Simulations of Present-day Tropical Cyclone Climatology and Their Temporal Variability Associated with ENSO with a 20km-mesh High-Resolution AGCM
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1. INTRODUCTION
Tropical cyclones (TCs) continue among the most horrible natural disasters. Recently, a number of studies have been conducted using global circulation models (GCMs) to explain the influence of TC activity on global warming. For example, Oouchi et al. (2006, JMSJ) evaluated TC changes in a warm-climate experiment using a 20-km-mesh high-resolution Atmospheric GCM (AGCM). However, it is uncertain whether the GCM can reproduce the real TC climatology given the observational sea-surface temperature (SST) and sea-ice concentration (SIC).

The goal of this study is to evaluate the TC simulation of seasonal variability of genesis position, intensity variability, and trend with the AGCM. The AGCM performance of the dependence of TC activity on the El Niño-Southern Oscillation (ENSO) in the Western North Pacific (WNP) basin is also evaluated in terms of position of TC variability and difference of accumulated cyclone energy (ACE).

2. MODEL AND EXPERIMENTAL DESIGN
Integration Period: 1979~2003 (25 years)
Initialization Condition: The Hadley Centre Sea and Sea Surface Temperature data on version 1 (HadISST1) (Rayner et al., 2003)

Observation Data (a) Observation 1979~2003 (b) AGCM 1979~2003

3. SAMPLE OF SIMULATED TROPICAL CYCLONE

(a) Observation 1979~2003
(b) AGCM 1979~2003

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4. SIMULATED TROPICAL CYCLONE CLIMATOLOGY

The AGCM captures very well observational features of the latitudinal and longitudinal distribution of genesis position and the seasonal variability for each basin.

6. ENSO INFLUENCE ON TROPICAL CYCLONE ACTIVITY OVER WESTERN NORTH PACIFIC

The AGCM reveals a subtle southward shift during the La Niña years though there are fewer TCs around the lower latitudes. The longitudinal distribution is different from the observation. This is caused by few TCs over Western North Pacific Ocean, and too much TCs over Indian Ocean basin.

ACE difference between El Niño and La Niña years

Although the interannual variability of TC formation is not highly correlated with observation for some basins, the western North Pacific and the north Atlantic shows relatively highly correlated. The total number of TC formation is not so much highly correlated with the local SST (figure not shown).

5. INTERANNUAL VARIABILITY OF TC FORMATION

The total maximum wind speed and duration are underestimated. The local SST, when TCs are formed, are well simulated. The maximum wind speed exceeds 17m/s are a little bit underestimated.

Summary

We conducted a 25-year, present-day simulation with a 20-km-mesh AGCM using observational SST and SIC as lateral boundary conditions in order to evaluate the model performance of interannual and seasonal variabilities of the genesis position and genesis frequency of TCs. We found the following features:

The genesis position and its seasonal variability for each basin are quite realistic, though TCs over the western North Pacific basin are underestimated.

The maximum wind speed and duration in which the maximum is underestimated by 20%. The maximum wind speed of AGCM is longer than that of the observation.

The observation data reveal that genesis positions during the El Niño years shift southward, while those during the La Niña years shift northwestward, as reported by Wang and Chan (2002, J.Climate). The AGCM reveals a subtle southward shift during the La Niña years though there are fewer TCs around the lower latitudes and eastern area (e.g., around 140-175E, 5-15N).

ACE difference between El Niño and La Niña years

Although the ACE value by the AGCM is underestimated compared with the observation, the general feature that the ACE increases in El Niño years is well simulated. The genesis position shift by ENSO was confirmed by the AGCM.