New, Updated Atmospheric Deposition Projections for Chesapeake Bay Watershed and Tidal Bay

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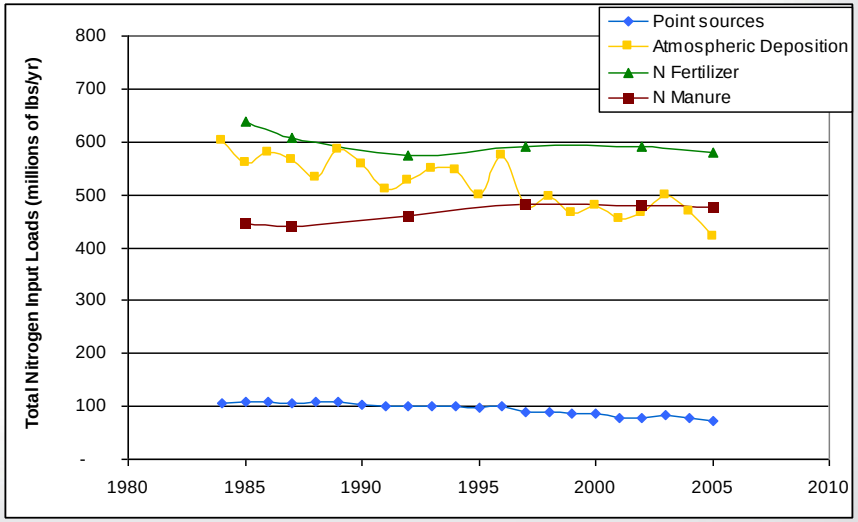
Atmospheric Deposition

- State of the science and atmospheric deposition reductions have progressed to a significant degree:

  Atmospheric deposition is among the highest N loads in the Chesapeake watershed and tidal Bay, but it also has high estimated N reductions.

- Future reductions are likely, but at reduced rate.

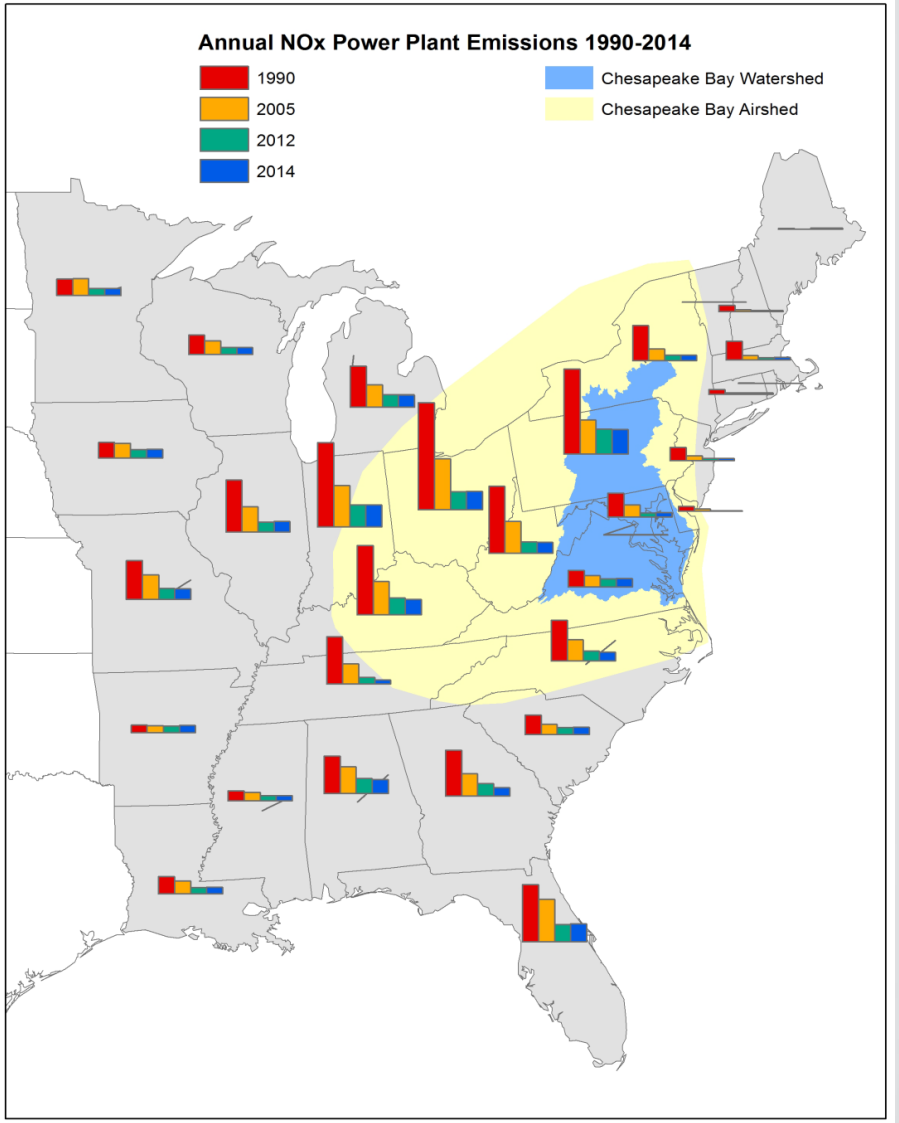
- New bi-directional ammonia CMAQ initial results are different, but look very reasonable



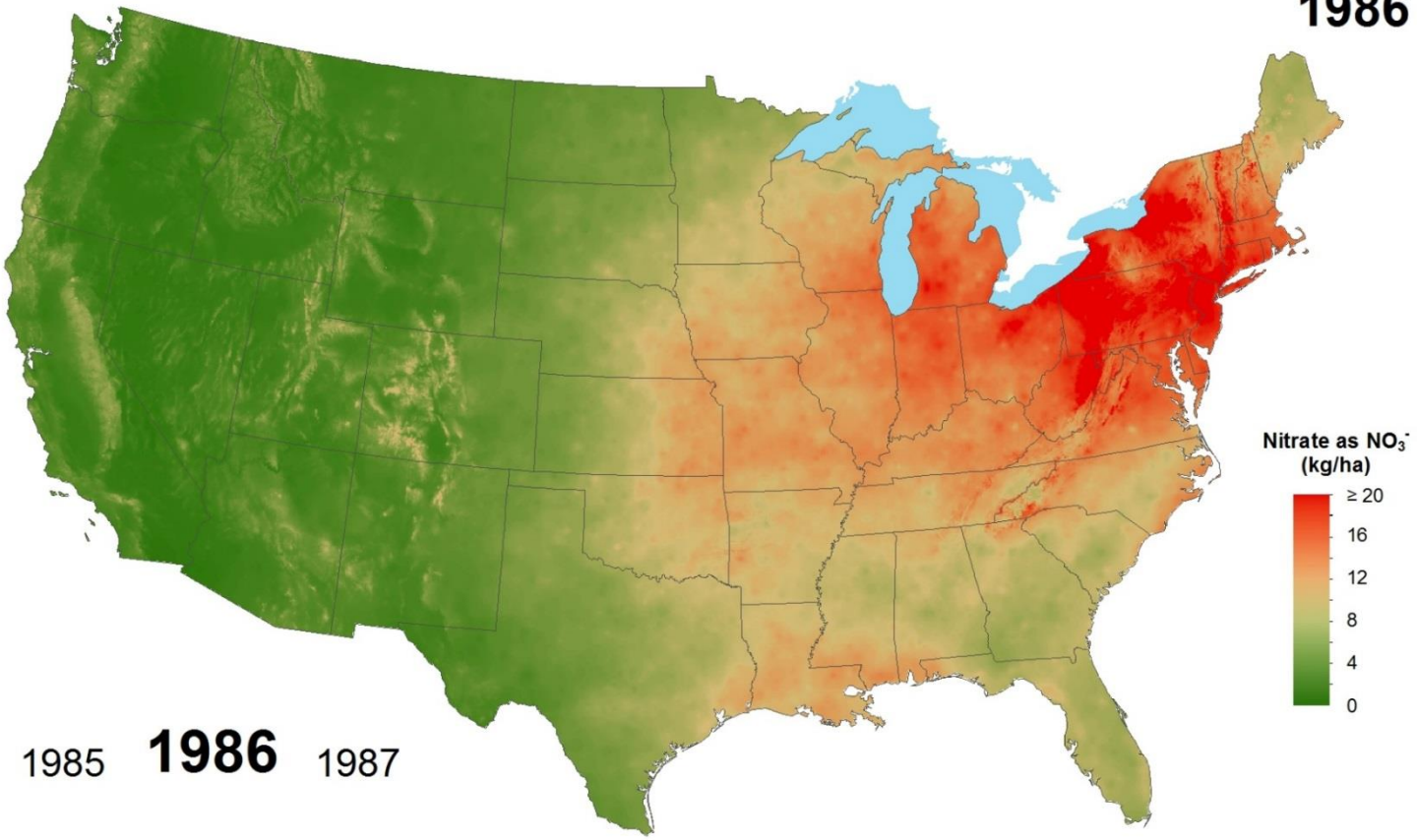
Air Emissions are Declining

- Atmospheric deposition of nitrogen was among the highest TN inputs in watershed ~595 million pounds in 1985 (compared to ~105 million pounds in 1985 for point source loads). We see historical ox-N deposition declining.

- The older 2020 CAIR estimate of atmospheric deposition of nitrogen in the Chesapeake watershed is 326 million pounds, a 45% reduction. In comparison point source TN loads are estimated to be reduced by 50% percent from 1985 to 2025.

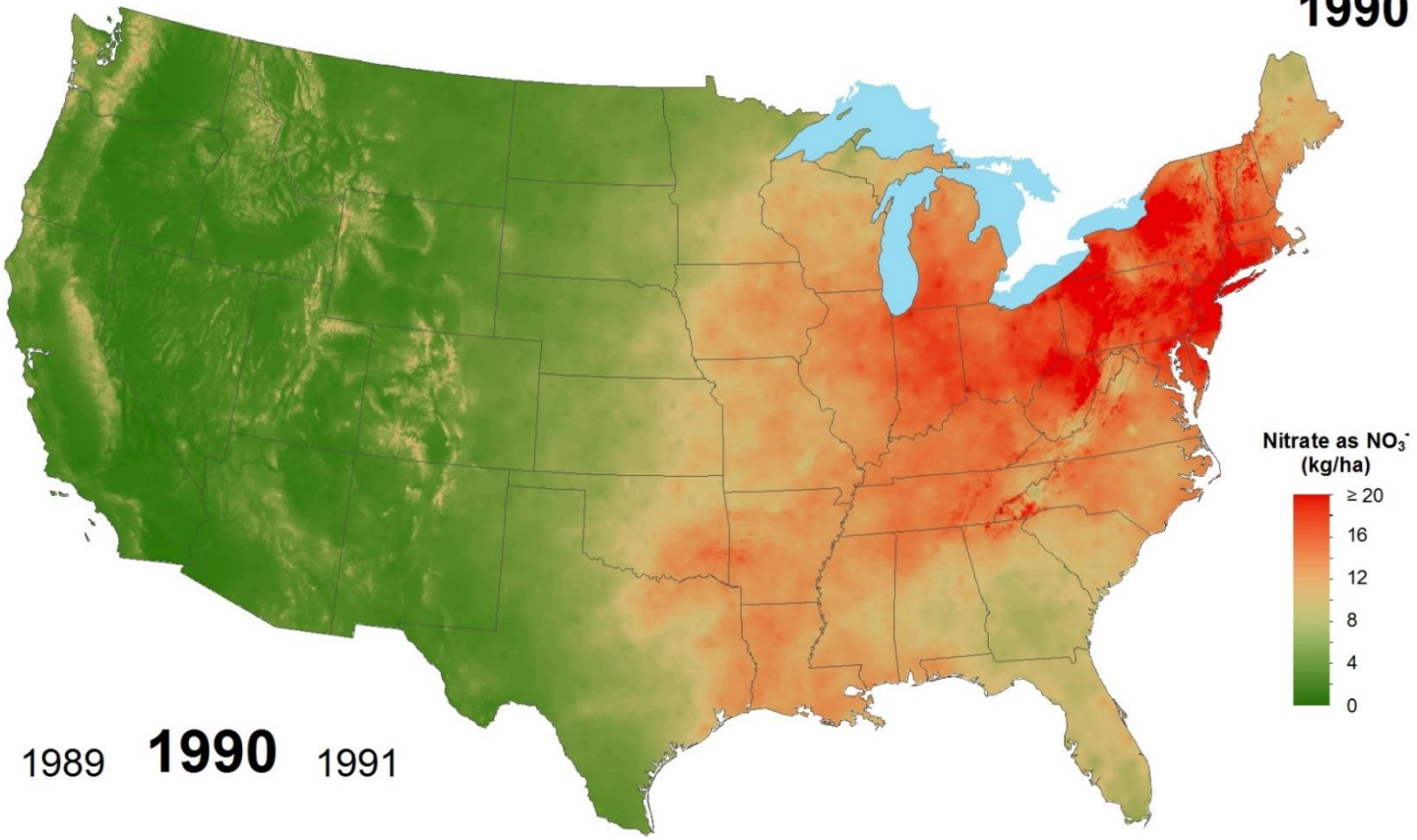


Nitrate ion wet deposition
1986



National Atmospheric Deposition Program/National Trends Network
http://nadp.isws.illinois.edu

Nitrate ion wet deposition
1990



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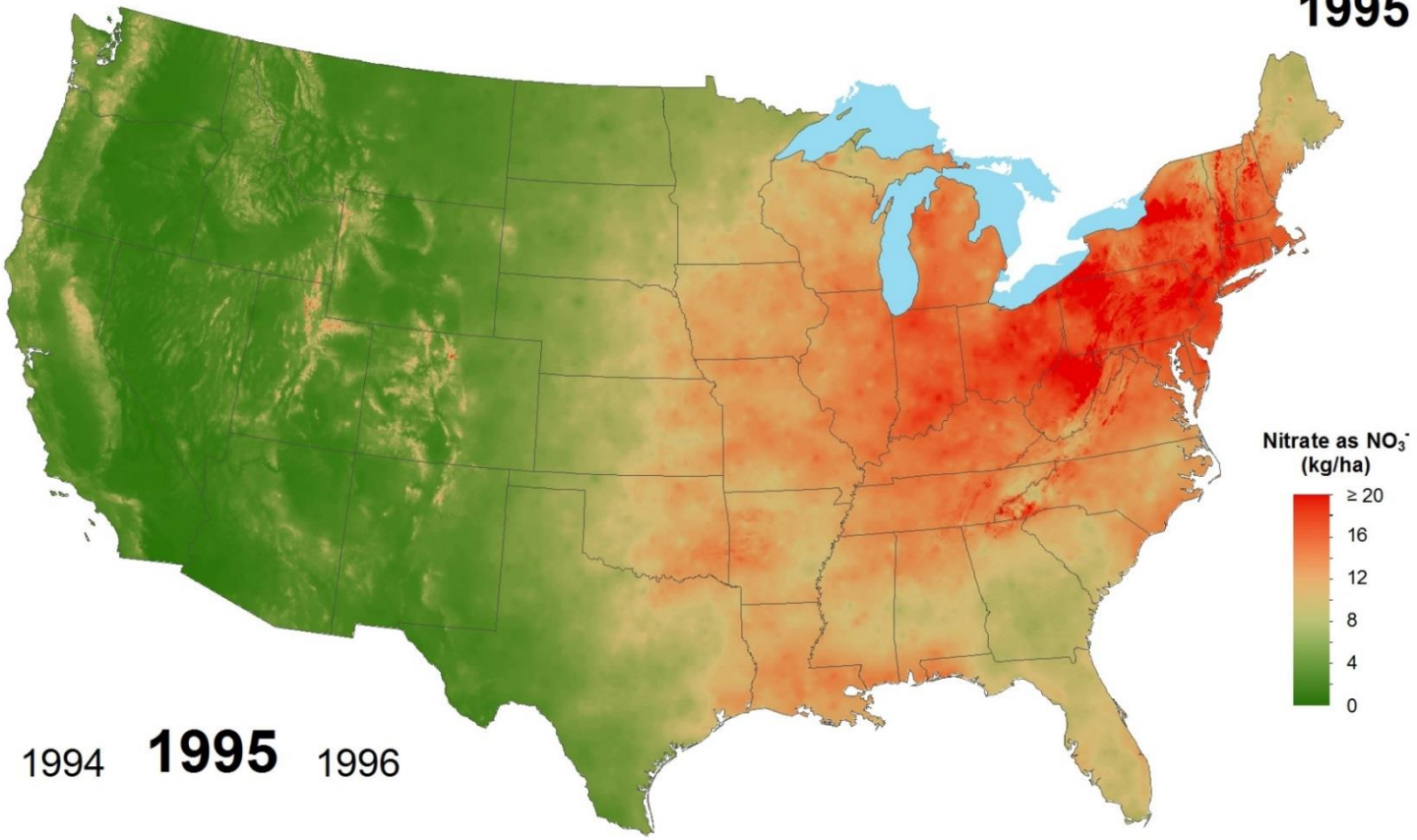
Nitrate ion wet deposition
1995



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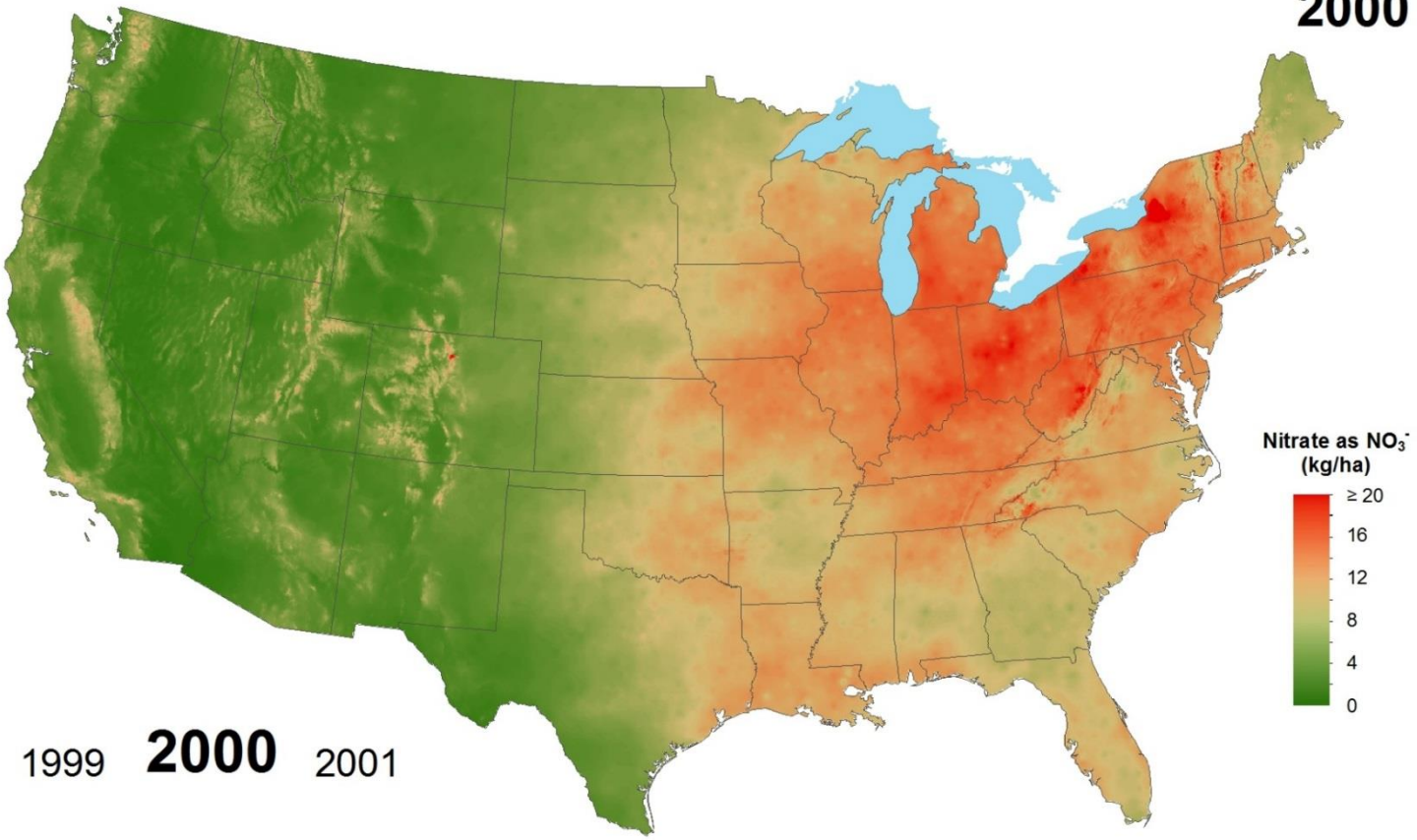
Nitrate ion wet deposition 2000



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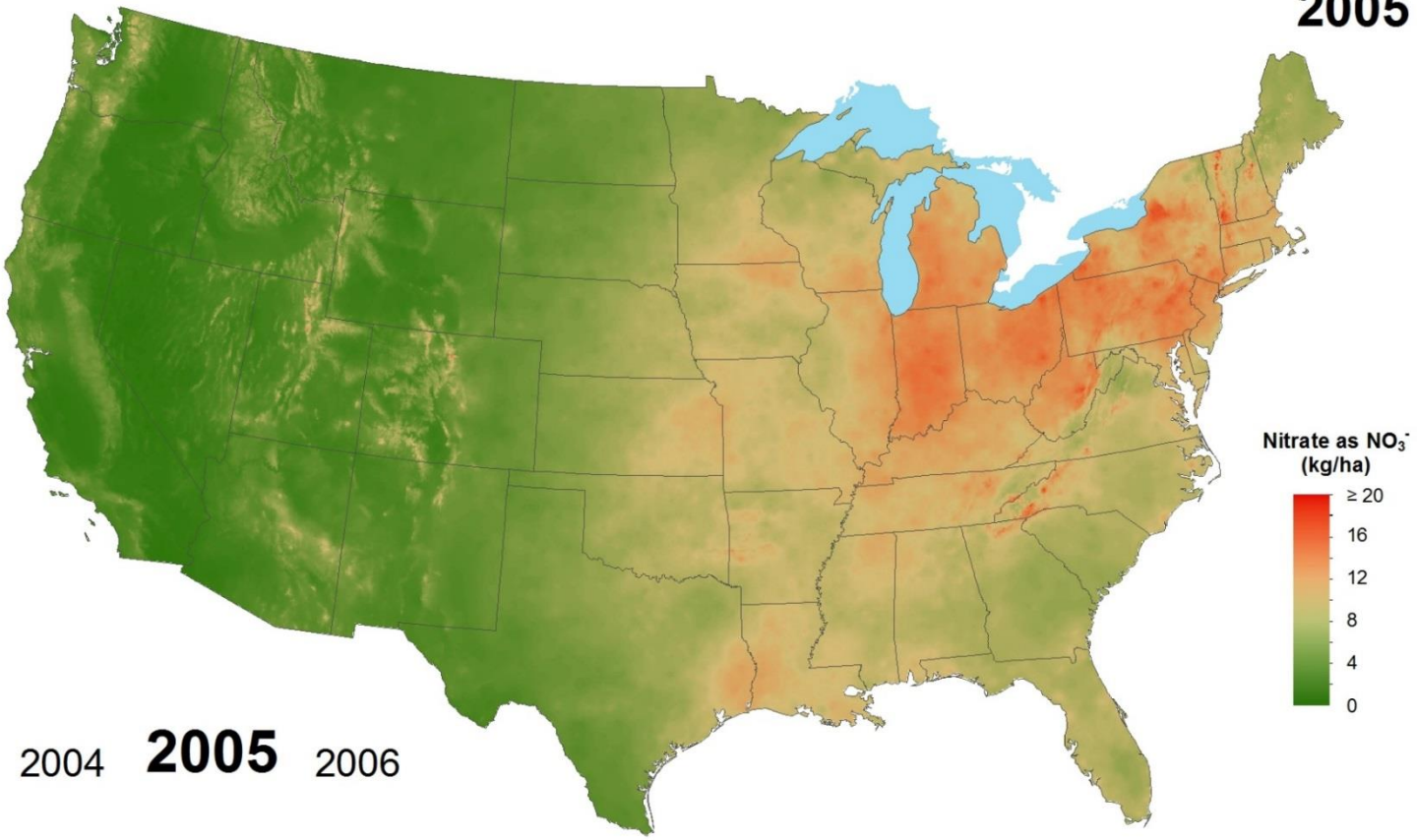
Nitrate ion wet deposition 2005



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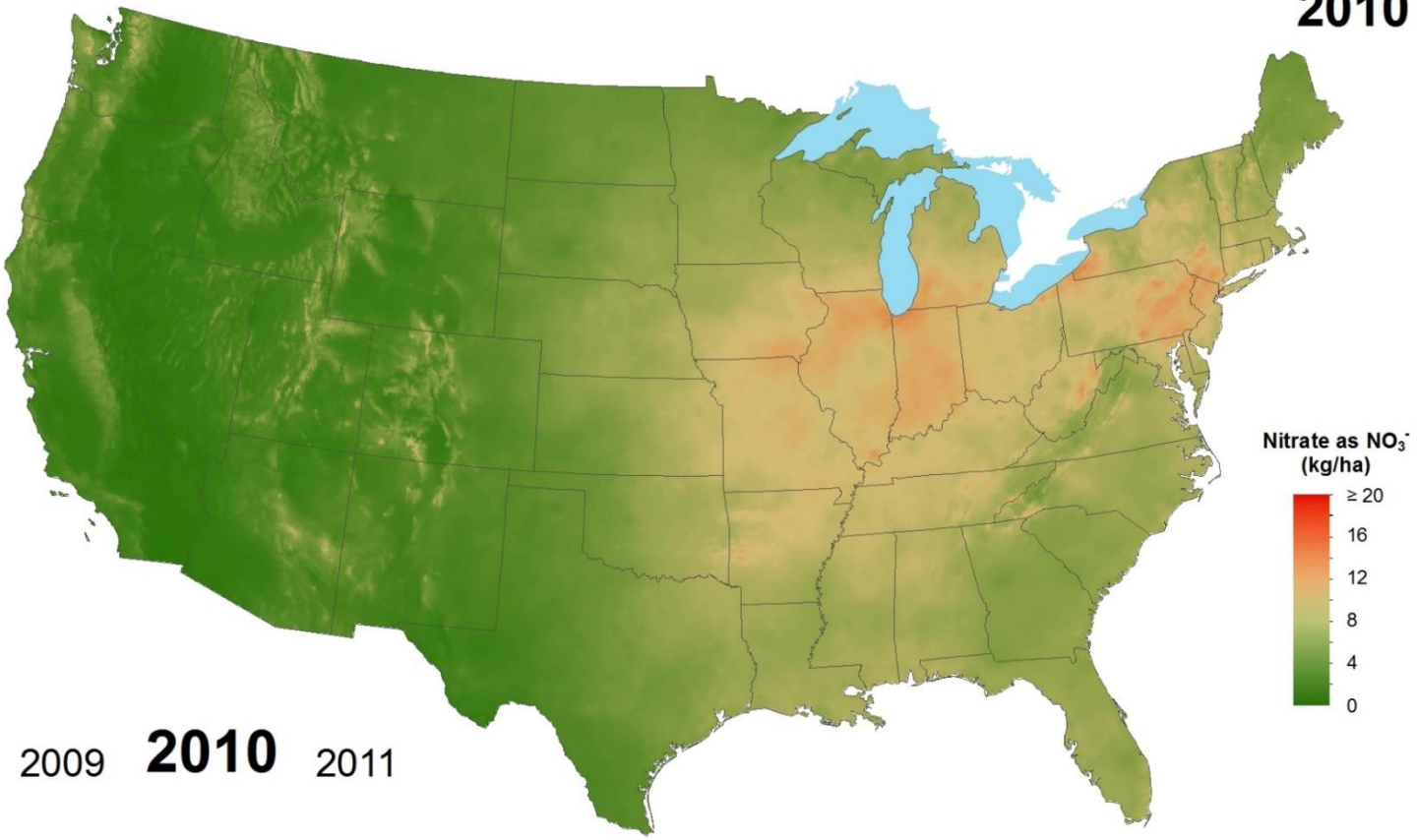
Nitrate ion wet deposition
2010



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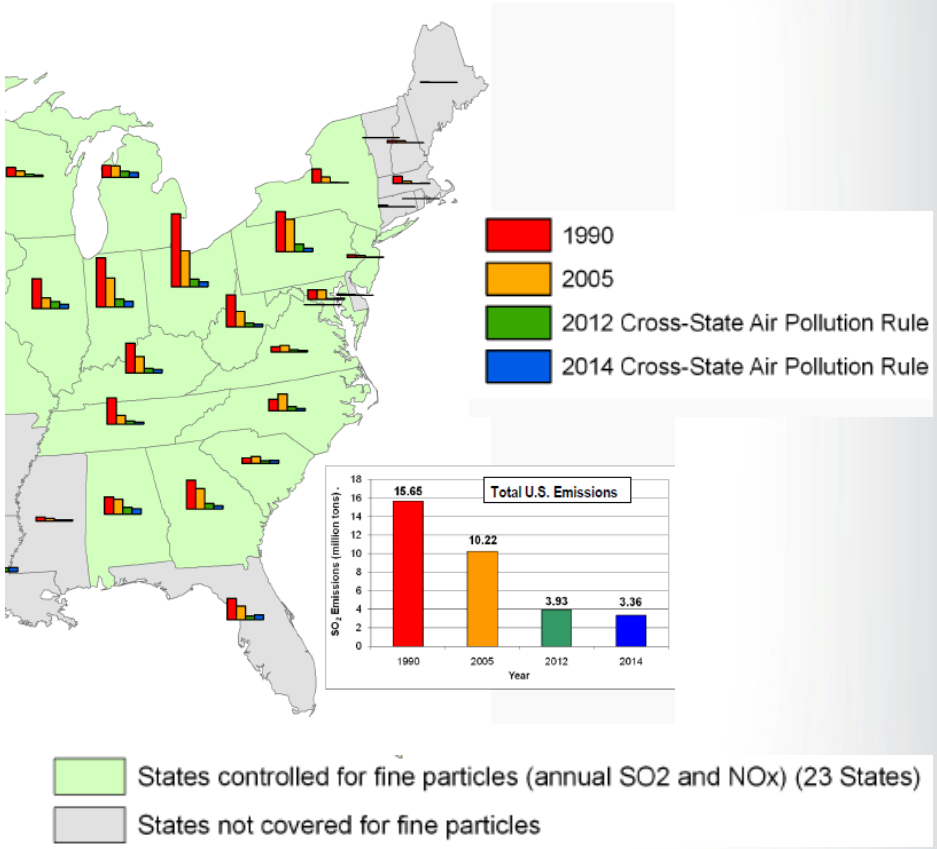
Further, smaller reductions Anticipated to 2025

- Tier 3 Fuel Rule in 2017
- Proposed reduction in primary ozone standard from (75 ppb to 70-60 ppb)
- Proposed Power Plant Carbon Rule
- Continued implementation of CAFE standards



❖ The Tier 3 Rule & CAFE stds only are included in new CMAQ projections to 2025

New CMAQ Scenarios Prepared For 2002, 2011, 2018 and 2025

The 2002, 2011, 2018, and 2025 CMAQ Scenarios are developed with CMAQ 5.0.2 which is the latest release. It has bidirectional ammonia simulated and all scenarios use hourly meteorology for 2011. The meteorological data are simulated by the WRF met model.

The CMAQ model has a domain of all the US including some of southern Canada and some Northern Mexico. The CMAQ uses a 12 km grid size across the domain. The back cast scenario is to 2002.

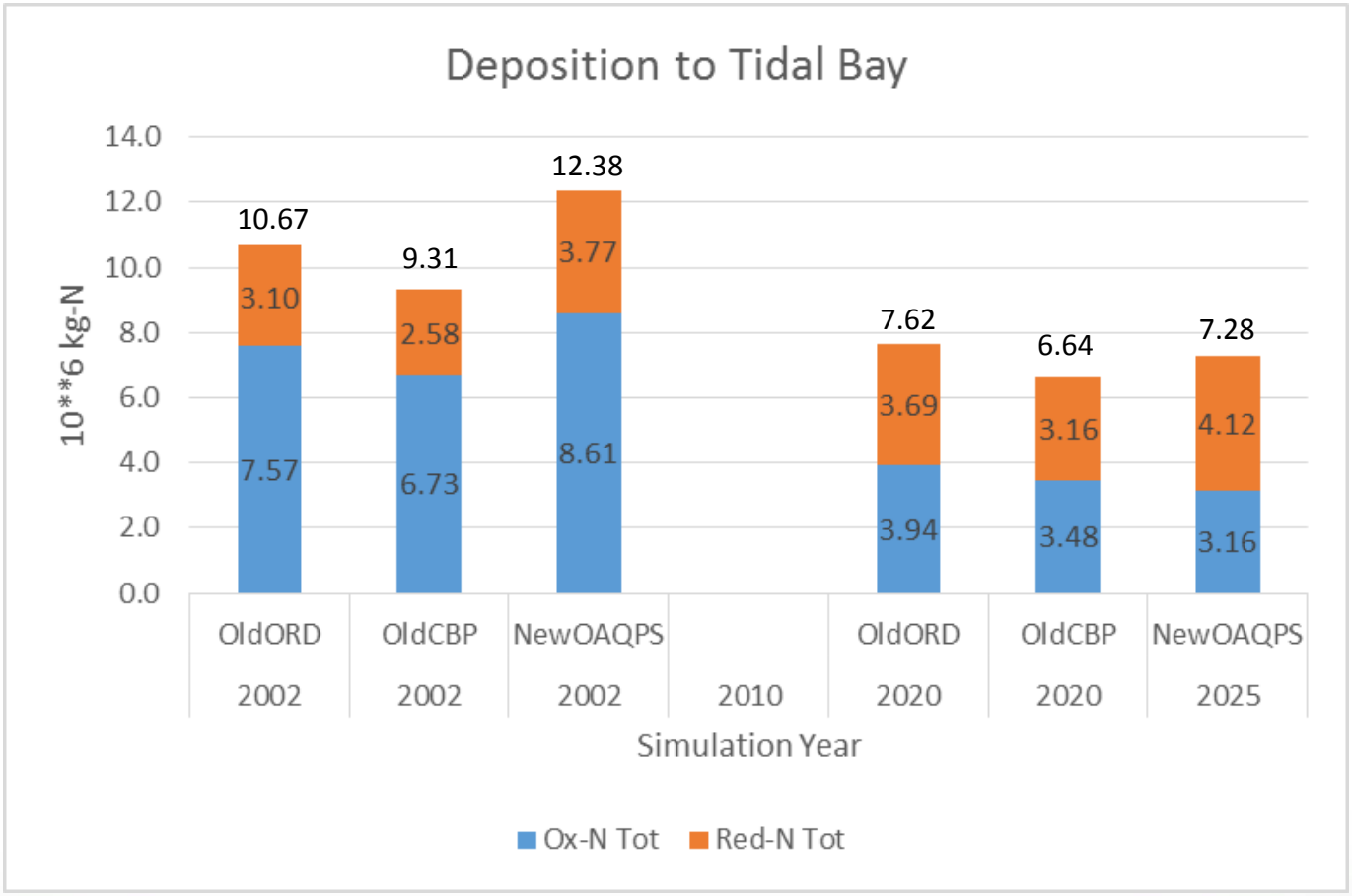
All future scenarios are projected from the 2011 NEI emission inventories and the EGU forecasts were by the IPM model. Mobile emissions were provided by the MOVES T3FRM, which was also used for the Tier 3 Rule. (A new version of MOVES just came out in 2014 but this version was not used.)

The new CMAQ runs will be applied in the integrated models used for Phase III WIPs in 2017.

Summary of Regulations Included

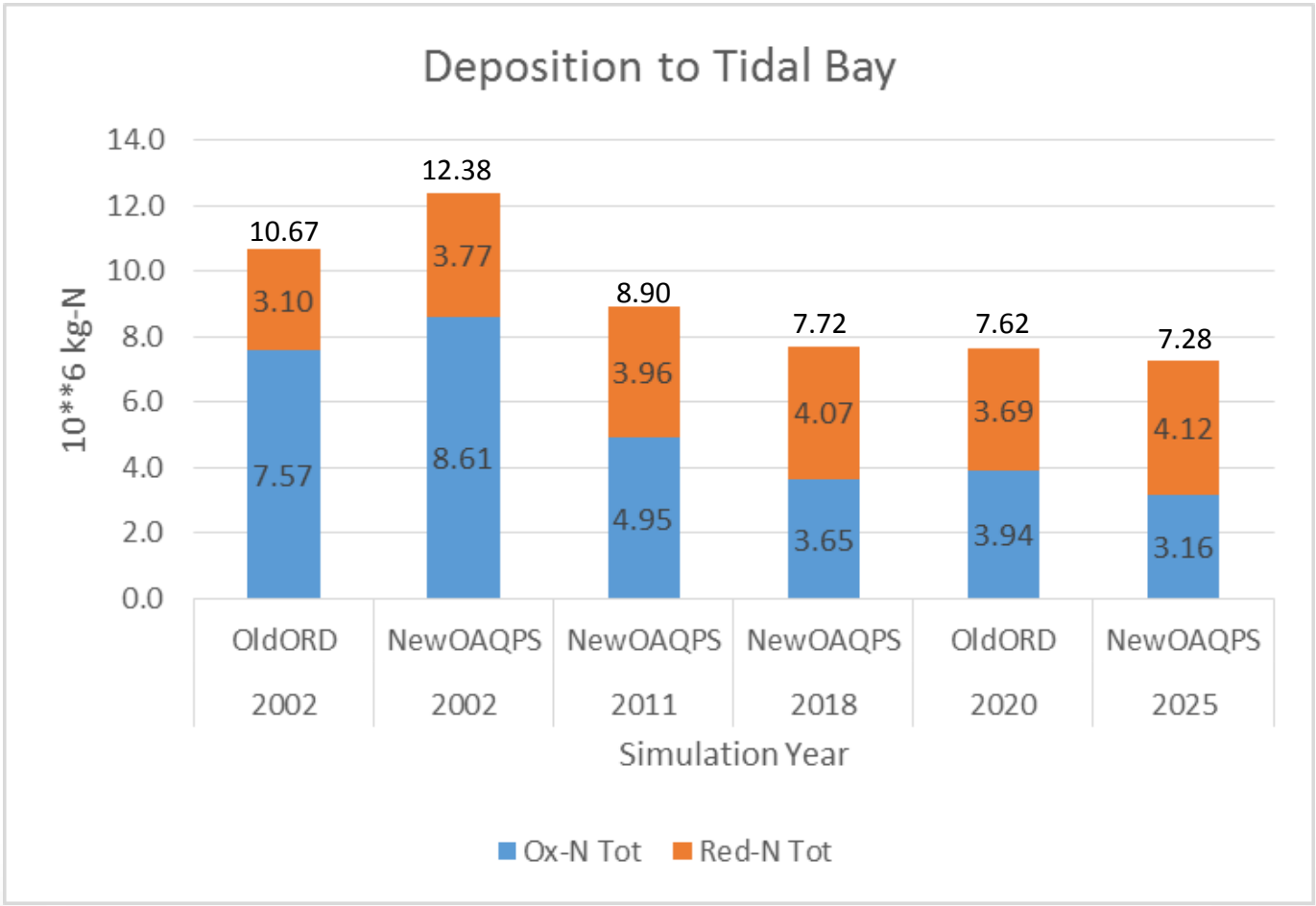
- Power plant Rules: MATS (mercury & air toxics) and CAIR (Clean Air Interstate Rule)
- Industry Rules: CSAPR (Cross State Air Pollution Rule) + local rules, consent decrees, Portland cement plant controls and closures
- Adjustments for new Biofuel futures due to EISA
- Light-Duty Vehicle Tier 2 Rule
- Tier 3 Motor Vehicle Emissions and Fuel Standards Rule
- Heavy Duty Diesel Rule
- Renewable fuel standards (RFS2)
- Light Duty Greenhouse Gas/CAFÉ standards
- Heavy Duty Greenhouse Gas Rule
- Local I/M and National Low Emission Vehicles (NLEV)
- Ozone Transport Commission LEV programs (Northeast corridor)
- Clean Air Nonroad Diesel Rule
- Small Engine Spark Ignition Rule
- Locomotive and Marine engine rules

Bay Deposition Comparison



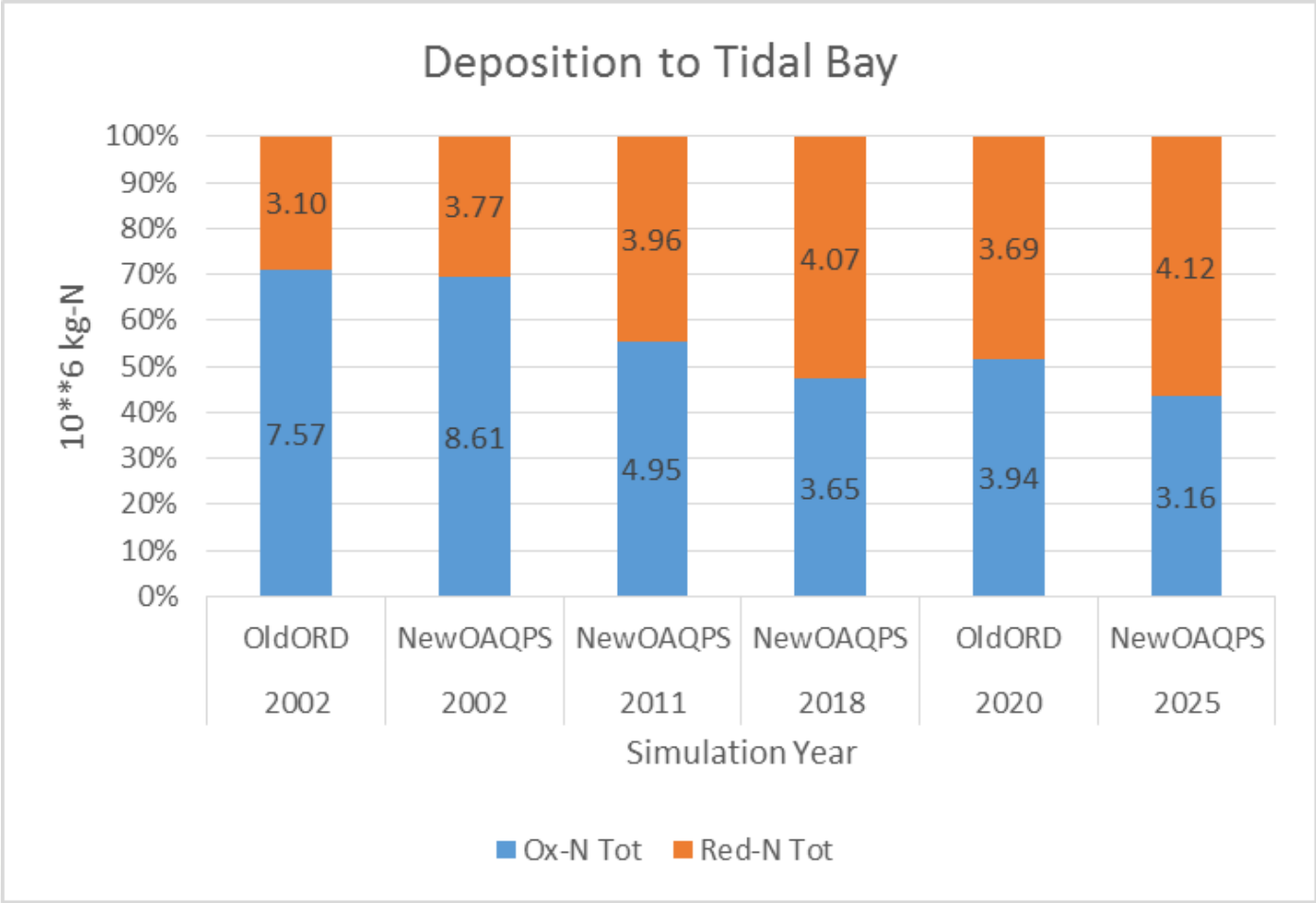
2002 estimates of Inorganic-N deposition are about 16% higher (OldORD vs NewOAQPS) in the new CMAQ than the previous version, yet the new CMAQ 2025 estimate is about the same as the previous 2020 Air Allocation scenario

Bay Deposition Comparison



The time series shows the anticipated diminishing rate of future decline.

Bay Relative Contribution



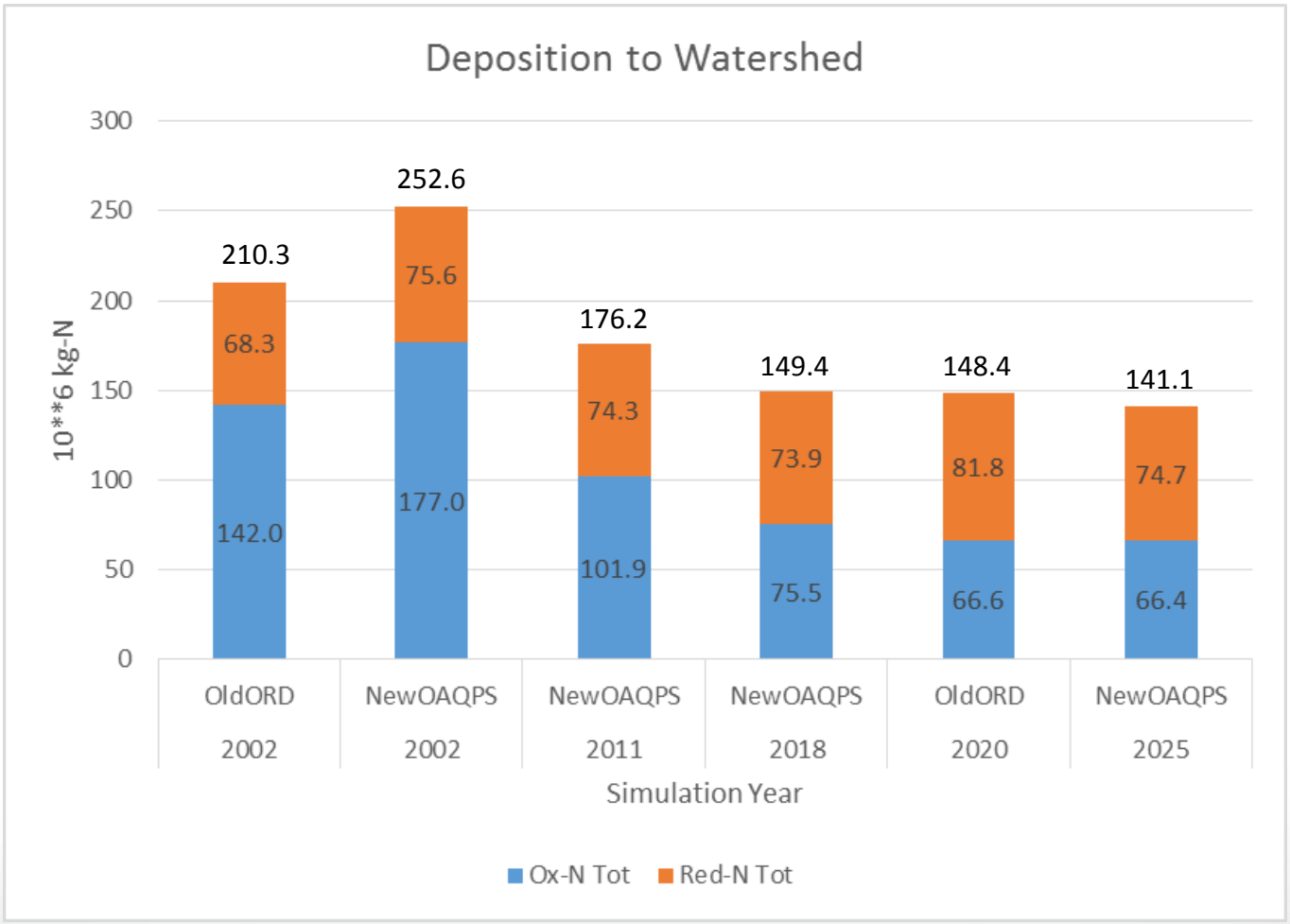
While the partitioning is very similar, the new scenarios suggest reduced-N will be in the majority prior to 2020

Bay Relative Change Comparison

Tidal Bay							
	Wet Ox-N	Dry Ox-N	Total Ox-N	Wet Red-N	Dry Red-N	Total Red-N	Total N
2020ORD | 2002ORD	-45.9%	-49.4%	-48.0%	4.0%	52.6%	19.1%	-28.5%
2020JAWRA | 2002JAWRA	-46.8%	-49.0%	-48.3%	4.3%	53.1%	22.5%	-28.7%
2025OAQPS | 2002OAQPS	-60.7%	-64.9%	-63.3%	-17.9%	67.8%	9.3%	-41.2%
2020JAWRA | 2010JAWRA	-21.6%	-25.4%	-24.2%	7.0%	17.6%	11.7%	-10.5%
2025OAQPS | 2011OAQPS	-32.1%	-38.6%	-36.1%	-10.3%	25.3%	4.1%	-18.2%

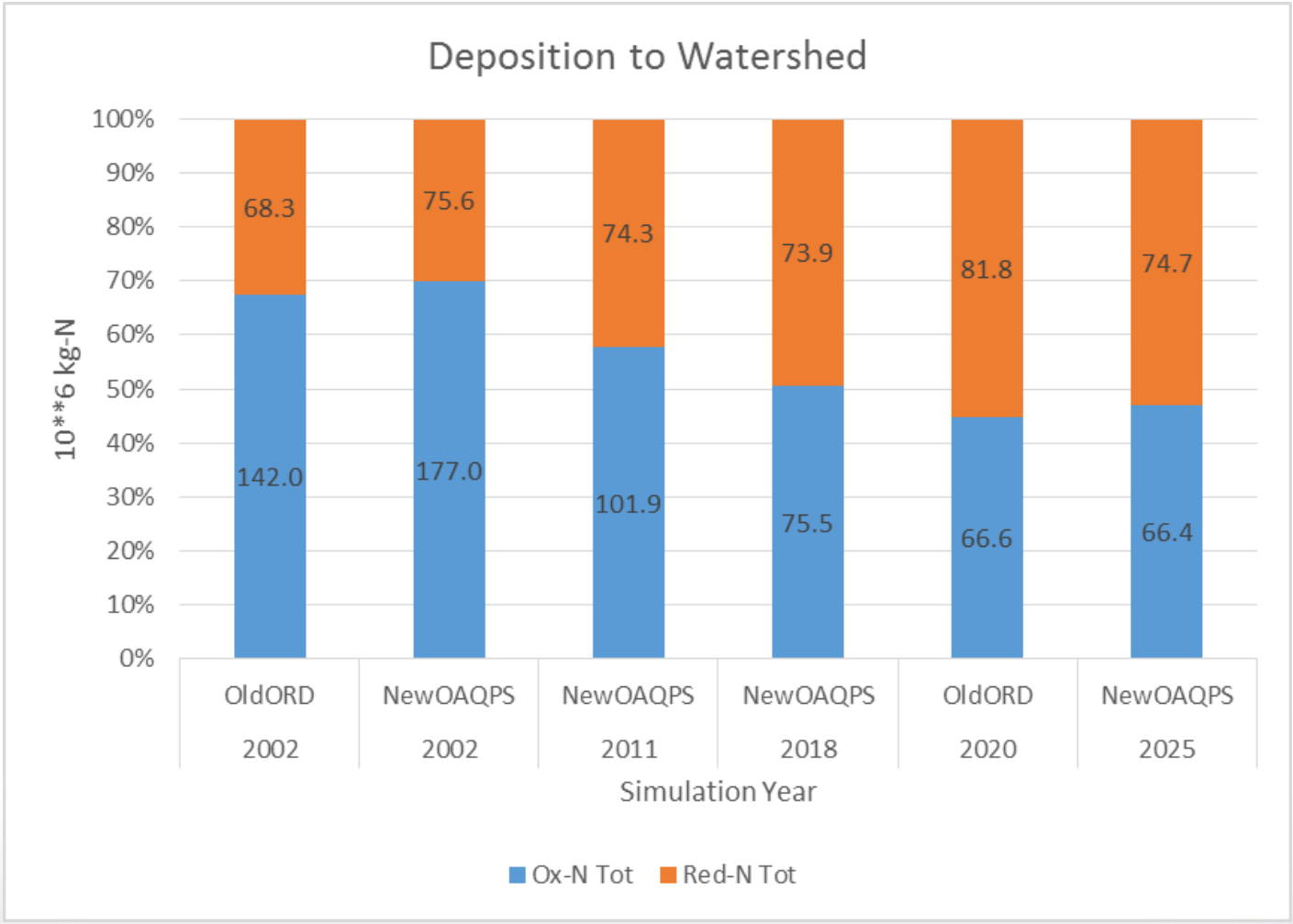
- The relative changes between the ORD and JAWRA (CBPO) are very close as they should be
- The new simulations show wet NH4 dep (Wet Red-N) declining, instead of increasing
- Total N decreases significantly more from 2002 or 2010/2011 in the new simulations

Watershed Deposition Comparison



2002 20% higher, 2025 5% lower

Watershed Relative Contribution



Watershed Relative Change Comparison

Watershed							
	Wet Ox-N	Dry Ox-N	Total Ox-N	Wet Red-N	Dry Red-N	Total Red-N	Total N
2020ORD | 2002ORD	-51.0%	-54.2%	-53.1%	-1.2%	46.8%	19.8%	-29.4%
2025OAQPS | 2002OAQPS	-60.8%	-63.4%	-62.5%	-18.4%	39.8%	-1.2%	-44.2%
2011OAQPS | 2002OAQPS	-42.5%	-42.4%	-42.4%	-9.8%	17.6%	-1.7%	-30.2%
2018OAQPS | 2002OAQPS	-56.1%	-58.1%	-57.4%	-18.6%	36.7%	-2.3%	-40.9%
2025OAQPS | 2002OAQPS	-60.8%	-63.4%	-62.5%	-18.4%	39.8%	-1.2%	-44.2%

- The new simulation shows wet NH4 dep significantly declining, instead of barely declining
- The new simulation shows dry NHx (Red-N) dep increases less compared to old runs
- The new simulation shows dry NOy (Ox-N) dep decreases more compared to olds runs
- Total N decreases significantly more from 2002 or 2010/2011 in the new simulations

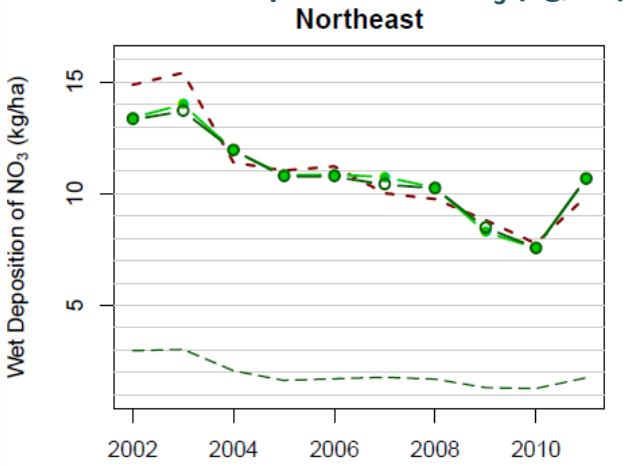
Summary of Model Changes

- Inclusion of lightning NO_X
- MOVES replacing MOBILE6 (on-road vehicles, increased NO_X)
- Basic Implementation of CAIR accomplished (Major point emissions better known)
- Bi-directional NH_3 air-surface flux (more wet & less dry)
- EPIC plant demand for NH_3 fertilizer application (not sales)
- New CAFO NH3 diurnal profile (more long-range transport)
- New mesophyll deposition parameterization
- Surface layer cut in half (to 19m)
- Full CONUS domain at 12km
- Land use converted from USGS to new NLCD 2001 & 2006
- Land-Water Mask bug fix
- New convective scheme (improved precipitation simulation)
- Better nocturnal jet representation

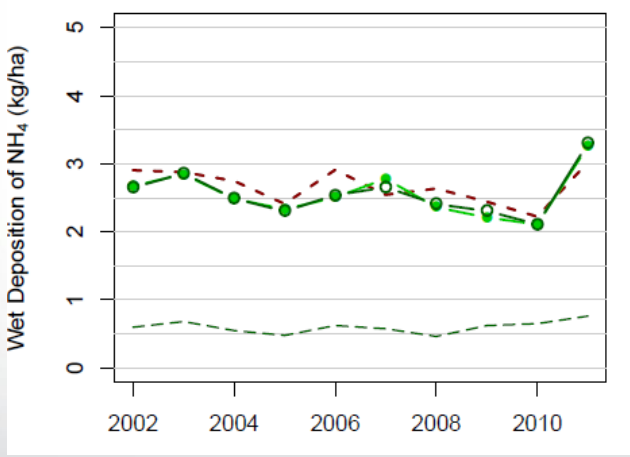
categories: CMAQ / System / Meteorology

Wet Deposition Evaluation

Regional Average of Annual Total Wet Deposition of NO_3 (kg/ha)

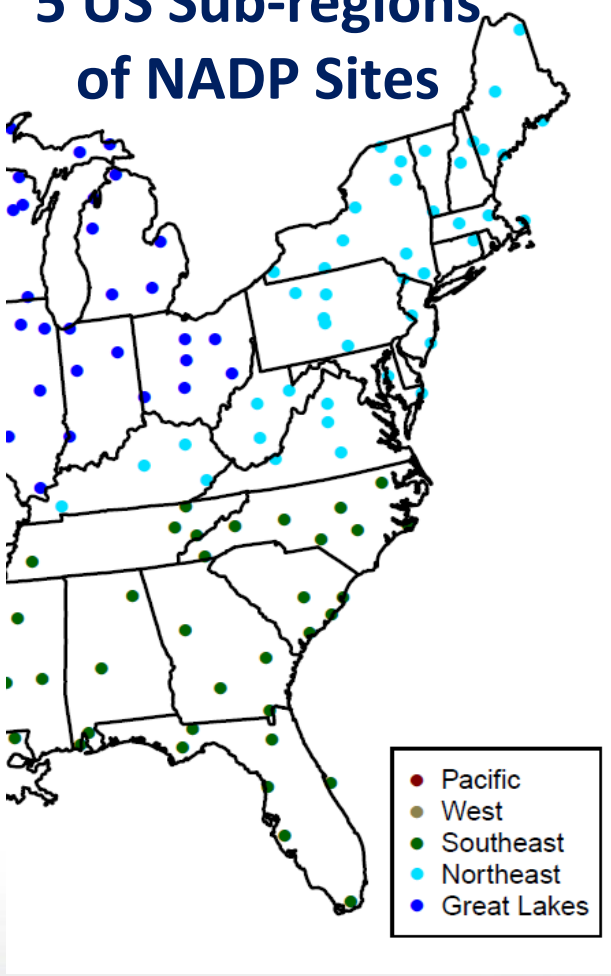


Regional Averages of Annual Total Wet Deposition of NH_4 (kg/ha)

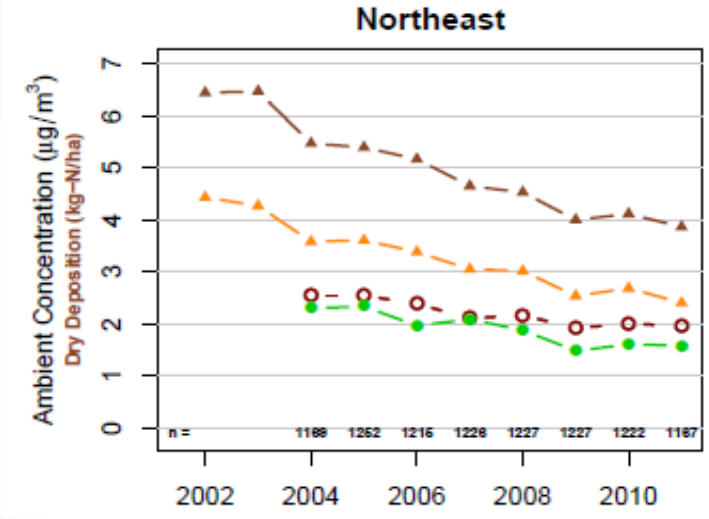


NADP Observations
CMAQ "Raw"
CMAQ Adjusted

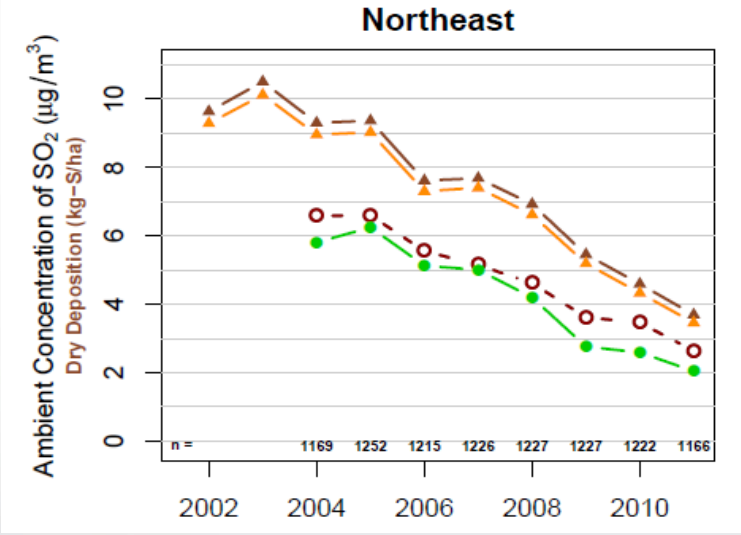
5 US Sub-regions of NADP Sites



Air Concentration Evaluation



- CASTNet TNO3 Concentration
- CMAQ TNO3 Concentration
- CMAQ Oxidized N Dry Deposition (kg–N/ha)
- CMAQ Oxd. TNO3–N Dry Deposition (kg–N/ha)



- CASTNet SO2 Concentration
- CMAQ SO2 Concentration
- CMAQ S Dry Deposition (kg–S/ha)
- CMAQ SO2–S Dry Deposition (kg–S/ha)

Conclusions

- Higher Deposition for 2002 with new simulations (absolute terms)
- Steeper deposition reductions to 2025 in new runs (relative change)
- 2025 estimate about the same a previous 2020 Air Allocation scenario (absolute terms)
- Somewhat higher fraction of total-N as reduced-N deposition in new runs at 2020/2025
- New model trends from 2002 to 2011 agree well with observed trends in wet deposition and air concentrations. Very encouraging!
- Thus, we have more confidence in the new Bi-di model simulations as to current trends and relative change out to 2025

Conclusions

- We've simulated and observed considerable reductions in atmospheric deposition of nitrogen from 1985 to the present.
- Reductions in atmospheric deposition are expected to continue, but at a reduced pace.
- The new Airshed Model is being developed with load estimates from both the bidirectional CMAQ simulation and the Penn State NADP Regression Model. Both elements are expected to be operational by end of summer 2015 and provide new atmospheric deposition inputs for the calibration of the Phase 6 and 2017 version of the WQSTM.