Tracking Northward Migration of the ITCZ in the equatorial Atlantic from the LGM through the Early Holocene Using Mg/Ca as a SST Proxy

Pierre*, Jenny*, Caroline*, Peter*, Tristan*, David*, Winny*

*Affiliated with LDEO Columbia University

Introduction

- The Intertropical Convergence Zone (ITCZ) is an atmospheric band of low pressure that circles the earth near the equator
- The position of the ITCZ is identified by the patterns of evaporation and precipitation, which coincide with the ascending limb of the Hadley Circulation Cell.
- The mean current position of the ITCZ is ~5°N of the equator, but migrates with the seasons. The marine ITCZ is the portion of the ITCZ over the ocean and has less of a latitudinal range than the ITCZ overland masses, thus making it efficient for tracking mean northward migration.

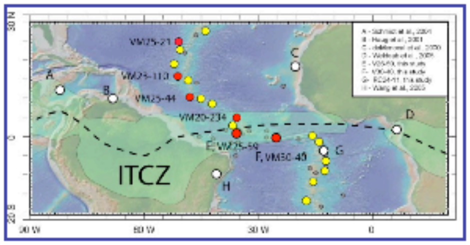

Figure 1. Locations of: sediment cores used in this study (red), proposed sediment cores (yellow) and records documenting past tropical Atlantic ITCZ migrations (letters A-H [see fig. 3]). The dashed line depicts the modern mean position of the ITCZ, and the green cloud its seasonal range. The grey dots are additional cores used in the SST and SSS calibration study. Average core depth is 3700m.

Motivation/Scope

- Movements of the ITCZ affect patterns of wind and rain causing the wet and dry seasons in the tropics and the regulating the strength of monsoonal weather.
- Past studies have documented shifts in the ITCZ using such diverse proxies as near shore sediment cores, terrestrial cave deposits, lake sediments and dust fluxes.
- This investigation used 6 sediment cores (Fig. 2, in red) from the northern equatorial Atlantic to track shifts in the marine ITCZ by looking at changes in SST across a meridional range from 0.5°S - 26°N.

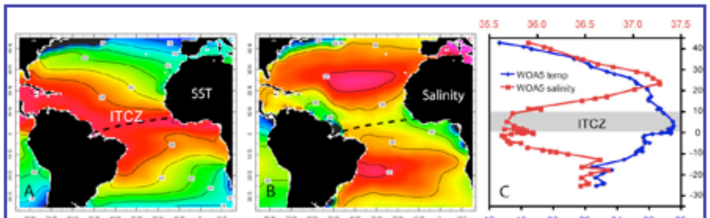

Figure 2a-c. WOA05 mean annual SST (2a) and SSS (2b) for tropical/sub-tropical Atlantic. The dashed line depicts the mean position of the ITCZ. Panel C represents the mean SST and salinity for the core transect sites described in figure 1.

References

[illegible]

Method

- This study constrained SST estimates using Mg/Ca rations for *G. ruber s.s. (w)* because of their prevalence in the upper 50 meters of the water column, which allows *G. ruber s.s. (w)* to serve as a faithful proxy for near-surface SST (Spero, 1998).
- All samples were cleaned for trace metal analysis using procedures from Marchitto (2002), which involved crush, clay removal with methonal, oxide removal, and organic matter removal.
- SST was derived from Mg/Ca using an equation from Dekens et al. (2002) , which was regressed specifically for *G. ruber*, Atlantic :

$$Mg/Ca = 0.38 \exp 0.09[SST-0.61(\text{core depth km})]$$

Results

- Data from all 6 sediment cores depict increase in SST (as indicated by elevated Mg/Ca in Figure 4).
- Where available, $\delta^{18}O$ data corroborates an inferred increase in SST as indicated by and increase in Mg/Ca from the Last Glacial Maximum (LGM) (green line) to the Early Holocene (EH) (red line).
- The documented increase in SST after the LGM (As indicated by increased Mg/Ca) in Figure 4 is supported by the proxy measurements of salinity and/or aridity/humidity represented in Figure 3.

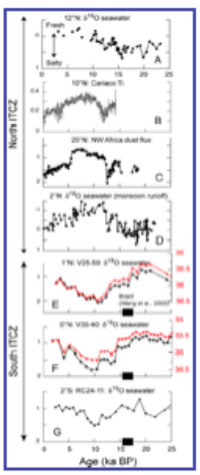

Figure 3. A summary of paleohydroligical indicators depicting changes in salinity and/or regional aridity/humidity over the last 25 ka BP. Note the antiphase behavior of records above/below the equator. Panel letters refer to labeled stations from Figure 1.

Conclusions

- Results from this investigation confirm the findings off previous studies (fig. 3), while strengthening the evidence of ITCZ migrations by adding an additional proxy (Mg/Ca from deep ocean sediment cores) to the corroborative record.
- Migration of the maritime ITCZ as evidenced by this study are strongly coupled with high latitude Atlantic climate forcing (e.g. the last glacial maximum).
- Thought, the significance of the modern ITCZ is well known, it is difficult to know the amount of forcing the ITCZ movements have had on tlobal scale climate change through the Holocene into the Last Glacial Maximum, and beyond.
- The current understanding of these presented data will be augmented by a full record of $\delta^{18}O$ data to be available by the end of the summer.

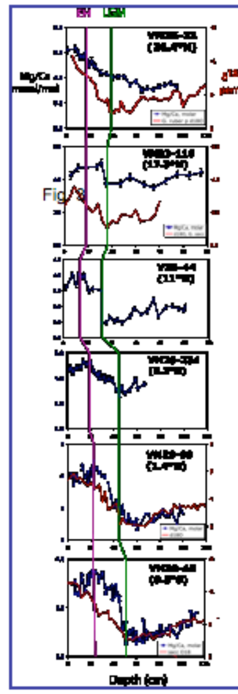

Figure 4. A summary of Mg/Ca data for the red core sites shown in Figure 1. Available $\delta^{18}O$ stratigraphy data is represented in red.