Geophysical Research Abstracts, Vol. 9, 10393, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-10393

The role of atmospheric dynamics in climate change scenarios

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The atmospheric dynamics is a key component of the climate system which is likely to react to global warming, and more specifically to SST changes. These changes in atmospheric dynamics trigger many of the hydrological changes associated with climate change. Diagnosing in more details what are the geographical features of the Sea Surface Temperature (SST) changes which may affect the circulation is therefore of a critical importance to assess the performance of coupled models. This is done here through atmospheric simulations forced by prescribed SST distributions; they use the atmospheric component of the IPSL-CM4 (Institut Pierre Simon Laplace Coupled Model 4) CGCM, e.g. the LMDZ4 atmospheric GCM, as well as SST changes diagnosed from the coupled model. When the carbon dioxide concentration is doubled, the IPSL-CM4 shows a weakening of the Hadley circulation, accompanied with a comparatively smaller increase of the precipitation. To diagnose the processes explaining those changes, and determine the extent to which they are axisymmetric, we run specific atmospheric simulations in response respectively to the zonal mean SST changes, the global mean SST changes and the longitudinal anomalies of the SST fields. When forced by uniform changes of the SST, the LMDZ4 GCM fails to represent changes in the geographical extension of the Hadley cells, but is able to reproduce fairly well the modifications in the intensity of the hydrological cycle simulated by the coupled model. Prescribing the zonal component of SST changes is enough to represent both the changes in the hydrological cycle and Hadley circulation simulated by the coupled model, whereas the longitudinal SST changes have a much lesser impact on the precipitation and on the large scale tropical circulation, with mostly an opposite sign.