Holocene changes in the Southern Hemisphere westerly winds using marine sediment cores from southwest New Zealand

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The Southern Hemisphere westerly winds are an important component of the global carbon cycle due to their influence on Southern Ocean CO2 flux. In addition, the winds drive mid-latitude storm tracks, thereby controlling moisture balance over much of the Southern Hemisphere, including the South Island of New Zealand. Fiordland, New Zealand is an ideal locale to investigate Holocene changes in westerly wind behavior: It sits at the northern margin of the wind field maximum, is sensitive to latitudinal and strength fluctuations of the winds, and holds numerous fjord sub-basins with high sedimentation rates (up to 3 mm/yr).

Due to the strong positive relationship between wind speed and regional rainfall, reconstructions of past precipitation and fjord circulation can inform us of past westerly wind behavior. These processes can be observed through changes in the rate of organic carbon delivery from land: When precipitation is high, more terrestrial organic carbon is delivered to the fjords, while low precipitation shifts the balance toward accumulation of marine organic carbon. In addition, weaker winds can cause restricted basins to experience local anoxia. Geochemical characterization of modern surface sediments in the fjords shows that in the current climate regime, the region may be exporting up to 2.9 x 106 kg C yr-1 of >50% terrestrial organic carbon.

Here we present downcore geochemical results from selected sub-basins in Fiordland that resolve westerly wind behavior in the second half of the Holocene. We reconstruct precipitation patterns using the concentrations and isotopes of carbon and nitrogen and lipid biomarker concentrations, which provide information on the source environment of organic carbon in the sub-basins. Additionally, we explore the application of redox-sensitive trace metal concentrations and uranium 'stable' isotopes (238U/235U) to constrain past periods of restricted water mass movement. The resulting record of wind variability adds an important regional component to the hemispheric climate processes occuring over the last 5,000 years.