Abstract View

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Thermohaline Oscillations in the LSG OGCM: Propagating Anomalies and Sensitivity to Parameterizations

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ABSTRACT

New experiments are reported that extend previous studies of the internally generated variability found when the Hamburg LSG Ocean General Circulation Model is integrated under mixed boundary conditions. All model integrations have stochastic forcing added to the freshwater flux to excite the variability. It is demonstrated that the salinity anomalies that propagate around the meridional circulation of the Atlantic Ocean are merely signals emitted from the source of the variability in the Southern Ocean; they do not play an active role in its generation. It is the Southern Ocean flip–flop oscillator, as suggested by a previous study, that is the driving mechanism of the 320-yr period oscillations. A second mode of propagation is identified that may be related to the periodicity of the oscillations: westward propagation of upper-ocean salinity anomalies around the coast of Antarctica. It is shown that this mode is driven by the same density-upwelling wave motion as reported elsewhere in the literature.

The sensitivity of the simulated variability to changes in some of the model's numerical and physical algorithms is investigated. The computationally expensive step of retriangularizing the matrix equation for the barotropic velocity can be done very infrequently without affecting the characteristics of the variability. Changing to a convective overturn parameterization that leaves fewer residual instabilities has a small effect on the variability, while changing to one that mixes, rather than interchanges, statically unstable water masses can reduce the magnitude of the variability by up to 70%. The latter change, however, is attributed entirely to the different freshwater flux forcing that the new parameterization implies. Using a more realistic haline and thermal coupling between sea ice and the ocean also leads to greatly reduced internal variability on the 320-yr timescale. Again, changes in surface fluxes implied by the alteration to the model are important, and these changes have implications for the flux adjustments necessary when the LSG model is coupled to an atmosphere model. The results presented here indicate considerable scope for reducing such flux adjustments.

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