Performance assessment of REGional Climate Model for Indian summer monsoon rainfall during ENSO

Shruti Verma[1], R Bhatla[1,2], Manas Pant[1,2], R K Mall[2]

1. *Department of Geophysics, Institute of Science, Banaras Hindu University, Varanasi, India.*
2. *DST-Mahamana Centre of Excellence in Climate Change Research, Institute of Environment and Sustainable Development, Banaras Hindu University, Varanasi, India*

Email: shrutiverma072@gmail.com; shruti.verma@bhu.ac.in

Abstract

The dynamical downscaling of European Centre for Medium Range Weather Forecasts (ECMWF) ERA-Interim for simulating Indian summer monsoon rainfall has been done using Regional Climate Model version 4 (RegCM4) over the South-Asia Co-ordinated Regional Climate Downscaling Experiment (CORDEX) domain. To examine the relationship between El Nino and La Nina event and ISMR at interannual time scales of 1986-2010. The study begins with analysis of the summer monsoon rainfall simulation using different convective parameterized schemes (CPSs) of RegCM4 over India. The model simulation realistically represented the monsoon rainfall with Grell scheme simulation during ENSO. The also analysis includes the calculation of wet spell, dry spell and empirical cumulative distribution function of Indian summer monsoon rainfall during ENSO.

1 Introduction

ISM is the world's most important monsoon system that affect nearly one third of the world population. ENSO as phenomena of coupled ocean atmosphere used to explain unusual climatic changes across the globe. Extreme El Nino severely disrupt global weather patterns affecting ecosystem, agriculture, tropical cyclone, drought and flood and other extreme weather events worldwide. ElNino are the large scale ocean atmosphere climate interaction linked to the periodic warming in the SST across central and East Equatorial pacific. La Nina (a cold event) represent period of below average SST across east central Equatorial pacific. The ICTP's regional climate model (RegCM) has wide range application for climate change simulation and prediction. The *state-of-art* in the regional climate model (RegCM) [1,2]) has been utilized to study detailed Indian monsoon characteristic features and sensitivity analysis of the different cumulus convection parameterization.

2 *Data description and methodology*

2.1 Data:

For the performance assessment of the RegCM4.3 the model simulated climate data compared with observed rainfall data of India Meteorological Department [3].

2.2 Methodology:

The identification of ENSO years on the basis of Nino3.4 SST anomaly Index (190°–240°E, 5°S–5°N) during Northern Hemispheric summer (June–September: JJAS) 1986-2010. The high-resolution dynamical downscaling with the resolution 0.5^ox 0.5^o was set up in RegCM-4.3 over South Asia CORDEX domain (22°S–50°N; 10°E–130°E) using six convection schemes of RegCM 4.3 (Table 1). The interannual variability of rainfall and circulation features associated with El Nino, and La Nina are studied by comparing observed gridded rainfall dataset of IMD. Also, Consecutive Dry days (CDD) (below 1 mm rainfall) and consecutive wet days (CWD) (more than 1 mm rainfall) are calculated during El Nino, and La Nina over India.

3. Result and Conclusions:

The capability of RegCM4.3 in simulating ISMR proves that the El Nino/La Nina produced weaker/strong monsoon over India and it increases the interannual variability of the South west summer monsoon system. Although, model performance is sensitive towards the predicting/simulating extreme rainfall events. The Grell is the best CPS of RegCM4.3 in simulating monsoon rainfall during El Nino and La Nina years. Defining the characteristic, spatial distribution of Dry spell and wet spell during ENSO with model and observation shows that model realistically can capture the similar observed pattern during El Nino years. With the response of global warming, the increased frequency of atmospheric convection in the eastern equatorial region has been observed [4]. So that frequent cases of El Nino and La Nina has been occurred after 2003. In global warming scenario, it is an important to examine how the ENSO-monsoon relationship changes in future climate and to understand the possible changes in predictability of monsoon rainfall.

4. Figures and Tables

Table 1. Model (RegCM4.3) configuration

Resolution	50 km horizontal
Map projection	ROTMER
Vertical level	18 sigma vertical levels
Radiation scheme	Community Climate Model 3
Land surface model	Biosphere-Atmosphere Transfer Scheme
Land surface process	Community Land Model v3.5
Planetary boundary layer	Holtslag
Convective Precipitation Schemes	(1).Modified-Kuo scheme (2).Grell scheme (3)MIT-Emanuel scheme (4) Tiedtke
Large-Scale Precipitation Scheme	Subgrid explicit moisture scheme
Ocean flux scheme	Zeng's scheme

Table 2. List of onset year of El Nino, La Nina and Neutral Year.

El Nino	*1986, 1987*, 1991*,1994, 1997**, 2002, 2004, 2006, 2009*
La Nina	*1988*, 1995, 1998*, 1999*, 2000, 2005, 2007*, 2008, 2010**
Neutral	*1989, 1990, 1992, 1993, 1996, 2001, 2003*

***strong, **very strong.**

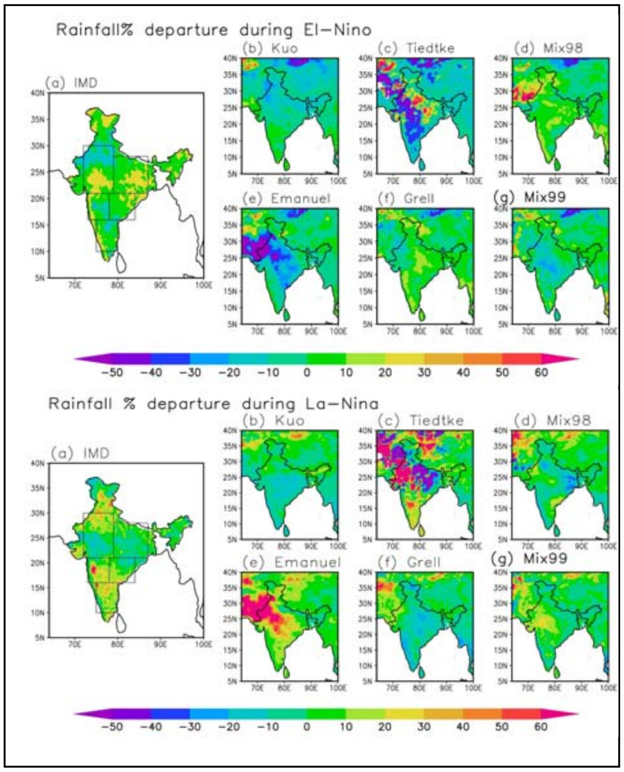

Figure 1 Average Indian summer rainfall Percentage monsoon rainfall departure from accumulated ISMR during El Nino and La Nino years. (a) IMD and compared with the simulation of six different convection schemes of RegCM4.3 (b) Kuo, (c) Tiedtke, (d) Mix98, Emanuel, (f) Grell, and (g) Mix99.

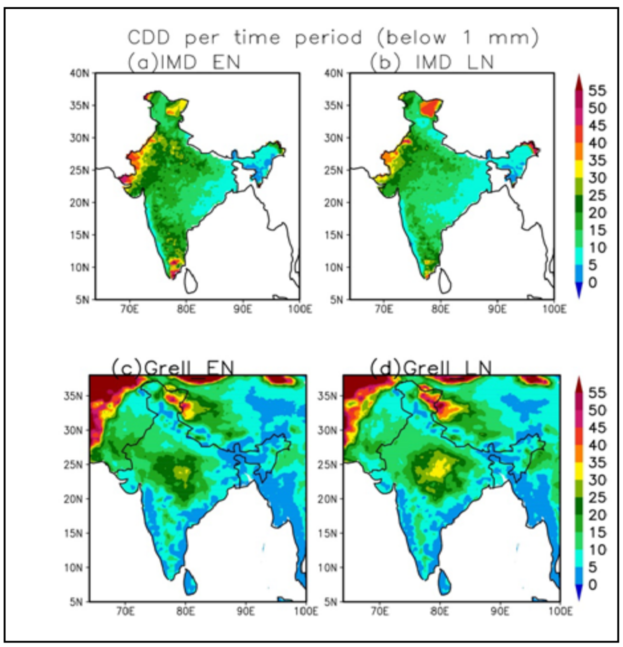

Figure 2 Spatial plot for consecutive dry days (below 1 mm) for observed rainfall data of IMD (First row) and Grell CPS (Second row) during El Nino and La Nina.

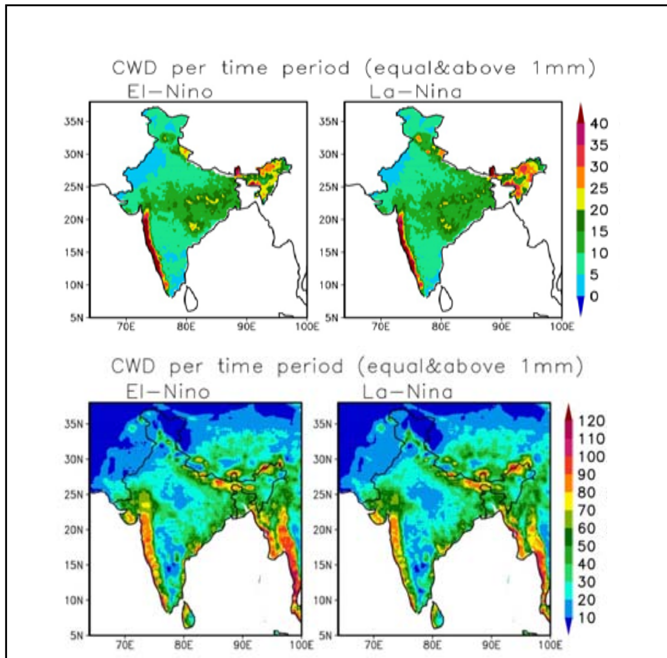

Figure 3 Spatial plot for consecutive wet days (equal &above 1 mm) for observed rainfall data of IMD (First row) and Grell CPS(Second row) during El Nino and La Nina.

Acknowledgements

This work is a part of a R&D project, funded by Department of Science and Technology (DST), Thanks to the India Meteorology Department (IMD) for providing the necessary datasets. Special thanks to International Center for Theoretical Physics (ICTP), Italy for providing RegCM-4.3.

References

1. Giorgi F (2006) Regional climate modeling: status and perspectives. Journal de Physique IV 139:101-118.
2. Giorgi F, Elguindi N, Cozzini S, Giuliani G et al (2013) Regional climatic model RegCM user manual version 4.3. The Abdus Salam International Centre for Theoretical Physics Strada Costiera, Trieste.
3. Pai DS, Sridhar L, Rajeevan M, Sreejith OP, Satbhai NS, Mukhopadhyay B (2014) Development of a new high spatial resolution (0.25× 0.25) long period (1901–2010) daily gridded rainfall data set over India and its comparison with existing data sets over the region. Mausam 65(1):1-8.
4. Cai W, Borlace S, Lengaigne M, Van Rensch P, Collins M, Vecchi G, Timmermann A, Santoso A, McPhaden MJ, Wu L, England MH (2014) Increasing frequency of extreme El Niño events due to greenhouse warming. Nature climate change. 4(2):111-6.