LACUSTRINE SEDIMENTARY PROCESSES NEAR A HIGH ARCTIC DELTA, LAKE TUBORG, ELLESMERE ISLAND

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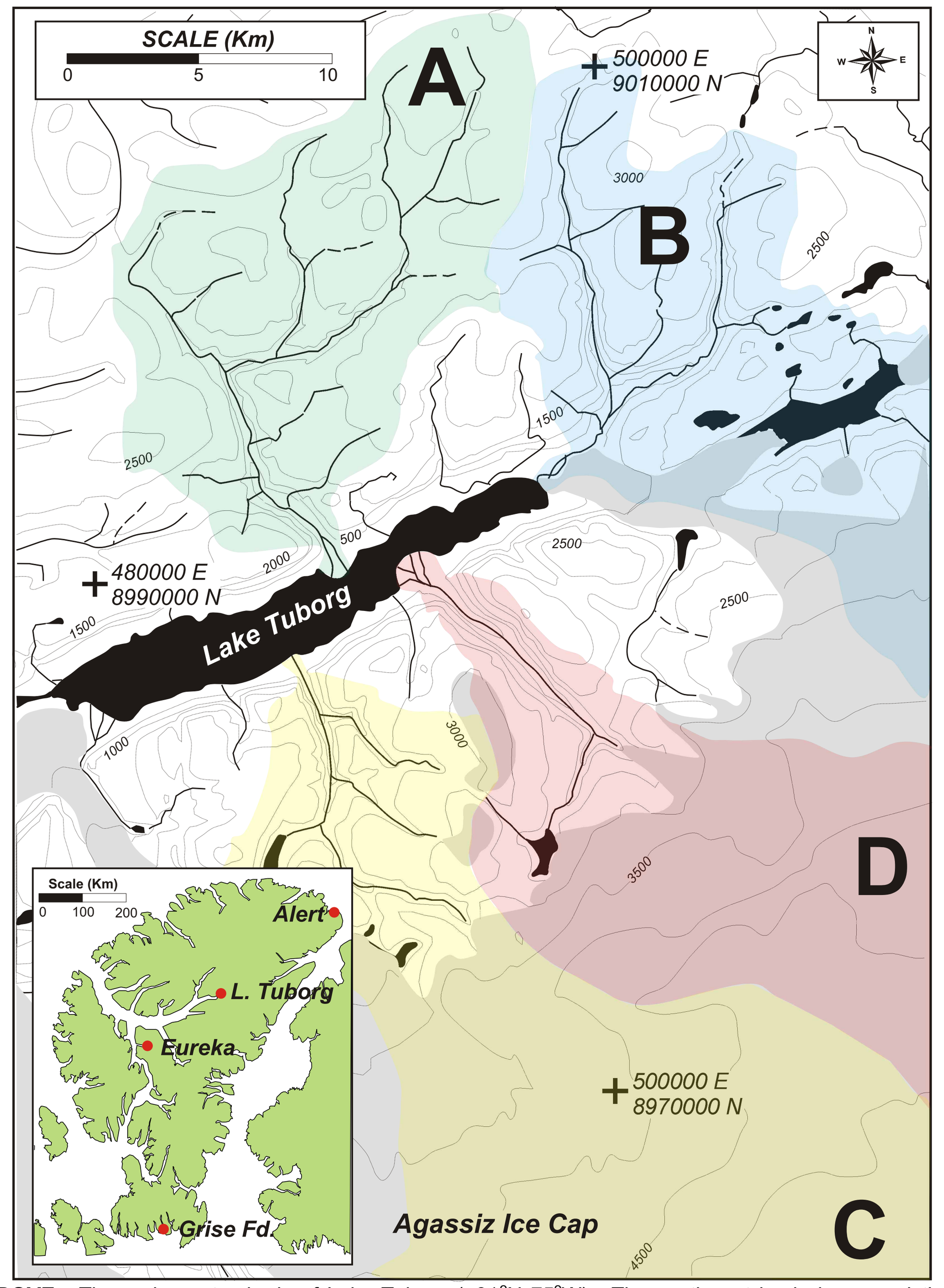
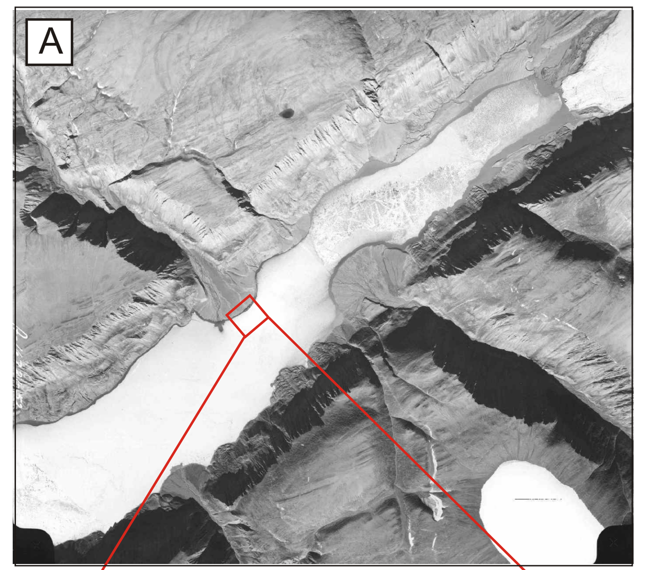
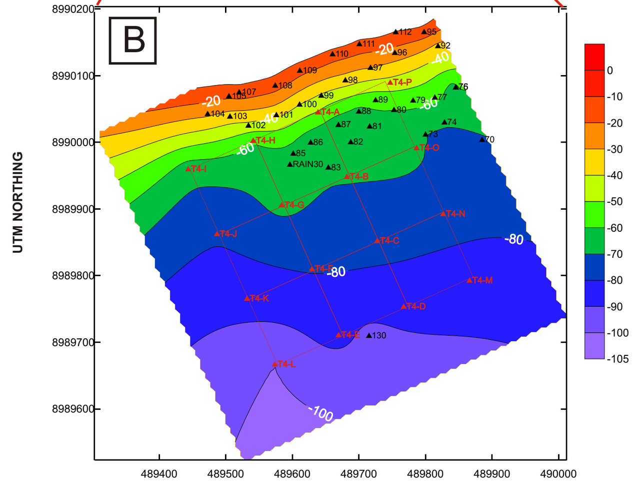


ABOVE: The major watersheds of Lake Tuborg (~81°N 75°W). The southwest basin is meromictic (about 155 m deep); the northeast basin is entirely freshwater (about 80 m deep). Watershed A is nivally fed, B is mostly nivally fed, C and D are mostly glacially fed. Inset shows location of Lake Tuborg on Ellesmere Island.



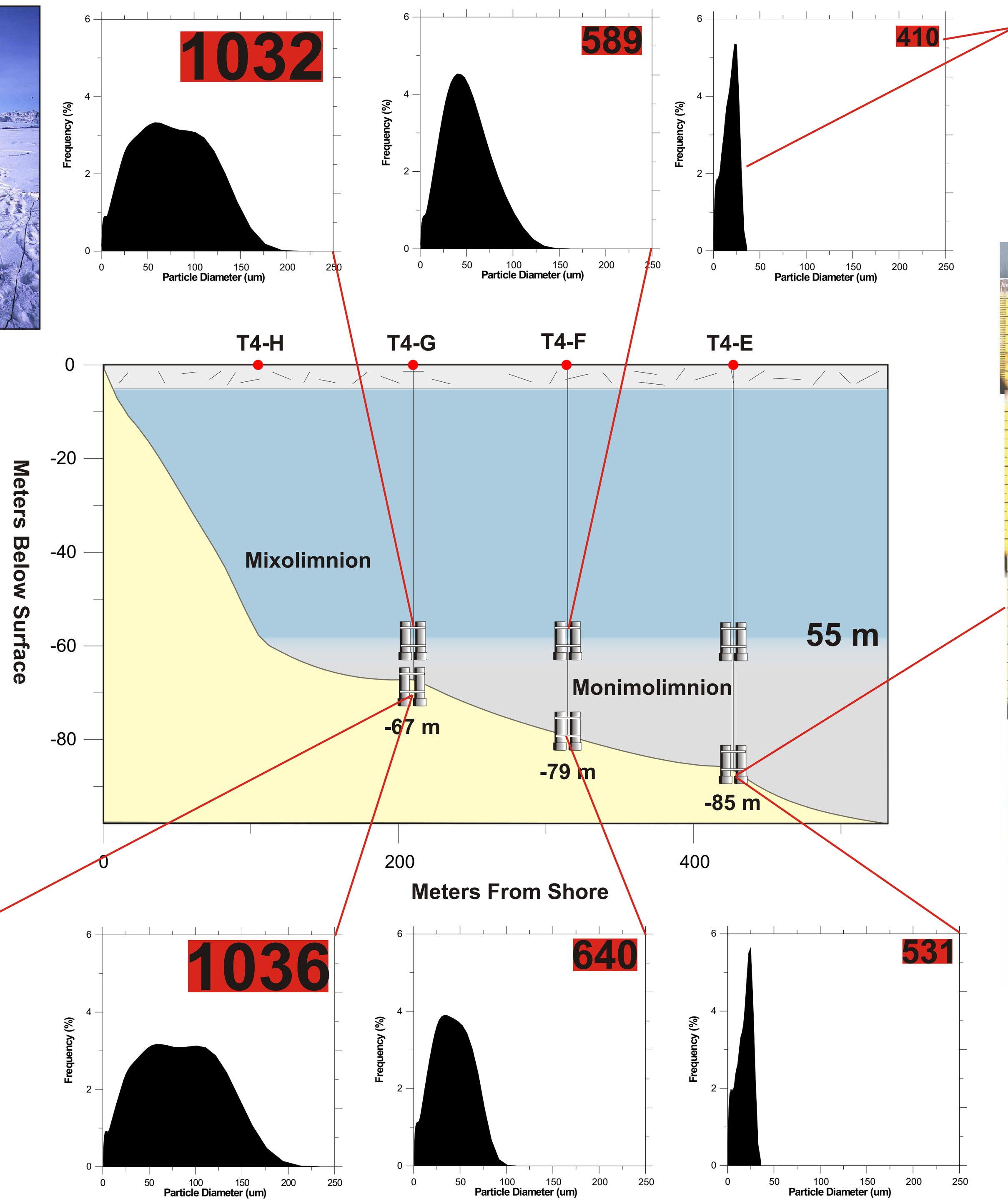


ABOVE: **(A)** 1959 aerial photograph of Lake Tuborg highlighting Delta A. **(B)** Bathymetric map of the study area near Delta A. Black symbols are points where bathymetry was measured. Red symbols are CTD cast sites. The red grid illustrates the sampling area. White labels are depth (m) below lake level.

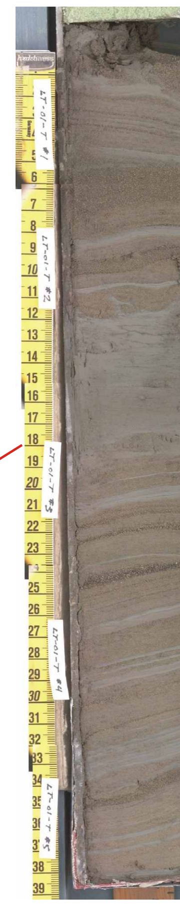
INTRODUCTION: Lake Tuborg is a large glacially fed and glacially dammed lake on west-central Ellesmere Island. It has two sub-basins. The southwest sub-basin is meromictic, and has a maximum depth of 155 m. The northeast sub-basin is freshwater and is shallower (Zmax, ~80 m).

This poster shows processes of sedimentation recorded near a large nival delta (watershed A at left, photo at right) located at the north-central portion of the lake. Processes were recorded during peak nival melt in 2001 with sediment traps, a datalogging flow meter, and a CTD.

Annual suspended sediment discharge from this nival delta is likely much less than glacially-fed deltas at Lake Tuborg. However, the nival tributary flows into the lake in its meromictic basin, and the delta face is steep. Therefore, this is an ideal location to study how sedimentary processes are affected by meromixis.



LEGEND: Numbers in red boxes represent mass accumulation rate, and are size-scaled. Black histograms are



Results from delta-proximal sediment traps deployed from June 20-30, the period of peak nival melt. Sediment traps were deployed to determine the effect of the monimolimnion on sedimentation. One trap on each mooring was placed at the top of the chemocline, and one was 1.5 m above the lake bottom.

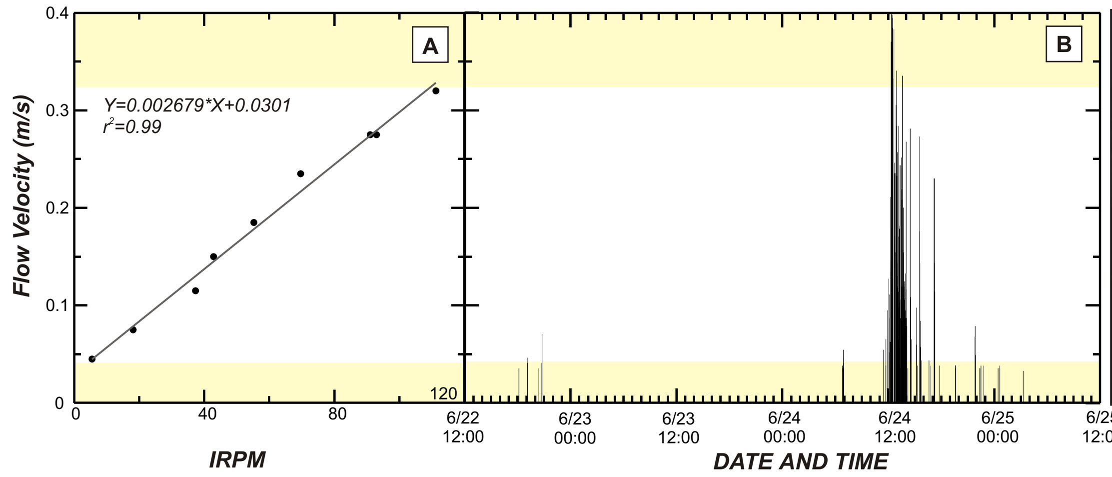
Mass accumulation rate (MAR) units are g/m2/d. Grain size data are averages of 3-runs per sample. Each trap was "double barreled", and grain size and MAR results are averages of the two barrels.

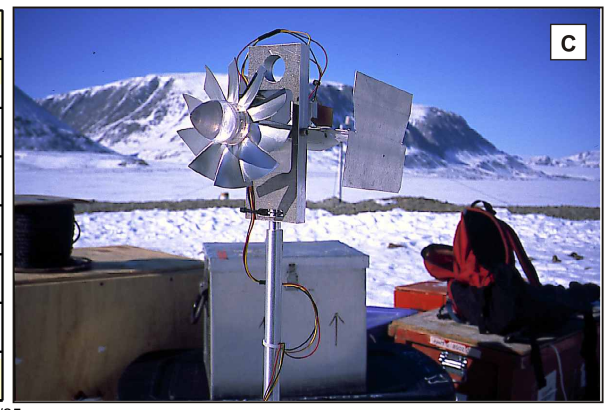
MAR and grain size mode decreased with distance from shore. Interestingly, MAR for upper and lower traps on the same mooring are similar. This implies that little additional sediment is added in the monimolimnion. These results agree with CTD casts and current recordings, which imply that stratified flows (interflows and overflows) are confined to the mixolimnion.

Gravity cores were obtained with a Glew corer.
Core T4G is mostly massive sand. Two silt clasts are present in the upper 12 cm. These are likely slump blocks, transported from the steep delta slope. Sandy laminae between 13-18 cm could record daily sediment pulses.
Core T4E consists mostly of sand laminae separated by silt and clay laminae, except for a massive silty section from 12-18 cm.

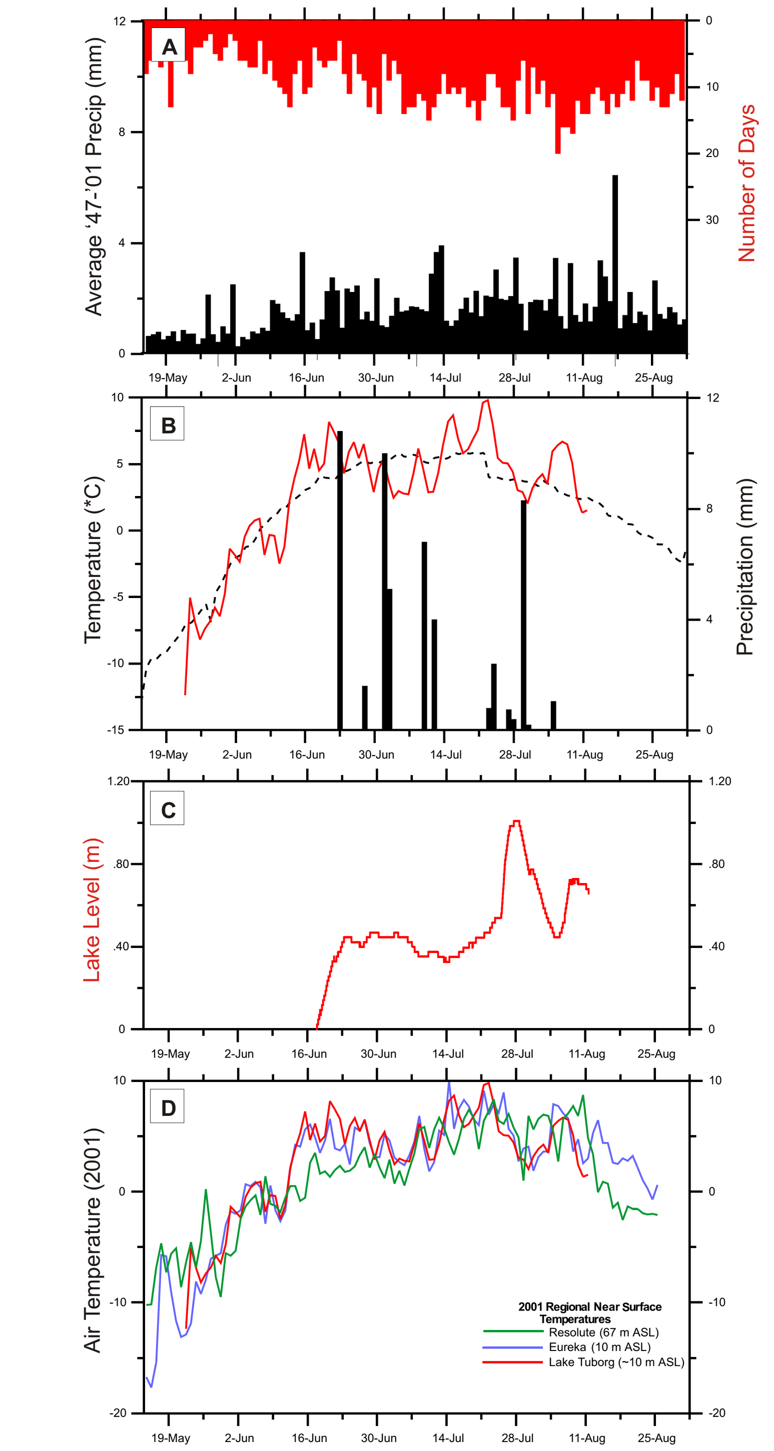
Joe Rogers

Brrrrrr!





At left: Current meter results from Site G. Currents were recorded when the meter was hung at the chemocline (55 m). Repeated deployments were made below the chemocline, even during times of peak nival melt.
(A) Calibration curve
(B) Lake Tuborg Currents
(C) Current meter courtesy of Roger Lewis and John Sweeney.
Based on CTD profiles, the difference in concentration between freshwater and saltwater based on salinity and temperature is about 20 g/L. During the 1995 slush flow at Delta D, SSC reached 5 g/L (Braun, 1997), while SSC reached 2 g/L during the 2001 nival flood at Delta A. This theoretically precludes the occurrence of fluvially generated underflows in the meromictic sub-basin of Lake Tuborg, even during extreme events.



Above: Weather and climate at Lake Tuborg and regional weather stations.

(A) Precipitation at Eureka, 1948-2001. Lower graph (black) shows mean precipitation for each day. Upper graph (red) shows the number of days used for to calculate mean precipitation.

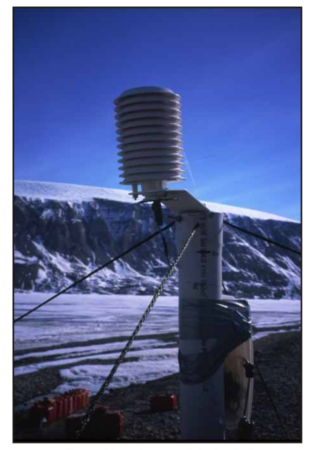
(B) Red line graph shows mean daily 2001 air temperature recorded at lake level with a datalogging thermistor. Temperature was recorded with a 15-minute interval. Black line graph shows 1947-2001 air temperatures recorded at Eureka. Black bar chart shows 2001 Lake Tuborg precipitaton (mm).

(C) Lake level fluctuations at Lake Tuborg in 2001. Zero datum is the lowest recorded lake level.

(D) Air temperatures recorded at Lake Tuborg, Eureka and Resolute in 2001. R-squared for Resolute and Tuborg is 0.57; R-squared for Eureka and Tuborg is 0.90.

Mean daily temperature (5/21-8/11) for:
Lake Tuborg , 2.9 *C
Resolute, 2.9 *C

Rain Gauges



Radiation Shield

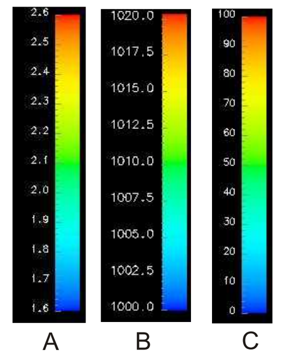
The images below were produced in an open source software package called OpenDX. Data were collected with a Sea Bird Instruments SBE19 CTD (**C**onductivity **T**emperature/**T**ransmissivity **D**epth) profiler with a 660 nm, 25 cm path length SeaTech transmissometer.

OpenDX (http://www.opendx.org) is a visualization and analysis application. OpenDX provides tools for manipulating, transforming, processing, realizing, rendering and animating data and allows for visualization and analysis methods. OpenDX was developed by the Deep Computing Institute at IBM, and was released as open source on May 24, 1999. It runs on UNIX-based machines, but has been ported to Windows 95/NT.

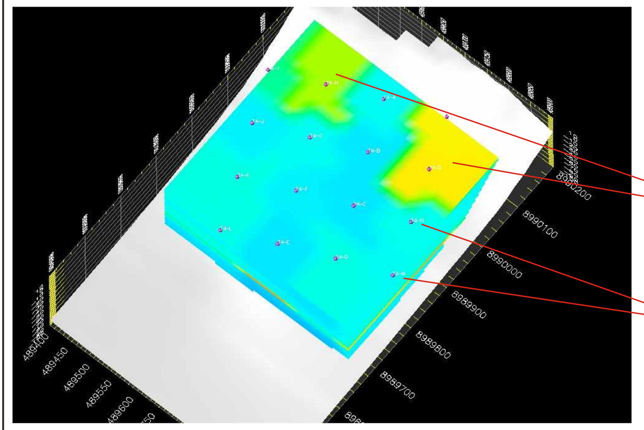
Most importantly for this project, interpolated data can be exported and analyzed. It is hoped that the SeaTech transmissometer can be calibrated to suspended sediment concentration. The mass of sediment within each water volume could then be calculated.

Table 1: CTD AND TRANSMISSOMETER SPECIFICATIONS

	Temperature	Conductivity	Pressure	Transmissivity
Range	-5 to +35 °C	0-7 S/m	50 to 10,000 psia	0-5 V (~0.004-20 mg/L)
Accuracy	0.01 °C /6 months	0.001 S/m/month	0.5% of full scale	?
Resolution	0.001 °C	0.0001 S/m	0.03% of full scale	0.001 V



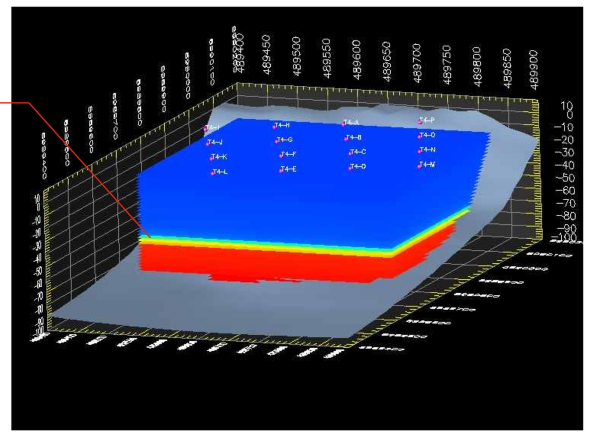
At left: Colorbars for OpenDX images.
A represents temperature (°C).
B represents conductivity (us/cm)
C represents attenuation (%, 100-transmissivity).



Conductivity (us/cm). Sharp and strong chemocline at approximately 55 m.

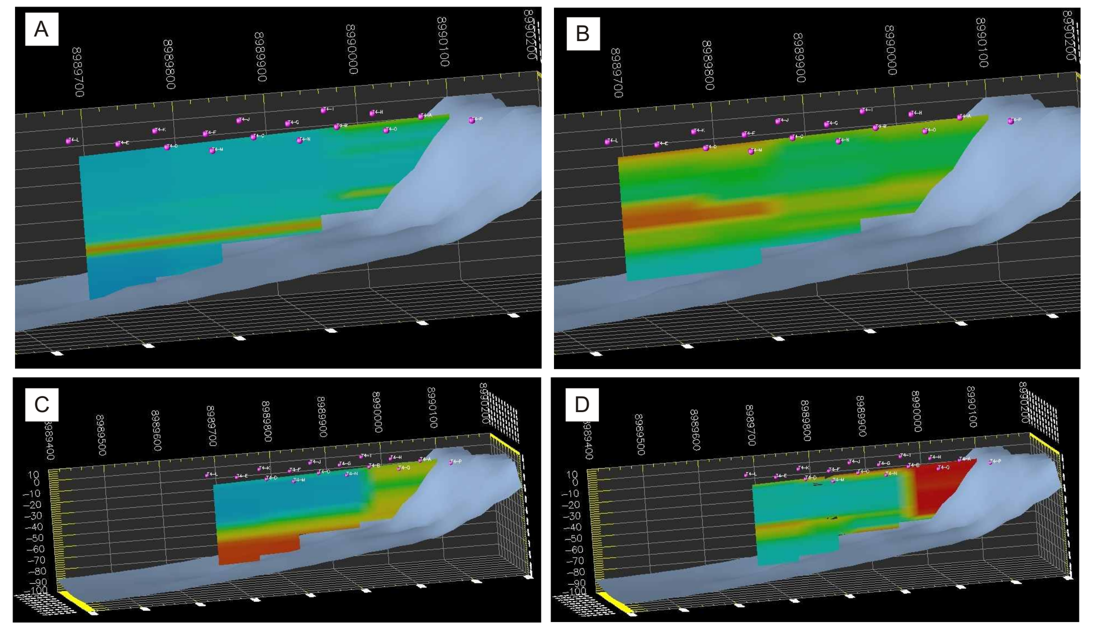
Overflow plumes (attenuation increases) adjacent to tributary inputs.

Cast Locations, 105 m apart

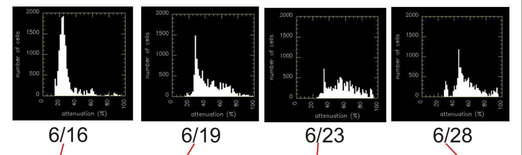


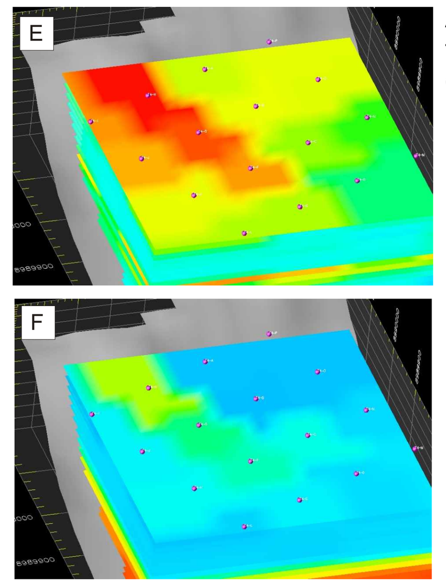
ATTENUATION ON JUNE 16, 2001

CONDUCTIVITY ON JUNE 19, 2001



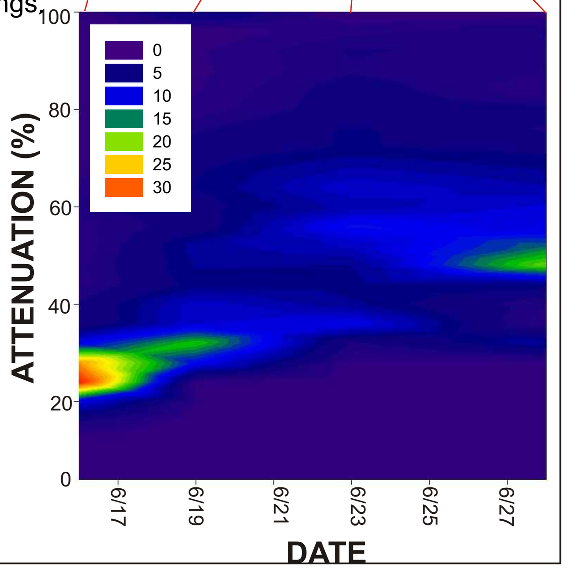
At left: **(A)** Attenuation on June 16, 2001. Note the large attenuation increase at the chemocline (~55 m). This attenuation spike is seen throughout the meromictic basin even before the onset of summer snowmelt. This could be a result of algal mats, sediment of insufficient density to pass into the monimolimnion, or precipitation from the dissolved load when anoxic water (in the monimolimnion) comes in contact with oxic water (in the mixolimnion).
(B) Attenuation on June 28. The attenuation spike is thicker, less well defined, and has shallowed somewhat. Meltwater may have caused some mixing, and suspended sediment may have "ramped" on the density difference at the chemocline.
(C) Water temperature on June 19. Note the relatively warm water of the monimolimnion and mixing near the delta face.
(D) Attenuation on June 19. Turbid water near the delta face.





At left: **(E)** Attenuation on June 19. **(F)** Water temperature on June 19. The overflow plume is composed of water slightly warmer than its surroundings.

At right: **Top:** Each 3-D visualization is composed of volumetric pixels (voxels). Each voxel has an interpolated value. Histograms of attenuation for each date were produced. **Bottom:** A surface plot combining the four histograms (cf. Beierle et al., 2002).
Each voxel has a known volume, and field calibration of the transmissometer to suspended sediment concentration should be possible. Therefore, the mass of sediment within each visualization (or a portion of each visualization) could be calculated



See http://www.geo.umass.edu/gradstud/lewist/lewist.htm and http://www.paleoclimate.org for more details.

ACKNOWLEDGMENTS

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