The response of the Gulf of Mexico to wind and heat flux forcing

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The Loop Current and its shed eddies frequently dominate the circulation and dynamics of the Gulf of Mexico (GoM). Those eddies are strongly energetic and are the cause of intense currents that may penetrate several hundred meters deep. However, there are regions in the GoM and periods of time in which the local atmospheric forcing plays an important role in its dynamics and thermodynamics. The circulation on the shelves, and particularly on the inner shelf, is mainly wind-driven with seasonality, changing direction during the year with periods of favorable upwelling/downwelling conditions. The wind-driven circulation is associated with the transport of waters with different temperature and salinity characteristics from one region to another. The interannual variability of the circulation on the shelves is linked to the atmospheric variability. Intraseasonal variability of the wind patterns considerably affects the likelihood and magnitude of upwelling and downwelling. The geometry of the GoM is such that large-scale winds may drive opposing upcoast/downcoast currents along different parts of the curving coast, resulting in convergence or divergence zones. The width of the shelves in the GoM is variable, with the West Florida Shelf, the Texas-Louisiana shelf and the Campeche Bank being more than 200 km wide, and narrower near Veracruz and Tabasco. Another consequence of the GoM physiography and the wind forcing is the development of cross-shelf transports in particular areas, which in turn vary during the year. During autumn-winter (from September to April), the GoM is affected by cold fronts coming from the northwest United States, which are associated with strong, dry, and cold winds that mix its waters and generate large sensible and latent heat fluxes from the ocean to the atmosphere. These frontal passages also cool the GoM due to mixing of warm surface waters with lower temperature subsurface waters. During summer, tropical cyclones crossing the GoM can dramatically affect circulation and coastal upwelling.