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Abstract

Increase in in-situ observations over the Bay of Bengal (BoB) on implement of IndOOS (Indian Ocean Observing System) has encouraged studies to investigate the influence of upper ocean thermodynamics on cyclone intensity. A number of such studies infer that the subsurface mesoscale eddies significantly modulate the intensity of cyclones through exchange of air-sea fluxes around the storm environment and suspected to be the root cause for rapid intensification of hurricane Opal in Atlantic ocean and cyclone Nargis in BoB. Sea Surface Temperature (SST) is conventionally used as a representative of Upper Ocean Heat Content (UOHC) in Numerical Weather Prediction (NWP) models. Some recent studies suggested that SST is not a good representative of UOHC and Sea Surface Height Anomaly (SSHA) obtained from satellite altimeter observation can well represent the subsurface mesoscale eddies in the ocean.

The present study deals with representation of UOHC in numerical model for mesoscale simulation of cyclones over North Indian Ocean (NIO). In an attempt to find a good representative of UOHC, a detailed analysis of satellite derived AVHRR-SST and SSHA is carried out in relation to the intensity and track of NIO cyclones. It indicates that SSHA has good correlation with cyclone intensity. The upper ocean thermal structure is derived using the two layer reduced gravity model by approximating the mixed layer depth. The Tropical Cyclone Heat Potential (TCHP) is then estimated by integrating the derived thermal structure using polynomial interpolation in order to fit the classic in-situ thermal profile. TCHP is computed at every 0.25° x 0.25° grid over NIO (10^0S-35^0S & 50^0E-115^0E). The derived TCHP is validated with the TCHP computed using in-situ observations and found to be more accurate compared to TCHP obtained using conventional methodology. Thus TCHP derived as mentioned above is a better representative of UOHC but cannot be directly incorporated in NWP models. Hence a new state variable called Upper Ocean Mean Temperature (UOMT) is defined as $UOMT = \frac{TCHP_{2layer\ \mathrm{mod}\ el}}{C_p * \rho_0 * D_{26}} + 26$where $D_{26}$is the mean depth of 26° isotherm.[1]

The impact of the derived UOMT and AVHRR-SST on intensification of NIO cyclones is analysed for all cyclones during 2006-2011. It is observed that the intensity of the cyclones decreased on passing over low UOMT zones (cold eddies) and increased sharply while passing over high UOMT zones (warm eddies). It is also observed that UOMT has better correlation with cyclone intensity both in pre-monsoon (0.4) and post-monsoon (0.33) seasons whereas SST has negative correlation. Analysis of in-situ Argo profiles (2006-2011) reveals that the decrease in correlation in the post-monsoon season is primarily due to the haline stratification of the upper ocean which is not included in the estimation of TCHP.

The impact of UOMT and SST in the mesoscale simulation of tropical cyclones is investigated using WRF-ARW model. The results indicate that the intensity of the cyclones is better simulated with UOMT than SST. However, there is no significant improvement in simulation of track of the cyclones.

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