Cold, Wet, and Dirty: Supraglacial Streams on the Greenland Ice Sheet

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Research Questions

1. How do spatial and temporal changes in supraglacial streams affect the routing of meltwater off of the Greenland Ice Sheet?
2. How does sediment move off of the ice surface and what affect does that have on albedo?

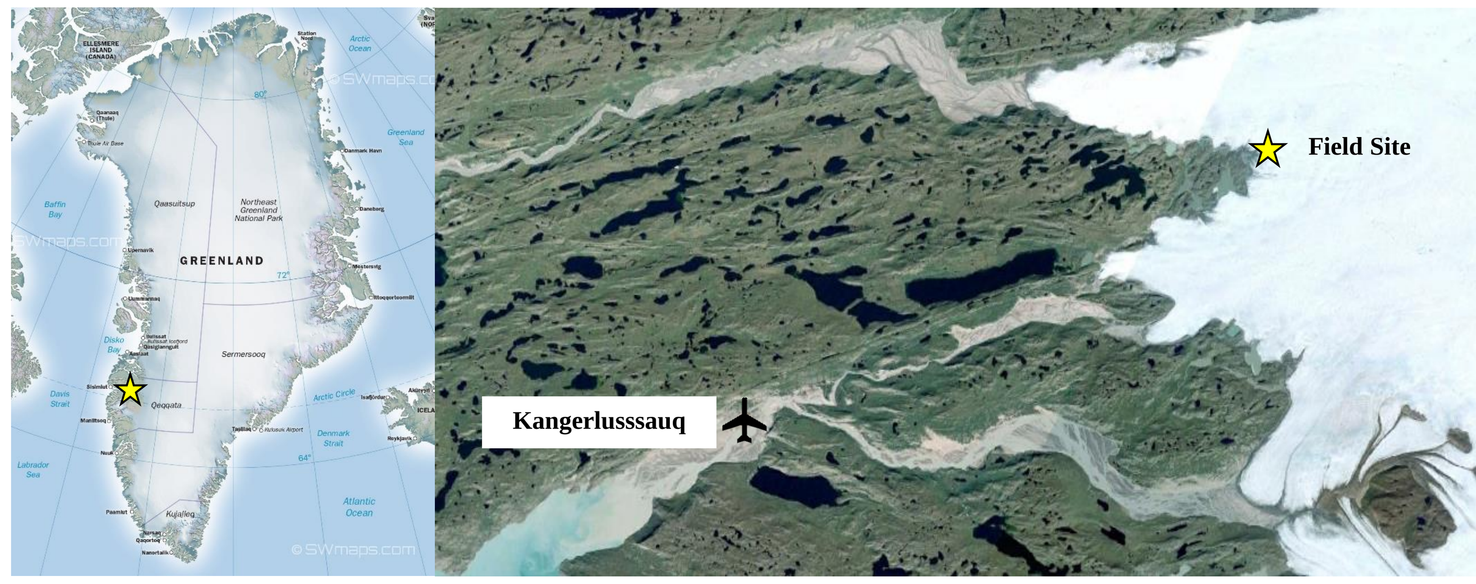

Fig 1: Map of Greenland with location of field site starred (left) and field site in relation to Kangerlussauq township between Russell Glacier and Isunnguata Sermia (right).

Methods

- 3 month field campaign Southwest Greenland in 2016
- Discharge rates with pygmy anemometers and stage loggers
- Ablation rate with fixed stakes and repeat UAV imagery
- Albedo measurements with hyperspectral handheld ASD and multispectral UAV mounted camera
- Weather station monitoring wind, temperature, humidity, precipitation, ice height, etc.
- Sediment transport capacity by analyzing the grain size distribution of stream samples
- Ice surface roughness using Structure-from-Motion images
- Ice hydraulic conductivity using dye tracers and slug/bail tests

Fig 2: (left to right) Taking discharge measurements on an upper basin stream, maintaining the weather station, and flying the UAV drone.

Fig 3: 1) Main study site displaying extensive incision and deposition of dark sediment along areas of low flow. These areas demark the daily low flow stage. 2) Younger river with sediment strip through the center formed from fusing cryoconite holes. 3) Helicopter view of stream in the upper ablation zone showing sediment depositing behind a mid-channel bar. 4) Overhung river banks causing shadowing-out of the lower albedo stream.

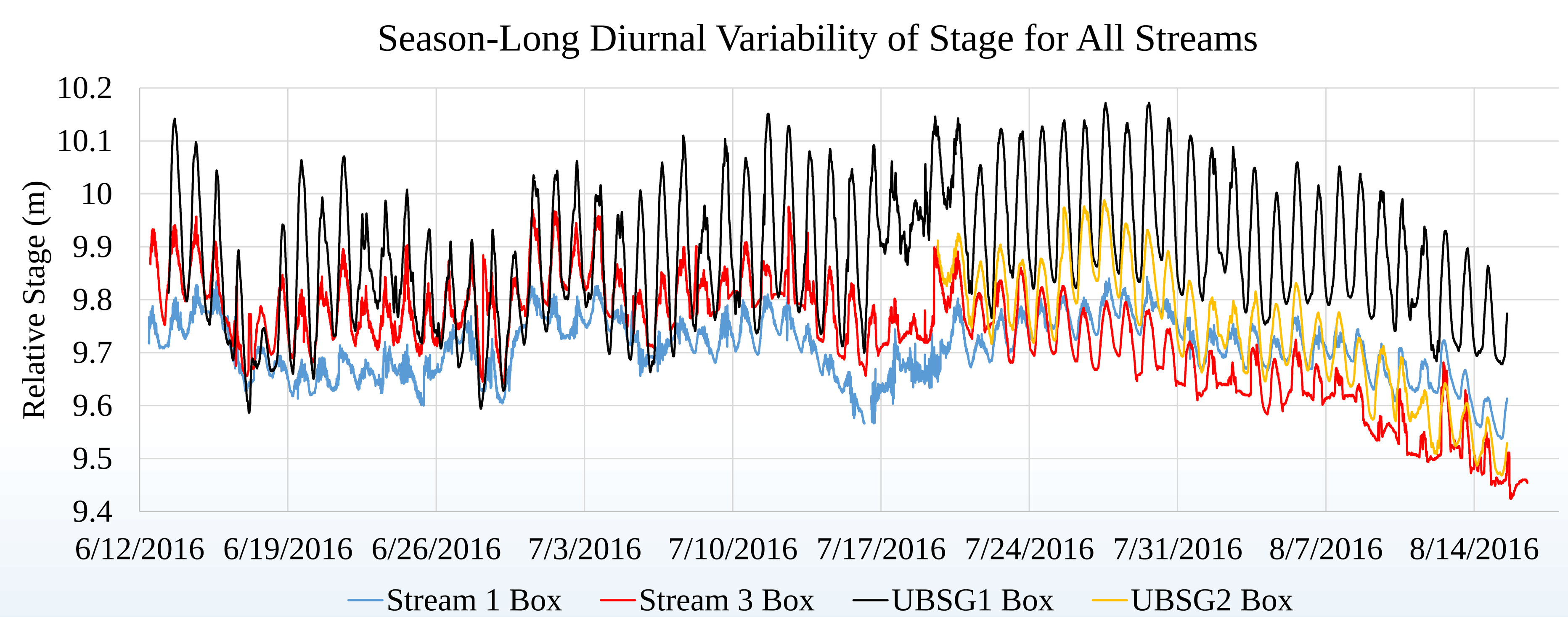

Fig 4: Graph of corrected stage values for the four streams studied throughout the field season of 2016 showing that diurnal variability is more sinusoidal within the upper catchment and daily fluctuations in stage can be as high as half a meter.

Discussion

- Sediment in supraglacial streams has a very low albedo relative to its surroundings and will therefore absorb more solar radiation and enhance melting. Thus, understanding sediment spatial distribution is important for determining controls on the GrIS's surface mass balance.
- The dynamics of supraglacial streams (how they evolve over time, how meltwater reaches the streams, and how streams change due to increased flows) is poorly understood causing inaccurate flow predictions.
- Processes such as shadowing from local ice topography, locally derived wind blown sediment, local weather conditions, and surface slope are likely to influence melt rates but have not been well quantified.

Future Research

- Sediment sample analysis and hydrologic modeling to determine how sediment contributes to surface albedo and how it can be moved by different flows.
- Development of a shadowing map geoprocessing script to determine the effect of ice topography on melt rates.
- Analysis of a catchment scale albedo map based off of hyperspectral and multispectral data and an ablation rate map from SFM data.

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