Numerical Experiments of Myanmar Cyclone Nargis

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On 27 April 2008 cyclone Nargis formed in the Bay of Bengal and made landfall on 2 May in southwestern part of Myanmar. The cyclone and the associated storm surge caused heavy human damages. If an appropriate warning was issued about 2 days before the landfall, the number of casualties might have been reduced drastically. In order to show the performance of the downscale NWP using NHM and JMA data, we performed a forecast experiment of Nargis. We also simulated the storm surge with the Princeton Ocean Model (POM) using the NHM forecast data.

We conduct a regional forecast with NHM, using the JMA global analysis (horizontal resolution is about 20 km) as the initial condition and the GSM global forecast (horizontal resolution is about 50 km and valid time is every 6 hours) as the boundary condition. We also use the JMA global land surface analysis and JMA global SST analysis. NHM is executed with a horizontal resolution of 10 km for a square region of 3400 km around the Bay of Bengal (Fig. 1).

Considering the lead time for warning, the initial time is set to 12 UTC 30 April, 2008. In the JMA analysis, Nargis was expressed as a weak depression of 999 hPa in the center of the Bay of Bengal, and its position was deviated eastwardly about 0.7 degree in longitude compared with the best track (Fig. 2). After 42 hour (06 UTC 2 May), the depression developed to a 972 hPa cyclone and reached southwestern part of Myanmar in the NHM forecast (Fig. 1, right). Although this central pressure is weaker than estimated intensity of Nargis (Category 4), the value is much deeper than the GSM forecast (994 hPa; Fig. 1, left).

Figure 2 compares tracks of Nargis predicted by NHM and GSM with the best track. Cyclone landfall time in the NHM forecast was 6 hours earlier than the best track, and this is mainly attributable to the 0.7 degree positional lag in the initial condition mentioned above. In the GSM forecast, predicted course of Nargis is closer to the best track than NHM, but the positional lag at FT=42 is larger than NHM because the timing of landfall is earlier than NHM. Although the landfall point of NHM forecast was deviated about 100 km northwardly than the best track, NHM predicted the strong winds which covered the southern part of Myanmar including the Irrawaddy and Yangon Deltas.

Using the NHM forecasted data (surface wind and pressure), we conducted a numerical simulation of the associated storm surge with POM. POM is a free surface ocean model developed at Princeton University. The horizontal resolution is about 3.5 km and vertically 12 layers sigma coordinates are employed. The domain size is 451x391 which covers eastern part of the Bay of Bengal (broken rectangle in Fig. 1). In the simulation, the initial state is assumed to be static, and the astronomical tide and wind waves are not considered.

Figure 3 shows displacement of sea surface level simulated by POM at 00 UTC 2 May 2008 (FT=36). At this time, the center of the simulated Nargis is located off the west coast of southern Myanmar, and a rise of sea-level due to low pressure near cyclone center is seen as a circular contour. In the enlarged view, we can see that southerly sea surface current generated by surface wind flows into mouths of rivers in southern Myanmar (*e.g.*, Irrawaddy River and Yangon River).

Figure 4 indicates time sequence of surface (10 m) wind speed, wind direction and water displacement of sea surface level at the mouths of Irrawaddy River (16.10N, 95.07E) and Yangon River (16.57N, 96.27E). At points in these river mouths, water levels become highest at the times when the southerly winds are strongest. This correspondence between peaks of wind speed and water level suggests that surface current generated by wind is a major cause of water level rising in these areas. At 07 UTC (FT=43), displacement of sea surface level about 3.2 m is simulated at the Irrawaddy River point, which is roughly consistent with the reported magnitude of storm surge in southern Myanmar.

Result of a mesoscale ensemble forecast with NHM to consider uncertainties of initial and lateral boundary conditions is given by a separate study (Saito et al.; this volume). To further reduce errors of intensity and track forecast, data assimilation is a future subject.

Acknowledgement

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References

K. Saito, T. Kuroda and M. Kunii, 2009: Ensemble Forecast Experiment of Cyclone Nargis. *CAS/JSC WGNE Research Activities in Atmospheric and Oceanic Modeling*. **39**. (this volume)

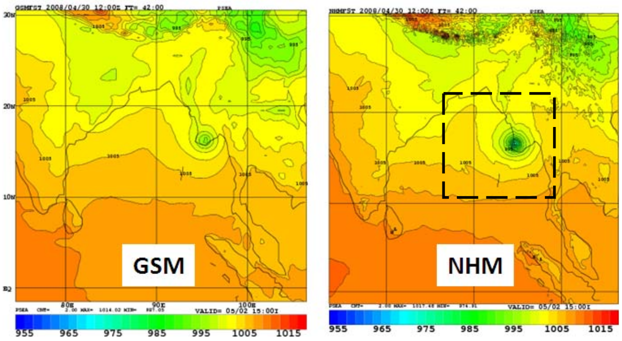

Fig. 1. Sea level pressure at 06 UTC 2 May 2008 (FT=42) predicted by GSM (left) and NHM (right). Figures show the domain of NHM and broken rectangle indicates the domain of POM.

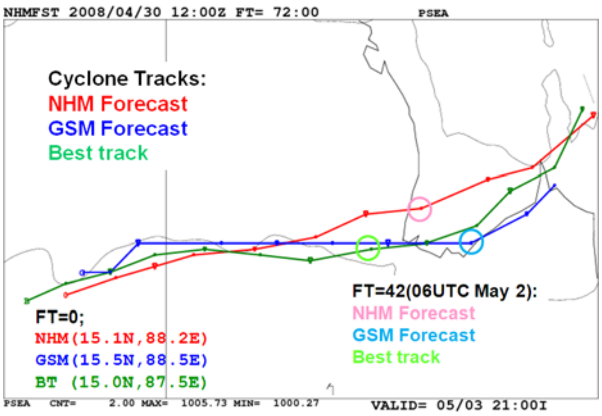

Fig. 2. Best track of Nargis and tracks predicted by NHM and GSM. Points enclosed with circles represent locations of the cyclone center at 06 UTC 2 May (FT=42).

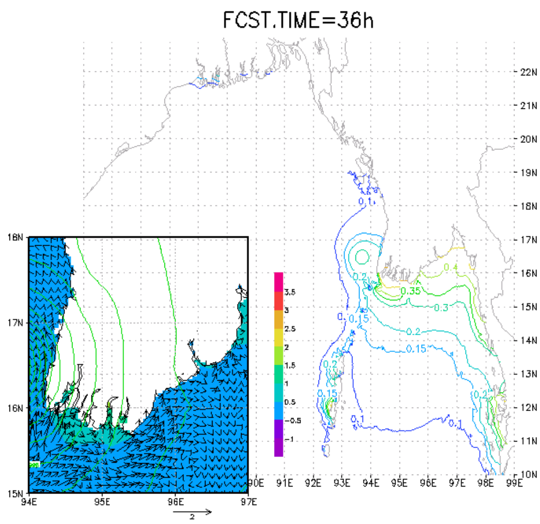

Fig. 3. Displacement of sea surface level simulated by POM at 00 UTC 2 May 2008 (FT=36). Lower left panel shows the enlarged view of sea level pressure (contour) and sea surface current (arrows).

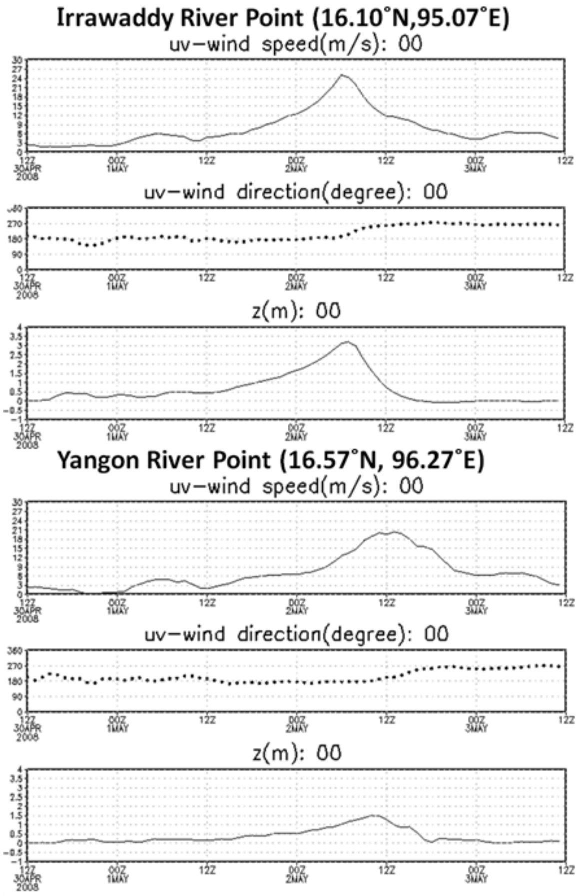

Fig. 4. Time sequence of surface (10 *m*) wind speed (upper) and wind direction (middle) given by NHM forecast, and water displacement of sea surface level simulated by POM (bottom) at the mouths of Irrawaddy River and Yangon River. Horizontal axes represent time window form 12UTC 30 Apr. to 12UTC 3 May. Value ranges of vertical axes are [0, 30] (*m/s*, wind speed), [0, 360] (*degrees*, wind direction) and [-1, 4] (*m*, water level).