Impacts of Cumulus Schemes and Interaction between Deep and Shallow Convection on Intraseasonal Oscillation Simulation over the Asian Summer Monsoon Region

Wenting Hu, Anmin Duan, Guoxiong Wu

(LASG, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing, 100029)

Objective

➢Evaluate the simulation of ISO over the Asian summer monsoon region for the new version of LASG/IAP AGCM (SAMIL-R42L26), using different cumulus schemes;

➢ Illustrate the impact of shallow convection in Zhang-McFarlane Scheme on the ISO simulation in South Asia;

Model & Experiment

➢**Model:**

SAMIL (Spectral Atmospheric Model of IAP LASG)-R42L26

(Hybrid vertical coordinates; Edwards and Slingo radiation parameter scheme; Three cumulus schemes (Mananbe, Zhang McFarlane and Tiedtke scheme);…)

➢**Experiment (integrated for 30 years and the last 27 years daily output is used for analysis :**

Experiments	Cumulus Scheme	Goal
Ctrl1	Manabe Scheme	Evaluate the capability of ISO simulation over the Asian summer monsoon region, using different convective schemes
Ctrl2	Zhang McFarlane Scheme	
Ctrl3	Tiedtke Scheme	
NS	Zhang McFarlane Scheme (No Hack Shallow convection Scheme)	Illustrate the importance of shallow convection to the ISO simulation

Data & Method

➢**Data:** NOAA OLR daily data and NCEP/DOE reanalysis data set of 27yrs from 1980-2006.

➢**Method of calculating climatological intraseasonal oscillations (CISO) and transient intraseasonal oscillations (TISO):**

(1)We partition climatological daily mean series $y_c(i), i = 1,365$ into three components by Fourier analysis:

$$y_{ciso}(i) = y_c(i) - y_{ac}(i) - R(i)$$

Where y_{ac} denotes the sum of the first three Fourier harmonics (period longer than 3 months), that is annual cycle. R represents synoptic fluctuations (removing it by taking a 5-day running mean).

(2) TISO was obtained from the "raw" daily OLR time series through first removing climatology, and then removing synoptic fluctuations by taking a 5-day running mean.

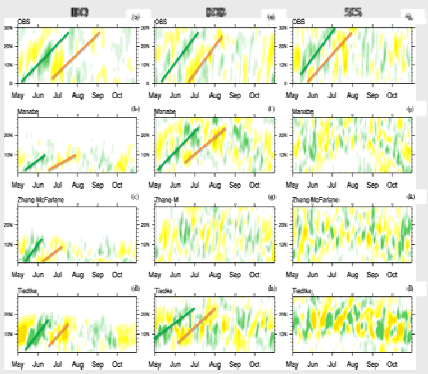
➢**Selection of Asian summer monsoon region**

(1)Summer time: May to October

(2) Three main Asian monsoon regions: IDO (Indian Ocean) 10° N-20° N,50° E-75° E; BOB (Bay of Bengal) 10 ° N-20° N,80° E-100° E; SCS (South China Sea) 10 ° N-20° N,110° E-120° E

Results

➢ **CISO simulation Analysis (Tiedtke Scheme is best)**



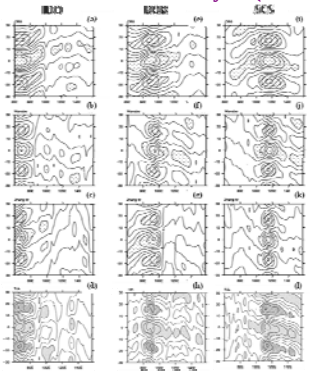
Meridional propagations of CISO along the longitudes of each region, detected from observed daily OLR and daily precipitation simulated by different cumulus schemes. Yellow shading represents dry anomaly and green one is wet anomaly. Unit: W/m² for OLR and mm/day for precipitation.

The characteristics of CISO in Asian Summer Monsoon Regions:

(1) Obvious northward propagation of wet phase from equator to 30° N, beginning in May.

(2) Wet phase and dry phase occur alternately.

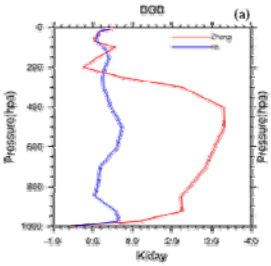
➢ **TISO simulation Analysis (Zhang-McFarlane Scheme is best)**



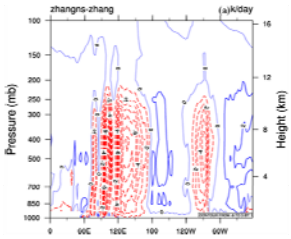
The characteristics of 27-50 day TISO mode in Asian Summer Monsoon Regions: significant eastward propagation from 70° E to 120° E and westward propagation from 120° E to the east.

Zonal propagations of 27-50 day TISO mode averaged along the latitudes between 10° N and 20° N, respectively based on observed OLR and model precipitation simulated by three cumulus schemes, calculated by point-based lead-lag correlation analysis with reference to each Asian Summer Monsoon Region. The shadings denote the correlation coefficients above 99% confidence of t-test.

➢ **NS experiment (No Hack shallow convection)**

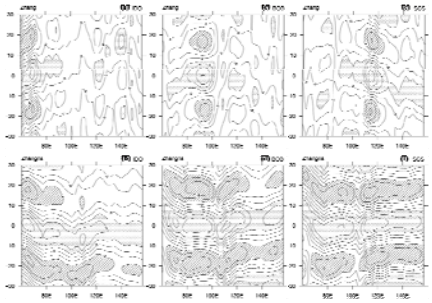


The diabatic heating profile of BOB area averaged, obtained from Ctrl2 and NS experiments.



Height-longitude cross section of diabatic heating (NS minus Ctrl2) averaged along the latitudes between 10° N and 20° N.

Without the impact of shallow convection heating, the deep convection also weakens. In the case of Zhang and Hack combination, it's easy to tell why if shallow convection is turned off.



The eastward propagation from 70° E to 120° E disappears in NS experiment.

Zonal propagations of 27-50 day TISO mode averaged along the latitudes between 10° N and 20° N, respectively based on model precipitation simulated by Ctrl2 and NS, calculated by point-based lead-lag correlation analysis with reference to each Asian Summer Monsoon Region. The shadings denote the correlation coefficients above 99% confidence of t-test.

Summary

➢ CISO simulated by the Tiedtke scheme is found to be more realistic than that by the Manabe scheme and the Zhang-McFarlane scheme;

➢Only Zhang-McFarlane scheme rather than the other two schemes can simulate the eastward propagation of 27-50 day TISO mode in Indian Ocean. It may be associated with the more realistic diabatic heating profile simulated by using Zhang-McFarlane scheme;

➢ Without the shallow convection, the deep convection in Zhang-McFarlane Scheme weakens and the ISO eastward propagation signals become weak.

☆ Wenting Hu (hwt@lasg.iap.ac.cn)

☆ Supervisor: Prof. Guoxiong Wu, Prof. Anmin Duan