Opportunities to Inform Air Quality Management

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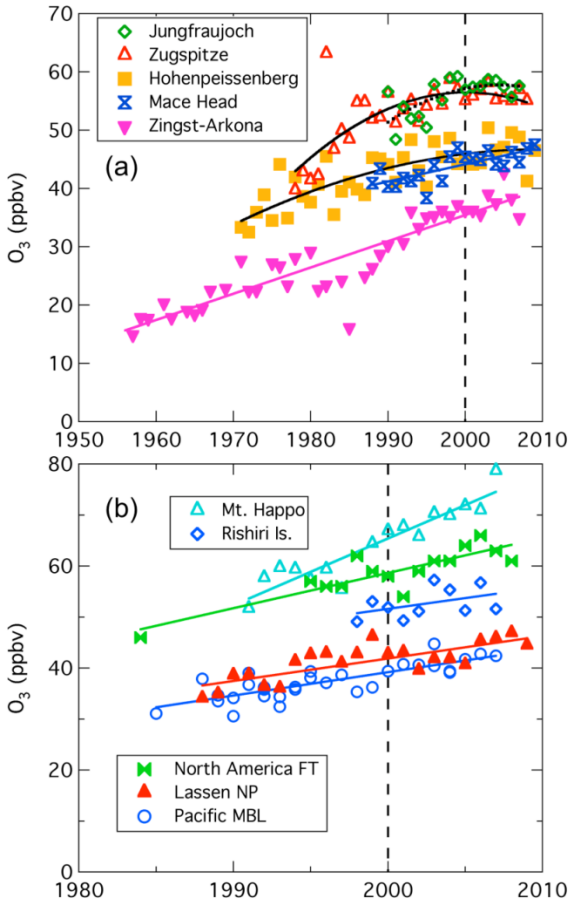
2nd Annual TOLNet Meeting
Boulder, CO
June 16, 2015

My Message

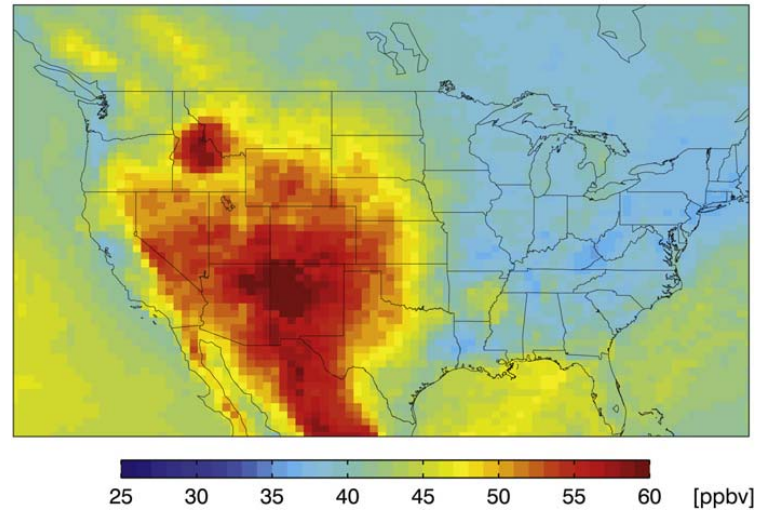
- A tightening vise: O_3 background is going up, O_3 standards are coming down
- Air quality management requires source apportionment.
- Source apportionment requires improving models.
- Improving models will require more observations of processes aloft.
- There is still time to inform policy development.
- Need to focus delivery of data and analysis to air quality modelers at federal, state, and local level.

Increasing Background Ozone: A Major Challenge in the Western U.S.



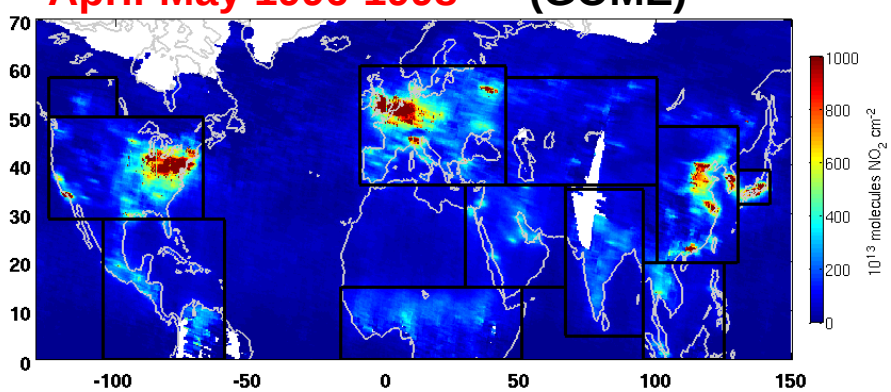
←Average springtime O_3 levels at remote or high-altitude sites across the Northern Hemisphere have shown very consistent trends. These trends suggest that baseline O_3 in northern mid-latitudes has increased by at least a factor of two since 1950. (HTAP, 2010)

→Annual 4th highest daily maximum 8-hour average O_3 (2006-8) due to emissions outside of North America is near or equal to the range being considered for the NAAQS. (Zhang et al 2011)

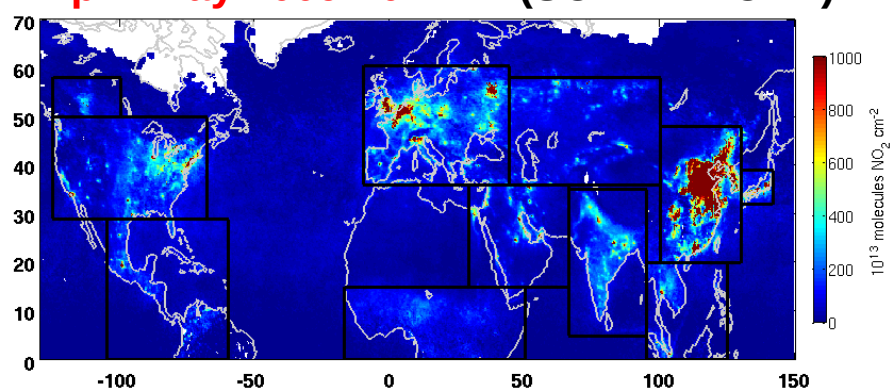


↓Satellite observations of NO_2 show that over the last decade emissions of O_3 precursors in US and EU have declined while doubling in China. (Cooper, 2013)

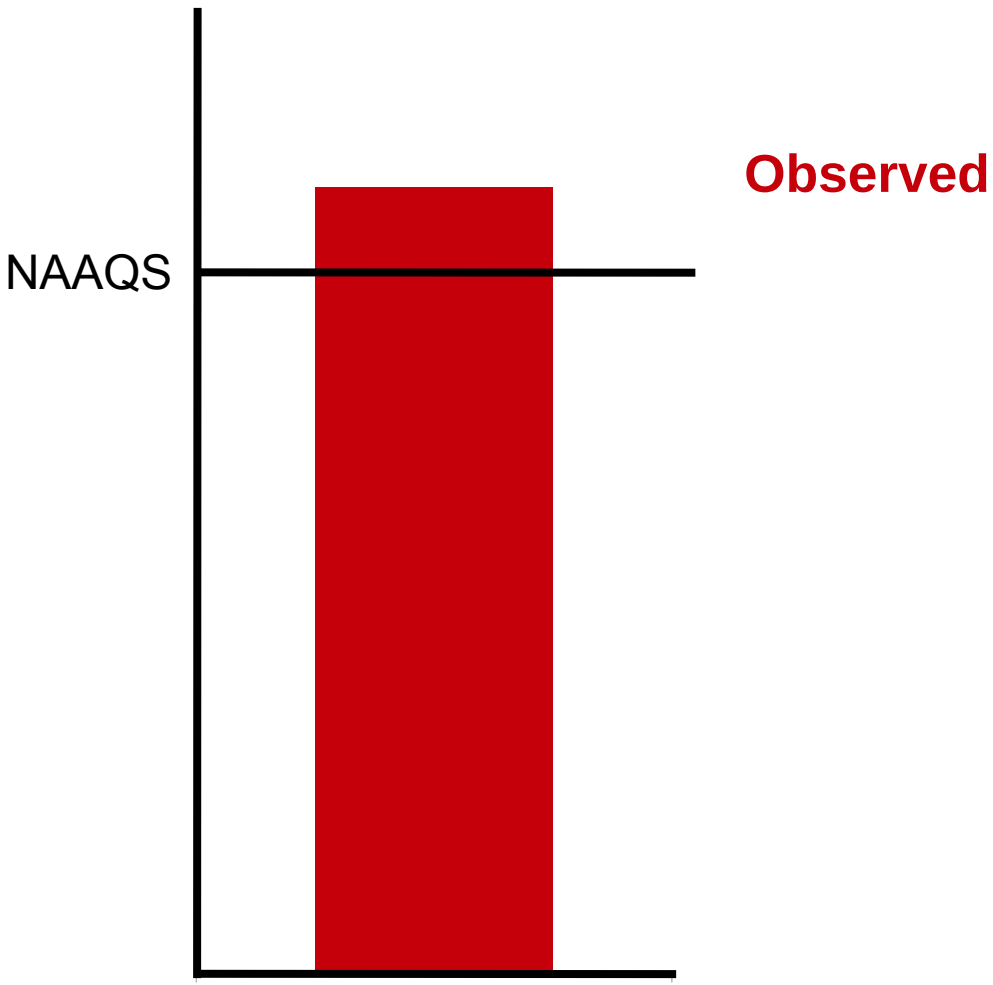
April-May 1996-1998 (GOME)



April-May 2009-2011 (SCHIAMACHY)



Air Quality Management Requires Source Apportionment



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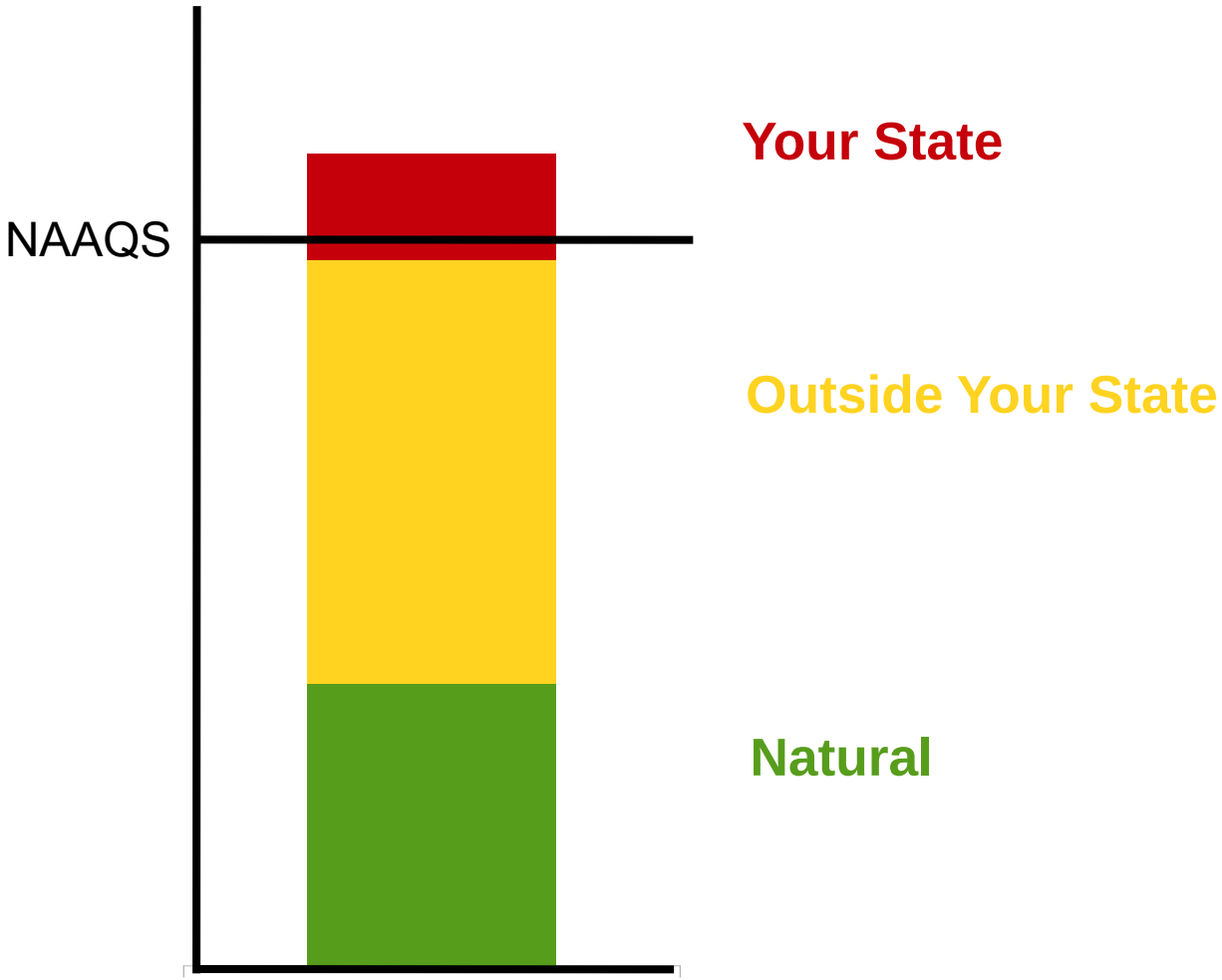

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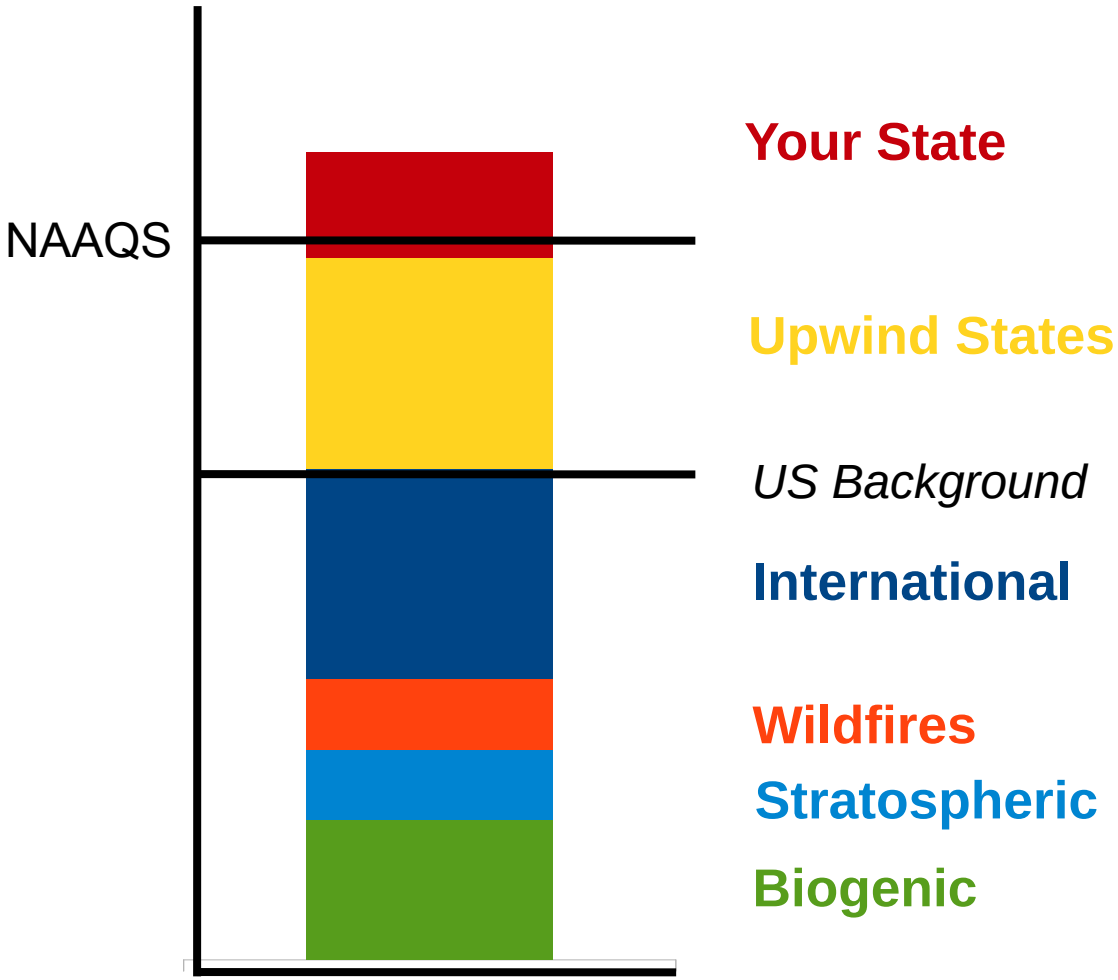

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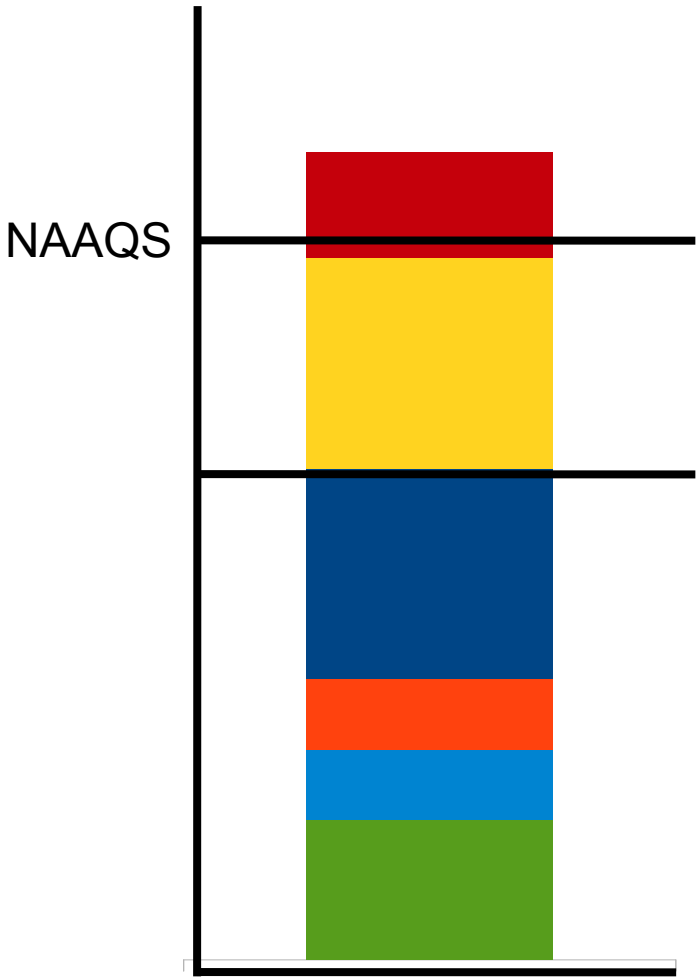
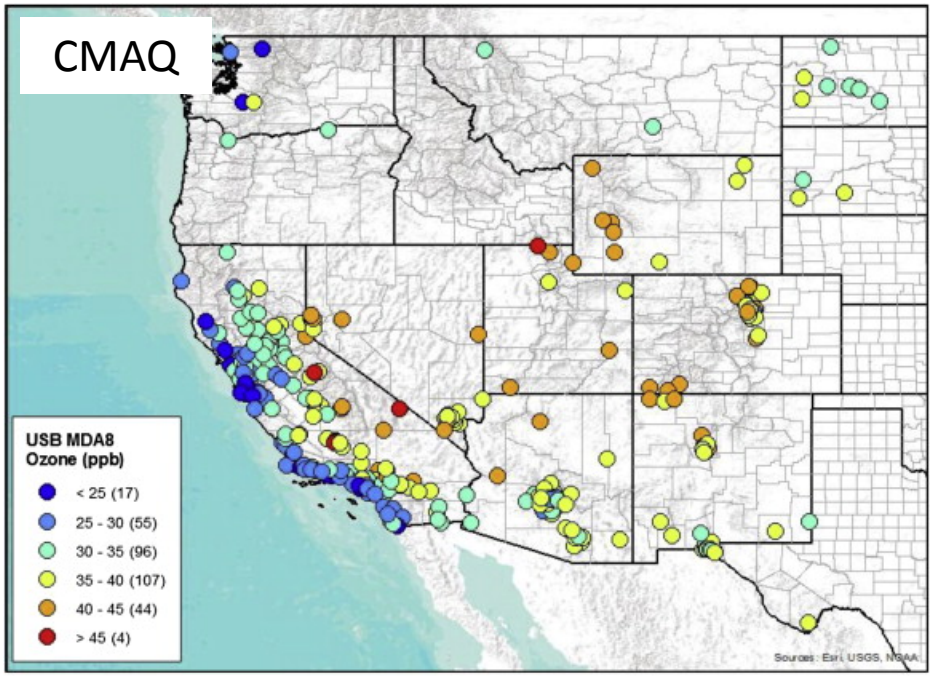


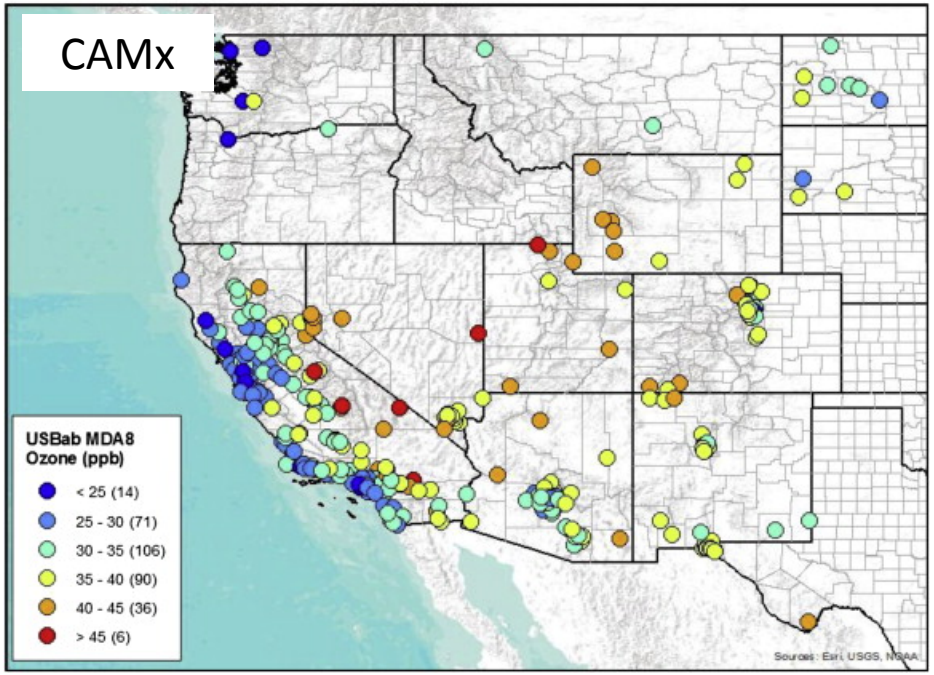
	Clean Air Act Provisions
Your State	**110 State Implementation Plans**
Upwind States	**110(a)(2)(d) Interstate Transport**
US Background	**182(h) Rural Transport Areas**
International	**179(b) International Transport**
Wildfires **Stratospheric**	**319 Exceptional Events**
Biogenic	

We need to be able to describe the sources that contribute to each exceedance day.

EPA estimates of seasonal mean U.S. background ozone

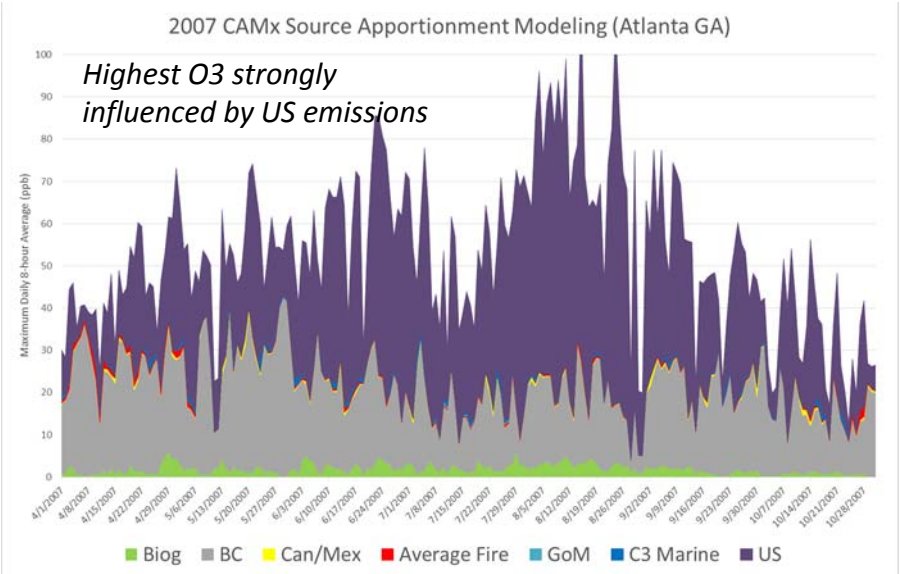
- Seasonal mean, bias-adjusted, 2007 USB and USBAB ozone levels range from 25-50 ppb
- USB: CMAQ zero out
- USBAB: CAMx OSAT
- Two methodologies provide similar estimates
- Seasonal mean USB is meaningful, but also need to consider background levels on high days

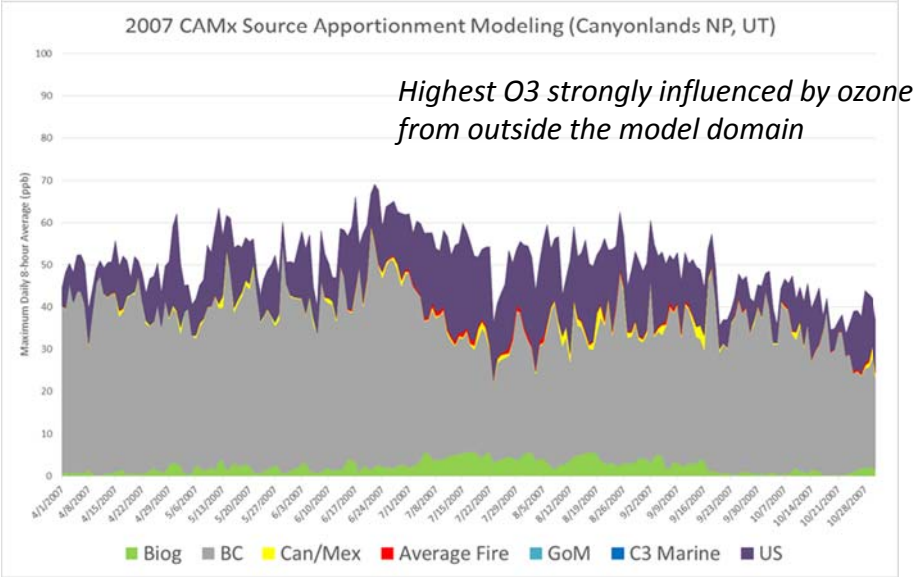




From Pat Dolwick

Temporal and Spatial Variability in Source Apportionment



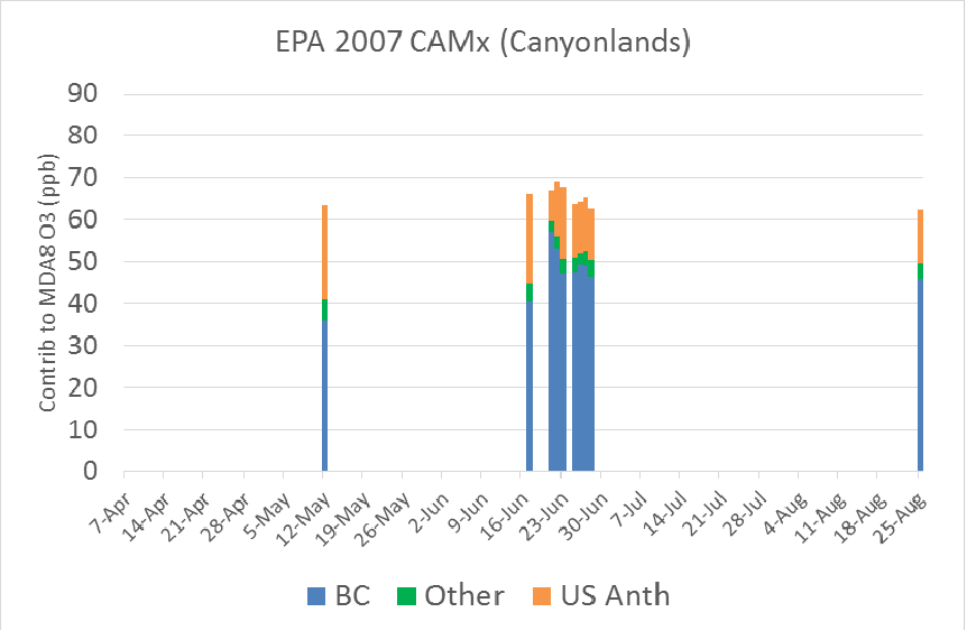


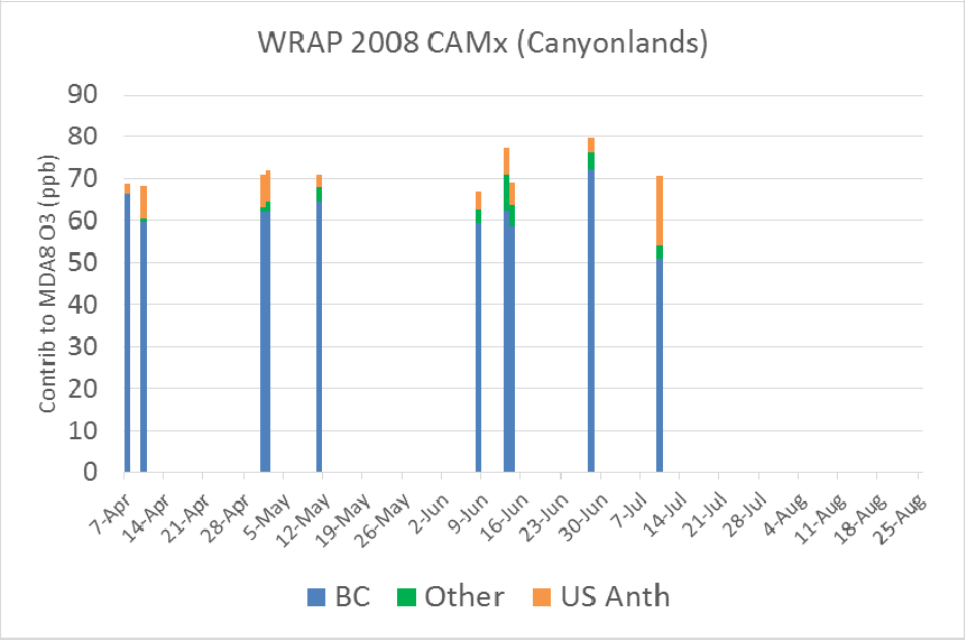
Big Differences

- East and West
- High and Low Elevation
- Rural and Urban
- Seasonally
- Synoptically

From Pat Dolwick

CAMx simulations for 2007 (EPA) and 2008 (WRAP) at Canyonlands National Park – Eastern UT





EPA 2007 CAMx model:
BC contributions of 36-57 ppb; still substantial U.S. anthropogenic contribution to O3.

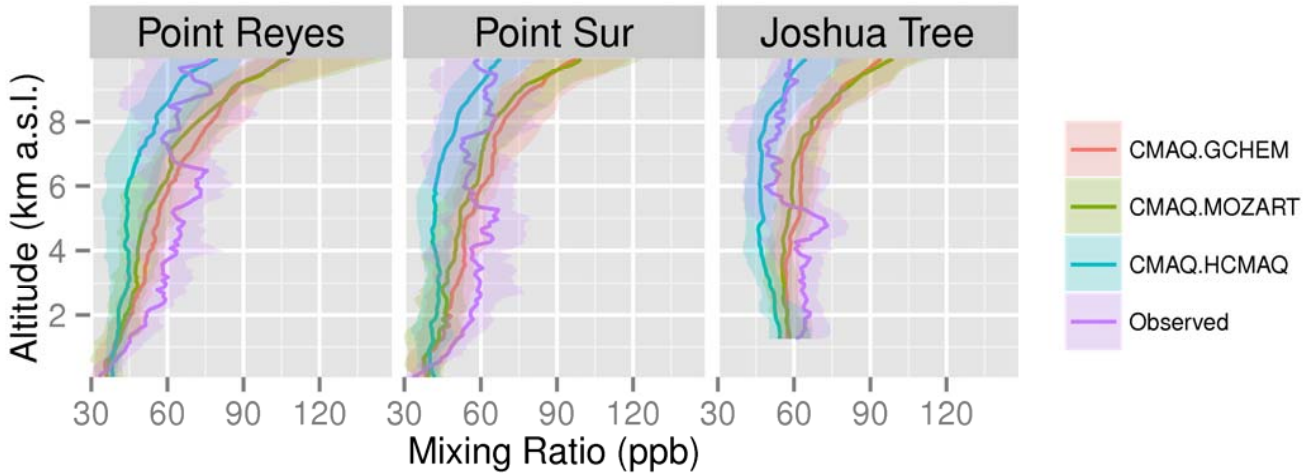
WRAP 2008 CAMx model:
BC contributions of 50-72 ppb, much larger than OAQPS modeling.

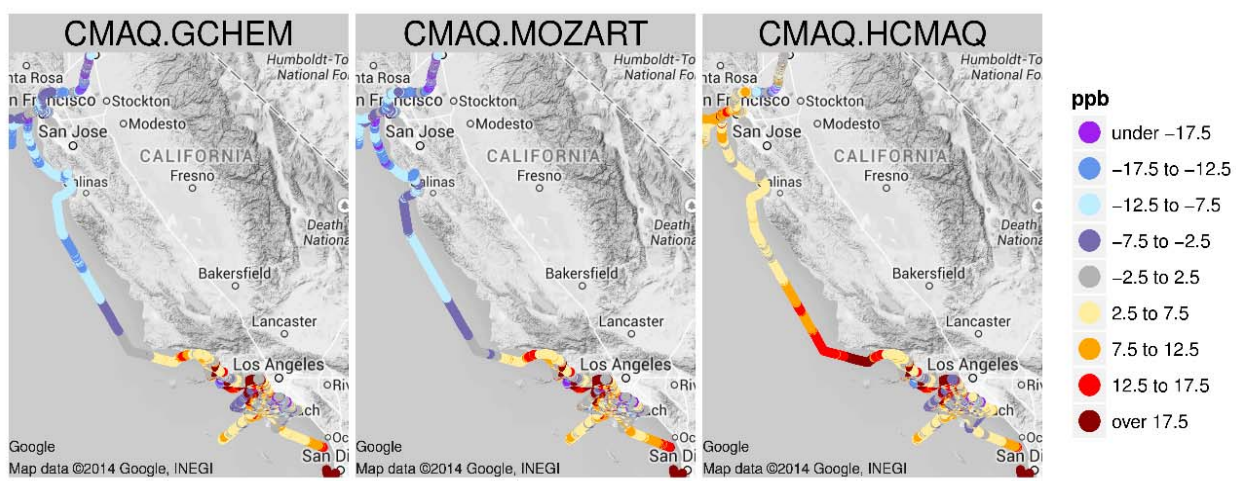
Reasons for modeled differences are not fully understood

From Gail Tonnesen

Evaluation of BC approaches using 2010 CalNex field study data

- BC's from GEOS-Chem, MOZART, and Hemispheric CMAQ
- Comparison with IONS ozonesondes
  - Hemispheric CMAQ yields lower O3 aloft than MOZART and GEOS-CHEM
  - Mixed results at lower altitudes
- Comparison with CalNex R/V Atlantis O3 observations
  - MOZART and GEOS-CHEM yield underpredictions north of Point Conception, whereas hemispheric CMAQ yields overpredictions
- Results are preliminary
  - Would be interested in a more complete systematic comparison if global model output and processing tools were readily available



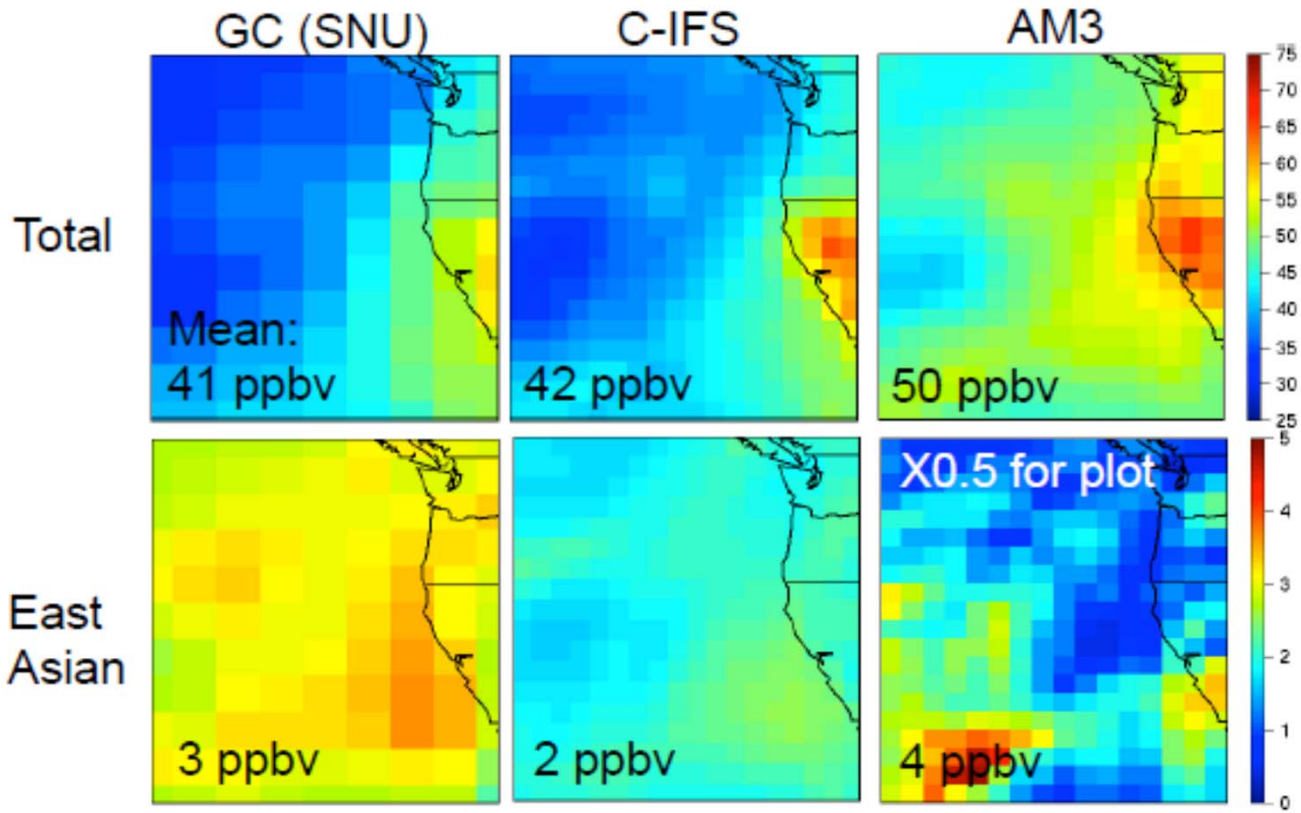


Ozonesonde and R/V Atlantis measurements provided by Owen Cooper, Eric Williams, and Brian Lerner

From Pat Dolwick, Kirk Baker

An Initial Look at Early HTAP2 Results

Ozone in boundary condition global models (Jun 15-30, 2008, ~700-900 hPa)

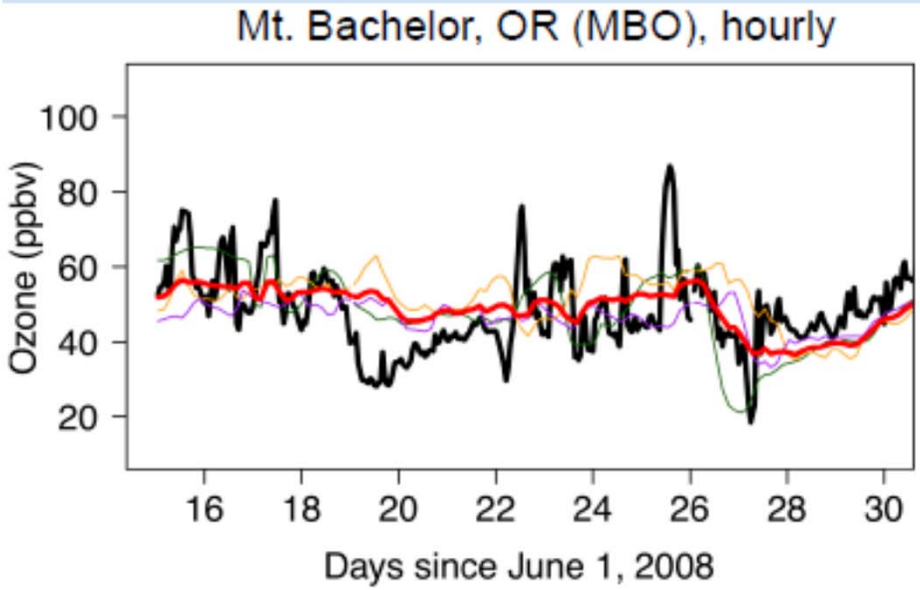


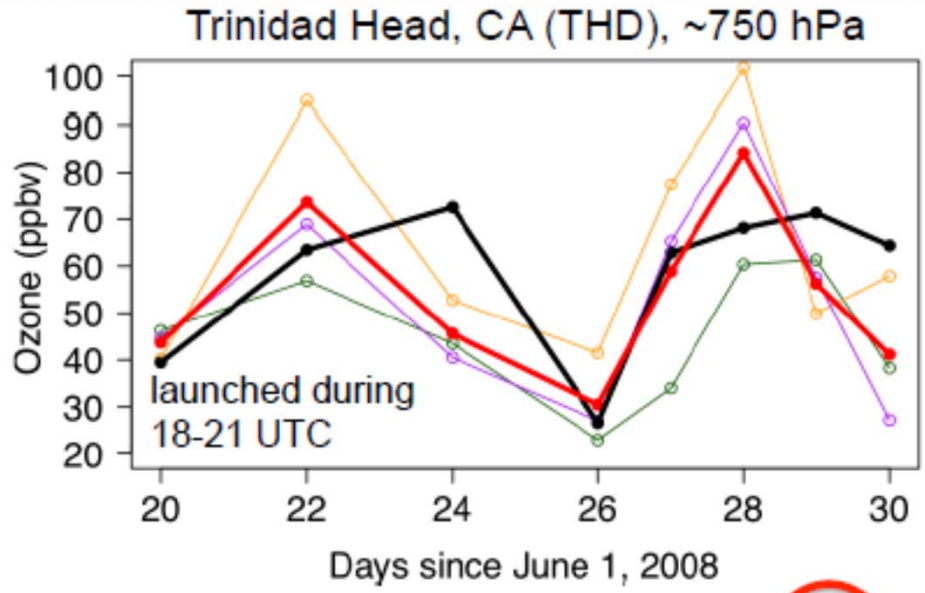
- Inter-model variability occurred in modeled total ozone and East Asian anthropogenic contributions
- East Asian anthropogenic emissions contributed to <10% of the total ozone
- Reducing the uncertainties in global model in FT requires reducing uncertainties from other contributors (such as transport from the stratosphere, and non-US wildfires)

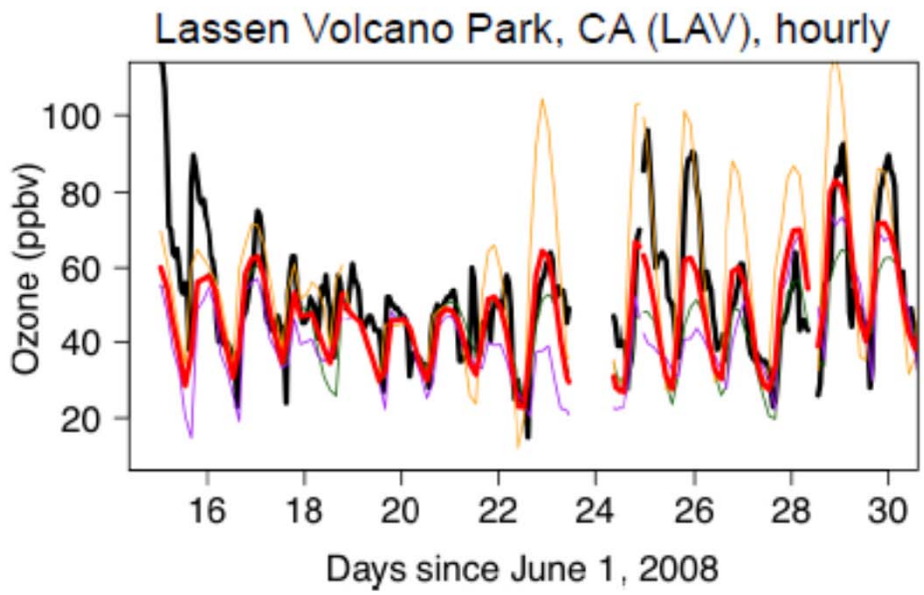
From Min Huang

An Initial Look at Early HTAP2 Results

Evaluation of ozone in boundary condition global models at western US remote sites







Mean Error (ppbv)	GC 2x2.5	AM3 1x1.25	C-IFS 1.125x 1.125	HTAP mean
MBO	8.35	10.86	8.65	8.24
THD	14.81	17.84	14.83	12.93
LAV	10.90	13.92	13.13	9.73

Three-model mean better than any single-model free run

From Min Huang

Proposed Timeline for O_3 NAAQS Implementation

Oct 2015	Final O_3 NAAQS
	Final Guidance on Monitoring, PSD
Jan 2016	Guidance on Designations
Oct 2016	States and Tribes submit Designation Recommendations
	Proposed Rules and Guidance for State Implementation Plans (SIPs)
Oct 2017	Final Designations (likely based on 2014-2016 observations)
	Final Rules and Guidance for SIPs
2020-2021	States and Tribes submit SIPs and TIPs with Attainment Demonstrations
2020-2037	Attainment Deadlines

It's not too late. We've only just begun.

Informing Model Evaluation for AQM

- Make observational data easily accessible and usable to modelers at federal, state, and local level.
- Harmonizing data formats, naming conventions, and metadata with existing practices are all important investments.
- Provide data within tools already being used by modelers:
  - Remote Sensing Information Gateway (RSIG)
  - Atmospheric Model Evaluation Tool (AMET)
  - Common data visualization packages…
- Provide examples of analyses and applications (O_3, aerosol, PBL)
  - What can be learned from NASA/AQAST?
- Present at CMAS (CMAQ annual meeting)
- Reach out through existing coordination mechanisms
  - Federal Level: Air Quality Research Subcommittee
  - State Level: NAACA, ...

Where to add or deploy?

Over the next year,

- EPA and state analyses will identify locations where background is most problematic.
- HTAP2 analysis will identify performance issues for global and regional models for 2010 (and 2008).

How can we use these to inform candidate sites for additional observations? How well do these match up to other networks (Ncore, PAMS, IMPROVE, Sondes, Pandora,...)

Needs are most immediate in West, but interstate transport is still an issue in the East.