**ACCESS NUMBER: IA5-26**

**STUDY TITLE:** Model Studies of the Circulation Patterns in the Gulf of Mexico Physical Oceanography

**REPORT TITLE:** A Numerical Modeling and Observational Effort to Develop the Capability to Predict the Currents in the Gulf of Mexico for Use in Pollutant Trajectory Computation

CONTRACT NUMBER: BLM: 08550-IA5-26

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**KEY WORDS**: Eastern Gulf; Central Gulf; Western Gulf; physical oceanography; modeling; Florida Straits; Yucatan Straits; gyre; Loop Current; Western Central Gulf of Mexico Gyre; Texas-Louisiana Gyre; DeSoto Canyon Gyre; West Florida Shelf Gyre

**BACKGROUND:** The ability to predict circulation patterns is central to assessing fates of pollutants emanating from offshore sources. To provide a predictive base for pollution trajectories in the Gulf of Mexico, available data and numerical models were used to characterize circulation patterns.

**OBJECTIVES:** (1) To modify an existing numerical model for application in the Gulf of Mexico; (2) to evaluate the ability of the model to simulate circulation using various types of data as input information; and (3) to describe circulation using results of the model.

**DESCRIPTION:** A comprehensive literature review of Gulf of Mexico circulation studies was completed. Two models were then employed to simulate Gulf of Mexico circulation. The geostrophic model computed ocean currents from density field measurements. Horizontal equations of motion were replaced by geostrophic balance between the pressure gradient and Coriolis acceleration terms. Retarding and driving forces were neglected. Temperature and salinity values were required to determine velocities at each grid point.

The numerical model was based on a set of physical laws governing motion of a fluid on a rotating spherical earth. These laws were expressed mathematically as a set of partial differential equations which govern the temporal evolution of seven independent field variables; three velocity components (eastward, northward, vertical), temperature, salinity, pressure, and density. Spatial resolution of the model was determined by distance between grid points. In diagnostic mode, the numerical model required information on lateral boundaries, bottom topography, surface wind stress field, and total volume transport through the Florida and Yucatan Straits. In prognostic mode, only surface boundary conditions and total transports at the Florida and Yucatan Straits were specified.

Archived temperature and salinity data were combined to form spatial and seasonal temperature-salinity profiles in 1° square grid points. These values were interpolated to provide 0.5° square grid points required by the models. Climatological dynamic heights were also computed from temperature and salinity data with a similar interpolation to 0.5° square grid points. Dynamic heights, salinity, and temperature data from four synoptic cruises were also input to both models.

**SIGNIFICANT CONCLUSIONS:** Six large-scale gyres were identified in the Gulf of Mexico by simulation modeling. The most intense gyres were the Loop Current and the Western Central Gulf of Mexico Gyres, both anticyclonic. Simulations revealed temporal variability of these gyres which agreed with published accounts.

**STUDY RESULTS:** The Loop Current Gyre was the largest, most intense, anticyclonic gyre in the Gulf of Mexico. The anticyclonic Western Central Gulf of Mexico Gyre was centered at approximately 23.5°N lat and 95.5°W long. A cyclonic gyre in the Bay of Campeche (20.5°N lat, 95°W long) was an annual circulation feature. A cyclonic pattern was found along the Texas-Louisiana shelf, hence referred to as the Texas-Louisiana Gyre. The De Soto Canyon Gyre was centered at 28.50°N lat and 87°W long, near the head of the Canyon. The West Florida Shelf Gyre was a weak cyclonic feature centered at 27.5°N lat and 85.5°W long.

Seasonal variations of the Loop Current showed the apex at 26.5°N lat in summer, and 25.0°N lat in winter. The western limb of the Loop Current extended to 88.5°W long in summer, and 87°W long in winter. The core of the Loop Current migrated considerably from May to July. The well developed Loop disappeared during August, and from September to December showed reduced core variability. January to April core positions were less variable yet. A deep westerly flow between 22.5°N and 23.5°N lat was observed in all months from Campeche Bank to the east coast of Mexico. During Fall, the northern limb of the Texas-Louisiana gyre appeared to be continuous from the eastern to western Gulf. The center of the Western Central Gulf of Mexico Gyre was located farther northwest in summer than in winter; the northern limb flows across the central Gulf in summer.

Synoptic cruise data were used in the numerical model to simulate realistic current fields. The 0.5° grid spacing hindered the results. Only large-scale currents were considered accurate. Vertical sections of geostrophic velocity were computed; most of the flows were above 700 db.

**STUDY PRODUCTS:** Molinari, R. L., D. W. Behringer, an J. F. Festa. 1976. A Numerical Modelling and Observational Effort to Develop the Capability to Predict the Currents in the Gulf of Mexico for Use in Pollutant Trajectory Computation. A final report by the U.S. Department of Commerce, National Oceanic and Atmospheric Administration for the U.S. Department of the Interior, Bureau of Land Management Gulf of Mexico OCS Office, New Orleans, LA. Contract No. 08550-IA5-26. 145 pp + app.

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