

Acidification in the Western US
- is this still an issue?
Chronic and Episodic Acidification

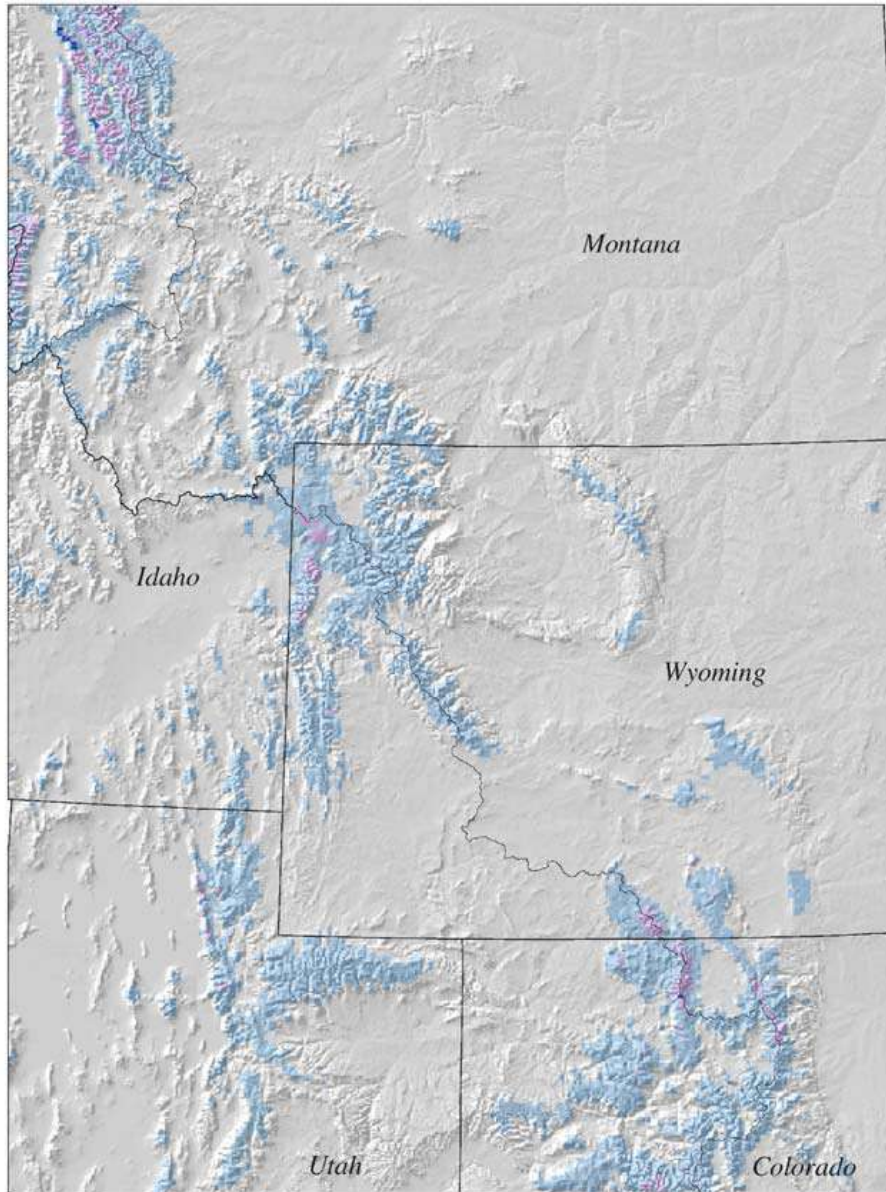
Robert Musselman
Rocky Mountain Research Station
Fort Collins, Colorado

Amount of Deposition

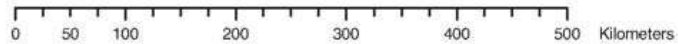
Is Deposition Increasing

Watershed Sensitivity

Amount of Deposition

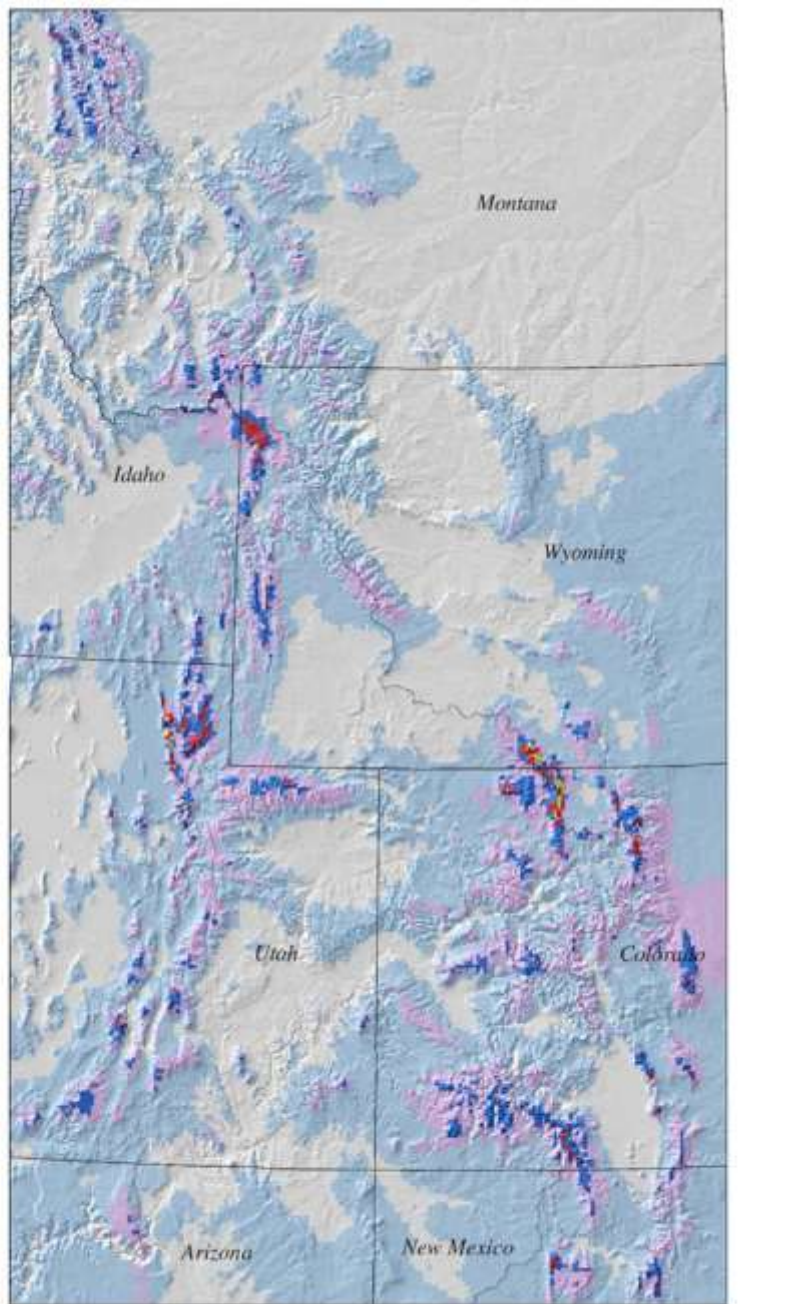


H⁺ Deposition 1992-1999
Nanus et al. 2003

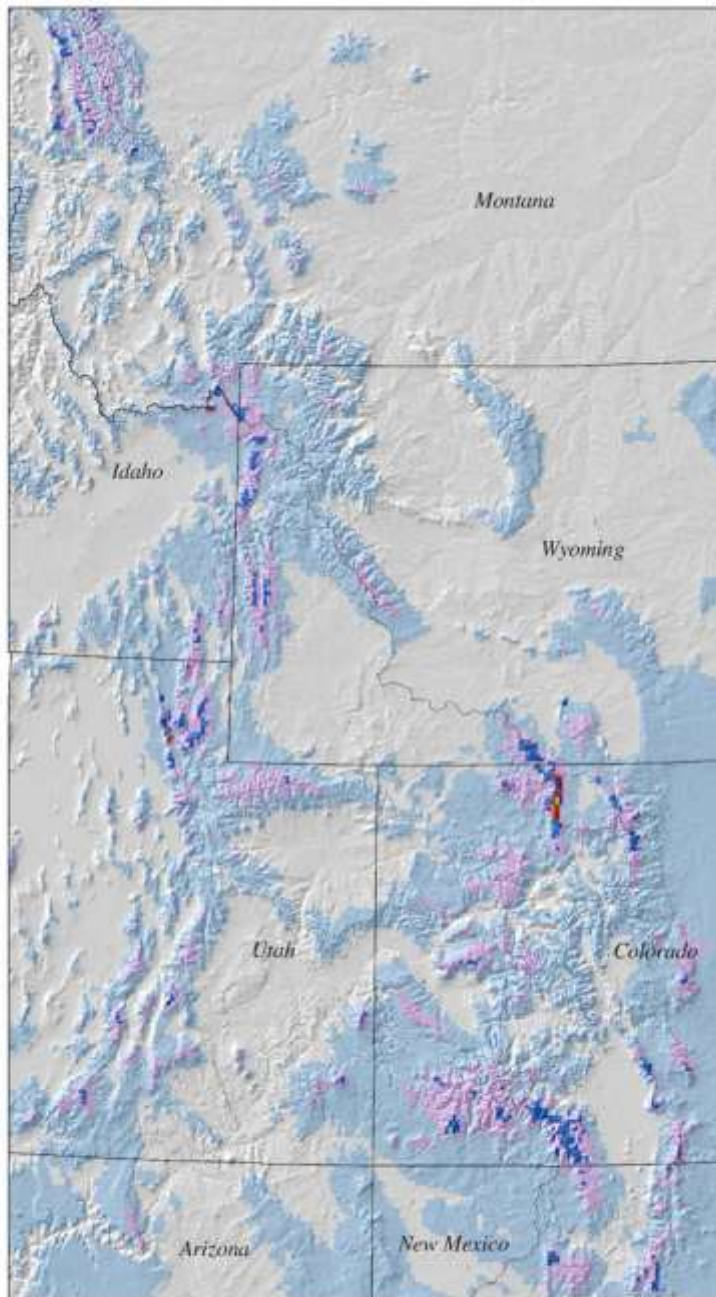


H Deposition(kg/ha H⁺)



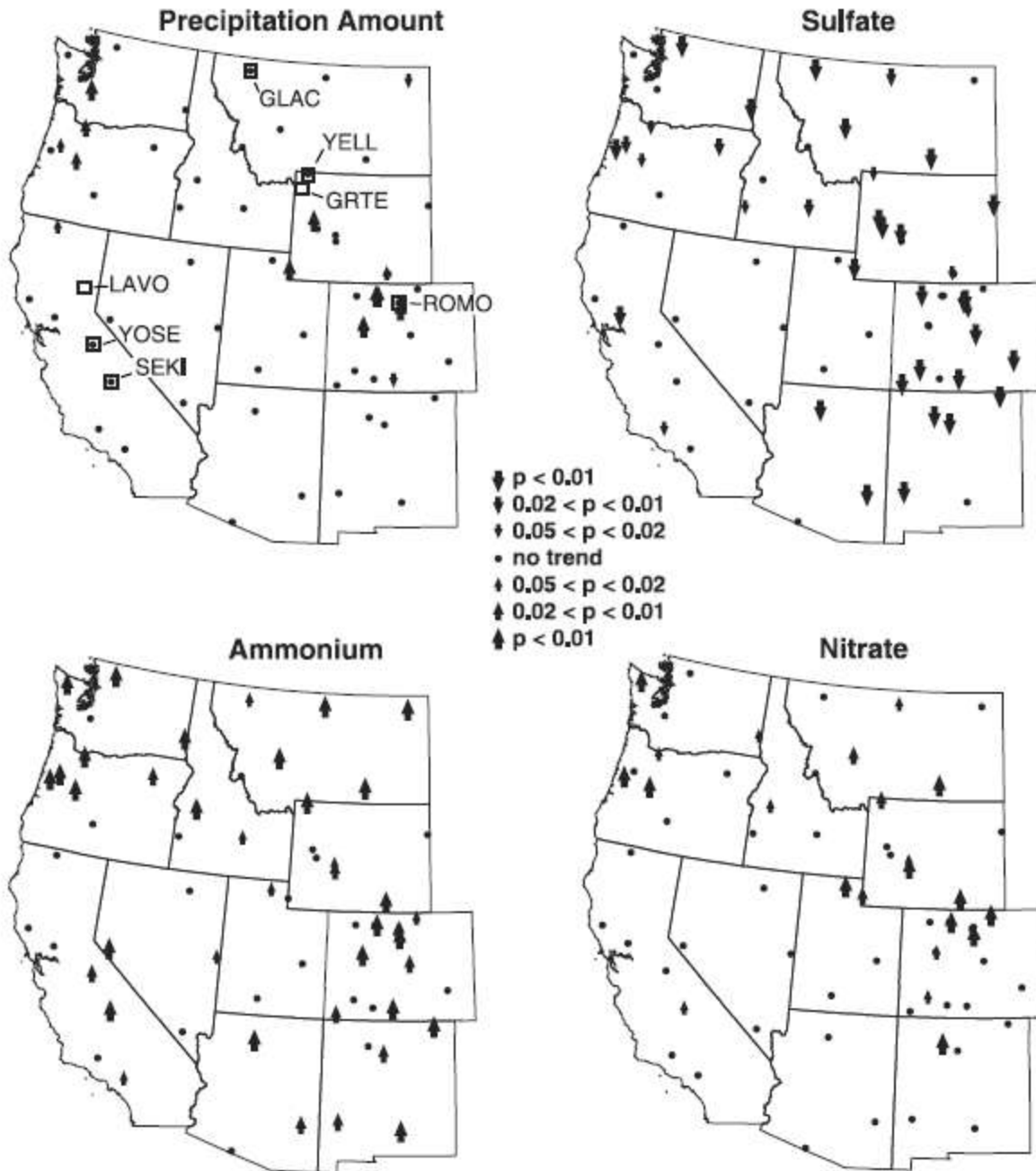


NO₃ deposition 1992-1999
Nanus et al. 2003



SO₄ deposition 1992-1999
Nanus et al. 2003

Is Deposition Increasing



Trends 1985-1999, Clow et. al. 2003

Deposition since 1999 analyses?

Watershed Sensitivity

Chronic Acidification

Critical load:

'a quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge '

(FLAG Critical load: 'the concentration of air pollution above which a specific deleterious effect may occur')

Critical loads of sulphur and nitrogen acidity:

'the highest deposition of acidifying compounds that will not cause chemical changes leading to long-term harmful effects on ecosystem structure and function'

<u>Modifying factor effect on critical load:</u>	<u>Decrease</u>	<u>Increase</u>
Precipitation	High	Low
Vegetation	Coniferous	Deciduous
Elevation, slope	High	Low
Soil texture	Coarse-sandy	Fine
Soil drainage	Free	Impeded
Soil sulfate adsorption capacity	Low	High
Base cation deposition	Low	High

Critical Loads Models

- Terrestrial
 - Steady State Simple Mass Balance (SMB)
 - Dynamic
 - VSD (Very Simple Dynamic)
 - Simulation Model for Acidification's Regional Trends (SMART)
 - Soil Acidification in Forest Ecosystems (SAFE)
- Waters
 - Steady State Water Chemistry (SSWC)
 - Dynamic
 - Model of Acidification of Groundwater in Catchments (MAGIC)

Vegetation and Terrestrial data

- Critical loads plots
- FIA/FHM plots
- Soils maps
- NADP/CASTNet

Aquatic and Waters data

- NRIS
- Soils maps
- NADP/CASTNet

For More Information

Terrestrial:

- www.icp-forests.org/

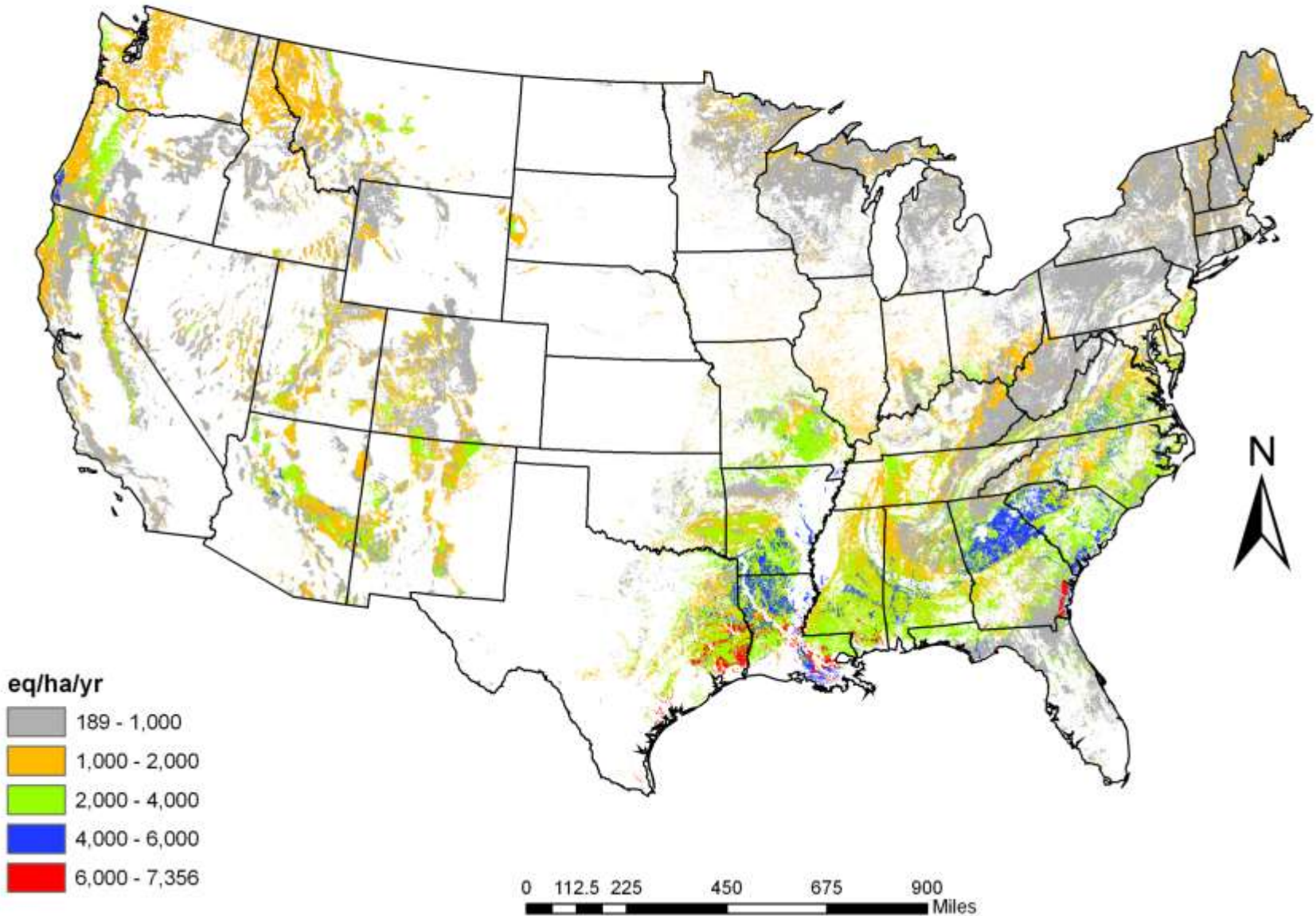
Aquatic:

- www.iis.niva.no/ICP-waters/

Models:

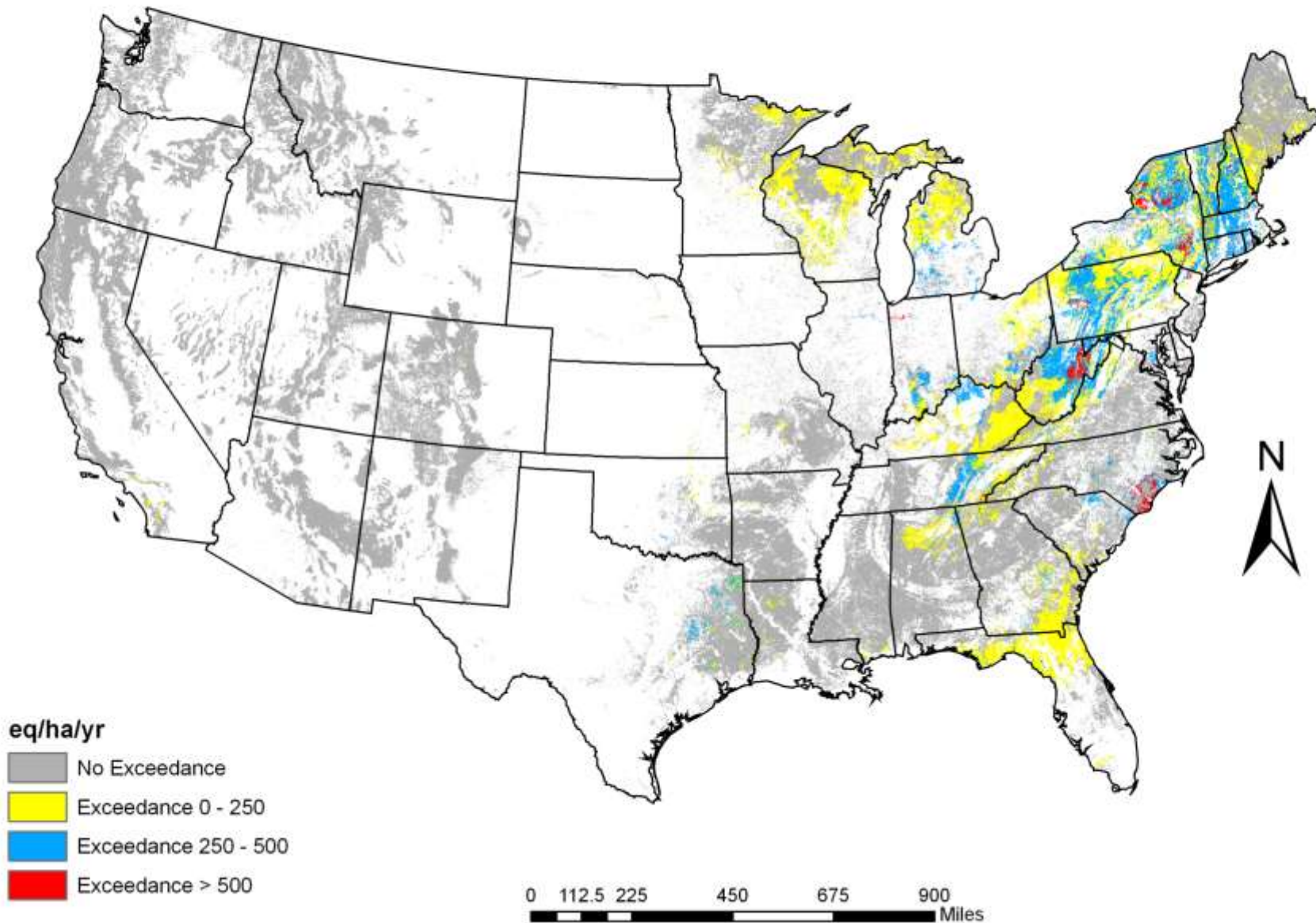
- www.icpmapping.org/

Critical Acid Load



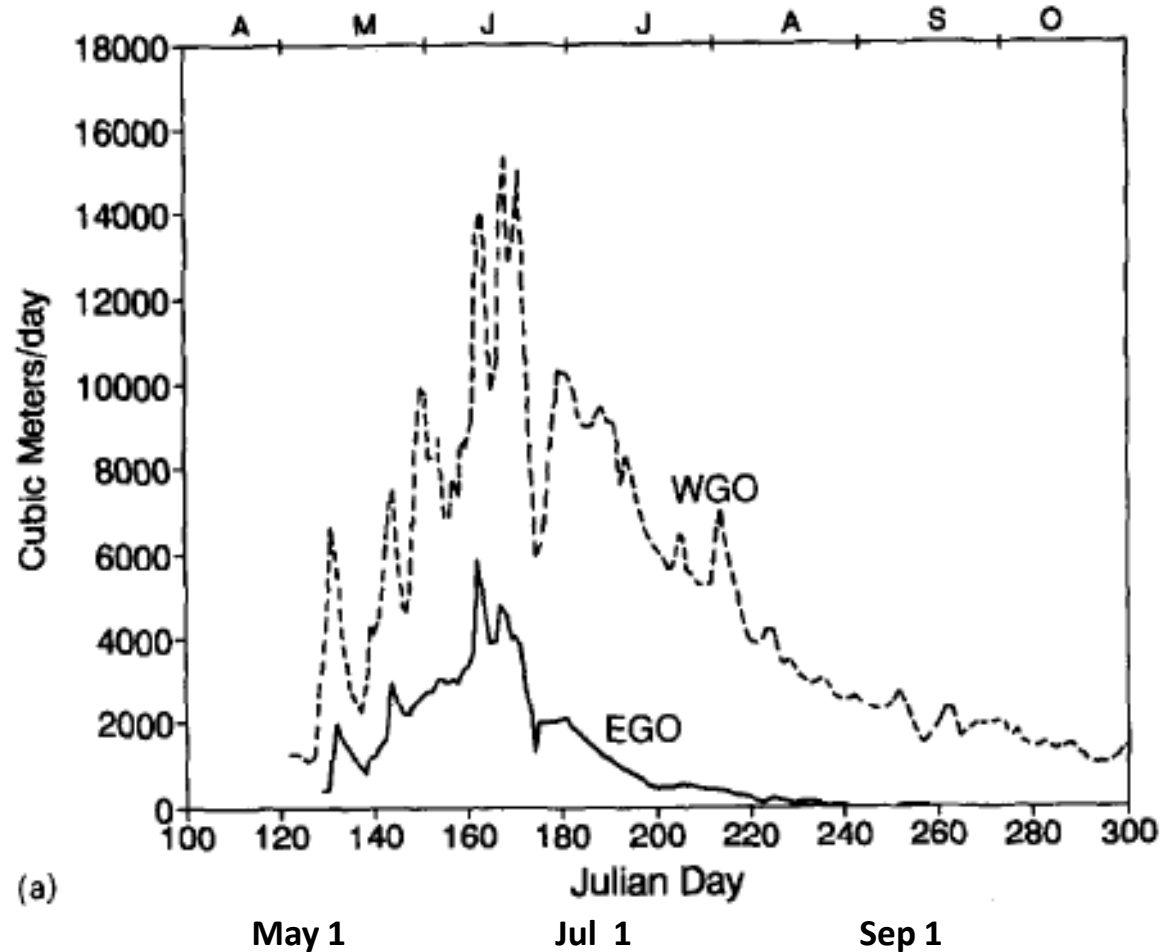
McNulty et al. 2007

Exceedence of the Critical Acid Load



McNulty et al. 2007

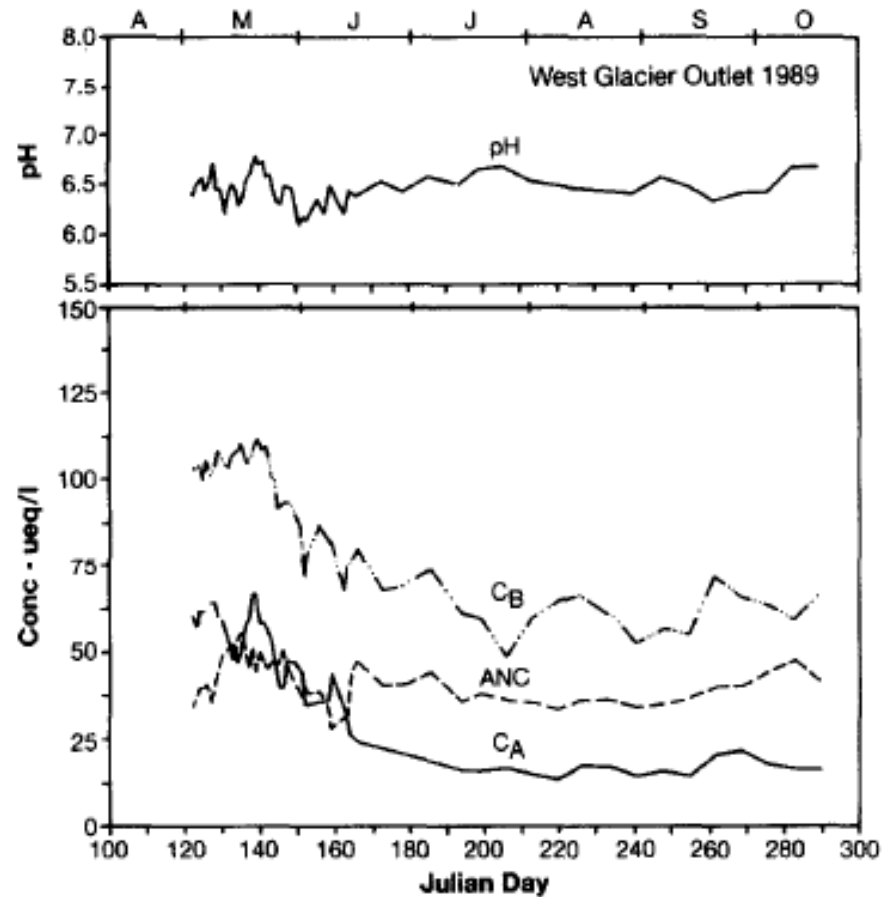
Episodic Acidification



(a)

Reuss et al. 1994

Episodic Acidification



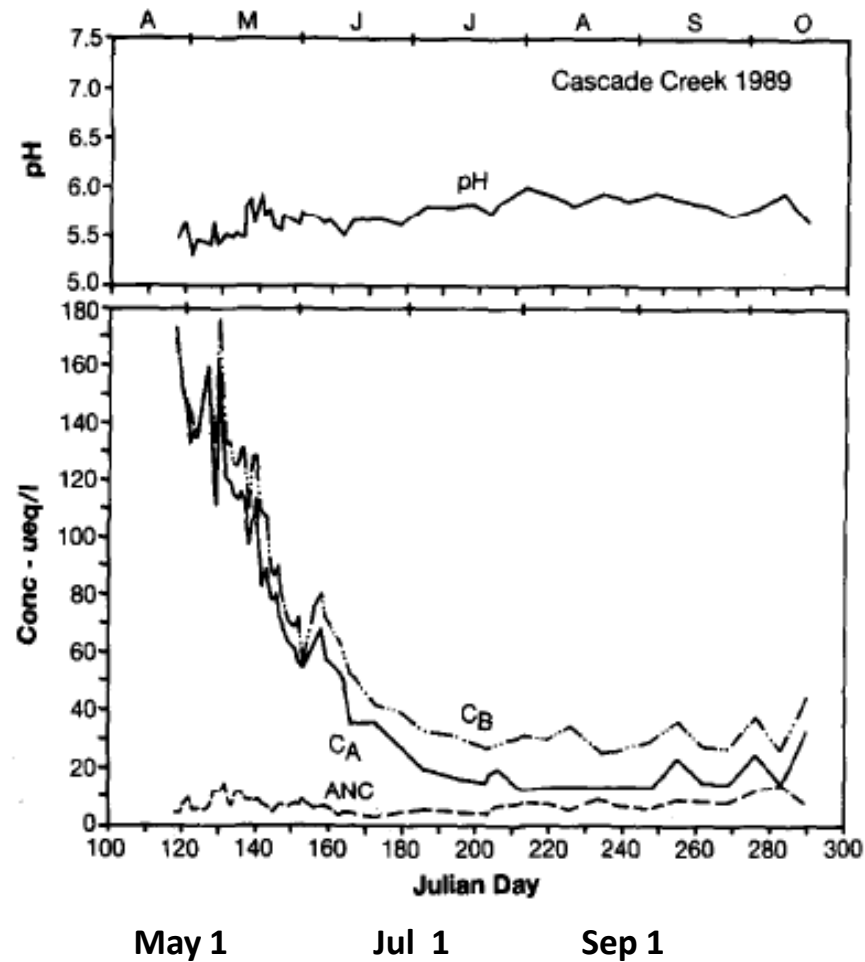
May 1

Jul 1

Sep 1

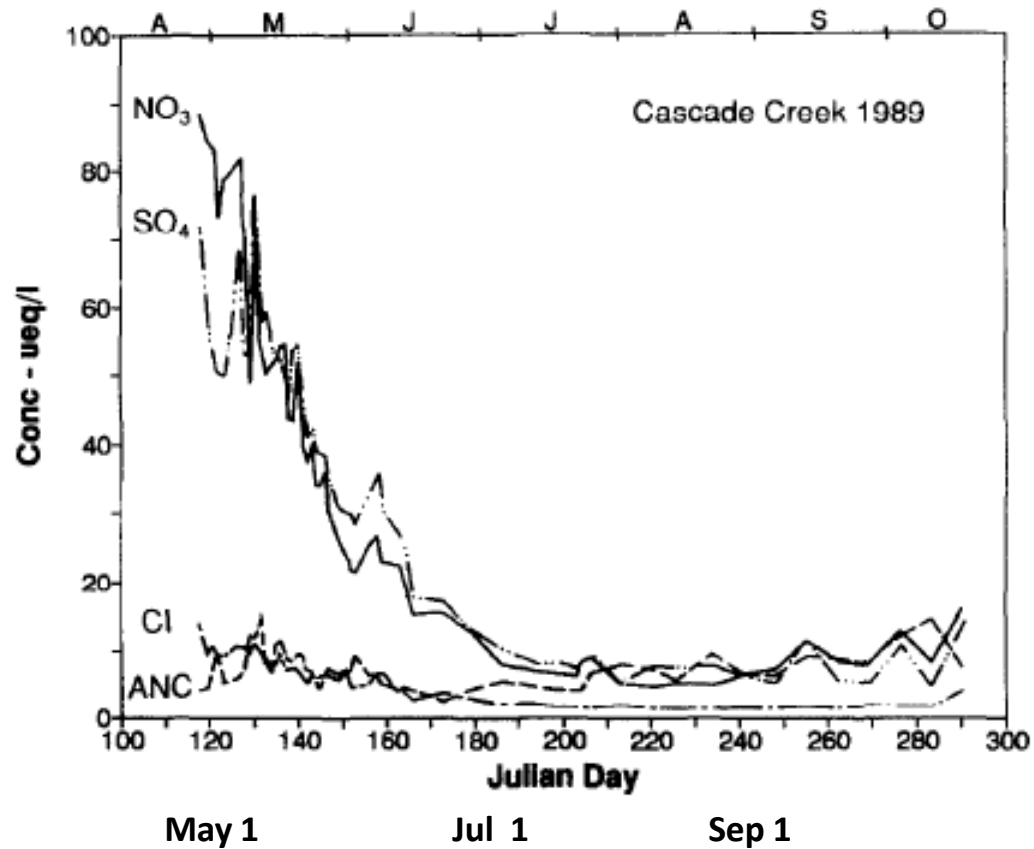
Reuss et al. 1994

Episodic Acidification



Reuss et al.

Episodic Acidification



Reuss et al.

Surface Water Acidification

MAGIC Model

Surface Water Acidification

MAGIC Model

Need Soils Data
Weathering

Surface Water Acidification

MAGIC Model Uncertainties?

Selection of Exchange Coefficients

Role of Organic Acids

Lumped Parameter Approach for Complex Soils

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Acidification in the Western US - is this still an issue?



"Come on in—the pH is fine!"