SIMULATING THE RESPONSE OF EIGHT FORESTED LAKE-WATERSHEDS IN THE ADIRONDACKS REGION OF NEW YORK TO ACID DEPOSITION

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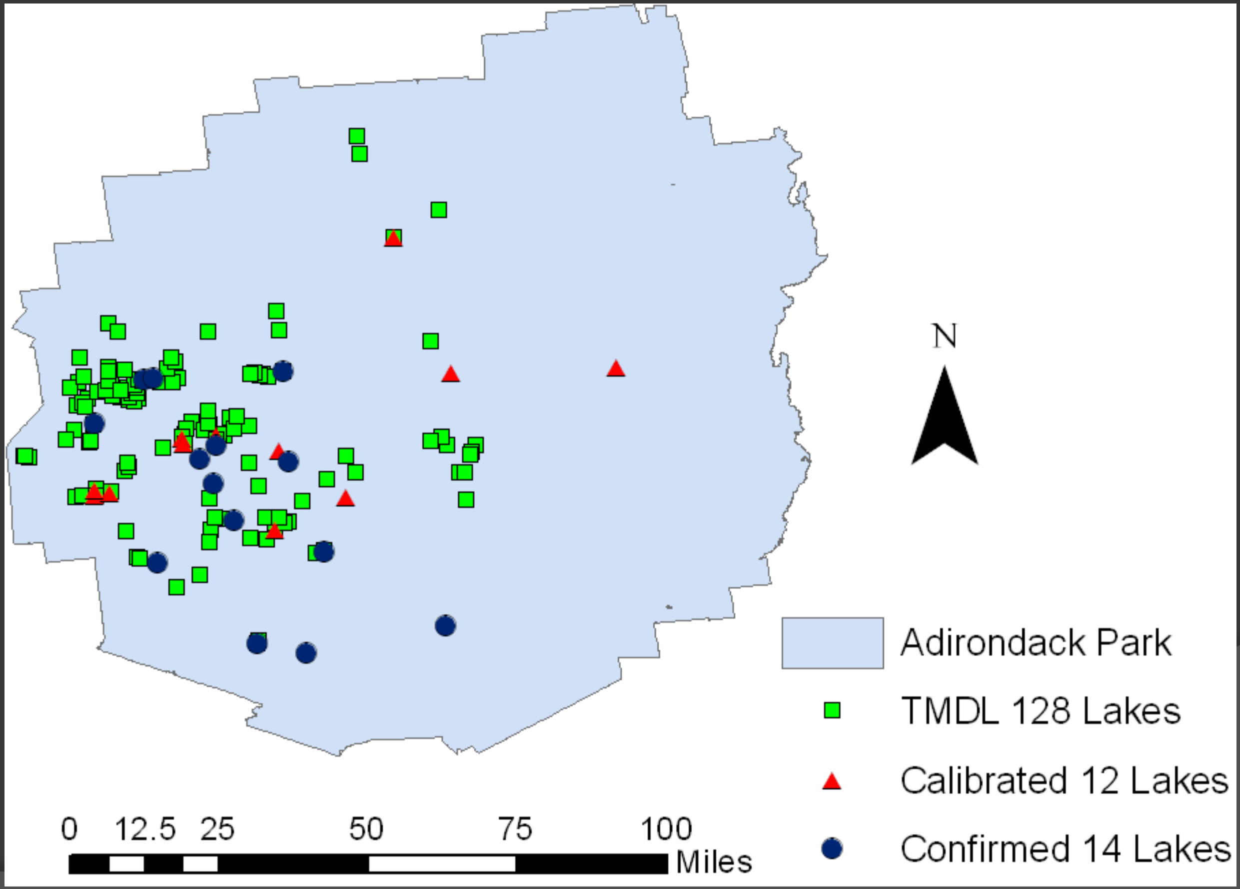
Introduction

- The Adirondack region of NY receives among the highest rates of sulphur and nitrogen deposition in the USA (Driscoll *et al*., 1991; Stoddard and Murdoch, 1991)
- The median pH and soil % base saturation of 44 Adirondack lakes decreased from 6.6 and 12.3 % (pre-industrial condition) to 5.9 and 7.9% (near peak acidification), respectively (Zhai *et. al.*2008)
- NYSDEC designated 128 lakes that are impaired due to acidity which are mostly located in southwestern Adirondacks; critical loads of acidity will be determined for impaired lakes.
- To develop critical load an integrated biogeochemical model (PnET-BGC) was applied.
- The model was calibrated by 12 lakes then confirmed by 14 other lakes.

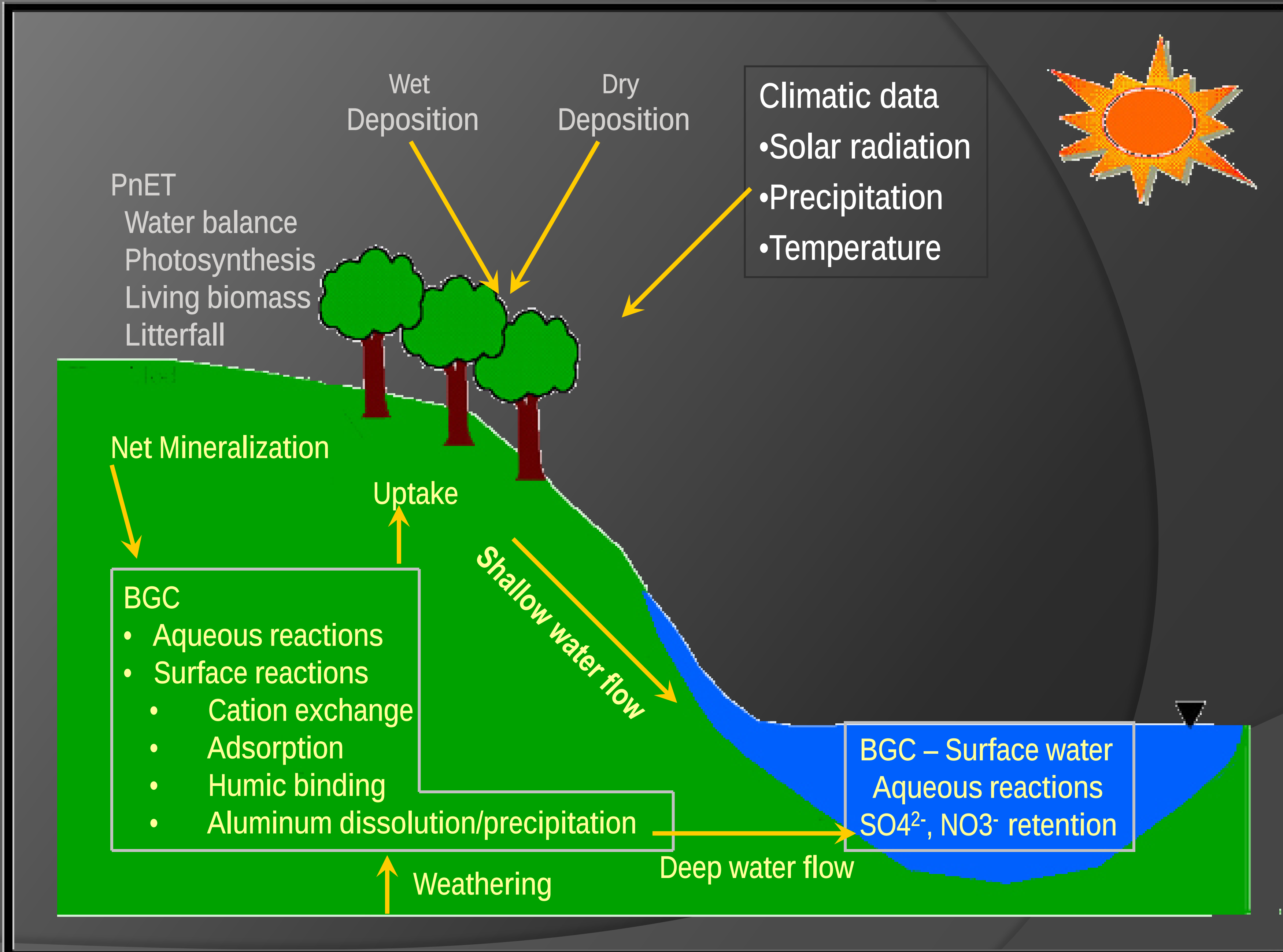

Adirondak State Park
New York State


N
Adirondack Park
TMDL 128 Lakes
Calibrated 12 Lakes
Confirmed 14 Lakes
0 12.5 25 50 75 100
Miles

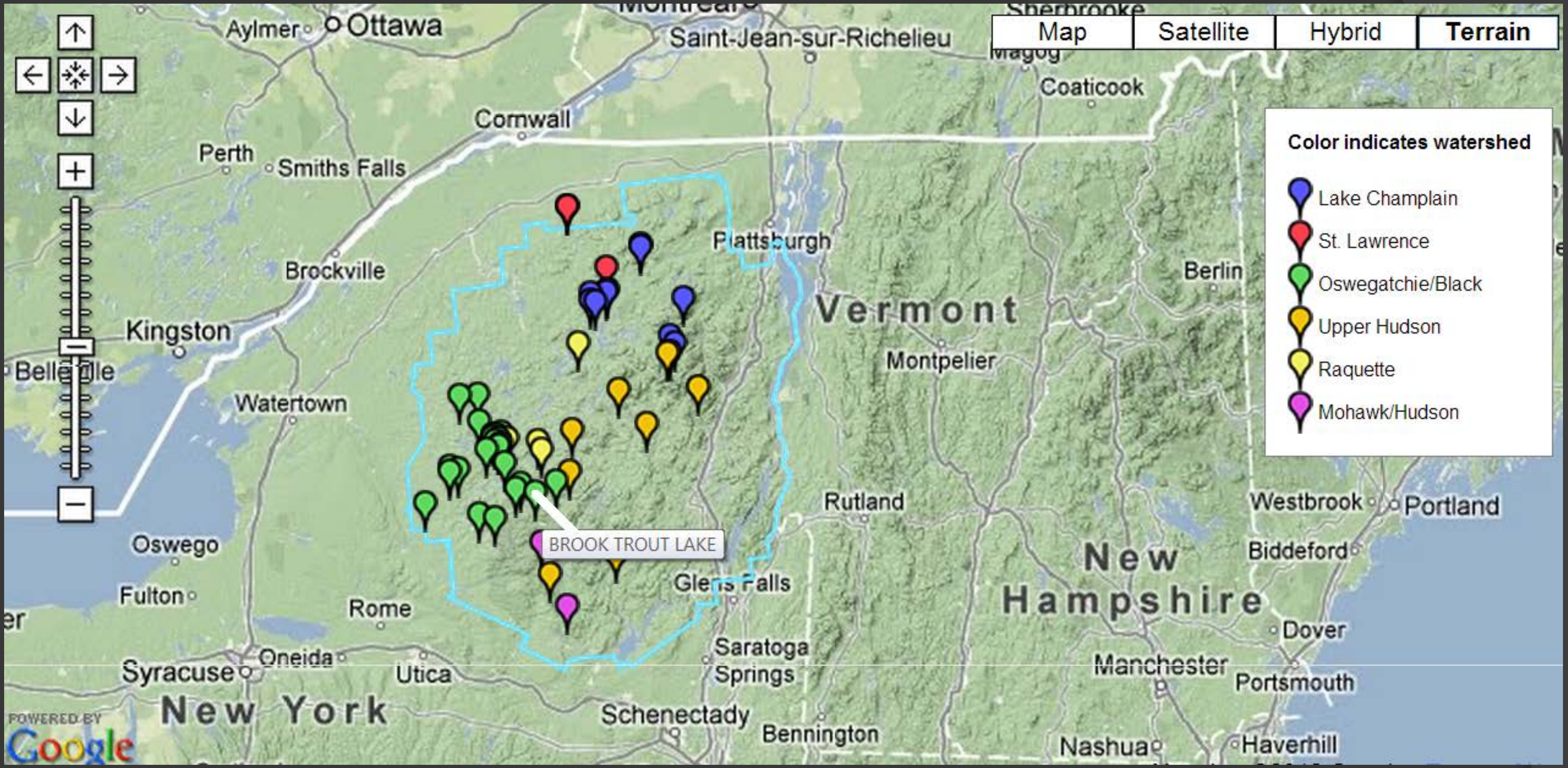
Calibrated lakes

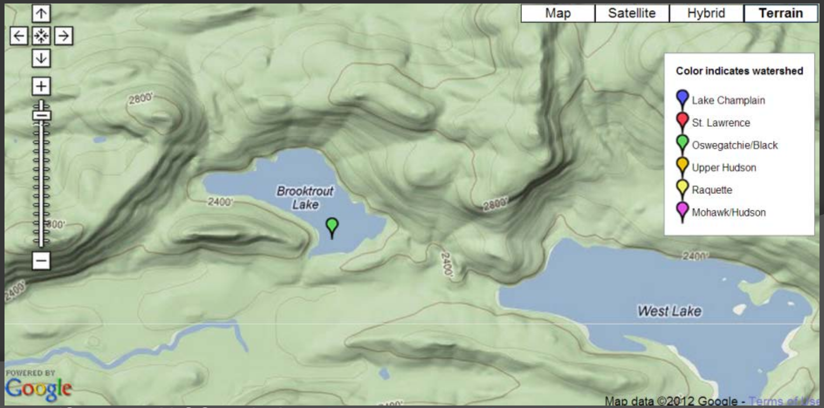
No	Lake	Surficial geology	Lake type	DOC	HRT Year	SO_4^{2-} µmoles L^{-1}	NO_3^- µmolesL^{-1}	ANC µeqL^{-1}	Lab pH SU
1	**Arbutus Lake**	medium till	drainage	low	0.50	57	7	70	6.5
2	**Brook Trout Lake**	thin till	drainage	low	1.64	42	10	3	5.4
3	**Carry Pond**		Seepage	low	1.00	28	3	0	5.1
4	**Clear Pond**	thick till	drainage	low	1.80	48	4	98	6.9
5	**Constable Pond**	thin till	chain drainage	low	0.06	55	18	15	5.2
6	**East Copperas Pond**	thin till	drainage	high	0.28	19	2	-25	4.6
7	**Grass Pond**	medium till	drainage	low	0.04	45	17	36	5.8
8	**Middle Branch Lake**	thin till	drainage	low	0.37	41	5	62	6.3
9	**Middle Settle Lake**	thin till	drainage	low	0.63	37	5	13	5.5
10	**Raquette Reservoir**	medium till	drainage	high	0.01	48	13	43	5.5
11	**Squash Pond**	thin till	chain drainage	high	0.05	45	19	-26	4.5
12	**West Pond**	thin till	drainage	low	0.20	44	9	10	5.1

PnET-BGC MODEL



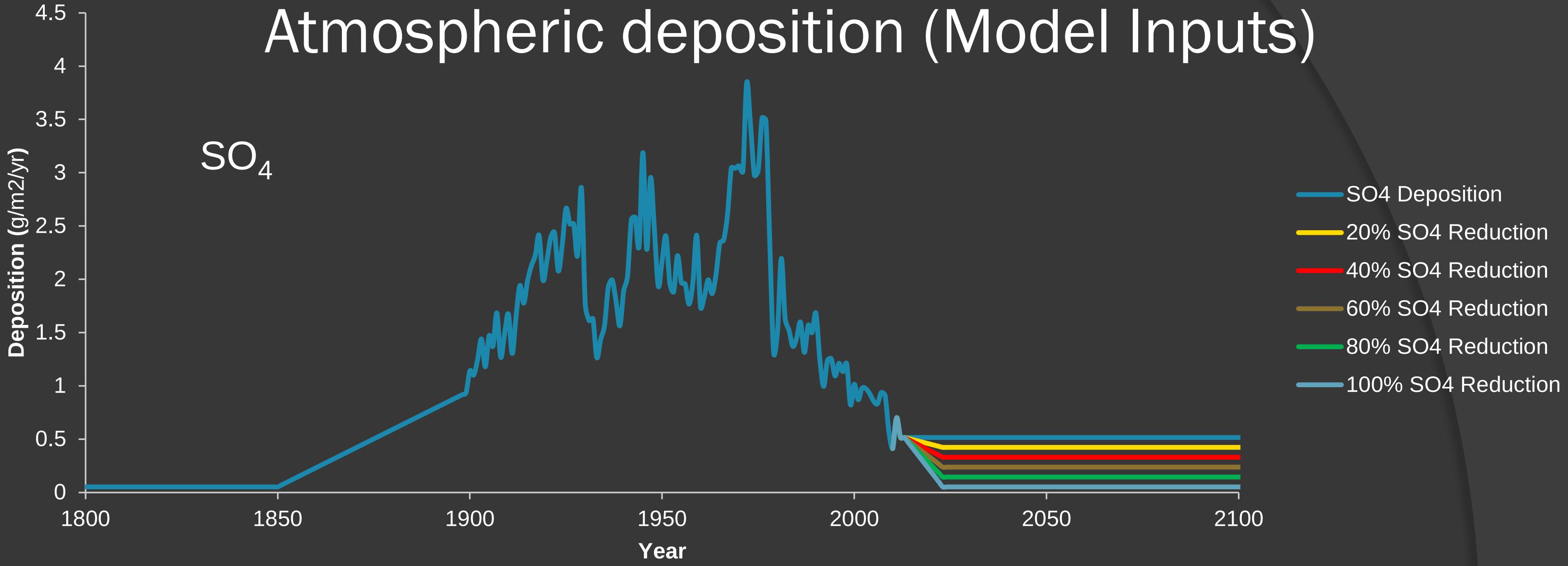
Brook Trout Lake

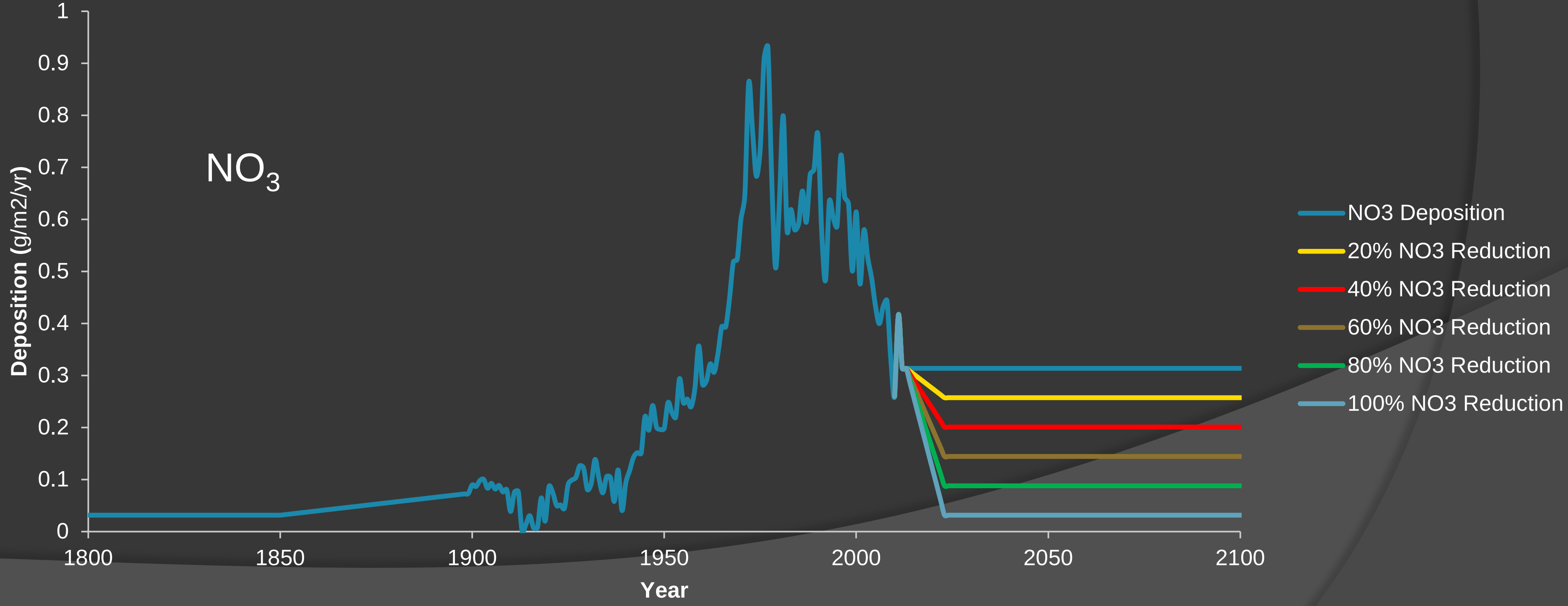


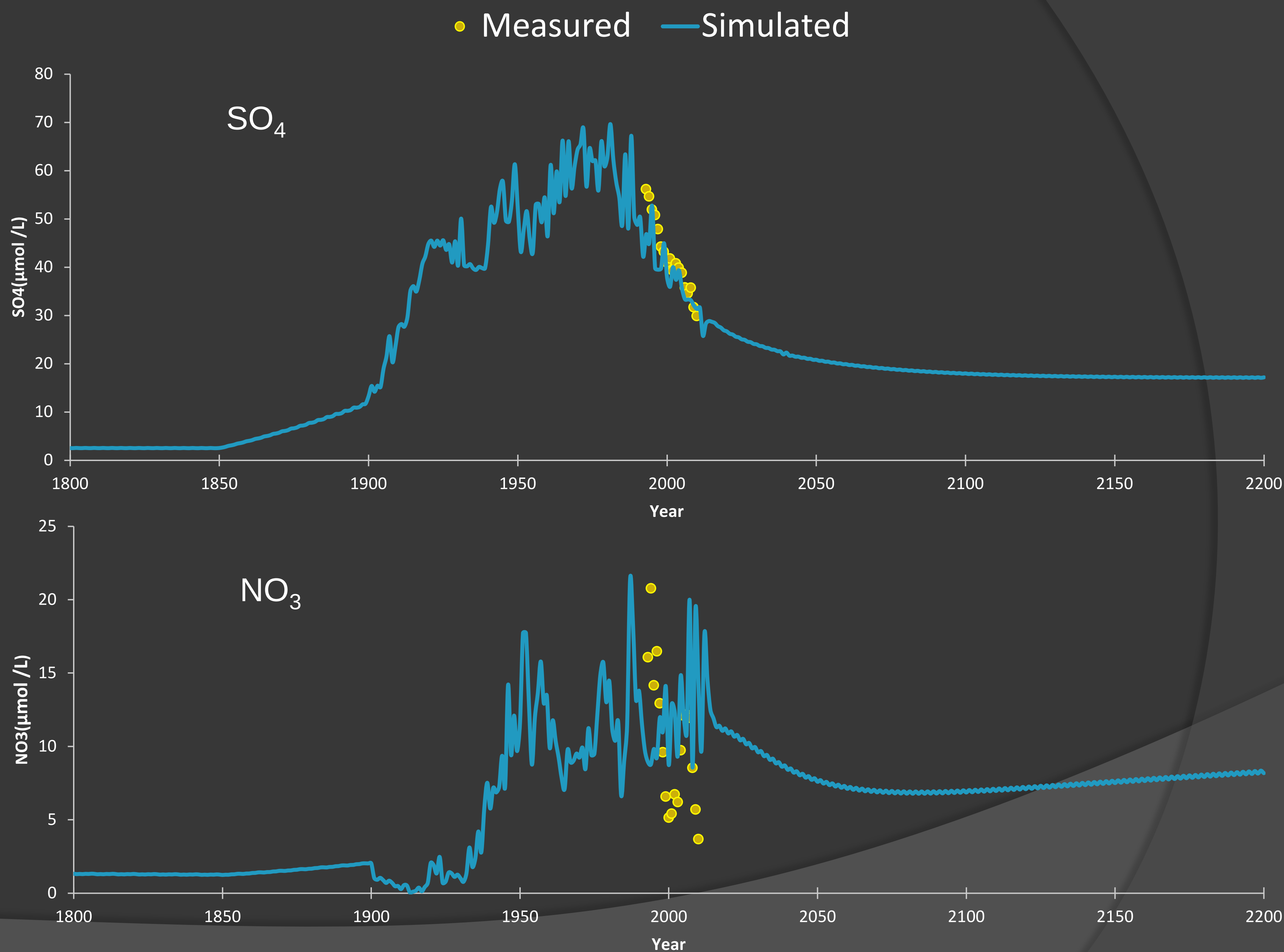


(Source: ALSC website , http://www.adirondacklakessurvey.org)

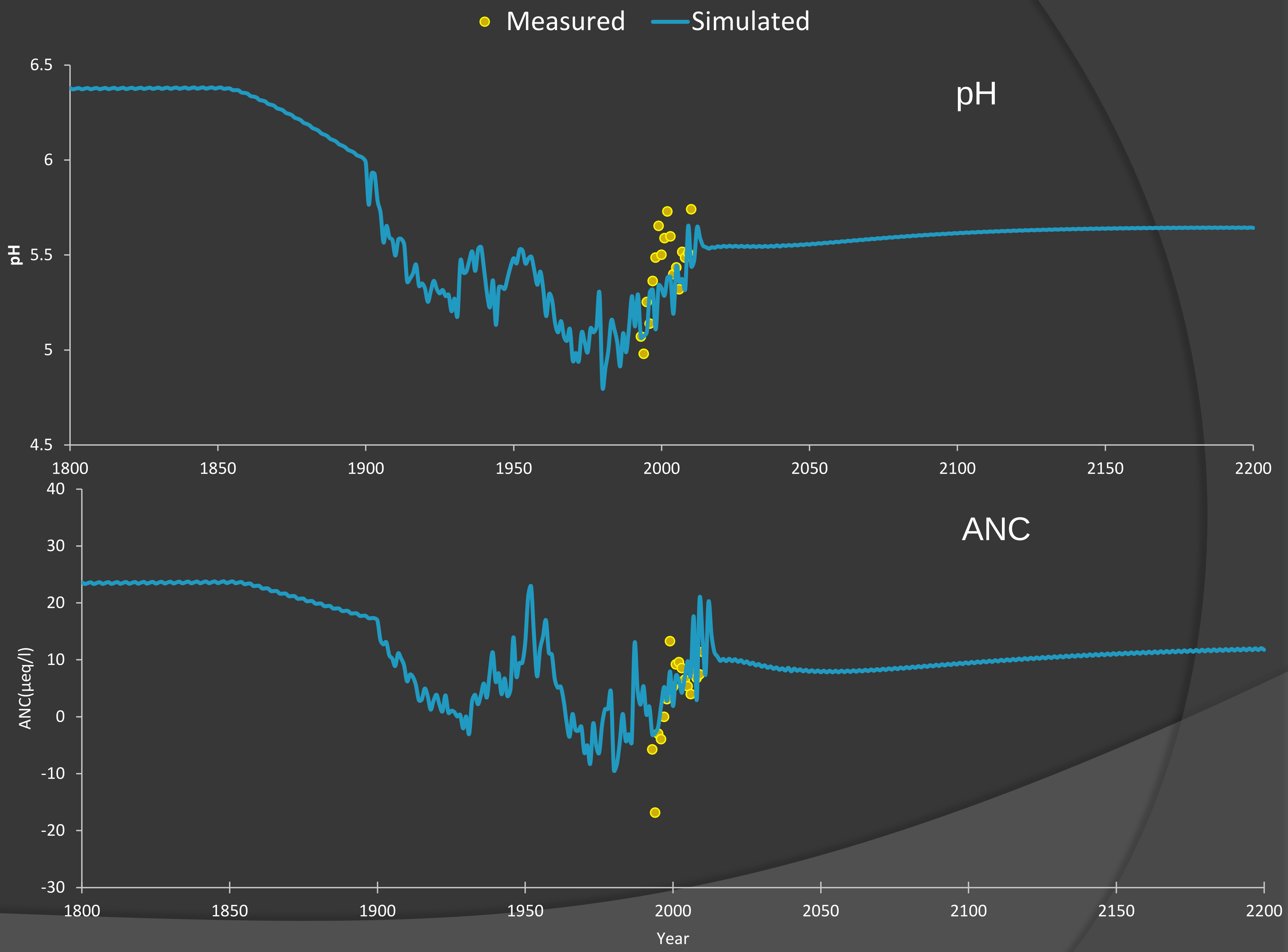
Atmospheric deposition (Model Inputs)



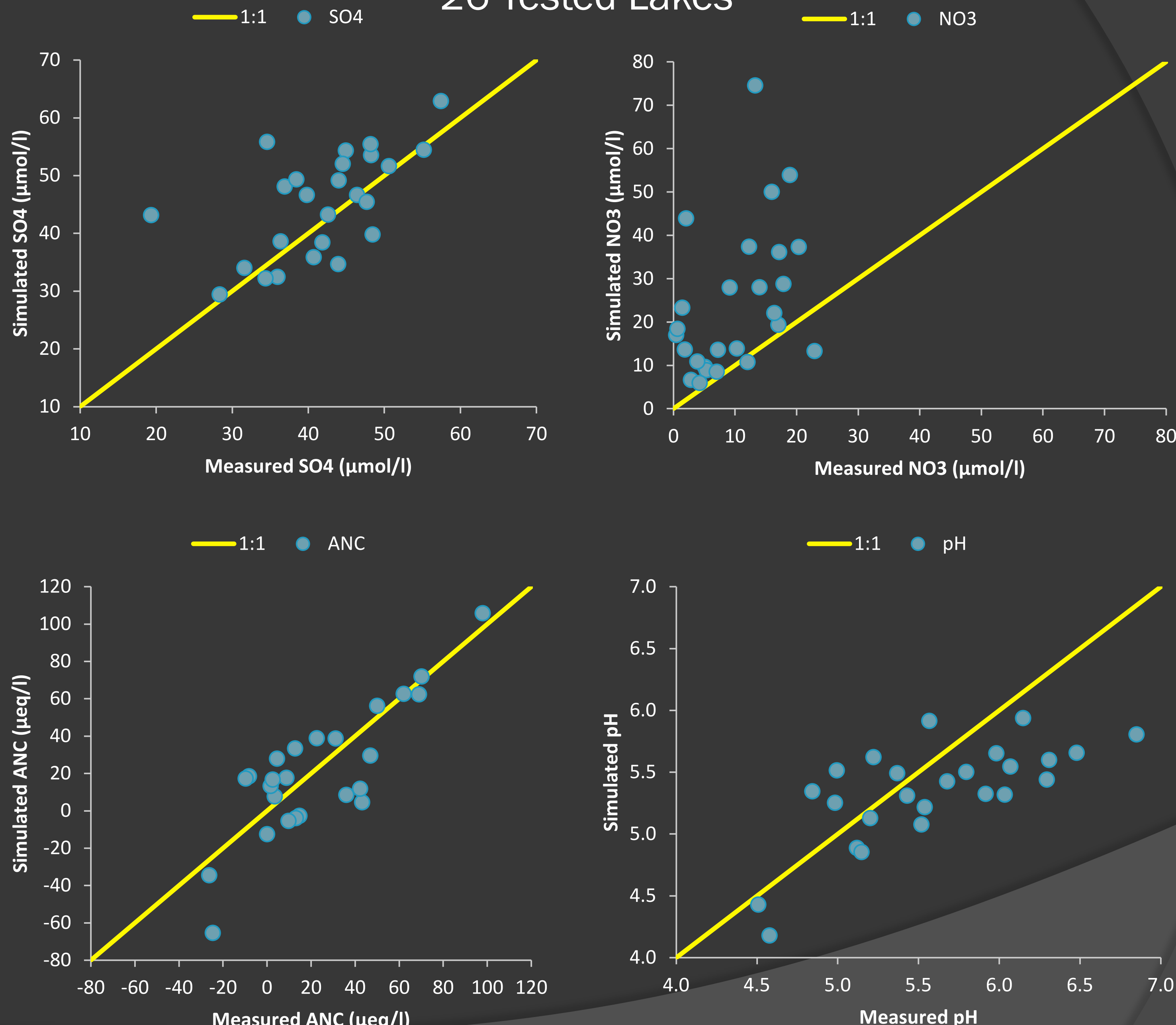


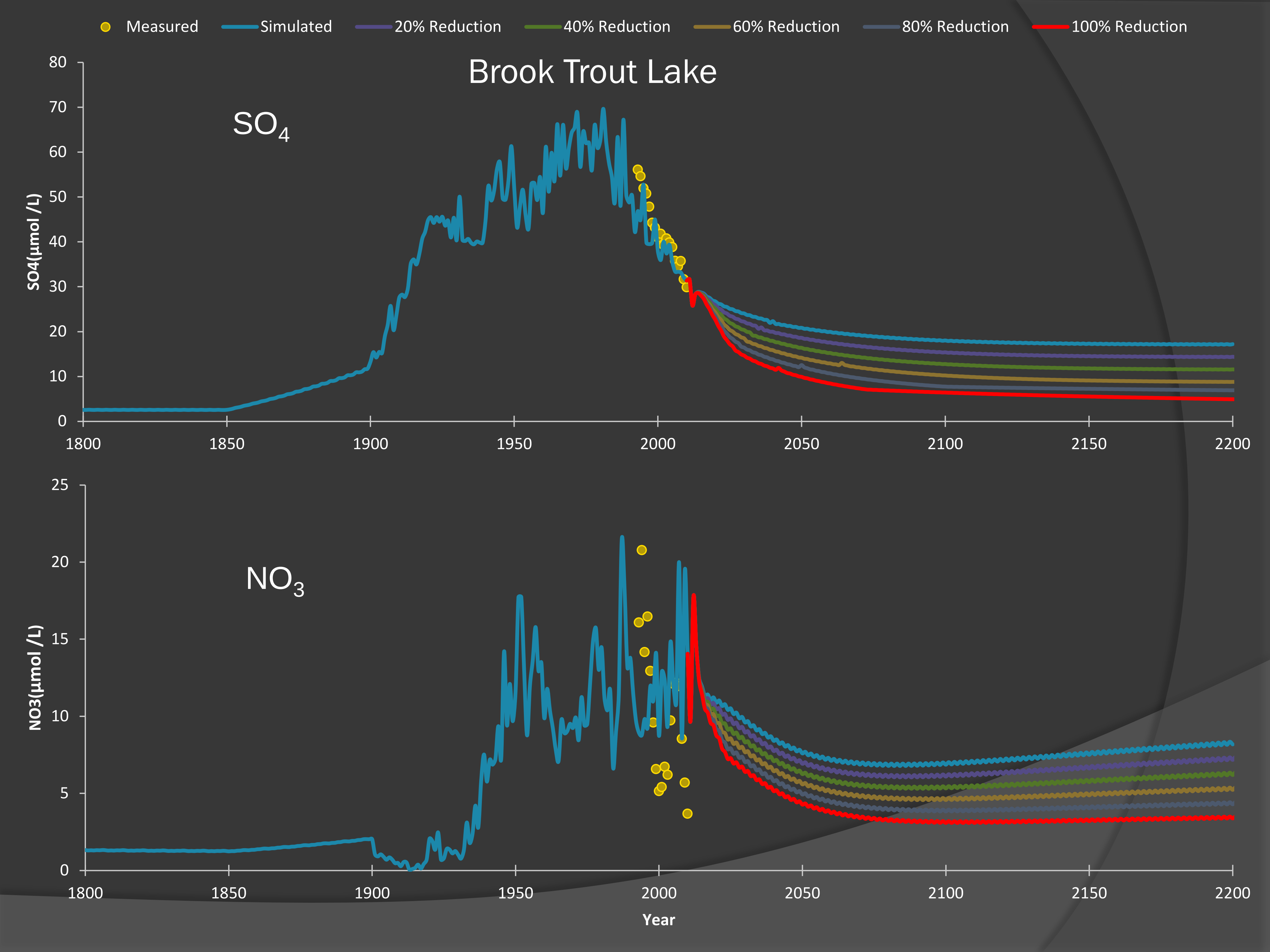


Measured
Simulated
SO4
SO4(µmol /L)
0
10
20
30
40
50
60
70
80
1800
1850
1900
1950
2000
2050
2100
2150
2200
Year
NO3
NO3(µmol /L)
0
5
10
15
20
25
1800
1850
1900
1950
2000
2050
2100
2150
2200
Year

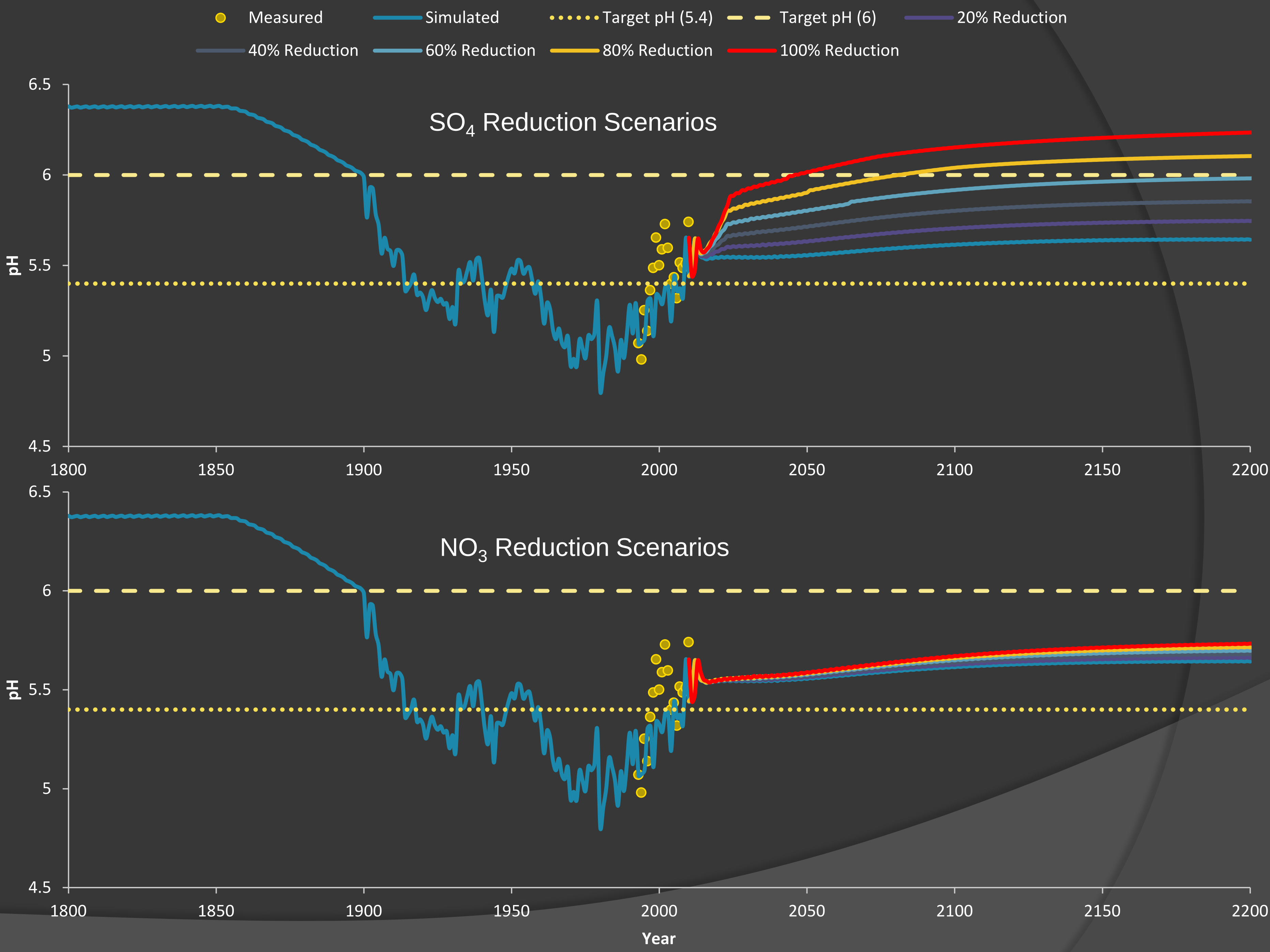

Measured
Simulated
pH
pH
6.5
6
5.5
5
4.5
1800
1850
1900
1950
2000
2050
2100
2150
2200
ANC
ANC(µeq/l)
40
30
20
10
0
-10
-20
-30
Year

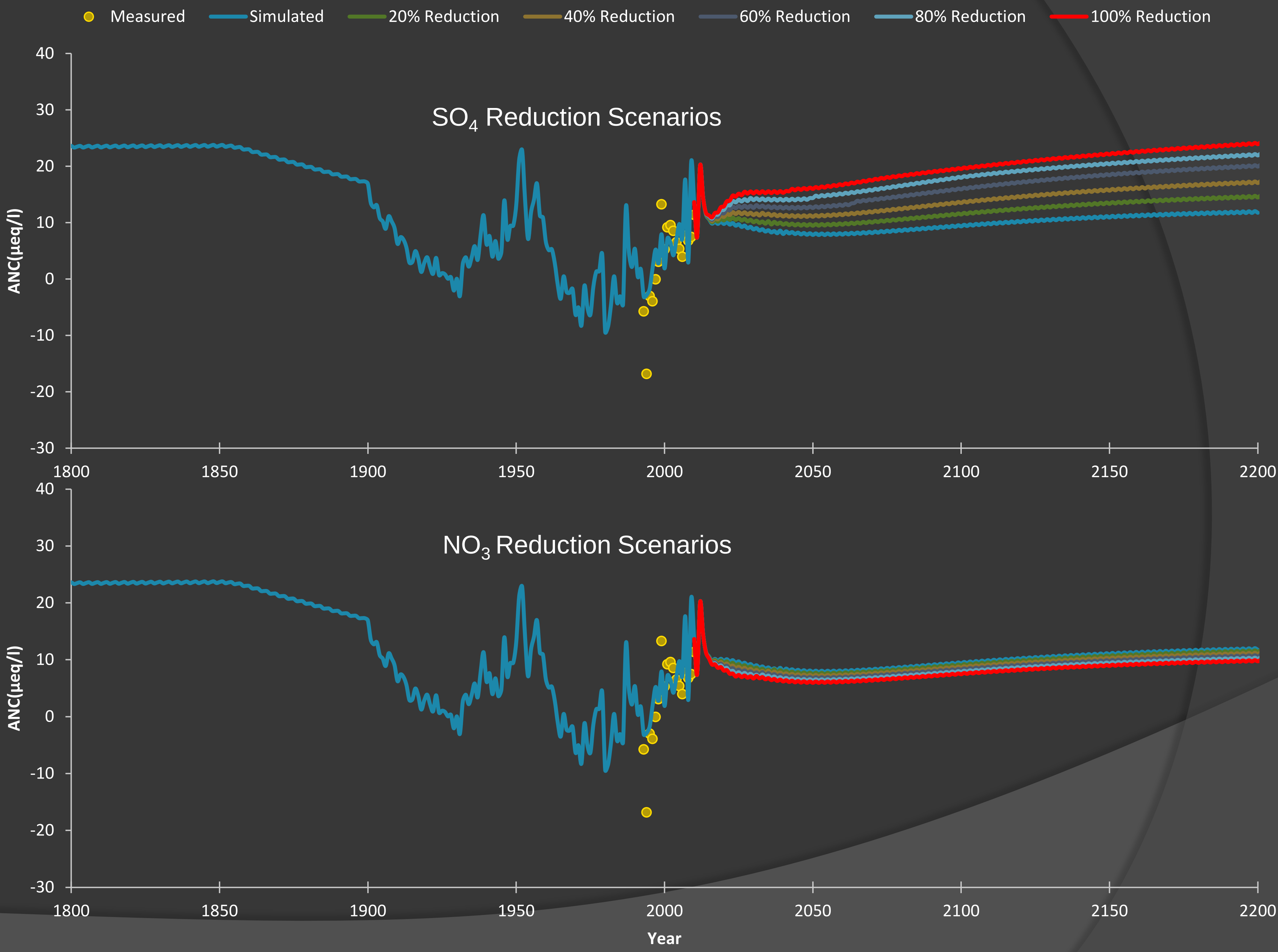
26 Tested Lakes



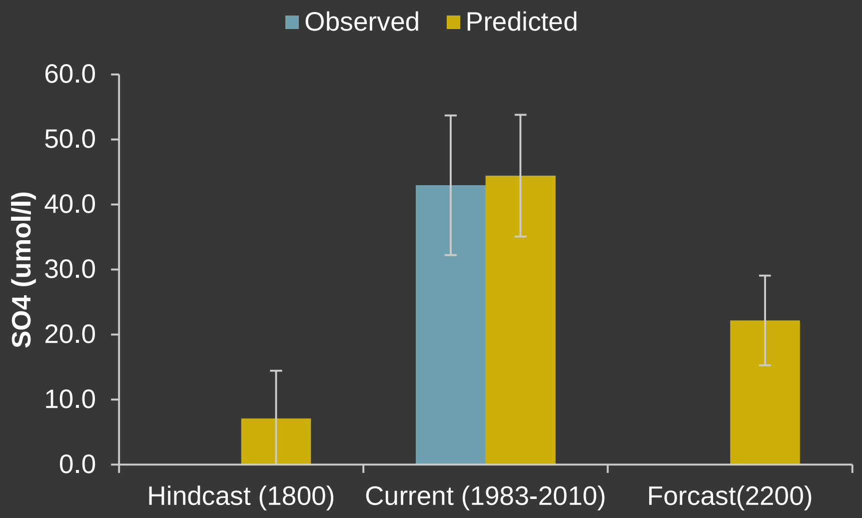


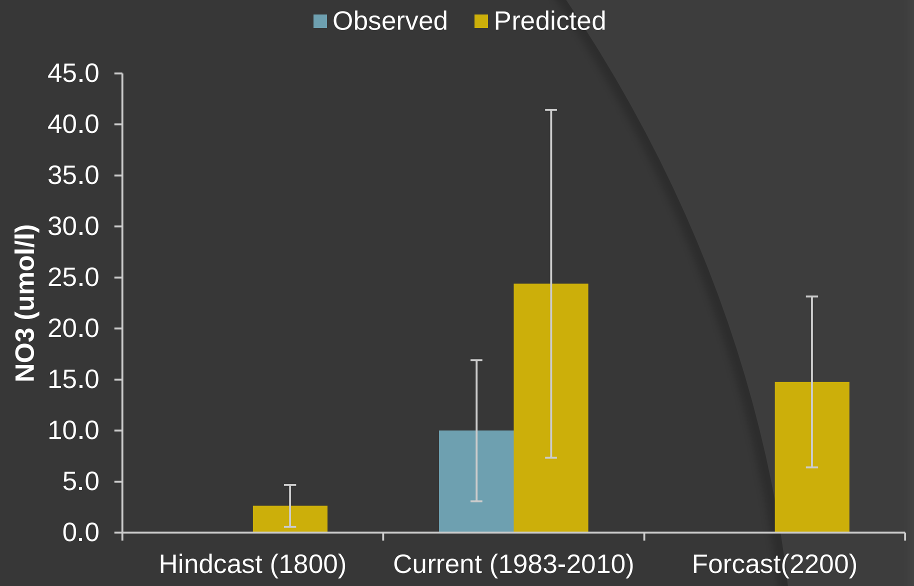
Measured
Simulated
20% Reduction
40% Reduction
60% Reduction
80% Reduction
100% Reduction
Brook Trout Lake
SO4
SO4(µmol /L)
NO3
NO3(µmol /L)
Year
0
10
20
30
40
50
60
70
80
0
5
10
15
20
25
1800
1850
1900
1950
2000
2050
2100
2150
2200

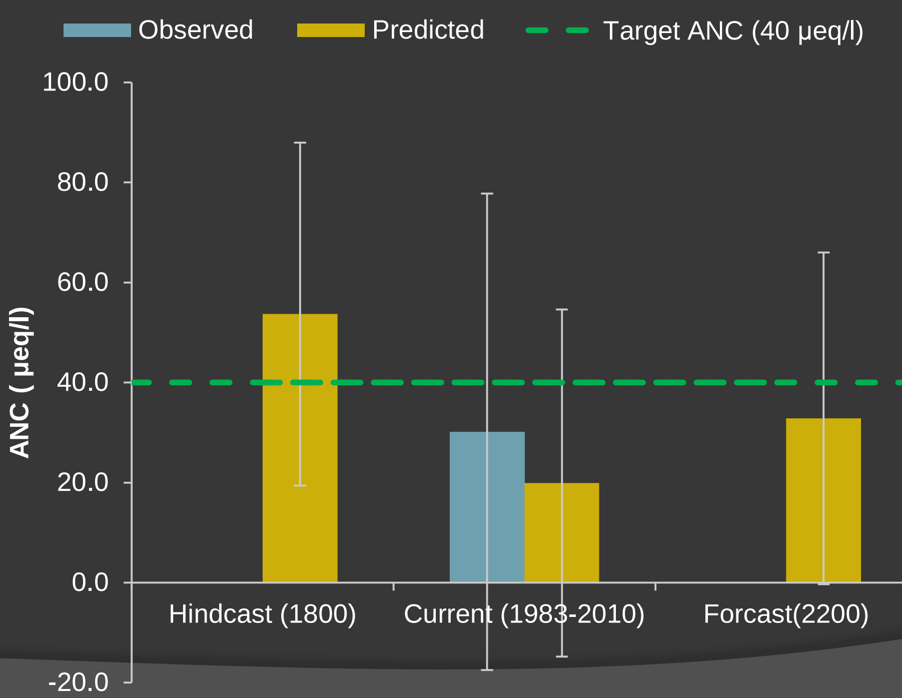

Measured
Simulated
Target pH (5.4)
Target pH (6)
20% Reduction
40% Reduction
60% Reduction
80% Reduction
100% Reduction
SO4 Reduction Scenarios
NO3 Reduction Scenarios
pH
Year
6.5
6
5.5
5
4.5
1800
1850
1900
1950
2000
2050
2100
2150
2200

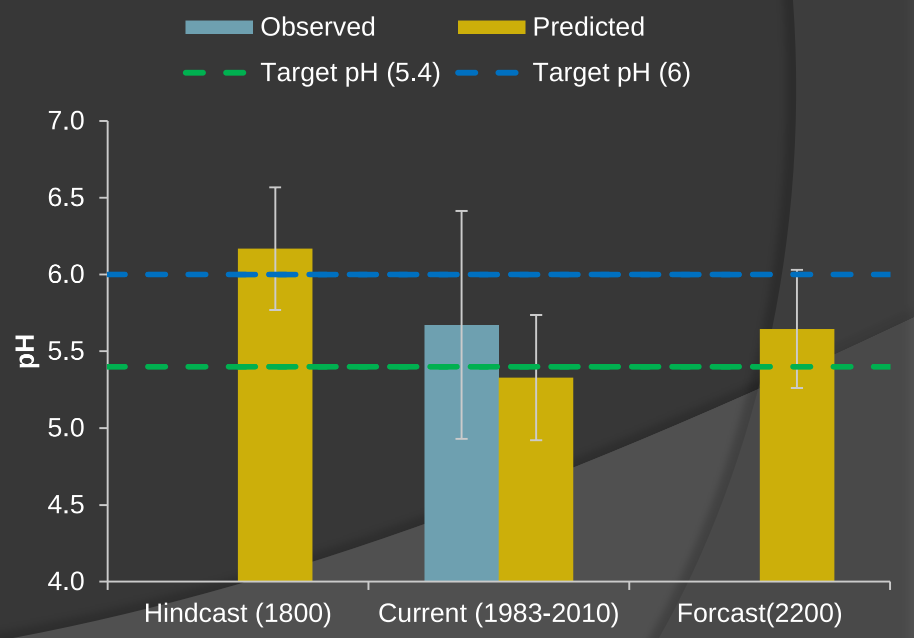

Measured
Simulated
20% Reduction
40% Reduction
60% Reduction
80% Reduction
100% Reduction
SO4 Reduction Scenarios
NO3 Reduction Scenarios
ANC(μeq/l)
Year
40
30
20
10
0
-10
-20
-30
1800
1850
1900
1950
2000
2050
2100
2150
2200

26 Tested Lakes









Conclusions

- This project is in progress; to determine Critical Loads for 128 impaired lakes we will use the data from the simulations of the 26 sites to extrapolate to the population of impaired lakes.
- Model does a good reasonable job in simulating sulfate and ANC, it is less effective in simulating nitrate and pH.
- Simulations suggest mean ANC and pH decreased 30 µeq/l and 1 unit, respectively, from pre anthropogenic to current conditions.
- Simulations suggest that it will take approximately 200 years for lake-watershed to achieve to the steady state.
- Decreases in sulfate are more effective in increasing ANC and pH than decreases in nitrate.