



TEMPO Air Quality Applications

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Air Quality Division

HAQAST

Cambridge, Massachusetts
June 4, 2024

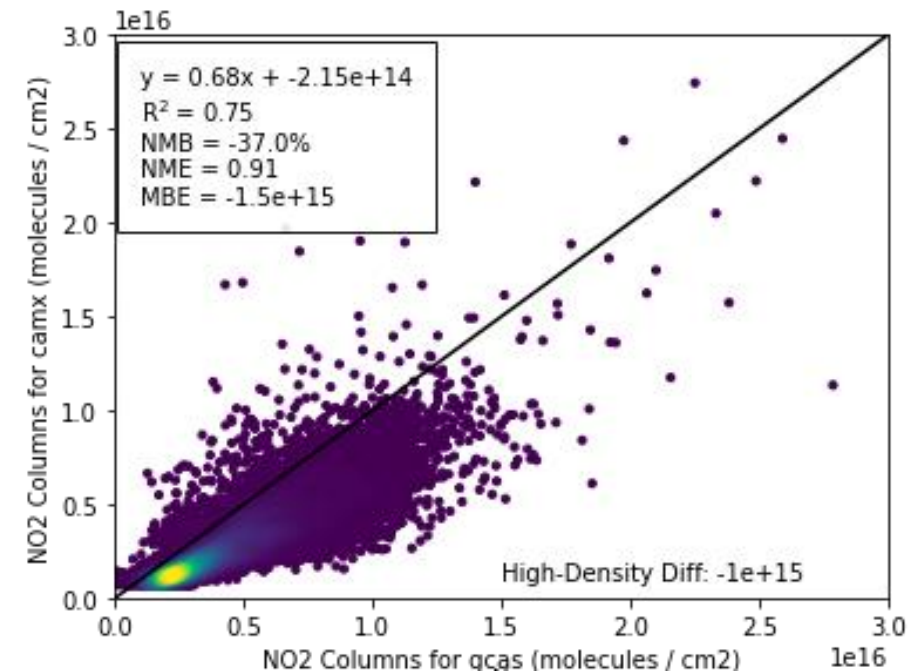
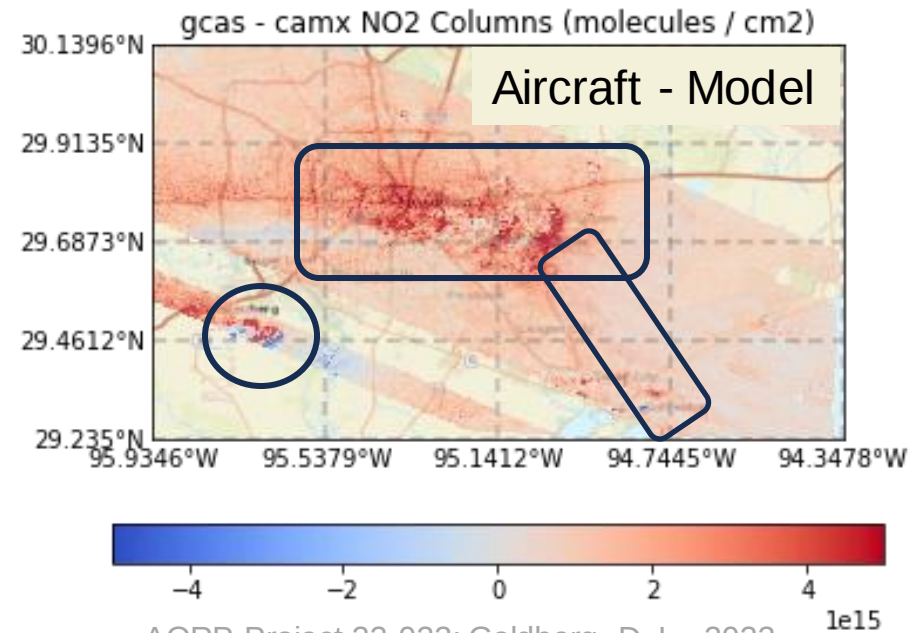
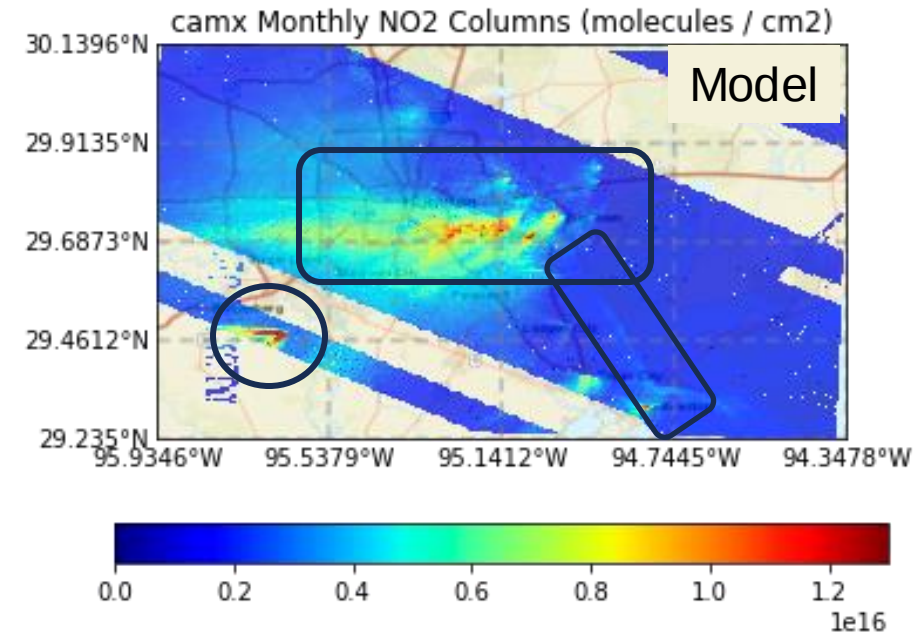
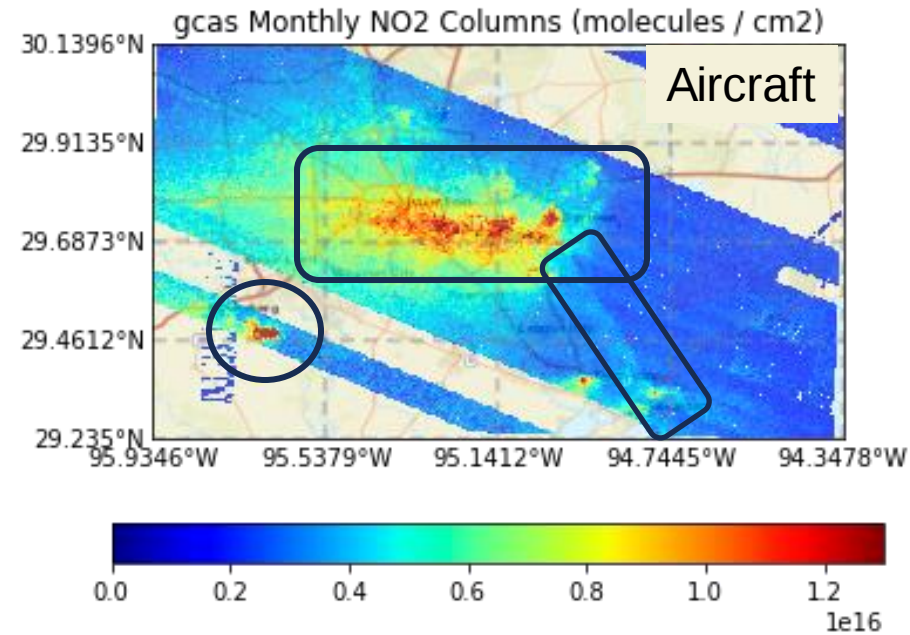
Overview

Doug: What can we learn about emission sources?

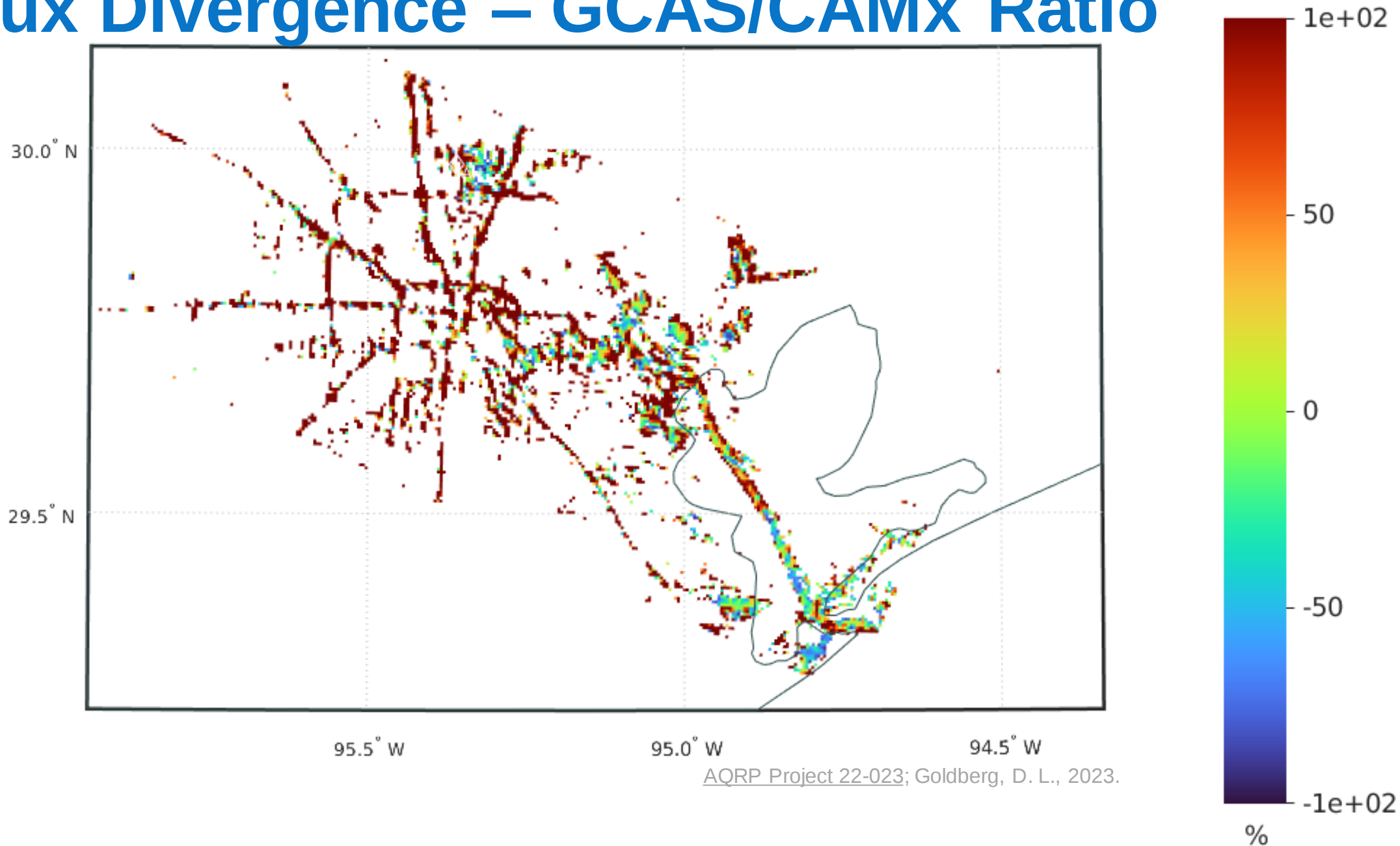
Chola: Is ozone formation sensitive to Nitrogen Oxides (NO_x) or Volatile Organic Compounds (VOC)?

2021 Aircraft (GCAS) vs Model (CAMx): NO_2

- Regional Nitrogen Dioxide (NO_2) has low bias in model.
- Power plants, eastern ship channel, and shipping are similar.
- Downtown has low bias in model.

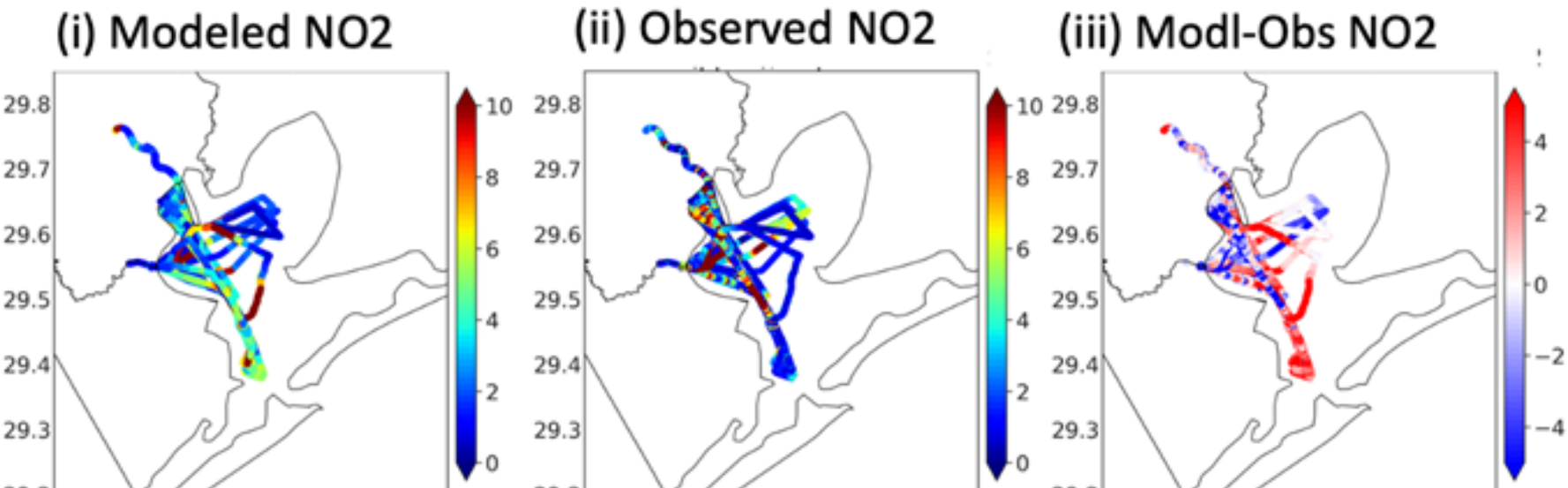


NO₂ Flux Divergence – GCAS/CAMx Ratio

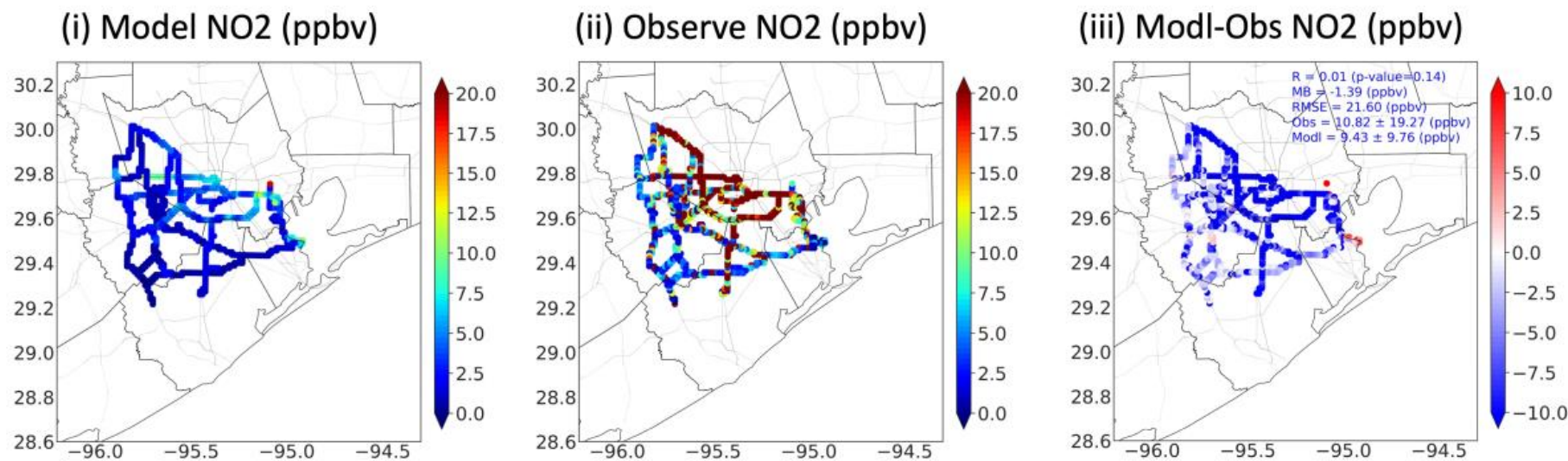


AQRP Project 22-023; Goldberg, D. L., 2023.

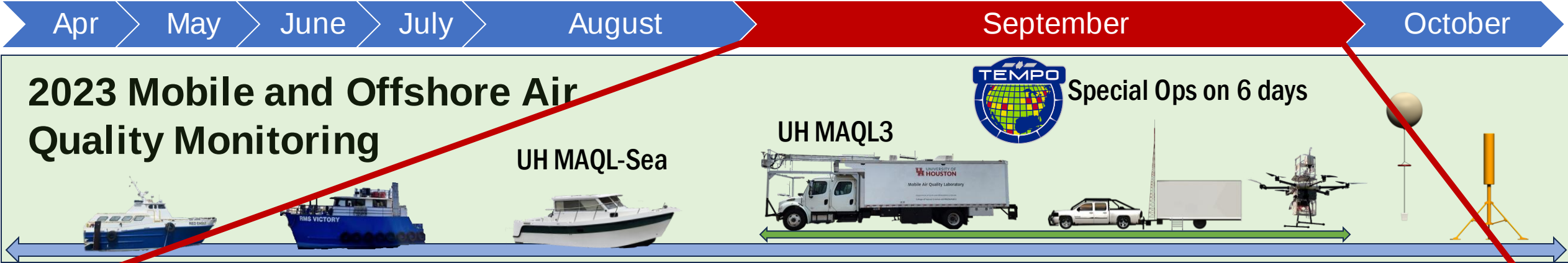
September 2022 Mobile and Offshore Monitoring



(a) Episode days



2023 Houston Mobile and Offshore Air Quality Campaign



September HGB Region	1-Sep	2-Sep	3-Sep	4-Sep	5-Sep	6-Sep	7-Sep	8-Sep	9-Sep	10-Sep	11-Sep	12-Sep	13-Sep	14-Sep	15-Sep	16-Sep	17-Sep	18-Sep	19-Sep	20-Sep	21-Sep	22-Sep	23-Sep	24-Sep	25-Sep	26-Sep	27-Sep	28-Sep
HGB High Monitor MDA8 O3	88	82							85	76	97	97	74				83	97	89	72						86	76	80
HGB # Exceedances	25	22							13	1	30	25	3				3	15	13	2						7	5	6
MAQL3 operations																												
MAQL-Sea operations																												
Drone flights																												
HGB Ozonesondes							2	2		4	3						6	4	4								4	5
HGB TEMPO Special Obs																												

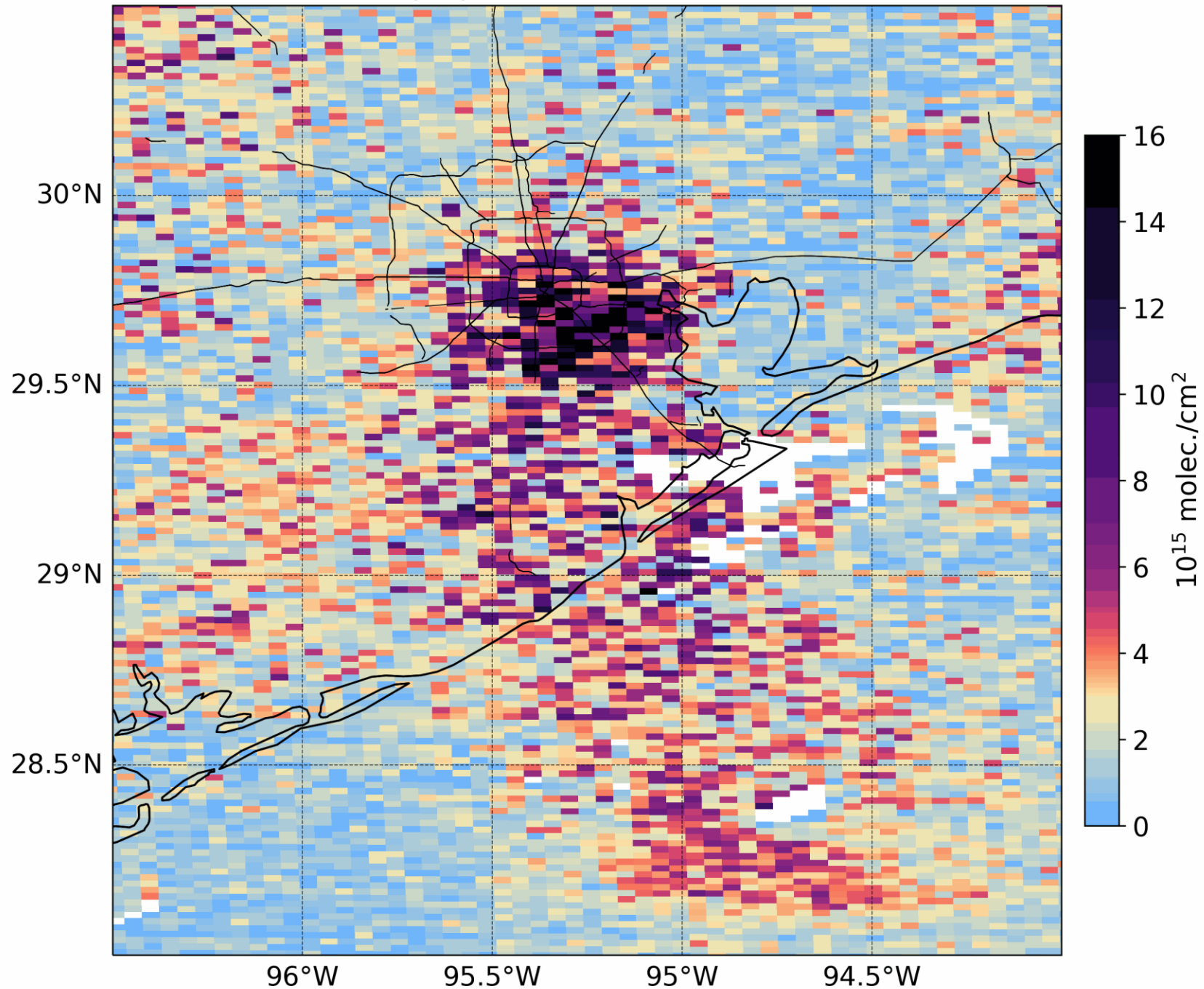
TEMPO Special Ops Days:

- 9/11, 9/17-19: 1-3 pm CDT (land-sea breeze influence), 9/27-28: 9-11 am CDT (morning rush hour)

TCEQ-funded work in progress with University of Houston.

TEMPO NO₂: September 17, 2023

TEMPO Tropospheric NO₂ 20230917 09:30 CDT



TEXAS COMMISSION ON
ENVIRONMENTAL QUALITY

Case Study: Understanding Ozone Chemistry Using Satellite Data

Motivation and Acknowledgements

Utah HAQAST Meeting,
October 19-20, 2023

em • The Magazine for Environmental Managers • A&WMA • December 2023

Satellite Data to Inform Ozone Sensitivity:

A Practical Methodology Using Google Earth Engine

by Jennifer McGinnis, Tracey Holloway, Jenny Bratburd, Madankui Tao,
and Arlene Fiore

[Tutorials — The Holloway Group @ SAGE](#)

Satellite Data: Technical Difficulties

- Data access and manipulation
- Downloading the satellite data
- Calculating averages and ratios
- Limited resources in organizations

Case Study: Understanding Ozone Chemistry Using Satellite Data (continued)

- Calculated Formaldehyde (HCHO) to Nitrogen Dioxide (NO_2) ratio (FNR) using satellite data over the Houston-Galveston-Brazoria (HGB) nonattainment area (2022 and 2023), using TROPOMI satellite data from May-September using Google Earth Engine
- High ozone days defined as days having daily maximum eight-hour average ozone greater than 70 ppb
- FNR ratio for ozone chemistry for HGB taken from Jin et al., 2020. Below is the reference paper:

[Environ Sci Technol](#). Author manuscript; available in PMC 2021 Jun 2.

PMCID: PMC7996126

Published in final edited form as:

NIHMSID: NIHMS1639358

[Environ Sci Technol](#). 2020 Jun 2; 54(11): 6518–6529.

PMID: 32348127

Published online 2020 May 14. doi: [10.1021/acs.est.9b07785](https://doi.org/10.1021/acs.est.9b07785)

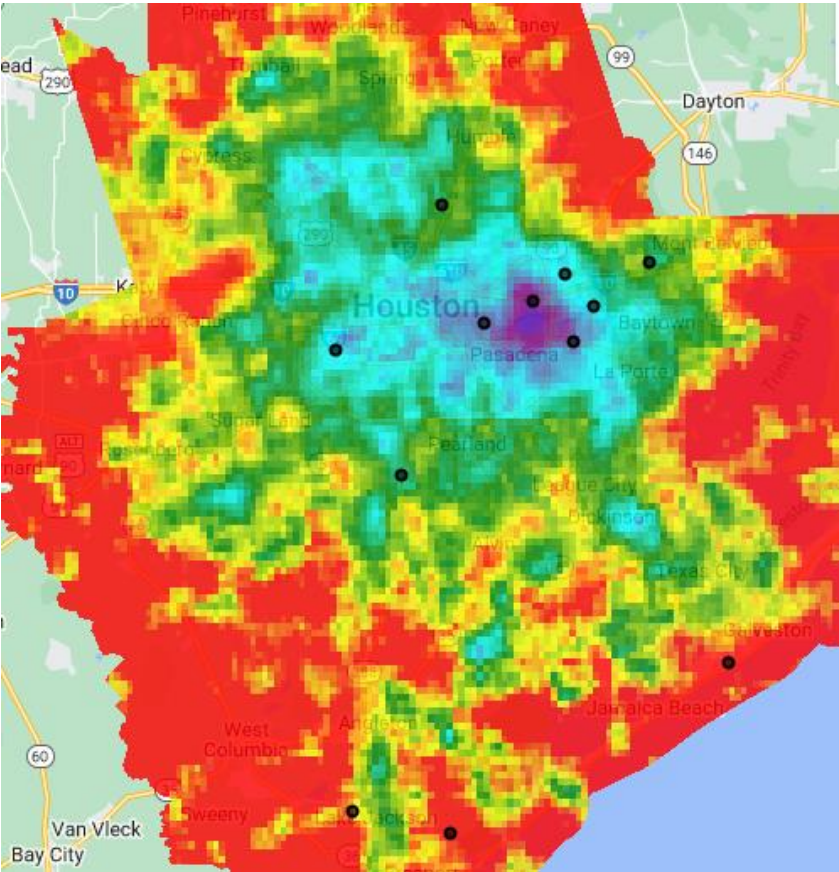
Inferring changes in summertime surface ozone- NO_x -VOC chemistry over U.S. urban areas from two decades of satellite and ground-based observations

[Xiaomeng Jin](#),^{1,2} [Arlene Fiore](#),^{1,2} [K Folkert Boersma](#),^{3,4} [Isabelle De Smedt](#),⁵ and [Lukas Valin](#)⁶

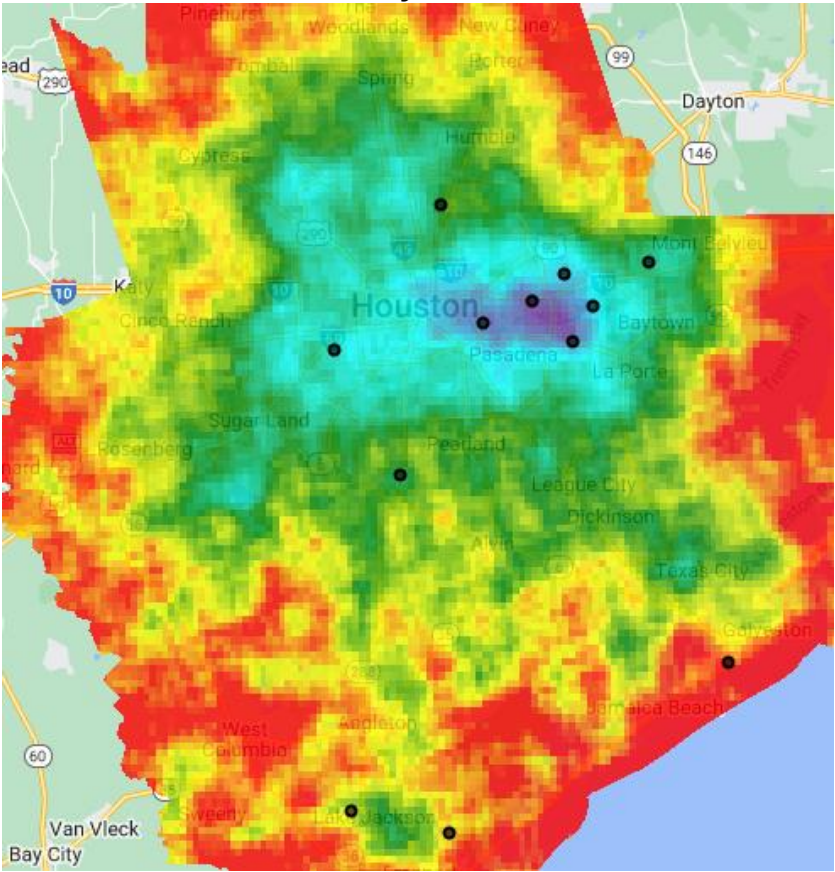
Air Quality Division · TEMPO Air Quality Applications · DB & CR · June 4, 2024

Ozone Chemistry: 2022 HGB Ozone Season (May-September) FNR

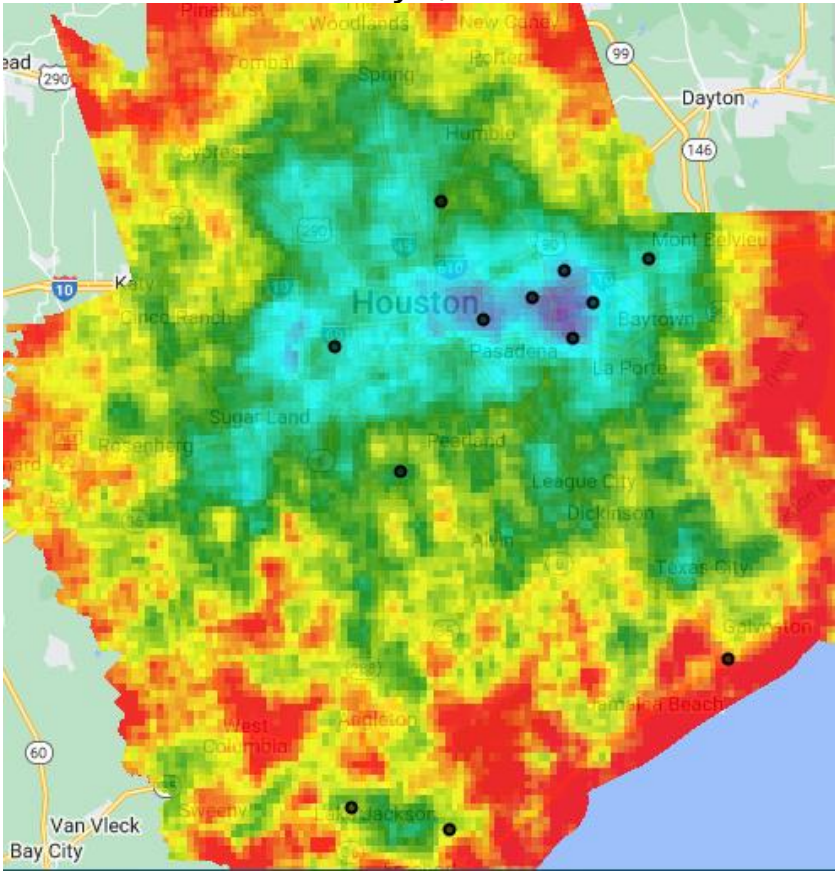
High Ozone Days, 2022 (26 days)



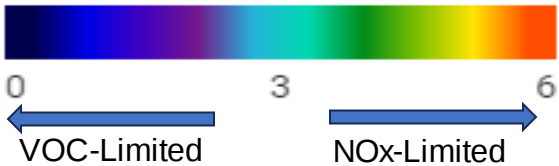
All Days, 2022



Low Ozone Days, 2022



Map Legend: FNR

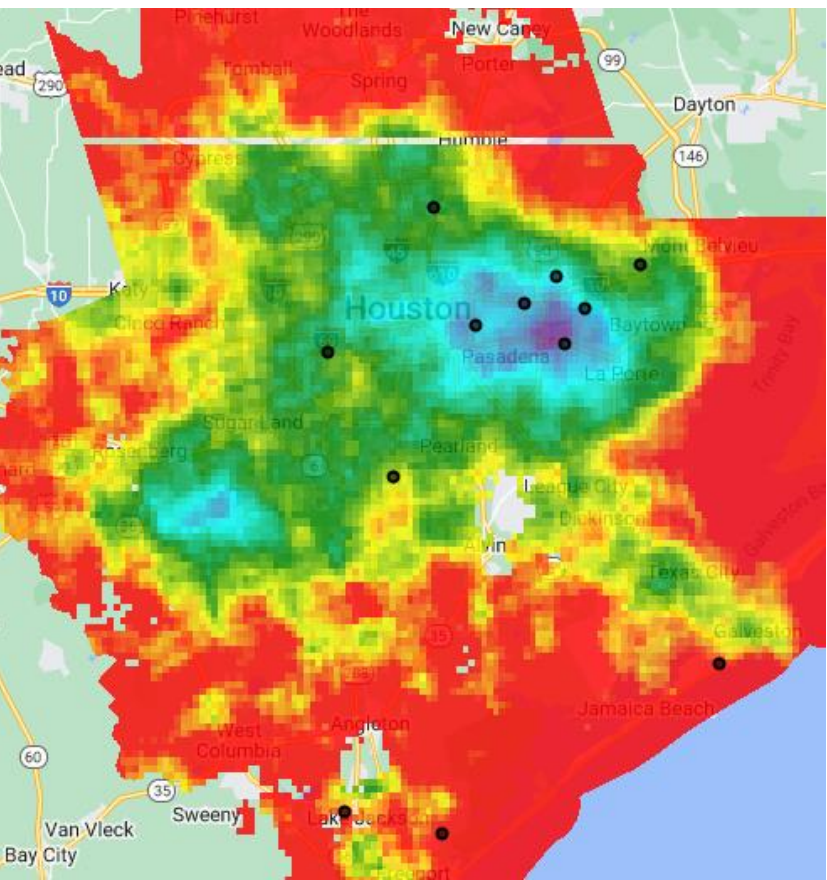


2.6 =< FNR =< 3.5: Transitional

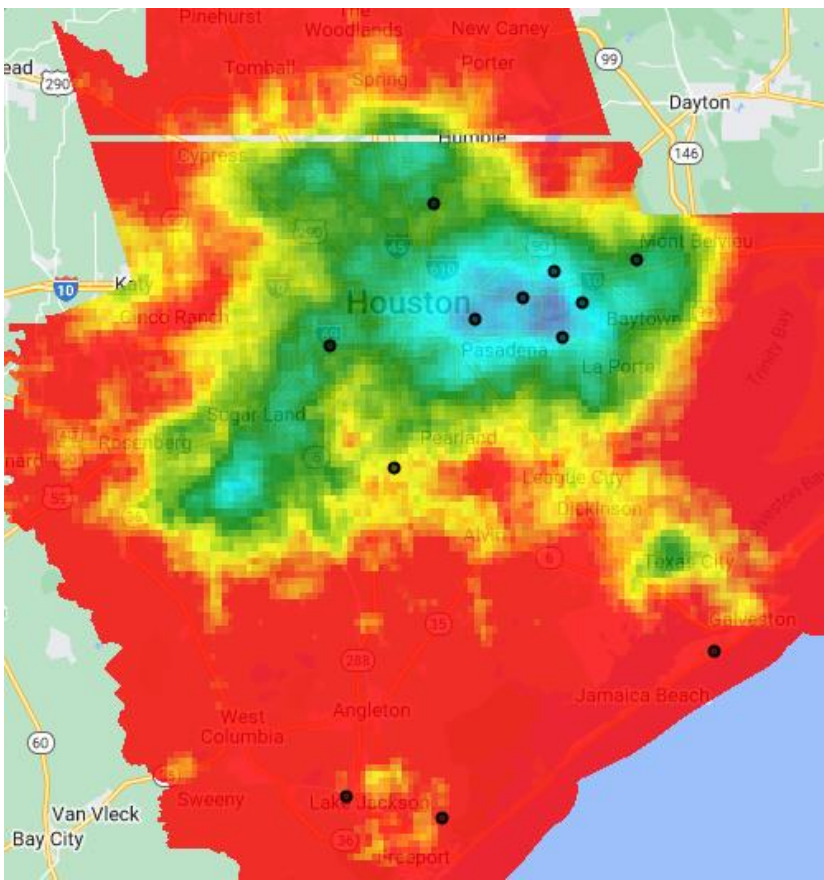
****Black Dot: Ground monitor location**

Ozone Chemistry: 2023 HGB Ozone Season (May-September) FNR

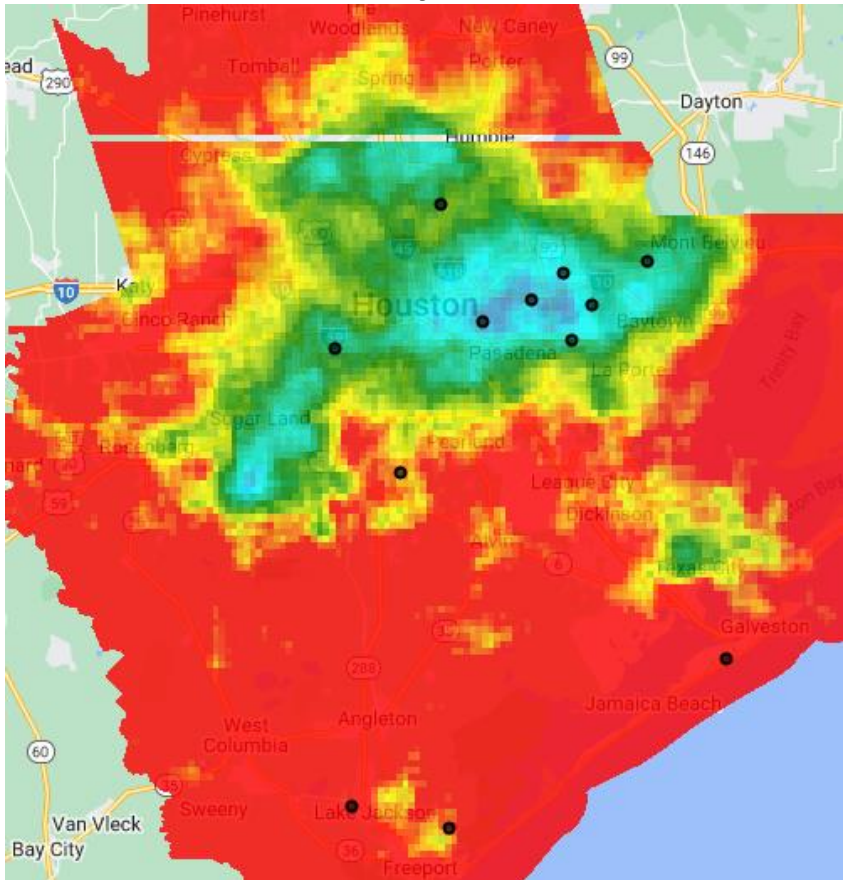
High Ozone Days, 2023 (50 days)



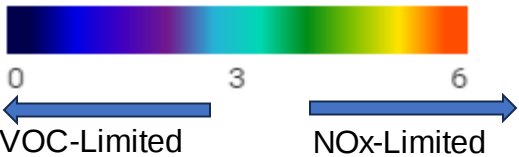
All Days, 2023



Low Ozone Days, 2023



Map Legend: FNR

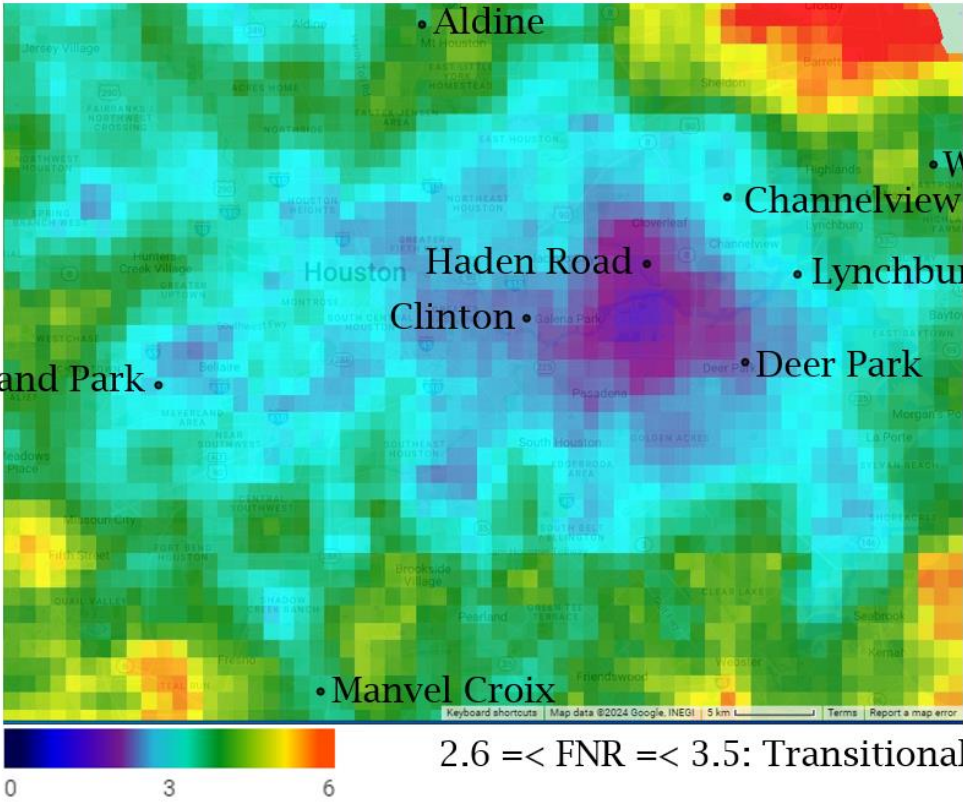


2.6 ≤ FNR ≤ 3.5: Transitional

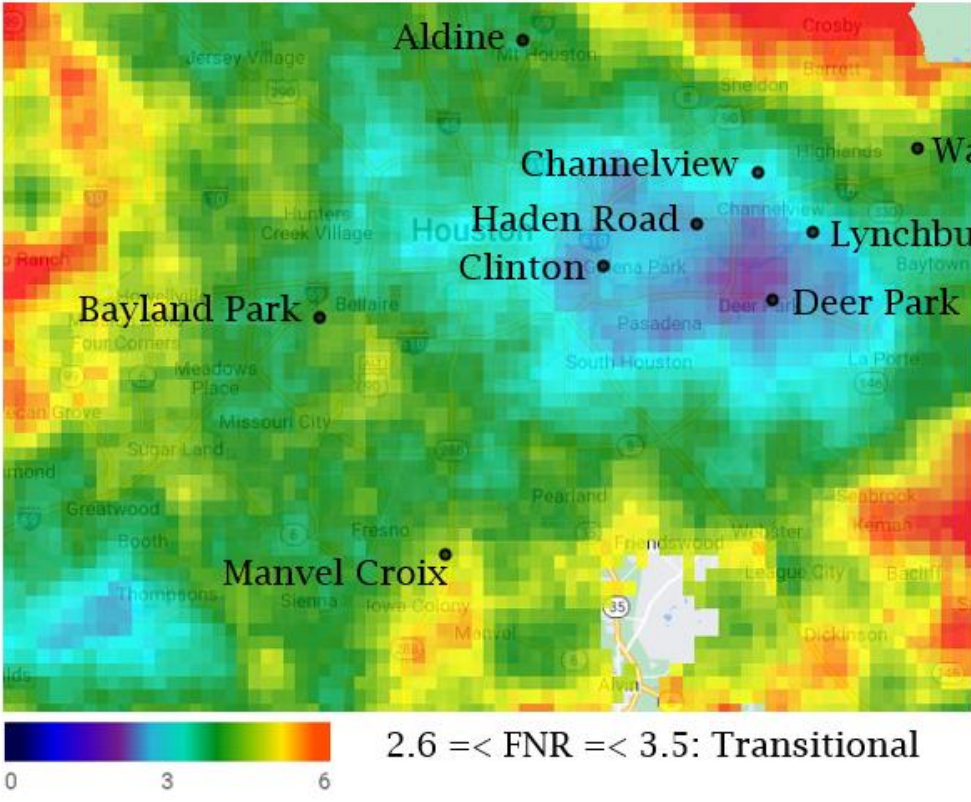
****Black Dot: Ground monitor location**

Ozone Chemistry on High Ozone (>70 ppb) Days Based on FNR

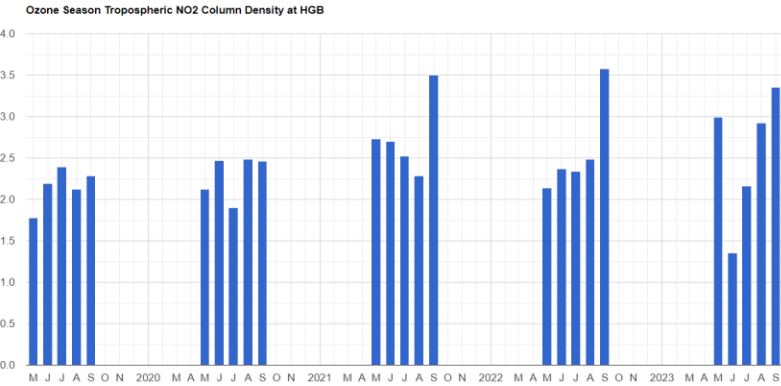
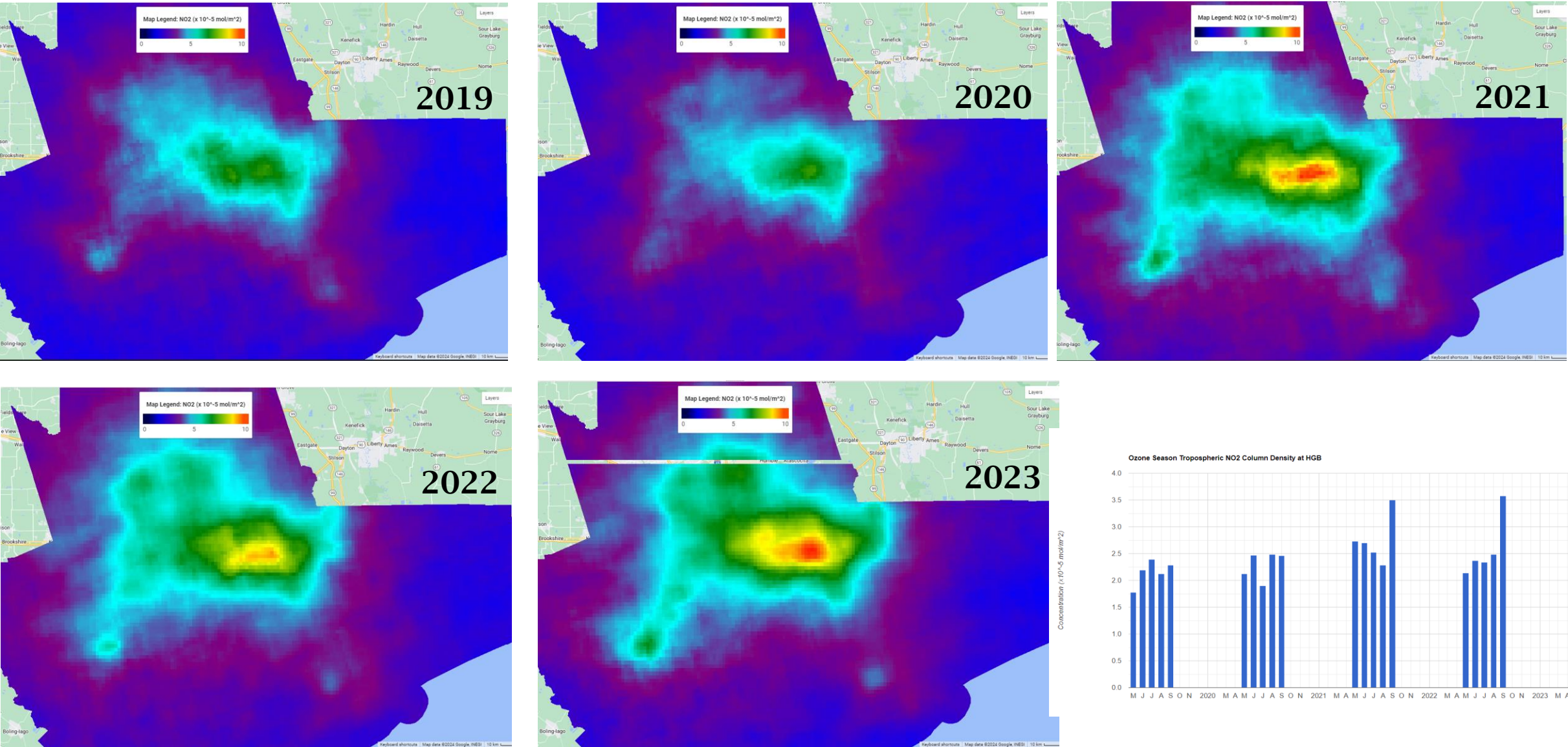
HGB High Ozone Days, 2022 (26 days)



HGB High Ozone Days, 2023 (50 days)



Tropospheric Column NO₂ Trends



Questions ?

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