Geophysical Research Abstracts, Vol. 8, 11008, 2006
SRef-ID: 1607-7962/gra/EGU06-A-11008

Covariation in SE Pacific surface and intermediate water properties on centennial-millennial timescales-constraints on the role of the "oceanic tunnel" in abrupt climate change

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The equatorward ventilation of Southern Hemisphere extratropical water masses to the low latitude thermocline has been proposed as a window through which the high latitude ocean can modulate tropical climate on anything from decadal to orbital timescales. This hypothesis is founded largely on the observation that tropical thermocline waters originate mostly in the Southern Hemisphere and that computer simulations suggest property anomalies in these source regions can advect through the intermediate ocean, "the oceanic tunnel", to influence tropical SST. Unfortunately, observational records of extratropical ocean changes are too brief to assess their impacts on multi-decadal and longer timescales. Here we supplement the observational record using planktic and benthic foraminiferal based proxy reconstructions of extratropical surface and intermediate ocean physical properties through the last 50 kyr. The exceptionally high sedimentation rate (1.5m/kyr) at our site (ODP 1233; 41˚S, 74˚W) allows us to achieve (sub)decadal resolution-thus resolving the inferred minimum timescale at which variations in the extratropical ocean can affect low latitude changes. On centennial to millennial timescales, changes in intermediate water properties track those in the near surface albeit with a reduced amplitude-confirming the idea that changes in the extratropical ocean effect the oceanic tunnel on these timescales. The scale of our ocean changes and their covariance with reconstructed

rainfall suggest that they are driven by variations in the Southern Westerly Winds. The persistence of high amplitude surface and intermediate ocean property variability within the Holocene demonstrates that Southern Hemisphere ocean-atmospheric dynamics are nearly as variable during warm (NADW stable) climate states as during glacial (NADW variable) conditions-suggesting a driving mechanism other than mode switches in North Atlantic Deep Water formation. Therefore, we compare the timing of our reconstructed extratropical ocean-atmospheric changes to those observed in the tropics and Northern Hemisphere to assess the role of tropical-extratropical teleconnections in abrupt climate change.