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Dynamic subglacial hydrology inferred from yearlong behaviour in Greenlandic subglacial lakes

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Climate warming over the 20th century has forced dramatic changes across the Greenland Ice Sheet. Satellite observations have revealed increased ice discharge to the sea, increased surface melting, lowering of the Ice Sheet surface, retreat of the glaciers' fronts, and gravity anomalies related to ice mass loss. These changes reflect a reduction in mass and a consequent contribution to rising global sea levels.

Sub-glacial hydrology plays a key role in the mass budget of the Greenland Ice Sheet through its impact on the rate of basal sliding and thus ice discharge to the sea. However, the structure, distribution and source of meltwater in the sub-glacial drainage system beneath much of the Greenland Ice Sheet is still largely unknown and so far, no glacial lake has been linked to an active and open hydrological system.

Here, we use satellite derived Synthetic Aperture Radar (SAR) from the German TanDem-X mission to map the time variability of surface elevation and surface velocity with unprecedented meter-scale spatial resolution along major outlet systems of northern Greenland's Ice Sheet margin between 2011 and 2013. Analysis of the SAR data reveals circular patches of surface elevation change that we attribute to the filling and drainage of several subglacial lakes. Surface elevation change reaches up to 5 meters and the patches average 3km in diameter. Movement of water beneath the ice sheet in and out of these lakes is observed outside of periods of surface melting indicating considerable dynamics within the subglacial drainage system throughout the year. Filling starts well before the onset of surface melt, continues during the summer before drainage occurs at the end of the melting season. Over the period of measurement, we observe no long-term (i.e. longer than a few months) filling or drainage of these lakes.