ADAM's Modeling Comparison Project – Intentions and Prospects

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Guest Editors

Despite of the failure of the Copenhagen Summit in December 2009 the world will move forward with plans to limit greenhouse gas emissions much more aggressively than before. The Copenhagen Accord makes reference to the 2°C target as a potential goal for global climate protection. Moreover, it indicates that this goal will be evaluated by 2015 including a consideration of strengthening the long-term goal, referencing various matters presented by science. It seems that the scientific debate on the feasibility of a high chance of achieving the 2°C target will become important over the next few years. It is open to debate as to which extent such a low stabilization target can technically be achieved and at what costs. Therefore, a good understanding of all the major mitigation cost projections is of the utmost importance.

Within this Special Issue the technical and economic conditions for achieving a low stabilization level are explored. At the same time we have identified some of the side risks and benefits of these scenarios. The Fourth Assessment Report of the IPCC has explored the costs and the portfolio of mitigation options within a "first-best" world assuming that all relevant technologies are at hand and all countries participate in a climate agreement. However, we believe that it is critically important for the Fifth Assessment Report of the IPCC to produce an ensemble of mitigation scenarios covering a larger set of targets, policy and market imperfections, and technology assumptions than are currently available for the decision-making community. Scientists should not be put in a position to decide *as scientists* the kind of climate policy that should be implemented. Instead of prescribing decisions, decision-makers and the public have to be informed about the costs and benefits of different options. This includes the assessment of the consequences, if assumptions about particularly important options were too

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optimistic. Moreover, science should be explicit about the unintended side effects of their decisions and informative about alternative path ways.

The modeling teams that have worked together within this project are not the only ones who have committed themselves to carry out what could be called "second-best" scenarios. Other modeling teams are working hard to explore the impact of delayed participation and of other market failures on the costs of mitigation and their associated mitigation portfolios. The EMF 22, for example, has also followed this line of research and will proceed with this kind of scenario analysis in EMF 24. The need for scientific research to explore the full chain of different stabilization levels is twofold: the assessment of mitigation costs and of the required technologies for achieving low stabilization scenarios has to be complemented by an assessment of impacts associated with different stabilization levels; over the next few years an impact and vulnerability assessment for a 2°C and 3°C world will be indispensable for a comprehensive assessment of climate policy.

This Special Issue contributes to the first half of this scientific exercise. It makes a further attempt to evaluate the economics of climate change mitigation – with a special focus on the technical feasibility and economic viability of low stabilization scenarios. Within the EU project ADAM (Adaptation and Mitigation Strategies – Supporting European Climate Policy) a model comparison was set up to explore the feasibility of energy-economy models to achieve the 2°C target that the EU Commission pursued. The focus of the ADAM model comparison is: firstly, the evaluation of emission pathways with different probabilities of achieving the 2°C target; secondly, testing the robustness and viability of the emission pathways by evaluating second-best technology scenarios which assume that some technologies may be not available.

The models surveyed in this Special Issue illustrate ways in which a low stabilization target of 400ppm CO_2-eq for atmospheric greenhouse gas concentrations can be achieved. Model results suggest that achieving emission reductions for a 2°C target are feasible at a maximum cost of a few per cent of discounted global GDP, but very challenging in terms of the technological transformation needed. Annual decarbonisation rates of up to 6% per year of global emissions are required. Moreover, besides global participation, a broad range of technologies and further options for decarbonisation are needed to achieve this objective. The models presented in this Special Issue provide first answers to the questions at which costs and with which technologies low mitigation targets can be achieved. The models show that there is more than one transition path towards a low carbon economy. Despite the very different model characteristics and nature of the models, the importance of the individual technologies turns out to be a robust feature. The analysis shows that in a second-best world, where some of the technologies are not available or have a limited potential, the costs of mitigation are substantially higher than those of a first-best world where all technology options are available.

The synthesis of the model comparison is presented in the paper by *Edenhofer et al.* The individual papers in the Special Issue cover different aspects of low stabilization. The paper by *Kitous et al.* focuses on the transformation requirements in the energy system. It presents a long-term assessment of the worldwide energy system in contrasted futures, from a business-as-usual pathway to a very low stabilization scenario, using the energy system model POLES. With the coupled energy-economy model MERGE-ETL, *Magné et al.* analyze the economic aspects of low stabilization showing, for example, the interplay between the transformation in the energy system and the macro-economy. In the paper by *Leimbach et al.* regional aspects of mitigation are analyzed with a particular focus on trade-related impacts, for example, trade of emission permits or reduced revenues of fossil fuel exports. The model E3MG by *Barker et al.* then brings in a different modelling perspective. Here – in contrast to neo-classical models – a Keynesian model is applied to the mitigation problem that leads to new insights concerning barriers and opportunities for the implementation of low-carbon technologies. *Van Vuuren et al.* focus on regional differences of climate change mitigation and point out that ambitious climate policies play out differently in terms of energy and land use for different regions. They further explore the importance and the side-effects of bio-energy use for mitigation and draw attention to co-benefits of climate policy such as energy security and air pollution. As it turns out that bio-energy is an important option for mitigation, biomass potentials in the models are further explored in a second paper by *van Vuuren et al.* These potentials are analyzed with respect to sustainability aspects, and implications for agricultural yields and dietary patterns are given. Finally, *Knopf et al.* focus on the institutional prerequisites and requirements to overcome the implementation barriers. This last paper therefore goes beyond the modelling perspective and addresses important questions, e.g. of market failures or institutional premises, that are not explicitly accounted for in the models.

Despite important conclusions derived from the models concerning costs and technologies however, none of the models show how the mitigation scenarios can be implemented by means of policies, except for assuming a global cap on carbon emissions. It is clear that a pure model analysis is insufficient to address the full range of economical, political and risk management issues raised by low stabilization. Further research is needed in many areas. Prominent knowledge gaps and directions for further research include:

- Combining long-term models that cover all sectors and greenhouse gases i. e. not purely focussing on mitigation options in the energy sector.
- Further assessment of bio-energy. It turned out that biomass plays an important role for mitigation in the energy sector but may lead to co-emissions from deforestation and agricultural intensification. It may also affect other sustainability goals such as food security, especially in ambitious low stabilization scenarios. This issue has to be addressed in further model analyses with fully-fledged integrated assessment models.

- Further exploration of second-best (policy) scenarios by integrated assessment models. This includes the analysis of delayed climate policy participation and extended evaluation of technology failures. The robustness of the results against crucial model assumptions such as biomass or carbon capture and storage potentials, a particular focus of the model comparison in this Special Issue, should also be analyzed. Moreover the interplay between different instruments and policies, for example climate and energy policy, should be evaluated.

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