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Detection of Permafrost Features with Sentinel 2 Satellite Imagery and Deep Learning Methods

In a permafrost environment that is undergoing rapid change due to climate change and anthropogenic disturbances, tracking geomorphological dynamics is a crucial task, not only to provide hazard monitoring, but also to evaluate climatological feedback processes. Yet, the impact on rapid permafrost disturbances on the Earth system is still uncertain, making the availability of reliable, long term data a very important building block to understand the interconnections and feedbacks among various environmental subsystems. Specifically, Retrogressive Thaw Slumps (RTS) are a significant mass-wasting phenomenon and a rapid disturbance in ground-ice rich permafrost landscapes. RTS can mobilize large quantities of formerly frozen ground and consequently sediment, carbon, and nutrients. The spatial distribution and temporal dynamics of RTS are currently poorly quantified on a pan-arctic scale, with the exception of some focus regions that have been subjected to more intensive research.

To expand the existing body of RTS inventories, we train and utilize a convolutional neural network to detect these permafrost features from Sentinel 2 satellite imagery to create a multi-year dataset of detected thaw slumps in the circumpolar arctic. A performant inference pipeline is created to detect and segment RTS, enabling the observation and monitoring of permafrost disturbance in near real time.

The result of our work will be an open dataset of detected RTS and their temporal development (see image). We present ongoing work on the RTS segmentation dataset and the pipeline, with a special focus on the deep learning pipeline and challenges and achievements regarding the image segmentation process of multi-modal Earth observation image data. Also, we present work-in-progress data products and current key downstream results.

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