Mississippi River Discharge During The Little Ice Age and Medieval Warm Period: A Gulf of Mexico Perspective on Hydrologic Variability Over North America

J.A. Flannery[1] (flannery@marine.usf.edu), H.W. Hill[1], R.Z. Poore[2], and D.J. Hollander[1]

[1]College of Marine Science, University of South Florida, St. Petersburg, FL 33701, [2]United States Geological Survey, St. Petersburg, FL 33701

1. Research Questions

1. How has Mississippi River (MR) discharge varied over the late Holocene, the past 1400 years?
2. Is there a climate control on MR discharge during the Late Holocene?
   - Is the accepted paradigm of a cold/dry Little Ice Age and a warm/wet Medieval Warm Period reflected in the discharge record?
   - Are there centennial-scale changes or higher frequency variations recorded in the record?
   - Are there linkages between North American hydrology and Gulf of Mexico sea surface temperature (SST) and salinity?

2. Background

- ITCZ/BH migrates seasonally and controls meridional moisture flux from the Gulf of Mexico (GOM) (Figure 1)

ITCZ/BH Migration

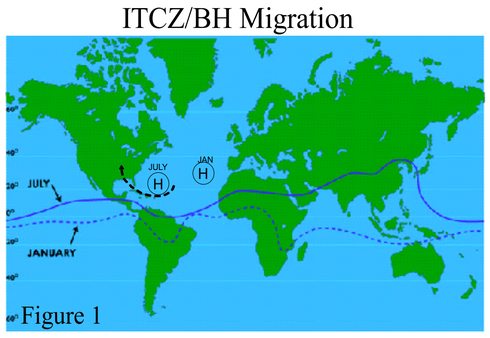


Figure 1

North American Air Masses

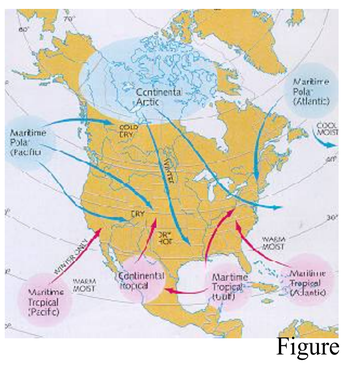


Figure 2

- Convergent processes responsible for precipitation in North America
- Warm/moist GOM air masses from South interact with dry/cold polar air masses from N/NW to produce storm fronts (Figure 2)

- Pigmy Basin in Northern GOM records terrigenous input from continent as well as oceanic response (Figure 3)

Mississippi River Drainage Basin

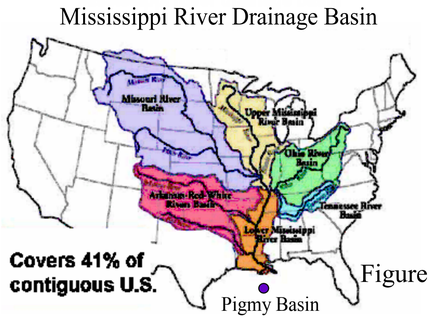
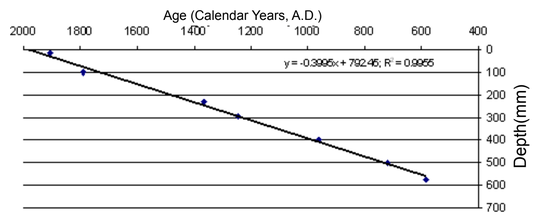


Figure 3

3. Methods

Field Site and Sample Material

- Pigmy Basin, Gulf of Mexico
- High resolution sampling (5mm)
- ^{14}C Dating enables creation of Age Model



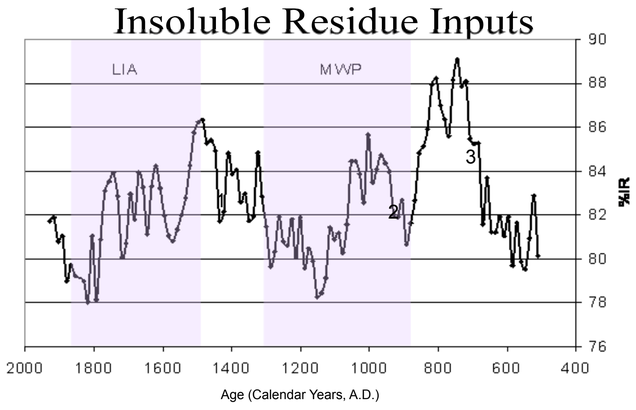
- 7 Radiocarbon (^{14}C) dates on foraminifera
- 0 Age at surface
- Constant sedimentation rate = 25cm/kyr
- Age model projected from a companion subcore

Analytical

- Weight % Insoluble Residue: Reflects lithogenic inputs
- Bulk density determined
- Accumulation Rates = Bulk density*sedimentation rate
- Molecular Organic Geochemical (Biomarkers)
  - Long-chain n-alkanes
  - Species-specific Sterols
  - Alkenones

4. Insoluble Residues as an Indicator of MR Discharge

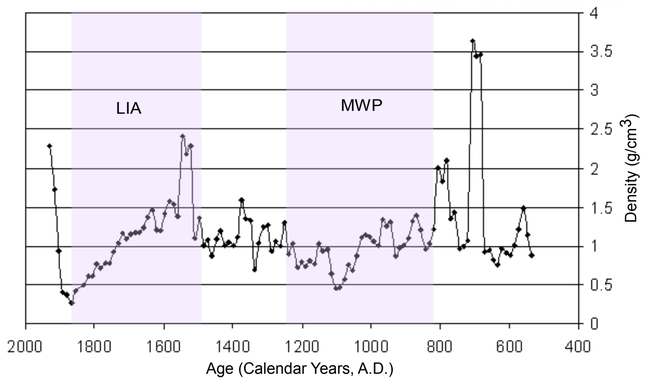
Insoluble Residue Inputs



- IR inputs are indicative of increased terrestrial inputs into the Gulf of Mexico via the Mississippi River
- Terrestrial input maxima occur at ~1450 A.D. and ~750 A.D.; not during the LIA and MWP
- Terrestrial input minima occur at ~1800 A.D. and ~1150 A.D.; within the LIA and MWP
- IR shows significant and systematic variability with apparent, high-frequency cycles at 600 and 200 years
- Continental North American hydrology varies independently from GOM SST and salinity (Richey et. al., T3-002)
  - Peaks 1 & 2 correspond to salinity maxima in the companion subcore (paired foraminifera $\delta^{18}O$ and Mg/Ca)
  - Peaks 2 & 3 correspond to sea surface temperature maxima (Mg/Ca record of companion subcore)

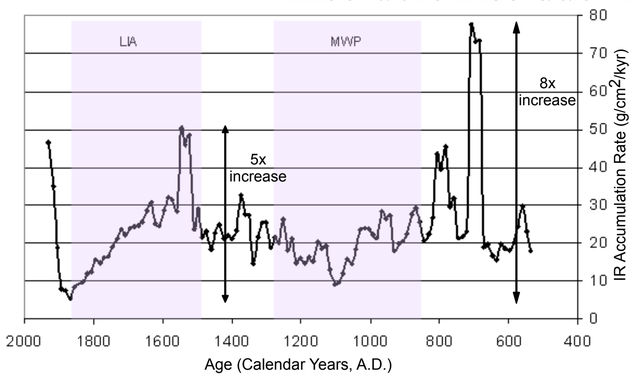
5. Preliminary Results and Future Work in Pigmy Basin

Marine Sediment Densities



- Bulk density varies up to 7 fold
- Higher densities infer increased MR lithogenic input
- Density minima occur at ~1850 and ~1100 A.D. within the LIA and MWP, respectively

Insoluble Residue Accumulation Rates



- IR Accumulation Rates reflect the flux of terrigenous material to the seafloor
- IR accumulation rates show up to a 8-fold increase with maxima occuring at ~1550 and ~700 A.D., not within the LIA and MWP

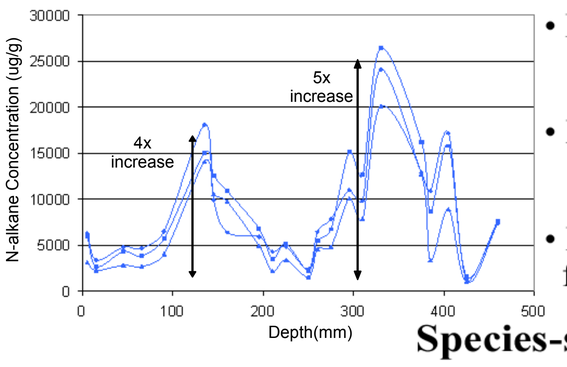
Climatological Implications

On the North American continent, cold and warm climate events (LIA and MWP) result in the same hydrologic response, decreased MR discharge. Will future climate changes (cold or warm) result in reduced hydrologic cycling over North America?

Marine Organic Geochemistry

Long-chain n-alkanes

- Hydrocarbons consisting of single carbon-carbon bonds
- Used to trace organic matter back to its origins
  - High molecular weight (HMW) n-alkanes = terrestrial organic matter
  - Low molecular weight (LMW) n-alkanes = algal organic matter



- Preliminary n-alkane results from a companion subcore
- Increased terrestrial organic matter input during two intervals
- Increased terrestrial organic matter inputs result from enhanced MR discharge

Species-specific Sterols

- Specific biomarkers unique to individual organisms
- Used to reconstruct ecosystem assemblages
  - terrestrial = C_3/C_4 plants
  - marine = phytoplankton

Alkenones

- Produced by coccoliths and used to reconstruct sea surface temperature
- Differ in the number of double and triple bonds
- Utilizes U_k^{37} unsaturation index equation

ACKNOWLEDGEMENTS: I would like to thank: Ethan Goddard, David Adams, Jenna LoDico, and the entire Paleo Lab at USF for continual support and guidance. Travel support from the NSF IGERT Program Grant DGE 0221681and the USF Office of Research.