

# Glacial-Interglacial climate variability in the Subtropical Atlantic: Evidence from alkenone-based SST records at ODP Site 1058



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#### Context

Earth's climate experienced profound shifts during the Mid-Pleistocene Transition (MPT), a pivotal interval when glacial cycles become longer and more intense. Two standout glacial periods - MIS 12 (~428-468 ka) and MIS 16 (~624-678 ka) mark some of the most extreme glaciations of the last 700,000 years. However, the processes behind their contrasting climate signals are still debated.

The Subtropical Atlantic, a region strongly shaped by the Gulf Stream, the Subtropical Gyre (STG), and the Atlantic Meridional Overturning Circulation (AMOC), plays a central role in global climate dynamics. Yet, the evolution of thermal gradients across this region during glacial and transitions remains poorly understood.

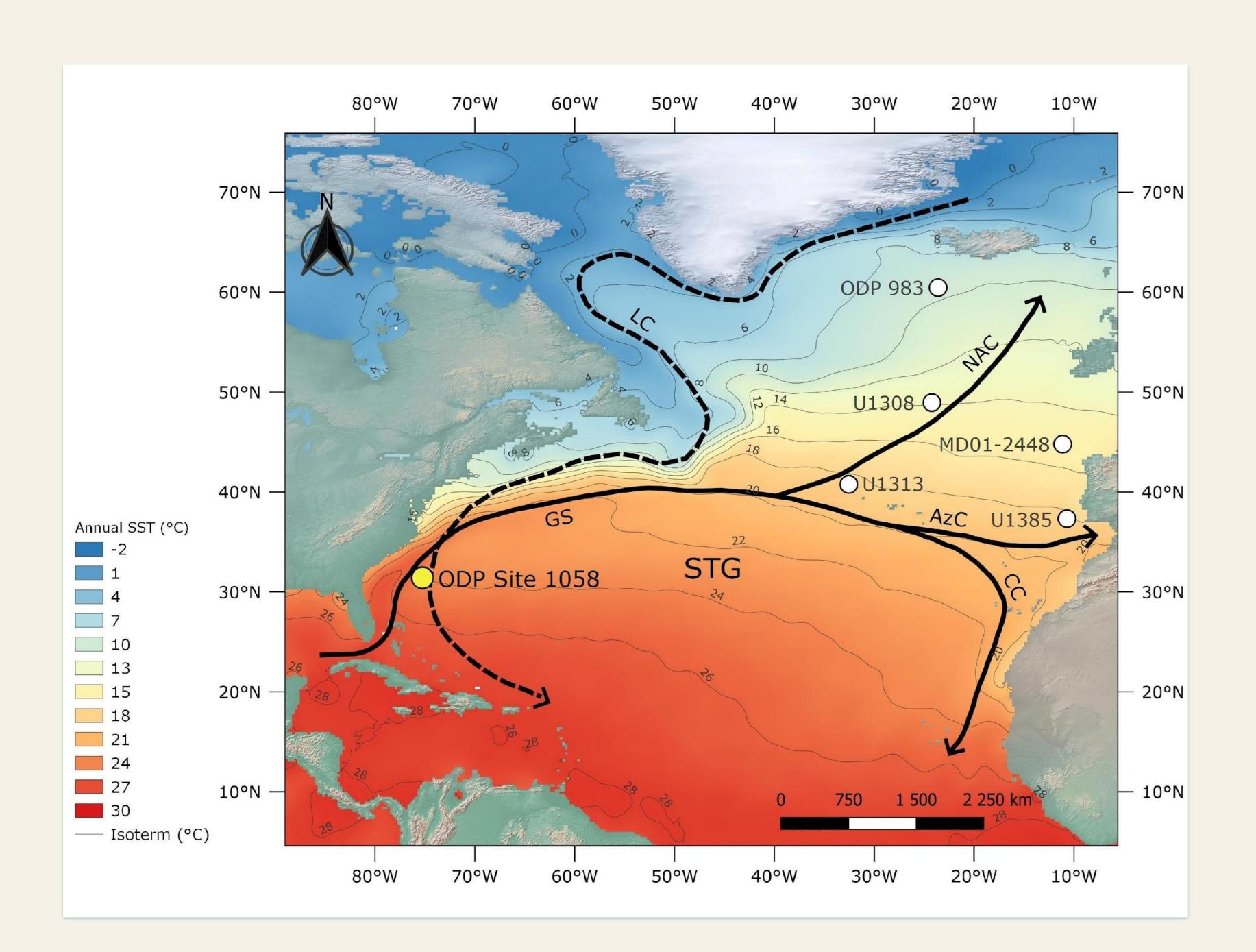
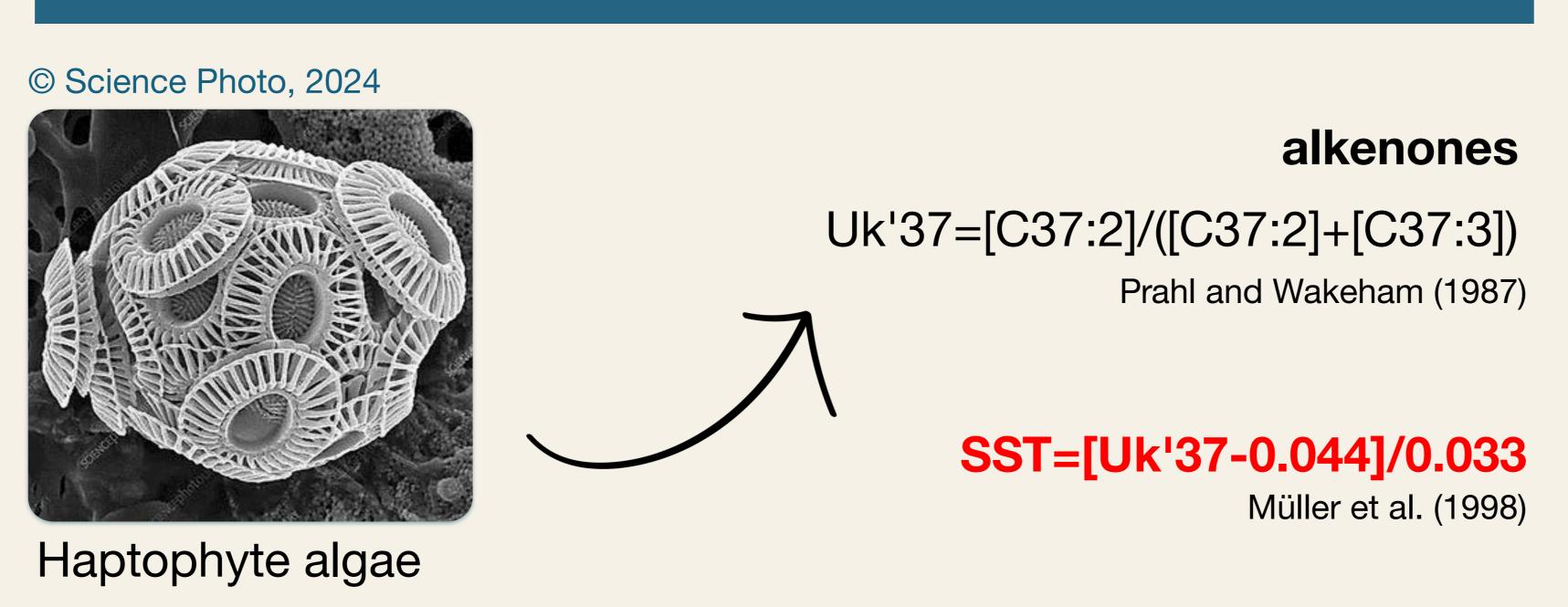
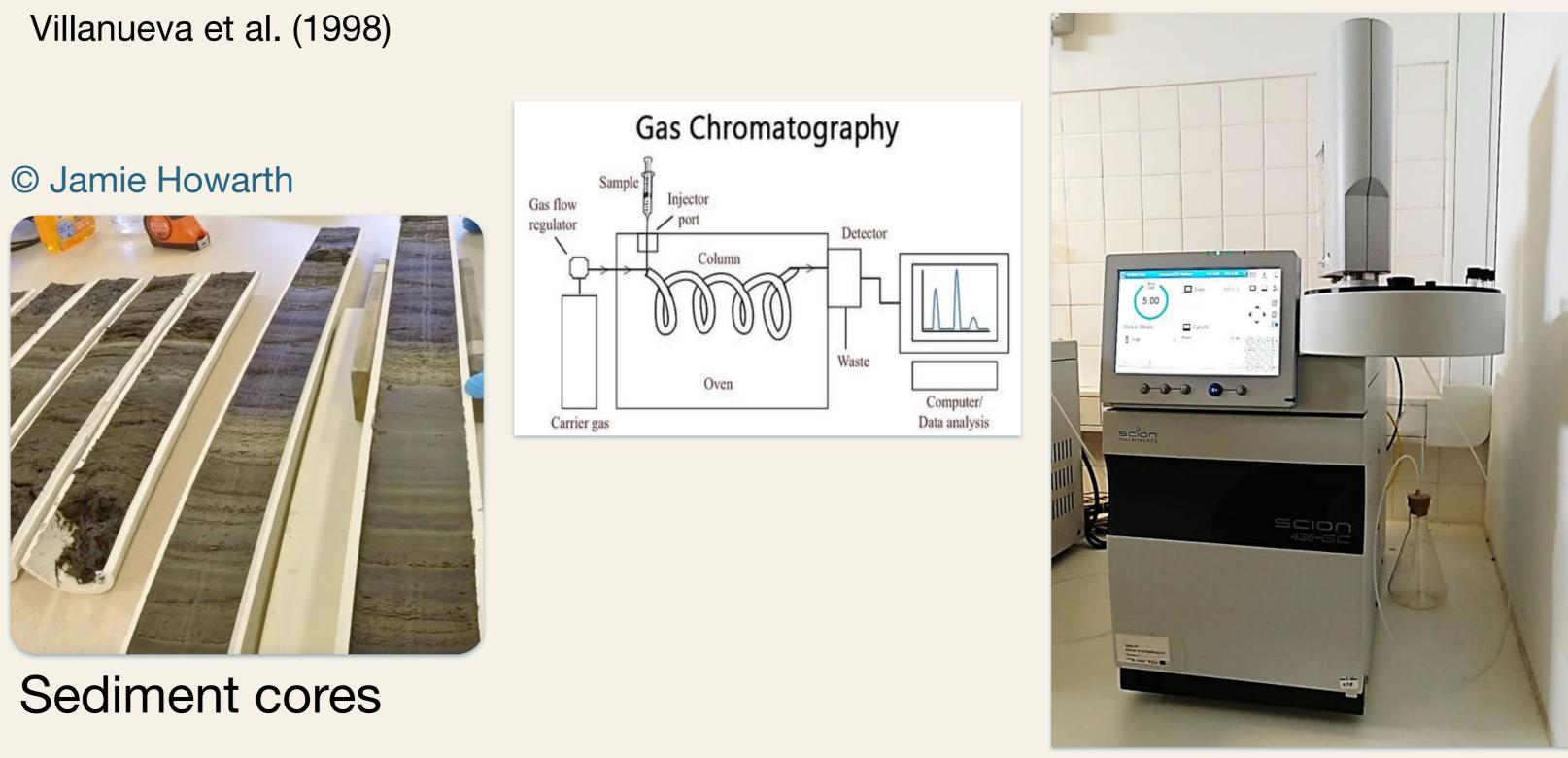


Figure 1. Modern circulation patterns in the North Atlantic showing annual sea surface temperatures (World Ocean Atlas, 2018). Surface currents (solid arrows) and subsurface currents (dashed arrows) are marked: AzC (Azores Current), CC (Canary Current), GS (Gulf Stream), LC (Labrador Current), and NAC (North Atlantic Current). Grey lines show 2°C isotherms. The Subtropical Gyre (STG) is outlined. Key study sites are marked: ODP 1058 (yellow dot), U1313 (Naafs et al., 2013), and U1385 (Rodrigues et al., 2017) (white dots), important for east-west SST gradients. Other sites (MD01-2448, Toucanne et al., 2009; U1308, Hodell et al., 2008; ODP 983, Barker et al., 2021) help reconstruct past ocean circulation.

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#### Method





Biogeochemistry Lab. (IPMA)

# Objectives

In this study, we aim to:

- \* Reconstruct sea surface temperature (SST) patterns during the extreme glaciations of MIS 12 and MIS 16;
- ★ Characterize short-term climate variability
- \* Assess how shifts in the East-West thermal gradient shaped ocean circulation and the dynamics of the Subtropical Gyre

By achieving these goals, we enhance understanding of the subtropical Atlantic's role in global climate during a critical phase of Earth's climatic history.



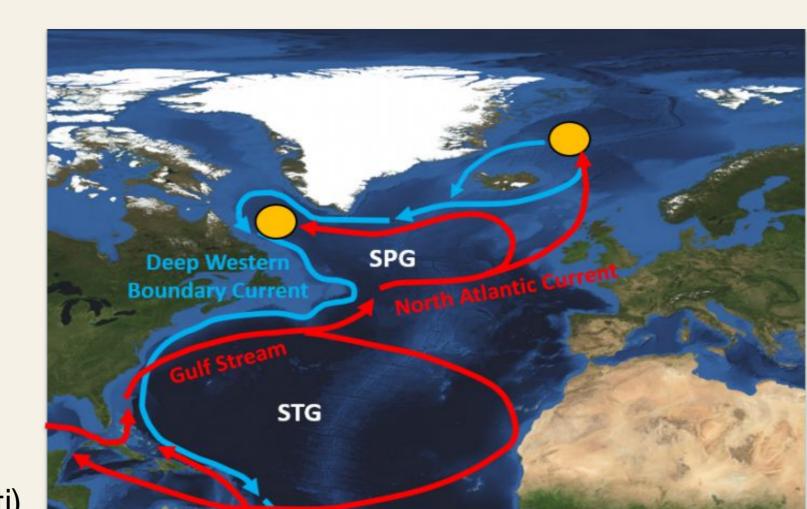


Figure 3. Climate variability at Site U1058 during MIS 12 (left) and MIS 16 (right). (a) Global ice volume: benthic δ<sup>18</sup>O stack (Lisiecki & Raymo, 2005); (b) Surface δ<sup>18</sup>O: *G. ruber* (white) from U1058 (Weirauch et al., 2008); (c) SST: alkenone-based reconstructions from U1058 (this study); (d) Orbital forcing: eccentricity, obliquity, and precession (Laskar et al., 2004), and insolation at 39° N (Laskar, 1990). Blue shading marks MIS 12 and MIS 16; TV and TVII indicate glacial terminations (Lisiecki & Raymo, 2005).

## Results

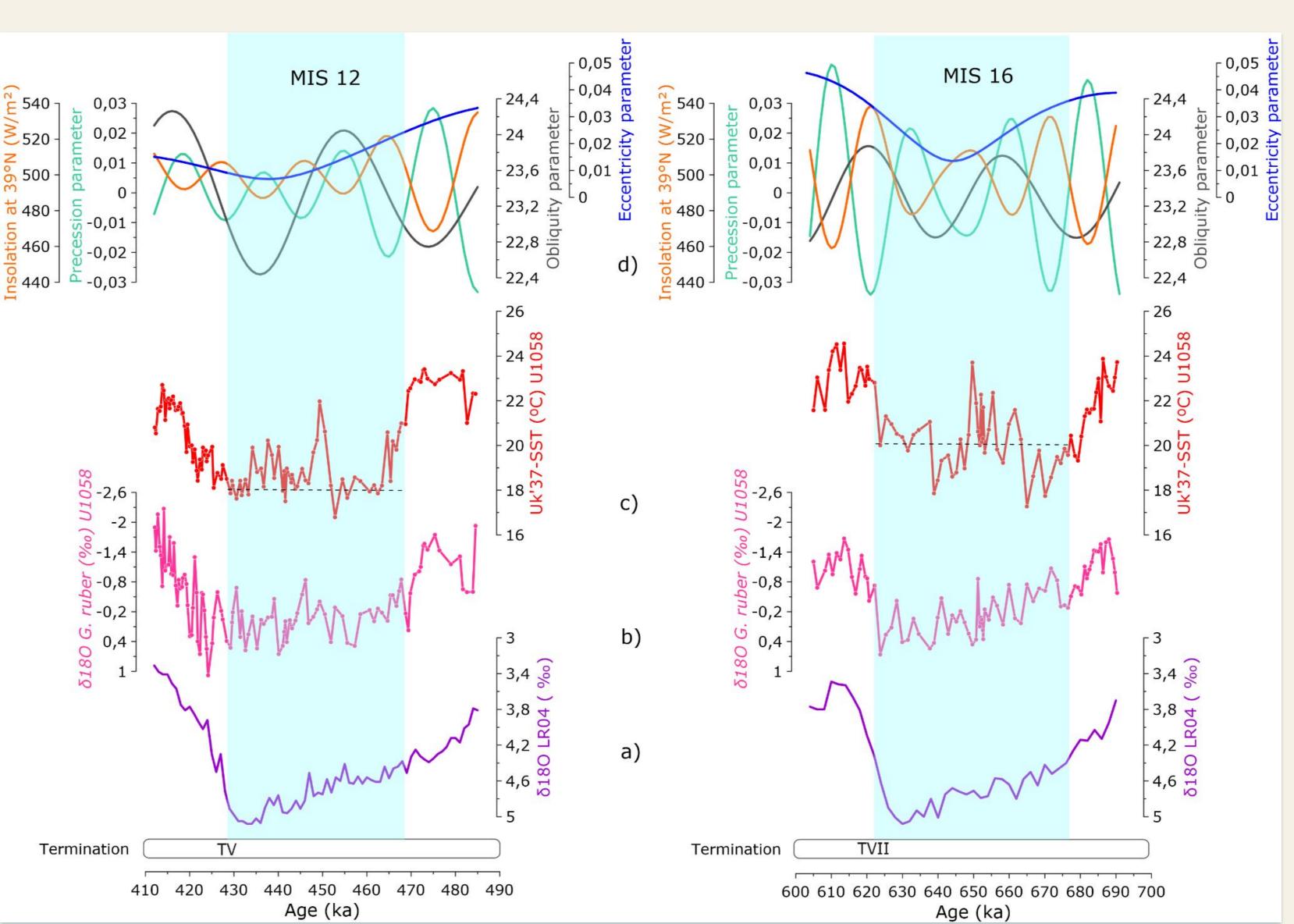
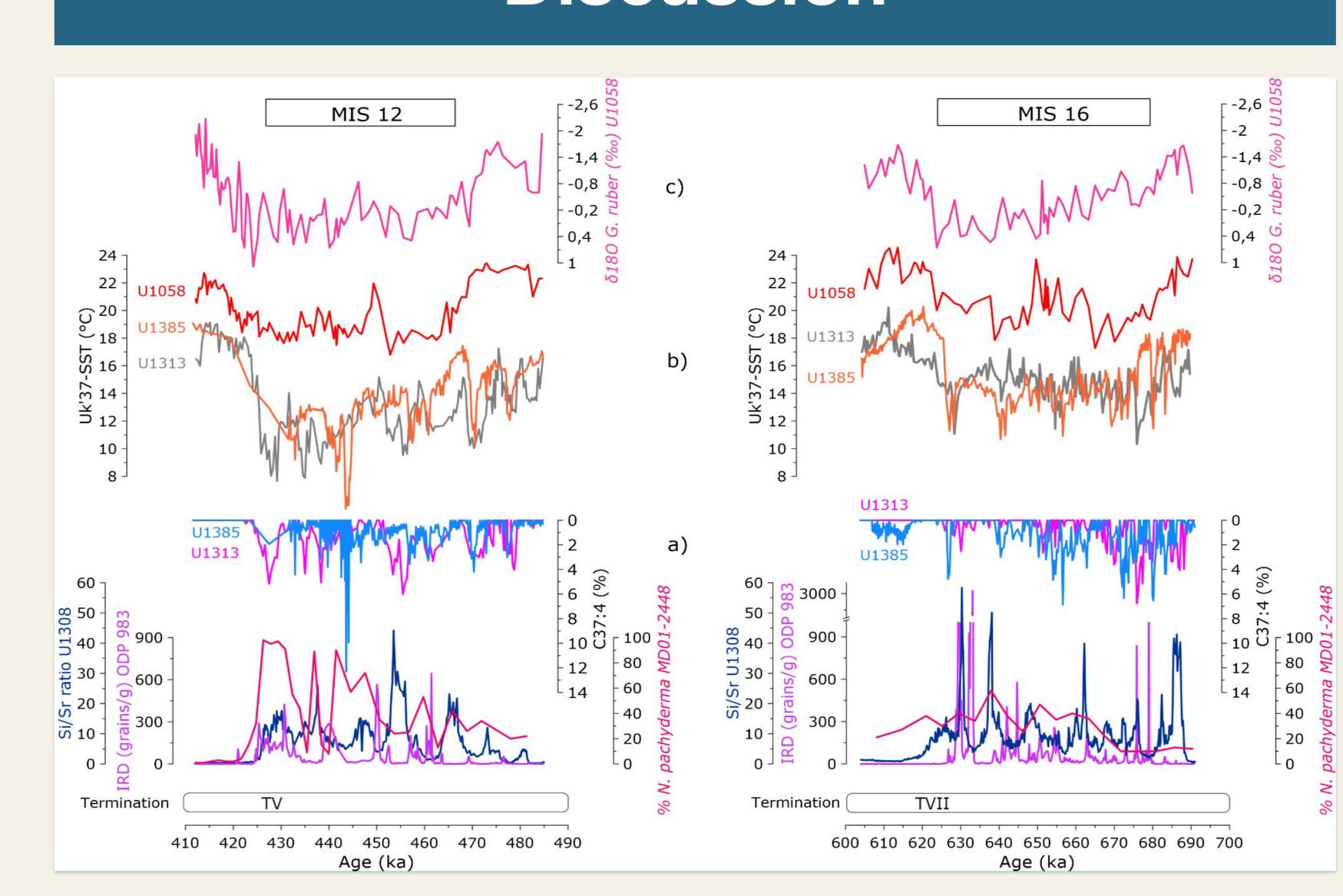


Figure 2. West-East SST gradient and climate proxies during MIS 12 (left) and MIS 16 (right). (a) Si/Sr (U1308, Hodell et al., 2008), IRD (ODP 983, Barker et al., 2021), N. pachyderma % (MD01-2448, Toucanne et al., 2009), and %C<sub>37</sub>:<sub>4</sub> (Naafs et al., 2013; Rodrigues et al., 2017); (b) UK'<sub>37</sub>-SST from U1058 (this study), U1313 (Naafs et al., 2013), U1385 (Rodrigues et al., 2017); (c)  $\delta^{18}$ O of *G. ruber* (U1058, Weirauch et al., 2008). TV and TVII = Terminations V and VII (Lisiecki & Raymo, 2005).

### Discussion



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Figure 4. Gulf Stream position during MIS 12 (a) and MIS 16 (b). SST reconstructions and meltwater proxies highlight contrasting Gulf Stream dynamics and ice melt intensity. Sites include U1058 (this study), U1313 (Naafs et al., 2013),U1385 (Rodrigues et al., 2017), MD01-2448 (Toucanne et al., 2009), U1308 (Hodell et al., 2008) and ODP 983 (Barker et al., 2021).

Key Takeaways

★ MIS 12: Characterized by a weaker GS, reduced STG activity,

★ MIS 16: Featured a more northerly Arctic Front (AF), a stronger

climatic variability during glacial periods.

causing short-lived cooling events.

and cooler SSTs, especially in the mid-Atlantic and Iberian

Margin. These oceanographic conditions contributed to greater

and more stable GS, and significantly warmer SSTs at sites

U1058, U1313, and U1385. Reduced N. pachyderma abundance

and IRD records suggest enhanced meridional heat transport but

also intermittent disruptions to AMOC due to freshwater influxes,

### References

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