Background
Recent Modeling/Satellite/Measurement studies showed large overestimations of NOx emissions from on-road mobile sources in NEI2013:
- Such emissions in NOx estimated using MOVES are at first time
- Overestimated by 50-70%
- May partly due to light duty gasoline vehicles
- Large impacts on modeling for ground-level ozone

MOVES overestimates NOx emissions when higher sulfur content gasoline is used:
- Default sulfur content of gasoline is 30 ppm (Tier 2 gas phase) for 2011 and 2012 in MOVES2014a
- Local testing indicates a lower sulfur content (20-25 ppm), since many districts have very complex bank credits to get extra time for Tier 3 transition to 10 ppm.
- MOVES overestimation of higher sulfur means overestimation of NOx, assuming the sulfur level.

Methodology
Investigate the impact of sulfur content in gasoline on NOx emissions estimated by MOVES:
- Sulfur sensitivity test with MOVES2014a using different sulfur levels
- Modeling years: 2014 and 2030
- 15 counties in Atlanta
- Mostly fuel inputs using fuel wizard in MOVES2014a.
- When sulfur content is charged, aromatic, E10 and T90 are also charged.
- Sulfur levels in 2014:
  - 20 ppm (MOVES default)
  - 10 ppm (Tier 3 limitation in 2017)
  - 5 ppm (very conservatively high estimate)

Same inputs used in Atlanta ozone maintenance SIP:
- Vehicle type and age from recently updated vehicle registration data from Polk/IHS
- VMP (vehicle miles driven) from Atlanta’s newly developed Activity-Based Model (ABM) for 2014 and 2030 model years for maintenance demonstration.

Compare NOx Emissions Outputs:
- Total emissions from light duty gasoline cars and trucks
- Total emissions from light duty, all fuel types
- Total emissions from all vehicles, all fuel types
- Total emissions breakdown by model year vehicle

Results
Sulfur Content in Gasoline Does Not Account for Large Discrepancy Reported

| % Change in NOx Emissions From Gasoline Content in MOVES2014a Year 2014 |
|---------------------------------|------------------|------------------|------------------|------------------|
| % Change in NOx Emissions From Gasoline Content | 30 ppm (Tier 2) | 10 ppm (Tier 3) | 5 ppm (very conservatively high estimate) |
| Change in Sulfur Content by Year | 2014 | 2015 | 2016 | 2017 |
| 30 ppm | 0% | 0% | 0% | 0% |
| 10 ppm | -40% | -40% | -40% | -40% |
| 5 ppm | -80% | -80% | -80% | -80% |

Emissions Impact of Over-carrying Tier 2 and 3 Gasoline Standards

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Sensitivity of MOVES2014a to Fuel Sulfur Content In Full Range of Possible Sulfur Content By Model Year of Vehicle

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Conclusions
- MOVES2014a sensitivity of NOx emissions to sulfur content such as use of 50ppm defaults instead of 20ppm (the highest likely level used in local fuel data), does not account for the large overestimation of NOx, identified in recent modeling/satellite/measurement studies in 2011 and 2014.
- MOVES2014a sensitivity of NOx emissions to sulfur content in line with laboratory and emission control studies cited in EPA’s fuels experts report.
- Sulfur content by vehicle model year mimicking tier levels.
- MOVES2014a sensitivity of NOx emissions to sulfur content in future years (e.g., budget year 2030) is similar to year 2014, even lower sulfur levels.
- Over-compliance with Tier 3, 10ppm requirement, involves much smaller S variation (0-5ppm to Tier 3 30ppm to Tier 2 requirement as worst case) to lose impact. Under-compliance with bunk credits likely to fade away in the near future. Therefore 10ppm MOVES2014a default until 2016 may be key line.
- Sulfur issue could be contributor to overestimation for 2011 and 2013 years, but not major one and decreases after banking period impacts fade.
- Local blend distillates still better than defaults, with impacts significant, just not 0 or 50%.
- EPA planning to replace 50ppm S with more realistic 20ppm S in NEI2014 and future MOVES versions for default Tier 2 gasoline.

Reference Documents: “Recent Studies” Refer to Studies Since 2014
- Gill, James Boylan. MOVES2014a: a sensitivity of NOx emissions to sulfur content such as use of 50ppm defaults instead of 20ppm (the highest likely level used in local fuel data), does not account for the large overestimation of NOx, identified in recent modeling/satellite/measurement studies in 2011 and 2014.
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