Field	Study Information
Title	Air Quality Modeling in the Gulf of Mexico Region - 2025 Update (GM-25-02)
Administered by	Gulf of Mexico Region
BOEM Contact(s)	Cholena Ren (cholena.ren@boem.gov)
Procurement Type(s)	Interagency Agreement, Cooperative Agreement
Performance Period	FY 2025–2028
Final Report Due	TBD
Date Revised	March 28, 2024
Problem	BOEM needs updated photochemical modeling assessing air quality impacts from oil and gas activity scenarios in the Gulf of Mexico (GOM) used in BOEM's environmental impact statements, and to improve air dispersion modeling for oil and gas plans in the GOM.
Intervention	Use BOEM's emission inventories to estimate scenario air emissions, generate necessary meteorological data files, and conduct air quality modeling to report ambient air concentrations under different oil and gas activity scenarios.
Comparison	The modeled ambient air concentrations from an oil and gas single sale scenario would be compared against the ongoing and cumulative scenarios. The modeled meteorological conditions and ambient air concentrations may also be compared to field measurements and/or satellite data, if available.
Outcome	Modeled ambient air pollutant concentrations from oil and gas activity scenarios to address air quality impacts in BOEM's environmental impact statements.
Context	Western GOM, Central GOM, Eastern GOM

BOEM Information Need(s): BOEM needs updated air quality photochemical modeling (including meteorological modeling) to support the air quality analysis in BOEM's environmental impact statements (EISs) for the National Environmental Policy Act (NEPA) and to support the requirements in the Outer Continental Shelf Lands Act (OCSLA). This information would also be used to address air quality impacts specific to Environmental Justice (EJ) areas, as required by Executive Order 12898. Under E.O. 12898, to consider disproportionate environmental effects of agency actions to EJ communities.

Background: In 2019, BOEM completed a study, "Air Quality Modeling in the Gulf of Mexico Region" (OCS Study BOEM 2019-057); now that information is dated. The study performed meteorological modeling using the Weather Research and Forecasting (WRF) model to support the air quality modeling for calendar years 2010-2014 and used single lease sale scenarios from the 2017–2022 GOM Multisale EIS. Also, the 2019 study did not model a range of impacts to address low, mid, and high impacts, and emissions from other air pollutants like hazardous air pollutants and greenhouse gases. Recent BOEM emission inventories include estimates of hazardous air pollutants and greenhouse gases that can be used in future air quality modeling efforts. A tiered-observing strategy using airborne measurements may also be used to address uncertainties in the emission inventories and modeling (McDonald et al., 2023).

Oil- and gas-related activities authorized under OCSLA must comply with the National Ambient Air Quality Standards (NAAQS). Section 5(a)(8) of OCSLA requires compliance with the NAAQS pursuant to the Clean Air Act (42 U.S.C. 7401 et seq.), to the extent that activities authorized under the subchapter significantly affect the air quality of any State. The NAAQS cover six common criteria air pollutants (carbon monoxide [CO], lead [Pb], nitrogen dioxide [NO_2], ozone [O_3], particulate matter [PM], and sulfur dioxide [SO_2]) that are considered harmful to the public. Hazardous air pollutants and pollutant greenhouse gas types are also considered harmful to the public (USEPA 2024; USEPA 2009).

Objective(s): This study will use emission inventories to model ambient air concentrations from oil and gas activity scenarios for a single proposed oil and gas lease sale in the GOM.

Methods: This project would collaborate with the U.S. Environmental Protection Agency (USEPA) and leverage ongoing work to develop a new photochemical modeling platform representing 2022. That USEPA effort would be augmented with resources from BOEM to add a finer resolution (~4 km) model domain over the GOM to best represent meteorology, offshore emissions, and the complex land-water interface. Model contribution from offshore sources output from that finer resolution modeling would be processed in a way that is consistent with USEPA's Guideline on Air Quality Models (Appendix W to 40 CFR Part 51) and other relevant permit program modeling guidance.

The project would additionally involve funding from BOEM to conduct meteorological modeling with the Weather Research and Forecasting Mesoscale Model (WRF) for two more annual fine-scale (~4 km) simulations in addition to 2022 (specific years will be determined later). These additional WRF simulations will leverage new WRF data generated by USEPA with a 12-km grid. All the WRF output will be evaluated for use over the GOM and used to make inputs for the photochemical grid modeling. Further, all three years of WRF output would be used to develop the mesoscale model interface (MMIF) files for air dispersion modeling. Wilson et al. (2019) generated meteorological data for WRF and MMIF and are provided at https://boem.gcoos.org/. These meteorological files would replace the existing files.

BOEM resources will support photochemical grid modeling for the fine scale (4 km) domain over the GOM for 2022. This photochemical model application will include source apportionment for specific offshore sources and/or defined offshore source regions to estimate contribution to model predicted O_3, secondary $PM_{2.5}$, and primary $PM_{2.5}$ at distances greater than 50 km. A comprehensive air emission inventory would be developed using USEPA's existing data added with BOEM's emission inventories to depict emissions within the study area for a low, mid, and high impact using the base case (ongoing scenario), single lease sale plus base case, and future year scenario (cumulative scenario with and without the single lease sale) to support photochemical grid modeling. Photochemical grid modeling would be conducted to examine the potential air quality impacts of a low, mid, and high single sale scenario representative of a typical oil and gas lease sale for the GOM.

The baseline photochemical model simulation will be processed and compared with routine surface measurement network data to support an operational model evaluation. The modeled ambient air concentrations would be processed and compared to applicable standards such as the NAAQS and AQRVs. Select air toxins (i.e., hazardous air pollutants) would also be modeled and, when possible, compared to any standards. Model predictions will be paired with demographic data to support environmental justice analytical efforts.

Core model products developed with BOEM funding leveraging USEPA modeling efforts: 1) annual 4 km WRF simulations for 2022 and two additional years (likely 2023 and 2024); 2) annual 4 km

photochemical grid modeling simulation for 2022 for a) baselines scenario, b) low impact scenario, c) mid-impact scenario, and d) high impact scenario; 3) annual 4 km photochemical grid model simulation for 2022 with source apportionment to track specific sources and/or source regions in the GOM; 4) annual 4 km MMIF output files for dispersion model applications for 2022 and two additional years (likely 2023 and 2024); and 5) WRF and photochemical model baseline model performance (for 2022) technical support document.

Optional tasks would be to address uncertainties in emission inventories and provide more complex diagnostic model evaluation using satellite data and special measurements made as part of relevant field studies like "Airborne Surveys on Oil and Gas Activities in the Gulf of Mexico Region" and the NASA's SCOAPE II cruise. The optional tasks would include:

1. Examine how well does the modeling system capture meteorological conditions and processes in the GOM related to elevated levels of $PM_{2.5}$ and O_3 using special field measurements made as part of field studies. Examine how well does the model capture $PM_{2.5}$, O_3, and important precursors and intermediate chemical compounds in the GOM using measurements made as part of special field studies (e.g., SCOAPE 2019 and 2024) and if feasible satellite products (e.g., TEMPO).
2. How can emissions inventories (criteria air pollutants and methane) for sources in the GOM be evaluated and improved through airborne measurements and satellite products.

Specific Research Question(s):

1. Which meteorological conditions are realistic and most conducive to higher ambient air concentrations overland and overwater, including expected future trends in emissions and climate change projections? And how do these meteorological conditions align (temporally and spatially) with the forecasted emissions from a representative single sale?
2. What are the differences between the emissions using activity and production levels from the activity scenarios? Which is more appropriate to use for modeling and why?
3. What are the low, mid, and high modeled ambient air concentrations offshore, onshore, and within the modeling grid for all scenarios and their locations?
4. What are the low, mid, and high modeled ambient air concentrations on areas with EJ communities for all scenarios?
5. (Optional) Do EJ communities in the Gulf Coast located within NAAQS nonattainment areas have air quality impacts from OCS oil and gas activities (either cumulatively, from a single sale, or cancellation of a single sale)? If so, is it possible to determine if they are disproportionate compared to impacts experienced by other communities in the NAAQS nonattainment areas?
6. (Optional) How can emission inventories (criteria air pollutants and methane) for sources in the GOM be evaluated and improved through airborne measurements and satellite products?

Current Status: N/A

Publications Completed:

Wilson D, Stoeckenius T, Brashers B, Do B. 2019. Air quality modeling in the Gulf of Mexico Region. New Orleans (LA): U.S. Department of the Interior, Bureau of Ocean Energy Management. 656 p. Report No.: OCS Study BOEM 2019-057.

National Academies of Sciences, Engineering, and Medicine. 2019. Review of the Bureau of Ocean Energy Management "air quality modeling in the Gulf of Mexico region" study. Washington (DC): The National Academies Press. https://www.nap.edu/catalog/25600/review-of-the-bureau-of-ocean-energy-management-air-quality-modeling-in-the-gulf-of-mexico-region-study.

Affiliated WWW Sites: N/A

References:

McDonald B, He J, Harkins C, de Gouw J, Elguindi N, Duren R, Gilman J, Kort E, Miller C, Peischl J, et al. 2023. A review of U.S. oil and gas methane and air pollutant emissions. em: The Magazine for Environmental Managers. September 2023. 6 p. https://csl.noaa.gov/pubs/EM202309McDonald.pdf.

USEPA. 2009. Endangerment and cause or contribute findings for greenhouse gases under section 202(a) of the Clean Air Act. Washington (DC): U.S. Environmental Protection Agency, Climate Change Division, Office of Atmospheric Programs. 210 p.

USEPA. 2024. Health effects notebook for hazard air pollutants. Washington (DC): U.S. Environmental Protection Agency. [accessed 2024 Jan 4]. https://www.epa.gov/haps/health-effects-notebook-hazardous-air-pollutants

Wilson D, Stoeckenius T, Brashers B, Do B. 2019. Air quality modeling in the Gulf of Mexico Region. New Orleans (LA): U.S. Department of the Interior, Bureau of Ocean Energy Management. 656 p. Report No.: OCS Study BOEM 2019-057.