Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Carbon Mapper and Air 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) (under FY22 National Aeronautics and Space Administration [NASA] IAA, but a separate order)
Conducting Organization(s)	NASA
Total BOEM Cost	TBD
Performance Period	FY 2023–2026
Final Report Due	TBD
Date Revised	February 9, 2022
PICOC Summary	
Problem	BOEM has been tasked with reducing greenhouse gas emissions, including methane (CH_4) and carbon dioxide (CO_2), from its authorized offshore energy activities. BOEM needs to identify facilities and emissions sources to target for potential rulemaking and reduction. BOEM has CH_4 and CO_2 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 offshore satellite validation and to improve BOEM's emissions inventory.
Intervention	Conduct several Carbon Mapper measurement flight campaigns in the GOM to obtain CH_4 and CO_2 data, conduct several flight campaigns measuring column NO_2 with the GCAS and continuous vertical profiles of ozone and aerosols with the High Spectral Resolution Lidar-2 (HSRL2), 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	GOM

BOEM Information Need(s): The main need is pollutant measurement data in the GOM. The Carbon Mapper instrument deployed on aircraft will provide BOEM measured CH_4 and CO_2 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_2 (CO_2 and NO_2 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

(launching in January 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_4 and CO_2, 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 Carbon Mapper instrument, using advanced remote sensing technology, deployed on aircraft will measure CH_4 and CO_2 data (https://carbonmapper.org/). Carbon Mapper is both a nonprofit organization and a program to monitor and help accelerate reductions in global CH_4 and CO_2 emissions. Infrared imaging spectroscopy offers the ability to pinpoint, quantify and track high-emission CH_4 and CO_2 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 is scheduled to be launched in early 2023. There are several campaigns to validate the satellite onshore, but no scheduled offshore studies. NASA will conduct airflights in the GOM with their Johnson Space Center Gulfstream-V (GV) aircraft to measure column nitrogen dioxide (NO_2) with the GEOCAPE Airborne Simulator (GCAS) and continuous vertical profiles of ozone and aerosols with the High Spectral Resolution Lidar-2 (HSRL2). 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 (2023), after the TEMPO satellite launch (early 2023) so that BOEM will have a valuable emission (CH_4, column NO_2, 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_4 and CO_2 datasets. Additionally, temporally-coordinated aircraft measurements of CO_2 and NO_2 can be used to estimate emissions factors from facilities, enabling estimates of CO_2 emissions from TEMPO NO_2 data, as NO_2 is measured from satellite far more frequently and at better spatial resolution than CO_2. These datasets will be used for proposed rulemaking and in the proposed FY24 Improving BOEM's Bottom-Up (BU) Emissions Inventory study profile to improve the current BU emissions inventory.

This study would tie-into the proposed study profile mentioned above and the Department of Energy Argonne IAA and would utilize the FY22 NASA IAA as a vehicle to purchase the Carbon Mapper and measurement data (as a separate order under the over-arching IAA).

Objectives:

- Collect measured CH_4 and CO_2 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_2 data in the GOM to improve the emissions inventory data and validate TEMPO satellite data.

Methods:

1. Conduct Carbon Mapper flight campaigns in the GOM in coordination with NASA's SCOAPE II cruise, satellite data and BOEM's voluntary efforts with operators (if possible).
2. Conduct flight campaigns in the GOM in coordination with the NASA's SCOAPE II cruise with their Johnson Space Center Gulfstream-V (GV) aircraft to measure column NO_2 with the GEOCAPE Airborne Simulator (GCAS) and continuous vertical profiles of ozone and aerosols with the High Spectral Resolution Lidar-2 (HSRL2).
3. Conduct basic analysis of the Carbon Mapper data identifying top facility and source emitters.
4. Conduct analysis of the column NO_2 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 Carbon Mapper data, what are the top facility and source emitters for CH_4 and CO_2?
2. Do the top facility and source emitters from the measured CH_4 and CO_2 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_2 data compare with the newly launched TEMPO satellite data?
5. Do CO_2 and NO_2, which are co-emitted by combustion processes, compare well enough for satellite NO_2 data to expand emissions studies beyond airborne measurements?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: https://carbonmapper.org/

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.