US Regional Haze Studies: EPRI's Project on International Contributions to Regional Haze & WESTAR-WRAP Regional Haze Simulations

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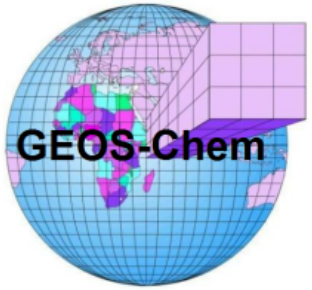
June 10, 2019

EPRI Project Scope



- 3 GEOS-Chem simulations (**all have been completed**)
  - Provide international transport contributions through CAMx boundary conditions (BCs)
    - 2016 Baseline
    - 2028 Base Case
    - 2028 Scenario with all anthropogenic emissions outside the U.S. set to zero (Zero Out Rest of World run; ZROW)
  - Global anthropogenic emissions based on the CEDS and regional inventories
  - Natural emissions driven by 2016 meteorology (in-line)

CAMx Ozone Particulates Toxics

- 3 CAMx simulations with corresponding GEOS-Chem BCs
  - 2016 Baseline, 2028 Base Case, 2028 ZROW
  - **Build off State/Federal Collaborative 2016/2028 modeling databases**
  - Develop 2016 natural emissions

- Visibility analysis

Non-US Global Emissions : EPRI 2016 Baseline

- Emissions inventories based on GEOS-Chem v11.02f

Region	Inventory	Latest year	2016 simulation
Canada	APEI	2014	No projection
China	MEIC	2015, 2016, 2017	2016
Global; rest of the world	CEDS (GEOS-Chem default)	2014	2014
Aircraft	AEIC	2005	Projected 2016 (RCP4.5)
Shipping	NEI, EMEP, HTAP2	2011, 2012, 2010	Projected 2016 (RCP4.5)
Biomass	QFED2	2016	2016
Volcanic SO2	Aerocom	2009	Degassing emissions only
soil NOx, sea-salt aerosol, oceanic DMS, biogenic VOC, wind-blown dust, short-lived bromo-carbon	On-line		Meteorology-driven

Non-U.S. Global Emissions: EPRI 2028 Projections

Region	Inventory	Base year	2028 simulation
Canada	APEI	2014	ECCC's projections (2013 to 2025)
China	MEIC	2016	Wang et al., (2014)
Global; rest of the world	CEDS (GEOS-Chem default)	2014	RCP4.5
Aircraft	AEIC	2005	RCP4.5
Shipping	NEI, EMEP, HTAP	2011, 2012, 2010	RCP4.5
Biomass	QFED2	2016	2016
Volcanic SO2	Aerocom	2009	Degassing emissions only
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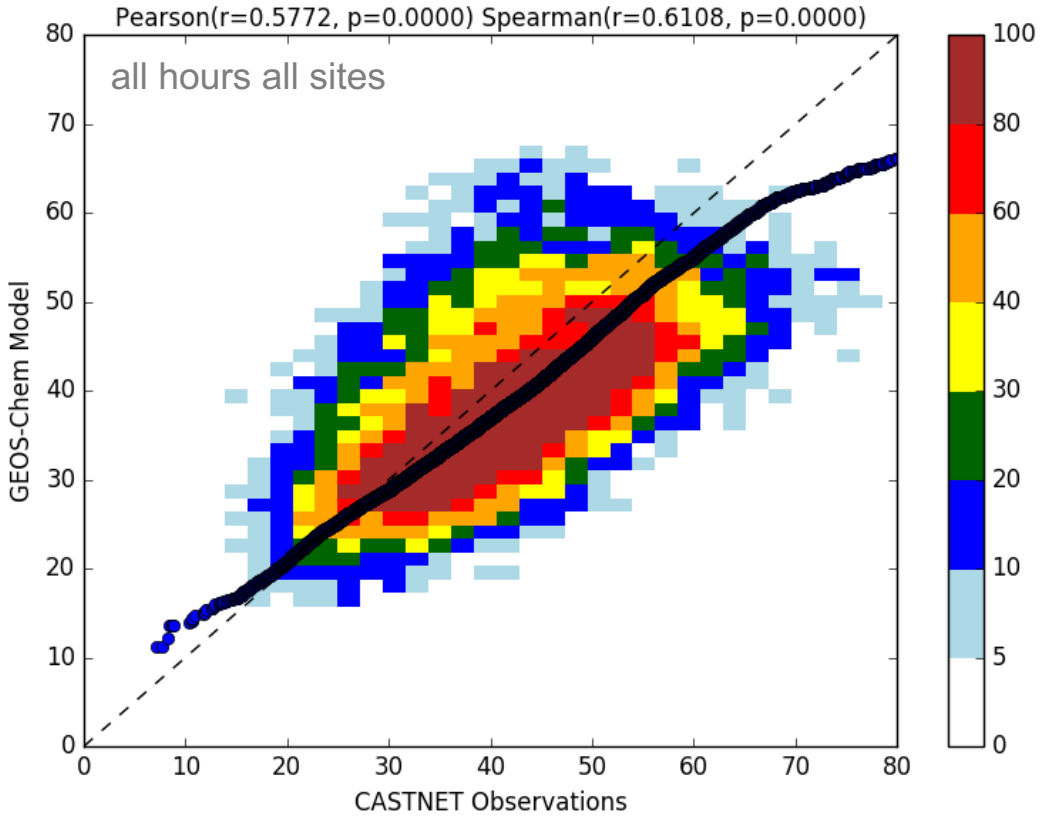
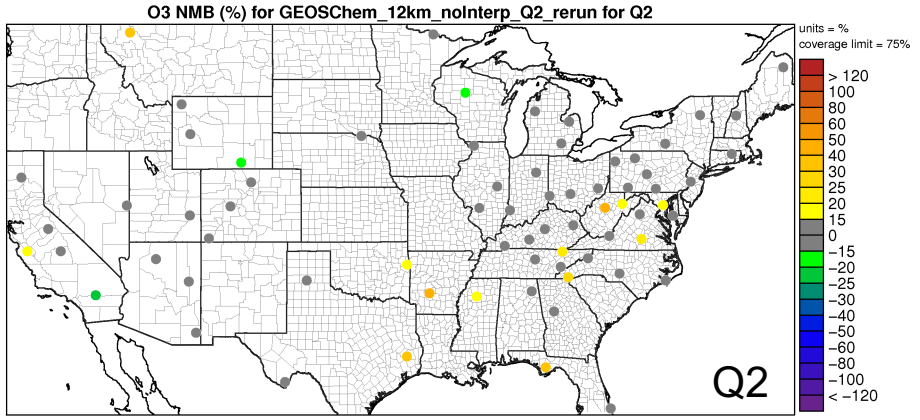
Baseline 2016 Model Performance

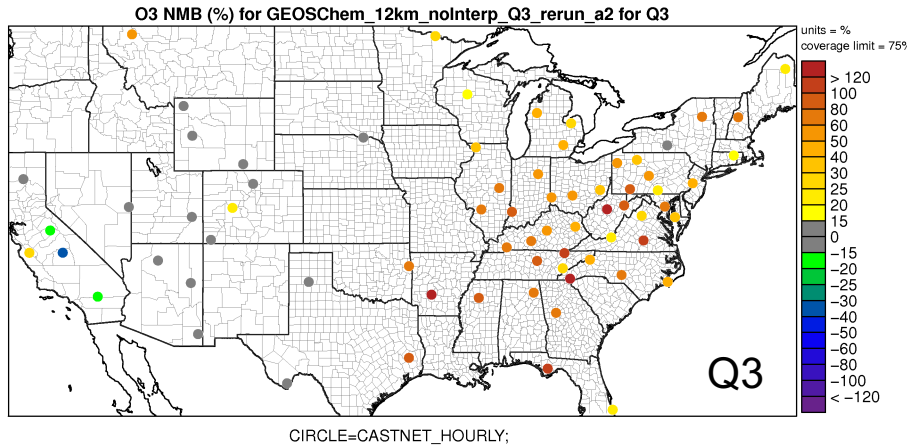
Ozone

Ozone predictions are within reasonable ranges

- r=0.6; tendency to underestimate

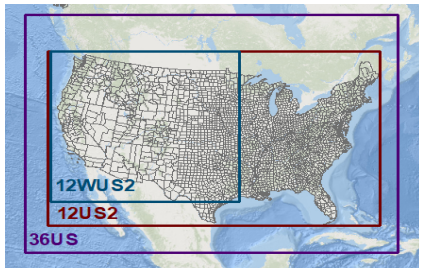






- Biases (NMB) generally within 15%
- Overprediction in Q3 in the east influenced by local emissions

WESTAR-WRAP Regional Haze Analysis – Boundary Conditions for U.S. Photochemical Grid Modeling



Task 1.7 – Two additional sets of 2014 GEOS-Chem and PGM modeling:

- (NAT) natural conditions simulation that eliminates all anthropogenic emissions across the earth (U.S. and international); and (ZROW) eliminate non-U.S. (International) anthropogenic emissions (Zero-Out Rest of World). Post-process to examine natural background conditions and conditions without international anthropogenic sources.

Task 1.8 – Broad Anthropogenic vs. Natural Source Apportionment Modeling:

- CAMx 2014 36/12-km PSAT source apportionment modeling to separate PM contributions natural and anthropogenic emissions. (8 Source Groups total for BCs and within U.S. domain, so CAMx/PSAT simulation will run relatively quickly)

Optional Task 1.9 - No U.S. anthropogenic emissions (NOUS) 2014 GEOS-Chem & PGM36/12-km modeling.

Applies same natural/anthro definitions as EPRI study

EPRI Project Extension

- Georgia Tech (PIs: Talat Odman and Ted Russell)
- Conduct 2016 and 2028 Ozone and PM Source Apportionment Simulations
- 7 EPRI Source Categories (tentative):
  - EGU, Non-EGU Point, On-Road, Non-Road, Area, “Natural + All Fires,” Boundary Conditions
- 8 WESTAR-WRAP Source Categories:
  - BC Intl Anthro, BC US Anthro, BC Natural, Mex/Can, Off-shore Anthro, Wildfire, Prescribed Burns, Other Natural Emissions, US Anthropogenic
- 7 EPRI Source Regions in US (TBD)

- Note:
  - EPRI project extension is not focused on regional haze but rather providing context on contributions from different anthropogenic sectors and contributions from regional US transport
  - No cross tags, i.e., sector × source tags
  - Boundary conditions are not apportioned – different from WRAP-WESTAR approach

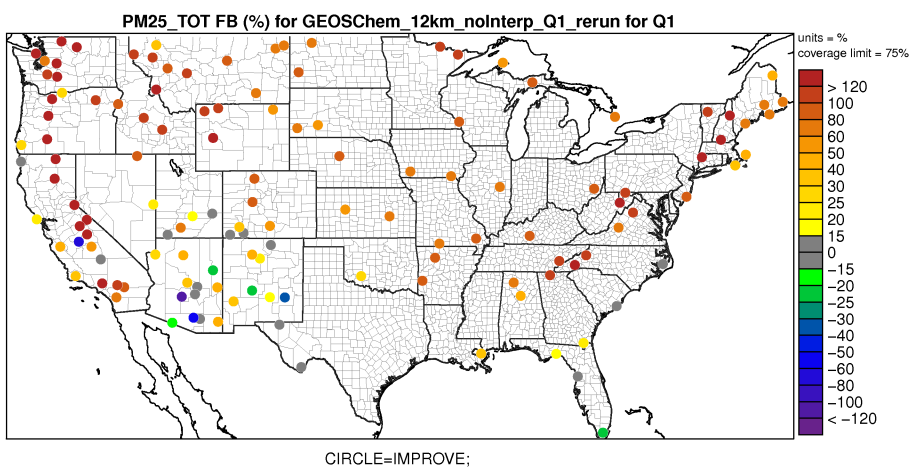
Complementary Nature of EPRI and WESTAR/WRAP Studies + Next Steps

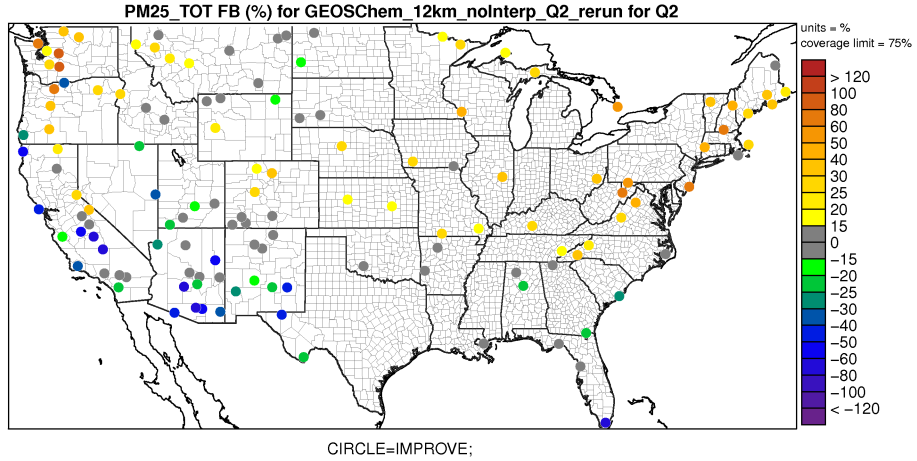
- By looking at different baseline years and using different methodologies for projecting to 2028, we can get a better understanding of the robustness of regional haze projections and estimates of the internal transport contributions
- Different source apportionment techniques are similarly complementary
- Overall, these studies provide a basis of comparison to the EPA modeling efforts (using CMAQ-Hemi and CMAQ)
- How can the HAQAST Team leverage these efforts, answer additional questions, and provide additional context? What are the key issues to address?

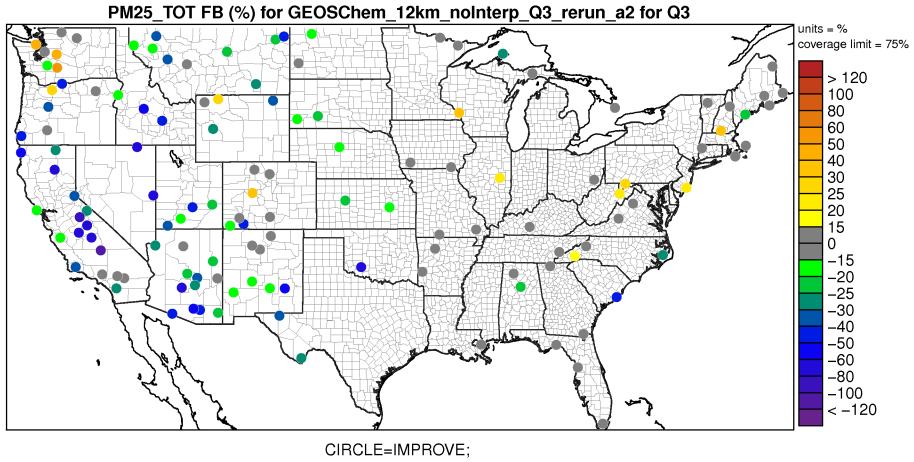
Appendix

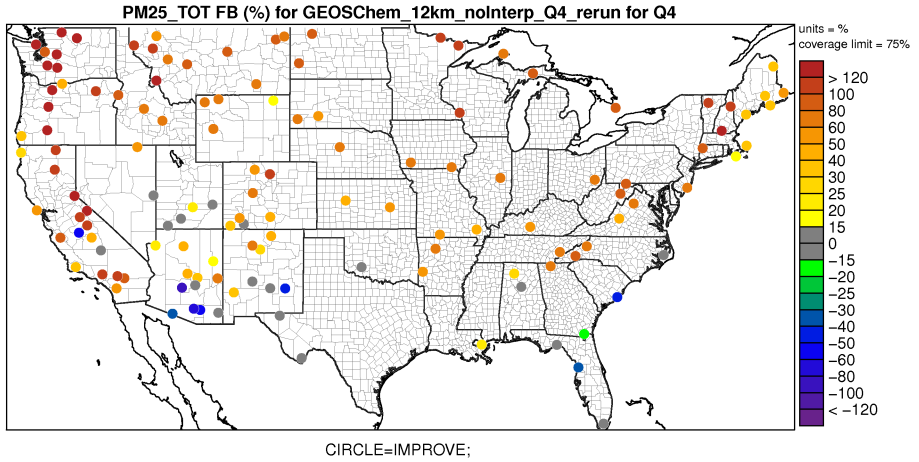
Baseline 2016 Model Performance

$PM_{2.5}$ FB (%)









- Biased high in Q1 and Q4
- Tendency to under estimate in Q2 and Q3

Baseline 2016 Model Performance

Key takeaways

- Ozone predictions are within reasonable ranges
  - NMB generally within 15%
  - Biased high in the eastern US likely related to local (US) emissions
- $PM_{2.5}$ performance is not as good
  - Driven largely by local sources
  - Not clear how PM performance affects CAMx boundary conditions
- Emission assumptions could affect model performance
  - Shipping ECA zones not considered
  - They will be in CAMx simulations

CAMx v7 (Summer 2019)

- New features/Updates
  - DMS chemistry
  - SOA chemistry updates (reduced terpene yields, reduced SOA photolysis, no biogenic polymerization to SOPB)
  - Bi-directional ammonia
  - 8 elemental species (now with chemistry influences)
  - netCDF file format
  - Expanded tracer arrays (larger SAT, DDM applications)

Natural Emissions for CAMx

Sources	Our approach	Note
Day-specific Wildfire	2016 Modeling Platform	
Biogenic VOC	MEGAN modeling	
Sea-salt	Ramboll sea salt pre-processor using a scheme described by Ovadnevaite et al. (2014)	Uses CAMx met and landuse inputs (and global oceanic chlorophyll-A if generating halo-methanes)
Windblown Dust	Ramboll wind blown dust pre-processor using a scheme described by Klingmüller et al. (2017)	Uses new CAMx met, landuse, and soil moisture inputs; uses global fields for emissive areas, LAI, clay content and mineral fraction
Oceanic dimethyl sulfide (DMS)	Updated the current sea-salt pre-processor to include DMS	Uses CAMx met files and Lana et al. (2011) global DMS concentrations
Lightning NOx	Lightning NOx pre-processor	Uses new CAMx met files and other inputs (flash rates, yields per flash, cloud-to-grid ratio) from literature

EPRI Project Schedule (assumed 2016v1 MP ready to use by early October)

Proposed Tasks	Estimated Completion
Task 1. Global modeling	Dec 2018
Task 2. Regional modeling (CAMx)	October 2019 – May 2020
Task 3. Communication	Throughout the project (Preliminary results – March 2020)
Task 4. Final Report and Data Distribution	May/June 2020 (Est.)

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