Ocean mixed layer response to the tropical cyclone moving in different directions in the south Indian Ocean

A.A.Deo, D.W.Ganer and P.S.Salvekar
Indian Institute of Tropical Meteorology, Pune 411 008
E-mail : aad@tropmet.res.in

Introduction

For the dynamical prediction of tropical cyclone the knowledge about the ocean response to storm forcing is essential. In the earlier studies the surface circulation and mixed layer depth variation in response to moving cyclones in the Indian Ocean has been studied considering idealized vortex and tracks by using 1½ layer reduced gravity ocean model.[2,3,4,5] In the present study the thermodynamics is included to study the variation in the temperature of the mixed layer during the passage of the cyclone. The model circulation, mixed layer depth variation and temperature change are compared for two different tracks in the southern hemisphere.

Numerical experiment

The 1½ layer reduced gravity ocean model[1] is now modified by including thermodynamic equation which contains the advection term, horizontal diffusion term and the effect of vertical mixing with bottom water. The cooling by evaporation and the effect of sensible heat transfer are neglected as in earlier study[3]. The effect of vertical mixing terms is incorporated implicitly, so that the final temperature equation uses the mixed layer depth before and after entrainment as well as the temperature difference between the mixed layer and the bottom layer. The initial thermocline is assumed to be 50 m deep with top and bottom layer temperatures as 29C and 22C respectively.

Two cases of storm tracks in the southern hemisphere have been chosen. The idealized symmetric cyclonic vortex (Similar to Rankine vortex) having radius 400 km and maximum winds 20 m/s is allowed to move on two tracks say, Track 1 and Track 2. Track 1 is westward, along the line joining the points (70E,15S) and (61E,15S) and Track 2 is southward, along the line joining the points (90E,5S) and (90E,14S). These tracks are close to the observed tracks of the cyclones Mariola (21 S) and Willy (30S) of the year 1994. The duration of the storm in both the cases is kept 5 days so that the storm speed remains same and hence the model integration is carried out for 5 days.

Results and conclusion

Figure 1 shows the model currents, upper layer thickness deviation (ULTD) and temperature change on fourth day for Track 1 (left panel) and for Track 2 (right panel). Results indicate that the maximum currents , ULTD and temperature change has left bias for Track 2 and no bias for Track 1, which are in agreement with earlier reported work[4,5]. However for Track 1, the region of cooling tilts to the left side of the track which suggests that the mixed layer on the left, is cooled slightly more than the right of both the tracks for all the tracks. the number of waves in the ULTD field are in correspondence with the number of waves in temperature field. The area of temperature change is widely spread as compared to that of upper layer thickness deviation. Consequently, the lag between the storm position and maximum cooling is less than that of maximum upwelling. The inertial wave in the wake of the cyclone is clearly seen for Track 1 but is not seen for Track 2. The maximum magnitude of currents (.4 m/s), upwelling (10 m) and cooling (2 C) is less for Track 1 as compared to that for Track 2 for which these values are .6 m/s, 20m and 4 C. These results are found to be reversed in the northern hemispheric cases of cyclones the in earlier study[4], where it was found that the magnitude of maximum upwelling is significantly less for the northward track than that for the westward track. From this study it can be said that the results of both the hemisphere differ mainly because of the sign of coriolis parameter.

References

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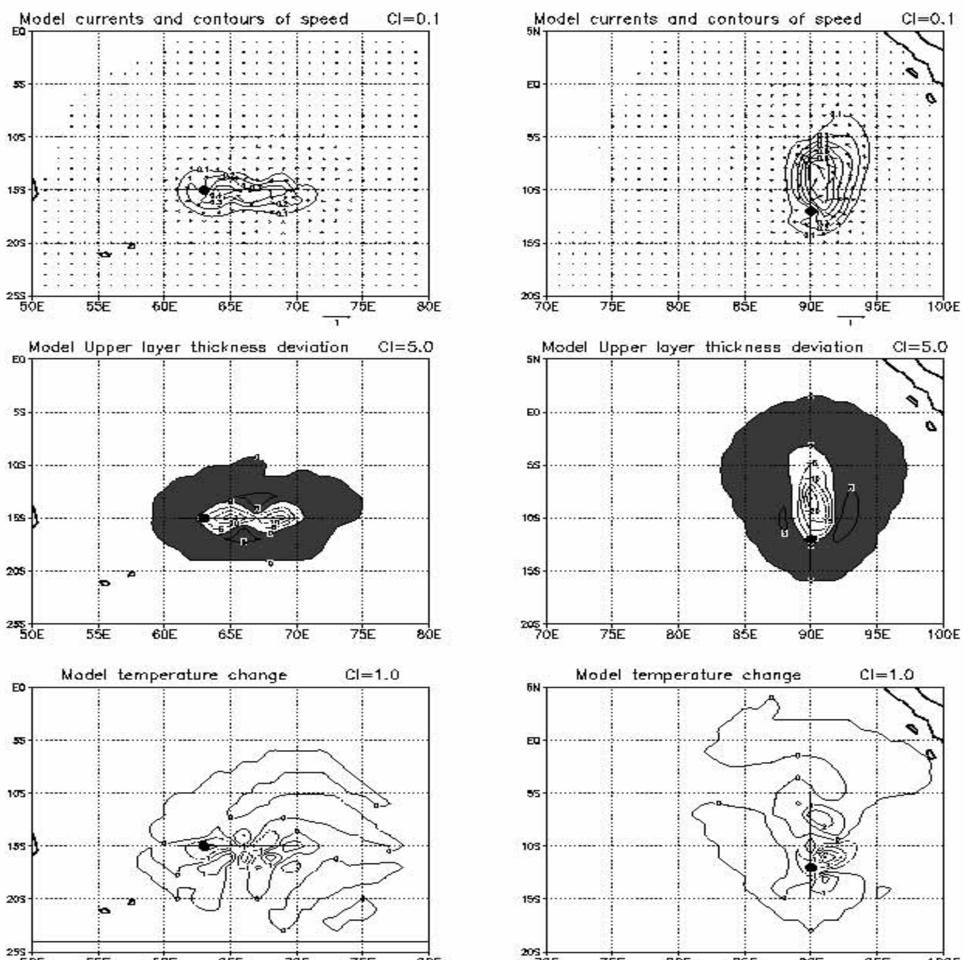

Fig.1 Model currents with contours of speed, Model upper later thickness deviation and temperature change for westward and southward track in SH for Day 4 ● indicates the position of the storm center on fourth day. Solid line drawn is the storm track