Third-Year Results from the Circumarctic Lakes Observation Network (CALON) Project

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Overview

- About half of the Arctic Coastal Plain (ACP) of Alaska isthermokarstlakes 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

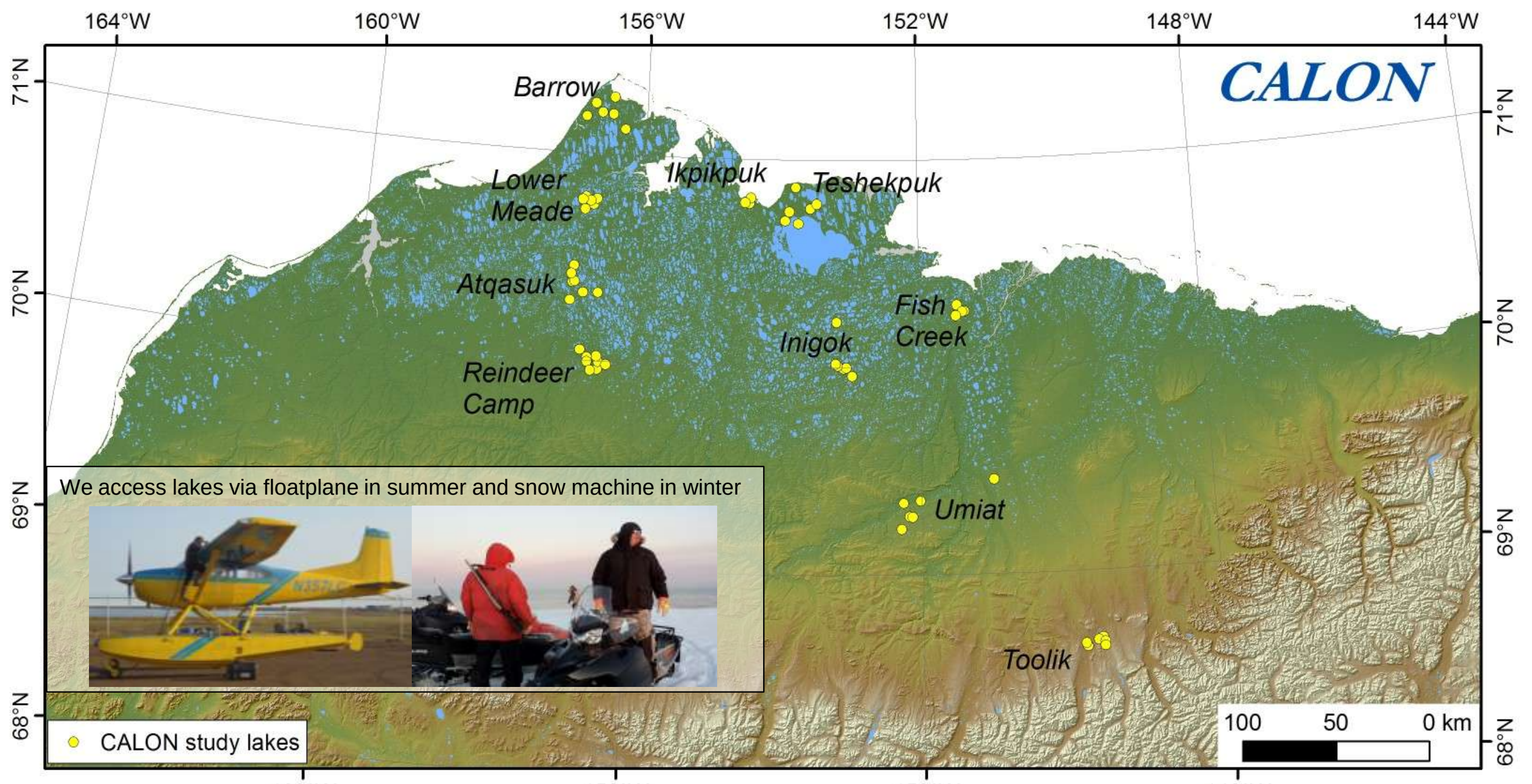


Figure 1. Location of monitoring hubs in two transects; each hub has a terrestrial met station. ~ Six lakes are monitored at each hub, with basic instrumentation at all lakes and enhanced instrumentation at two lakes per hub. At Barrow, Atqasukand Toolik, instrumentation at “Focus Lakes” measures water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

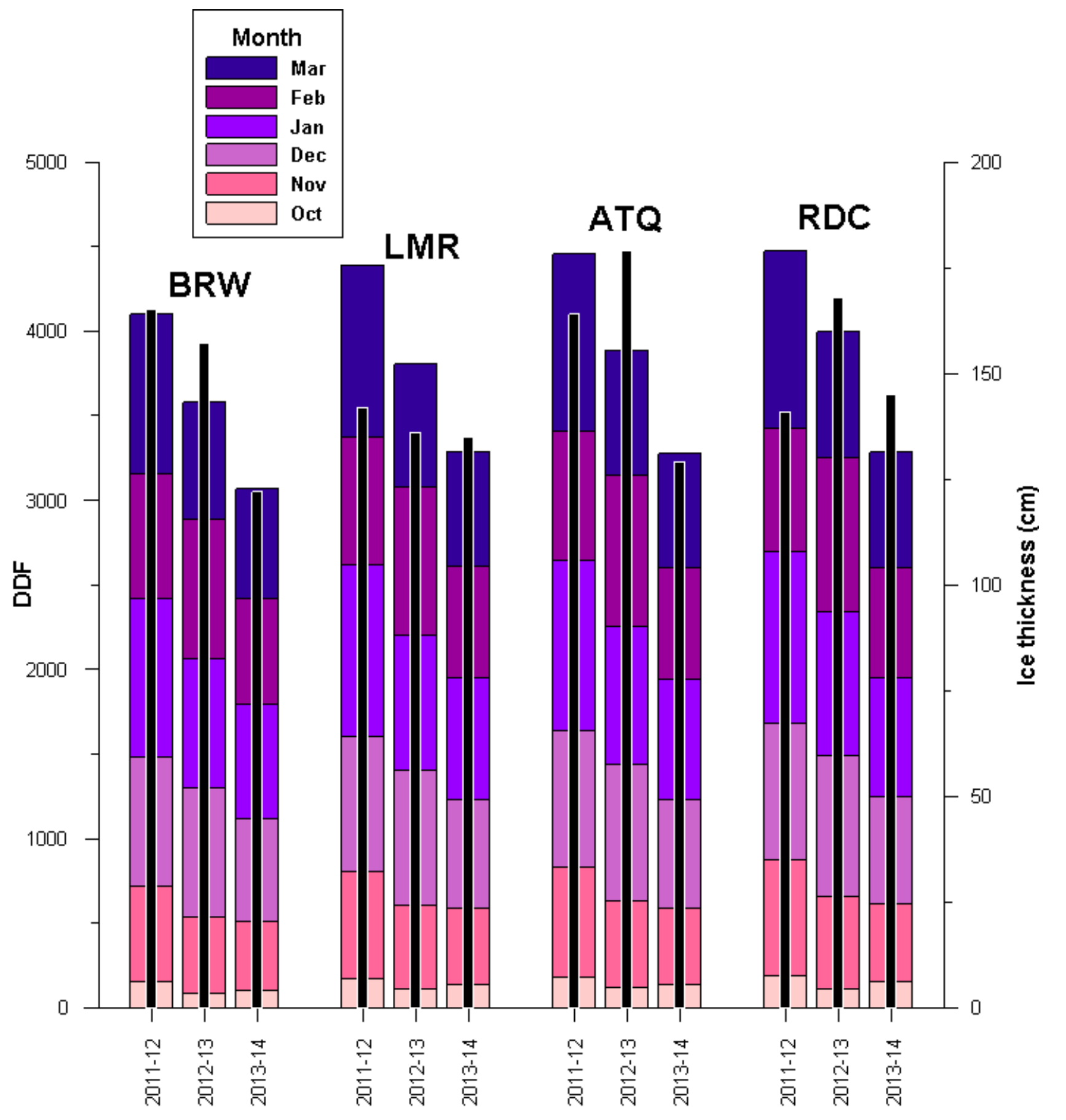


Figure 2. Winter severity as expressed by the Degree Days of Frost for the four nodes on the western transact (Barrow, Lower Meade, Atqasuk and Reindeer Camp). Winters have warmed over the 3 years, and ice thickness has declined. Early snow accumulation explains some of the interannual and intersite variability.

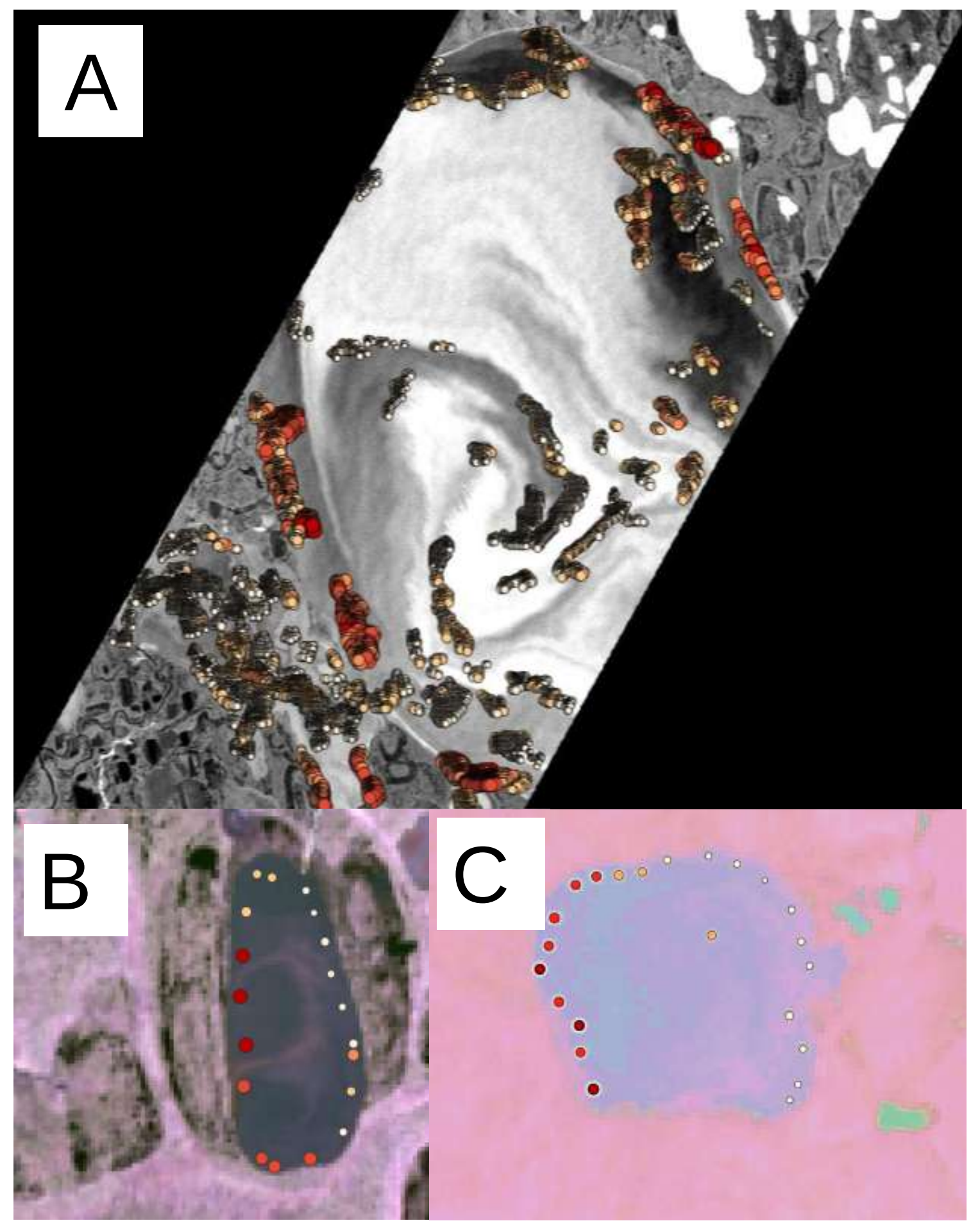


Figure 3. Velocity distributions (magnitude only) from A) time-series imagery from Teshekpuk Lake (1.2 to 10.2 cm/s); and in situ measurements from B) Lake 100 (8.3 to 40 cm/s) and C) Lake 310 (5.1 to 24.0 cm/s)

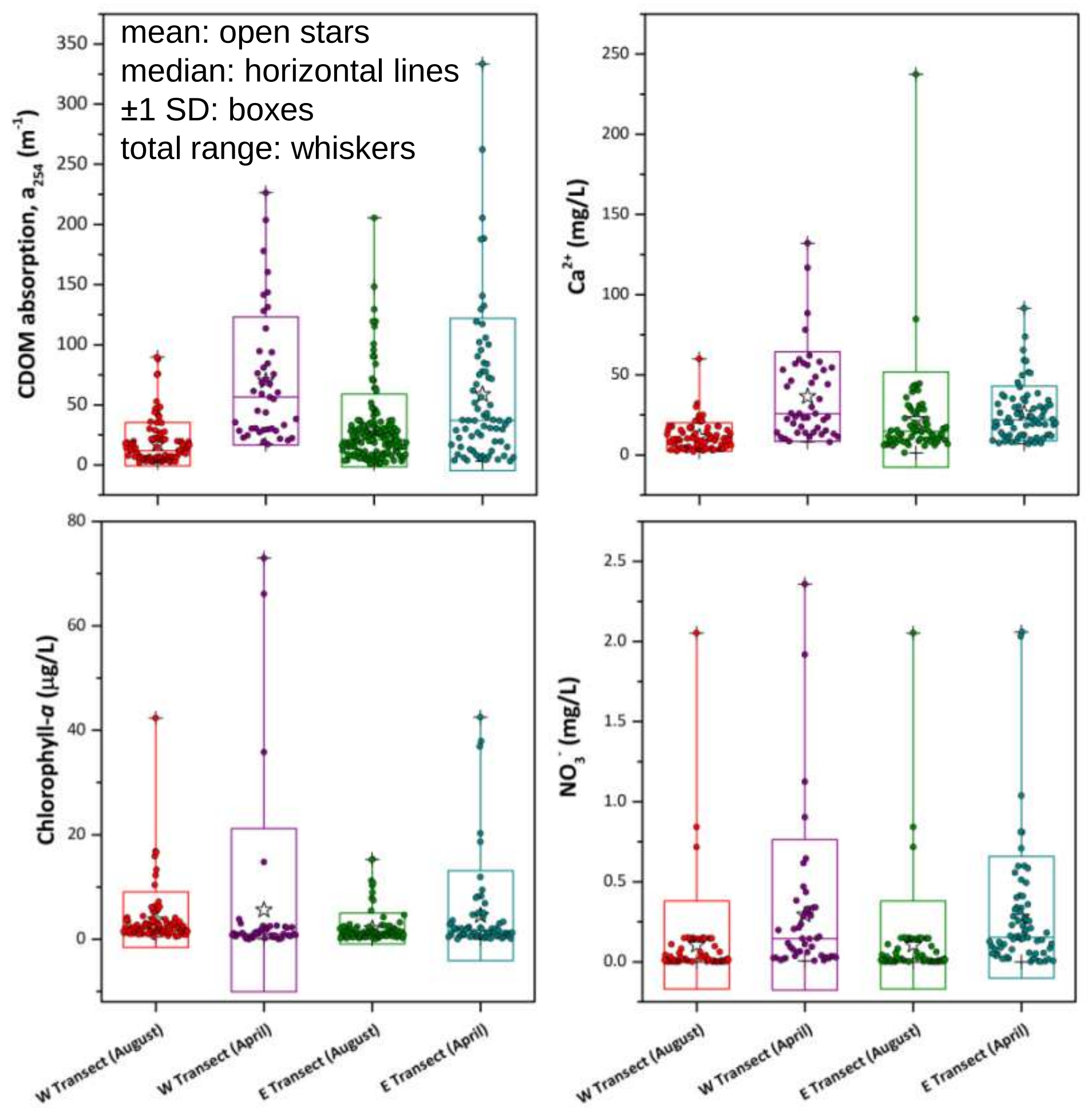


Figure 4. Concentrations of CDOM (254 nm), Ca^{2+}, chl-a, and NO_3^- in August & April 2012-14. CDOM absorption and Ca^{2+} are higher in April vs August. Chl-a is slightly higher in winter, perhaps from higher concentrations of nutrients (e.g., NO_3^-). Light transmittance through the lake ice is sufficient for primary production in winter.

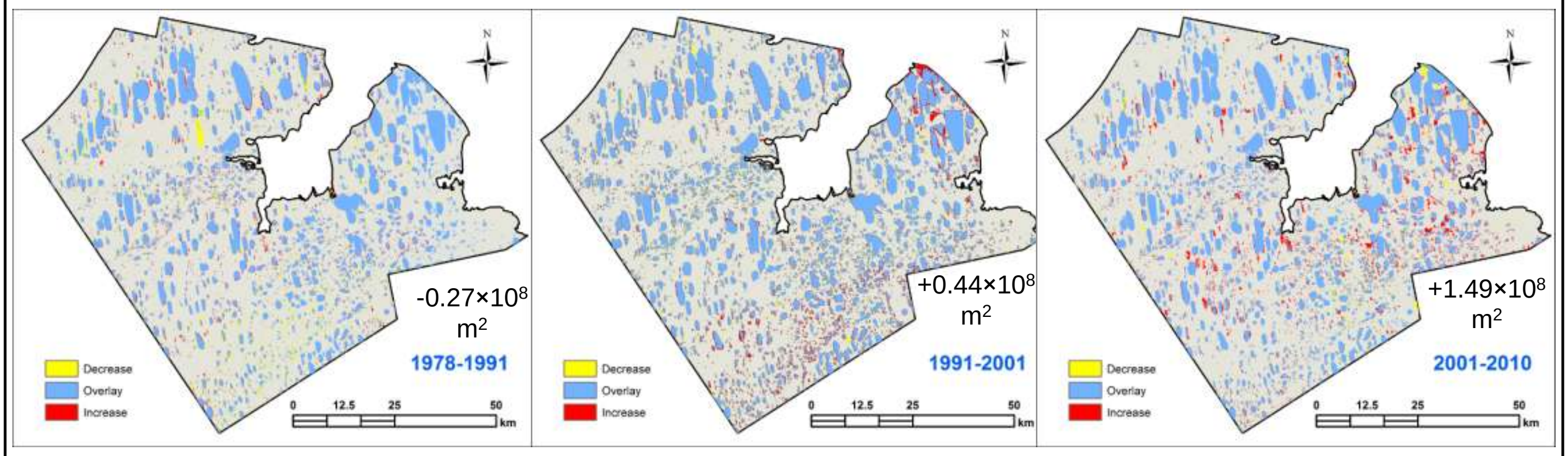


Figure 5. Maps of thermokarst lakes from satellite remote sensing data. In the past 3 decades, thermokarst lakes in Arctic Alaska increased in number and areal extent, in contrast to the shrinking and disappearing trend in discontinuous permafrost zones.

Want to learn more about CALON at AGU?

B33G-05. Townsend-Small et al., Sources and fluxes of atmospheric methane from lakes in the Alaskan Arctic. Wednesday, 2:40 PM, Moscone West 2003

B41I-0164. Zhan et al., Thermokarst lake gyre flow speed and direction derivation using image matching from sequential satellite images. Thursday morning poster session

B23H-02. Lenters et al., Physical drivers of lake evaporation across a gradient of climate and lake types. Tuesday, 1:55 PM, Moscone West 2003

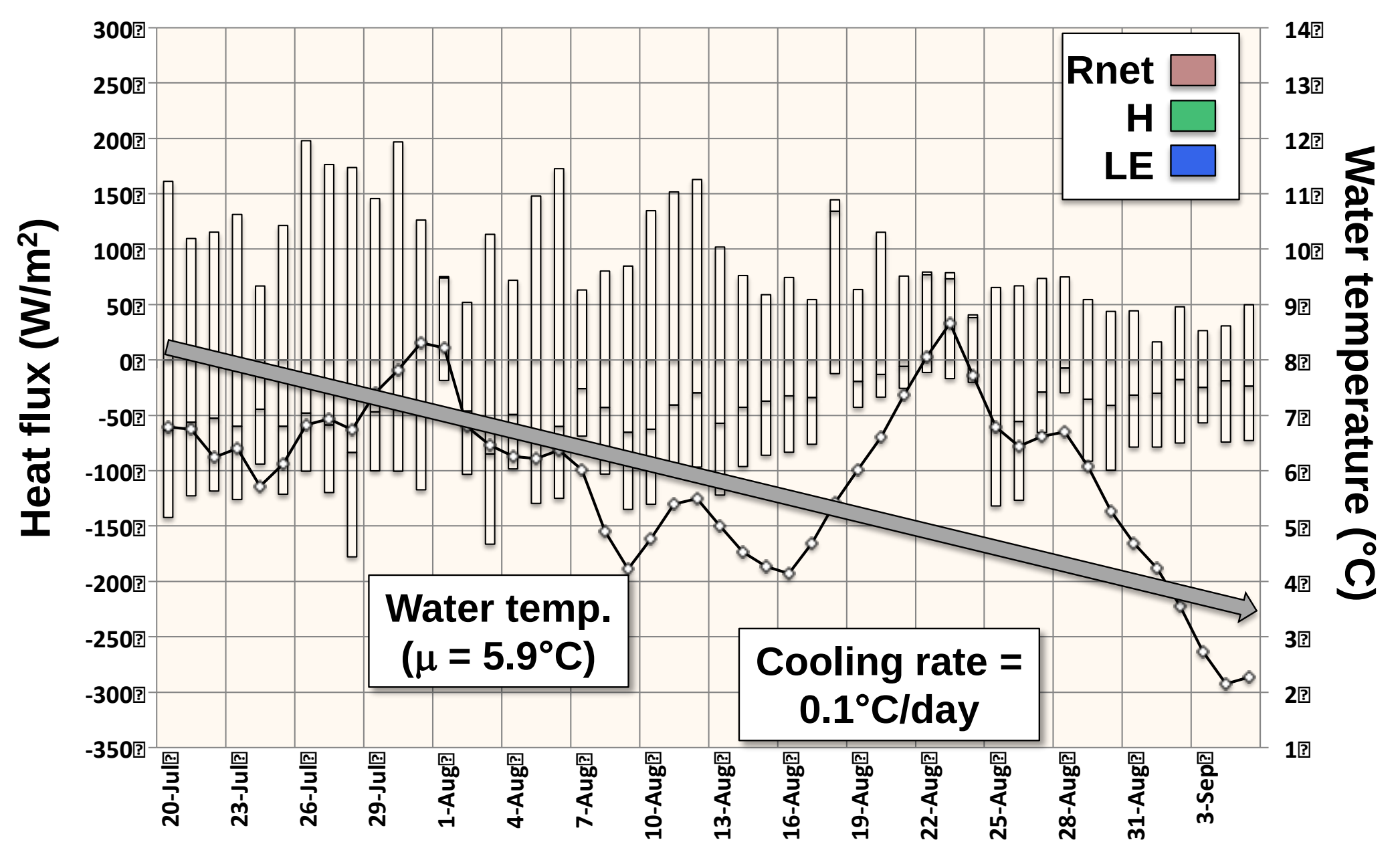
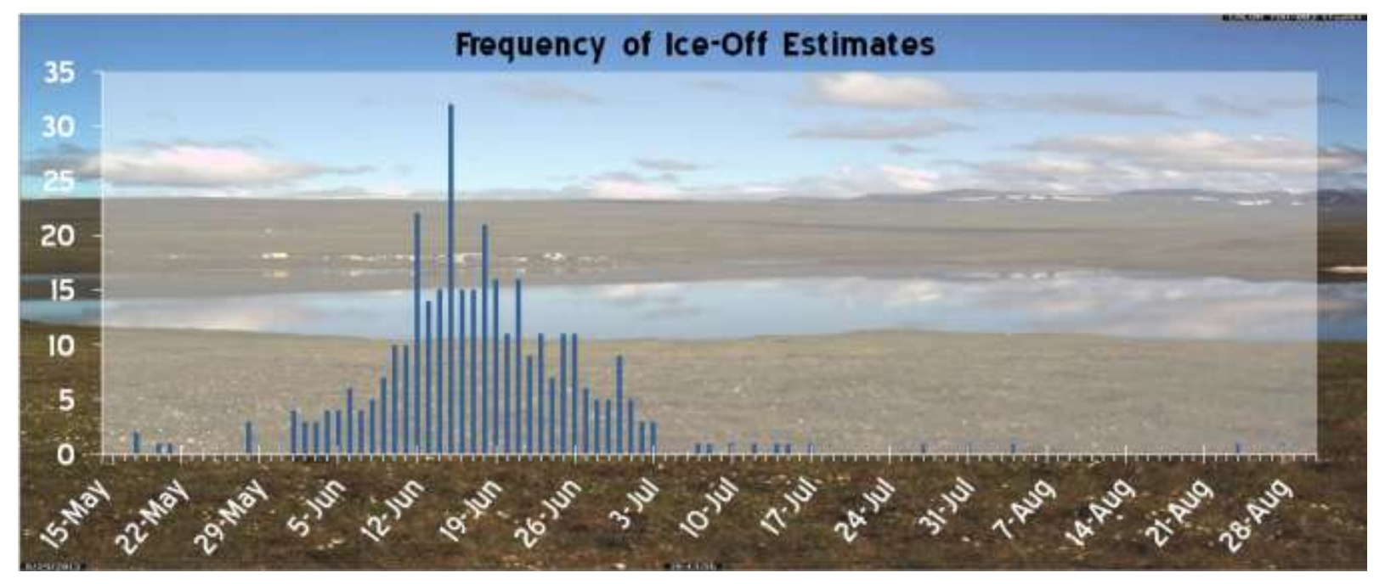


Figure 6. Energy balance in Emaiksoun Lake during summer 2014. Unlike the previous two years, summer 2014 is much less episodic, showing persistent turbulent heat fluxes during the first 2/3 of the summer. Combined with cooler air temperatures (3.0°C vs 7.4°C and 4.2°C in the previous two years), this leads to much cooler mean water temperatures than the previous two years. The overall rate of cooling, however, is comparable to 2012, while the Bowen ratio is identical to 2013 (B = 0.74).



There were 346 guesses logged during the 2nd annual Toolik Lake Ice Classic, a fun and educational phenological competition sponsored by the Circum-Arctic Lakes Observation Network (CALON) project and Toolik Field Station.

Figure 7. Above, photos from the Toolik webcam. Left, guesses logged for the 2014 Toolik Ice Classic. The day with the highest number of guesses logged was June 15. The average ice-off date for Toolik since the year 2000 is June 19. In 2014, Toolik became 100% ice free on June 23. Eleven competitors selected this ice-off date.

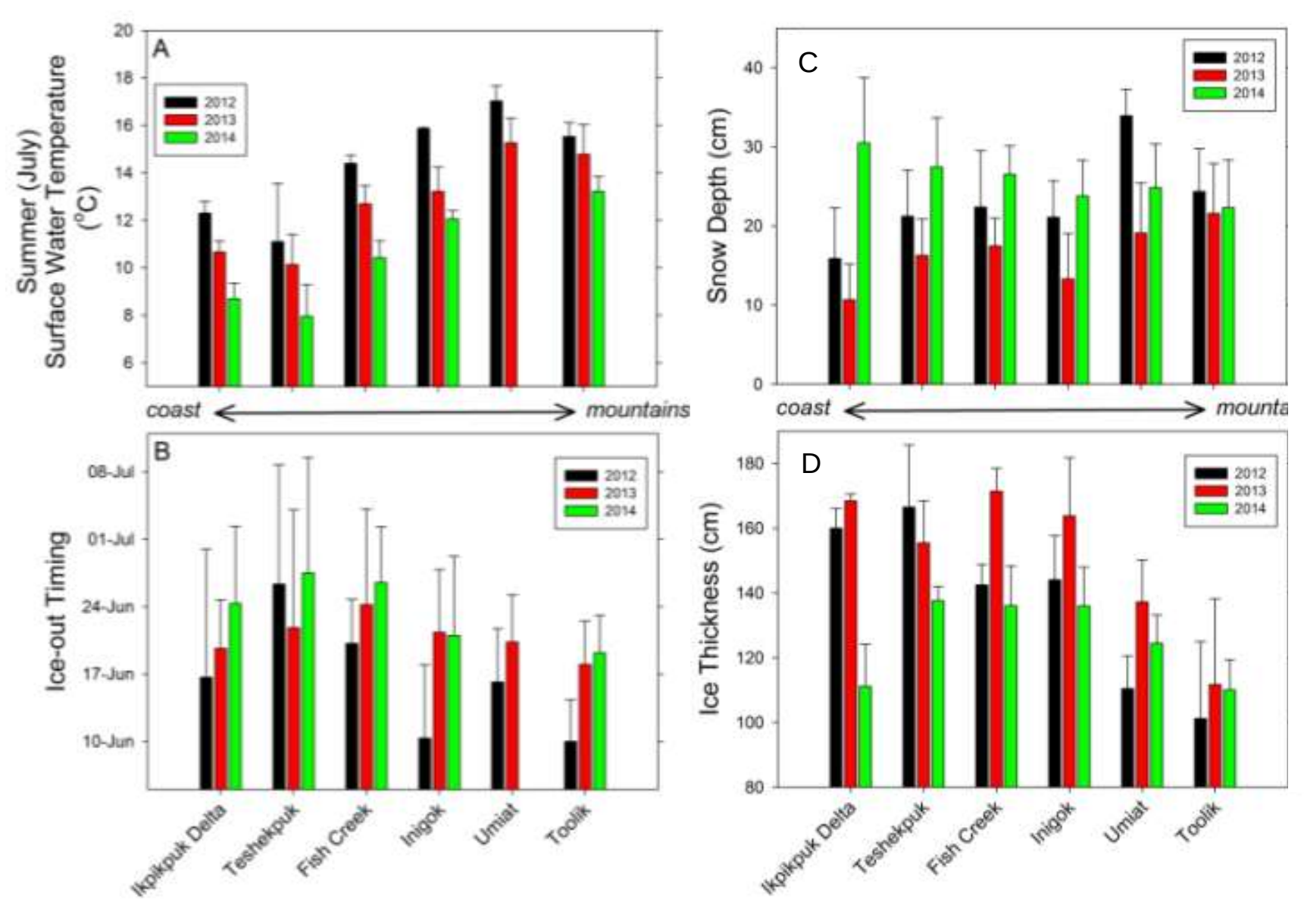


Figure 10. A), Average surface water T; B), ice-out date; C), snow depth; and D), ice thickness on lakes in the eastern transect, 2012-2014.

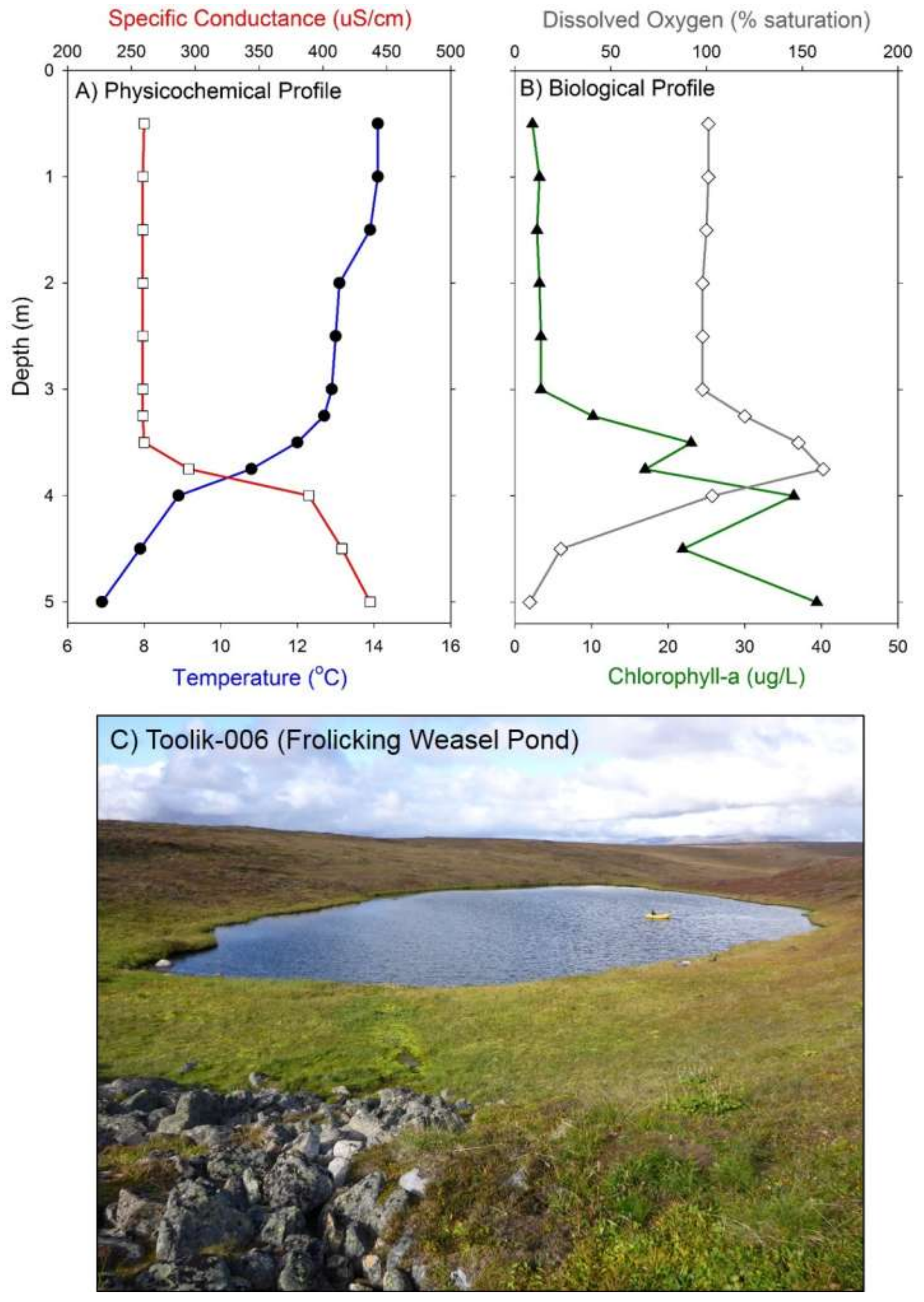


Figure 8. Most of the CALON lakes are shallow and well-mixed, but TOO-006 is deep enough that stratification develops in summer. This lake has the highest summer CH_4 concentrations observed in the CALON lakes.

Conclusions and Future Work

We have one more field season – spring/summer 2015

Assessing physical and biogeochemical feedbacks to climate warming requires long-term monitoring in the Arctic

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

ACKNOWLEDGMENTS

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Figure 9. A), Rachel Riley and her ARGO all-terrain amphibious vehicle; B), the CALON Team E crew in Anaktuvuk Pass; and C), Rhoda Ahgook, one of the oldest residents of Anaktuvuk Pass, describing her family’s epic journey from Barter Island in Canada all the way to Anaktuvuk Pass by boat, dog sled, and on foot.

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 so far on this project we’ve talked to Elders and hunters from Barrow and Atqasuk. This past May, Team E went much further afield to a village we’ve never been to before: Anaktuvuk Pass (“place of the caribou droppings”).

This village holds a special significance: it is where the last of the Nunamuit people—the People of the Land—reside. The Inupiat are basically divided into the inland people, who hunt the caribou, and the sea people, who mainly hunt whales and walrus. During the late 1800s and early 1900s, many Numamuit people had to leave their inland hunting grounds due to disease, famine, and the dwindling of the caribou herds. Today, most of them have intermarried and live in other areas, but in 1949 some families returned inland and founded Anaktuvuk Pass. Today, it is the only Numamuit settlement remaining, with a population of 320 people.

We interviewed 10 Elders who gave us a very different perspective on landscape change from the coastal Inupiat. Many of them are active hunters who travel by foot in the mountains and Arctic Slope region, and they have covered a wider, more diverse territory and studied it in detail. They identified new pingos and ground contraction cracking north of AKP, and they noted changes in vegetation and animal migration that may be due to anthropogenic disturbance. One of their most interesting observations was that the upland lakes and ponds near AKP have been drying up.

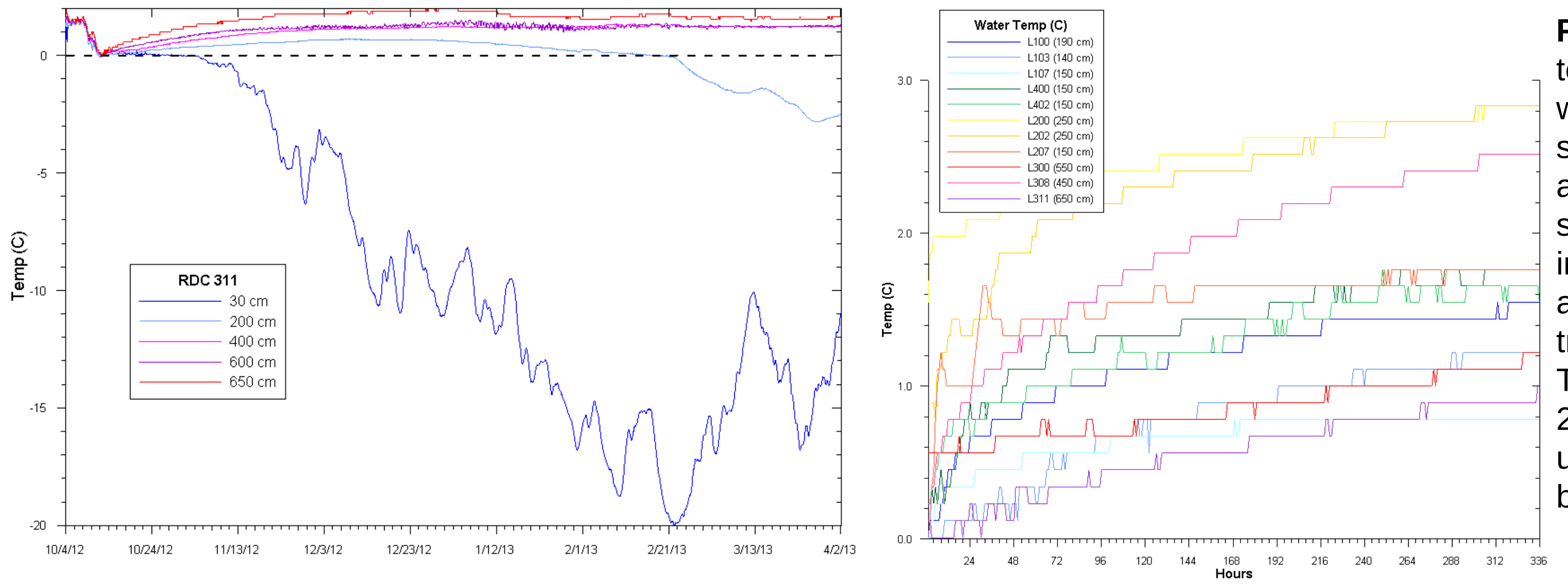

Figure 11. Water temperature at water depths in a single lake (left) and at the sediment-water interface for lakes along the western transect (right). Temp change over 24-hr periods was used to calculate basal heat flux