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STUDY TITLE: Synthesis, Analysis, and Integration of Air Quality and Meteorological Data for the Gulf of Mexico Region

REPORT TITLE: Synthesis, Analysis, and Integration of Air Quality and Meteorological Data for the Gulf of Mexico Region, Volume I: User's Manual for the Gulf of Mexico Air Quality Database (Volume 1.0), Volume II: Technical Reference Manual for the Gulf of Mexico Air Quality Database, Volume III: Data Analysis, and Volume IV: CART Analysis of Modeling Episode Days

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SPONSORING OCS REGION: Gulf of Mexico

APPLICABLE PLANNING AREAS: Western, Central, and Eastern Gulf of Mexico

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BACKGROUND: The Minerals Management Service (MMS), together with the oil and gas industry, have collected a variety of meteorological, air quality and emission inventory data for the Gulf of Mexico (GOM) region. These data span the years 1988 to present, and have been used to support various air quality related data analysis and modeling activities. The focus of this data synthesis study was to assemble these data, as well as other data available from federal, state, and oil and gas industry studies and databases, into a coherent dataset, so that an integrated analysis of the data could be conducted.

OBJECTIVES: The objective of this analysis was to prepare an integrated dataset that could be used to provide the basis for an improved understanding of the relationships between meteorology, emissions and air quality in the Gulf of Mexico region and support future regulatory data and modeling analyses related to ozone, fine particulate matter ($PM_{2.5}$) and regional haze. The data synthesis study also included some basic

analyses of the data, which were conducted in order to ensure the integrity and usability of the dataset, and to provide new information about meteorological and air quality conditions in the GOM Region.

DESCRIPTION: The Gulf of Mexico Air Quality Database (GMAQDB) incorporates data from several MMS-sponsored studies including the 1993 Gulf of Mexico Air Quality Study (GMAQS), the Atmospheric Boundary Layer (ABL) study (spanning 1998-2001), and the recent offshore activities and emissions data for the Breton area and the entire Gulf of Mexico (2000 and 2005 Gulfwide Emission Inventories). Data collected as part of the Breton Aerometric Monitoring Program (BAMP) October 2000–September 2001), co-sponsored by MMS and the offshore oil and gas industry, are also included. To support the conduct of air quality related analysis, data from the U.S. Environmental Protection Agency (EPA) Air Quality System (AQS), the National Weather Service (NWS), the National Data Buoy Center (NDBC) and other sources have also been included. The resulting GMAQDB is a relational database that contains hundreds of millions of data points. An interactive database tool has been designed to provide users with easy-to-use query capabilities to retrieve specific subsets of the data based on a variety of criteria such as date range, location and parameter type. The graphical user interface (GUI) consists of menus, forms and reports developed with Microsoft Access 2003. The form controls, such as list views, drop-down list boxes, command buttons etc., are standard controls used in many Microsoft Windows applications and should be familiar to most users.

A variety of data analyses were conducted in order to “mine” the integrated GMAQDB and ensure the integrity and usability of the dataset. Statistical and graphical summaries were prepared to provide an overview of the meteorological, air quality and emissions data and to highlight key features/components of the integrated dataset.

SIGNIFICANT CONCLUSIONS: Air quality, meteorological, and emission inventory data for the Gulf of Mexico for a 10-year period have been successfully integrated into a master database tool that can be used to further evaluate and explore relationships among the data throughout the Region.

STUDY RESULTS: Classification and Regression Tree (CART) analysis and other data analysis techniques were used to probe the relationships between meteorology, ozone, fine particulate matter ($PM_{2.5}$) and visibility (regional haze) at the Breton NWA and other coastal areas. The CART analysis results for ozone reveal that high ozone days for most areas along the Gulf Coast are characterized by low relative humidity, low wind speed, little or no precipitation and stable conditions, compared to lower ozone days. Within each monitored area, however, different combinations of regional meteorology, local meteorology and carryover and/or transport of ozone comprise an ozone episode. The CART results also indicate that meteorological data are reasonably good indicators of ozone concentration for areas along the Gulf Coast. The CART results for $PM_{2.5}$ reveal that on an annual basis, high $PM_{2.5}$ concentrations occur in connection with a regional build up of $PM_{2.5}$ concentrations, low wind speed and stability. However, different mechanisms lead to high $PM_{2.5}$ concentrations during different times of the year. Specifically, the regional build up of $PM_{2.5}$ is an important mechanism during the warmer

months, while local factors such as low temperatures, low wind speeds and stability are important during the colder months. For Class I area along the Gulf Coast (the Breton, St. Mark's and Chassahowitzka National Wilderness Areas), the worst visibility days occur under a variety of conditions. The predominant conditions include very high $PM_{2.5}$ and low to moderate relative humidity, high to moderate $PM_{2.5}$ and relative humidity, and low $PM_{2.5}$ and high relative humidity. Meteorologically adjusted trends for ozone, $PM_{2.5}$ and visibility were developed based on meteorological typing provided by CART analysis. The meteorological adjusted values show less variation from year to year than the actual values. For most areas, the results for ozone indicate that observed high ozone for 2000 and low ozone for 2002 are attributable to the effects of meteorology. The year-to-year trend in ozone is relatively flat between 2000 and 2004. The results for $PM_{2.5}$ indicate a slight upward trend in $PM_{2.5}$ concentrations for Houston and a downward trend for all other areas between 2000 and 2004. The meteorologically adjusted values confirm the tendencies indicated by the actual data. For visibility, there is a slight upward tendency in extinction coefficient (toward poorer visibility) for Breton between 2000 and 2004, and a downward tendency for the other coastal Class I sites.

STUDY PRODUCTS: Study report consisting of four volumes as below and Gulf of Mexico Air Quality Database (GMAQDB) consisting of Graphical User Interface and Oracle-based background database:

a) Davis-Noland, B., J. Ward, J. Adlhoch. 2009. Synthesis, analysis and integration of meteorological and air quality data for the Gulf of Mexico region. Volume I: User's manual for the Gulf of Mexico air quality database (Version 1.0). U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2009-055. 77 pp.

b) Davis-Noland, B., J. Ward, J. Adlhoch. 2009. Synthesis, analysis and integration of meteorological and air quality data for the Gulf of Mexico region. Volume II: Technical reference manual for the Gulf of Mexico air quality database. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2009-056. 49 pp.

c) Douglas, S.G., J.L. Haney, A.B. Hudischewskyj, and Y. Wei. Synthesis, analysis and integration of meteorological and air quality data for the Gulf of Mexico region. Volume III: Data analysis. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2009-057. 265 pp.

d) Douglas, S.G., A.B. Hudischewskyj, and J.L. Haney, Synthesis, analysis and integration of meteorological and air quality data for the Gulf of Mexico region. Volume IV: CART analysis of modeling episode days. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2009-058. 30 pp.

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