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Centennial-millennial scale coupling between Pacific surface and intermediate water variability over the last 30 kyr

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Antarctic Intermediate water affects climate through the meridional transfer of heat associated with its production, and through its influence on the distrubution of carbon in the ocean atmospheric system. Observational and modelling studies both suggest that intermediate water properties are sensitive to climate changes in their source regions and can propogate these anomalies great distances along the base of the thermocline. This equatorward advection of extratropical surface water properties to the low latitude thermocline has been proposed as an 'oceanic tunnel' through which the extratropical ocean can modulate tropical climate on anything from decadal to orbital timescales. Assessing the role of this oceanic tunnel in past climate variations has been hindered by the lack of paleoceanographic records capable of resolving extratropical surface and intermediate water variability down to decadal timescales.

Here we present (sub)decadally resolved planktonic and benthic foraminiferal isotopic records from the Chilean slope ODP Site 1233—located beneath the northernmost reaches of Southern Westerlies at a water depth intersecting AAIW (41˚00'S, 74˚27'W, 838m). Our benthic foraminiferal carbon and oxygen isotopic records monitor the physical and chemical properties of AAIW close to its source in the SE Pacific, while our planktonic foraminferal isotopic records monitor the surface ocean climate and current systems west of Chile. Together these records constrain the properties of the waters which constitute the upper and lower bounds of the 'oceanic tunnel'. The similarity between the surface and intermediate water variability suggests a strong

coupling between high latitude surface ocean climate and intermediate water ventilation over the last 30 kyr. The timing of the surface and intermediate water millennial-scale variability is similar to that observed in ice core reconstructions of Antarctic air temperature suggesting that these polar events extend to mid latitudes and involved the major dynamical systems of Southern Hemisphere ocean-atmospheric circulation. The presence of high amplitude surface and intermediate water variability within the Holocene suggests that these dynamical systems are nearly as variable during warm climate states as they are under glacial boundary conditions.

Our results provide a historical perspective on the “natural variability” in intermediate and extratropical surface water properties against which the trends observed over recent decades can be compared.