Quantifying the Seasonal and Interannual Variability of the North Brazil Current and its Influence on the Migration Pattern of North Brazil Current Rings

Neha Sharma, Steven Anderson, Peter Brickley, and Matthew Cadwallader

The complex nature of the North Brazil Current (NBC) has lead to various studies regarding its seasonal variations and eddy-shedding regime. Horizon Marine, Inc. has conducted operational analysis of the NBC for the past 8 years, making use of drifting buoys, satellite imagery, and ADCP data. We have validated observations made by previous studies such as Richardson et al. (1994), Fratantoni et al. (1995), Johns et al. (1999), and Wilson et al. (2002) during this time period. The strength and vertical structure of the NBC varies significantly with changes to the inter-tropical convergence zone (ITCZ), wind forcing (local winds and trade winds along the western boundary of the Atlantic Ocean), and outflow from the Amazon River. Local precipitation and discharge from the river strongly influences the hydrographic structure of the NBC and local shelf flow. During the summer, fall, and winter seasons, the NBC changes direction east of the Guiana Plateau to flow eastward, forming the North Equatorial Counter Current (NECC). Energy fluctuations within the NBC Retroflection can create a closed circulation at the point of inception of the NECC. This closed circulation can spin off to create a separate anticyclonic eddy, known as an NBC ring. These rings vary from 150 to 400 km in diameter and 70 to 200 cms^{-1} in surface intensity. The depth of the coherent velocity structure can vary from 200m to 1000m (Fratantoni et al., 1995; Richardson et al., 1994). Our observations indicate that, on an average, the NBC Retroflection sheds 5 to 8 NBC rings over the period of 1 year. The structure and intensity of each of the rings varies seasonally as does their migration rate and trajectory. The offshore energy sector of Trinidad and Tobago is most strongly impacted by the NBC ring influence on local oceanographic conditions, most critically the vigorous near-surface currents associated with the rings' strong vertically coherent velocity fields. Discharge from the Orinoco River has been observed to vary in response to strong currents created in and around the NBC rings. The extent of this influence depends on the NBC ring proximity to the shelf break, the ring swirl velocity, and vertical variation in the ring velocity field.

In this study, we quantify characteristic patterns of oceanographic variation imposed by NBC rings observed in our operational datasets and compare these with climatologies obtained from moored equatorial buoys (PIRATA), surface currents derived from satellite altimeter and scatterometer data (NOAA's OSCAR), and river discharge (Pujos and Froidefond, 1995). Of central importance is determining the variations in migration patterns of NBC rings with changing seasonality and sources of energy. Outputs from the Global HYCOM model and NLOM model have also been studied and compared to the above datasets. A central question is the role of local versus remote sources of interannual fluctuations in ring genesis, trajectory, and vertical structure. Variation in the thermocline depth and horizontal gradient in the equatorial Atlantic Ocean have been observed in moored buoy measurements and are expected to result in subsequent intensity variations of the NBC and NBC rings. This phenomenon is also investigated to determine existence of any possible seasonality, frequency, and duration patterns.