Response of the monsoon climates to enhanced greenhouse effect

H. Douville, R. Ashrit, and P. Rao
Meteo-France, Centre National de Recherches Meteorologiques (CNRM), Toulouse, France
herve.douville@meteo.fr

The issue of the sensitivity of the monsoon climates to anthropogenic emissions of greenhouse gases and aerosols is particularly delicate for at least two reasons. First, these regions are potentially more vulnerable than others due to their dense populations, to the crucial role of water resources and agriculture in their economical development, and to their climate specificity, namely the concentration of annual precipitation during a relatively short rainy season. Second, these regions do not show homogeneous and robust patterns of climate change, neither in the recent instrumental record, nor in the available climate projections based on general circulation models (GCMs). In this lecture, we will mainly concentrate on two specific monsoon regions, namely India and Sahel. After a brief and non-comprehensive review of the litterature about observed and/or projected climate change in these regions, we will describe and analyse global climate projections that have been recently produced at CNRM with the coupled ocean-atmosphere OPA-ARPEGE climate Model (CCM). Before focusing on India and Sahel, we will validate the model climatology against available observations, looking not only at monthly or seasonal means, but also at interannual variability and possible trends over the second half of the 20th century. Comparisons between coupled and forced atmospheric simulations will be also briefly discussed in order to show that the coupling does not deteriorate all aspects of the ARPEGE climatology. Then, the impact of the enhanced greenhouse effect will be investigated by comparing two time-slices of the coupled experiments: 1950-1999 and 2050-2099 respectively. The transient response of the Indian and Sahelian monsoon climates will be also described and the physical mechanisms that control the simulated precipitation changes will be analysed. It will be shown that monsoon rainfall is expected to increase over both India and Sahel over the 21st century. Internal multi-decadal variability rather than global warming could explain the decrease in the Sahelian precipitation as well as the weakening of the ENSO-Indian monsoon teleconnection that have been recently observed. Such modes of variability are still likely to mask the signal of climate change in the late 20th century, but could be dominated by this signal over future decades. Additional works are however necessary to confirm this hypothesis. Besides the intercomparison of coupled GCMs and their projections that is currently conducted within CMIP and at IPCC, more detailed studies are needed to understand better the internal variability of the global climate system. Moreover, sensitivity studies can be performed to test the robustness of the climate projections provided by coupled GCMs. Such sensitivity snapshot experiments are currently conducted at CNRM and should allow us to investigate how the simulated climate changes resist various modifications in the treatment of the SST or land surface boundary conditions.

Wednesday I (Keynote Talk)