ePoster

Leveraging simulated source contributions to improve understanding of atmospheric ozone

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Motivation

The influence of natural and intercontinental emissions on air quality has received increasing attention as 1) regulations tighten, and 2) developing nations exported pollutants increase. There is a consensus that hemispheric transport does affect ozone concentrations transported into nations including the United States of America[1]. Differences in simulated natural and intercontinental emissions underscore model process differences.

Problem Demonstration

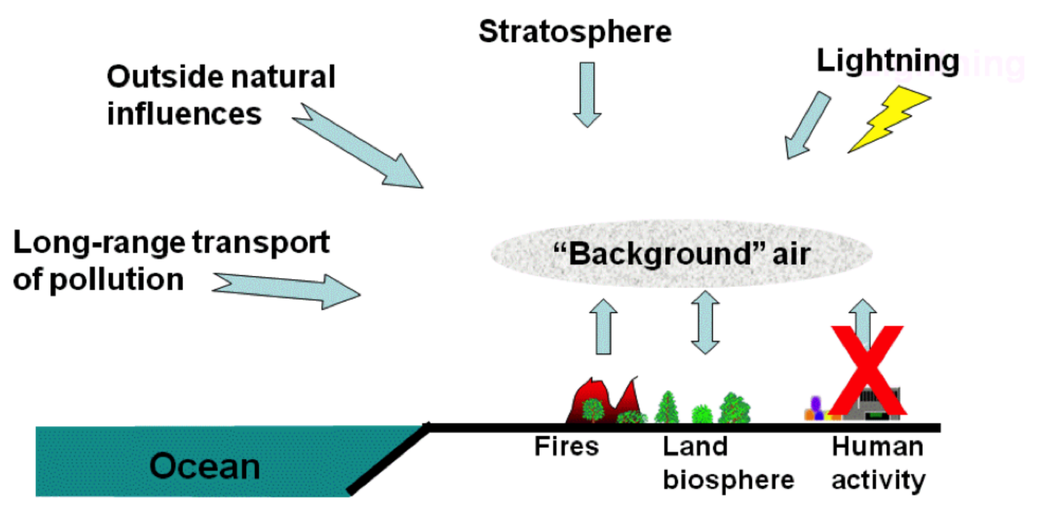


Figure 1: Background is defined here as ozone in the absence of North American (NA) anthropogenic emissions.

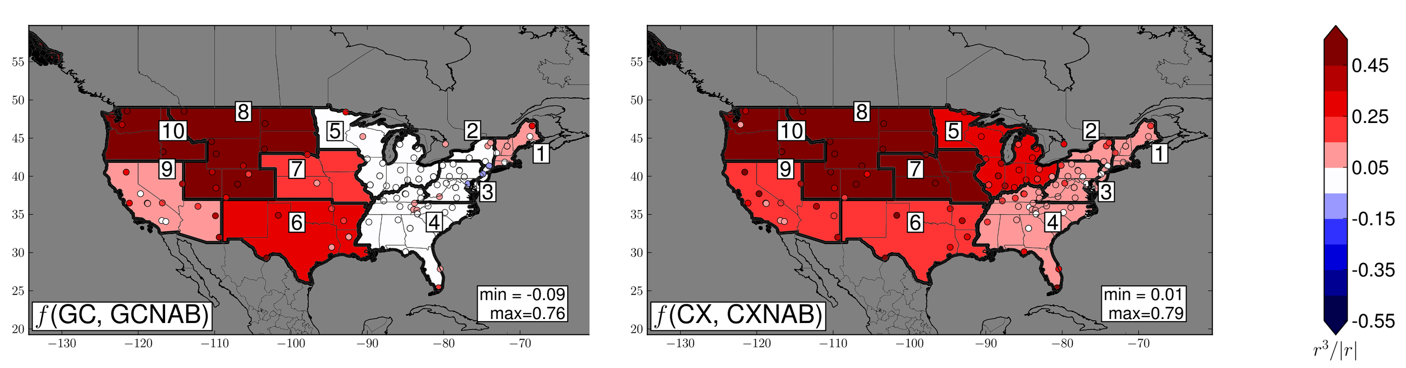


Figure 2: Signed coefficient of determination ($r^3/|r|$) calculated for simulations from Zhang et al.[6] (left) and Emery et al.[2] (right) demonstrate disagreement on the relationship of background and total ozone, particularly in the East.

Modeling Results

All modeling model predictions in this analysis were developed by Zhang et al.[6] or Emery et al.[2]; key differences between the results are summarised in Table 1.

Table 1: Model configuration summary for Zhang et al.[6] (GC) and Emery et al.[2] (CX) simulations.

	GC*	CX†
Model	GEOS-Chem	CAMx
Resolution	1/2° x 2/3°	12km x 12km
Meteorology	GEOS5	WRF
Chemistry	Version 8-02-03‡	Carbon Bond '05§
Boundaries	GC 2x2.5°	GC 2x2.5°
Biogenic Emiss	MEGAN	BEIS
Lightning Profile	LTDIS scaled with Pickering et al.[4] profile	Scaled with Koo et al.[3] profile
Wildfires Emiss	GFED monthly average	SmartFire daily estimate

*Zhang et al.[6]; †Emery et al.[2]; ‡Updates to chemistry in v8-02-04 will decrease nitrogen oxide loss to isoprene nitrates §Does not include updated isoprene as in Xie et al.[5]

Models Diverge in the Southeast

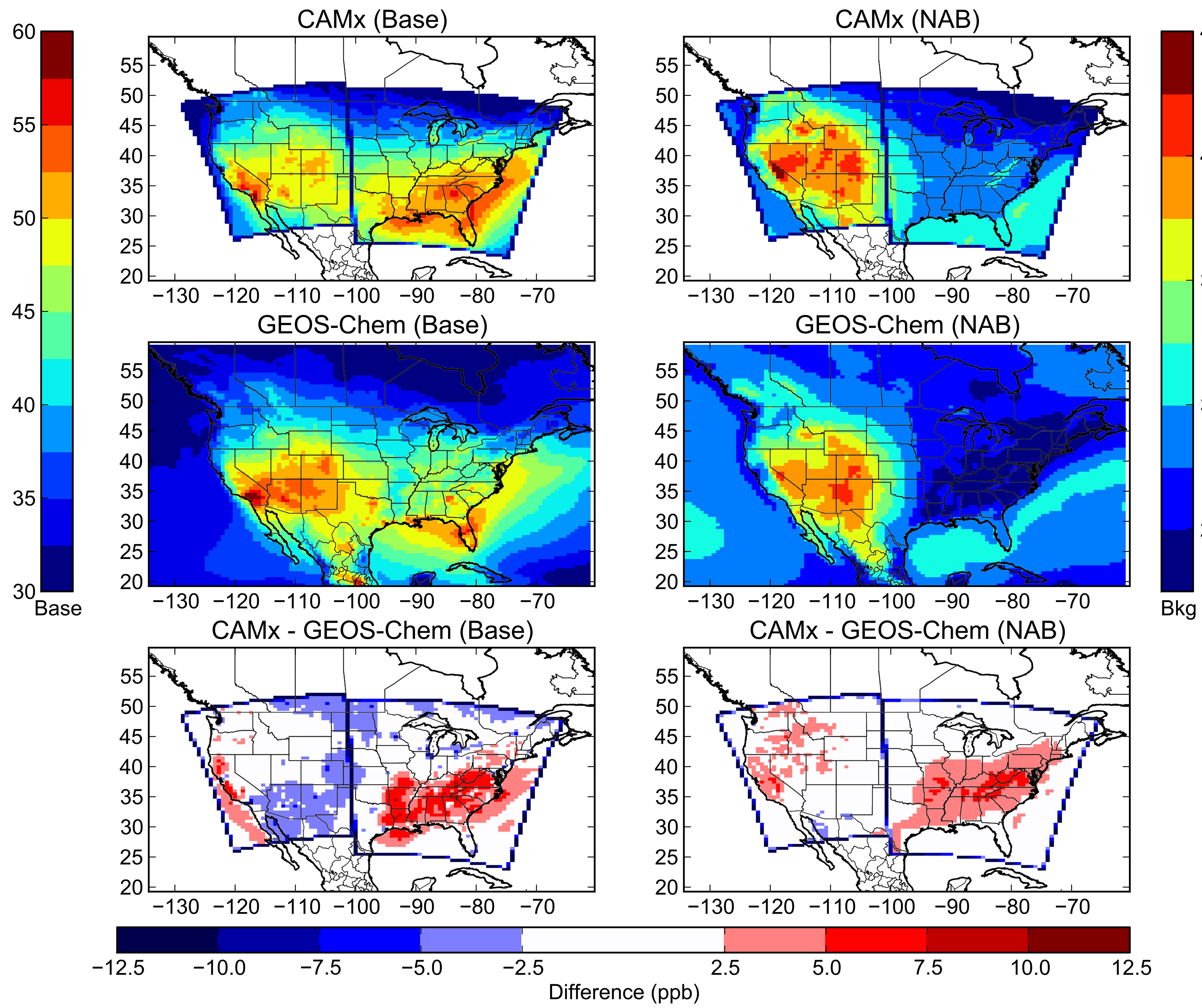
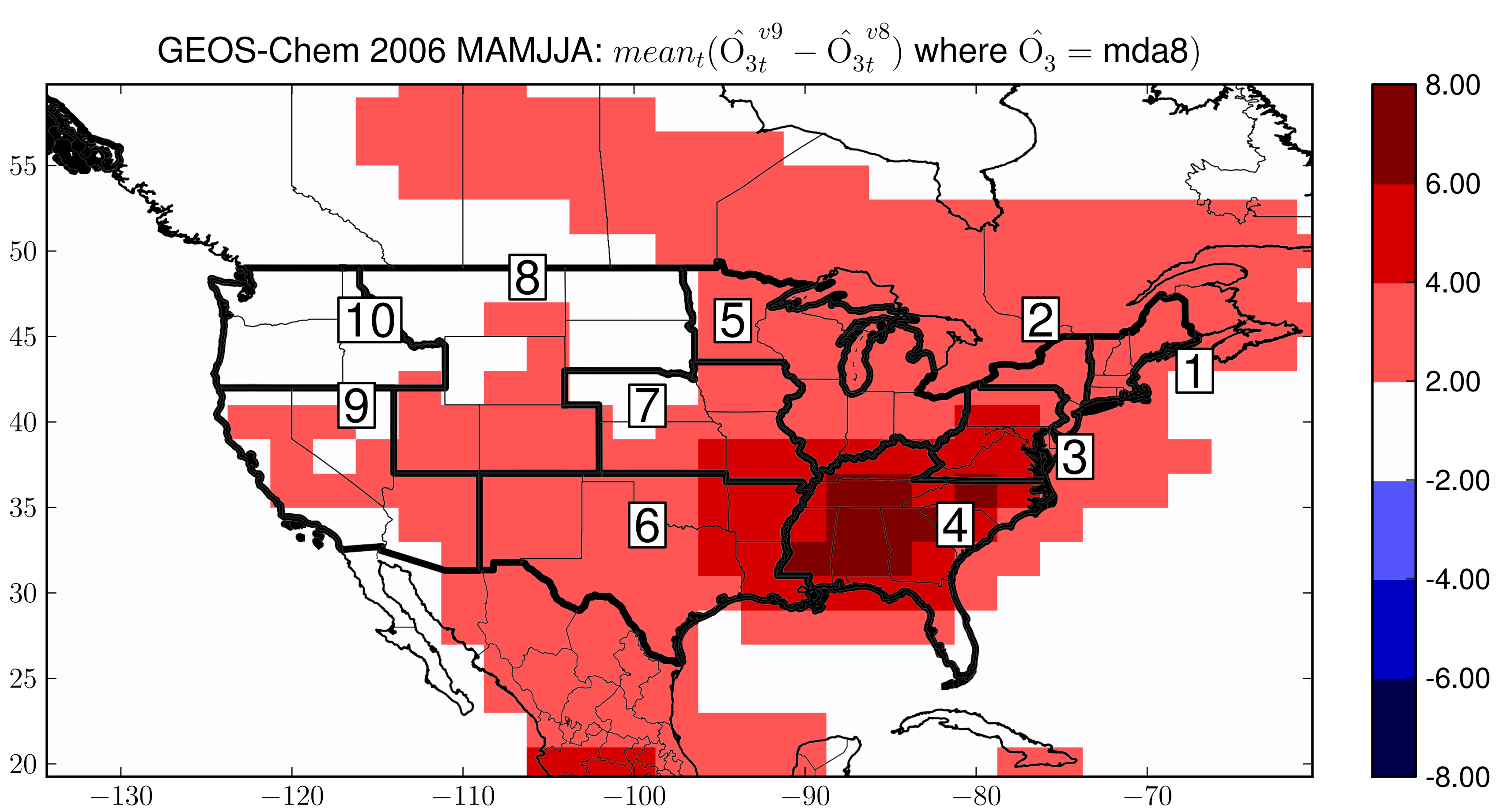


Figure 3: Maximum daily 8-hour average O_3 predictions show biggest differences (based on regridding to 1/2° x 2/3°) in the Southeast with (Base) or without NA anthropogenic emissions (NAB). NAB also shows some differences in the West.

Isoprene Chemistry Explains Model Differences

Figure 4: Spatial distribution of average difference between of O_3 from GEOS-Chem with version 9 and version 8 chemistry. Version 9 chemistry reduces isoprene nitrate production in GEOS-Chem 2°x2.5° simulations, increasing ozone most in the Southeast and Mexico (not shown).



Improving Isoprene Nitrates Increases Bias

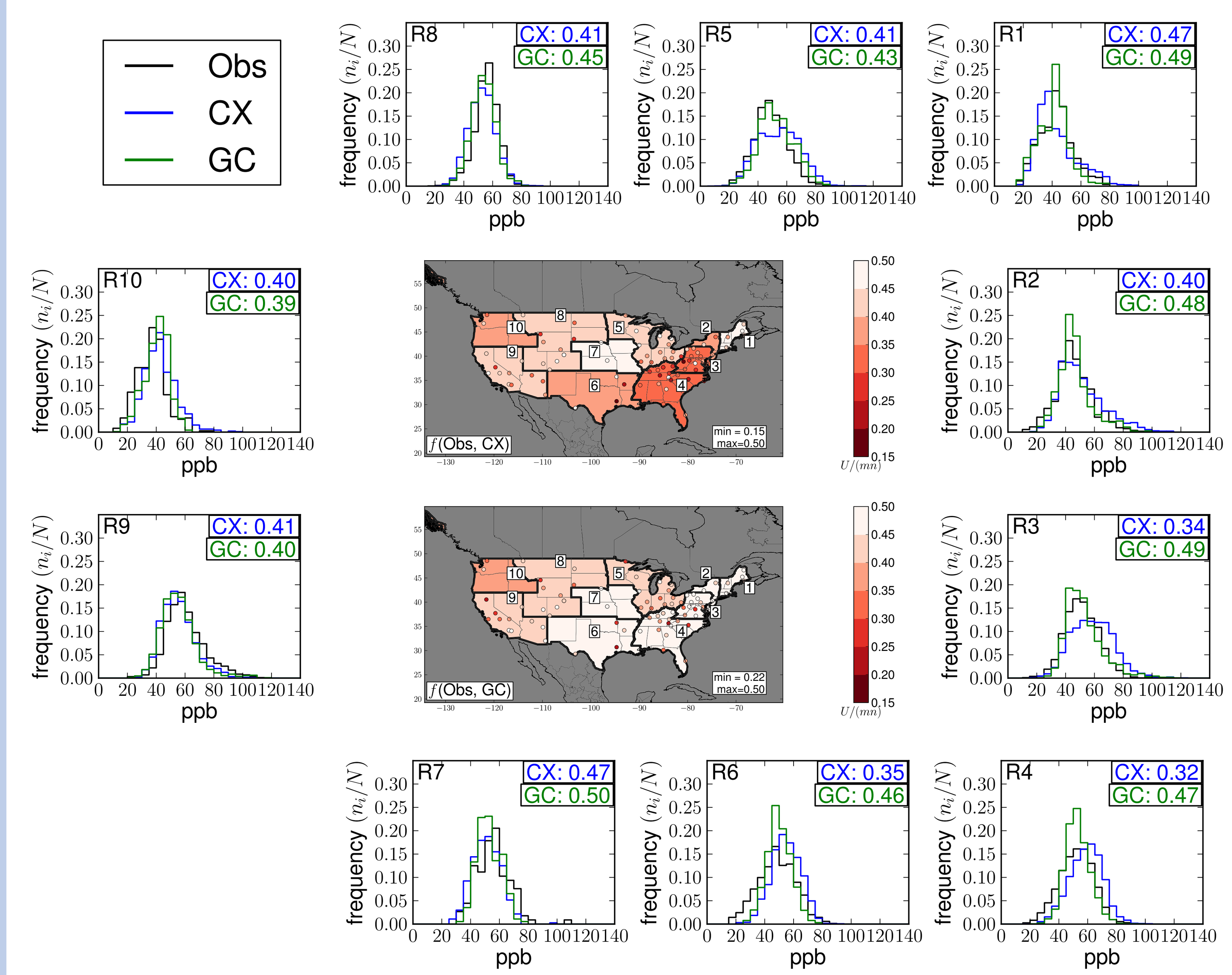


Figure 5: Mann-Whitney ρ ($\rho = U/(mn)$; $0 \rightarrow 0.5$ =worst $\rightarrow$ best agreement) score for O_3 shows that reduced nitrates is associated with high-bias. CAMx/Carbon Bond '05 has lower isoprene nitrate yield – more nitrogen oxides and ozone. Similar increased bias is seen when comparing updated GEOS-Chem (not shown).

Summary

Background ozone, measurements and predictions, are getting increased attention because of their relevance in policy. Models inter-comparison show some inconsistent results:

1. largest difference between CAMx and GEOS-Chem (v8) in the East,
2. difference is attributable to isoprene nitrate branching ratio,
3. updating GEOS-Chem isoprene nitrate yield (v8 $\rightarrow$ v9) improves model consistency by increasing Base/NAB correlation and bias,
4. Isoprene nitrates production remains uncertain and strongly affects the NO_x budget, and model updates are underway[5],
5. updated chemistry is associated with a high-bias that future chemistry updates must address.

Isoprene is a globally ubiquitous organic compound and isoprene nitrate budgets meaningfully influence NO_x budgets in both present day and responses hypothetical emission reductions.

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