

Routine Evaluation of TEMPO Tropospheric Column NO₂ Product at NOAA

Zigang Wei, IM Systems Group

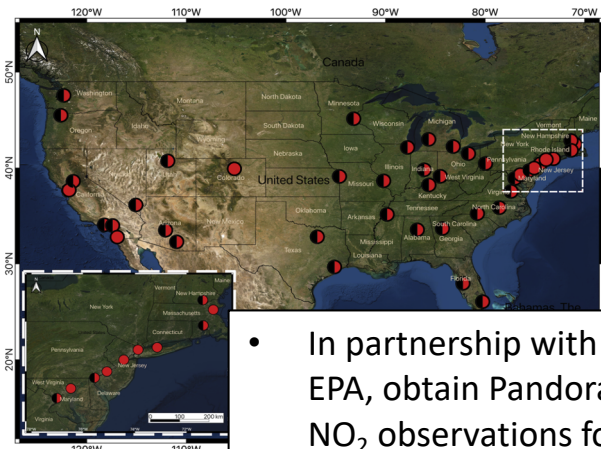
Shobha Kondragunta (NOAA), James J. Szykman (EPA), Lukas Valin (EPA)

Recommended GeoXO Constellation

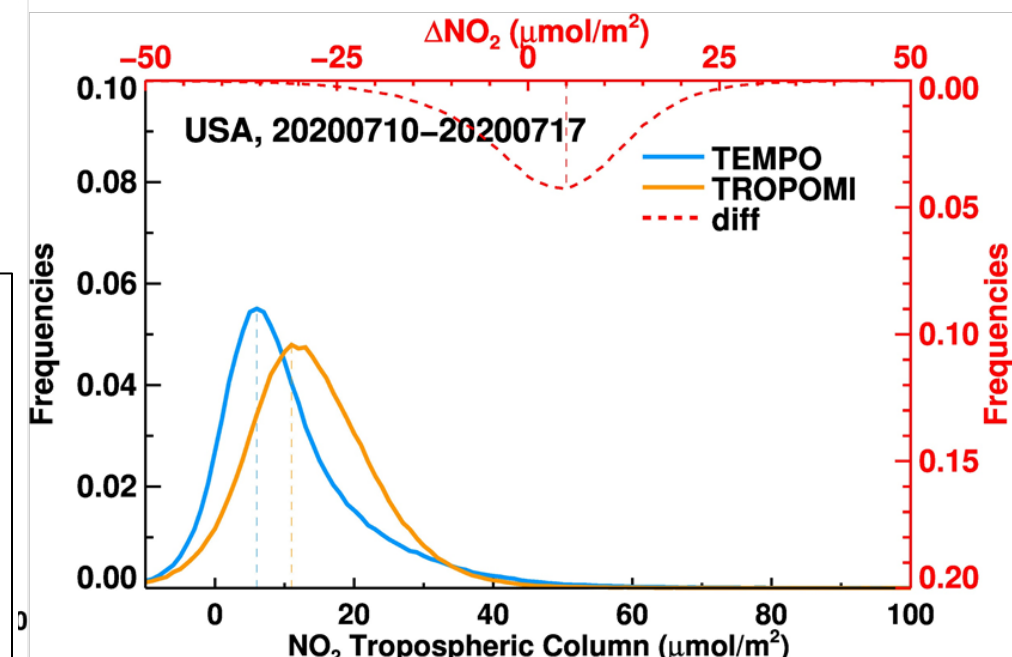
(Preliminary, pending program approval)



*Instruments provided by NOAA Space Weather Program



- In partnership with EPA, obtain Pandora NO₂ observations for routine evaluation of TEMPO tropospheric NO₂ column
- Compare TEMPO tropospheric NO₂ column with TROPOMI and OMPS
- Prior to TEMPO launch, work with proxy data to develop cal/val tools and model applications (e.g., NO_x emissions updates)



- TEMPO proxy NO₂ retrievals for July 10-17, 2020 obtained from science team (POC: Aaron Nager)
- Comparisons with TROPOMI show a mean bias of 5 $\mu\text{moles}/\text{m}^2$

ACX
Instrument
Team Lead:
**Joanna
Joiner**

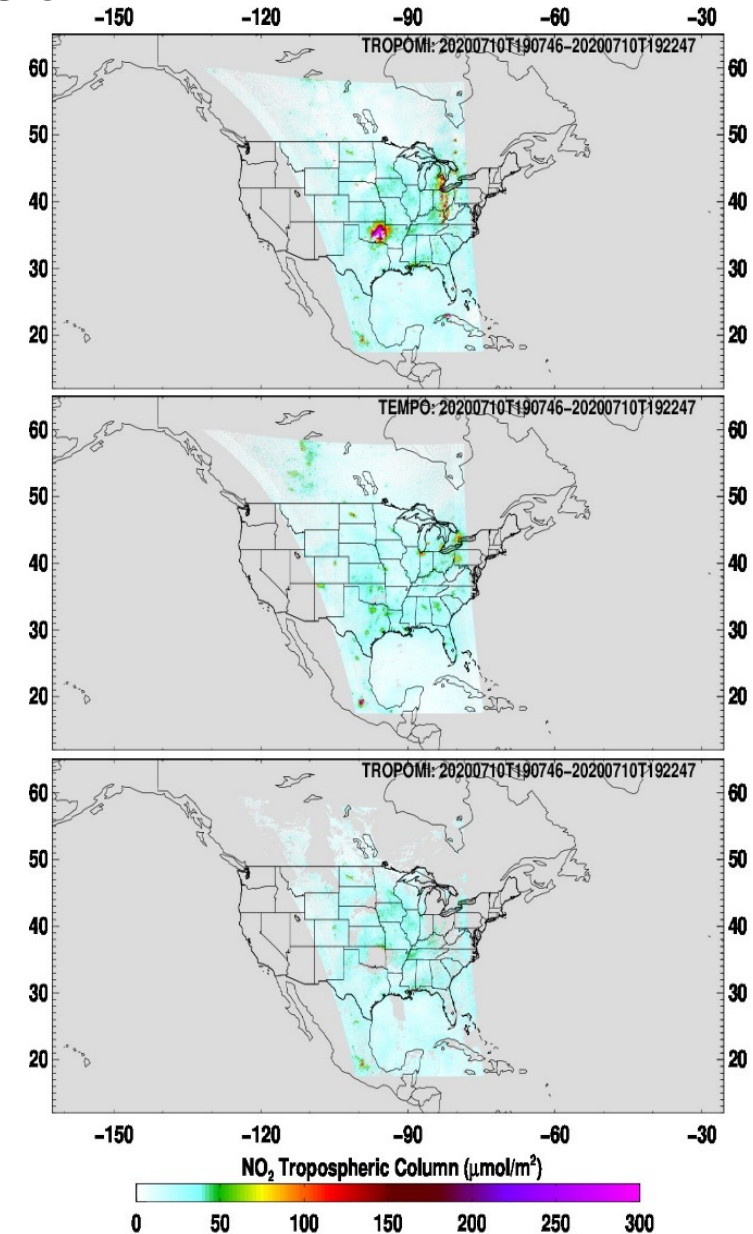
ACX Product
Team Lead:
**Shobha
Kondragunta**

ACX User
Team Lead:
**Gregory
Frost**

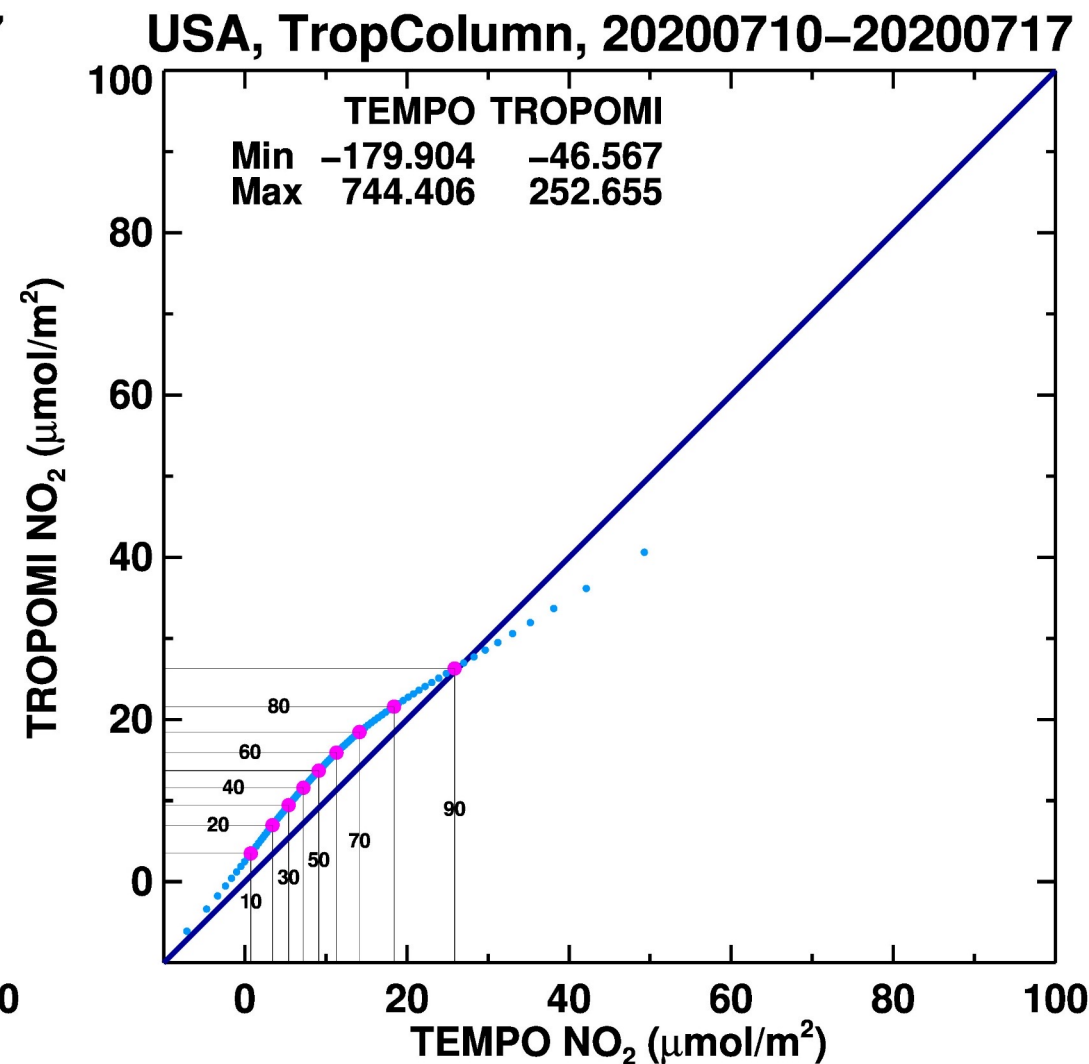
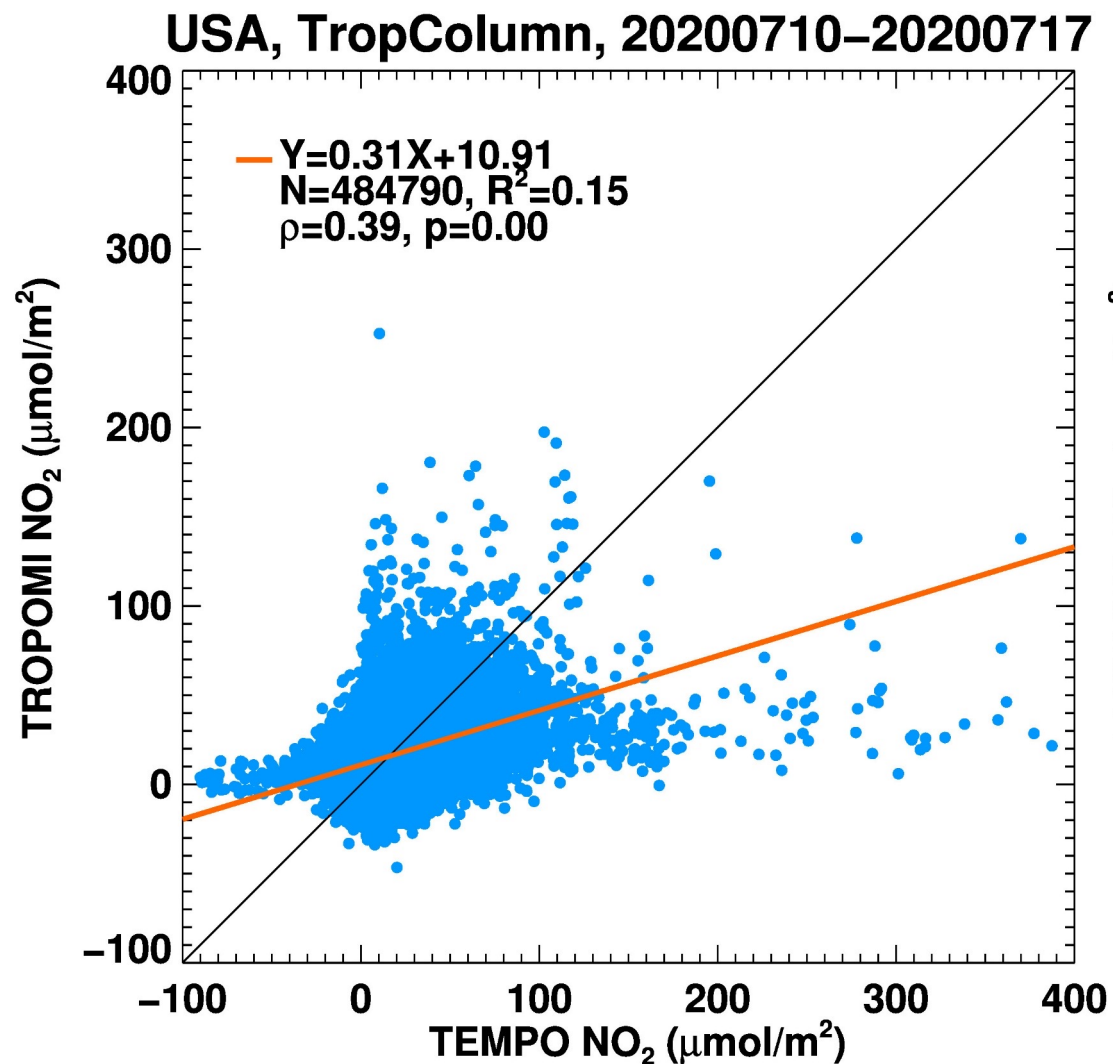
In preparation for GeoXO atmospheric composition capability which includes a planned TEMPO-like instrument, NOAA is preparing to work with TEMPO L1B and L2 products. Prior to the products becoming ready for regular use in air quality models, NESDIS and OAR would like to develop routine cal/val activities of key TEMPO products.

Preparing for GeoXO ACX NO₂ product

- Work with NASA proxy TEMPO NO₂ retrievals (*obtained from Aaron Nager*)
 - July 2020 and additional proxy data prior to launch
 - After launch, work with near real time TEMPO data
- Matchups of TROPOMI and TEMPO are generated after remapping both data to a gridded with 0.05°x0.05° resolution
- Temporal matchup window ± 18 minutes.
 - The matchup process uses the TROPOMI swath and TEMPO field of regard to constrain each other. The top panel shows a TROPOMI swath underpass the TEMPO at 19:07:46, July 10, 2020. The middle panel shows the TEMPO field of view at the same time period (within ± 18 minutes). The Bottom panel shows the final collocated valid TROPOMI pixels (Quality Flag >0.75)

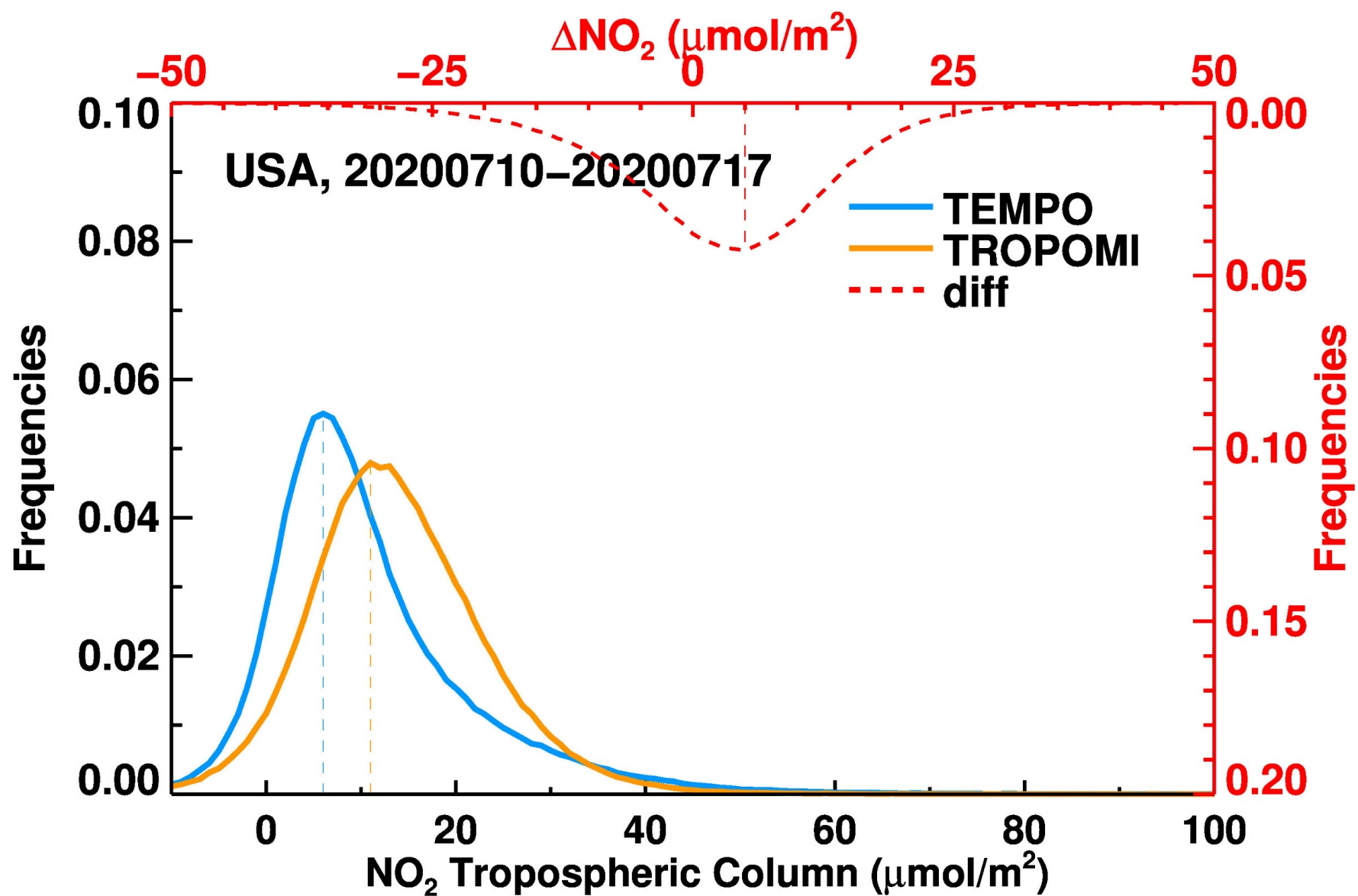


Preparing for GeoXO ACX NO₂ product

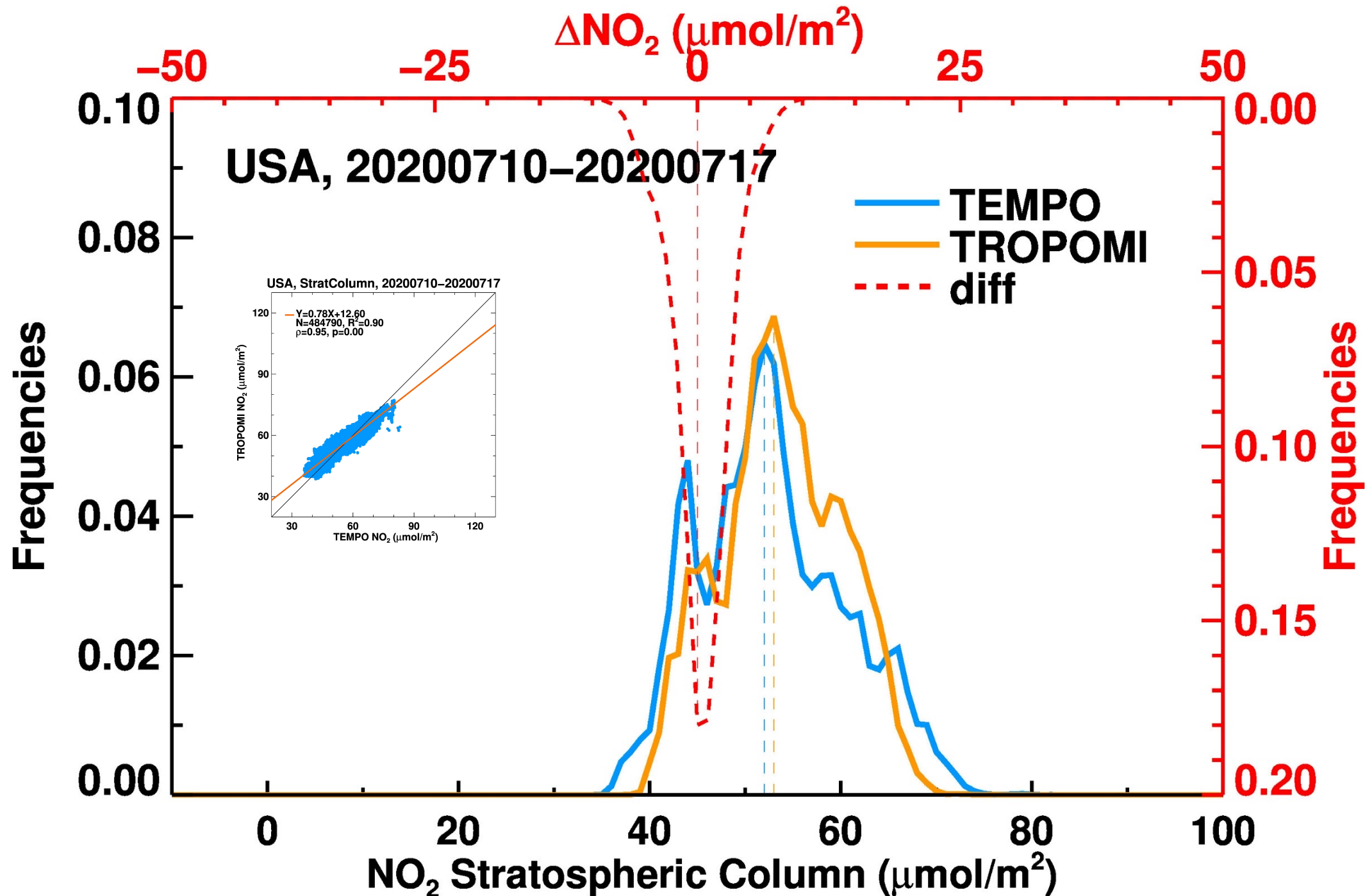


- Work with NASA proxy TEMPO NO₂ retrievals (*obtained from Aaron Nager*)
- Matchups of TROPOMI and TEMPO are generated after remapping both data to a gridded with 0.05°x0.05° resolution
- Quantile-quantile plot shows TROPOMI tropospheric column NO₂ is biased high but some extremely high NO₂ values in TEMPO proxy data

Preparing for GeoXO ACX NO₂ product



Preparing for GeoXO ACX NO₂ product



Field Campaigns

- NOAA will work with NASA in conducting periodic field campaigns to validate TEMPO data
 - AEROMMA field campaign is planned for 2023
- NOAA will partner with EPA to develop routine calibration and validation tools for NO_2 and aerosols.
- NOAA is planning for 10+ years of work with TEMPO L2 products until GeoXO ACX launches as a follow-on to TEMPO



AEROMMA:

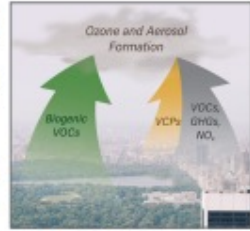
Atmospheric Emissions and Reactions
Observed from Megacities to Marine Areas

A comprehensive study led by NOAA's Chemical Sciences Laboratory investigating anthropogenic and marine emissions that alter tropospheric composition and impact air quality and climate

The AEROMMA project addresses emerging research needs in urban air quality, marine chemistry influences on cloud formation, and interactions at the marine-urban interface

NOAA research has identified an emerging source of volatile organic compounds to the urban atmosphere that contributes to ozone and aerosol

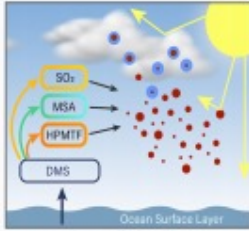
More than 100 million Americans live in non-attainment areas for ground-level ozone. Tropospheric ozone is a toxic air pollutant formed through reactions involving VOCs and NO_x . Volatile chemical products (VCPs) are emerging as a major urban source of petrochemical organics [McDonald et al., Science, 2019].



VOCs = volatile organic compounds
GHGs = greenhouse gases

A recent NOAA discovery has redefined the marine sulfur cycle, prompting a renewed look at air-sea exchange

Oxidation of ocean-emitted dimethyl sulfide (DMS) produces sulfate aerosol, which in turn impacts albedo, cloud formation, and climate. CSD's discovery of an additional DMS oxidation product (HPMTF) shows that the marine sulfur cycle in current models is incomplete [Veres et al., PNAS, 2020].

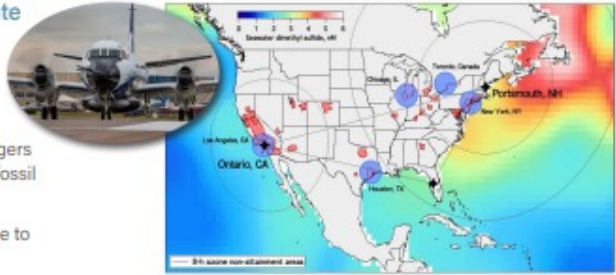


MSA = methane sulfonic acid
HPMTF = hydroperoxymethyl thioformate

AEROMMA will expand upon these new findings to assess their impacts on air quality and climate and improve our understanding of air pollution in a changing environment

Anticipated outcomes:

- » Provision of timely information to environmental managers and stakeholder groups on emissions from VCPs and fossil fuel sources that impact climate and air quality.
- » Reduction of uncertainties in global climate models due to marine aerosols from biogenic sulfur emissions.
- » Provision of urban and marine datasets to improve the representation of emissions and chemical and physical processes in the next generation NOAA weather-chemistry models.



AEROMMA will use an extensively instrumented NOAA P-3 research aircraft through a series of flights in May - July 2021. The aircraft will base in California and New England to access several major coastal and inland cities and two ocean basins. The P-3 flight range is indicated as rings on the above map.