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Climatic and Oceanographic Conditions in the Mid-Atlantic through the Peak Interglacial Period

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Introduction

Reconstructing Earth's climatic and oceanographic conditions is essential for understanding past and future climate variability. Today, the Earth is in an interglacial period and sea surface temperatures and sea levels are rising raising concern for Earth's future climate (Wuebbles et al., 2017). To understand the trajectory of Earth's climatic conditions, I focus on the transitional interval between the penultimate deglaciation through the peak of the last interglacial period and until the beginning of the last glacial inception. I study two ways that the climate and ocean conditions are determined: through the approximation of iceberg discharges and through the estimation of sea surface temperatures. I examine a deep-sea sediment core to understand the trajectory of Earth's climate by determining the amounts of ice-rafted debris and foraminifera species to gauge the quantity of icebergs and the sea surface temperatures, respectively. The varying abundance of these indicators reveal the timescale and magnitude of changing oceanographic and climatic conditions.

Methods

- The deep-sea sediment core studied is VM 30-100 located by the Mid-Atlantic Ridge with a latitude of 44º06'N and longitude of 32º30'W and at water depth of 3519 m (Fig. 2).
- I sampled the core at Lamont-Doherty Earth Observatory.
- Under the microscope, I counted ice-rafted debris, total foraminifera, and a polar foraminifera species *N. pachyderma* from depths 400 cm to 500 cm in the core (Fig. 1).
- Total ice-rafted debris, total foraminifera, and *N. pachyderma* grams and percent were calculated for each sample.

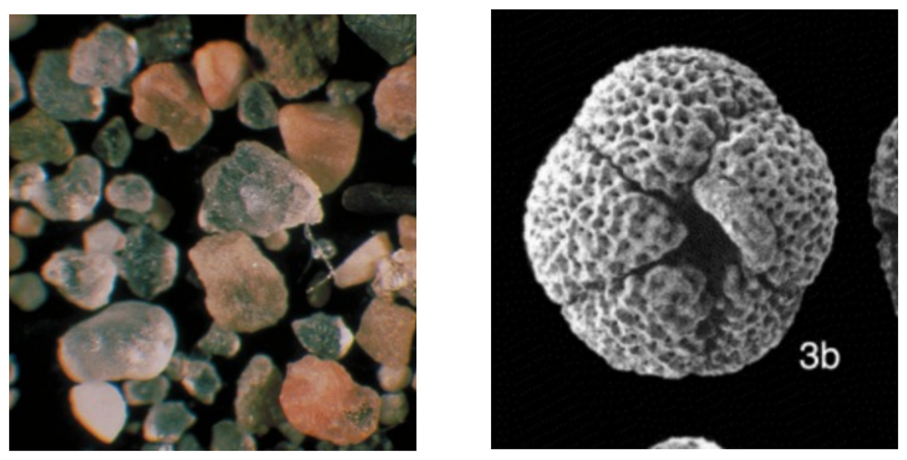

Figure 1: Ice-rafted debris (left) (Jennings). Polar foraminifera species N. *pachyderma* (right) (Eguchi *et al*., 2003).

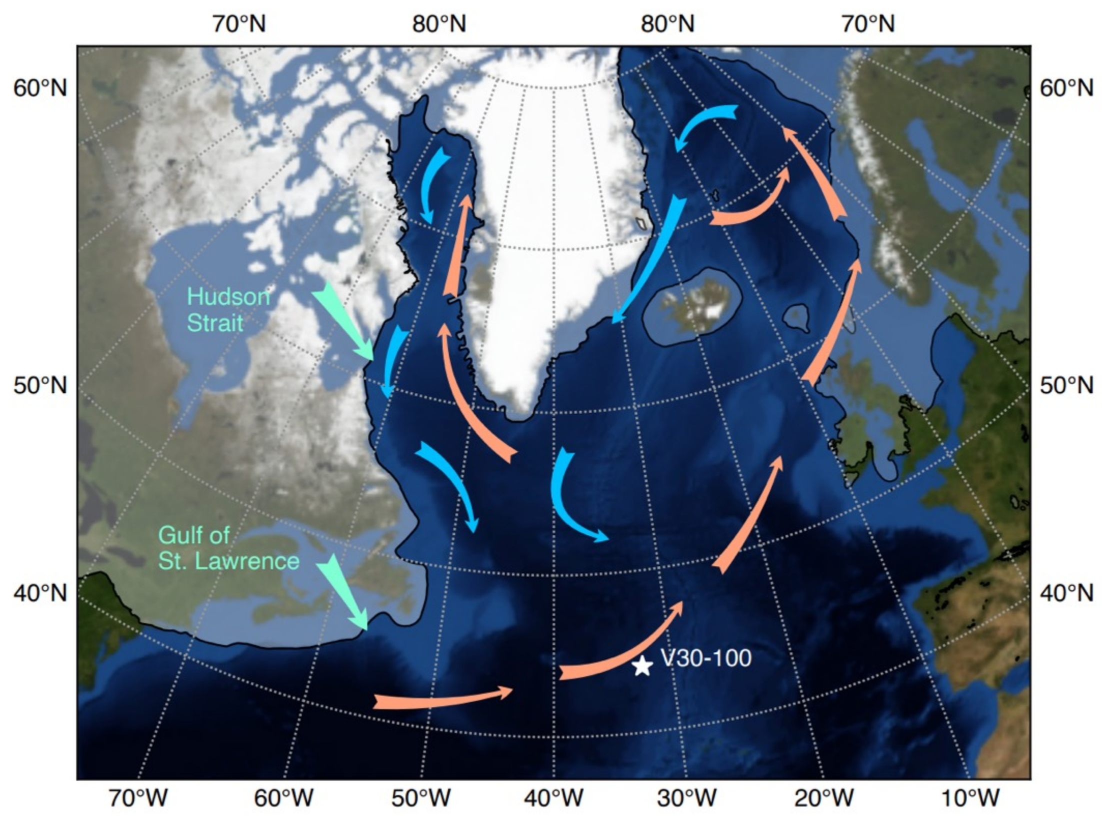

Figure 2: Map of core VM30-100 (Yuxin Zhou). Location of the core in the North Atlantic is shown by the star. The Laurentide Ice Sheet where icebergs calve and head through the Hudson Strait then into the North Atlantic Ocean is depicted. The blue arrows show deep water circulation and the red arrows show current circulation.

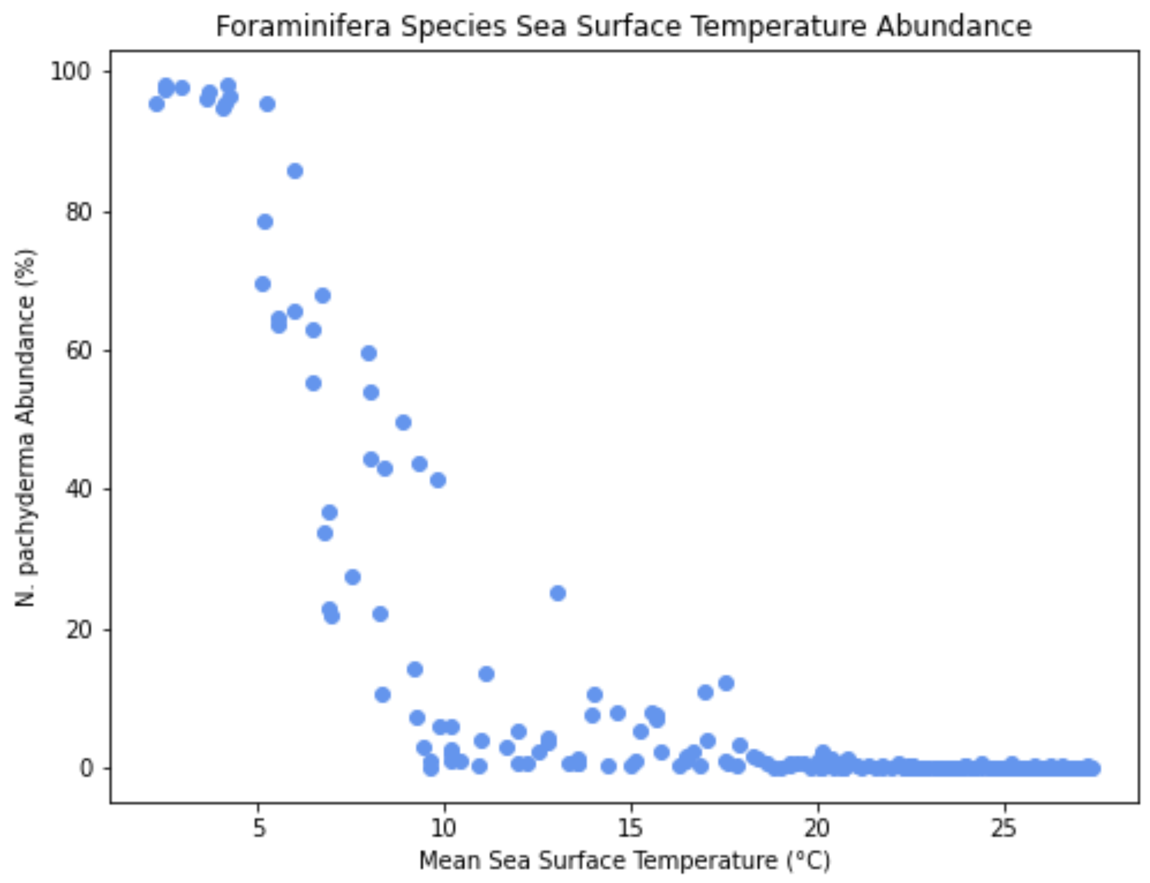

Figure 3: Abundance of N. *pachyderma* is shown at the mean sea surface temperature (Dowsett et al., 2013). N. *pachyderma* abundance is highest at low mean sea surface temperatures and N. *pachyderma* abundance is lowest at high mean sea surface temperatures.

Results and discussion

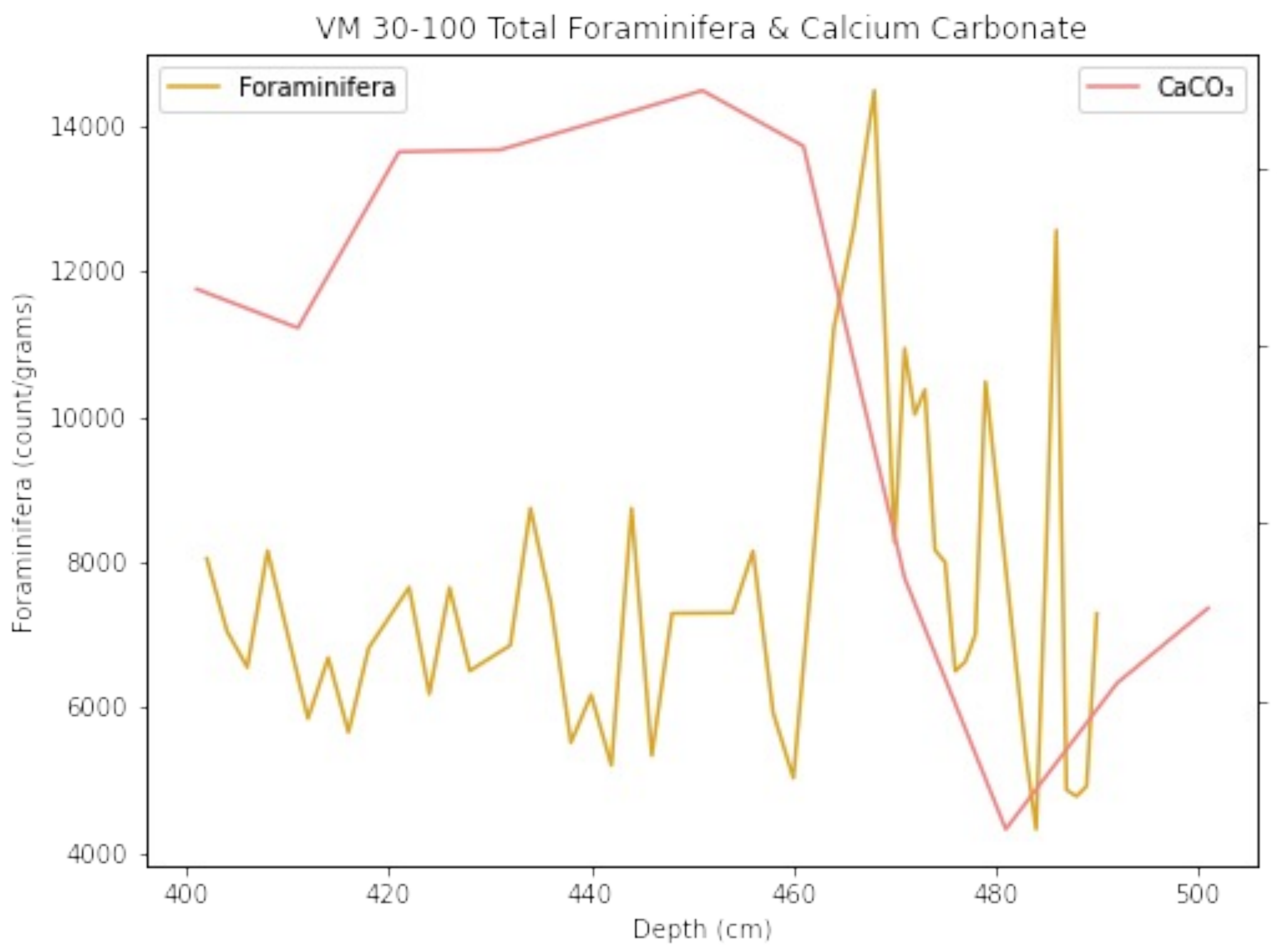

Figure 4: The total foraminifera counts in the core VM 30-100 were plotted alongside the calcium carbonate from depths 500 cm to 400 cm. The yellow line is the foraminifera counts per gram and the red line is the calcium carbonate percentage (Ruddiman and Ferrell, 1996).

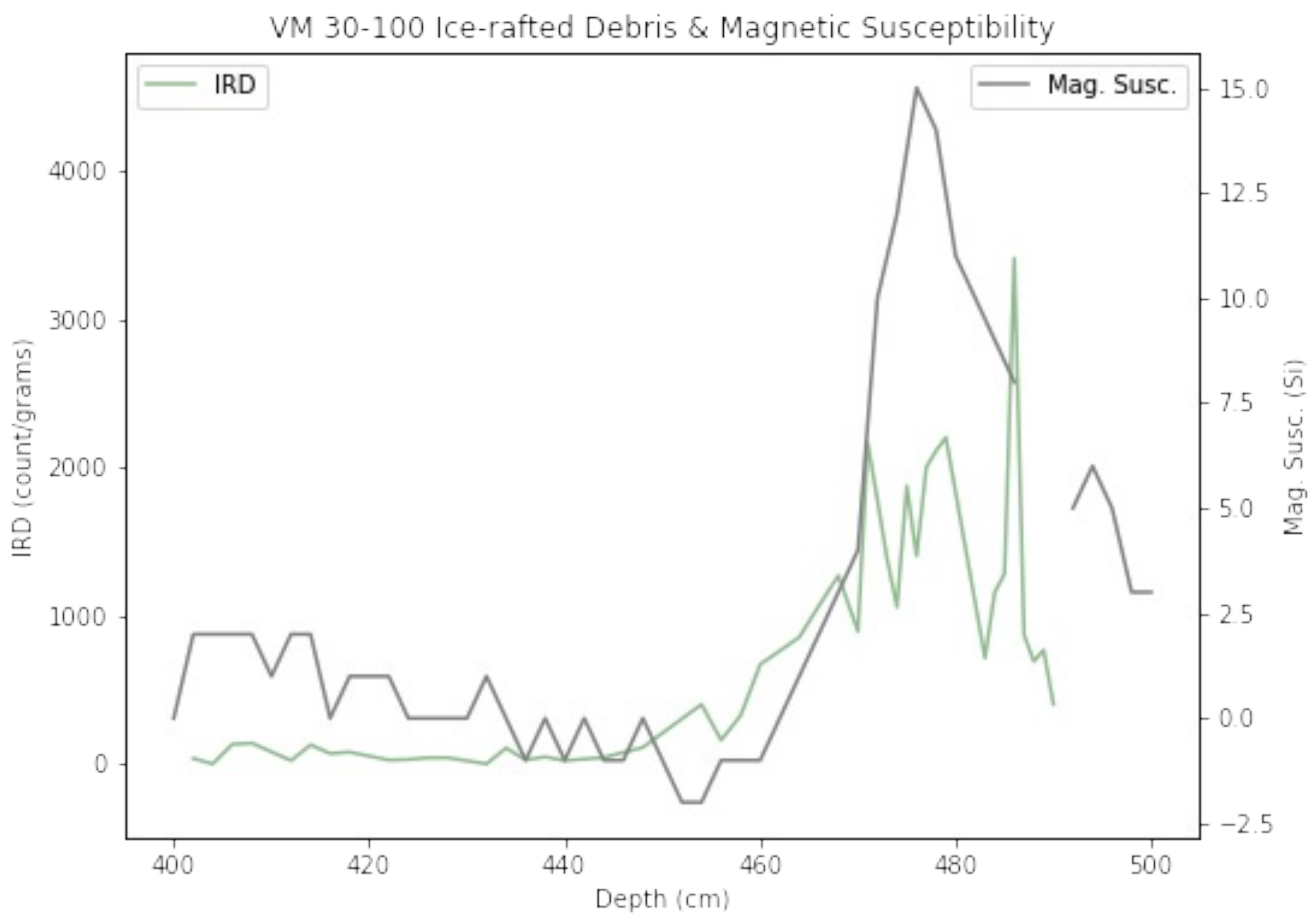

Figure 5: The ice-rafted debris counts in the core VM 30-100 were plotted alongside the magnetic susceptibility from depths 500 cm to 400 cm. The green line is the ice-rafted debris counts per gram and the grey line is the magnetic susceptibility (Downing, 2008).

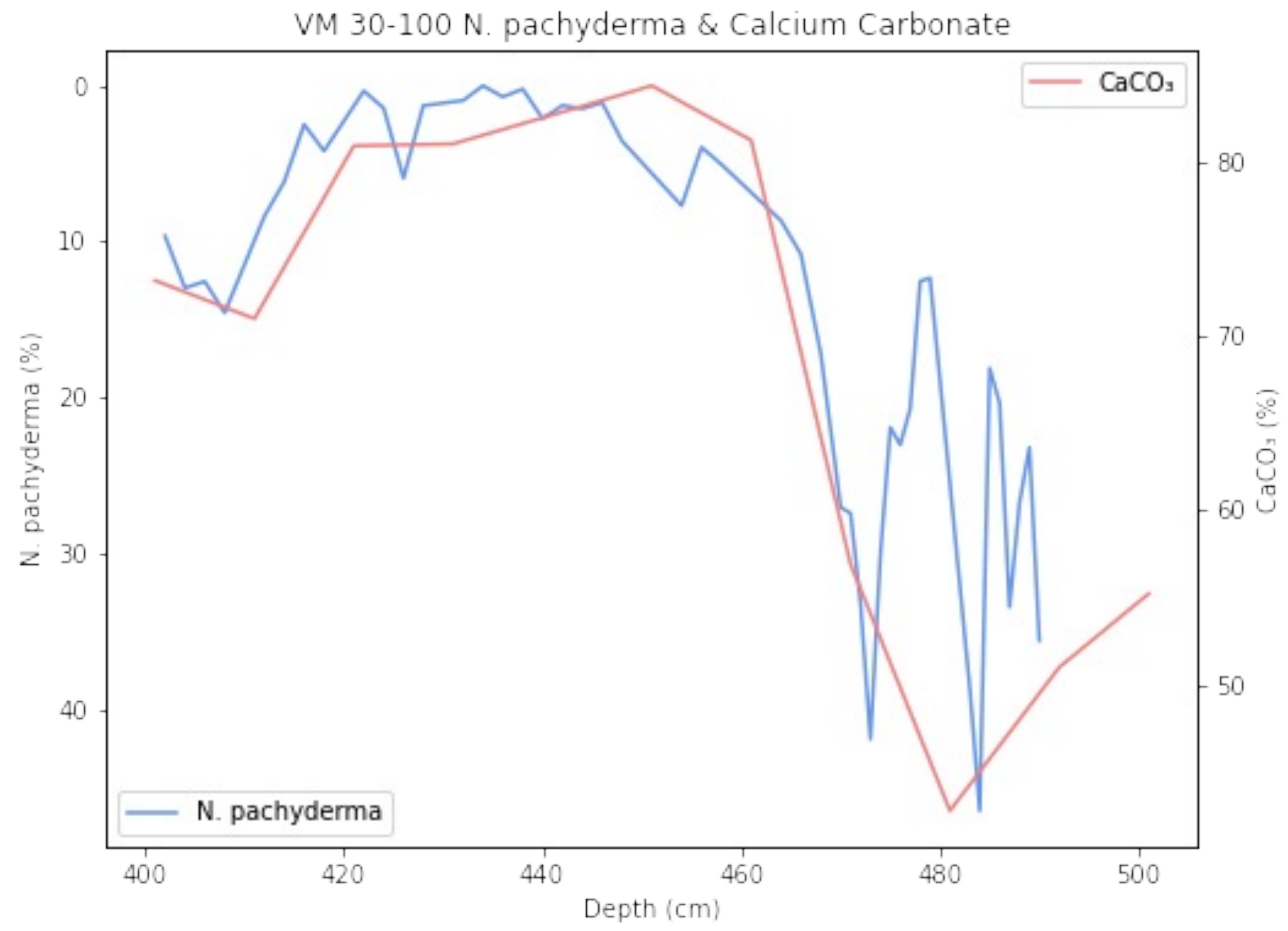

Figure 6: The polar foraminifera species *N. pachyderma* in the core VM 30-100 was plotted alongside the calcium carbonate of the core from depths 500 cm to 400 cm. The blue line is *N. pachyderma* percentage and the red line is calcium carbonate percentage (Ruddiman and Ferrell, 1996).

- Low percent of calcium carbonate between depths 500 cm and 471 cm indicates the penultimate deglaciation.
- High percent of calcium carbonate between depths 461 cm and 421 cm indicates the peak of the last interglacial.
- After the peak of the last interglacial, calcium carbonate percent decreased from depths 411 cm to 400 cm indicating the beginning of the last glacial inception.
- Total foraminifera is relatively high throughout the entire interval from depths 500 cm to 400 cm.

- During the penultimate deglaciation, ice-rafted debris and magnetic susceptibility increased from 500 cm to 464 because the Laurentide Ice Sheet melted resulting in iceberg discharges into the Atlantic Ocean.
- During the peak of the last interglacial, ice-rafted debris and magnetic susceptibility decreases drastically from depths 456 cm to 416 cm suggesting there were no iceberg discharges into the Atlantic Ocean.
- At the beginning of the last glacial inception, ice-rafted debris and magnetic susceptibility increases slightly from depths 414 cm to 400 cm.

- N. *pachyderma* abundance was high during the penultimate deglaciation between depths 500 cm to 470 cm which corresponds to the mean sea surface temperature 7.55°C.
- During the peak of the last interglacial, N. *pachyderma* abundance drops between depths 468 cm to 414 cm which corresponds to the mean sea surface temperature 17.05°C.
- N. *pachyderma* abundance increased from the last interglacial to the last glacial inception between depths 412 cm to 402 cm which corresponds to the mean sea surface temperature 16.95°C.

Conclusions

- The percent of calcium carbonate determined when the penultimate deglaciation, the peak of the last interglacial, and the beginning of the last glacial inception occurred in the core VM 30-100.
- High ice-rafted debris and magnetic susceptibility depicted iceberg discharges into the Atlantic Ocean during the penultimate deglaciation. Low ice-rafted debris and magnetic susceptibility depicted no or few iceberg discharges into the Atlantic Ocean during the peak of the last interglacial and the beginning of the last glacial inception.
- The N. *pachyderma* abundance revealed that mean sea surface temperatures increased 9.5°C from the penultimate deglaciation to the peak of the last interglacial and then decreased 0.1°C to the beginning of the last glacial inception.

References

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