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Errors in the simulation of Indian and African Monsoon Rainfall in IPCC AR4 simulations of the 20th century climate in coupled models and atmospheric GCM

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The simulation of monsoon rainfall by atmospheric General Circulation Models (GCM) and Coupled Ocean-Atmosphere models has proved to be a challenging problem. Most models are unable to simulate monsoon rainfall accurately. We have examined the simulation of monsoon in 12 Coupled models (20C3M scenario of IPCC) and their respective AGCM forced with observed SST.

We find that Indian monsoon is weaker in 11 out of 12 coupled model simulations vis-à-vis the AGCM forced with observed SST. The SST in coupled models are lower than observed . We show that in many GCM the relationship between rainfall and integrated water vapor is quite different from observations. Hence AGCM forced by observed SST the monsoon rainfall simulated by these models tends to be too high. To understand this we have used a simple diagnostic model. The diagnostic model relates rainfall to the net radiation at the top of the atmosphere, integrated water vapor and vertical stability. The coupled models using tend to produce realistic rainfall because the SST in the coupled model simulation is colder than the observations. The colder SST leads to a lower integrated water vapor over the Arabian sea. This leads to less advection of water vapor from ocean to land and hence reduces the monsoon rainfall in coupled simulations. Hence an accurate simulation of monsoon rainfall by coupled models could be on account of fortuitous cancellation of errors. In some GCM the atmosphere is vertically more unstable than observations. In such models, small increase in integrated water vapor leads to a large difference in the simulated monsoon rainfall. High rainfall over Sahelian Africa in some of the models is related the net radiation at the top of the atmosphere being much higher than observations.