Multi-Emissions Scale Contribution Assessments

Kirk Baker

U.S. Environmental Protection Agency

Photochemical Model Source Apportionment

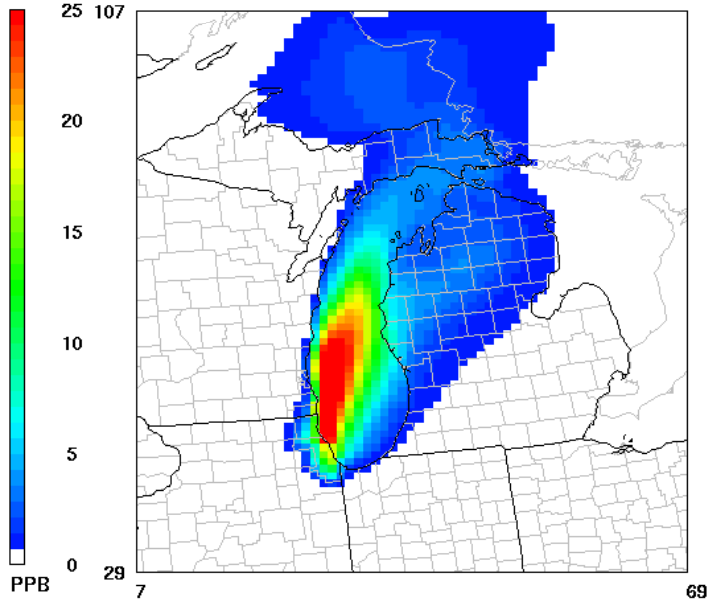
- State of the science photochemical grid models simulate formation and transport of particulate matter and ozone

- Photochemical model source apportionment tracks the formation and transport of ozone and PM2.5 from specific emissions sources and allows the calculation of contributions to receptors

- This approach is different from other methods to estimate source contribution:
  - observation based source apportionment (PMF, CMB)
  - Forward sensitivity: brute-force zero out simulations, Decoupled Direct Method (DDM)
  - Backward sensitivity: adjoint

Photochemical Model Source Apportionment

- Photochemical model source apportionment very efficient for estimating culpability for many sources and does not perturb important atmospheric chemical processes
- Source groups may be single sources, groups of sources (sector), entire States or entire Counties
- Receptors are each individual grid cell--which may be matched to any monitor located in the model domain—and do not need to be specified before the model run



8-hr maximum O3 contribution from Cook County to all modeled locations for a single day in July, 2005

Modeling Background

- CAMx v5.01 photochemical model
- APCA source apportionment

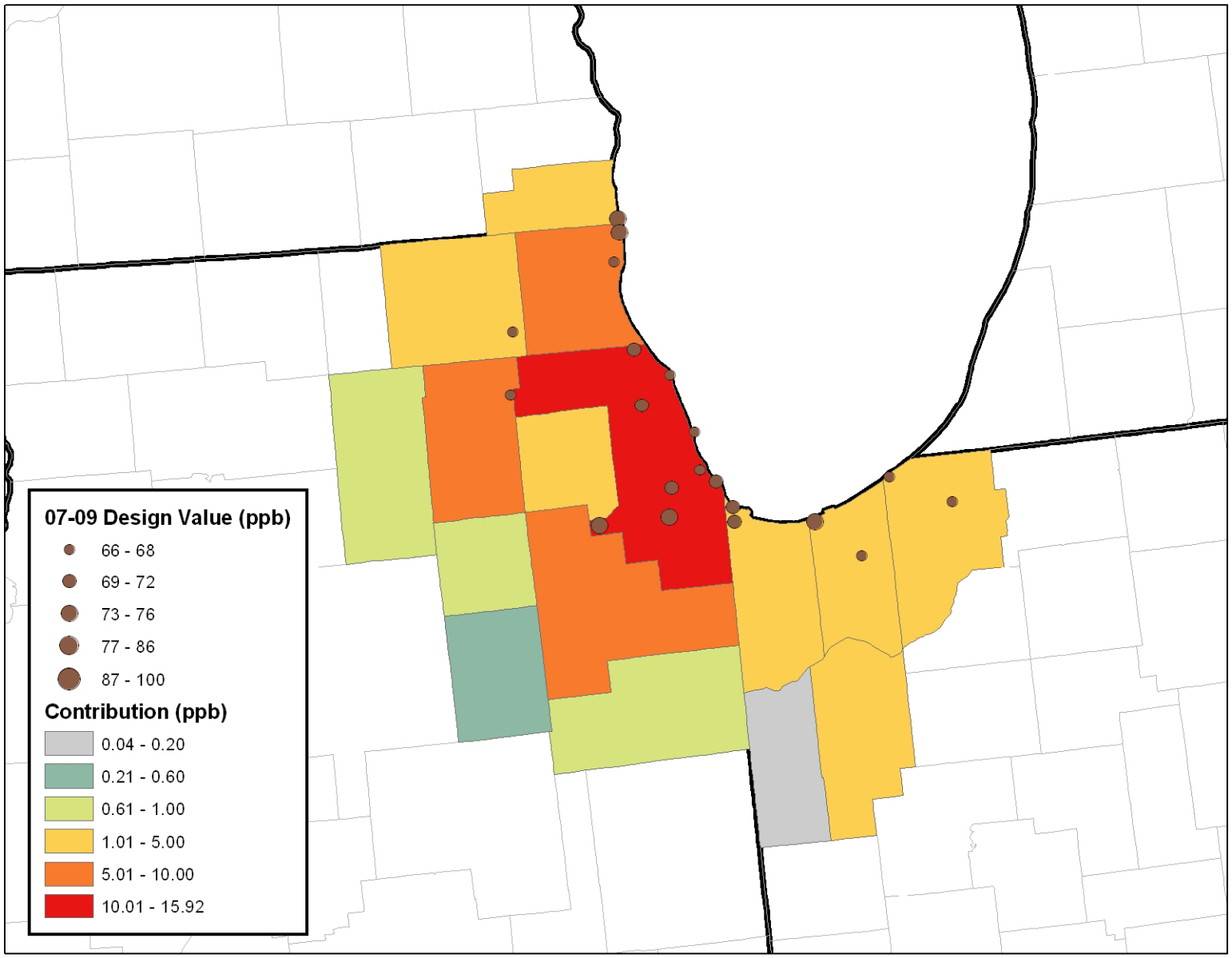
- Annual simulations using 2005 and 2006 meteorology
- 12 km sized grid cells

- Emissions based on the 2005 version 2 National Emissions Inventory

- County emissions are processed using an enhancement to the SMOKE emissions modeling system, which is much more precise than commonly used approaches to matching gridded emissions to Counties or States

County Contribution Illustration

- Contributions are the average of all modeled days at a receptor location where 8-hr max ozone is greater than 65 ppb for this example
- Plots show highest contribution to any monitor in the CSA/CBSA for illustrative purposes
- These plots are not intended to convey specific information about whether a county is included or excluded from a nonattainment area


07-09 Design Value (ppb)
66 - 68
69 - 72
73 - 76
77 - 86
87 - 100
Contribution (ppb)
0.04 - 0.20
0.21 - 0.60
0.61 - 1.00
1.01 - 5.00
5.01 - 10.00
10.01 - 15.92

Sector Modeling Project

Purpose/Outcomes of Sector Modeling

- Developing better estimates of rule benefits with sector modeling results (upcoming MACT rules)
  - Improved benefit per ton estimates
  - Previous benefit per ton estimates based on CMAQ RSM
- For each sector, we can characterize:
  - The total $PM_{2.5}$ and ozone-related public health burden posed, in terms of premature deaths and other illnesses in 2005 and 2016
  - The change in the PM and ozone public health burden between 2005 and 2016
  - The $PM_{2.5}$ and ozone-related public health burden on EJ populations (i.e. those most susceptible/vulnerable to impacts)
  - The impact on 8-hr ozone, annual PM2.5, and daily PM2.5 design value monitors
  - The impact on visibility at Class I area receptors
- This information may be useful to prioritizing sectors for upcoming and future regulatory activities

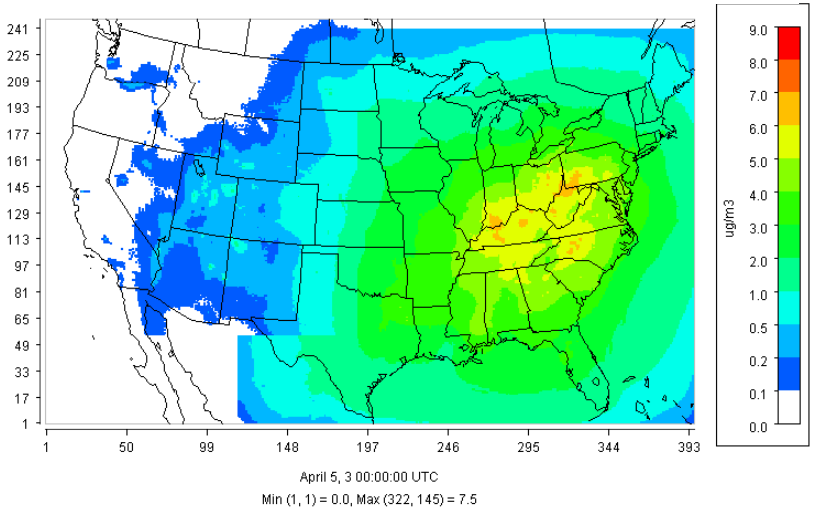
Modeling Background

- CAMx version 5.30
- PSAT and APCA source contribution
- no SOA contribution assessment
- 2005 baseline and projected 2016 emissions
- Annual simulations covering the U.S. with 12 km sized grid cells using 2005 meteorology (MM5)
- ICBC from 36 km simulation

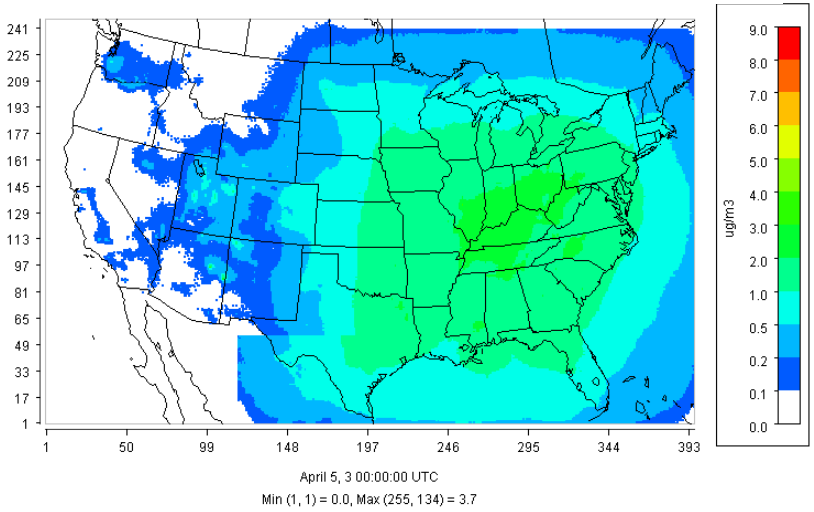
Sector Contribution

Industrial Point sectors	Broad Categorization Sectors
Cement Kilns	Airport/Locomotive/Marine
Coke Ovens	Biogenics
Electric Arc Furnaces	Canada and Mexico
Ferroalloy Production	Commercial Marine
Integrated Iron and Steel	Fugitive Dust
Iron and Steel Foundries	Electrical generating units (PTIPM)
Pulp and Paper	Fires
Refineries	Agricultural Ammonia
Residential Wood Combustion	Nonroad
Taconite Mining	Onroad
Other non-EGU point	Other area (NONPT_OTH)
Lateral boundary inflow	
Secondary organic aerosol (SOA)	

2005 Annual PM2.5 Contribution

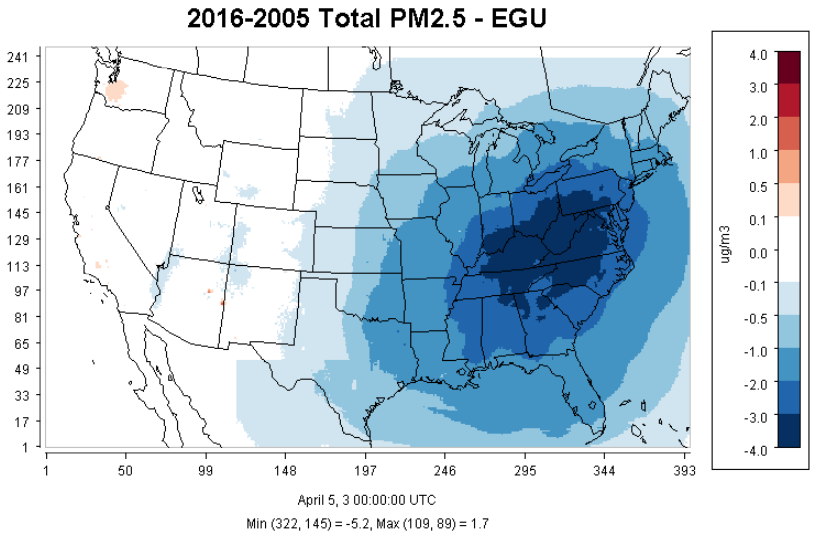


2016 Annual PM2.5 Contribution

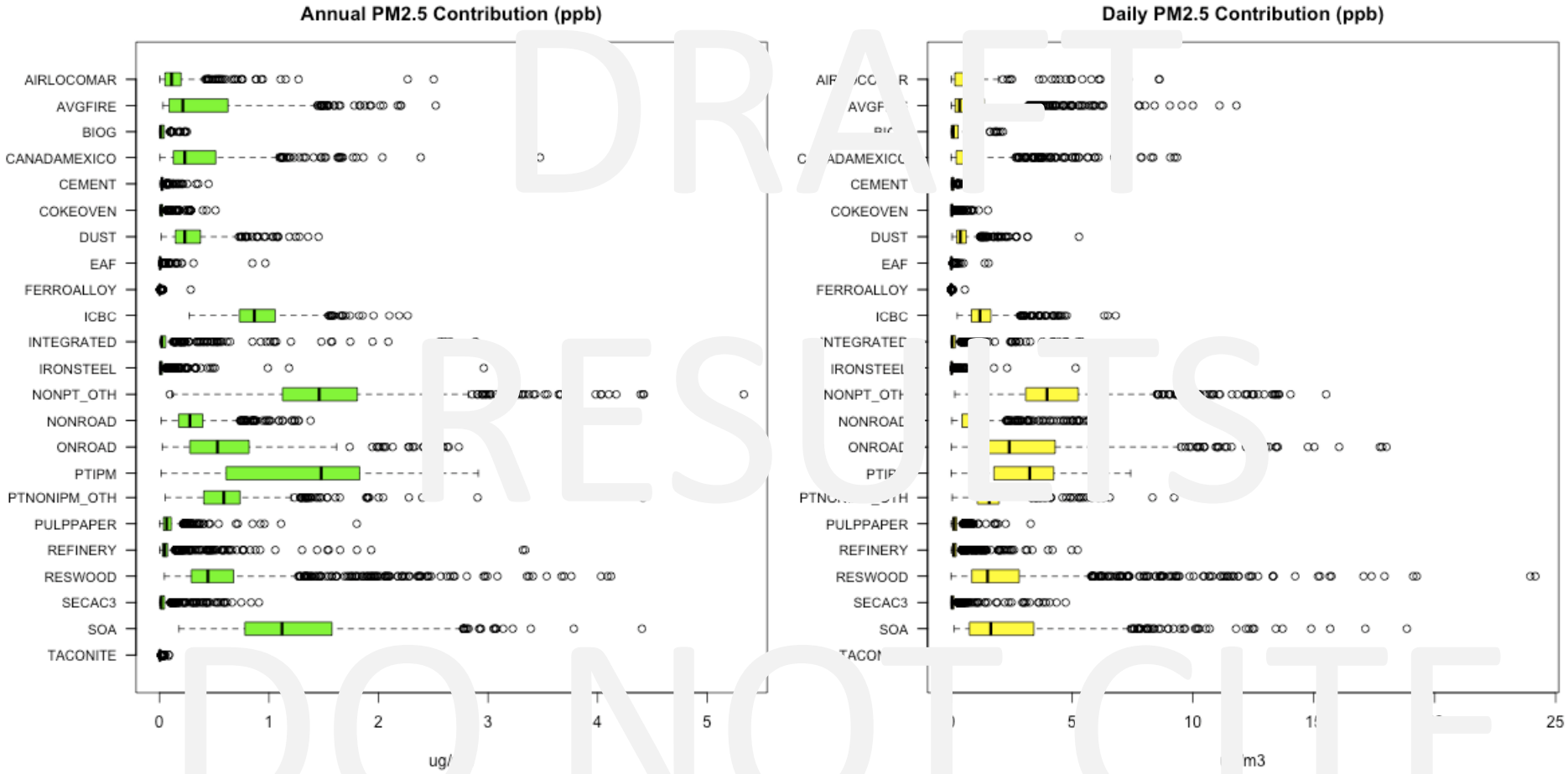


EGU sector Annual PM2.5 contribution for 2005 (top left) and 2016 (top right).

The change in contribution is shown at right.

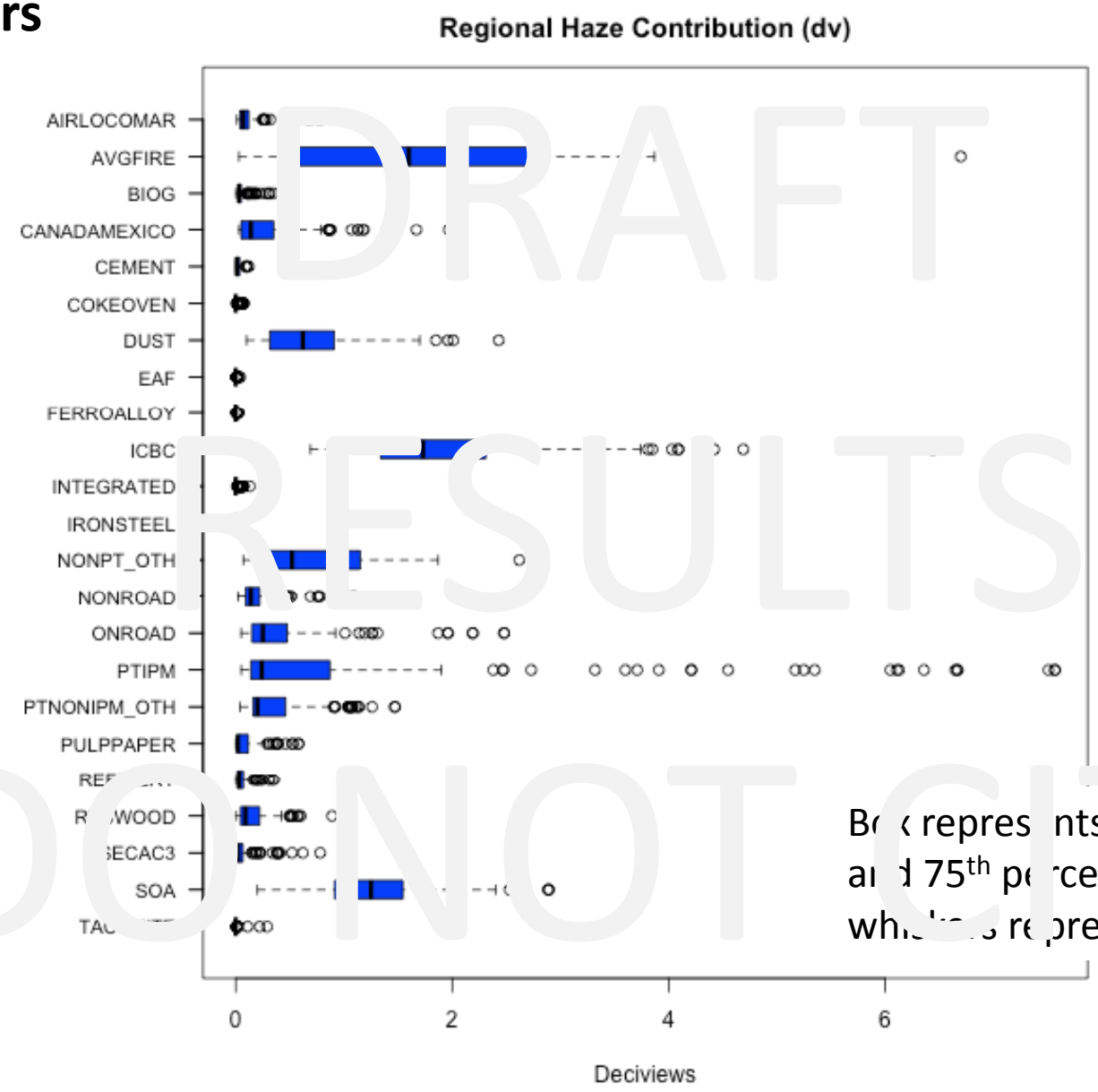


Distribution of design value contribution in 2016 over all monitors



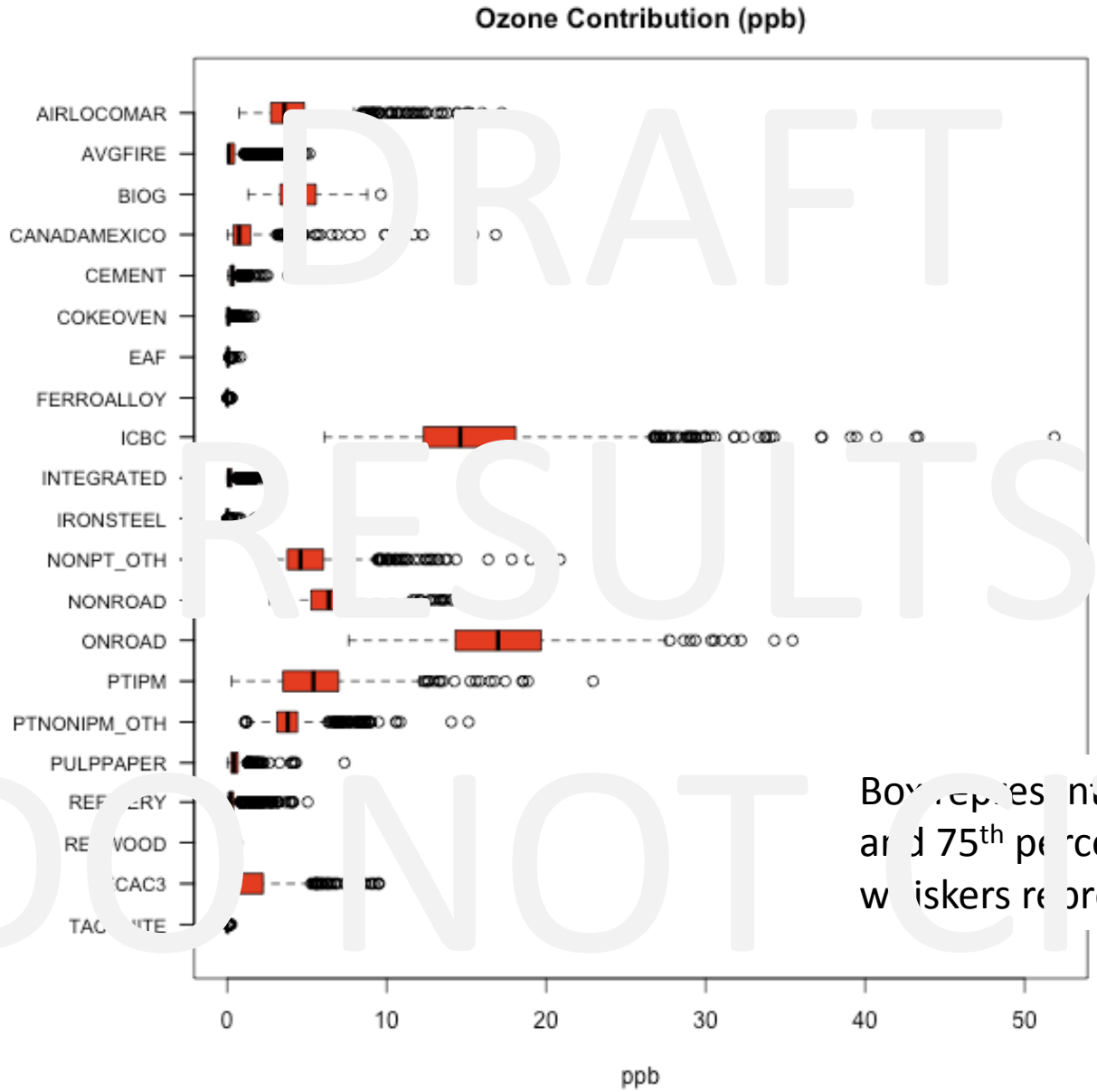
Box represents 25th, 50th, and 75th percentiles (IQR); whiskers represent 1.5*IQR

Distribution of worst 20% days visibility contribution in 2016 over all monitors



Box represents 25th, 50th, and 75th percentiles (IQR); whiskers represent 1.5 IQR

Distribution of design value contribution in 2016 over all monitors



Box represents 25th, 50th, and 75th percentiles (IQR); whiskers represent 1.5*IQR

Annual PM2.5-related premature deaths attributable to each sector

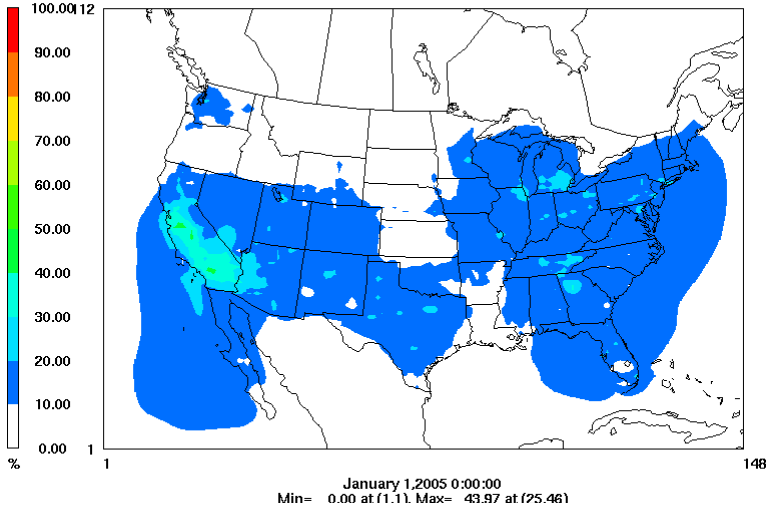
***PM2.5 premature deaths calculated using risk coefficient from Krewski et al. (2009).**

Annual PM2.5-related premature deaths attributable to each sector

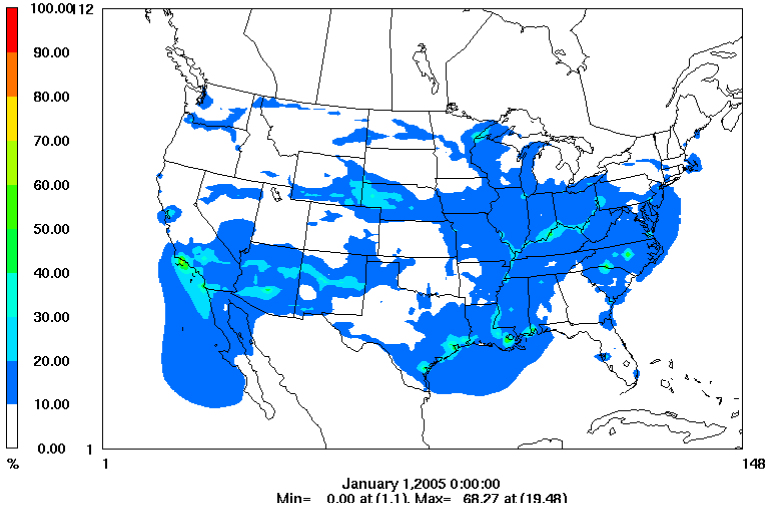
***PM2.5 premature deaths calculated using risk coefficient from Krewski et al. (2009).**

The % contribution to annual average PM2.5 Elemental Carbon

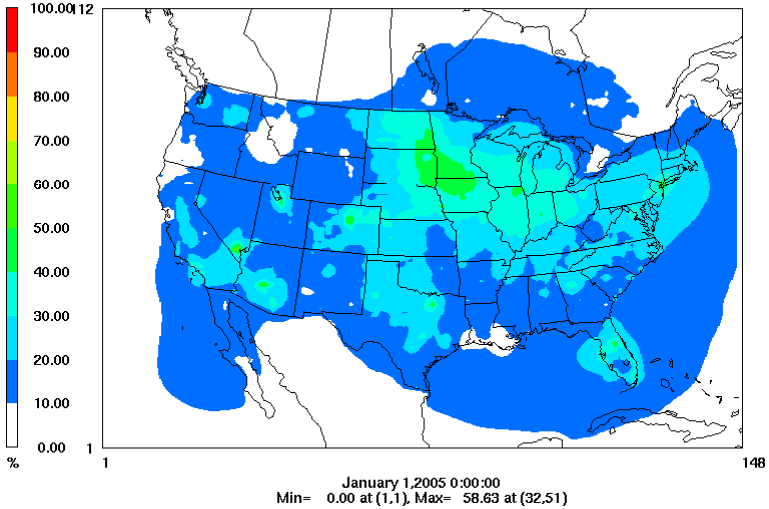
ONROAD



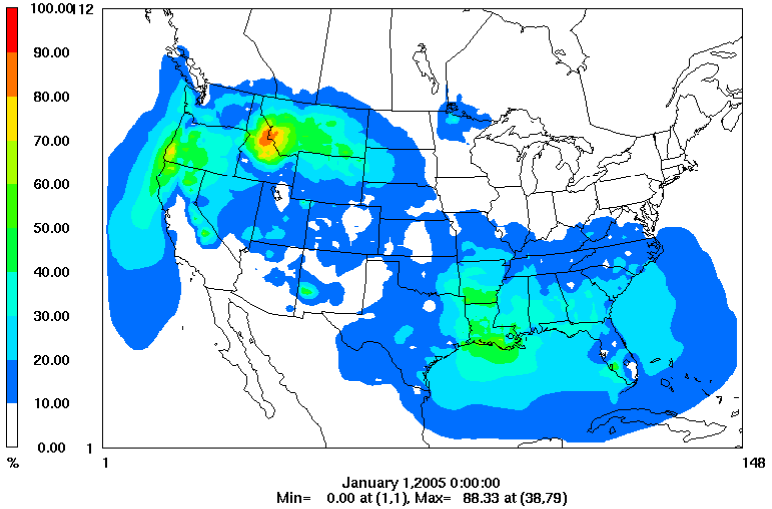
Air/Locomotive/Marine



NONROAD



Fires (avg)



Acknowledgements

- Neal Fann, Charles Fulcher
- Allan Beidler, Chris Allen, James Beidler
- Rich Mason, Alison Eyth