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The stick-spots of Whillans Ice Stream, Antarctica

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The Whillans Ice Stream is a major outlet of the West Antarctic Ice Sheet. Numerous studies have now shown that this ice stream is slowing down, possibly stagnating by the end of this century. Numerous observations over the past decade have revealed a range of surprising behaviors on this ice stream, including a dynamic system of subglacial lakes and large-scale stick-slip motion of the downstream portion of the ice stream, where the ice stream accomplishes most of its motion by moving approximately 40 cm during two thirty-minute periods each day. The stick-slip motion appears to be in response to the presence of several large subglacial stick-spots that inhibit forward motion until the accumulation of elastic strain from steadily moving portions of the ice stream allow slip to commence. To better understand these sticky-spots, we deployed a network of seismic and GPS units during Antarctic summers of 2010-11 and 2011-12. These networks show, that in contrast to earlier lower resolution studies, that a pair (not one) of large ($\sim$20 km in diameters) subglacial sticky-spots resist motion between slip events, with tidal modulation of inter-event stress accumulation modulating from which of the sticky-spots the slip events initiate. Our seismic array reveals an increase in seismic activity during slip events. However, increased seismic activity is not consistently observed across the nucleation regions of the slip events, indicating a high degree of spatial variation in basal conditions beneath the geodetically imaged sticky-spots.