A PALEOCLIMATE PERSPECTIVE ON ATLANTIC MULTIDEcadAL VARIABILITY

The View from the Tropics

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North Atlantic SST Anomaly (°C)

0.25
0
-0.25

1200 1300 1400 1500 1600 1700 1800 1900 2000

AMO index, Enfield et al., 2001
Kilbourne, K.H., Alexander, M.A., J.A. Nye, A Paleoclimate Perspective on Atlantic Multidecadal Variability


Alexander, M.A., K.H. Kilbourne, J.A. Nye, Climate Variability During Warm and Cold Phases of the Atlantic Multidecadal Oscillation (AMO) 1871-2008

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• Different definitions exist
• North Atlantic SST anomalies with multi-decadal scale variability

First rotated EOF of non-ENSO SST (linear trend removed)
Goldenberg et al, 2001 *Science*

• Two centers of action

• Not all sites in the N. Atlantic equally appropriate for reconstructions
Multidecadal Atlantic SST Anomalies

Causes:
Ocean Heat Content (AMOC transport)

Need more reconstructions of AMV/AMO HERE!

Causes:
Multi-site reconstructions of AMV/AMO (esp. tree-ring or ice core based)

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

- What variables are important to look at?
- What time-resolution do we need?
- What spatial distribution of data do we need?
Summary of Paleo Lit (a la HK)

- 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: networks of SST records only please
Tropical Reconstruction
• 1 of 2 Centers of Action
• Related to Hurricanes and
• Precip Anomalies

Goldenberg et al., 2001 Science
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"

Only lower resolution sediment cores available for other low lat regions.
- 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.
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
How does the regional data compare to tropical North Atlantic and global SST anomalies?
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%)
- 35 yrs (95%)
- 16 yrs (95%)

Carib. SST Reconstruction

PC 1 only
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.

Need high latitude perspective on SST.
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 still not available (but we’re getting closer)