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Draining and Filling of an Interconnected Sub-glacial Lake Network in East Antarctica

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The Antarctic Ice sheet is a key component of the Earth system, impacting on global sea level, ocean circulation and atmospheric processes. Meltwater is generated at the ice sheet base primarily by geothermal heating and friction associated with ice flow, and this feeds a vast network of lakes and rivers creating a unique hydrological environment. Subglacial lakes play a fundamental role in the Antarctic ice sheet hydrological system because outbursts from 'active' lakes can trigger, (i) change in ice speed, (ii) a burst of freshwater input into the ocean which generates buoyant meltwater plumes, and (iii) evolution of glacial landforms and sub-glacial habitats. Despite the key role that sub-glacial hydrology plays on the ice sheet environment, there are limited observations of repeat sub-glacial lake activity resulting in poor knowledge of the timing and frequency of these events. Even rarer are examples of interconnected lake activity, where the draining of one lake triggers filling of another. Observations of this nature help us better characterise these events and the impact they may have on Antarctica's hydrological budget, and will advance our knowledge of the physical mechanism responsible for triggering this activity. In this study we analyse 9-years of CryoSat-2 radar altimetry data, to investigate a newly identified sub-glacial network in the Amery basin, East Antarctica. CryoSat-2 data was processed in 'swath mode', increasing the density of elevation measurements across the study area. The plane fit method was employed in 500 m by 500 m grid cells, to measure surface elevation change at relatively high spatial resolution. We identified a network of 10 active subglacial lakes in the Amery basin. 7 of these lakes, located below Lambert Glacier, show interconnected hydrological behaviour, with filling and drainage events throughout the study period. We observed ice surface height change of up to 6 meters on multiple lakes, and these observations were validated by independently acquired TanDEM-X DEM differencing. This case study is an important decade long record of hydrological activity beneath the Antarctic Ice Sheet which demonstrates the importance of high resolution swath mode measurements. In the future the Lambert lake network will be used to better understand the filling and draining life cycle of sub-glacial hydrological activity under the Antarctic Ice Sheet.