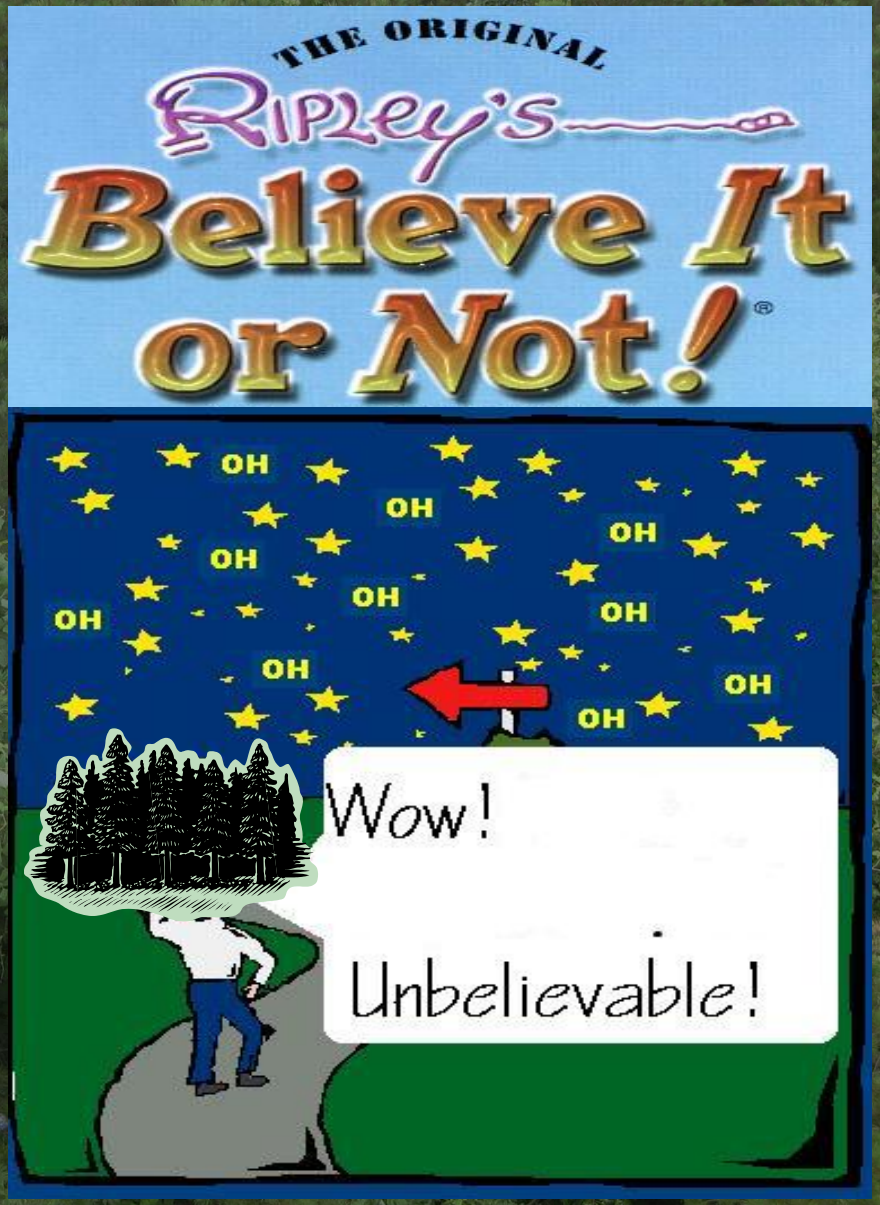
Hot Air in the Forest Primeval

William Brune
Pennsylvania State University

Collaborators: Li Zhang
Philip Feiner
David Miller
and SOAS Colleagues

See Phil's poster: "Ground-Based OH and HO_2 Measurements", Session #2; poster # 17.



Thanks to our Alabama hosts and NCAR for logistics and NSF for support!

a little history – first nighttime OH measurements in PROPHET 1998

Michigan forest

Lab tests - no observed interference (Ren et al, *J. Atm. Chem.*, 2004)

Nighttime OH *only* when O_3 & alkenes present

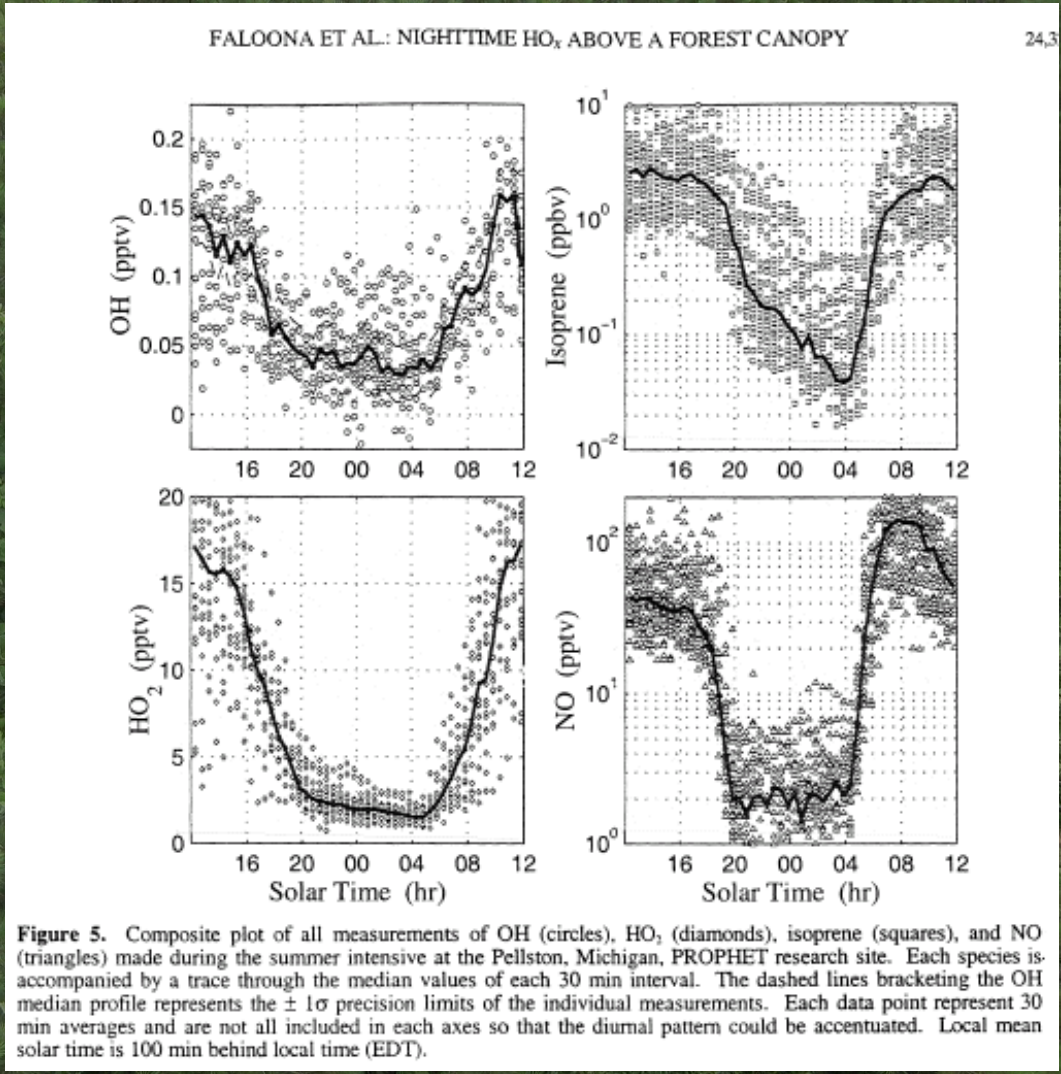
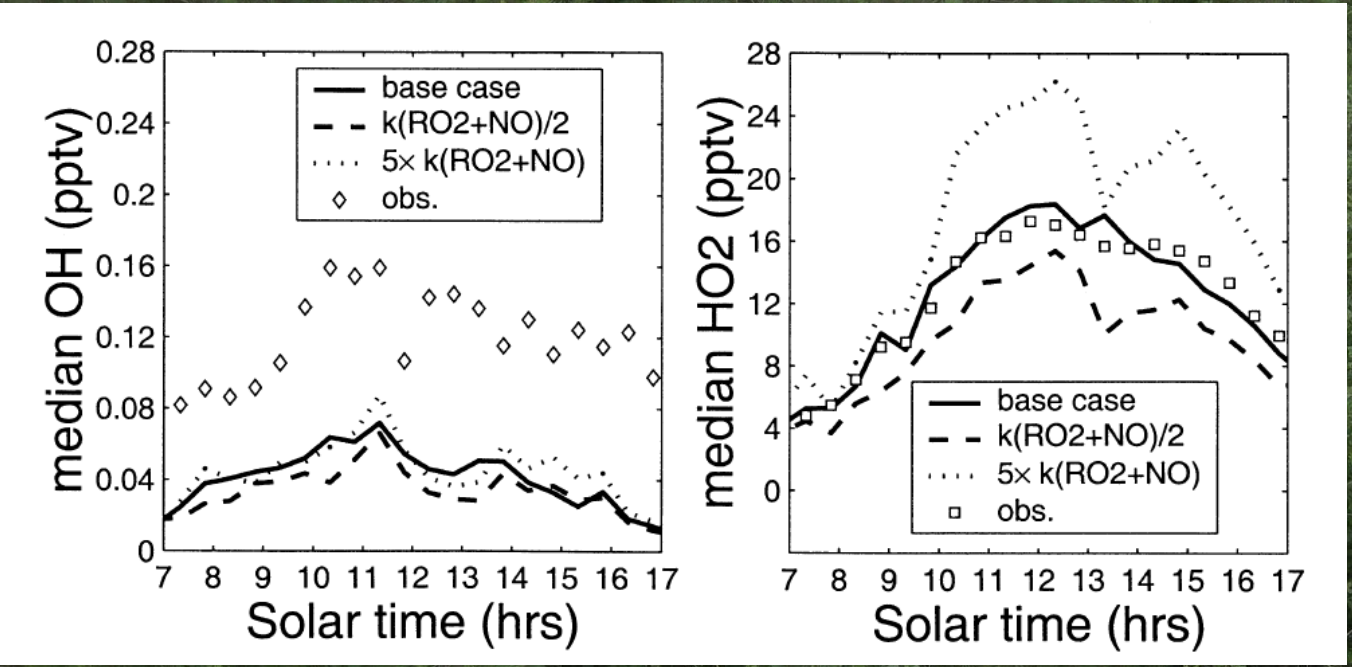


Figure 5. Composite plot of all measurements of OH (circles), HO_2 (diamonds), isoprene (squares), and NO (triangles) made during the summer intensive at the Pellston, Michigan, PROPHET research site. Each species is accompanied by a trace through the median values of each 30 min interval. The dashed lines bracketing the OH median profile represents the ± 1σ precision limits of the individual measurements. Each data point represent 30 min averages and are not all included in each axes so that the diurnal pattern could be accentuated. Local mean solar time is 100 min behind local time (EDT).

Faloona et al., *JGR, 106*, 24,315, 2001

More problems with forest OH …

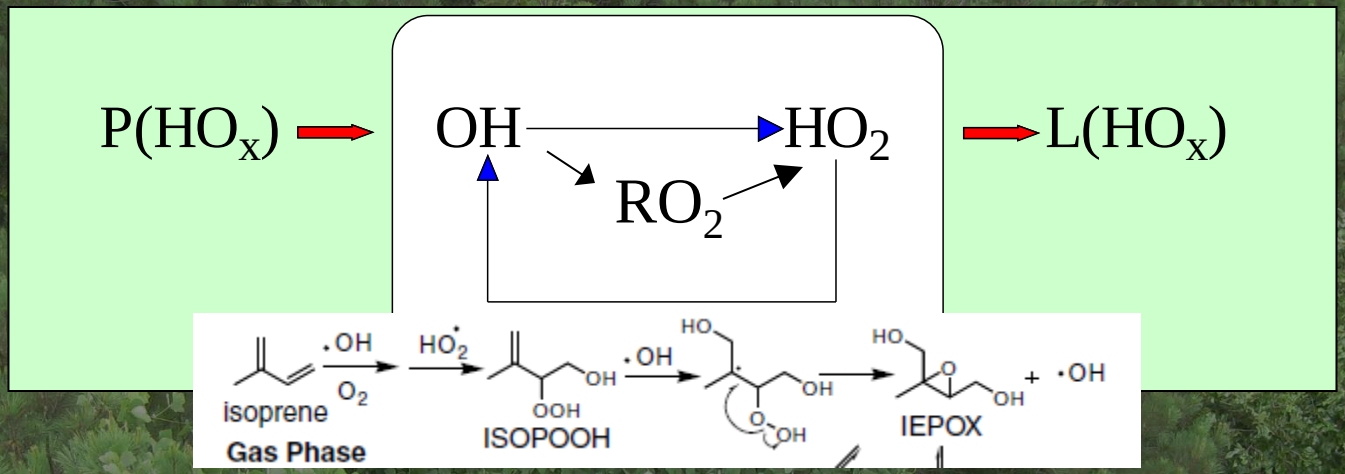
Measured OH ~2.7 x modeled; Measured HO_2 ~ modeled



Tan et al., *JGR, 106*, 24,407, 2001

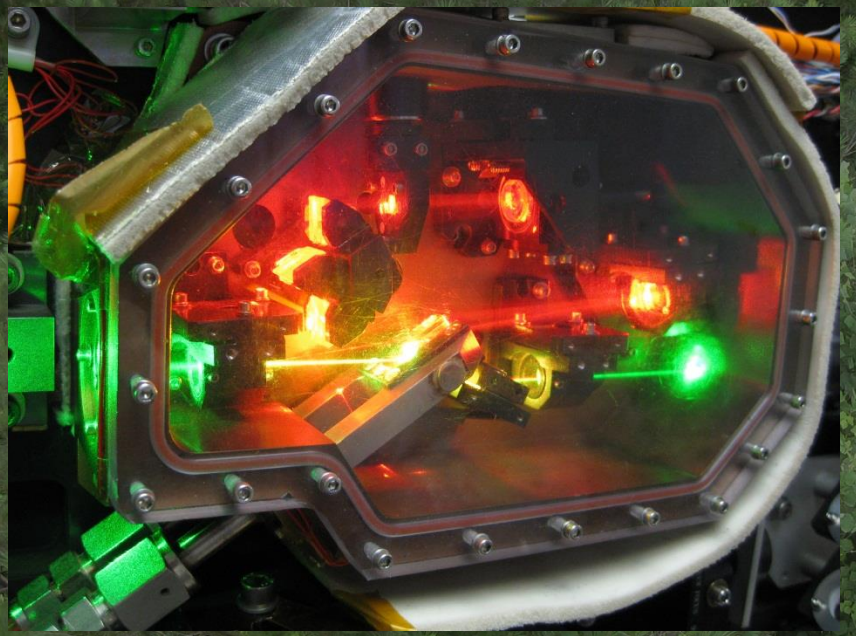
Observed OH greater than model in several other studies of low-NO_x, high-VOC environments.

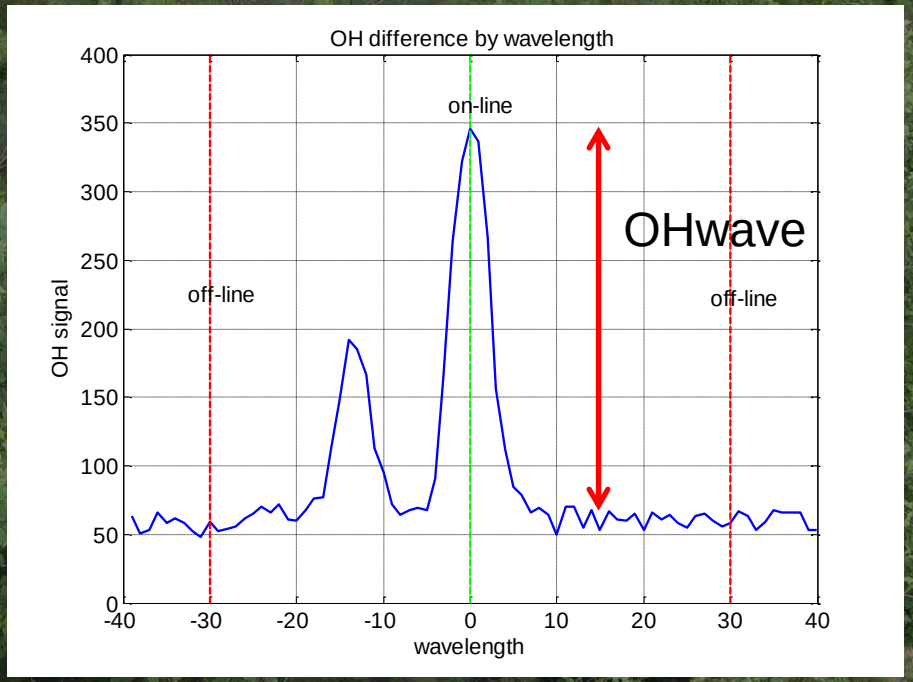
The dilemma of the OH discrepancy



- Difficult to get modeled OH to agree with observations of elevated OH without making modeled HO_2 much greater than observed

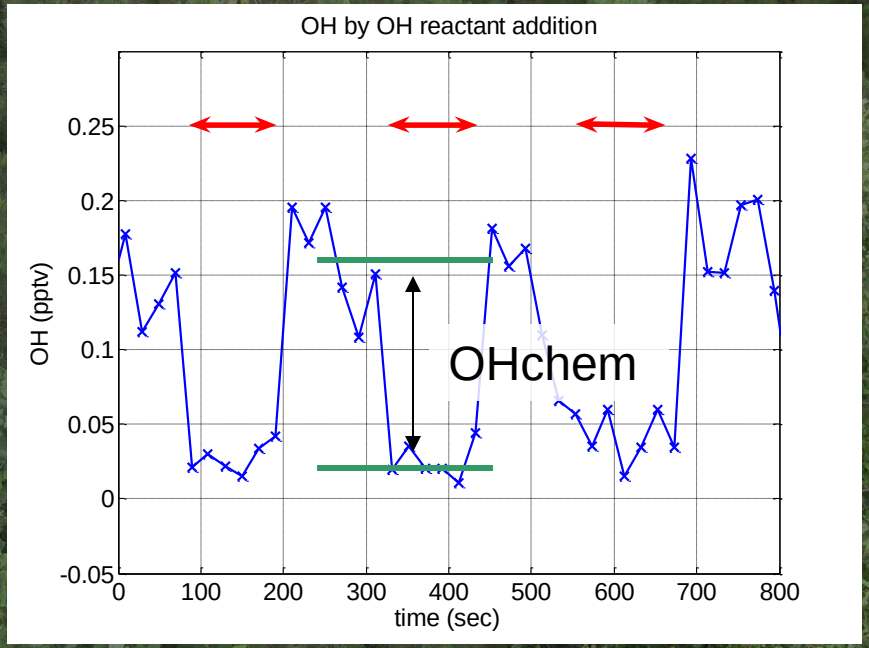
OH measured by our usual method …





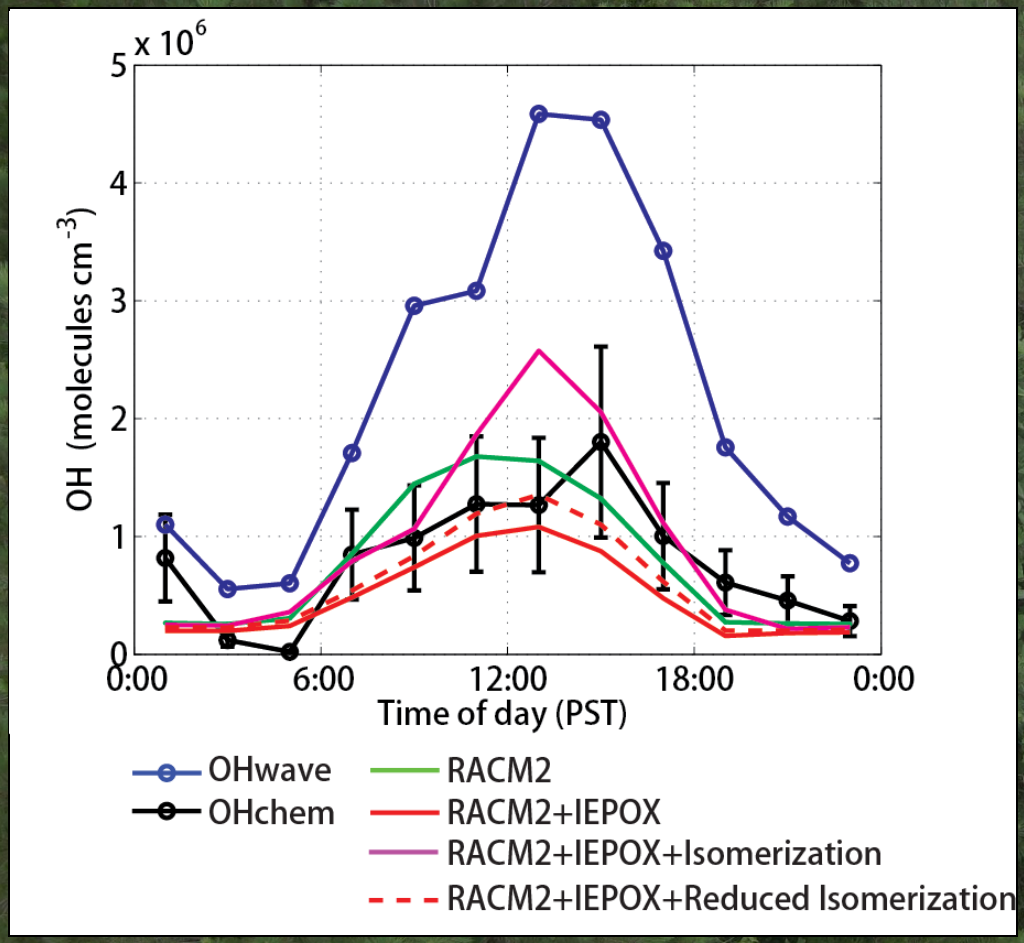
change wavelength between on-line (OH fluorescence) to off-line (background) every 20 sec (called OHwave)

and also by a second method …



- remove OH with an OH reactant (called chemical modulation or OHchem) every two minutes.
- OHwave-OHchem = OH interference (OH_int)
- Did both in Houston 2009, BEARPEX 2009, Calnex 2010, DC3 2012, SOAS, FIX

OH for BEARPEX09 (Mao et al., 2012)



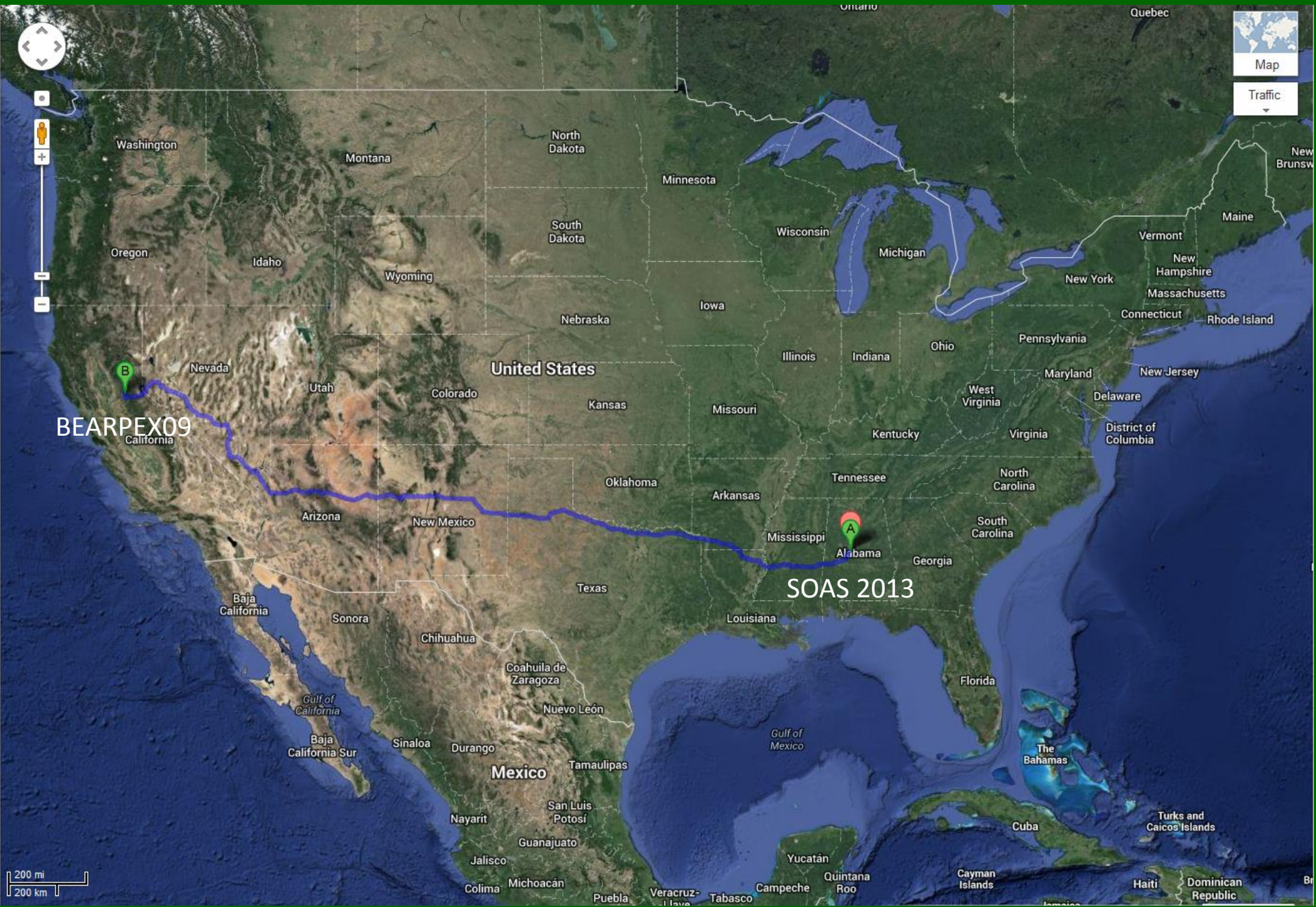
uncertainty (2σ):
observation, ±40%
model: ±40-60%

OHwave/models ~2-3
OHchem/models ~ 1

So, no big problem between low-OH model & measurement*

* does not necessarily apply to other instruments or forests

A tale of two forests

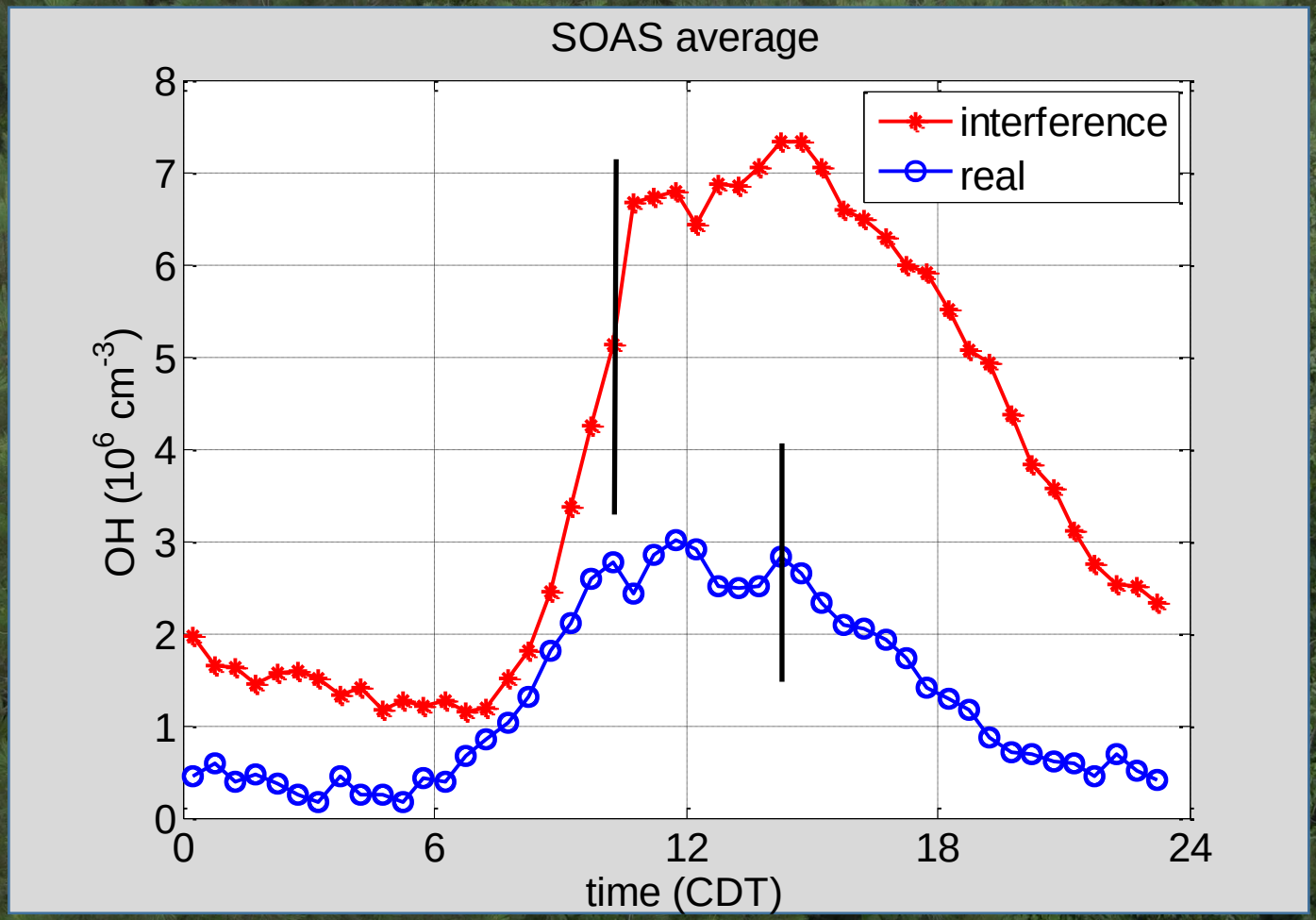


A tale of two forests

BEARPEX09

SOAS 2013

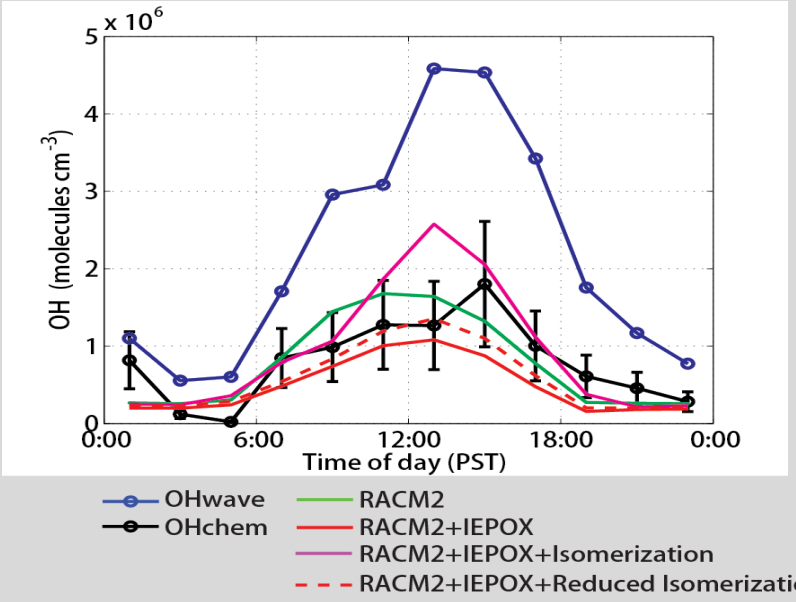
OH – real and interference



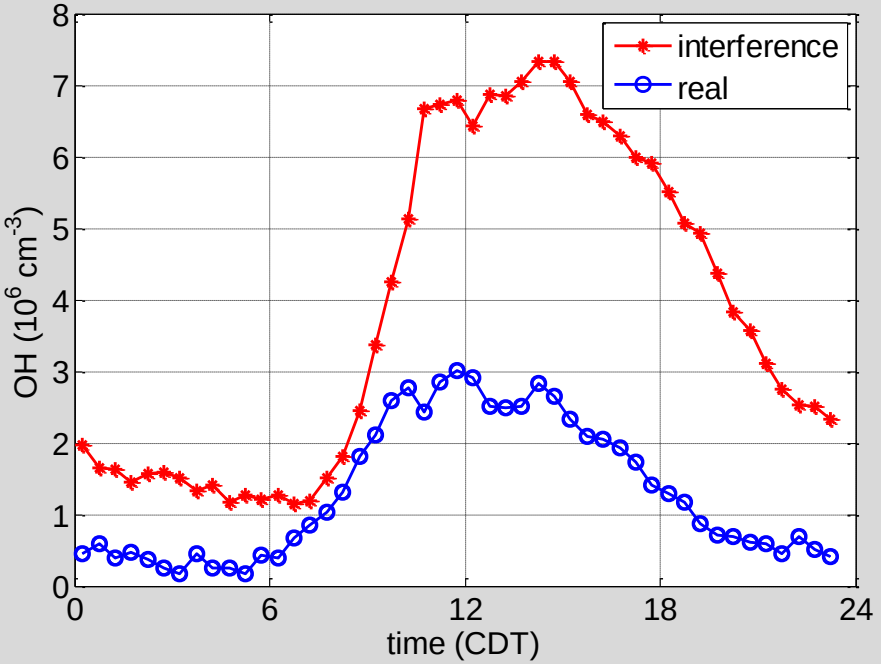
calibration and OHchem/OHint separation still preliminary

Comparison: BEARPEX09 to SOAS

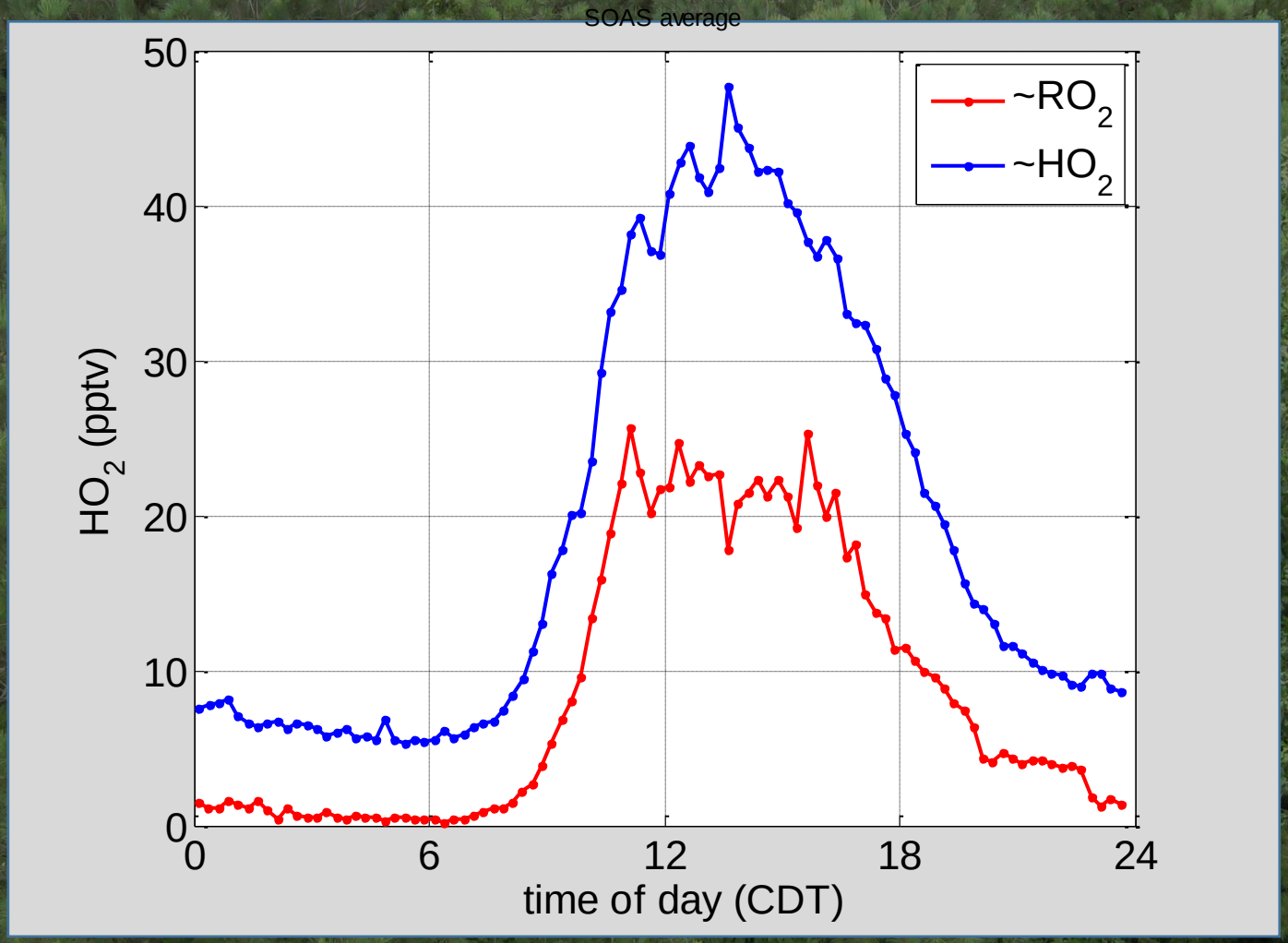
BEARPEX09



SOAS average

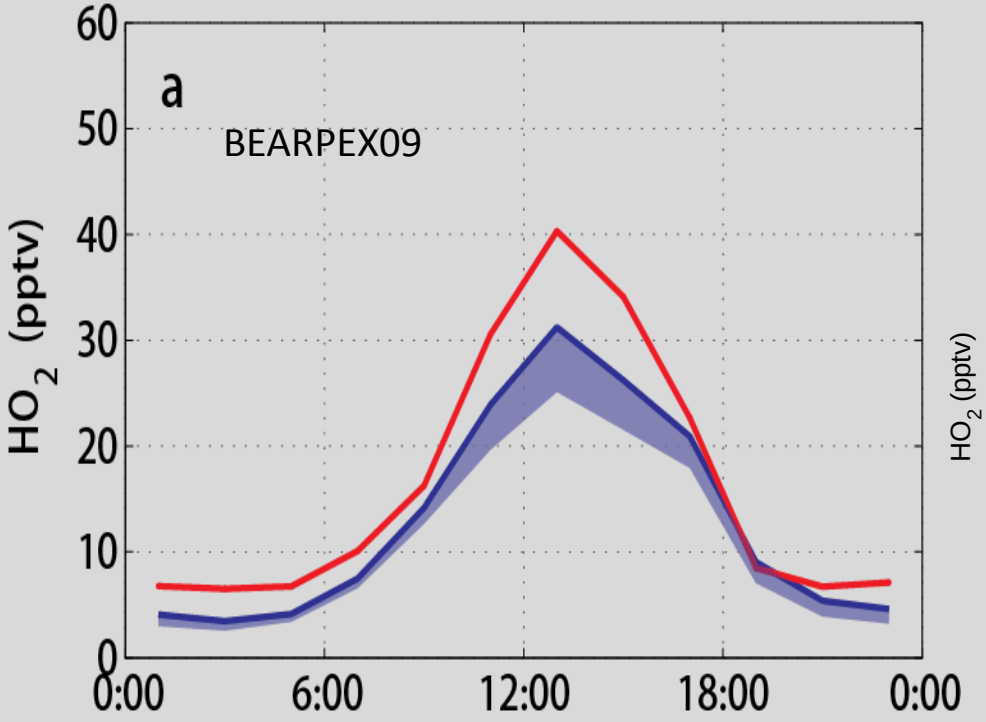


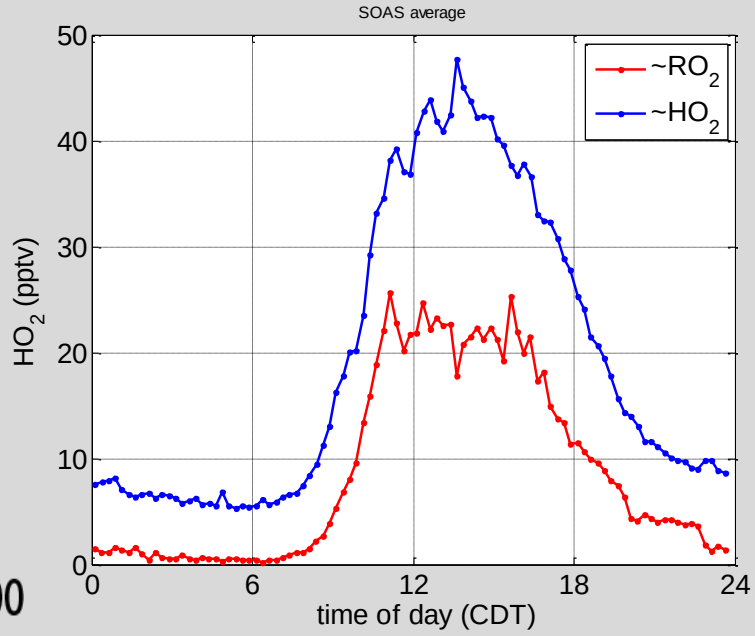
HO_2



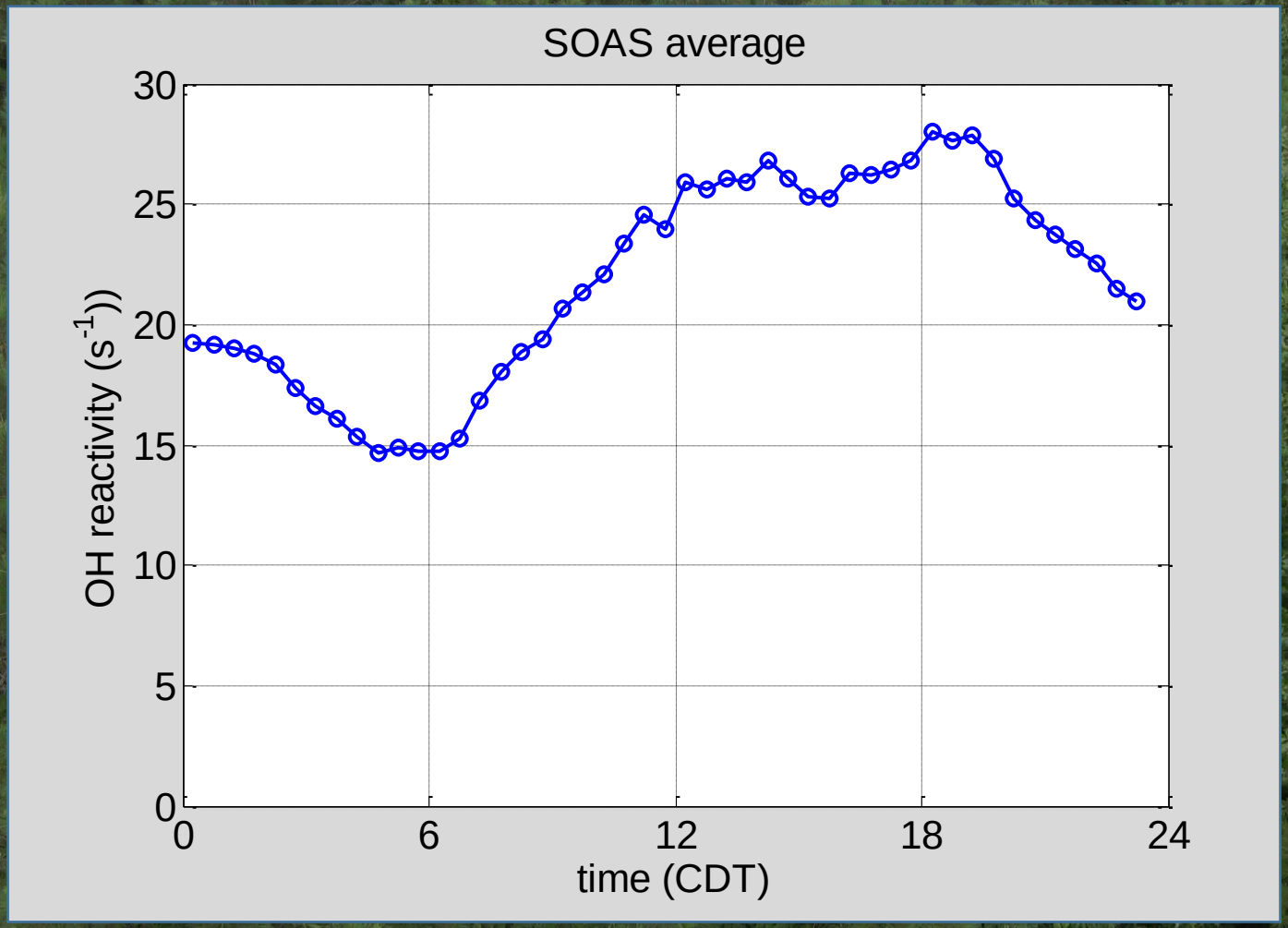
still working on separating HO_2 and RO_2

Comparison: BEARPEX09 to SOAS

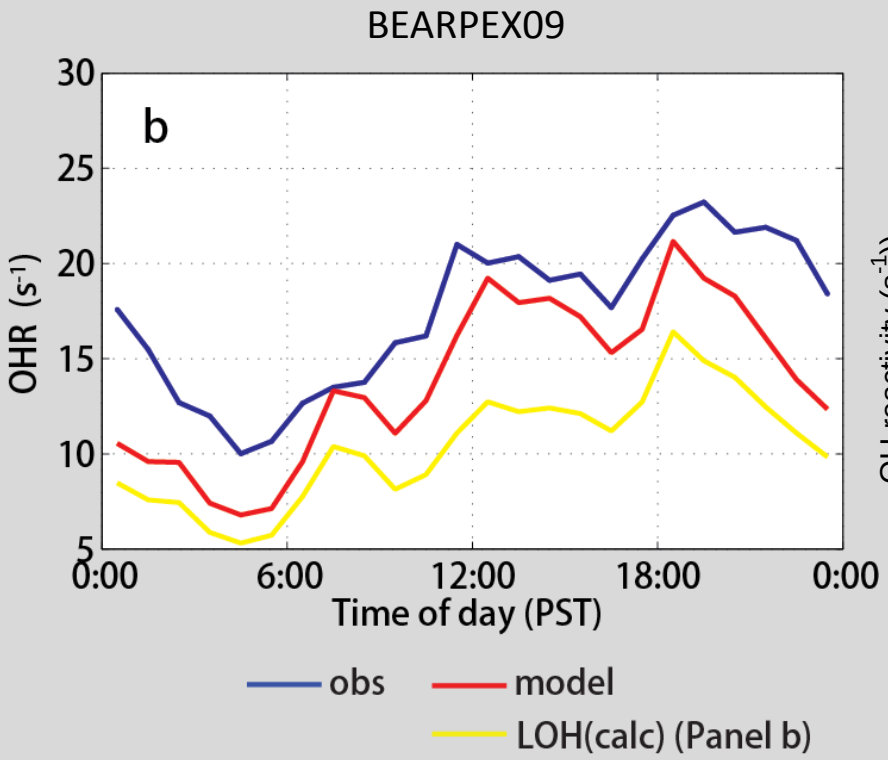


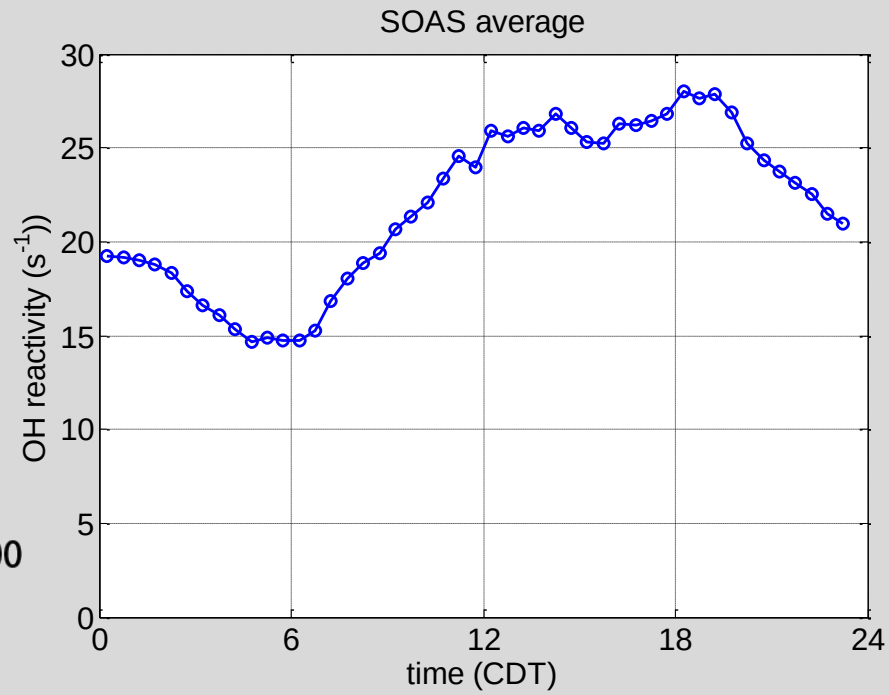


OH reactivity (1/(OH lifetime))

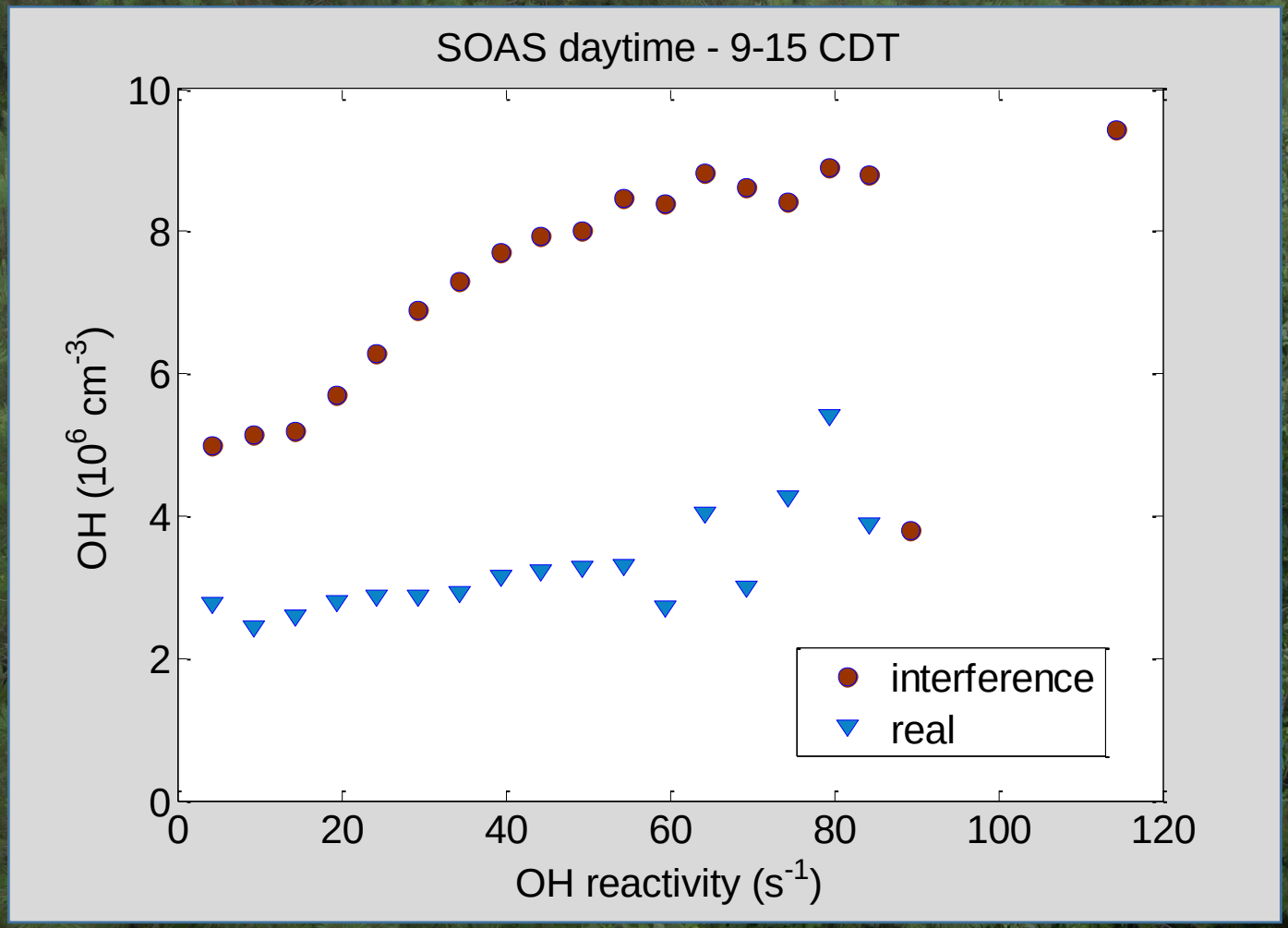


Comparison: BEARPEX09 to SOAS

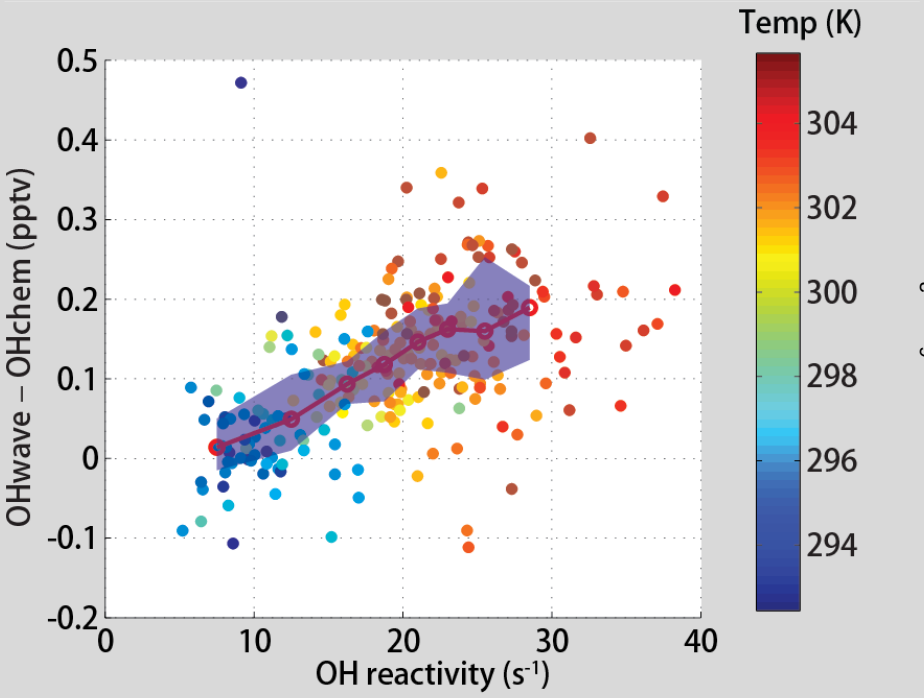


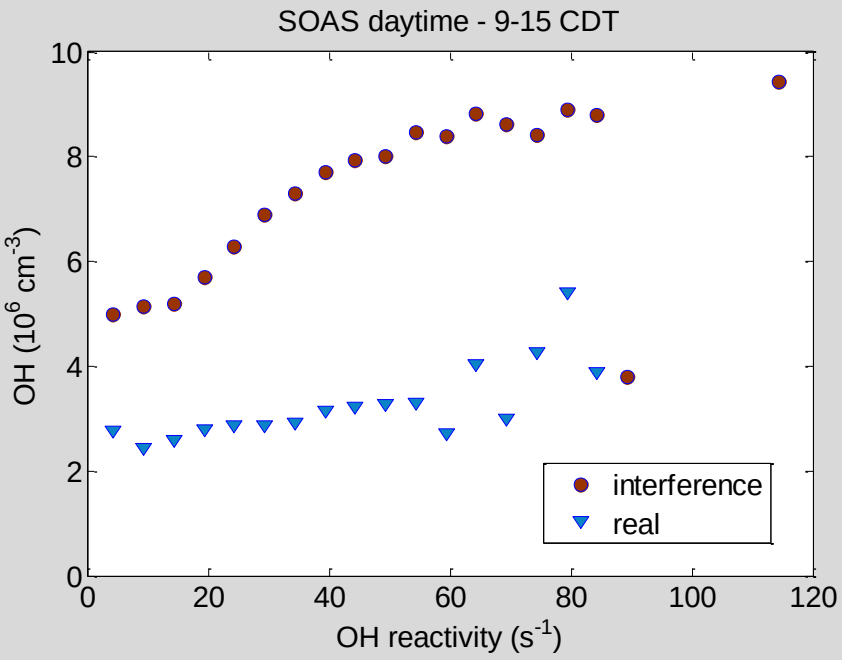


OH dependence on OH reactivity

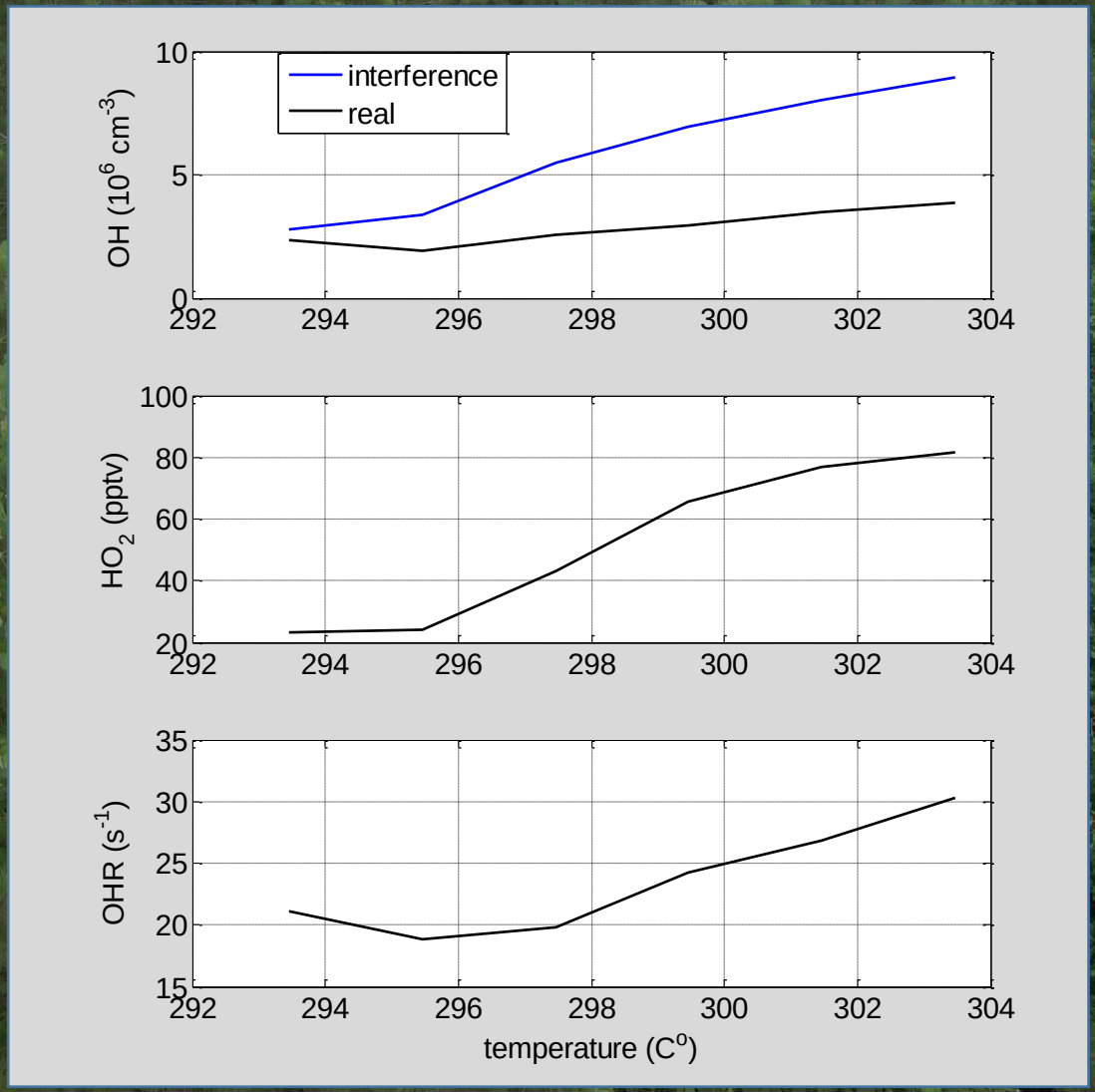


Comparison: BEARPEX09 to SOAS

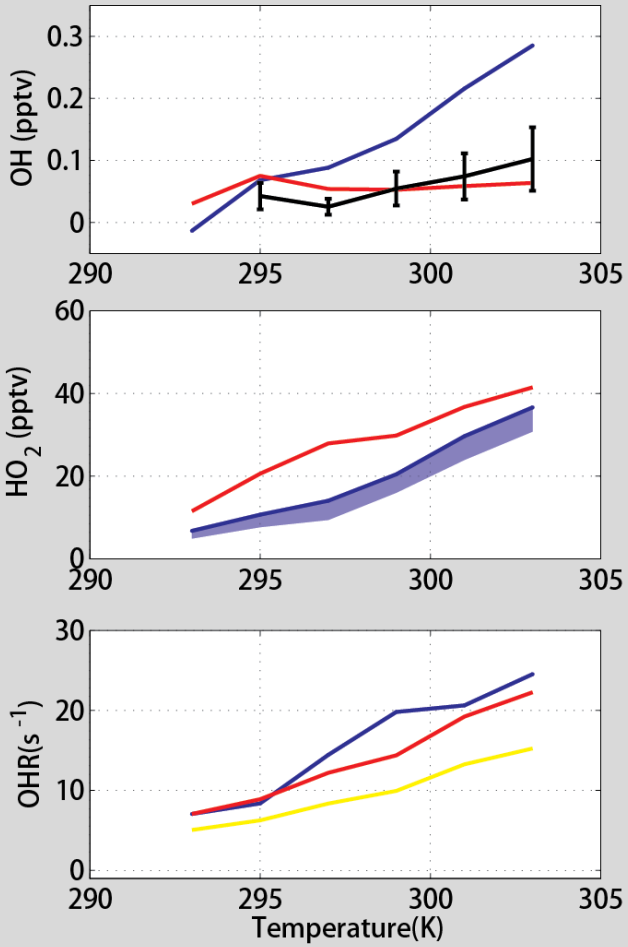


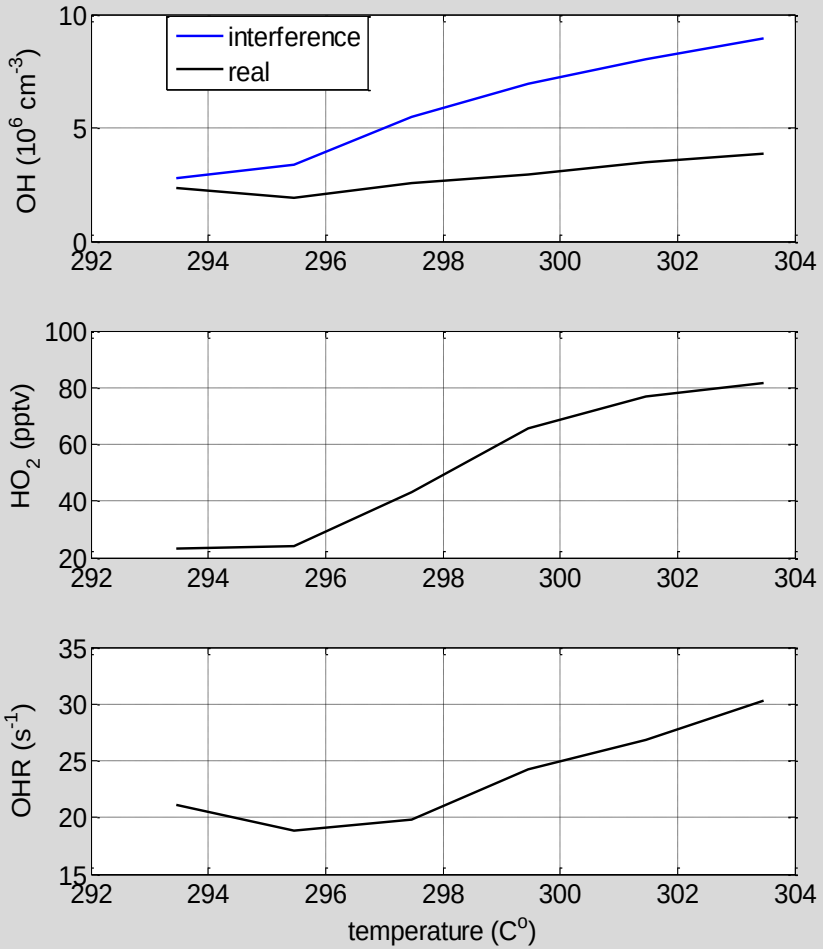


OH, HO_2, and OHR dependence on temperature

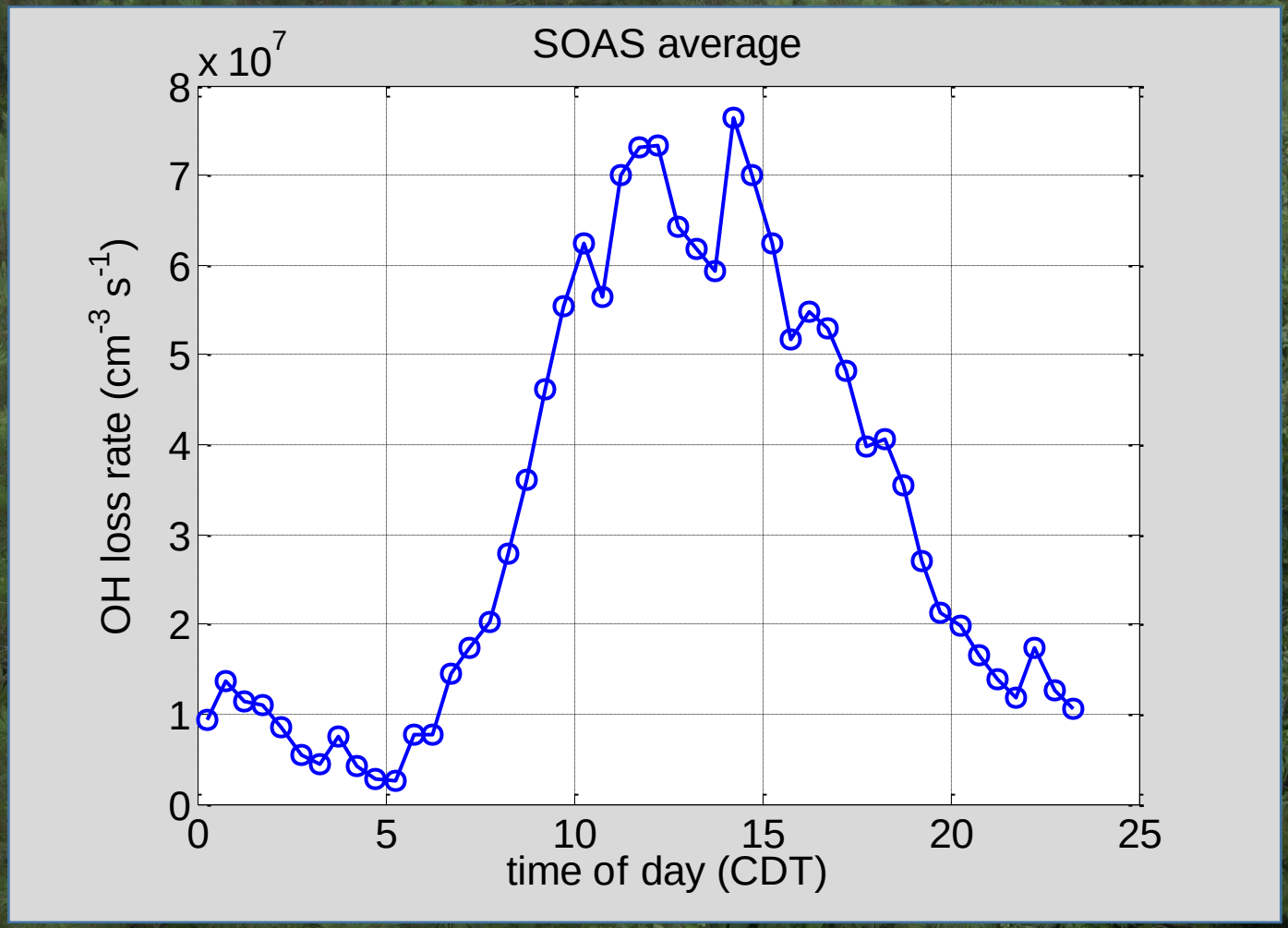


Comparison: BEARPEX09 to SOAS





OH loss rate = [OH]xOH reactivity = OH production rate



Conclusions

- HO_x behavior similar in SOAS and BEARPEX despite site differences
- Chemistry more active in SOAS, likely due to larger HO_x source
- For SOAS, modeled HO_x will likely agree with HO_x measurements once we run it
- More work separating HO_2 from RO_2
- Need merged data sets to run model


Thanks!