ACCESS NUMBER: 30826

STUDY TITLE: Meteorology of the Northeastern Gulf of Mexico

REPORT TITLE: Meteorology of the Northeastern Gulf of Mexico: Data from 1995 to 1997, Final Report

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BACKGROUND: There is renewed interest in oil and gas extraction activities in the Northeastern Gulf of Mexico (NEGOM). Further, the National Environmental Policy Act (NEPA) mandates multidisciplinary environmental assessments of major Federal actions, such as oil and gas leases and related activities in the NEGOM. Such assessments could benefit from a meteorological database. The research conducted for this study resulted in a database useable for ongoing and future MMS studies in the NEGOM. In addition, the meteorological and oceanographic science communities should benefit from an improved understanding of atmospheric-oceanic interactions in this area. The database and software system from this study may be used as a “handbook” by planners and analysts in future industrial activities in the area, or as initial assessment of conditions associated with non-routine or accidental hazardous events. Knowledge acquired in this study will improve understanding of wind field patterns and sea breeze structures, atmospheric boundary layer behavior and its moisture fluxes across the land-sea interface, wind stress patterns on the sea surface, and cold air outbreaks.

OBJECTIVES: (1) To collect wind data from available sources (National Weather Service, National Data Buoy Center, stations funded by Minerals Management Service, and other private sources) spanning the NEGOM, and estimate the temporal/frequency contents and spatial scales of variation from these measurements; (2) To collect humidity, and air and sea-surface temperature measurements throughout the NEGOM from these same institutions, prepare maps of the mean and variance fields, and estimate the temporal and spatial scales of variation; (3) To calculate mean and variance fields of surface wind stress and heat flux over the NEGOM and prepare maps of these quantities, to estimate wind curl and vertical vorticity means and variability with and without effects of sea breezes (i.e. with and without filtering techniques), and to use these data to the maximum extent possible to study winter cyclogenesis and cold frontal passage in the NEGOM; (4) To assess how frontal passage and the modification of air masses affect the local fields of temperature, humidity, pressure and other relevant meteorological parameters; (5) To estimate the transport of water-vapor and latent heat across water-land boundaries or coastlines and the properties of the atmospheric boundary layer, and to evaluate the temporal and spatial variation scales analyzed as functions of atmospheric and climatological forcing; (6) To collect, archive, and analyze the gridded output of a prognostic meteorological model (the Eta model) for the same time periods as the observational database. (7) To develop an ACCESS relational database containing both observed data, derived parameters, and gridded Eta model output for a two-year period (1996-1997); and (8) To develop an expert software system to provide the users of the NEGOM meteorological database with a simple way to access and display the database and the data analysis products of the study.

DESCRIPTION: The study area was defined as the region enclosed within the latitudes of 28º-32ºN and the longitudes 82º-90ºW. The data collection period of interest for this study was Jan 1,1996 through December 31, 1997. (In addition, 1995 observational data were included in the ACCESS database because they were collected at the beginning of the study to test archival and analysis methods.) Data were acquired data from many agencies and more than 200 gigabytes of meteorological data from more than 50 measurement sites were processed. From this raw data, a very large relational ACCESS relational database was produced, containing more than 5.2 gigabytes of meteorological data. Extensive analyses of these data were conducted, numerous derived meteorological parameters were calculated, and graphical products and maps created. A software system was developed to access and display raw data, analysis results, and graphical products.

SIGNIFICANT CONCLUSIONS: Review of annual and seasonal frequency of occurrence of meteorological pattern types for the period 1996-1997 reveals that, the NEGOM is dominated by fair weather conditions.

- Conditions are infrequently punctuated in all seasons by frontal passage.
- Tropical storms occur infrequently, most often in fall.
- Winds are strongest in the winter, and lighter and more variable in the summer.
- Winds are generally from the east, yet progressively turn from southerly in the summer to northeasterly in the winter.

- Surface air temperatures follow expected season patterns.
- Annually, sea-surface temperature (SST) is greater than air temperatures (unstable regime). In spring and summer, SST is less than the air temperature (stable regime), but in the fall and winter, unstable conditions prevail as offshore flow moves cooler continental air over the Gulf.
- Geostrophic vorticity is slightly positive annually, suggesting the dominance of cyclonic curvature of surface-level winds; negative vorticity (anti-cyclonic curvature) is evident in spring and summer, likely due to the dominance of high pressure regimes.
- Variability in vorticity is larger in the winter, possibly due to the larger frequency of transient systems moving through the area, while it is least variable in the summer with the establishment of constant and stationary high-pressure systems.
- Wind stress curl follows the vorticity patterns since the two are directly related.
- The effects of land-sea breeze recirculation and flow reversals are not felt far offshore; certainly less than 80 km and probably no further than about 50 km. This finding is consistent with prior analyses of coastal meteorology in the Gulf of Mexico. The land-sea breeze effect is much less pronounce offshore Louisiana; probably due to the predominance of swamps and a poorly defined coastline.

These findings are consistent with expectations based on common-sense meteorological reasoning, prior studies, and longer-term historical climatology. However, it must be remembered that a strong El Niño event marked the second half of 1997, and the related eastern movement of the Southern Oscillation in the Pacific was signaled in late 1996. El Niño events are known to suppress western Atlantic tropical storm development in the summer and fall months following onset.

STUDY RESULTS: Meteorological data for the 1995-1997 period from all available sources (National Weather Service, National Data Buoy Center, stations funded by Minerals Management Service, and other private sources) spanning the region of the Northeastern Gulf of Mexico (NEGOM) were collected. Estimates of the temporal/frequency contents and spatial scales of variation from these wind measurements were prepared. Humidity, air and sea-surface temperature measurements for the same period throughout the NEGOM were also analyzed and maps of the mean and variance fields, and estimate the temporal and spatial scales of variation were prepared. Calculations of mean and variance fields of surface wind stress and heat flux over the NEGOM were made and maps prepared of the quantities to estimate wind curl and vertical vorticity means and variability after effects of sea breezes were identified via filtering techniques. These data were used to study winter cyclogenesis and cold frontal passage in the NEGOM. Assessments were made of frontal passage and the modification of air masses affecting the local fields of temperature, humidity, pressure and other relevant meteorological parameters. Temporal and spatial variation scales were analyzed as functions of atmospheric and climatological types. Prognostic meteorological model output was also archived for the same period to supplement the observational database for the NEGOM region. A computer-based expert software system was developed that allows rapid, real-time

access to the information and products developed in this study and aid in interpretation of current and forecast meteorological conditions.

STUDY PRODUCT(S): Yocke, M.A., C.A. Emery, P. Roberts, C. MacDonald, D. Ladner, J. Prouty, and A. Barnett. 1999. *Meteorology of the Northeastern Gulf of Mexico*. An Interim Report for U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, La. 70123-2394.

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An ACCESS relational database containing more than 5.2 Gigabytes of meteorological data. Users can easily access this data and rapidly sort and prepare reports of the data subsets utilizing MS Access97 software. The Access data set is available on magnetic tape cartridge from MMS or the National Climatic Data Center (NCDC). The ACCESS database contains all observational data and Eta model output for the study period.

A software system called the North East Gulf of Mexico Expert System (NEGOMES). This software allows its users to browse the statistical and analysis products of the study. The system's graphical user interface capabilities allow users to easily access, select, sort, view, and navigate data maps and other tabular and graphical data products. The expert system also allows the user to quickly forecast and view projections of wind trajectories based on the stored wind statistics. The expert software system and supporting data are available from the MMS on a 5 CD-ROM set. The supporting NEGOMES database consists of nearly 3 Gigabytes of processed meteorological data and graphical displays that includes:

- 1996-1997 surface observation statistics;
- 1996-1997 aloft observation statistics;
- 1996-1997 gridded observation statistics;
- 1996-1997 transect data derived from observed surface data;
- 1996-1997 Eta gridded surface data;
- 1996-1997 Eta gridded 3-D data;
- 1996-1997 gridded Eta surface statistics.

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