Influence of model horizontal resolutions (1.667 km, 3 km and 5 km) in the prediction of super cyclone Amphan 2020 over the Bay of Bengal

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Introduction

- In last two decades over the Bay of Bengal (BoB) region most of the extremely severe cyclonic storms (ESCS; wind speed more than 46.25 m/s) making landfall with extreme intensity (Singh et al., (2021).
- The forecast of track has been improved significantly but intensity and rapid intensification (wind speed changes more than 30 knots in 24 hours) forecast is not improved up to the level and hence need to improve forecast of intensity and structure of the BoB cyclonic storms.
- A high horizontal resolution plays an important role in the prediction of tropical cyclones (Jihong Moon et al., 2021 and Hongxiong Xu et al., 2021) and hence an accurate forecast of these storms over the BoB can help to decrease the losses and infrastructure during landfall.
- Hence to improve our understanding and forecast skill of RI and its maximum intensity is also very important and model horizontal resolution less than 2 km required for better representations of physical processes in the eyewall.
- It is expected that by using the high resolution (1.667 km, 3 km and 5 km) of WRF-ARW modeling system for the prediction of super cyclone Amphan 2020 may provides the better prediction in terms of intensity.

Objectives

To analyse the impact of high horizontal resolution on the prediction of intensity, rapid intensification (RI) and inner core structure of super cyclone Amphan (2020) using high resolution WRF-ARW model

Methodology

Model	WRF-ARW (version 4.2)
Initial condition	NCEP GFS analysis 0.25°×0.25°
Lateral boundary conditions	NCEP GFS Forecasted 3 hourly
Model Integration time step Forecast length	75 seconds 108 hours
Horizontal resolution Outer domain Inner domain	 15 km 5km, 3km and 1.667km
Number of horizontal grid points in finer domain	301X301(5km), 326x321(3km), 403x403(1.667km),
Model top	10 hPa
Shortwave radiation	Dudhia scheme
Long wave radiation	Rapid Radiative Transfer Model
Cumulus Parameterization	Kain-Fritsch (new Eta) scheme
PBL scheme	YSU scheme
Microphysics schemes	Lin et.al scheme
Data used for the analysis	best-fit track data obtained from India Meteorological Department (IMD), and satellite observations

Results

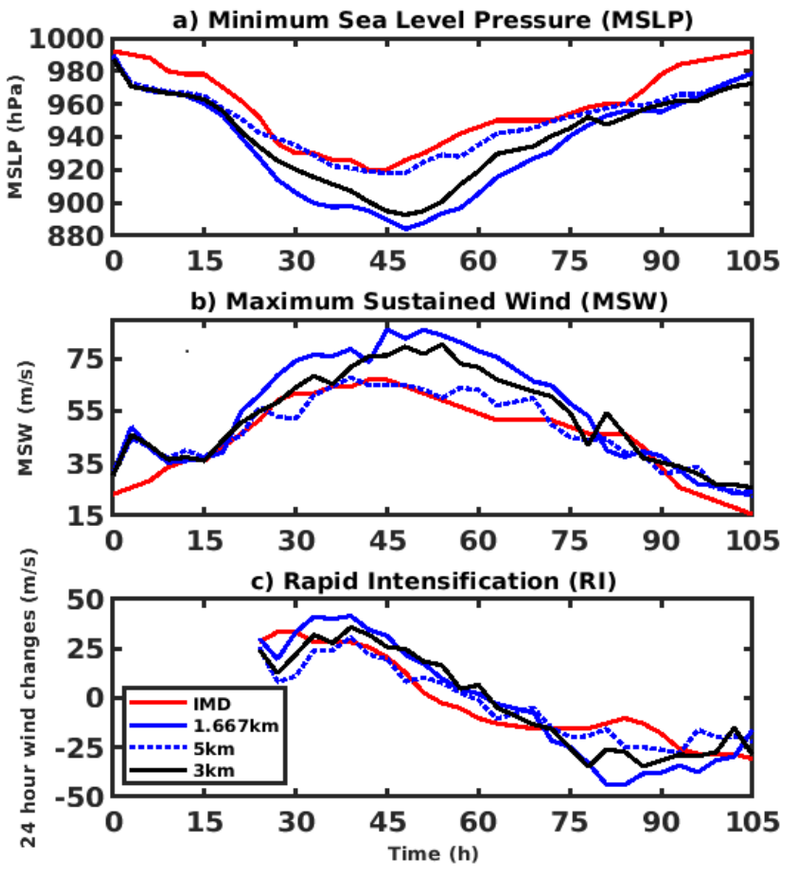

Figure 1: Model predicted MSLP, MSW and RI of the super cyclone Amphan 2020 along with IMD best fit track.

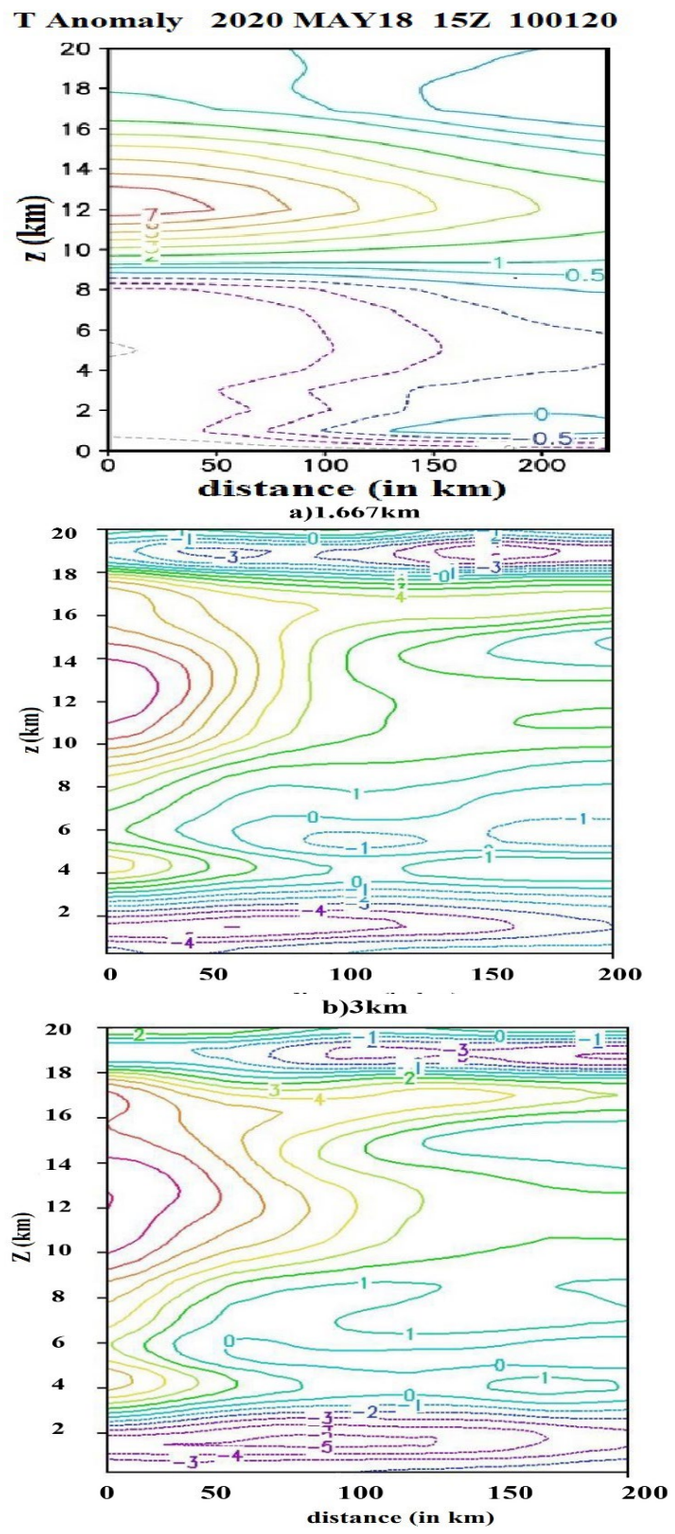

Figure 2: Temperature anomaly obtained from different horizontal resolutions 1.667 km and 3 km along with Satellite observations at 15UTC on 18 May 2020.

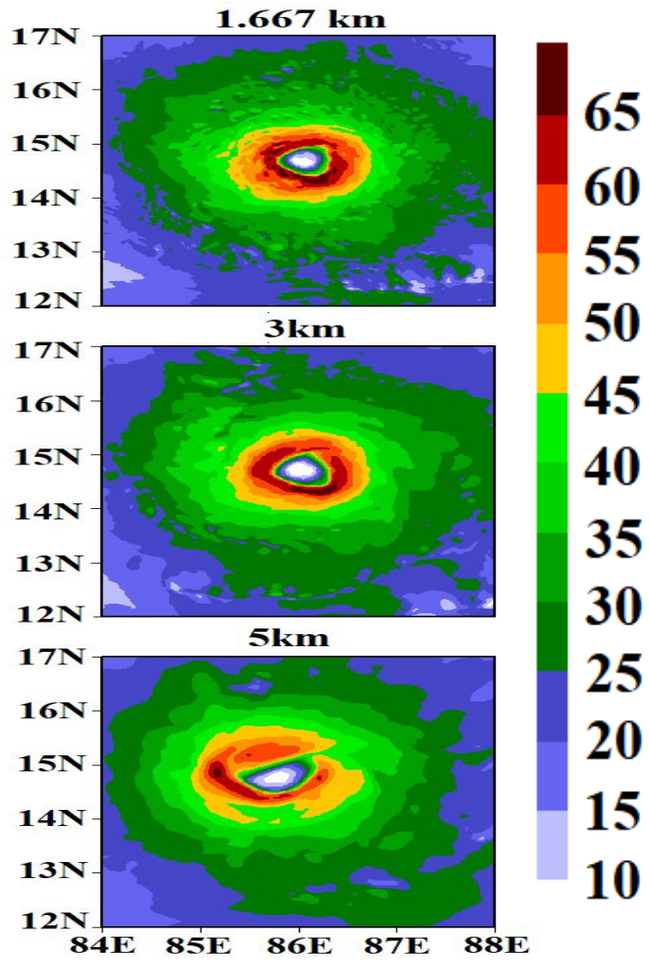

Figure 3: Surface wind speed (in m/s) obtained from different horizontal resolutions 1.667km,3km and 5km at 15UTC on 18 May 2020.

Conclusions

- The WRF model using high horizontal resolution well captured the prediction of Amphan in terms of intensity, rapid intensification in a moving nested domain.
- The structure of the storm compared with available observations in terms of maximum reflectivity, temperature anomaly showed that high horizontal resolution (1.667km) well captured the results with some limitations.
- It can be concluded that increasing horizontal resolution is not only sufficient to improve the forecast of maximum intensity, and rapid intensification.
- It is expected that result could be enhanced by using suitable data assimilation techniques and physics parametrization schemes with more number of cases across the region.

Reference

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