Field	Study Information
Title	Monitoring Air Quality in the Gulf of America Coastal Region (GR-26-02)
Administered by	New Orleans Office
BOEM Contact(s)	Stacie Merritt (stacie.merritt@boem.gov)
Procurement Type(s)	Contract
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2026–2031
Final Report Due	TBD
Date Revised	April 15, 2026
Problem	Available monitoring data is insufficient to fully characterize baseline concentrations of criteria air pollutants and their precursors along the Gulf of America shoreline, and existing monitoring networks were not designed to support attribution of observed concentrations to specific source categories relevant to Outer Continental Shelf (OCS) regulatory analyses.
Intervention	Criteria air pollutant concentrations, their precursors, and a suite of source-attribution tracer measurements will be collected continuously at a designated coastal site using BOEM's mobile monitoring station, supplemented by instruments for sulfur dioxide, methane and ethane with stable carbon isotope ratios ($\delta^{13}C\text{-}CH_4$), and black carbon.
Comparison	Measured concentrations of criteria air pollutants will be compared to the National Ambient Air Quality Standards (NAAQS) to aid in understanding baseline air quality conditions. Source apportionment findings derived from the tracer suite will be compared to source attribution results from the prior Gulf of America coastal ambient air quality monitoring pilot study to assess consistency, refinement, or revision of earlier conclusions.
Outcome	Measured concentrations of criteria air pollutants will be used to characterize baseline air quality conditions along the Gulf of America coastline and will be evaluated relative to the NAAQS, including design value calculations where data completeness permits.
Context	Gulf of America

BOEM Information Need(s): BOEM is required to evaluate whether activities authorized under the Outer Continental Shelf Lands Act (OCSLA) are consistent with the NAAQS, as established under the Clean Air Act (CAA), where such activities may significantly affect the air quality of any state. Data collected through this study will improve BOEM's ability to characterize baseline coastal air quality conditions and support environmental analyses conducted under National Environmental Policy Act (NEPA). Characterizing baseline concentrations alone is insufficient for OCS-specific analyses if the contributions of offshore versus onshore sources cannot be distinguished.

Background: The NAAQS establish limits for six criteria air pollutants: carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), particulate matter (PM), and sulfur dioxide (SO_2), which are known to be harmful to public health. Under OCSLA, BOEM is required to evaluate whether activities it authorizes may significantly affect the air quality of any state and are consistent with the NAAQS. To support these responsibilities, BOEM relies on accurate characterization of baseline coastal air quality conditions to reduce uncertainty in air quality analyses and support efficient, defensible decision-making.

Existing air quality monitoring along the Gulf of America shoreline is limited and largely concentrated near major highways or industrial facilities. As documented in Louisiana's 2023 Annual Monitoring Network Plan (LDEQ 2023), many coastal monitoring sites are designed to evaluate emissions from onshore industrial sources rather than to characterize broader coastal or offshore-influenced air quality conditions. This limits the usefulness of existing monitoring data for evaluating air quality impacts associated with activities permitted under OCSLA and contributes to uncertainty in project-level air quality analyses conducted under NEPA.

The Gulf coastal zone is characterized by multiple overlapping emission source categories, including offshore oil and gas operations, onshore petrochemical and refining facilities, marine vessel traffic, urban mobile sources, and biogenic methane from coastal wetlands. Measurements of criteria pollutants alone cannot distinguish among these contributions. Source attribution has traditionally relied on speciated volatile organic compound (VOC) measurements, which provide detailed chemical fingerprints capable of separating emissions from natural gas, petrochemical, mobile, and biogenic sources. However, continuous speciated VOC monitoring is prohibitively expensive for a multi-year single-site study, requiring laboratory-grade instrumentation, multi-component calibration standards, and intensive on-site maintenance that would consume the entire projected budget for this study on its own. This study instead employs a targeted tracer suite - ethane as a marker of thermogenic natural gas activity, the methane-to-ethane ratio to distinguish biogenic from thermogenic methane sources, the stable carbon isotope ratio of methane ($\delta^{13}C\text{-}CH_4$) to separate thermogenic, biogenic, and combustion signatures, black carbon to distinguish combustion sources from non-combustion fugitive emissions, and sulfur dioxide as an indicator of high-sulfur combustion sources - that together provide robust source discrimination for the dominant Gulf coast source categories using commercially available instruments with modest operational overhead.

Photochemical modeling studies have identified episodes of elevated ozone concentrations in the Gulf of America region, including offshore areas. Wilson et al. (2019) estimated that offshore oil and gas sources contributed approximately 43 percent (30.1 ppb) of the modeled 8-hour ozone NAAQS during certain high-ozone episodes. However, a subsequent review by the National Academies of Sciences, Engineering, and Medicine (NAS 2019) identified key gaps in that modeling study, including wind speed bias, inadequate representation of sea breeze circulation and planetary boundary layer dynamics, and insufficient treatment of offshore-to-onshore transport processes. The ground-based monitoring data collected through this study will support evaluation of those modeling gaps and improve confidence in future photochemical modeling analyses used to support BOEM permitting and NEPA review decisions.

BOEM currently owns and has previously operated a mobile air monitoring station equipped with trace-level analyzers capable of measuring criteria air pollutants and their precursors. Strategic deployment of this existing mobile platform along the Gulf Coast, at a location providing geographic coverage beyond the prior pilot study area, provides a cost-effective approach to addressing identified data gaps without the need for permanent monitoring infrastructure or additional long-term capital investment. Data

collected through this effort will directly inform air quality modeling inputs used in project-level analyses, improving accuracy and supporting more timely and defensible decisions.

In addition to ground-based monitoring, satellite instruments such as TEMPO and TROPOMI provide valuable atmospheric chemistry observations. However, satellite-based measurements primarily represent column-integrated concentrations and cannot directly discern ambient surface-level concentrations. BOEM's mobile monitoring station is equipped with a Pandora spectrometer capable of measuring total column trace gases alongside surface concentrations, enabling direct comparison between satellite-derived and ground-based observations. Such comparisons have been shown to improve interpretation of satellite data and reduce uncertainty in coastal and nearshore environments (e.g., Thompson et al. 2023). BOEM maintains an active interagency agreement with the National Aeronautics and Space Administration (NASA) to support evaluation and validation of TEMPO and TROPOMI data products, and this study complements those efforts by integrating ground-based monitoring with satellite observations and existing EPA data systems.

Objective(s): This study seeks to address current limitations in characterizing baseline coastal air quality conditions by incorporating source-attribution tracer measurements that enable partitioning of observed concentrations by source category, directly supporting project-level air quality analyses conducted under OCSLA and NEPA.

Methods: This study leverages BOEM's existing mobile air monitoring station, constructed and funded through prior study efforts, to efficiently address identified gaps in coastal air quality data without the need for new permanent infrastructure. The station will be deployed at a coastal site along the Gulf of America, in a different geographic area than the prior pilot study to extend baseline coverage, in a location less influenced by emissions from major highways or onshore industrial sources, improving the representativeness of collected measurements for offshore-related analyses.

The mobile monitoring station continuously measures trace-level concentrations of key criteria air pollutants and their precursors. CO is measured using infrared absorption, nitrogen oxides (NO_x) by chemiluminescence, NO_2 via chemiluminescence with a photolytic converter, O_3 through ultraviolet absorption, total reactive nitrogen (NO_y) using chemiluminescence with a heated molybdenum converter, and the photolysis rate of nitrogen dioxide (jNO_2) using a filter radiometer. In addition, Pandora spectrometer measures total column NO_2, O_3, and formaldehyde collocated with the surface measurements.

Three additional instruments will be integrated into the station to support source attribution: a trace-level sulfur dioxide analyzer using pulsed fluorescence; a continuous methane, ethane, and methane carbon isotope analyzer ($\delta^{13}C\text{-}CH_4$) based on cavity ring-down spectroscopy, providing simultaneous real-time measurement of CH_4 mixing ratio, C_2H_6 mixing ratio, the CH_4:C_2H_6 ratio, and $\delta^{13}C\text{-}CH_4$; and a continuous black carbon monitor using filter-based aethalometry or multi-angle absorption photometry. Together these instruments enable continuous, automated source attribution without the operational burden of speciated VOC monitoring.

Meteorological measurements include three-dimensional wind speed and direction using an ultrasonic anemometer, relative humidity, barometric pressure, precipitation, and differential temperature at both 2- and 10-meter heights. These data support interpretation of pollutant variability, transport patterns, and atmospheric mixing conditions.

All ambient air quality data will be submitted to U.S. Environmental Protection Agency's (EPA) Air Quality System (AQS) and total column data will be archived to NASA's Pandonia Global Network. Source apportionment analysis will use the tracer suite alongside the criteria pollutant and meteorological data to partition contributions from offshore oil and gas operations, marine vessel traffic, onshore industrial activity, and biogenic sources, using bivariate polar plots, wind rose analysis, diurnal and seasonal decomposition, and receptor modeling techniques including Conditional Probability Function, Potential Source Contribution Function, or Concentration-Weighted Trajectory analysis. The Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model will be used to evaluate air mass transport patterns associated with periods of low and elevated pollutant concentrations, supporting assessment of onshore versus offshore flow regimes and identification of contributing source regions.

If funding is available, additional analyses will include evaluation of ground-based Pandora total column measurements against TEMPO and TROPOMI satellite-derived observations, evaluation of meteorological and photochemical model outputs against the monitoring site observations with specific attention to the gaps identified by NAS (2019), and assessment of the role of land-sea breeze recirculation in coastal ozone formation using the surface and column measurements together with the source-attribution tracer dataset.

Specific Research Question(s):

1. What meteorological and transport factors influence variability in observed pollutant concentrations at coastal monitoring locations?
2. How do measured concentrations of criteria air pollutants compare to the NAAQS when used as a reference for describing baseline conditions?
3. During periods of low and elevated pollutant concentrations, what air mass transport patterns are observed, and to what extent are these conditions associated with onshore versus offshore flow, as evaluated using the HYSPLIT model?
4. Using ethane, the methane-to-ethane ratio, stable carbon isotope ratios of methane ($\delta^{13}C\text{-}CH_4$), black carbon, and sulfur dioxide as source-attribution tracers, what are the relative contributions of offshore oil and gas operations, marine vessel traffic, onshore industrial activity, and biogenic sources to observed methane and criteria pollutant concentrations at the coastal monitoring site?
5. How do source apportionment findings from this study compare to results from the prior Gulf of America coastal ambient air quality monitoring pilot study, and what do any differences suggest about temporal variability, geographic influences, or methodological refinement?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

2023 Louisiana Annual Monitoring Network Plan. Louisiana Department of Environmental Quality Office of Environmental Assessment Air Planning and Assessment Division. Accessed February 13, 2025. Internet website:

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