

STUDY TITLE: Meteorological and Wave Measurements for Improving Meteorological Modeling

REPORT TITLE: Meteorological and Wave Measurements for Improving Meteorological and Air Quality Modeling

CONTRACT NUMBER: M08PC20057

SPONSORING OCS REGION: Gulf of Mexico

APPLICABLE PLANNING AREA: Central

FISCAL YEARS OF PROJECT FUNDING: 2008 – 2012

COMPLETION DATE OF REPORT: July 2013

COSTS: FY 2009: \$49,641; FY 2010: \$219,559; FY 2011: \$467,744;
FY 2012: \$298,456; CUMULATIVE PROJECT COST: \$1,035,400

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KEY WORDS: Atmospheric Boundary Layer Measurements, Air-Sea Interaction, Fluxes, Gulf of Mexico, Meteorology, Meteorological Instruments; Sodar; Ceilometer; Microwave Radiometer

BACKGROUND: Over the last two decades, the Bureau of Ocean Energy Management (BOEM) has conducted several meteorological and air quality studies to understand and develop plans to mitigate the impacts of current and future emissions from oil and gas production and to support air quality and meteorological forecasting for routine planning and emergency response. These studies include field measurements, data analysis, model development, emissions inventory development, and model applications. While these previous studies have greatly improved our understanding of offshore meteorological processes, data shortcomings meant that several scientific issues still needed to be addressed. In particular, there was a lack of data to:

1. properly describe the diurnal and seasonal characteristics of lower boundary winds (i.e., from the surface and 200–300 m msl) and how meteorological and oceanographic processes influence those characteristics;
2. characterize other meteorological processes and how air-sea interactions influences those processes; and
3. improve meteorological models' ability to properly represent micro-, local-, and meso-scale processes.

To help address these scientific issues, this 18-month field program was undertaken, which included the collection of a full-range of oceanographic and atmospheric measurements.

OBJECTIVES: The primary goals of this project were to provide data that will be used to (1) improve our understanding of boundary layer processes and air-sea interaction over the Gulf of Mexico; (2) improve regional-scale meteorological and air quality modeling; and (3) provide a framework for advanced offshore measurements to support future needs, such as emergency response, exploration and lease decisions, wind energy research and development, and meteorological and air quality forecasting.

DESCRIPTION: Sonoma Technology Inc. (STI), University of Colorado at Boulder (CU), and Louisiana State University (LSU) researchers and technicians, with scientific input from BOEM and a Scientific Review Board, developed an atmospheric boundary layer environmental observations program on an offshore platform in the Gulf of Mexico. Beginning in October 2010, meteorological and oceanographic sensors were deployed for approximately 18 months on a Chevron service platform 12.4 miles south of Terrebonne Bay, Louisiana, to collect atmospheric boundary layer and sea surface data. Observations from this project include surface meteorology; marine boundary layer wind profiles; vertical profiles of atmospheric temperature, relative humidity, and liquid water; cloud base heights; atmospheric boundary layer height; ocean temperature; ocean surface temperature; ocean wave height and frequency; downwelling (shortwave) solar and infrared (longwave) radiation; and lower atmospheric boundary layer momentum and heat fluxes.

SIGNIFICANT CONCLUSIONS: The project collected data that captured atmospheric and oceanographic processes over an extended period. The data have been quality controlled and are available to support future analyses and modeling. From this study, we can conclude that long-term unmanned operations of highly sophisticated instruments on an active oil platform are feasible and can provide high quality data, provided that the following key elements are addressed:

1. Sodar instruments require both electronic and physical noise reduction systems to obtain high-quality lower-boundary layer winds in the busy and noisy environment of an operating oil platform.
2. Fast-response specific humidity instruments require a daily lens cleaning to remove salt deposits.
3. Using catwalks between platforms to obtain near-surface flux measurements is ideal.
4. A mini-shelter cooled with only ocean water can be used to house computers if an air-conditioned shelter is not available.
5. Constant-depth, near-surface ocean temperature measurements can be made without a buoy using a system mounted to a platform leg.

6. Two-way Internet is needed to monitor instruments and their data so that problems can be quickly identified and resolved.

In addition, limited analysis has shown that model predictions of boundary-layer processes do not always agree with the observations from this study; thus, these data provide an excellent source of information to use for evaluating and improving meteorological models.

STUDY RESULTS: This study yielded an unprecedented set of atmospheric boundary layer and oceanographic measurements over the Gulf of Mexico that captured a range of air-sea interactions and processes that occur over all seasons.

This project provided about 18 months of hourly and sub-hourly meteorological and oceanographic data at a single location 12.4 miles south of Terrebonne Bay, Louisiana. All data have been quality controlled, are ready for use in data analysis and modeling, and are available on DVD. Observations from this project include

- surface meteorology collected on the platform deck;
- marine boundary layer wind profiles collected using a mini-sodar;
- vertical profiles of atmospheric temperature, relative humidity, and liquid water collected using a microwave radiometer;
- cloud base heights and atmospheric boundary layer height collected using a ceilometer;
- ocean temperatures collected using a thermistor;
- ocean surface temperatures collected using an IR sensor;
- ocean wave height and frequency collected using acoustic and pressure sensors;
- downwelling (shortwave) solar and infrared (longwave) radiation collected using a pyranometer and pyrgeometers; and
- lower atmospheric boundary layer momentum and heat fluxes collected using sonic anemometers and fast-response specific humidity sensors.

STUDY PRODUCTS: MacDonald C.P., A.E. Ray, P.T. Roberts, C.A. Knoderer, L. Bariteau, C.W. Fairall, W.J. Gibson, and J.E. Hare. 2013. Meteorological and wave measurements for improving meteorological and air quality modeling. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2013-01110. pp. 102.

MacDonald C.P., A.E. Ray, P.T. Roberts, C.A. Knoderer, L. Bariteau, C.W. Fairall, W.J. Gibson, and J.E. Hare. 2012. Meteorological and wave measurements for improving meteorological and air quality modeling, October 1, 2010 – April 1, 2012. Data

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MacDonald C.P., P.T. Roberts, A.E. Ray, C.A. Knoderer, C. Huang, R. Lai, D. Herkhof, C.W. Fairall, L. Bariteau, and W.J. Gibson. 2012. Meteorological and wave measurements for improving meteorological and air quality modeling – project summary. Presentation prepared under BOEM Contract M08PC20057 for the U.S. Department of the Interior, Bureau of Ocean Energy Management, Environmental Sciences Section, New Orleans, LA, by Sonoma Technology, Petaluma, CA. STI-908059-5417, July 11.

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