Change Detection in Arctic Lakes with the NASA Arctic and Boreal Vulnerability Experiment (ABoVE) Project

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1. Problem

- NASA Arctic and Boreal Vulnerability Experiment (ABoVE) researchers want to examine changes in individual Arctic lakes over the past 35 years.
- Hard to display 24,000+ Alaskan lakes on a single view and allow drill-down to individual lakes
- Landsat satellites collect data for each lake every 15 days but heavy cloud cover obscures the lake surface >60% of the time.
- Careful filtering needed to remove cloudy scenes while ignoring bright (e.g., snowy) land.
- Landsat data files are large, requiring cloud computing resources to view them quickly, remove cloudy images, and zoom to lake level.

- Google Earth Timelapse enables rapid viewing of high-quality satellite imagery for a given location over time but is unsuitable for our technical audience who use different methods for generating annual composites and want to inspect timeseries from individual bands of the satellite

- <u>Solution</u>: A data visualization framework that allows quick exploration of 7 Arctic lakes of interest to our collaborator, which can be easily scaled up to include any other lakes of interest to the broader, technical audience of the ABoVe science team.

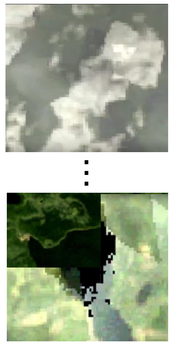
2. Motivation

- Arctic is warming 2x faster than the global average[1].
- Arctic lakes are an understudied piece of high-latitude carbon budgets with important carbon sequestration potential and greenhouse gas fluxes.
- Changes in these processes can be studied via observations of lake color and size.
- Field work is difficult in this region so using satellite measurements is preferred.
- Satellite data over lakes needs careful calibration and correction since features are small and optically complex.

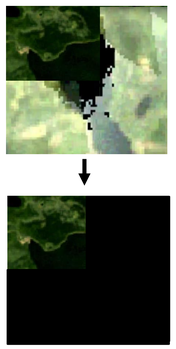
3. Approach

- We completed the following process in Google Earth Engine (GEE) for each of the seven lakes of interest for our project.
- Completing these steps in GEE made the process substantially faster since all of the imagery and computations were handled on their servers.

Data Wrangling, Clean-up, and Visualizing

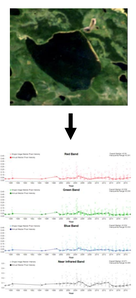


1) Start by pulling all available images taken over the lake area from 1984 to 2018 by Landsat 4, 5, 7, and 8 (~840 images). Images are taken roughly every 15 days at 30-meter resolution.

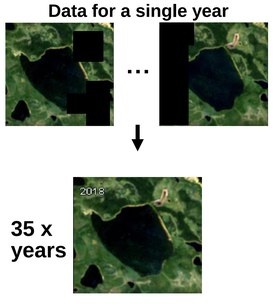


2) Mask out clouds which cover the lakes >60% of the year.

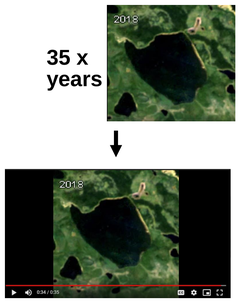
3) Apply small color correction to Landsat 8 to better match up with previous satellites[2].



4) Export median values of red, green, blue, and near infrared bands over entire lake area for each remaining good image.



5) Compute median value for each pixel within the lake area across an individual year to create an annual composite (35 images).

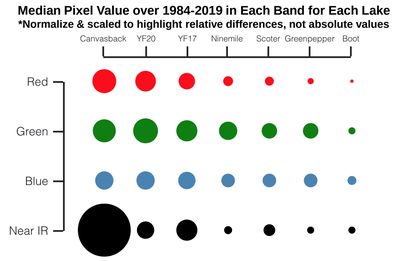


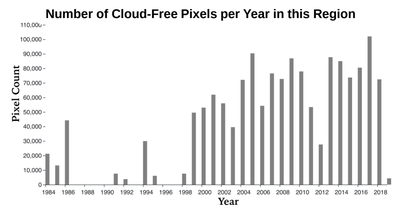
6) Stitch together annual composites into video for each lake at 1 frame per second and brighten to appropriate viewing levels.

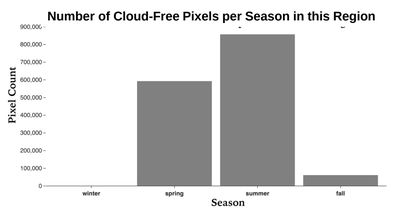
4. Results

- This data exploration tool will aid the technical audience of the NASA ABoVE science team in their analysis to detect changes in Arctic lakes.
- Users will be able to quickly drill-down on individual lakes and compare between lakes through this interactive webpage instead of via scripting in GEE or in other client-side heavy tools, which will speed up their analysis pipeline substantially.

Overview of Full Dataset

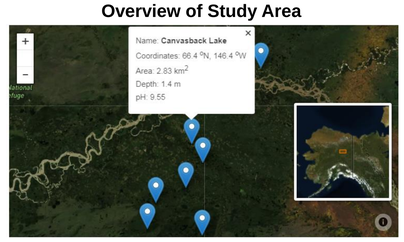






Drill-Down to Specific Lake

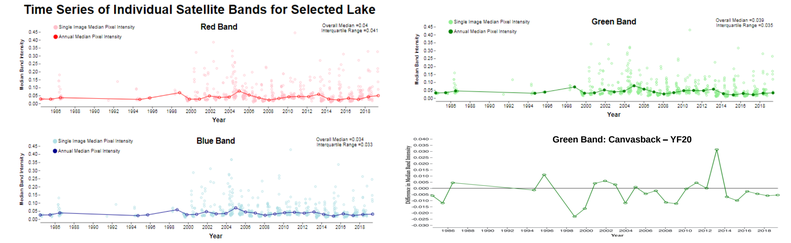
Overview of Study Area



Satellite Imagery of Selected Lake over Time

Keep your eye out for changes in color and size of lake. Fire damage in the greenery surrounding the lake (i.e., a sudden shift to red or tan earth) can also be seen.

Time Series of Individual Satellite Bands for Selected Lake



References

1) Serreze, M. C., and R. G. Barry (2011), Processes and impacts of Arctic amplification: A research synthesis, *Glob. Planet. Change*, *77*(1–2), 85–96, doi:10.1016/J.GLOPLACHA.2011.03.004.

2) Roy et al., 2016, Characterization of Landsat-7 to Landsat-8 reflective wavelength and normalized difference vegetation index continuity, Remote Sensing of Environment, 185, 57- 70, doi:10.1016/j.rse.2015.12.024.

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