Abstract View

Volume 16, Issue 1 (January 1986)

Journal of Physical Oceanography
Article: pp. 11–24 | Abstract | PDF (1.20M)

Computational Efficiency and Accuracy of Methods for Asynchronously Coupling Atmosphere-Ocean Climate Models. Part II: Testing with a Seasonal Cycle

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(Manuscript received December 17, 1984, in final form July 5, 1983)

DOI: 10.1175/1520-0485(1986)016<0011:CEAAOM>2.0.CO;2

ABSTRACT

The asynchronous coupling schemes used in the seasonal, coupled atmosphere–ocean general circulation models (A/O GCMs) of Manabe *et al*. 1979 and Washington *et al*. 1980 are tested in the seasonal, coupled atmosphere–ocean model of Harvey and Schneider. In these schemes ocean temperatures are held fixed during atmospheric integrations and, conversely, atmospheric temperatures are held fixed during ocean integrations. The alternative atmospheric boundary conditions investigated using a simple mean annual model in the first part of this study are also tested. The occurrence of a seasonal cycle poses a number of problems for the accurate simulation of the synchronous transient response using asynchronous coupling methods. Unlike the mean annual model, it is necessary to integrate the atmosphere at 1east one year at a time in order to recalibrate the entire seasonal array of atmospheric variables before each multiyear ocean model integration. However, with such long atmospheric integration times it is no longer reasonable to hold ocean temperatures fixed during atmospheric integrations. This problem leads to the definition of a periodically-synchronous coupling mode, whereby atmosphere–ocean integrations of length τ_a years alternate with asynchronous ocean integrations of length τ_0 years. A periodically-synchronous mode using a second-order Taylor series extrapolated atmosphere-mixed layer temperature difference during asynchronous ocean integrations is tested for a step-function increase of the solar constant, sinusoidal solar constant variations with periods of 100, 200, and 500 years, and a time dependent CO_2 increase. This method is found to closely reproduce the synchronously coupled results. For the CO_2 increase, using τ_a = 5 years and τ_0 = 20 years gives temperature errors of only a few percent while reducing potential problems associated with stochastic variability during atmosphere GCM integrations.

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