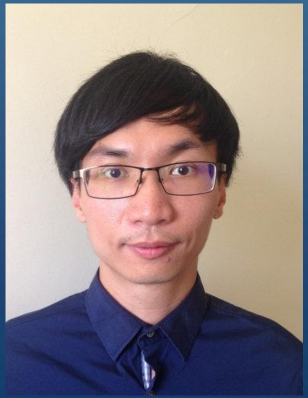
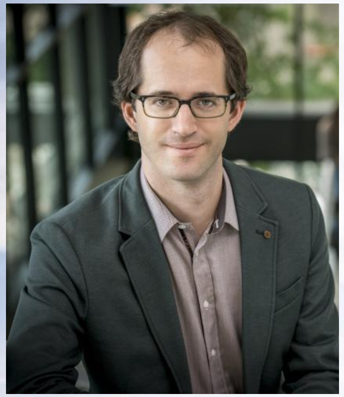
Demonstrating Value of GeoXO ACX for Near Realtime Emissions Estimation

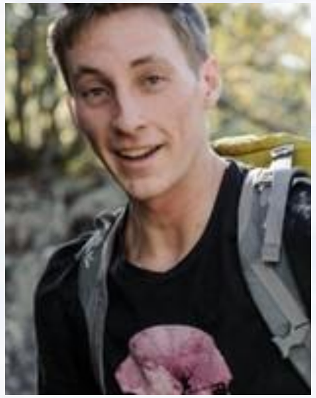


Chia-Hua Hsu
(CU/NOAA)

Arthur Mizzi
(NASA/NOAA)



Daven Henze
(CU)



Colin Harkins
(NOAA)

Trammell Lyu
(NOAA)

Jian He
(NOAA)

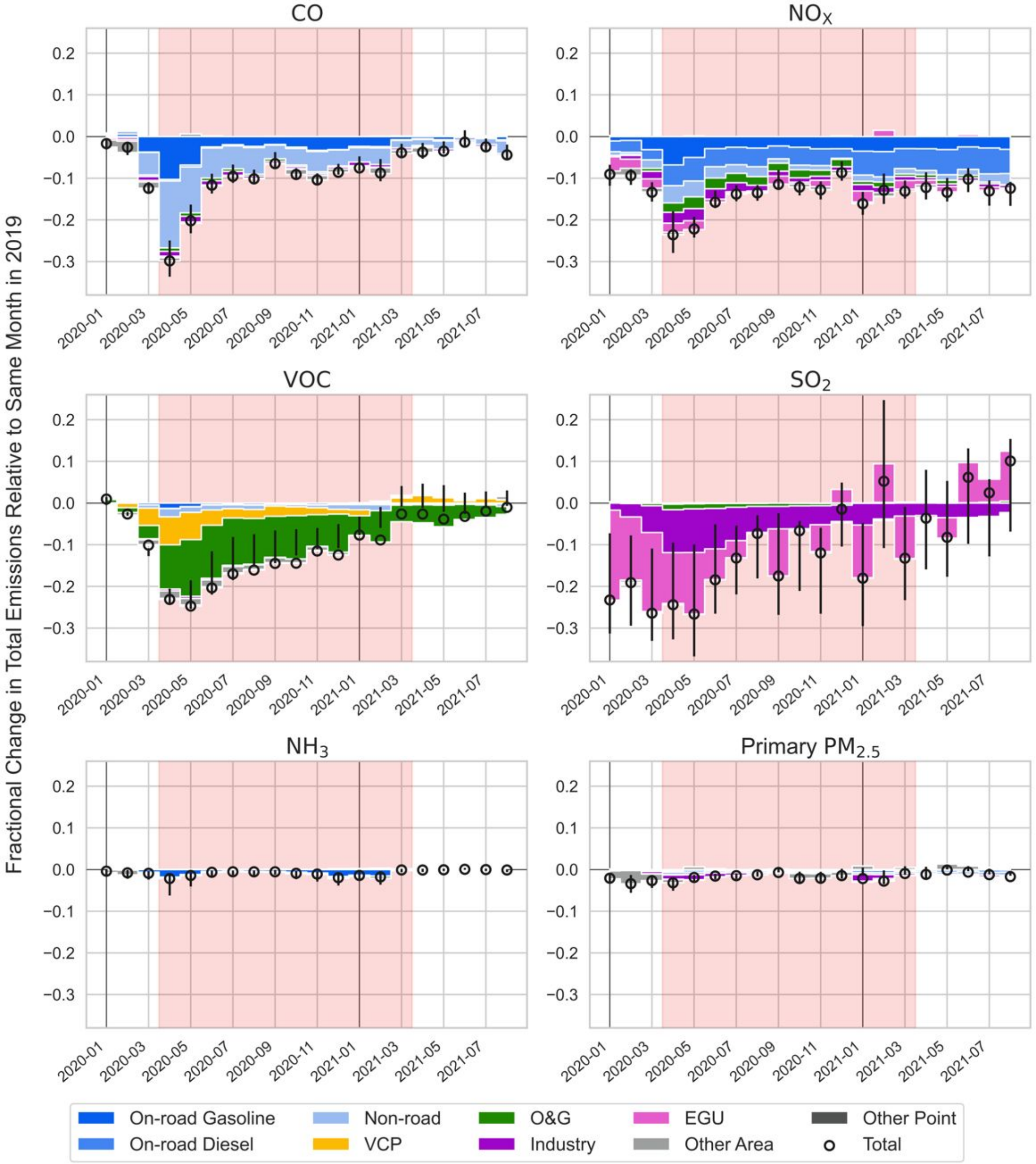
Brian McDonald, Program Lead
Atmospheric Composition Modeling

NOAA CHEMICAL SCIENCES LABORATORY
CIRES

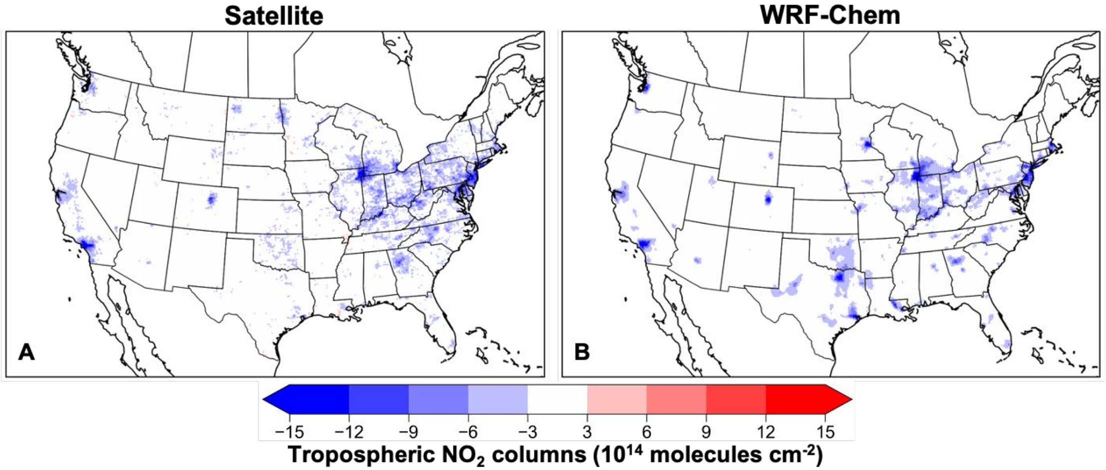
COVID-19 Pandemic Impact on Emissions

Jian He
(NOAA)

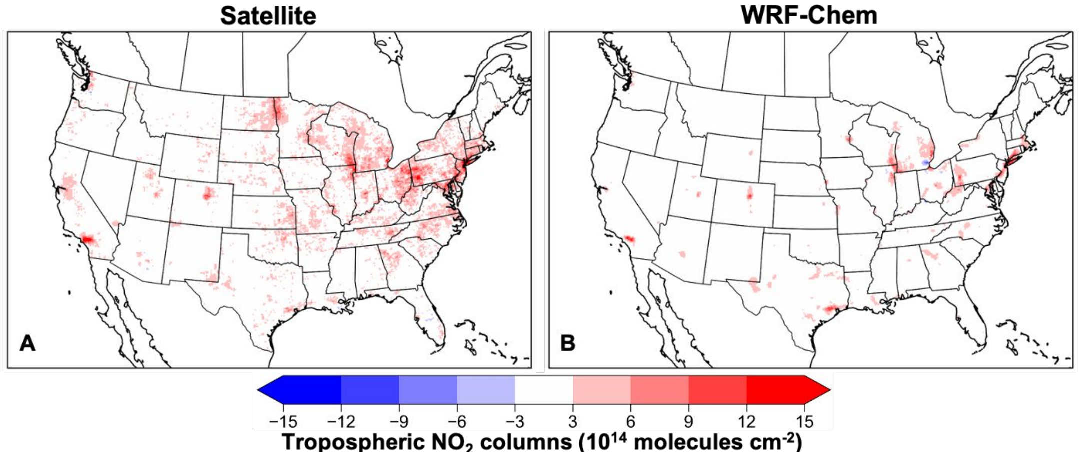
Colin Harkins
(NOAA)



2019 → 2020 Changes (Apr – Jul)

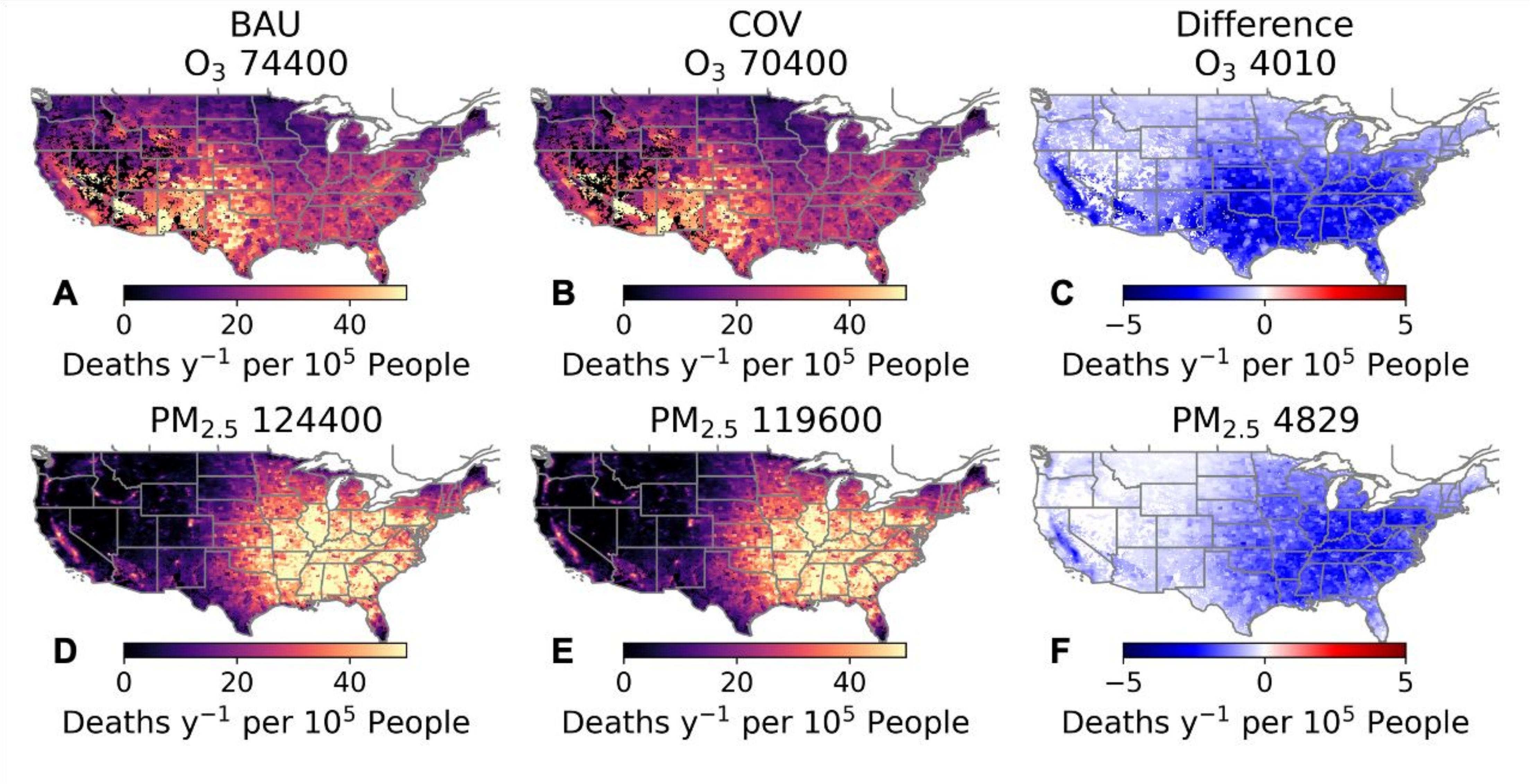


2020 → 2021 Changes (Apr – Jul)



He et al. (*PNAS Nexus*, 2024)

COVID-19 Pandemic Impact on Air Quality



He et al. (*PNAS Nexus*, 2024)

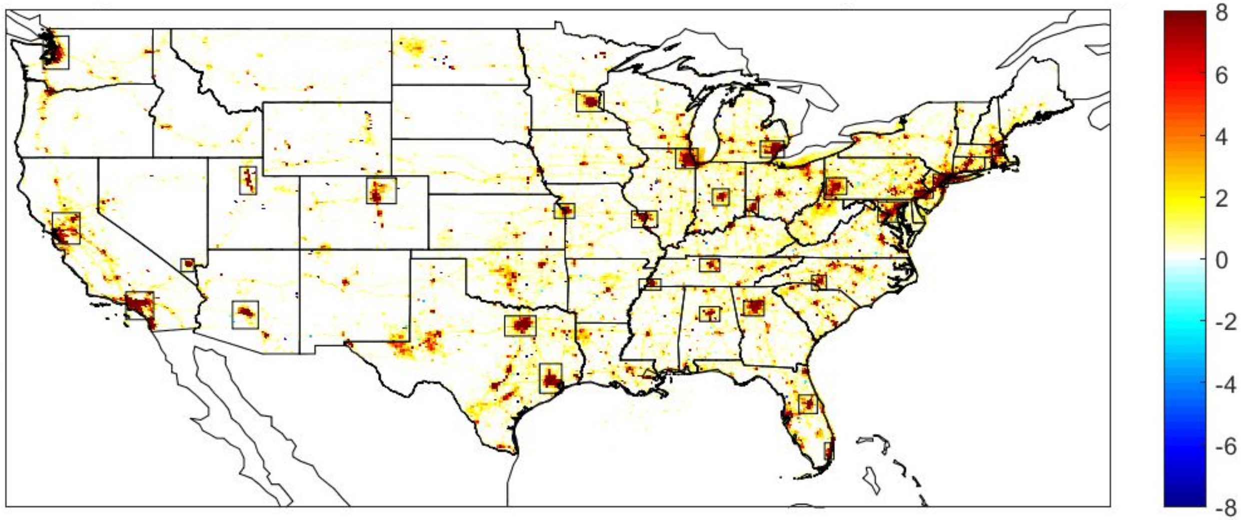
Research Objectives

(1) Advancing multi-species emissions monitoring capability, including nitrogen dioxide (NO_2), formaldehyde (HCHO), aerosol optical depth (AOD) and aerosol layer height (ALH) into the Weather Research Forecasting with the Chemical Data Assimilation Research Testbed (WRF-Chem-DART)

(2) Building an experimental research-to-application (R2X) on Near Real-time Emissions estimation in support of the NOAA User Readiness Plan for Atmospheric Composition Observations from Space (NURPACS)

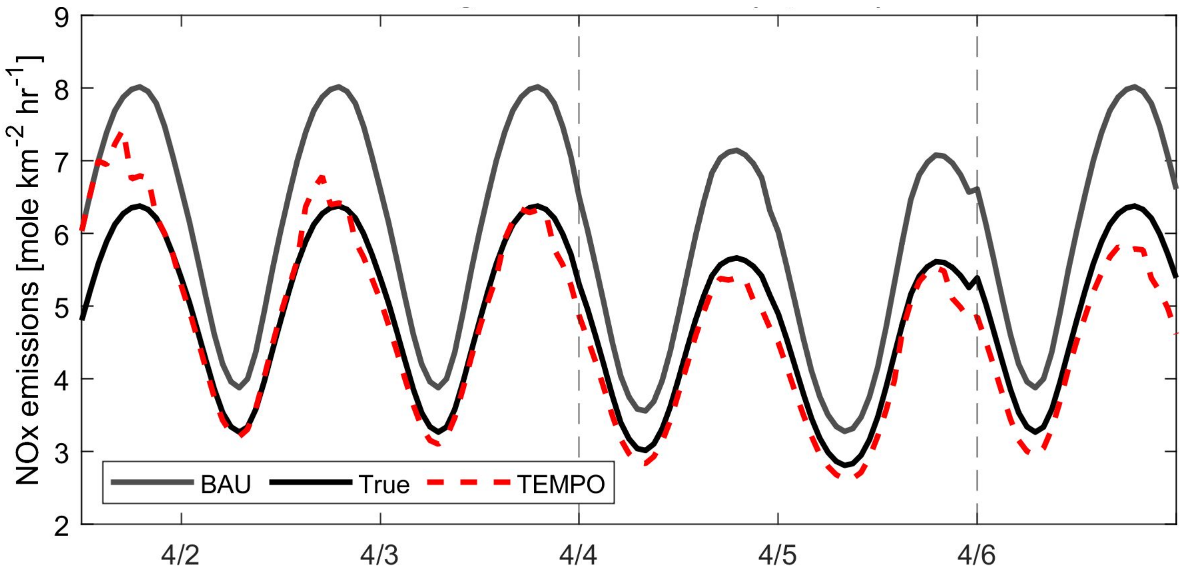
Utilizing Satellite Chemical DA for NRT Emissions Estimation

Business-as-usual (BAU) – COVID-19

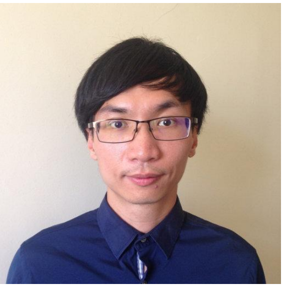


Without COVID-19 pandemic, NO_x emissions would be ~30% higher in April 2020

Business-as-usual (BAU) – COVID-19



Geostationary NO_2 observations can update NO_x emissions within 1-3 days accounting for pandemic



Chia-Hua Hsu
(CU/NOAA)

Daven Henze
(CU)

Arthur Mizzi
(NASA/NOAA)

NOAA CHEMICAL SCIENCES LABORATORY

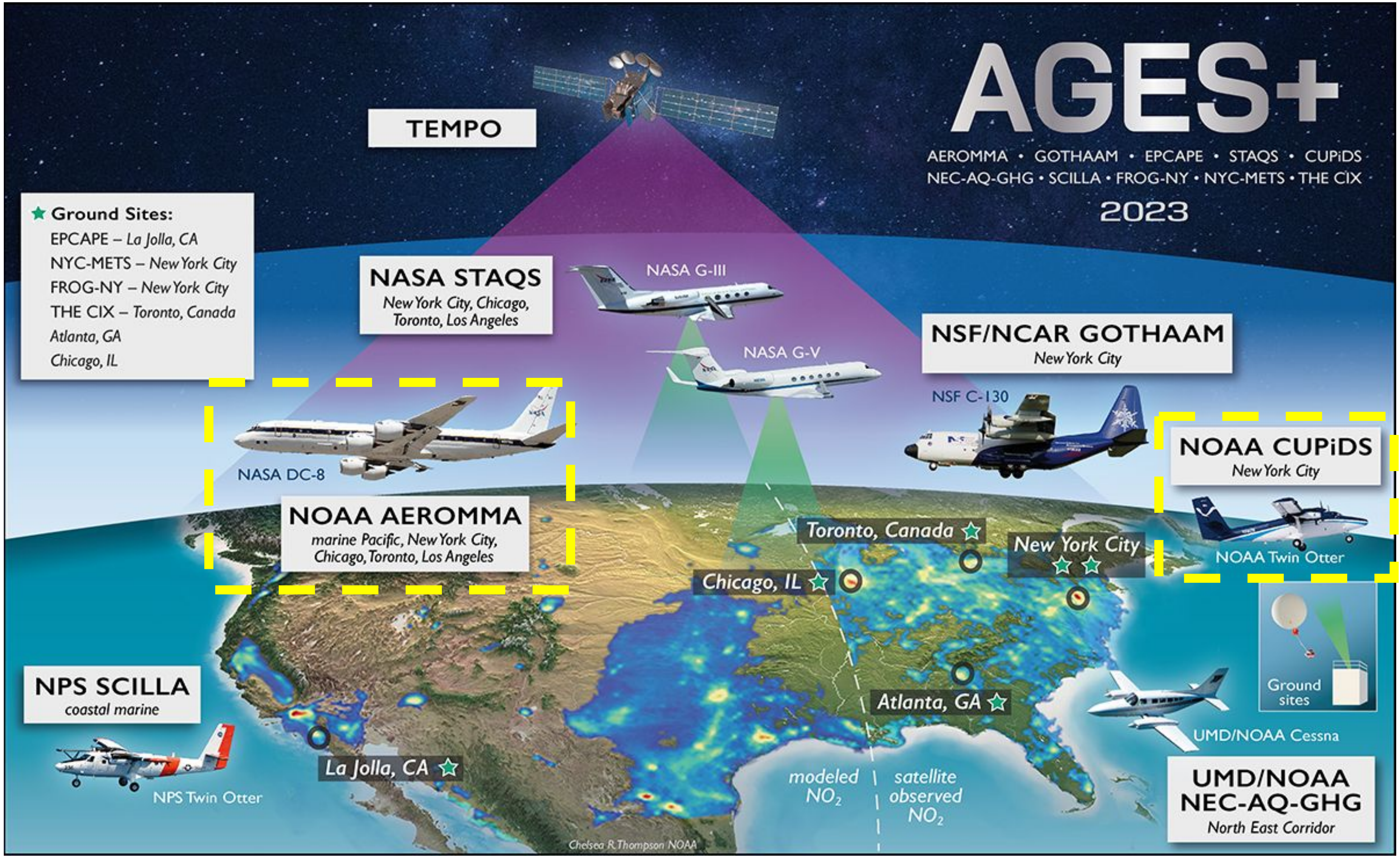
GeoXO GEOSTATIONARY EXTENDED OBSERVATIONS

NASA Ames Research Center

JOINT POLAR SATELLITE SYSTEM PROGRAM · NOAA · NASA · JPSS

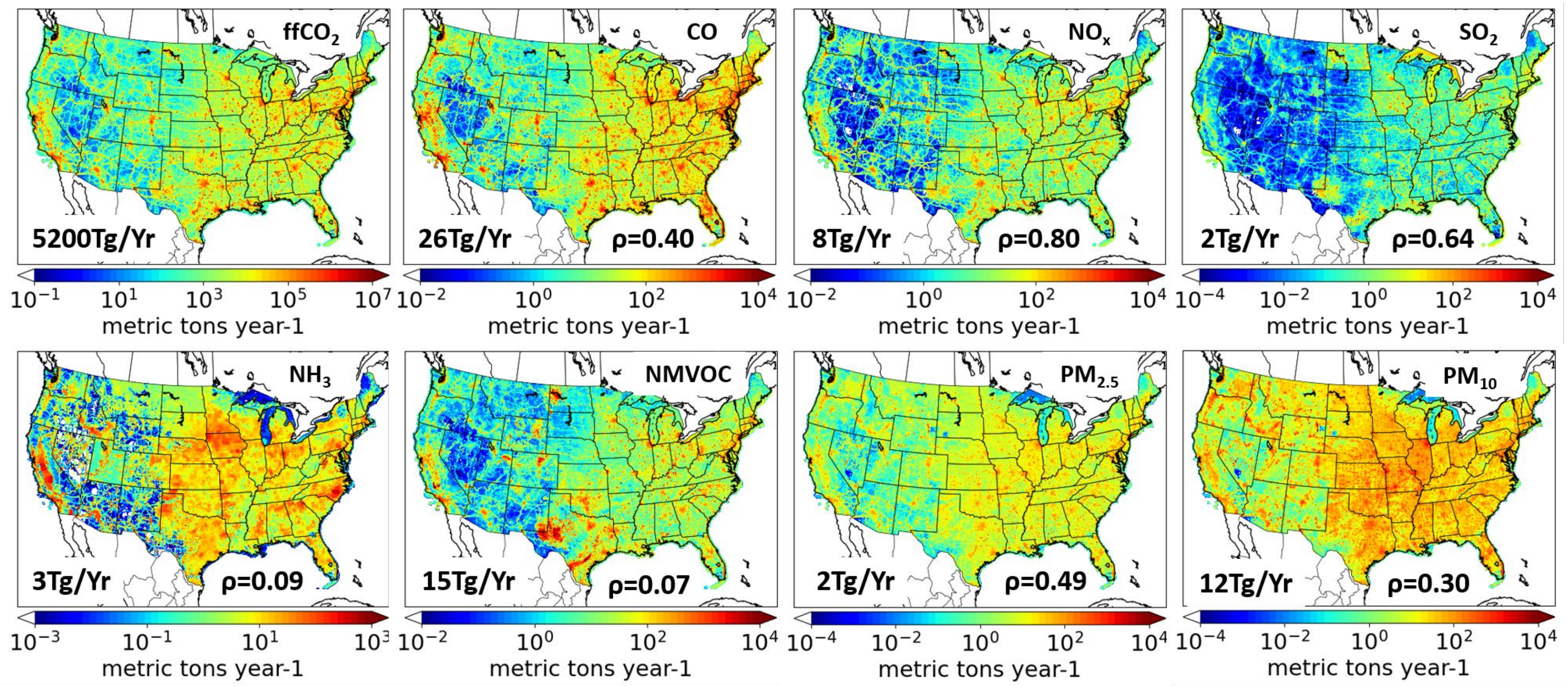
Hsu et al. (*JGR*, 2024)

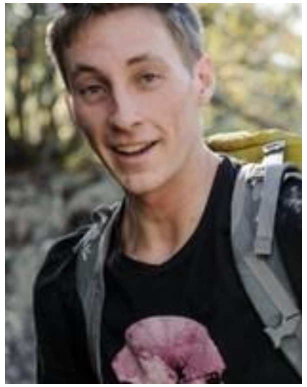
Airborne Field Campaigns in Summer 2023



https://csl.noaa.gov/projects/ages/

GReenhouse gas And Air Pollutants Emissions System (GRA^{2}PES)





Colin Harkins (NOAA)

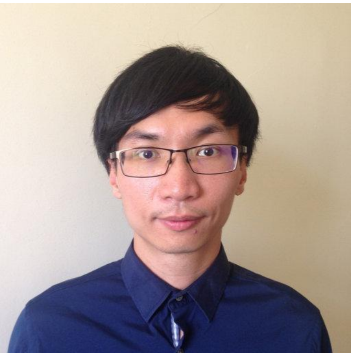
Trammell Lyu (NOAA)

GRA²PES Greenhouse Gas And Air Pollutants Emissions System

https://csl.noaa.gov/groups/csl4/gra2pes/

WRF-Chem-DART Model Setup

- Domain: CONUS (12 km x 12 km)
- Chemistry: RACM_ESRL
- Emissions: 2021 GRA^{2}PES anthropogenic, BEIS for biogenic, no fire emissions
- IC/BC: Monthly climatological mean of RAQMS from 2019-2021
- MET: NAM w/ 6-hour grid nudging
- DA: Chem-DART (Mizzi et al., 2016)
- Simulation time: 07/24 – 08/15
- Observations: AEROMMA DC-8 & CUPiDs aircraft data

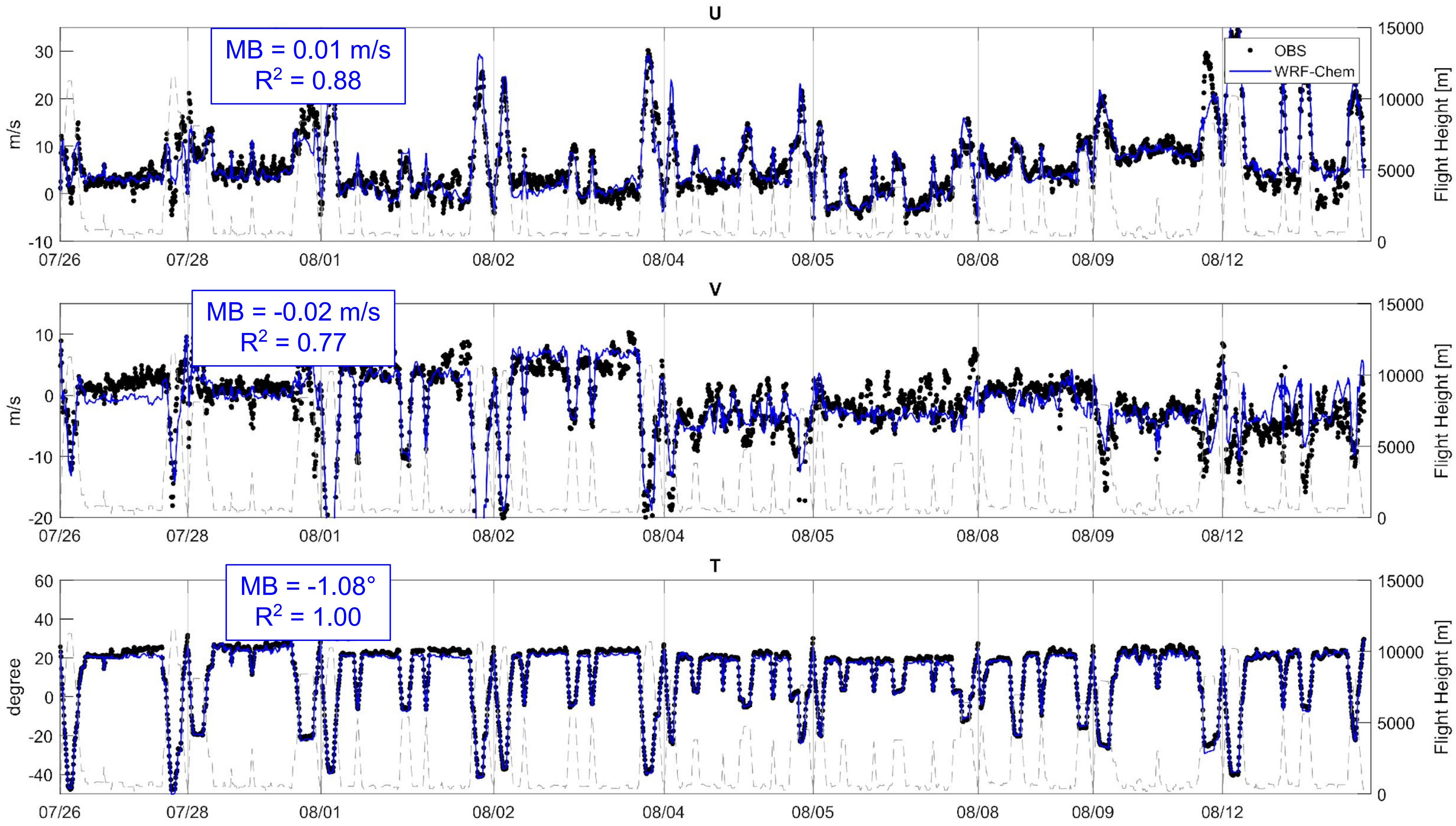


Chia-Hua Hsu
(CU/NOAA)

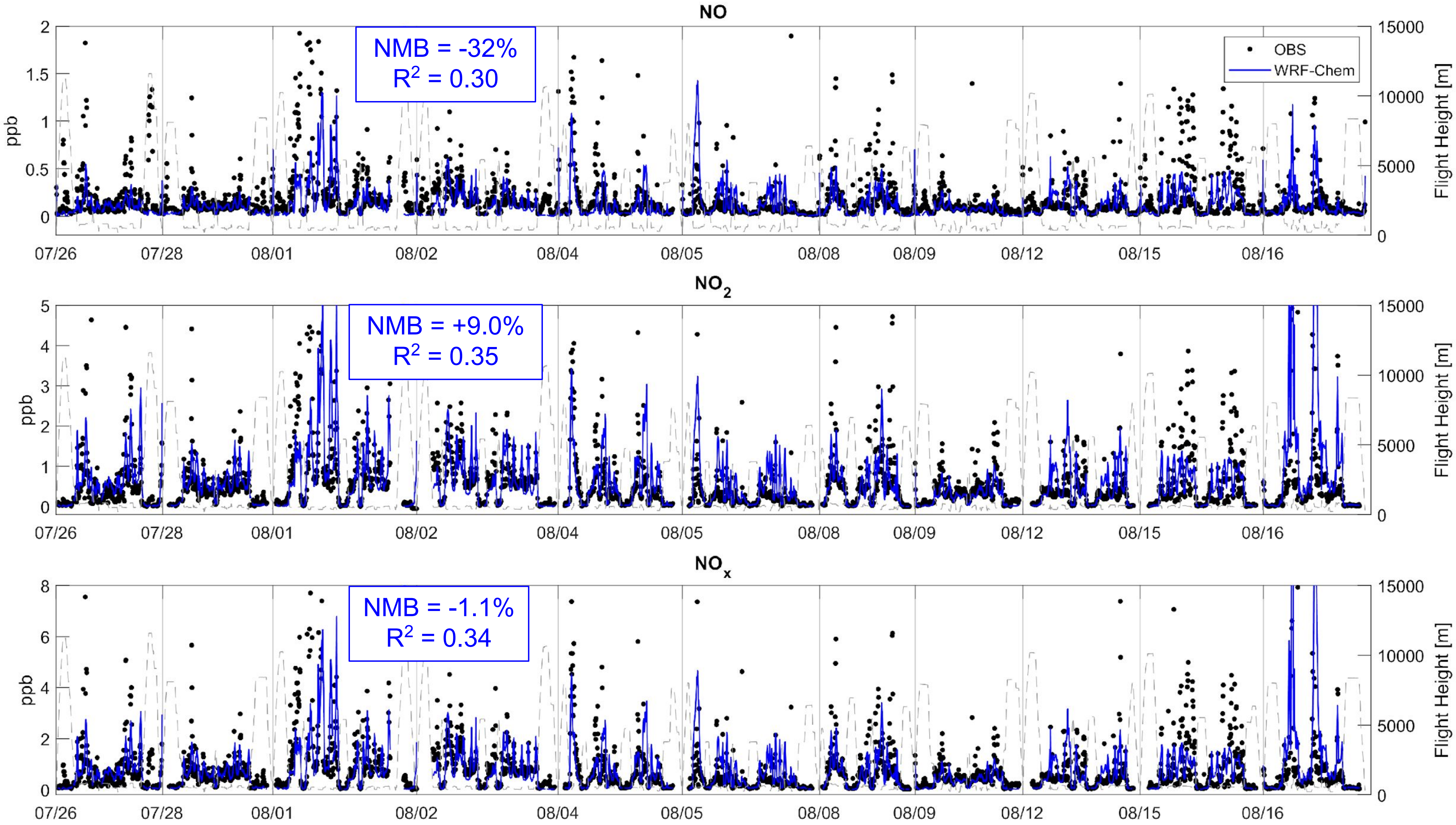
	08-01	08-02	08-03	08-04	08-05	08-06	08-07	08-08	08-09	08-10	08-11	08-12	08-13
DC-8	CHI	CHI		TOR	TOR			CHI	NYC			CHI	
CUPiDS (NYC)	x								x		x	x	x
TEMPO		15-20		12-22	12-22	12-22	12-22	17-22	12-22		12-22	12-22	

	08-14	08-15	08-16	08-17	08-18	08-19	08-20	08-21	08-22	08-23	08-24	08-25	08-26
DC-8		CHI	NYC		Salt Lake				LA	LA		LA	LA
CUPiDS (NYC)	x		x										
TEMPO		17-23	11-23	16-23	10-23	10-23	10-23	10-23	11-23	10-21		11-23	11-23

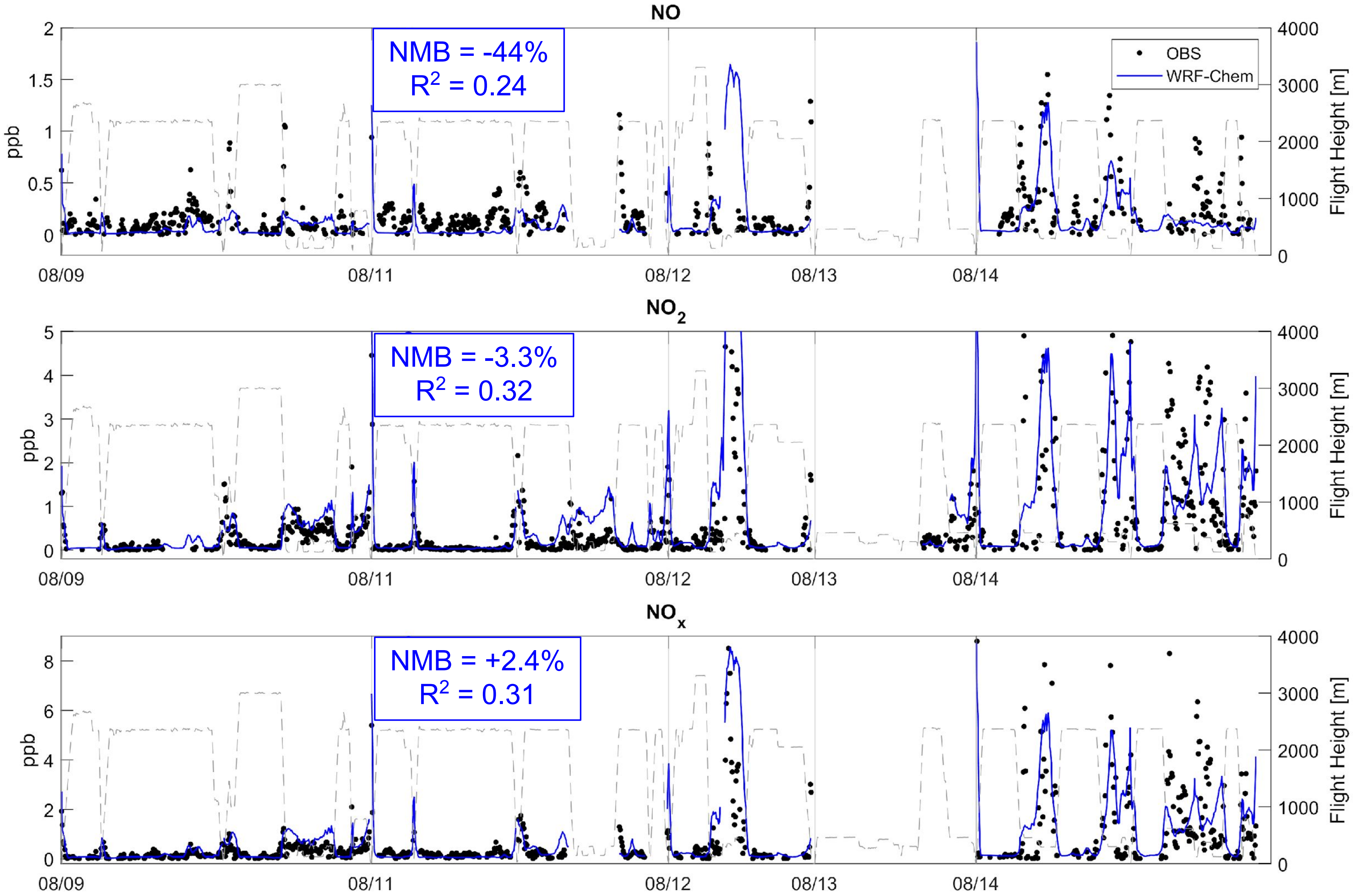
Evaluating Meteorology with AEROMMA Data (CHI, NYC, TOR)



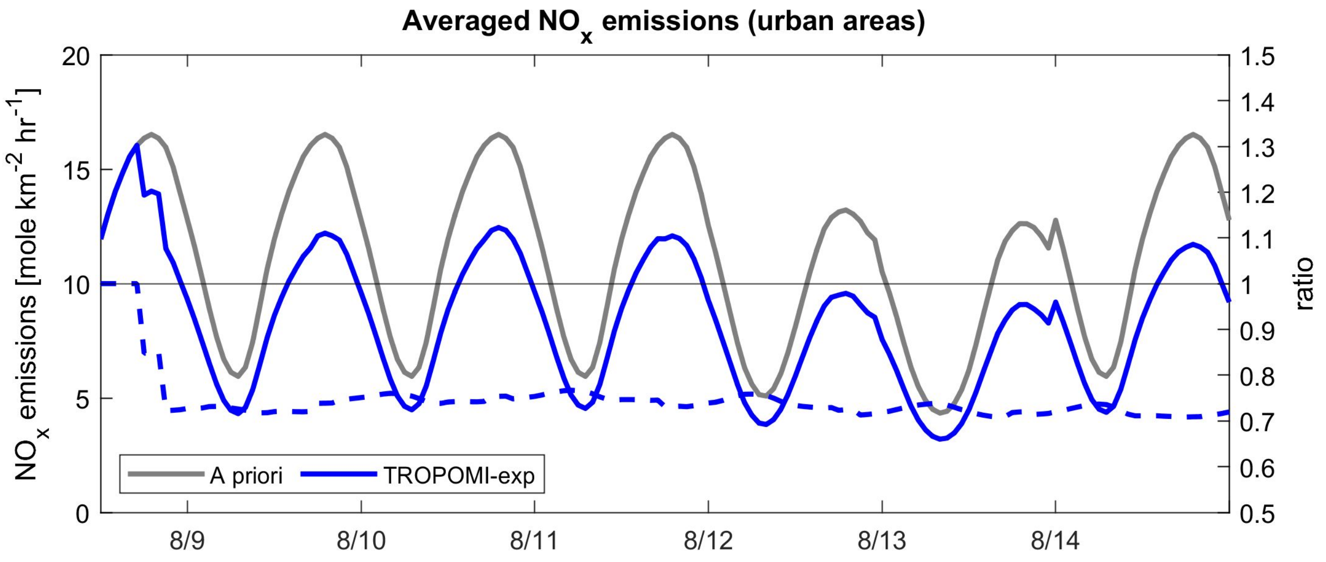
Evaluating NO_x with AEROMMA Data (CHI, NYC, TOR)

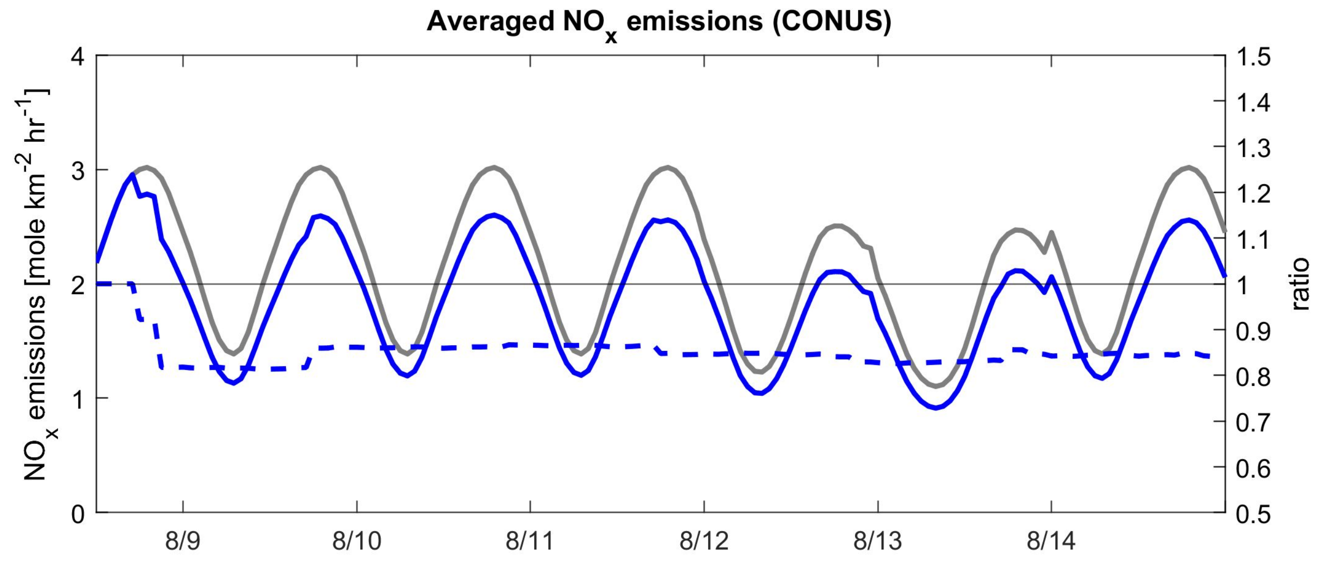


Evaluating NO_x with CUPiDS Data (NYC)

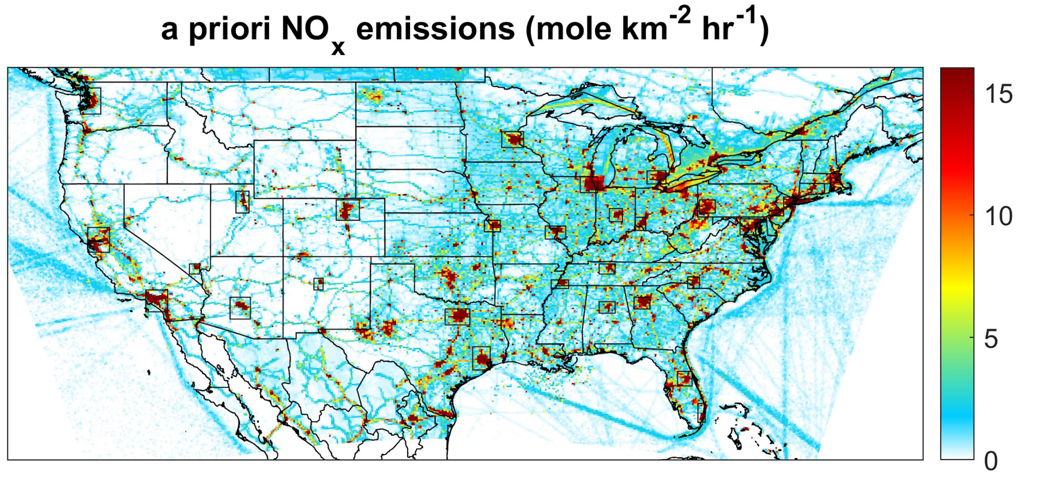


Assimilating TROPOMI NO_2 During AEROMMA

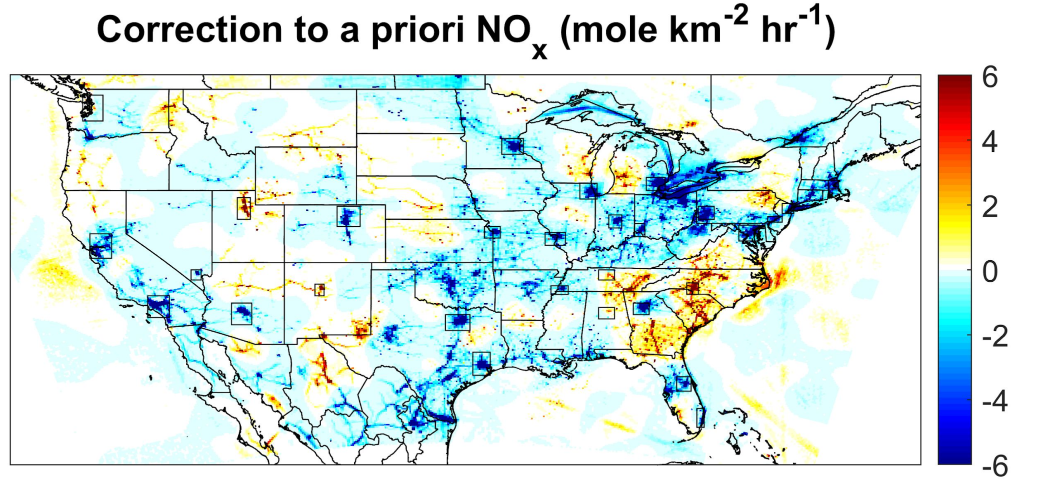




a priori NOx emissions

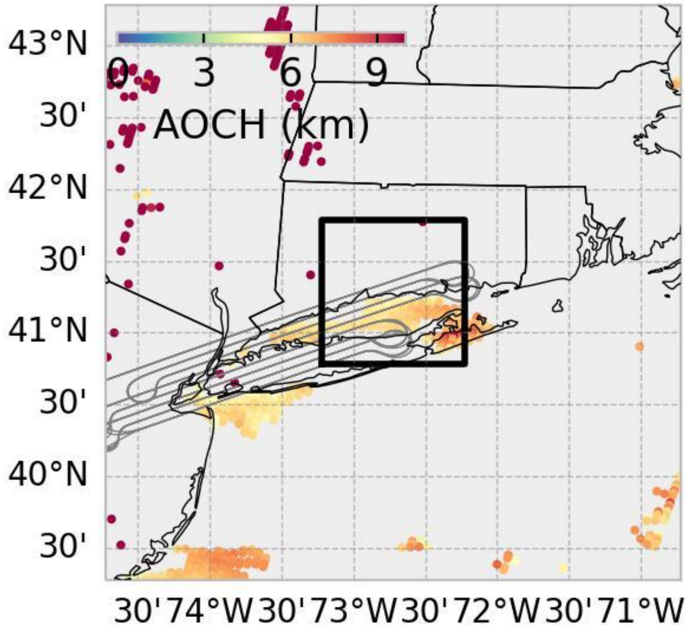


08/08-14 average correction

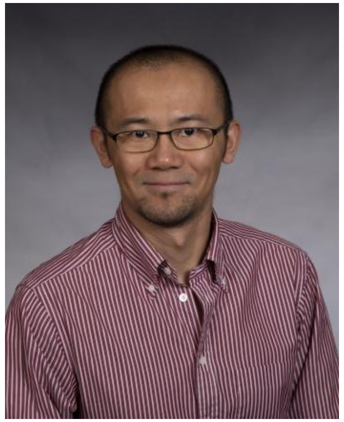


Next Step: Start performing TEMPO experiments during AEROMMA

TEMPO Aerosol Layer Height Products Under Development

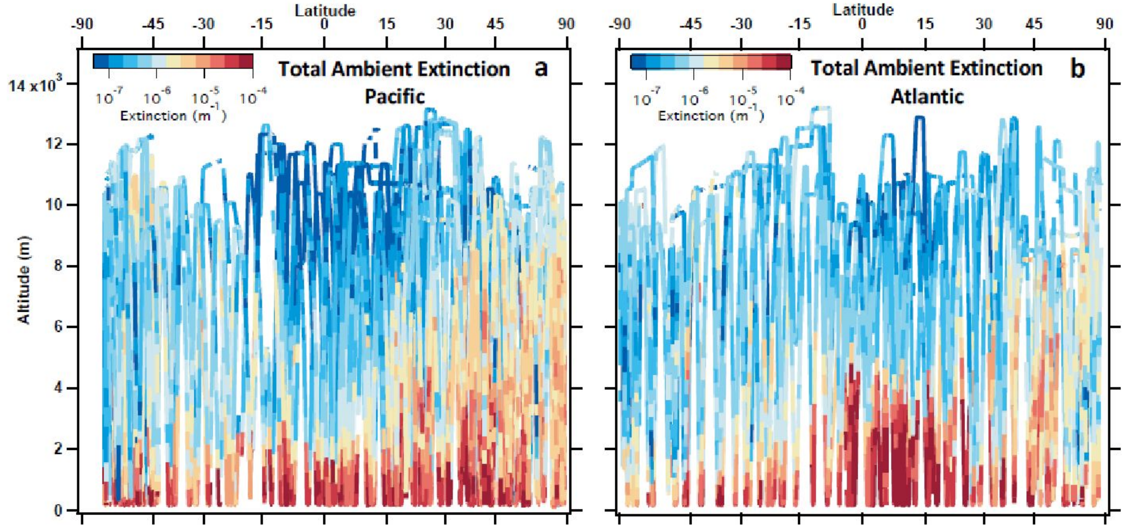


TEMPO ALH provided by S. Kondragunta

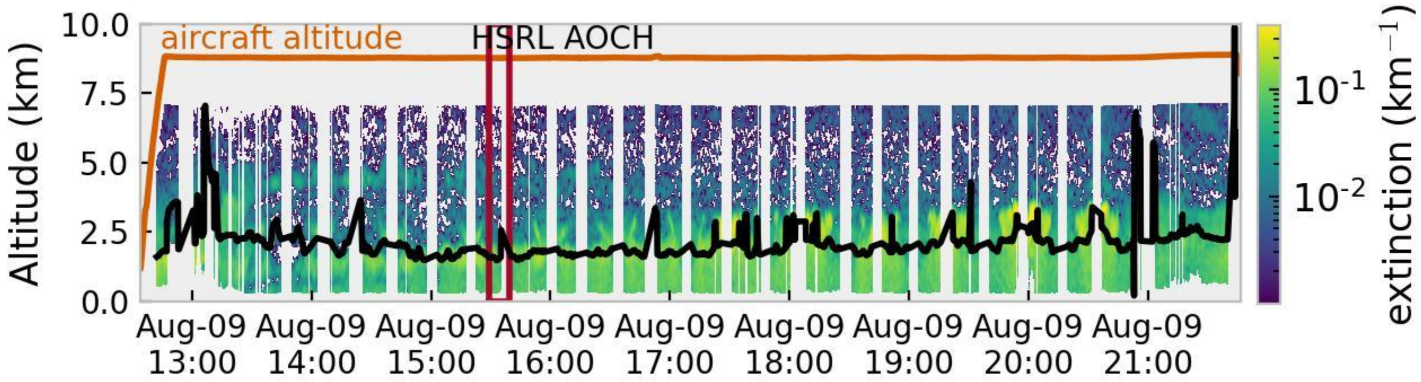


Siyuan Wang
(NOAA/CIRES)

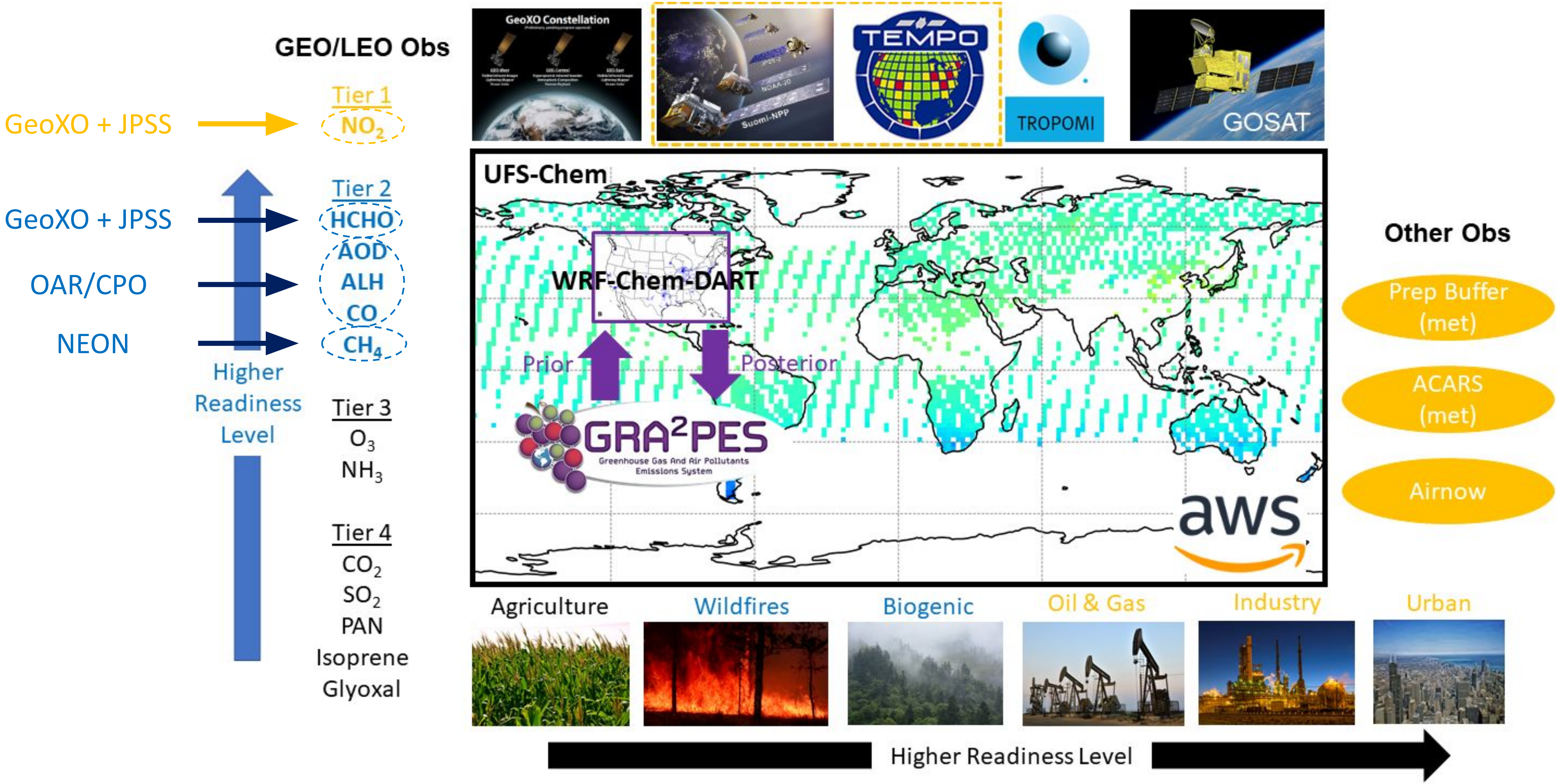
Example NASA DC-8 in-situ aerosol extinction profile during ATom
Brock et al. (*Atmos. Chem. Phys.*, 2021)



NASA G-V HSRL2 aerosol extinction profile (PI: Laura Judd)



Building Towards Near Real-Time Emissions Capability



Summary

- Setup WRF-Chem simulations during the AEROMMA (NASA DC-8) and CUPiDS (NOAA TO) airborne field campaigns in summer 2023
- NO_2 is overall well-simulated using the GRA^2PES 2021 anthropogenic inventory when evaluated with airborne data
- Performing real TROPOMI experiments during AEROMMA tends to adjust NO_x emissions downward across US urban areas
- Next Step: Perform real TEMPO + TROPOMI / OMPS experiments