Biogeochemistry and Hydrology of an Adirondack Watershed: A Comparative Approach

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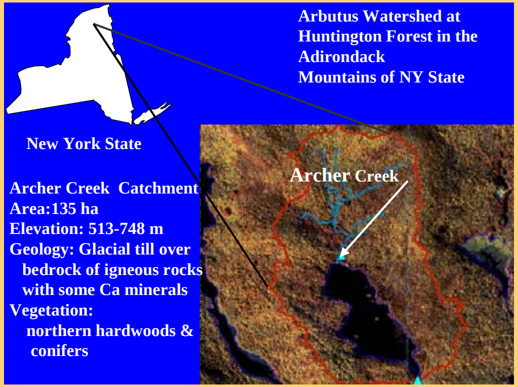

Introduction

The Adirondack Long Term Monitoring (ALTM) was established in 1982 and has provided important information on the spatial distribution and temporal changes in water chemistry for a range of lake-watersheds in response to atmospheric deposition (Driscoll and Van Dreason, 1993). The Arbutus Lake site, operated by SUNY-ESF, is the only ALTM site with direct measurements of hydrology and weekly chemistry measurements. The Arbutus has also extensive analyses of a broad range of environmental issues including effects of acidic deposition and the effect of climate change (e.g., Mitchell et al. 2001, 2006; Christopher et al., 2006). Thus two sets of lake chemistry results were available for evaluating how:
1)the frequency of sampling and;
2) the availability of hydrological information affects interpretation of watershed chemical responses.

Methods

-Chemistry data from both ALTM and SUNY-ESF were compared from January 1995 through December 2002, except for DOC, which was from January 2000 to December 2002 for SUNY-ESF.

-Monthly discharge-weighted solute fluxes from the Arbutus outlet were calculated from each data set and concentrations compared.

-Annual and monthly discharge solute fluxes were compared using the ALTM and SUNY-ESF chemistry values.

References

Christopher, S.F., B.D. Page, J.L. Campbell and M.J. Mitchell. 2006. Contrasting stream water NO_3^- and Ca^{2+} in two nearly adjacent catchments: the role of soil Ca and forest vegetation. Global Change Biology 12:364-381.

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Mitchell, M.J. K.B. Piatek, S. Christopher, B. Mayer, C. Kendall and P. McHale. 2006. Solute sources in stream water during consecutive fall storms in a northern hardwood forest watershed: a combined hydrological, chemical and isotopic approach. Biogeochemistry 78: 217-246.

For more extensive list of references associated with the Arbutus Watershed see: http://www.esf.edu/hss/related_literature.htm

Table 2. Average Annual Solute Concentrations ($\mu mol_c\ L^{-1}$)

	pH	H^+	NH_4^+	K^+	Na^+	Ca^{2+}	Mg^{2+}	DOC	Cl^-	NO_3^-	SO_4^{2-}	Total Al
SUNY-ESF discharge weighted average	6.3	0.7	2.6	7	32.6	142	41.9	374.2	10.5	8.9	112.4	1.4
SUNY-ESF non-discharge weighted average	6.3	0.7	3	7.5	33.8	144.6	42.3	374.2	10.8	8.6	115.1	1.5
ALSC average	6.5	0.4	1.9	7	31.2	141.3	41.4	374.1	10.1	7.5	115.5	2.4
absolute average difference[1]	0.3	0.3	1.2	1.1	3.2	10.2	2.4	30.3	1.3	3	7.5	1.2
Maximum difference[1]	1.4	4.7	5.5	12.8	26.1	41.2	10	138.9	7	20.5	63.5	8.5
Minimum difference[1]	0	0	0	0	0.1	0.1	0	0.1	0.2	0.2	0.2	0

[1]Values refer to differences between the ALTM and SUNY ESF discharge weighted average values

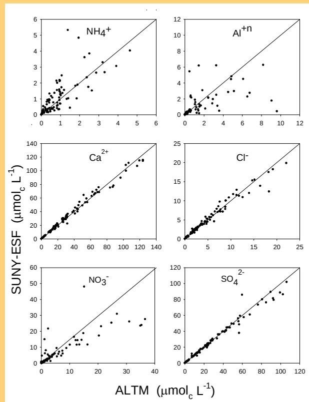

Figure 1. Correlations between select monthly solute concentrations for SUNY ESF and ALTM. Line represents 1:1 relationship.

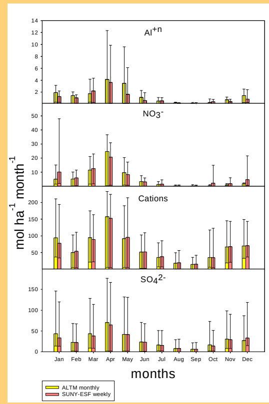

Figure 2. Monthly fluxes at the Arbutus outlet for the SUNY ESF and ALTM (1995-2002) solute calculations. Error bars represent maximum and minimum values for the calculated period

Table 1. Correlations comparing monthly solute measurements between the ALTM and SUNY-ESF

solute	p -value	*r*
H^+	0.28	0.75
NH_4^+	0.39	0.79
K+	0.82	0.85
Na^+	0.99	0.99
Mg^{2+}	0.89	0.99
Ca^{2+}	0.83	0.99
NO_3^-	0.63	0.84
SO_4^{2-}	0.66	0.99
Cl^-	0.86	0.98
DOC	0.94	0.99
AL	0.16	0.57

Monthly Solute Concentrations--For most solutes there was excellent correspondence (Figure 1; Table 1) between the monthly solute concentrations between the ALTM and the SUNY-ESF (discharge weighted weekly values converted to monthly values) with the exception of NH_4^+ and total Al.

Annual Solute Concentrations--Differences in calculated annual mean concentrations (Table 2)varied among solutes with notable differences depending on method of calculation for DOC and SO_4^{2-}

Solute fluxes--Differences in annual average solute fluxes between ALTM and the SUNY-ESF were the greatest for H^+ (15%), NH_4^+ (7%), NO_3^- (6%) and total Al (6%) with all other solutes showing mean annual flux differences of <3%. However, the highest flux differences were associated with solutes that had the greatest differences in concentration measurements (e.g., H^+, NH_4^+, NO_3^- and total Al). Note, however, that NH_4^+ and total Al values were close to detection limits.

Comparisons of monthly fluxes --The maximum, mean and minimum values for select solute fluxes using ALTM and SUNY-ESF results for each month among years are shown in Figure 2. Results were generally similar among months, but maxima/minima showed variation most notably between January and May, the period with maximum discharge due to snowmelt.

Conclusions

1)Annual solute concentrations using monthly chemistry values (ALTM) were similar to those using weekly chemistry (e.g., SUNY-ESF) especially when weighted for discharge.

2)Solute fluxes, especially over shorter times scales (e.g., monthly), showed more marked differences when using the two data sets.

3) The ALTM monthly monitoring program provides useful data on lake responses to changes in atmospheric deposition. For watershed responses that are more sensitive to changes in hydrological changes which are expected with climate change more frequent sampling of solute chemistry coupled with discharge measurements will likely be necessary.

Acknowledgements

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