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# A forward-backward scheme three-dimensional ocean circulation model and its validation

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A two-time-level, three-dimensional numerical ocean circulation model was established with a two-level, single-step Eulerian time-differencing scheme. The mathematical model of the large-scale oceanic motions was built based on the terrain-following coordinated, Boussinesq, Reynolds-averaged primitive equations of ocean dynamics. A simple but very practical Eulerian forward-backward method was adopted to replace the most preferred leapfrog scheme as the time-differencing method for both barotropic and baroclinic modes. The forward-backward method is of second order of accuracy, requires only one function evaluation per time step, and is free of the computational mode inherent in the three-level schemes. It is superior in many respects to the original leapfrog and Asselin-filtered leapfrog schemes in practical use. A volume-conserved spatial smoothing method was introduced to control the nonlinear instability. The performance of the newly-built circulation model was tested by simulating a barotropic (tides in marginal seas of China) and a baroclinic phenomenon (seasonal evolution of the Yellow Sea Cold Water Mass), respectively. Three-years' time histories of four prognostic variables were intercompared between the POM model and the two-time-level model in a regional simulation experiment for the northwest Pacific to further prove the reliability of the two-level scheme circulation model.