Abstract View

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Decadal Variability in an Idealized Ocean Model and Its Sensitivity to Surface Boundary Conditions

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ABSTRACT

Variability in a three-dimensional ocean model of idealized geometry is analyzed. The variability is induced in the model by adding a stochastic component to the surface buoyancy forcing. The influence of the surface thermal forcing on the model variability is investigated under conditions in which the surface freshwater flux is specified. The thermal boundary conditions that have been considered include restoring boundary conditions with different restoring times, fixed surface heat flux, and boundary conditions derived by assuming an energy balance model for the atmosphere. It is found that the ocean model response varies considerably with the thermal boundary conditions used, given the specific ratio of thermal to haline forcing chosen for these calculations. A behavior characterized by sudden transitions between states of strong overturning and states of much weaker overturning dominates the model's response when a strong restoring is used, while quasi-regular oscillations at a period of approximately 24 years are found with boundary conditions that allow the sea surface temperature to respond to changes in the oceanic heat transport. The spatial pattern of the stochastic forcing is considered here as a variable of the problem, and the model's response to different spatial patterns is analyzed. The same decadal signal is found for all spatial patterns, suggesting that the variability at this timescale can be considered as an internal mode of the system and not associated with some characteristics of the forcing. However, different special patterns can be more or less effective in exciting the oceanic mode. Large-scale forcing directly contributing to the east–west pressure gradient appears to produce the largest response.

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