Antarctic ice shelf thickness estimates derived from satellite altimetry

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Ice shelf thickness is an important boundary condition for ice sheet and sub shelf cavity ocean modelling and is needed to improve mapping of all the ice shelves in Antarctica. It is also required near the grounding line to calculate the ice fluxes required to determine ice sheet mass balance. In this approach, the accuracy of the ice thickness is one of the constraining parameters on the uncertainty in the estimate. Ice thickness is also required to calculate the sub-shelf mass balance and bottom melting rates based on the principles of conservation of mass.

Ice thicknesses can be determined from in situ radio echo sounding measurements but these data provide, in general, rather sparse spatial coverage. Ice thickness can also be estimated from the surface elevation of floating ice if it is assumed to be in hydrostatic equilibrium, an assumption which we will discuss in the presentation. Satellite altimetry has dramatically increased the accuracy and coverage of elevation data and the capability to infer the ice thickness of all Antarctic ice shelves now exists.

We present a satellite retrieval of the ice thickness for all Antarctic ice shelves mainly using the ERS-1 geodetic phase data from 1994-5 supplemented by GLAS data for regions where ERS-1 data are not available. Surface elevations derived from these instruments are interpolated onto regular grids using krigging and converted to ice thicknesses using a modelled firn density correction. We focus particularly on Larsen C as a case study for concerted validation effort. This is our worse case scenario shelf due to its northerly location meaning lower data densities and its melting surface as melting is not included in our modelled firn density correction. Validation for Larsen C suggests that ice thickness can be determined with an accuracy of -0.22 ± 36.7 m. The random error determined is equivalent to about 13% of the mean ice shelf thickness.