

STUDY TITLE: Air Quality and Dispersion Meteorology Over the Northern Gulf of Mexico: Measurements, Analyses, and Syntheses

REPORT TITLE: Air Quality and Dispersion Meteorology Over the Northeastern Gulf of Mexico: Measurements, Analyses, and Syntheses

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BACKGROUND: Several areas in the coastal reaches of the northeast Gulf of Mexico have been designated as Wildlife Refuges and National preserves. In recent years, there has been notable growth in population (and hence increased power production, traffic, etc.) landward of the coast. At the same time, energy exploration and production remains very active in the offshore waters of the northeast Gulf. Therefore, considering their location, it may be inevitable that the air quality in these protected areas is being influenced by emissions from these various sources. However, since some of the area is assigned Class I and II status by the U.S. EPA, it is subject to the most rigorous requirements for air quality. Monitoring of ambient air quality and meteorological conditions at multiple near-shore stations was performed to investigate the pollutant concentrations impacting these areas and the meteorological characteristics which affect dispersion and transport over the OCS region. This project report presents the findings from these observations.

OBJECTIVES: (1) To establish and maintain two monitoring stations for ambient air

quality and surface meteorological conditions in the near coast area of the northeast Gulf; (2) To collect data from other sources in the area including NOAA buoys and coastal stations; (3) To derive and compare annual pollutant statistics between stations; (4) To define and determine meteorological parameters pertinent to dispersion and transport in the OCS region; and (5) To associate pollutant fluctuations with prevailing meteorological conditions.

DESCRIPTION: In order to study spatial and temporal variations over the northeast Gulf, one monitoring station was deployed on Breton Island, located at the southern extent of the Chandeleur Island chain off the southeast coast of Louisiana. This island is part of the Breton National Wildlife Area, and has Class I designation. The second station was installed on the eastern end of Dauphin Island, Alabama, near the southwest entrance of Mobile Bay. Dauphin Island is part of the Gulf Islands National Seashore. The stations were similarly equipped for measurement of ambient SO₂ and NO_x using EPA approved monitors. At Breton, a surface meteorological monitoring system was also installed, and included wind speed and direction, relative humidity, air and water temperatures, and turbulence intensity (from uvw values). No meteorological measurements were made at Dauphin since the site was located adjacent to the NOAA C-MAN station DPIA1. All data was stored on site and offloaded during regular servicings, at which time the air quality monitors were inspected and calibrated in accordance with methods described in the Code of Federal Regulations. The period of record at Breton extended from October 1994 through August 1998 and at Dauphin from March 1996 to May 1998. Air quality data was recorded at 5-minute intervals; most meteorological values were recorded hourly. All data was quality controlled through calibration reports and station operator notes. The data was reduced and analyzed to determine significant characteristics of ambient air quality and meteorology affecting these locations.

SIGNIFICANT CONCLUSIONS: Hourly concentrations of SO₂ and NO₂ at both stations were less than 6 ppb for over half the study period. Annual and maximum concentrations of both pollutants were well below the NAAQS. Mean concentrations are generally higher in the fall and winter months at both stations. No significant diurnal trends are evident. Maximums at Dauphin are mostly associated with winds from north-northeast. SO₂ maximums at Breton are primarily seen with northerly winds while NO₂ maximums are generally from south-southwest. On average, SO₂ concentrations are higher at Dauphin than Breton while NO₂ is nearly equivalent. Higher maximums are seen at Breton. Good agreement is noted between time series of 24 hour averaged SO₂ at Breton and Dauphin; poorer correlation for NO₂, suggesting this pollutant is more locally influenced. High SO₂ at Breton is mostly seen under Continental High synoptic conditions (northerly winds); high NO₂ observed predominantly under Gulf Return (southerly winds). Turbulence intensities over Breton are in reasonable agreement with those in the literature, but are influenced by terrain effects. Monthly mean stability over the Breton area is typically unstable, with free convection observed up to 15% of the time. Under unstable conditions offshore, the mixing height is equivalent to the lifting condensation level, and on average is below 750 m. Stable conditions offshore can produce mixed heights near 100 m.

STUDY RESULTS: The difficult logistics involved in maintaining a monitoring station at the remote location of Breton Island is reflected in the relatively poor data return achieved. Power on the island was produced by generators, and frequently fluctuated or failed. When combined with lightning strikes, hurricanes, and other natural phenomena, many long data gaps resulted due mainly to damaged electronics. Hurricane Danny (July 1997) caused complete removal of the station and re-installation in an adjacent building. These facts, along with a lack of baseline measurements, invalidate comparison of concentration values to PSD increments. Dauphin Island mean annual SO₂ concentration for year 1 (March 1996 - April 1997) was 1.86 ppb and for year 2 (May 1997 - April 1998) was 2.28 ppb. Mean annual NO₂ for year 1 was 4.58 ppb and for year 2, 4.38 ppb. Seasonal trends show consistent SO₂ values, however NO₂ clearly peaks in fall and winter. Observed maximum concentrations were strongly associated with north-northeast winds. NO₂ / NO_x ratios were typically high, suggesting transport of an aged air mass from the mainland. With the exception of the final reporting period (May 1997 - May 1998), annual statistics at Breton were not considered due to the incomplete record. On the other hand, consistent values were obtained from existing samples. For SO₂, mean values were 1.2, 1.3, 1.0, and 1.6 ppb and for NO₂, 3.0, 5.3, 3.8, and 5.4 ppb for years 1994, 1995, 1996, and 1997, respectively. A "composite" year assembled from the most complete months during those years yielded an "annual" mean SO₂ and NO₂ of 1.14 ppb and 4.58 ppb, respectively. All of these values are in good agreement with the annual mean values during May 1997 - April 1998 for SO₂ of 1.2 ppb and during June 1997 - May 1998 for NO₂ of 6.2 ppb. The slightly higher NO₂ is attributed to re-location of the monitoring station. Similar seasonal trends are evident as at Dauphin. SO₂ maximums are clearly associated with northerly winds, while NO₂ maximums are more distributed but mostly seen with southerly winds. It should be noted that the generator housing was located to the south of the monitoring site, and NO₂ / NO_x values were often low suggesting a nearby source. SO₂ maximums were most often recorded under Continental High synoptic conditions, while NO₂ maximums were primarily seen with the Gulf Return pattern.

The low terrain elevation at Breton Island influences the turbulence intensities as crosswind values were found to be higher than those in the literature (North Sea), although downwind and vertical values were in reasonable agreement. Unstable conditions prevail over the area throughout the year. A relationship between the mixed height, or lifting condensation level, under unstable conditions and the surface dewpoint depression shows mean mixed heights over the area to range from 250 m to 750 m. Much lower heights can occur under stable conditions. Methods for determining the proper values of drag coefficient, stability parameter, mixed height, turbulence intensity, and vertical eddy diffusivity from routine measurements are provided and demonstrated, and recommended for use in offshore modeling efforts.

STUDY PRODUCTS: Hsu, S. A. and B. W. Blanchard. 1998. Long-term measurements of SO₂ and NO₂ concentrations and related meteorological conditions in the northeastern Gulf of Mexico region. OCS Study MMS 98-0020. U.S. Dept. of the

Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. 308 pp.

Hsu, S. A. and B. W. Blanchard. 2000. Air quality and dispersion meteorology over the northeast Gulf of Mexico: measurements, analyses, and syntheses. OCS Study MMS 2000-014. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. 210 pp.