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A global assessment of supraglacial debris cover extents

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In mountainous regions, glacier surfaces are frequently covered by supraglacial debris that can amplify or dampen ice melt rates, depending on its thickness. The extent and thickness of supraglacial debris cover is likely a complex function of debris supply rates from ice-surrounding headwalls, its transport by the ice, and ice ablation that exposes englacial debris at the glacier surface. Previous studies suggest that the extent of debris cover is related to the topographic setting: the higher and steeper the surrounding hillslopes, the more widespread and extensive is debris cover. In addition, climatic (e.g., frost-cracking efficiency) and ice dynamic factors (e.g., flow rates) could also influence the extent of debris cover. However, we currently lack observational data to test such controls.
Here, we propose a new approach to automatically map supraglacial debris cover from optical satellite images at a global scale. Our approach makes use of the cloud-computing platform Google Earth Engine (www.earthengine.google.com) and exploits the large number of optical satellite images that are currently available. Our approach allows mapping changes in the pattern and extent of debris cover at arbitrary time periods. We present global mapping results for the time periods 2013-2017 from Landsat 8 images and 2015-2017 from Sentinel-2 images, at 30 m and 10 m spatial resolution, respectively. Both data sets show a high degree of coherence. We currently analyze this data set in conjunction with digital elevation models to isolate factors that control the extent of debris cover. Preliminary results support the importance of topographic steepness on debris cover extents but also ice dynamic factors.