CAMx HDDM Simulations with the 2011/18 Modeling Platform to Estimate Precursor Emissions Meeting Future US Ozone Standards

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BACKGROUND

- EPA is about to propose alternative ozone standards
  - Considering new standard in 60-70 ppb range
  - Many potential new non-attainment areas in US.
  - How much additional emission reductions will be necessary?
- Ozone modeling with HDDM is an appropriate projection tool
  - Tracks ozone sensitivity to US anthropogenic emissions
  - Captures realistic non-linear ozone responses
  - Eliminates multitude of "brute-force" emission scenarios
  - Subject to usual model uncertainty and higher-order truncation errors

OBJECTIVES

- Run CAMx/HDDM with EPA's 2011/2018 v1 modeling platform
- Evaluate CAMx performance against 2011 urban and rural observation networks
- Estimate NOx and VOC emission reductions needed beyond 2018 to meet a 60 ppb ozone standard
- Analyze for 22 US cities and 20 rural areas across the US

ABSTRACT

The US EPA is considering lowering the ozone National Ambient Air Quality Standard (NAAQS) to a range of 60-70 ppb in the form of a three-year average of the annual 4th highest daily maximum 8-hour concentration. Photochemical model simulations employing the High Order Decoupled Direct Method (HDDM) have been used to estimate ozone response from US anthropogenic emissions reductions that just attain alternative standards in several US cities, based on modeling historical years from 2005 to 2007 (Simon et al., 2012; EPA, 2014; Nopmongcol et al., 2014). We report on new applications of the HDDM technique developed by Yarwood et al. (2013) using the Comprehensive Air quality Model with extensions (CAMx) with meteorological, emissions and boundary condition inputs from EPA's 2011/2018 modeling platform. Emission reductions from 2018 are estimated to meet a 60 ppb standard. These results demonstrate the level of additional emission controls needed beyond the reductions that have occurred since 2006 and that are expected to occur out to 2018. Results are specific to the 2011 analysis year and to this particular CAMx/HDDM modeling technique.

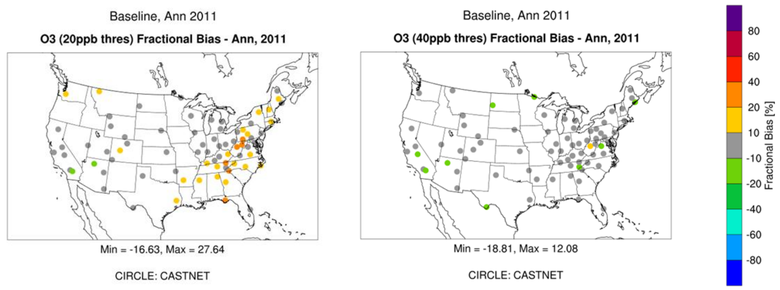
APPROACH AND RESULTS

MODEL APPLICATION AND PERFORMANCE

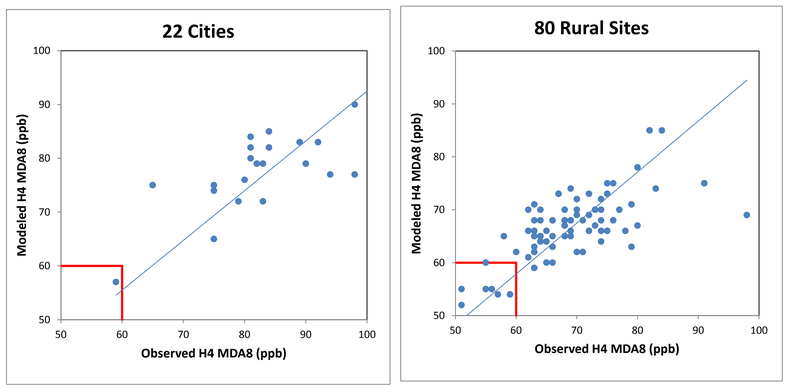
- CAMx v6.10 with 2011/2018 EPA modeling platform at 12 km resolution
  - Evaluate 2011 model-observation performance statistics
    - Annual/seasonal mean bias and error for hourly O_3
    - 4th high maximum daily 8-hour O_3 (H4 MDA8)
    - At all rural CASTNET sites and at AQS sites in 22 cities

2011 Annual Bias for Hourly O_3 : All Rural Sites

O_3>20 ppb O_3>40ppb

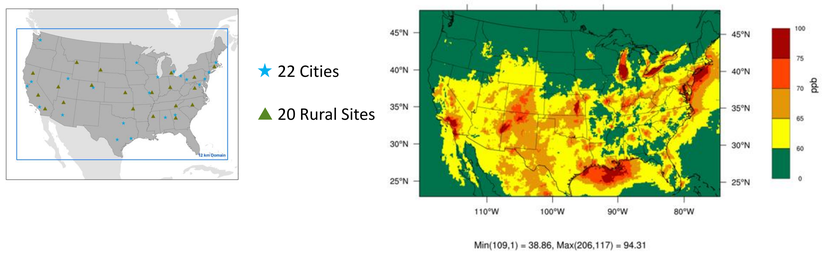


2011 CAMx H4 MDA8 O_3 Performance

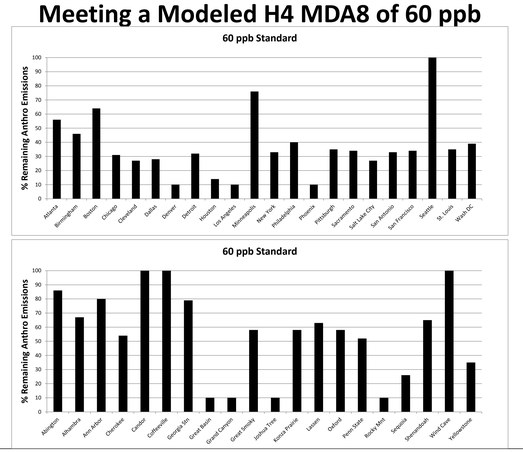


HDDM APPLICATION

- HDDM calculates 1st and 2nd order sensitivities (derivatives) of O_3 to changes in US anthropogenic NOx and VOC
  - HDDM configuration of Yarwood et al. (2013), applying H4 MDA8 bias adjustment (Nopmongcol et al., 2014)
  - Estimate NOx and VOC reductions from 2018 needed to meet a simulated H4 MDA8 O_3 = 60 ppb
  - 22 cities and 20 rural CASTNET sites to cover various geographies



Percent Remaining 2018 NOx and VOC Emissions Meeting a Modeled H4 MDA8 of 60 ppb



EPA, 2014. Health Risk and Exposure Assessment for Ozone, US Environmental Protection Agency (EPA 452/R-14-004f, August 2014), http://www.epa.gov/ttn/naaqs/standards/ozone/s_o3_2008_rea.html.

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Simon, H., K. Baker, F. Akhtar, S. Napelenok, N. Possiel, B. Wells, B. Timin, B., 2012. A direct sensitivity approach to predict hourly ozone resulting from compliance with the National Ambient Air Quality Standard, *Environ. Sci. Technol.*, 47 (5), 2304e2313. http://dx.doi.org/10.1021/es30674e.

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SUMMARY

- 2011 hourly performance:
  - CAMx performs quite well for ozone > 40 ppb
  - <10% bias at 13/20 rural sites, 20/22 cities
  - Tends to over predict low ozone (east), under predict high ozone (east and west)
- H4 MDA8 performance:
  - Balanced over/under predictions
  - <10% bias at 13/20 rural sites, 14/22 cities
  - BIG under predictions in Southern California (LA, Joshua Tree, Sequoia)
- Deep cuts (>50%) needed beyond 2018 for many cities to achieve 60 ppb NAAQS
- Less reductions are needed at rural sites except in west where background is higher
- Results are specific to the 2011 analysis year and to this particular CAMx/HDDM modeling technique.

FUTURE DIRECTIONS

- Use modeling results in EPA MATS to project recent observed DVs
- Confirm and adjust emission reduction estimates with brute force modeling
- Report US-wide NOx carrying capacity meeting 60 ppb