

Background: Gulf of Mexico Air Quality & Greenhouse Gases

The US Dept of Interior’s Bureau of Ocean Energy Management (BOEM) has air quality (AQ) jurisdiction in the US Outer Continental Shelf including the Gulf of Mexico (GOM)

BOEM is mandated to ensure that emissions (e.g., NO₂) from oil and gas (ONG) facilities do not significantly affect the air quality of any US state. BOEM is also interested in ONG greenhouse gas emissions, particularly CH₄, but it relies on ONG operator reporting for GOM emissions inventories (Figure 1). Before BOEM and NASA joint work there were NO GOM AQ DATA

SCOAPE-II: 2-13 June 2024 Ship and AVIRIS-3 Measurements

BOEM & NASA evaluated satellite NO₂ data during the May 2019 Satellite Coastal and Oceanic Atmospheric Pollution Experiment (SCOAPE-I). Thompson et al. (2023) addressed Can satellites be used to monitor GOM AQ? They concluded Yes. Accuracy is within ~5-15%

SCOAPE-I led BOEM to fund a June 2024 SCOAPE-II (Figure 2) to evaluate TEMPO & to sample CH₄ emissions from ONG platforms. AVIRIS sampled CH₄ Both SCOAPES took place on the R/V Point Sur. Point Sur measurements collected during SCOAPE-II are in Table 1

Full 12-day SCOAPE-II timeseries of in-situ trace gas measurements are shown in Figure 3. Dozens of spikes in CH₄ occur near shallow water platforms (compare Figure 2).Large NO₂ spikes more typical near deepwater platforms

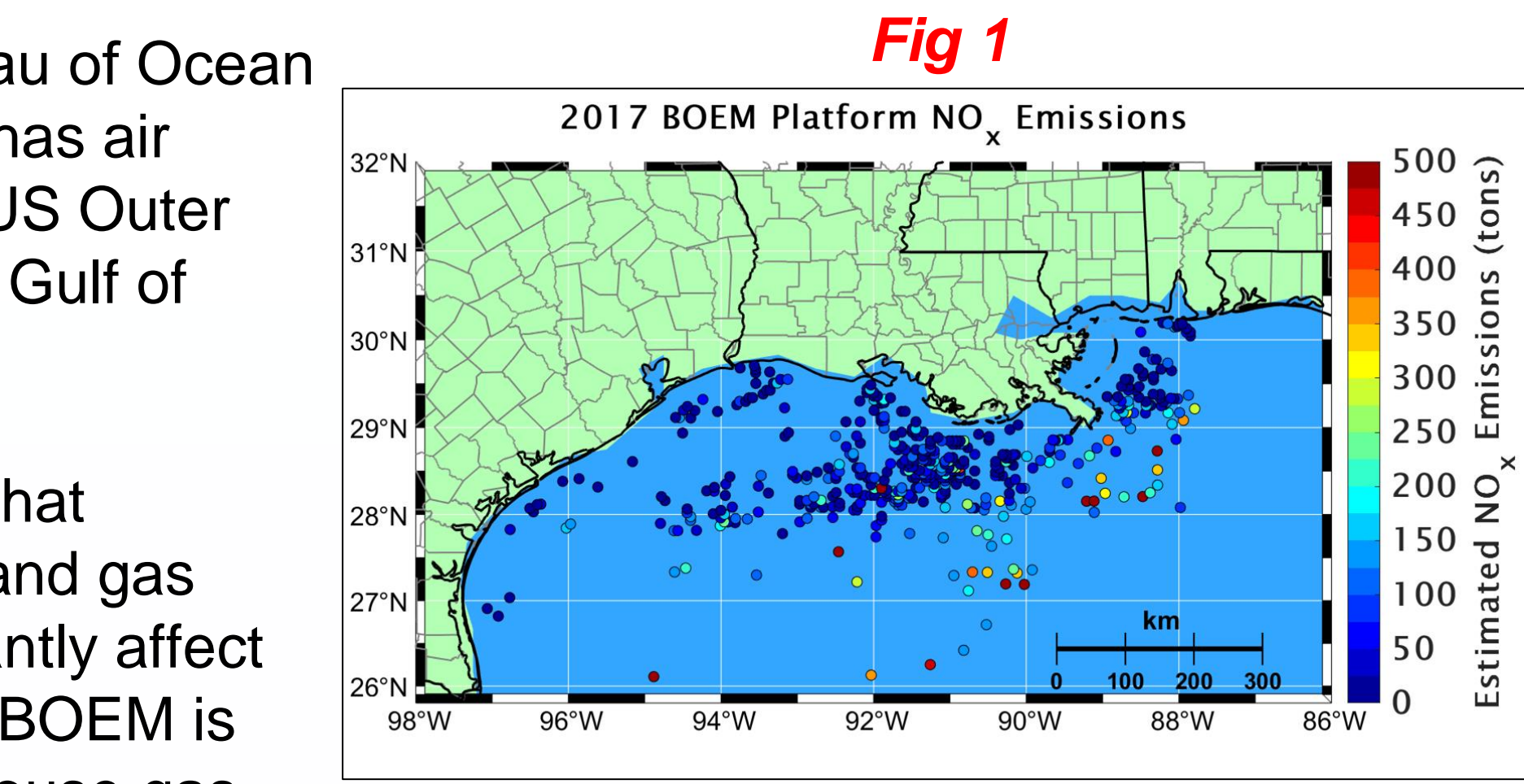
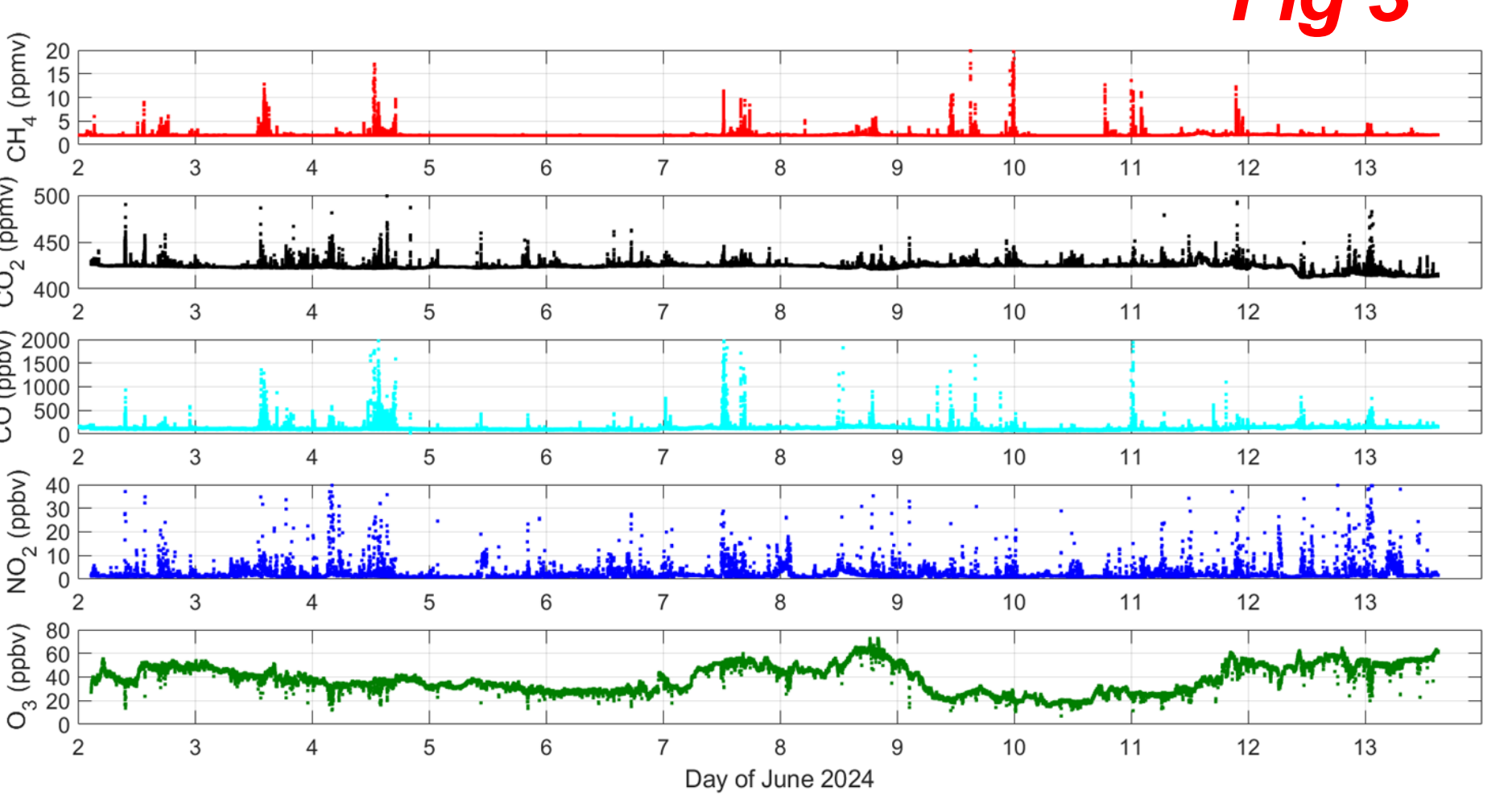
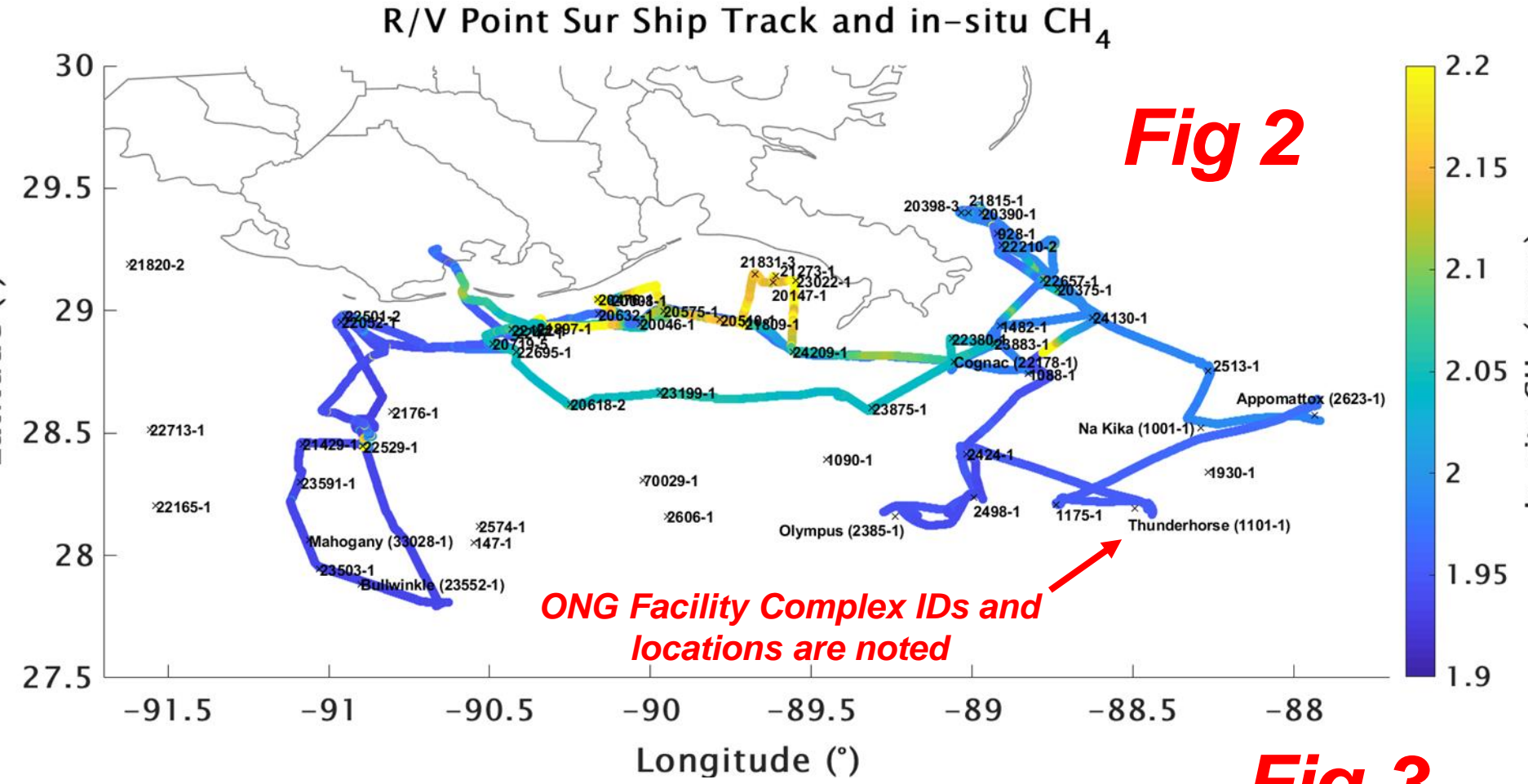


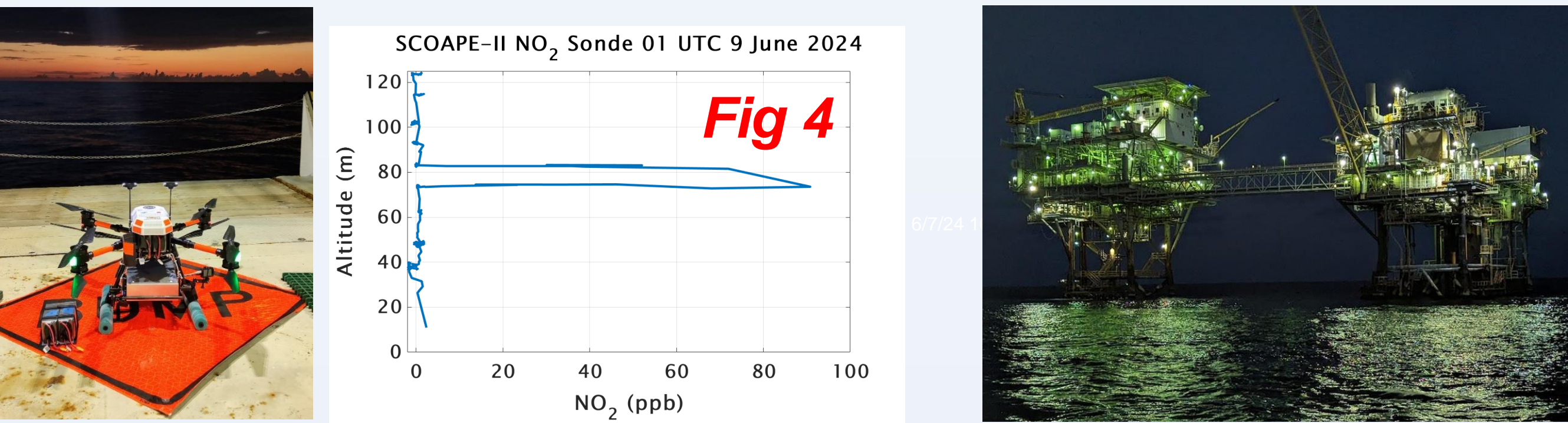
Figure 1. 2017 platform estimated NO_x emissions from BOEM’s GOM inventory. A total of 457 platforms are shown. The individually lower-emitting, shallow water platforms (blue colors) far outnumber the large, higher-emitting deep-water platforms (green to red colors)

Data needed to verify emissions inventories and understand GOM AQ and GHG impacts!

Measurement	Instrument	Source/Contributor
Continuous (1-sec) CH ₄ , CO ₂ , CO, H ₂ O	Picarro G-2301	L. Ott/GSFC Table 1
Continuous (1-sec) CH ₄ , HCHO, H ₂ O	Picarro G-2307	L. Ott/GSFC
Continuous (1-min) NO ₂	Teledyne API T500U	R. Stauffer/GSFC
Continuous (1-min) O ₃	Thermo 49i	R. Stauffer/GSFC
Column NO ₂ , O ₃ , HCHO	Pandora Spectrometer	T. Hanisco/GSFC
Vertical (UAS) NO ₂ profiles	GSFC-developed NO ₂ sonde	T. Hanisco, S. Bailey/GSFC
Balloon-borne ozonesondes	En-Sci, Internet radiosondes	R. Stauffer/GSFC
Aerosol backscatter profiles, mixed layer height	Lufft CHM-8k Ceilometer	R. Stauffer/GSFC
Dozens of VOC species	VOC canister samples	D. Blake/UCI
Aerosol Optical Depth	MicroTops-II Sunphotometer	A. Smirnov/GSFC
T, RH, p, winds, GPS location	RMYoung, Trimble ABX GPS	R/V Point Sur



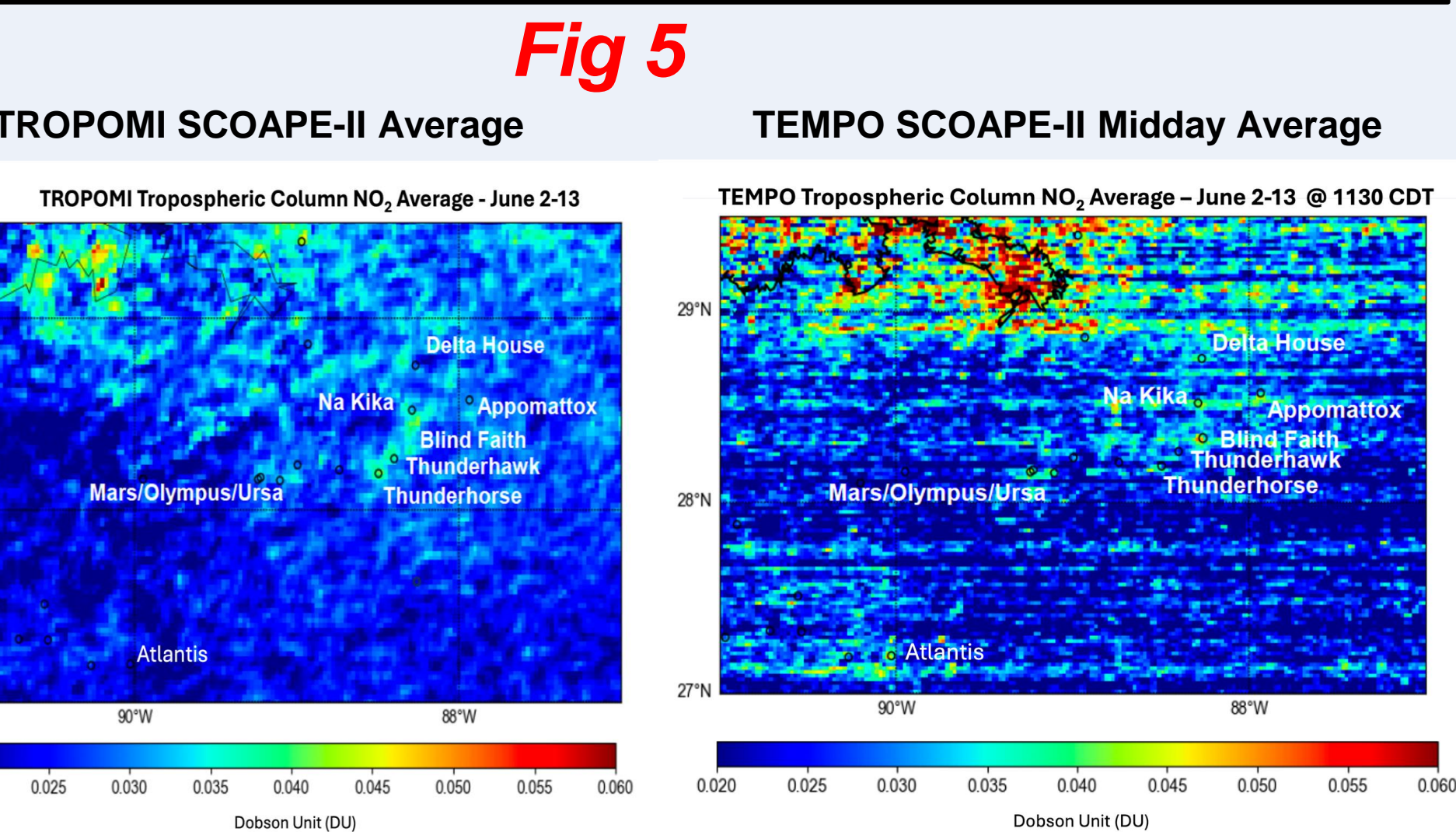
Vertical In-Situ NO₂ Profiles



Vertical NO₂ profiles were collected on a UAS platform (Left) with flights up to 200 m. Example shows NO₂ plume near platform 21897-1 (Right), up to 90 ppbv at 70 m (Figure 4). Vertical NO₂ profiles link satellite NO₂ data to “nose-level” pollution and AQ

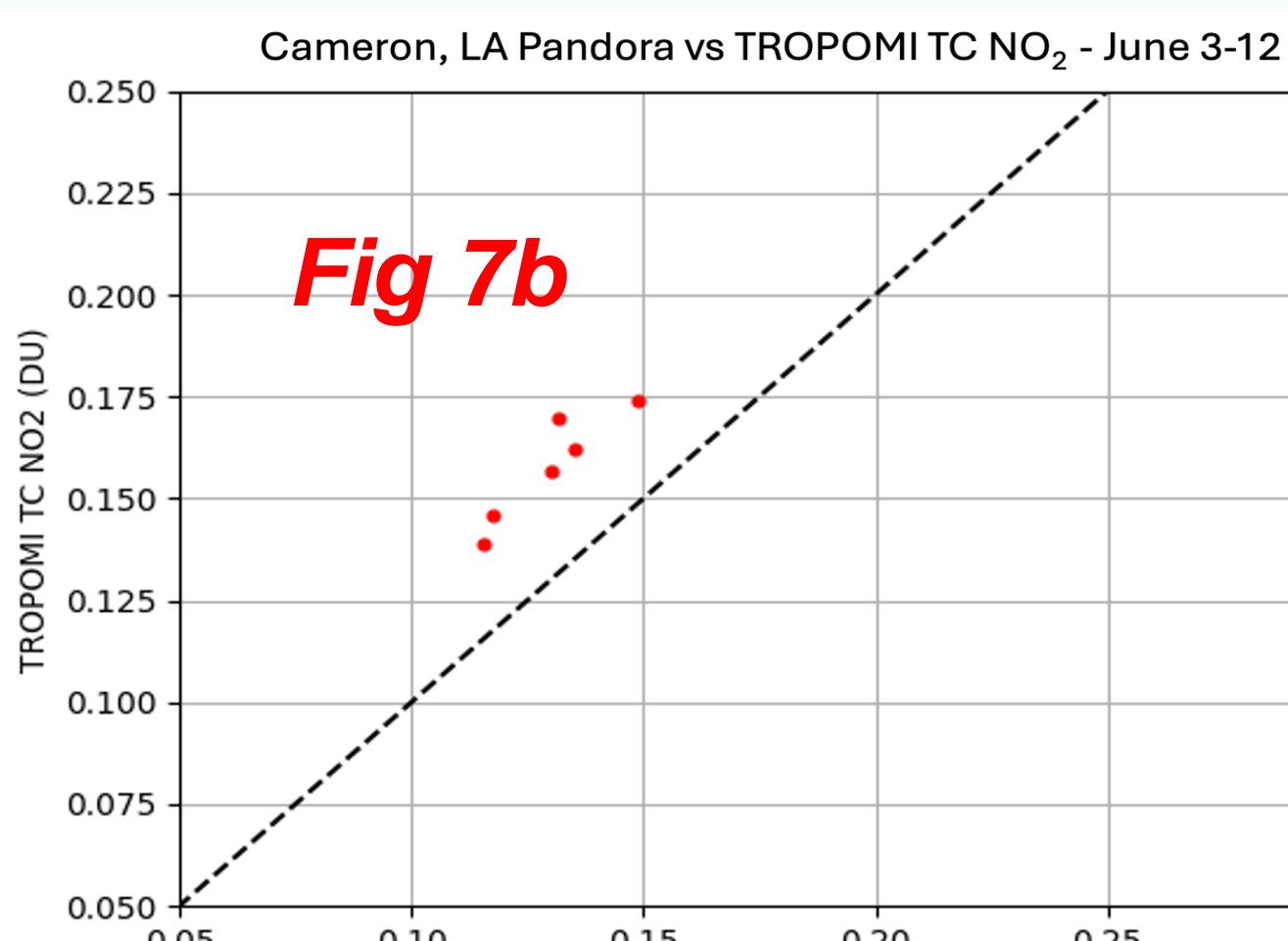
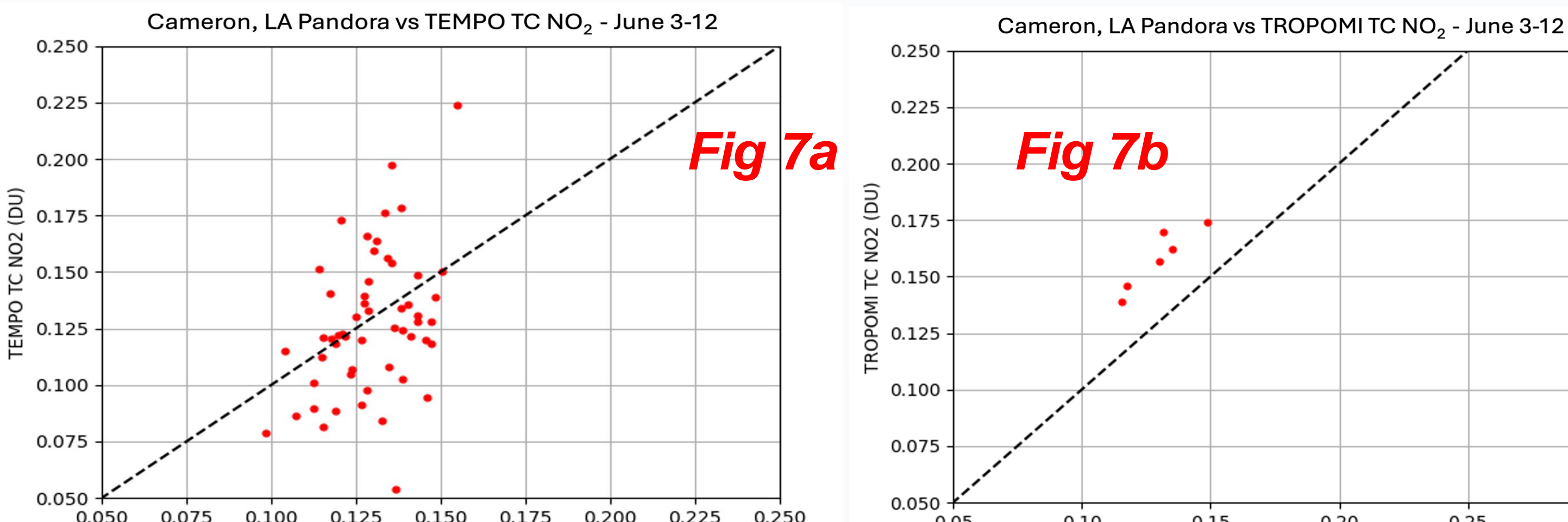
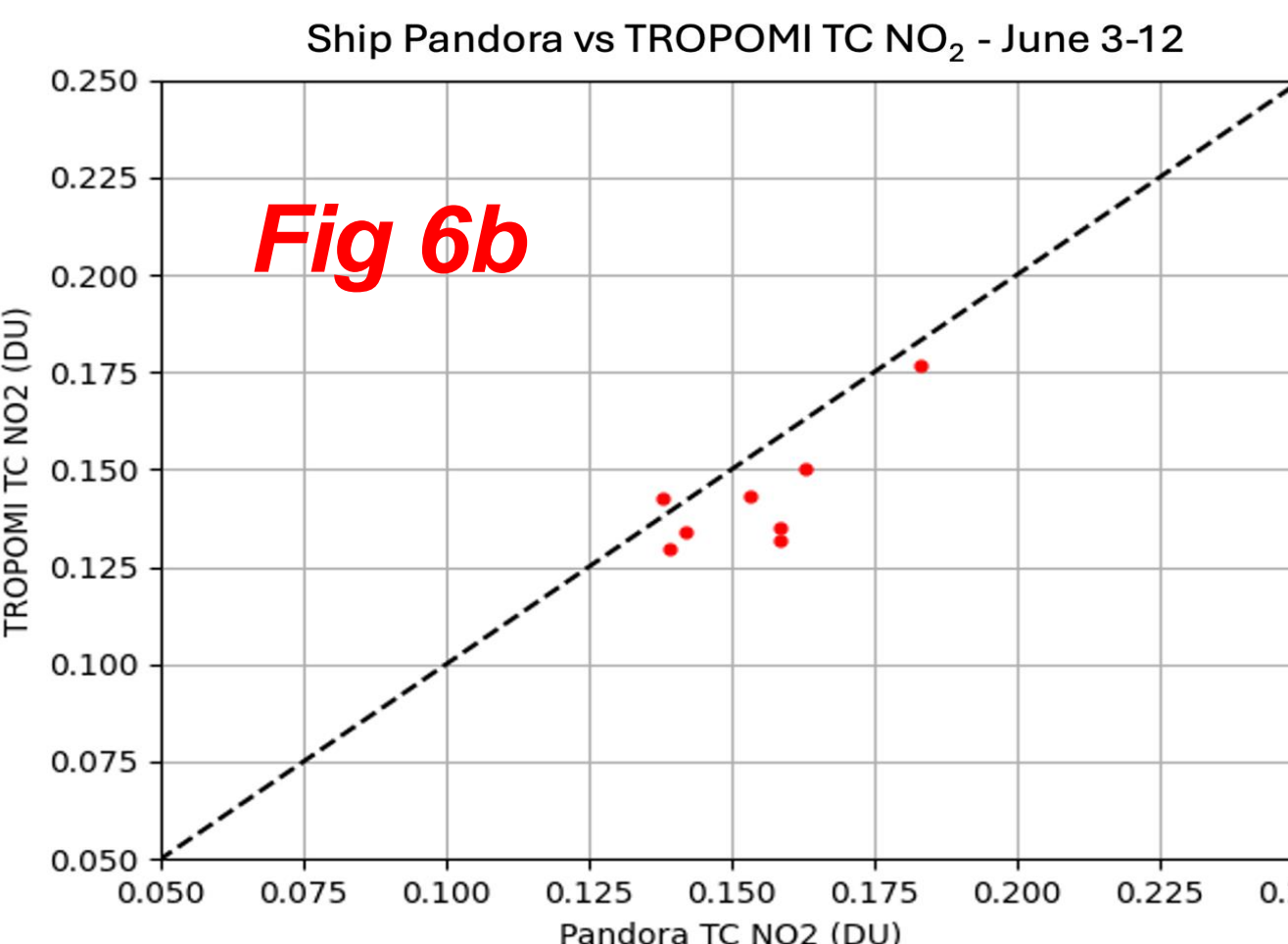
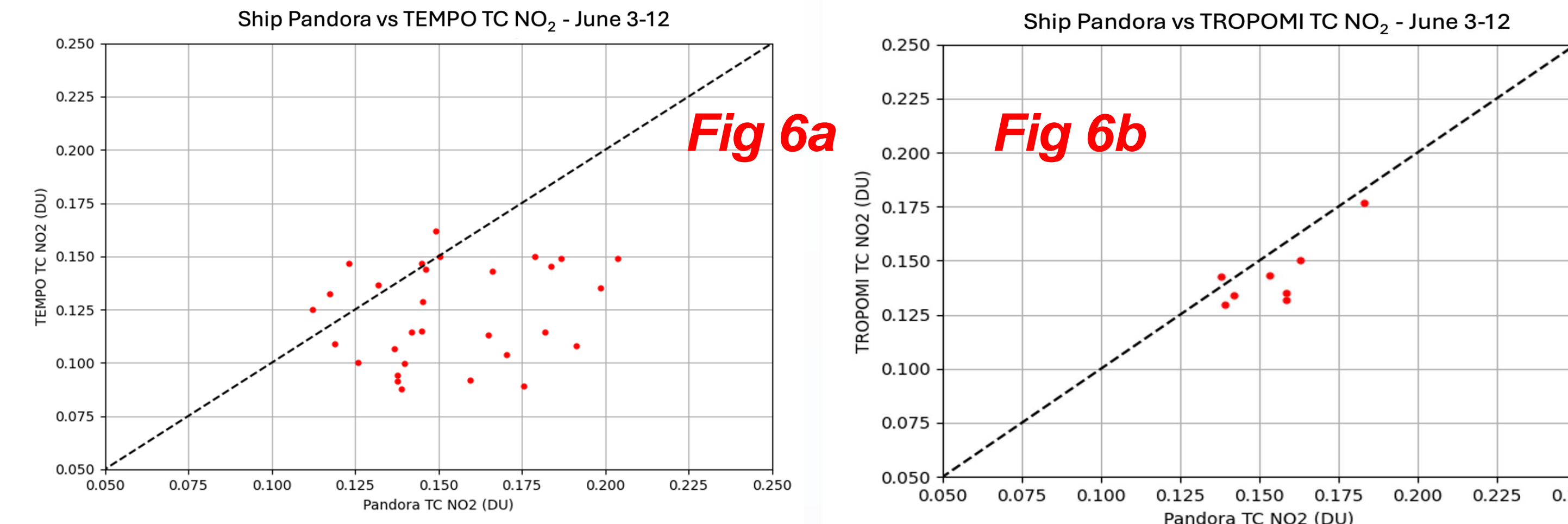
Satellite NO₂ Measurements: TROPOMI & Midday TEMPO

SCOAPE-II shipboard, in-situ Pandora columns of NO₂ are compared to TROPOMI and TEMPO NO₂ measurements during the campaign. TROPOMI (left) and TEMPO (right) tropospheric NO₂ columns for SCOAPE-II show ONG platform “hotspots” (e.g., Fedkin et al., 2024; Fig 5)



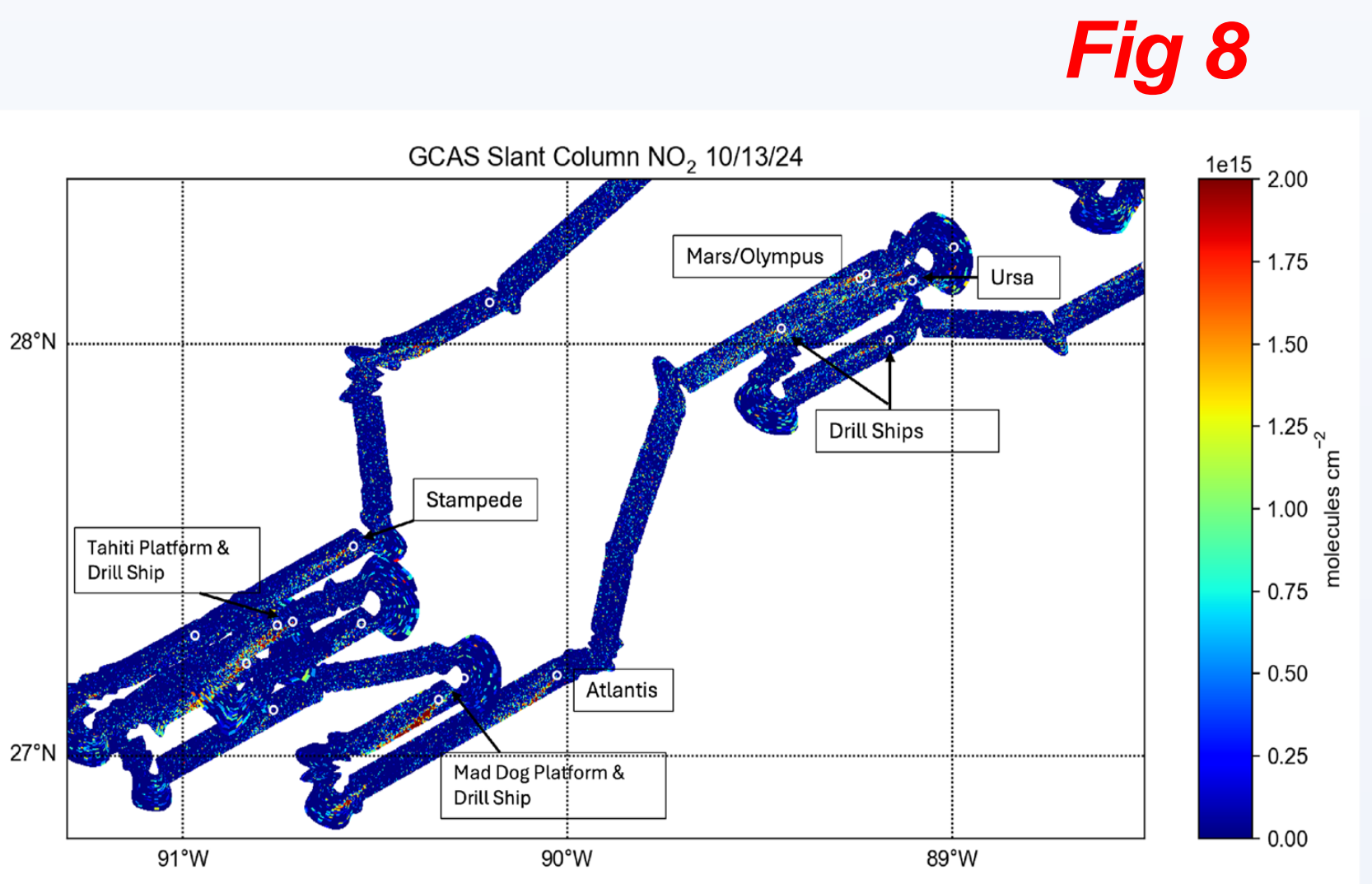
Pandora and Satellite NO₂ Comparisons

These comparisons are made midday, for the TROPOMI overpass NO₂ columns and for the 1130 Local Time TEMPO measurement. In Figure 6 overpass comparisons are illustrated with the R/V Point Sur (shipboard) Pandora NO₂ columns. Pandora readings are often 50% higher than TEMPO whereas TROPOMI and Pandora are very similar. In Figure 7 comparisons are made with a coastal Louisiana Pandora at Cameron, operated for BOEM. In both cases the TROPOMI correlations are better than those from TEMPO, for which algorithm optimization is still in progress.



SCOAPE-II Add-on (Oct. 2024 GCAS) and Data Availability

NASA/GSFC’s GEO-CAPE Airborne Simulator (GCAS) collected below-aircraft column NO₂ amounts during seven SCOAPE-II follow-on flights, 7-14 October 2024. Initial results (Figure 8) indicate that drill ships, which explore the Gulf to help install oil-producing platforms, are as large or larger emitters of NO₂ than the permanent platform locations. GCAS data will be compared to TEMPO & TROPOMI NO₂ measurements for the Oct. period, as well as June SCOAPE-II Pandora measurements.



SCOAPE-II “field” data are in the process of being archived. Final data are expected in December 2024 (or later for GCAS). May 2019 SCOAPE-I data are located at the same page! We plan to make SCOAPE-I/SCOAPE-II comparisons to determine if GOM AQ changed in the last 5 years. Scan QR code to visit the SCOAPE data archive →



Contact and Data Information, References

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We have a lot of data. Want to use it? Contact ryan.m.stauffer@nasa.gov, scan the QR code above! Also at AGU:
Poster Tuesday: Fedkin et al: Assessment of NO₂ Columns... A21I-1870
Talk Thursday: Stauffer et al: Ship, Satellite and Aircraft-based Views.... A42E-08
SCOAPE Publications:
Thompson et al., (2023), “Two Air Quality Regimes in Total Column NO₂ over the Gulf of Mexico in May 2019: Shipboard and Satellite Views”
<https://doi.org/10.1029/2022EA002473>
Fedkin et al., (2024), “Satellite NO₂ trends and hotspots over offshore oil and gas operations in the Gulf of Mexico”, Earth and Space Science, 11, e2023EA003165. <https://doi.org/10.1029/2023EA003165>
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