

## Environmental Studies Program: Studies Development Plan | FY 2022–2023

Title	Offshore Air Quality (AQ) from NASA’s Satellites and Related Experiments (NT-22-02)
Administered by	Headquarters
BOEM Contact(s)	Holli Wecht ( <a href="mailto:holli.ensz@boem.gov">holli.ensz@boem.gov</a> )
Procurement Type(s)	Inter-agency Agreement
Conducting Organization(s)	NASA Goddard Space Flight Center
Total BOEM Cost	TBD
Performance Period	FY 2022–2026
Final Report Due	TBD
Date Revised	March 14, 2021
PICOC Summary	
<i><u>Problem</u></i>	No air quality (AQ) monitors exist in the offshore areas of the Gulf of Mexico (GOM), Atlantic, or Pacific Regions to aid BOEM in the management of AQ impacts as required under the Outer Continental Shelf Lands Act (OCSLA) and/or the National Environmental Policy Act (NEPA).
<i><u>Intervention</u></i>	NASA’s measurements from SCOAPE-I & TROPOMI with TRACER-AQ Experiment data will support TEMPO satellite algorithm development. NASA will also provide nitrogen dioxide (NO <sub>2</sub> ) pollutant validation post-launch. These estimates will allow BOEM to potentially monitor and track offshore pollutants using the TEMPO satellite leading to better management of impacts in the future.
<i><u>Comparison</u></i>	NASA will compare NO <sub>2</sub> data in GOM during TRACER-AQ with TROPOMI & SCOAPE-I, followed by TEMPO validation to ensure accuracy of TEMPO data.
<i><u>Outcome</u></i>	NASA will provide BOEM a Standard Operating Procedure for use of TROPOMI and TEMPO data in their management of air quality pollutants.
<i><u>Context</u></i>	Development measurements are provided by SCOAPE-I and TRACER-AQ measurements using OMI and TROPOMI with prototype over the GOM. All satellite data will also be available in the Pacific and Atlantic Regions.

**BOEM Information Need(s):** BOEM has no air quality (AQ) monitors over the waters in the Gulf of Mexico (GOM), Atlantic, and Pacific Regions, making it difficult to measure and track pollutants, which may impact the air quality of states. Two of BOEM’s responsibilities under the Outer Continental Shelf Lands Act (OCSLA 1334(a)(8)) is to ensure activities authorized do not significantly impact the state’s air quality compliance with the National Ambient Air Quality Standards (NAAQS) in the GOM and to draft National Environmental Policy Act (NEPA) documents in the Atlantic and Pacific Regions assessing impacts from our authorized activities. Using NASA’s 2021 TRACER-AQ field measurements and the upcoming TEMPO (Tropospheric Emissions: Monitoring of Pollution) satellite mission’s hourly, high resolution pollutant data offshore, will allow BOEM to better manage air quality from energy resources, including oil and gas, renewables, and sand/gravel projects. This study would build on the previous NASA’s Satellite Coastal Oceanic and Atmospheric Pollution Experiment (SCOAPE) in 2019 in the GOM (Thompson 2020).

**Background:** A 3-year Interagency Agreement between BOEM and NASA’s Goddard Space Flight Center successfully addressed two questions:

1. Can satellite data be used to inform BOEM about AQ over the OCS (Outer Continental Shelf)?  
Yes, NASA provided examples of pollutants over GOM, including TROPOMI satellite NO<sub>2</sub>.
2. How accurate are the NO<sub>2</sub> satellite data over the GOM and Atlantic Regions? TROPOMI Total Column (TC) NO<sub>2</sub> satellite data agreed with both coastal and shipboard Pandora spectrometers that provided independent ground-truth. Under clean air conditions, satellite-Pandora agreement was 2-3%; for more polluted conditions, agreement was 15-20%.

**Objectives:**

1. The NO<sub>2</sub> impact of ONG emissions will be studied in TRACER-AQ with GCAS.
2. Prepare for TEMPO by developing a Standard Operating Procedure (SOP) for BOEM air subject matter experts to use for air management using OMI/TROPOMI satellite TROPNO<sub>2</sub> routinely over GOM OCS (publicly available data), then extending to Atlantic and Pacific coasts.
3. Optional: Post-TEMPO launch. Conduct a SCOAPE-II in central GOM, revisiting SCOAPE-I region with a dedicated oceanographic cruise during NASA aircraft operations to be conducted, as TRACER-AQ with GV and GCAS, possibly other platforms, e.g. NASA’s P-3B aircraft?
4. Optional: Add TEMPO sampling SOP for BOEM to TROPOMI SOP to monitor future air quality impacts of ONG.

**Methods:**

1. The NO<sub>2</sub> impact of ONG emissions will be studied in TRACER-AQ. Because the current GV aircraft sampling does not extend to the central GOM, NASA will augment the 2021 TRACER-AQ field measurements with 1-3 flights that (a) transect western and central GOM; (b) sample central GOM NO<sub>2</sub> with “racecar track” sampling over the SCOAPE-I region (blue line in Figure 1). Figure 1 also shows the annual average TROPOMI TROPNO<sub>2</sub> and platforms with greater than 250tpy of NO<sub>x</sub> emissions (Wilson 2019). The measurements also includes two permanently placed Pandoras to measure TC NO<sub>2</sub> in the coastal GOM.

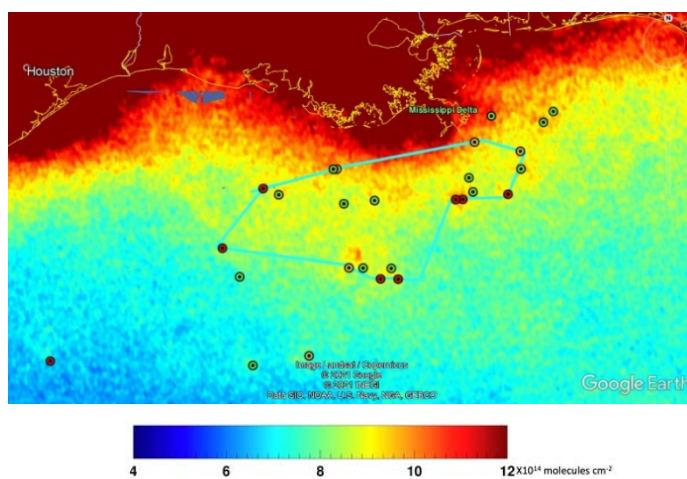


Figure 1: Using the Annual Average TROPOMI TROPNO<sub>2</sub> column NO<sub>2</sub> to determine the Draft G-V Flight Path

2. To prepare a SOP, a nominal sampling protocol will range from weekly to rolling 2-3-week averages. Assume Pandora spectrometers are aligned on GOM coast (have been deployed in Houston for several years); Pandoras are currently operating along mid-Atlantic coast from Long Island-NJ-MD-VA-NC.

**Specific Research Question(s):**

1. Although SCOAPE-I gave a snapshot of OCS AQ in May 2019, what is the distribution of TC NO<sub>2</sub> and tropospheric column (TROPC) NO<sub>2</sub> over the GOM year-round? NASA will develop a climatology for BOEM that discriminates land and ONG sources using TROPOMI satellite data.
2. How do TROPOMI and Pandora TC NO<sub>2</sub> measurements during NASA's 2021 TRACER-AQ aircraft and ground campaign in the Houston area and western GOM compare to SCOAPE-I measurements? BOEM will derive the answer from NASA's Gulfstream V (GV) aircraft operating a TROPC NO<sub>2</sub> instrument "GCAS" (GEOstationary Coastal and Air Pollution Events (GEO-CAPE) Airborne Simulator) during TRACER-AQ over ONG platforms near Houston and Galveston. GCAS will also evaluate TROPOMI and fly over a Pandora and *in-situ* NO<sub>2</sub> analyzer network operating in TRACER-AQ. A second remote sensor on the GV, the UV-Differential Absorption Lidar (UV-DIAL) will provide vertical profiles of ozone and aerosols to track plumes that are transported downwind from emissions sources.
3. How can SCOAPE-I and TRACER-AQ be linked when they are not in the same part of GOM? BOEM will support collection of NASAs GCAS TROPC NO<sub>2</sub> and UV-DIAL data over the central GOM (off Louisiana) by augmenting GV flights, re-sampling the SCOAPE-I region, thus connecting SCOAPE-I measurements to TRACER-AQ. This requires Pandora(s) along the Louisiana coast to further connect TRACER-AQ and SCOAPE-I and to prepare for the hourly air quality measurements from TEMPO.

**Current Status:** N/A

**Publications Completed:** N/A

**Affiliated WWW Sites:**

TRACER-AQ Mission Page: <https://www-air.larc.nasa.gov/missions/tracer-aq/index.html>

SCOAPE Mission Page: <https://www-air.larc.nasa.gov/missions/scoape/index.html>

NASA SCOAPE Technical Report: <https://ntrs.nasa.gov/citations/20205008618>

BOEM OCS Study 2019-072: [https://espis.boem.gov/final%20reports/BOEM\\_2019-072.pdf](https://espis.boem.gov/final%20reports/BOEM_2019-072.pdf)

**References:**

Demetillo MA, Navarro A, Knowles KK, Fields KP, Geddes JA, et al. 2020. Observing Nitrogen Dioxide Air Pollution Inequality Using High-Spatial-Resolution Remote Sensing Measurements in Houston, Texas. *Environmental Science & Technology*, 54 (16), 9882-9895, doi: 10.1021/acs.est.0c01864.

Duncan BN. 2020. NASA resources to monitor offshore and coastal air quality. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2020-046. 32 p.

Judd LM, Al-Saadi JA, Janz SJ, Kowalewski MG, Pierce RB, Szykman JJ, Valin LC, et al. 2019. Evaluating the impact of spatial resolution on tropospheric NO<sub>2</sub> column comparisons within urban areas using

high-resolution airborne data, *Atmos. Meas. Tech.*, 12, 6091–6111,  
<https://doi.org/10.5194/amt-12-6091-2019> .

Thompson AM. 2020. Evaluation of NASA's remote-sensing capabilities in coastal environments. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2020-047. 33 p.

Thompson AM, Stauffer RM, Boyle TP, Kollonige DE, Miyazak K, Tzortziou M, Herman JR, Jordan CN, Lamb BT. 2019. Comparison of near-surface NO<sub>2</sub> pollution with Pandora total column NO<sub>2</sub> during the Korea-United States Ocean Color (KORUS OC) campaign, *J. Geophys. Res.*, 124, doi: 10.1029/2019JD030765.

Thompson AM, Kollonige DE, Stauffer RM, Abuhassan N, Kotsakis AE, Swap RJ, Wecht HE. 2020. Satellite and shipboard views of air quality along the Louisiana coast: The 2019 SCOAPE (Satellite Coastal and Oceanic Atmospheric Pollution Experiment) cruise. *Environmental Manager [EM]*  
<http://pubs.awma.org/flip/EM-Oct-2020/thompson.pdf>.

Wilson D, Billings R, Chang R, Do B, Enoch S, Perex H, Sellers J. 2019. Year 2017 emissions inventory study. New Orleans (LA): US Department of Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2019-072. 231 p.