



## **Future changes in the Indian summer monsoon under the RCP-scenarios simulated by the MPI-ESM**

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In this study the potential future changes in different aspects of the Indian summer monsoon associated with the so-called Representative Concentration Pathways (RCP) scenarios, which will be used in the forthcoming IPCC-report, are assessed. There will be focus on the role of the different kind of mechanisms leading to these changes, with some of them working locally and some of them remotely. The study is based on several sets of ensemble simulations with the newly developed MPI-ESM. In one set of simulations (1850-2005), emissions and concentrations, respectively, of the well-mixed greenhouse gases and the sulphate aerosol load have been prescribed according to observations, in three other sets of simulations (2006-2100), the aforementioned anthropogenic forcing agents have been prescribed according to the RCP2.6-, RCP4.5- and RCP8.5-scenario, respectively. For each of these scenarios, one simulation has been extended over the period 2101-2300, with the prescribed anthropogenic forcing agents kept constant at the levels for 2100.

The three kinds of scenario simulations are characterized by marked changes in different aspects of the Indian summer monsoon, such as an intensification of the summer monsoon precipitation despite a weakening of the large-scale monsoon circulation. The magnitude of these changes varies with the strength of the underlying scenario, with the strongest (weakest) scenario showing the largest (smallest) changes, respectively. Interestingly, the long simulations for the three scenarios reveal three different kinds of long-term behaviour of the Indian summer monsoon after the stabilization of the anthropogenic forcing agents at the levels for 2100. While the RCP8.5-scenario shows a further amplification of the projected changes in the Indian summer monsoon, the RCP2.6-scenario is characterized by a weakening of these changes. As for the RCP4.5-scenario, the strength of the projected changes slightly changes over the period 2101-2300.

The increase in the monsoon rainfall is related to a variety of different mechanisms, with the intensification of the atmospheric moisture transport into the Indian region as the most important one. The weakening of the large-scale monsoon circulation is mainly caused by two mechanisms, firstly, by a reduction of the meridional temperature gradient in the mid-troposphere in the Indian region and, secondly, by changes in the Walker circulation with large-scale divergence (convergence) in the lower (upper) troposphere over the Indian Ocean in response to changes in the convective activity over the tropical Indian and Pacific Ocean.