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Analysis of the Greenland Ice Sheet's surface hydrology using Synthetic Aperture Radar imagery

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The behaviour of surface water on the Greenland Ice Sheet (GrIS) has recently received much attention due to its ponding to form supraglacial lakes. These can drain and impact ice sheet dynamics by facilitating increased basal sliding, thus leading to a more rapid transfer of ice to the oceans and contributing to rising sea levels. Research into supraglacial lakes has primarily used the optical and infrared wavelength bands of MODIS due to their high temporal resolution. However, this comes with an associated low spatial resolution, potentially resulting in smaller lakes being overlooked, and an inability to image through clouds or in darkness. Conversely, Synthetic Aperture Radar (SAR), a satellite-borne active imaging method uses microwave wavelength bands which are unaffected by cloud or lack of illumination from the sun. SAR imagery often has a much higher spatial resolution than optical imagery without compromising temporal resolution, and radar systems have even detected lakes covered by ice/snow or buried at shallow depths [Koenig et al., 2015]. This gives SAR imagery the potential to significantly increase the size of the database of supraglacial lakes.

The current Sentinel-1A mission comprises two polar-orbiting satellites performing C-band SAR imaging, and provides a novel method for investigating the surface hydrology of the GrIS. Here, we explore a year's worth of images since the launch of Sentinel-1A in April 2014. These images have a higher spatial (5 m x 20 m) and temporal (up to daily) resolution than any previously available imagery, so will revolutionise the amount of information that can be yielded about GrIS hydrology. We use these images in combination with other remotely sensed data, including Landsat-8 imagery, to elicit spatial and temporal variations in the water content of the GrIS's surface ice layers. Our primary focus is on the area upstream of Jakobshavn Isbræ, where preliminary analysis has indicated that liquid water may persist throughout winter not only in lakes, but also in a more spatially distributed form within snow and firn [Benedek and Tedesco, 2015].