BOEM BUREAU OF OCEAN ENERGY MANAGEMENT

Evaluation of OCS AQS and Development of a Satellite-based Top-down Emissions Inversion System

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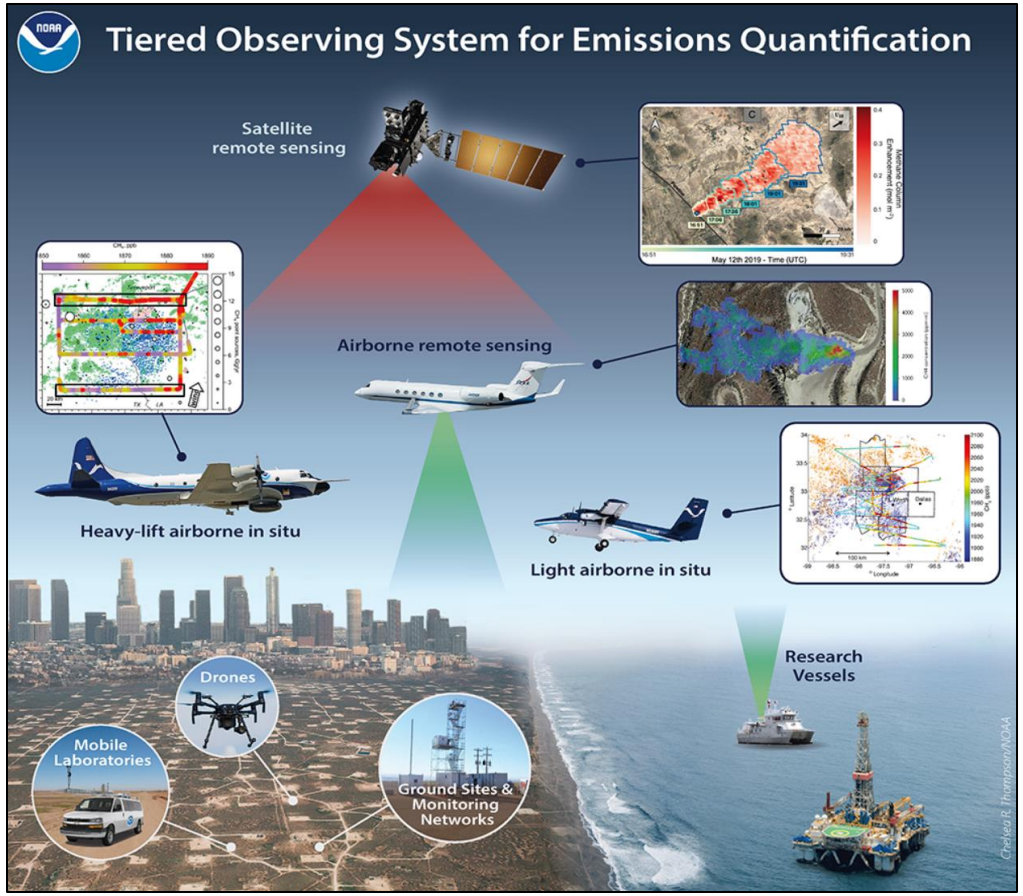
Background

- Previous studies have highlighted uncertainties in BOEM's Outer Continental Shelf Air Quality System (OCS AQS) inventory for the Gulf of Mexico Region (Gorchov-Negron and others, 2023).
- Bottom-up emission estimates -
  - BOEM's OCS AQS inventory
  - Use information gained from previous campaigns invested in by BOEM (e.g., SCOAPE I and II research cruise)
- Top-down emission estimates -
  - Comprehensive airborne surveys, measuring multiple pollutants, to evaluate BOEM's OCS AQS inventory on a basin-wide scale and quantifying the associated uncertainties. However, these campaigns are costly to be repeated.
  - High-resolution satellite technologies offer a more practical mean of continuous long-term monitoring of air pollutants
  - Can be used to derive regional emission fluxes through techniques such as inverse modeling.
- NOAA is planning to lead a series of airborne campaigns in 2024–2026 and can be extended to the Gulf of Mexico.

Top-down

Bottom-up



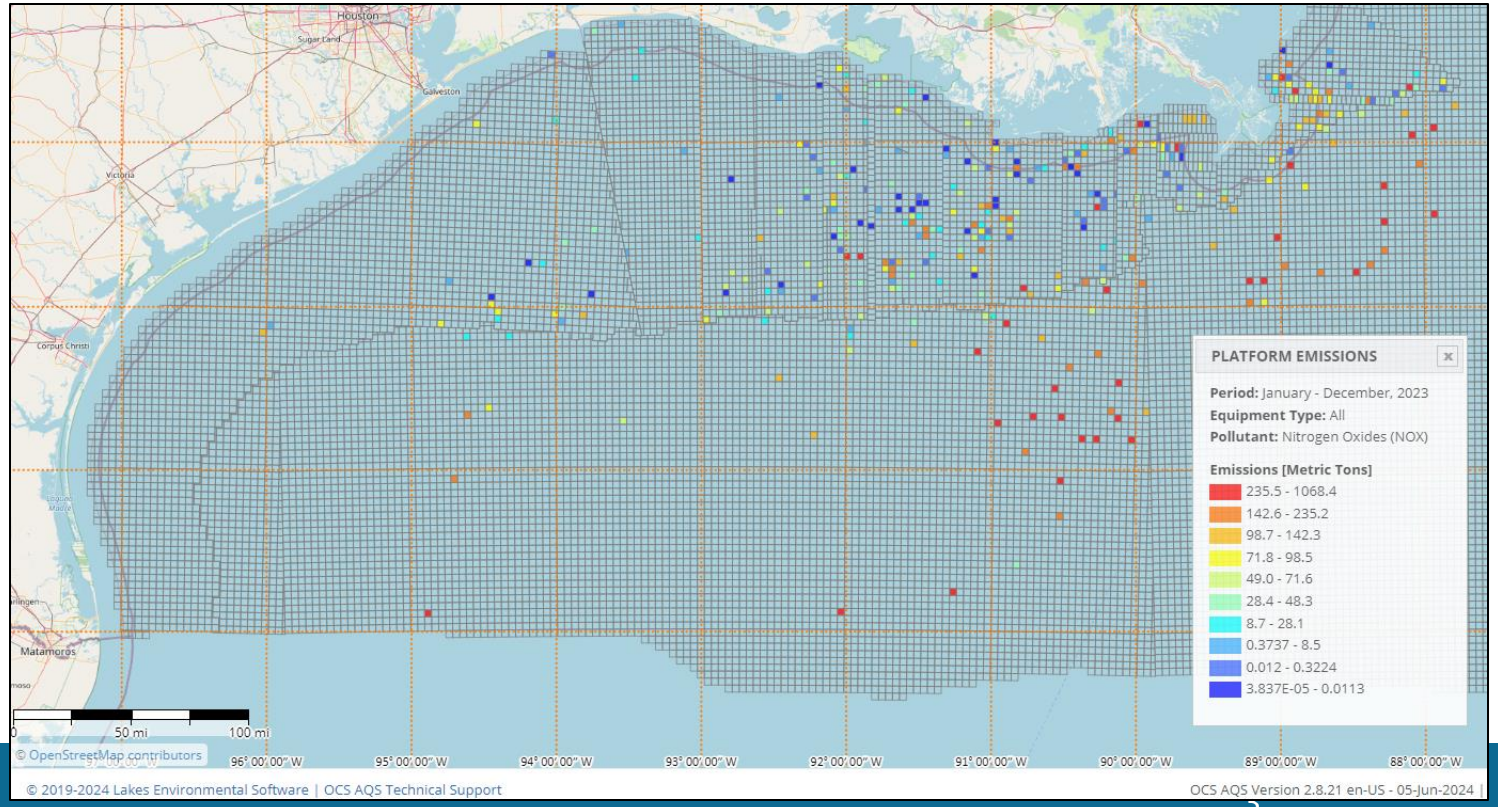
https://csl.noaa.gov/projects/airmaps/about/system.html#:~:text=Schematic%20of%20a%20tiered%20observing,Adapted%20from%20McDonald%202023.

AirMAPS supports the 2023 White House National Strategy to Advance an Integrated U.S. Greenhouse Gas Measurement, Monitoring, and Information System (GHG MMIS) by demonstrating the use and value of tiered, integrated satellite, airborne and ground-based greenhouse gas (GHG) observing system.

BOEM Information Need

- Accurate emissions inventory is critical to properly assess the impact of BOEM authorized oil and gas activities on air quality and climate.
- Oil- and gas-related activities authorized under the Outer Continental Shelf Lands Act (OCSLA) must comply with the National Ambient Air Quality Standards (NAAQS).
- This study supports BOEM's ability to monitor air emissions over the OCS and improve quantification approaches.

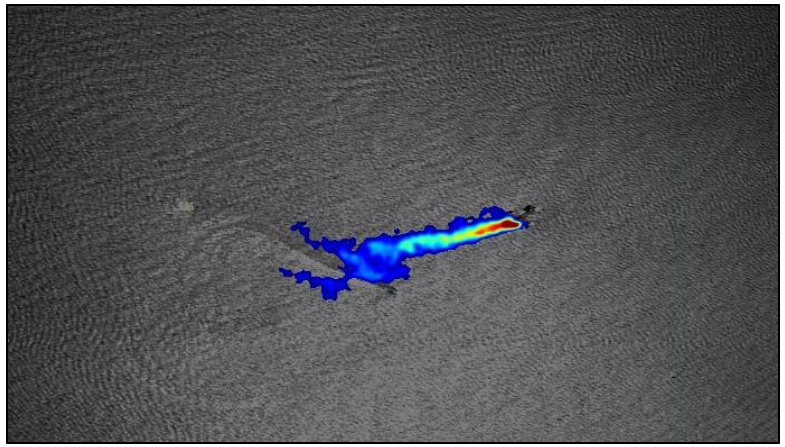
BOEM's Emission Inventory Tool



Study Objectives

1) **Conduct a comprehensive aircraft campaign to measure multiple air pollutant concentrations in 2026 to estimate basin-wide (top-down) emissions fluxes from Gulf of Mexico oil and gas activities.**
   - NOAA in-kind contributions will include facility-scale measurements.
2) **Compare BOEM's OCS AQS bottom-up emissions inventory to the top-down atmospheric measurement-based estimates of basin-wide emissions fluxes to assess its accuracy.**
3) **Develop an inverse modeling system to derive basin-wide emissions flux estimates of selected air pollutants from satellite data.**
   - Verify these satellite-based estimates with the aircraft-derived emissions fluxes described in (1) to assess the uncertainty and potential of using satellite data for long-term, continuous monitoring of trends and regional emissions fluxes in the GOM to complement the OCS AQS bottom-up inventory.

SCOAPE II Research Cruise - June 2024
Flaring (top) and aircraft CH4 measurements (bottom)



Methods

1) **NOAA airborne campaign in 2026:**
   - NOAA WP-3 aircraft to measure greenhouse gases (GHGs) and co-emitted pollutants in the GOM to provide quantitative top-down emissions data for methane, other GHGs, and major air pollutants from oil and gas activities at basin scale.
   - A mass balance approach will be used to estimate emissions using the difference between upwind and downwind mixing ratios.
   - BOEM's OCS AQS inventory will be compared to the atmospheric-based emissions estimates derived from the aircraft campaign to determine which air pollutants or GHGs may be under- or over-estimated in OCS AQS for the month(s) of aircraft measurements.
   - Repeat flights to improve the robustness of the comparison and spatial coverage.

2) **NOAA will collaborate with BOEM to assess satellite-based emission inversions by the Greenhouse and Air Pollutant Emissions System (GRAAPES) for the GOM:**
   - GRAAPES will ingest satellite retrievals of trace gases over the GOM using weather-chemistry models and chemical data assimilation to estimate basin-level emissions. The aircraft mass balance emissions estimates and Doppler lidar will be used to evaluate the performance of the meteorological model and fluxes estimated by GRAAPES.
   - Utilize the data collected during the NASA/BOEM SCOAPE cruises.

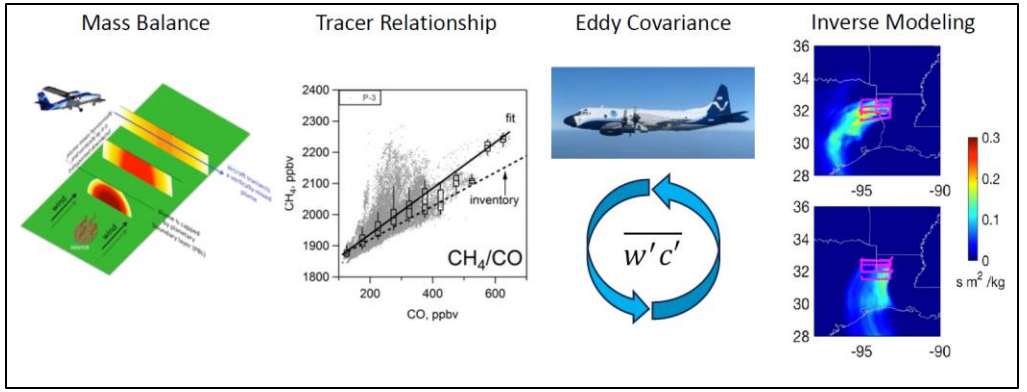
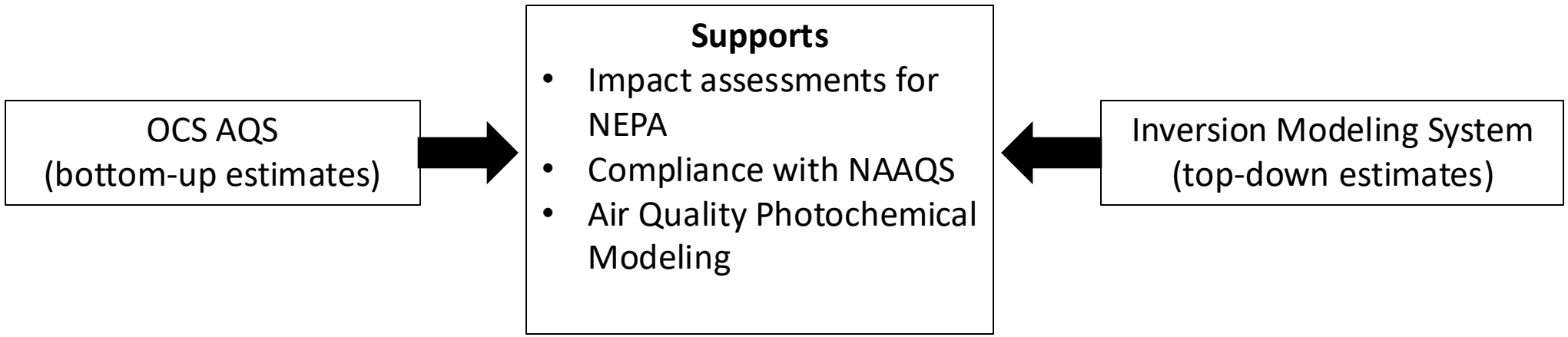


Figure provided by NOAA.

Research Questions

- **What are the quantified errors of the OCS AQS emissions estimates for selected GHGs and air pollutants?**
- **Are satellite-based top-down emissions (derived from a modeling inversion system) of oil and gas operations in the Gulf of Mexico reliable enough to be used to supplement the OCS AQS inventory? If yes, for which species and in what capacity?**



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