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Potential future changes in the Indian summer monsoon associated with a global warming of 2 ∫C with respect to pre-industrial times

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In this study the potential future changes in different aspects of the Indian summer monsoon associated with a global warming of 2°C with respect to pre-industrial times are assessed, focussing on the role of the different mechanisms leading to these changes. In addition, these changes as well as the underlying mechanisms are compared to the corresponding changes associated with a markedly stronger global warming exceeding 4.5°C, associated with the widely used SRES A1B scenario. The study is based on two sets of four ensemble simulations with the ECHAM5/MPI-OM coupled climate model, each starting from different initial conditions. In one set of simulations (2020-2200), greenhouse gas concentrations and sulphate aerosol load have been prescribed in such a way that the simulated global warming did not exceed 2°C with respect to pre-industrial times (May, 2008). In the other set of simulations (1860-2200), greenhouse gas concentrations and sulphate aerosol load have been prescribed according to observations until 2000 and according to the SRES A1B scenario after 2000. The study reveals marked changes in the Indian summer monsoon associated with a global warming of 2°C with respect to pre-industrial conditions, namely an intensification of the summer monsoon precipitation despite a weakening of the large-scale monsoon circulation. 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 changes in the Walker circulation with large-scale divergence (convergence) in the lower (uppper) troposphere over the Indian Ocean in response to enhanced convective activity over the Indian Ocean and the central and eastern Pacific and reduced convective activity over the western tropical Pacific. The comparison with the changes in the Indian summer monsoon associated with a global warming of 4.5°C reveals that both the intensification of the monsoon precipitation and the weakening of the large-scale monsoon circulation (particularly in the lower troposphere) are relatively strong (with respect to the magnitude of the projected global warming by the end of the 20th century for the two scenarios) in the scenario with a global warming of 2°C. The relatively strong intensification of the monsoon rainfall is related to rather strong increases in evaporation over the Arabian Sea and the Bay of Bengal, while a rather weak amplification of the meridional temperature gradient between the Indian Ocean and the land areas to the north contributes to the relatively weak reduction of the large-scale monsoon flow. May, W., 2008: Climatic changes associated with a global 2°C-stabilization scenario simulated by the ECHAM5/MPI-OM coupled climate model. Clim. Dyn., 31, 283-313.