

Ice Flow Speed Variability of the Vaughn Lewis Icefall, SE Alaska, From Tiltmeters

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Abstract

Icefalls are steep ice flow features that form over steps in bedrock elevation. With their high driving stresses, icefalls have long been assumed to have a constant ice flowspeed. This assumption has not been thoroughly tested as methods using satellite feature tracking rapidly lose coherence and long-term GPS installations on the ground are unlikely to be retrievable. In this study, we test the hypothesis that the Vaughn Lewis Icefall in Southeast Alaska experiences daily velocity variations with daily variations in subglacial hydrology. Using high resolution tiltmeters, we observe change in ice surface tilt across eight days at two sites near the glacier centerline. We find daily variation in ice surface tilt, suggesting there are variations in daily ice flowspeed velocity. A weak and lagged correlation with air temperature suggests that velocity variations may be due to daily variations in subglacial hydrology. Future modeling efforts focused on describing ice flow over icefalls should consider adding daily or seasonal velocity variations. These results additionally have implications for theoretical models of ogive formation, which could result from seasonal flow speed variations across icefalls.

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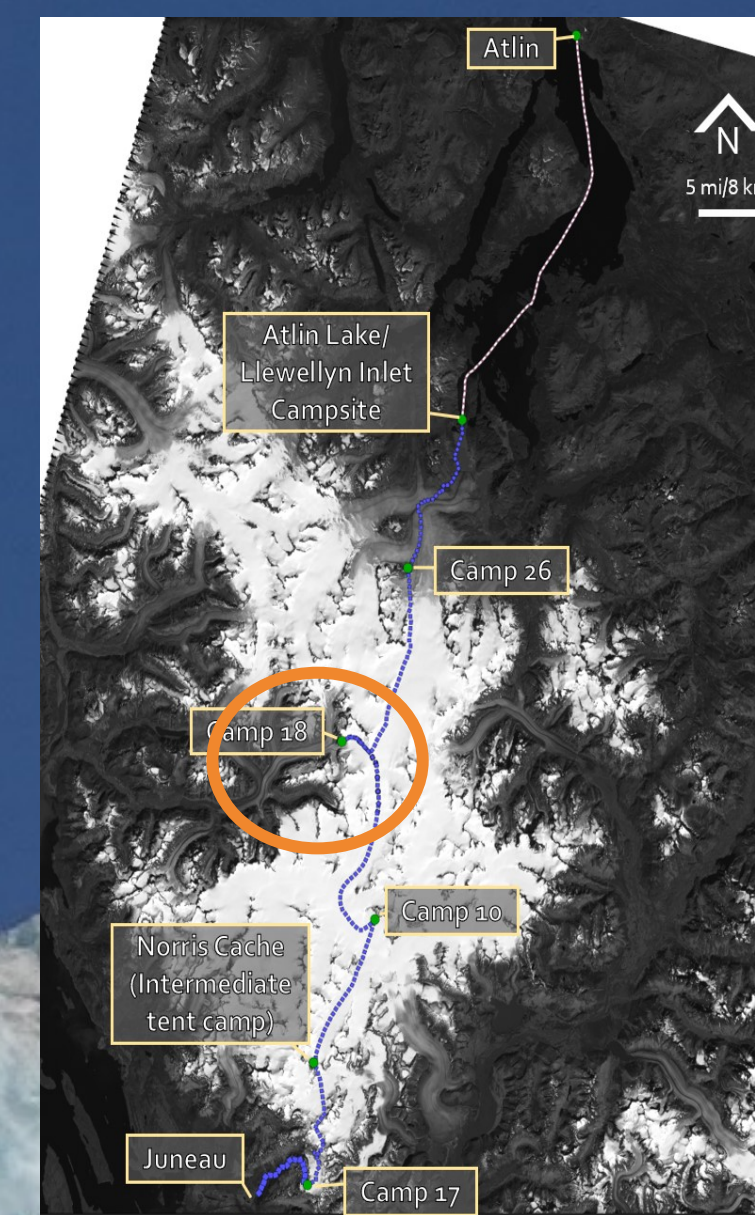
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Introduction

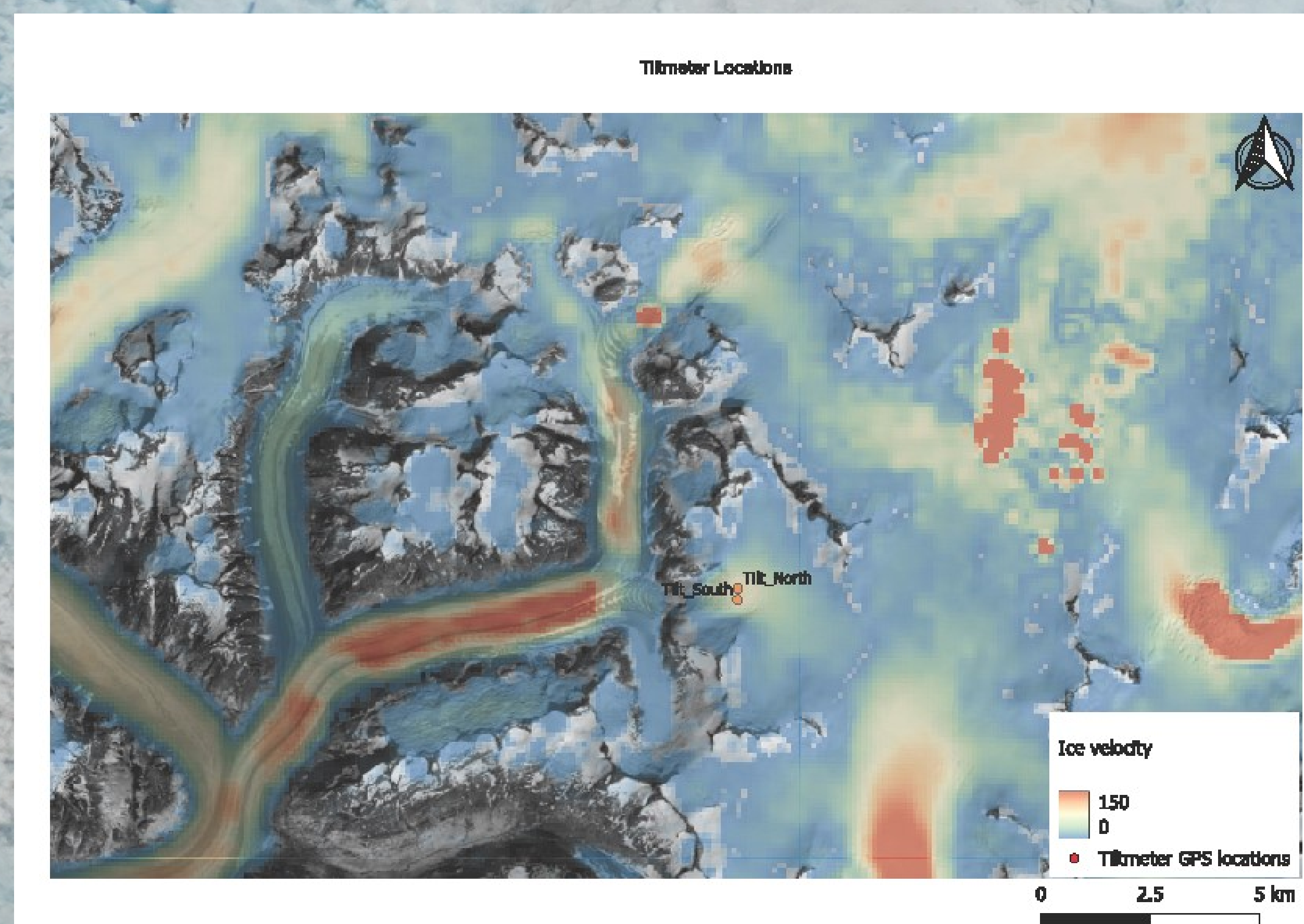
Icefalls are glacial features that occur where a glacier flows over a step in bedrock elevation. The Vaughn Lewis Icefall lies on the Juneau Icefield where the Vaughn Lewis Glacier empties into the Gilkey Trench. Ogives, alternate bands of light and dark ice at the glacier surface, form at the bottom of this icefall.



Motivation

Daily Icefall flow speed has long been assumed to be constant due to their high driving stresses. However, thorough testing of this assumption has not been done since long-term ground GPS are unlikely to be retrievable and methods using satellite feature tracking rapidly lose coherence.

In this study, we test the hypothesis that the Vaughan Lewis Icefall in Southeast Alaska experiences daily velocity variations with daily variations in subglacial hydrology

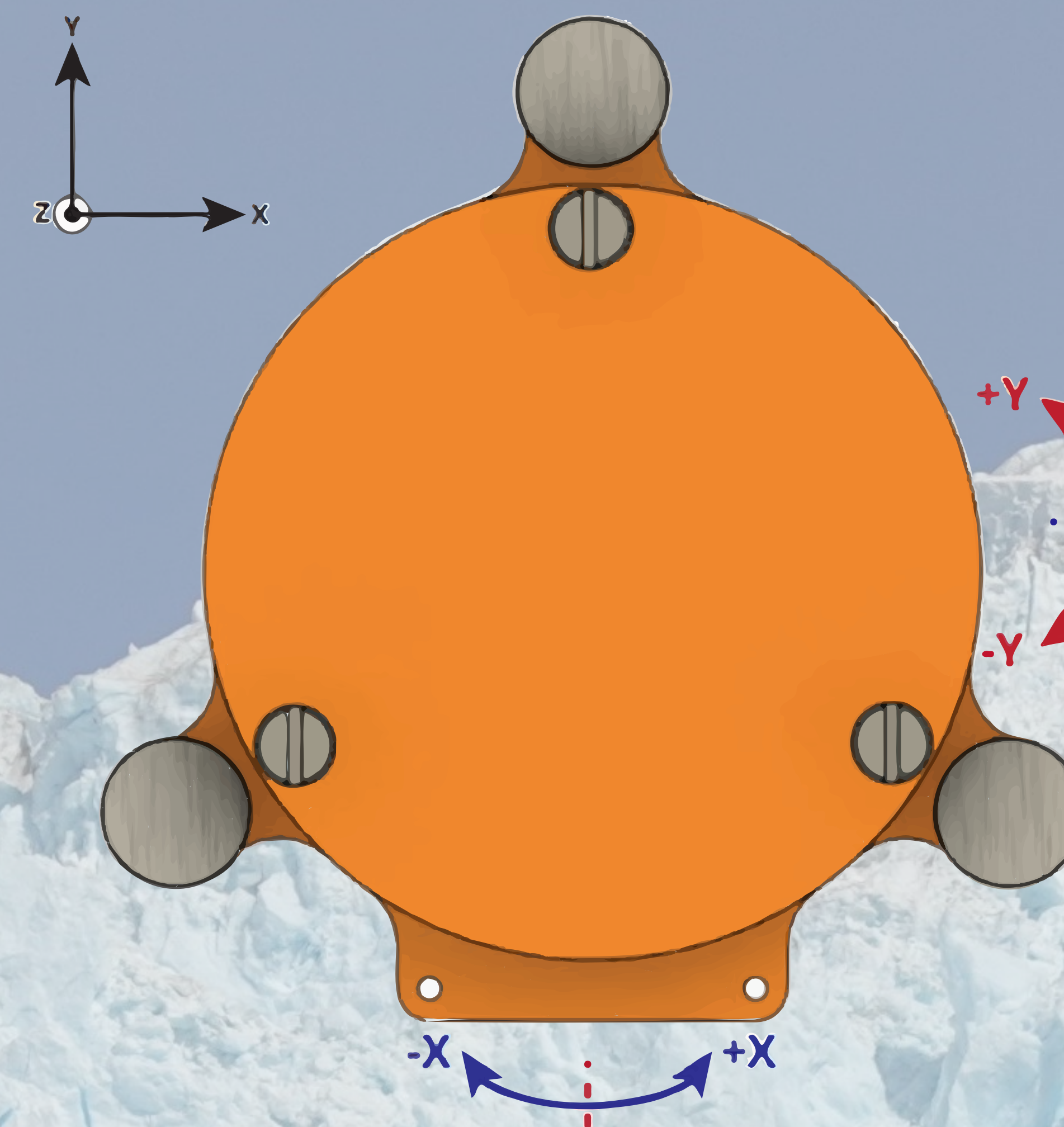


Study Area

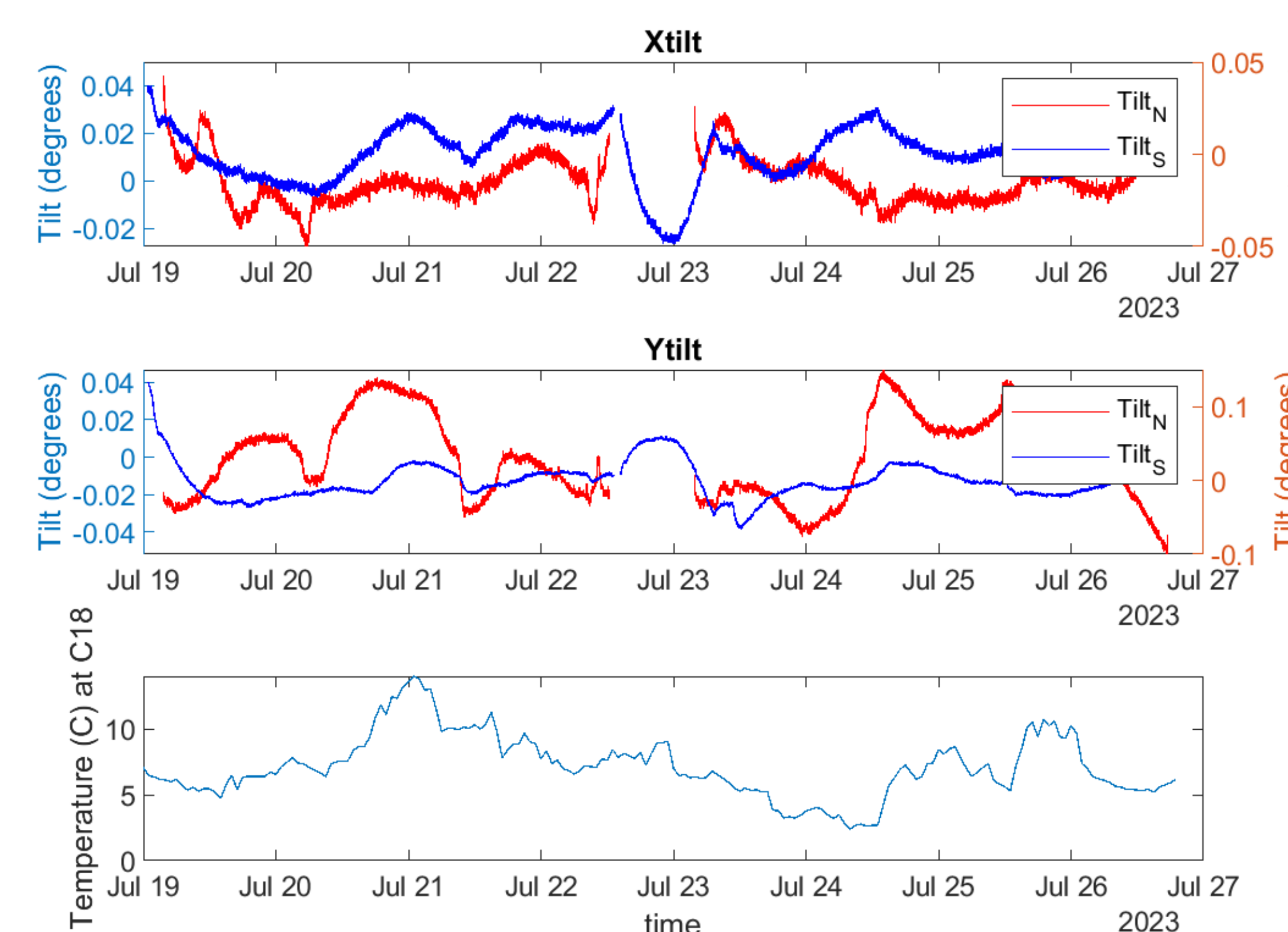
Tiltmeters are installed at two positions (see above) at the top of the Vaughn Lewis Icefall. They are placed to the north and south 200m from the centerline of the ice flow.

Tiltmeter Trends Suggest Daily Variations in Icefall Flow Speed!

What is a Tiltmeter?



The tiltmeter measures the incline or 'tilt' of the surface it is placed on. A positive Y indicates that the front of the tiltmeter has dipped down with a negative Y showing that the back had dipped down. A Positive X indicates the right side of the tiltmeter had dipped and a negative X would be a dip of the left side.



The tilt trends seen in the above graphs show that there are daily variations in icefall tilt, which we hypothesize are due to daily variations in icefall velocity.

Tiltmeter Installation

- Before entering the Icefall, all instruments are checked to insure they will begin collecting data at the time of installation.
- Holes are dug at each study area, approximately .5 meters deep. A board is placed into each hole and leveled to create a stable surface for the tiltmeter to rest on.
- Tiltmeters were deployed such that the X-axis points along the fall line of the icefall.

Installation of South Tiltmeter



Conclusions

- There are daily variations in icefall tilt, which we hypothesize are due to daily variations in icefall velocity
- The changes in flow speed have a lagged correlation with air temperature

What does it mean?

- The weak and lagged correlation between tilt and temperature indicate that the subglacial hydrology could be the main factor in daily ice fall velocity variation.
- The daily and sub-daily variation in icefall velocity has implications for future modeling of icefalls and ogives.

Next Steps

Given the results of this study, we hope to use tiltmeters to continue studying icefall velocity variation.