

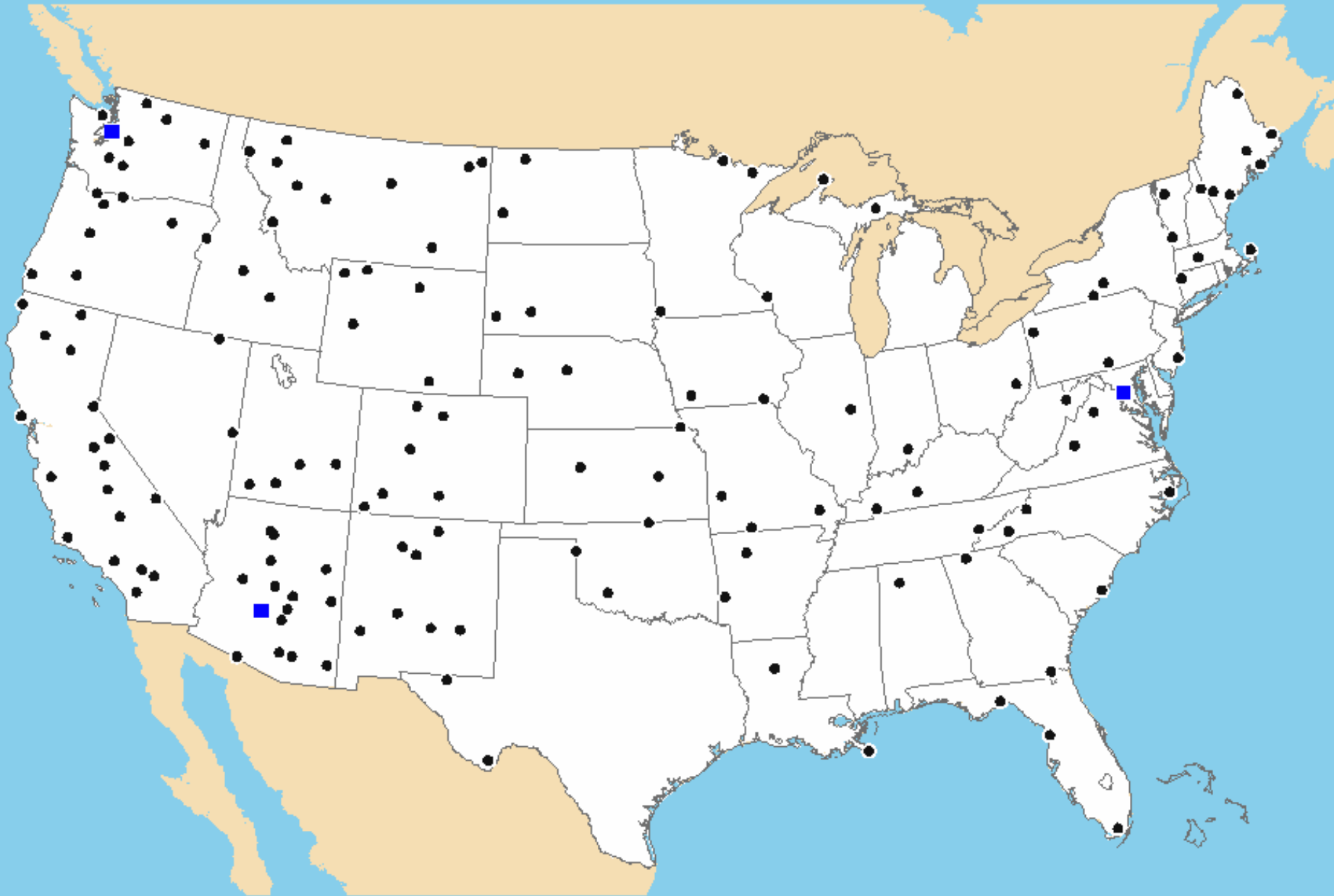
IMPROVE Report 2006

L. Debell, K. Gebhart, B. Schichtel
and W. Malm

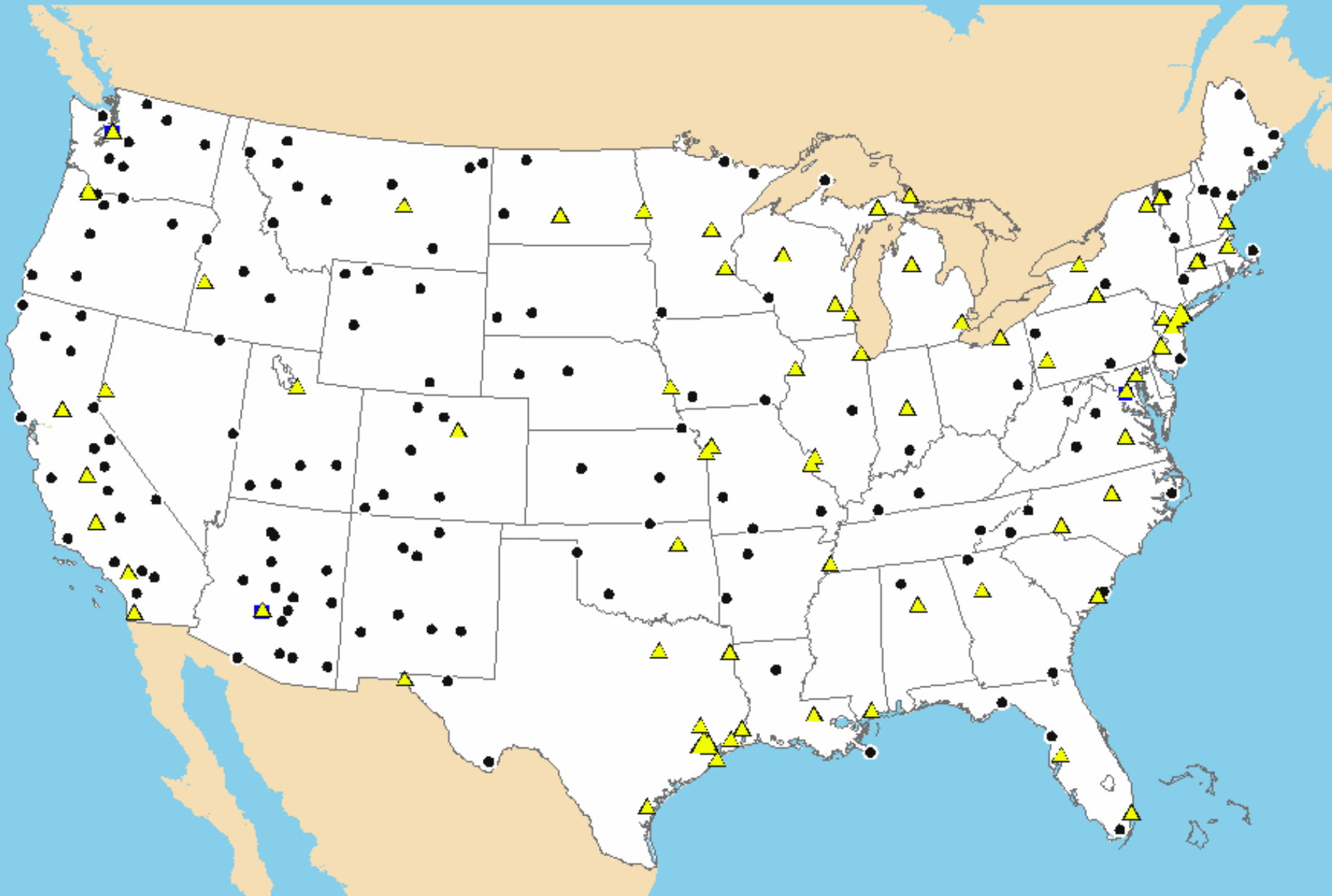
IMPROVE Report Outline

- Section 1: IMPROVE Data summaries
 - Chapter 1: Network Overview
 - **Chapter 2: IMPROVE-STN Data Comparability**
 - **Chapter 3: Spatial trends in the annual average aerosol concentrations and extinction coefficients**
 - **Chapter 4: Spatial Variability of monthly patterns in aerosol concentrations and extinction coefficients**
 - **Chapter 5: Trends in aerosol concentrations and extinction coefficients**
- Section 2: Special Study Summaries
 - Chapter 1: BRAVO Executive Summary and Link to full report
 - Chapter 2: Yosemite Executive Summary and Link to full report
 - **Chapter 3: Coarse Mass Study**
 - **Chapter 4: IMPROVE Algorithm Review**
- Section 3: QA Studies
 - Chapter 1: Historical Data QA/QC Review
 - Chapter 2: Denuder Study
- Other work
 - ***Carbon 12/14 study***
 - ***Hygroscopicity of Smoke and Carbon Aerosols***

IMPROVE Network

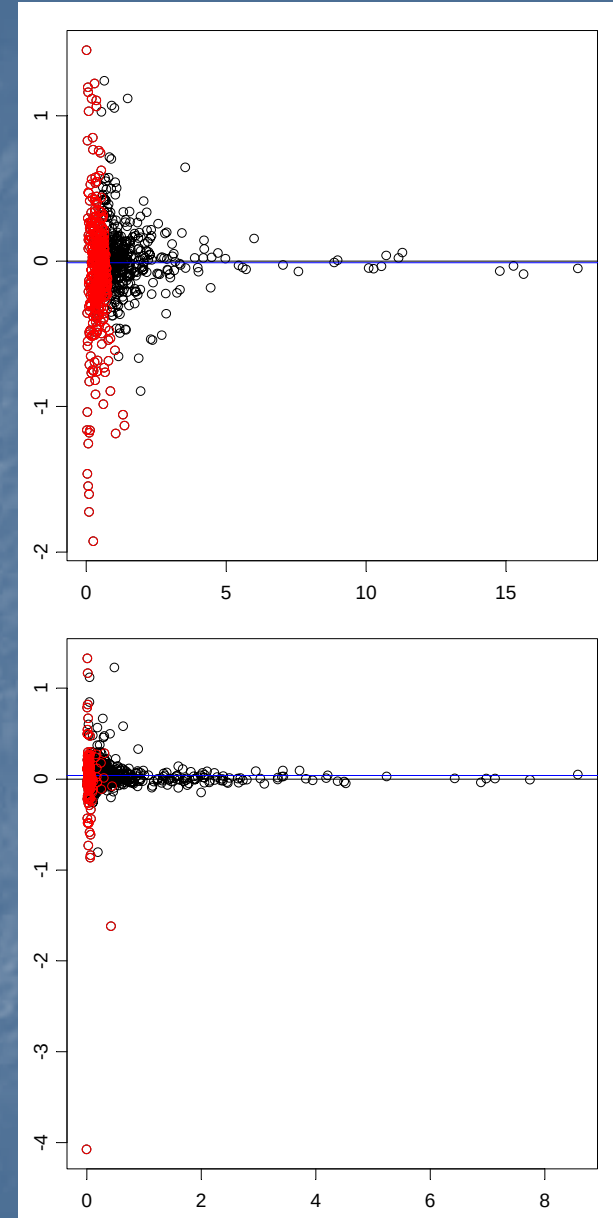
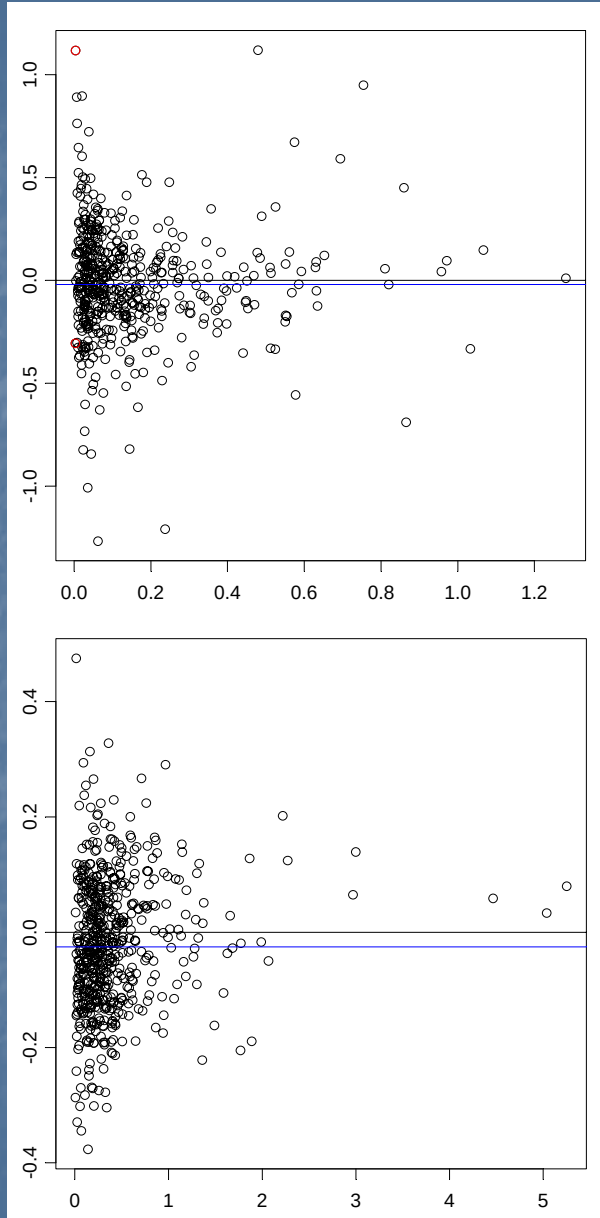


Fusion of IMPROVE & STN Networks



Relative Errors from Six Collocated IMPROVE Monitors

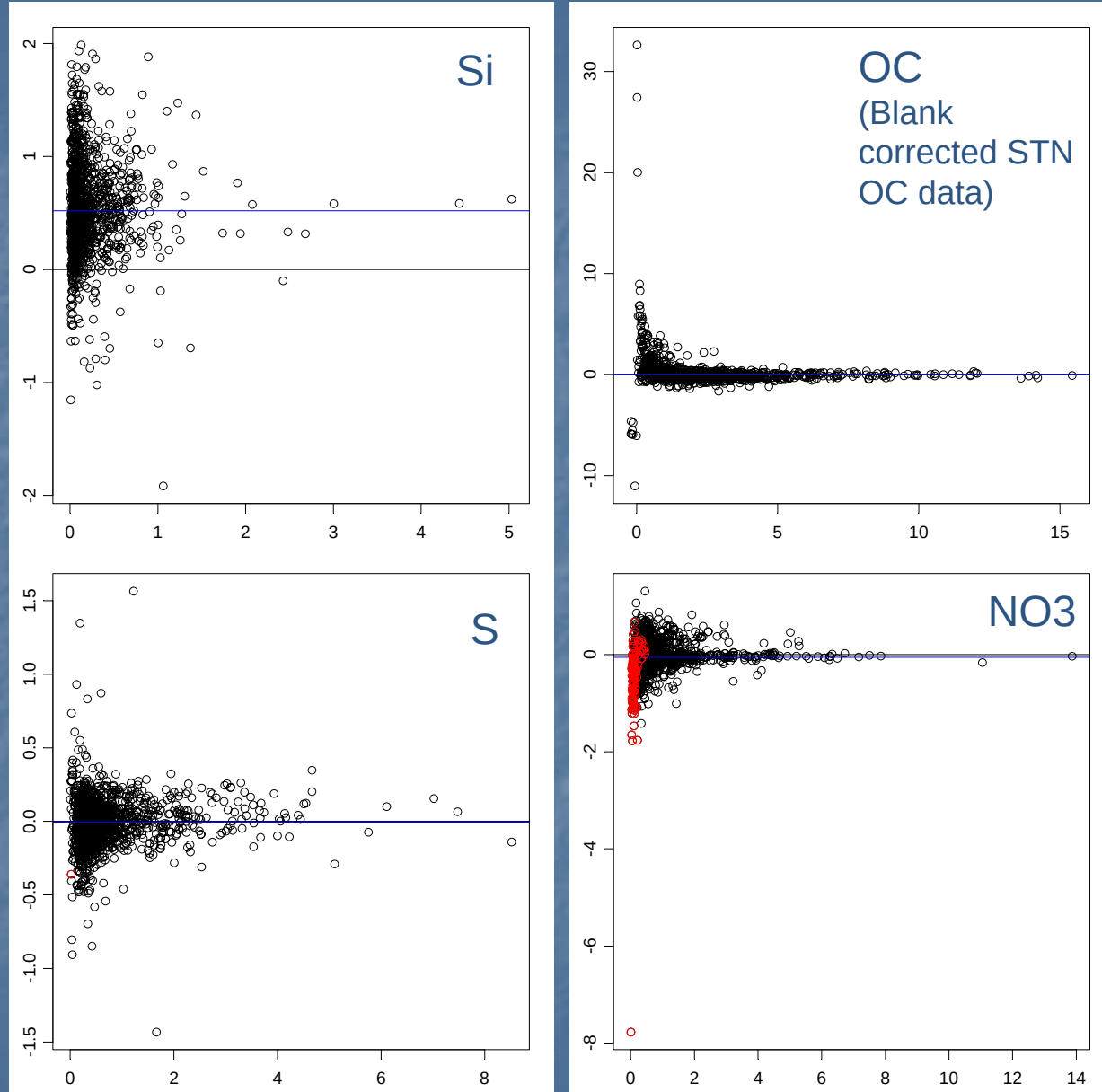
Relative Error $[(x_i - y_i) / (x_i + y_i)/2]$



Average Concentration, $(\mu\text{g}/\text{m}^3)$

Relative Errors from Six Collocated IMPROVE & STN Monitors

Relative Error
 $(\text{IMPROVE} - \text{STN}) / \text{Avg}$



Average Concentration, ($\mu\text{g}/\text{m}^3$)

Comparability of IMPROVE and STN Measurements

Precision in Annual Average Concentrations calculated from collocated data

1- σ Uncertainty		
	IMPROVE in-network	IMPROVE-STN cross network
Al	19%	33%
Ca	7%	28%
Fe	5%	21%
Si	5%	11%
Ti	4%	25%
S	3%	11%
SO4	2%	5%
NO3	5%	14%
EC	7%	24%
OC	7%	36%
blank- corrected STN OC data	NA	8%

$$\text{Uncertainty} = \sqrt{2 * \text{var}(O_rd(\bar{X})_{site})}$$

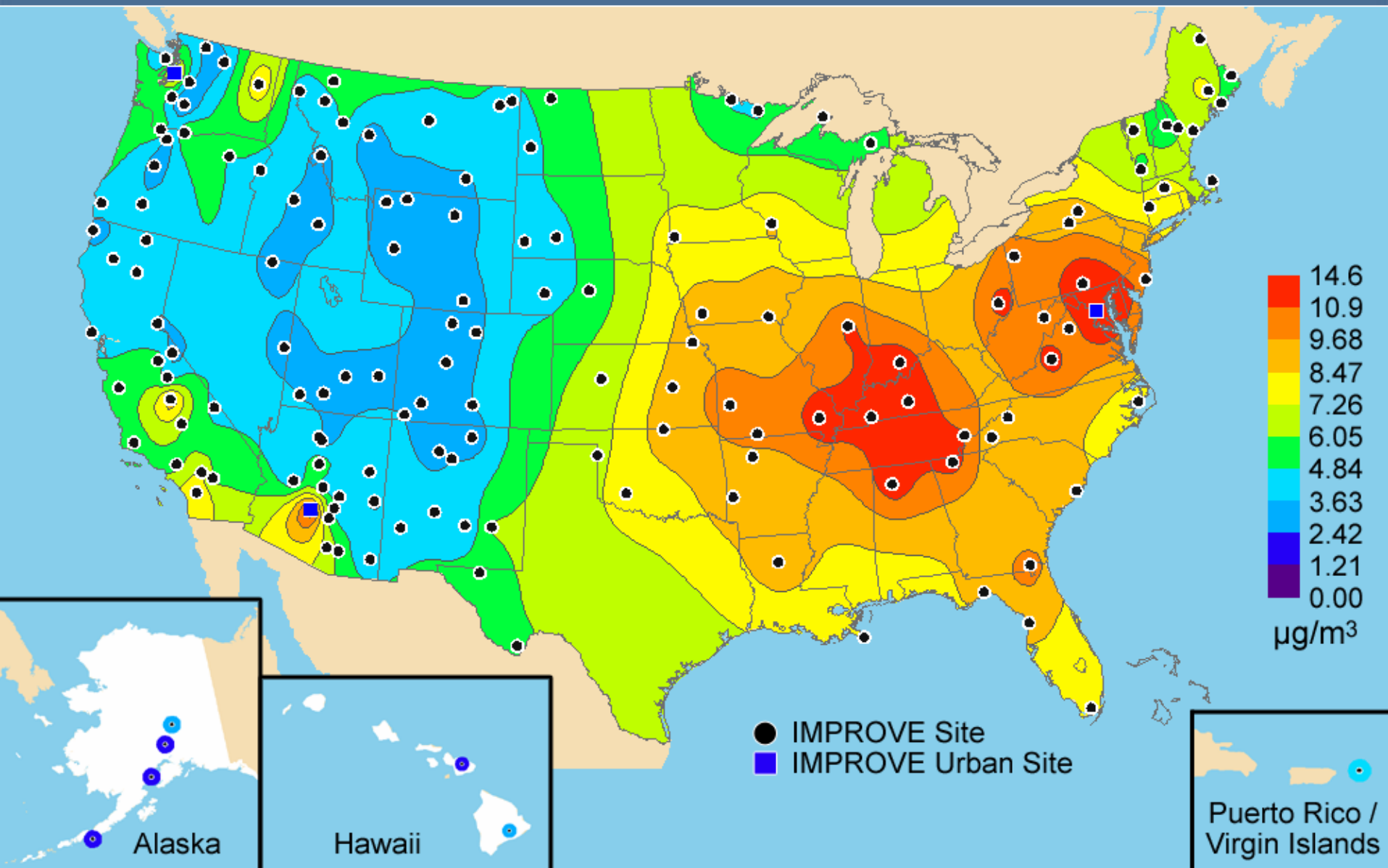
Where:

$$O_rd(\bar{X}) = \frac{(\bar{X} - \bar{Y}) * 2}{(\bar{X} + \bar{Y})}$$

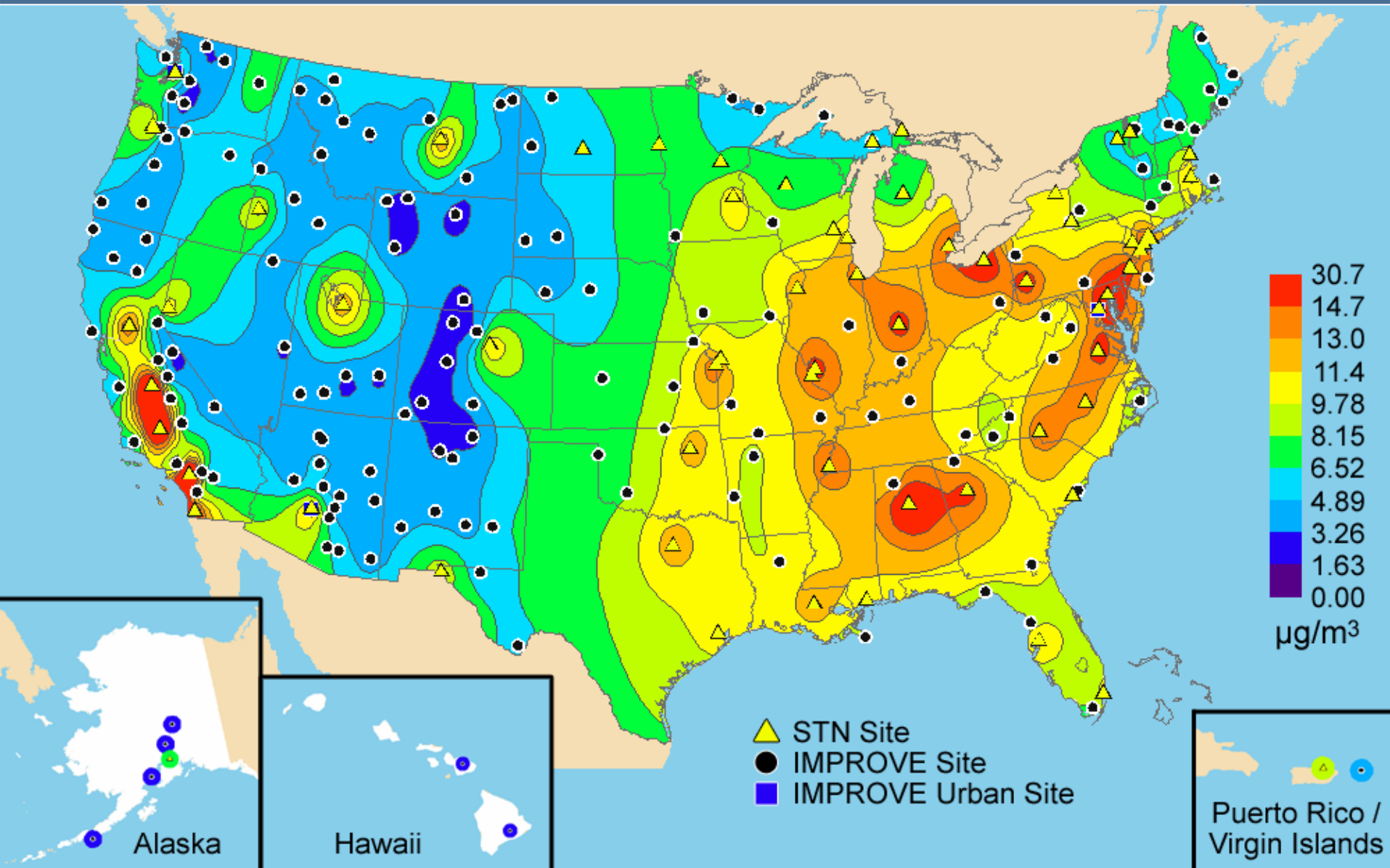
X and Y represent the paired annual means

- Note, these uncertainties do not contain the error due to a systematic bias

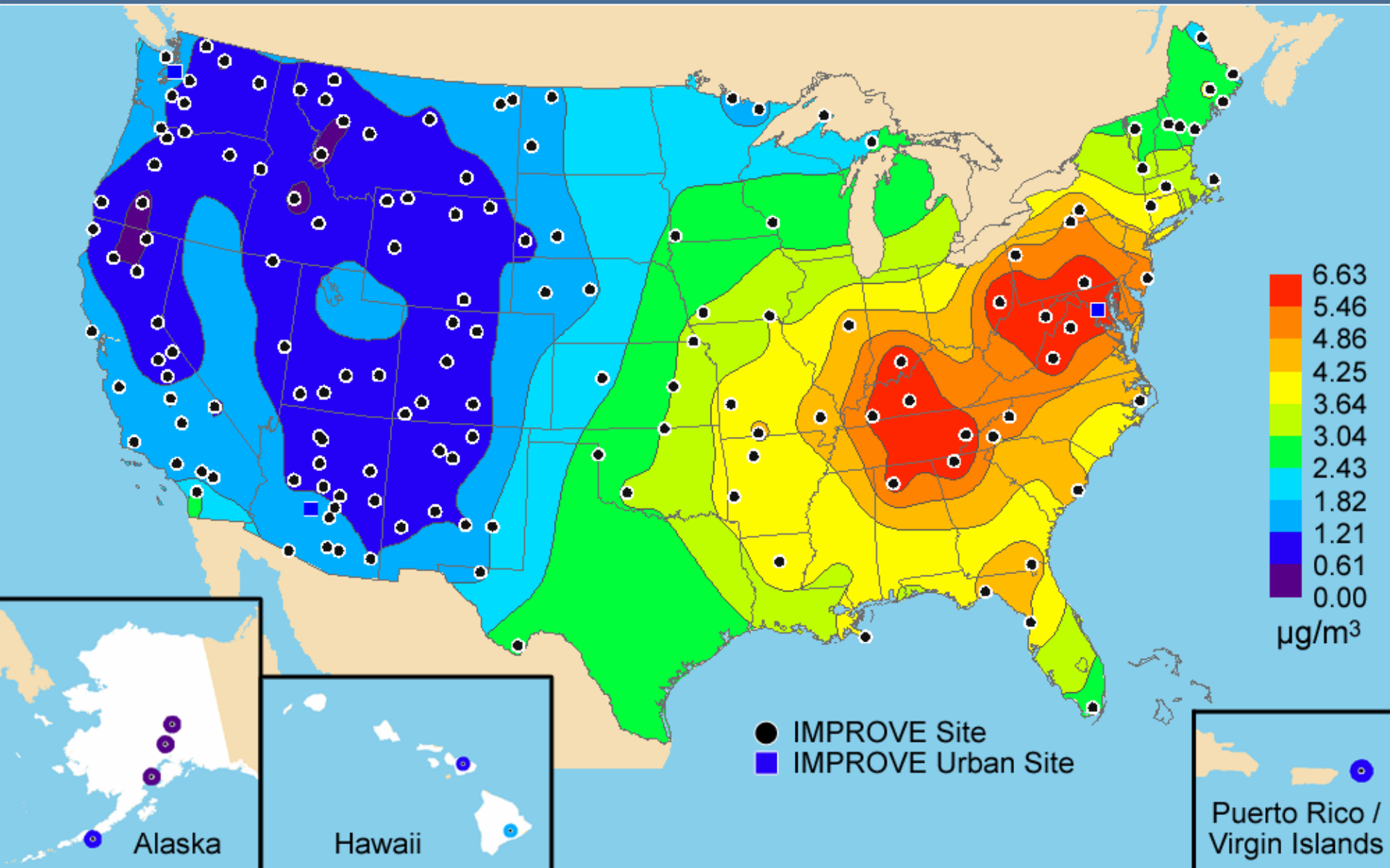
IMPROVE Reconstructed Fine Mass



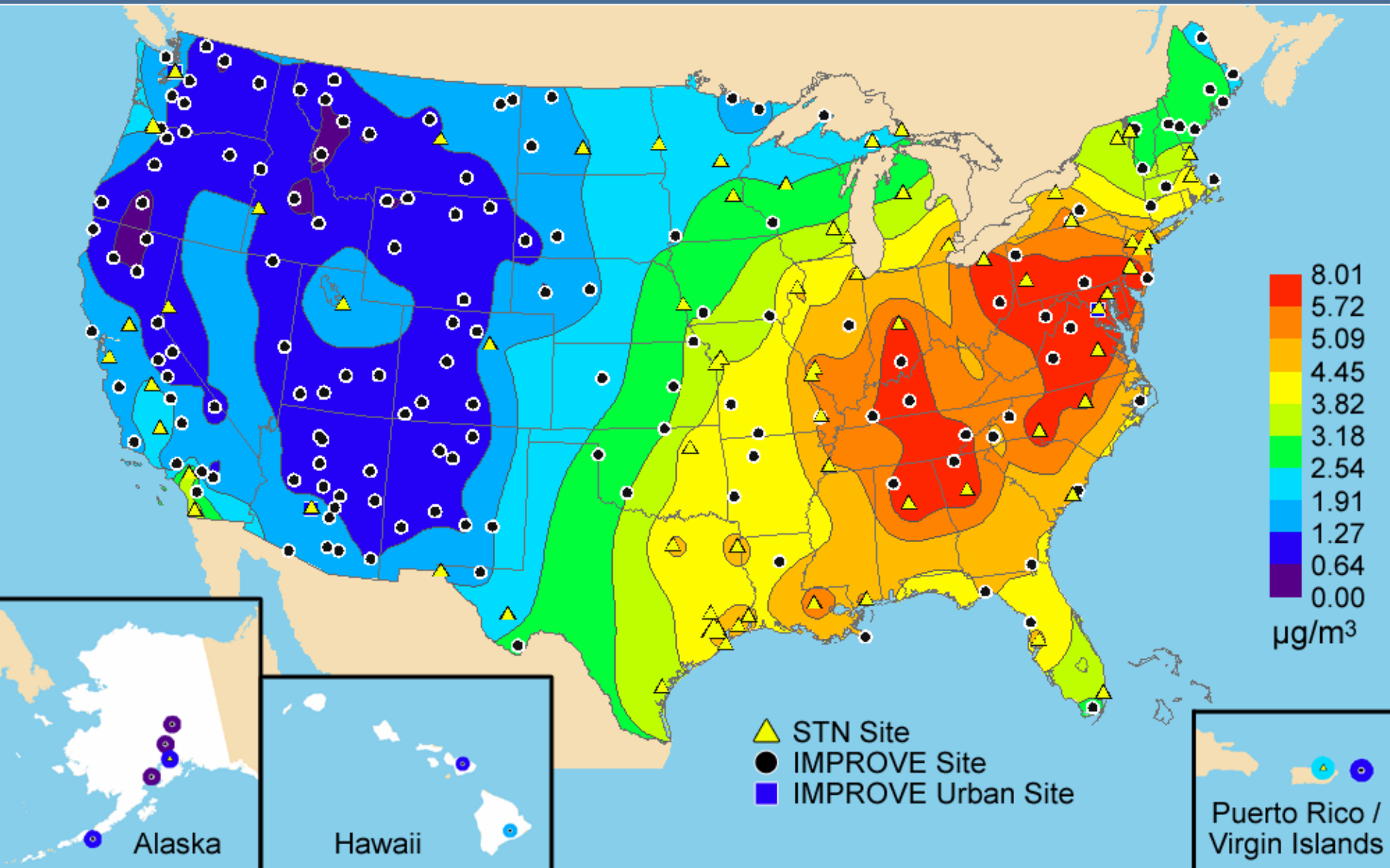
IMPROVE & STN Reconstructed Fine Mass



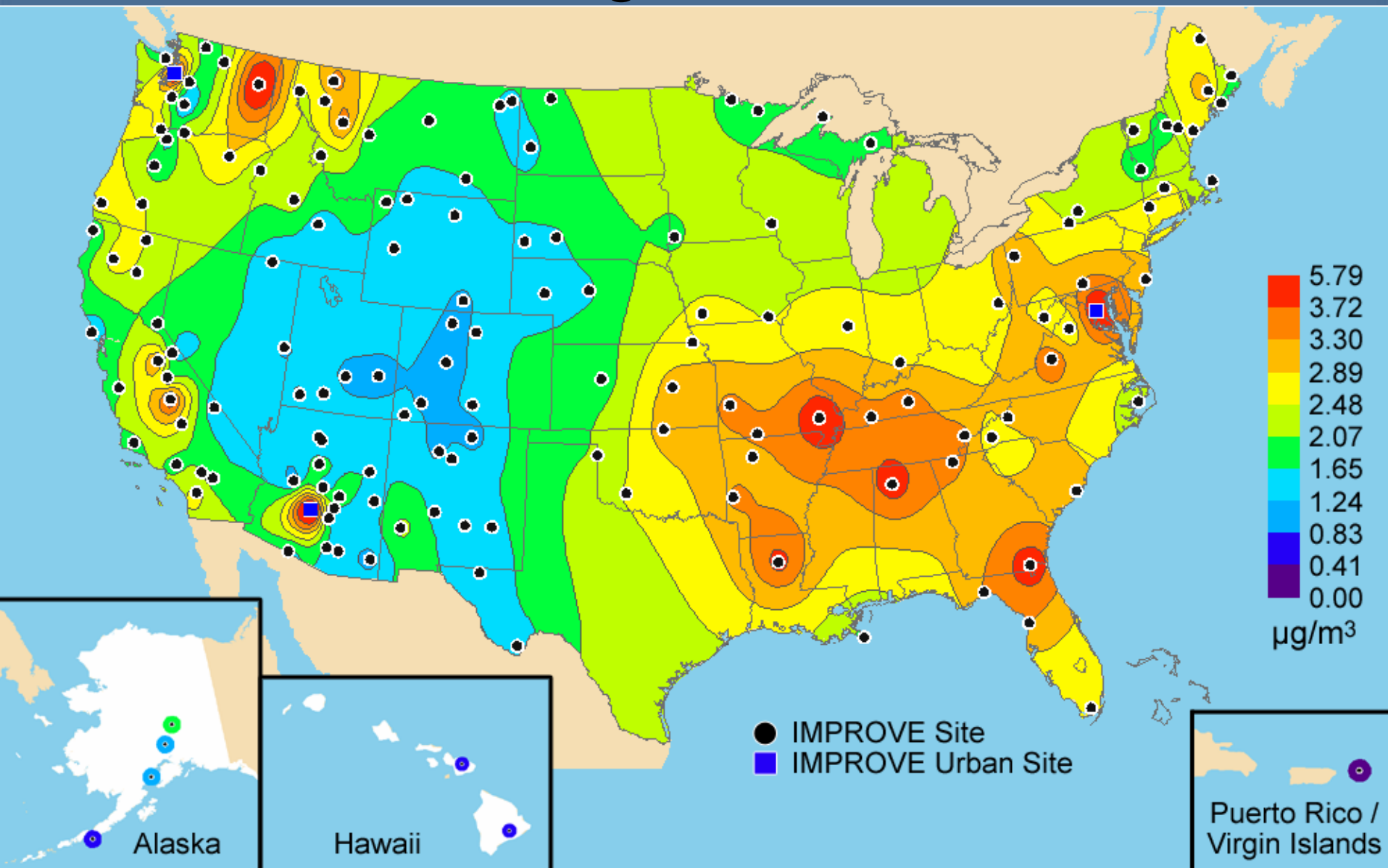
IMPROVE Ammonium Sulfate Mass



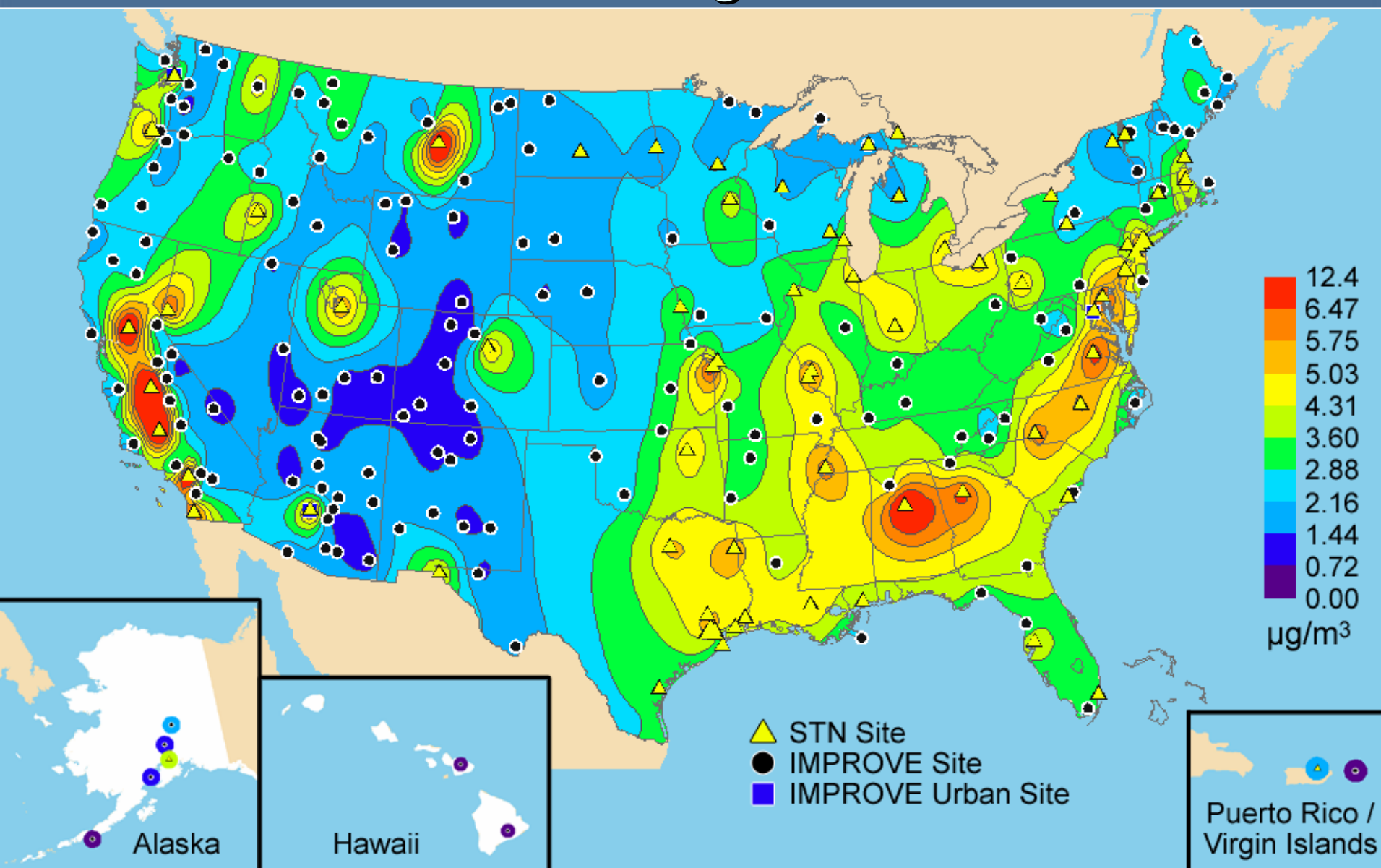
IMPROVE & STN Ammonium Sulfate Mass



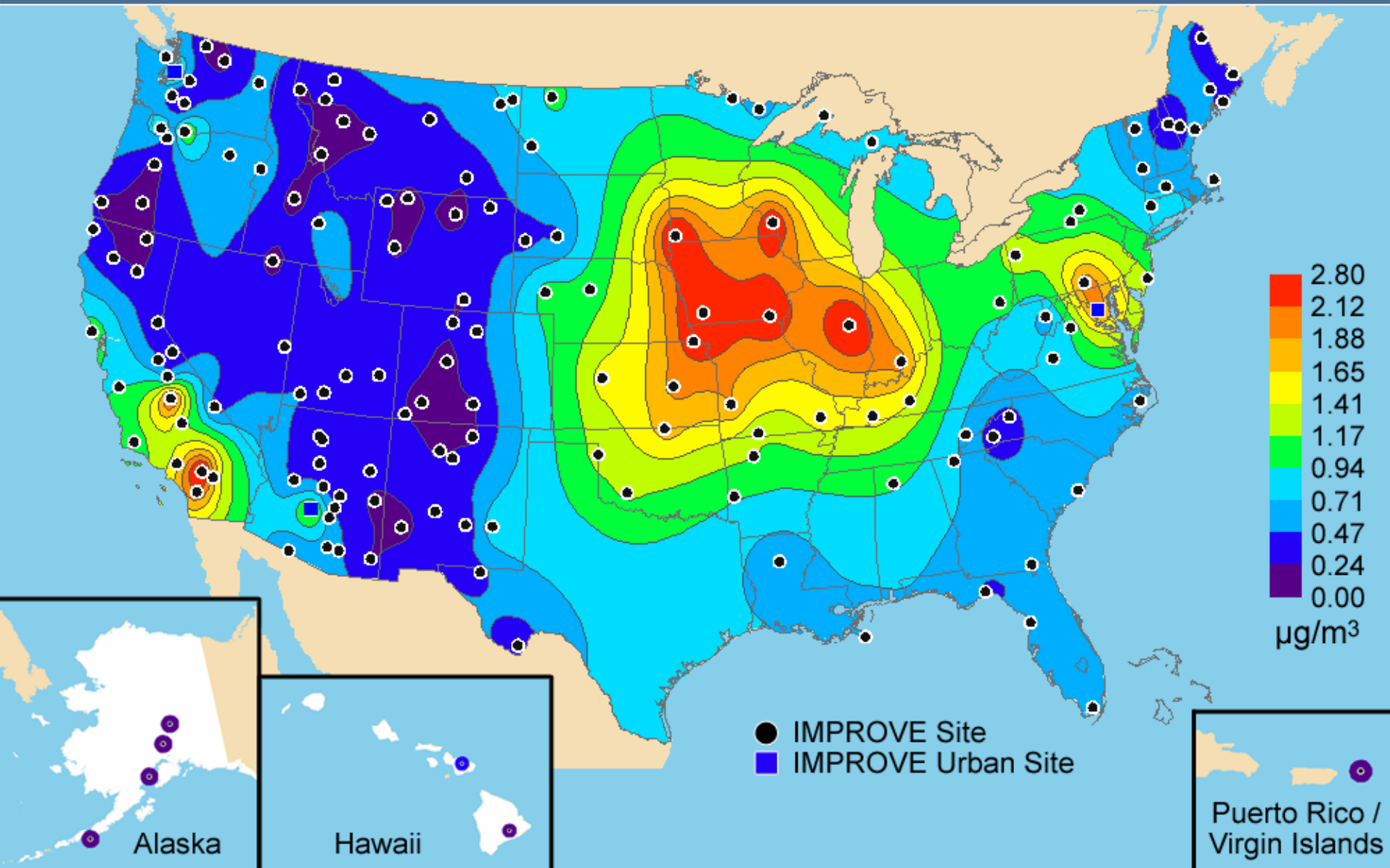
IMPROVE Organic Carbon Mass



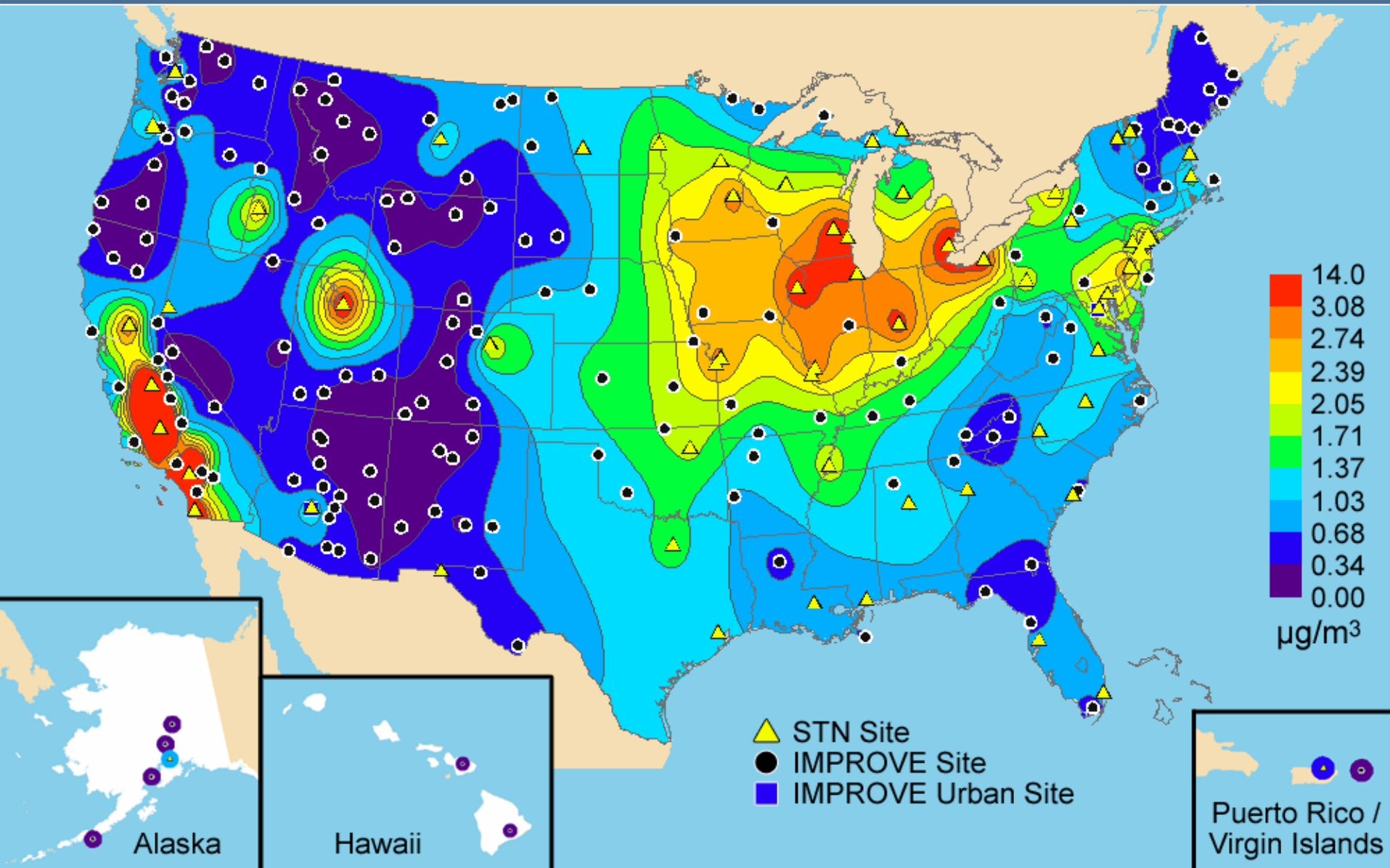
IMPROVE & STN Organic Carbon Mass



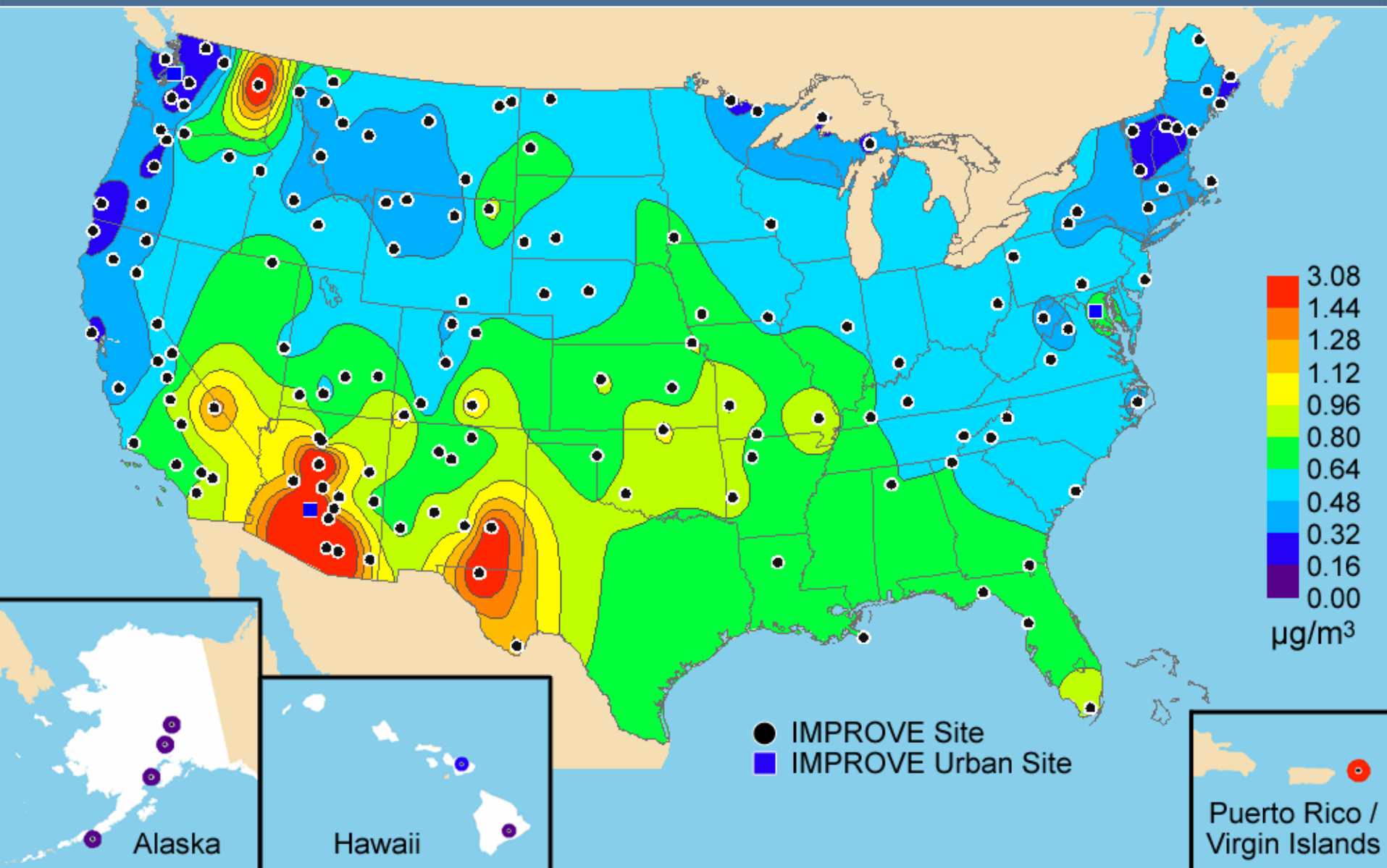
IMPROVE Ammonium Nitrate Mass



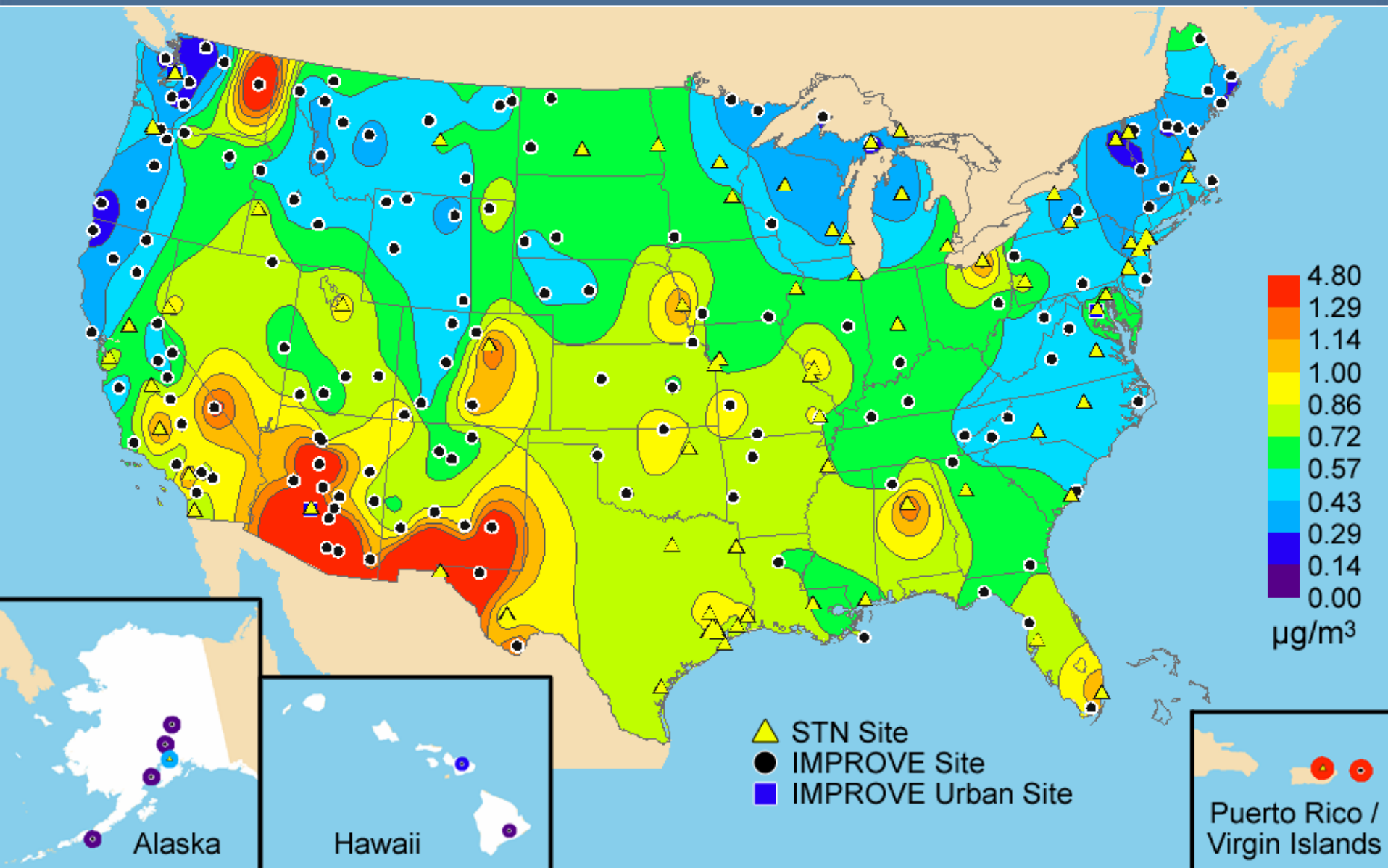
IMPROVE & STN Ammonium Nitrate Mass



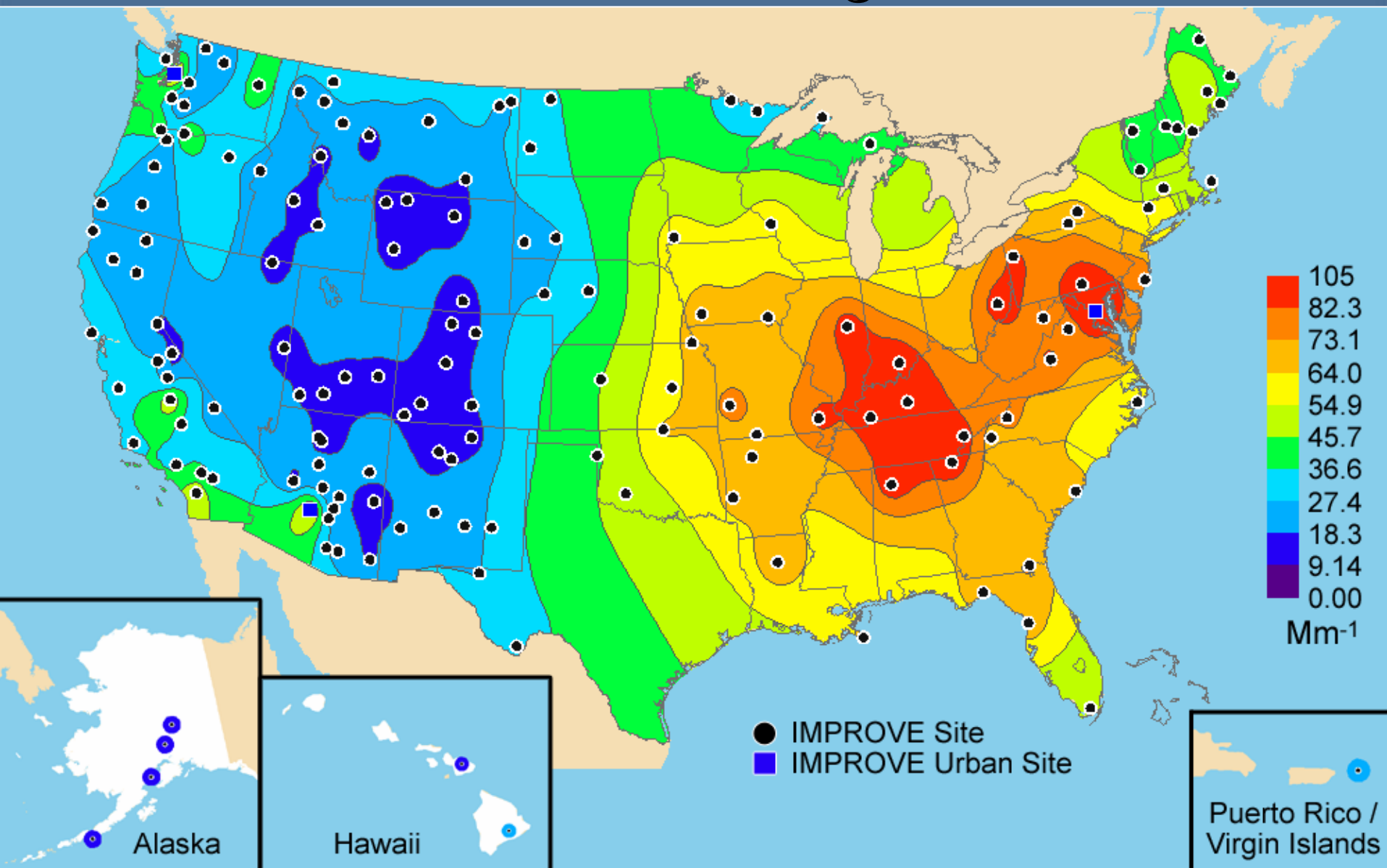
IMPROVE Fine Soil Mass



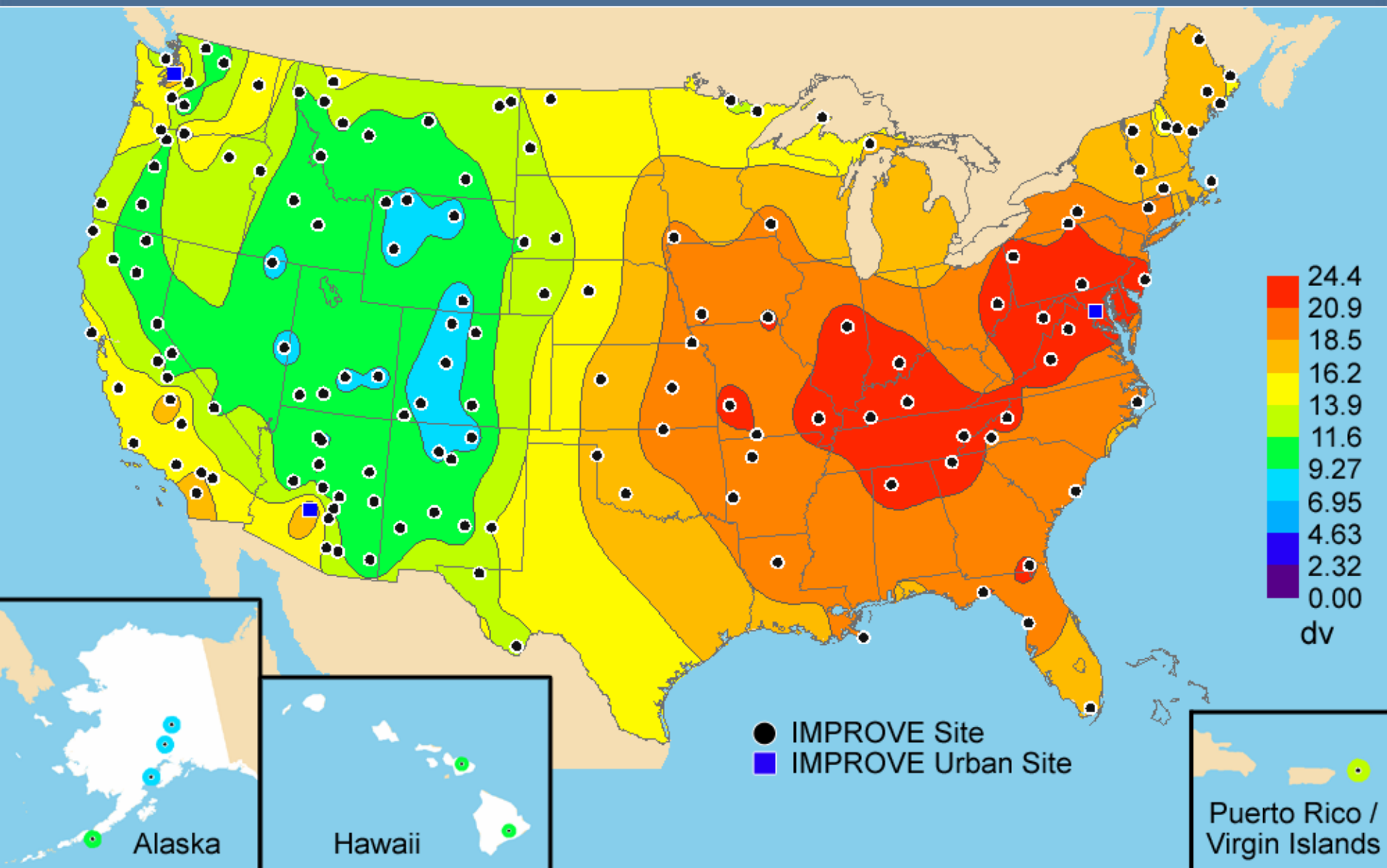
IMPROVE & STN Fine Soil Mass



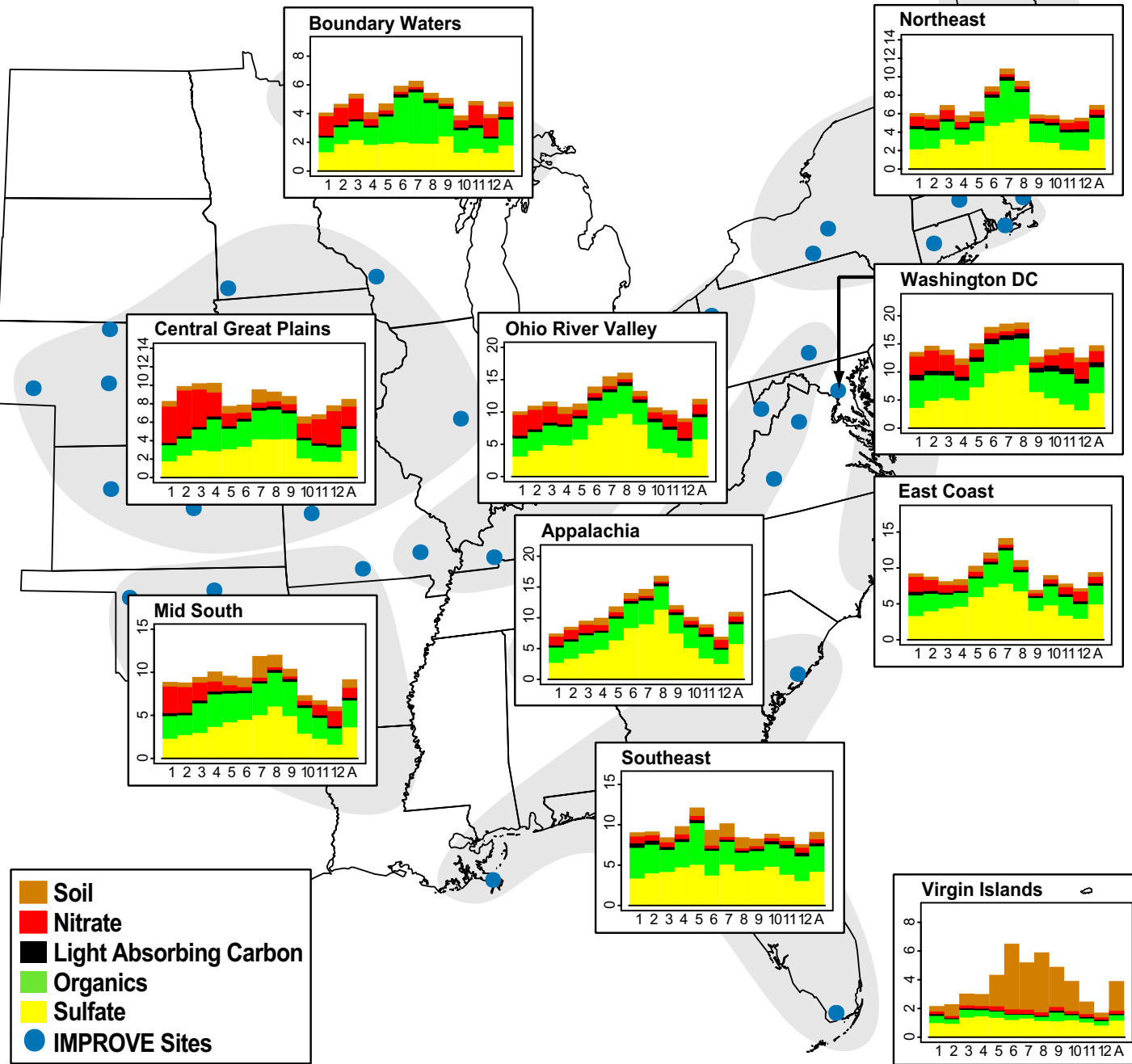
IMPROVE Particulate Light Extinction



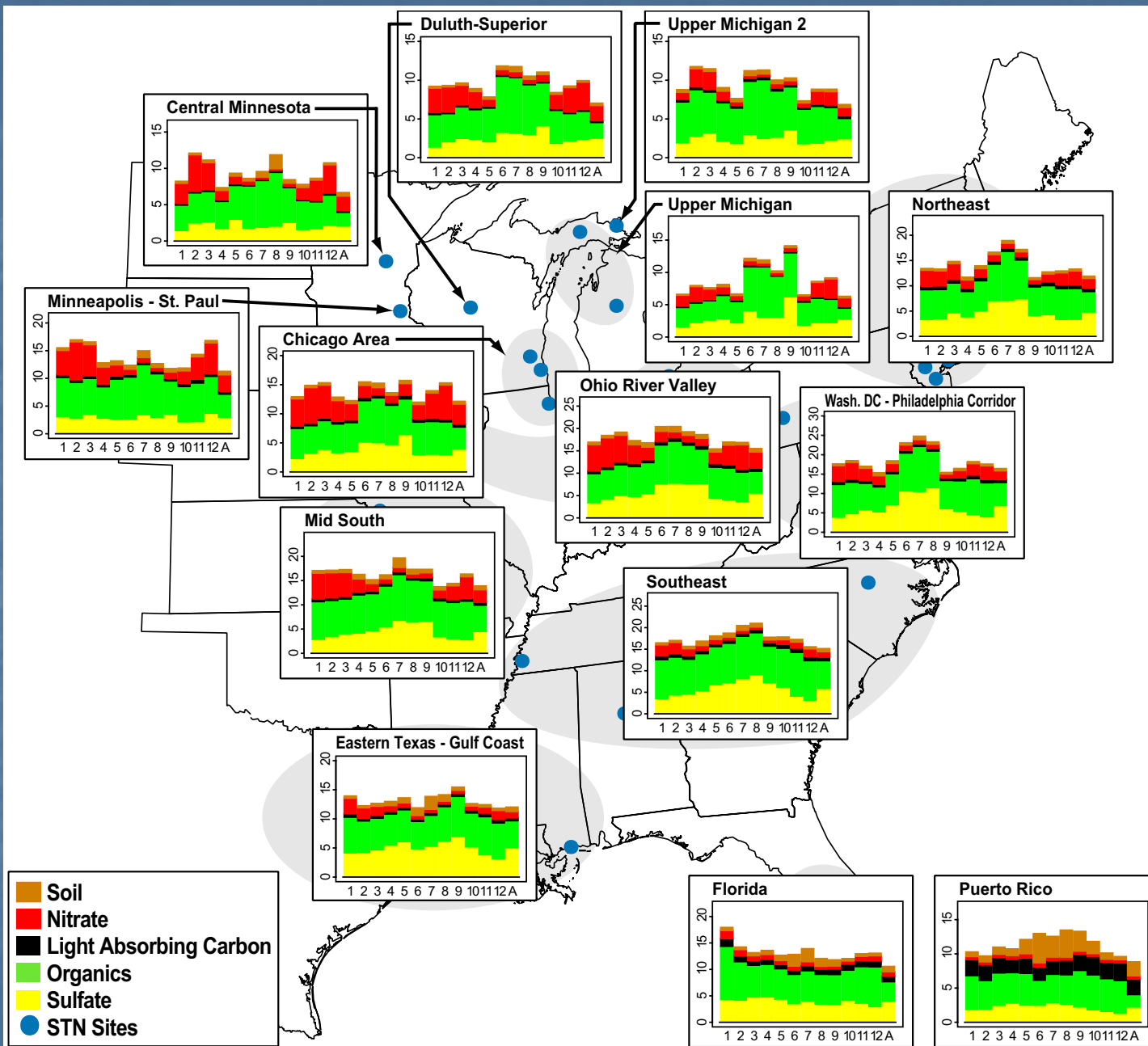
IMPROVE Deciviews



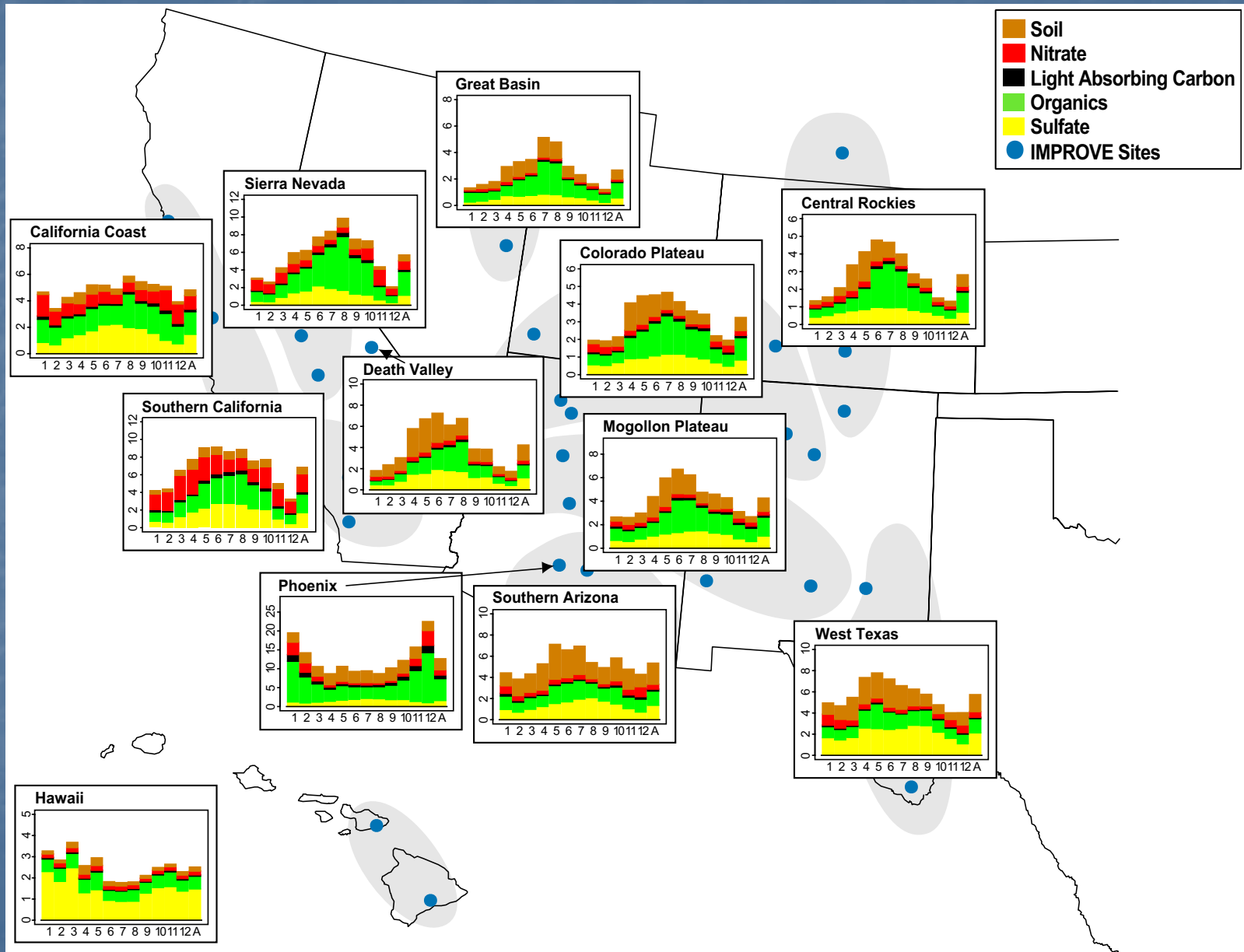
IMPROVE Monthly Fine Mass Budgets



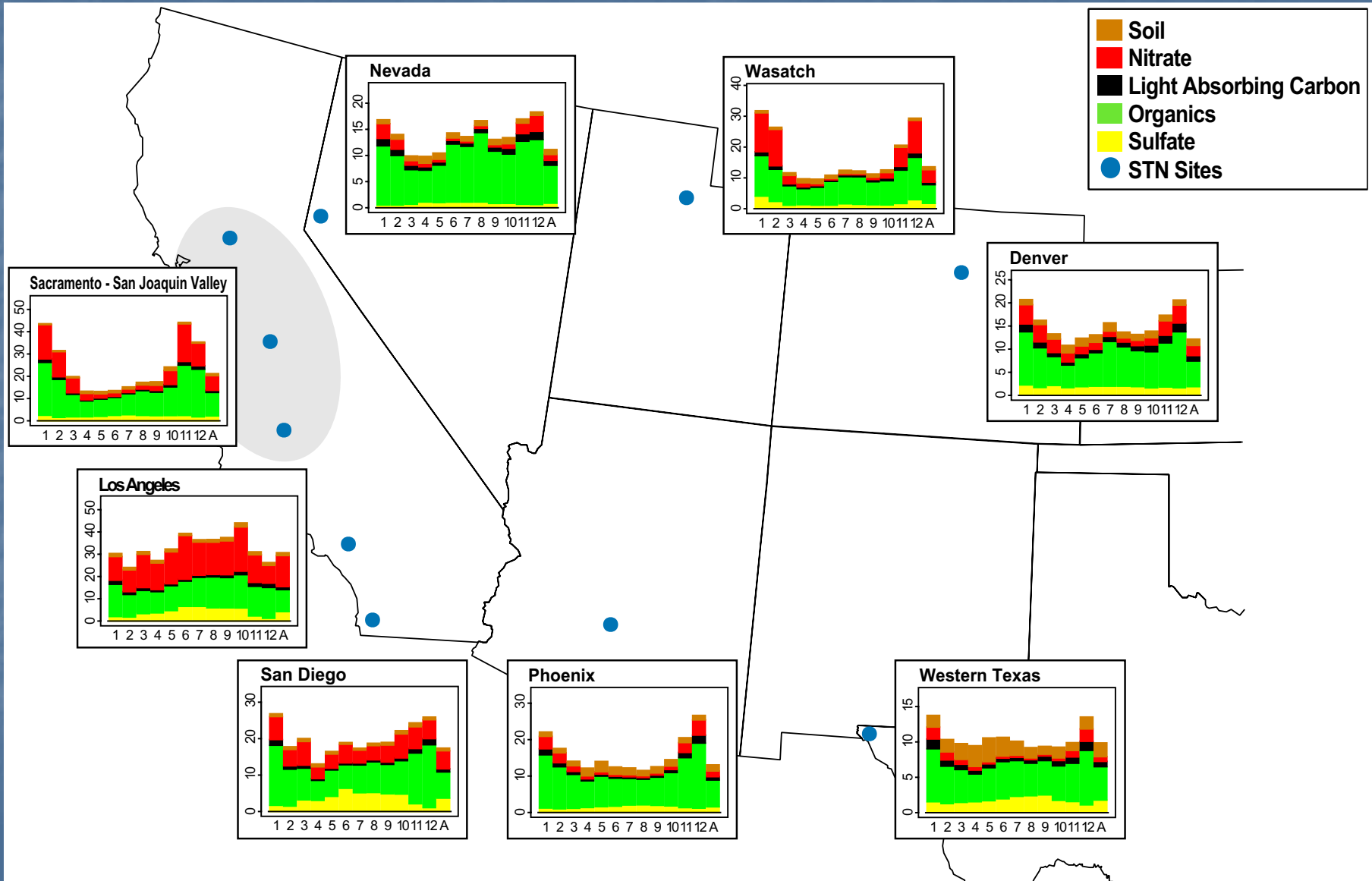
STN Monthly Fine Mass Budgets



IMPROVE Monthly Fine Mass Budgets

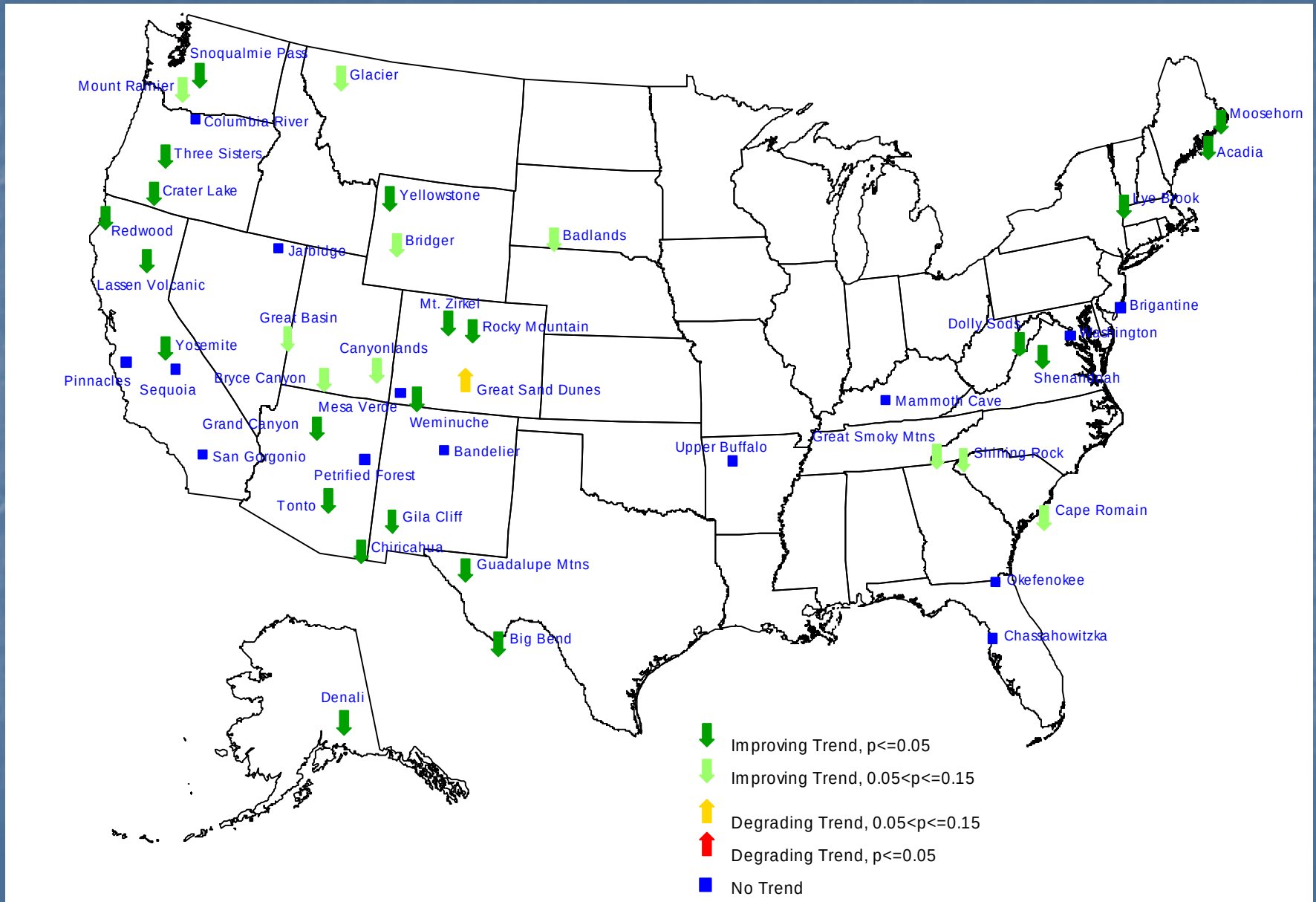


IMPROVE Monthly Fine Mass Budgets

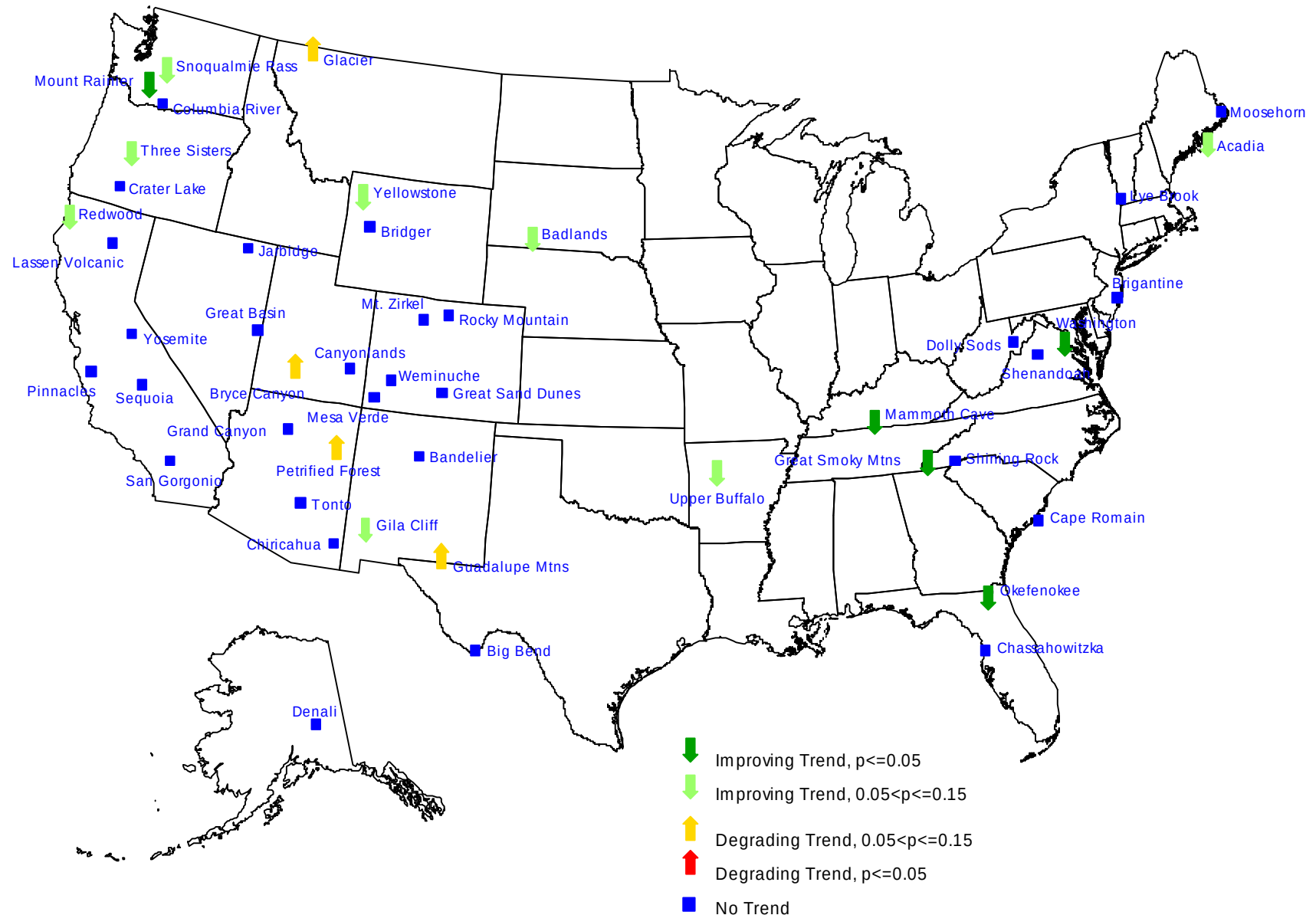


Trends in the Best and Worst Haze Days

Clear Day Deciview Trend 1995-2004



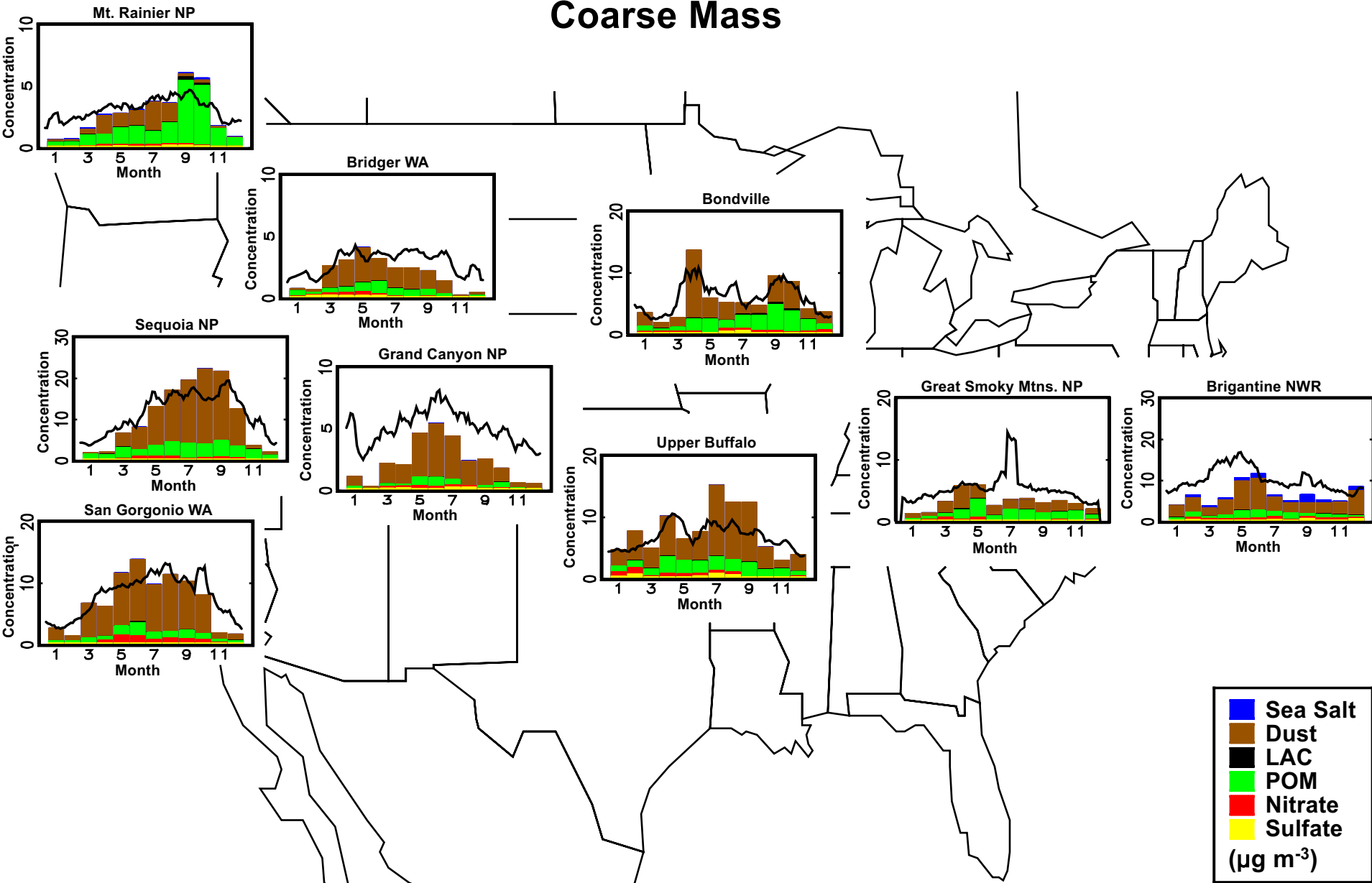
Hazy Day Deciview Trend 1995-2004



Speciated Coarse Mass

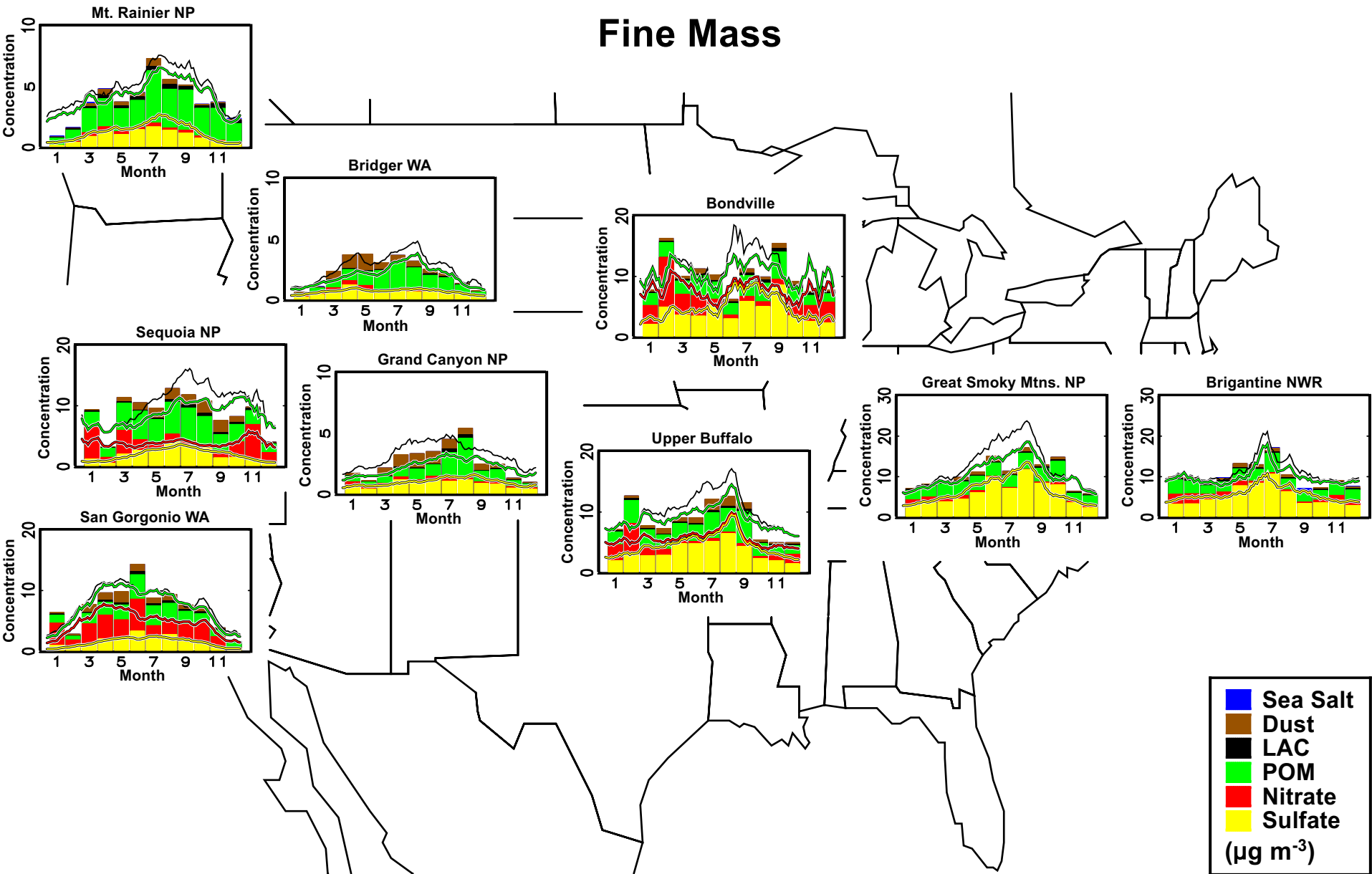
Coarse Mass

Coarse Mass



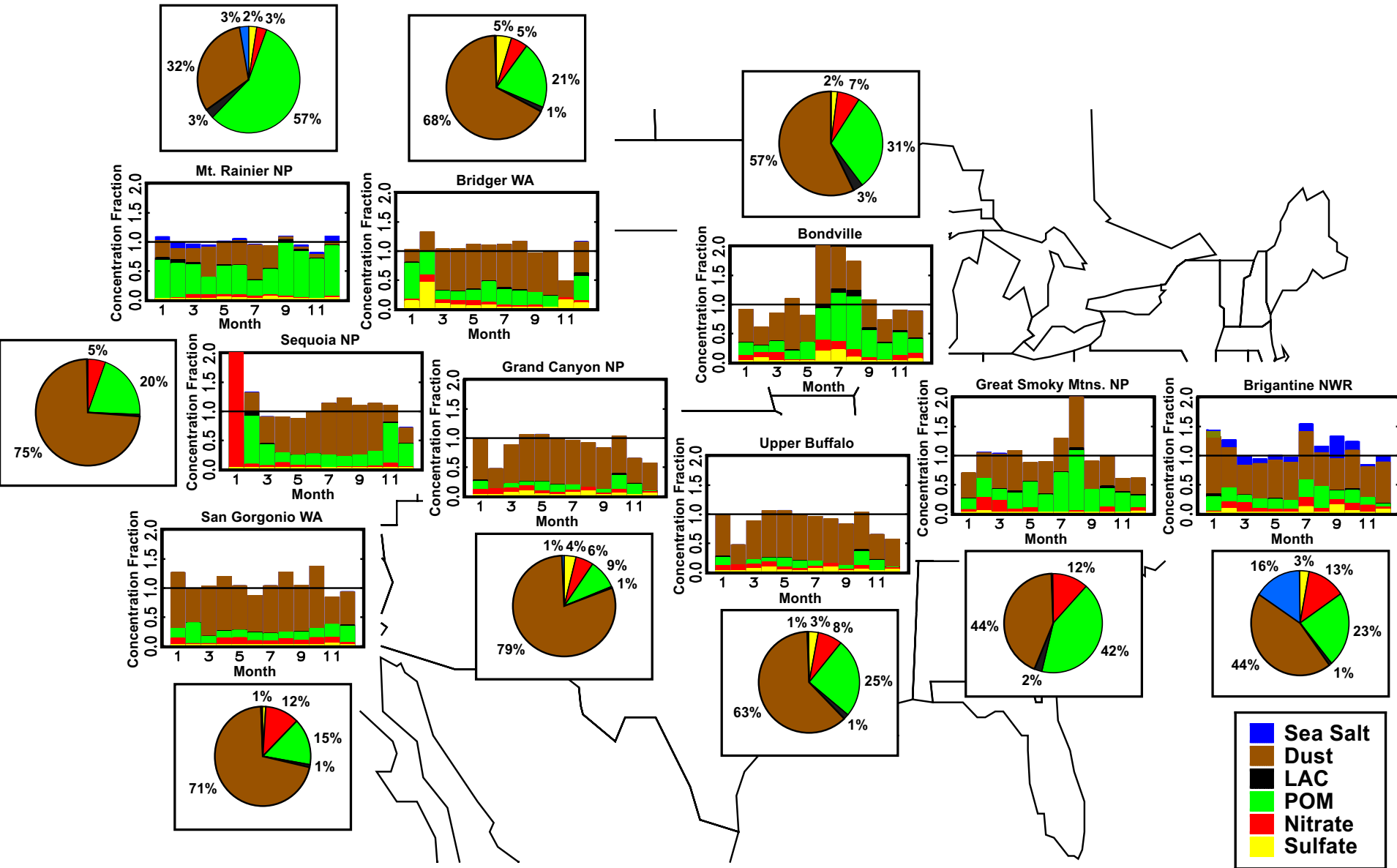
Fine Mass

Fine Mass



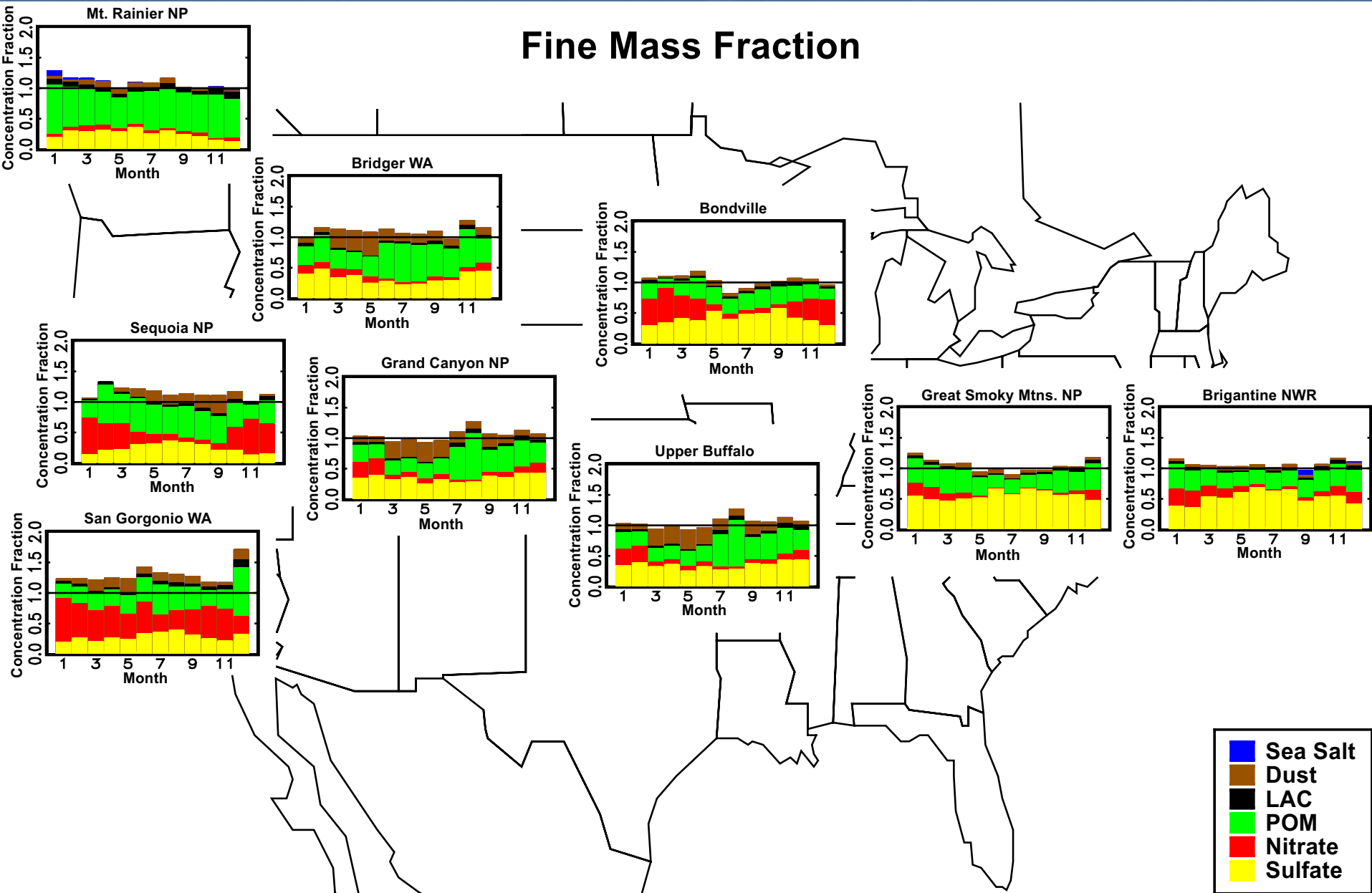
Coarse Mass Fraction

Coarse Mass Fraction



Fine Mass Fraction

Fine Mass Fraction



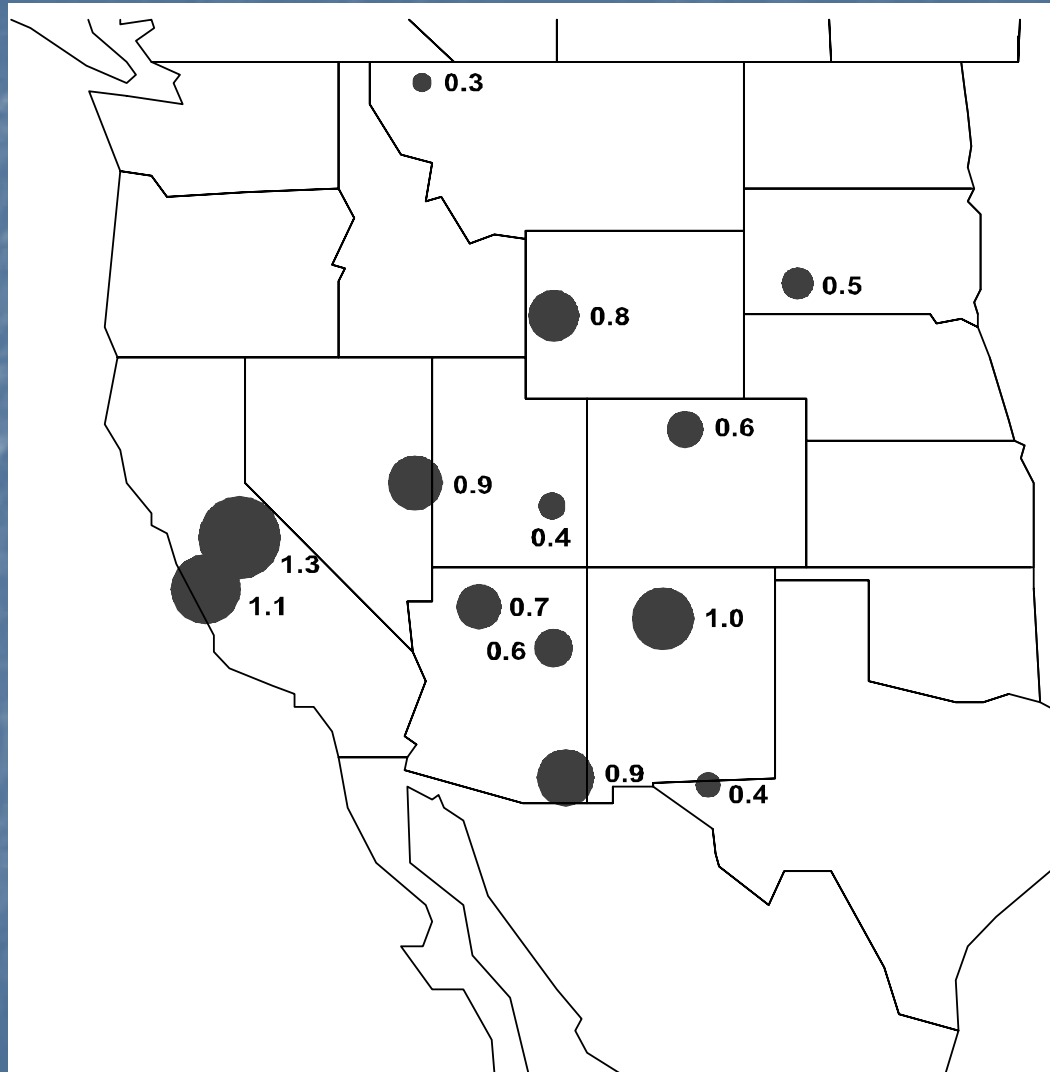
Review of Aerosol Optical Properties Derived from IMROVE Particulate and Optical Data

The map displays the mean annual precipitation in inches for 1980 across the United States. The data is represented by black and gray circles of varying sizes, with numerical values labeled next to each circle. The distribution shows higher precipitation in the Pacific Northwest and the Northeast, and lower precipitation in the central and southern regions.

State	Precipitation (inches)
Washington	3.0
Oregon	2.9
Idaho	3.0
Montana	3.0
Wyoming	3.1
Nebraska	3.1
Kansas	1.9
Oklahoma	2.8
Colorado	3.2
Utah	2.3
Nevada	3.0
California	2.4
Arizona	2.1
New Mexico	2.5
New Mexico	2.8
New Mexico	2.6
New Mexico	2.0
New Mexico	2.7
New Mexico	3.4
New Mexico	2.7
Texas	2.9
South Dakota	2.9
North Dakota	3.1
Minnesota	3.0
Wisconsin	3.0
Illinois	3.1
Indiana	3.1
Ohio	3.1
Pennsylvania	3.1
Delaware	2.8
Maryland	3.1
Virginia	3.1
North Carolina	3.3
South Carolina	3.3
Georgia	3.3
Florida	3.3
Alabama	3.3
Mississippi	3.3
Louisiana	3.3
Arkansas	3.3
Missouri	3.3
Iowa	3.3
Illinois	3.3
Indiana	3.3
Ohio	3.3
Pennsylvania	3.3
Delaware	3.3
Maryland	3.3
Virginia	3.3
North Carolina	3.3
South Carolina	3.3
Georgia	3.3
Florida	3.3
Alabama	3.3
Mississippi	3.3
Louisiana	3.3
Arkansas	3.3
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Illinois	3.3
Indiana	3.3
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Pennsylvania	3.3
Delaware	3.3
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Maryland	3.3
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South Carolina	3.3
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Arkansas	3.3
Missouri	3.3
Iowa	3.3
Illinois	3.3
Indiana	3.3
Ohio	3.3
Pennsylvania	3.3
Delaware	3.3

Organic bext efficiency =
(density inorganic / density organic) * inorganic bext efficiency

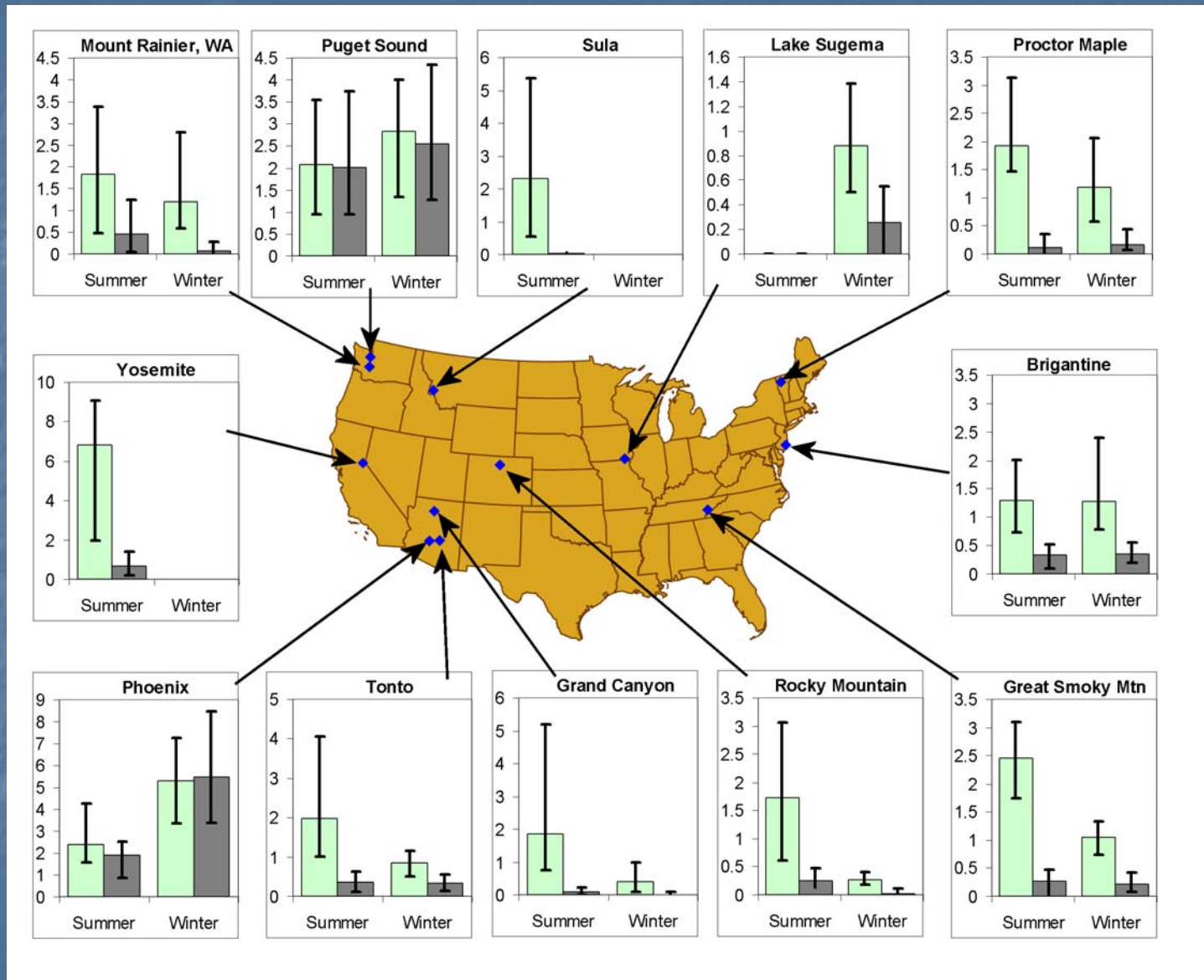
Coarse Mass Efficiency



- Derived from Transmissometer and Particulate data

Other NPS/CIRA Work

Seasonal Contemporary and Fossil C ($\mu\text{g}/\text{m}^3$)



The error bars represent the range in six day concentrations

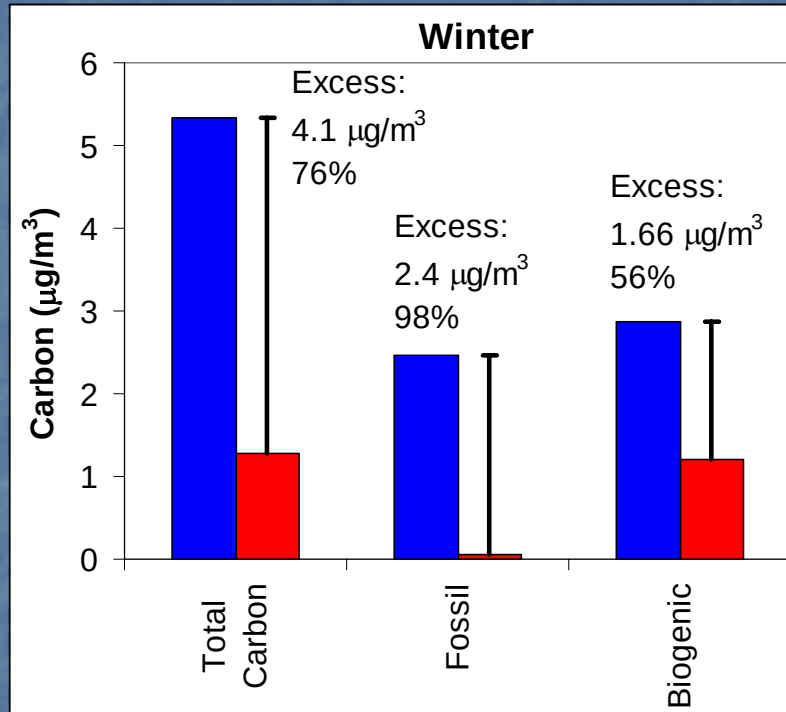
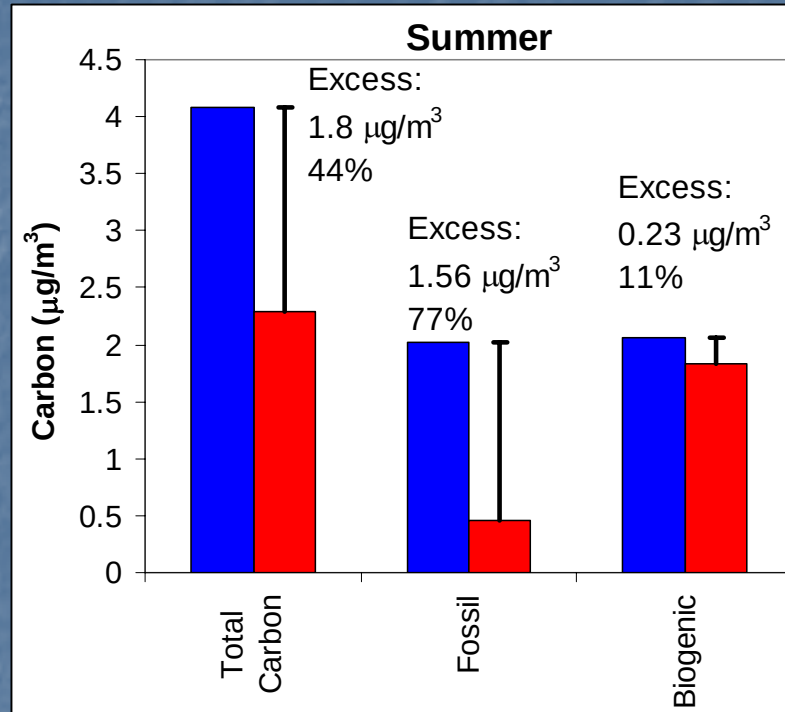
Seasonal Fraction Contemporary Carbon



The error bars represent the fraction contemporary range

Urban Excess

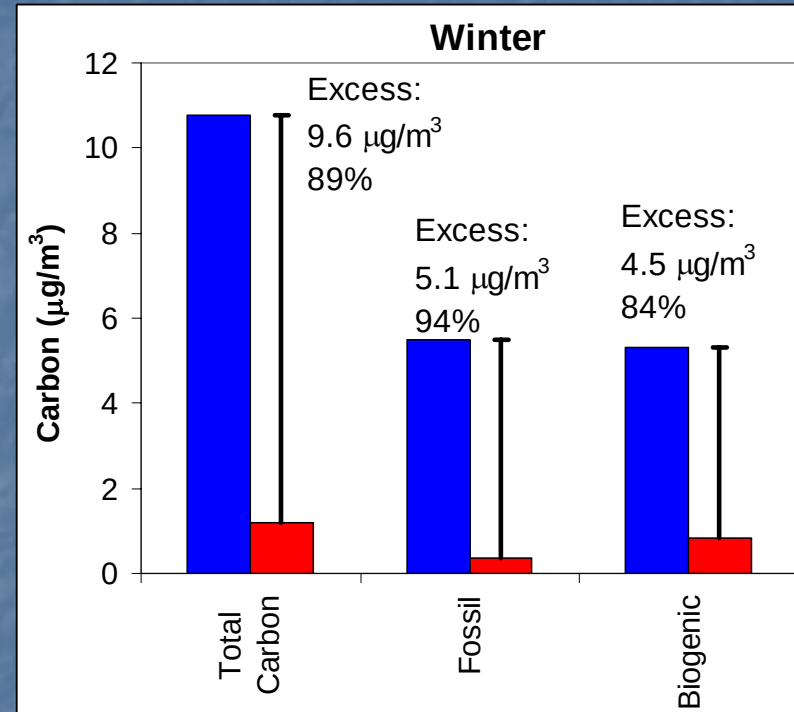
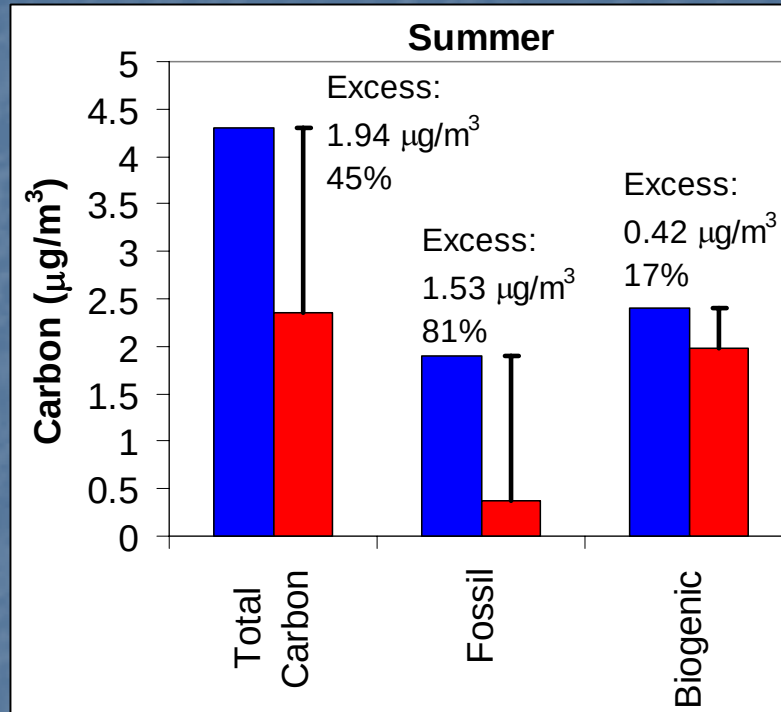
Puget Sound, WA - Mount Rainier, WA



- Puget Sound fossil carbon is primarily due to local sources during winter and summer
- Summer biogenic carbon is regionally distributed
- ~40% of the winter urban excess is biogenic carbon
 - Not all biogenic carbon is “natural”

Urban Excess

Phoenix, AZ – Tonto, AZ

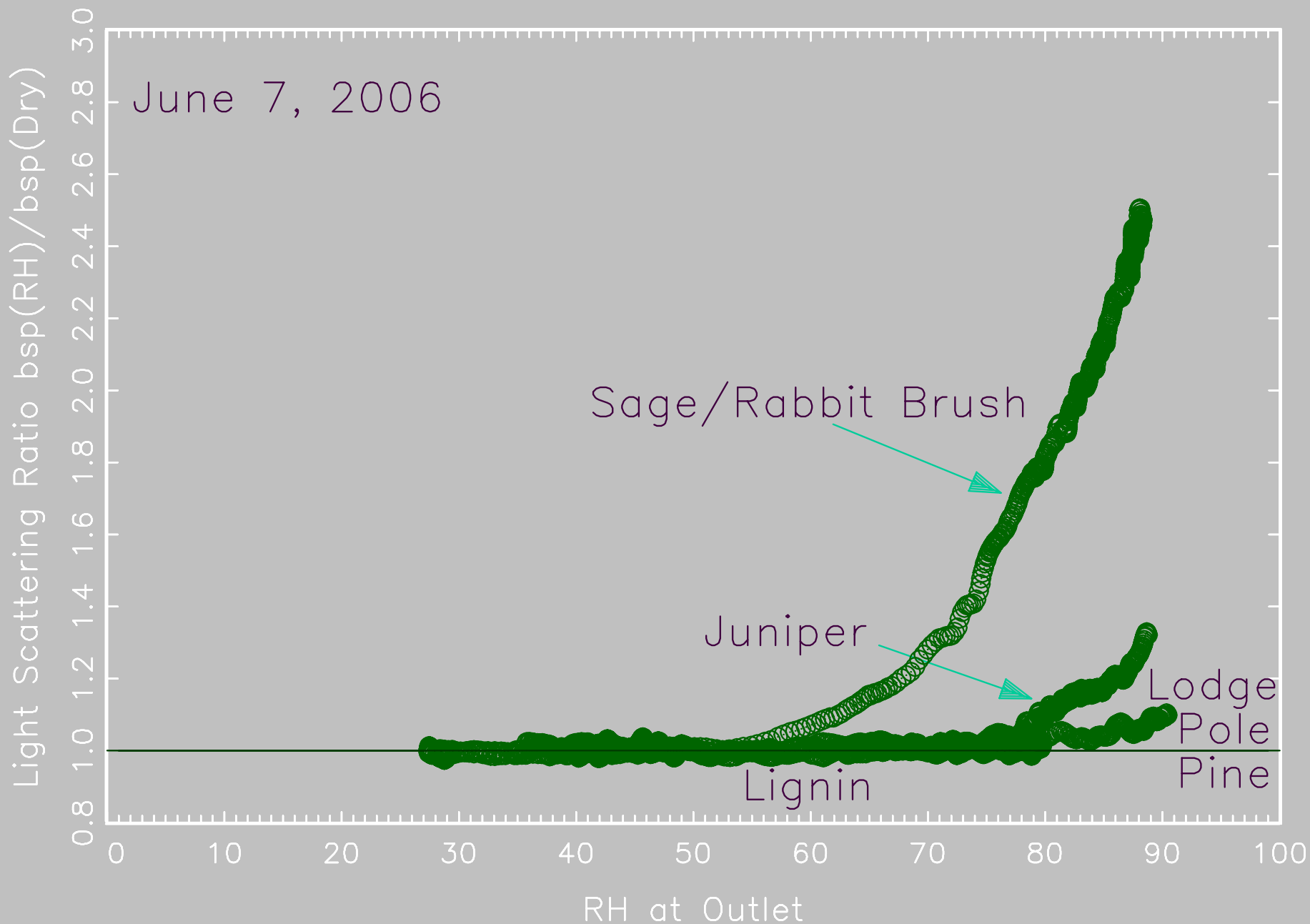


- Phoenix fossil carbon is primarily due to local sources during winter and summer
- Summer biogenic carbon is regionally distributed
- About half of the winter urban excess is biogenic carbon
 - Not all biogenic carbon is “natural”

Hygroscopicity of Smoke

Juniper; Sage/Rabbit Brush; Lignin; Lodge Pole Pine

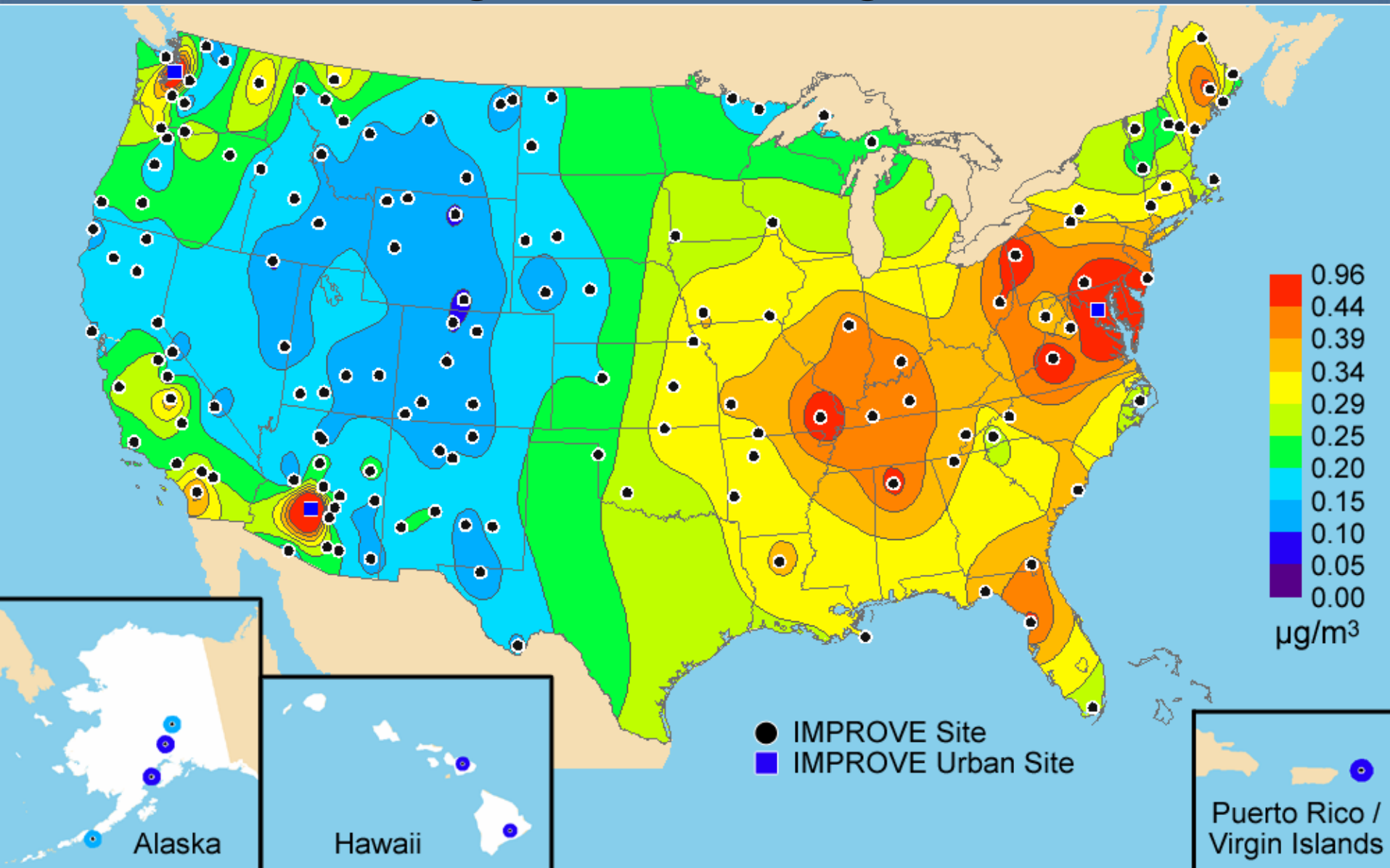
June 7, 2006



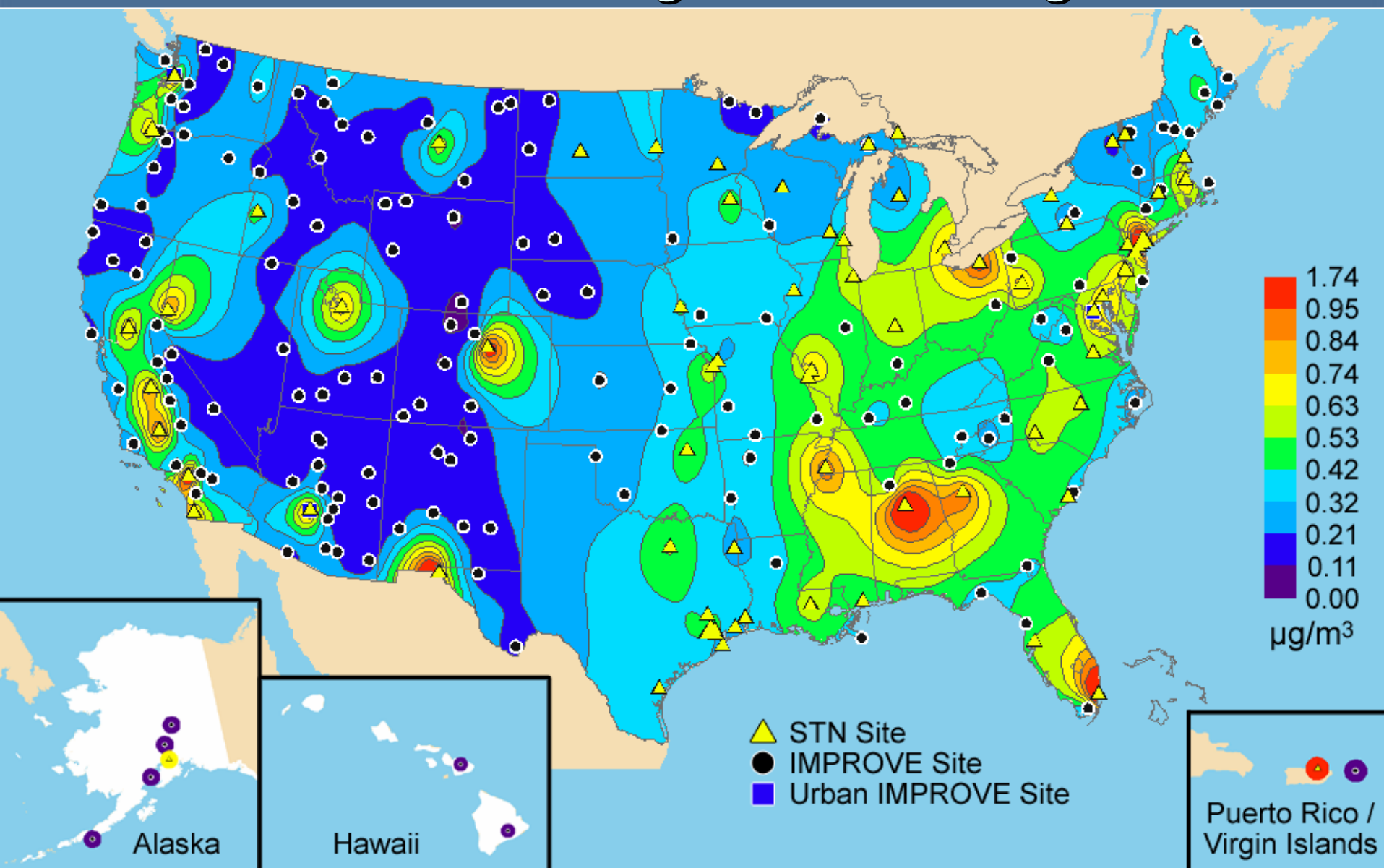


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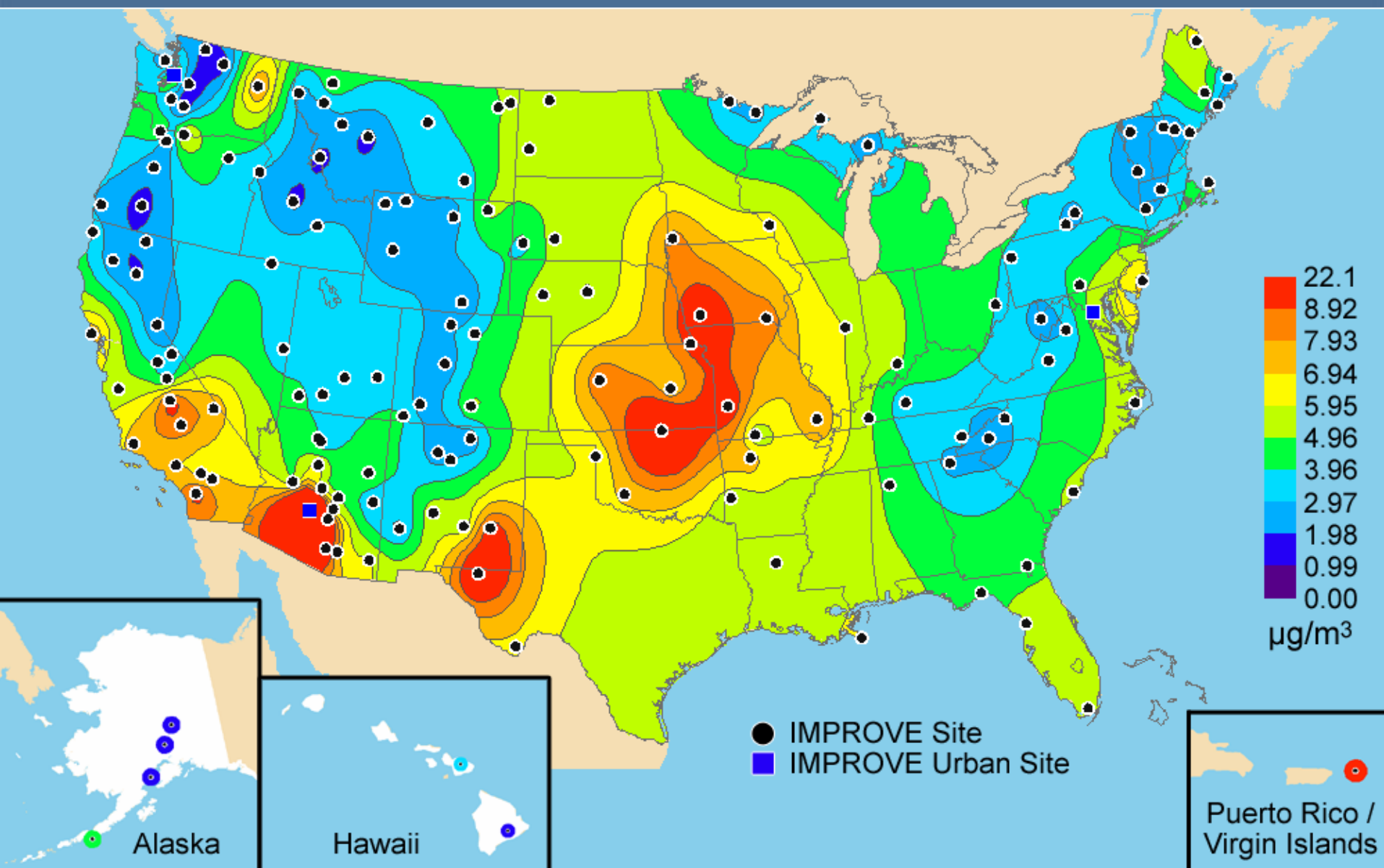
IMPROVE Light Absorbing Carbon Mass



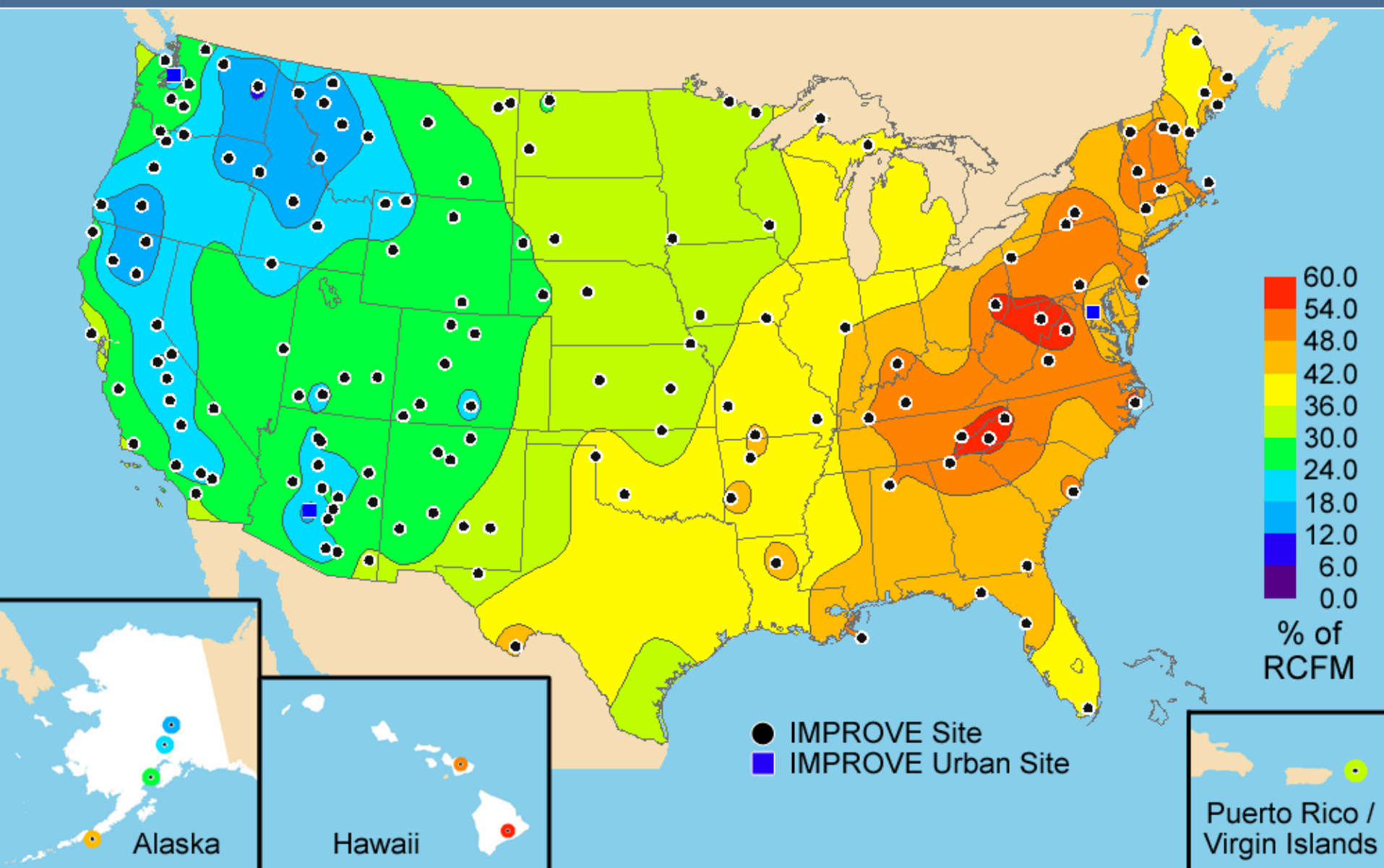
IMPROVE & STN Light Absorbing Carbon



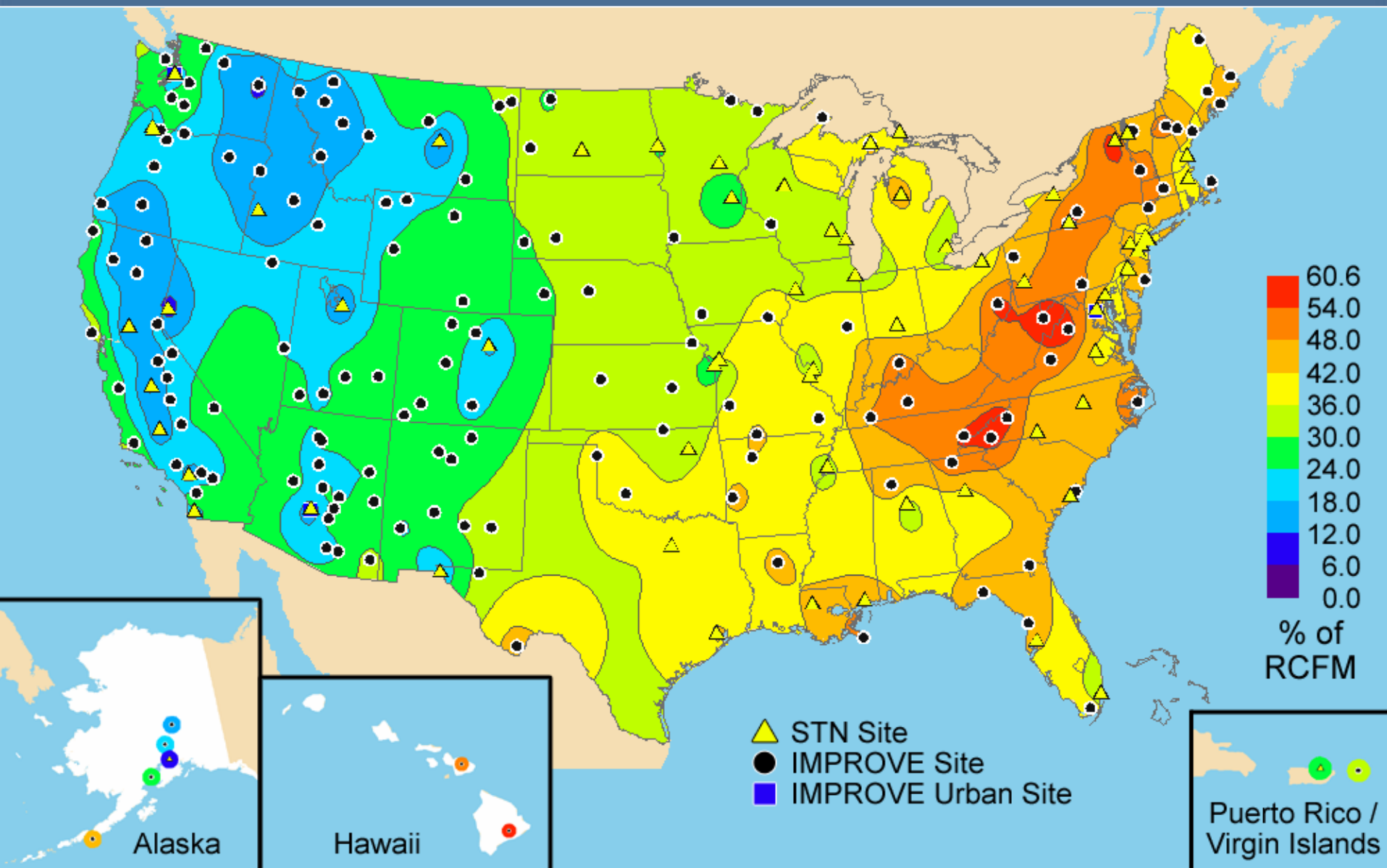
CM



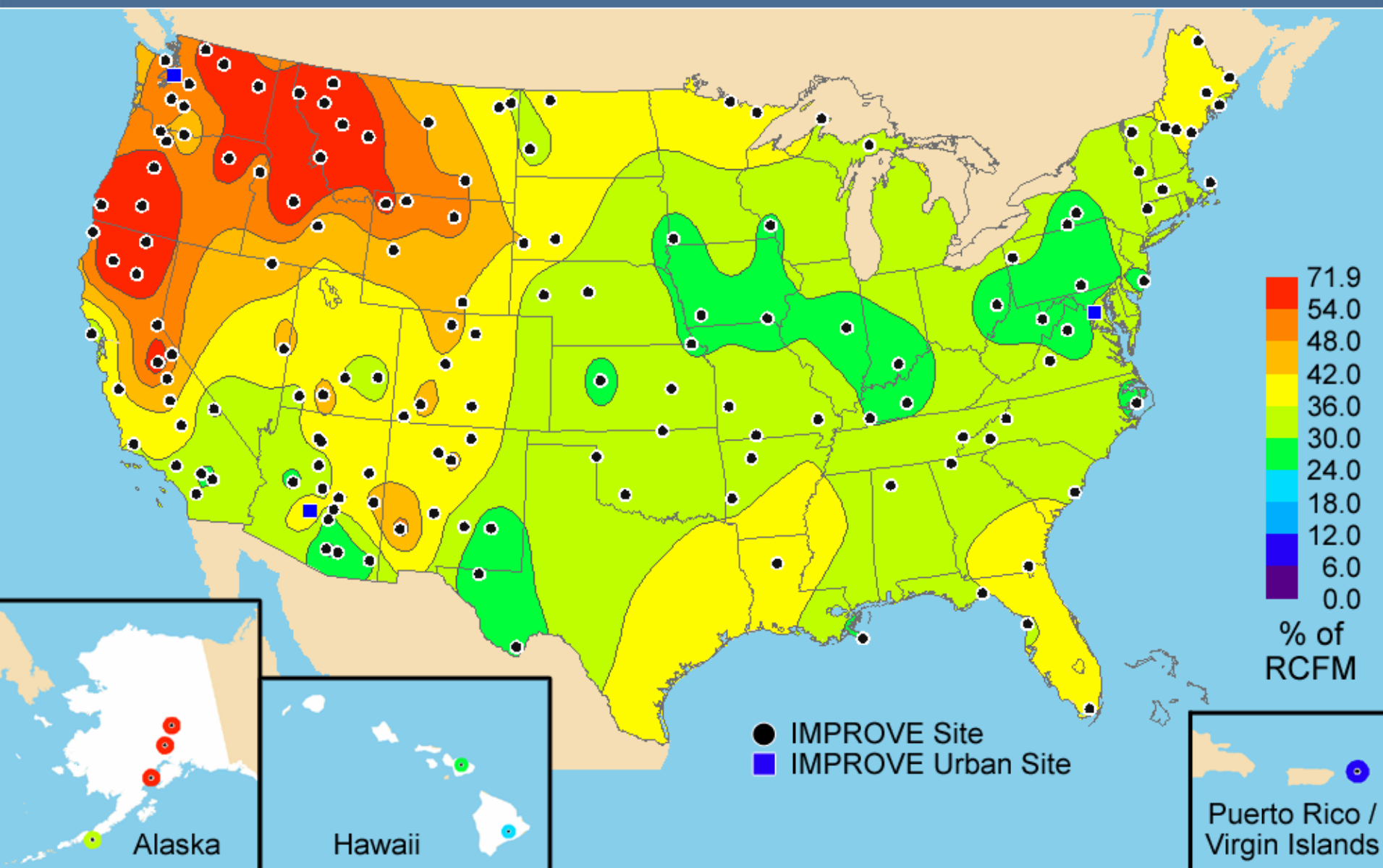
%SO₄



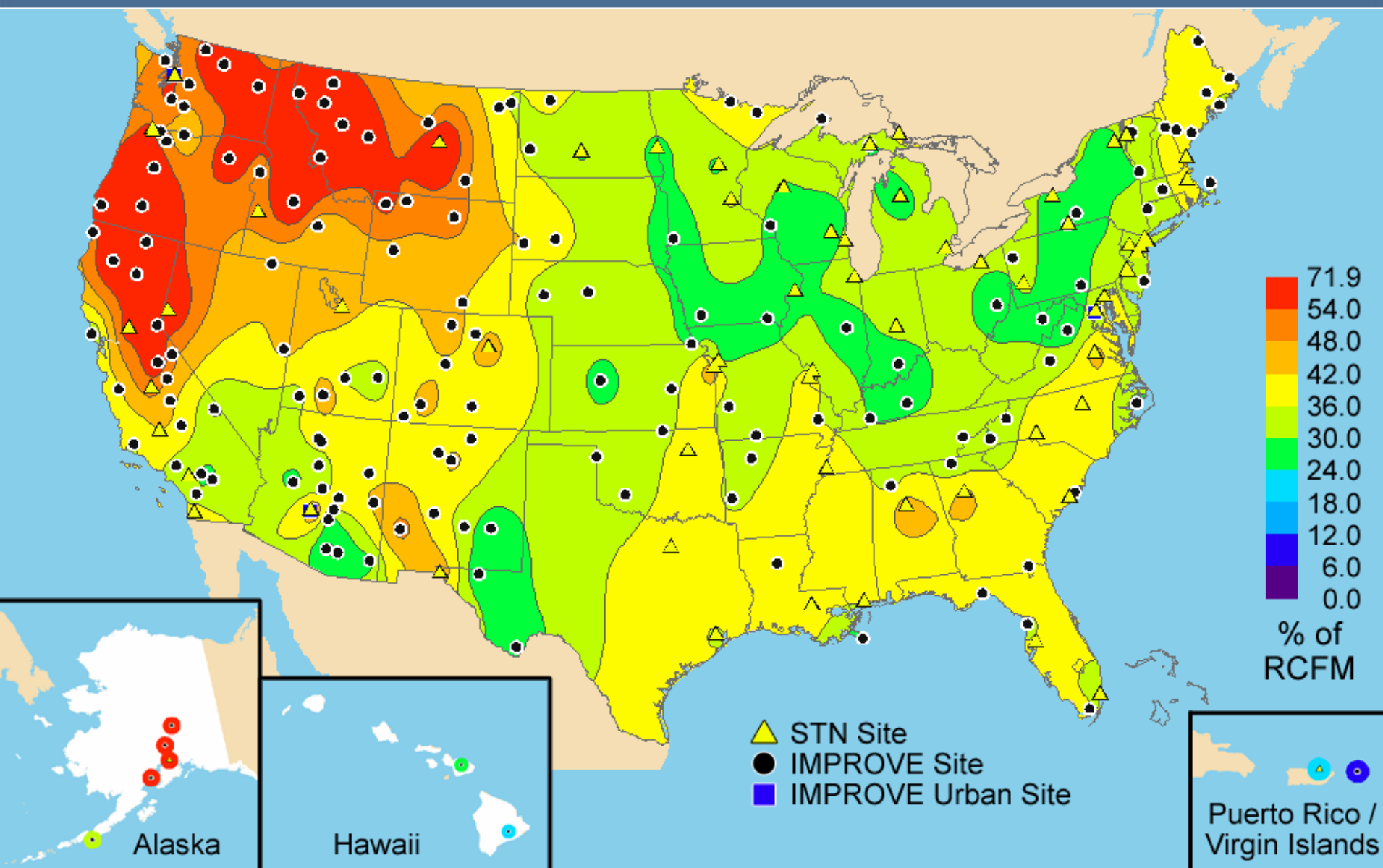
% SO₄



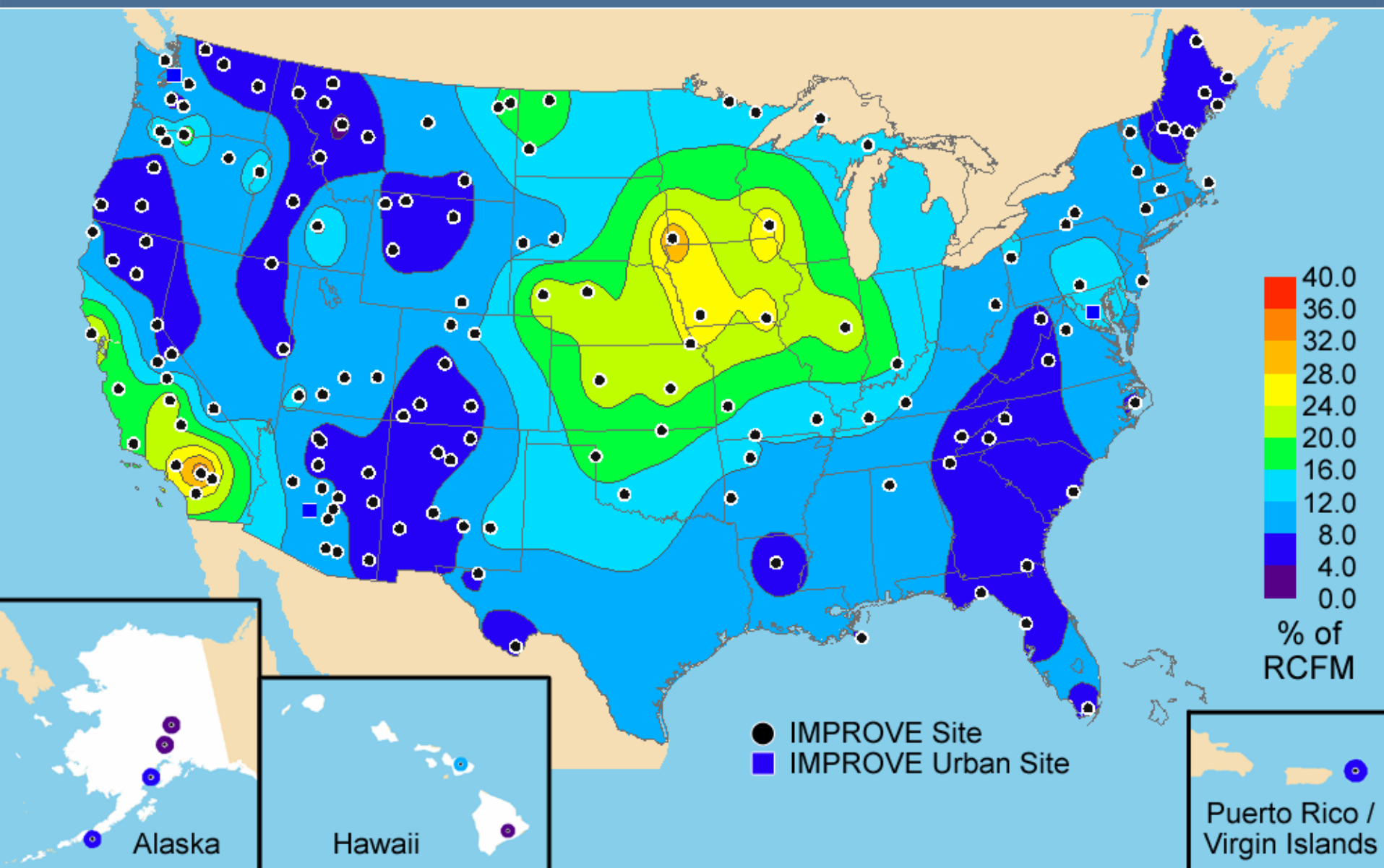
% OMC



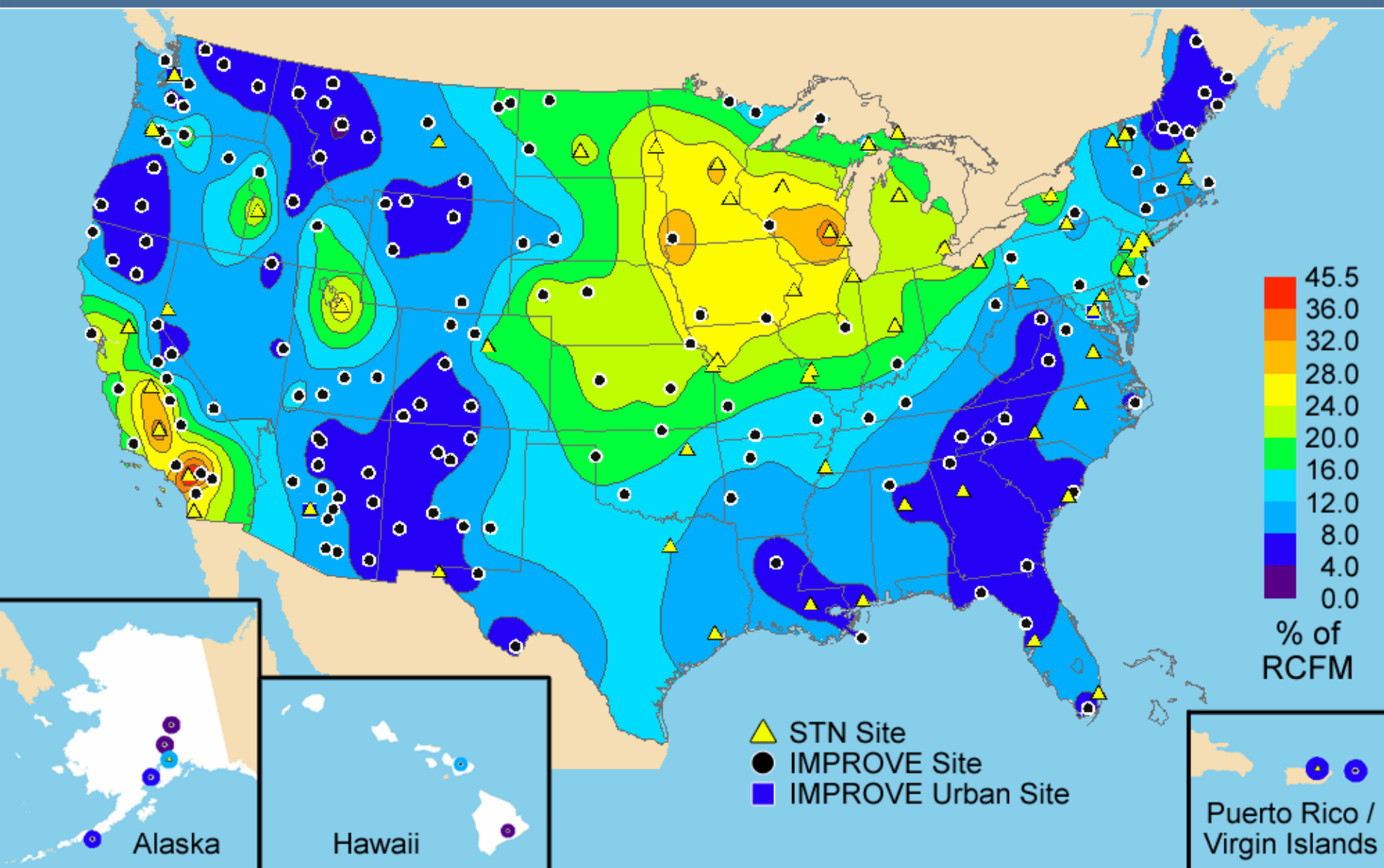
% OMC



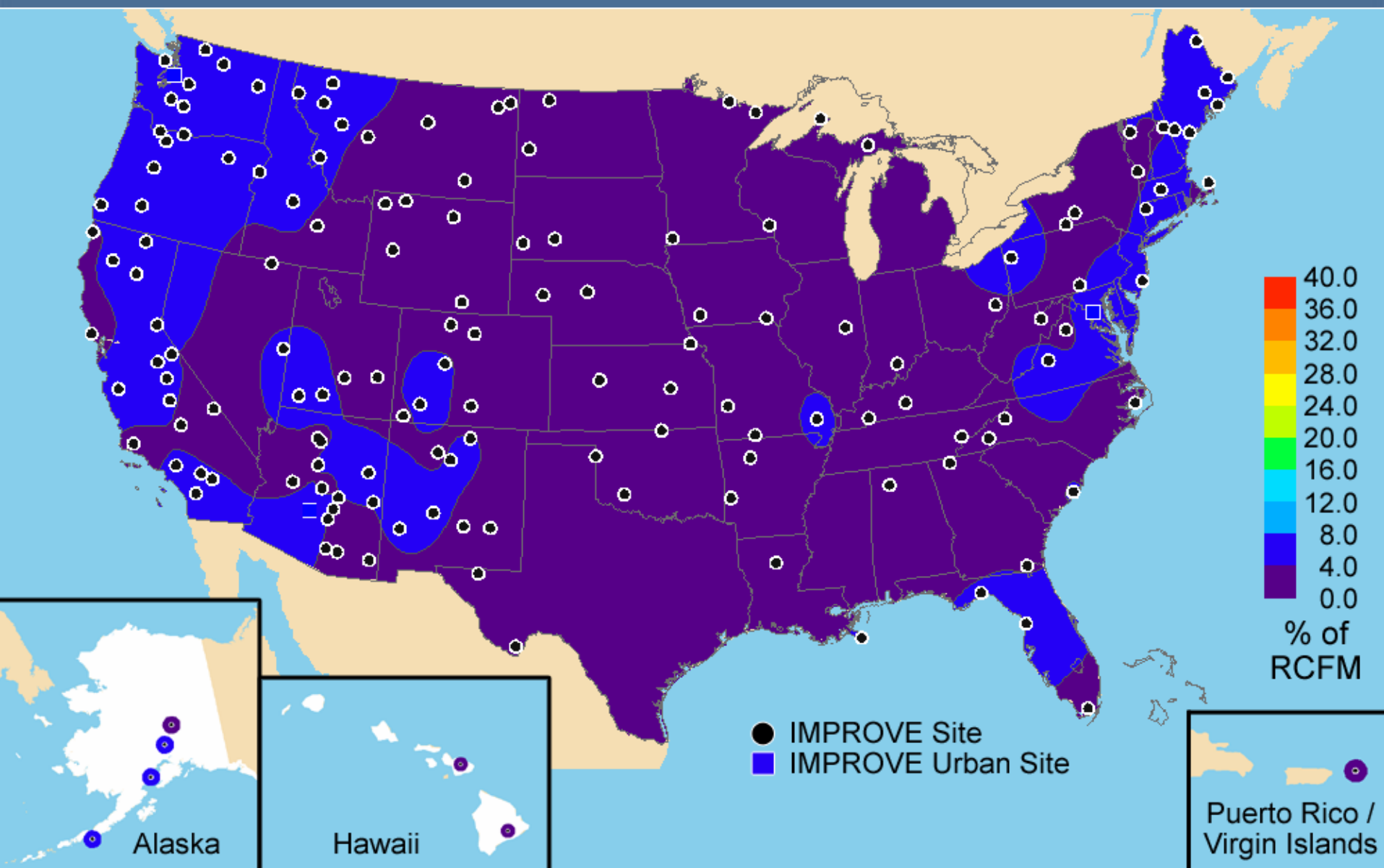
% NO₃



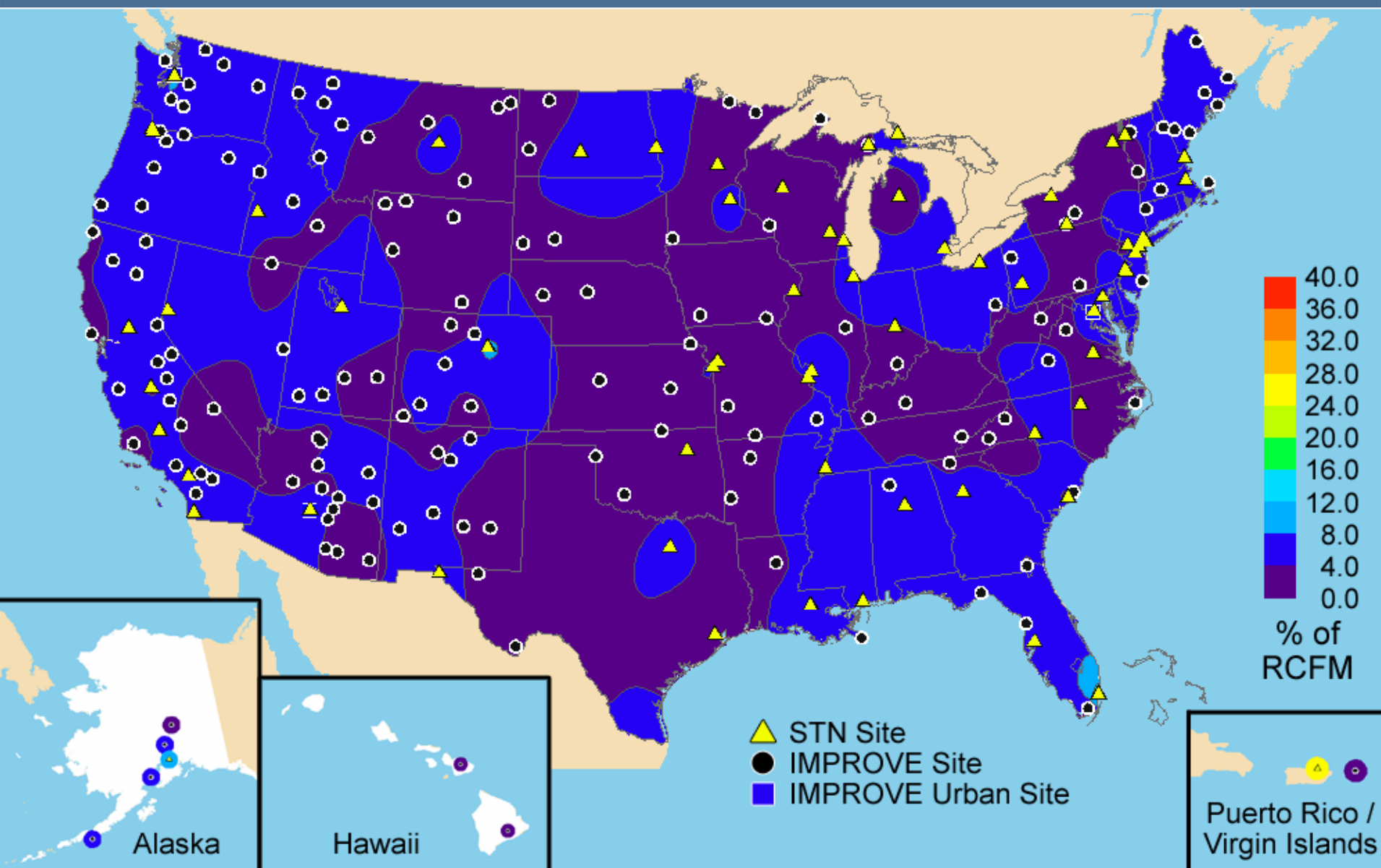
% NO₃



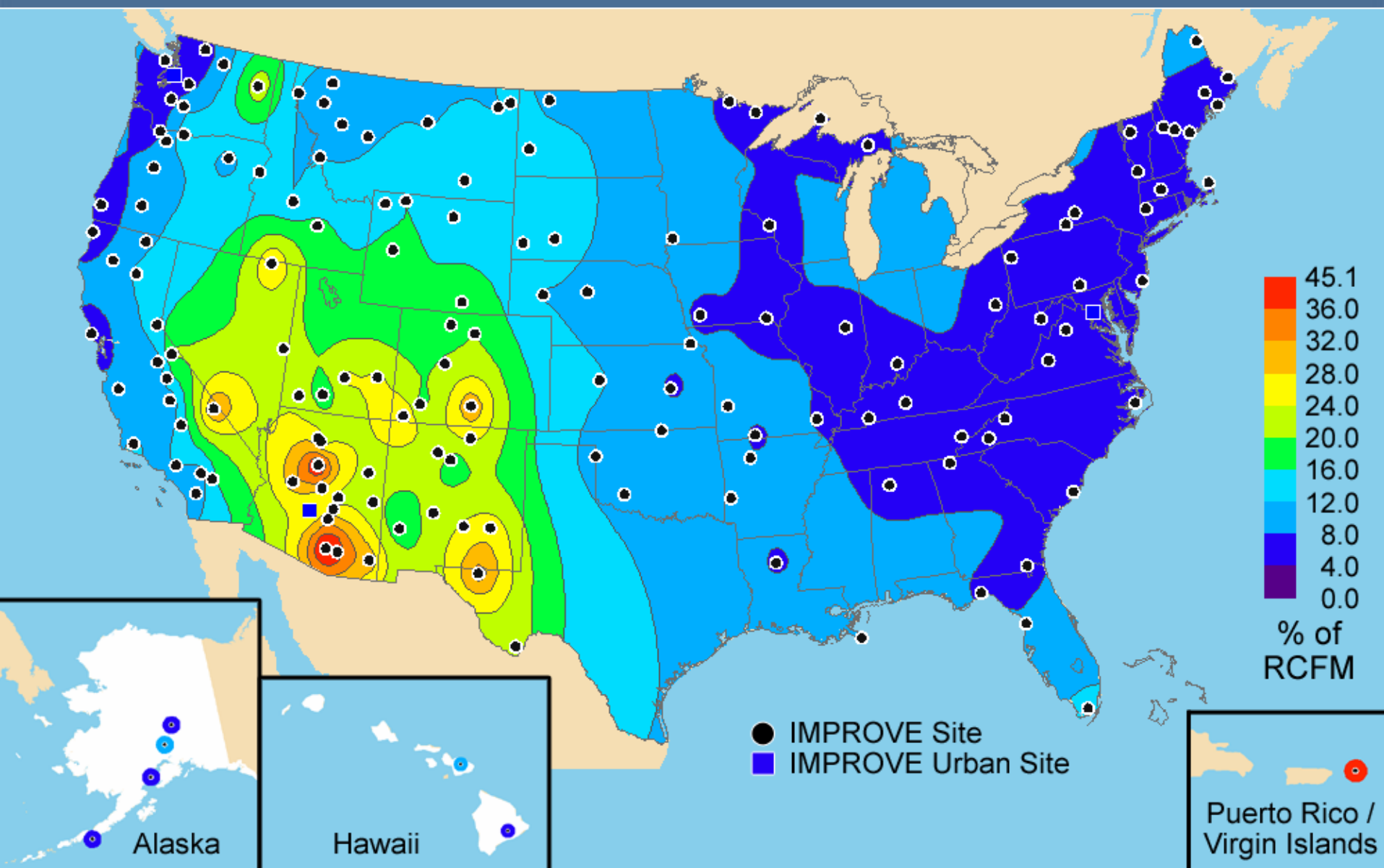
% LAC



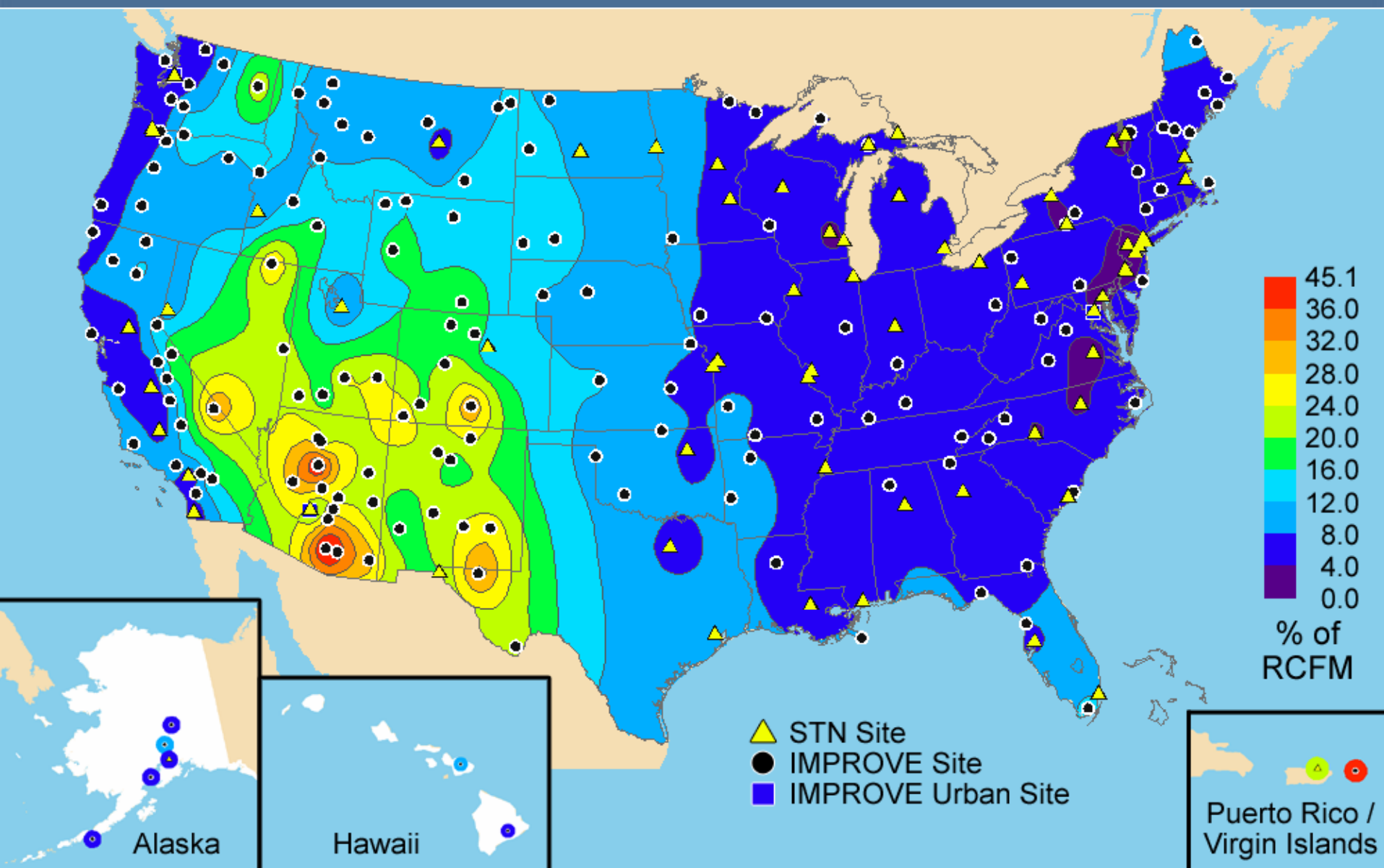
% LAC



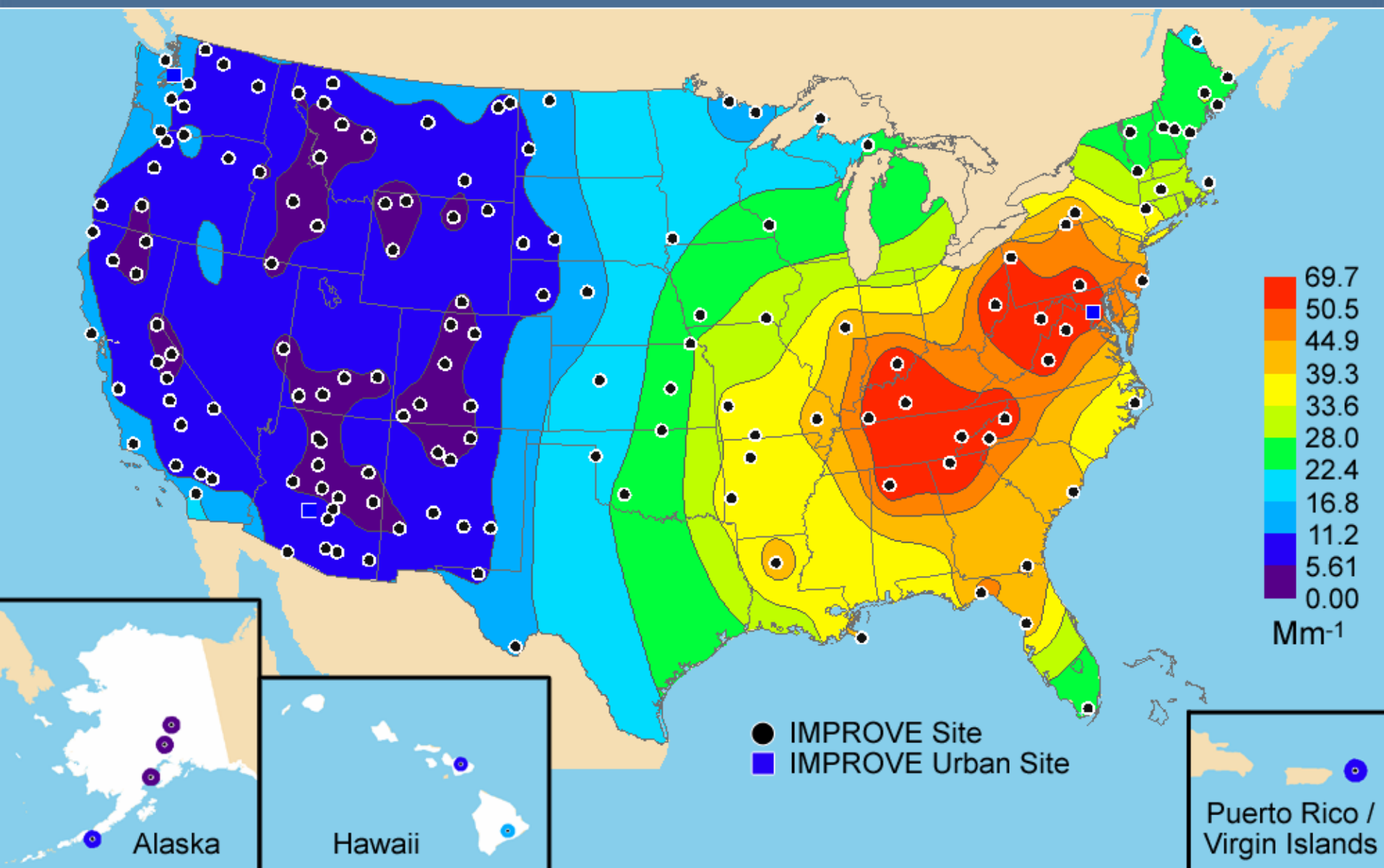
% Soil



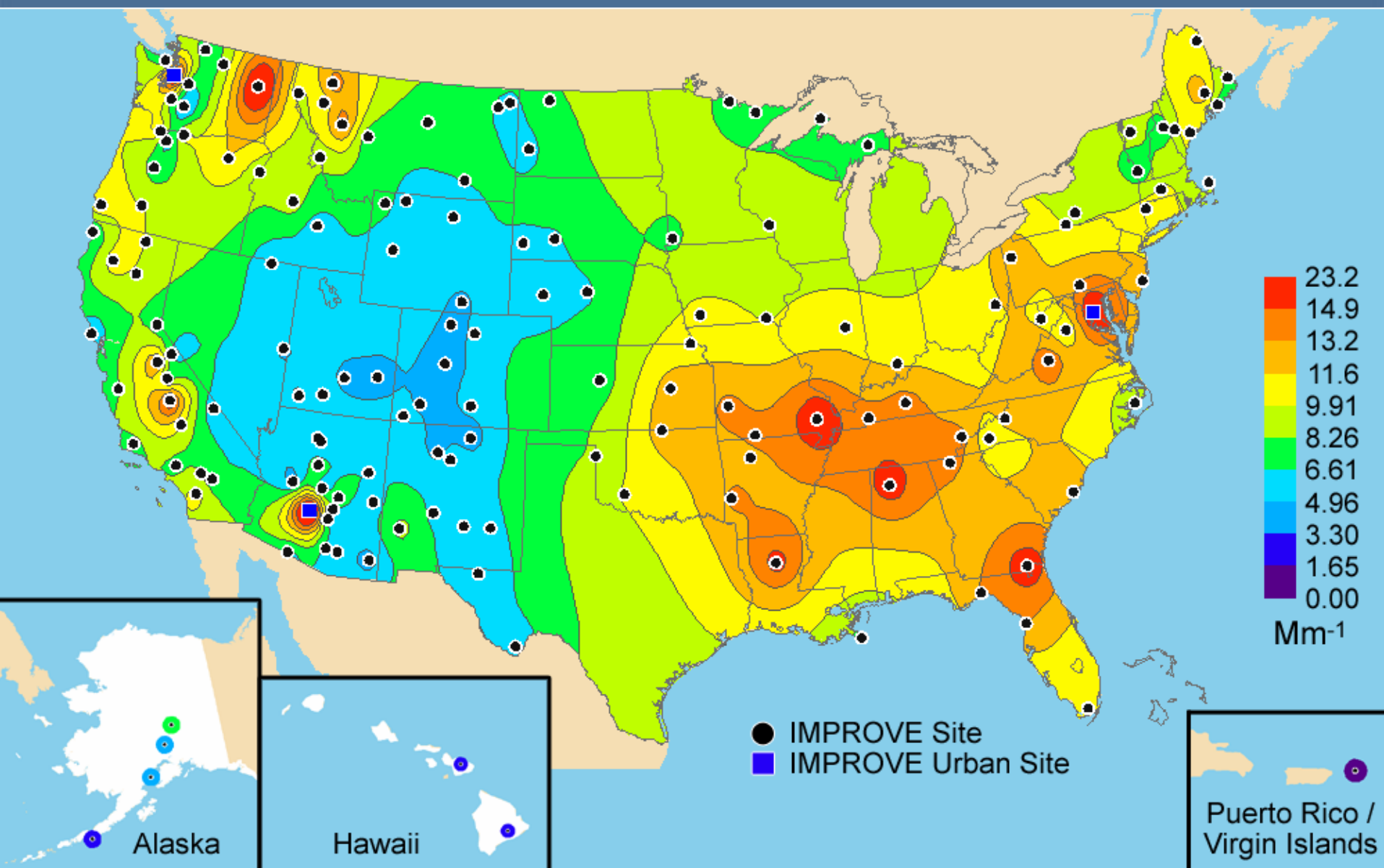
% Soil



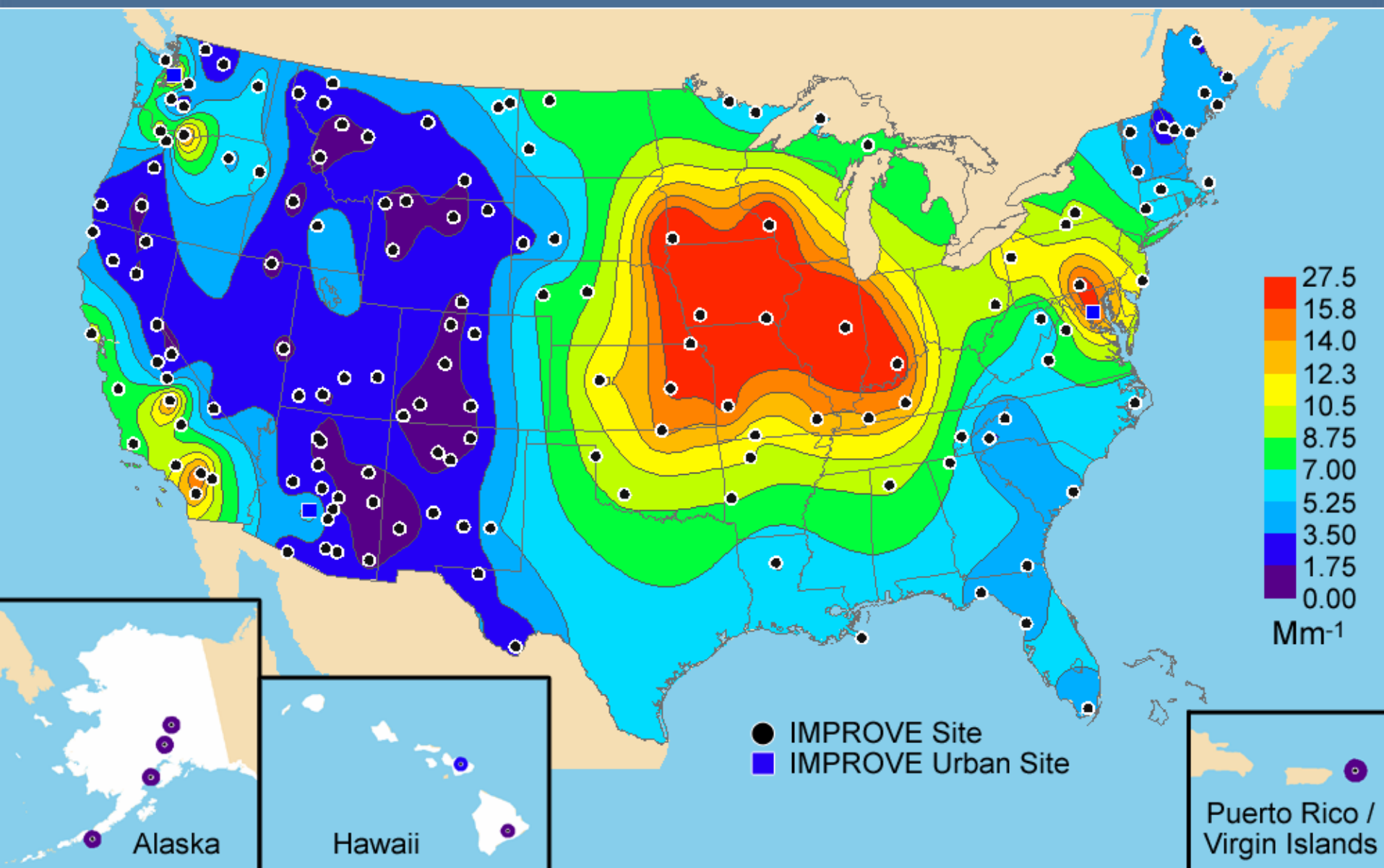
SO₄ extinction



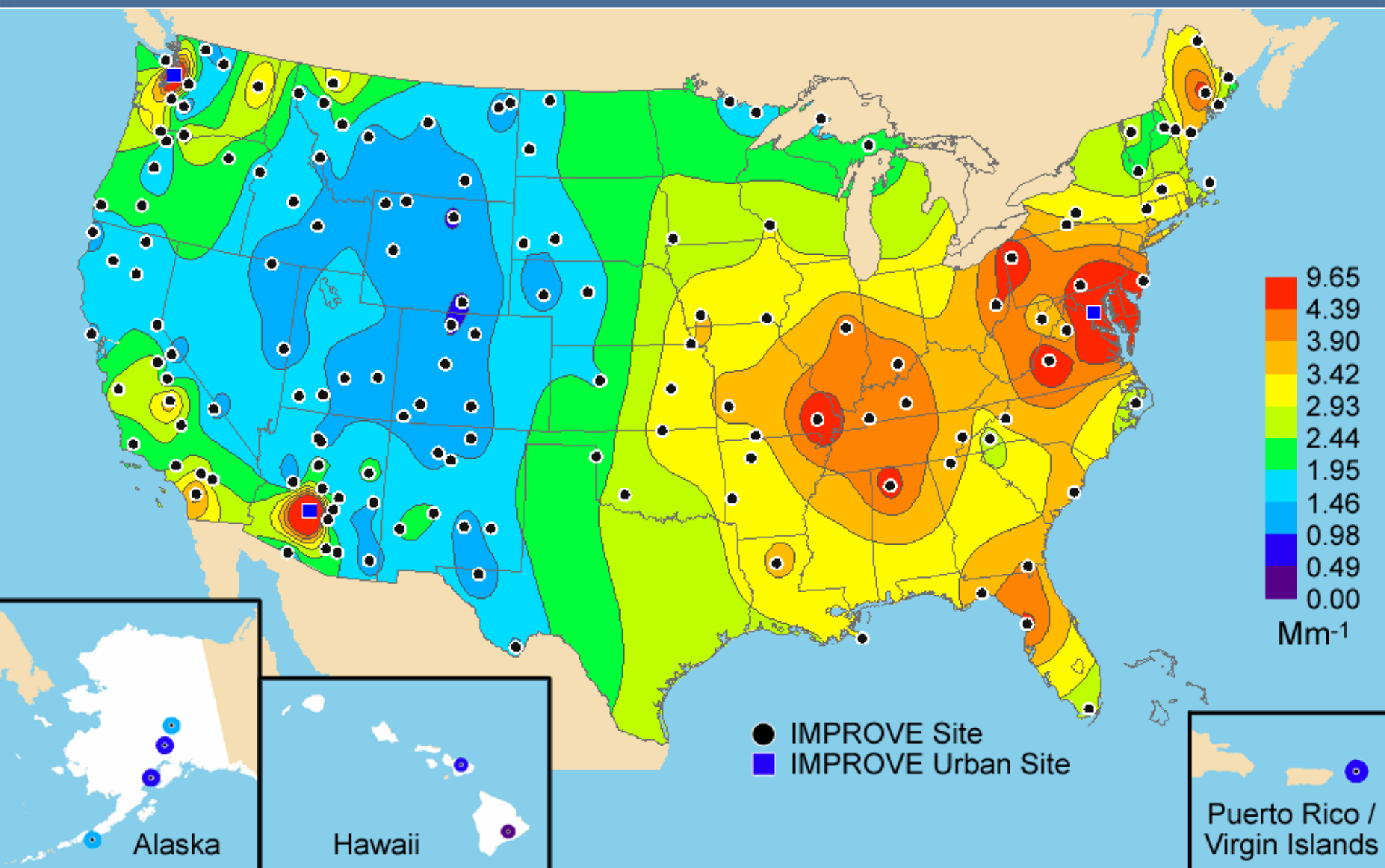
OMC extinction



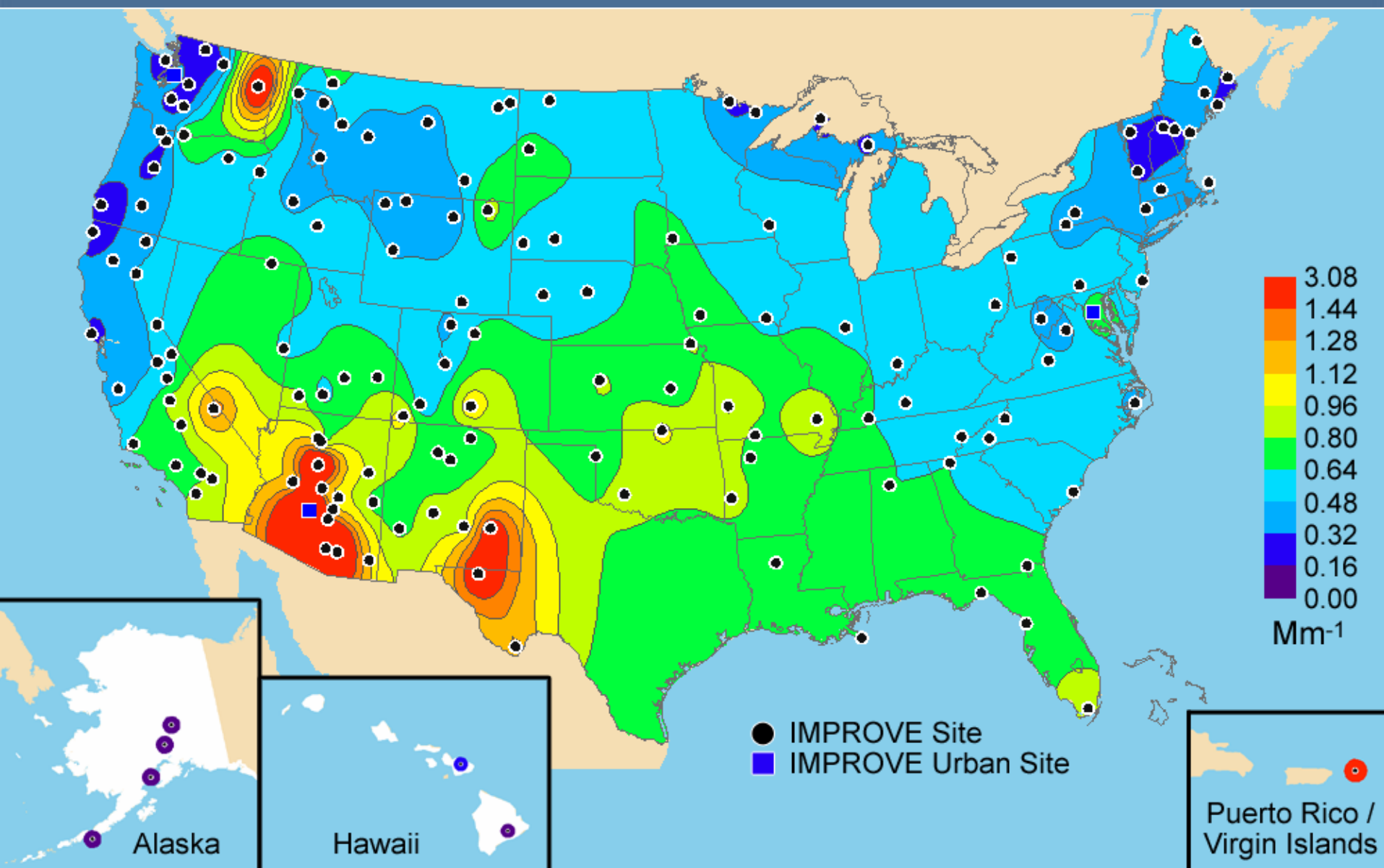
NO₃ extinction



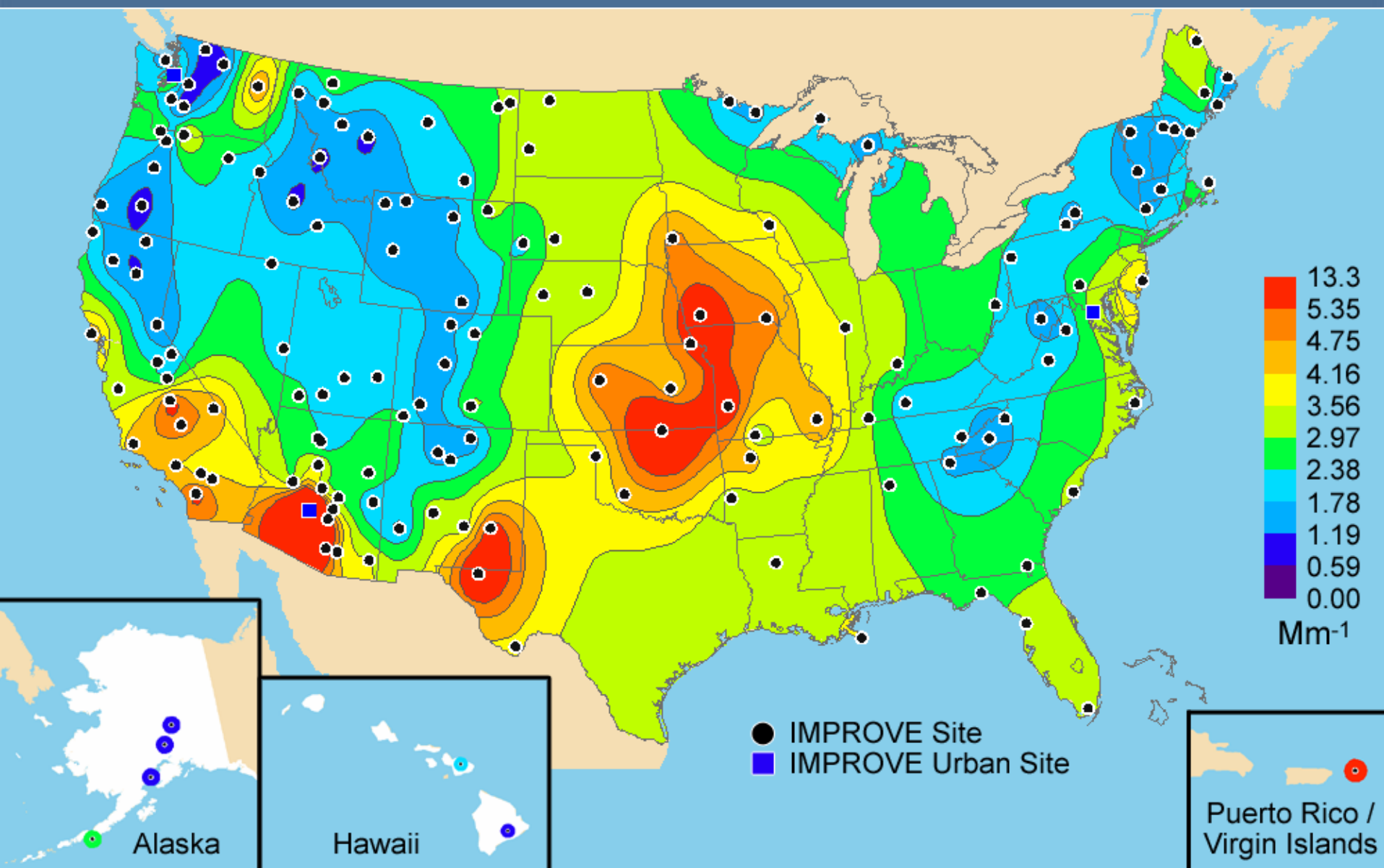
LAC extinction



Soil extinction

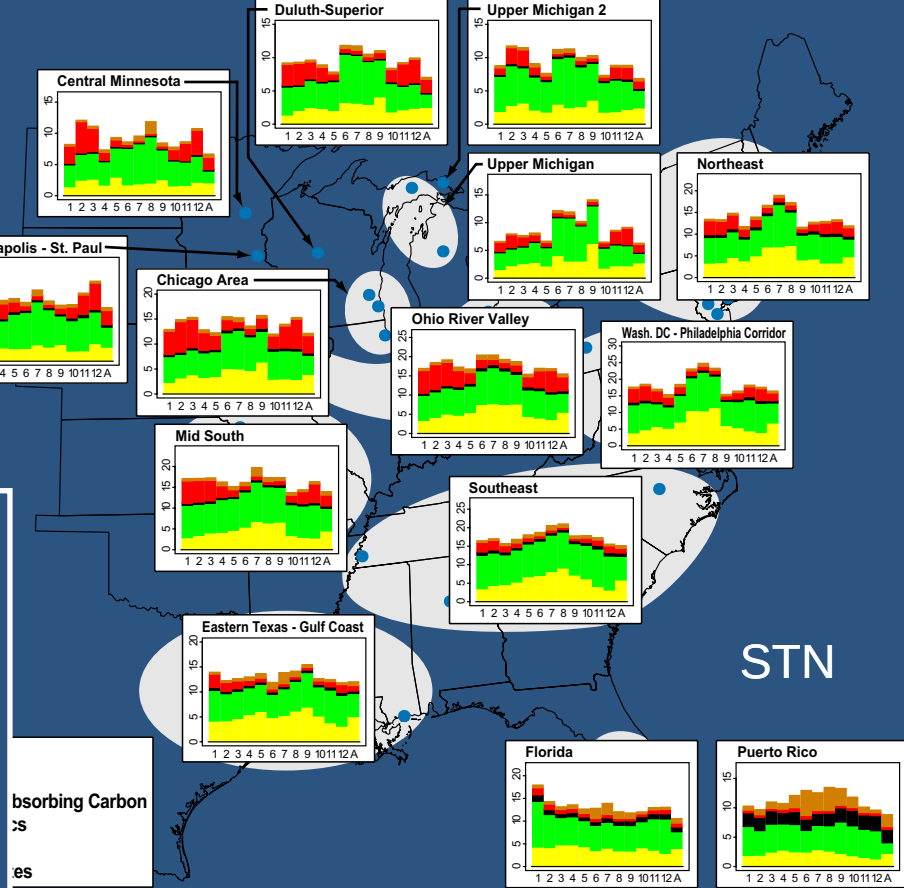
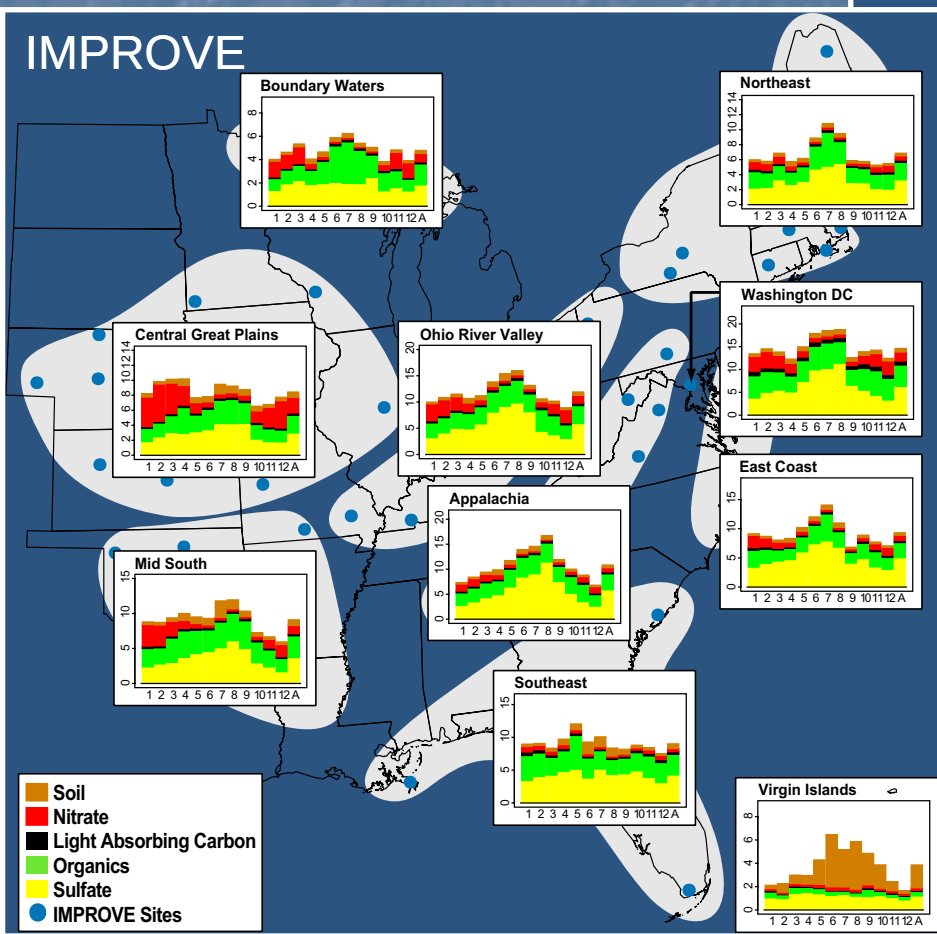


CM extinction



East

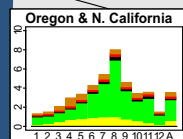
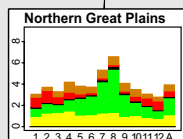
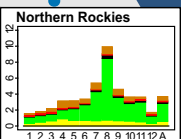
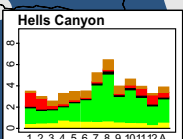
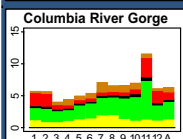
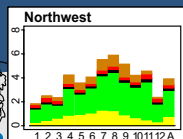
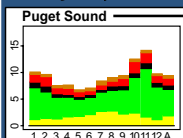
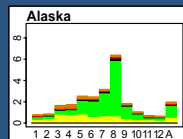
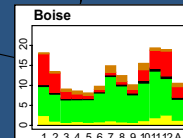
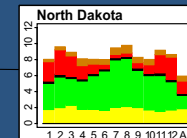
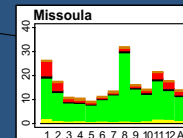
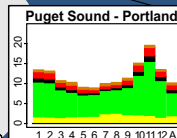
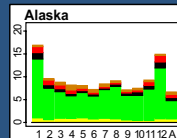
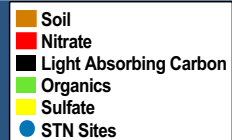
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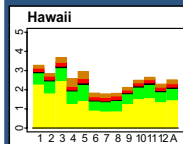
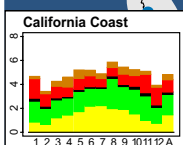
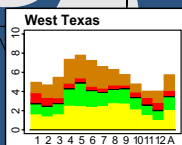
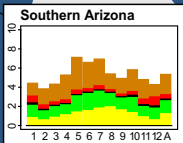
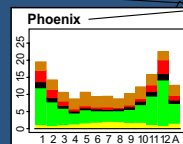
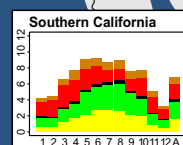
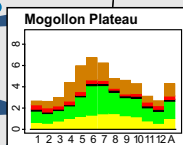
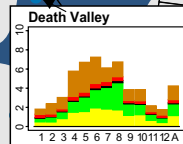
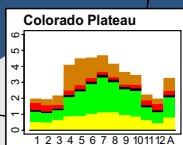
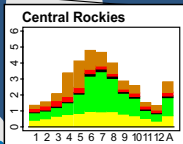
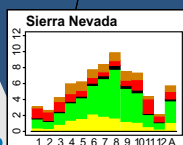
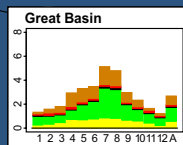
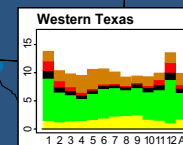
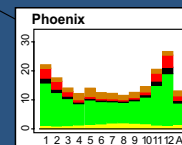
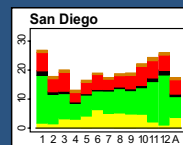
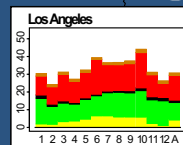
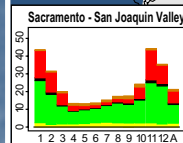
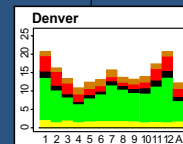
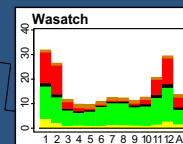
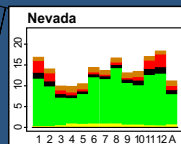
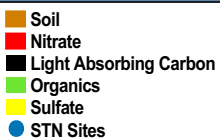
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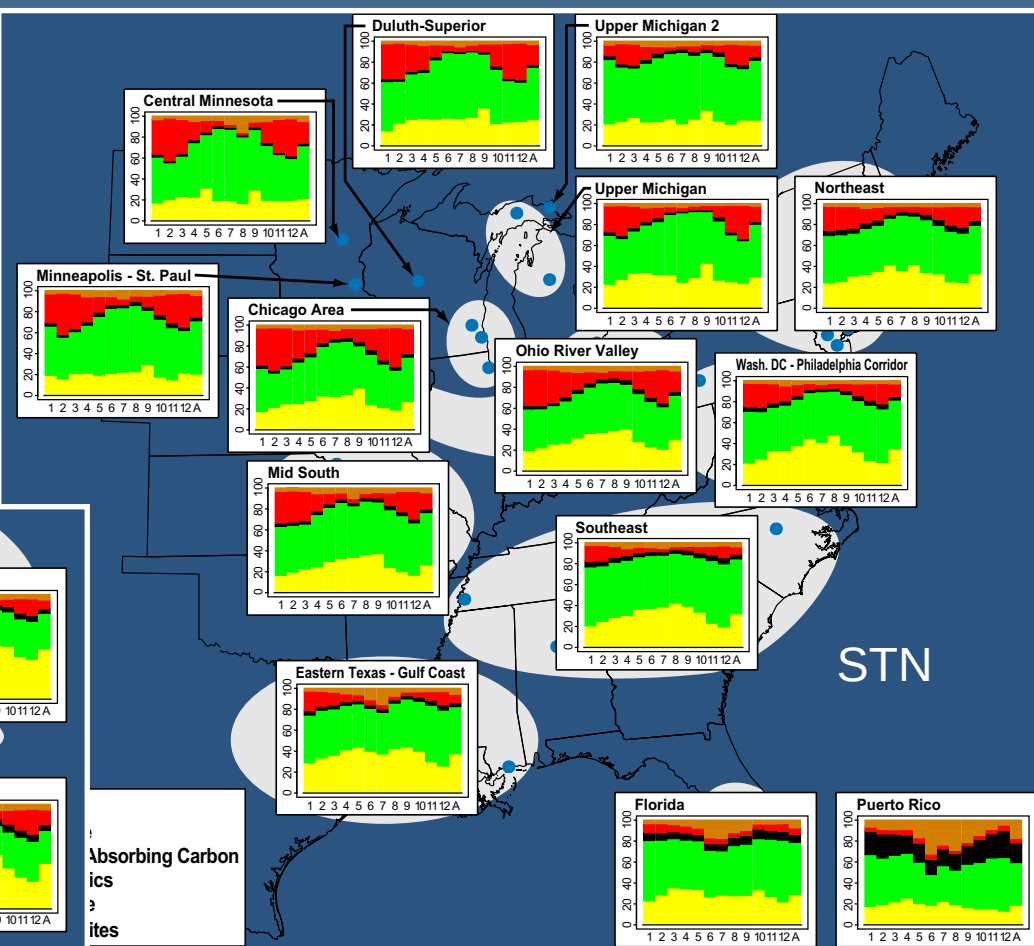
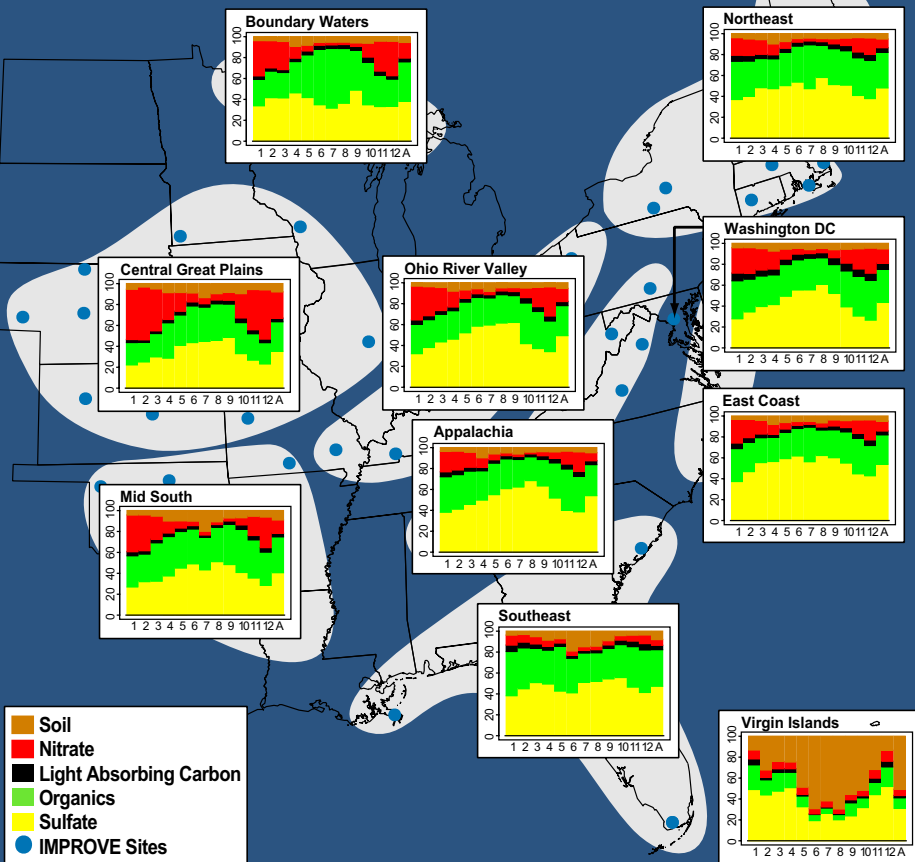
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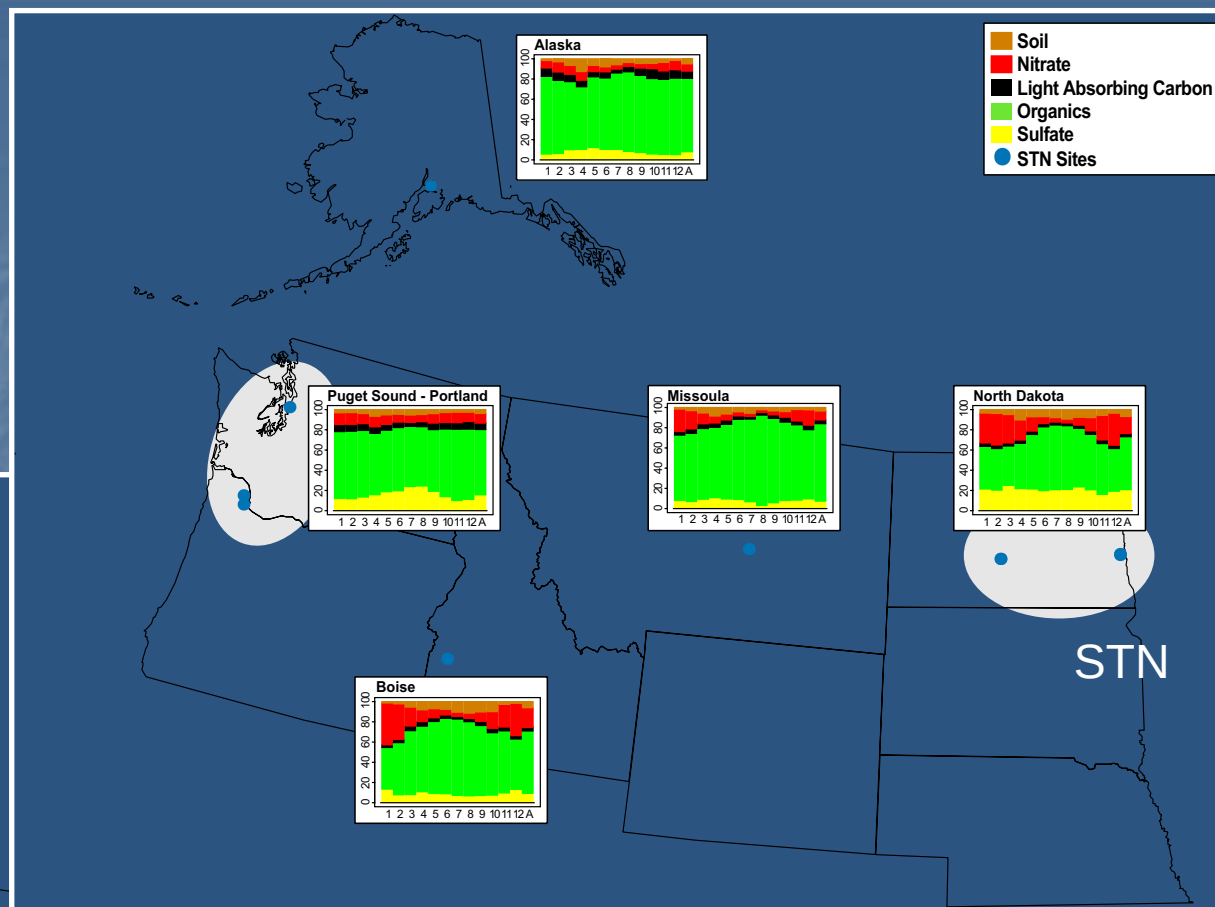
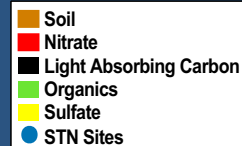
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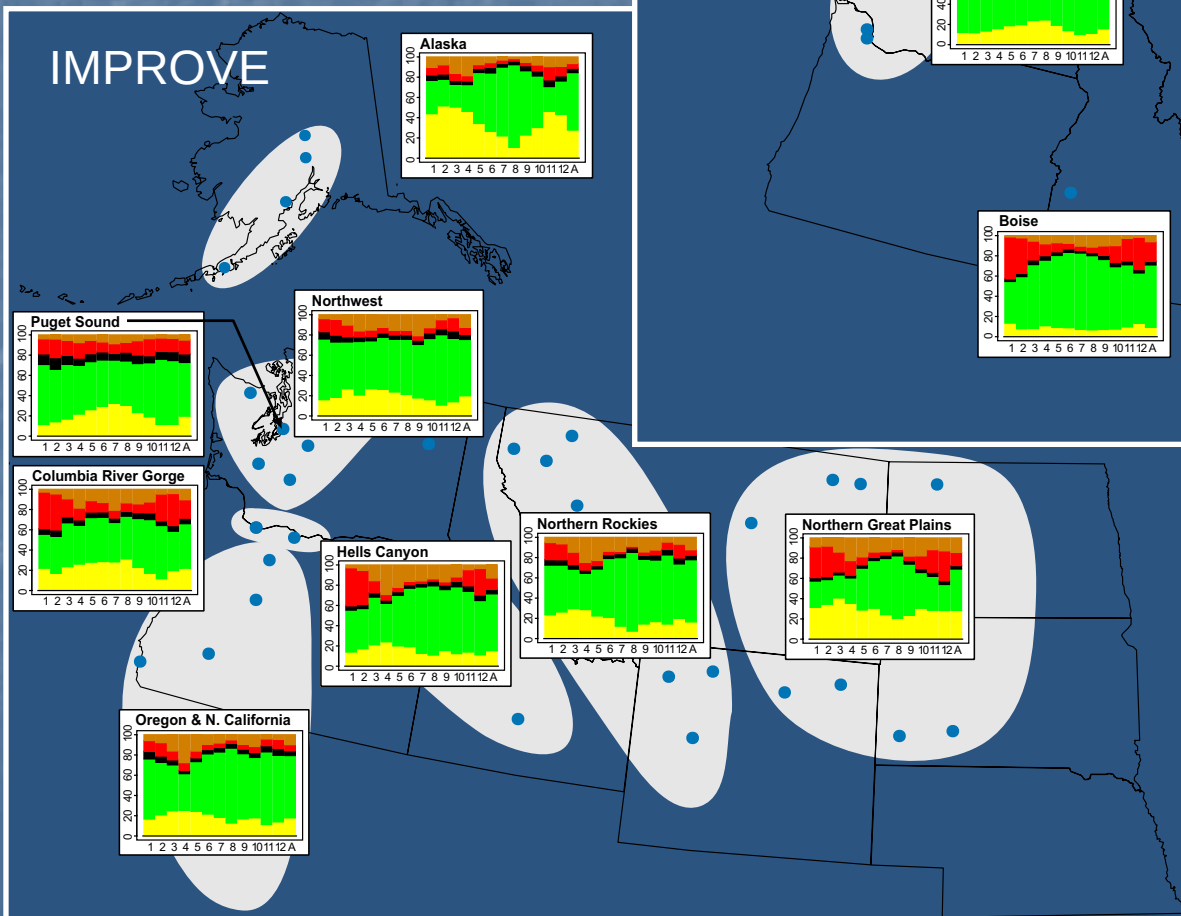
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