Feedbacks and Time Scale Interactions in Climate Change

Stéphane Hallegatte, CIRED and CNRM/Météo-France

Future climate change will probably modify the BAU emission scenario and assessing this effect is one of the challenges of integrated assessment. The aim of my work is to assess and characterize this effect using simple model coupling. Two approaches have been followed: (i) An evaluation of the long characteristic times of the coupled climate-economy system, through a complete dynamic feedback analysis. A Solow-Swan model and an impact-adaptation module (modeling a race between the climate change and the adaptation process) have been developed. The feedback analysis lead to a climate-economy feedback with a -10% static gain (a 1% growth will only represent a 0.9% growth because of the additional climate change induced). The main characteristic time is about 80 years and is robust to changes in the impact level. It shows that a 100-year cost-benefit analysis does not take into account most of the benefits of an emission reduction. (ii) An identification and quantification of the short-term interactions, with a simple disequilibrium economic model. This model has been built without the equilibrium constraints of classical growth models, because they prevent the model from accounting for short-term perturbations. The results show that, for reasonable sets of hypotheses, the short-term perturbations change the model long-term behavior. As a consequence, it seems not justified to assume that it is possible to average the short-term processes over a long time step to feed long-term growth models, as done in usual cost-benefit analyses. These two approaches have shown that further work on economic short-term/long-term interactions is needed in order to produce confident results on climate change impacts. This work will require the development of new tools able to characterize dynamic processes and to analyse scale interactions.