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Southern Hemisphere westerly wind strength at sub-Antarctic Macquarie Island since the end of the Last Glacial Maximum

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Recent climate changes have been attributed to increasing atmospheric greenhouse gas concentrations (e.g. CO_2). Atmospheric CO_2 concentrations are partly controlled by changes in the oceans' capacity to absorb or release CO_2 at the surface. These increases are partly controlled by changes in the oceans' capacity to absorb CO_2 at the surface vs. upwelling of deep-water old carbon. The Southern Ocean is considered to play a major role in this, particularly on glacial-interglacial timescales. Southern Ocean circulation is strongly influenced by changes in Southern Hemisphere westerly wind strength. Understanding past changes in the Southern Hemisphere westerly winds is needed for interpreting past variations in atmospheric CO_2 concentrations. Most palaeoclimate reconstructions disagree on past Southern Hemisphere westerly wind strength. The main reasons include the location of sites, assumptions made and methods used. Sub-Antarctic islands such as Macquarie Island (54°S, 158°E) are ideally located to address these limitations. They occur at latitudes where the Southern Hemisphere westerly winds are strongest. Strong winds cause a west-east conductivity gradient in lakes as ions are delivered by wind-derived sea spray. A diatom-conductivity model for Macquarie Island was applied to a lake sediment core on the western side of the island to infer past lake water conductivity (sea spray), where more/less sea spray is related to stronger/weaker Southern Hemisphere westerly winds. This showed the Southern Hemisphere westerly winds were stronger at Macquarie Island during the Last Glacial Maximum, then abruptly decreased at the a similar time to decreases in dust flux and increases in CO_2 concentrations recorded at EPICA Dome C, Antarctica. The winds were generally weaker during the Holocene. An increase in the lake's sedimentation rate during the mid Holocene revealed distinct oscillations and high variability similar to those observed in the Dome C dust flux record. This is the first direct Southern Hemisphere westerly wind strength reconstruction from their core belt.