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Grounding zone heterogeneity around the Ross Ice Shelf

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Grounding lines are most accurately mapped by identifying patterns of differential vertical movement from SAR interferometry. The apparent grounding line position at the upstream limit of flexure and the width of the flexure zone are influenced by satellite acquisition time relative to the tides, even for steep bedrock slopes. Here we identify and interpret spatial variations in flexure around the Ross Ice Shelf using a suite of TerraSAR-X interferograms. A small change in grounding line position can indicate short-term dynamic variability in ice thickness or the onset of ocean-induced instability, though neither are observed here. Nevertheless, interferograms also contain information about the stiffness of ice, its time-dependent response to tides and basal characteristics at the ice shelf boundary. Using flexure zone width, we estimate ice stiffness and link it to variations in thickness and rheology.

Surface profiles across the grounding line from ICESat laser altimetry are re-interpreted and used to clarify the process of buoyancy-induced bending. Observations match well to theoretical models predicting an ice-shelf bump of variable amplitude and wavelength downstream of the transition. A deviation from hydrostatic balance is particularly clear at the steep, fast-flowing outlet glaciers of the Transantarctic Mountains (Mulock / Beardmore) but is also found in non-moving areas such as the Kamb Ice Stream. This deviation can lead to a positive bias of up to 15% of ice thickness and may cause significant miscalculation of ice shelf basal melt rates and errors in 'flux gate' type mass balance calculations. Here, cross-sections through the grounding line are modelled analytically in 1D from fundamental glaciological parameters using the new grounding line locations, leading to much improved estimates of ice thickness from ICESat surface profiles. Thickness is validated using airborne ground penetrating radar data where available.