Temporal Changes of Surface Elevation and Velocity of the Juneau Icefield

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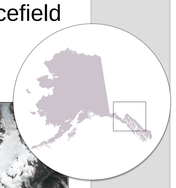
Introduction

Glaciers are retreating at unprecedented rates worldwide. Past studies of the Juneau Icefield show that 50 glaciers have receded, two have remained stationary, and one has advanced. The advancing glacier, the Taku, is the primary glacier of this study. As part of the Juneau Icefield Research Program, glacier surface elevation and short-term velocity are measured annually during the summer season along longitudinal and transv ers profiles using a Trimble Global Positioning System (GPS).

In order to better understand the data we are collecting through our measurements, we have compared our survey results from 2016 to those of recent decades to determine long-term changes in surface elevation and velocity over time. In addition, we have generated a detailed surface model and measured the pattern of local surface flow to constrain the location of the Matthes-Llewellyn divide, to determine if it is migrating through time. These results will help us understand the evolving dynamics of the Taku Glacier and the rest of the Juneau Icefield, while continuing to build a databaset hat can be utilized in future research.

Research Area

The research area for this study was the Juneau Icefield located in Southeast Alaska.



- 3,176 square kilometers total area
- 53 outlet glaciers
- Taku, Llewellyn, and Meade comprise 51% of the total area of the Juneau Icefield
- Data was collected for this study on Lemon Creek, Taku, Matthes, Demorest, and Llewellyn Glaciers.
- A grid was set up at points estimated to be the Matthes-Llewellyn divide

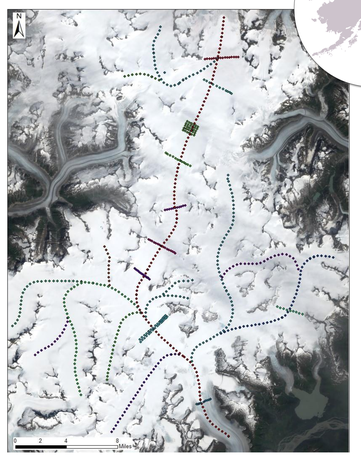
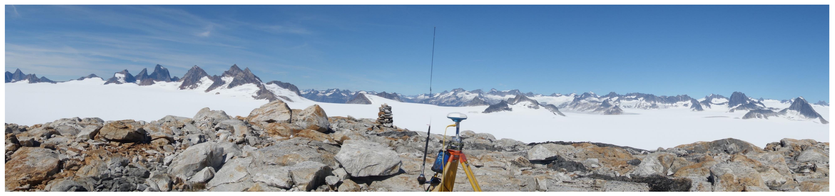


Figure 1: A map of the longitudinal and transverse profiles surveyed on the Juneau Icefield.

Methodology

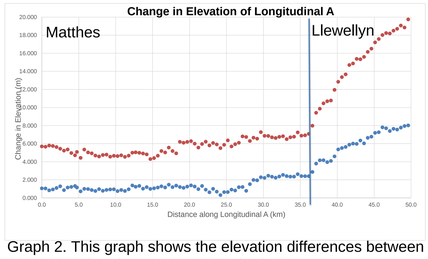
Data was taken by the use of a survey grade Trimble GPS with centimeter accuracy and real time corrections. The survey style used was fixed static which was used to measure longitudinal profiles, transverse profiles, and elevation. The longitudinal and initial transverse profile points were taken within 0.5 meters of the survey point, and transverse profile points were marked with a flag. The second measurements of the transverse profiles were taken at the location of each flag, and the measurements taken were calculated to solve for velocities of the profiles.



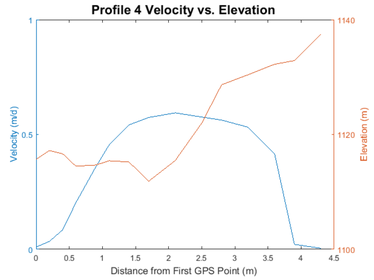
Above: A photo of a base station set up for a day of surveying on the Juneau Icefield.

Results

Graph 1. The graph above shows the elevation change between the years 2000 - 2016 i n 8 year periods along Longitudinal A. The vertical line represents the divide between the Matthes and Llewellyn glacier. The scale of this graph has been modified by a factor of 20 to show greater change.



Graph 2. This graph shows the elevation differences between 2000-2008 (blue) and 2008-2016 (red). There is a five meter difference in change of elevation between the two time periods. This graph highlights that the rate of change has increased exponentially in the past eight years. The vertical line shows t he Matthes-Llewellyn divide.



Graph 3. The above graph shows the velocity o f Profile 4 vs. elevation. It highlights that ve locity is slower at the margins of the glacier.

Discussion

Surface Elevation

- As time progresses on the Juneau Icefield, surface elevation on the glaciers are decreasing.
- Surface elevation decrease on the Taku glacier is representative of the amount of ice mass lost in the vertical direction.
- Graphs 1 and 2 show that based on two eight year time periods, surface elevations along Longitudinal A have significantly decreased in the most recent 8 year time period. Longitudinal A profile points run along the center lines of the Taku connecting into the Matthes-Llewellyn.
- Graph 3 shows that surface elevation increases at the margins, supporting a hypothesis that the Taku is gaining mass from the Matthes and other branches of the Taku.

Velocity

- The velocities of the Taku glacier are larger in the center of the glacier and slower along the margin.
- This is due to higher friction and less mass along the margins as compared to the center line of ice flow.
- Velocity measurements can be used in many glaciological calculations including erosion rates, ice thickness, and mass transport.

Conclusion

The overall surface elevation of the Juneau Icefield glaciers has been in a period of decline. These changes are attributed to the warming climate that leads to a later and shorter accumulation season and a earlier and longer ablation season.

The velocities of the Taku glacier show that it has currently slowed its advance to a stable position, and is no longer advancing. This is a pivitol time to continue research on the Taku Glacier to record it's behavior in the next decade. Understanding what happens to the Taku in this period will help in future research towards glacier dynamics around the world.

References

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2. Whitehead, K., Moorman, B., and Wainstein, P. 2014, instruments and Methods: Measuring daily surface elevation and velocity variations across polythermal arctic glacier using ground based photogrammetry, *Journal of Glaciology,* v.60, no. 224