A Numerical Study of the Circulation on the Western Shelf of the Gulf of Mexico

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The seasonal to synoptic scale circulation on the western shelf of the Gulf of Mexico (WSGM) is studied using the Navy Coastal Ocean Model (NCOM) (*Martin*, 2000; *Morey et al*., 2001). The model domain includes the entire Gulf, from 15.55°N to 31.50°N and from 80.60°W to 98.15°W, in a 1/20° resolution C grid with 20 sigma coordinates in the upper 100 m and 20 z-level coordinates below 100 m. The domain includes the entire Gulf because of the importance of the remotely generated Loop Current eddies on the western Gulf. The model is forced with monthly mean fluxes at the surface, a prescribed constant current in the open boundary at the Caribbean Sea, and an open boundary at the Florida Strait.

The WSGM is characterized by a wide shelf off the coast of Louisiana and Texas (LATEX) of around 200 km that narrows toward the south in the Mexican states of Tamaulipas and Veracruz, becoming narrowest (~40 km) in the southern part of the Campeche Bay (Fig. 1). There are not many previous studies in this region (Bouicourt et al., 1998) so we focus this study on the dynamics at a seasonal scale.

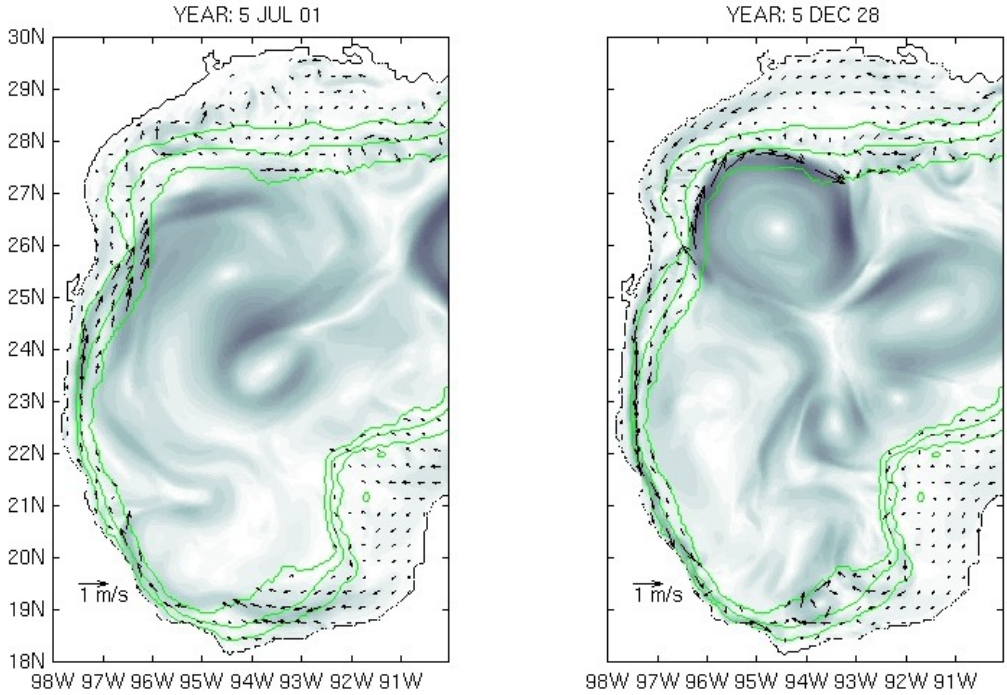

Figure 1. Surface velocity on the shelf of the western Gulf of Mexico for representative days of the spring-summer (July 1) and fall-winter (December 28) conditions. Also contours of the 50, 200, and 1000 m depth.

Our results show that there is a strong seasonal component in the circulation variability of the WSGM. During spring-summer, south of 27°N, the dominant circulation is to the north, beginning in March-April. The summer regime remains until early September when the circulation reverses to a counterclockwise direction (Fig. 1). Velocities are typically ~50 cm/s, and transports between the coast and the 50 m isobath vary from 0.1 to 0.5 Sv. Most of the seasonal signal is confined between the coast and the location of the 50 m isobath, but this varies in different locations of the shelf. South of 26 °N, where the continental shelf is narrower, the seasonal signal reaches as far as the 200 m isobath. The fall-winter current reaches the southern Bay of Campeche where it collides with an along-shelf current running in the opposite direction.

During winter, fresh water from the Mississippi and Atchafalaya rivers is advected along the LATEX shelf onto the Tamaulipas shelf, developing along-shelf thermal and salinity fronts (Fig. 2). The summer

circulation is associated with an upwelling generated by local Ekman transports with sloping isotherms and a northward along-shelf current (Fig. 2).

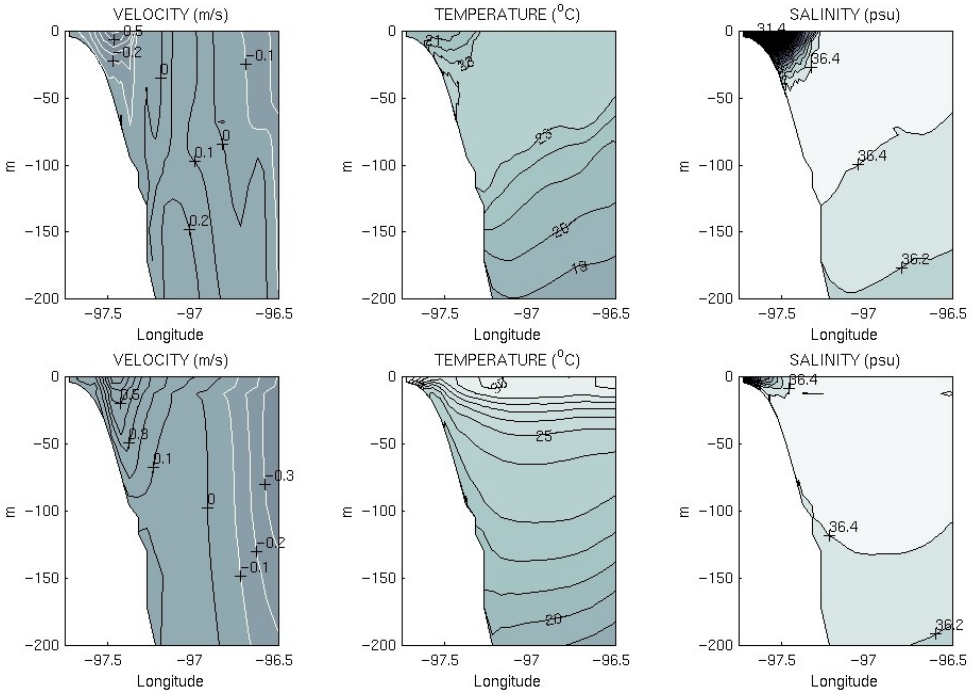

Figure 2. Vertical sections of meridional velocity, temperature, and salinity at 24°N for representative days of spring-summer (upper panel) and fall-winter (lower panel) conditions.

The seasonal circulation is caused by the combination of the local wind stress forcing and an important remote component caused by coastal waves originating in the LATEX shelf as follows. During winter the Ekman transport on the LATEX shelf piles water toward the coast developing coastal Kelvin waves that migrate southward. Associated with these waves is a coastally attached current running counterclockwise that continues along the Mexican shelf. The current is trapped by the topography and reinforced by the local Ekman transport. From April to September the Ekman transport in the LATEX shelf shifts 90 degrees clockwise generating an eastward transport along the external shelf. Over the Mexican shelf, the local winds in the Mexican shelf change direction favoring upwelling.

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