

Indian monsoon rainfall variability in coupled climate model simulations and projections under IPCC AR4

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This work analyses the outputs of the coupled climate models under the Intergovernmental Panel on Climate Change Fourth Assessment Report to study the simulation of Indian summer monsoon rainfall

Outputs of 19 models are examined. The method of pattern correlation has been applied to examine the ability of models to simulate the spatial characteristics of monsoon. Out of 19 models, 11 reproduce the shape of the annual cycle well, however most models underestimate the summer precipitation. Four models show a gradual evolution of the annual cycle, while three models show a late occurrence of the monsoon. Only one model fails to show summer monsoon. Several models are able to simulate high rainfall over the west coast, Bay of Bengal and the equatorial oceanic regions and low rainfall over northwest India and the southeast peninsula. Seven of these models are unable to simulate the west coast rainfall.

Inter-annual fluctuations, long-term trends, biennial oscillation and the coefficient of variation are examined and tested for their statistical significance. While six models exhibit long-term trends, nine models are able to simulate the biennial nature. Mean seasonal precipitation, percentage of annual, coefficient of variation for each model are also presented. On the whole the models have performed well in simulating the regional complex precipitation characteristics.

Three models are selected to examine the future projections under the doubling CO₂ scenario. All the 3 models project an increase in summer monsoon precipitation over India varying from 4 to 18% for India as a whole. The rate of increase in precipitation is faster during the CO₂ increase period and slower during the CO₂ stabilization period. On regional space scales these models project a substantial increase in precipitation of nearly 40 to 50 % over northwest India and the southeast peninsula, the regions of low rainfall. One model suggests that in the warming world, the low-frequency monsoon variability normally associated with the decadal Pacific variability may shift to high frequency variability related with the biennial Indian Ocean oscillation.