Simulation of upper Ocean response to the observed cyclones in the Indian Seas

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Introduction

Ocean feedback factor (in particular upper ocean temperature) is important for dynamical prediction of tropical cyclones. In this study the oceanic response to the two cases of Indian Ocean cyclones (TC 01A) and (TC 02B) in 2004, is studied. The simple 1½ layer wind driven reduced gravity ocean model is employed for this study. The model derived Sea Surface Temperature change is validated with the observation for both the cases.

The first cyclone TC 01A (designated ARB0401 by IMD) formed early in the month of May just off the southwestern Indian coast. TC-01A (5 -10 May) moved erratically for several days, then began to move on a north- westerly trajectory paralleling the Indian coastline. Based on Joint Typhoon Warning Center's analysis, the system peaked at 23 m/s. The second cyclone TC 02B (designated BOB0401 by IMD), during the period 17-19 May, formed south of Kolkata, in Bay of Bengal and then moved east-northeastward, reaching hurricane intensity and smacking into the northwestern coast of Myanmar where it was quite destructive. The Indian Meteorological Department classified TC 02B as a Very Severe Cyclonic Storm implying winds in excess of 33 m/s.

Results and discussion

The reduced gravity model with horizontal resolution ½° x ½°, is integrated for the entire life span of these two tropical storms separately, from the initial condition of rest. The idealized cyclonic vortices suitable for these storms are used to force the model in separate numerical experiments. Figure 1 displays the results for the third day for the tropical storm TC 01A in the left panel and for TC 02B in the right panel. The first three figures in each panel are model derived currents, Mixed layer depth anomaly (MLDA) and temperature change for corresponding storm cases. The maximum currents of 0.6 m/s lie on the left of the track for TC 01A. Similarly, the MLDA and Temperature field also has left bias giving maximum upwelling (30 m) and maximum cooling (3 °C) on the left of the track. In the northern hemisphere tropical cyclones generally have maximum cooling in association with maximum upwelling to the right of the track [3,4]. The left bias may be due to the erratic nature of the storm track in the first three days. The storm travels southeastward for sometimes when there is looping of the track. Hence the bias is opposite to that of the earlier findings [1,2,3,4]. For the track of TC 02B the model currents, MLDA and temperature change, have right bias. The maximum currents of 0.2 m/s, maximum upwelling (7 m) and maximum cooling (3.5°C) are on the right of the track. The right bias is in agreement with the earlier model studies [1,2,3,4]. For both the tracks the surface circulation shows the divergence of the flow near the storm center. Also the region of upwelling (cooling) is surrounded by the region of downwelling (warming).

The model simulated temperature change is validated using observed temperature change from daily TMI SST, during the passage of the cyclones. This observed temperature change is shown in the last figure in each panel for both the tracks. It is seen that the observed cooling of 2.5 °C for TC 01A and 3.5 °C for TC 02B is well simulated by the models. The left bias in model temperature field for the cyclone TC 01 A and right bias for TC 02 B is also in agreement with the observed temperature change. The higher value of maximum cooling in the case of TC 02B as compared to TC 01A is attributed to the high intensity of the TC 02B over TC 01 A.

References

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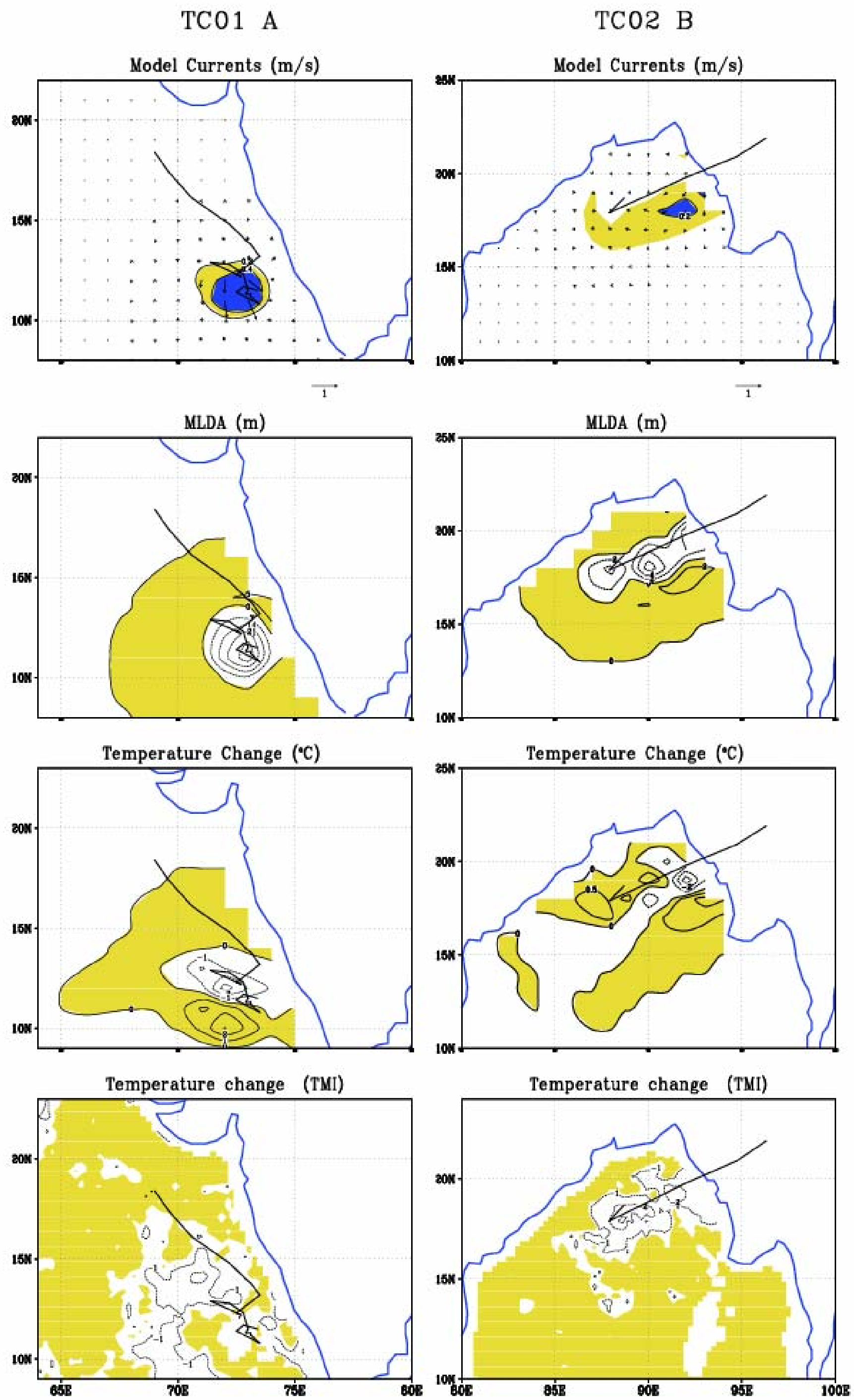

Model currents, Mixed Layer Depth Anomaly, Temperature change and observed temperature change on the third day for the two observed tracks (tracks shown as solid line). Positive values are shaded.