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Glacial discharge, upwelling and productivity off the Adélie coast, Antarctica: results from a 171 m Holocene sediment core from IODP Expedition 318

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Antarctica's coastal oceans play a vital role in controlling both the global carbon cycle and climate change, through variations in primary production, ocean stratification and ice melt. Yet, the Southern Ocean remains the least studied region on Earth with respect to Holocene climate variability. The few Antarctic proximal marine sedimentary records available tend to be short, low resolution, and discontinuous. However, sediments recovered from the Adélie drift during IODP Expedition 318 present a new opportunity to study East Antarctic Holocene climatic evolution, at a resolution that facilitates direct comparison with ice-cores. A 171m core of Holocene laminated diatom ooze was recovered from site U1357, representing continuous Holocene accumulation in a climatically-sensitive coastal polynya.

We present results of biomarker analyses (TEX86-L and compound specific fatty acid delta-D and delta-13C, and sterol delta-D) and grain size from throughout the Holocene, revealing the complexities of this climatically sensitive environment. Carbon isotopes are interpreted predominantly as a productivity signal via CO_2 drawdown, whilst hydrogen isotopes reflect inputs of isotopically-depleted glacial meltwater from the large Mertz glacier tongue and other proximal glaciers.

Both upwelling, as shown by TEX86-L and grain size, and glacial meltwater inputs, indicated by biomarker delta-D, appear to have an important control on productivity on various time scales. The latter may be forced by warm subsurface temperatures through basal melting of the Mertz glacier tongue, indicating both direct and indirect effects of upwelling on productivity. The post-glacial, Early Holocene appears to be characterized by a highly variable system, due to both strong upwelling and meltwater inputs, followed by a more stable and highly productive Middle Holocene under a warmer climate. During the Late Holocene, characterized by a sea-ice expansion, temperature-induced sea-ice melt may have become a more important control on productivity.

Millennial and centennial-scale isotopic excursions are also superimposed on the long-term trend. Productivity in particularly appears to follow some cyclicity, similar to that identified in other Antarctic productivity records, which may indicate a sensitivity of the environment to solar activity. Notably, a cyclicity of 2.3 ka is significant throughout the delta-13C record, closely resembling the previously recognised 'Hallstattzeit' solar cycle. Despite the strong importance of local forcing factors on the polynya system, our data suggest that, globally recognised, rapid climate changes are recorded in the site U1357 record.