

## Environmental Studies Program: Ongoing Study

Field	Study Information
Title	NASA Aircraft Measurements in the Gulf of Mexico (GOM) (NT-23-02)
Administered by	Office of Environmental Programs
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Procurement Type(s)	Inter-agency Agreement (IAA)
Conducting Organization(s)	NASA
Total BOEM Cost	\$600,000
Performance Period	FY 2024–2027
Final Report Due	October, 2027
Date Revised	July 10, 2024
Problem	BOEM has been tasked with reducing greenhouse gas emissions, including methane (CH <sub>4</sub> ) and carbon dioxide (CO <sub>2</sub> ), from its authorized offshore energy activities. BOEM needs to identify facilities and emissions sources to target for potential rulemaking and reduction. BOEM has CH <sub>4</sub> and CO <sub>2</sub> emissions estimates in our emissions inventories, however these monthly emissions estimates are not based on measurement data, but on emissions factors (some based on information from the 1990s) and operational data. Having measured data, along with the emissions inventory data, will strengthen BOEM's justification for potential rulemaking. In addition, all measurement data (methane and other pollutants) will be used for satellite validation and to improve BOEM's emissions inventory.
Intervention	Conduct several AVIRIS-NG and GCAS measurement flight campaigns in the GOM to obtain CH <sub>4</sub> , CO <sub>2</sub> , and NO <sub>2</sub> data, plus provide a general analysis of the data (which facilities and sources are the highest emitters based on the measurement data and comparison to satellite data and emissions inventory).
Comparison	All measurement data can be compared with BOEM's satellite and emissions inventory data.
Outcome	Datasets with analysis showing the top facility and source emitters and comparisons to the satellite and emissions inventory.
Context	Gulf of Mexico

**BOEM Information Need(s):** The main need is pollutant measurement data in the GOM. The Airborne Visible/Infrared Imaging Spectrometer – Next Generation (AVIRIS-NG) instrument deployed on aircraft will provide BOEM measured CH<sub>4</sub> and CO<sub>2</sub> data for the GOM, which can increase BOEM's knowledge for future rulemaking and will also improve BOEM's bottom-up emissions inventory. The GCAS measurements deployed on aircraft will provide BOEM measured column NO<sub>2</sub> (CO<sub>2</sub> and NO<sub>2</sub> are co-emitted pollutants) data for the GOM, which can be used to evaluate the utility of the Tropospheric Emissions: Monitoring of Pollution (TEMPO) satellite instrument (launched in April 2023) for continued

measured emissions assessments and improvement of the emissions inventory, which is shared with the U.S. Environmental Protection Agency (EPA) for the National Emissions Inventory.

**Background:** BOEM has been tasked with reducing greenhouse gas emissions, including CH<sub>4</sub> and CO<sub>2</sub>, in Executive Orders 14008 (“Tackling the Climate Crisis at Home and Abroad”) issued January 27, 2021 and Secretary’s Order 3399 (“Department-Wide Approach to the Climate Crisis and Restoring Transparency and Integrity to the Decision-Making Process”) issued April 16, 2021. BOEM needs to identify facilities and emissions sources to target for potential rulemaking and reduction. BOEM has emissions estimates in our emissions inventories (Gulfwide Offshore Activity Data System and OCS AQS) however these monthly emissions estimates are not based on measurement data but on emissions factors and operational data. Having measured data, along with the emissions inventory estimates, will only strengthen BOEM’s justification for potential rulemaking as well as using the measurement data for making improvements to the emissions inventories.

The AVIRIS-NG instrument, using advanced remote sensing technology, deployed on aircraft will measure CH<sub>4</sub> and CO<sub>2</sub> data ([AVIRIS-Next Generation \(nasa.gov\)](https://www.nasa.gov/aviris-next-generation)). Infrared imaging spectroscopy offers the ability to pinpoint, quantify and track high-emission CH<sub>4</sub> and CO<sub>2</sub> point sources at the scale of individual facilities.

The NASA TEMPO satellite will take hourly measurements of atmospheric gases — including ozone, nitrogen dioxide and formaldehyde as well as aerosols — across North America and provide air quality products that will be made publicly available and help improve air quality forecasting. It was successfully launched in April 2023. There are several campaigns to validate the satellite onshore, but no scheduled offshore studies. NASA will conduct flights in the GOM with their Johnson Space Center Gulfstream-V (GV) aircraft to measure column nitrogen dioxide (NO<sub>2</sub>) with the GEOCAPE Airborne Simulator (GCAS). This opportunity would leverage the airborne payload of NASA’s Synergistic TEMPO Air Quality Science mission in summer 2023. This data can be utilized to validate the TEMPO satellite data, improve BOEM’s emissions inventories, and evaluate methods for using TEMPO data to monitor offshore emissions beyond the timeline of this study.

In addition, all measurement campaigns should be coordinated temporally with the BOEM study’s NASA SCOAPE II cruise (summer 2024), after the TEMPO satellite launch so that BOEM will have a valuable emission (CH<sub>4</sub>, column NO<sub>2</sub>, etc.) dataset of both aircraft and vessel measurement data and satellite data. Lastly, BOEM will also seek volunteer coordination with the Offshore Operators Committee to get hourly operational data of the facilities sampled so that there can be a direct comparison of all the CH<sub>4</sub> and CO<sub>2</sub> datasets. Additionally, temporally-coordinated aircraft measurements of CO<sub>2</sub> and NO<sub>2</sub> can be used to estimate emissions factors from facilities, enabling estimates of CO<sub>2</sub> emissions from TEMPO NO<sub>2</sub> data, as NO<sub>2</sub> is measured from satellite far more frequently and at better spatial resolution than CO<sub>2</sub>. These datasets will be used for potential proposed rulemaking and in the proposed FY24 Improving BOEM’s Bottom-Up (BU) Emissions Inventory study profile to improve the current BU emissions inventory.

#### **Objectives:**

- Collect measured CH<sub>4</sub> and CO<sub>2</sub> data in the GOM to identify top facility and source emitters. These sources may fall under BOEM, BSEE, EPA/USCG, or Department of Transportation regulatory authority.

- Collect measured column NO<sub>2</sub> data in the GOM to improve the emissions inventory data and validate TEMPO satellite data.

**Methods:**

1. Conduct flight campaigns in the GOM in coordination with the NASA's SCOAPE II cruise, satellite data and BOEM's voluntary efforts with operators (if possible) with the Johnson Space Center Gulfstream-V (GV) aircraft to measure CH<sub>4</sub> and CO<sub>2</sub> with AVIRIS-NG, and column NO<sub>2</sub> with the GEOCAPE Airborne Simulator (GCAS).
2. Conduct basic analysis of the AVIRIS-NG data identifying top facility and source emitters.
3. Conduct analysis of the column NO<sub>2</sub> data comparing with the TEMPO satellite and identifying top facility and source emitters and suggestions for improvement of the emissions inventory.

**Specific Research Question(s):**

1. Based on the AVIRIS-NG data, what are the top facility and source emitters for CH<sub>4</sub> and CO<sub>2</sub>?
2. Do the top facility and source emitters from the measured CH<sub>4</sub> and CO<sub>2</sub> data match the emissions inventory top facility and source emitters?
3. Are there commonalities among the emitters, such as age or production volume?
4. How does the offshore column NO<sub>2</sub> data compare with the newly launched TEMPO satellite data?
5. Do CO<sub>2</sub> and NO<sub>2</sub>, which are co-emitted by combustion processes, compare well enough for satellite NO<sub>2</sub> data to expand emissions studies beyond airborne measurements?

**Current Status:** The Satellite Coastal Oceanic and Atmospheric Pollution Experiment- Part 2 (SCOAPE-II) campaign was conducted June 2–12, 2024 in the GOM. The campaign included the taking of aircraft methane measurements using the AVIRIS III instrument. This study is part of a larger effort including an interagency agreement with NASA "Offshore Air Quality (AQ) from NASA's Satellites and Related Experiments" (NT-22-02) which is the vessel part of the SCOAPE-II measurements.

**Publications Completed:** None

**Affiliated WWW Sites:**

<https://avirisng.jpl.nasa.gov/>

<https://tempo.si.edu/>

**References:**

Nowlan C, Liu X, Janz S, Kowalewski M, Chance K, Follette-Cook MB, Fried A, Abad GG, Herman JR, Judd L, et al. 2018. Nitrogen dioxide and formaldehyde measurements from the GEOstationary Coastal and Air Pollution Events (GEO-CAPE) airborne simulator over Houston, Texas. *Atmos. Meas. Tech.* 11:5941–5964. doi:10.5194/amt-11-5941-2018.