NARSTO Multi-Pollutant Accountability Assessment

Integrated System Modeling Discussion
Getting to Exposure

Authors' Meeting

January 9th & 10th, 2007
Sheraton, RTP NC

Integrated Systems Modeling: Human Health

- Ozone
  - Relatively mature science
  - Working on linkages to exposure models
  - Issues
    - Do models replicate change; right production for right reason?
    - Uncertainty in NOx emissions from mobile (on-road & off-road) sources
    - Grid size (12km) still fairly large

- PM2.5
  - Maturing science
  - Inorganics in relatively good shape
  - Issues
    - Uncertainty in total-nitrate predictions (biases), especially in winter
    - Primary organics and secondary organics not well simulated; science still evolving (but first applications involve mostly inorganics)
    - Ultra-fine particle production not well characterized or simulated
    - Uncertainty in primary emissions, even carbon

Integrated Systems Modeling: Human Health (cont.)

- HAPS
  - Simple chemistry components relatively mature
  - Are working on subgrid modeling for spatial detail
  - Issues
    - Emissions very weak (1999 poor; expect 2002 to be better and be more consistent with criteria inventory)
    - Chemistry of POPs still needs work
    - Many primary HAP sites located near point sources – problem for grid model @ 12kms (representativeness)
    - Air-surface exchange of POPs currently not considered.
    - Not all HAPS modeled at this time; are we missing key ones?

- Multi-Pollutant Interactions
  - Most major interactions captured in the chemistry and process descriptions of the models
    - NOx and SOx and VOC interactions connecting O3 and PM2.5 components are in
    - Still some uncertainties in indirect effects of precursors and products
  - Some experience with development of reduced-form models from full model

Integrated Systems Modeling: Ecosystem: Aquatic

- General
  - Models need Mosaic land-use approach to connect to ecosystem models
  - Models have some advantage over current monitoring for N deposition

- Acidification
  - Mature science for acidic deposition
  - Sulfur budget reasonably well represented
  - Weakness
    - Base cations not predicted; base cation emissions highly uncertain

- Eutrophication (nitrogen)
  - Relatively mature science
  - Nitrogen budget has some uncertainties
  - Issues
    - Uncertainty in total-nitrate production, especially in winter, but this may not affect ox-N deposition very much.
    - Uncertainty in NH_3 emissions; uncertainty in growth in NH_3 emissions
    - Uncertainty in NH_3 air-surface exchange (bi-directionality/compensation point)

Integrated Systems Modeling: Ecosystem: Aquatic (cont.)

- Hg Bioaccumulation
  - Maturing Science
  - Issues
    - Immature science in chemical transformations in models (GEM ox'n; RGM red'n)
    - Models are missing coupled, bi-directional air-surface exchange of mercury
    - Models are missing coastal chemistry enhancements (e.g., halogen chemistry)
    - Models are missing fog deposition
    - Uncertainty in hemispheric boundary conditions

- HAPS (e.g., pesticides)
  - Immature Science
  - Issues
    - Models missing coupled, bi-directional air-surface exchange

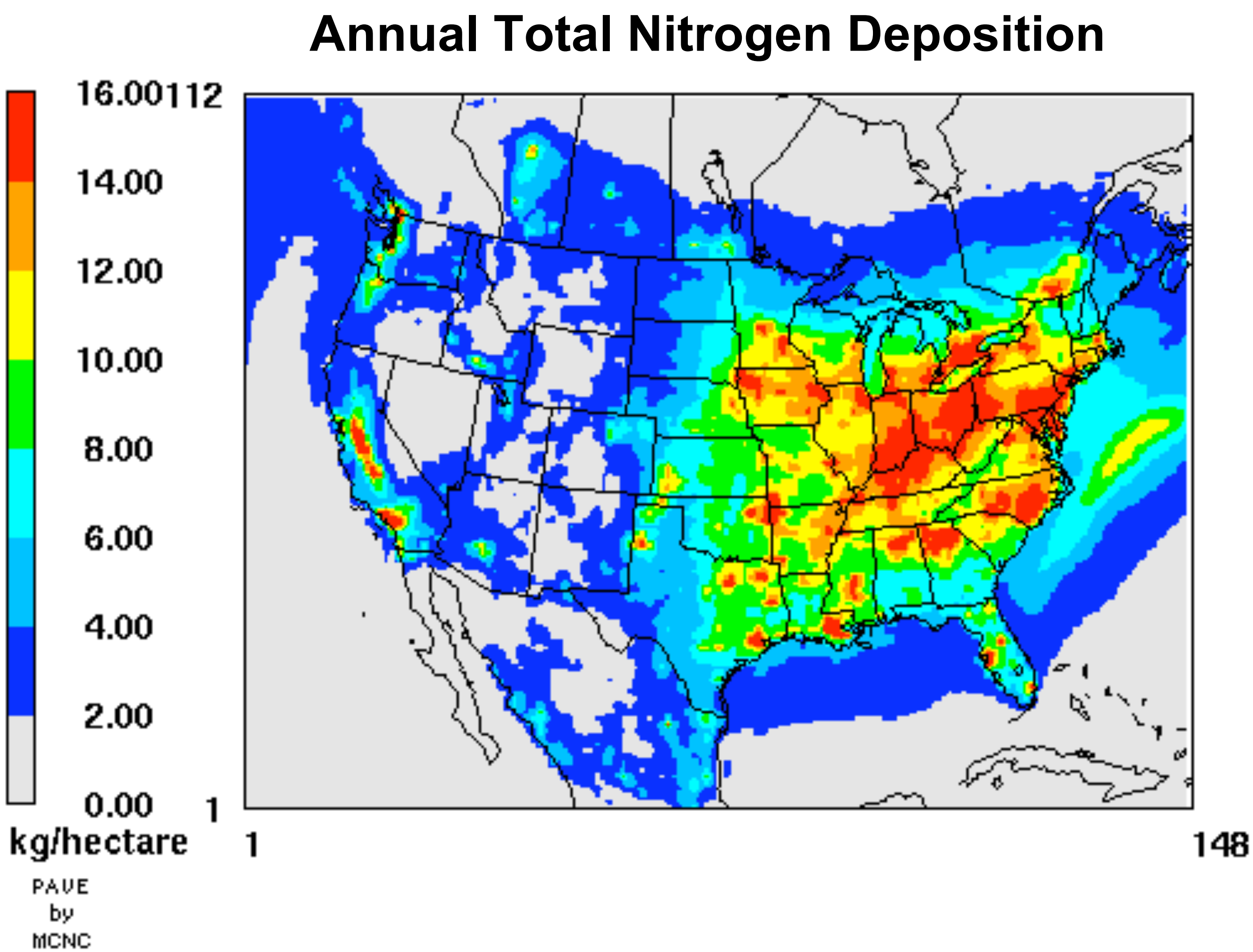
- Multi-Pollutant Interactions
  - Relatively mature for inorganic interactions regarding deposition
    - Acidification and eutrophication (N) deposition
  - Issues
    - Links between sulfur, nitrogen and mercury require ecosystem model interfaces

Integrated Systems Modeling: Ecosystem: Terrestrial

- General
  - Models need Mosaic land-use approach to connect to ecosystem models
- Ozone
  - Mature science
  - Issues
    - Low exposures are biased high
    - Is it exposure or deposition that we need?
- Nitrogen
  - Relatively mature science
  - Issues
    - Missing cloud deposition. Is this crucial?
- Acidity
  - Issues
    - Missing cation balance. Is this crucial?

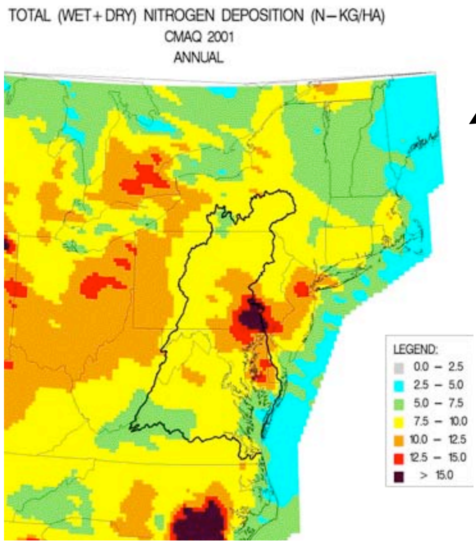
Now Continental and Coastal Ocean Coverage

Including the Gulf Coast

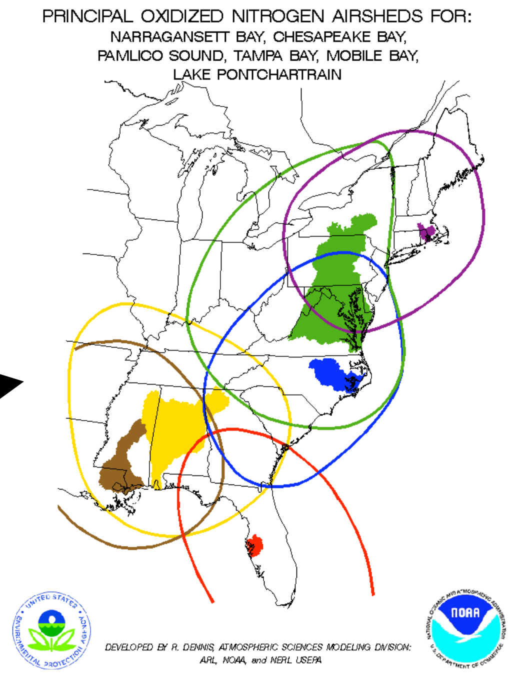


Chesapeake Bay Program: What we have learned

Unique Capabilities of Atmospheric Models

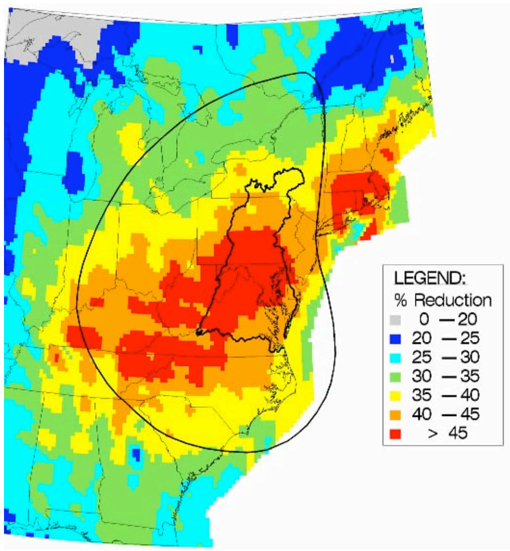


Fill in for space (sparse monitoring)
Fill in for dry deposition (avoid guessing)



Assess relevant scales (airsheds); sector responsibility

NOx SIP Reg +
Tier II Mobile +
Heavy Duty Diesel Regs
2020
ox-N Dep % Change from 1990



Estimate contribution of CAA regulations (aimed at protecting health) toward ecosystem health

NITROGEN DEPOSITION TO THE CHESAPEAKE BAY (LAND + WATER)

CMAQ 36km - J4f and J4g

NO BIAS ADJUSTMENTS

ANNUAL		Base	Sensitivity	
		J4f	J4g	
MAIN	SPECIES	(lbs)	(lbs)	
1) DRYOX_N	DRYNO2_N	31,967,088	34,243,019	(7.1%)
	DRYNO_N	9,273,265	9,597,669	(3.5%)
	DRYN2O5_N	8,671,448	16,414,557	(89.3%)
	DRYHNO3_N	121,266,418	99,518,580	(-17.9%)
	DRYHONO_N	262,290	271,378	(3.5%)
	DRYNO3T_N	3,577,350	2,652,012	(-25.9%)
	DRYORGNO3T_N	3,627,020	3,713,229	(2.4%)
	DRYPANT_N	11,920,777	12,189,141	(2.3%)
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1) DRYOX_N		190,565,657	178,599,585	(-6.3%)
2) WETOX_N	WETN2O5_N	6,803	11,798	
	WETNO3T_N	108,311,822	105,550,661	
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2) WETOX_N		108,318,625	105,562,458	(-2.5%)
3) TOTALOX_N	TOTALOX_N	298,884,282	284,162,044	(-4.9%)

NITROGEN DEPOSITION TO THE CHESAPEAKE BAY (LAND + WATER)

CMAQ 36km - J4f and J4fs

NO BIAS ADJUSTMENTS

	ANNUAL	Base J4f (lbs)	Sensitivity J4fs (lbs)	
MAIN	SPECIES			
1) DRYOX_N	DRYNO2_N	31,967,088	31,995,216	(0.1%)
	DRYHNO3_N	121,266,418	115,857,579	(-4.5%)
	DRYNO3T_N	3,577,350	4,382,215	(22.5%)
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1) DRYOX_N		190,565,657	186,050,956	(-2.4%)
2) WETOX_N		108,318,625	109,603,205	(1.2%)
3) TOTALOX_N	TOTALOX_N	298,884,282	295,654,161	(-1.1%)
4) DRYRED_N	DRYNH3_N	76,448,294	47,658,106	(-37.7%)
	DRYNH4T_N	16,539,245	18,793,707	(13.6%)
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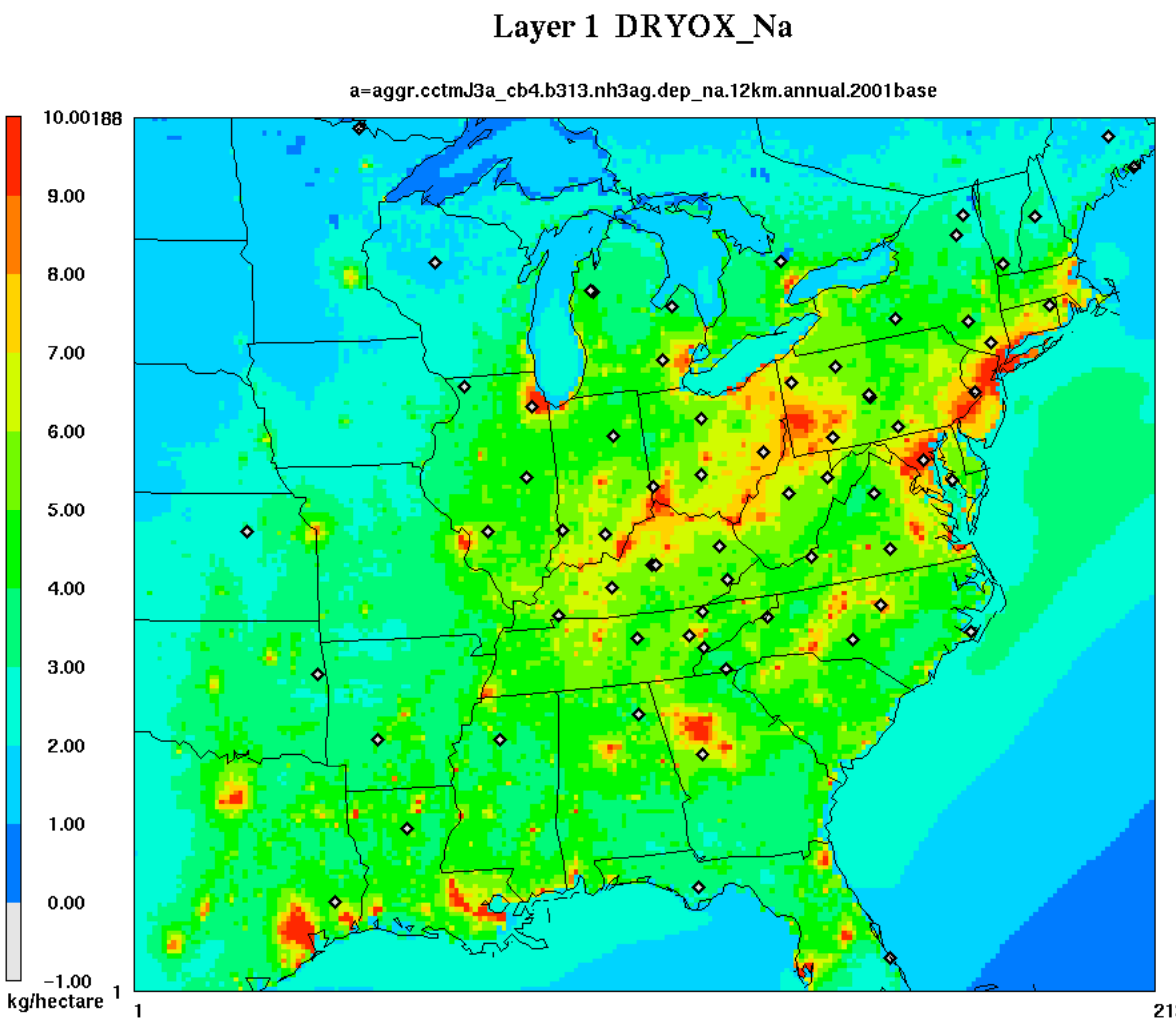
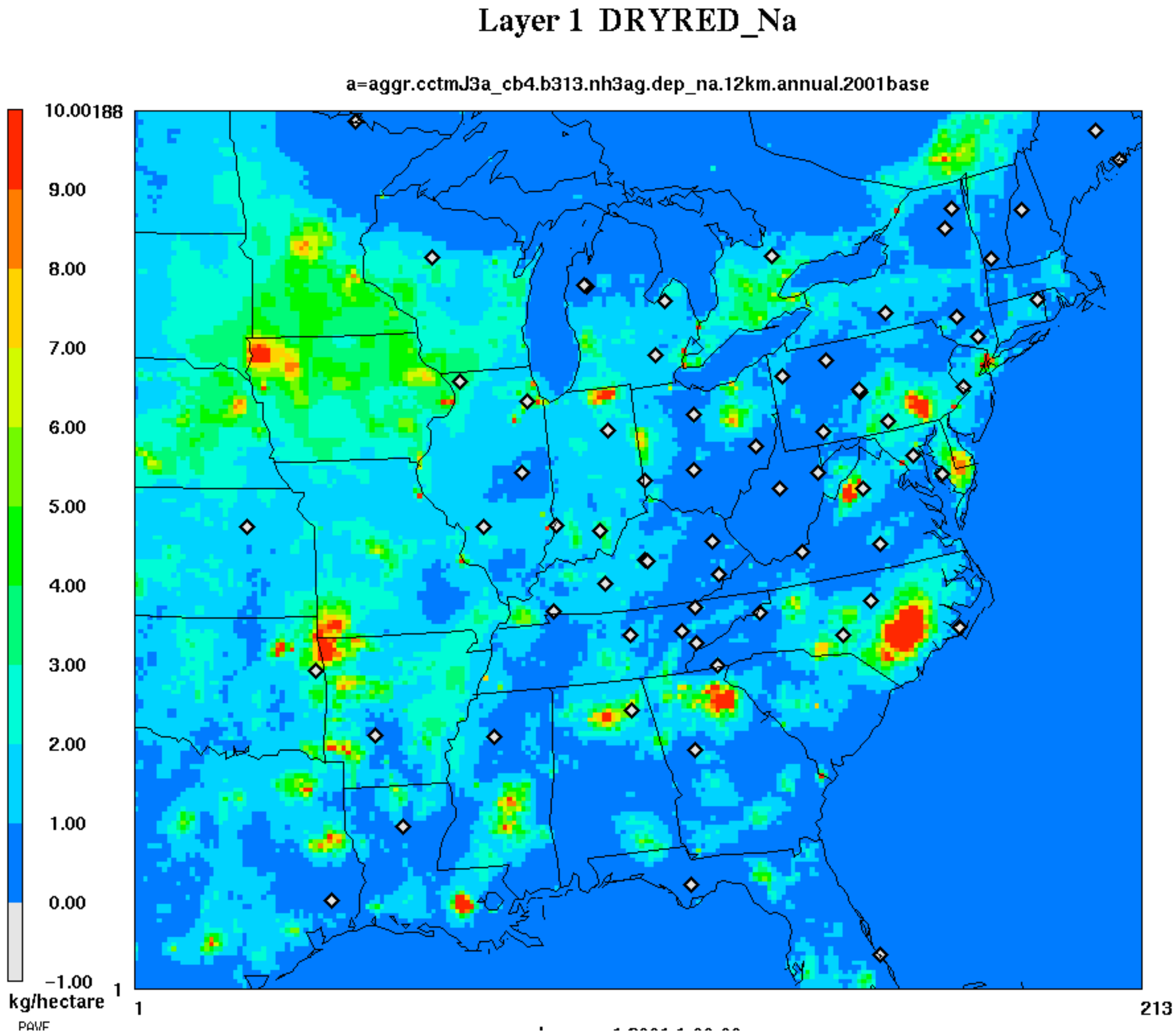
4) DRYRED_N		92,987,539	66,451,812	(-28.5%)
5) WETRED_N	WETNH4T_N	101,750,572	113,825,595	(11.9%)
6) TOTALRED_N	TOTALRED_N	194,738,111	180,277,407	(-7.4%)



Monitoring Has Incomplete Species Set For Ox-N Dry Deposition

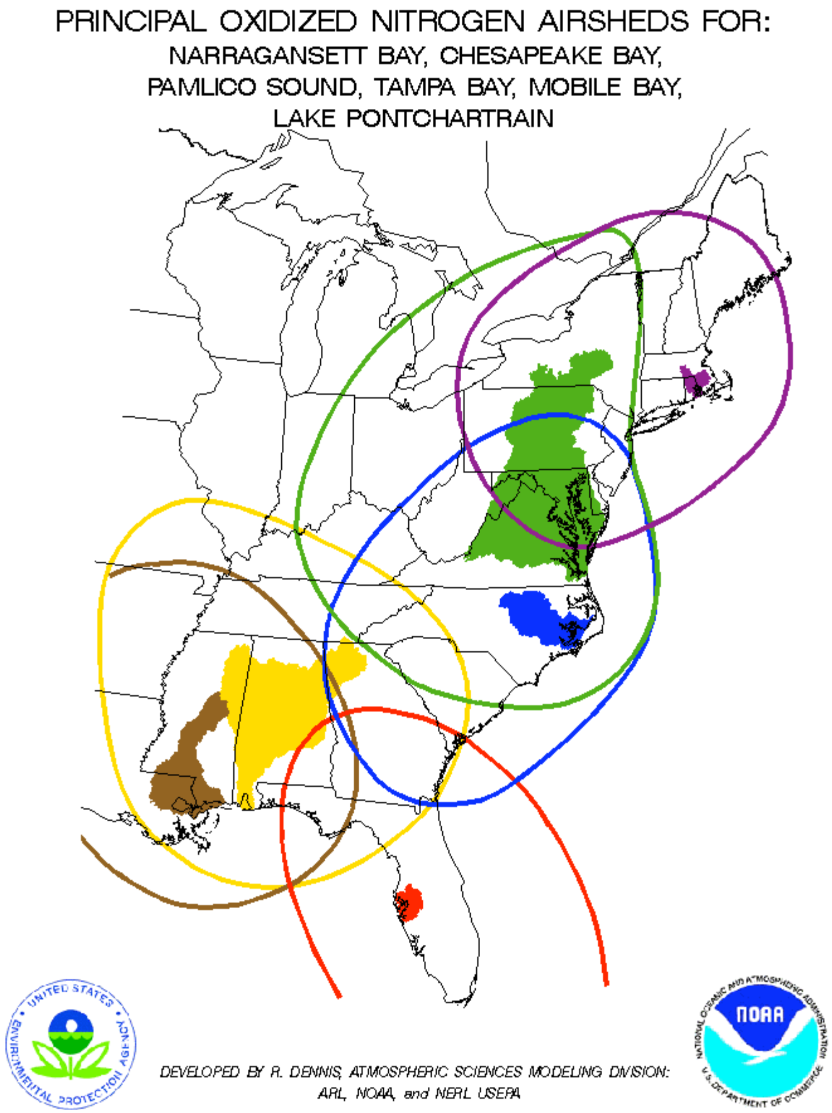
Poor Spatial Coverage; It is Not Representative



Monitoring Has Incomplete Species Set For Red-N Dry Deposition

Poor Spatial Coverage; It is Not Representative

Airshed Scales Very Different from Watershed Scales



National Air Regulations Are Very Important

We Are Undergoing a Shift to Ammonia Deposition Dominance Resulting from the CAA Focus on NO_X Emissions Reduction

Fraction of total-N as ox-N