Geophysical Research Abstracts
Vol. 12, EGU2010-7372-2, 2010
EGU General Assembly 2010

Using immersed boundary methods to couple a dynamical ocean model to a dynamical ice sheet/ice shelf model

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The melting of the West Antarctic Ice Sheet (WAIS), the world's largest marine ice sheet, would mean a ~5 meter sea level rise worldwide. About a third of the WAIS lies in the Amundsen Sea Embayment, where small ice shelves provide buttressing for outlet glaciers. Warming oceans may melt the supporting ice shelves leading to accelerated flow of the outlet glaciers. Perhaps more importantly, warming oceans may mean that warm circumpolar deep water can more easily reach the ice sheet grounding line, where it can melt grounded ice directly and force retreat. Previous theoretical work suggests that ice sheets, such as the WAIS, with seabeds that deepen inland may be unstable to grounding line retreat.

We present simulations from a coupled dynamical ocean model (based on POP) and dynamical ice sheet/ice shelf model (Glimmer-CISM). This work is a stepping stone toward a global scale simulation of the southern ocean (using CCSM) together with the full Antarctic ice sheet (using Glimmer-CISM). The ocean model uses an immersed boundary method (IBM) to represent the complex, time-evolving geometry of the ice shelf. The IBM allows for accurate representation of the boundary conditions at the ocean/ice interface without the need for a modeling grid that conforms to the boundary or that changes in time. Using simplified seabed and ice shelf geometries, our simulations explore the effects of varying the seabed slope on the stability of ice sheets. We also investigate the melt rates that result from varying levels of seawater warming beneath the ice shelves.