SIMULATION OF NO_2 VERTICAL PROFILES OVER EAST ASIA & THEIR RELATION TO OXIDANT CHEMISTRY

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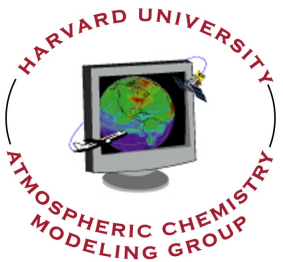
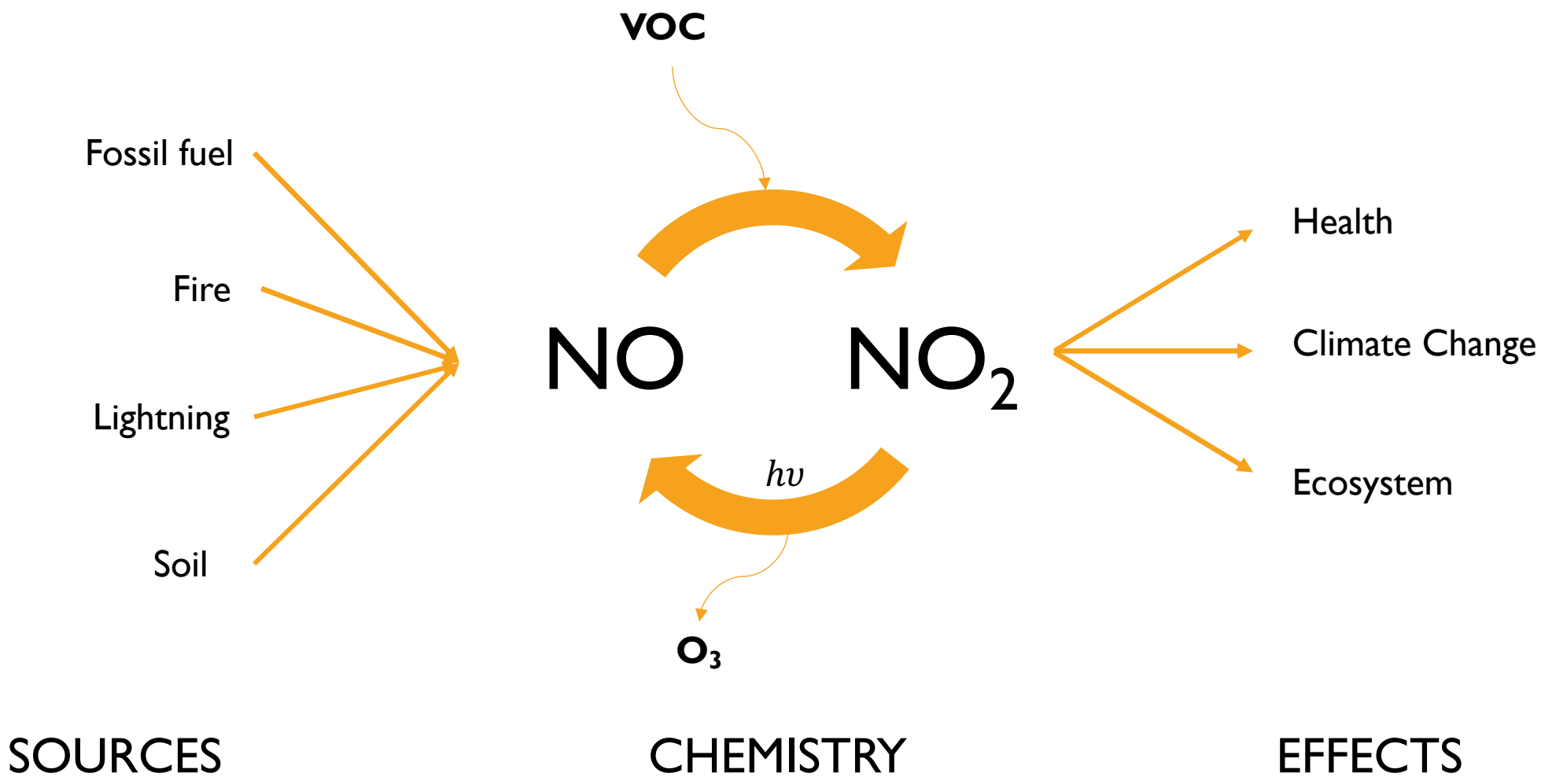
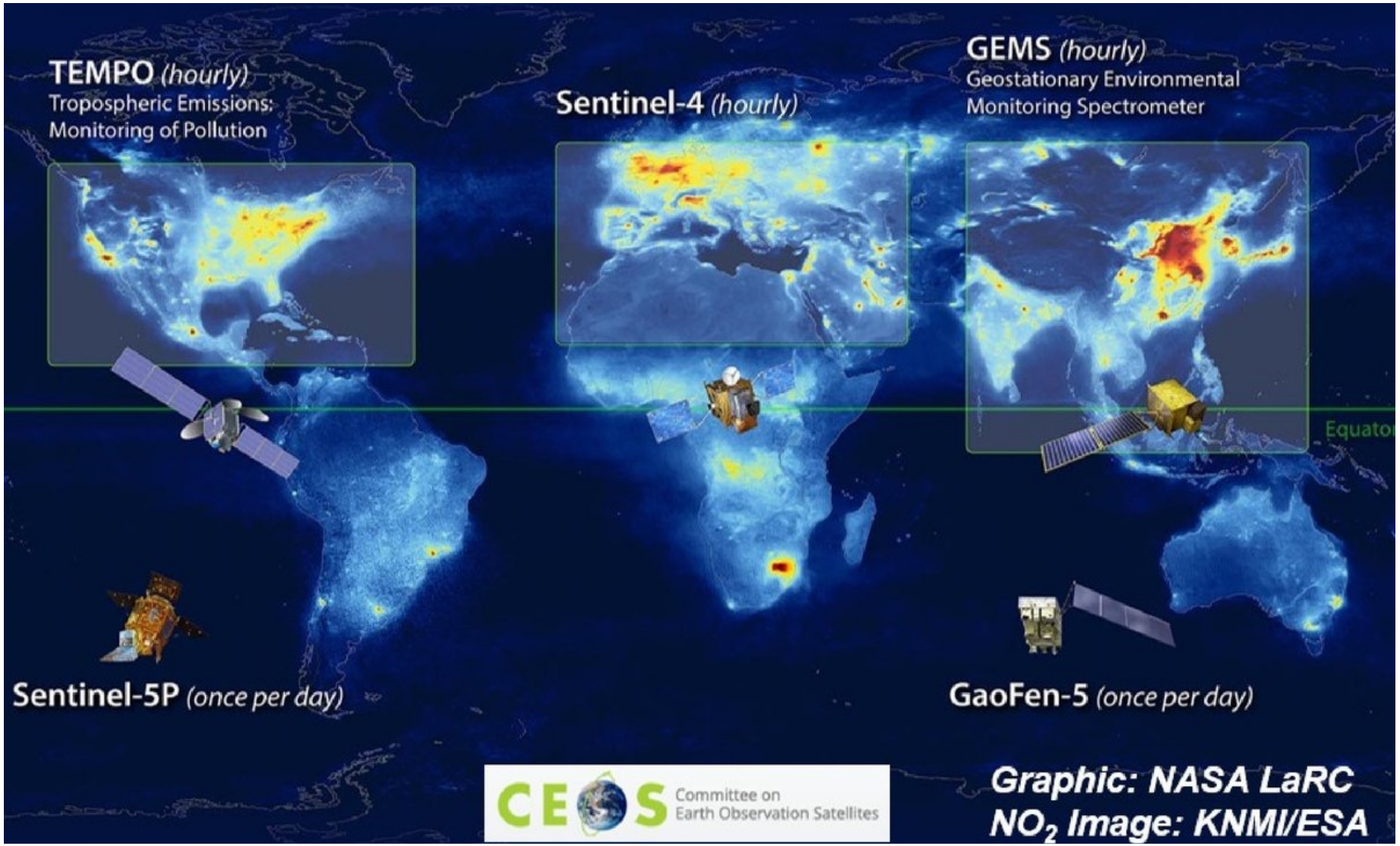
IGC10, June 7, 2022



Background Information on NO_2



Why should we care about vertical profiles?



- O_3
- NO_2
- CH_2O
- Glyoxal
- SO_2
- Aerosol

GEOS-Chem and aircraft observation comparison

GEOS-Chem

Version 13.3.4

Standard Model

0.25° × 0.3215°

No nitrate aerosol photolysis

No HNO_3 uptake by PMC

No VCP emission

CO boundary condition not scaled up

γ_{HO_2} = 0.2

GEOS-Chem

Version 13.3.4

Modified/Updated Model

0.25° × 0.3215°

With nitrate aerosol photolysis

With HNO_3 uptake by PMC

With VCP emission

CO boundary condition ×1.5

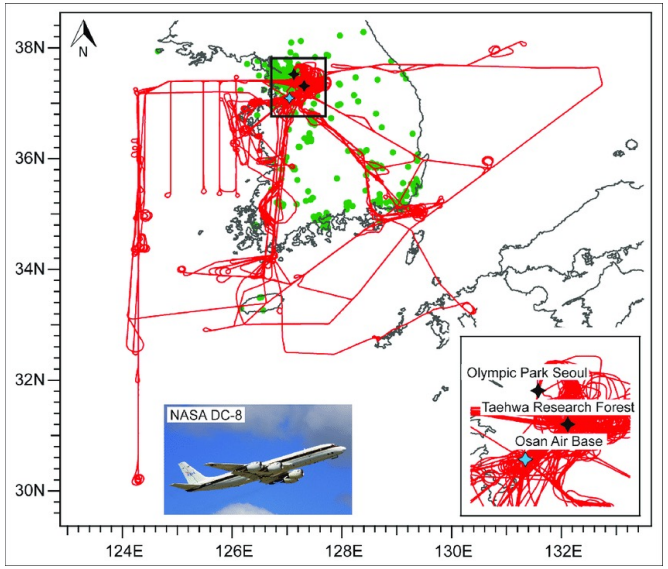
γ_{HO_2} = 0.1

PMC: Coarse PM
VCP: Volatile Chemical Product
γ_{HO_2}: HO_2 uptake coefficient

KORUS-AQ

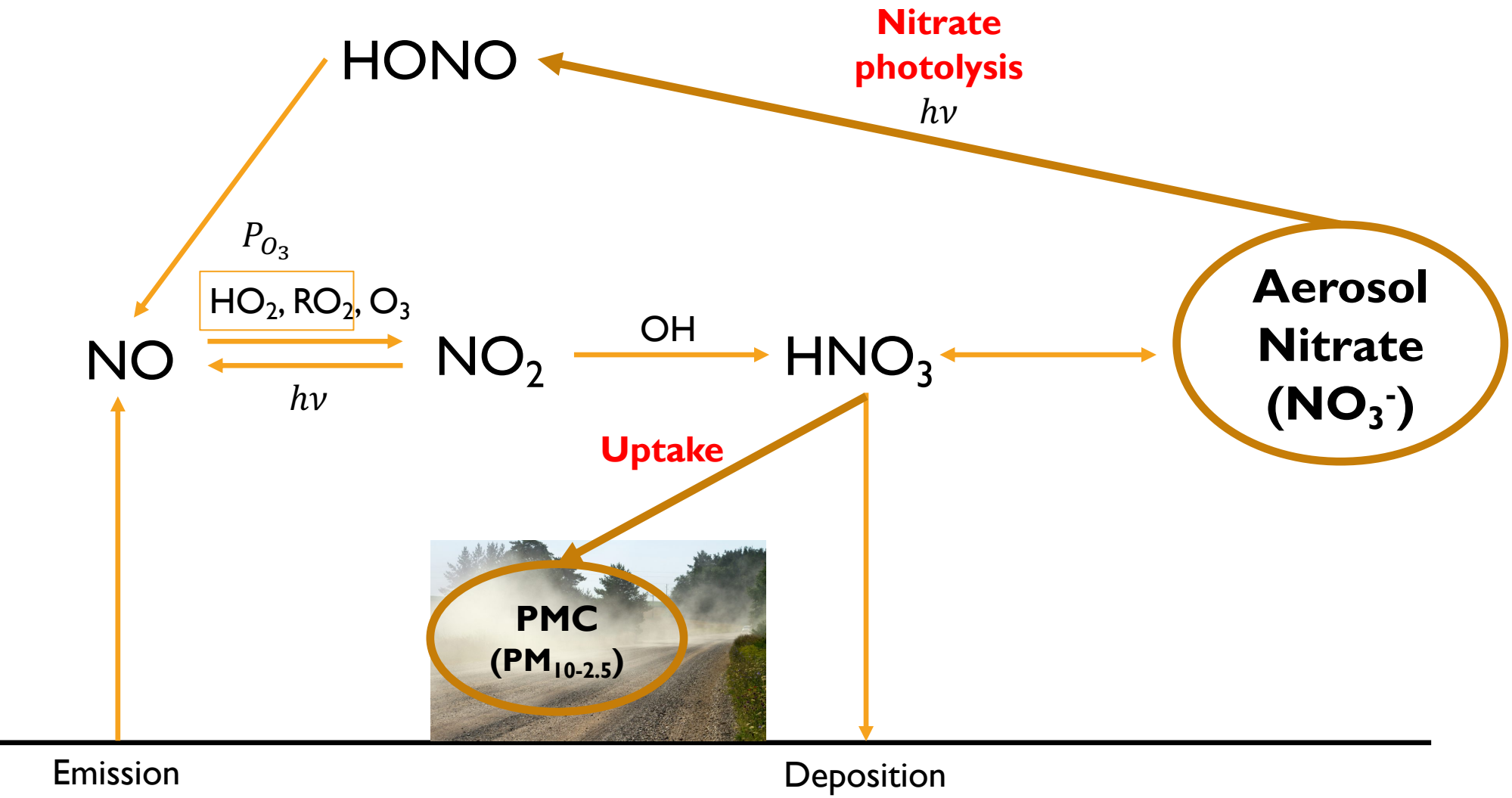
May – June 2016

Aircraft Observation



[Peterson et al. 2019;
Crawford et al. 2021]

Why did we make such modifications? (pt. 1)



Nitrate Photolysis
[Shah, n.d.]

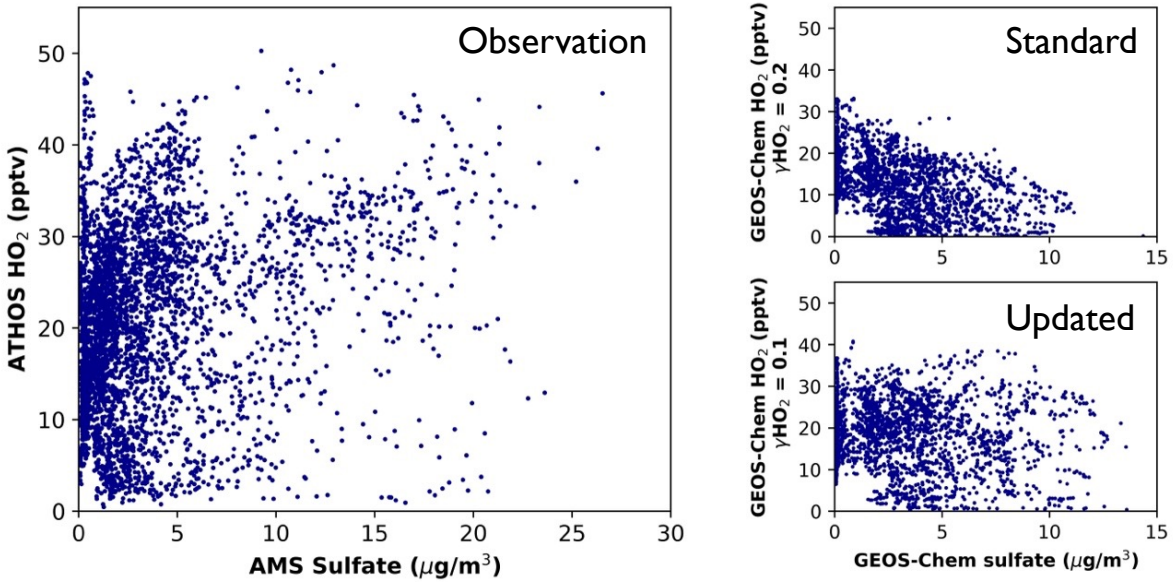
Reduces low model biases of O_3 & NO_x
[Kasibhatla et al. 2018]

PMC uptake of HNO_3
[Zhai, n.d.]

Reduces high model bias of NO_3^- & HNO_3
[Travis et al. 2022]

Why did we make such modifications? (pt. 2)

	Observation	Updated GEOS-Chem	Standard GEOS-Chem
calculated OHR (s^{-1})	6.59	4.38	3.85



VCP Emission
[Bates, n.d.]

Reduces low model bias of OH reactivity (OHR) & CH_2O

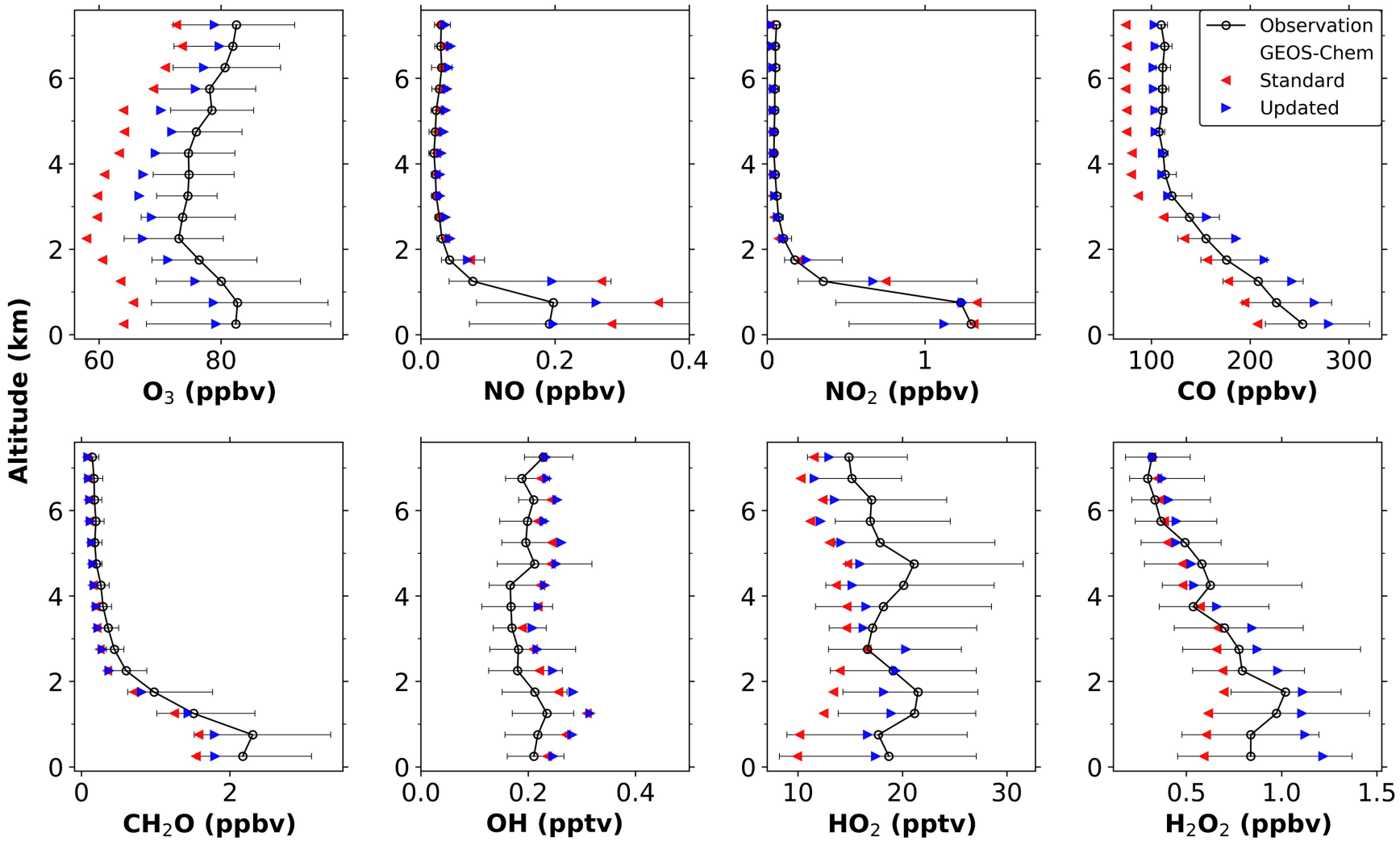
γ_{HO_2} = 0.1
[Yang, n.d.]

Reduces low model bias of HO_2

CO BC ×1.5
[Yang, n.d.]

Fixes model low bias of CO
[Gaubert et al. 2020; Park et al. 2021]

Median vertical profiles of key photochemical species

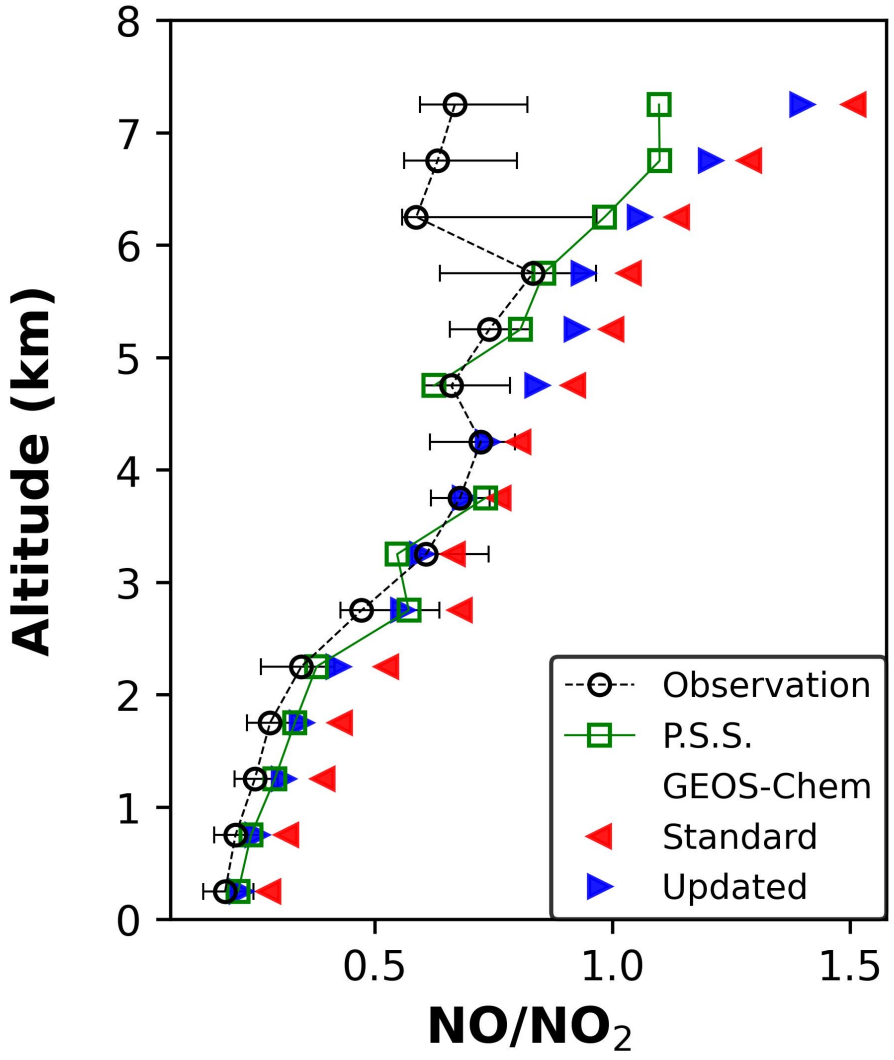


Instruments/PIs

Chemiluminescence:	A. Weinheimer
TD-LIF:	R. Cohen
DACOM:	D. Glenn
CAMS:	A. Fried
ATHOS:	W. Brune
CIT-CIMS:	P. Wennberg

Updated model better agrees with the observation for NO_2 & other key species.

Median vertical profiles of NO/NO_2



$\left(\frac{NO}{NO_2}\right)_{P.S.S}$ Equation

$$\frac{j_{NO_2}}{k_{O_3+NO}[O_3] + k_{HO_2+NO}[HO_2] + k_{BrO+NO}[BrO] + k_{RO_2+NO}[RO_2]}$$

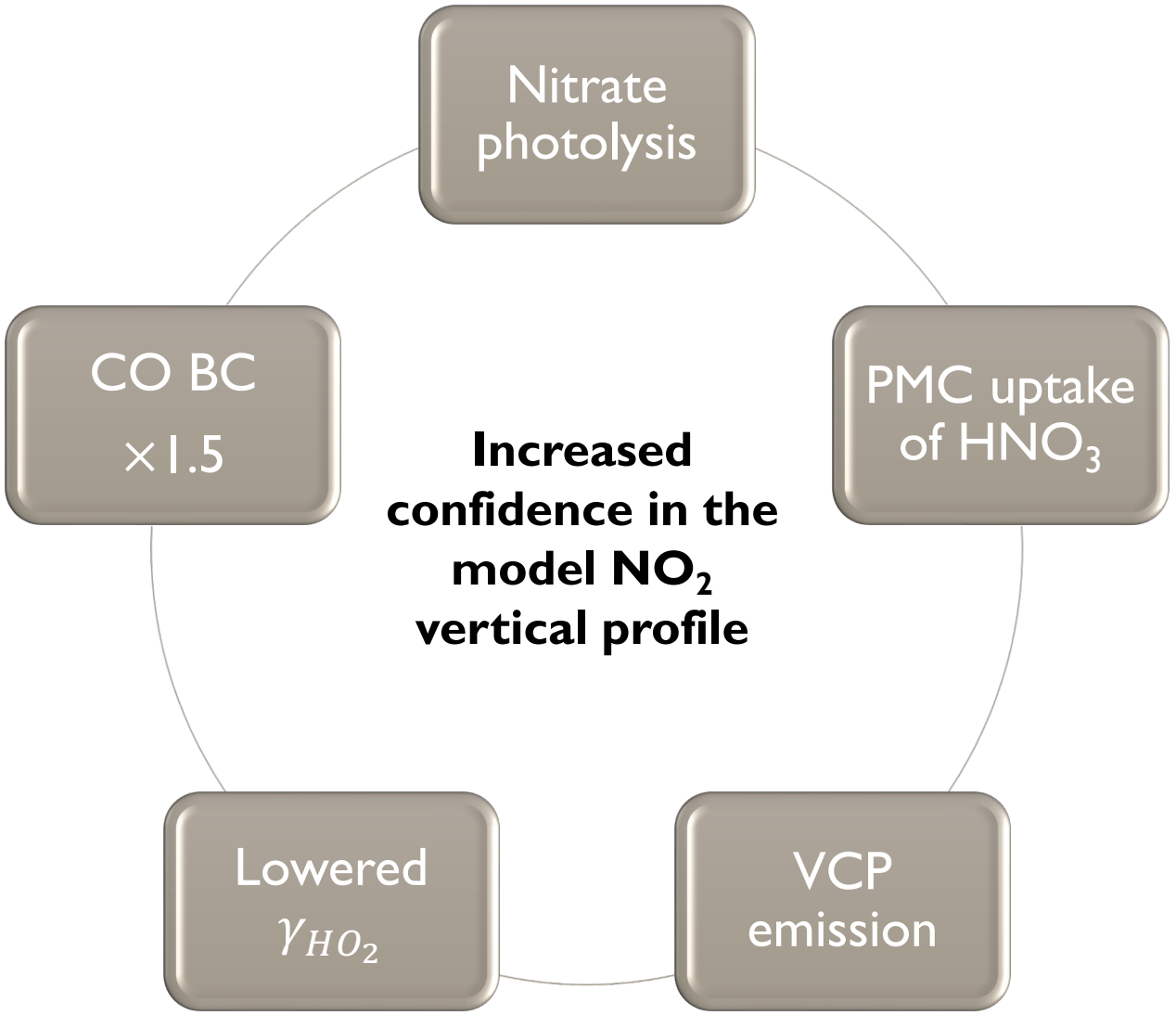
Updated Model

$\uparrow HO_2$
$\uparrow O_3$

NO/NO_2 observation departs from the model above 5km (TD-LIF NO_2 positive interference).

Photostationary state (P.S.S.) is more reliable & updated model is in closer agreement with P.S.S.

Takeaway



Future Direction

Temporal variation in vertical profiles

Spatial variation in vertical profiles

Compute air mass factor