The carbon cycle and the climate system are interrelated; this interaction is important since it affects probable global-mean surface temperature projections. Future carbon dioxide concentrations depend on anthropogenic processes that generate carbon dioxide and biogeochemical processes that cycle carbon between vegetation, ocean and atmosphere. Many of the biological processes are temperature dependant, which means that climate models need to allow for carbon cycle feedbacks.

Uncertainty in the carbon cycle and the climate system has been investigated with a reduced complexity Earth system model, namely MAGICC (Model for the Assessment of Greenhouse-gas Induced Climate Change), a model that has contributed to all of the IPCC assessment reports. The results demonstrate that the model’s carbon cycle parameters have the strongest influence on carbon dioxide concentrations at 2100, but also a considerable impact on temperature projections. The climate sensitivity also contributes to the carbon cycle uncertainty. These interactions indicate that, for any Earth system model, estimates for the carbon cycle parameters are important for future temperature projections.

To investigate setting both the climate and carbon cycle parameters, prior probability distributions were estimated using observational constraints and existing calibration results. These probability distributions were then combined with climate and carbon cycle observations using a Monte Carlo Metropolis Hastings algorithm. This produced revised estimates for these model parameters, which were then used as a basis for warming projections. These revised parameter distributions then lead to probabilistic temperature and atmospheric carbon dioxide concentration projections for a given emissions scenario.