A comparison of grounding zone features and flexure dynamics in two geometries over a 12-hour tidal range

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The grounding zone (GZ) of an ice sheet, where meteoric ice transitions from fully grounded to freely floating, is a critical boundary where land ice interacts directly with the ocean. Since floating ice responds to tides while grounded ice does not, the GZ is a region of significant ice flexure, which can pump warm, saline seawater upstream beneath the ice sheet. The GZ can be mapped on large spatial scales with limited temporal sampling using satellite data, yet the GZ has never been studied continuously over a diurnal tidal cycle. Here we describe a high-rate, kinematic Global Positioning System (kGPS) survey experiment completed as part of the Whillans Ice Stream Subglacial Access Research Drilling (WISSARD) project, collecting repeat surface-elevation profiles over a 12-hour tidal range of two ~20 km, along-flow transects across the GZ of the Whillans Ice Stream (WIS), West Antarctica. One transect crosses a bedrock promontory, representing a "typical" GZ (i.e. orthogonal to ice flow, steep surface slopes). The second is through a narrow embayment, over which ice flexure is supported both longitudinally and laterally (i.e. bridged). Bridged embayments are typical at subglacial water outlets, where outflow causes local grounding line retreat. We combine these kinematic GPS surveys with nearby continuous GPS data to map GZ features and contrast ice flexure mechanics between two types of GZs. These geometry-induced differences in GZ behavior are ignored in simple models, but must be incorporated to more realistically capture ice-ocean interactions in the GZ and upstream.