A New Zealand perspective on centennial-scale Southern Hemisphere westerly wind shifts during the last two millennia

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The strength and latitudinal position of the Southern Hemisphere westerly winds control regional climate and influence the global carbon cycle by physically regulating Southern Ocean CO_2 exchange with the atmosphere. However, the mechanisms driving interannual to millennial variability of the westerlies remain poorly understood. Here, we present an 1800-yr record of westerly wind variability recorded in New Zealand fjord sediments. Located west of the Southern Alps, fjord basins receive large amounts of westerly-driven orographic precipitation (>6 m yr^{-1}) and strong winds lead to vigorous fjord mixing. Because of these links, reconstructing precipitation and fjord circulation provides information on westerly wind behavior over southwest New Zealand. Applying a multiproxy approach, we find several intervals of inferred regional wind variability. The intervals of 1450-1400, 825-775, 575-550, and 50-0 cal yr BP were anomalously wet, while 325-300 and 250-225 cal yr BP were anomalously dry. These interpreted intervals appear to be in phase with regional paleoclimate records. Two centennial-scale wet intervals align with a multi-centennial warm interval identified in the Pages2k Australasian temperature reconstruction, while the drier intervals generally occur during cooler times. The wet/dry intervals presented here are matched by opposite wind and/or precipitation trends reconstructed from the windfield core in Chile and the southern windfield margin in Antarctica. Such spatial patterns support the notion of centennial-scale latitudinal wind shifts or contraction/expansion of the core. Consistent with observations, all sites show wind strengthening from ~50 cal yr BP to present, indicating an overall intensification of winds that is observed in modern instrumental and reanalysis data sets.