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Simulations of Ocean Circulation under Static and Dynamic Ice Shelves

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We present simulations of both static and dynamic ice shelves within a dynamical ocean model (the Parallel Ocean Program, POP) using an immersed boundary method (IBM) to represent the geometry of the ice-ocean interface. In this work, the ice shelf dynamics are prescribed, though our near-term goal is to use the IBM to couple the ocean model to a fully dynamic ice sheet model (Glimmer, the Community Ice Sheet Model) within the Community Earth System Model (CESM). The IBM allows for geometrically correct representation of the boundary conditions at the ocean/ice interface without the need for a modeling grid that conforms to the boundary or changes in time. We present simulation results of flows under both idealized ice shelf geometries. We show that the velocities and melt rates produced by the IBM approach compare favorably with other modeling approaches that have been applied to the same simple geometries. We demonstrate that ice advance and retreat over hundreds of kilometers can be represented using the IBM, with the ocean dynamics varying smoothly as the ice shelf moves through grid cells. This is a prerequisite for realistic, fully coupled climate simulations of that are capable of representing the collapse of the West Antarctic Ice Sheet.