

Centennial-scale links between Gulf Stream variability and Western Hemisphere hydroclimate

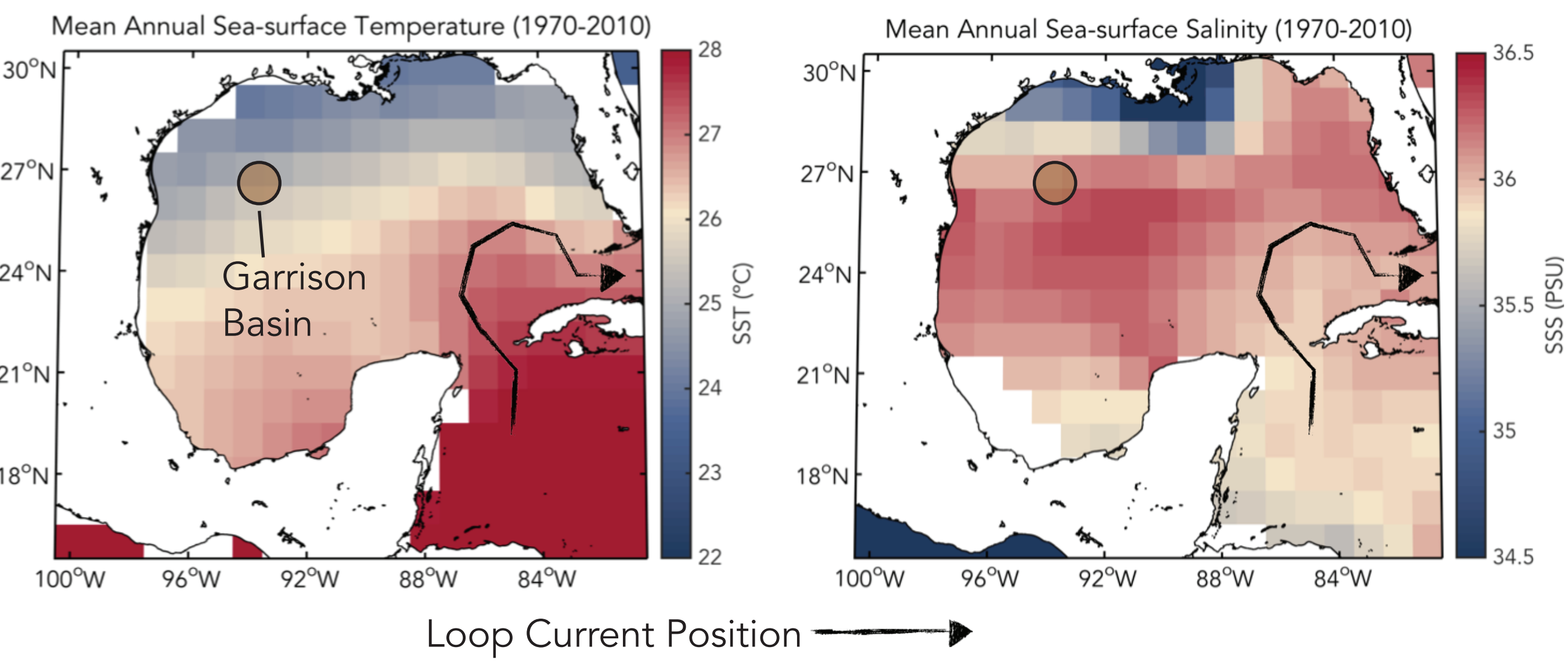
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1. Overview

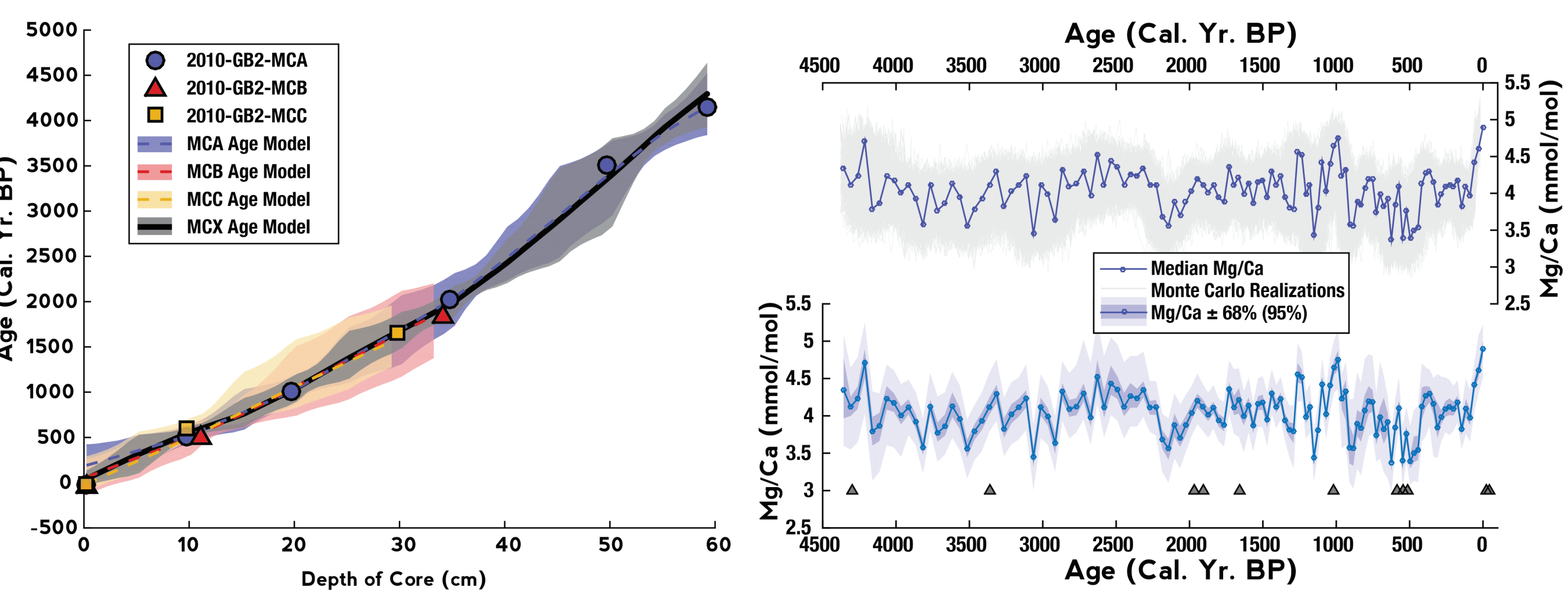
- 4.4 kyr replicated reconstruction of sea-surface temperature (SST) and $\delta^{18}\text{O}$ variability from sediment cores (~15-30 yr/sample) in Garrison Basin, northern Gulf of Mexico (NGOM)
 - *G. ruber* $\delta^{18}\text{O}$ - $f(\text{SST}, \delta^{18}\text{O}_{\text{sw}})$
 - *G. ruber* Mg/Ca - $f(\text{SST}, \text{SSS})$
 - Three cores from same multicore cast
- Observation of coherent, multi-centennial surface ocean variability in the NGOM during late Holocene
- Identification of centennial-scale linkage between salinity and precipitation in observations, proxies, and modelling simulations.

2. Gulf of Mexico Oceanography



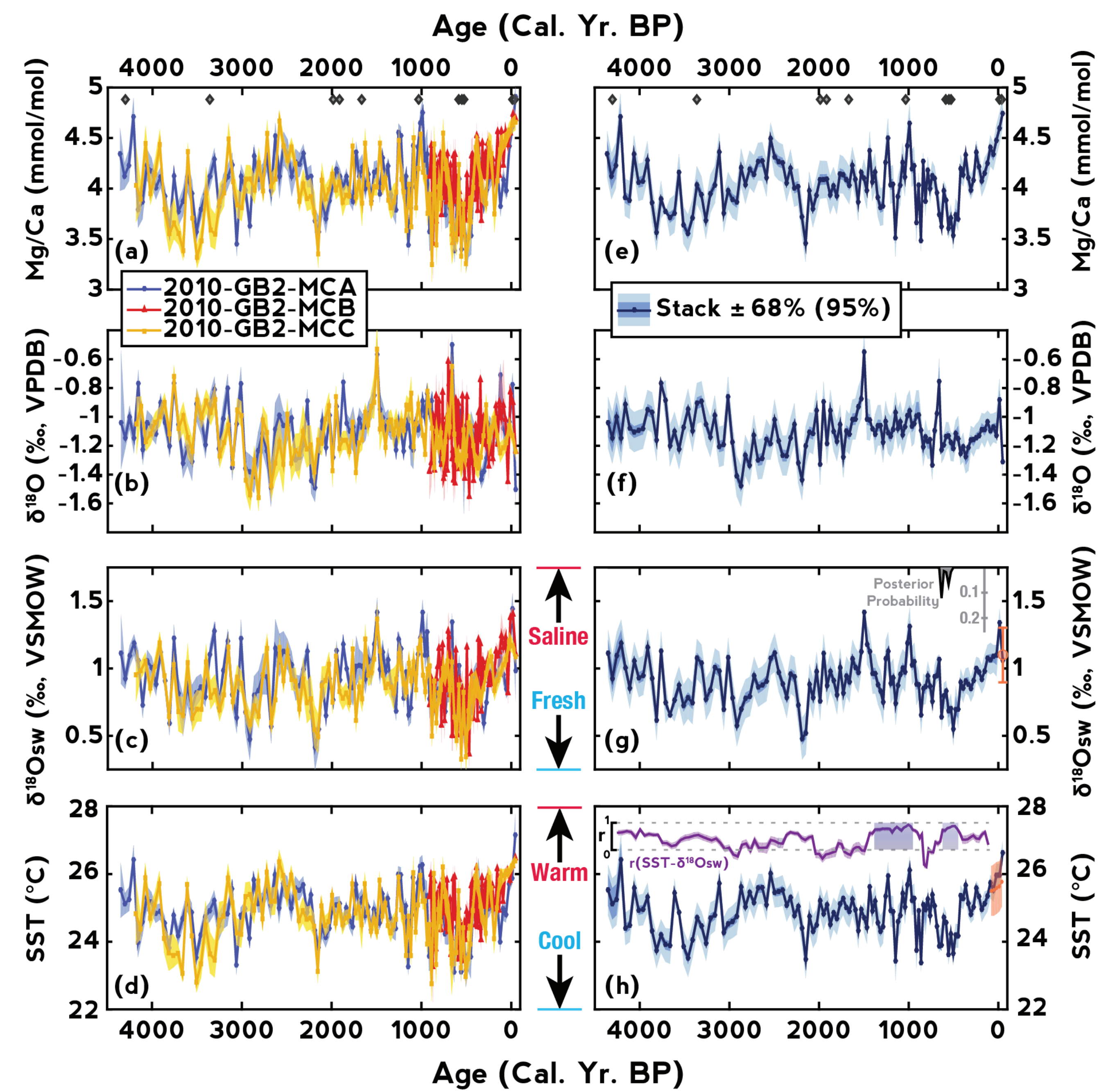
- GOM SST and SSS affected by Loop Current and greater Atlantic Ocean circulation: vary in phase due to circulation changes
- Eddy shedding connects Loop Current and Atlantic to NGOM

3. Methodology

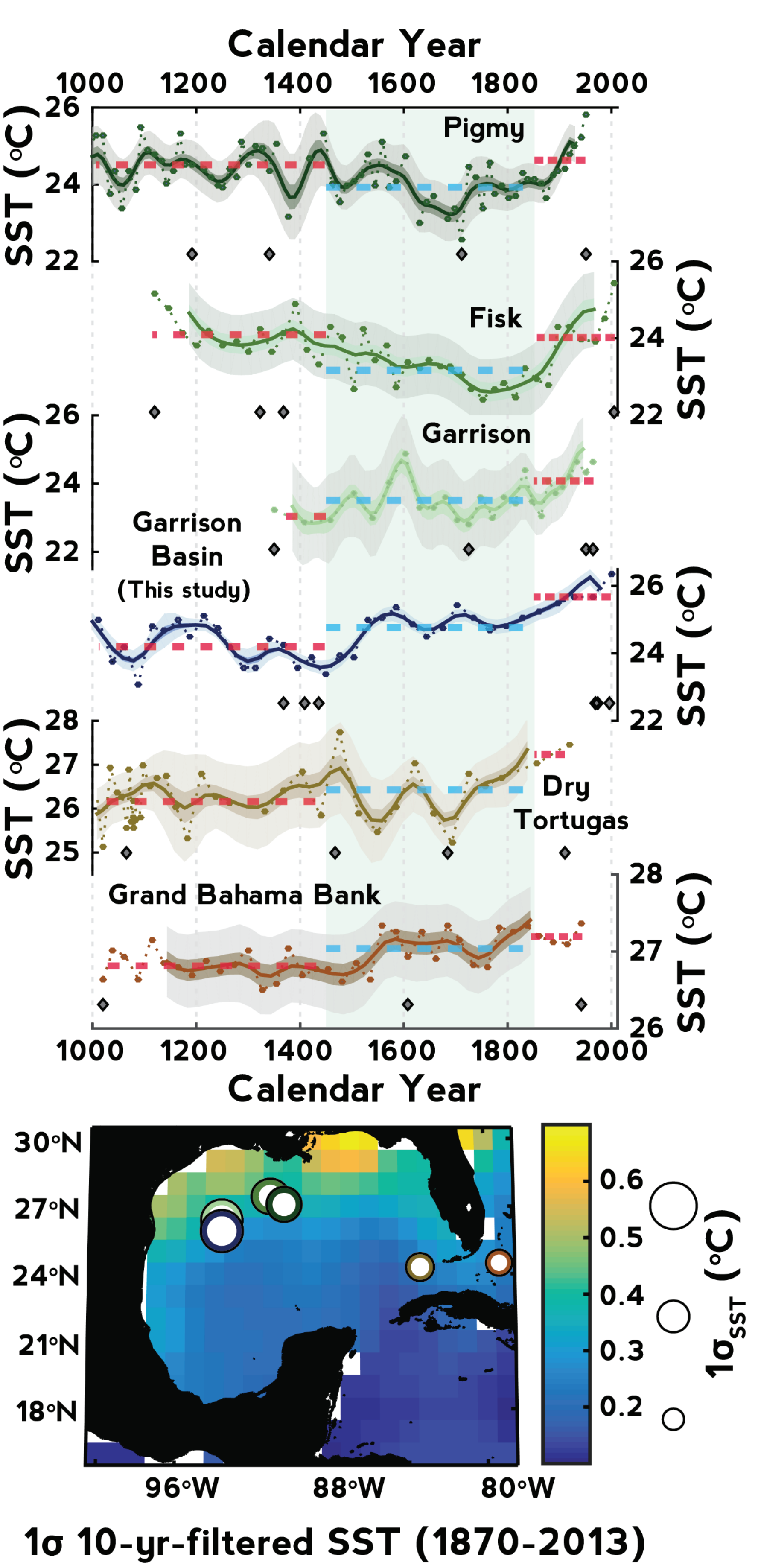


- Three multicores from same cast; independant age model + sampling
- Bayesian and bootstrap Monte Carlo error modeling
- Stacking methodology incorporating total uncertainty

4. Replicated Multicore Record

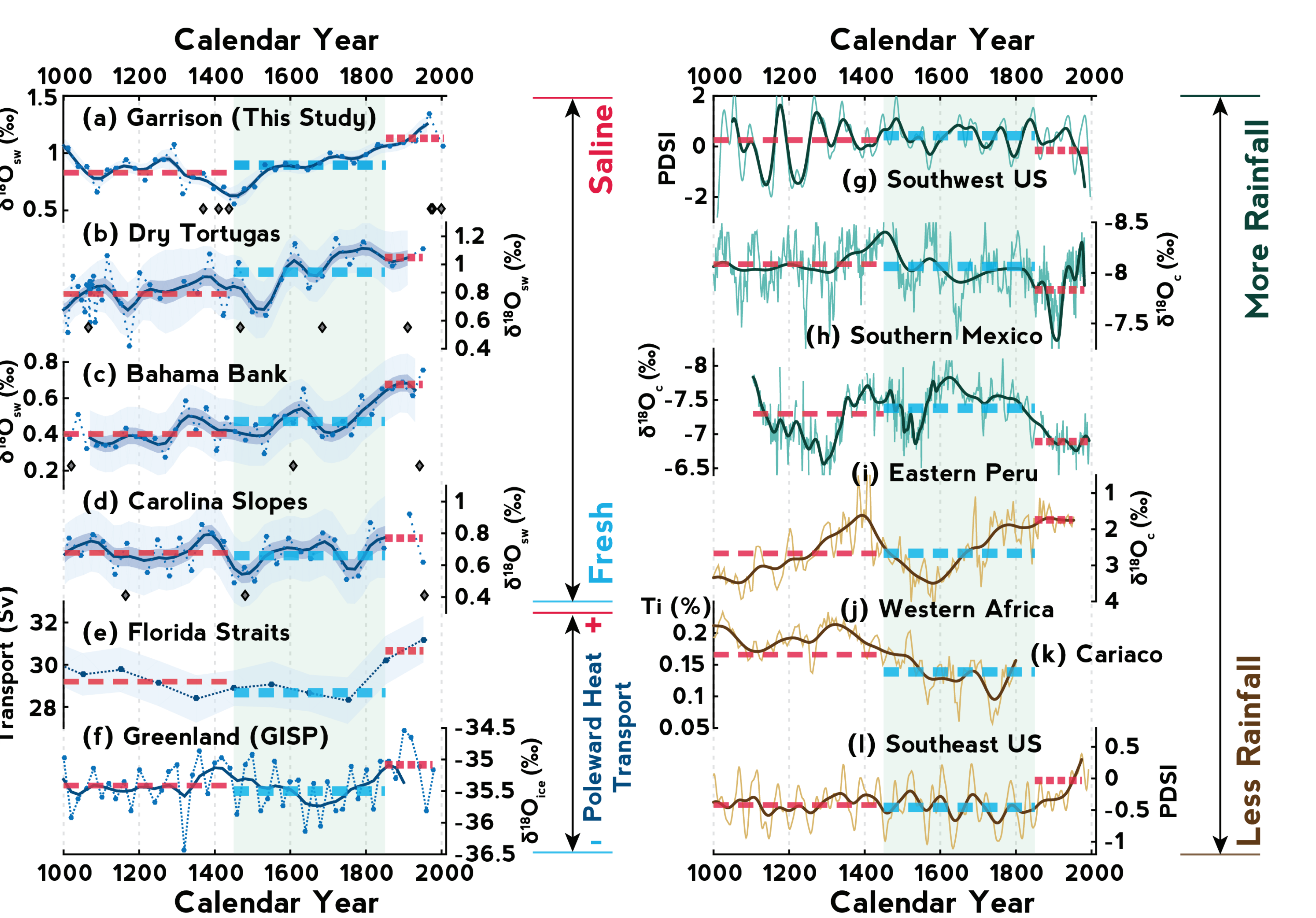


5. Regional SST Variability



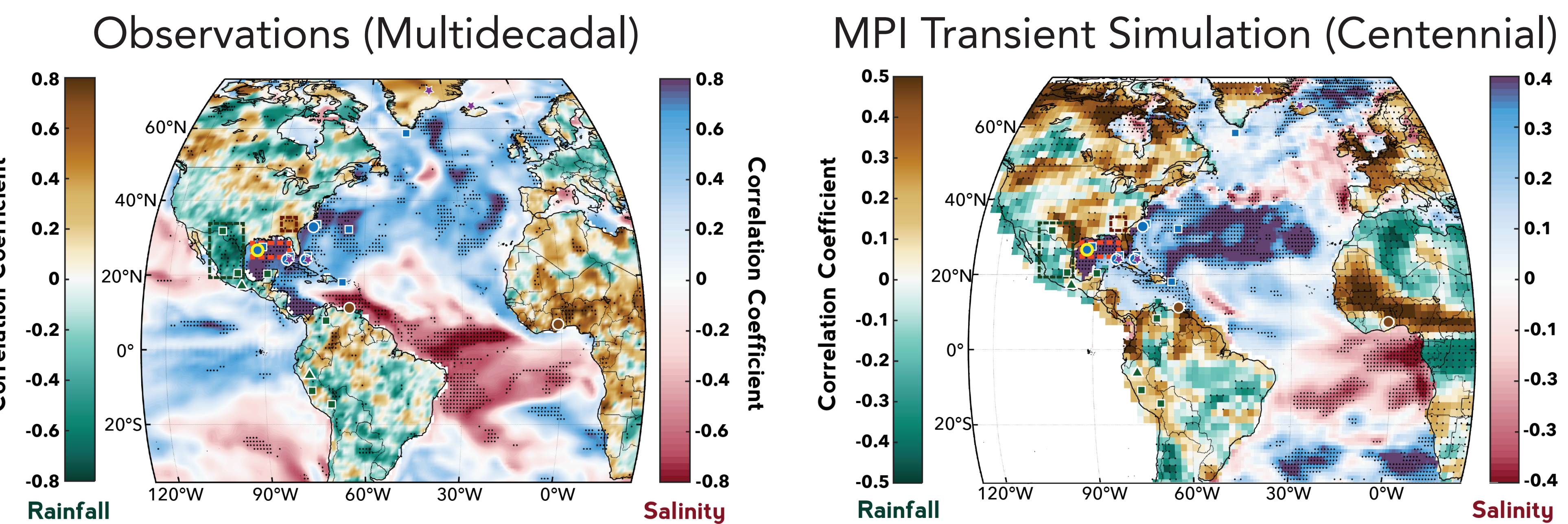
- New and previously published GOM records indicate LIA cooling, consistent with modeling studies of slowdown in Loop Current circulation
- Refined uncertainty constraints provide robust estimates of LIA cooling in GOM.
- Magnitude of long-term SST variability between regional proxy records consistent with multidecadal observations
- Collectively, GOM was 0.5-1.1°C ($\pm 0.4^\circ\text{C}$) cooler during the LIA (1450-1850 C.E.)

6. Last Millennium Hydroclimate Variability



- Synthesis of marine records (with uncertainty modeling) indicate fresher LIA in north Atlantic.
- Precipitation records indicate wetter conditions during LIA in southern N. America & Altiplano.
- Fresher LIA in Atlantic is coeval with records indicating diminished poleward heat transport.
- Similarly, fresher north Atlantic is coeval with dry conditions in W. Africa, Cariaco, & S.E. US

7. Circulation-Precipitation Linkages



- Multidecadal correlational analysis in salinity (ORA-S4) and precipitation (GPCC) observations are consistent with mean signal displayed by proxy records during the LIA (indicated by color in shapes).
- Centennial-scale correlation analysis of salinity and precipitation from transient simulation of the last millennium (MPI model) in a GCM with realistic forcings also largely consistent with proxy records.
- Evidence suggests slowdown in Gulf Stream during the LIA linked with drastic rainfall changes.

- Models, observations, and proxy records indicate diminished Atlantic salt and heat transport (Gulf Stream) linked to precipitation patterns in Americas and Africa on century timescales.

8. Conclusions

- Gulf of Mexico: 'part and parcel' of long-term Atlantic Ocean surface circulation as observed in SST and SSS variability.
- Garrison Basin multicore records replicate well and display persistent centennial-scale variability on the order of $\sim 1^\circ\text{C}$ SST and $\sim 0.25\%$ $\delta^{18}\text{O}_{\text{sw}}$ variability over the last 4.4 kyrs
- Statistical analysis indicates that onset of LIA is unique in the Garrison Basin record, despite other time periods with anomalously cool and fresh conditions.
- Uncertainty modeling and synthesis of marine records during LIA indicate anomalously fresh north Atlantic conditions, indicative of reduced salt transport associated with Gulf Stream transport.
- Correlation analysis using observations, reanalysis datasets, and a fully coupled transient modeling simulation suggest long-term (multidecadal-centennial) linkage between Gulf Stream transport and Western Hemisphere rainfall variability. This linkage is consistent with proxy observations and appears to have been at play during the LIA and perhaps over the late Holocene.