Relationship between Microclimate and Erosion of a Retrogressive Thaw Slump on Herschel Island, Yukon Coast

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Key Findings

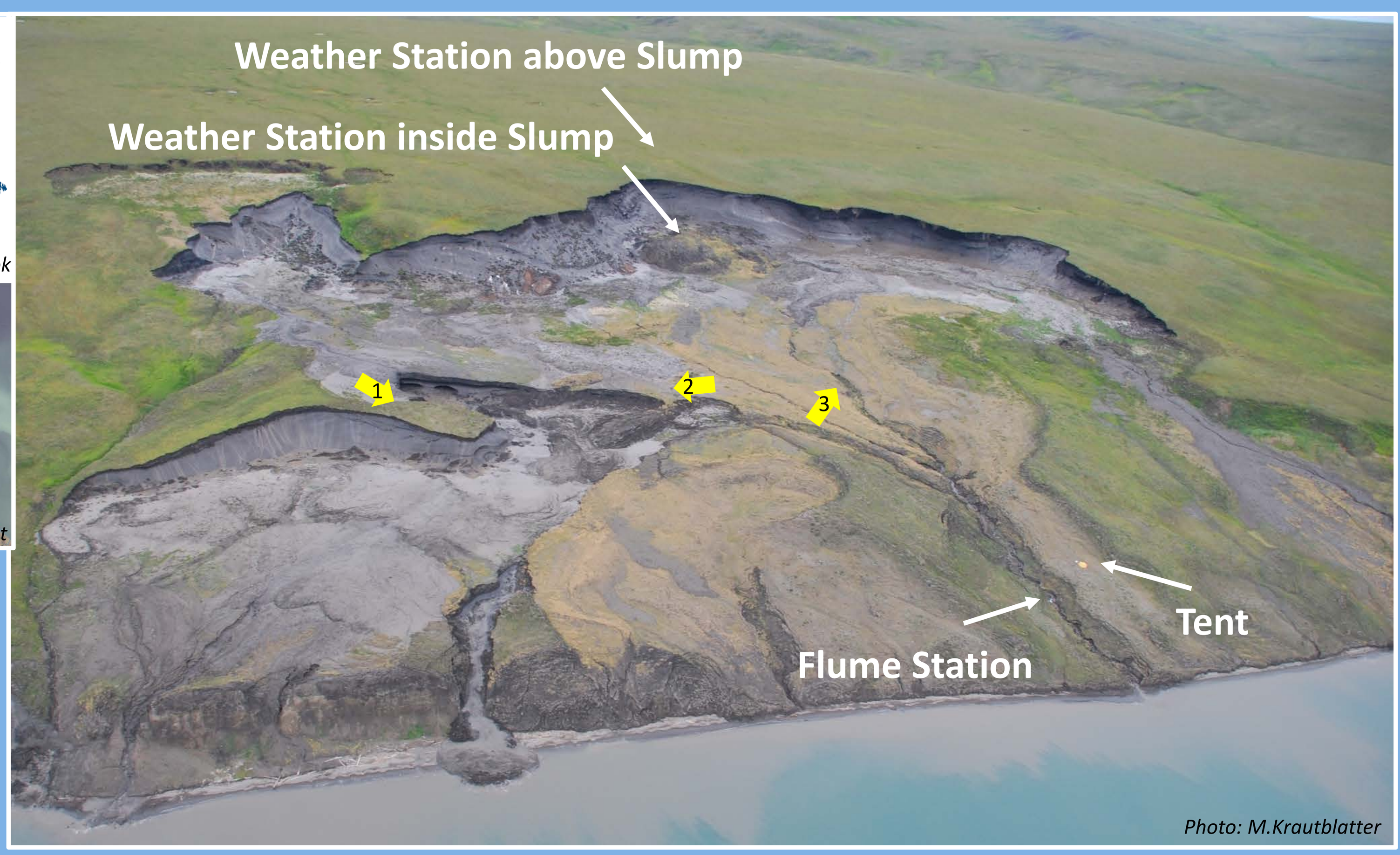
Discharge from the eroding Retrogressive Thaw Slump is **characterized by a strong intra-seasonal, as well as inter- and intra-diurnal variability**. This can **best be explained by** changing microclimatic conditions, specifically **temperature and precipitation**.

Introduction

The Canadian Yukon Coast is an ice-rich permafrost region and is highly vulnerable to environmental change. Rising sea level, increasing summer temperatures, and changing sea ice conditions are projected to lead to accelerated permafrost degradation and coastal erosion.

Retrogressive Thaw Slumps are a commonly occurring thermal erosion feature along the Yukon Coast and are triggered by wave erosion and thawing of exposed ice-rich permafrost. Current and predicted future environmental change may lead to an increase in slump activity and further to accelerated release of large quantities of sediment and nutrients to the nearshore zone. However, so far the relationship between changing climate and slump activity is not greatly understood.

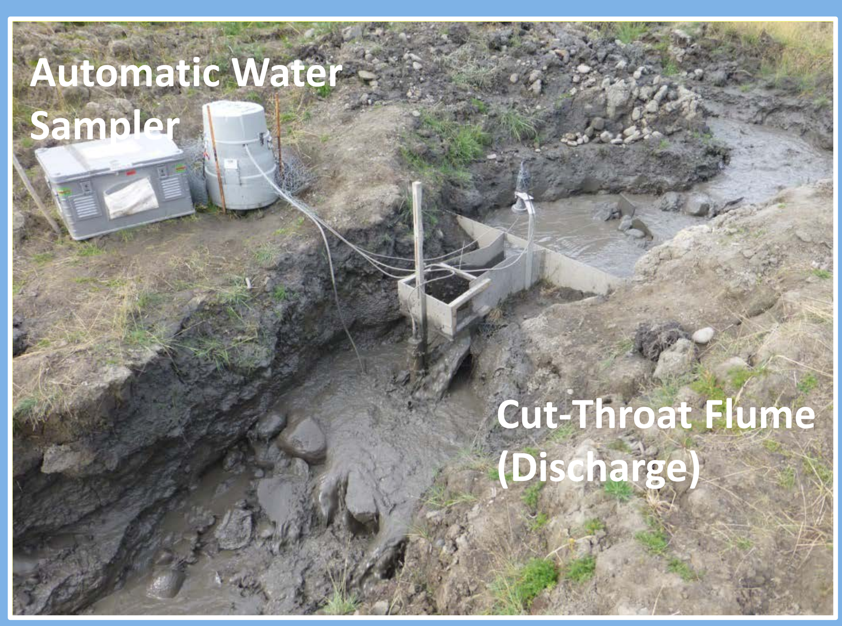
Here we present a study of the relationship between microclimatic conditions and the discharge of a thawing headwall of one of the largest Retrogressive Thaw Slumps in the Arctic. Research was performed over the summers of 2012 and 2013 on Herschel Island situated off the Yukon Coast. The observed Retrogressive Thaw Slump is over 400 m wide, has an exposed headwall of up to 30 m, and undergoes erosion at a rate exceeding 9 m/yr.



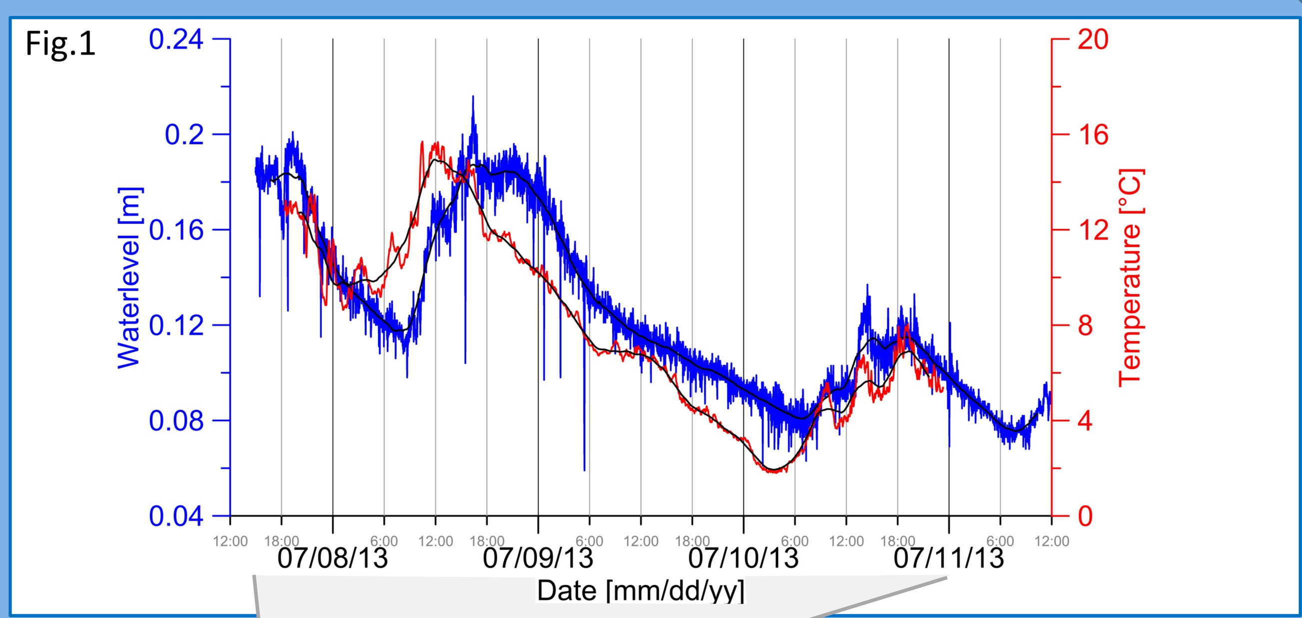
Thawing of a Retrogressive Thaw Slump

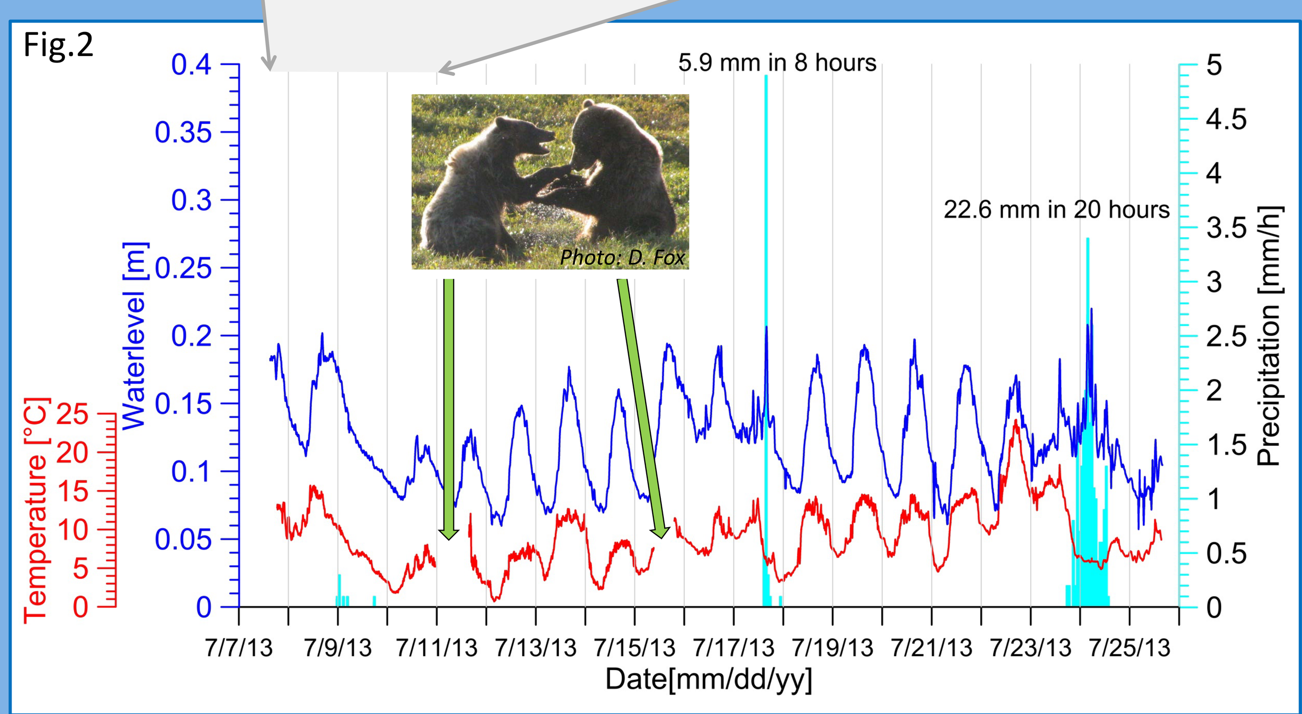
Field Setting

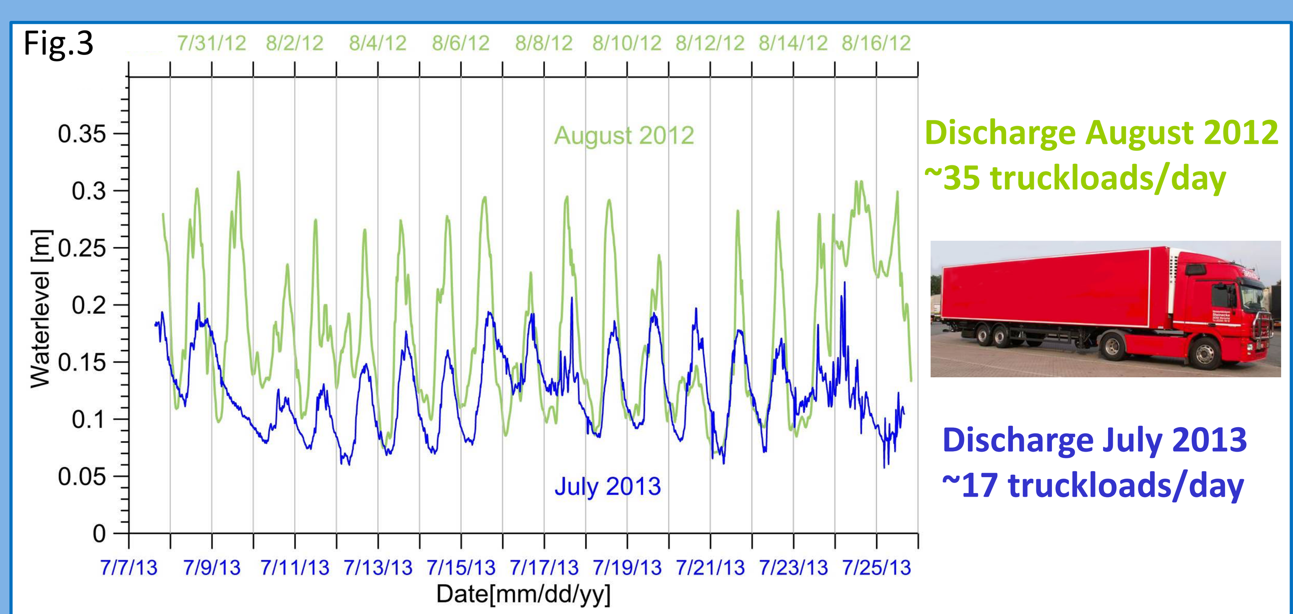
Our study utilised a Cut-Throat Flume constructed within the outflow channel located at the outlet of this Retrogressive Thaw Slump. The Flume was equipped with a radar sensor measuring the discharge before the material entered the nearshore zone, determining the amount of eroded volume and sediment released.



Two weather stations were deployed, one situated on the undisturbed tundra and one within the slump. These were measuring incoming solar radiation, temperature, precipitation and wind speed determining the microclimatic effects on the thawing of the headwall.







Results

The two weather stations located within the slump and above the slump showed only few differences in the data collection. The Cut-Throat Flume equipped with a radar sensor determines the water level which quantifies the discharge of the eroding Retrogressive Thaw Slump into the nearshore zone. Temperature has an effect on the discharge with a delay of thirty minutes to six hours (Fig. 1). It will take more analyses to see if incoming solar radiation is affecting the thawing processes and therefore the discharge in the outflow channel.

The data shows that temperature is strongly affecting the discharge (water level) in the outflow channel. When temperatures increase the water level in the Cut-Throat Flume rises. As a result the discharge of eroding material increases from the Retrogressive Thaw Slump. Additional precipitation shows an increase of discharge in the outflow channel although temperatures may decrease (Fig.2). Further data processing is necessary to entirely understand the interrelations between these environmental parameters.

Thawing and erosion of the Retrogressive Thaw Slump occurs from May to October. Data analysis of the discharge shows an average eroding volume of about 1400 m^3/day (~17 truckloads/day) in July 2013 and about 2900 m^3/day (~35 truckloads/day) in August 2012 (Fig. 3). Discharge from the eroding Retrogressive Thaw Slump is characterized by a strong intra- seasonal, as well as inter- and intra-diurnal variability (between days and within a day). This can best be explained by changing micro-climatic conditions, specifically temperature and precipitation.

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