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Representation of horizontal strain due to tidal bending by observation and modeling

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An important control of ice sheet mass balance is the ice dynamics in the grounding zones around Antarctica. On many outflow glaciers a large temporal variability in ice flow has been observed, which is at least partly related to tides. Here we investigate the tide induced short term ice deformation in an ice shelf grounding zone and the related bending stresses and strain. We make use of the arguably most precise measurement method, differential SAR interferometry, in combination with ground based measurements and model assumptions for tidal bending. Ground validation and satellite data have been acquired within a dedicated field campaign.

The Southern McMurdo Ice Shelf in the Western Ross Ice Shelf region was chosen as the experiment site. This area is optimal for the data interpretation because of a simple grounding line configuration, small ice flux, and favourable satellite imaging geometry. It is also a safe area which allowed the installation of tiltmeters and GPS stations, and glaciological measurements such as ice thickness and snow accumulation. From November 2014 to January 2015 the tidal movement was recorded over a period of 2.5 months. TerrSAR-X radar images have been acquired over the same period as a basis to derive ice shelf flexure maps.

Despite the viscoelastic effects in ice shelf bending a simple elastic bending model for a beam of finite ice thickness can largely explain the GPS-observed surface strain. Using the same model and taking into account the viewing geometry of the satellite radar, it is now possible to separate horizontal and vertical displacement components in the satellite data. As a result we can obtain more realistic ice shelf flexure profiles from the interferometric SAR measurement. The newly derived flexure profiles are therefore more suitable to recover viscoelastic effects of tidal bending in grounding zones of ice shelves and outlet glaciers. These effects would have otherwise remained unnoticed.