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Influence of Southern Ocean seasonal variability on the western North Atlantic

Vladimir Ivchenko (1), Bablu Sinha (1), Neil Wells (1), Mitsuhiro Kawase (2), Vladimir Zalesny (3), Jeremy Grist (1), Adam Blaker (1), and Beverly De Cuevas (1)

(1) National Oceanography Centre, Southampton, United Kingdom (voi@noc.soton.ac.uk, +44 (0)2380 593059), (2) University of Washington, Seattle, USA (kawase@u.washington.edu), (3) Institute of Numerical Mathematics, Moscow, Russian Federation (zalesny@inm.ras.ru)

The huge seasonal variability in Antarctic sea ice extent is well known. The seasonal variation is approximately $18x10^6$ km^2, an area larger than that of Antarctica and its ice shelves. We demonstrate that the pronounced variability in the Antarctic influences other regions of the World Ocean on timescales of months to years. Particularly strongly influenced are the equatorial regions; the western boundary currents, such as the Gulf Stream and the Kuroshio; and parts of the Arctic. The mechanism involves propagation of planetary waves and their interaction with boundaries and strong currents. The effectiveness of this mechanism in connecting the Southern Ocean with the Equatorial Pacific has been described by Atkinson *et al.* (**Geophys. Res. Lett., 36, L08603, doi:10.1029/2008GL036976**) and other earlier studies. In the present study we analyze the western North Atlantic, including the Gulf Stream, using two simulations with the Global Ocean General Circulation Model NEMO (Nucleus for European Modelling of the Ocean) at 1/4˚ horizontal resolution. A control experiment simulates the ocean state for the period 1989-1994. A perturbed experiment is identical except surface fluxes from/to the atmosphere south of 40˚S are replaced by an annual mean. Between 40˚S and 30˚S the seasonal component of forcing is gradually increased to the unperturbed value to ensure a smooth transition between the region with and without seasonal forcing. Anomalies of temperature, salinity and velocity are obtained by subtracting the results of these two experiments. The experiments clearly and unambiguously demonstrate and quantify the remote effects of the Southern Ocean variability. There is a reasonably strong seasonal modulation of the temperature, salinity and kinetic energy in the Gulf-Stream area. The anomalies are statistically significant, i.e. bigger than standard error for each of the runs and stand out above eddy variability. The anomaly of the Atlantic Meridional Overturning Circulation (MOC) is persistent between 20˚N and 40˚N, reaching about 1 Sv for annual means.