

# Does GLOBE Observer photo data add value to the satellite data being collected on freshwater ice cover?

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## Introduction

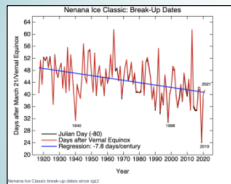


Figure 1. Date of the Nenana Ice Classic break-up over the last 104 years (1917-2021). The date is earlier on average by about one week over the time period<sup>1</sup>.

A changing climate has influenced both our river and lake ice and our ability to observe them from satellites. The duration of the freshwater ice season is getting shorter<sup>1</sup>, and the timing of ice freeze-up and break-up is a sensitive indicator of climate change (Fig. 1). At the same time, cloud cover is increasing as temperature warms in the Arctic, making ice observations from space more challenging. The UAF Fresh Eyes on Ice program has launched a campaign to collect photos from community members across Alaska to improve the data available on river and lake ice conditions. We investigated whether this citizen science data is actually adding anything to the data already available from satellites.

## Questions and Hypotheses

**Q1: How do GLOBE Observer photos taken by community members compare to satellite images taken by Sentinel 2 on the same date for that location?**

- H1: The satellite images will be fairly accurate and match the photos. This is based on an optimistic assessment of satellite technology.

**Q2: Did the photos add observations that couldn't be captured by the satellite?**

- H2: There will be a high proportion of cloudy days and the photo observations could help fill in gaps on cloudy days. The photos will not add very much in the quality of observation. This is because of the fact that the photos were taken with cell phone cameras, which are likely to take photos that aren't very detailed - especially in poor weather conditions.

**Q3: Are lakes or rivers more accurately captured by the satellite images?**

- H3: Lake ice observations are more likely to agree with satellite images than river ice observations.

## Methods

- We retrieved all GLOBE Observer Landcover Photos<sup>3</sup> that have been submitted to the UAF Fresh Eyes on Ice program from 20 Dec 2020 through 21 Feb 2022 (totalling 198 observations and 792 photos). We ourselves contributed ice photos using the app.
- We selected 80 observations (4 photos each) to analyze and retrieved the corresponding Sentinel 2 image for the location and date using Sentinelhub Playground<sup>4</sup>.
- We classified each pair of photo and satellite observations as either a match (i.e. photo and satellite image show same interpretation, Fig. 2), mismatch (i.e. photo shows open water and satellite does not, or photo does not show open water and satellite does, etc.), cloudy satellite image, or no satellite image available on date.
- We calculated the percentage of classifications in each category and compared the frequency of the classifications between river and lake ice.

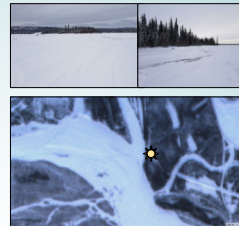


Figure 2. Example of a match between the ground photo and satellite image observation of river ice. GLOBE Observer Landcover photo taken on 8 Feb 2022 at the confluence of the Chena and Tanana Rivers near Fairbanks Alaska facing west (top left) and south (top right). Matching Sentinel 2 satellite observation (bottom) with location of where the photos were taken indicated by the star.

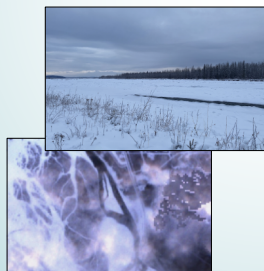


Figure 3. Example of a mismatch. GLOBE Observer photo Tanana River off the Richardson Hwy near Satcha shows little to no open water, while Satellite image shows large stretch of open water on 5 December 2021.



Figure 4. Example of a photo adding data that couldn't have otherwise been captured by satellite. GLOBE Observer photo of Dasher Lake near Cantwell was solid ice, while the satellite saw only clouds on 6 Feb 2022.

## Discussion

**Q1: GLOBE Observer Photo and Satellite Image Comparison**

41% of the 80 photo and satellite image pairs were a good match, while 23% showed some sort of mismatch in interpretation of ice cover and open water. We think this is largely due to the geometry and visibility of linear features of rivers, which we investigate in Q3 below.

**Q2: Novel Information from Photos**

We were surprised to find that the photos, despite the potential for low quality photos on cell phones, did provide noteworthy observations that the satellites couldn't provide. As we expected, the novel data was provided primarily on the cloudy days, and a few were due to a total lack of satellite data on the date. The photos will provide a way to better capture the freeze-up stages or exact ice-off dates during cloudy periods. A few of the photos and satellite images were taken in twilight hours and made the quality of observations poor. The having both types of observations can help improve the interpretation of these images, providing a cross check for each other. The GLOBE Observer photos also provide local context for the satellite images and give the ability to take a close look at the immediate surroundings.

**Q3: Lakes vs. Rivers**

For lakes, we found the photos and satellite images to be consistent. They always matched each other, unless the clouds completely covered the satellite view. However, when it came to river ice, we found that the personal observations were showing white ice conditions where the satellite images were showing dark unfrozen. The braided channels and linear nature of many open water holes made it hard for the GLOBE Observer photos to clearly capture the status of the location. Most of these observations in the sub-sample were mid-winter. We think that the much clearer events, such as break-up may have a better match rate with the satellite imagery, since it is easier to see this from the bank.

It is particularly important for us observe with photos during fall freeze-up and spring break-up, where knowing the exact date or length of the process can tell us a lot about our changing climate. The cloud cover can be increased in spring due to tree leaf out and the photo observations could help account for the decreased satellite visibility.

## Results

Percentage of GLOBE Observer and Sentinel 2 Satellite image pairs accurately matching, inaccurately matching, or adding data unavailable by the satellite (n=80)

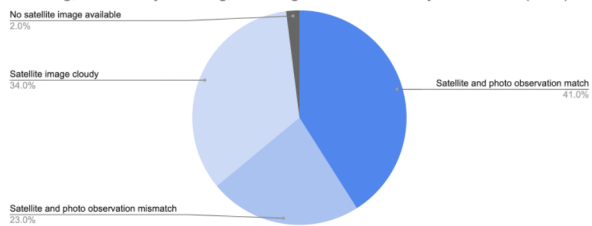


Figure 5. Percentage of photo and satellite image pairs matching, mismatching, cloudy, and without satellite data (n=80 observation pairs).

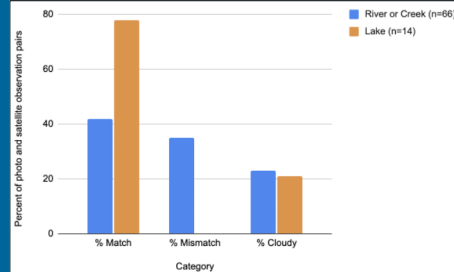


Figure 6. Percentage of photo and satellite image pairs matching, mismatching and cloudy in lake and river ice observations (n=80 observation pairs).

## Further Directions

This is the first attempt at quantifying the value of GLOBE Observer photos to ice observing in Alaska. We think it would be good to conduct this study again in the future, particularly if cloud cover is expected to increase.

## Acknowledgements

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Works cited:  
<sup>1</sup> Vargo et al., 2020. The past and future of Global River Ice. *Nature* 577:69-73.  
<sup>2</sup> Sentinel 2. 2021. *Nenana Ice Classic data update 2021*. [https://www.researchgate.net/publication/350424944/nenana-ice-classic-2021/](https://www.researchgate.net/publication/350424944/nenana-ice-classic-2021)  
<sup>3</sup> Retrieved from the GLOBE database at <https://globe.noaa.gov/>  
<sup>4</sup> Retrieved from Sentinelhub Playground <https://www.sentinelhub.com/sentinelconsole/>

