A comparison of the Temporally Integrated Monitoring of Ecosystems and Adirondack Long Term Monitoring programs in the Adirondack Mountain region of New York

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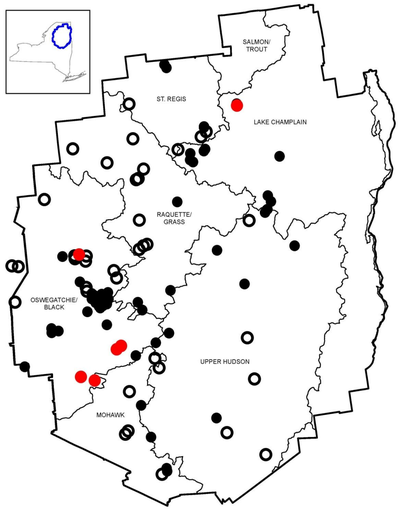
Introduction

The Temporally Integrated Monitoring of Ecosystems (TIME) and Adirondack Long Term Monitoring (ALTM) programs were established in the early 1990s to assess the impacts of acid deposition on surface water chemistry and track the efficacy of emission reduction policies (***1***). Additionally, the data from these programs may be used to characterize the emerging chemical recovery of these waters. This is one of the first assessments of trends at selected Adirondack TIME sites and a first using crossover lakes common to the ALTM program over the past two decades.

The Adirondack TIME program utilizes a probability-based approach to assess chronic acidification in a population of lakes with one summer or fall sample each year. The ALTM tracks changes in chronic and episodic acidification across a range of lake types using monthly samples. There are six lakes common to both programs. In addition, the ALTM program provides inorganic monomeric aluminum (Al_{IM}), the fraction of Al which is most toxic to biota. This poster updates our recent comparison between these two monitoring programs (***2***).

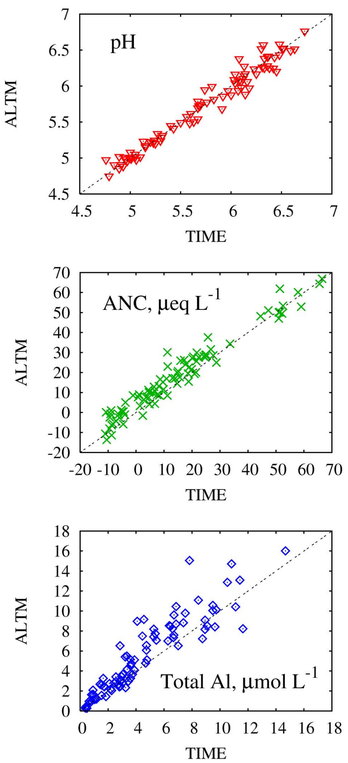


Map of 43 TIME (open circles) and 52 ALTM (closed circles). The six lakes common to both programs are shown in red. These six common lakes span a range in surface area (SA) and maximum depth (Z_{max}) from Hope Pond (shore; SA=8.9 ha, Z_{max}=11.5 m) to South Pond (aerial; SA=197.4 ha, Z_{max}=18.3 m)

Mann-Kendall (TIME) and Seasonal Kendall (ALTM) trend analysis of key chemical parameters through 2010

	TIME	ALTM
SO_4^{2-}, µeq L^{-1} yr^{-1}	-3.56 to -2.00 (n=6)	-3.19 to -2.15 (n=6)
ΣC_B, µeq L^{-1} yr^{-1}	-1.92 to -0.94 (n=5)	-2.20 to -1.07 (n=5)
NO_3^-, µeq L^{-1} yr^{-1}	-1.16 to -0.05 (n=5)	-1.24 to -0.26 (n=5)
DOC, µmol L^{-1} yr^{-1}	+5.09 to +11.27 (n=3)	+3.97 to +7.74 (n=3)
H^+, µeq L^{-1} yr^{-1}	-0.41 to -0.02 (n=4)	-0.37 to -0.04 (n=6)
ANC, µeq L^{-1} yr^{-1}	+0.96 to +1.77 (n=3)	+0.74 to +2.08 (n=6)
Total Al, µmol L^{-1} yr^{-1}	-0.28 (n=1)	-0.56 to -0.16 (n=4)
Al_{IM}, µmol L^{-1} yr^{-1}	N/A	-0.68 to -0.01 (n=6)

The table above lists the ranges in trends of eight chemical parameters across the six common ponds, with the numbers of significant ($p<0.05$) trends shown in parentheses. Trends in SO_4^{2-}, NO_3^-, and the sum of base cations (ΣC_B), highlighted in green, are consistent in terms of the trend magnitudes and numbers of statistically significant trends. Trends in DOC and H^+, highlighted in yellow, are less consistent, while trends in ANC and total Al are not consistent between the two programs. There is also some indication from the ALTM that long-term changes in Al_{IM} may be more evident than changes in total Al, which has been observed previously (***3***).



Comparisons at the six common lakes

The panels to the left compare pH, acid neutralizing capacity (ANC), and total Al from the TIME and ALTM samples from the six common lakes, 1992-2010. The dashed lines denote 1:1. In general the comparison of summer/fall samples displays consistency between the two programs. Other parameters, including SO_4^{2-}, NO_3^-, base cations, and dissolved organic carbon (DOC) also compare favorably.

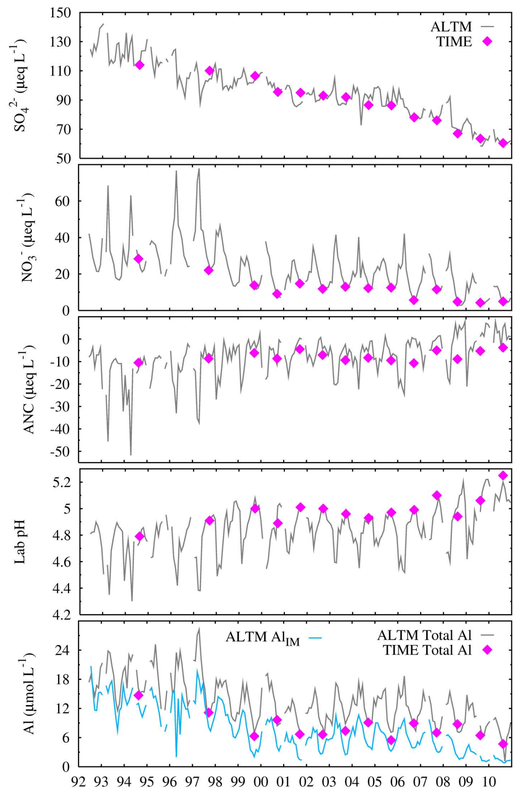
Summary

- The TIME and ALTM are simultaneous, complementary, ongoing, yet different surface water monitoring programs in the Adirondacks, and are mature enough to infer trends
- Measurements of chemical parameters sampled by both programs during the summer/fall at six common lakes compare favorably
- However, long-term trends inferred from these six lakes vary in terms of consistency in the magnitude and significance of these trends
- Spring melt sampling and Al speciation from the ALTM program provide additional information for a more complete assessment of acidification effects on biota in this region

Annual versus monthly sampling – Willys Lake

The monthly ALTM (gray lines) and annual TIME (magenta dots) data from Willys Lake – chosen to illustrate findings for a chronically acidified lake – are shown. The monthly Al_{IM} data from the ALTM (blue lines) are also shown in the bottom panel.

The monthly ALTM data can characterize the strong seasonal variability in each parameter, and the summer/fall TIME data do not capture the highest NO_3^-/Al values and the lowest pH/ANC values during the spring melt period. The ALTM data also show that Al_{IM} can be a large portion of total Al, and often exceeds the 2 µmol L^{-1} threshold for risks to aquatic biota (***4***).



References

(1) http://www.epa.gov/airmarkets/progress/ARP09_3.html
(2) Civerolo, K. L., et al., A comparison of the Temporally Integrated Monitoring of Ecosystems and Adirondack Long Term Monitoring programs in the Adirondack Mountain region of New York, *Water, Air, & Soil Pollut*., in press, 2011.
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