Development of a regional climate model (BCC_RegCM) and its simulation and hindcast over different regions

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1. Introduction

The regional climate model of Beijing Climate Center (hereafter the BCC_RegCM) has been developed to study the Asian summer monsoon. This study presents the development of the BCC_RegCM and the analyses of a 10-year simulations and hindcasts (1991-2000) over different regions, such as South China (SC) and Pakistan.

2. Ensemble simulations and hindcasts (1991-2000) of BCC_RegCM over South China (SC) and South China Sea(SCS)

In this study ensemble method of physical process parameterization schemes is used. The model was initialized at April 1 and integrated up to the end of June for the ten years.

For the 10-year simulation experiments the initial atmospheric conditions and lateral boundary data used are from the European Centre for Medium-range Weather Forecasts "40-year" reanalysis data. Lateral boundary conditions are provided every 6 h via a relaxation method with a 15-grid buffer zone. The Reynolds weekly optimum interpolation (OI) sea surface temperature (SST) data with a 1° latitude × 1° longitude spatial resolution generated by the US Climate Diagnostics Center are linearly interpolated into daily values.

10-year ensemble hindcast experiments have been done by using the first-generation coupled global climate model of Beijing Climate Center (BCC_CGCM1.0) nested BCC_RegCM. The BCC_CGCM1.0 is established in open oceanic surface based on global atmospheric circulation model T63L30 AGCM_1.0 and global ocean circulation model T63L30 OGCM_1.0 through Daily Flux Anomaly coupling scheme exchange.

Physical process	Scheme
convection	Kuo、Grell、MFS、Betts-Miller
large scale precipitation	implicit、explicit、Pal
land surface process	BATS、LPM
radiation transfer	CCM3
planet boundary layer	Hotslag、TKE
terrain	envelope topography

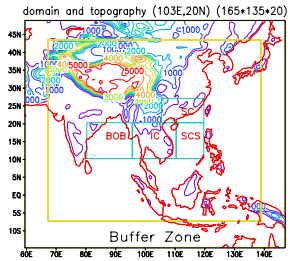


Fig.1 Model domain and topography

SC: 105-120° E, 20-27° N
SCS: 110-120° E, 10-20° N
IC: 95-110° E, 10-20° N
BOB: 80-95° E, 10-20° N

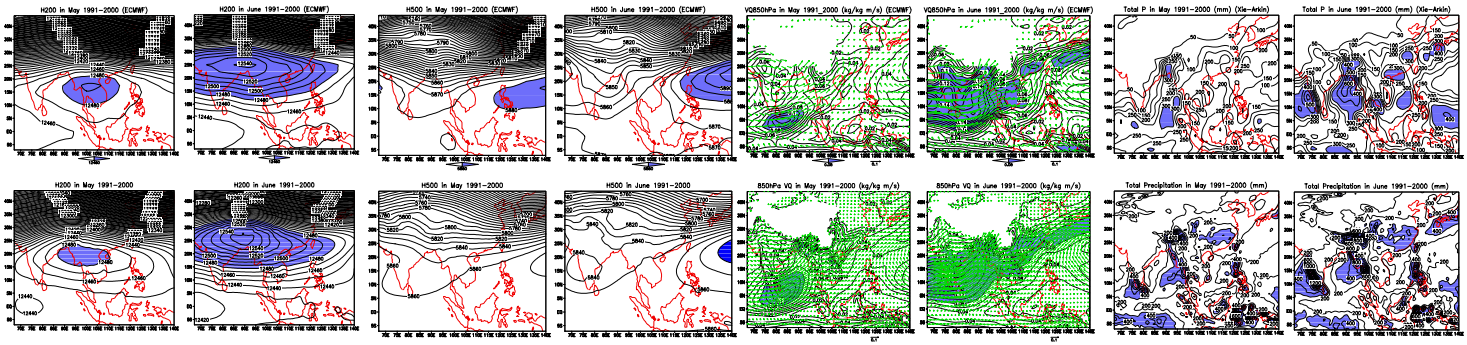


Fig.2-5 Observed (top) and simulated (bottom) geopotential height averaged in May and June 1991-2000 at 200hPa, 500hPa, and moisture transport at 850hPa and precipitation.

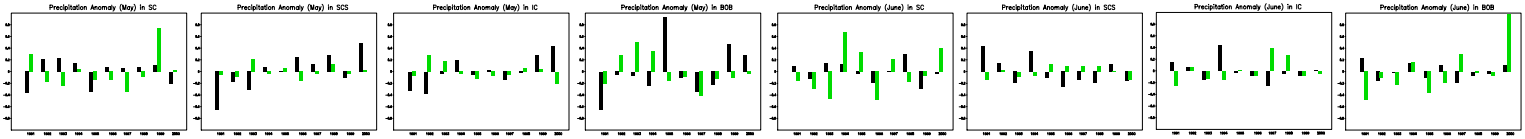
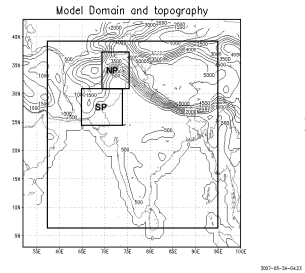


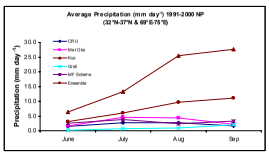
Fig.6 Observed (black) and hindcasted (green) precipitation anomaly in May and June 1991-2000 over SC, SCS, IC and BOB.

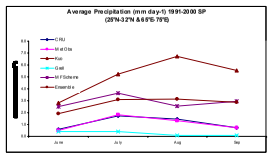
3.Ensemble hindcasts (1991-2000) of BCC_RegCM over Pakistan

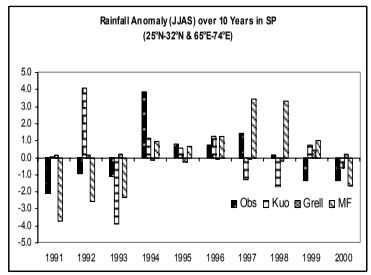


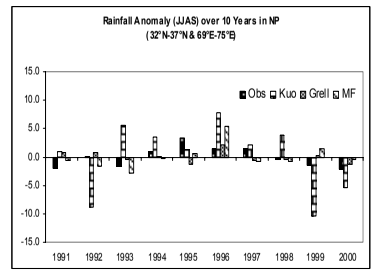
BCC regional Climate Model (BBC_RegCM0) is used to Hindcast the Summer Monsoon over Pakistan. The driving data of BCC Global Model (BCC_CGCM1.0) is used as initial and lateral boundary conditions. The model was integrated for 10 year period from 1991-2000. Each time model was initialized from 0000 of May 01 and ends on 1200 of Sep 31. This gives model a spin up of one month. The CRU observed data together with meteorological station data of precipitation from 54 station in Pakistan was used to compare and verify the model hind cast experiments.

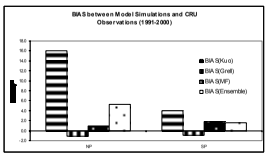
Domain: No of grid points along x-axis = 115 No. of grid points along y-axis= 95 Centre of the domain= (77° E ,22° N)
Horizontal Resolution = 50km
Two regions are selected for area averages over Pakistan, (1) NP (32° N-37° N, 69° E-75° E), (2) SP (25° N-32° N, 65° E-74° E)
Parameterization Schemes: (1) Kuo Scheme (2) Grell Scheme (3) Mass Flux Scheme
Implicit large scale parameterization scheme was used with the above convective schemes.

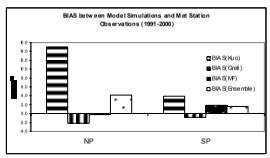












4. Conclusion

For the 10-year simulation over SC and SCS, the BCC_RegCM can reproduce well the main features of the monsoon circulation and vertical structure of the atmosphere. The BCC_RegCM can simulate the intensification and northwestward displacement of the South Asian upper anticyclone from May to June, as well as the low-level moisture transport from the Bay of Bengal to the SC.

The hindcast experiments over SC and SCS show that the BCC_CGCM1.0 nested BCC_RegCM can reproduce the major monsoon circulation. But the precipitation anomalies is not so good as in the 10-year simulation. This will be analyzed further.

Three kinds of convective parameterization schemes (Kuo, Grell and Mass Flux Scheme) have been compared in this hindcast experiments over Pakistan. The regional climate model realistically hindcasts the interannual variability of the precipitation over Pakistan. Kuo overestimated the precipitation in almost all cases. BIAS in the Kuo hindcast of precipitation was found much higher than the other two schemes over Pakistan. The upper air patterns such as geopotential heights at 850hPa, 500hPa and 250hPa are well hindcasted by the Kuo scheme. The Mass flux and Grell Scheme reproduced very low heights compared to observed heights. Grell Scheme hindcasted very poorly the precipitation and underestimated the precipitation over Pakistan in all cases. The Mass Flux Scheme reasonably hindcasted the seasonal precipitation over Pakistan and the BIAS in the simulations is minimum compared to all other schemes. The minimum precipitation BIAS in the Mass Flux Scheme was found in the month of July and August. The ensemble results of precipitation and minimum temperature are found better over the South Pakistan. The over all performance of the model simulations with Mass Flux Scheme was found very encouraging over Pakistan.