Geophysical Research Abstracts
Vol. 12, EGU2010-12162, 2010
EGU General Assembly 2010

Quantifying uncertainties in projections of climate extremes — a perturbed land surface parameter experiment

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Changes in frequency, intensity and duration of climate extremes have socio-economic impacts that reach far beyond the effects of rising global mean temperatures. We explore changes in climate extremes in response to a doubling of CO2 and corresponding uncertainties using a perturbed physics ensemble. Based on NCAR CCSM 3.5 with a mixed-layer ocean, a 108 member ensemble experiment is performed by perturbing five poorly constrained land surface model parameters individually and in all possible combinations.

While the ensemble range of climate sensitivity is found to be substantially smaller than in corresponding atmospheric ensembles, temperature variability changes are highly sensitive to land surface parameter changes. These variability changes have strong implications for the tails of the temperature distribution, the extreme events. Consequently uncertainties of cold and heat extremes induced by poorly constrained land surface parameters are very large. Furthermore, simple land surface parameter perturbations regionally alter the sign of the precipitation response to increased greenhouse gas concentrations. Projections of droughts and heavy rainfall events are highly sensitive to land surface parameters.