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Effects of increased CO2 levels on monsoons

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Increased atmospheric carbon dioxide concentration provided warmer atmospheric temperature, higher atmospheric water vapor content, but not necessarily more precipitation. A set of experiments performed with a state of the art coupled general circulation model (CGCM) forced with increased atmospheric CO2 concentration (two, four and sixteen times the present-day mean value) have been analyzed and compared with a control experiment to evaluate the effect of increased CO2 levels on monsoons. Generally, the monsoon precipitation responses to CO2 forcing are largest if extreme concentrations of carbon dioxide are used, but they are not necessarily proportional to the forcing applied. In fact, despite a common response in terms of atmospheric water vapor increase to the atmospheric warming, two out of the six monsoons studied simulate less or equal summer mean precipitation in the 16xCO2 experiment compared to the intermediate sensitivity experiments. The precipitation differences between CO2 sensitivity experiments and CTRL have been investigated specifying the contribution of thermodynamic and purely dynamic processes. As a general rule, the differences depending on the atmospheric moisture content changes (thermodynamic component) are large and positive, and they tend to be damped by the dynamic component associated with the changes in the vertical velocity. However, differences are observed among monsoons in terms of the role played by other terms (like moisture advection and evaporation) in shaping the precipitation changes in warmer climates. The precipitation increase, even if weak, occurs despite a weakening of the mean circulation in the monsoon regions (“precipitation-wind paradox”). In particular, the tropical east-west Walker circulation is reduced, as found from velocity potential analysis. The meridional component of the monsoon circulation is changed as well, with larger (smaller) meridional (vertical) scales.