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Uncertainty in the carbon cycle and its contributions to overall uncertainty in future climate projections.

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The contribution of carbon cycle uncertainty to the uncertainty in future climate projections is studied by means of numerical simulations with the MIT Integrated Global System Model (IGSM). Three ensembles of 21st century climate simulations were carried out using input probability distributions for climate sensitivity, rate of heat uptake by the ocean and strength of aerosol forcing consistent with the changes in climate over 20th century. Uncertainties in the rate of oceanic carbon uptake and strength of CO2 fertilization were also included. Each ensemble consists of 400 simulations.
In first ensemble all sub-components of the IGSM were fully coupled. To evaluate uncertainty in the feedback between climate and carbon cycle, an additional ensemble of radiatively uncoupled simulations was carried out. Because the terrestrial ecosystem model used in the IGSM takes into account nitrogen limitation on carbon uptake by vegetation, feedbacks associated with terrestrial and oceanic carbon cycle have different signs. As a result, total feedback between climate and carbon cycle is rather weak and can be either positive or negative. This explains why the probability distribution for surface warming obtained from simulations with the IGSM is more symmetric than ones presented in the IPCC AR4.
Reference greenhouse gases and aerosol emissions for business as usual scenario were used in first two ensembles. In all simulations of the third ensemble the IGSM was forced by the GHGs concentrations from the simulation with the median values of all climate parameter, thus eliminating uncertainty in the carbon cycle. Contribution of carbon cycle uncertainty to the uncertainties in projected climate changes turned out to be surprisingly small, at least for business as usual emission scenario.