Late Quaternary changes in the Westerly Winds over the Southern Ocean

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Project description

Climate changes have been attributed to the increasing concentrations of greenhouse gases in our atmosphere. Increase in atmospheric CO_2 is partly controlled by changes in the ability of the world's oceans to absorb CO_2 at the surface and the biological pump, versus release of old carbon from deep ocean reservoirs via upwelling and out-gassing.

The Southern Ocean has been identified by models as playing a major role in modulating global atmospheric CO_2. This is because: a) surface nutrients are high in this area, indicating their incomplete utilisation by the biological pump, and b) wind driven changes in ocean circulation can bring old carbon stored in deep ocean reservoirs to the surface.

Changes in the strength of the Southern Hemisphere Westerly Winds (SHWW) control how much of this carbon rich deep water reaches the ocean surface determining whether the Southern Ocean acts as a net source or sink of atmospheric CO_2.

At present, our understanding of past changes in the SHWW is based mainly on geological proxy records from South America, but there are no systematic studies of changes in the core belt of the SHWW over the Southern Ocean. This lack of spatial resolution has been identified by Stager et al. (2012) as a major limitation in our understanding of past climate. As a result, General Circulation Models either fail to produce the magnitude of past atmospheric CO_2 variations or do not agree with geological field data.

We propose to substantially improve the spatial resolution of the geological data by generating proxy records focusing on 3 Sub-Antarctic islands situated in the core belt of the SHW. Our approach relies on the ecological effects that sea spray has on coastal peatland communities including higher plants, testate amoebae and diatoms. These effects will be quantified for present day environmental conditions, and then applied to sub-fossil communities in radiocarbon-dated coastal peat cores to reconstruct changing salinity through time and hence infer past relative wind strength.We have demonstrated that this approach works at Macquarie Island and Marion Island and that diatoms respond to changes in salinity levels.

Ultimately the results of this work will provide improved boundary conditions for earth system models that simulate the impact of changes in wind strength on the upwelling of deep ocean carbon reservoirs. The results of this work will help improve our understanding of the relationship between past changes in global atmospheric CO_2 and temperature.