Meteorological and Emission Sensitivity of Hemispheric Ozone

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Overview

- Quantifying intercontinental air pollution impacts is sensitive to transport and emissions processes.
- Emissions and transport have independent uncertainties that need exploration and both affect US national composition.
- Our work evaluates two models, Hemispheric CMAQ and GEOS-Chem that cover the northern hemisphere for ozone for 2016.
  - CMAQ with two emissions cases demonstrations emission sensitivity.
  - CMAQ to GEOS-Chem includes both transport and emission differences.

Model Configurations

Table 1 : Model versions, options, and configuration.

Option	CMAQ	GEOS-Chem
Version	5.2.1	11.2
Domain	N. Hemisphere	Global
Horizontal Resolution	108km (1deg)	2x2.5 deg
Vertical Resolution	44 layers to 50 hPa	47 layers to 0.01 hPa
Met Model[1]	WRF v3.8	GEOS 5.x (FP)
Native Met Res	108km (1deg)	12km degraded
Chemistry/Aero	CB6r3 AE6 nvPOA	”soa”

Table 2 : Anthropogenic and natural 2016 emission inventories.

Emission	CMAQ	GEOS-Chem
Global Default	EDGAR-HTAPv2 x CEDS dE/dt	EDGAR-HTAPv2
United States	EPA 2016	EPA 2011 scaled
Canada	Env. Canada 2014 scaled	CAC scaled
Mexico	SEMARNAT[2] 2008 scaled	BRAVO 1998 scaled
Asia	MIX scaled	MIX scaled
China	THU[3]/EDGAR-HTAPv2	MIX scaled
Biogenic/Soil	MEGAN[4]/BEIS NA	MEGAN
Fires	FINN v1.5/EPA 2016	FINNv1.6
Lightning	GEIA Clim	On-line[5]

[1] Weather Research and Forecasting and Goddard Earth Observing System [2] Secretaría del Medio Ambiente y Recursos Naturales [3] 2015 baseyear via Collaboration with Dr. Jia Xing at Tsinghua University [4] Hemispheric MEGAN was processed using HEMCO [5] 2016 updates from Lee Murray at University of Rochester

CMAQ and GEOS-Chem Seasonal 500hPa Ozone

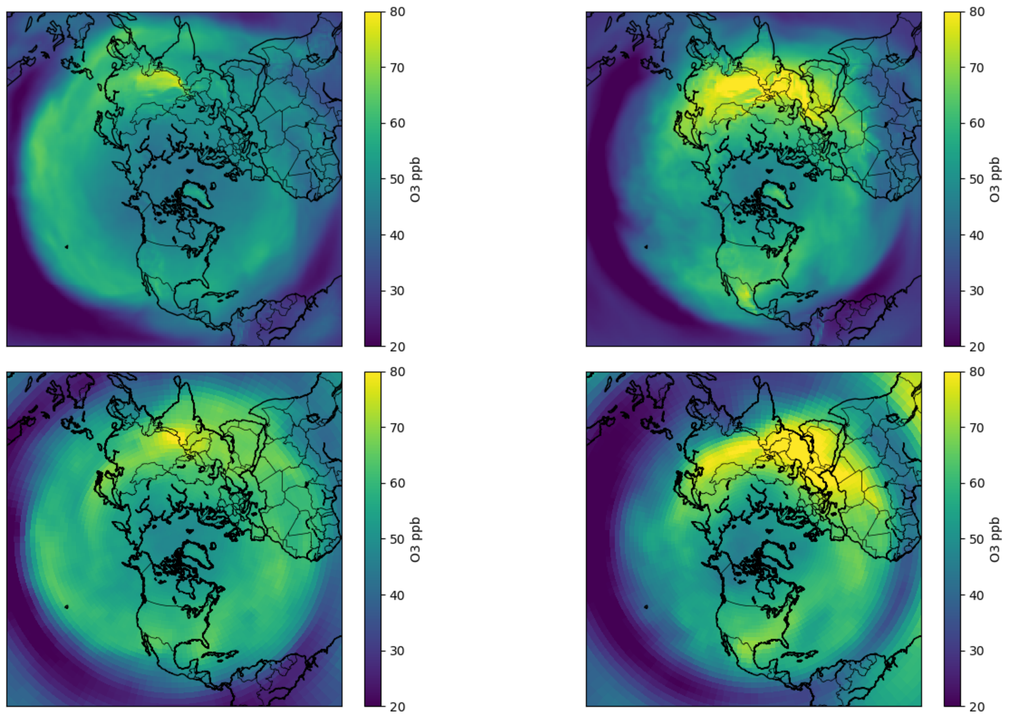

Figure 1 : CMAQ (top) and GEOS-Chem (bottom) ozone at approximately 500hPa in spring (left) and summer (right).

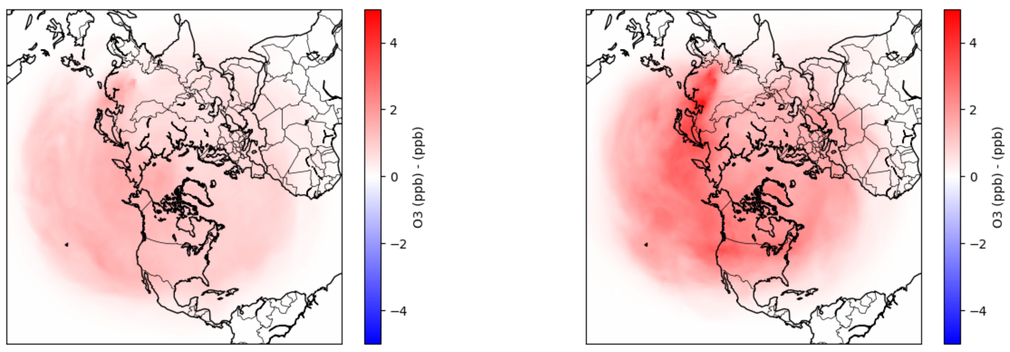

Figure 2 : Ozone enhancements in CMAQ from HTAPv2 relative to THU Chinese emissions in spring (left) and summer (right) at approximately 500 hPa.

Summary

- CMAQ and GEOS-Chem both show mild low biases near the tropopause.
- Surface bias has diurnally and seasonally structured bias.
  - diurnal: lower at night than in the day
  - seasonal: lower in winter than summer
- Alternate China emissions have more affect in mid trop than at surface.

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World Ozone and UV Data Centre (woudc.org) Sonde Evaluation

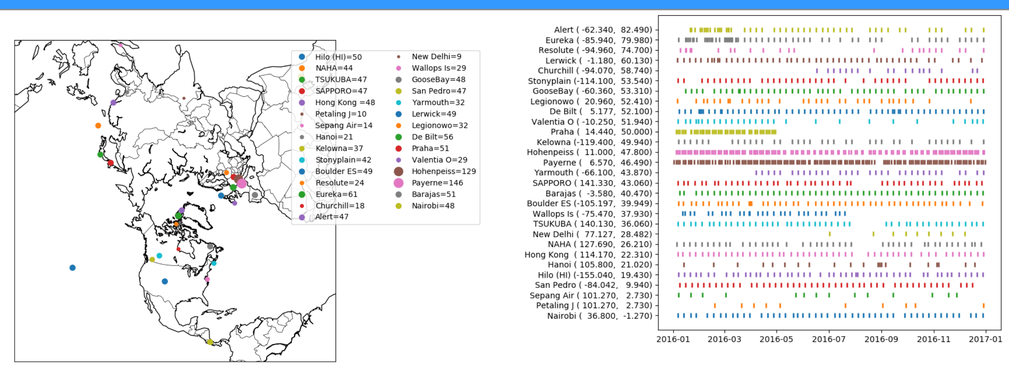

Figure 3 : Sonde locations (left) and time coverage by site (right).

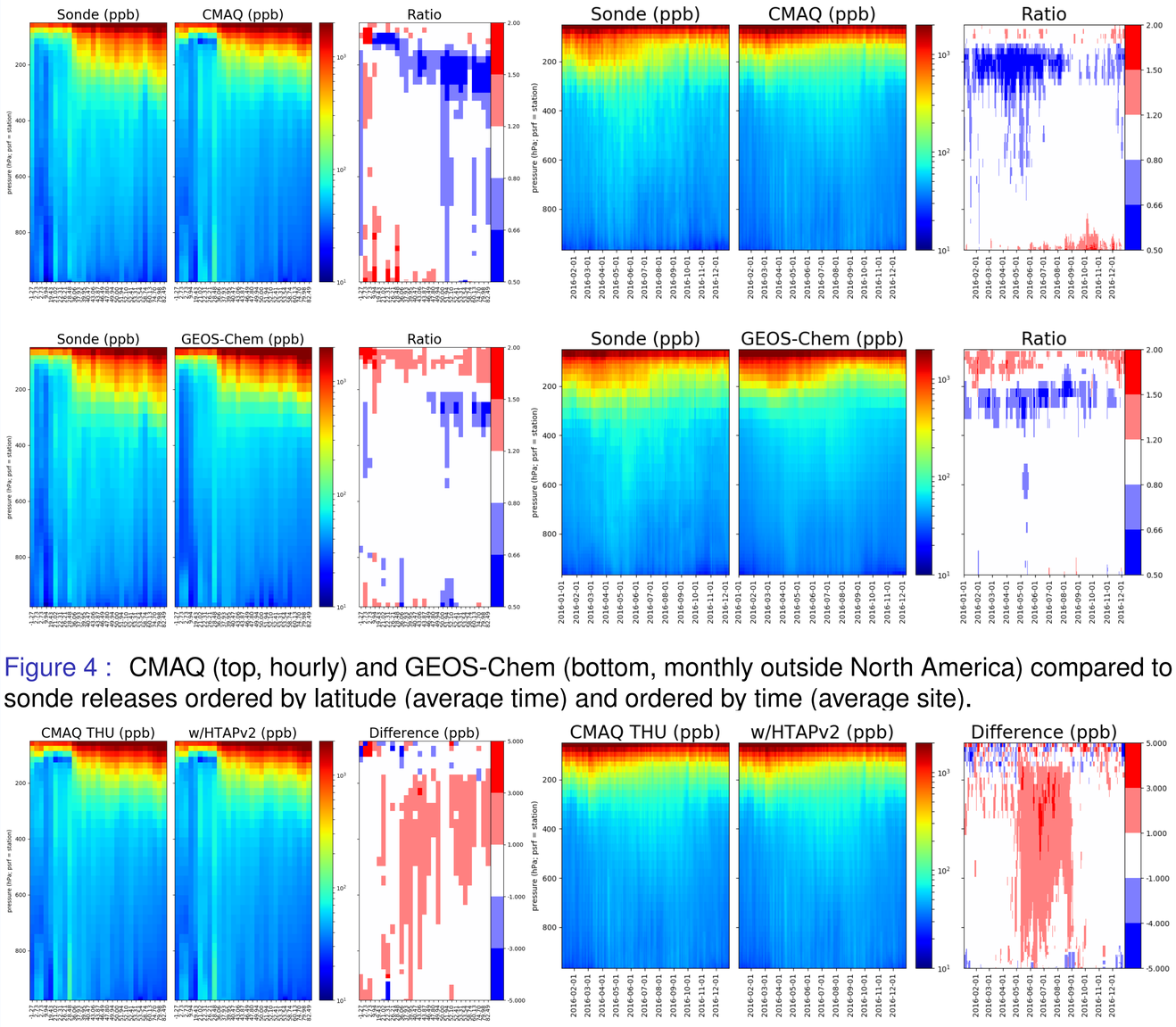

Figure 4 : CMAQ (top, hourly) and GEOS-Chem (bottom, monthly outside North America) compared to sonde releases ordered by latitude (average time) and ordered by time (average site).

Figure 5 : Comparison of CMAQ with THU and HTAPv2 for Chinese emissions and enhancements in ppb at sonde locations.

CASTNet Surface Hourly Evaluation

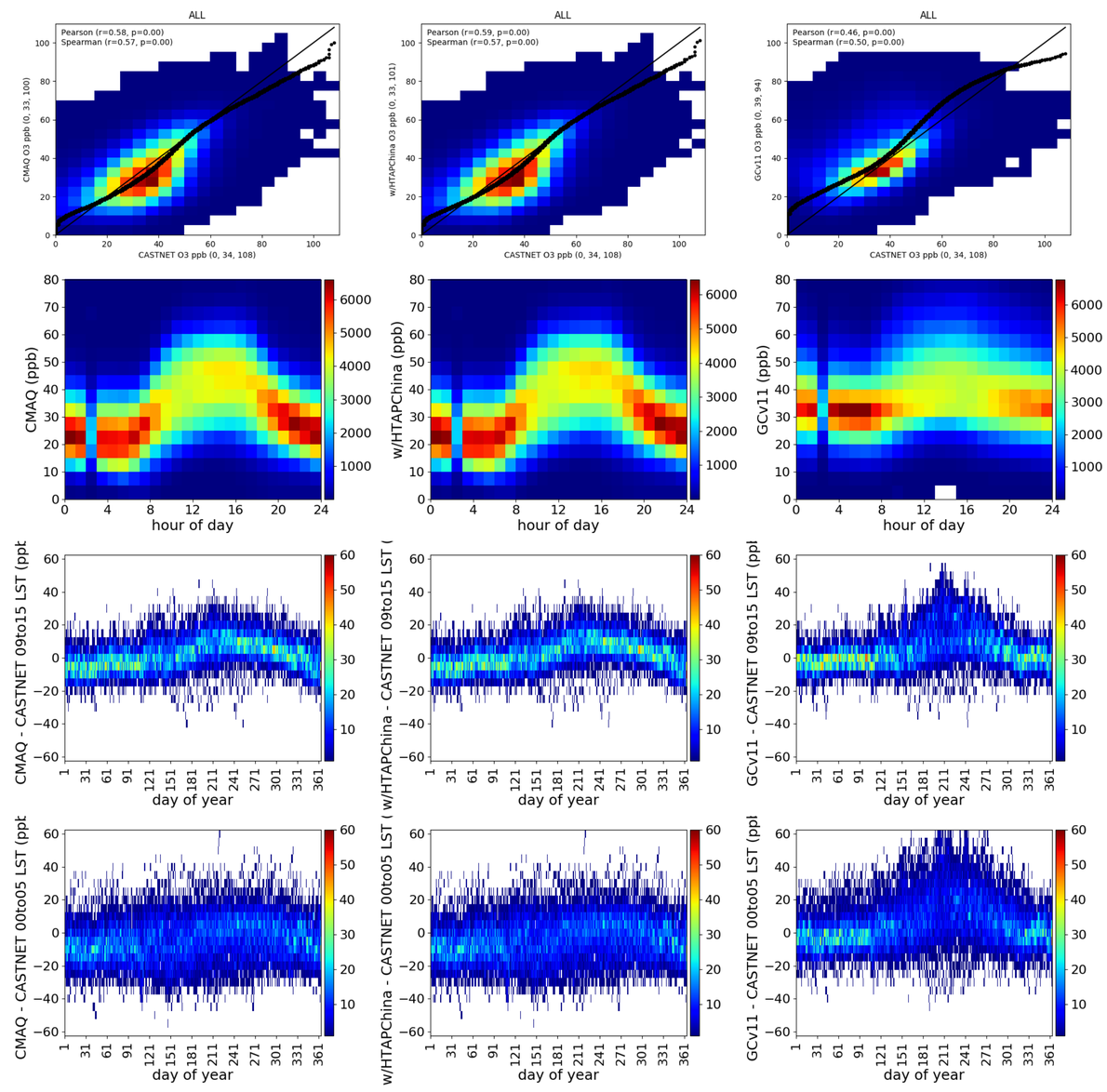

Figure 6 : CMAQ w/ THU (left), w/HTAP China (center), GEOS-Chem (right) hourly performance (top), diurnal profile (upper), mid day bias (09-15Z, upper), and morning bias (00-05Z, bottom). Color shows the site-days per bin.

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