Reconstructing the structure of Atlantic Ocean circulation during early-middle Eocene extreme climatic warmth

Conference or Workshop Item

Reconstructing the structure of Atlantic Ocean circulation during early-middle Eocene extreme climatic warmth

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The Atlantic meridional overturning circulation (AMOC) is a key component of the modern global ocean circulation, distributing heat, salt and biologically essential nutrients globally, and exerting a fundamental influence on regional and hemispheric climates. Yet we have little understanding how unstable the AMOC will be, or its sensitivity to climate change, under acute climatic warmth such as that marking Earth's future. The nature of any inter-hemispheric competition in deep water formation during such warmth is another unknown. These fundamental gaps in our knowledge prevent us testing the simulations of ocean models for past warm climates, and thus also diminish our confidence in the capabilities of these models to predict changes to our oceans during our future climate trajectory.

A solution is to reconstruct AMOC stability during an interval of past acute warmth. The early-middle Eocene (50-47 Myr ago) was a time of extreme warmth. The deep oceans were 10 to 14°C warmer than today (Sexton et al., 2006) and atmospheric carbon dioxide levels were ~2-4 times higher (Anagnostou et al., 2016; Pagani, 2005). Yet, it is currently unclear whether a well-developed AMOC existed during the early-middle Eocene, how sensitive it was to orbital forcing, and what influence it exerted on the Earth's climate during the early-middle Eocene (Hohbein et al., 2012).

To reconstruct the structure of any early-middle AMOC, we use an Atlantic transect of tightly correlated sites, spanning the northern Atlantic to Southern Ocean. New bulk carbonate $\delta^{13}C$ records for six new drill sites form a high resolution chemostratigraphy for each site, allow for detailed inter-site correlations and provide a common, high resolution age model. We use Nd isotopes to reconstruct water mass source pathways and benthic foraminifer $\delta^{13}C$ to reconstruct water mass ventilation state across a ~400 kyr interval of magnetochron C21n to resolve orbital-scale dynamism in the structure and stability of Atlantic Ocean circulation during extreme greenhouse warmth.

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