Scientific Insight from CAMx & OSAT Modeling

Presented by: Dan Goldberg Thursday April 23rd, 2015 Spring OTC Meeting

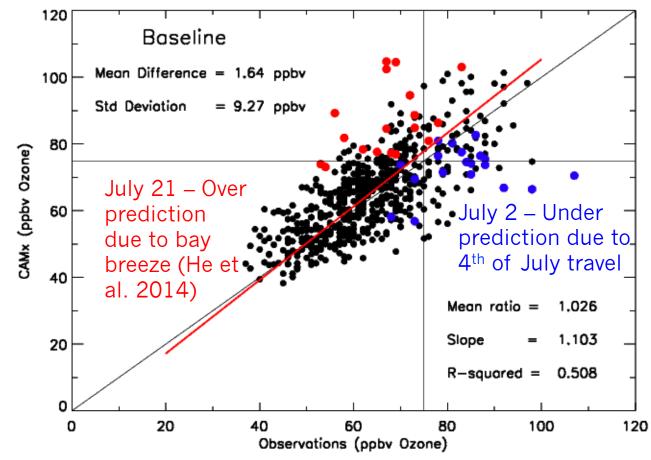


Description of model used:

- CAMx v6.10 (12 km OTC model domain)
 - EPA-approved regulatory model
 - Can use the CB6r2 gas-phase chemical mechanism (Ruiz & Yarwood, 2013)
 - Better alkyl nitrate chemistry
 - Ability to use ozone source apportionment technology (OSAT) to identify where the ozone "originated" by region & sector

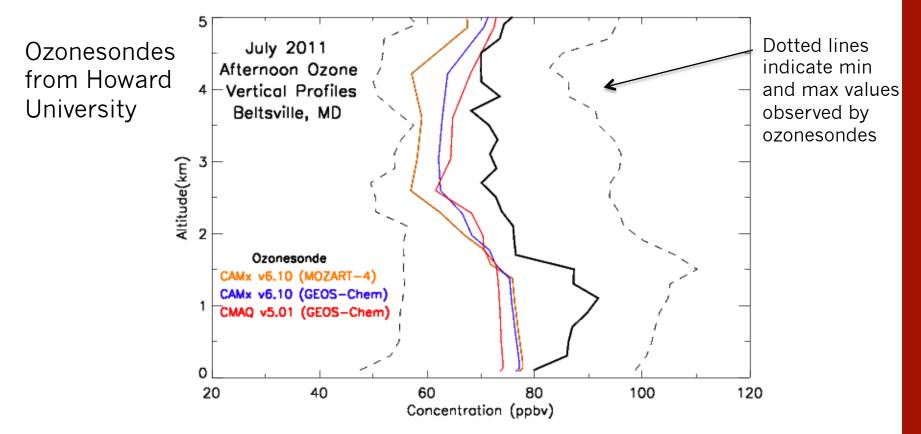


July 2011 8-hour maximum *surface* ozone: CAMx model vs. observations in Maryland



There is <u>excellent</u> model agreement in predicting *monthly surface* ozone when using the standard, "off-the-shelf" version of CAMx Dan Goldberg, University of Maryland. Please do not forward without prior approval

July 2011 Comparison in the Vertical Ozonesondes launched during 11 days at Beltsville, MD



- CAMx and CMAQ do not get the structure between 0.5 1.5 km above the surface; significant underestimation (up to 15 ppb)
- Consistent offset between 2 5 km above the surface; at 3.5 km the models approach the min value observed over 11 days

CAMx v6.10 Design Values (2011 Platform)

Edgewood, MD is the only Maryland monitoring location to be in non-attainment in any scenario

Maryland	Observed	Model-predicted	
Monitoring	2011 Design	2018 CAMx Design	
Location	Value (ppb)	Value (ppb)	
Davidsonville	83.0	70.7	
Padonia	79.0	71.3	
Essex	80.7	71.1	
Calvert	79.7	68.1	
South Carroll	76.3	66.8	
Fair Hill	83.0	70.9	
Southern Maryland	79.0	67.6	
Frederick Airport	76.3	67.0	
Piney Run	72.0	61.8	
Edgewood	90.0	79.0	
Aldino	79.3	67.6	
Millington	78.7	66.8	
Rockville	76.3	66.9	
HU-Beltsville	79.0	67.9	
PG Equestrian Center	82.3	70.0	
Hagerstown	72.7	63.9	
Furley	73.7	67.1	

CAMx v6.10 Design Values (2011 Platform)

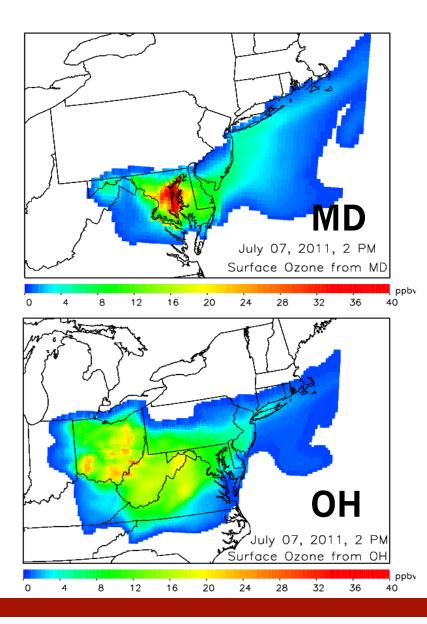
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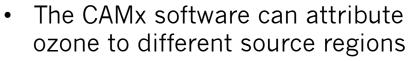
Maryland	Observed	Model-predicted	
Monitoring	2011 Design	2018 CAMx Design	2018 CMAQ Design
Location	Value (ppb)	Value (ppb)	Value (ppb)
Davidsonville	83.0	70.7	68.9
Padonia	79.0	71.3	68.2
Essex	80.7	71.1	69.4
Calvert	79.7	68.1	68.8
South Carroll	76.3	66.8	66.8
Fair Hill	83.0	70.9	70.0
Southern Maryland	79.0	67.6	66.9
Frederick Airport	76.3	67.0	66.9
Piney Run	72.0	61.8	59.7
Edgewood	90.0	79.0	76.0
Aldino	79.3	67.6	66.1
Millington	78.7	66.8	65.7
Rockville	76.3	66.9	64.5
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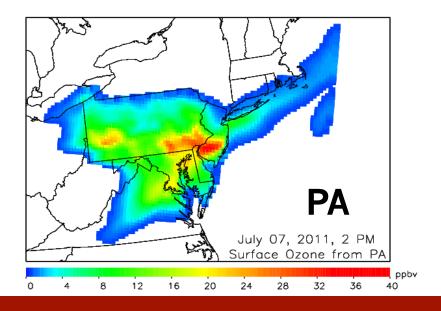
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Ozone Source Apportionment Examples



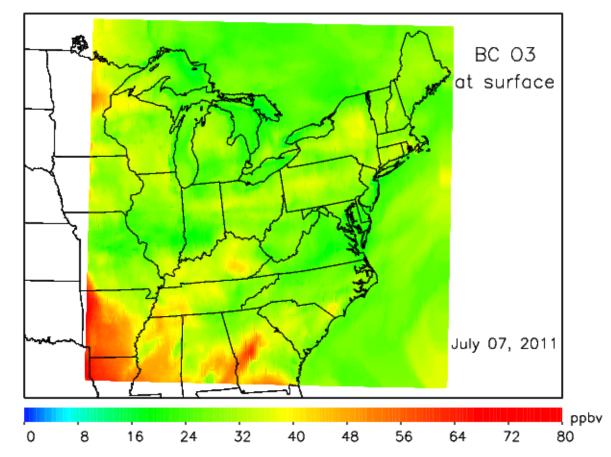


 Ozone can be transported long distances downwind of the original source



Ozone from the boundary

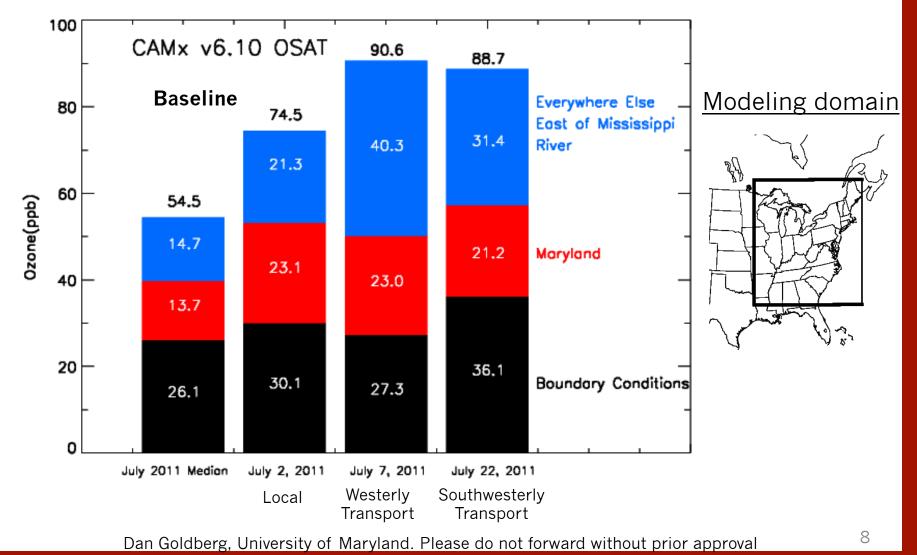
Ozone attributed to areas beyond the model domain, i.e., Texas, Cal, Asia

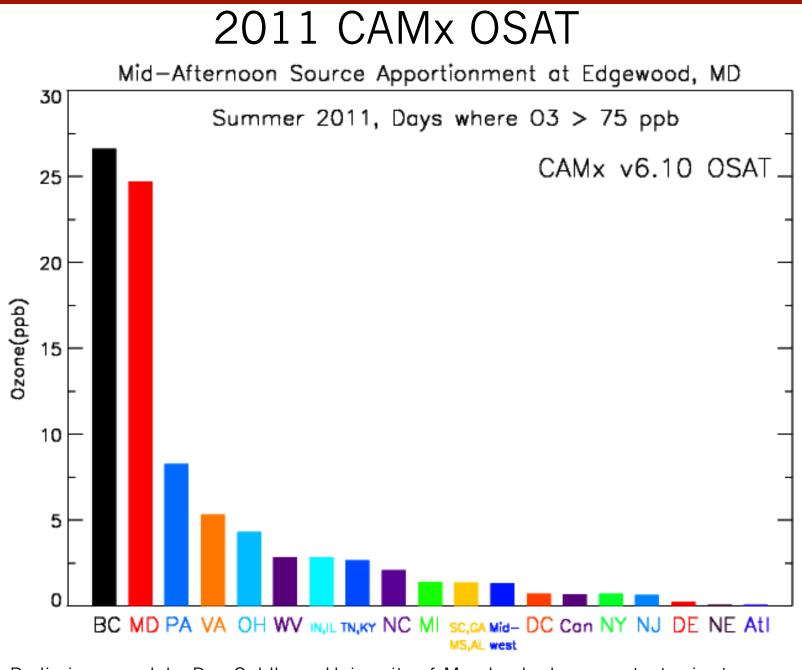


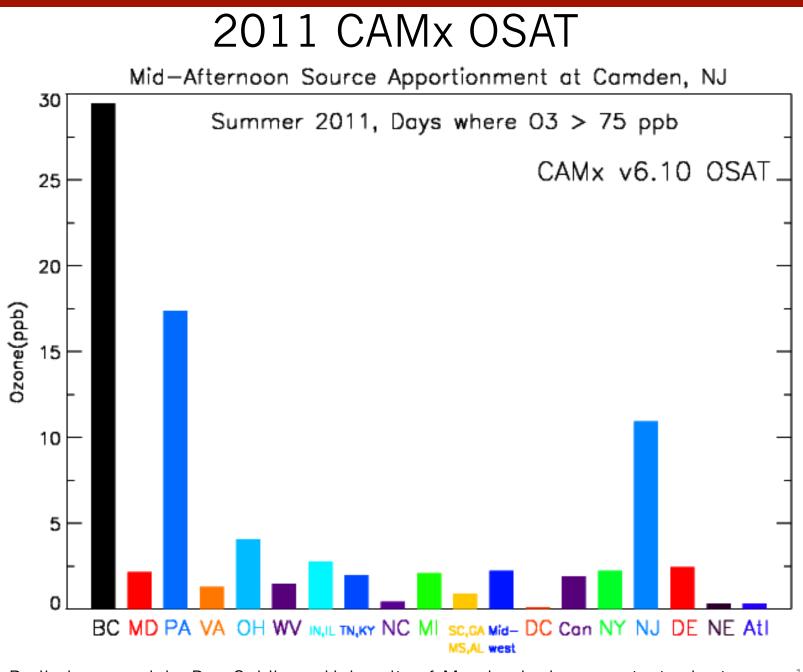
- Ozone from the boundary is uniformly greater than 15 ppbv
- Some locations, especially close to the boundaries, are higher

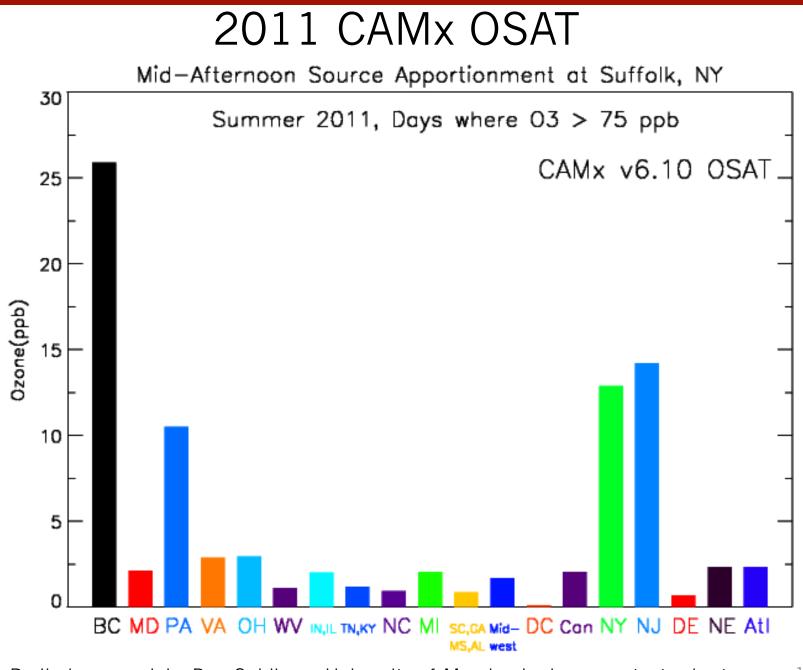
July 2011: Ozone Source Apportionment

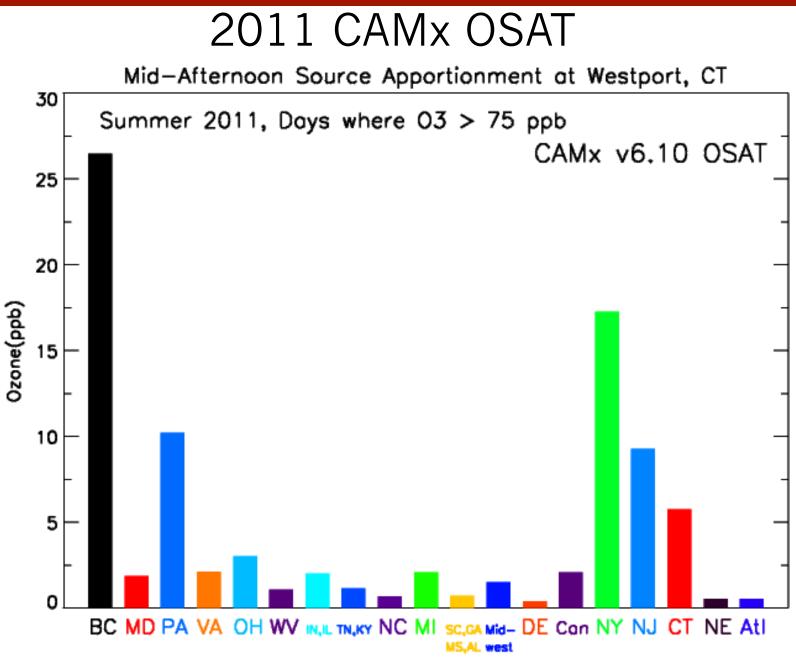
• Fraction of total surface ozone attributed to the boundary conditions, Maryland, and everywhere else in the modeling domain during the mid-afternoon at Baltimore, MD

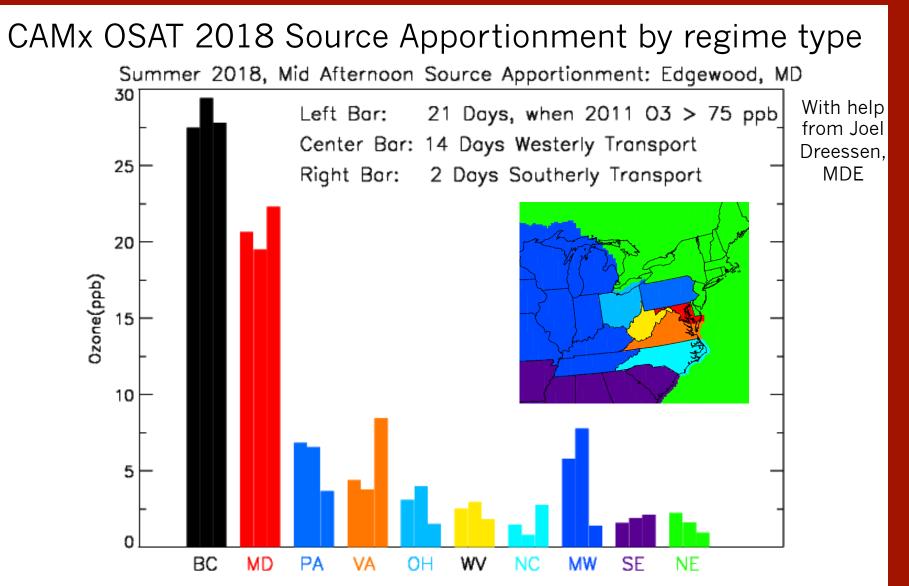








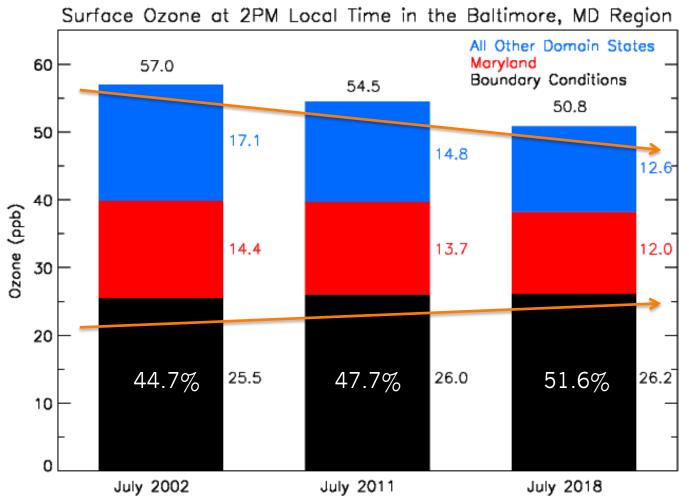




• Midwestern & Ohio River valley states have larger role during westerly transport days

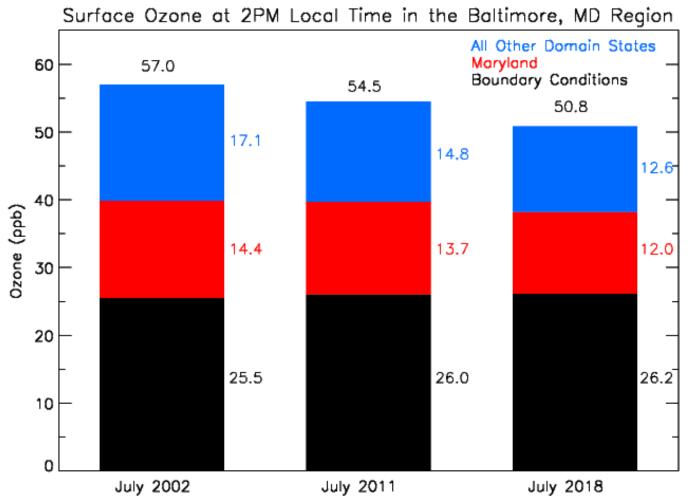
• Virginia & North Carolina have double the role during southerly transport days

Importance of Boundary Conditions



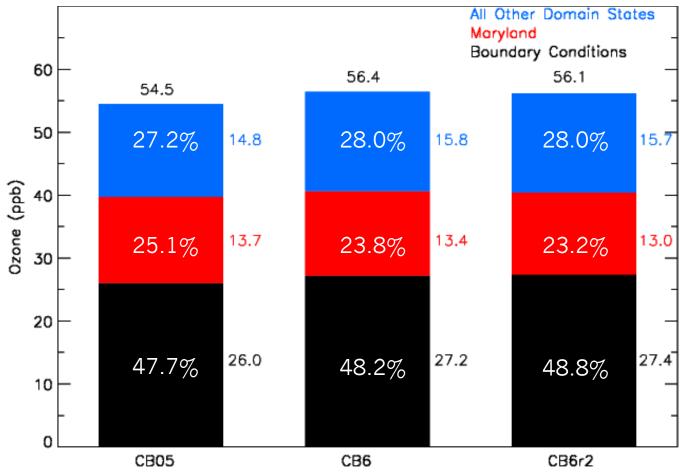
Emissions outside of the state of Maryland, <u>especially at the model domain</u> <u>boundaries</u>, are becoming more important when trying to show future attainment

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Mid-afternoon surface ozone in Baltimore, MD during July 2011: CB05, CB6 & CB6r2 gas-phase chemistry



New chemistry attributes less ozone to in-state sources and more to upwind regions including the model domain boundaries.

Conclusions

- CAMx v6.10 with CB05 chemistry has excellent simulation of monthly 8-hour maximum surface ozone, **HOWEVER...**
 - Vertical profiles of ozone show significant underestimation aloft
 - Are the ozone precursors being properly characterized?
- Ozone attributed to the boundary is the largest component of surface ozone and will continue to get larger; >50% of surface ozone by 2018.

- During the worst air quality days, in-domain sources still dominate

- Meteorology matters! Regime types differ from year-toyear. Westerly transport dominated during the summer of 2011, southerly transport occurred less than during 2007
- CB6r2 gas-phase chemistry has a better representation of alkyl nitrates, better captures the regional nature of ozone and the interstate transport of ozone

Future work

- May need a larger model domain to capture the increasingly regional nature of ozone
- Beta chemistry simulation will likely improve the characterization of ozone precursors
 - Better representation of control strategies

Detailed description of model used:

- CAMx v6.10 (12 km OTC model domain)
 - Date range: May 26 August 31, 2011
 - 10 days spin-up
 - CB05 Gas-phase chemistry
 - Anthropogenic Emissions: Baseline 2011 & 2018
 NEI v1 from EPA
 - Biogenic Emissions: BEIS v3.14 from EPA
 - Meteorology: WRF 2011 CONUS 12 km from EPA
 - Boundary conditions: GEOS-Chem 2011 from EPA

Sensitivity studies with: CB6 & CB6r2 gas-phase chemistry, MEGAN v2.10 biogenic emissions and MOZART-4 boundary conditions