International Max Planck Research School on Earth System Modelling

Relative contribution of the mid-latitude circumglobal wave train to the South Asian summer monsoon

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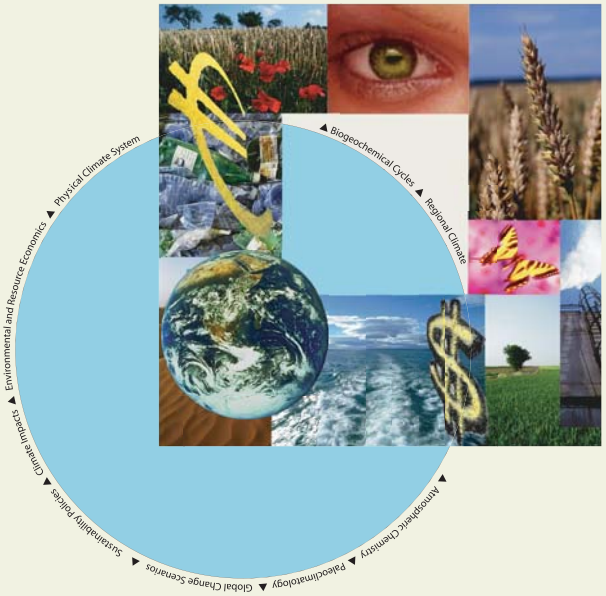

Abstract

Although there are increasing evidences of interaction between the mid-latitude circulation and intraseasonal variations of the South Asian summer monsoon, however, it is not fully clear that how the mid-latitude circulation may influence the summer monsoon over South Asia region. In this thesis ERA40 reanalysis data and ECHAM5 climate model simulations are used to examine the mid-latitude monsoon interaction. Special emphasis is given to the large scale mid-latitude circumglobal wave train (CGT) and its relationship to the South Asian summer monsoon. It is found that an eastward propagation of mid-latitude CGT can influence the surface heat low and associated monsoon precipitation over northwestern India and Pakistan. The intensification of the heat low is associated with enhanced southwesterly flow over the Arabian Sea and Persian Gulf that converge over northwestern India and Pakistan. A monsoon trough like condition develops over northwestern India and Pakistan which favors enhanced summer monsoon rainfall.

Moreover, sensitivity simulation experiments are carried out using the ECHAM5 climate model to study the response of rainfall/convection variation over the South Asian monsoon heat low to the large scale mid-latitude circulation and related precipitation over East Asia. It is found that an intensification of the heat low favors enhanced precipitation/convection over northwestern India and Pakistan. The enhanced precipitation/convection over northwestern India and Pakistan can further induce large scale circulation anomalies that resemble the northern summer CGT wavelike pattern extending well into the Asian monsoon region. Accordingly the wavelike response to rainfall increase over the heat low region is associated with anomalous ascent of air above northern China and descent above the South China Sea.

During the summer monsoon of 2010, Pakistan received very heavy rainfall that caused devastating flooding. More than 20 million people are directly affected

and the overall estimates of damage exceeded $US40B. Analysis reveals a blocking high pressure in the upper levels that developed over the western Russia during July 2010. It is found that a co-occurrence of the mid-latitude wave train and the blocking high is associated with a deepening of heat low over Pakistan and adjacent areas of Iran, Afghanistan and Arabian Peninsula. The intensification of the heat low favored the moist southerly flow to intrude deep in to the northern Pakistan where orographic lifting in association with upper level trough fostered convection and hence rainfall.

Finally, an analysis of the IPCC AR4 future climate scenario experiment with doubling CO2 has also been carried out to examine the future CGT and associated rainfall over northwestern India and Pakistan. Analysis reveals a northward shift of the CGT pattern over Eurasia region. The associated sea level pressure show positive anomalies over western parts of the heat low region. The projected monsoon rainfall shows enhanced interannual rainfall variation with increased drought like conditions over northwestern India and Pakistan in future climate.