A method to derive and validate supraglacial lake volumes along the western margin of the Greenland Ice Sheet from WorldView-2 and Landsat 8 imagery

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The integrated effect of supraglacial lake drainage events and continued meltwater influx to Greenland's englacial and subglacial hydrology systems leads to periods of ice flow acceleration which can potentially impact annual ice flux in the coming years. In this regard, assessments of meltwater volume stored in or drained from these lakes are of great significance. While estimating the extent of supraglacial lakes using satellite imagery is rather straightforward, retrieving the depth and thus their volume is not. Several passive remote sensing approaches based on the interpretation of Landsat, ASTER, and MODIS imagery have been proposed to calculate depth. Although providing valuable insight on lake bathymetry, most of these methods either lack field validation or rely solely upon sparse point measurements to verify lake depths. Worldview-2 (WV-2) sensor captures spectrally, spatially and radiometrically detailed information over ice sheet surface features and provides an underutilized source of data for cryospheric studies. Specifically, the target-orientated nature of the satellite provides an opportunity to acquire both multispectral images of full lakes and high precision stereo imagery of the same lakes after drainage. In this study we explore the capabilities of the WV-2 instrument in retrieving depths over melt ponds to more comprehensively and accurately validate depth estimates. We tune the parameters for a radiative transfer model by using lake reflectance values from WV-2 visible channels and a high resolution WV-2 DEM over the same lakes when drained at the end of the melt season. The optimized model is then applied to WV-2 coastal blue (401.4-453.2 nm) and blue band (447.5-508.3 nm) imagery over seventeen large lakes (other than the ones used in model optimization) in western Greenland to determine depths. We validate the results against the drained lake DEMs and assess the uncertainties associated with the model. Furthermore, we optimize the same radiative transfer model for Landsat 8's Operational Land Imager (OLI) using concurrent depth and reflectance *in-situ* measurements. We apply the model to OLI imagery along the western margin of the Greenland ice sheet to derive supraglacial lake volumes, which has great implications for estimating total water storage on the surface of the ice sheet.