Expected changes in deposition of sulfur and nitrogen over New York State following CAIR

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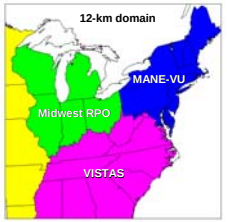
Introduction

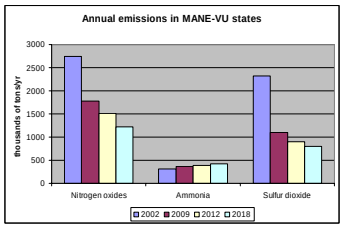
As part of the development of technical information for use in the state implementation plans for O_3, $PM_{2.5}$ and regional haze, NYSDEC participated in regional modeling efforts to simulate air quality for baseline and future years. Planned reductions in emissions of SO_2 and NO_x are needed to reach air quality goals, and are likely to have additional benefits in terms of sulfur and nitrogen deposition across New York. Here we summarize potential changes in deposition across important regions of the State.

Modeling system

Air quality & deposition: CMAQ v4.5.1
Emissions: SMOKE v2.1 (anthropogenic) & BEIS v3.12 (biogenic)
Meteorology: MM5 v3.6
Base case simulation: January 1 – December 31, 2002 (plus 15 day "spin-up" time in December 2001) with 12-km horizontal grid resolution
Future simulations: use base case meteorology with different emissions scenarios

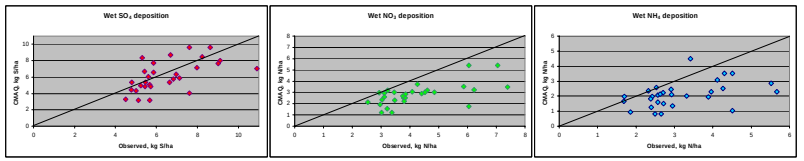
For the O_3, $PM_{2.5}$, and regional haze planning process, annual emissions in the MANE-VU states were generated for the base year of 2002, and for three future years – 2009, 2012, and 2018. The future years include implementation of the Clean Air Interstate Rule (CAIR) and measures that are "on the way" (e.g. full implementation of the NOx SIP call, various MACT standards, etc.), as well as additional controls (e.g. industrial boilers, cement kilns, etc. which are considered "beyond on the way").





- NO_x emissions in MANE-VU states are projected to **decrease** by 35-55% compared to 2002 (largely associated with reductions in mobile sources from fleet turnover)
- SO_2 emissions in MANE-VU states are projected to **decrease** by 53-66% (largely point source reductions)
- NH_3 emissions in MANE-VU states are small compared to NO_x and SO_2 in 2002, but are projected to **increase** by 18-36% in future years (growth in area sources)
- NOTE: Combined emissions in the Midwest (Midwest RPO) and Southeast (VISTAS) are roughly 3-4 times larger than in the MANE-VU region; by 2018 the NO_x and SO_2 emissions in these regions are projected to decrease by about 40-50%, whereas NH_3 emissions are projected to increase substantially

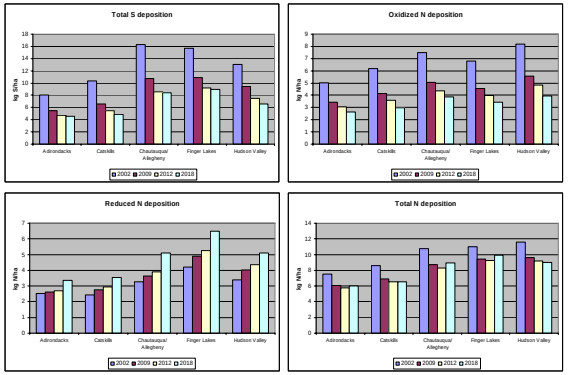
Base case (2002) evaluation – annual wet deposition

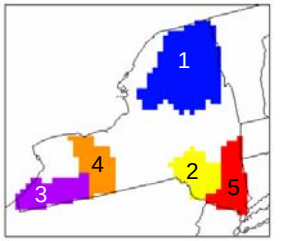


- Compare observed and predicted annual wet deposition of SO_4, NO_3, and NH_4 at 9 NADP/NTN, 1 AIRMoN-wet, and 19 NYSDEC sites across New York
- On average, CMAQ underpredicts NO_3 and NH_4 wet deposition by ~30%, and underpredicts SO_4 wet deposition by ~5% on an annual basis
- There are not enough CASTNet sites in New York and the region to evaluate CMAQ predictions of dry deposition in a similar manner

Annual nitrogen and sulfur deposition over five selected regions across New York

Oxidized, reduced, and total N, and total S deposition (wet + dry) over five sub-regions of New York – (1) Adirondacks, (2) Catskills, (3) Chautauqua/Allegheny, (4) Finger Lakes, and (5) Hudson Valley

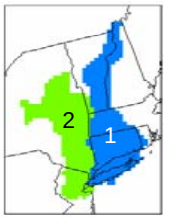


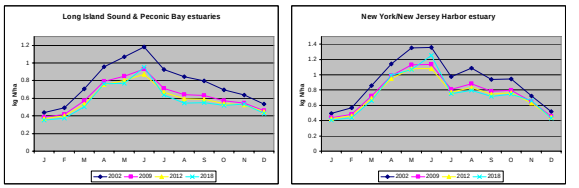


- Total S deposition is projected to **decrease** by 28-38% in 2009, and 43-53% in 2018 compared to 2002 levels
- Oxidized N deposition is projected to **decrease** by 31-33% in 2009, and 48-52% in 2018 compared to 2002 levels – largest decreases occur between 2002 & 2009
- Reduced N deposition, while smaller in magnitude than oxidized N deposition, is projected to **increase** by 3-19% in 2009, and 33-56% in 2018 compared to 2002 levels – large increases after 2012
- There are no additional improvements in total N deposition after 2009 – decreases in oxidized N may effectively be offset by increases in reduced N in later years

Nitrogen deposition to important watersheds

Total (wet + dry) N deposition on a monthly basis averaged over the (1) Long Island Sound/Peconic Bay and (2) New York/New Jersey Harbor watersheds





- Atmospheric deposition contributes roughly one-third of the total anthropogenic N loading to this region (e.g. Driscoll et al., *Bioscience*, 2003)
- Total maximum daily load (TMDL) plans for Long Island Sound and Peconic Bay call for reductions in N loading by roughly 40-60%, including atmospheric deposition sources
- Modeled total N deposition over these two watersheds peaks during the summer months, when the largest benefits of emissions reductions also occur
- Again, additional declines in N deposition after 2009 are projected to be minimal

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