P1.11 FEASIBILITY STUDY OF SEASONAL FORECASTS OF TROPICAL CYCLONES IN THE WESTERN NORTH PACIFIC AREA USING REGCM3

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1. INTRODUCTION

Past studies (Bengtsson et al. 2007, Vitart et al. 1997, Yokoi et al. 2009) devoted to tropical cyclone (TC) simulation in General Circulation Model (GCM) have shown that TC structure and tracks can be reasonably induced. These TC simulation experiments has also been investigated by using Regional Climate Model (RCM) in some studies (Camargo 2007, Landman 2005), in the light of lower requirement of computer resources and time. This study attempts to explore the potential use of a RCM for forecasting seasonal tropical cyclone activity in the western North Pacific. Seasonal tropical cyclone activity over the region is simulated by a modified version of Regional Climate Model Version 3 (RegCM3) to study the ability of the model to simulate the genesis and landfalling TC tracks.

2. DATA AND NUMERICAL SIMULATION

The 60-km-resolution RegCM is driven by ECMWF Re-analysis data as boundary conditions in the present study. The domain has 112 × 176 grid points and 18 vertical levels. It is over the region from 93°E to 188°E and from 14°S to 41°N. Emanuel cumulus parameterization scheme is employed with convection suppression criteria (Chow et al. 2006). Six-month ensemble (8 runs each) simulations are performed for May to October each year from 1982 to 2001 so that the climatology of the model can be compared to the Joint Typhoon Warning Center (JTWC) observed best track dataset.

3. VORTEX CRITERIA AND TRACKS

In the model, a TC is identified as a vortex with several conditions so that the genesis number each year is closest to the observation. These criteria include,

- local maximum vorticity at 850 hPa with vorticity larger than 450×10^{-6} /s,
- temperature at 300 hPa being 1 °C higher than the average temperature within 15° latitude radius from the TC center,
- TC life time at least 2 days, and
- genesis must be over ocean.

Tracks are traced by these found vortices. Tracks in 1997 and 1998 are shown in Fig. 1. TCs in RegCM3 experiments form far east in the Western North Pacific during 1997 and there is no genesis beyond 160°E in 1998. The influence from ENSO is obviously present within the model.

4. TROPICAL CYCLONES IN REGCM3

The 20-year ensemble experiments show that RegCM3 is able to simulate vortices with wind structure and temperature profile resembling the TCs in a real world (Fig. 2). The radius of maximum wind of a detected TC in 1997 (see Fig. 2b) is between 100 and 200 km.

5. MODEL CLIMATOLOGY

The model reproduces tracks which are very similar to the observed tracks with features like genesis in the tropics, recurvature, landfall and decay. Because TCs in the model tend not to appear close to the domain boundary, TCs in RegCM3 are rather short-lived comparing to JTWC dataset.

The simulated distributions of TC occurrence along latitude and longitude are similar to the JTWC data (Fig. 3). The TC genesis pattern in RegCM3 shows two maxima - one is around the South China Sea, the other one is over the west of Philippines. However, the genesis number over higher latitude region is larger than observed. RegCM3 also has small genesis number beyond 160 degree east.

Fig. 4 illustrates the interannual variation of TC number in RegCM3 and JTWC data. Except the period between 1992 and 1996, the variation in RegCM3 TC number over different years is similar to JTWC data.

It is noted that the general circulation is very important in both TC numbers and the tracks. If there is a month with average 500hPa geopotential height pattern close to the one in ECMWF reanalysis, the model will be able to simulate subtropical high to a large extend, and hence with tracks (and TC occurrence) more alike to the observation. It seems that the choice convection scheme has great influence on the general circulation pattern in RegCM3. Further investigation is needed in the effect of convection scheme on TC simulation.

6. SUMMARY

In this study, a regional climate model, RegCM3, is forced by the initial and boundary conditions from EAR40 reanalysis data to simulate TC in the Western North Pacific between 1982 and 2001, and May to October each year. The model is able to induce TCs with a spatial pattern very similar to JTWC data. The interannual variation of TC number in RegCM3 implies the possibility of seasonal forecast of tropical cyclones using real-time climate model predictions as boundary conditions for RegCM3. Further studies on regional climate change can also be considered by feeding in Intergovernmental Panel on Climate Change (IPCC) scenarios GCM data.

7. REFERENCE

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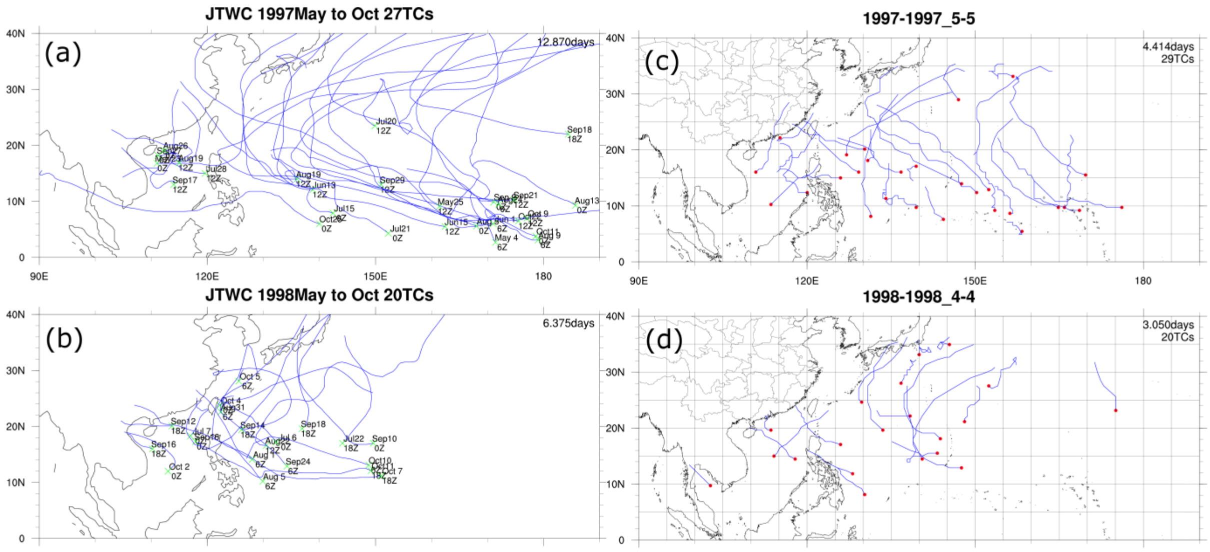

Fig. 1 – (a)(b): JTWC TC tracks in 1997 and 1998 May to October. (c)(d): Same as (a) and (b) except for tracks in one of the ensemble runs in RegCM3.

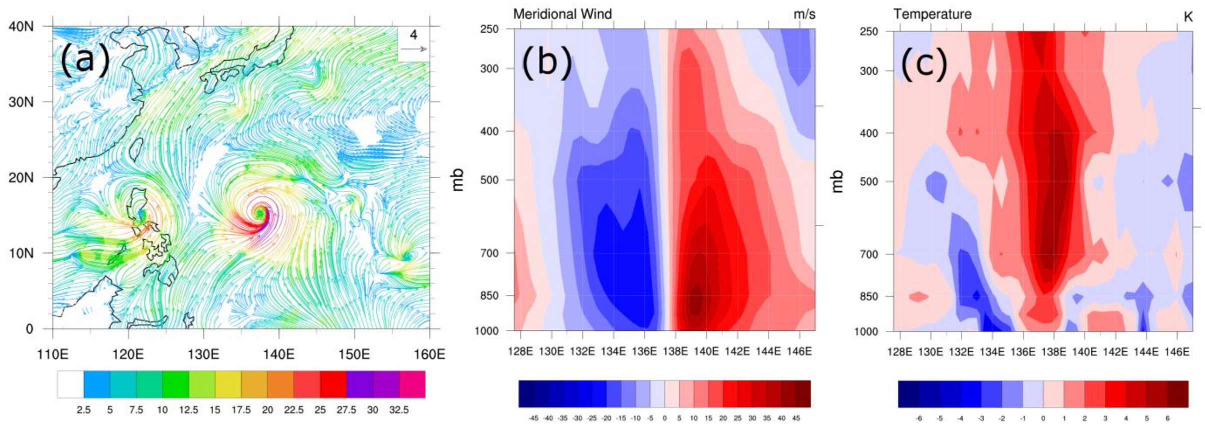

Fig. 2 – (a) A TC is detected in the West Northern Pacific, east of Philippines. (b) Cross-section showing the meridional wind of the TC. (c) Temperature anomaly from the environment.

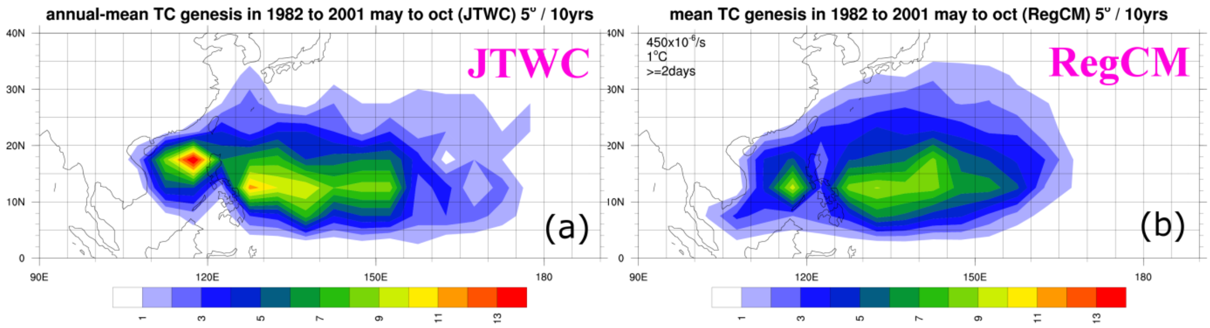

Fig. 3 – (a) TC genesis frequency from JTWC data in the Western North pacific (1982 to 2001, May to Oct) (b) Same graph for RegCM3 experiments. (unit: number per 5°x5° square per 10 years)

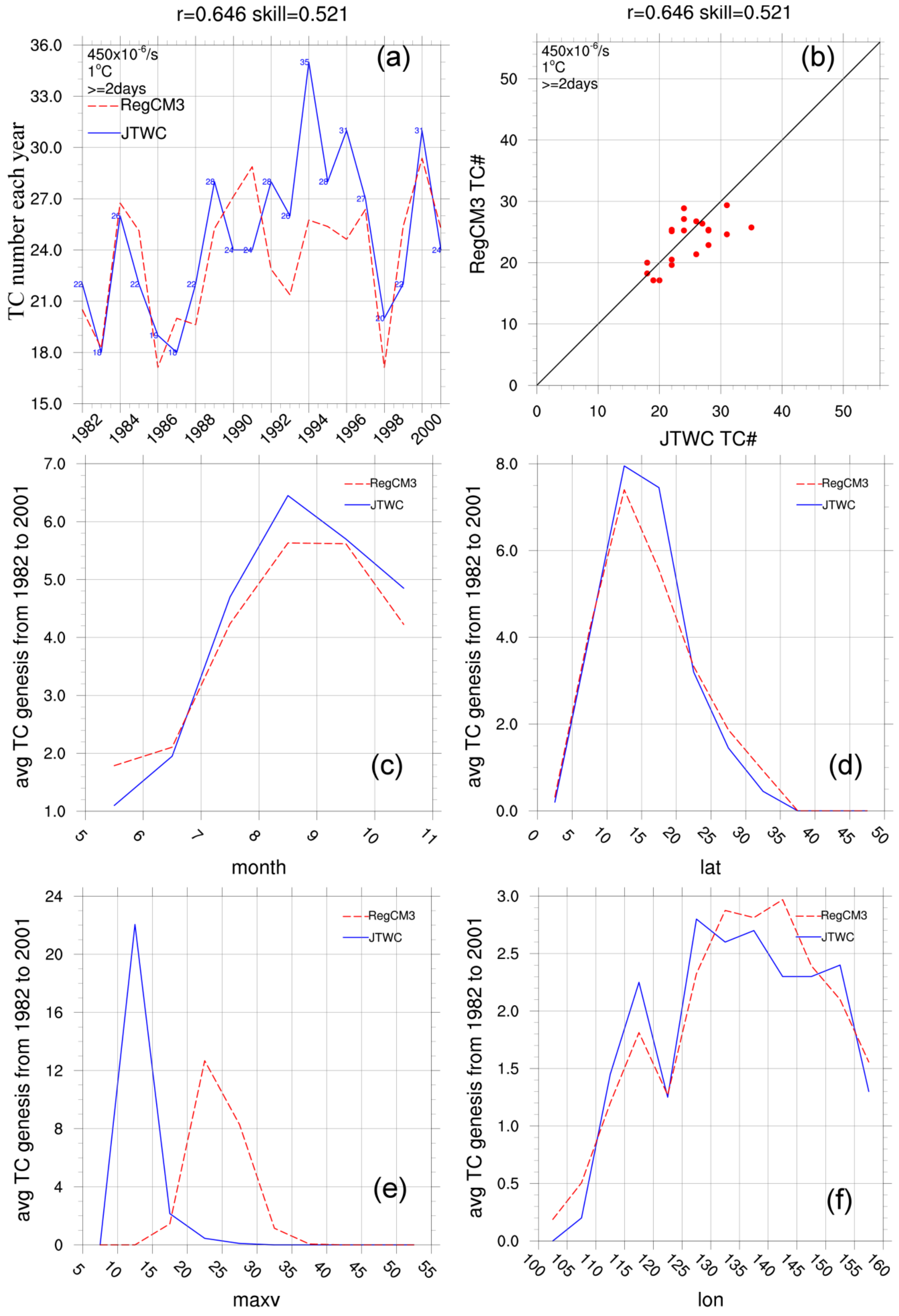

Fig. 4 – (a) Number of TC genesis in RegCM3 experiments (red line) and number in JTWC dataset (blue line). (c): Genesis distribution in different months. (d)(f) Genesis distribution along longitude and lattitude respectively. (e) Distribution of maximum wind speed during genesis.