Final Results from the Circumarctic Lakes Observation Network (CALON) Project

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Overview

- About half of the Arctic Coastal Plain (ACP) of Alaska is thermokarst lakes and drained lakes over permafrost (**Figure 1**)
- In April 2012, over 55 lakes in northern Alaska were instrumented for CALON, a project designed to monitor physical and biogeochemical processes in Arctic permafrost lakes
- Ten observation nodes along two ~ 200 km latitudinal transects from the Arctic Ocean to the Brooks Range foothills. At each node, six representative lakes of differing area and depth were instrumented to collect field measurements on lake physiochemistry, lake-surface and terrestrial climatology, and lake bed and permafrost temperature
- Each April, temperature and depth sensors are deployed through the ice, and water samples are collected
- Data are downloaded from lakes and met stations in August, recording a timeline of events including ice decay, summer energy and water balance, freeze-up and ice growth
- Discrete samples and measurements of geochemical and biogeochemical parameters in April and August
- Project includes an indigenous knowledge component, with interviews of elders, hunters, and fishers from four Arctic villages

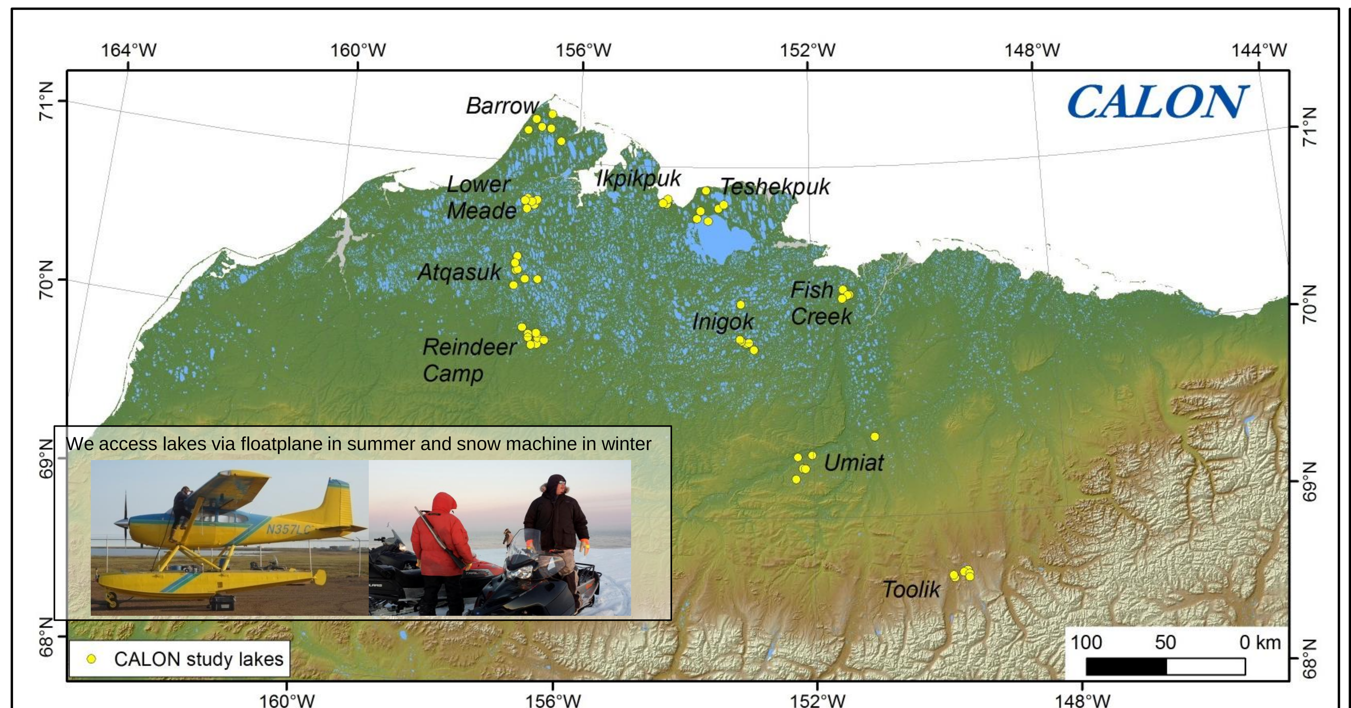


Figure 1. Location of monitoring hubs in two transects; each hub has a terrestrial met station. ~ Six lakes are monitored at each hub, with basic instrumentation at all lakes and enhanced instrumentation at two lakes per hub. At Barrow, Atqasuk and Toolik, intensive instrumentation at "Focus Lakes" measures water and energy balance throughout summer.

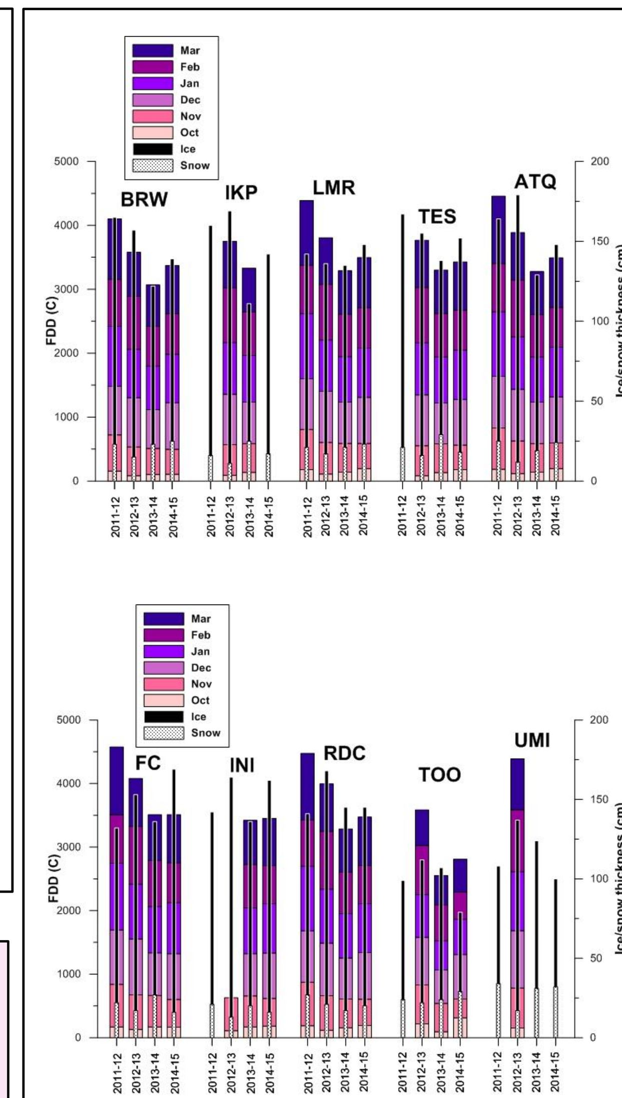


Figure 2. Winter severity as expressed by sum of monthly Freezing Degree Days for all nodes. Ice thickness and snow depth also shown as average for all six lakes.

Winters generally warmed during the first 3 years, and ice thickness declined. Winter 2014-15 slightly reversed this trend. Early snow accumulation explains some of the interannual and intersite variability.

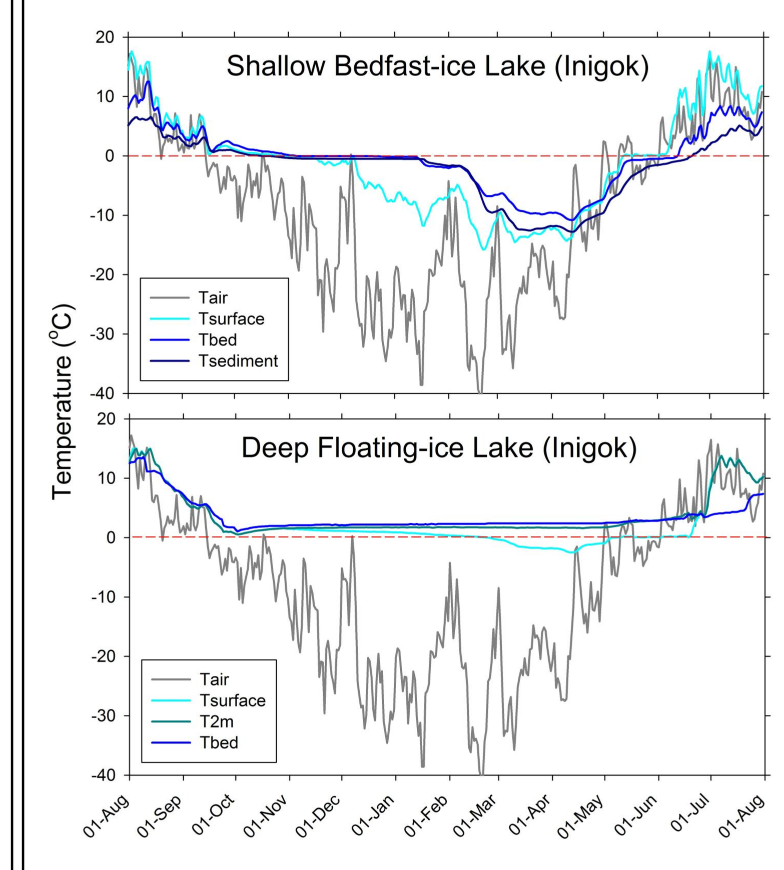
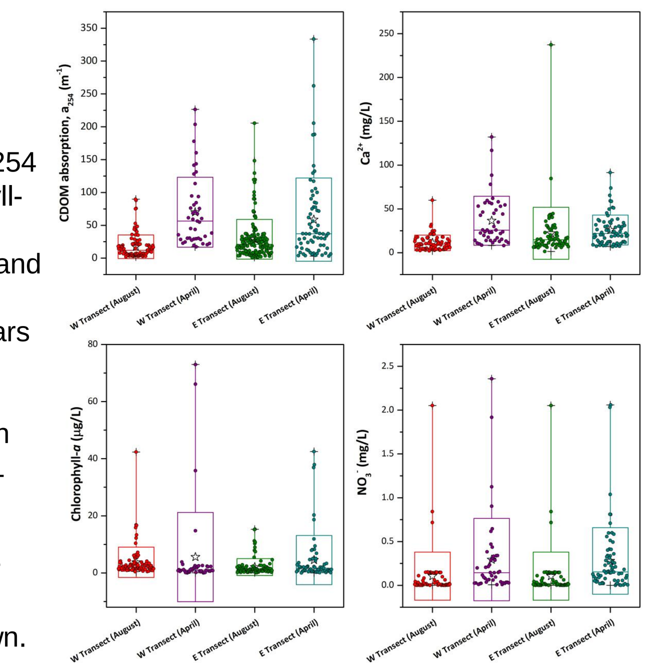


Figure 3. Thermal regime of shallow and deep lakes over annual cycle shows fundamental differences. Deep lakes (> 2 m) have a floating-ice cover and lake bed temperatures that remain above freezing. More lakes are transitioning to this mode as the climate warms and lake ice thins.

Figure 4. Concentrations of chromophoric dissolved organic carbon (CDOM) at 254 nm, Ca^{2+}, chlorophyll-*a*, and NO_3^- in lakes during both August and April along CALON transects for the years 2012, 2013, and 2014. The mean (open stars), median (horizontal lines), ±1 standard deviation (boxes), and total range (whiskers) for each sample population are shown.



CDOM absorption is higher during April compared to August, likely resulting from lower rates of photodegradation and bacterial decomposition during winter months. Similarly, most major elements analyzed show higher concentrations during April compared to August. Ca^{2+} is shown here as an example of how most cations/anions are found to behave seasonally and across the two transects. Chlorophyll-*a* concentrations are found to be slightly higher during April compared to August, likely resulting from the presence of higher concentrations of nutrients (e.g., NO_3^-) in the water column. Although ice is still present on the lakes during April, light transmittance through the lake ice seems to be sufficient for primary production to take place in these lake waters.

Figure 5. Dissolved organic carbon and total dissolved nitrogen for spring (April, under ice) and summer (August) in three years. The bars are averages and the error bars are the standard deviation. The lakes are organized from north to south (approximately).

Want to learn more about CALON at AGU?

B31C-0562: Akerstrom et al., Carbon cycling-climate change feedback of thawing permafrost in Arctic Alaskan lakes: Monitoring methane emissions. Moscone South Poster Hall, Wednesday AM

ED43D-0886: Eisner et al., Twelve Years of Interviews with the Inupiat people of Arctic Alaska: Report from a Community Workshop . Moscone South Poster Hall, Thursday PM

C21C-0754: Arp et al., Ice regime and melt-out timing cause divergent hydrologic responses among Arctic lakes. Moscone South Poster Hall, Tuesday AM

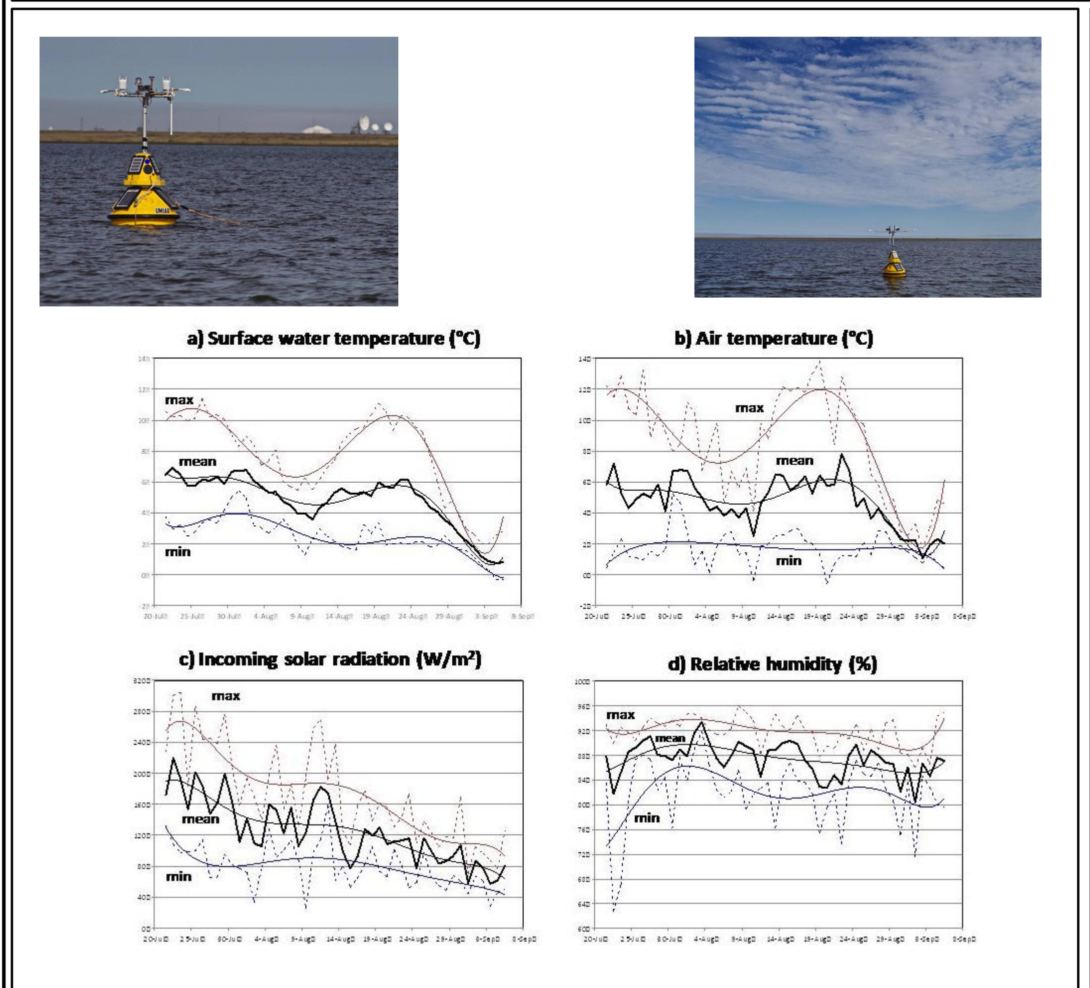


Figure 6. Illustration of the large interannual variability among study years (2012-2015) for Emaiksoun Lake (Barrow, Alaska). Shown are the 4-year mean, maximum, and minimum values of daily mean a) surface water temperature, b) air temperature, c) incoming solar radiation, and d) relative humidity, as measured from a data buoy deployed in the middle of the lake. Note the wide range of values among years, particularly early in the summer, immediately after ice-off. Water temperature is notably less variable than air temperature, due to thermal inertia and competing influences from other climatic factors, but both temperatures show a similar seasonal cycle. The large interannual variability illustrated here highlights the need for continued, long-term monitoring to detect climate-related trends in lake dynamics and hydrologic drivers.

We hope that future iterations of CALON will include the entire Pan-Arctic. Please contact us if you would like to be involved!

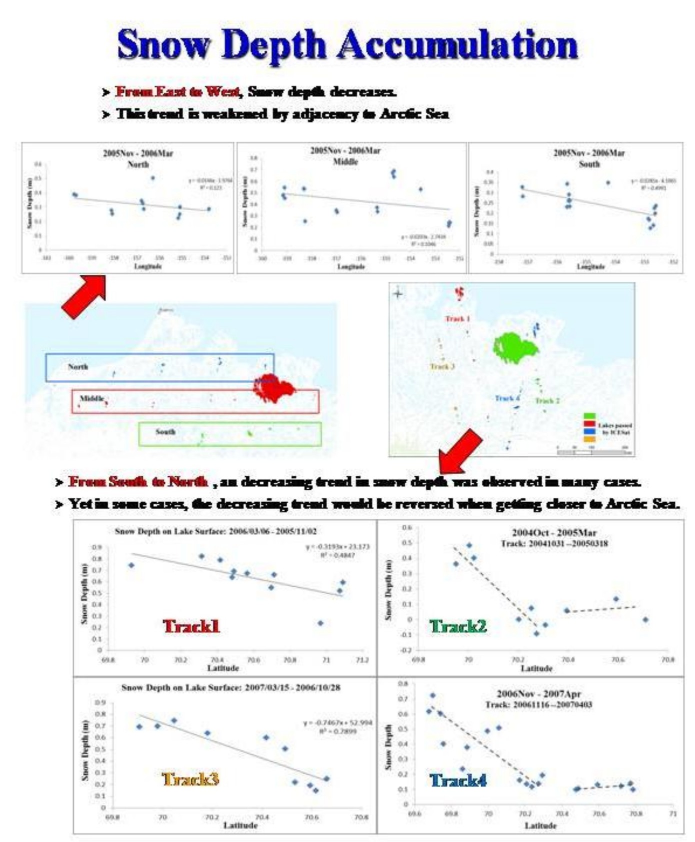


Figure 7, above

Snow depth derived from satellite imagery across latitudinal bands. Snow depth generally decreases from east to west across all three bands, and from south to north. However, there is a slight increase in snow depth near the coast of the Arctic Ocean.

Below: A remote time-lapse camera network has been in operation since 2011 and is being used to make seasonal and annual observations of lake ice and snow cover. Near-real time observations are available on the TLO webpage between April and November.

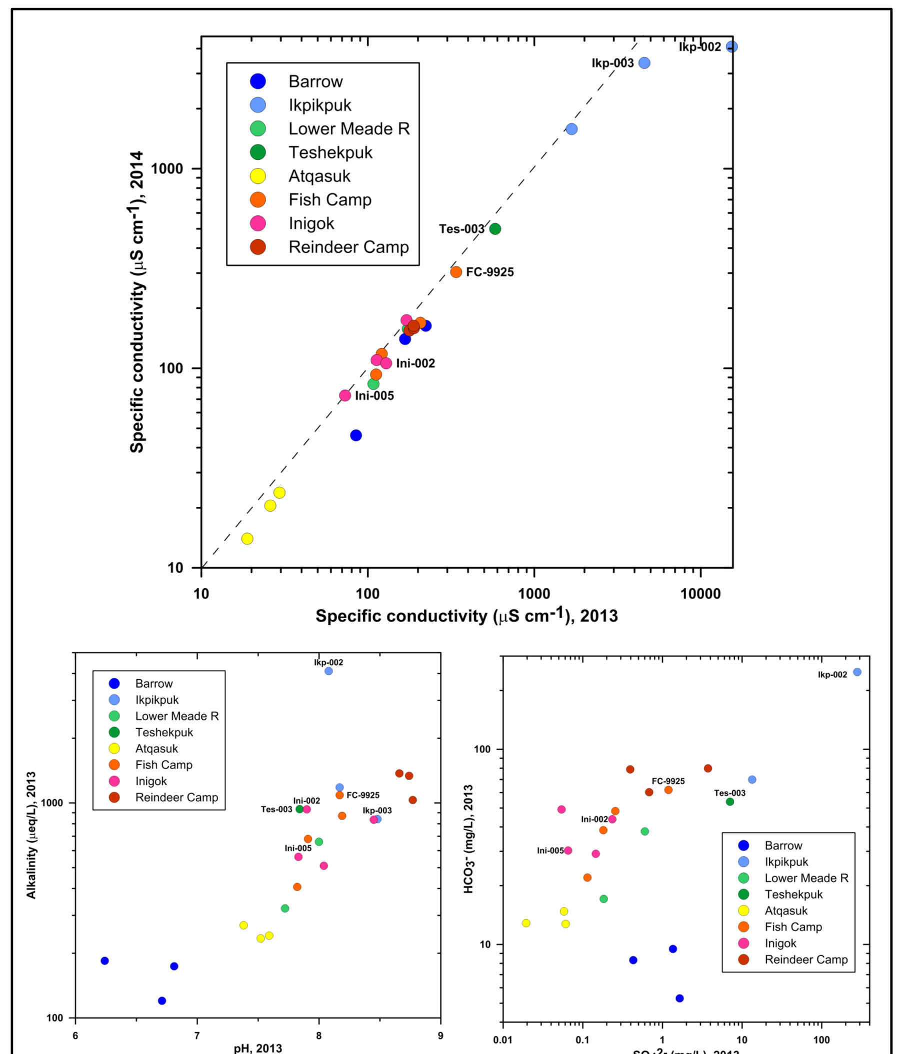


Figure 8. Application of a thermal equilibrium steady-state model developed by J.R. Mackay suggests a talik penetrating the permafrost under lakes exceeding ~66 ha. Analysis of water samples from August shows that there is little interannual variation in lake water chemistry for ion concentration, pH, and specific conductivity. Proximal lakes tend to have similar chemical signatures, but there are large variations across the study region. Although regional factors have some influence, local factors appear to largely control lake water chemistry. Lakes with suspected through taliks do not demonstrate a distinct chemical signature compared to nearby lakes (labeled in figures) lacking a through talik, although the sample size is small. This suggests that either (1) there is no hydrological connection due to the presence of aquicludes in the subsurface, (2) the flux of groundwater is too small to have a measurable impact on lake water chemistry, or (3) that the steady-state condition assumed in the thermal equilibrium model to estimate talik configuration is not justified.

Figure 9. One goal of the CALON project is to explore the intersection of native knowledge and landscape-process research in Arctic Alaska. We do this by interviewing the people of the villages on the North Slope, and have talked to Elders and hunters from Barrow, Atqasuk and smaller villages. **(L)** Team member Chris Cuomo talking to Thomas Rulland , who was showing her the location of a drained thaw lake. **R)** Rhoda Ahgook, one of the oldest residents of Anaktuvuk Pass, describing her family's epic journey from Barter Island in Canada to Anaktuvuk Pass by boat, dog sled, and on foot.

On 20 August 2015, a workshop was held in Barrow to present and summarize highlights and findings of 12 years of research on native observations of landscape changes and processes. Seventy-six Iñupiat elders, hunters, and other knowledge-holders from Barrow, Atqasuk, Wainwright, Nuiqsut, and Anaktuvuk Pass have been interviewed, and over 125 hours of videotaped interviews were produced. The goal of the workshop was to report on our findings, thank the community for their support, and ask their advice on best practices for archiving this data. Wendy Eisner and Chris Cuomo were the co-presenters of the workshop.

Approximately 60 members of the Barrow community as well as some scientific researchers attended the 2 hour presentation which consisted of a welcome, a powerpoint report on our findings, and a short film which explained the process of interviewing and highlighted clips from past interviews. The video library and searchable interview logs are archived with the North Slope community.

At the workshop, Eisner, Cuomo and Project leader Ken Hinkel presented Mrs. Lollie Hopson, our long-time community liaison, with a Certificate of Appreciation for her invaluable help, advice, and support.

ACKNOWLEDGMENTS

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