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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Purpose of the study
In accordance with the objective of Article 2 of the UNFCCC, the Copenhagen Accord (2009) aims at limiting the global warming at 2 °C with respect to pre-industrial times, in order to avoid dangerous anthropogenic interference with the climate system. 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.

Scenario simulations
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 (2000-2200; 26L), greenhouse gas concentrations and sulfate aerosol load have been prescribed in such a way that the simulated global warming does not exceed 2 °C with respect to pre-industrial times. In this scenario the atmospheric concentrations of the well-mixed greenhouse gases are prescribed according to the SRES A1B-scenario for 2020, while the global anthropogenic sulphate aerosol load is prescribed according to the SRES A1B scenario for 2100. In the other set of simulations (1860-2200; A1B), greenhouse gas concentrations and sulfate aerosol load have been prescribed according to observations until 2000 and according to the SRES A1B scenario after 2000.

Conclusions
The study reveals marked changes in the Indian summer monsoon associated with a global warming of 2 °C with respect to pre-industrial times, namely an intensification of the monsoon rainfall and a weakening of the monsoon flow, mainly due to an intensification of the atmospheric moisture flux into the region and by changes in the Walker circulation, respectively. The magnitude of the global warming primarily has local effects on the relative strength of the projected changes.

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