

the upper boundary condition. The effect of the upper boundary condition on the climatic variability of the ocean is discussed in section 4. The results are summarized in section 5. The model is described in section 2. The numerical experiments are described in section 3. The results are presented in section 4. The conclusions are given in section 5.

**2. Model description** The ocean model used in this study is the Princeton Ocean Model (POM) version 4.0 (Shchepetkin and McWilliams 2005). The POM is a three-dimensional finite difference model that uses a staggered grid. The horizontal grid is rectangular and the vertical grid is sigma. The ocean model is coupled to a land surface model (LSM) and a sea ice model. The ocean model is initialized with climatological conditions and forced by climatological wind stress and heat flux. The ocean model is run for 100 years to reach a steady state. The ocean model is then run for 1000 years to obtain the climatic variability.

**3. Numerical experiments** The numerical experiments are designed to investigate the effect of the upper boundary condition on the climatic variability of the ocean. The experiments are run for 1000 years. The experiments are run with different upper boundary conditions: (a) no upper boundary condition, (b) periodic upper boundary condition, (c) free-slip upper boundary condition, and (d) fixed upper boundary condition.

The ocean model is initialized with climatological conditions and forced by climatological wind stress and heat flux. The ocean model is run for 100 years to reach a steady state. The ocean model is then run for 1000 years to obtain the climatic variability. The climatic variability is calculated as the standard deviation of the monthly mean temperature and salinity.

The upper boundary condition has a significant effect on the climatic variability of the ocean. The upper boundary condition affects the climatic variability of the ocean by changing the vertical profile of the temperature and salinity. The upper boundary condition also affects the climatic variability of the ocean by changing the vertical profile of the wind stress and heat flux.

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