CLOUD SCALE SIMULATION AND VERIFICATION OF ORISSA SUPER CYCLONE (1999) IN THE NORTH INDIAN OCEAN

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I. INTRODUCTION

Tropical Cyclones (TCs) constitute one of the most destructive natural disasters that affect many countries around the globe causing tremendous loss of lives and property. Accurate forecasting of both track and intensity of TC is critical to mitigation of disasters. Modeling tropical cyclone requires high-resolution models, which gives accurate representation of physical processes over wide range of scales and the interaction of different scales of phenomena. The horizontal extent of the TC is typically several hundred to thousand kilometers, but the energy responsible for the whole system is mainly released in convective cells only a few kilometers across. It is the atmospheric system of interacting physical processes and multi-scale motions. The PSU-NCAR Mesoscale model MM5 (Dudhia 1993) has been used frequently to study tropical cyclones at cloud resolving scale (Braun 2002).

II. PRESENTATION OF RESEARCH

The numerical simulation of Orissa Super Cyclone (1999) is carried out using MM5. A 96-h simulation of the cyclone (0000 UTC 26 October 1999-0000 UTC 30 October 1999 is made using a variable resolution nested configuration. Here 3 domains with a horizontal grid spacing of 45, 15, and 5 km and having domain size of 110x110, 154x154 and 238x259 grid points respectively are designed. The grid meshes includes 23 vertical half-sigma (σ) levels from surface to 100 hPa. Physics options are the Kain Fritsch 2 cumulus parameterisation, a mixed phase explicit scale cloud microphysics scheme, Mellor-Yamada planetary boundary scheme and cloud radiative scheme of Dudhia.

For initial and boundary conditions, ECMWF Reanalysis data (horizontal resolution of 2.5^0 x 2.5^0) ERA-40 is used. The lateral boundary condition is supplied at every 12h.

III. RESULTS AND CONCLUSIONS

In this work, after simulating the Orissa Super Cyclone the evolution of the cyclone is analysed in terms of sea level pressure, wind flow, along with the structure of the mature cyclone. The movement of the cyclone and its final landfall point are compared with Indian Meteorological Department (IMD) reports.

The simulated sea level pressure indicated the gradual intensification of the storm during the first 2 to 3 days and then rapid intensification for about 24 hours agreeing well with the observations. The simulated minimum central sea level pressure of 915 hPa is comparable with observed 912 hPa pressure. The vertical velocity field shows subsidence at the centre surrounded by vertical motion extending throughout the troposphere (Figure 1a). The maximum updraft is 5-6 ms^{-1} near the 350 hPa level. Vertical cross section of simulated tangential component of the wind at 18.80 N (Figure 1b) shows the existence of radius of maximum wind throughout the troposphere in the eyewall. The strongest wind of 70-80 ms^{-1} occurs near 850 hPa.

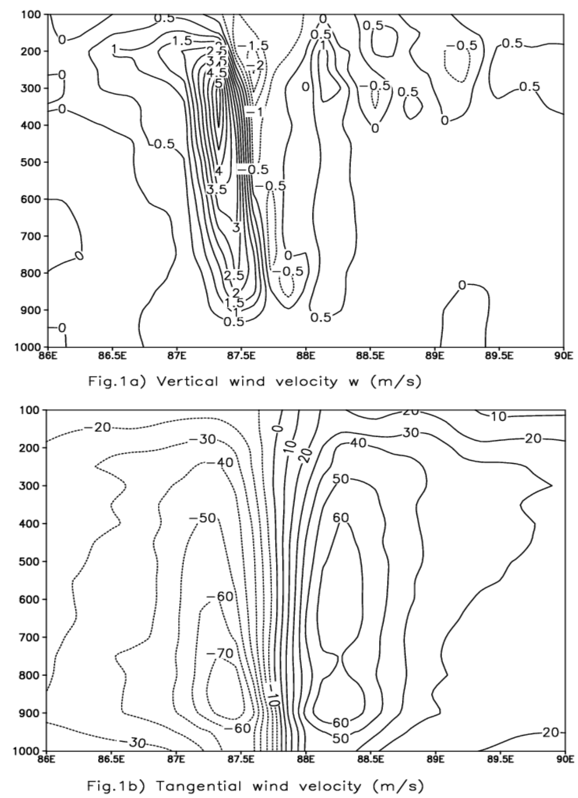

FIG. 1: Vertical cross section of simulated a) vertical wind velocity (ms^{-1}), b) Tangential wind velocity (ms^{-1}).

The results suggest that it may be possible to predict track, intensity and inner-core structures of devastating tropical cyclones with the help of high grid resolution and realistic model physics configuration. The results will be presented and discussed in more detail in the paper.

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