Daily monitoring of retrogressive thaw slumps in the Fosheim Peninsula, Ellesmere Island, Canada

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Retrogressive thaw slumps (RTS) occur from the mass wasting of ice-rich permafrost. These horseshoe-shaped features have an ablating or retreating ice-rich headwall with fluidized sediment that is transported along the RTS floor. RTS can remain active for up to decades and enlarge as the headwall retreats. With observed increases in RTS number, rates and sizes in recent decades, there is a need to understand these highly dynamic landforms, however there is a general lack of detailed field observations of RTSs. We monitored 3 RTS for over half of the 2017 thaw period by setting up and tracking survey transects on a near daily basis. We correlated mean daily and cumulative retreat to mean daily air temperature (MDAT), total daily precipitation (TDP) and thawing degree days (TDD) using various polynomial regressions and Pearson correlation techniques. Our results show that July retreat was highly variable and periods of increased RTS retreat did not always align with periods of increased air temperature. Also, multiple periods of increased retreat could occur within a single period of increased air temperature. These retreat trends were observed to be largely driven by sediment redistribution in the RTS floor. Retreat rates decreased suddenly in early August, indicating a threshold of either air temperature, solar radiation or a combination of both must be reached for increased retreat rates. There was a statistically significant correlation between daily mean and mean cumulative retreat with MDAT (p < 0.001) and TDD (p < 0.001 and < 0.0001) but not with TDP. Correlating mean cumulative retreat and cumulative TDD using polynomial regression (quadratic and cubic) generated R² values greater than 0.99 for all 3 sites as these variables account for past and current conditions within the monitoring period, as well as lag responses of retreat. This suggests the potential of accurately modelling RTS retreat with minimal field data (air temperature and headwall position), however this is currently restricted to individual RTSs and only within short time scales. We tested this idea by modelling 2 weeks of cumulative retreat in 2018 for 2 of our sites we monitored using the 2017 regression equations. Percent prediction error was 8% at one site and 16% at the other. Monitoring RTS on a daily scale allows RTS behaviour and trends to be identified that may be obscured at annual time scales. With the widespread increased numbers of RTSs being observed around the Arctic, understanding their dynamics is critical as these landforms impact surrounding ecosystems and infrastructure which will be exacerbated with climate change.