

Review of the Secondary Standards for Ecological
Effects of Oxides of Nitrogen, Oxides of Sulfur, and
Particulate Matter:
Risk and Exposure Assessment Planning Document

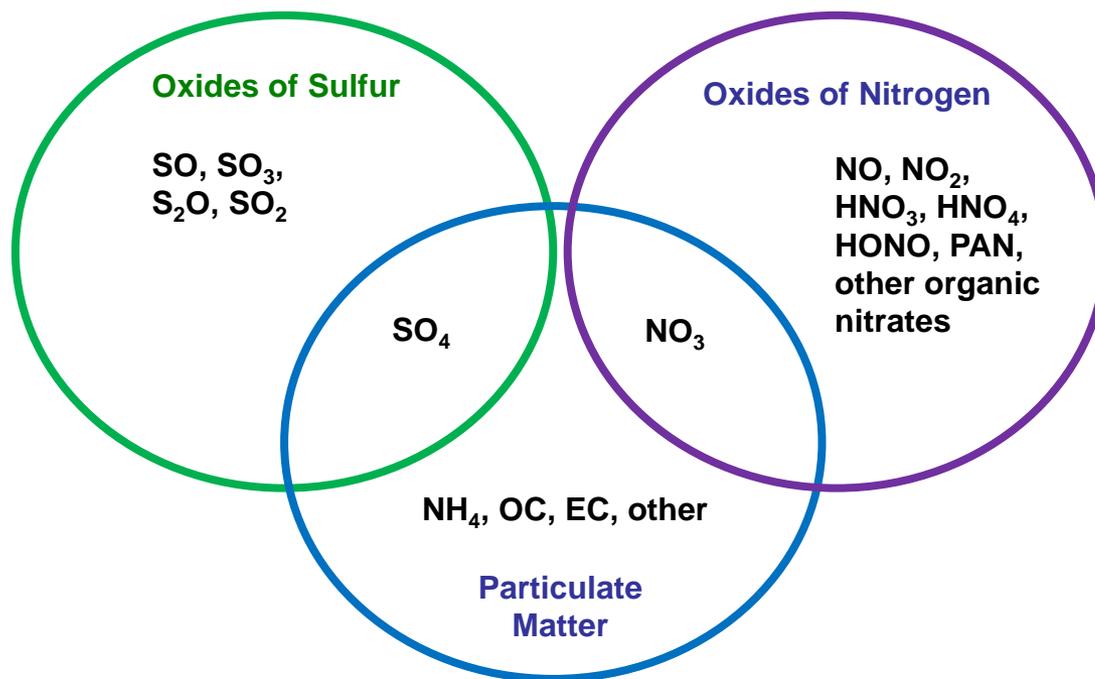
Staff from the
Office of Air Quality Planning and Standards
U.S. Environmental Protection Agency

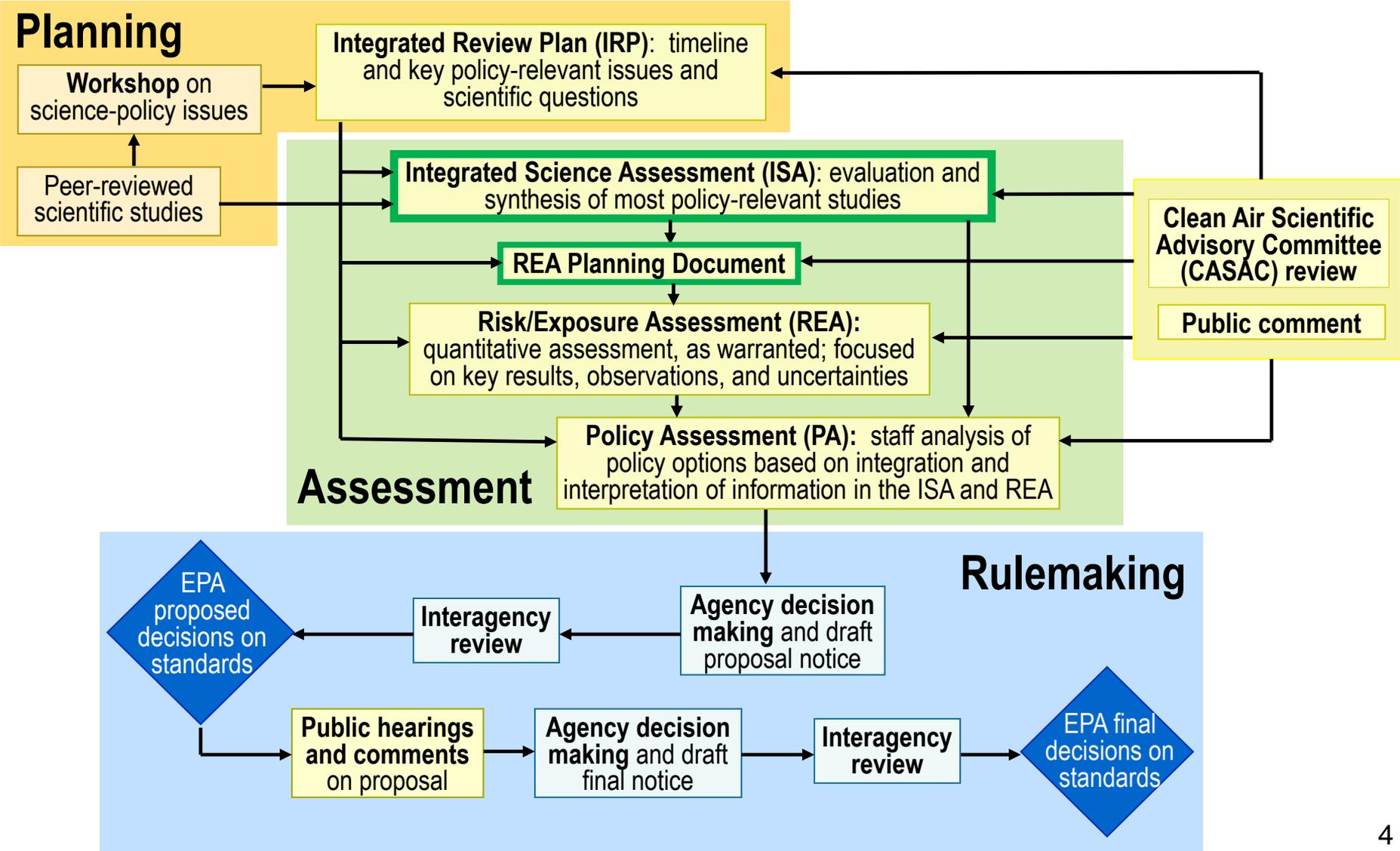
September 5-6, 2018
Clean Air Scientific Advisory Committee Meeting

Summary Information for the Current Review

- EPA is currently reviewing the secondary (welfare-based) NAAQS for oxides of nitrogen, oxides of sulfur and PM, focusing primarily on the contribution of these pollutants through atmospheric deposition to acidification and nutrient enrichment of both terrestrial and aquatic ecosystems
- Secondary standards are defined as standards which: “...specify a level of air quality the attainment and maintenance of which” in the “judgment of the Administrator” is “requisite to protect the public welfare from any known or anticipated adverse effects” (CAA section 109)
- This review recognizes that oxides of nitrogen and oxides of sulfur and PM contribute to ecological effects together, through atmospheric deposition of N and S. In recognition of these linkages, the reviews for these criteria pollutants are being conducted together
 - PM is included in this review given that ammonium (NH_4) contributes to N deposition; otherwise these ecological effects would have to be accounted for separately in the ongoing PM review
 - Additional welfare effects associated with PM, such as visibility impairment, climate effects and materials damage, and the health effects of PM are being considered as part of the current PM NAAQS review

Chemical Species Included In the Criteria Pollutant Categories

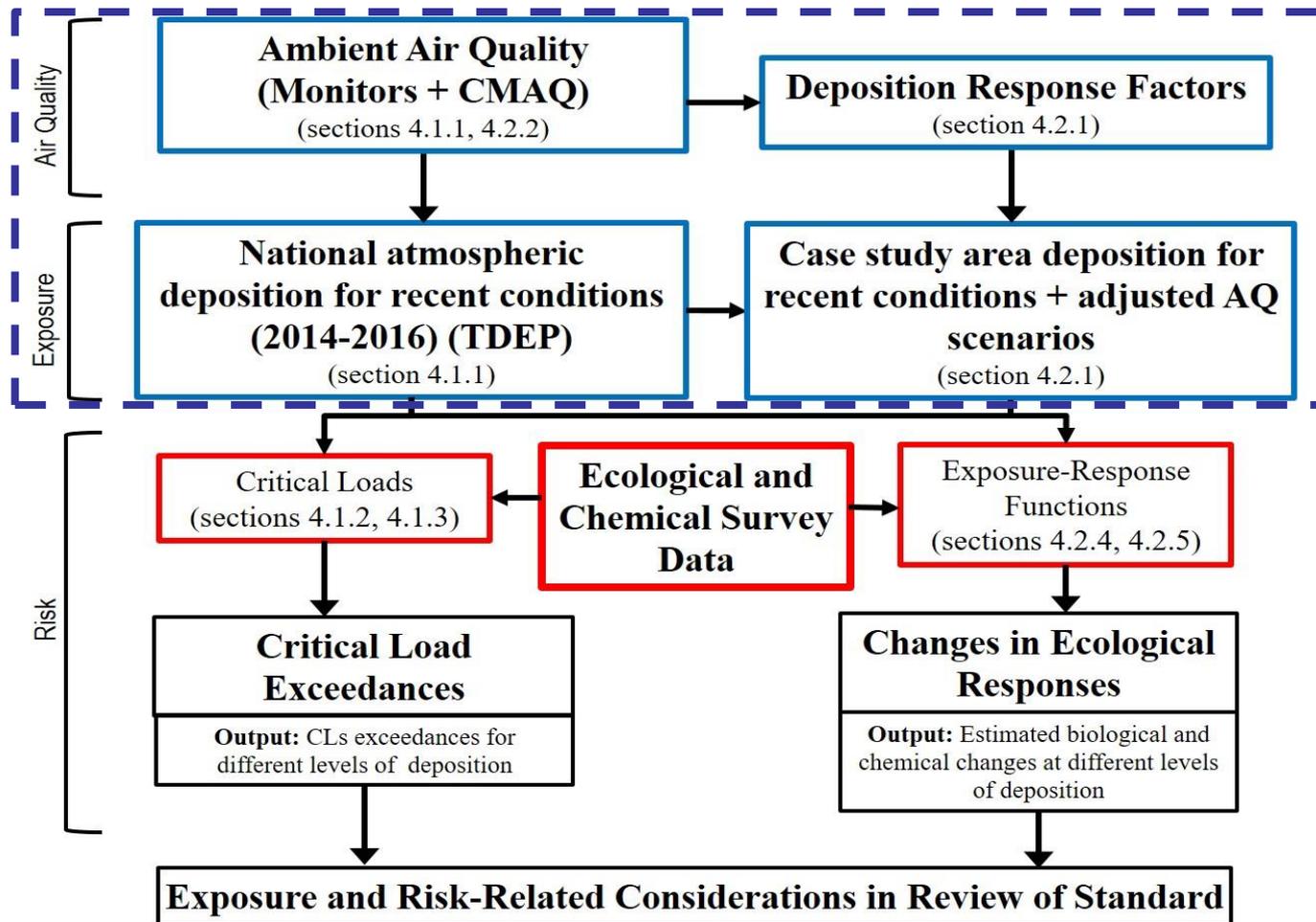




REA Planning Document Overview

- The REA Planning Document identifies limitations and uncertainties related to ecological risk and exposure as assessed in the previous NAAQS reviews (Ch 2) and the extent to which they may be addressed by currently available information, tools and methods (Ch 3)
- It concludes that there is support for new and updated assessments and proposes a quantitative plan for the REA for characterizing the nature, magnitude and uncertainties of risks and exposures for selected ecological endpoints under specified air quality conditions (Ch 4)
- Release of the draft REA and draft Policy Assessment for CASAC review is planned for late 2019

Overview of REA Planned for this Review

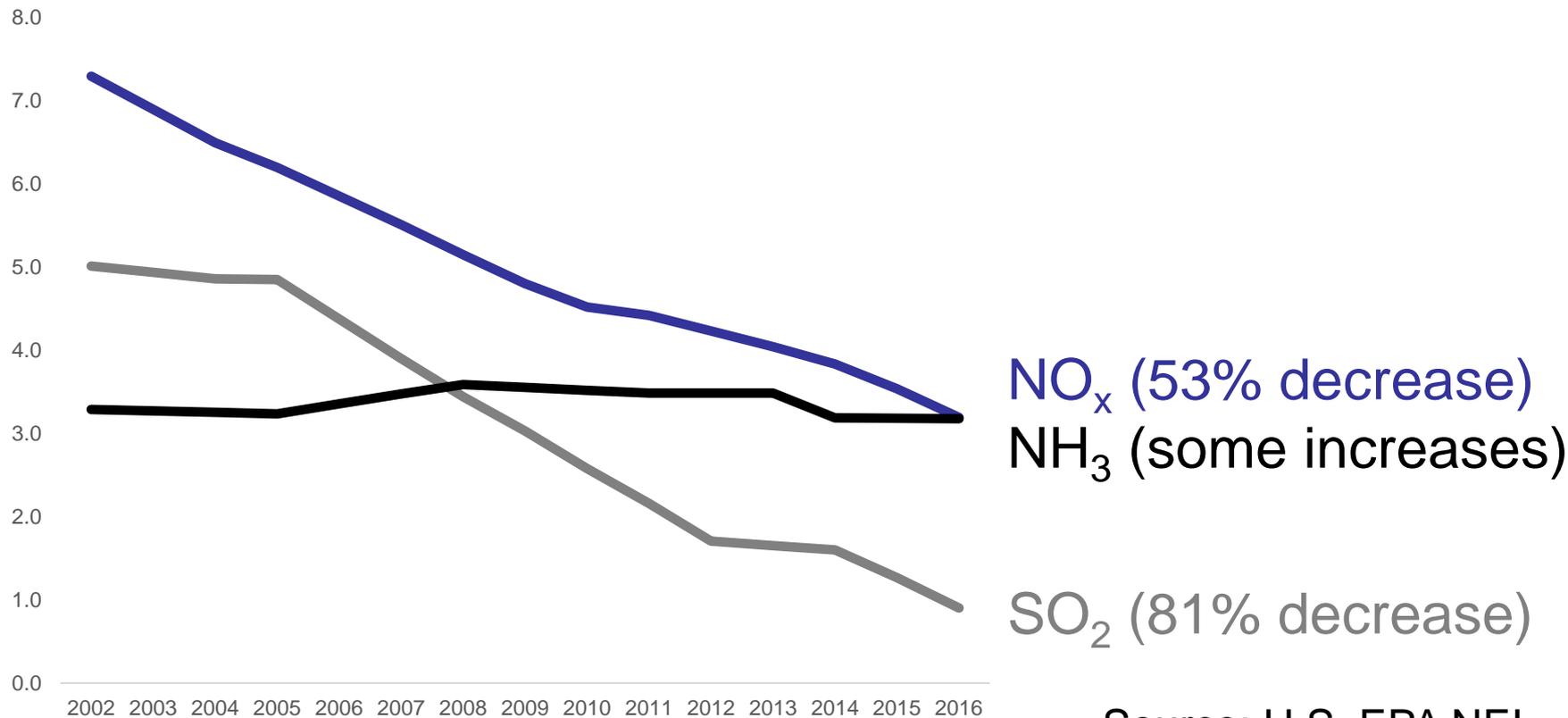


Air Concentrations and Deposition Overview

- National-scale analyses
 - Quantify recent levels (2014-2016) of N and S deposition (including contribution from N species) across the U.S.
- Case study area analyses
 - Focus on 5-10 case study areas (e.g. ~ 100x100 km in size)
 - Include air quality concentrations adjusted to reflect just meeting existing standards (e.g. NO₂, SO₂ and PM)
 - Statistically link change in concentration with change in N and S deposition
 - Utilize a similar approach to reflect conditions just meeting potential alternative standards, as appropriate
- Assessment of uncertainty and variability
 - Additional analyses proposed

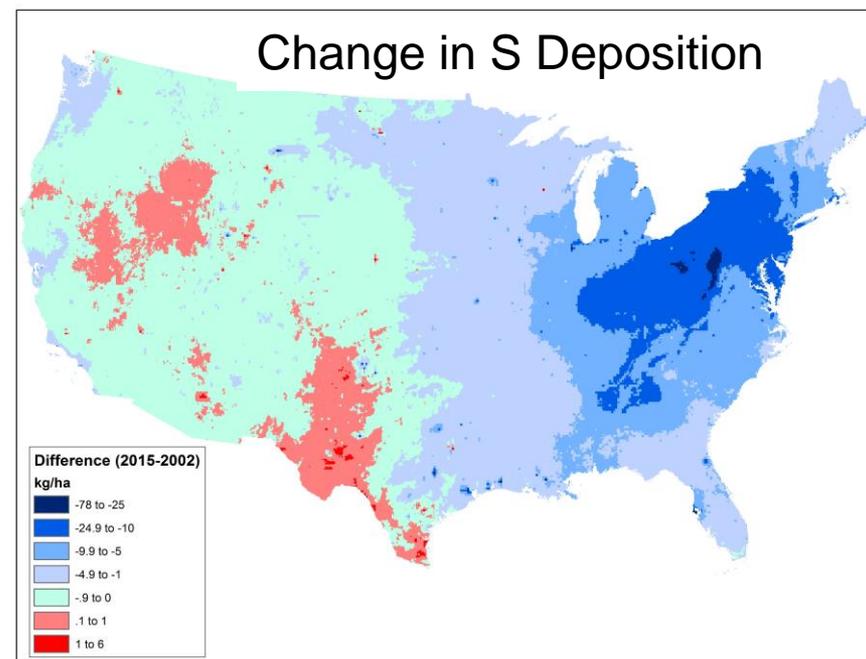
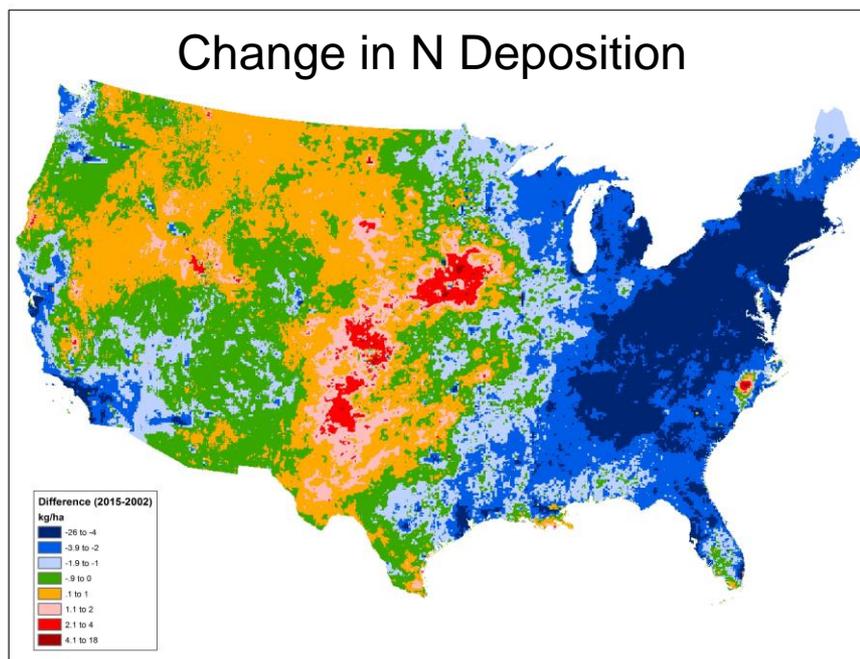
Emissions of N and S have greatly reduced since the last review (2002 – 2016)

US Total Emissions (MT S, N basis)



Source: U.S. EPA NEI

Deposition of Total N and S have declined in most places since the last review (2002 – 2015)



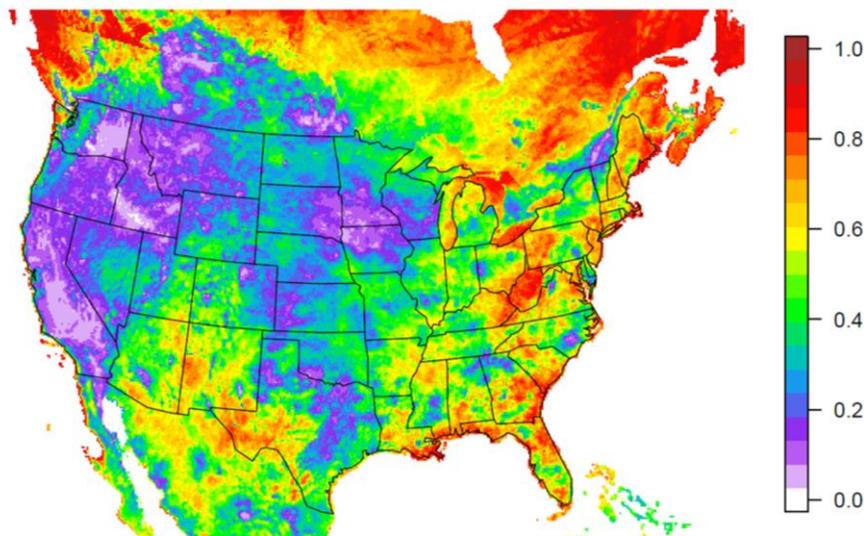
Source: TDEP approach described in Schwede and Lear (2014)

Plan for Quantitative Assessments

Air Quality: Assessment of recent conditions

- Create national-scale surface of current N and S deposition levels using a fused model and measurement approach (TDEP: Schwede and Lear, 2014)
- Model simulation will distinguish the contribution of air concentrations of NH_3 and NH_4^+ to wet and dry deposition
- Examine variability in dry deposition using several models/approaches

Fraction of reduced-form N deposition attributable to particle ammonium



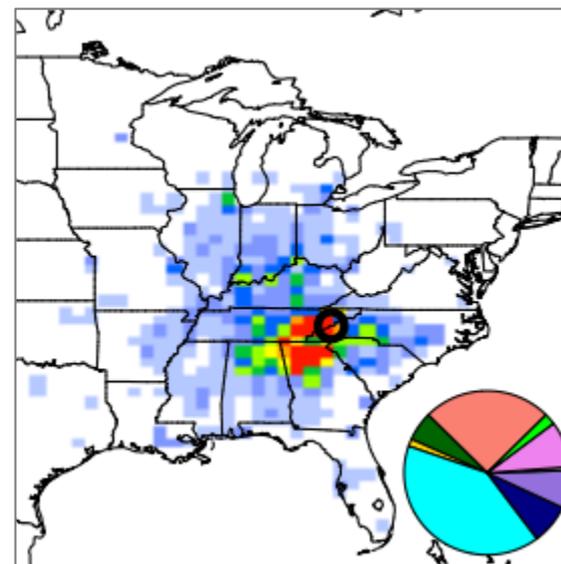
Source: CMAQ simulation from Napelenok *et al.* (2018)

Plan for Quantitative Assessments

Air Quality: Assessment of policy scenarios

- Several different approaches are being considered for adjusting air quality to reflect just meeting the current standards (and any potential alternative standards)
- Air quality considerations:
 - Spatial variability: SO_2 and NO_2 are highest near sources; $\text{PM}_{2.5}$ is more widespread
 - The area of influence for deposition is often > 1000 km
 - $\text{PM}_{2.5}$ includes soot, dust, organic carbon and other components that are not sulfur or nitrogen
- The approach may vary depending on the air quality conditions in each case study area

Average monthly footprint ($\text{kg N ha}^{-1} \text{ yr}^{-1}$) of N deposition in Great Smoky Mountain National Park



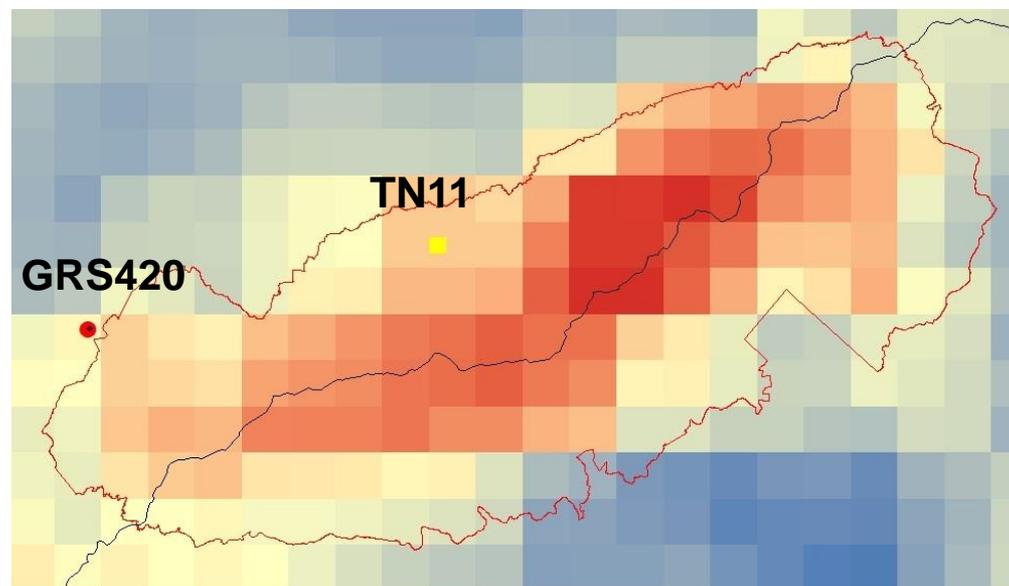
Source: Lee *et al.* (2016) Sources of N deposition in Federal Class I Areas in the U.S. *Atmos. Chem. & Physics*

Plan for Quantitative Assessments

Air Quality: Relating air concentration to deposition

- Propose to use a statistical approach to link a change in concentration with a change in N and S deposition
- Considerations:
 - Can we find a robust statistical relationship linking concentration and deposition?
 - How does that statistical relationship vary in space?

Sulfur deposition (2014 - 2016 TDEP) and location of monitors



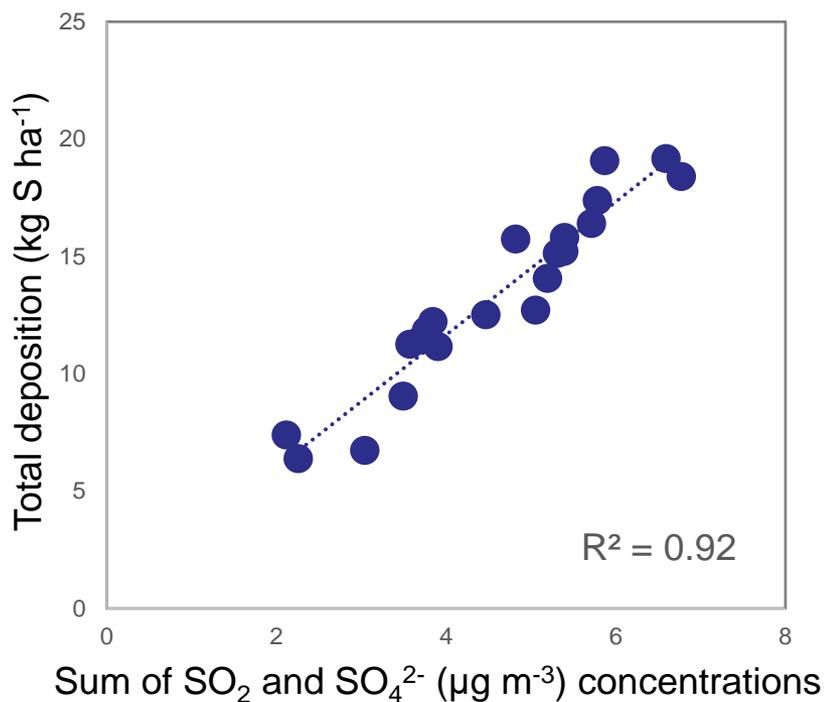
Example for Great Smoky Mountains National Park using data from CMAQ, NADP, and CASTNET

Plan for Quantitative Assessments

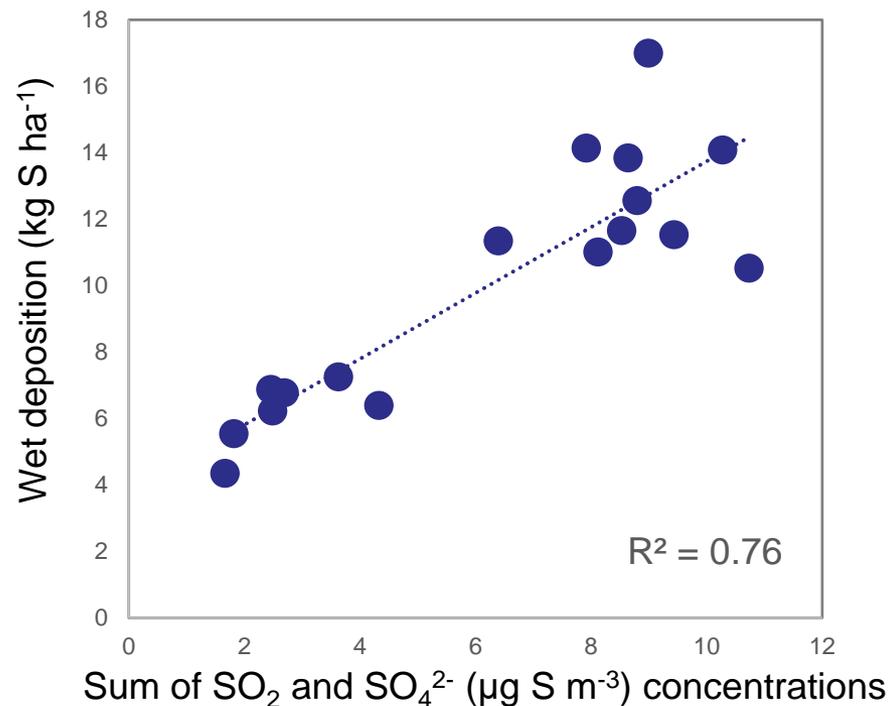
Air Quality: Estimating sulfur deposition

SO₂ and SO₄²⁻ air concentrations

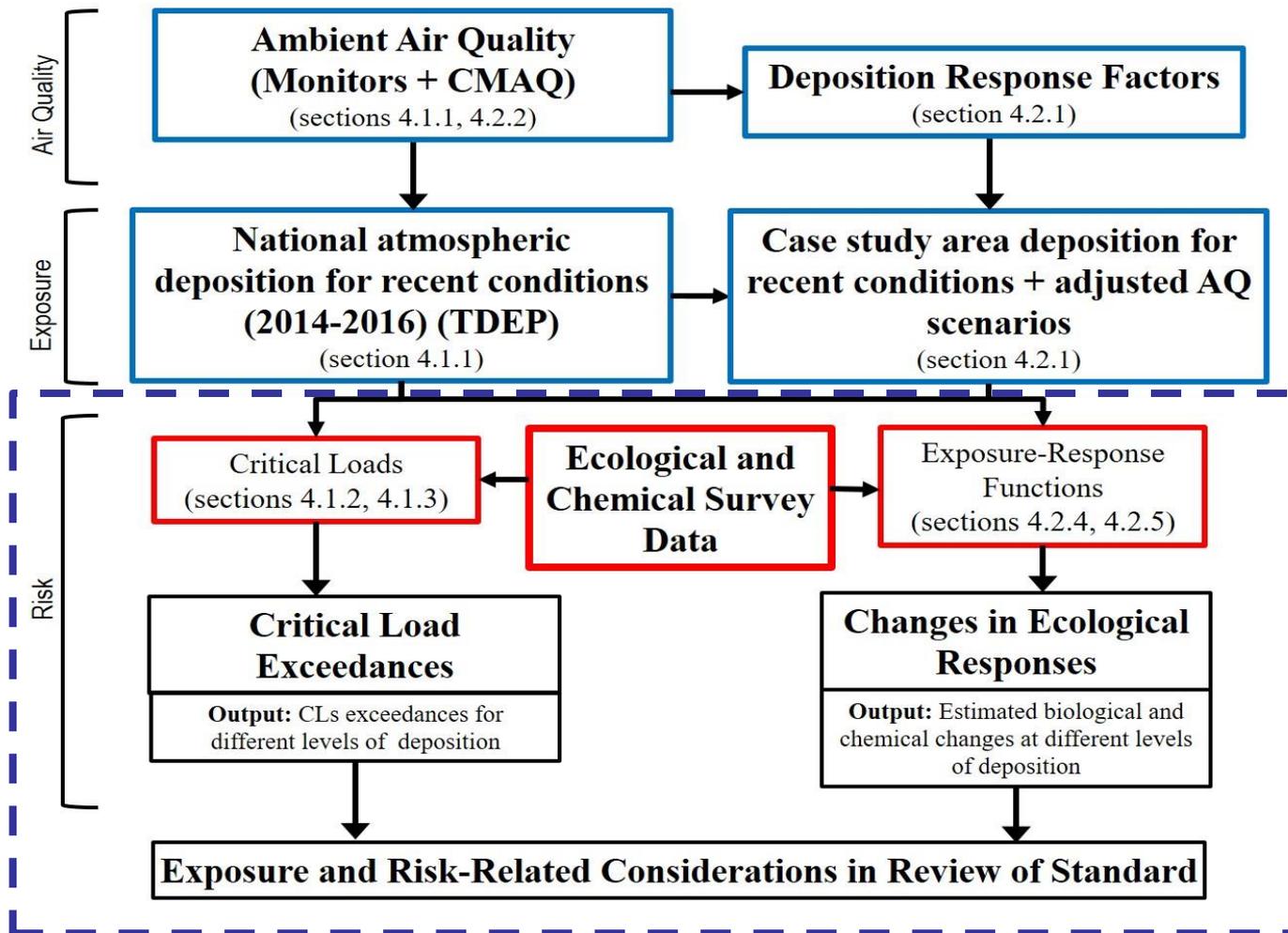
CMAQ Simulation (1990 – 2010)
Air concentrations and total deposition



CASTNET air concentrations
and NADP wet deposition



Overview of REA Planned for this Review



Ecological Effects Overview

- National-scale analyses (current conditions)
 - Characterize the magnitude of risks and exposures under current conditions
 - Critical Loads (CLs): soil acidification, aquatic acidification, herbs and shrubs, lichens, fungi, aquatic N enrichment, tree growth and mortality
 - Exposure-response functions: tree growth and mortality
- Case study area analyses
 - Characterize the magnitude of and changes in risks and exposures when air quality is just meeting the current standards (and any potential alternative standards, as appropriate)
- Assessment of uncertainty and variability
 - Additional analyses proposed, including assessment of representativeness

Plan for Quantitative Assessments

Ecological Effects: Terrestrial

- Forest Health (N & S)
 - Assess exceedances of soil acidification CLs (indicator for forest health)
 - Use base cation-aluminum ratio (Bc/Al) as a chemical indicator with critical levels based on forest type or individual tree species
- Effects on individual species
 - Assess tree growth and mortality using exposure-response functions
- Community composition and species richness (N & S)
 - Assess impacts on species richness for herbs/shrubs, lichens & mycorrhizal fungi
- Direct effects (e.g. foliar injury)
 - Will not be quantitatively evaluated in this review due to limited data

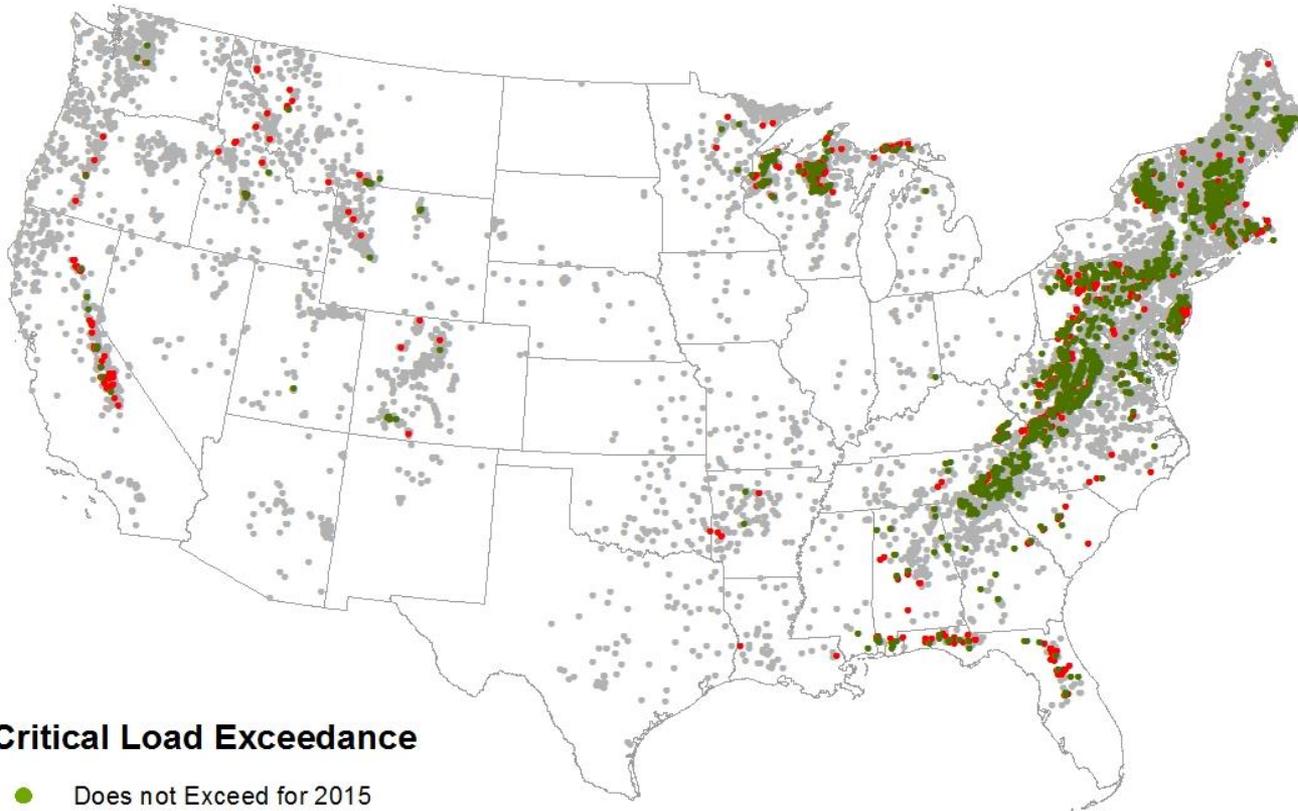
Plan for Quantitative Assessments

Ecological Effects: Aquatic

- Freshwater Acidification (N & S)
 - Assess exceedances of CLs and model impacts of changing deposition in case study areas
 - Use acid neutralizing capacity (ANC) as an indicator with critical levels based on fish health and species richness
- Freshwater Nitrogen Enrichment (N)
 - Need to further consider the extent of these analyses
 - Assess exceedances of CLs and use exposure-response information to estimate changes nitrate levels in case study areas
 - Relate water quality (nitrate levels) to ecological effects on biota
- Other categories will not be quantitatively evaluated in this review due to limited or no data and tools for analysis: wetlands N enrichment, coastal ocean acidification, sulfide toxicity, Hg methylation, estuarine N enrichment

Aquatic Acidification

Surface Water Critical Loads of Acidity (N+S): 2000 to 2015



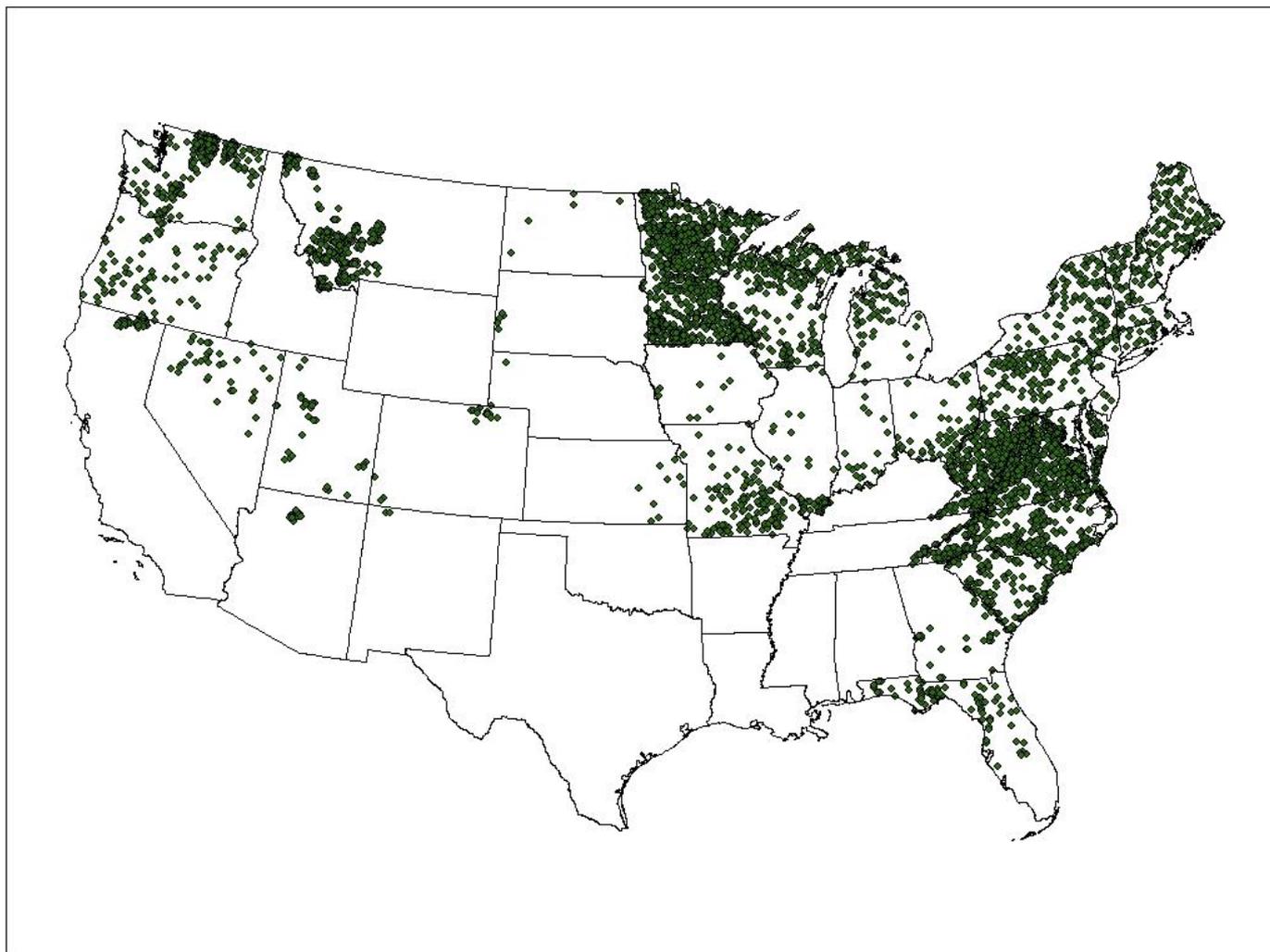
Critical Load Exceedance

- Does not Exceed for 2015
- Exceeds in 2015
- Does not Exceed since 2000

Based on CLs in the National Critical Loads Database (NCLD) version 3.0 (Lynch et al. 2017)

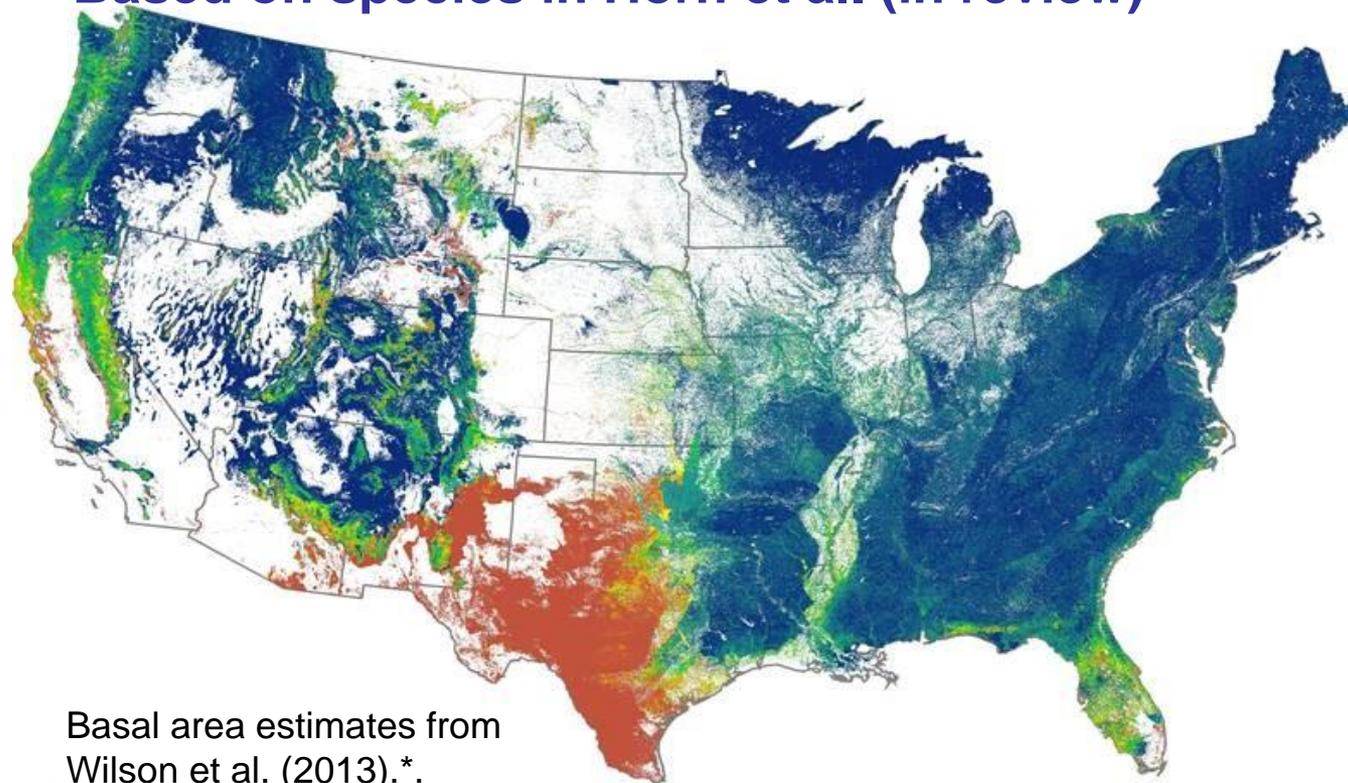
Herb and Shrub Species Richness

Geographic coverage of CLs from Simkin et al. 2016



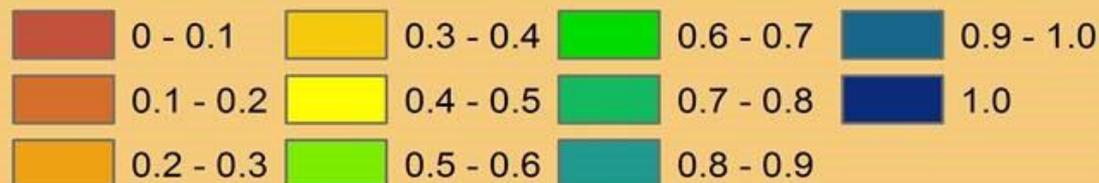
National Coverage of Tree Species

Based on species in Horn et al. (in review)



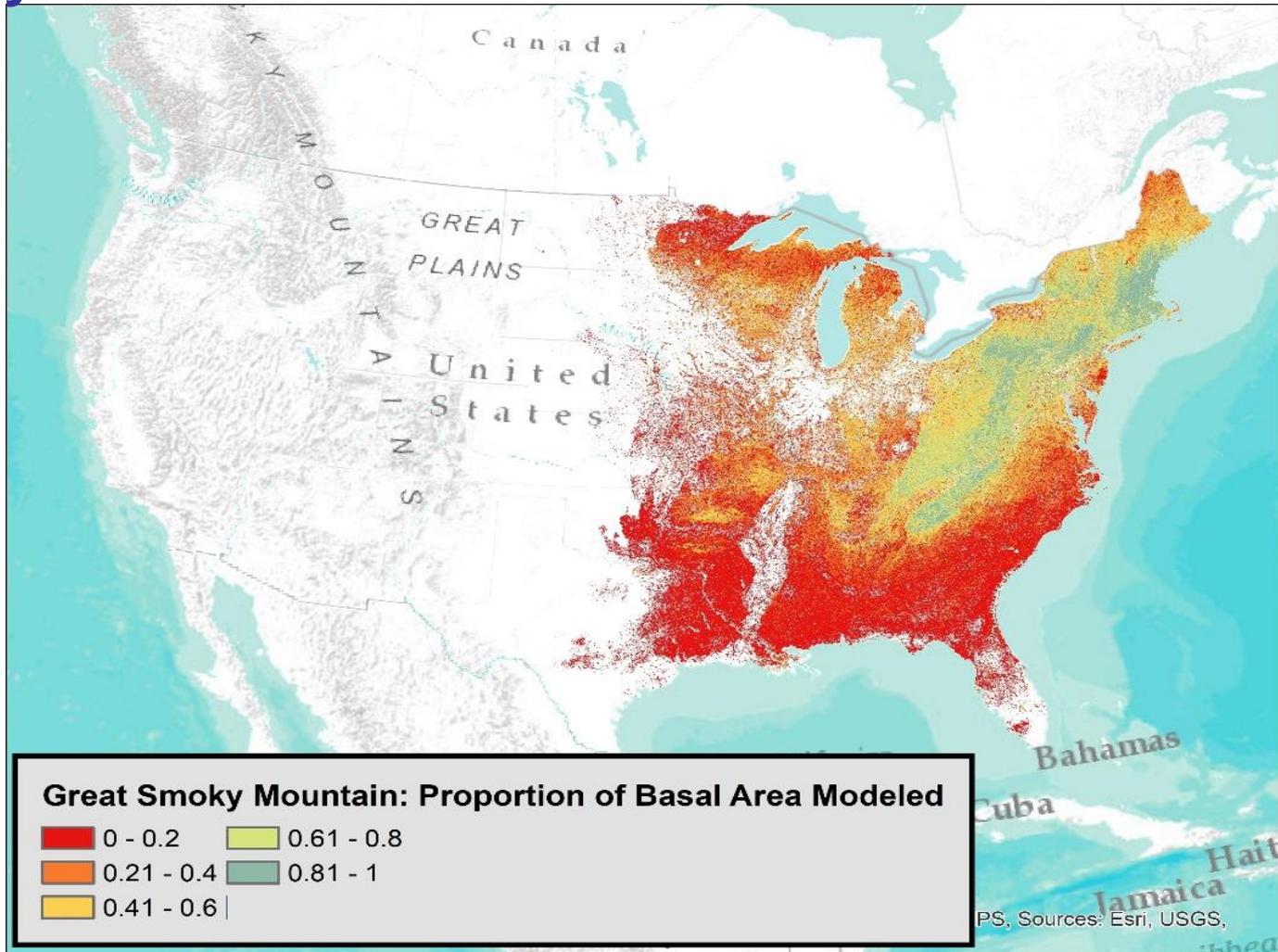
Basal area estimates from Wilson et al. (2013).*

Tree species coverage (as proportion of total basal area)



*Basal area estimates from the Forest Inventory Analysis (FIA) will also be assessed.

Representativeness of tree species occurring in Great Smoky Mountains NP that are included in Horn et al.



Basal area estimates from Wilson et al. (2013)

Questions?



Appendix

Pollutant	Primary / secondary	Averaging time	Level	Form
NO ₂	Primary	1 hour	100 ppb	98 th percentile of 1-hour daily maximum concentration, averaged over 3 years
	Primary & secondary	1 year	53 ppb	Annual mean
PM _{2.5}	Primary	1 year	12 µg m ⁻³	Annual mean, averaged over 3 years
	Secondary	1 year	15 µg m ⁻³	Annual mean, averaged over 3 years
	Primary & secondary	24 hours	35 µg m ⁻³	98 th percentile, averaged over 3 years
PM ₁₀	Primary & secondary	24 hours	150 µg m ⁻³	Not to be exceeded more than once per year on average over 3 years
SO ₂	Primary	1 hour	75 ppb	98 th percentile of 1-hour daily maximum concentration, averaged over 3 years
	Secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year ²⁴