Ozone and organic nitrates over the eastern US: sensitivity to isoprene chemistry

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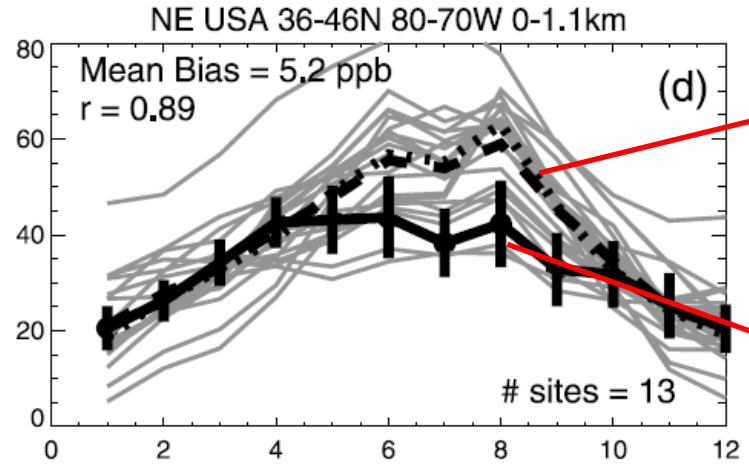
Summertime ozone over eastern US is a classic problem for most models

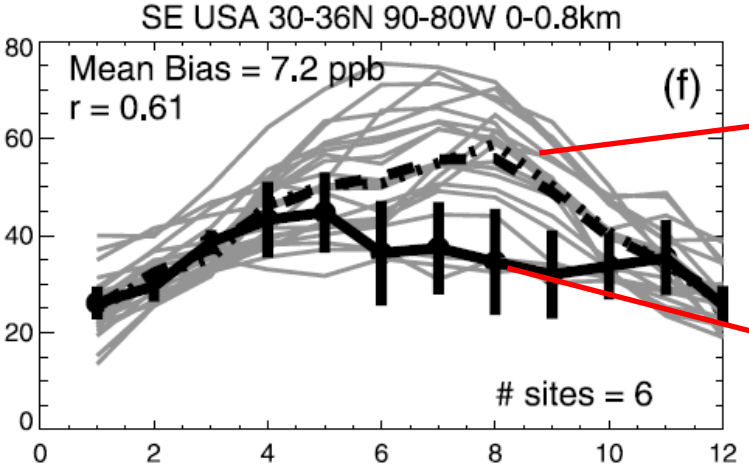
Northeast US



Multimodel mean

Obs from CASTNET surface sites

Southeast US



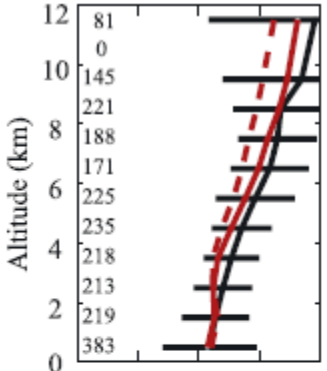
Multimodel mean

Obs from CASTNET surface sites

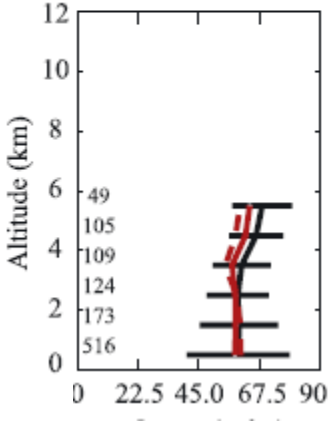
(Fiore et al., 2009, JGR)

We didn't have this problem during ICARTT!

DC-8 ozone

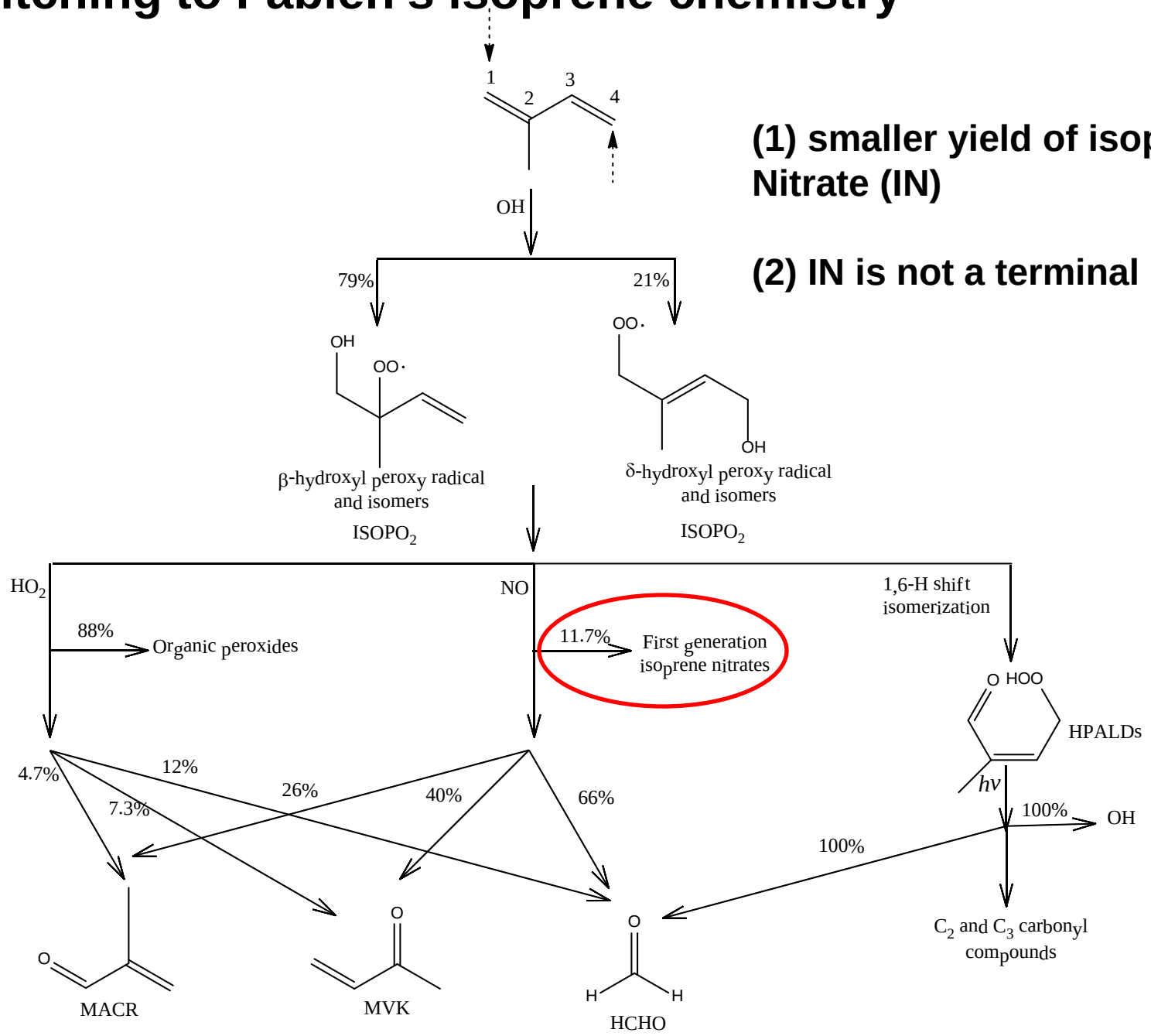


WP-3D ozone



(Hudman et al., 2007, JGR)

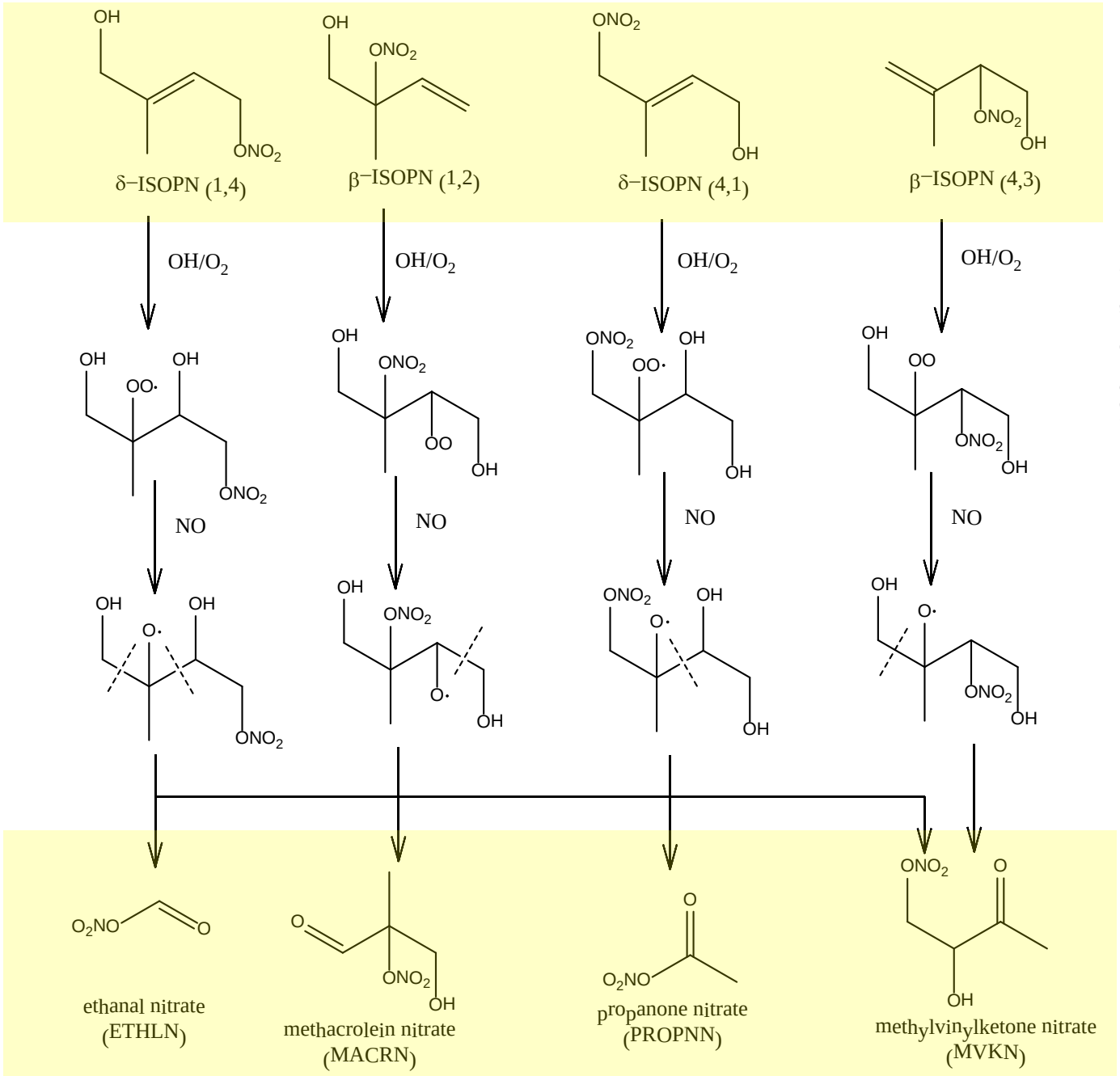
Switching to Fabien's isoprene chemistry



(1) smaller yield of isoprene Nitrate (IN)

(2) IN is not a terminal sink!

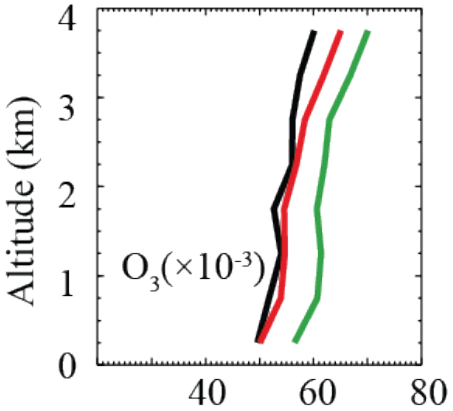
First generation of isoprene nitrates degraded to second generation nitrates!



Obs

Std chem (v8-2-3)

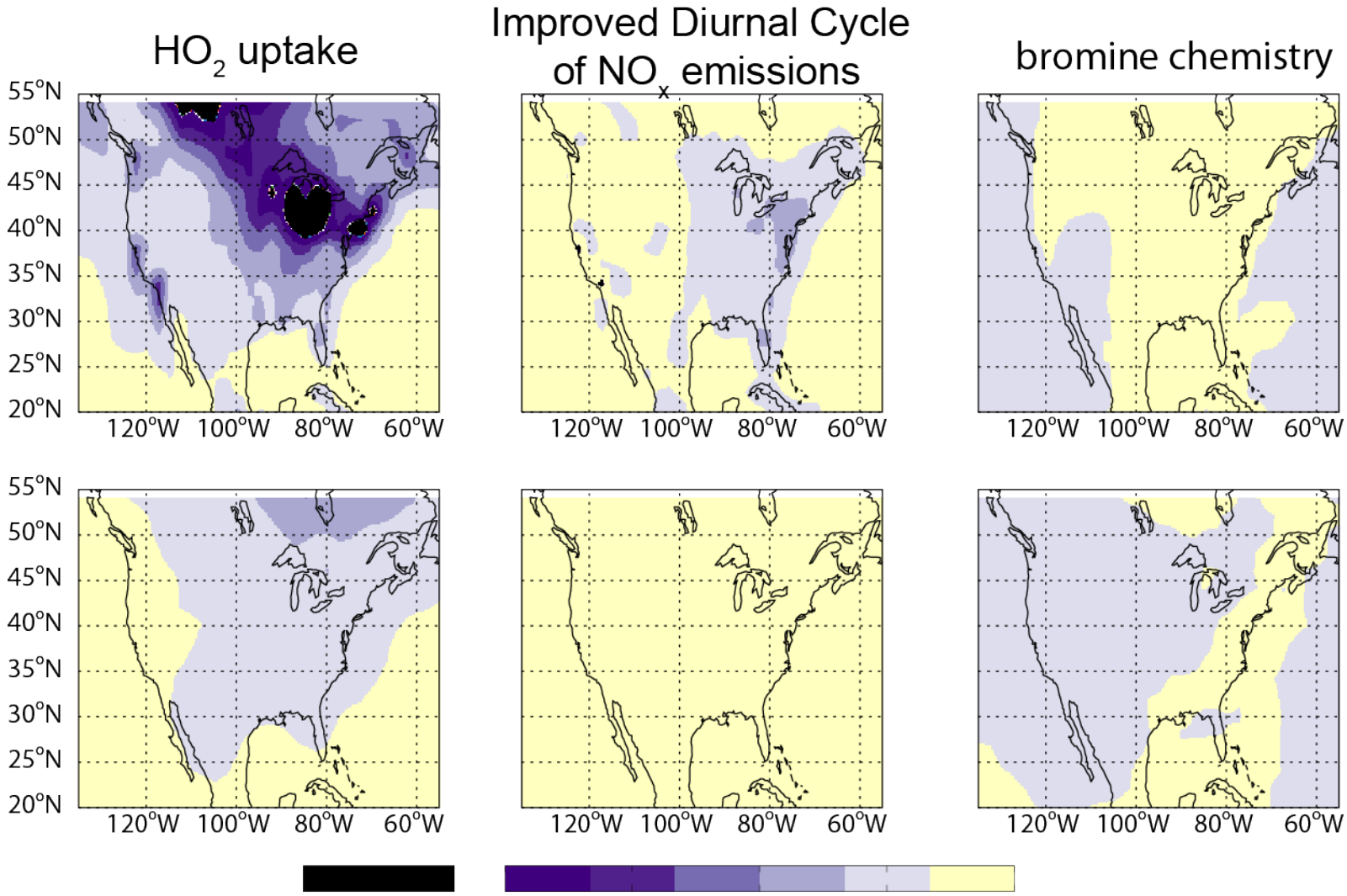
Paulot isoprene chem



Ozone bias is about +5 ppb in both boundary layer and free troposphere!

NO_x recycling efficiency is 55%!

A few more updates (impact on July afternoon ozone of 2004)



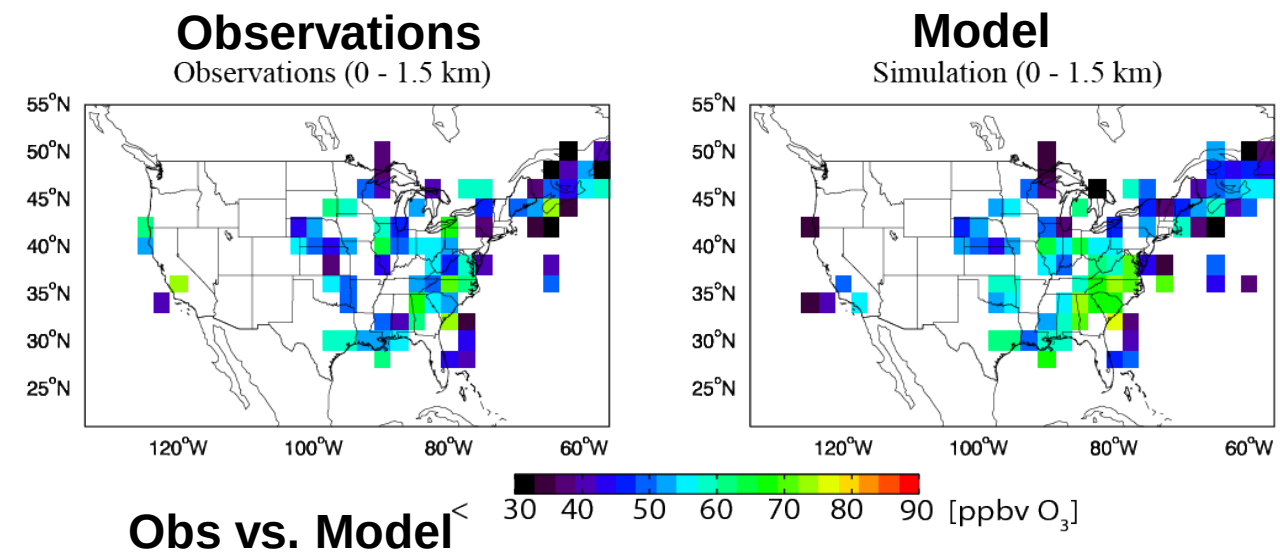
(Mao et al., ACP 2013)

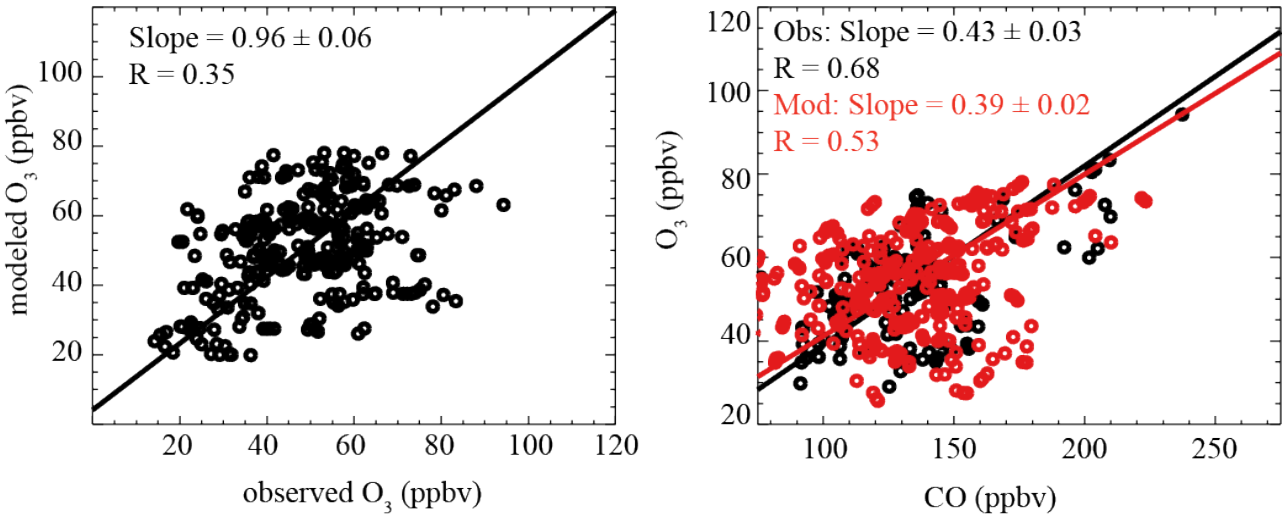
Implemented by Christoph Keller

(Parrella et al., ACP 2012)

We are now in good shape...

Ozone in the boundary layer during ICARTT



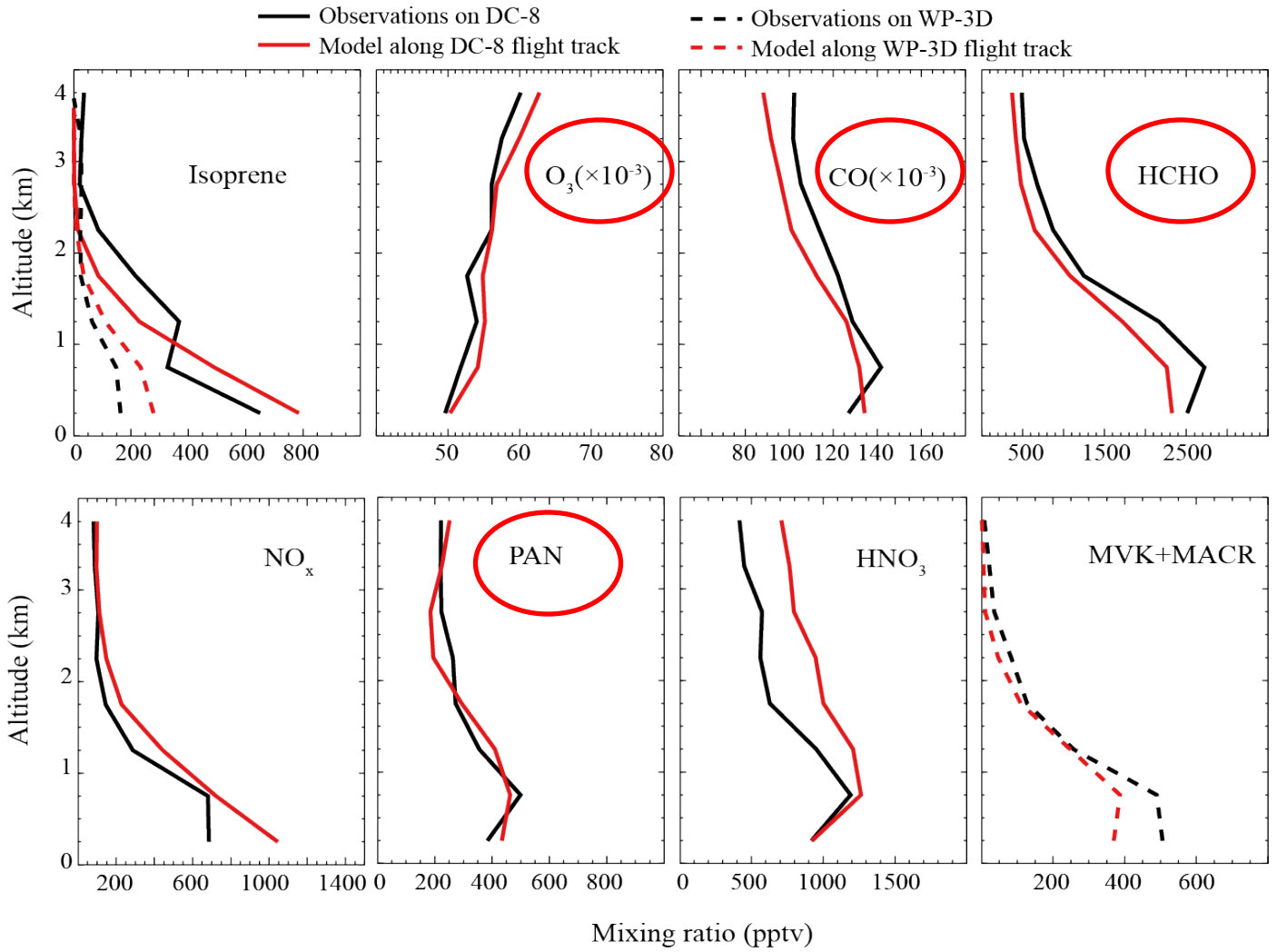


Improved O_3-CO correlations due to:

1. Recycling of NO_x from isoprene nitrates
2. HO_2 uptake (lower OH and increase NO_x lifetime).

Mean vertical profiles during ICARTT

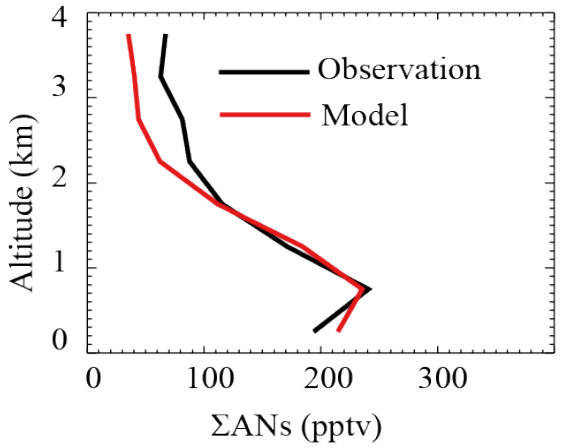
Observations
Model (this work)



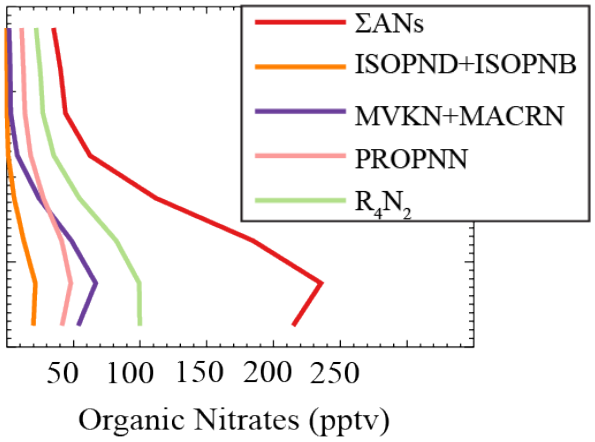
O_3 has no bias in boundary layer and free troposphere.
HCHO provides good constraint on isoprene emissions.

Total organic nitrates excluding peroxyacylnitrates (∑ANs)

Vertical profiles



Speciation of ∑ANs

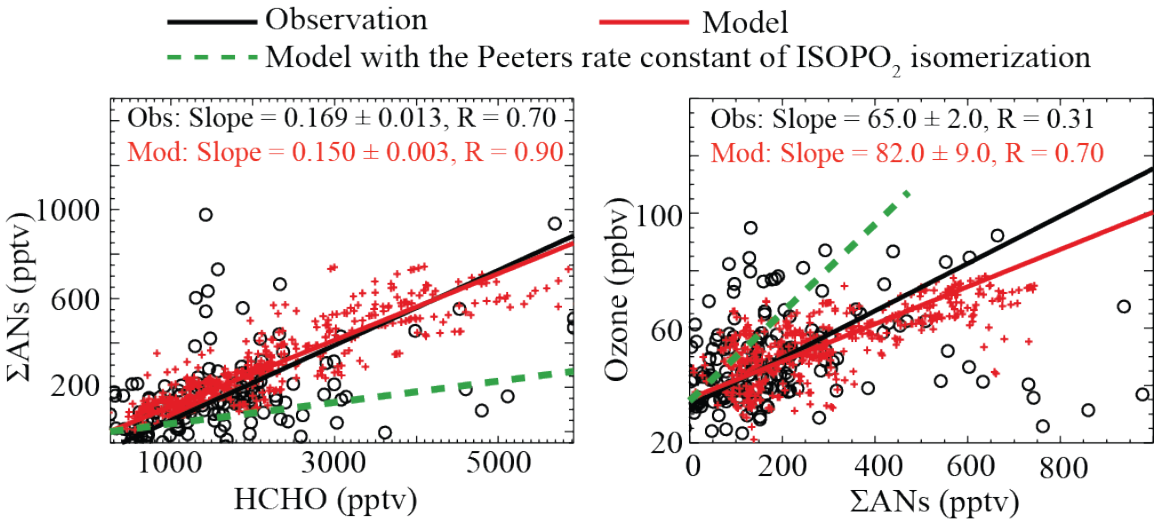


Model well reproduced ∑ANs.

∑ ANs is dominated by secondary organic nitrates.

∑ANs vs. HCHO

∑ANs vs. O_3



Model well reproduced ∑ANs vs HCHO and ∑ANs vs. O_3 correlations.

These correlations cannot be reproduced by a fast isomerization channel of $ISOPO_2$.

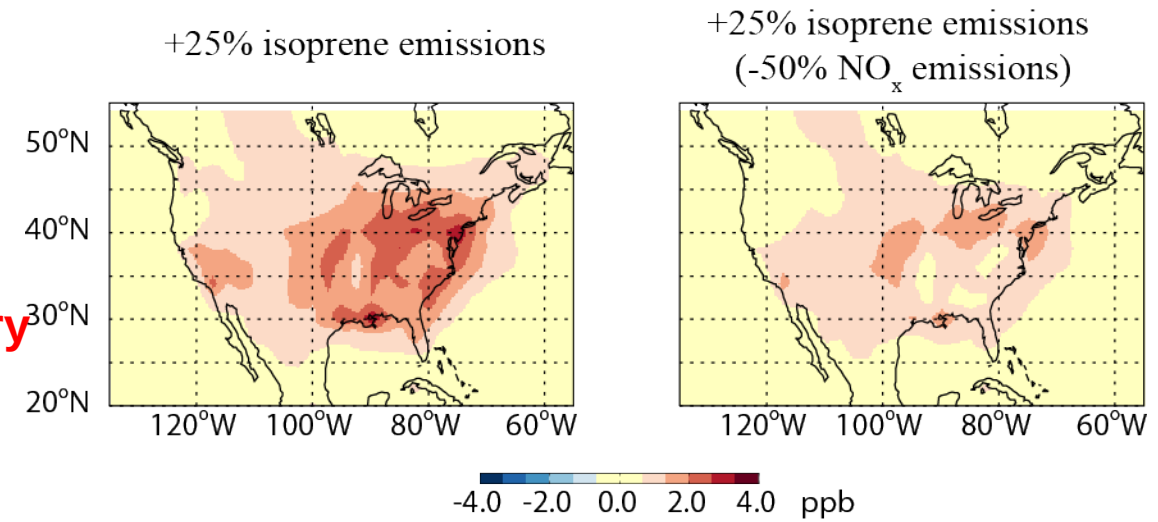
NO_y budget in eastern U.S. boundary layer for July 2004

Species	Emission	Chemical (P-L)	Dry Deposition	Wet Deposition	Net Export
NO_x	386	-337	44	------	5
PANs		24	13	------	11
∑ANs					
ANs		18	7.4	3.6	7
R_4N_2		10	0.5	-------	10
HNO_3		277	180	110	-3

Export of ∑ANs > Export of PANs

Surface ozone response to isoprene emissions

New chemistry



NO_x emissions↓

Sensitivity of ozone to isoprene emissions ↓

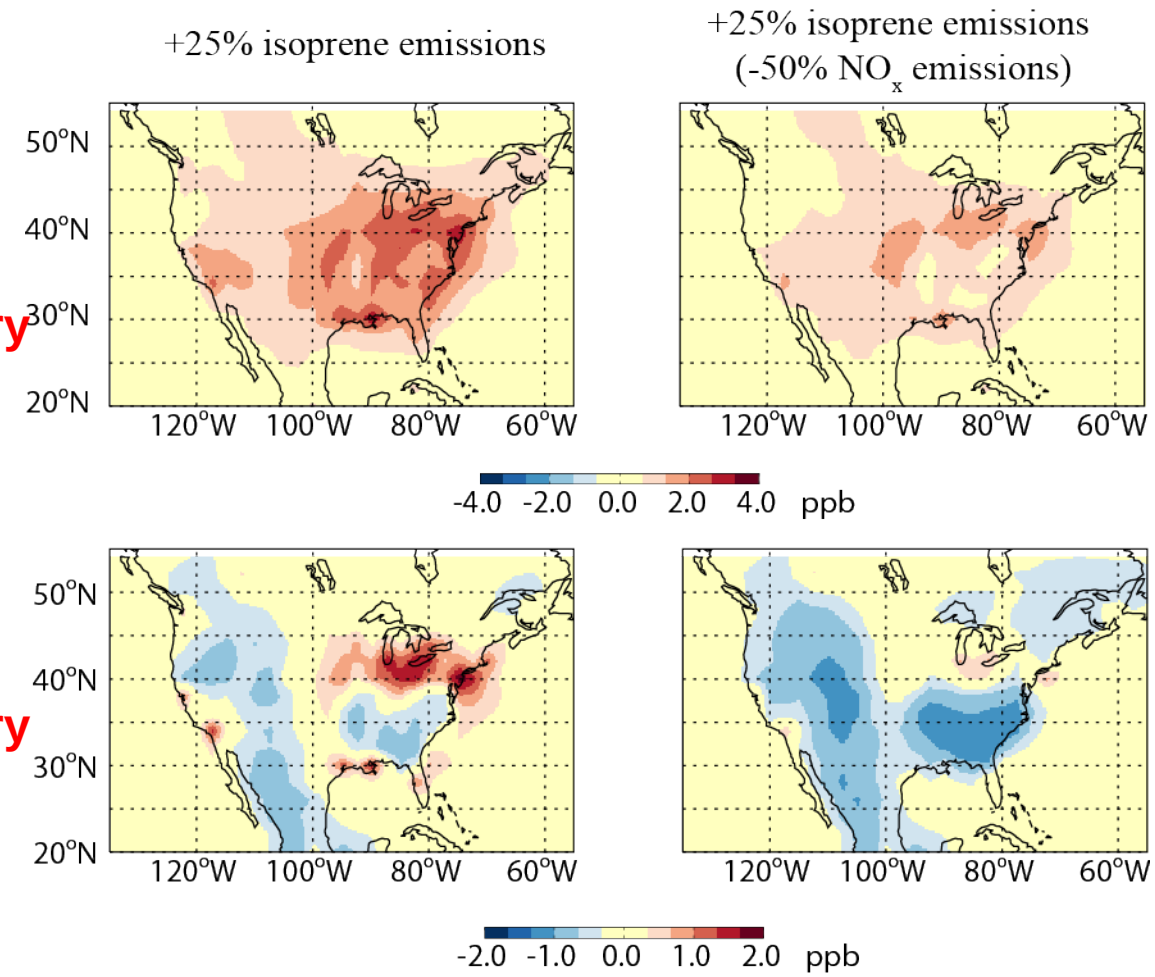
Current anthro NO_x emissions

Reduce current anthro NO_x emissions by 50%

Surface ozone response to isoprene emissions

New chemistry

V8-02-03 chemistry



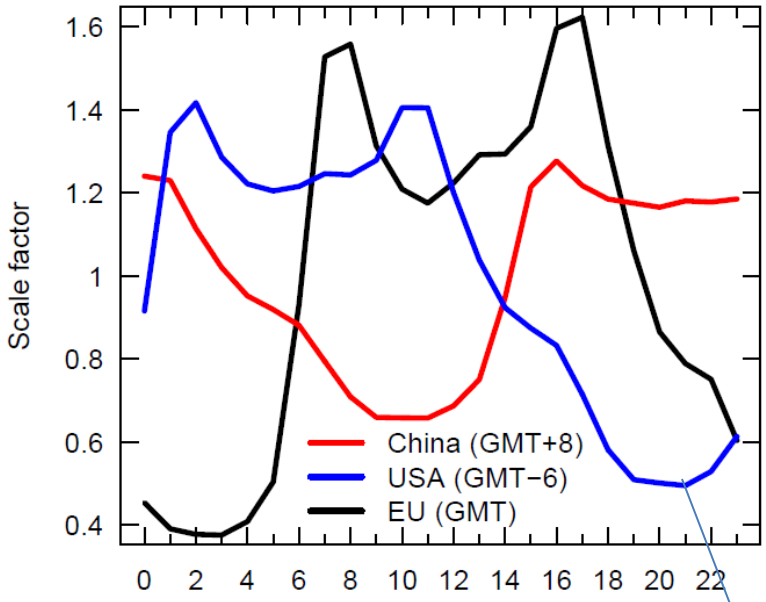
Isoprene↑
NO_x ↓
OH ↓
O_3 ↓ due to O_3+ISOP

Current anthro NO_x emissions

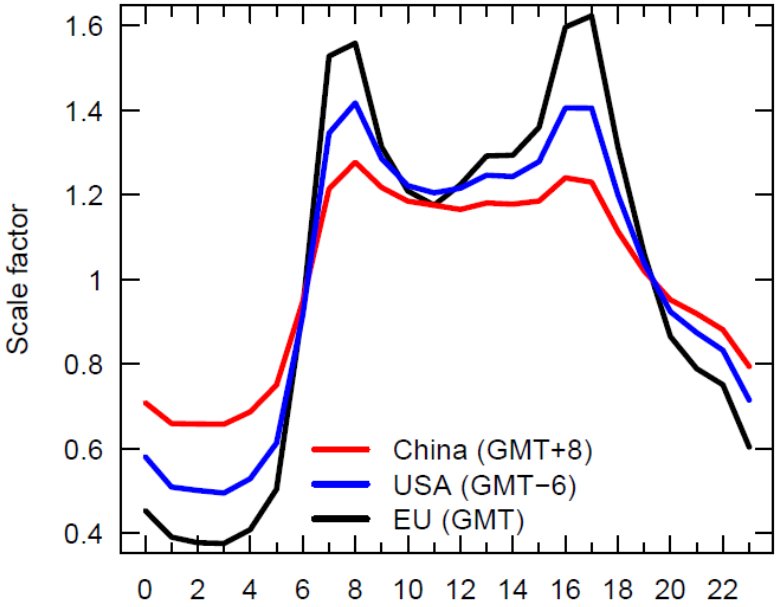
Reduce current anthro NO_x emissions by 50%

Extra slides

Old diurnal cycle for NOx emissions



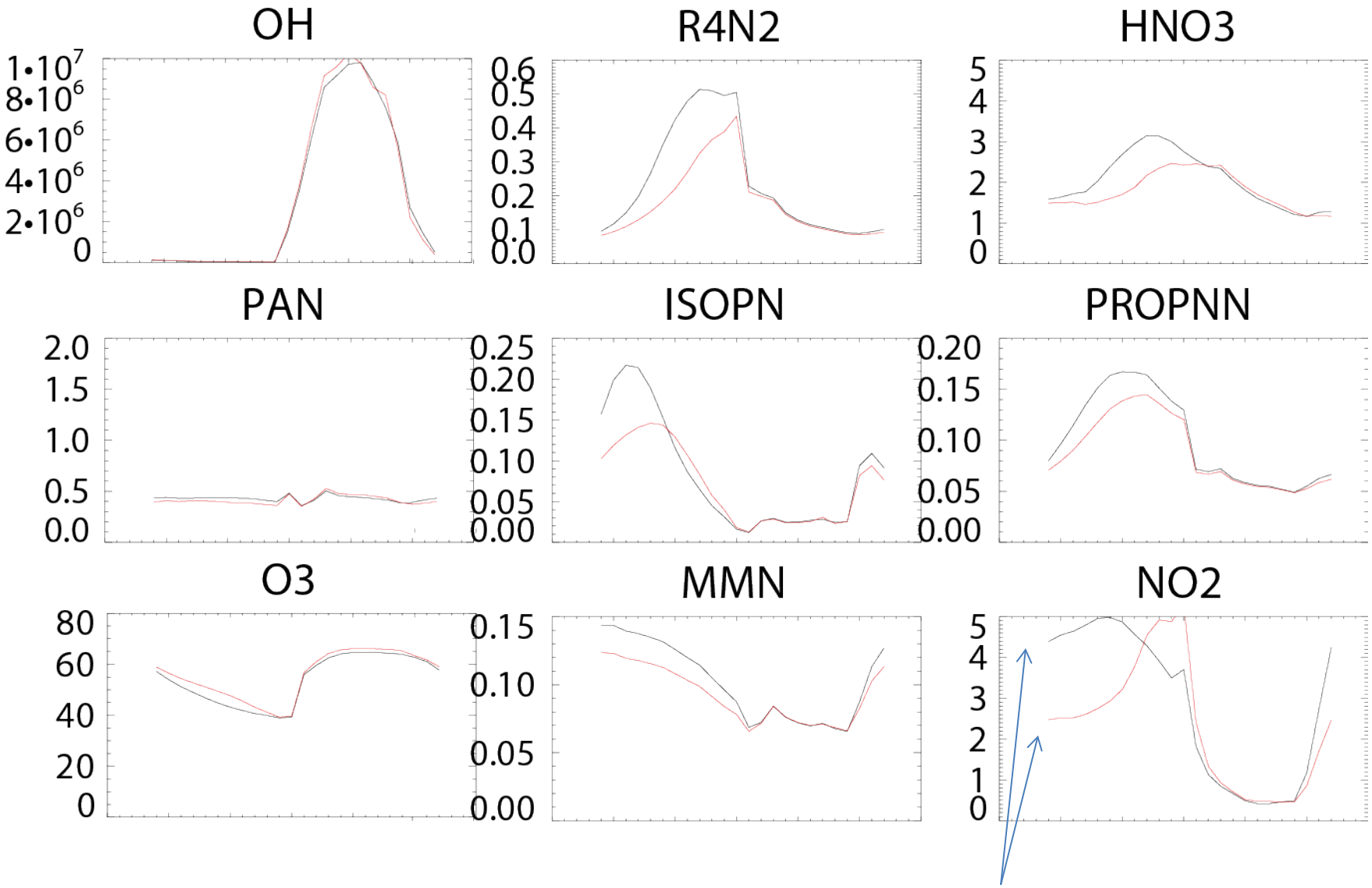
New diurnal cycle for NOx emissions



In the old diurnal cycle, very little NOx is emitted in the late afternoon.

Diurnal cycle in southeast US in summer

Red: old version Black: new version



Consequently NOx in new version is higher than in old version by a factor of 2.