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**Physics-based Preconditioning of JFNK for Free-surface
Ocean Modeling**

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Global ocean model equation systems contain a variety of normal modes and thus a variety of time-scales. The 3-D hydrostatic free-surface model with salinity and temperature contains: external gravity waves and Rossby waves, internal gravity waves and Rossby waves, dissipation, and advection. The Parallel Ocean Program (POP) uses knowledge of these various normal modes to execute an operator split, semi-implicit, time integration of this system. There is motivation to develop a fully implicit, unsplit, version of POP, imPOP. The JFNK method is currently used for the nonlinear solution required at each time step.

In this study we consider a reduced 2-D hydrostatic system of three equations for surface height, horizontal momentum, and temperature. This system contains external and internal gravity waves, dissipation, and advection. We develop and study operator split semi-implicit methods as a preconditioner to JFNK. These preconditioners are developed from the normal mode time scale knowledge embedded within the current POP time integration process.