Satellite Observations of Ice Thickness and Deformational Properties in Antarctic Grounding Zones

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Remote measurement of ice thickness in the Antarctic grounding zone is the key to understanding catchment-scale ice discharge and local mass-balance, and for quantifying ice-shelf basal-melt rates in the vicinity of the grounding line. Here we use satellite altimetry and InSAR to map the surface profile of the ice and changes in this profile due to interaction with the ocean. Both the static buoyancy bending length scale and the time-dependent vertical movement of the surface due to tides provide us with information about ice stiffness, rheology and basal properties. We show how regularization can be used to control the inverse form of the Euler-Bernoulli equation for an elastic plate. By combining satellite-derived diurnal flexure patterns and a regional tide model we can infer ice stiffness and estimate grounding zone ice thickness. At the Beardmore Glacier, a 2-D thickness map produced using detailed differential flexure information from TerraSAR-X imagery agrees with radio-echo sounding measurements to within ~50 m. A more extensive comparison of surface elevations with ice-penetrating radar data highlights the spatial extent of error in the commonly used hydrostatic equilibrium assumption in this region, reaching over 100m in some areas, and the consequent potential for miscalculation of ice shelf basal melt rates close to grounding zones. This new satellite-based approach provides potential for improvement to remote grounding line ice thickness measurements where airborne surveys are not available.

Ice-ocean interaction *(Surfin' USA)* - everywhere else (*Promised Land)*