Recent and potential future changes in the chemistry of surface waters of the Adirondack region of New York in response to decreases in atmospheric deposition

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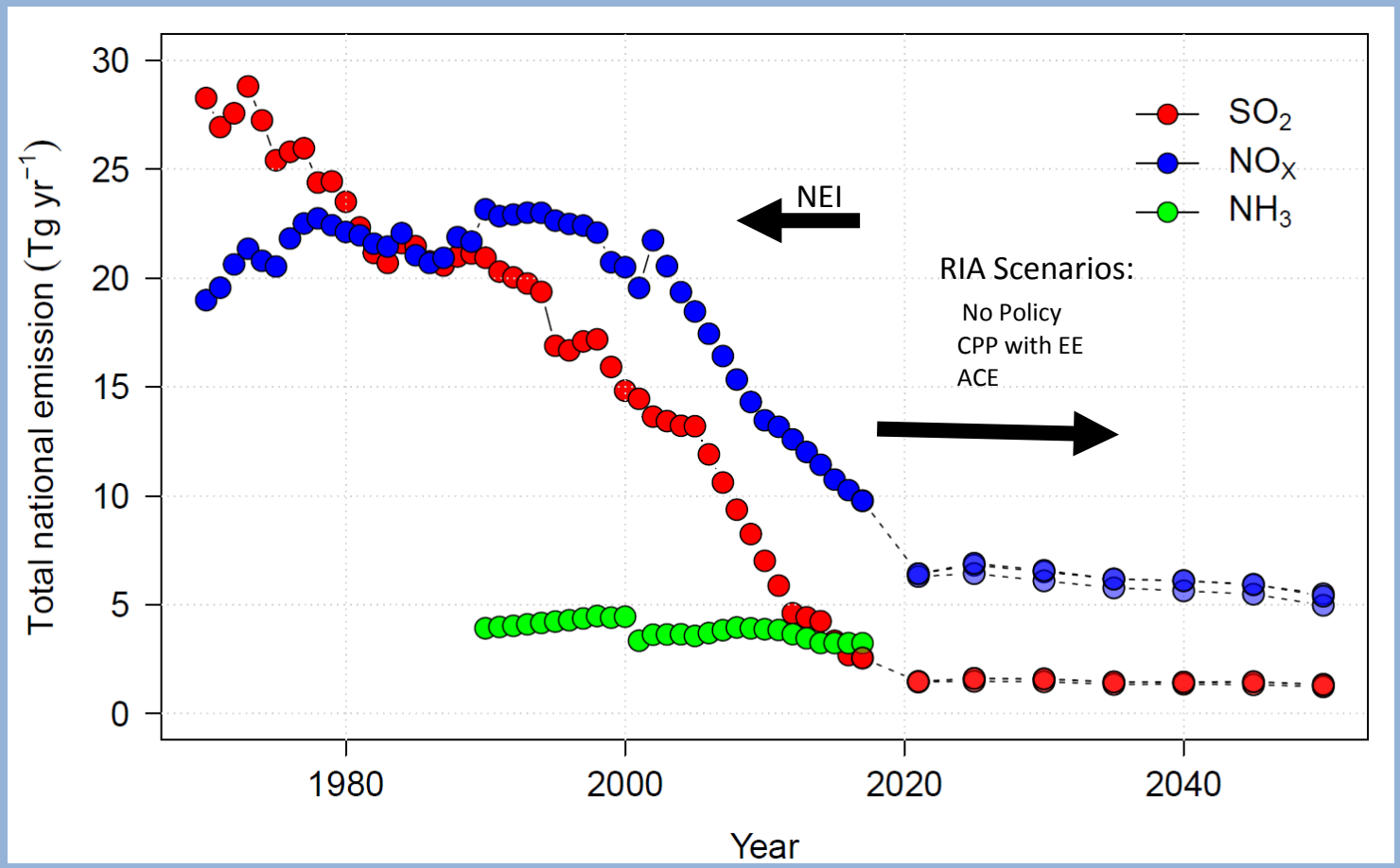
Outline

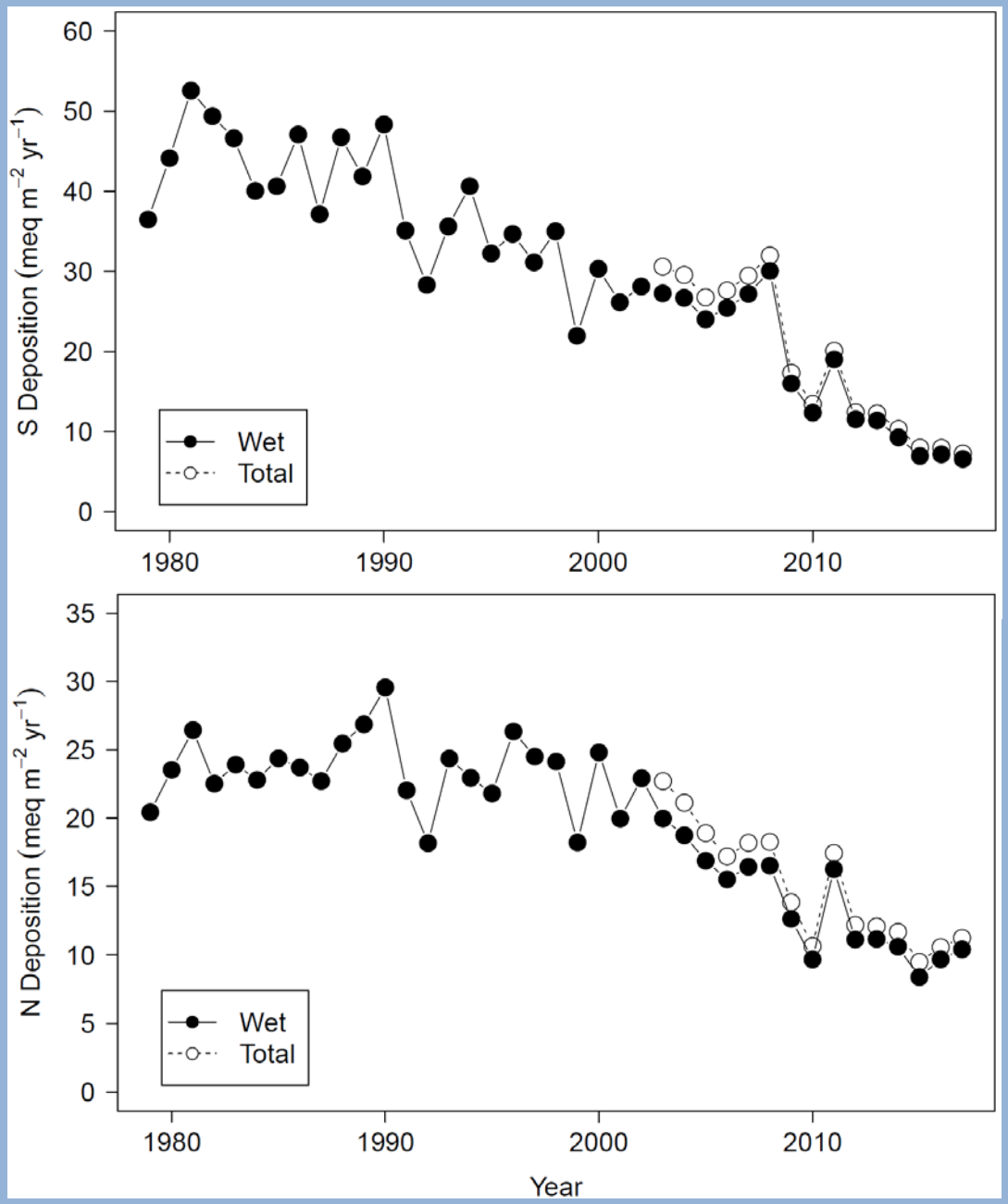
- Trends in Adirondack deposition and lakes

- Comparison of future recovery under changing and constant climate at Buck Creek watershed

Temporal Trends in Total U.S Emissions

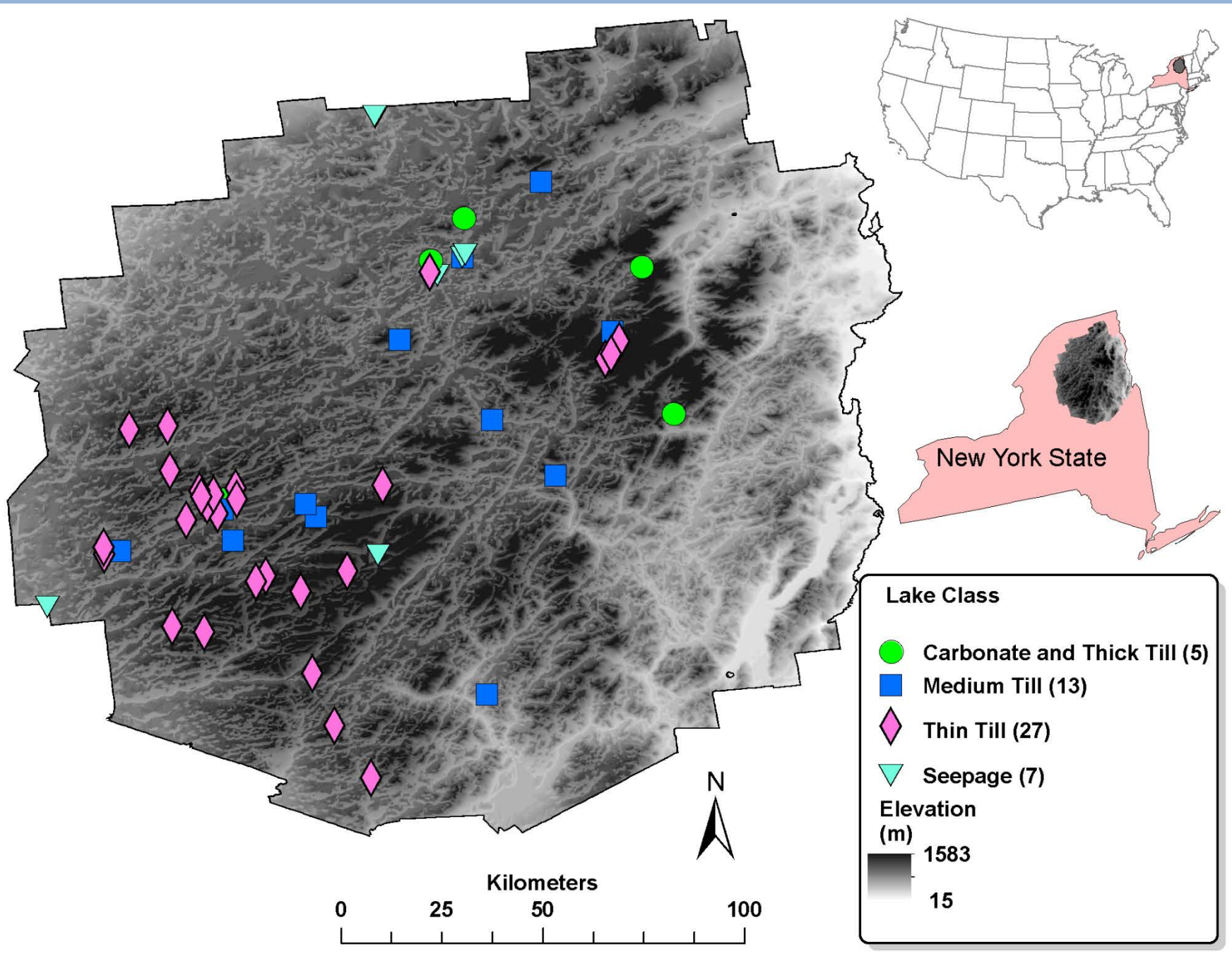


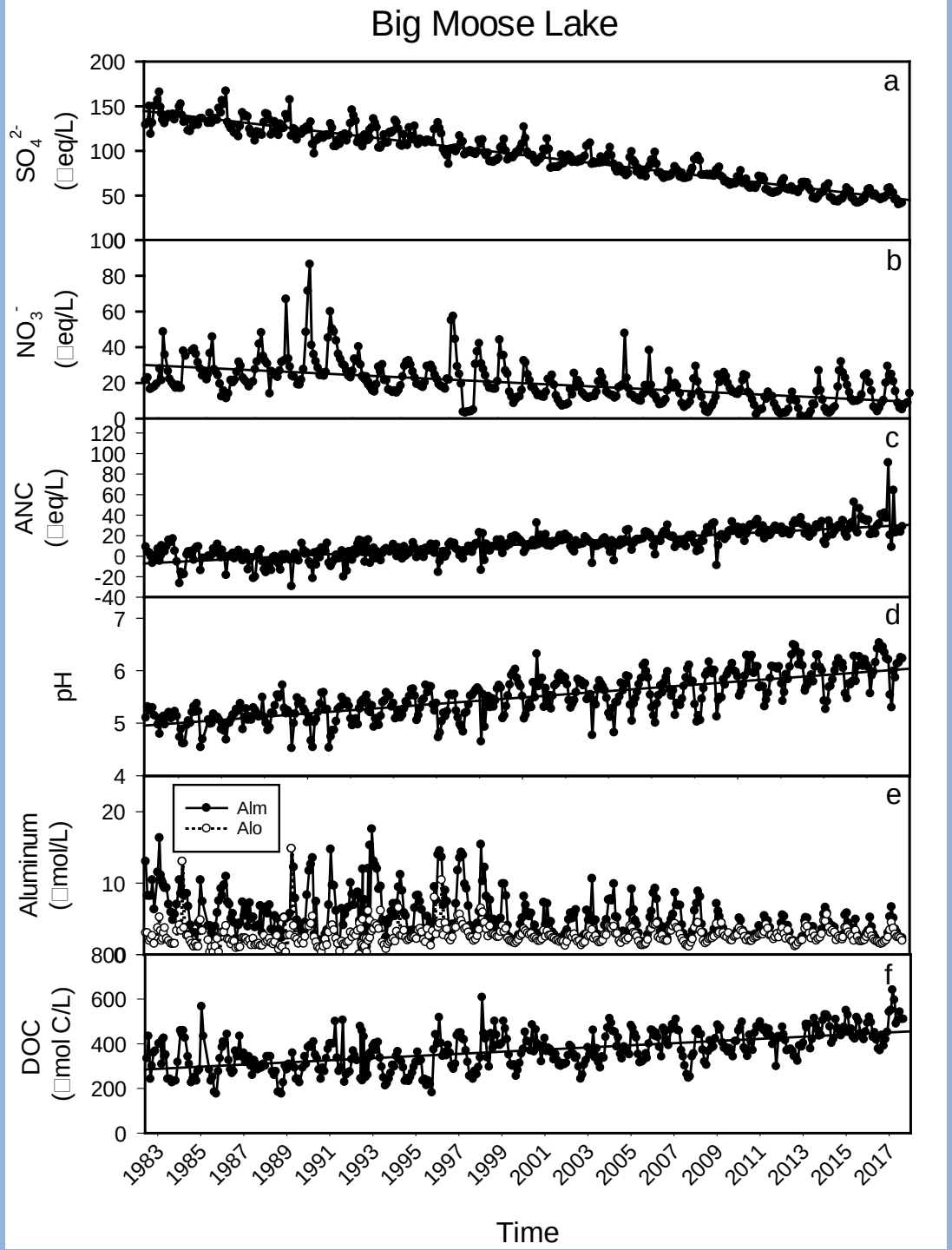
USEPA 2017



Controls on U.S. national emissions of sulfur dioxide and nitrogen oxides have driven decreases in atmospheric sulfate and nitrate deposition at Huntington Forest

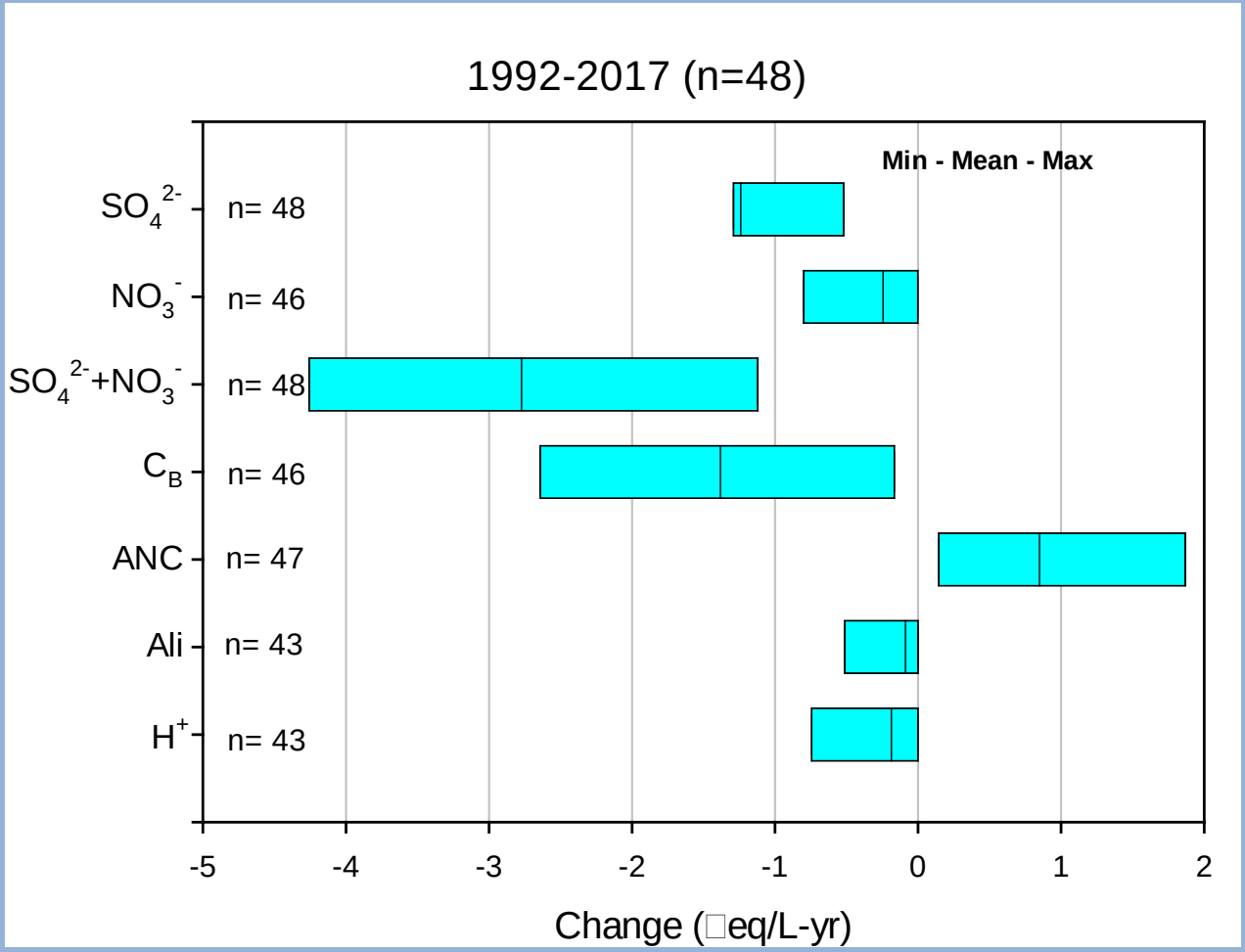
NADP, CASTNet


New York State
Lake Class
Carbonate and Thick Till (5)
Medium Till (13)
Thin Till (27)
Seepage (7)
Elevation
(m)
1583
15
N
Kilometers
0
25
50
100



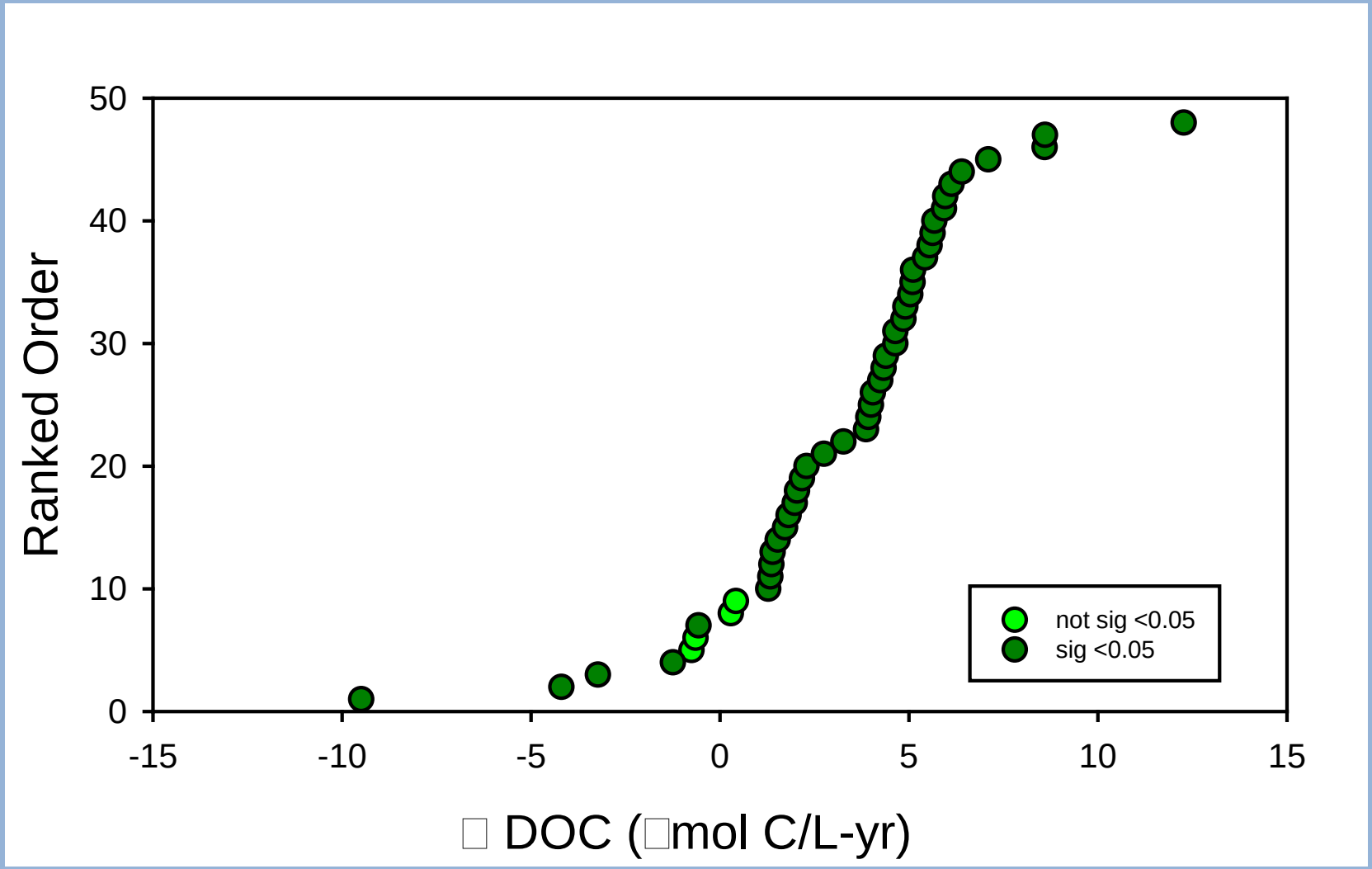
Long-term trends in water chemistry of Big Moose Lake.

A line through the observations shows a statistically significant trend ($p < 0.05$).

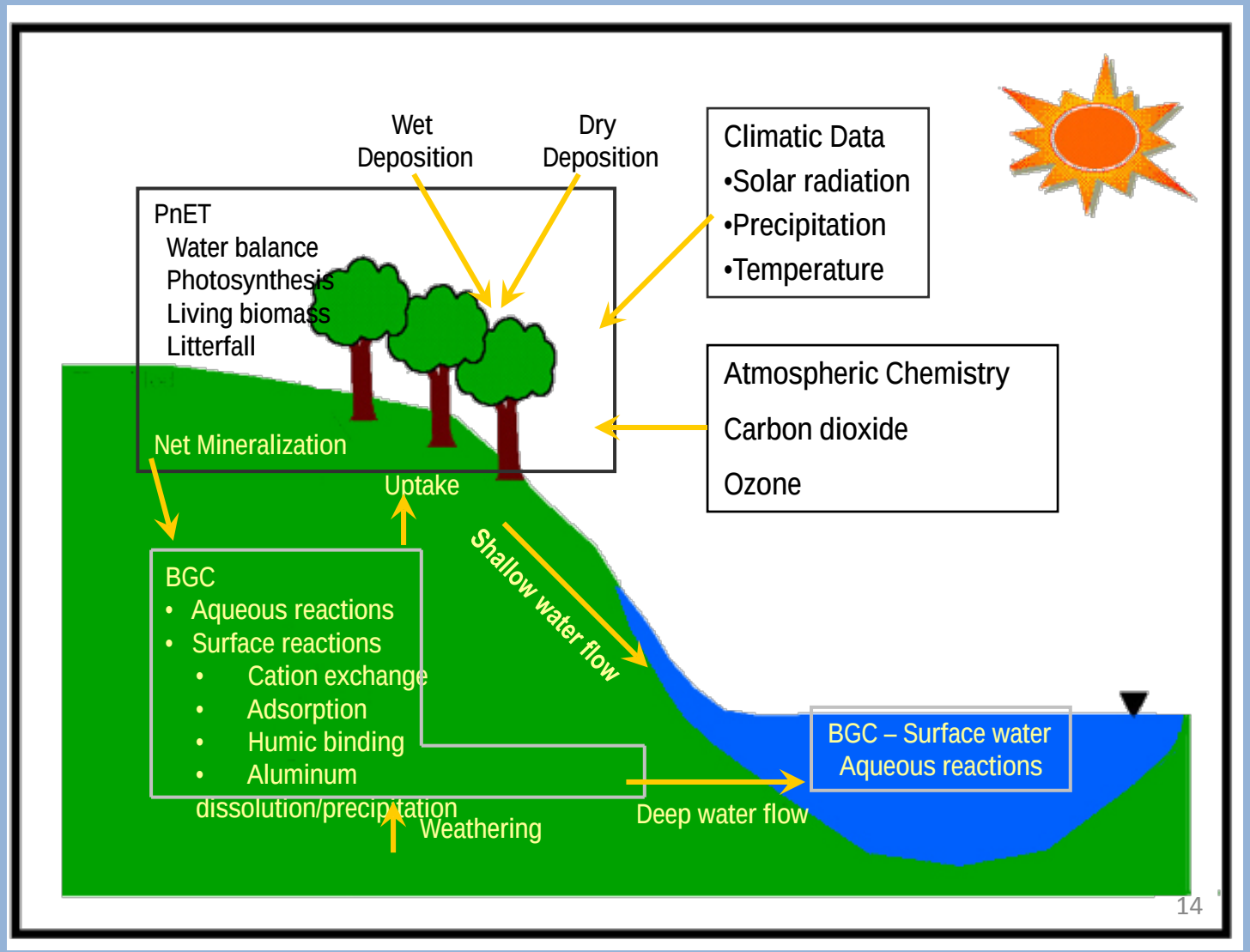


ALTM lakes are showing universal decreases in SO_4^{2-} and NO_3^- is decreasing in large numbers.

Many lakes are responding with increases in ANC and decreases in Ali.



ALTM lakes are showing long-term increases in DOC (1992-2017)

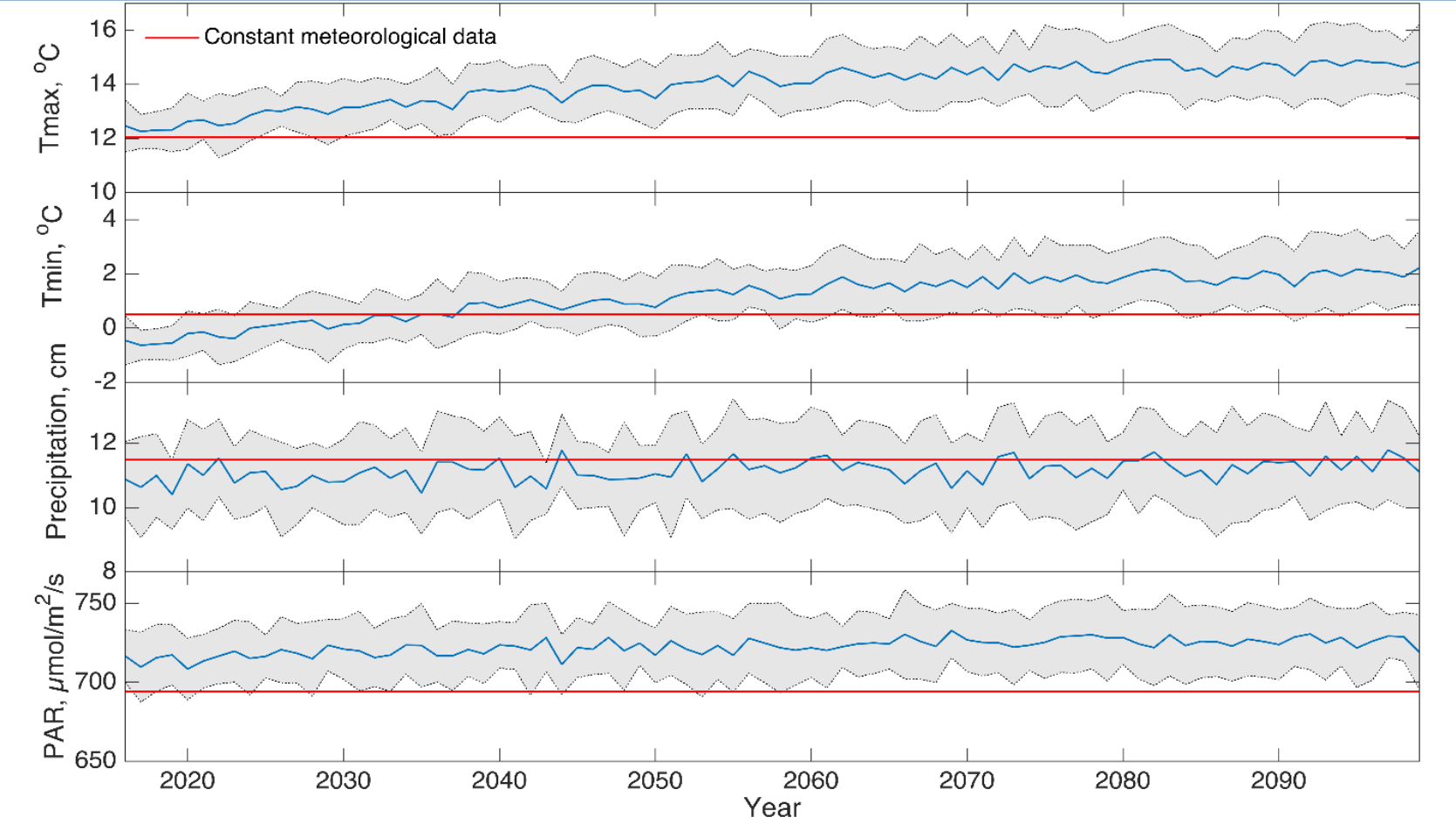

Wet Deposition
Dry Deposition
Climatic Data
•Solar radiation
•Precipitation
•Temperature
PnET
Water balance
Photosynthesis
Living biomass
Litterfall
Atmospheric Chemistry
Carbon dioxide
Ozone
Net Mineralization
Uptake
Shallow water flow
BGC
• Aqueous reactions
• Surface reactions
• Cation exchange
• Adsorption
• Humic binding
• Aluminum dissolution/precipitation
BGC – Surface water
Aqueous reactions
Deep water flow
Weathering

AOGCMS and emission scenarios

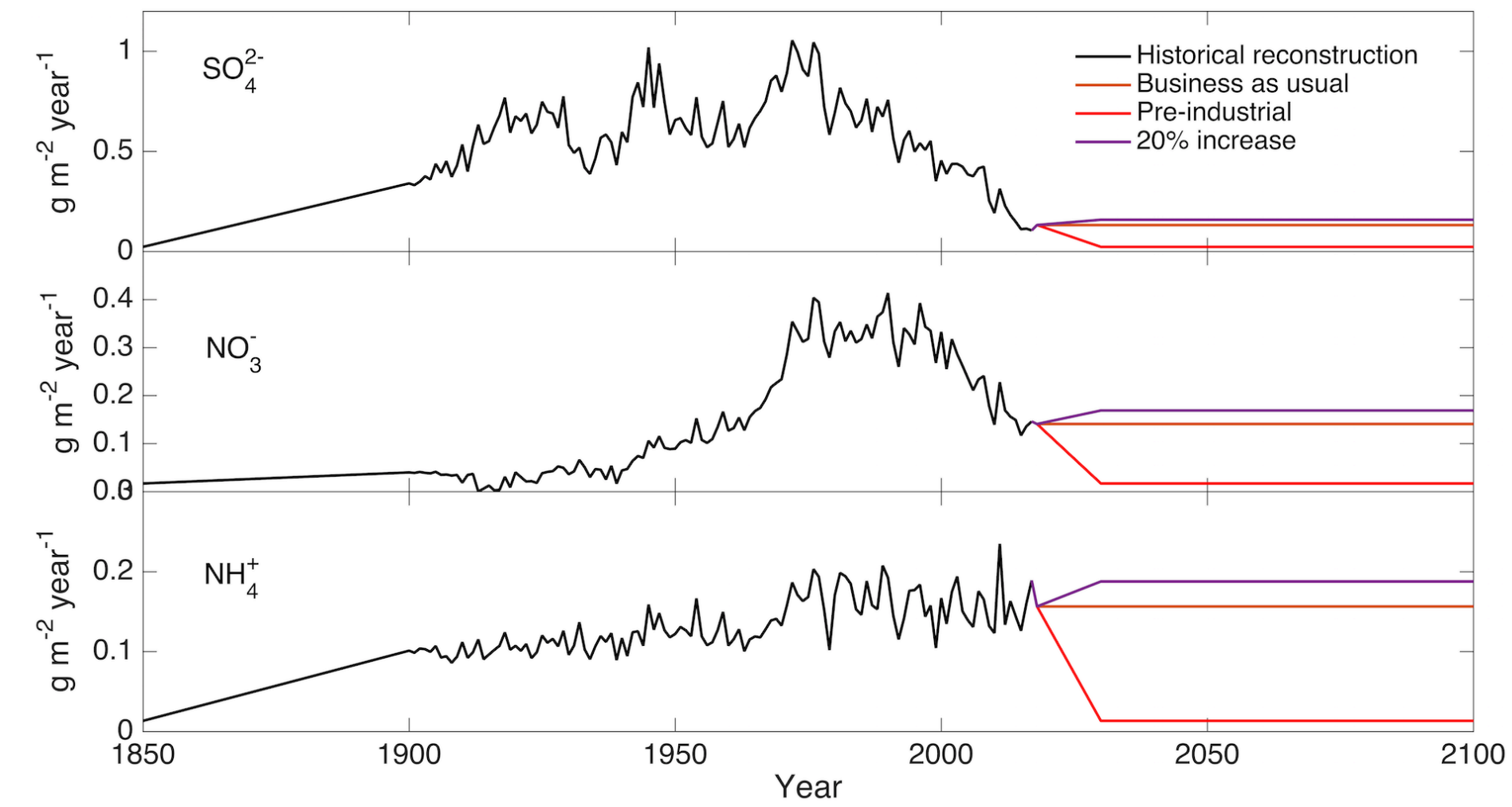
17 AOGCMs: BCC-CSM1-1, BCC-CSM1-1-m, BNU-ESM, CanESM2, CNRM-CM5, CSIRO-Mk3-6-0, GFDL-ESM2G, GFDL-ESM2M, HadGEM2-CC365, HadGEM2-ES365, IPSL-CM5A-LR, IPSL-CM5A-MR, IPSL-CM5B-LR, MIROC5, MIROC-ESM, MIROC-ESM-CHEM, MRI-CGCM3

Coupled with emissions scenario: RCP4.5

Statistically downscaled using Multivariate Adaptive Constructed Analogs and station observations.

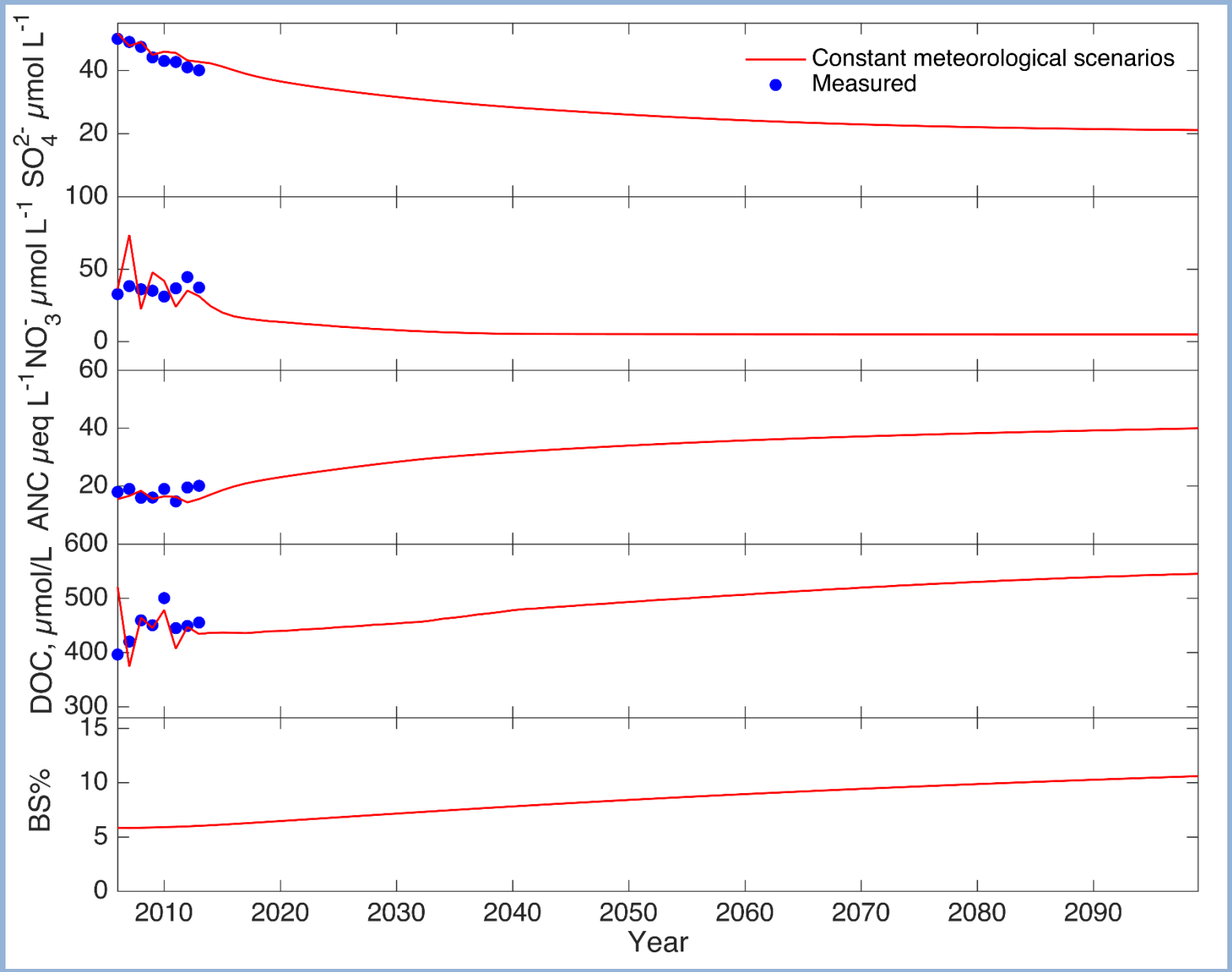


	Tmax	Tmin	Precipitation	PAR
Mann-Kendall coefficient	0.8243	0.8481	0.3489	0.5896
p value	<0.0001	<0.0001	<0.0001	<0.0001
Sen's slope	0.0307 °C yr^{-1}	0.0330 °C yr^{-1}	0.0068 cm yr^{-1}	0.1747

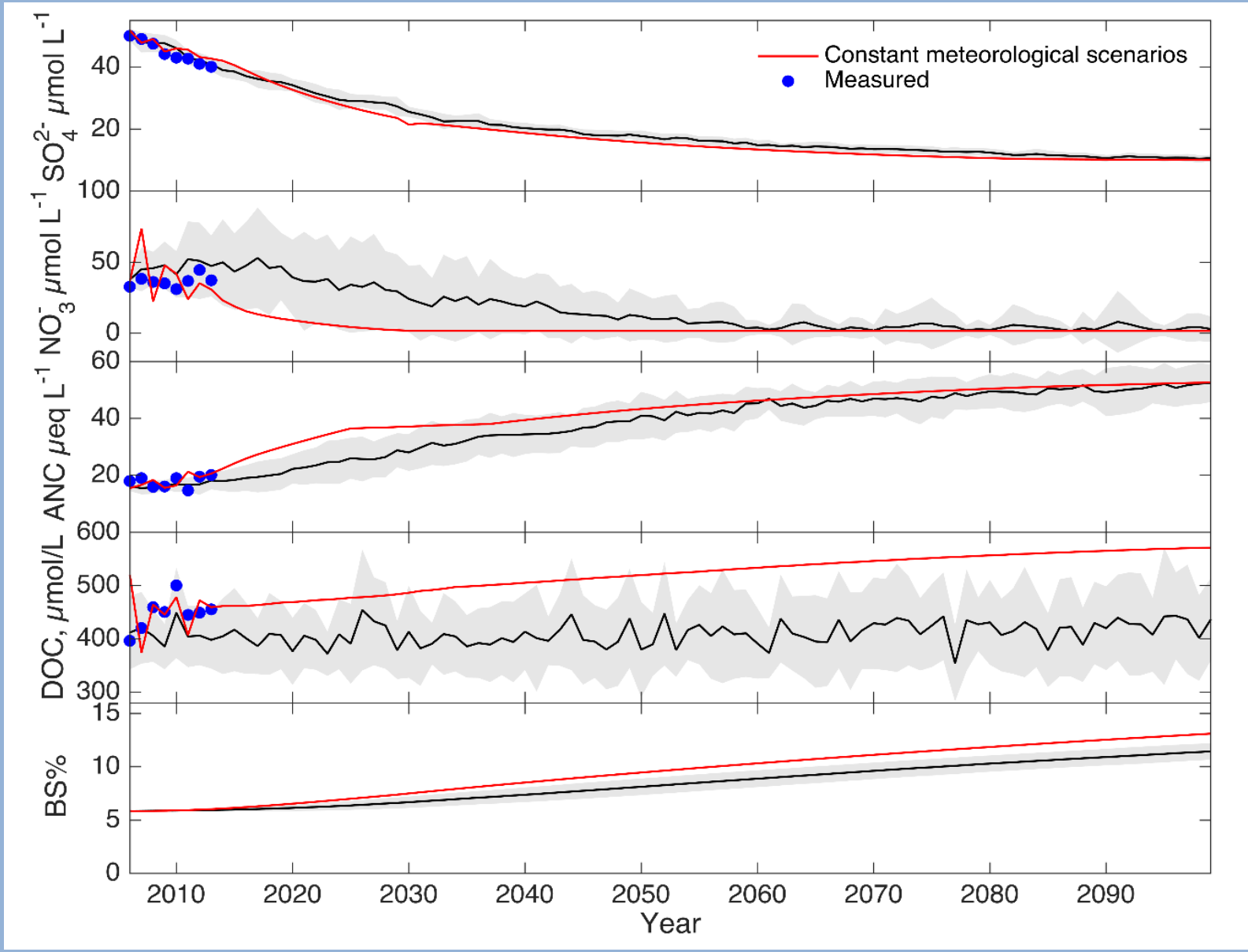


Reconstruction of historical deposition and projections of three future deposition scenarios: business as usual, 100% decrease to pre-industrial deposition and 20% increase from current deposition

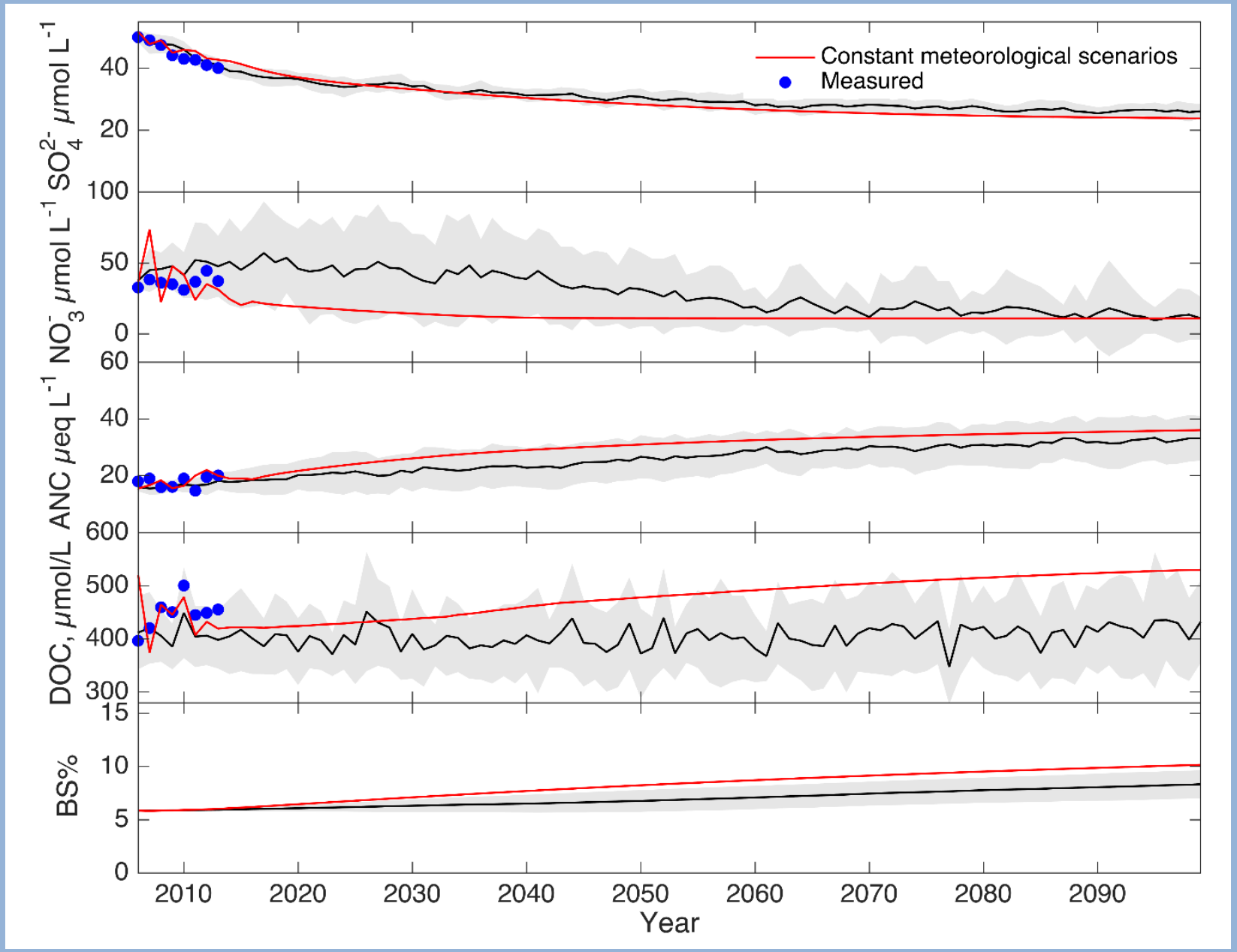
Business as usual deposition



Pre-industrial deposition



20% increase in deposition



Summary

- Atmospheric SO_4^{2-} and NO_3^- deposition continue to decrease.
- Adirondack lake chemistry continues to recover with decreases in SO_4^{2-}, NO_3^- and Ali and increases in ANC and DOC.
- Changing climate seems to initially enhance NO_3^- leaching (for some decades) and delay recovery of ANC and soil %BS.

Future analysis

- Continued deposition and lake monitoring.
- Comparison of lake trends with stream trends (11 streams).
- Examine response to individual climate scenarios and further understand DOC response.