Reconstructing Antarctic winter sea-ice extent during MIS 5e

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Background

Marine isotope stage (MIS) 5e (130-116 ka) is the warmest period in the recent past (Figure 1) and is therefore a valuable 'process analogue' for understanding the high latitude climatic feedbacks and processes likely to be active under future anthropogenic warming. Antarctic sea-ice extent is a critical component of the Earth's climate system through its impact on global albedo and it's role in Southern Hemisphere ocean and atmospheric circulation. Published marine sediment core records are located too far north to accurately constrain the timing and extent of the winter sea-ice minimum during MIS 5e (Chadwick et al. 2020) and researchers/models have therefore assumed that this minimum occurs synchronously with the peak Antarctic air temperatures reconstructed from ice core records (Holloway et al. 2017).

This study presents new MIS 5e Southern Ocean sea ice reconstructions from nine marine sediment core records (Figure 2) all located south of 55 °S.

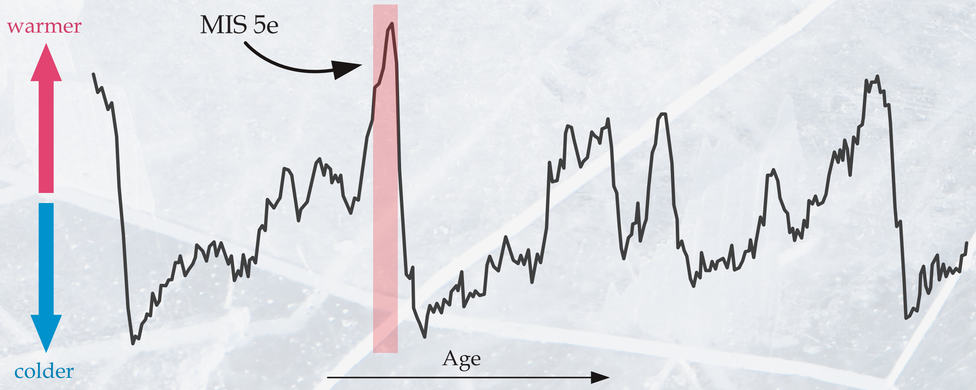

Figure 1: The LR04 benthic δ18O stack for the last 400 ka (Lisiecki & Raymo 2005) with MIS 5e marked by red shading.

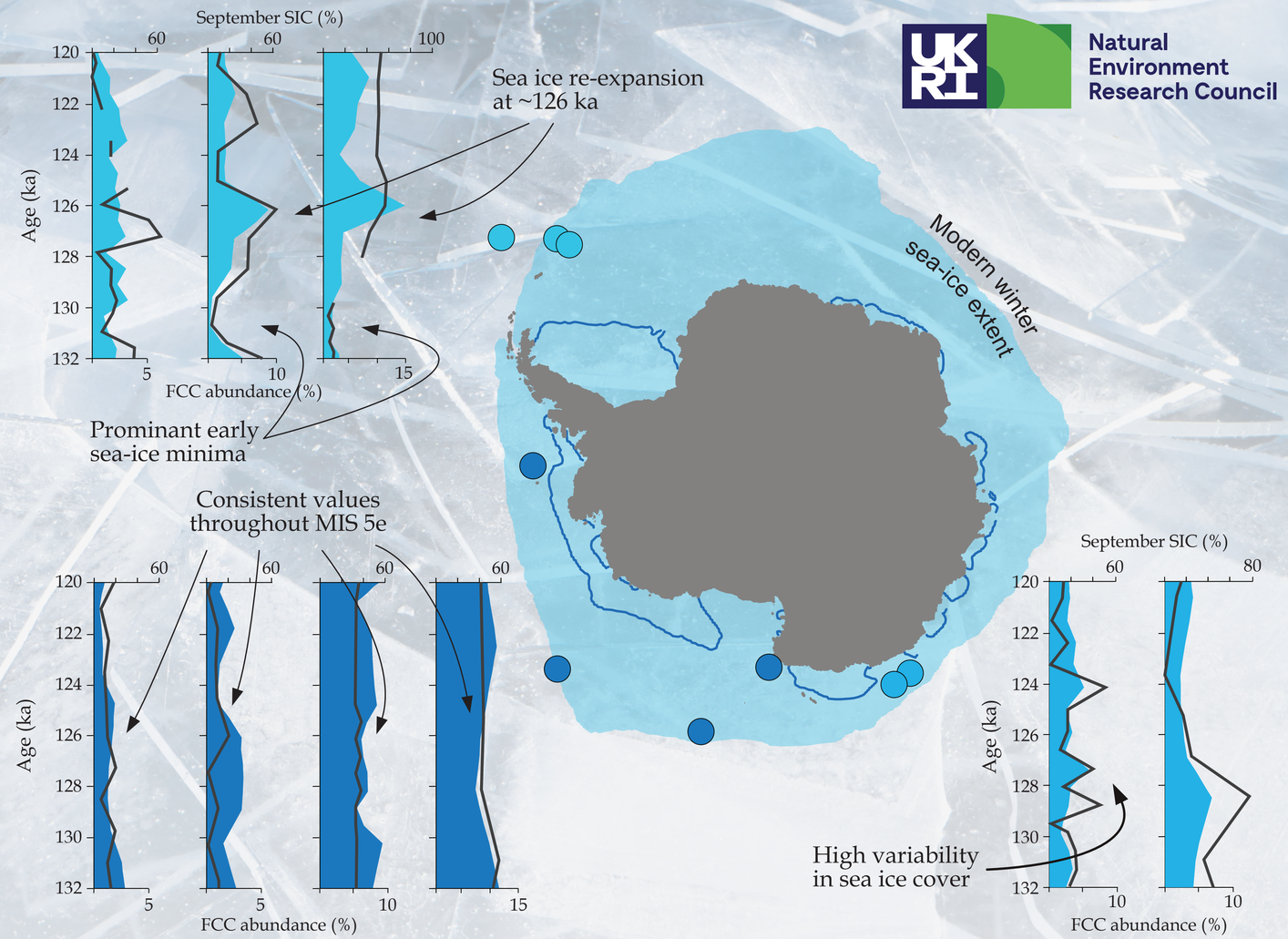

Figure 2: Graphs of the relative abundances of F. curta and F. cylindrus (blue shading and bottom axis) and September sea-ice concentrations (black lines and top axis) throughout MIS 5e for nine marine sediment core records. The different Southern Ocean sectors are given different shadings of blue. Blue shading on the map indicates the modern winter sea-ice extent and the blue line marks the modern summer sea-ice extent.

Methods

The MIS 5e winter sea-ice extent is reconstructed using the diatom species assemblages from nine marine sediment cores. The combined relative abundances of the sea-ice diatoms *Fragilariopsis curta* and *F. cylindrus* (Gersonde & Zielinski 2000) are presented alongside September sea-ice concentrations reconstructed using a Modern Analog Technique (MAT) transfer function (Crosta et al. 1998) in Figure 2.



Conclusions

The Pacific sector winter sea-ice extent is very stable throughout MIS 5e with relatively limited reduction compared to the modern. In contrast, the Atlantic sector records have an early minimum (~130 ka) in winter sea-ice extent before a substantial re-expansion at ~126 ka. This re-expansion is synchronous with evidence of increased iceberg and meltwater flux in the Weddell Sea and higher global sea-levels, all indicative of substantial mass loss from Antarctic ice sheets. The Indian sector records have high variability in MIS 5e September sea-ice concentrations but with an average winter sea-ice cover consistent with the modern extent. The more stable winter sea-ice extent in the Pacific sector compared to the Atlantic and Indian sectors is likely due to the influence of the ACC on Pacific sector sea ice (Ngheim et al. 2016) and the bathymetric pinning and restricted migration of the ACC during MIS 5e.

References

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