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Selection of General Circulation Model (GCM) ensemble over Nepal

Background

There are several GCMs available for study of dynamics of climate systems and climate change (CC) impact assessment, however, GCMs are associated with uncertainties. Further it is not practical to use all GCMs in CC studies due to constraints of resources. A suitable selection of GCM is therefore needed from a pool of GCMs by considering their better capability in projecting the historical climate. This study is conducted to select GCM ensembles for CC studies over Nepal.

Materials and Methodology

47 GCMs along with 205 ensemble members model output data from Coupled Model Inter-comparison Project Phase 5 (CMIP5) were used. Data processing and analysis were conducted at Data Integration and Analysis System (DIAS), The University of Tokyo (https://diasjp.net/en/; http://apps.diasjp.net/modelvis/cmip5/). GCM output are correlated with global reference dataset [Global Precipitation Climatology Project (GPCP) for precipitation, outgoing longwave radiation (OLR) from the National Oceanic and Atmospheric Administration (NOAA), and zonal wind and meridional wind, geo potential height, air temperature at 850 hpa and 200 hpa from Japanese 55- year Reanalysis (JRA-55)]. The study area covers local domain (26-31 N, 79-89 E) for precipitation and Regional domain (0-50 N, 60-110 E) for other variables. Climatological mean (1979-2005) of reference data and GCM output of these 10 parameters are analysed for four seasons: pre-monsoon (March-May; MAM), monsoon (June-September; JJAS), post monsoon (October-November; ON) and winter (December-February; DJF). A simple scoring method is implemented through performance assessment of Spatial Correlation (Scorr) and Root Mean Square Error (RMSE). A score of 1 was given to those GCMs whose Scorr are higher and RMSE are lower than the average of all GCMs; and a score of 0 is assigned if either of the two conditions is satisfied, and, if neither are satisfied, a score of -1 is assigned (Nyunt et al., 2016). These scores were assigned to every key parameter, and all scores of each GCM was summed.

Results

Top ranked 10 GCM-ensemble mean is shown in Table 1.

Table 1: List of top ranked 10 GCMs

No	GCM Name	Institute	Score
1	**CESM1(CAM5)**	National Science Foundation, Department of Energy, National Center for Atmospheric Research	8.25
2	**MPI-ESM-P**	Max Planck Institute for Meteorology, Germany	8
3	**ACCESS1.0**	CSIRO (Commonwealth Scientific and Industrial Research Organization, Australia), and BOM (Bureau of Meteorology, Australia)	5.75
4	**GFDL-ESM2M**	Geophysical Fluid Dynamics Laboratory, USA	5.25
5	**MIROC5**	Atmosphere and Ocean Research Institute (The University of Tokyo), National Institute for Environmental Studies, and Japan Agency for Marine-Earth Science and Technology	5.25
6	**HadCM3**	Met Office Hadley Centre, UK	4.75
7	**CanCM4**	Canadian Center for Climate Modeling and Analysis, Canada	4
8	**MIROC4h**	Atmosphere and Ocean Research Institute (The University of Tokyo), National Institute for Environmental Studies, and Japan Agency for Marine-Earth Science and Technology	4
9	**EC-EARTH**	European Community-Earth Consortium	3.25
10	**CanESM2**	Canadian Centre for Climate Modelling and Analysis, Canada	3.25

Fig. 1: Average Precipitation (mm/day) in 1979-2005

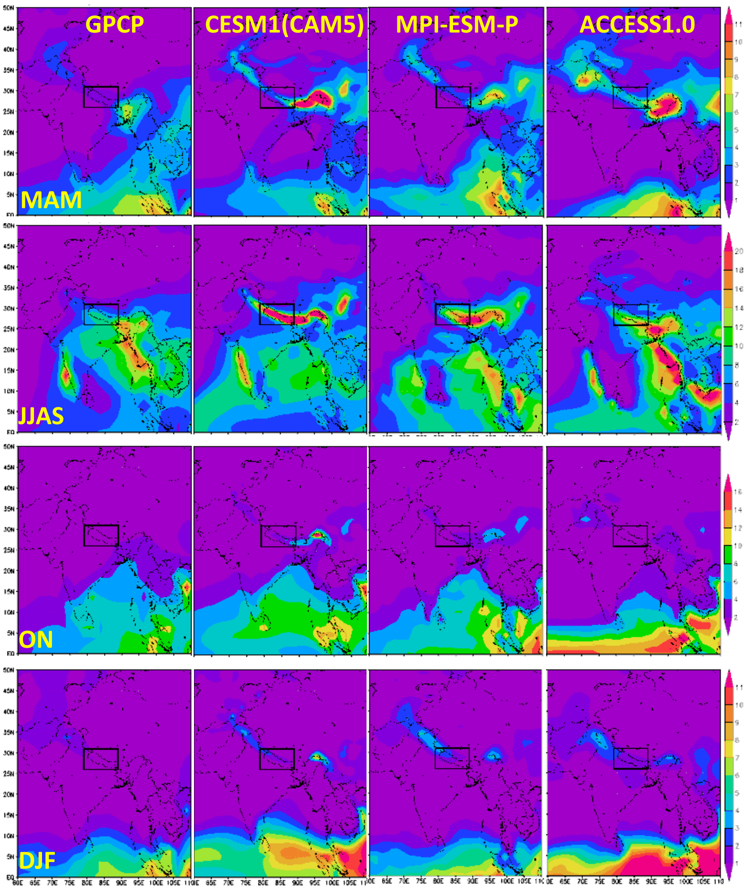


Fig. 2: Average Zonal Wind (m/s) in JJAS (1979-2005)

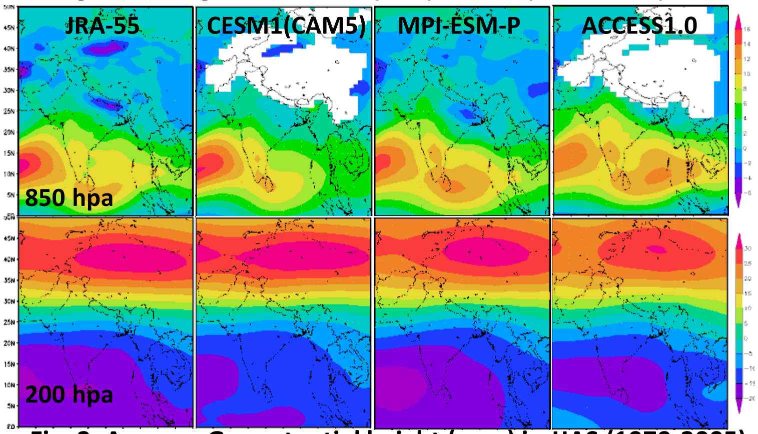
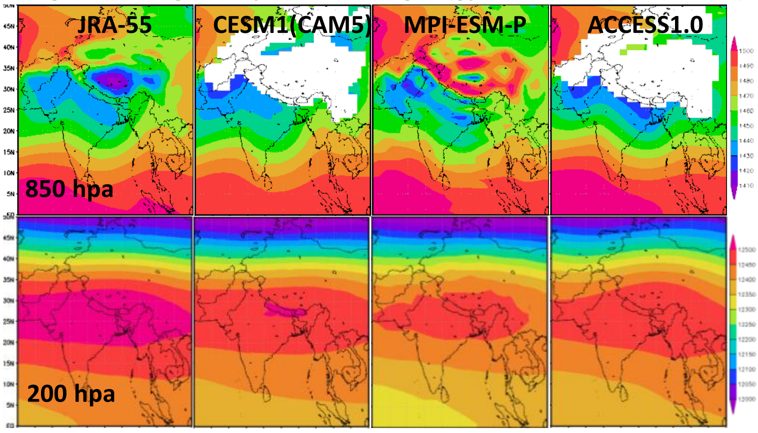


Fig. 3: Average Geopotential height (gpm) in JJAS (1979-2005)



Long term mean of spatial distribution of precipitation (mm/day) from GPCP and top ranked 3 GCMs in 4 seasons are provided in Figure 1. Summer monsoon in JJAS and westerly flow in DJF are well correlated with good prediction. Average zonal wind (m/s) in JJAS at 850 hpa and 200 hpa are provided in Figure 2 and the same for geopotential height are provided in Figure 3. Both have good correlation with JRA-55 reference dataset.

Conclusions

A suitable selection of GCM over Nepal is carried out using spatiotemporal correlation coefficient and root mean square error between reference climate dataset and GCM ensemble output. CESMI(CAM5), MPI-ESM-P, ACCESS1.0, GFDL-ESM2M, MIROC5, HadCM3, CanCM4, MIROC4h, EC-Earth and CanESM2 are found the top ranked 10 GCM-ensemble. Statistical bias correction of meteorological parameters for selected GCM over Nepal and their application for climate change impact assessment on water resources would be the future tasks to be carried out.

Acknowledgment

Data Integration and Analysis System (DIAS), The University of Tokyo (http://apps.diasjp.net/modelvis/cmip5/) is acknowledged for providing data integration resources.

Reference

Nyunt, C.T., Koike, T. and Yamamoto, A., 2016. Statistical bias correction for climate change impact on the basin scale precipitation in Sri Lanka, Philippines, Japan and Tunisia. Hydrol. Earth Syst. Sci. Discuss. [preprint], https://doi.org/10.5194/hess-2016-14, 2016.

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