Improved Understanding Of North American Background Ozone

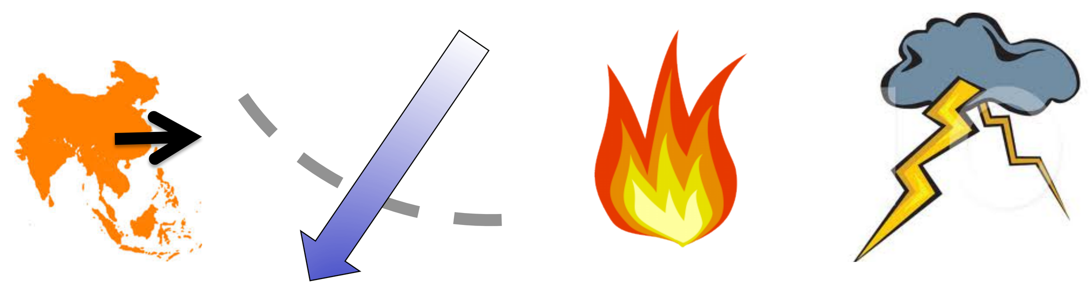
Katherine R. Travis (ktravis@fas.harvard.edu), Advisor: Daniel Jacob

1. Motivation

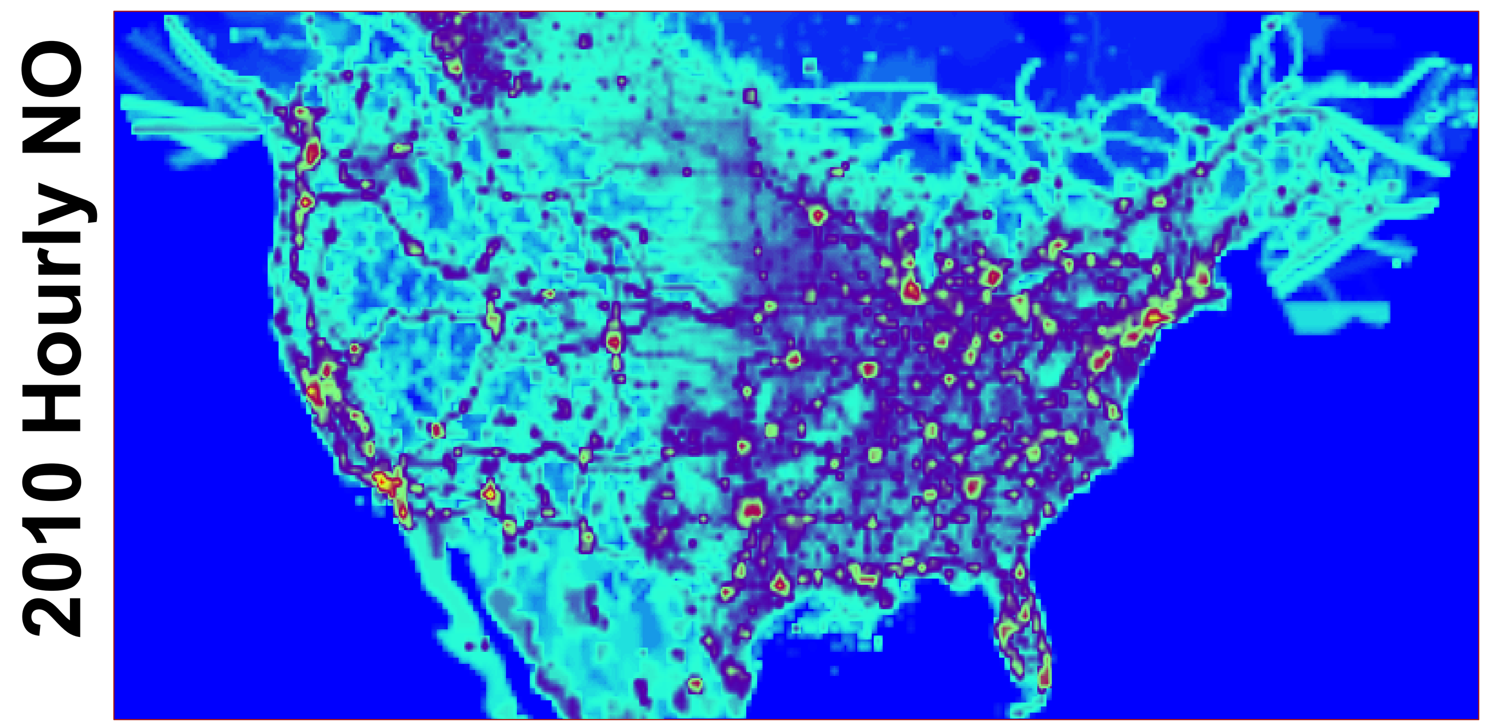
Ground-level ozone pollution is a serious public health and environmental concern in the United States. Tropospheric ozone is produced by photochemical oxidation of volatile organic compounds (VOCs) and carbon monoxide in the presence of nitrogen oxide radicals (NO_x). These precursors have both anthropogenic and natural sources. My work focuses on improving understanding and modeling of background surface ozone, a critical issue for setting of the National Ambient Air Quality Standards (NAAQS). EPA is considering tightening the ozone NAAQS (presently 75 ppbv) to a value in the range 60-70 ppbv for better protection of human health and welfare, but it is unclear to what extent uncontrollable background ozone would hinder achievement of a lower NAAQS[1]. Addressing this issue is of critical importance for air quality policy and presents a major scientific challenge to coupling atmospheric chemistry on global and regional scales.

2. Background Ozone

Background ozone is not directly measurable and thus must be calculated from a global chemical transport models (CTM). CTMs must achieve a successful global representation of tropospheric ozone including sources from the stratosphere, wildfires, lightning, and long-range transport of pollution. Current CTMs have difficulty capturing observed high background ozone events (over 70ppb) due to numerical limitations as well as potential deficiencies in emissions inventories and in parameterizing processes such as lightning, wildfires, and stratospheric influences[1]. CTMs also show large differences in their representation of the ozone background[2] which is very problematic for air quality policy.



4. Improved U.S. Emissions (NEI08)



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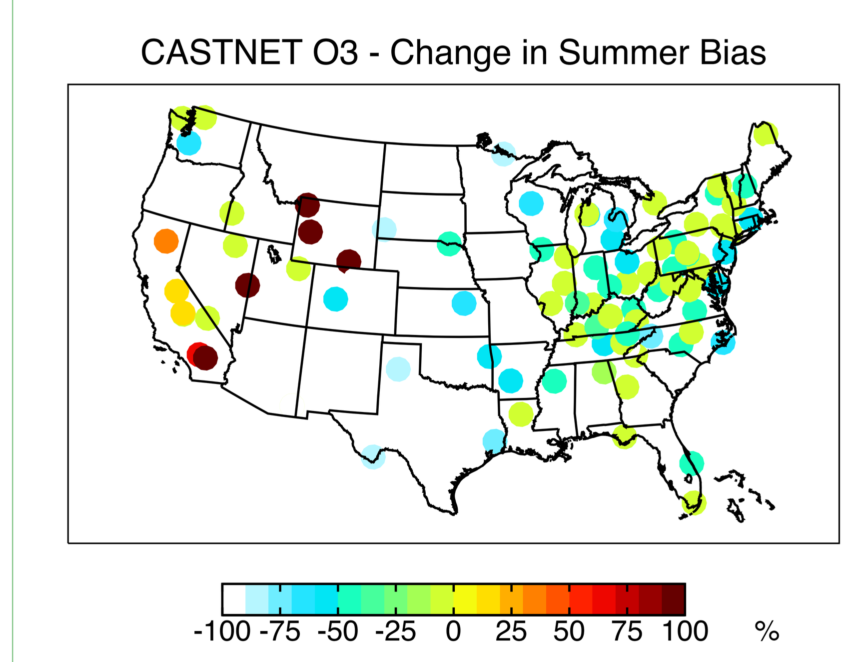
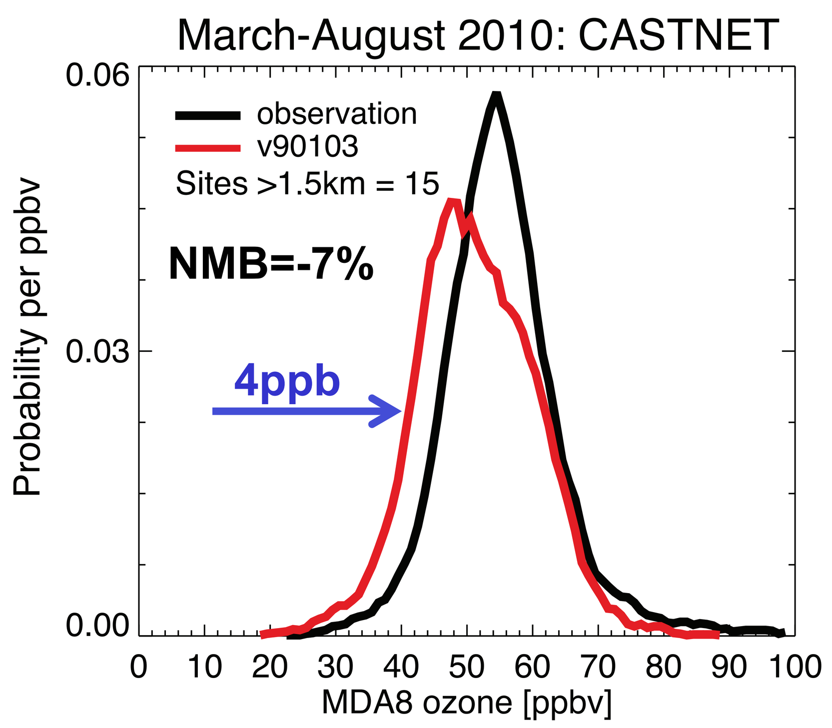
- Species: ALD2, NO, NO_2, HNO_2, RCHO, C2H6, ALK4, OC/BC, EOH, MOH, BENZ, TOLU, XYLE, C2H4, CH4
- Available for 2005 to 2010 through the NEI08 platform
- Next step is to implement Tsinghua University Asian emissions to complete emissions upgrade.

5. Results for 2010

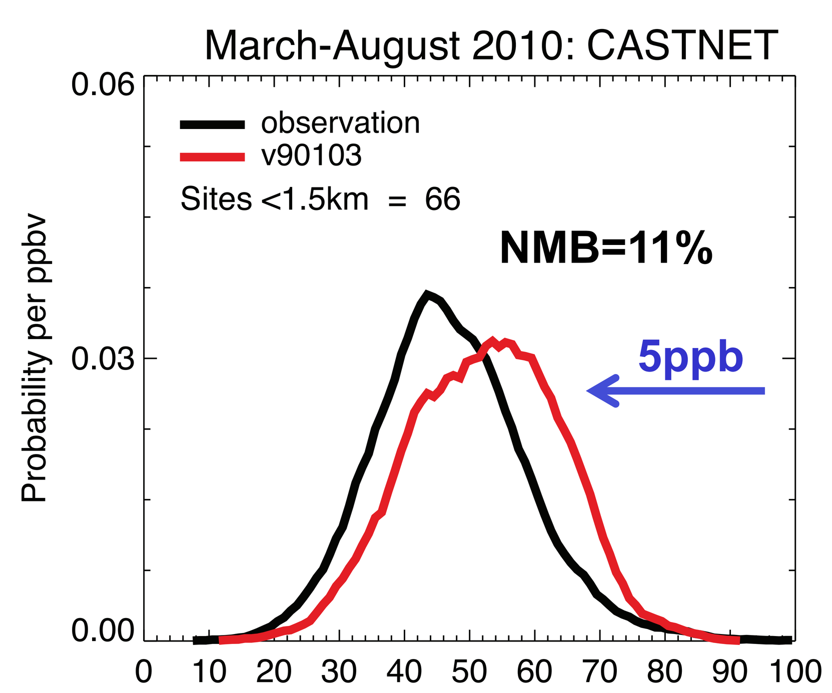


*High spatial and temporal resolution with up-to-date emissions **better captures summertime ozone**, particularly in the Northeast and Southeast.*

3. Geos-Chem Ozone Simulation

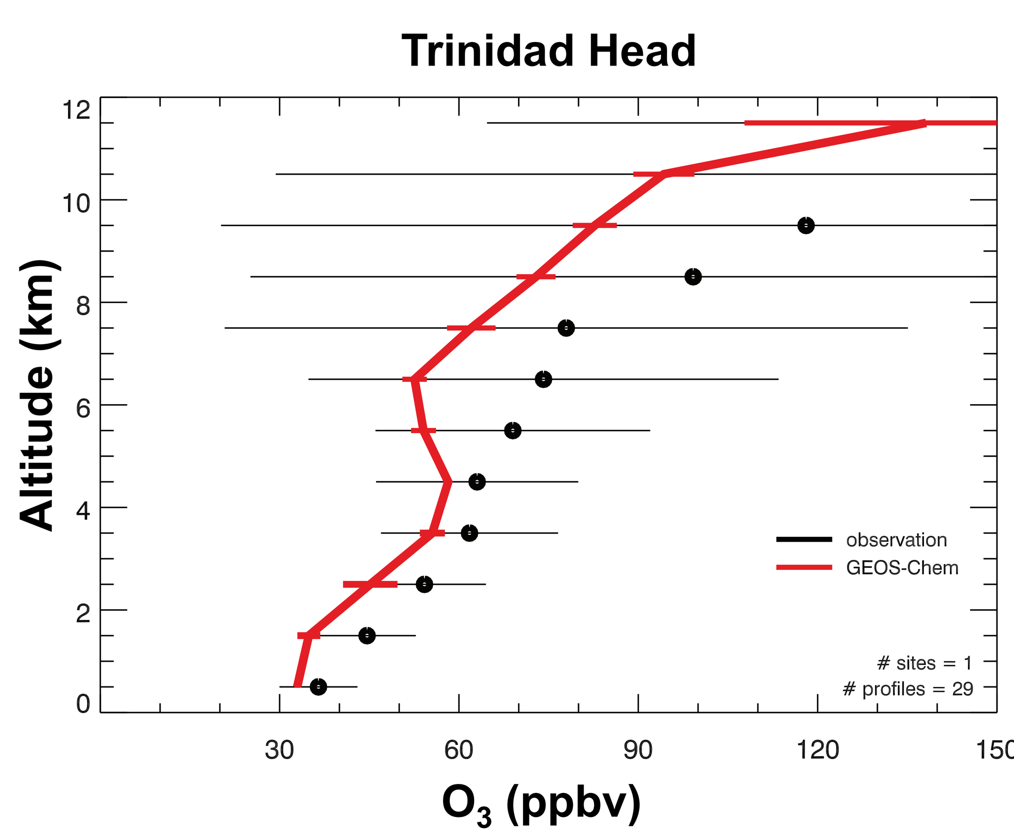


Underestimating transport?



Overestimating emissions & lightning?

Science Updates Have Degraded the Geos-Chem Ozone Simulation

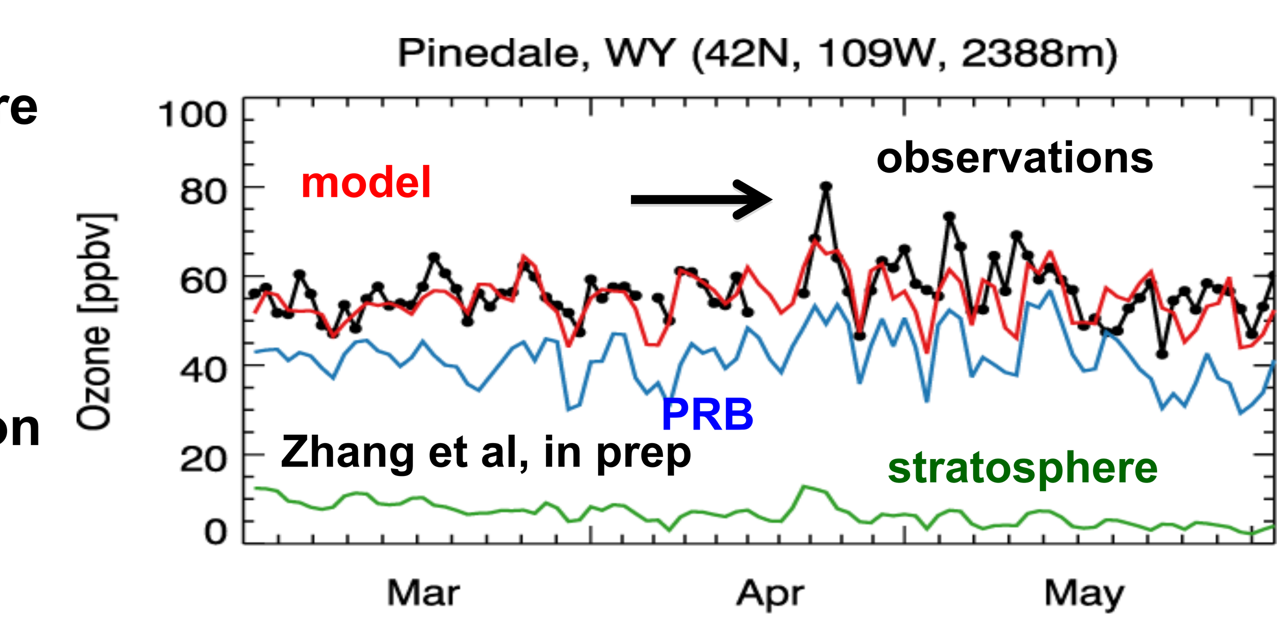


Next step is to compare with additional observations of ozone, its precursors, and related species from aircraft campaigns (CalNex, DC-3, DISCOVER-AQ, SOAS) and satellites (in particular TES and OMI ozone, OMI NO_2 and formaldehyde).

6. Assessing Errors Due to Resolution

Can we ever capture events?

What is the dependence of ozone concentration on resolution?



7. Assessing Errors Due to Resolution

Injection: Use a simplified relationship of fire radiative power (FRP) and atmospheric stability.
Emissions: Use an emissions parameterization to account for complex feedbacks (aerosols, photolysis, etc.)

In collaboration with Matt Alvarado (AER)

8. Proposed Projects

1. Can we achieve a good model representation of O_3 over the United States that can provide a tool to determine the NA background?
2. How does the background ozone simulation depend on model resolution?
3. How is background ozone in the US impacted by stratospheric intrusions, lightning, wildfires, and foreign pollution? Can we quantify the contribution of the ozone background to NAAQS exceedances?

9. Community Outreach

Harvard Ozone Garden!

ACKNOWLEDGEMENTS

EPA Emission Inventory and Analysis Group

REFERENCES

1. McDonald-Buller, E.C.et al. (2011), Establishing Policy Relevant Background (PRB) Ozone Concentrations in the United States. *Environmental Science and Technology,* doi: 10.1021/es2022818

2. Fiore, A., Jacob, D., Lin, M., Oberman, J., Zhang, L. (2012, June). Processes contributing to model differences in North American background ozone estimates, Presented at the NASA AQAST team meeting, University of Wisconsin-Madison. .

3. Zhang et al. Background surface ozone in the US intermountain West: sources and modeling, *in prep*