National Ambient Air Quality Standards For Oxides of Nitrogen

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National Ambient Air Quality Standards

- Primary standards: set with an ample margin of safety to protect human health.
- Secondary standards: set to protect public welfare from known or anticipated adverse effects.
- Current 0.053 ppm NO_2 annual arithmetic average, mean of 1-hr concentrations

National Ambient Air Quality Standard Review

(1) Evaluate relevant science
    Integrated Science Assessment (ISA)

(2) Design and conduct relevant risk and exposure assessments
    Risk and Exposure Assessment (R/EA)

(3) Take a broad view of potential policy outcomes
    Advanced Notice of Proposed Rulemaking (ANPR)

Stage of Review	Major Milestone	NO_2 Primary	NO_2/SO_2 Secondary
Integrated Review Plan	Call for Information	Dec 2005	Dec 2005
	Workshop on science/policy issues	Feb 2007	July 2007
	Draft IRP - CASAC & Public Review	Apr-May 2007	Sep-Oct 2007
	Final Integrated Review Plan	Aug 2007	Dec 2007
Integrated Science Assessment (ISA)	1st draft ISA - CASAC & Public Review	Aug-Oct 2007	Dec-Apr 2007
	2nd draft ISA - CASAC & Public Review	Feb-May 2008	Aug-Oct 2008
	Final ISA	**Jul 11, 2008**	**Dec 12, 2008**
Risk/ Exposure Assessment (RA)	RA scope/methods plan - CASAC & Public Review	Sept-Oct 2007	Mar-Apr 2008
	1st draft RA - CASAC & Public Review	Mar-May 2008	Aug-Oct 2008
	2nd draft RA - CASAC & Public Review	Aug-Sep 2008	Mar-May 2009
	Final RA	Nov 2008	Jul 2009
Policy Assessment/ Rulemaking	Prepare ANPR - CASAC & Public Review	Dec 2008-Jan 2009	Aug-Oct 2009
	Proposed rulemaking	**May 28, 2009**	**Feb 12, 2010**
	Final rulemaking	**Dec 18, 2009**	**Oct 19, 2010**

* **Underlined** dates indicate court-ordered deadlines

Current Status of Primary NAAQS

- Integrated Science Assessment, Second Draft
  - Concludes that the existing evidence is sufficient to infer a “likely causal” relationship between respiratory effects and short-term exposures to NO_2 (based on evidence from the epidemiological, controlled human exposure, and animal toxicological literature)
- Risk and Exposure Assessment, First Draft
  - Human health risks associated with NO_2 are characterized by comparing exposure estimates to potential health benchmark values (0.20, 0.25, and 0.30 ppm) from the controlled human exposure literature
  - Characterizes human health risks associated with recent ambient levels of NO_2 and levels associated with just meeting the current annual NO_2 NAAQS
  - Subsequent drafts will also characterize risks associated with any potential alternative standards under consideration
- Rulemaking
  - Advance Notice of Proposed Rulemaking to be signed in December, 2008

Secondary NAAQS

- Separate review of secondary standards from reviews of primary standards
- Take multi-pollutant approach, linking NOx and SOx as well as considering both oxidized and reduced forms of nitrogen
- Focus on environmental effects related to deposition of sulfur and reactive nitrogen into sensitive terrestrial and aquatic ecosystems
- Avoid unnecessary overlap across different NAAQS reviews

Science Assessment

Integrated Science Assessment

- Introduction
- Atmospheric chemistry and physics
- Exposure
- Effects on the environment
- Key findings and conclusions

10 Annexes with more detailed summaries of evidence

- Atmospheric chemistry and physics
- Atmospheric monitoring, deposition, and exposures
- Ecological monitoring and models
- Ecosystem acidification
- Ecosystem N enrichment
- Ecological interactions between SO_X and Hg
- Critical loads
- Modifying effects of climate factors on ecosystem responses to NO_X and SO_X
- Materials and structures damage
- Valuation

The weblink to the first draft of the NOx and SOx ISA
http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=187663

Chemical Indicators of Acidic Deposition

CHEMICAL INDICATORS OF EFFECTS ON AQUATIC ECOSYSTEMS

Chemical Indicator	Potential Threshold	References
• Surface water pH	5.0-6.0	Baker et al., 1990
• Surface water ANC	0-50 µeq/L	Bulger et al., 1999
• Inorganic Al	2-4 µmol/L	Wigington Jr. et al., 1996 Driscoll et al., 2001; Baldigo et al., 2007

CHEMICAL INDICATORS OF EFFECTS ON TERRESTRIAL ECOSYSTEMS

Chemical Indicator	Potential Threshold	References
• Soil base saturation	10-20%	Lawrence et al., 2006; Driscoll et al., 2001; Cronan et al., 1990
• Soil solution Ca:Al ratio	1.0	Cronan and Grigal, 1995
• Soil C:N ratio	20-25	Aber et al., 2003

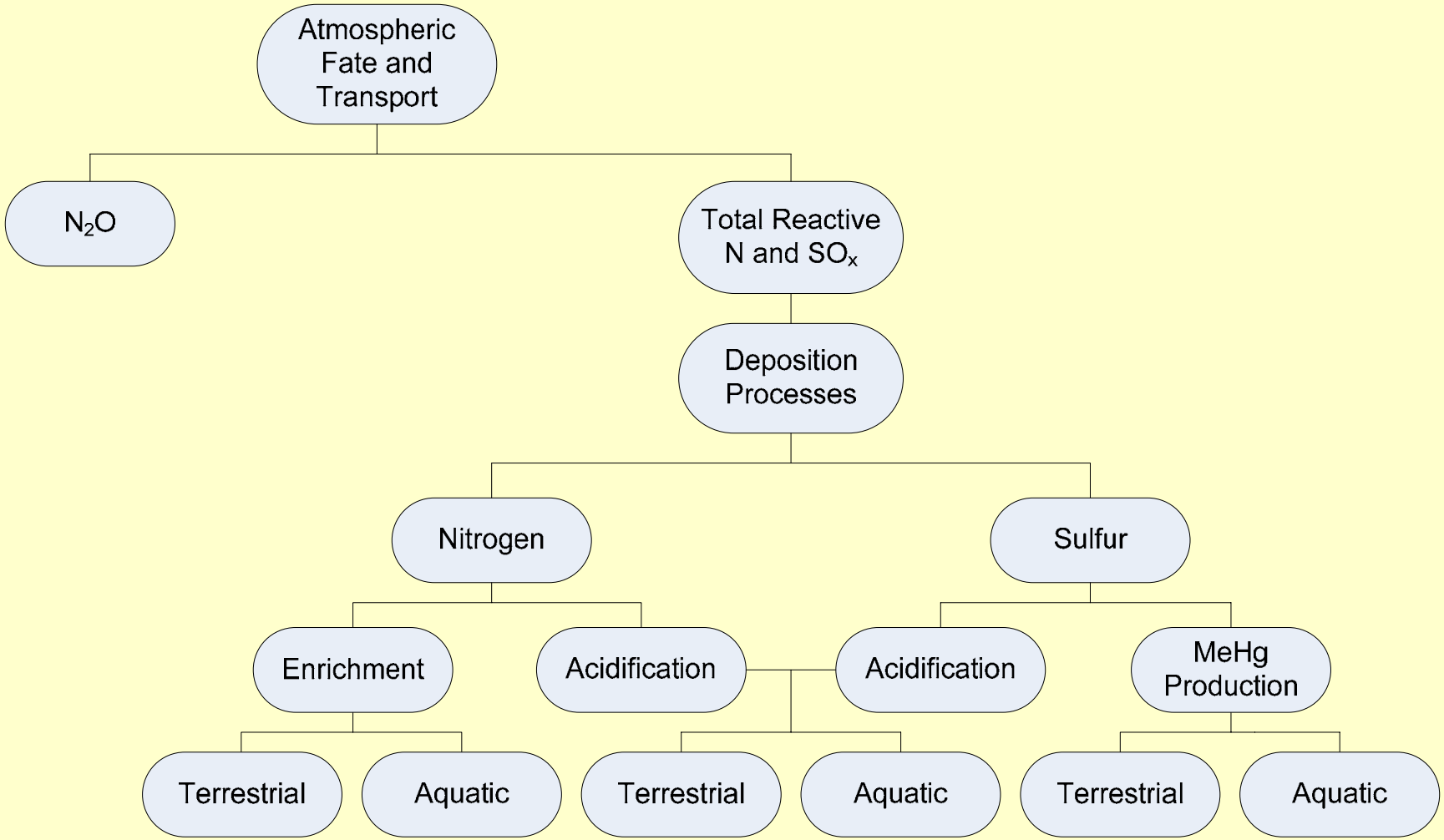
Nitrogen Nutrient Enrichment: Terrestrial, Wetland and Freshwater Aquatic

(kg N ha^{-1} yr^{-1})	
~1.5	Altered **diatom** communities in high elevation freshwater lakes Elevated **N in tree leaf tissue** high elevation forests (Colorado; Baron, 2000; Baron, 2006; Saros et al., 2003)
3 to 8	Mortality of sensitive **lichen** species (Pacific NW; Geiser and Neitlich, 2007)
5 to 35	**Species richness** declines as a linear function of the rate of inorganic nitrogen deposition, with a reduction of one species per 4 m^2 quadrant for every 2.5 kg N yr^{-1} deposition (U.K.; Stevens et al., 2004)
<6.3 to 10	Onset of **nitrate leaching in many U.S. forests** (Aber et al., 2003)
<10 to 15	**Altered community composition** in native grasslands (California; Fenn et al., 2003; Weiss, 1999)

Risk Exposure and Assessment Approach

- Identify Key Effects and Ecosystem Services
- Identify Sensitive Areas and Select Study Areas
- Evaluate Effects Under Current and Alternative Loading Scenarios
- Evaluate the Ambient Concentration to Deposition Relationship

Targeted Effects



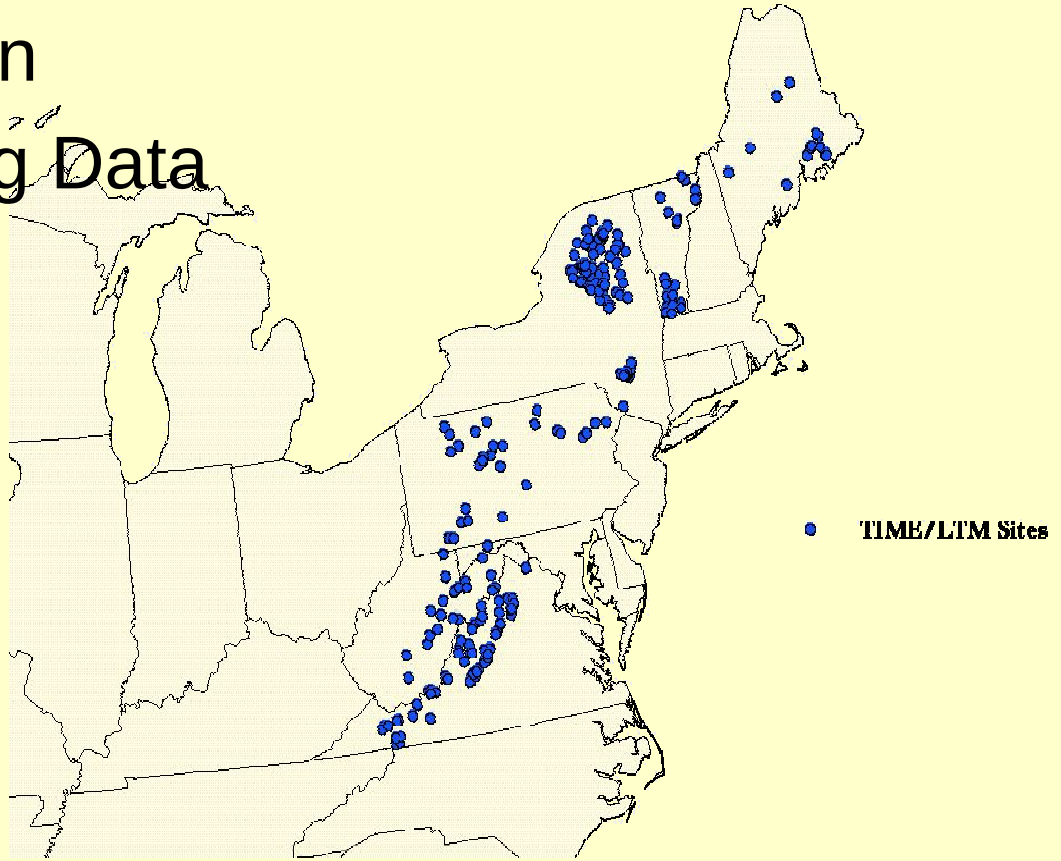
Aquatic Acidification

Examine ANC results and relationship to fish health

CMAQ deposition

NADP Monitoring Data

MAGIC model



Terrestrial Acidification

- Documented effects of acidification on red spruce and sugar maple
- Use the Simple Mass Balance model to examine changes in soil base saturation chemistry
  - If possible, correlate to tree health

Aquatic Nitrogen Enrichment

- East and Gulf Coast estuaries show significant effects, however are difficult to model
- NOAA eutrophication indices
- Model main stem river of one or more estuaries
- Also considering using DayCent-Chem model on some alpine lakes in the West

Terrestrial Nitrogen Enrichment

- Several studies document changes due to enhanced Nitrogen deposition
- Effects are varied; empirical data
  - Array results using GIS to examine commonalities

Alternative Levels of Protection

- Synthesis of impacts:
  - Ecosystem responses, biological indicators, and ecosystem effects related to deposition loadings
- Translation:
  - Map loadings back to their corresponding ambient air conditions
  - Define an ambient-based index at current conditions & compare with scenario-based alternative levels
- Evaluate different loadings scenarios (relating to alternative levels of ecosystem protection) & forms of the standard

Alternative Levels of Protection

- Heterogeneity
  - Ecosystem sensitivity
  - Atmospheric composition of N & S deposition (alone or combined)
  - Considering acidification, eutrophication, or both
- Form
  - Adequate protection of sensitive ecosystems?
  - Possibilities for flexibility for ecosystems with more resilience?
  - Factor in reduced forms of N?
  - Adjust for meteorology?