

## **Rapporteur's Summary**

**S. Cohen**

## SESSION I- "STATE OF THE ART IN COMPUTER MODELS"

### Rapporteur's Report: Dr. Stewart Cohen (Environment Canada)

This session, chaired by Jim Bruce (Canada, IPCC) was the first technical session of the IPCC Workshop on integrated assessment models (IAMs). There were four presentations in this session, all of which provided introductions to broad issues in each of the major components of IAMs: a) socioeconomic models on greenhouse gas (GHG) emissions, b) climate models, c) impact models, and d) economic issues associated with abatement strategies.

#### a) Socioeconomic models on GHG emissions

Jae Edmonds (USA) provided definitions for IAM, and noted that integrated assessment is no stronger than its weakest component. It cannot bring more than each discipline brings to the assessment, and can't create certainty if there is uncertainty in a component. IAMs are continually evolving, and becoming more interdisciplinary. IAM research teams are also becoming more interdisciplinary.

IAMs have provided some qualitative insights into the following issues: role of sulfates, timing of emission stabilization (when flexibility) and strategy for undertaking mitigation on an international level (where flexibility).

Dr. Edmonds then focused on emissions oriented socio-economic models. Energy consumption forecasts vary widely, so emission forecasts are very uncertain. One important trend is that emissions from Non Annex 1 countries will soon (if not already) exceed Annex 1 countries. There will be a transition to coal as oil and gas production will not keep up with demand, so the coal component of carbon emissions will increase. There are questions on how models treat technological change, and there is wide uncertainty in estimates of mitigation costs for various emission reduction strategies.

Q: (Rob Swart, The Netherlands) If model inputs and structures are uncertain, then how can we be certain about qualitative insights of IAM?

A: It is important not to oversell the IAM or emission model results, but also, don't look only at a single model. If there is a range of agreement among models, then this provides insight that is reproduceable.

Q: (Andrej Kranjc, Slovenia) Is stabilizing atmospheric concentrations cheaper than stabilizing emissions?

A: Emissions have to be reduced, but if the focus is on the when flexibility (timing of emission reductions), this will result in a less expensive response.

#### b) Climate Models

Stephen Schneider (USA) reviewed climate models within the context of IAMs, since one of the four model components is on climate and sea level. The challenge in this component is to account for changes in emissions over time, i.e. transient forcing. Sensitivity analyses of subcomponents of climate models provide important information about climate response to emission scenarios. Also, climate history provides context for the debate about projected climate changes. The warming trend from the last Ice Age to the current interglacial period has been 1°C/1000 years. Future warming may occur at a much faster rate.

In simple one-dimensional modelling of the energy balance within the global climate system, there is high confidence in the estimate of +4 W/m<sup>2</sup> from a doubling of greenhouse gas concentrations, while there is low confidence in knowledge of other sources of forcing (e.g. sulfates). A three-dimensional General Circulation Model (GCM) is needed, but inter-model comparison is important because various GCMs differ in their regional details. A hierarchy of approaches, from simple one dimensional models to analogues to GCMs, will help in the evaluation of regional climate impacts and the effectiveness of adaptation strategies, and this should be a dynamic process in which impacts are reassessed as climate, impact and adaptation scenarios evolve.

### c) Impact Models

Rik Leemans (The Netherlands) discussed impact models, focusing on ecological models. Concerns include direct effects of CO<sub>2</sub> fertilization and indirect effects due to climate change. Impacts would depend on sensitivity, adaptability and vulnerability of ecosystems and the communities that depend on them. However, there is no clear method for doing impact assessments, so many different approaches can be tried. Early studies from the 1980s used simple indicators ( e.g. growing degree days), but it is recognized that other factors must be included (e.g. moisture, CO<sub>2</sub> effects) and that transient scenarios should be used. Recent case studies using BIOME show how carbon sequestration changes if forest shifts into tundra areas, but there is the potential for forest die-back if climate change occurs too rapidly. This would reduce carbon sequestration and result in higher atmospheric concentrations of CO<sub>2</sub>.

Agriculture could also change, but this is a land-use decision, not just a vegetation change. How can such decisions be projected? More recent cases have also assessed the potential for adaptation to offset the impacts of warming, but this would vary between developed and developing countries. There have also been studies on malaria mosquitoes and biodiversity.

The IPCC Second Assessment Report (SAR) Working Group II report did not include cross-sectoral analyses. This is clearly needed. A case from the UK was cited which showed potential interactions between sectors. Can such integration be made part of an IAM?

The example of the IMAGE model was described, particularly the terrestrial environment subsystem, in which the world is divided into 13 regions, and includes a dynamic land-use component. One scenario is for reduction in agricultural land in Europe, while expansions would occur in Africa. IMAGE could then assess the implications of this scenario for CO<sub>2</sub> emissions. Yield changes would be region specific, with some areas affected more than others. There is no clear sense of winners and losers at the regional scale.

For impact scenarios in IAM, we need to look at simultaneous changes in GHG concentrations and climate; interactions and feedbacks of impacts on GHG emissions; regional and sectoral impacts; and links to such issues as food security, biodiversity and water resources management.

### d) Economic Issues Associated with Abatement Strategies

The last of the four IAM components, economic issues, was the focus of the presentation by Akihiro Amano (Japan). Key issues are discounting, technological change in the energy sector, and the concept of safe corridors for emissions. There is a debate about appropriate levels of discounting, which is important for consideration of appropriateness of abatement strategies. Perhaps this should be set as a social rate of return, rather than a private rate, and this would include negative externalities (such as environmental degradation) which are not normally included in such analyses. Rather than a discount rate of 1.5 to 3%, a more

appropriate rate would be much lower (rates below 1.4% were cited). It is very important to have better estimates of this, because this would create incentive for emissions to be reduced more quickly.

Choice of optimal timing is important because it affects the cost of emission reduction. Shifting such reductions to a future time would lower costs due to discounting and availability of better technology.

In IAMs, a lower discount rate, secondary benefits of emission control, and impacts in developing countries, should be included. New energy technologies should be modelled in an endogenous manner.

#### e) Additional Discussion

The session concluded with additional discussion with the audience.

Q (Marufu Zinyowera, Zimbabwe): How do such models consider Africa, especially subregion ecosystems? What are the important climate parameters in the assessment of disease impacts, and what is the role of current attempts to control the disease?

A (Rik Leemans): IAMs include many generalizations. Usually, Africa is seen as 1 region, even though we know that is not true. IMAGE has a grid spacing of 0.5 x 0.5 degrees, and can look at different driving forces at the grid level. In the malaria case, the relationship with climate was assessed with regression modelling. Adaptation was not included. This is a major challenge for modelling.

Q (Gerald Barney, Millennium Institute, USA): There is an opportunity to extend the influence of science on policy makers through religious organizations (Assembly of Religious and Spiritual Leaders). Could reports be shared with us so that we could prepare background papers?

A (Jae Edmonds): We all share information. Is this an institutional question for IPCC?

Q (Bert Bolin, Sweden, IPCC): We haven't heard about social dimensions of climate change. These are often chaotic. I feel uneasy that IAMs do not include this.

A (Steve Schneider): Conflicts occur over what we value, such as the rich-poor gap. There are problems with synergism and surprise. We can identify some surprises (e.g. changes in ocean currents), but we cannot anticipate changes in human values. In IAMs, we need a broader set of participants in the modelling process.