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Simulating basal melting of ice shelves with a plume model

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A new community effort, the Marine Ice Sheet Model Intercomparison Project (MISOMIP), has developed idealized tests for comparing ocean and marine ice sheet models. The ISOMIP+ experiments are designed to study ocean circulation and melting beneath ice shelves, and the MISOMIP1 experiments examine coupled ice sheet–ocean interactions. We have developed and applied a plume model for ISOMIP+, and have coupled it to the higher-order Community Ice Sheet Model for MISOMIP. The plume model simulates the buoyancy-driven rise of melt water beneath an ice shelf, as ambient seawater is entrained from below. It computes steady-state plume depth, temperature, salinity, and horizontal velocity in the presence of buoyancy forces, the Coriolis force and drag. The resulting pattern of basal melting is similar to that from sophisticated ocean general circulation models (GCMs), with melt focused at greater depths and in regions of faster flow. We suggest that a plume model is a useful tool for simulating the response of marine ice sheets to changing ocean forcing. It is more physically realistic than depth-based melt parameterizations, while much less expensive than ocean GCMs at the fine scales needed to resolve interactions with ice shelves.