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Block Preconditioning for Implicit Ocean Models

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Ocean modeling is a demanding multi-scale application, involving the coupling of phenomena at various time and spatial scales. One problem that scalable ocean models need to address is the spin-up problem, which requires time integration over intervals measured in centuries. Implicit models allow us to bypass CFL-induced timestep limits, but leave us with the challenge of developing effective preconditioners. We focus our attention on the implicit variant of the Parallel Ocean Program (POP), which solves a thin stratified fluid problem utilizing the hydrostatic and Boussinesq approximations. We consider block preconditioners to address the coupling between the velocity, salinity-temperature and pressure blocks. We present modest theoretical results which guide the choice of preconditioners as well as numerical results illustrating the effect of those choices in practice.