Analyzing the Extent of Tyndall Glacier

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GEOG 293 Intro to Remote Sensing

Introduction

- Glaciers affected by several environmental conditions that increase and decrease their overall volume and extent.
- Temperature is a large contributor to glacial melt. As climate change increases the overall temperature of the globe, especially in the Arctic region, glaciers are melting faster than the snow accumulation.
- When land glaciers melt into the sea, they contribute to sea level rise and introduce freshwater into the marine system which has numerous biological and physiological impacts.

Tyndall Glacier

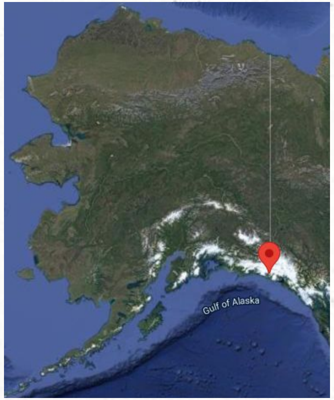
Objectives

Determine the snow gain, loss, and persistence from 2015 to 2020

Calculate the area of the glacier from 2015 and 2020

Correlate the gains and losses through snow accumulation measurements and degree days

Study Area



Tyndall Glacier, Alaska

True Color Composite 234

Throwback...

Aerial Image of Tyndall Glacier 07/07/1983

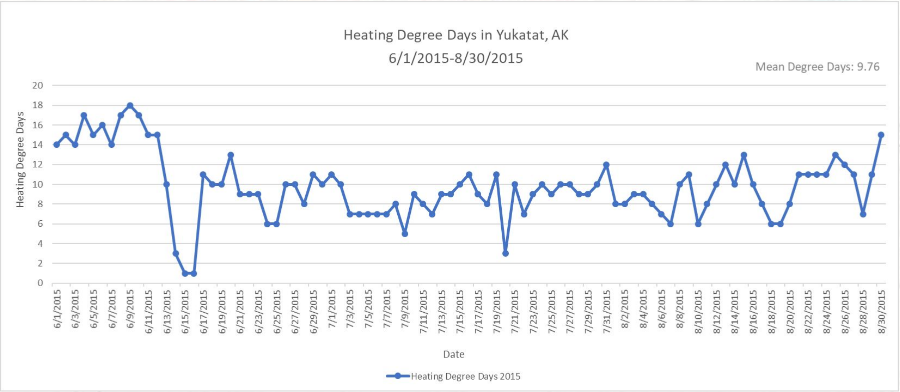
Degree Days

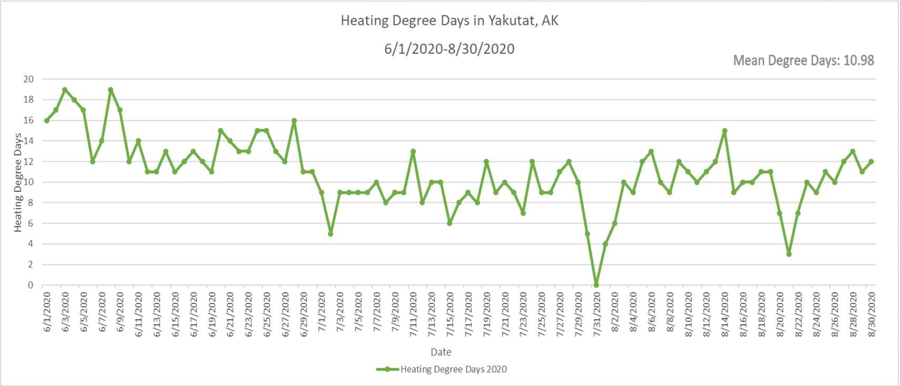
Heating degree days: number of degrees required to raise the ambient temperature to 0°C

More heating degree days implies cooler average temperature

2015
Mean degree days = 9.76

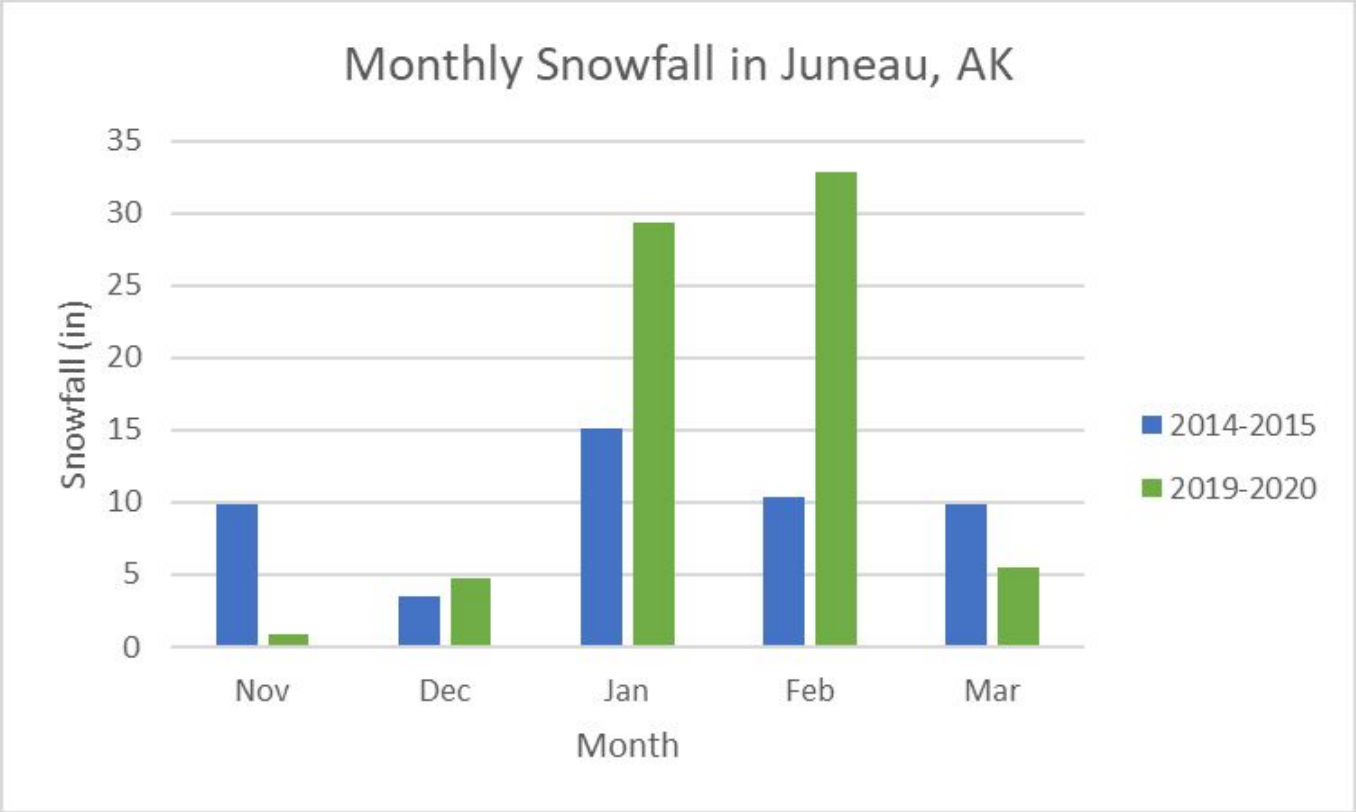
2020
Mean degree days = 10.98





Source: Alaska Climate Research Center

Snow Accumulation



2014-2015
Total Snowfall = 48.6 in

2019-2020
Total Snowfall = 73.3 in

Data

Google Earth Engine (Link)

- Landsat 8 (Bands 1-7)
- Polygon of study area
- TOA: Corrected for some clouds
- Time period 1: 2020-06-01 ↠ 2020-08-30
- Time period 1: 2015-06-01 ↠ 2015-08-30

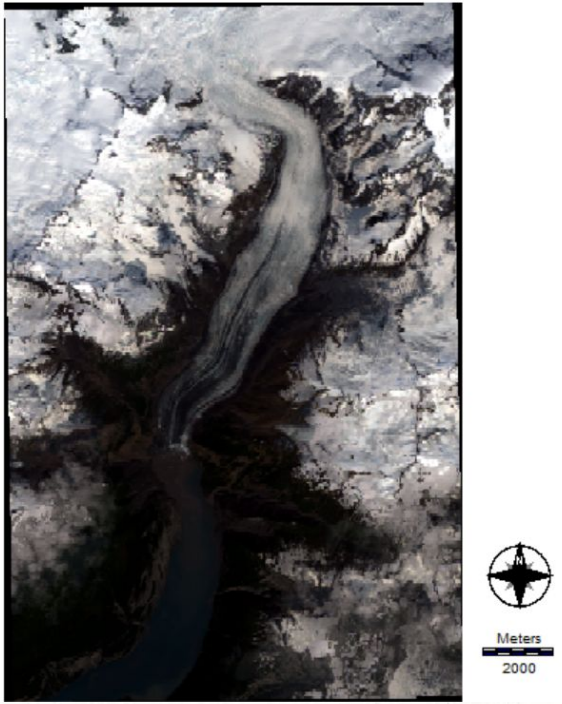
TerrSet

- Downloaded as .tif for 2015 and 2020
  - Scale: 30
- Imported into TerrSet
- Projected to SPC83AK2

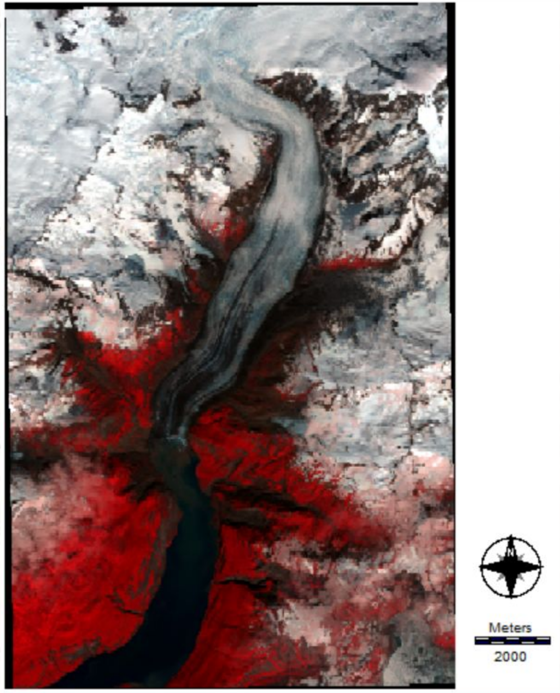
Landsat 8 Bands

- Band 1: Coastal aerosol
- Band 2: Blue
- Band 3: Green
- Band 4: Red
- Band 5: NIR
- Band 6: SWIR 1
- Band 7: SWIR 2

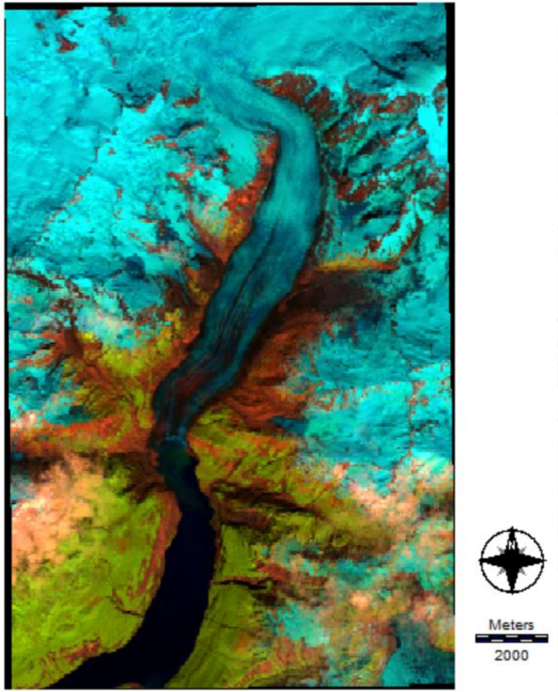
2015



TCC - 234



FCC - 345

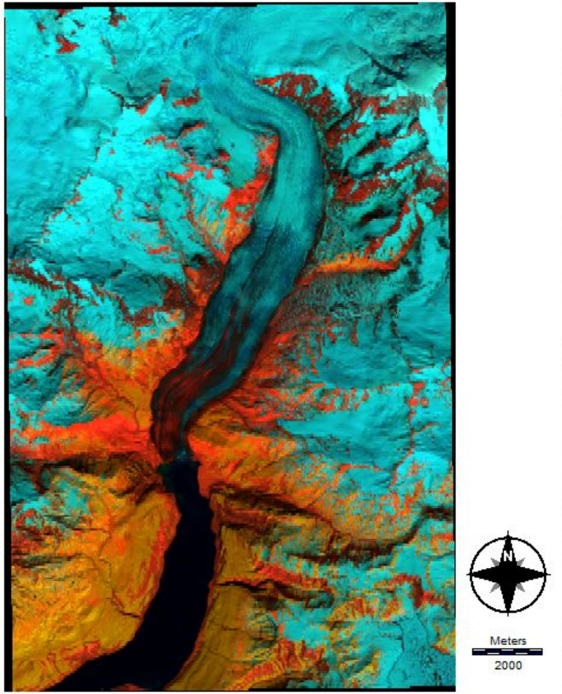


FCC - 356

2020

TCC - 234

FCC - 345

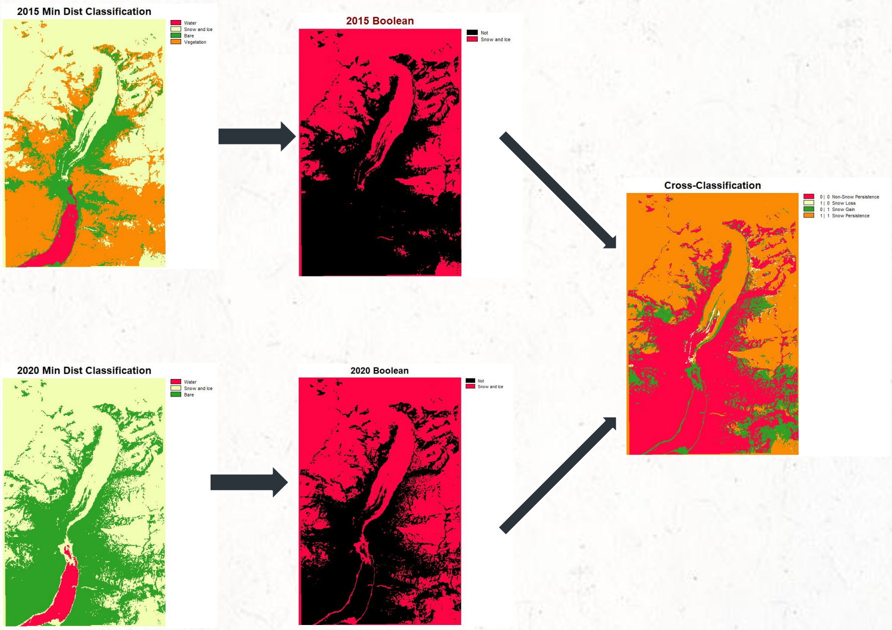


FCC - 356

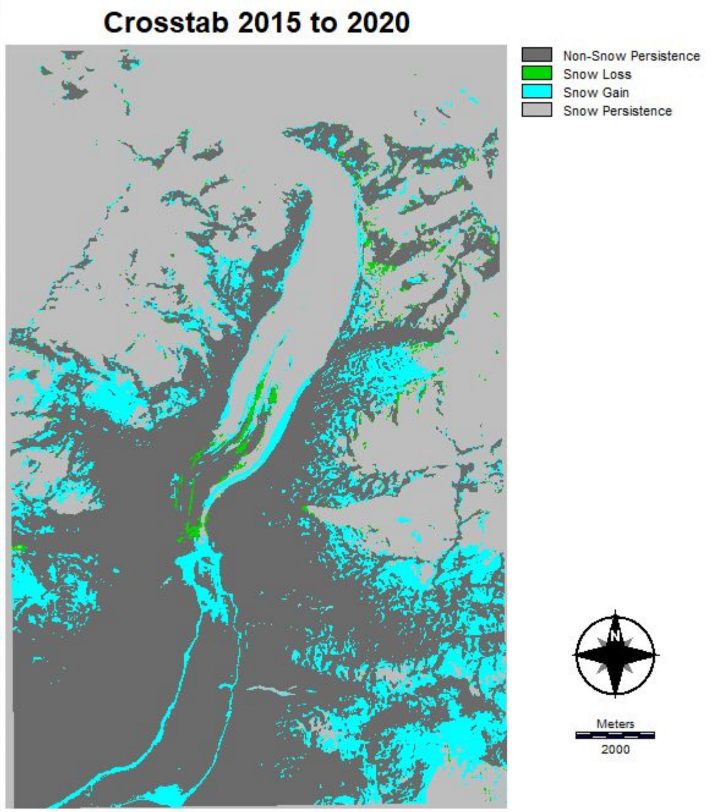
Snow Gains and Losses Methods

Snow Gains and Losses

- Open FCC - 356 for 2015 to create specific training sites
  - Training sites = Snow and Ice, Bare, Vegetation, Water
- Minimum distance classification
- Reclass for boolean of just snow and ice
- Open FCC - 356 for 2020 to create specific training sites
  - Training sites = Snow and Ice, Bare, Water
- Minimum distance classification
- Reclass for boolean of just snow and ice
- Crosstab both booleans



Snow Gains and Losses Results



Category	Square meters	Legend
1	98089502.495778	Non-Snow Persistence
2	1886576.324214	Snow Loss
3	26918572.265793	Snow Gain
4	104120913.783887	Snow Persistence

Category	Square kilometers	Legend
1	98.089502	Non-Snow Persistence
2	1.886576	Snow Loss
3	26.918572	Snow Gain
4	104.120914	Snow Persistence

Snow Gain 26.92 square kilometers

Glacial Area Tracing Methods

- Downloaded ORI data from https://elevation.alaska.gov/
- Downloaded DEM data from Index of /public_lidar/dds4/ifsar/dtm/ (alaska.gov)
- Imported multiple images
- Brought ORI and DEM into ArcPro
- Used images as reference to trace glacial extent polygon
- Attempted to import to Terrset
- Attempted to calculate the area of the polygon

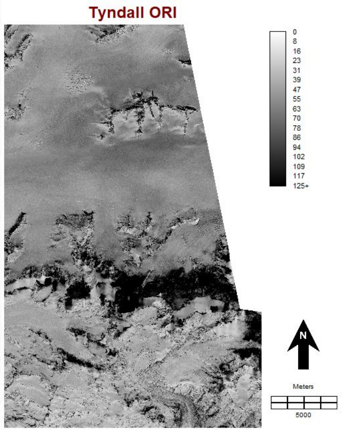
Qualitatively Identifying Tyndall in Radar Data

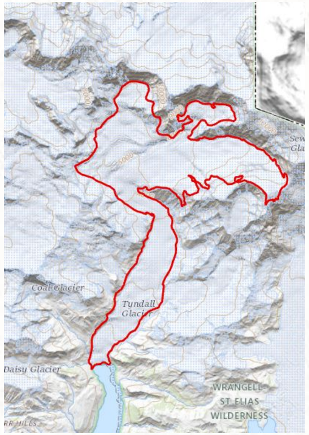
Orthorectified Radar Images are a form of radar data particularly appropriate for acquiring data in areas with consistent cloud cover, which is particularly appropriate for our study region.

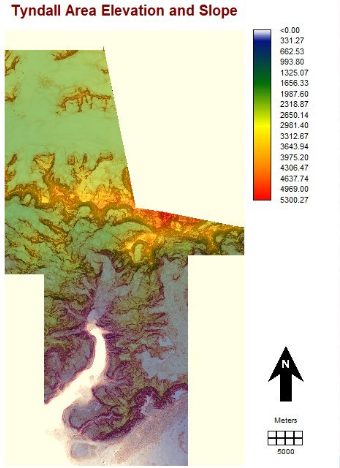
We used a DEM Mosaic, slope calculated from this mosaic, and an ORI image (far left) for the region to qualitatively observe the bounds of the glacier.

Displayed on the far right is a combination of the elevation and slope of the Tyndall area created from the DEM. While there are not any quantitative strategies we know of as a group to extract glacial extent from this map, the effects of glacial erosion leading to steep slopes bounding the edges of the glacier are clearly visible- allowing the glacier's extent to be eyeballed by the user. We attempted to trace this visible extent in ArcPro such as to calculate the area of it, but were unable to flesh out this method due to issues with transferring vector data between ESRI and IDRISI software. The tracing is displayed below.

Our group originally hoped to use only classification methods covered in class but found our results to be difficult to interpret/inconclusive and the extent so visibly clear in the radar data that we found it worthwhile to attempt tracing the extent and calculation area from that.







Discussion

- 2020's winter experienced significantly more snowfall than 2015's. Much of the snowfall was in the surrounding areas while the snow loss was concentrated at the mouth of the glacier. This likely contributed to the 25 km^2 increase in snow and ice extent.

- 2015 had a lower mean amount of heating degree days which means that it experienced warmer temperatures than 2020. This also likely contributed to the lower amount of snow in 2015.

- We originally anticipated a glacial or snow/ice decrease due to climate change. In the end, the yearly environmental conditions had a greater effect on the snow and ice extent than the longer term climate trends.

Limitations

Snow Gains and Losses

- Classification between snow and ice was difficult
  - Snow and ice grouped together for total area gain
- Classification overlap between edges of water and ice
  - Adding another water edge training site classified the darker glacial areas as water
- Our time period was only 5 years
  - We wanted to keep the years we chose in Landsat 8 for preprocessing purposes.

Snow Accumulation

- No 2020 snowfall data for Yakutat, AK ⤜ used Juneau, AK

Glacial Area

- Wasn’t able to calculate area
- Only used ORI and DEM which was not temporally different

Thank you

References

Google Earth Engine Code Link
Provided by Florencia Sangermano
https://code.earthengine.google.com/?scriptPath=users%2Fflorsangermano%2FGEOG293%3ATyndall

State of Alaska. Division of Geological and Geophysical Surveys, Elevation Portal, IFSAR, ORI
https://elevation.alaska.gov/

Alaska Climate Research Center, Data Portal, Snowfall and Heating Degree Days
Data Portal – Alaska Climate Research Center (akclimate.org)

Alaska.gov, Index of Public Lidar, DTM data
Index of /public_lidar/dds4/ifsar/dtm/ (alaska.gov)