Intercomparing Results of TEMPO NO_2 V3 and V4 using GCAS

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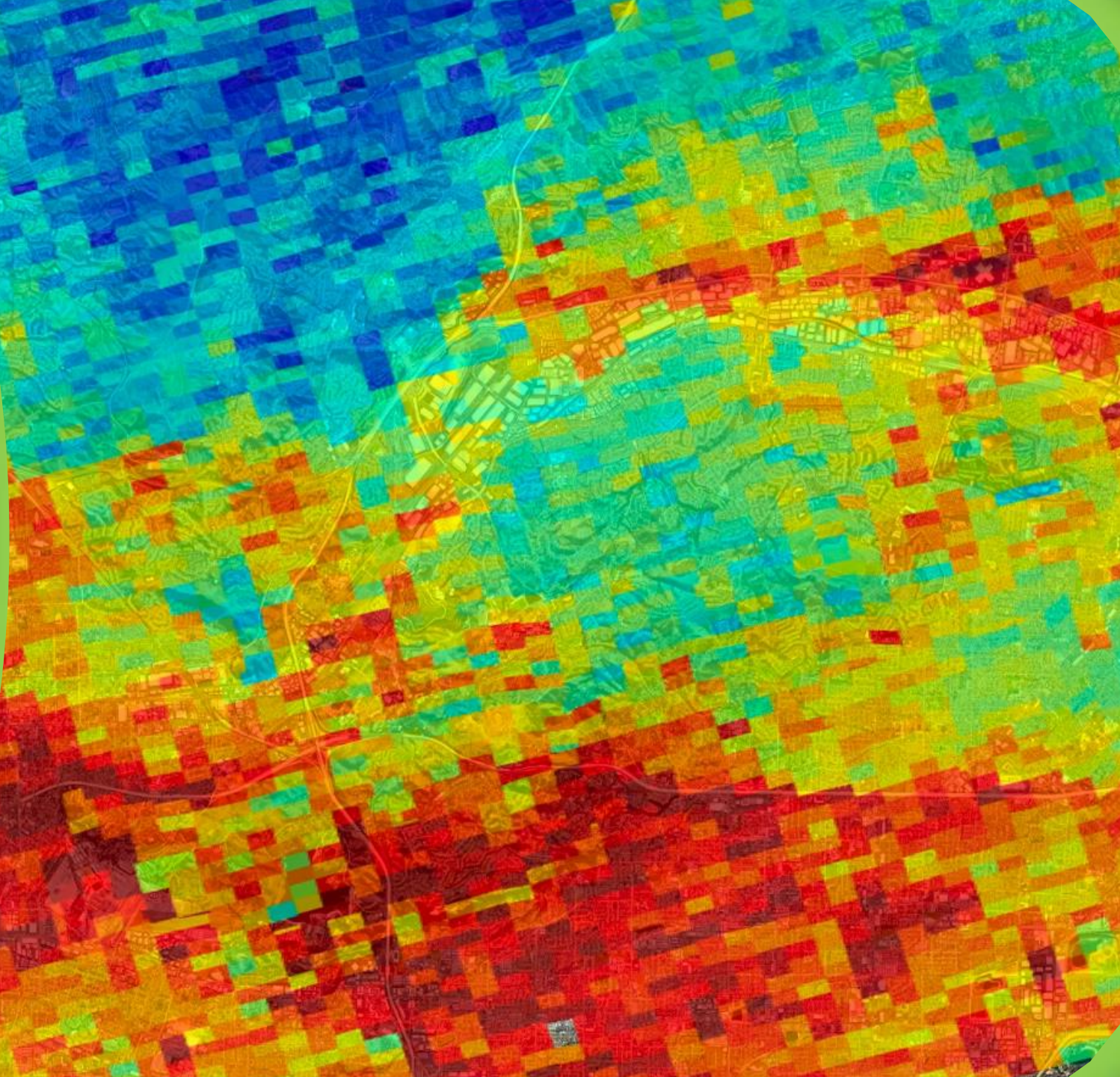
GCAS and Langley IMPAQT Groups

TEMPO Validation Team and STAQS Team



GEOCAPE Airborne Simulator (GCAS)

GCAS is an airborne UV-VIS pushbroom spectrometer meant to simulate satellite measurements like those from TEMPO, GEMS, TROPOMI, GOSAT-GW

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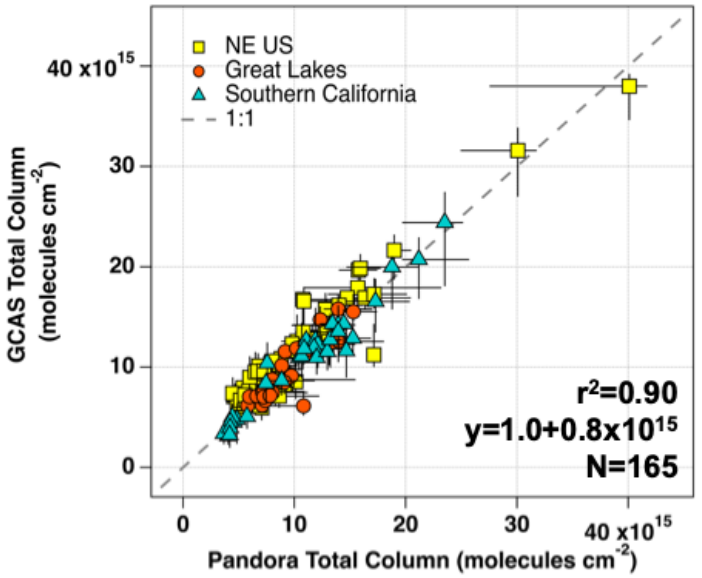
SQUAS

11 flight days
~100 TEMPO overpasses

GCAS Validation + Retrieval Details

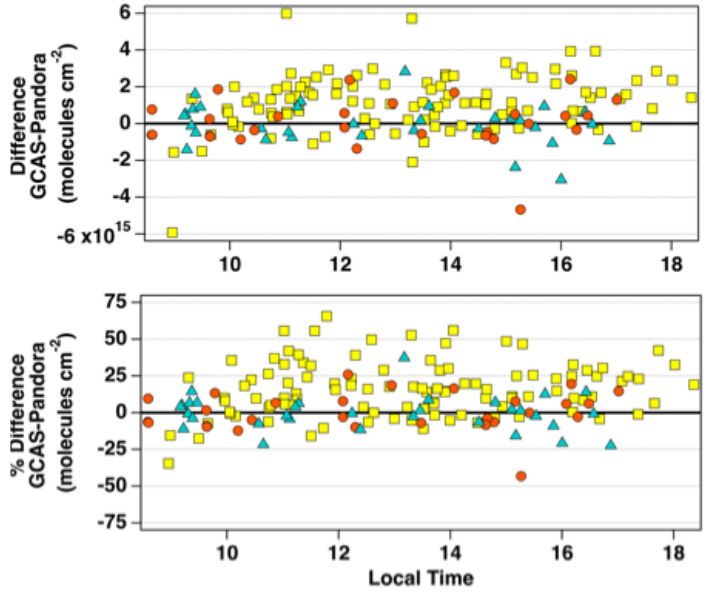


→ **Has a nearly 1:1 relationship with the PGN Pandora observations (within 25% according to DS).**

→ **GCAS has not been update to GEOS-CF V2 (should it be?)**

→ **Comparisons indicate a slight high bias in GCAS of ~1E15 like due to reference assumptions.**

→ **No obvious time of day bias**

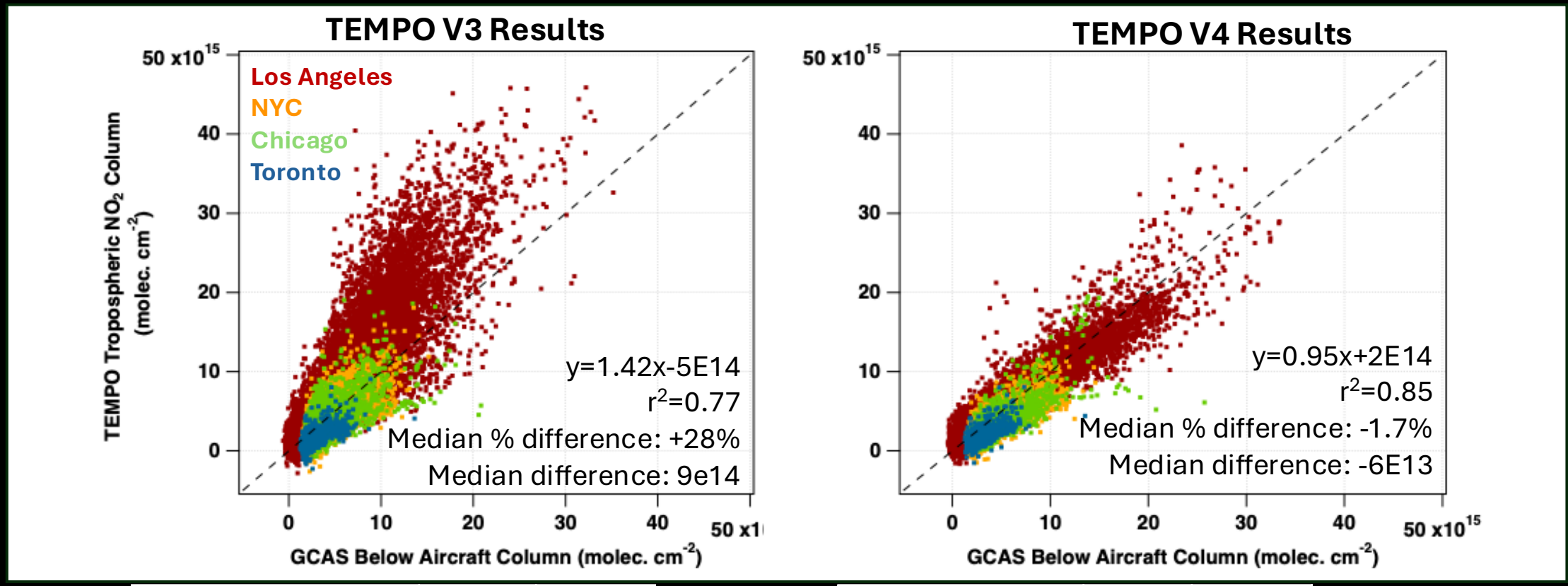


Parameter	GCAS	TEMPO V3	TEMPO V4
Atmospheric profiles	GEOS-CF **V1**	GEOS-CF **V1**	GEOS-CF **V2**
Surface reflectivity	MODIS BRDF Kernels MCD43A1 (**500m** resolution) + Cox-munk kernel	GLER using MCD43C2 BRDF kernels at **~ 5km** resolution or Cox-munk	Same but with a new GLER lookup-table
Clouds	**Cloud filtered** (cloud free scenes only)	independent pixel approximation and the TEMPO O2-O2 cloud retrieval **V3**	independent pixel approximation and the TEMPO O2-O2 cloud retrieval **V4**

Comparing GCAS to TEMPO

V4 shows a huge improvement over V3 in all regions measured during STAQS

r^2 improved from 0.77 → 0.85 for all sites
0.49 → 0.62 for East Coast



	y=mx+b	r^2	N
Chicago	y=0.98-6e14	0.58	1824
Toronto	y=0.78x-6e14	0.47	128
NYC	y=1.23x-13e14	0.30	1642
Los Angeles	y=1.38x-2e14	0.81	10779

y=mx+b	r^2	N
y=0.87x-4e14	0.66	2599
y=0.85x-7e14	0.43	590
y=0.97x-9e14	0.59	2659
y=0.90x+9e14	0.89	13703

Matching criteria

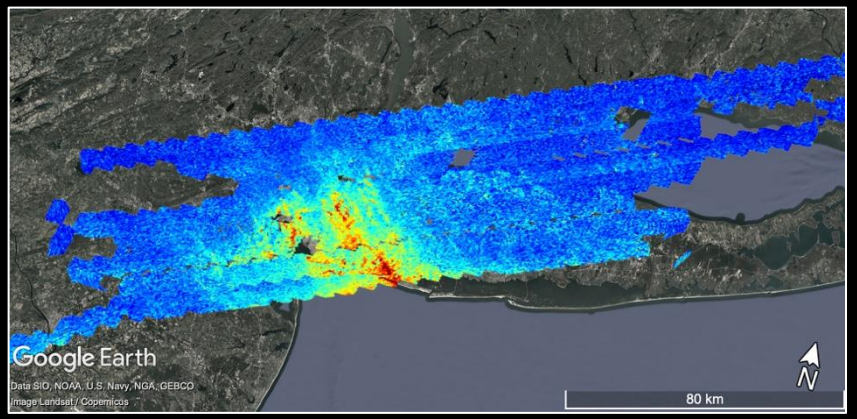
- → GCAS maps 75 % TEMPO
- → +/- 30 minutes
- → TROPOMI qa > 0.75
- → TEMPO qa=0
- → TEMPO CEF < 0.10

Visually comparing GCAS & TEMPO

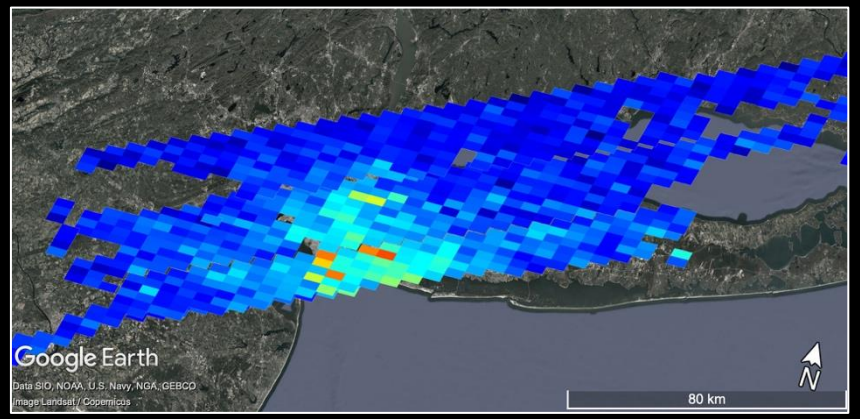
Matching criteria
- → GCAS maps 75 % TEMPO
- → +/- 30 minutes
- → TROPOMI qa > 0.75
- → TEMPO qa=0
- → TEMPO CEF < 0.10

New York City on August 9th, 2023: Scans 2,3,4

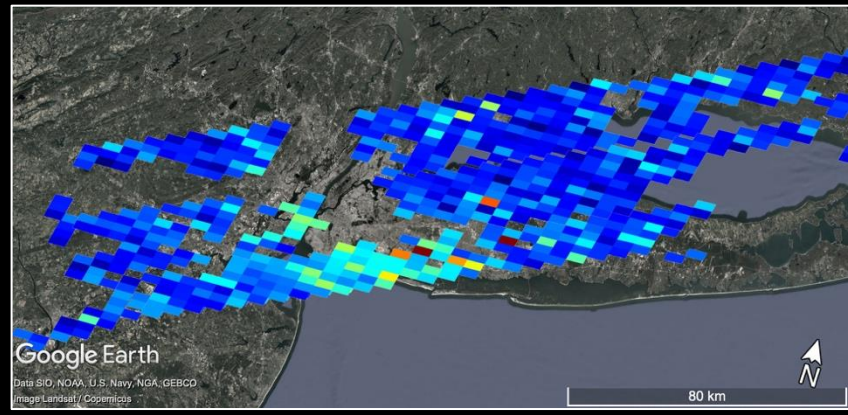
GCAS



TEMPO V4

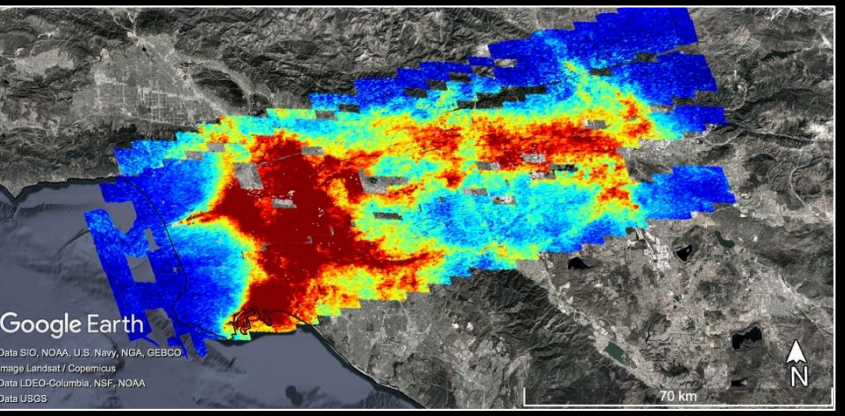


TEMPO V3

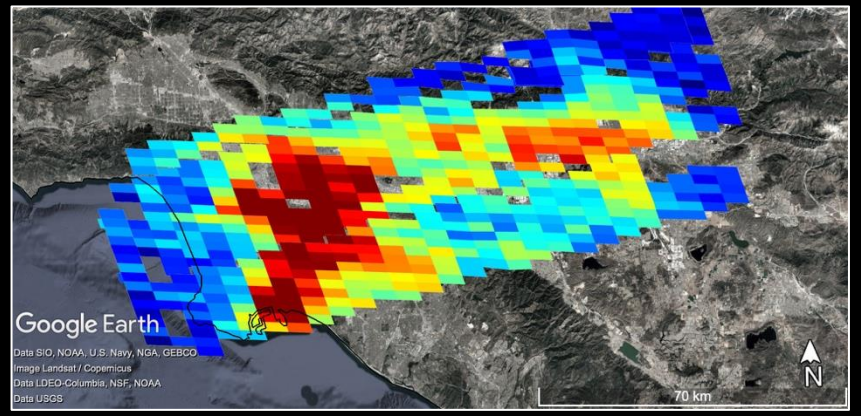


Los Angeles on August 22nd, 2023: Scans 9, 10

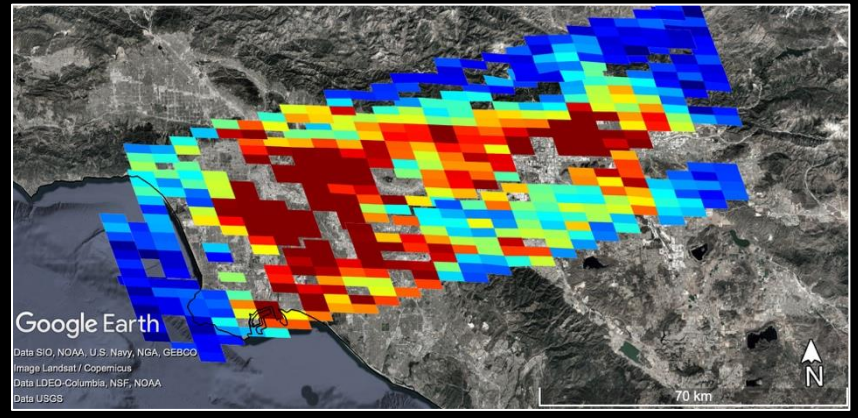
GCAS

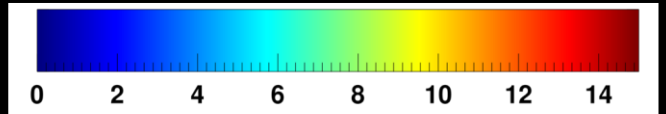


TEMPO V4



TEMPO V3





Both locations were cloud free.

TEMPO Trop. NO_2 is now seeing a much more comparable dynamic range to GCAS

V3 Results from Validation Report

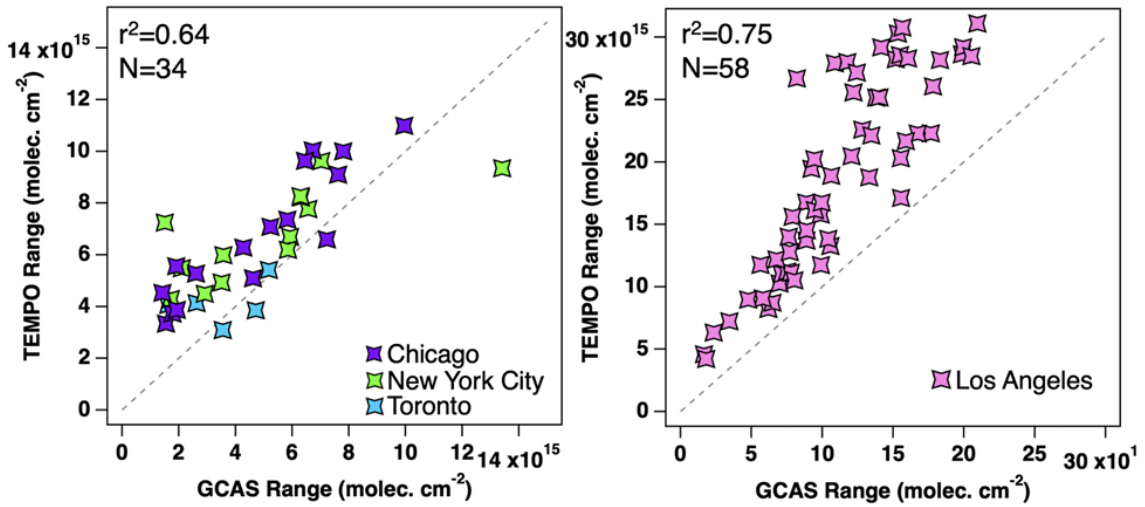
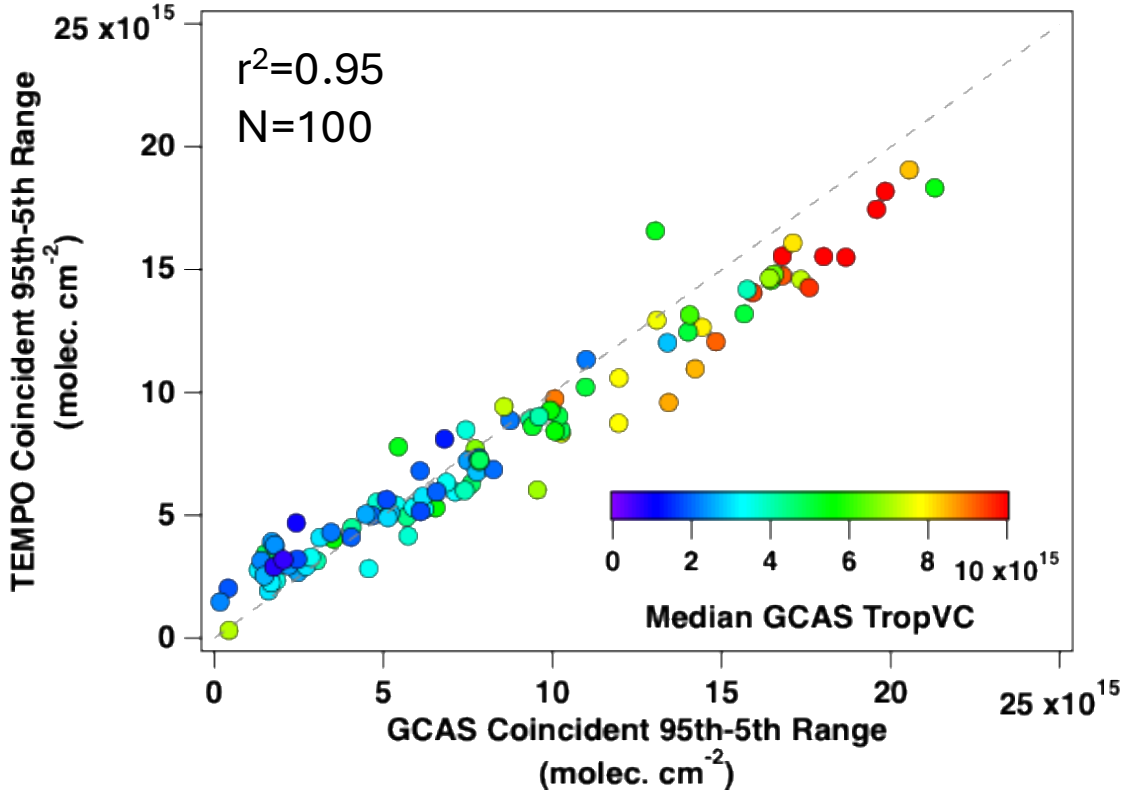
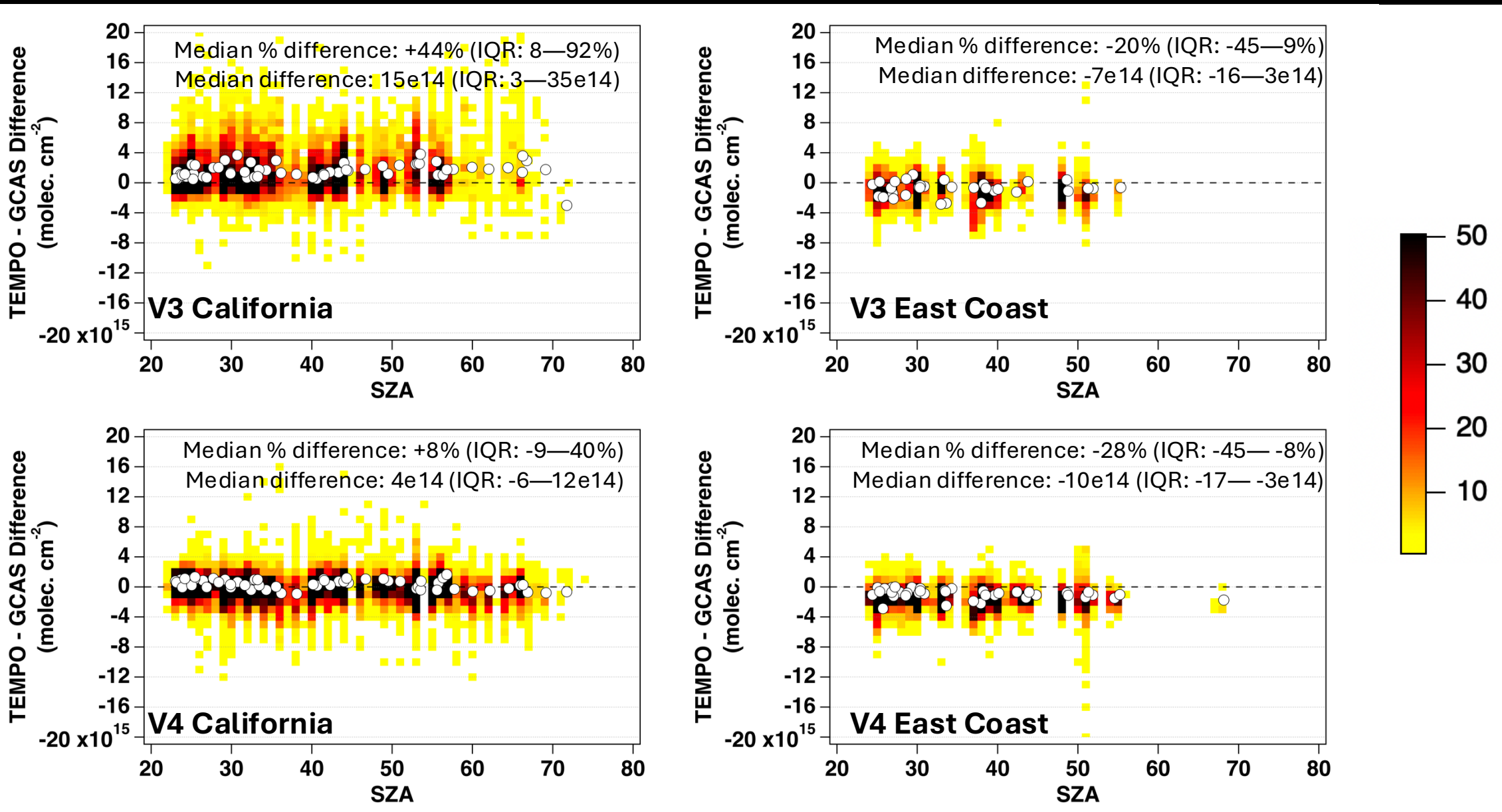


Figure 3.2.5.2: Scatter plot showing the dynamic range (defined as the 5th-95th percentile range) of tropospheric NO2 from GCAS and TEMPO for each individual TEMPO overpass colored by region. Each point is colored by city region the data was collected. Chicago, New York City and Toronto are shown on the left with a smaller axes scale and Los Angeles is on the right.

V4 Results for all coincident overpasses

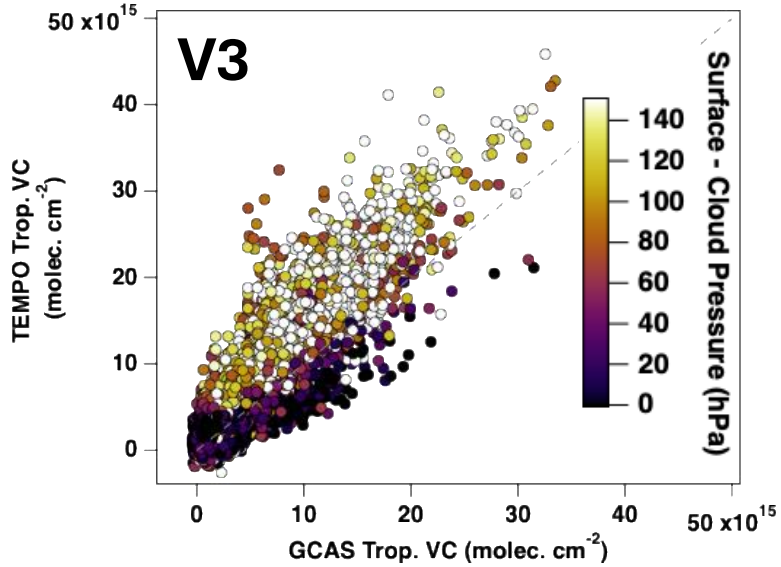


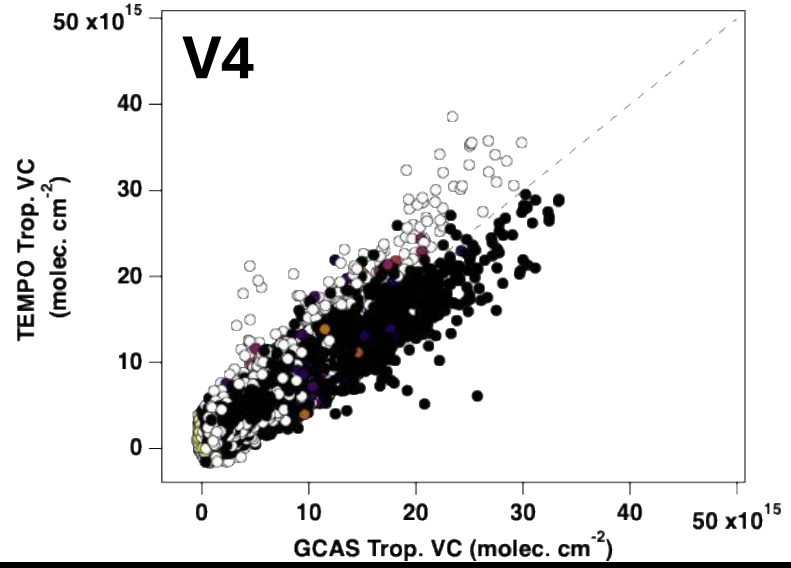
No apparent bias by solar zenith angle

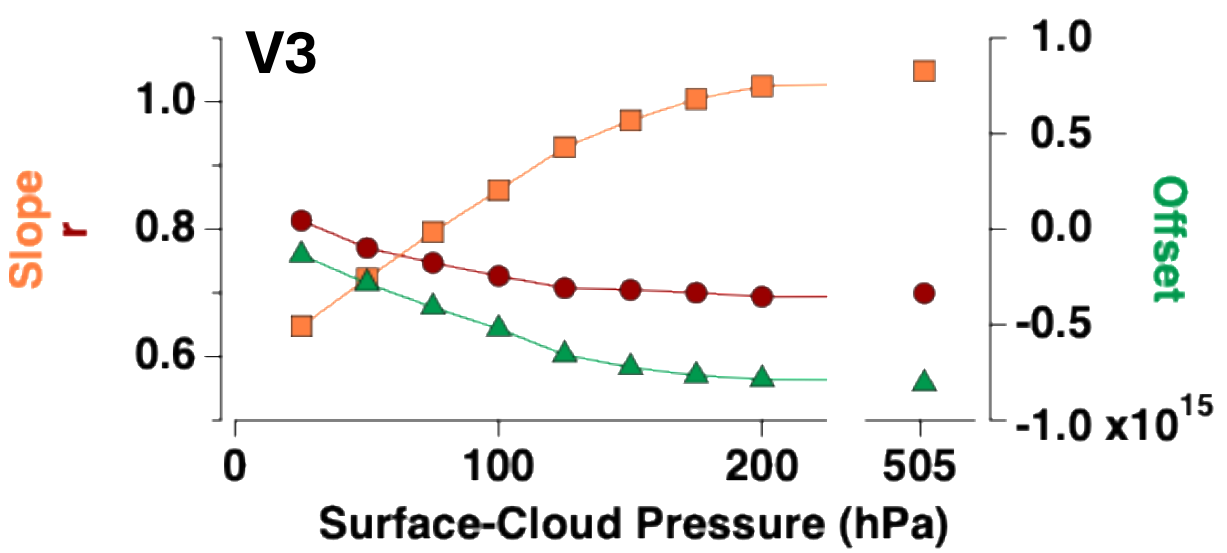


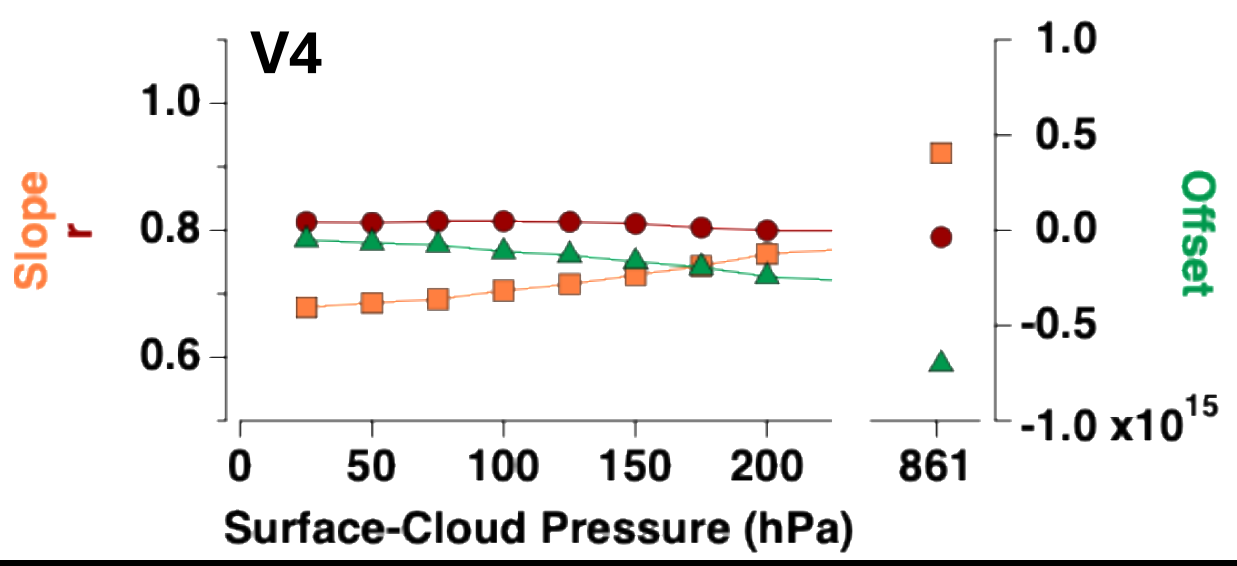
Improvement in cloud influence on comparison results

All points have reported cloud effective fractions less than 0.1









All results are from the NYC, Chicago, Toronto.

V3 has a lot of noise introduced by errors in the cloud retrieval.

This appears to be mostly results in V4 (will need to explore more in more cloudy scenes).

No obvious patterns found in cloud fraction/surface albedo

Intercomparisons—what are the roles of the geophysical assumptions to the retrieval?

Clouds

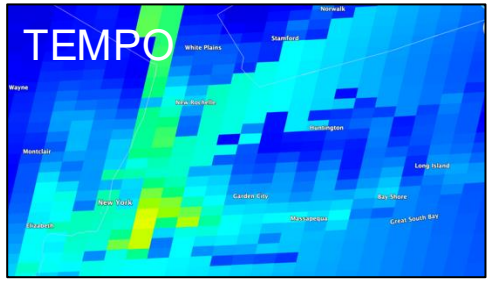
Alternative cloud information:

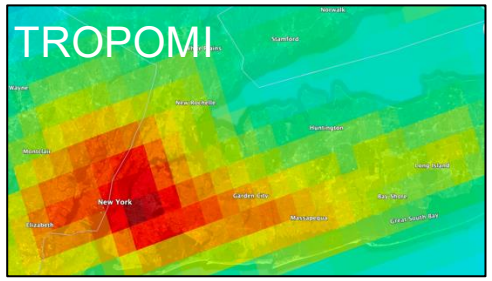
- GOES ABI cloud mask
- GCAS measurements
- HSRL measurements (height)

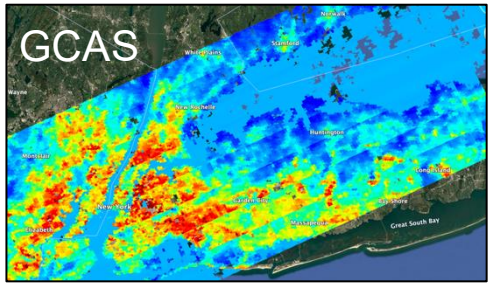
SNPP VIIRS Image

TEMPO Eff. Cloud Fraction

Surface reflectance





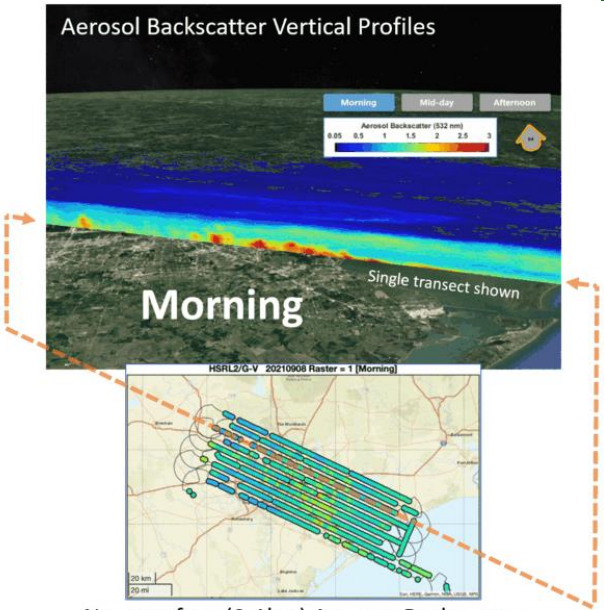


All inputs are from the same time on Aug 9th, 2023

Aerosols

STAQS provided extinction profiles with GCAS from HSRL2/HALO and lots of smoke examples.

Example below is from TRACER-AQ



Near-surface (0-1km) Average Backscatter

Prior profile

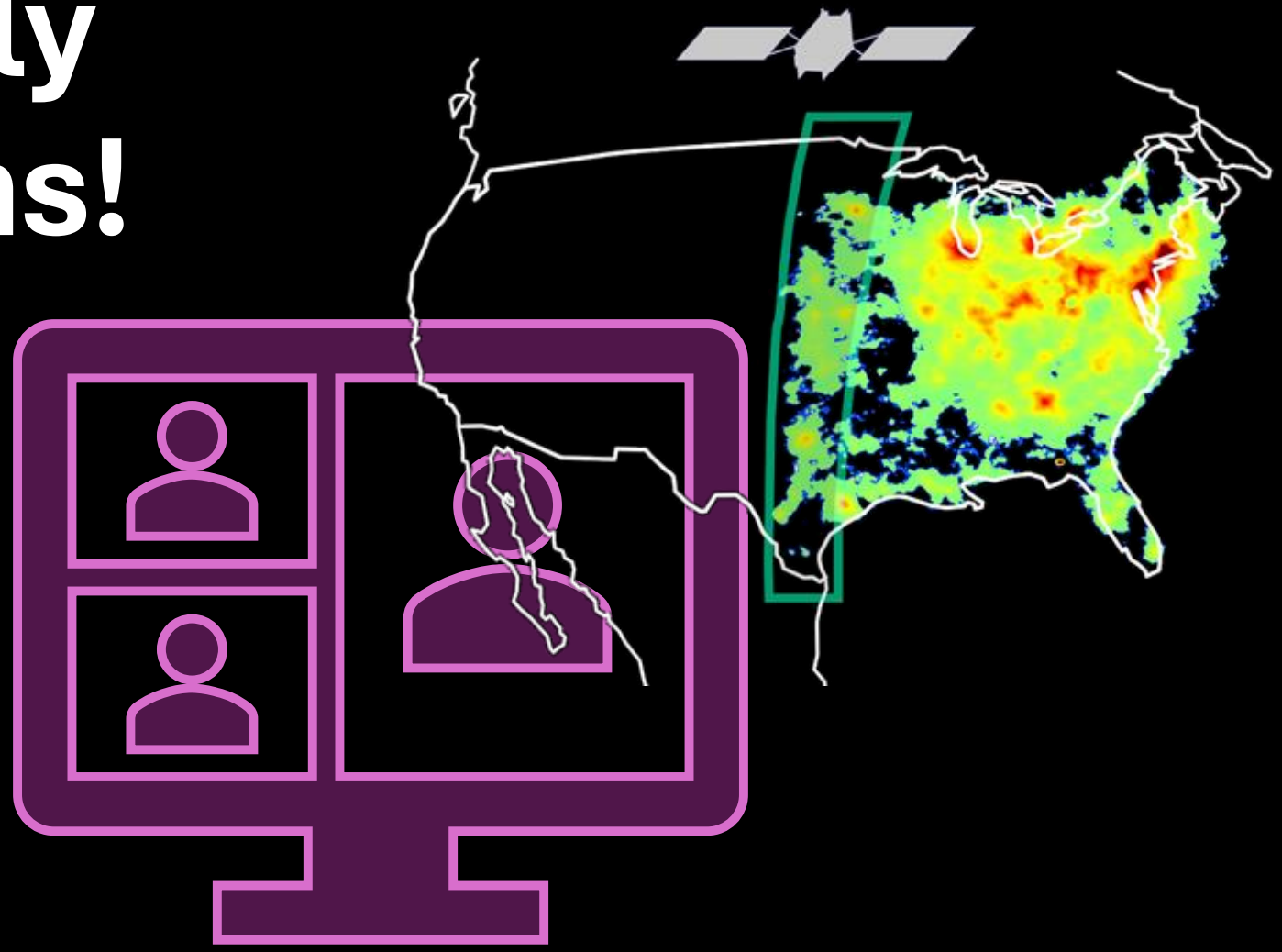
- GEOS-CF (V1 vs. V2)
- WRF-Chem—Brad Pierce and Jerrold Acdan, Univ. of Wisc.
- AEROMMA DC8 Profiles

& growing number of datasets

The plan is to use case studies to investigate in detail these individual components then run new AMF calculations by varying one component at a time

TEMPO

Join our monthly science telecons!



We invite all to share TEMPO relevant research that can span from preliminary → peer reviewed results!

Typical agenda includes (1) updates from the TEMPO leadership team and (2) two-three science presentations

Email laura.m.judd@nasa.gov or ggonzalezabad@cfa.harvard.edu to get added to the list

The DART Integrator (that's me!) serves as the formal coordination conduit between their operational mission's DART Team (TEMPO) and the other DARTs, creating a two-way bridge for information and collaboration

Current activities where you all can help!

- Applications that use TEMPO data integrated with other datasets
- Publications
- Validation/Calibration gaps

Email me if you have contributions:
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