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Ice shelf flexure at Antarctic grounding lines observed by high resolution satellite and ground measurements

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Climate change is expected to impact Antarctic ice sheets primarily through changes in the oceans. This will be felt most strongly near the grounding line, where the ice sheet first comes into contact with ocean water and becomes an ice shelf. The primary objective of this work is to make use of satellite techniques for better monitoring and interpretation of the link between floating ice shelves and grounded ice. By measuring the flexure of ice due to tides we can obtain critical data to derive information on ice properties.

Satellites can measure tidal bending over discrete time intervals and over large areas, whereas ground stations monitor ice dynamics continuously at discrete points. By the combination of the two we derive a complete picture of vertical ice displacement by tides for different grounding line geometries.

Our field site is the Southern McMurdo Ice Shelf in the western Ross Sea region at which horizontal ice dynamics can be neglected which simplifies corresponding satellite data analysis. During a field survey in 2014/15, we acquired data of tidal flexure along a straight line perpendicular to the grounding line using 8 ground stations equipped with differential GPS receivers and high precision tiltmeters. The most landward station was located close to the grounding line, and the last station was placed 5 km away at a point which was assumed to be freely floating. Additional data acquired for the flexure analysis are ice thickness, snow and ice stratigraphy and basal ice properties using ground radar systems; as well as information of snow morphology from snow pits and ice cores.

During the same period a series of TerraSAR-X 11-day repeat pass satellite data have been acquired to map tidal displacement using differential SAR interferometry (DInSAR). Before the onset of the melting season in December all interferograms show generally high coherence and are suitable for tidal flexure analysis.

The ice shelf in the area is around 200m thick, and tidal flexure could still be detected at a distance about 3 km away from the grounding line. The surface mass balance is heterogeneous and largest at the grounding line where the surface slope starts to increase, and the width of the grounding zone is dependent on ice properties and grounding line geometry. In this presentation we will showcase the main results of the combined field and satellite data analysis, which forms the basis to study the viscosity of ice in Antarctic grounding zones.