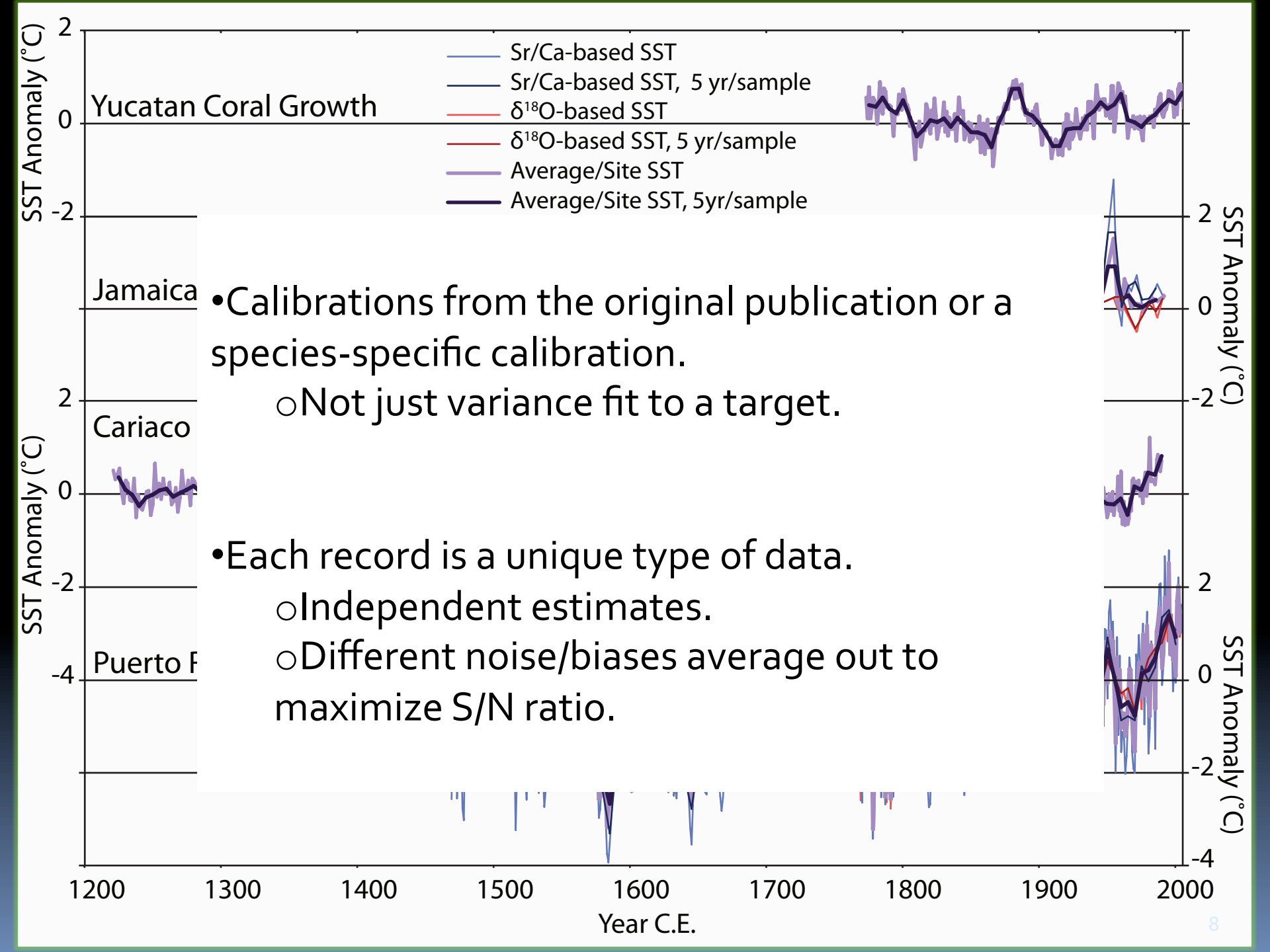
Data Selection Criteria

- Ocean temperature-sensitive paleoclimate proxy
  - Carbonate Sr/Ca, Mg/Ca
  - Carbonate $\delta^{18}O$
  - Coral growth rate
- < 5 years/sample on average
  - Heslop and Paul (2011)
- Location south of 22˚N



Goldenberg et al, 2001 *Science*

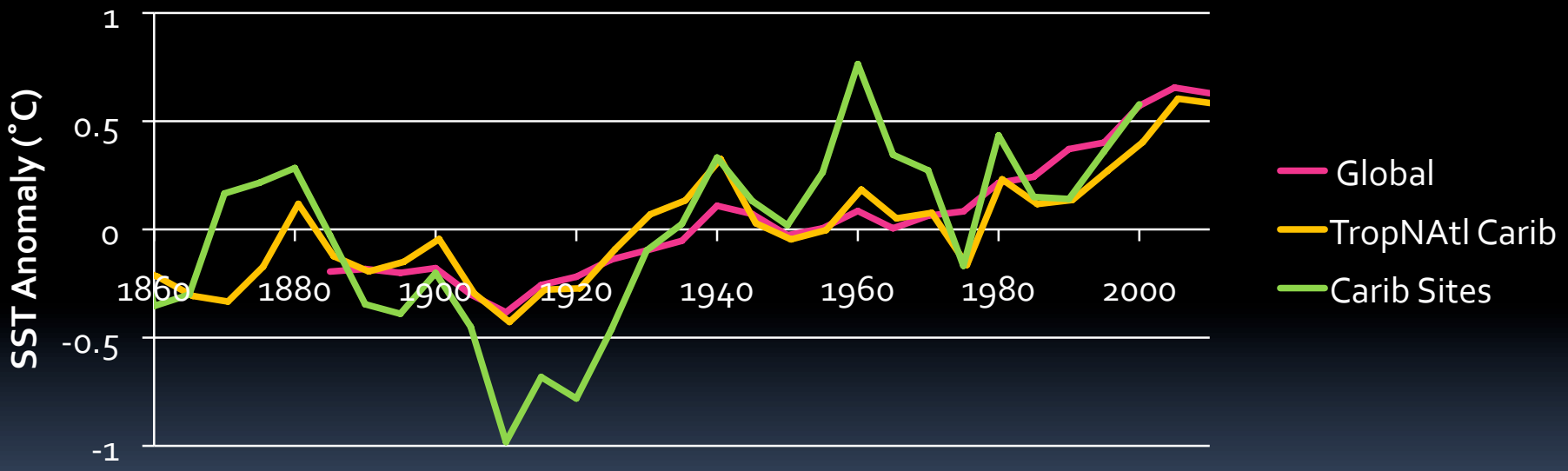

Sr/Ca-based SST
Sr/Ca-based SST, 5 yr/sample
δ18O-based SST
δ18O-based SST, 5 yr/sample
Average/Site SST
Average/Site SST, 5yr/sample
Yucatan Coral Growth
Jamaica Sclerosponge
Cariaco Basin Foraminiferal Mg/Ca
Puerto Rico Coral
SST Anomaly (°C)
SST Anomaly (°C)
2
0
-2
2
0
-2
2
0
-2
-4
1200
1300
1400
1500
1600
1700
1800
1900
2000
Year C.E.

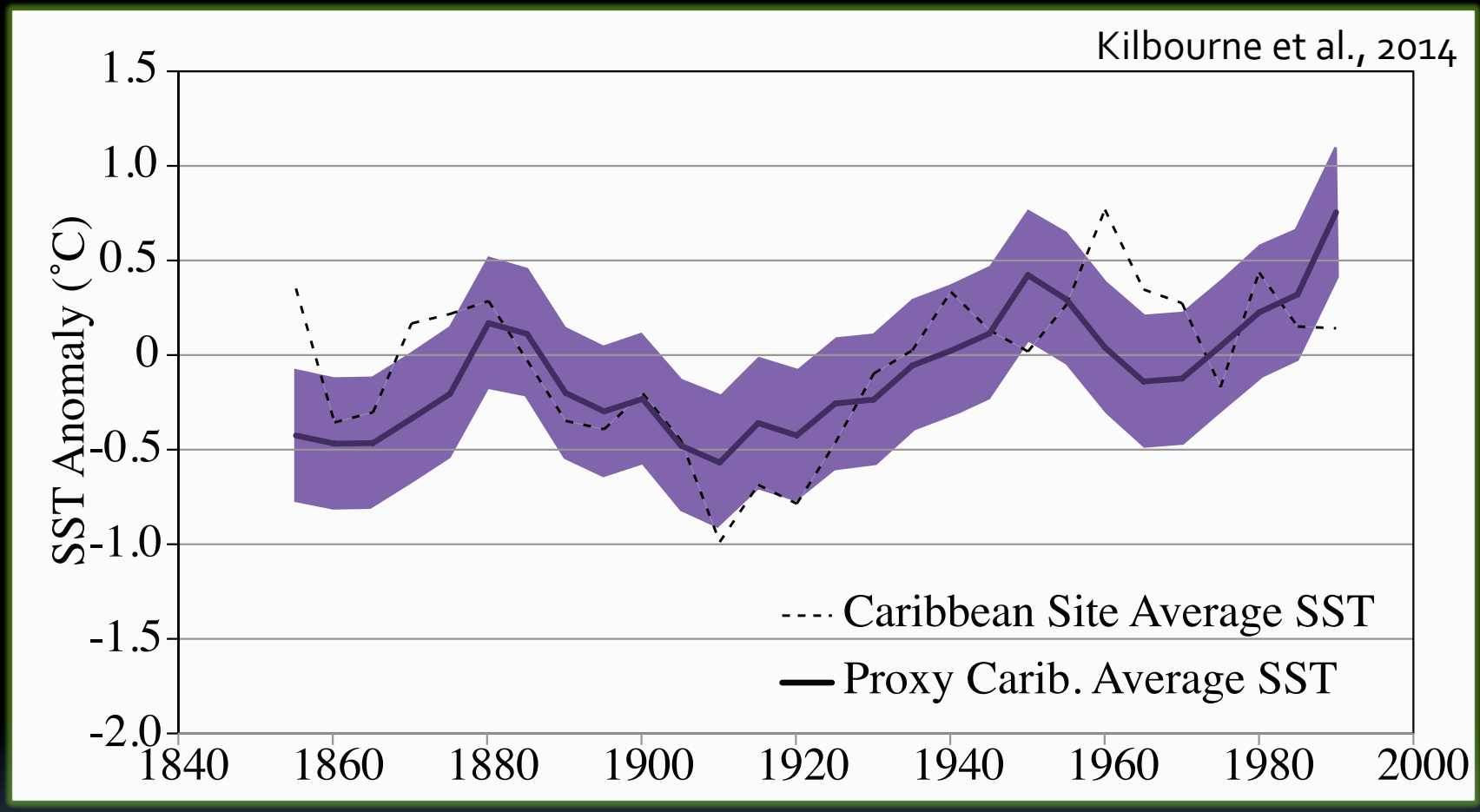


- Calibrations from the original publication or a species-specific calibration.
  - Not just variance fit to a target.

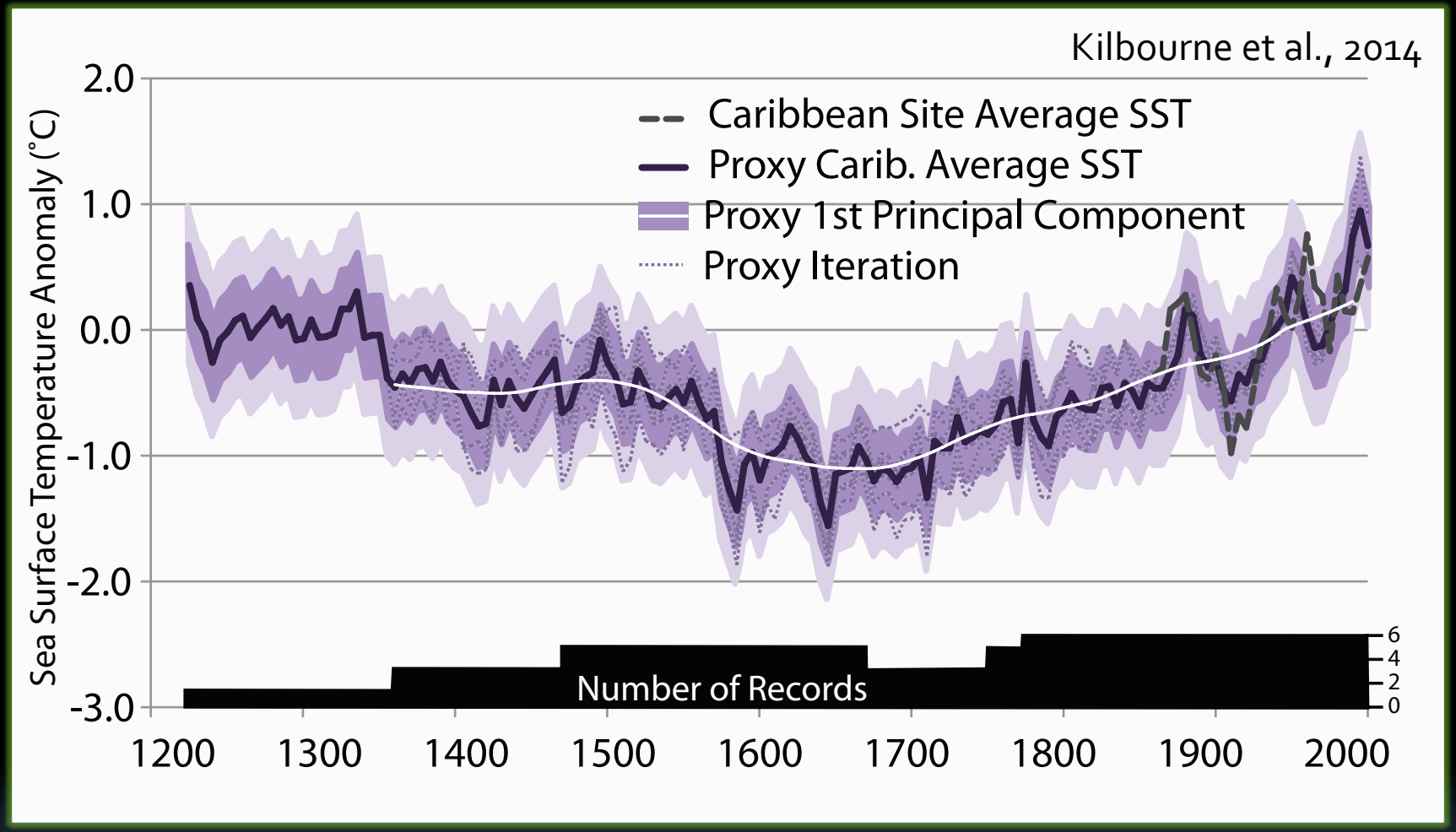
- Each record is a unique type of data.
  - Independent estimates.
  - Different noise/biases average out to maximize S/N ratio.

How does the regional data compare to tropical North Atlantic and global SST anomalies?



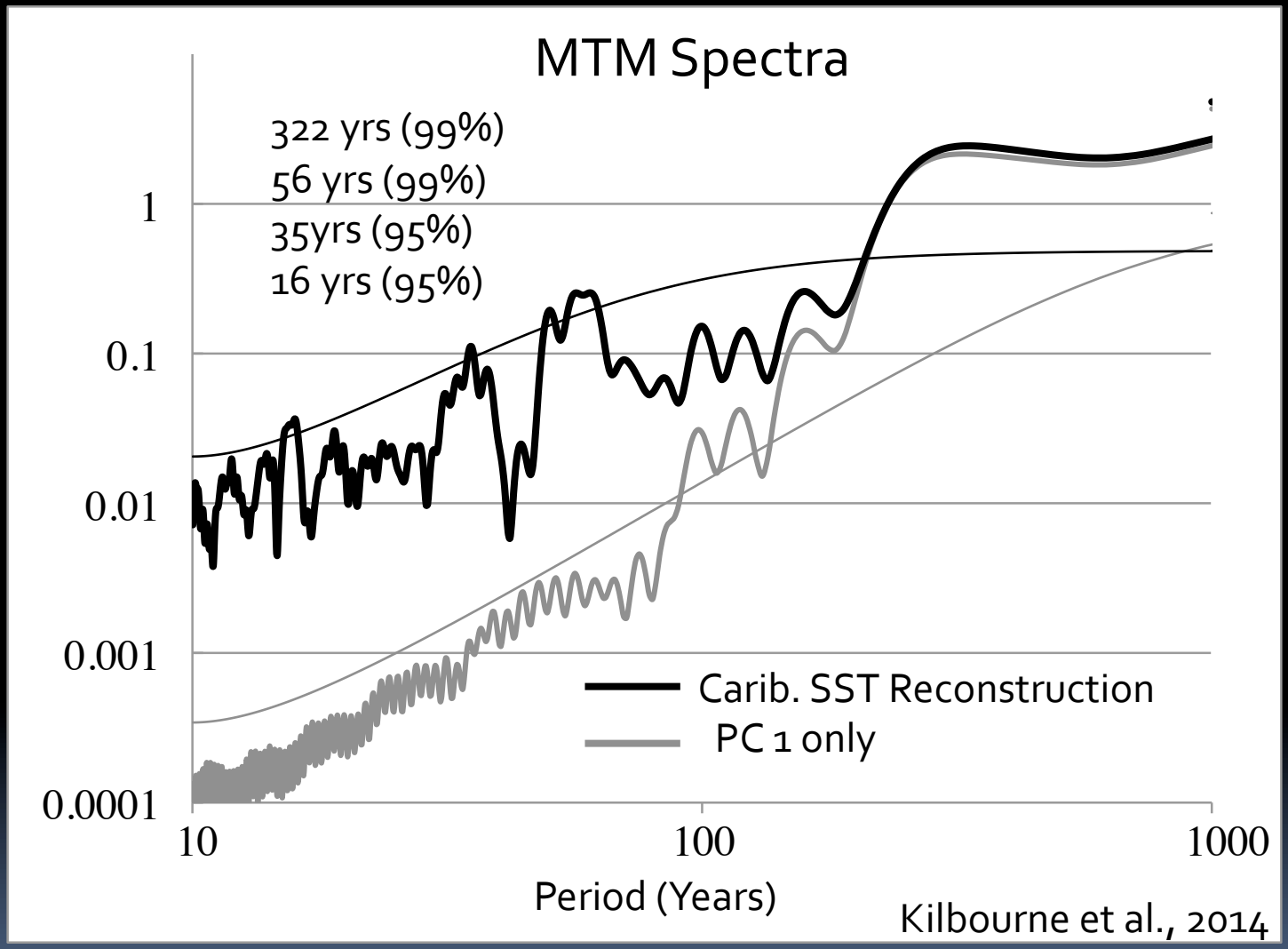


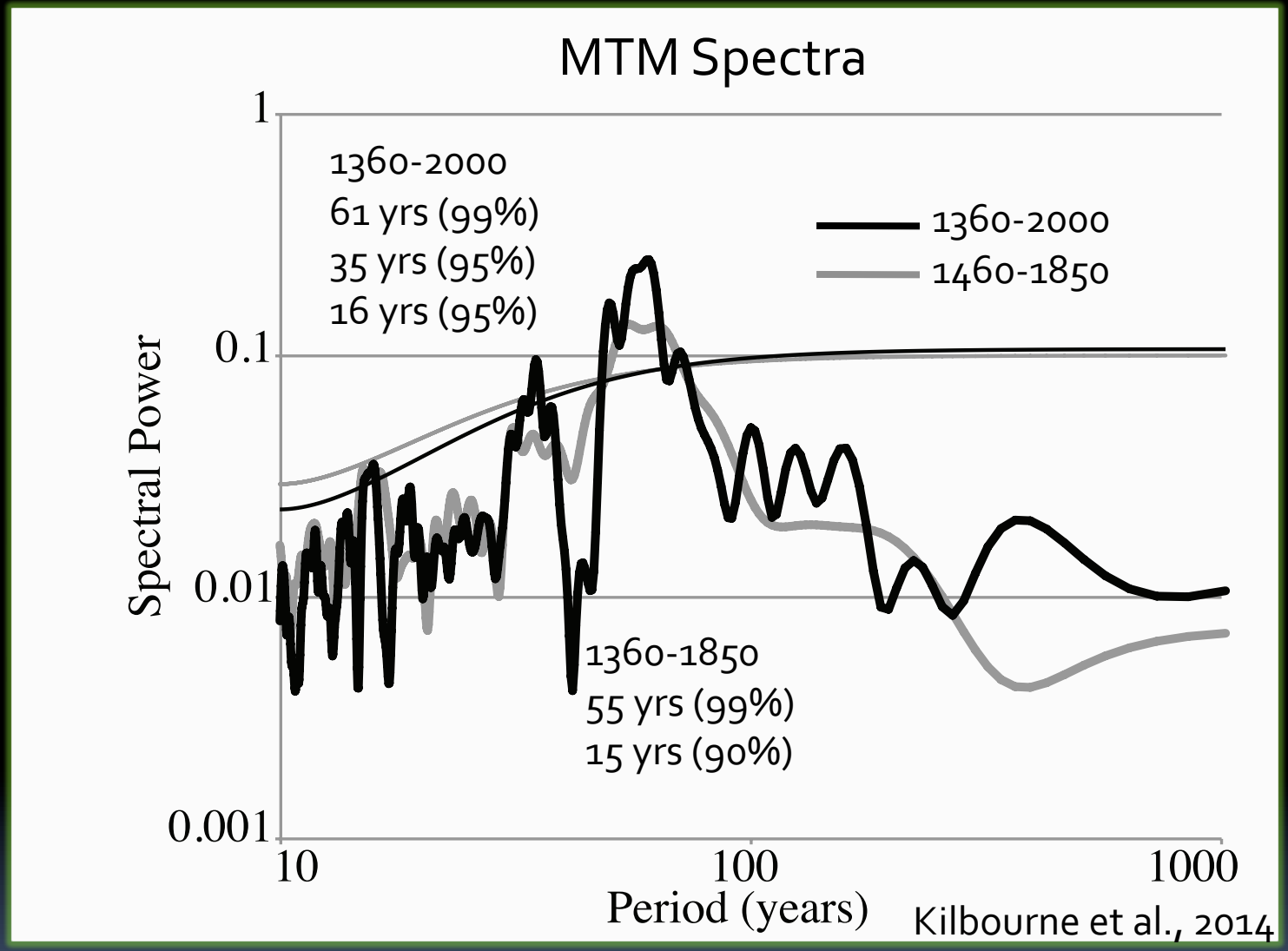
Proxy data from each site averaged to a regional compilation
Compared with ERSST from the grid boxes containing the sites
Standard error of reconstruction 0.34˚C



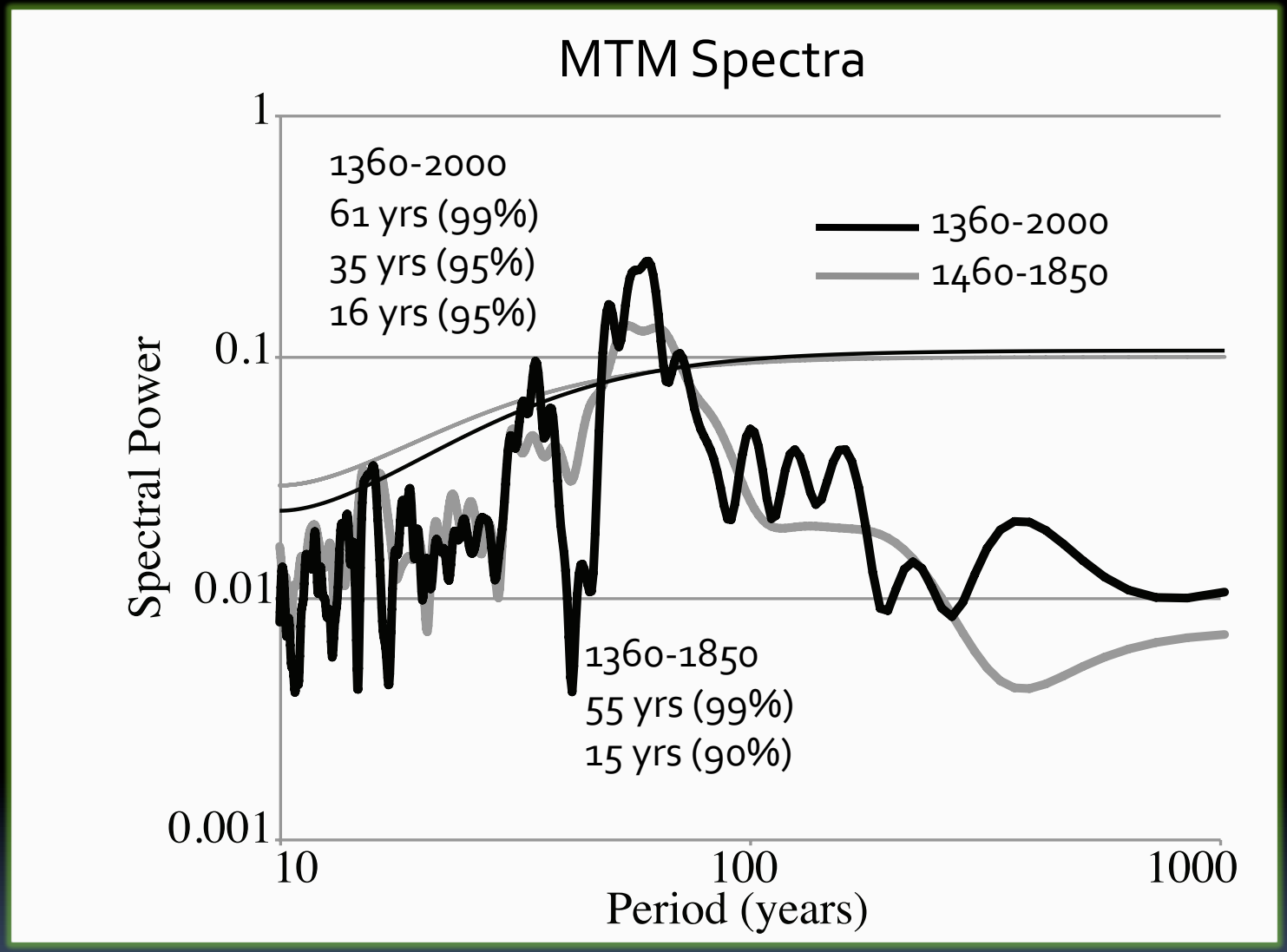
- Reconstruction iterated:
  1. Each site removed
  2. Each record removed
- Number of records varies through time 1-6
- Analysis on 1360-2000

- Error bars are regression standard error
- Singular spectral analysis 1st PC gives mean
- Multi-taper method spectral analysis
  - Good for spectral resolution of noisy data


MTM Spectra
322 yrs (99%)
56 yrs (99%)
35yrs (95%)
16 yrs (95%)
1
0.1
0.01
0.001
0.0001
10
100
1000
Period (Years)
Carib. SST Reconstruction
PC 1 only
Kilbourne et al., 2014



Another check on the significance
SSA analysis
Reconstructed the series with first 8 PCs
MTM spectral analysis
Results: same ~60 yr period peak

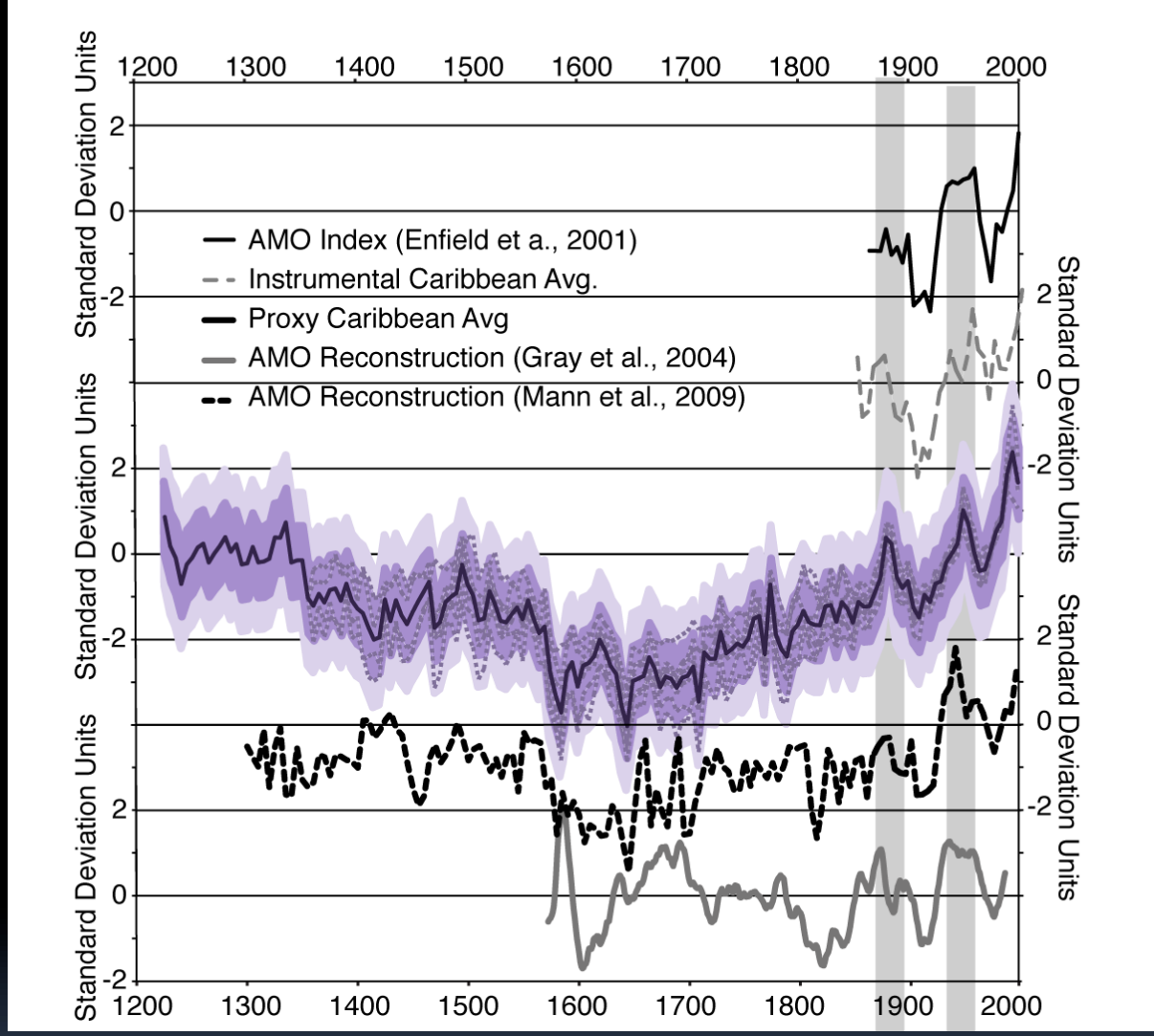


Significant multidecadal variability 1360-2000
Caribbean and possibly N. tropical Atlantic
Based on multiple proxies

Comparison With Other Multiproxy Reconstructions

Good coherence during instrumental period.

Little to no correlation in pre-instrumental times.



PAGES PAST GLOBAL CHANGES

OCEAN2K

AGU PUBLICATIONS Tierney et al., 2015

Paleoceanography

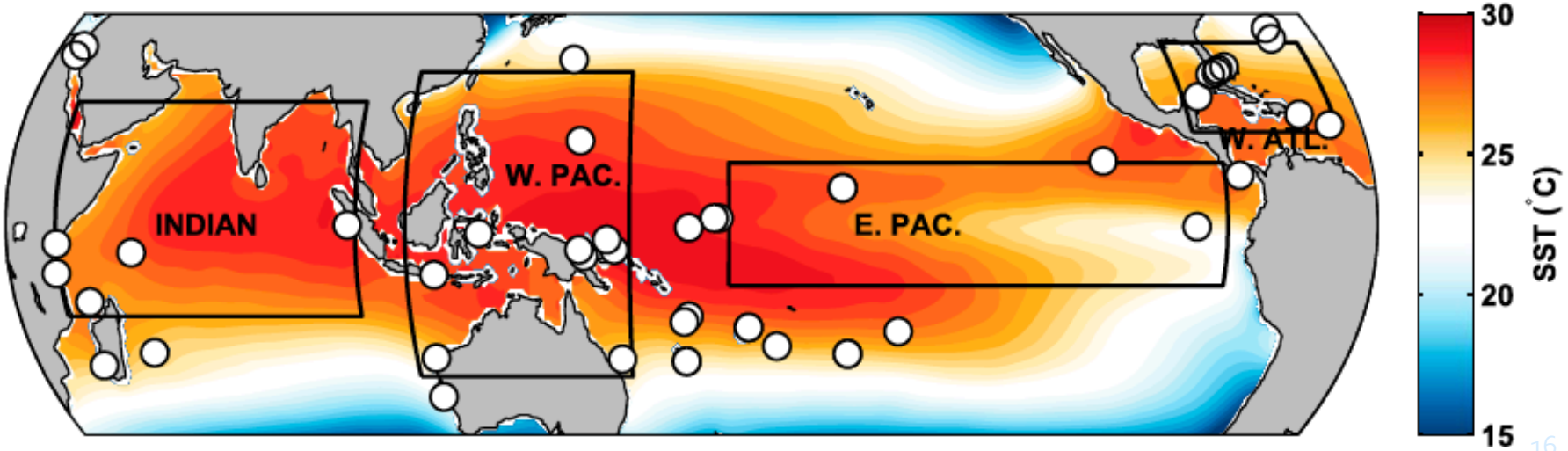
RESEARCH ARTICLE

10.1002/2014PA002717

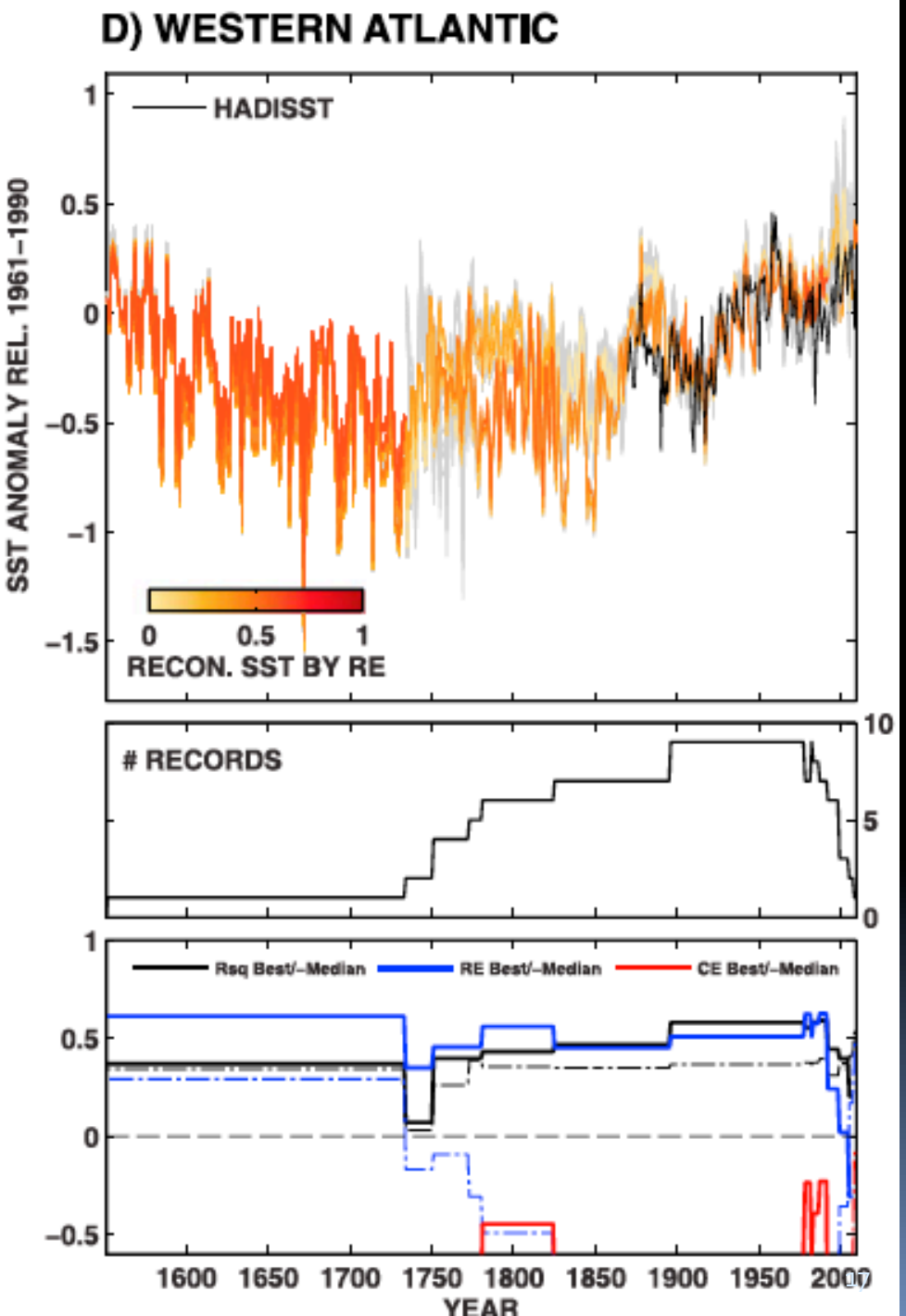
Key Points:
- We present four reconstructions of regional tropical SSTs based on

Tropical sea surface temperatures for the past four centuries reconstructed from coral archives

Jessica E. Tierney[1], Nerilie J. Abram[2], Kevin J. Anchukaitis[1], Michael N. Evans[3], Cyril Giry[4], K. Halimeda Kilbourne[3,5], Casey P. Saenger[6], Henry C. Wu[4], and Jens Zinke[7,8]



- Composite plus scale
- Leave-one-out iteration
- Moving 30yr window of calibration and validation
- Calibrates well, validates poorly



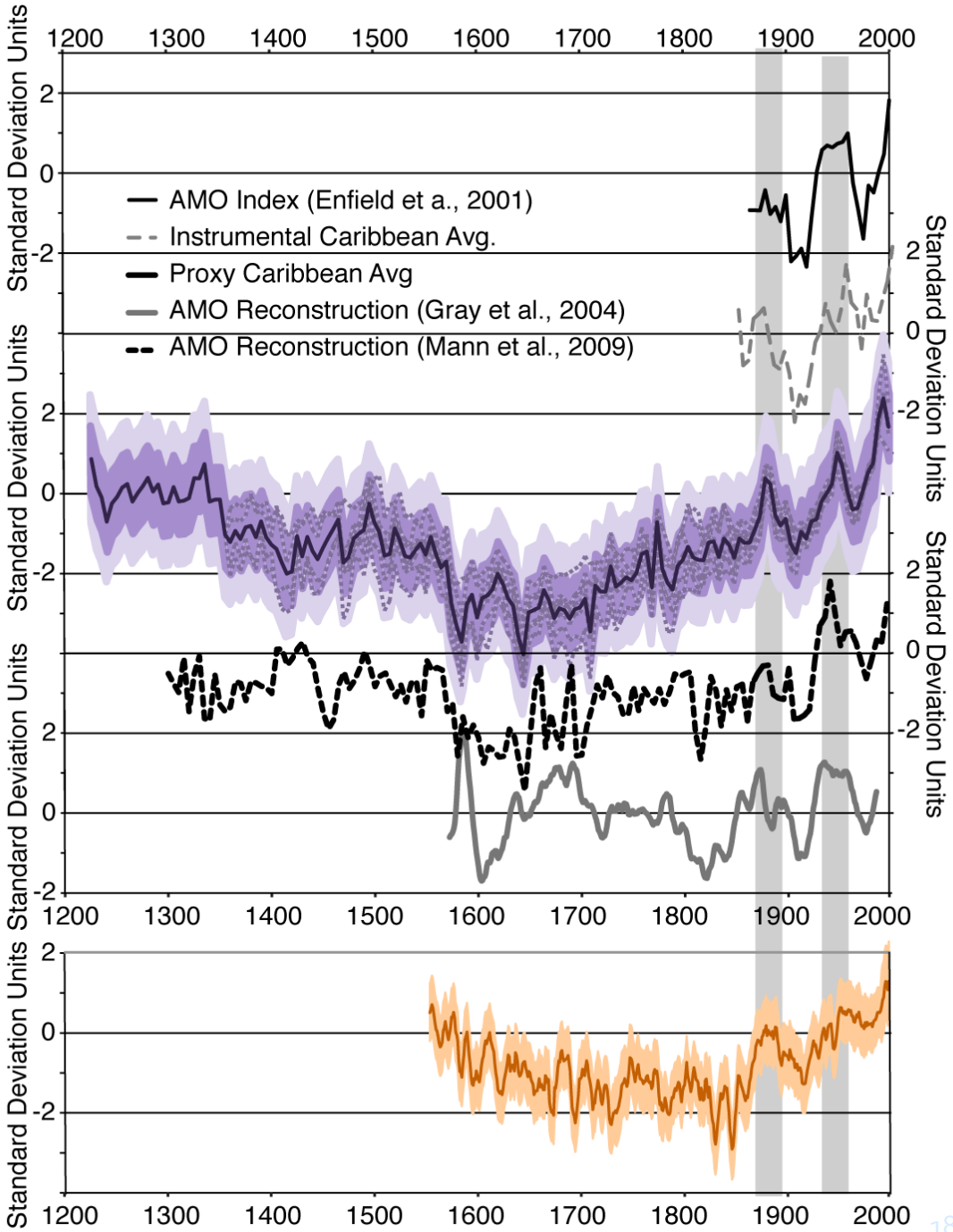
Comparison With Other Multiproxy Reconstructions

Good coherence during instrumental period.

Little to no correlation in pre-instrumental times.

Further analysis to determine important factors for discrepancy: methods or proxy data inclusion

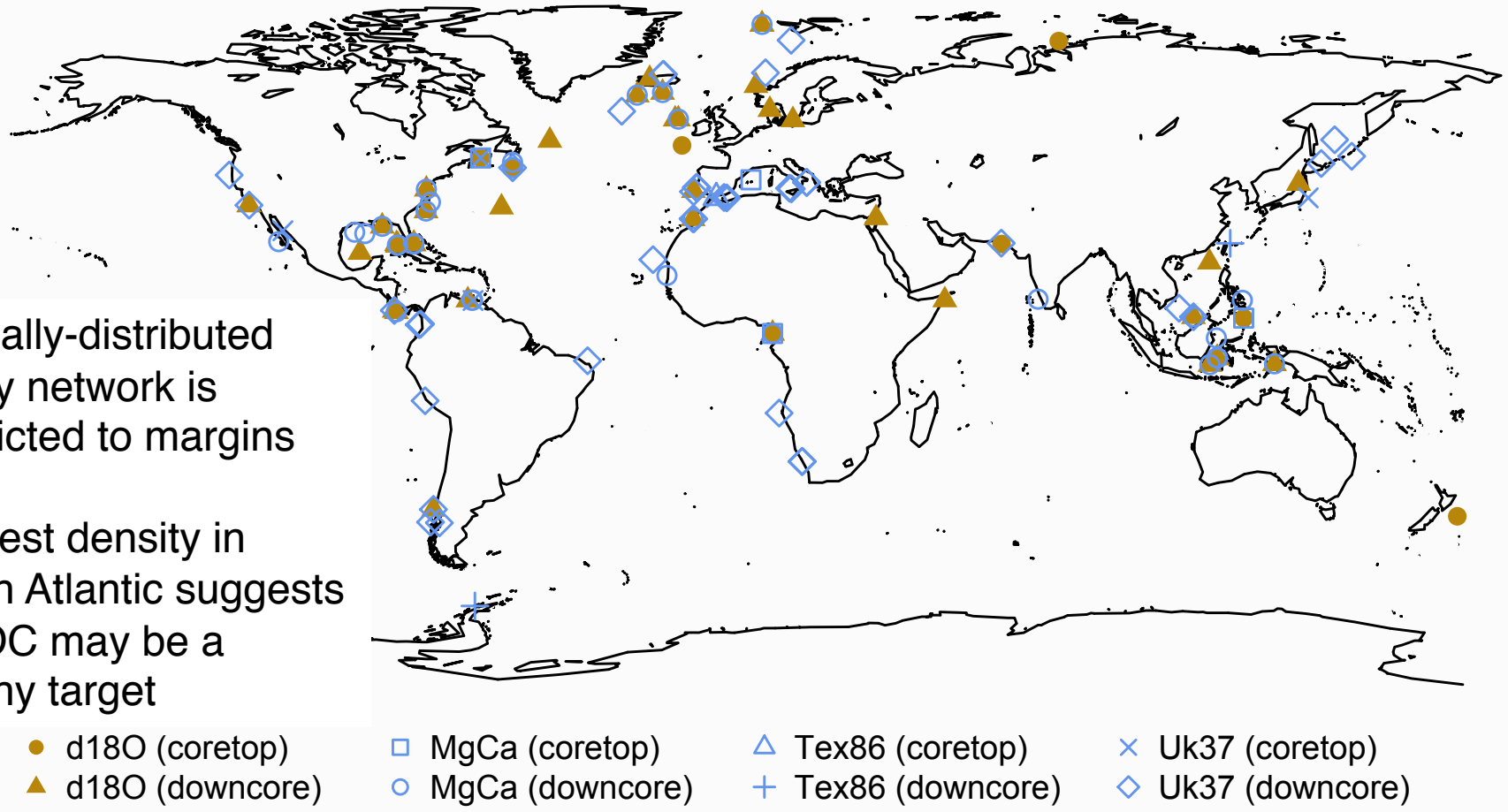
High latitude perspective on SST missing.



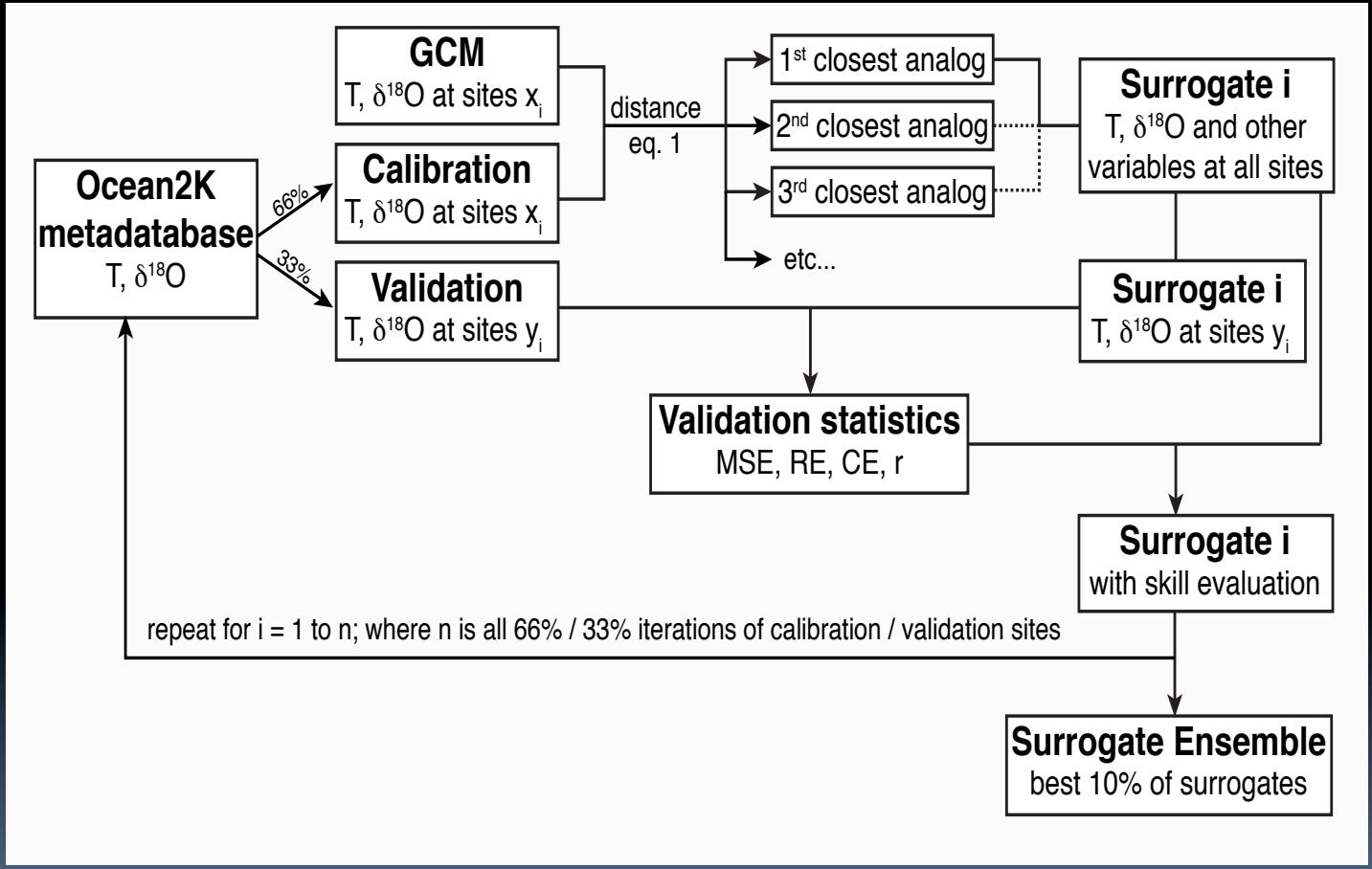
PAGES 2K Trans Regional Project

Ocean2K metadatabase: T and $\delta^{18}O$

Casey Saenger and Mike Evans



Proxy surrogate reconstructions



Existing CMIP5 runs as a catalog of realistic climate states

Identify model years with best proxy-model agreement

Estimate AMOC variability (with uncertainty) from best matches

Proxy could be anything, but limit to T and $\delta^{18}O$ (in isotope enabled models) for now

Scientific Organizing Committee

Hali Kilbourne (Chair), University of Maryland Center for Environmental Science

Ian Hall, Cardiff University, UK

Patrick Heimbach, University of Texas at Austin

Delia Oppo, Woods Hole Oceanographic Institution

Andreas Schmittner, Oregon State University

Rong Zhang, NOAA Geophysical Fluid Dynamics Laboratory

Conclusions

- Need for East Atlantic and northern North Atlantic high resolution SST data.
- Multidecadal scale variability persistent to 1360 in low latitude Atlantic.
- Clear history of North Atlantic multidecadal variability is getting nearer.