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Investigating the inception of supraglacial channels on the southwest Greenland ice sheet using high-resolution satellite images and digital elevation models

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The supraglacial hydrologic system on the Greenland ice sheet is poorly understood. Each summer, extensive, complex supraglacial river networks form on the southwest GrIS surface, draining large volumes of meltwater into the ice sheet and thus significantly impacting ice sheet hydrology, ice flow, and overall mass balance. However, a basic understanding of supraglacial channel formation, evolution, and hydrologic implications is currently lacking. Channel heads are geomorphologic features that in terrestrial settings identify where fluvial erosion begins and impact the dynamics of river networks over space and time. Terrestrial channel heads have been widely studied. This study provides a first investigation of supraglacial channel inception zones, which may differ from channel heads in terrestrial settings given the presence of ice flow rather than soil creep at small wavelengths (Karlstrom and Yang, 2016). First, channel inception zones are identified for several supraglacial catchments (area: ~20-60 km2, elevation: 1100-1500 m, and year: 2011-2014) using WorldView images. Second, concurrent WorldView DEMs are used to extract elevations, flow accumulation areas, slopes, and other variables for those channel inception zones. Third, surface mass balance models, such as MAR and $RACMO_2$, are employed to provide corresponding runoff intensities. Fourth, multivariable regressions are applied to investigate the factors that control meltwater channel formation and dynamics. The analysis results can reveal where meltwater channels form on the ice surface, the hydrologic/topographic factors that impact meltwater channel formation, and the responses of meltwater channel inception zones to surface melt and topographic variations.