

STUDY TITLE: Determining Overwater Visibility and Mixing Height Using Satellite and In-Situ Measurements Over the Gulf of Mexico

REPORT TITLE: Visibility and Atmospheric Dispersion Capability over the Northern Gulf of Mexico: Estimates and Observations of Boundary Layer Parameters

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BACKGROUND: The National Haze Program was enacted to address concerns about the effects of atmospheric pollutants on the visibility of National Parks and Wilderness Areas. Many of these designated areas are located in coastal zones, and are therefore under Minerals Management Service oversight. In the northern Gulf of Mexico, there are many energy production platforms in operation, which are supported daily by both marine vessels and airborne transports. Emissions from these stationary and transient sources, combined with natural emissions from the marine environment (such as sea salts) could potentially degrade the visibility over coastal park areas. Under certain conditions, land-based emissions could also impact these areas. This study was designed to monitor offshore visibility and to investigate the atmospheric boundary layer characteristics associated with impaired visibility events.

OBJECTIVES: (1) To deploy two offshore visibility and meteorological stations for continuous monitoring; (2) to integrate captured data from these stations into the LSU WAVCIS webpage so that near-real time information was available over the internet; (3) to determine whether wave-breaking was contributing to reduced visibility offshore; (4) to derive formulas which describe the offshore boundary layer characteristics (such as stability, mixed height, and ventilation factor index) using only easily and routinely acquired input data; (5) to apply the formulas from (4) to describe the mean atmospheric boundary layer conditions over the northern Gulf of Mexico using our offshore stations and existing NDBC C-MAN and buoy records; and (6) to identify low-visibility events from our offshore stations and analyze employing pertinent weather maps and available satellite imagery.

DESCRIPTION: Belfort Model 6100 visibility sensors and Rotronics MP101A temperature / relative humidity probes were added to the existing suite of instrumentation on two LSU WAVCIS platforms; CSI-3 (92°03.68' 29°26.47') and CSI-6 (90°29' 28°52'). Hourly data was recorded beginning in November 2001 at CSI-3 and June 2003 at CSI-6. The near-real time data was posted on the WAVCIS webpage (www.wavcis.lsu.edu). Simplified formulas were derived for computing atmospheric boundary layer parameters in the offshore environment. These new formulas, along with a NOAA algorithm for determining whether fog or haze is occurring, were applied to the WAVCIS platform hourly data along with longer-term records from NDBC coastal and offshore stations. Mean values of stability, mixing height, and ventilation factor index are described for the northern Gulf of Mexico. Episodes of reduced visibility recorded at our CSI-3 station were selected and investigated using weather map analysis and available satellite imagery.

SIGNIFICANT CONCLUSIONS: On average, sea temperatures are mostly warmer than air temperatures; however Stability Class D (neutral) prevails due to the wind contribution. Class C (free convective) is occasionally observed. Computed mixed heights ranged between 400 and 800 m, with higher values over the deeper Gulf. Areas of poor ventilation factor index often develop near shore, due to lower mixed heights in winter and lower wind speeds in summer. In these areas, the atmosphere's capability to disperse pollutants would be reduced. It is found that impaired visibility along the Louisiana coast and offshore is mostly due to naturally occurring fog conditions. Fog frequently and significantly reduces horizontal visibility. Haze can develop in each month, but generally less than 5% of the time (about 1.5 day). Reductions in visibility caused by haze conditions are usually less severe and are of shorter duration than those due to fog. Reductions in visibility at Boothville, Louisiana and CSI-3 were mostly associated with easterly winds. Satellite imagery revealed that plumes generated by land-based sources can impact and temporarily degrade offshore visibility.

STUDY RESULTS: In the fall and winter seasons particularly, the shelf waters off Louisiana cool down. When warm, moist Gulf air moves over the shelf, fog can form rapidly even in moderate winds. This effect is enhanced in the Mississippi River Delta region and over coastal wetlands and marshes. Fog is the dominant cause of impaired visibility in this region. Haze conditions were observed in most months, but usually for short duration (hours) and with lesser degradation of visibility. Salt particulates ejected by sea spray are known to contribute to haze, however episodes of impaired visibility at CSI-3 were mostly associated with light winds (hence limited wave breaking). Neutral to free convective stability conditions prevail over the northern Gulf of Mexico and average computed mixed heights range between 400 and 800 m. Nearer to shore, stable conditions sometimes occur, and very low mixed heights can develop. In summer months, light to near-calm winds can exist. Under these conditions, the atmosphere's dispersion capability can be very limited. Offshore visibility can temporarily be affected by smoke plumes generated from land-based fires.

STUDY PRODUCTS: Hsu, S. A., and B. W. Blanchard. 2005. Visibility and atmospheric dispersion capability over the northern Gulf of Mexico: estimations and observations of boundary layer parameters: Final Report. OCS Study MMS 2005-008. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. 184 pp.