Ford, H.L., and Raymo, M.E., 2020, Regional and global signals in seawater $\delta^{18}O$ records across the mid-Pleistocene transition: Geology, v. 48, https://doi.org/10.1130/G46546.1

# APPENDIX

## Site 1208

Based on sample availability, samples were taken at ~7, 10, and 20 cm intervals from 40-53, 21.7-24, and 24-40/53-87 mbsf, respectively. This equates to a temporal resolution of 1.4 to 3.7 kyr. As site 1208 is a single hole, we constructed a "re-compressed" depth, as in Venti and Billups (2012):

((reported depth - core-top depth)*(100/% core recovered) + core-top depth)

## Prob-stack and LR04

In the years since the publication of the $\delta^{18}O_{benthic}$ LR04 stack (Lisiecki and Raymo, 2005) researchers have produced new $\delta^{18}O_{benthic}$ records. An updated version of LR04 is Prob-stack (Ahn et al., 2017). Prob-stack includes 180 $\delta^{18}O_{benthic}$ globally distributed records whereas LR04 included 57 $\delta^{18}O_{benthic}$ records. Prob-stack and LR04 are similar in structure (**Data Repository Figure 1)**.

## Minor Elemental Analyses

*Uvigerina* spp. was used to reconstruct bottom water temperature at Ocean Drilling Program Site 1208. Marine sediment samples were washed and picked for *Uvigerina* spp. specimens from the > 250μm size fraction. Prior to analysis, 6-12 *Uvigerina* spp. specimens were crushed, washed using MilliQ water and methanol, and reductively and oxidatively cleaned. Prepared samples were analyzed for minor and trace elements on the Thermo Scientific iCAP-Q inductively coupled plasma mass spectrometer (ICP-MS) at the Lamont-Doherty Earth Observatory and Rutgers University. Long-term precision of a liquid consistency standard is ~1-

2%. The pooled standard deviation of the replicate *Uvigerina* spp. Mg/Ca determinations is 0.056 mmol/mol. Al, Fe and Mn were used to screen for contamination (**Data Repository Figure 2 and 3**; n = 4 samples were eliminated because the Mn/Ca or Fe/Ca values were >350 mmol/mol or μmol/mol, respectively). No preservation biases are observed in percent coarse fraction or lightness as a proxy for percent $CaCO_3$ (**Data Repository Figure 4)**.

**Converting to Bottom Water Temperature and $\delta^{18}O_{seawater}$**

PSU Solver (Thirumalai et al., 2016) was used to estimate bottom water temperature and $\delta^{18}O_{seawater}$ **(Data Repository Figure 5, 6 and 7)**. PSU Solver uses a Monte Carlo simulation (*n* = 1000) to propagate errors on bottom water temperature and $\delta^{18}O_{sw}$ estimates.

The following equations were used:

(1) Mg/Ca = 1.0 + (0.1*BWT) from (Elderfield et al., 2010; Elderfield et al., 2012) with oxidative cleaning only

(2) Mg/Ca = 0.9 + (0.1*BWT) modified from (Elderfield et al., 2010; Elderfield et al., 2012) with oxidative and reductive cleaning (Woodard et al., 2014; Ford et al., 2016)

(3) Mg/Ca = 1.16 + (0.15*T) from (Sosdian and Rosenthal, 2009)

(4) Temperature = 16.9 - 4.0 * ($\delta^{18}O_{carbonate}$ $\delta^{18}O_{sw}$ +0.27) from (Shackleton, 1974; Kim and O'Neil, 1997; Elderfield et al., 2010; Elderfield et al., 2012)

Bottom water temperature for *Uvigerina* spp. was estimated using equation 1 and equation 2 for ODP Site 1123 and Site 1208, respectively. For the multi-species bottom water temperature reconstruction at DSDP Site 607, equation 2 was used for *Uvigerina* spp. and

equation 3 was used *Cibicidoides wuellerstorfi* and *Oridorsalis umbonatus*. The Mg/Ca uncertainty for *Uvigerina* spp. is 0.06 mmol/mol and 0.16 mmol/mol for *Cibicidoides wuellerstorfi* and *Oridorsalis umbonatus*. The $\delta^{18}O_{carbonate}$ uncertainty is 0.06 per mill. The age model uncertainty is 1 kyrs.

## Constructing the $\delta^{18}O_{seawater}$ Stack

Using the $\delta^{18}O_{sw}$ estimates from ODP Sites 1123 and 1208 and DSDP Site 607 from PSU Solver **(Data Repository Figure 8)**, we created a $\delta^{18}O_{sw}$ stack. First, the $\delta^{18}O_{sw}$ estimates for each site were interpolated the records to an even 3-kyr interval (across the 338-1450 ka interval where all three records ≤ 3 kyr resolution, **Data Repository Figure 9**). During the 338 – 1450 ka interval Sites 607, 1123, and 1208 have a ~3.0 kyr, 2.7 kyr, and 1.0 kyr sampling resolution, respectively. Each record was then bootstrapped to estimate error ($n$ = 1000, **Data Repository Figure 10**). The interpolated means the bootstrapped error estimates were then averaged to create the mean and error estimate of the $\delta^{18}O_{sw}$ stack **(Data Repository Figure 11).**

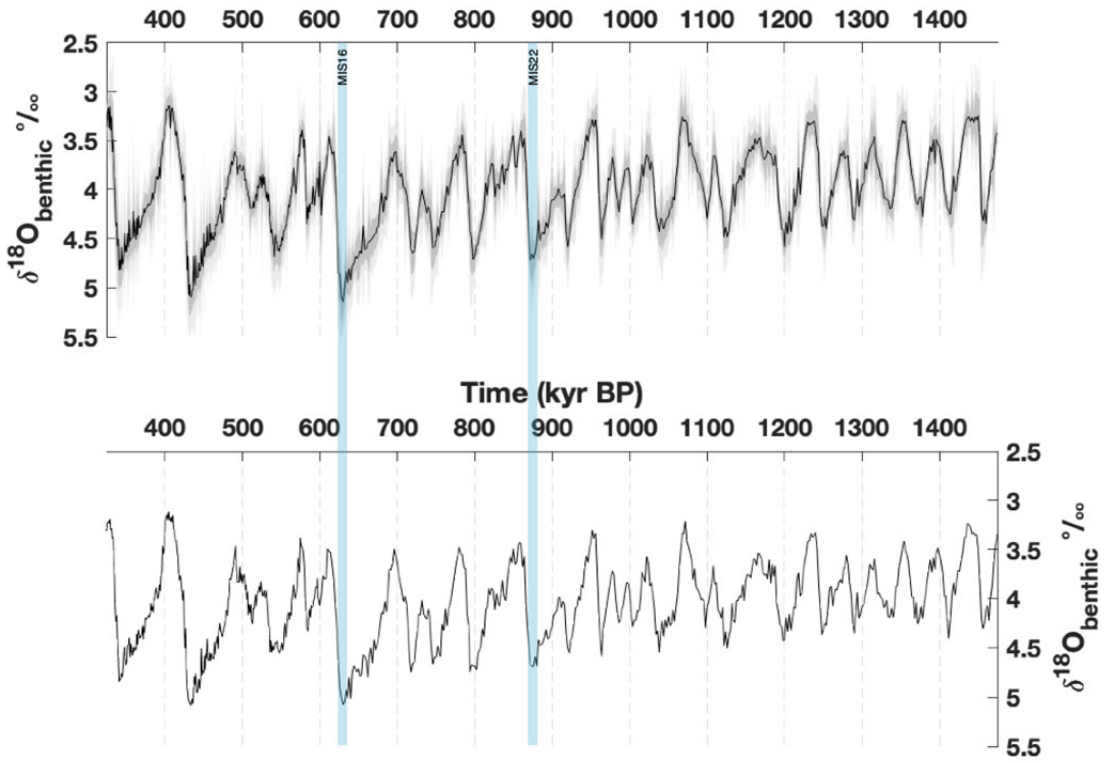
## Wavelet analyses of the individual $\delta^{18}O_{sw}$ and $\delta^{18}O_{sw}$ stack

Continuous 1-D wavelet transforms were calculated using the Matlab® function cwt (Data Repository Figure 12). The Probstack has strong 41- and 100-kyr signal. The d18Osw records have weak 41-kyr signal and 100-kyr signal that begins ~900 kyr and becomes stronger at ~600 kyr.

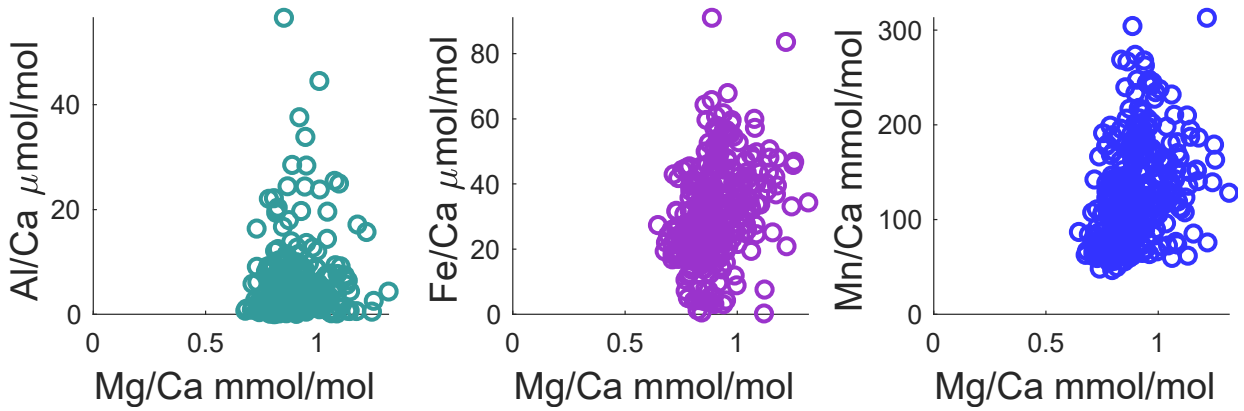
## Data Set

2020037_Data Set.xlsx

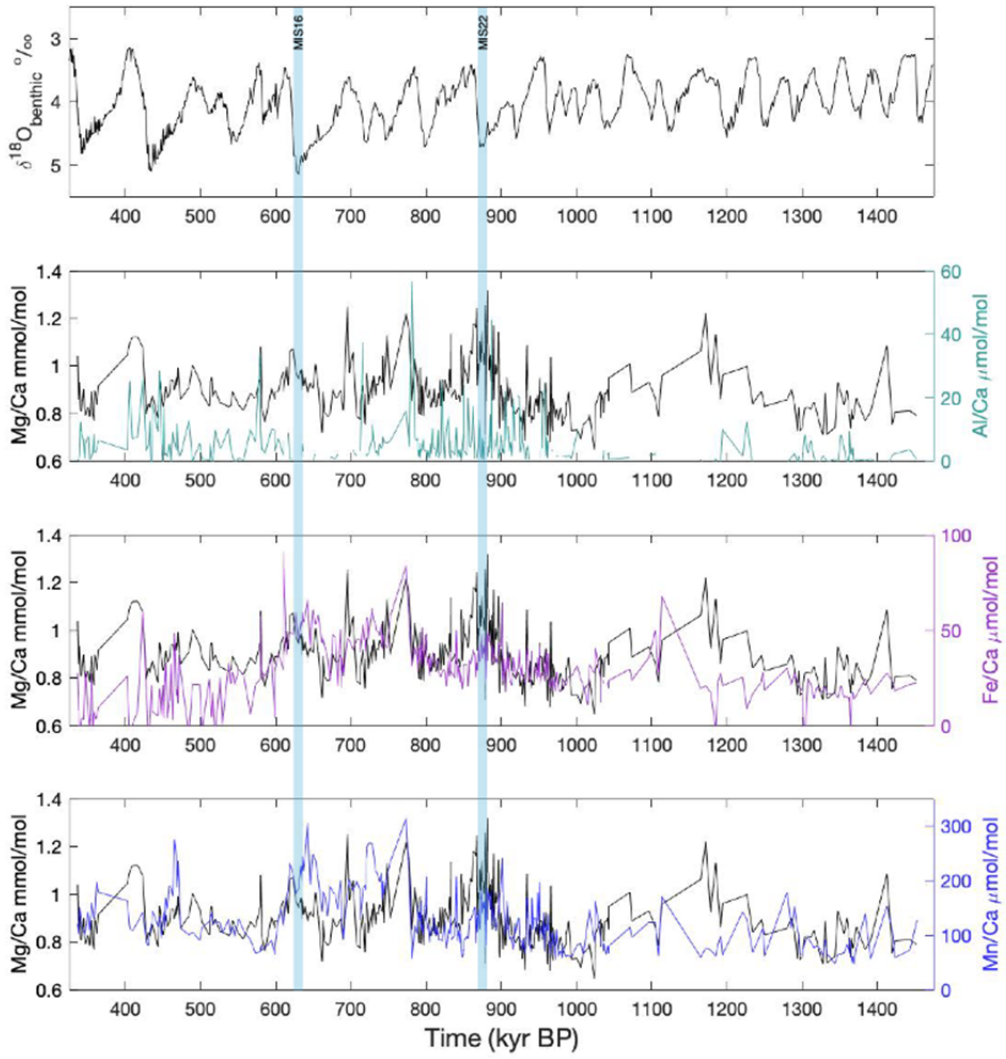
**Data Repository Figure 1:** Prob-stack (top) and LR04 (bottom). Error envelopes: dark grey = 1σ, light grey = 2 σ).



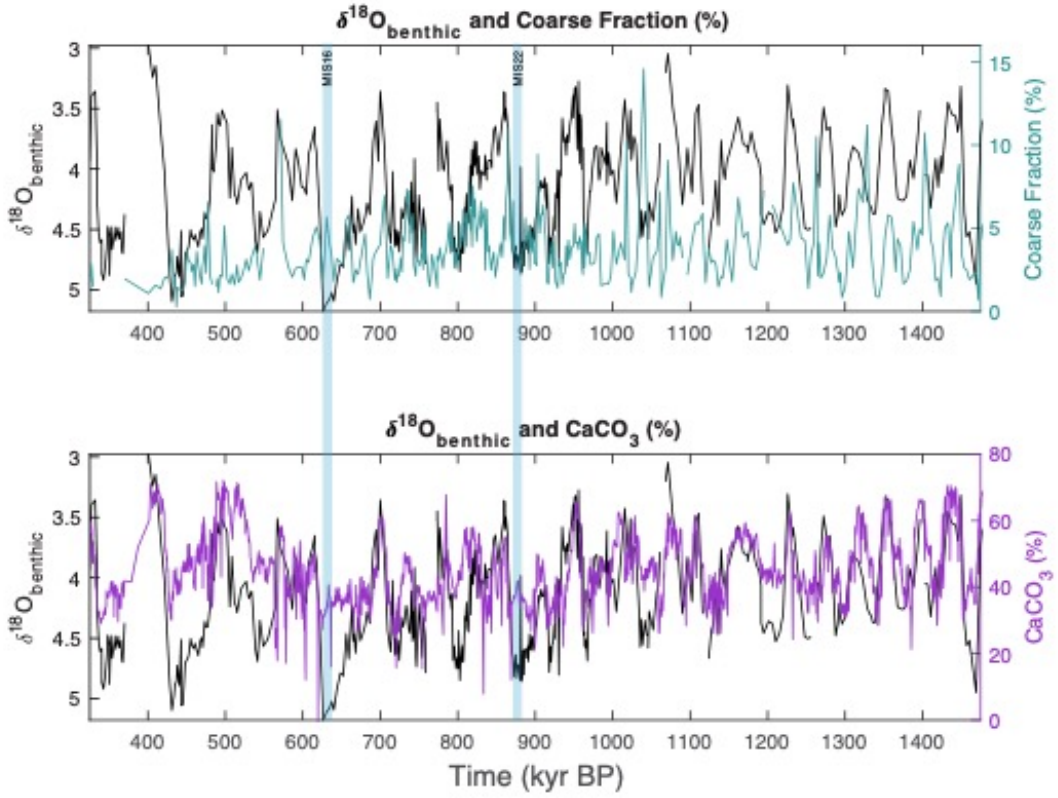
**Data Repository Figure 2:** Scatter plots of Mg, Al, Fe and Mn.



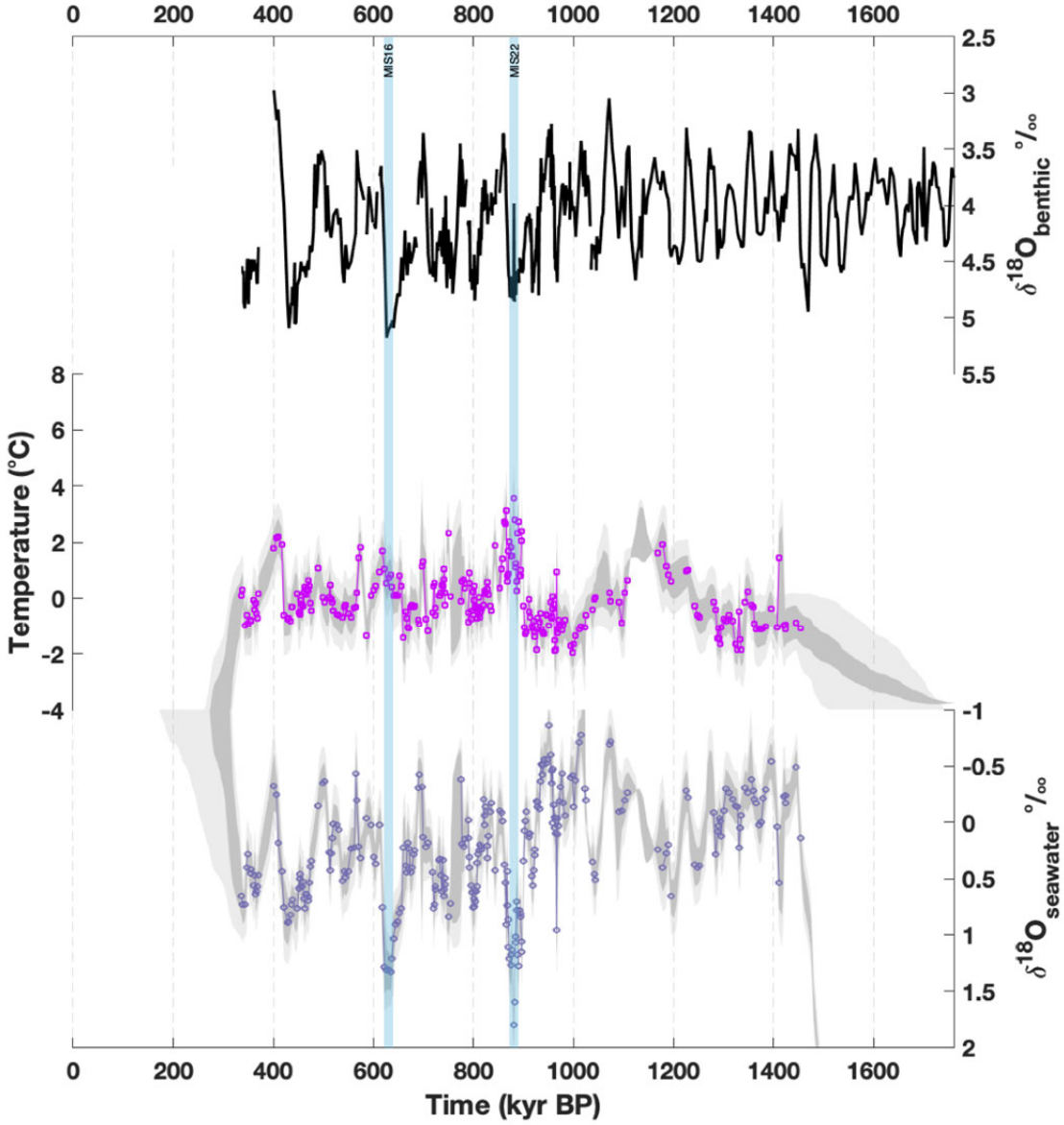
**Data Repository Figure 3:** Time series plots of Mg (black), Al, Fe and Mn.



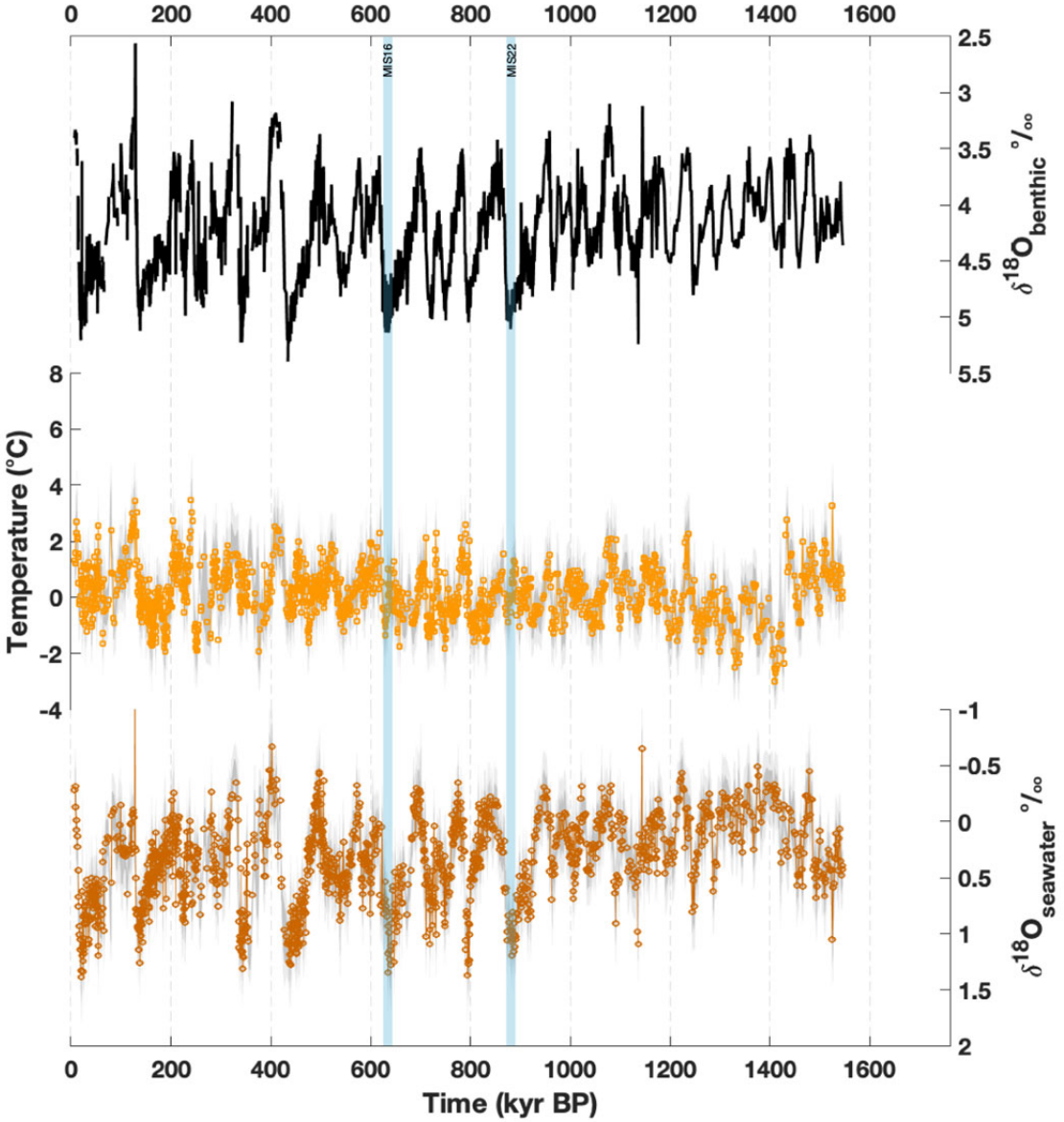
**Data Repository Figure 4:** Time series plots of Site 1208 $\delta^{18}O_{benthic}$ (black) and Coarse Fraction (%) and $CaCO_3$ (%) showing no obvious preservation bias in the Site 1208 Mg/Ca record.



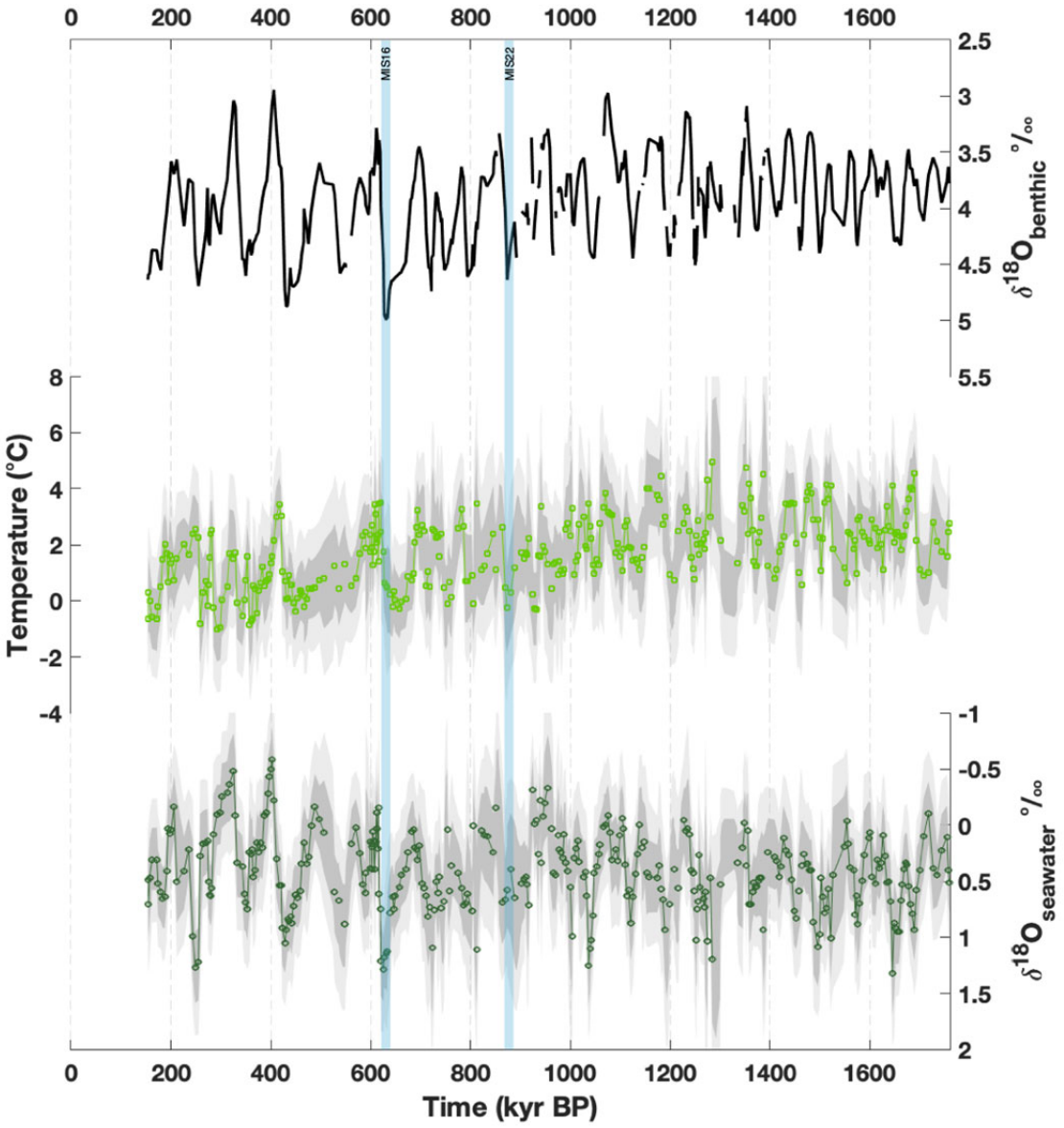
**Data Repository Figure 5:** N. Pacific ODP Site 1208 $\delta^{18}O_{benthic}$, Mg/Ca derived temperature and $\delta^{18}O_{seawater}$. Using Monte Carlo simulations, PSU Solver (Thirumalai et al., 2016) generated error envelopes (dark grey = 1σ, light grey = 2 σ) on temperature and $\delta^{18}O_{seawater}$.



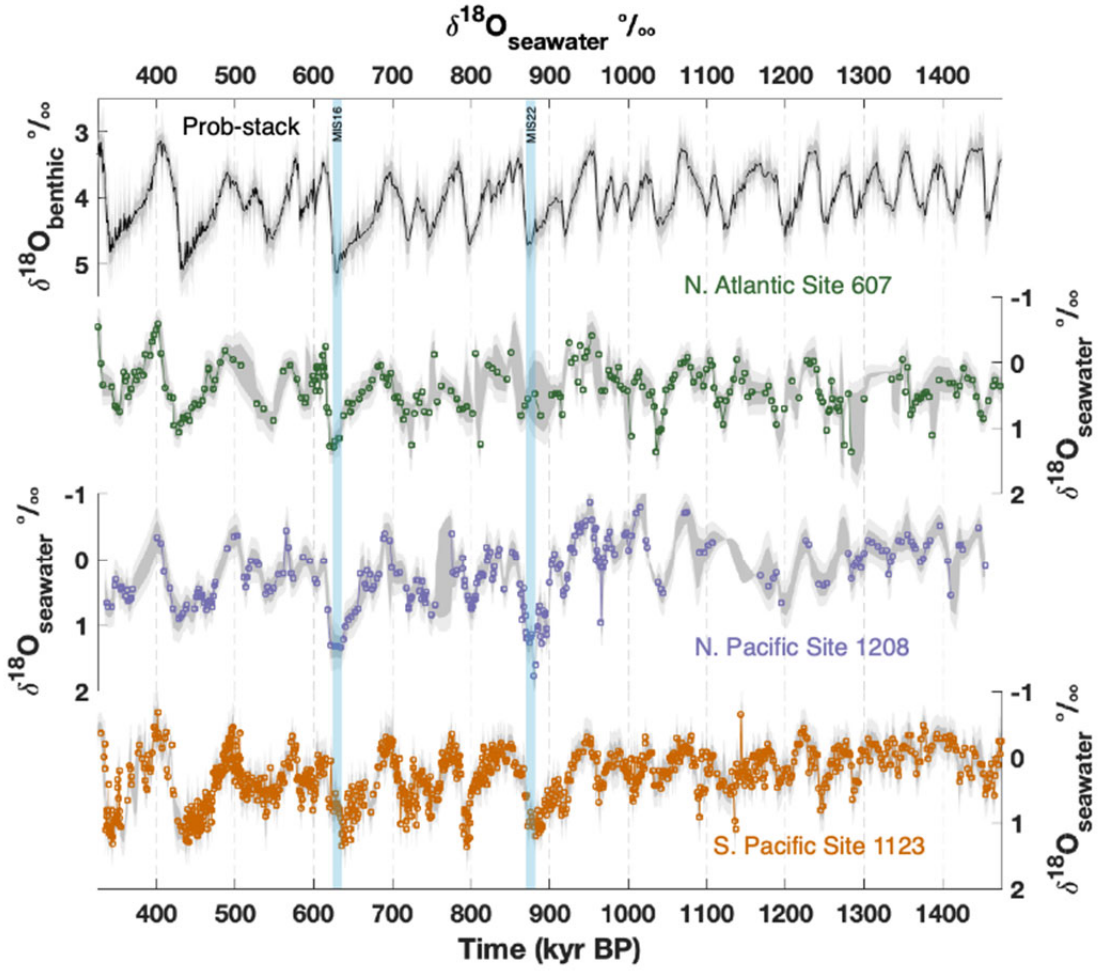
**Data Repository Figure 6:** S. Pacific ODP Site 1123 $\delta^{18}O_{benthic}$, Mg/Ca derived temperature and $\delta^{18}O_{seawater}$. Using Monte Carlo simulations, PSU Solver (Thirumalai et al., 2016) generated error envelopes (dark grey = 1σ, light grey = 2 σ) on temperature and $\delta^{18}O_{seawater}$.



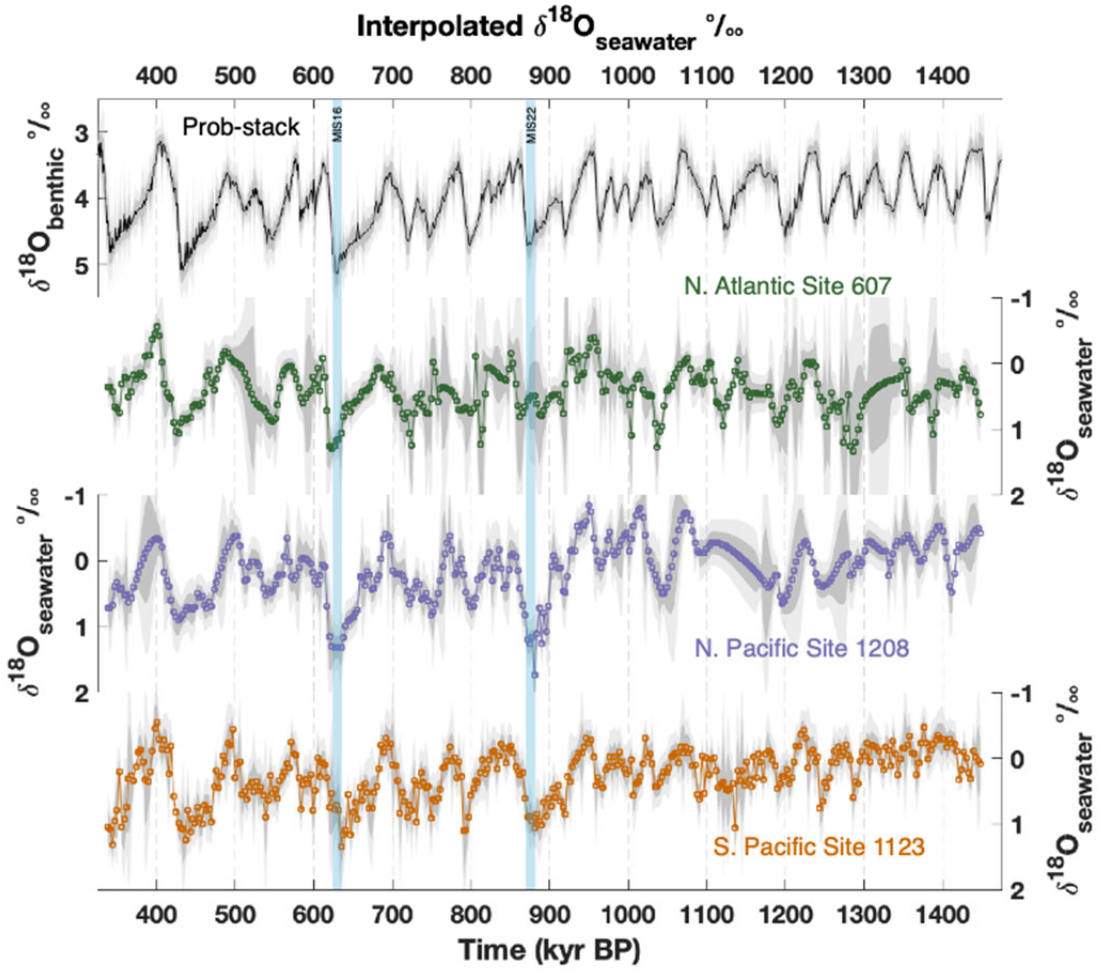
**Data Repository Figure 7: N.** Atlantic DSDP Site 607 $\delta^{18}O_{benthic}$, Mg/Ca derived temperature and $\delta^{18}O_{seawater}$. Using Monte Carlo simulations, PSU Solver (Thirumalai et al., 2016) generated error envelopes (dark grey = 1σ, light grey = 2 σ) on temperature and $\delta^{18}O_{seawater}$.



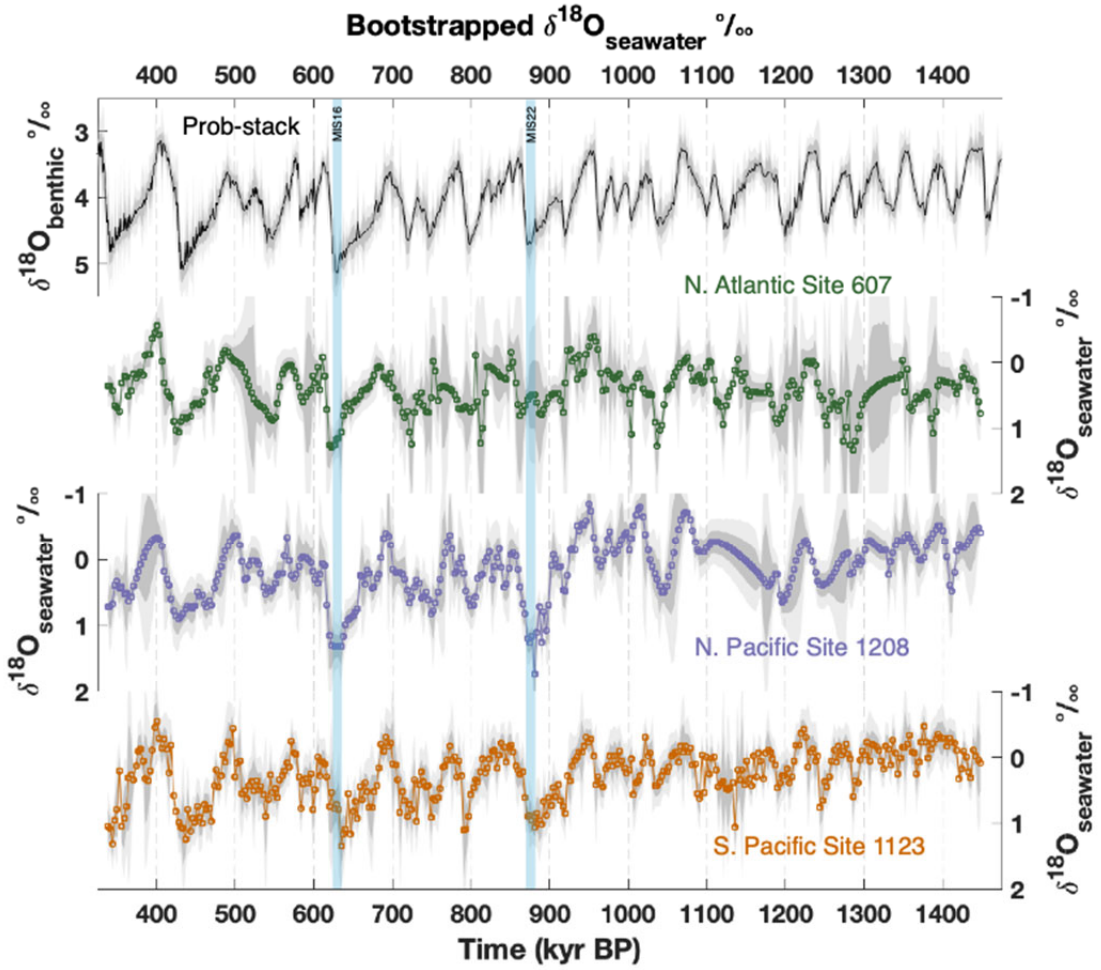
**Data Repository Figure 8:** Prob-stack and $\delta^{18}O_{seawater}$ records from ODP 1208 and 1123 and DSDP 607. Error envelopes: dark grey = 1σ, light grey = 2 σ).



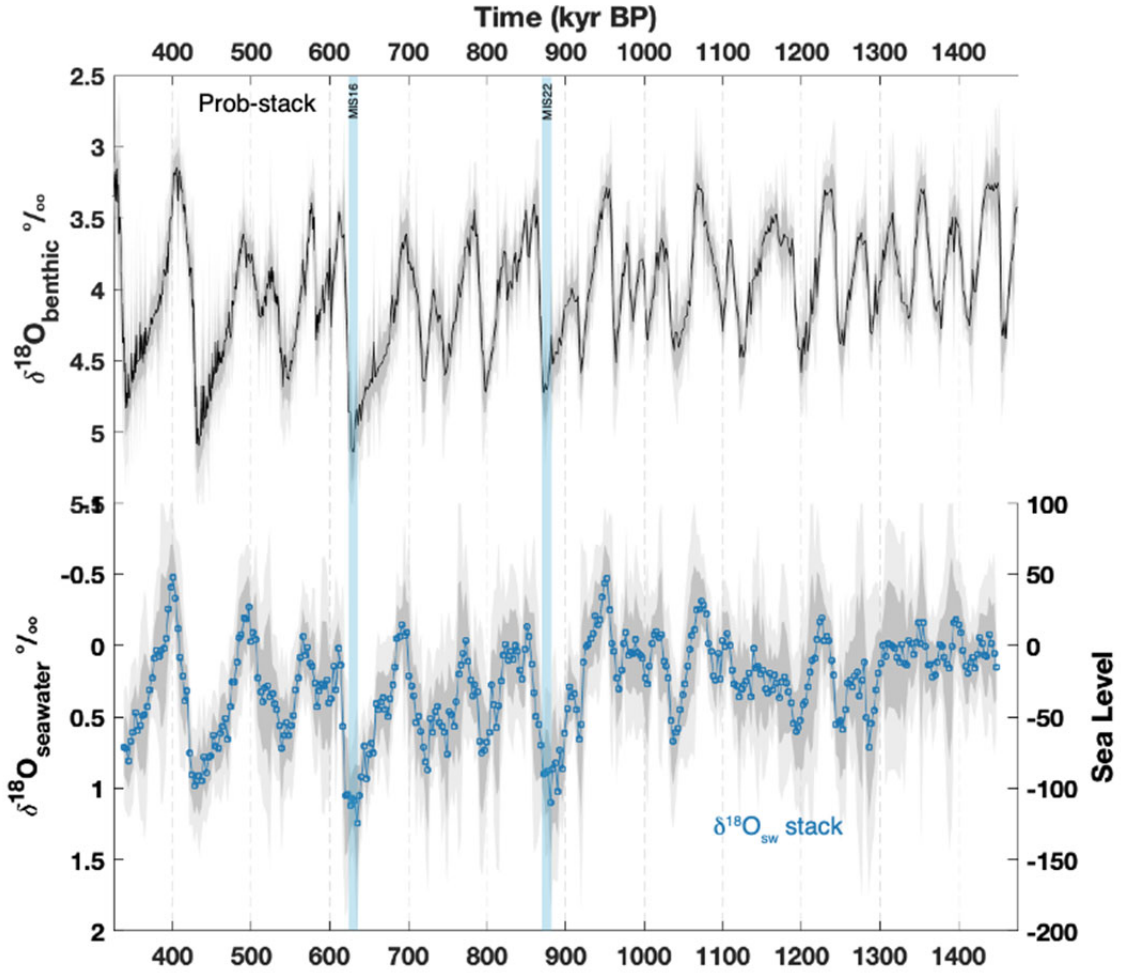
**Data Repository Figure 9:** Prob-stack and interpolated $\delta^{18}O_{seawater}$ records from ODP 1208 and 1123 and DSDP 607. Error envelopes: dark grey = 1σ, light grey = 2 σ).



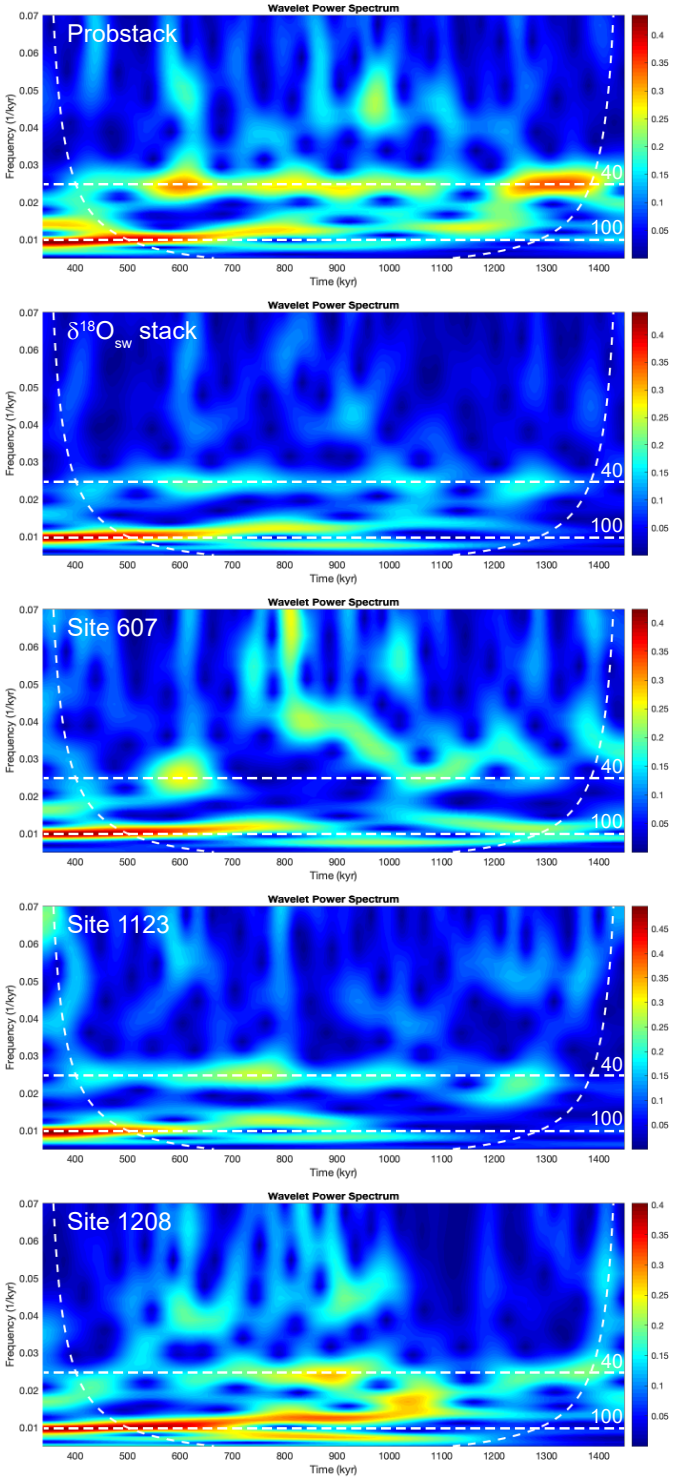
**Data Repository Figure 10:** Prob-stack and bootstrapped $\delta^{18}O_{seawater}$ records from ODP 1208 and 1123 and DSDP 607. Error envelopes: dark grey = 1σ, light grey = 2 σ).



**Data Repository Figure 11:** Prob-stack and $\delta^{18}O_{sw}$ stack. Error envelopes: dark grey = 1σ, light grey = 2 σ).



**Data Repository Figure 12:** Wavelet analyses of Prob Stack, $\delta^{18}O_{sw}$ stack, and $\delta^{18}O_{sw}$ records from Sites 607, 1123 and 1208.



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