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Recent results and updating of scientific and technical knowledge

Dynamic modelling

Report by the co-Chairs of the Joint Expert Group on Dynamic Modelling

Summary

The present report comprises the results of recent work in dynamic modelling and summarizes the discussion and outcomes of the thirteenth meeting of the Joint Expert Group on Dynamic Modelling, held from 24 to 26 October 2012 in Sitges, Spain. The information presented here is in accordance with the request of the Executive Body for the Convention on Long-range Transboundary Air Pollution in the 2012–2013 workplan for the implementation of the Convention (ECE/EB.AIR.109/Add.2, item 3.9), which was adopted by the Executive Body at its twenty-ninth session in December 2011.

I. Introduction

1. The thirteenth meeting of the Joint Expert Group on Dynamic Modelling under the Working Group on Effects (WGE) was held from 24 to 26 October 2012 in Sitges, Spain.

2. Seventeen experts from the following Parties to the Convention on Long-range Transboundary Air Pollution (Air Convention) attended the meeting: Austria, Canada, Czech Republic, Germany, Netherlands, Norway, Sweden, Switzerland, United Kingdom of Great Britain and Northern Ireland and United States of America. The International Cooperative Programme (ICP) on Assessment and Monitoring of Acidification of Rivers and Lakes (ICP Waters) and the ICP on Integrated Monitoring of Air Pollution Effects on Ecosystems (ICP Integrated Monitoring) were also represented.

3. The meeting was co-chaired by Mr. A. Jenkins (United Kingdom) and Mr. F. Moldan (Sweden). It was organized by the Centre for Ecology and Hydrology (United Kingdom) and by the IVL Swedish Environmental Research Institute (Sweden).

II. Aims and organization

4. The aims of the Joint Expert Group meeting were to examine progress in dynamic modelling of acidification, heavy metals and nutrient nitrogen, including the interactions between climate change and air pollution, biological response and terrestrial carbon sequestration. Specifically, and in accordance with the agreed WGE workplan (ECE/EB.AIR.109/Add.2), the objectives were to:

(a) Consider the proposed call for data 2012 by the ICP on Modelling and Mapping of Critical Loads and Levels and Air Pollution Effects, Risks and Trends;

(b) Assess progress in dynamic modelling;

(c) Assess progress in dynamic modelling of climate change/air pollution interactions;

(d) Consider progress in the workplan items common to all ICPs, the Joint Task Force on the Health Aspects of Air Pollution and the Joint Expert Group on Dynamic Modelling, namely, further development of the Guidelines on Reporting of Monitoring and Modelling of Air Pollution Effects (ECE/EB.AIR/WG.1/2008/16, adopted by the Executive Body by decision 2008/1).

III. Conclusions and recommendations

A. Proposed call for data 2012

5. The Joint Expert Group agreed with the need for another call for data asking for dynamic modelling outputs. The scope of the call should include both terrestrial and aquatic ecosystems and should encourage further national work on dynamic modelling of ecosystem effects on biota and in general.

6. The Joint Expert Group discussed ways to encourage maximum participation of Parties to the Convention in the coming call for data. Formulation of the call should be broad enough to reflect the national needs of as many Parties to the Convention as possible: the call should encourage further national work on all the relevant aspects of air pollution

ecosystem effects, including critical loads, focusing on the nationally most relevant receptors and the nationally most relevant effects.

B. Progress in dynamic modelling

7. The Joint Expert Group stressed the need for continued monitoring programmes for air pollution effects in Europe. Good monitoring data over long time periods are essential for calibration and development of dynamic modelling. More effort is needed to ensure that the data collected at different sites is used by different models and as many modelling groups as feasible.

8. The Joint Expert Group applauded the work undertaken in Switzerland on confronting outputs of the combination of geochemical and biodiversity models with observed data. Such efforts are essential and must be continued. Long-term monitoring programmes, such as ICPs, are essential for this work.

9. Several examples of using dynamic modelling to improve estimates of various terms in the steady-state critical loads models (First-order Acidity Balance (FAB), Simple Mass Balance (SMB), etc.) are now common and were presented at the meeting. This holds for base cation terms (such as weathering), as well as nitrogen (N) terms (such as N immobilization).

10. Dynamic modelling of soils and surface waters in Ukraine was presented at the meeting, thus extending the number of countries with available dynamic modelling outputs describing past, present and future impacts of air pollution. The work presented also made use of historical data on soil chemistry, plant species and dendrology collected in the 1930s. Use of historical data, as in this case, provides a powerful means to constrain dynamic modelling and consequently adds to credibility of the model outputs. The Joint Expert Group was encouraged by the ability of dynamic modelling to simulate measured long-term changes in soil and vegetation, probably due to air pollution.

C. Acidification

11. Sources and sinks of base cations still pose uncertainty in critical load calculations and in dynamic modelling predictions of recovery from acidification. Soil pools of exchangeable base cations become increasingly important as forestry practices such as whole tree harvesting become more common. An example from Canada demonstrated clear experimental evidence of forest soils being depleted of calcium (Ca) at alarmingly high rates at the same time that sulphur (S) deposition has been decreasing.

12. Contrary to simulations by dynamic acidification models, trends in decreasing sulphate (SO_4) are not always followed by decreasing base cation concentrations. Examples of such observations raised the question about representation of all relevant processes in the models. The lack of regional estimates of base cation deposition is still a source of uncertainty. Recent work of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) focusing on modelling of particulate matter (PM) opens the possibility for the much-needed improvement of this situation.

D. Nutrient nitrogen

13. New developments in dynamic modelling of ecosystem carbon and nitrogen (C and N) cycling and their interdependencies were presented. New microbial-based approaches

are promising and incorporate new data and understanding. Maximum possible use of data and observations for testing the models is an imperative in this model development.

14. The Joint Expert Group pointed out that continued work was necessary to further increase understanding of the factors and processes that controlled nitrogen saturation in terrestrial ecosystems. Again, the long-term monitoring data are crucial for testing models and for further model development.

15. There is convincing experimental evidence that total phosphorus (P) is the most practical and appropriate measure of P load on aquatic ecosystems relevant for modelling of the role of P in eutrophication. Including P in dynamic modelling of eutrophication improves the ability of a model to predict the future impact of N deposition.

16. The Joint Expert Group concluded that considering the stoichiometry of C-N-P in soils and in waters helps to constrain the models and improve their ability to predict the nutritional status of soils. It also noted that soil organic P reflected P availability and cycling more appropriately than the most commonly measured total P.

E. Heavy metals

17. The Joint Expert Group noted with satisfaction the progress on dynamic modelling of heavy metals, including combined environmental effects of heavy metals toxicity, acidity and other environmental factors. The development of models such as the aquatic cation mixture toxicity model (WHAM-Ftox)[1] provides the opportunity to assess environmental impacts of heavy metals emission reductions achieved to date. This work should — together with critical loads for heavy metals — be considered as an input in the negotiations of further reductions of heavy metals emissions.

18. The Joint Expert Group took note of the promising development in modelling mercury (Hg) cycling in soils in Scandinavia and in the United Kingdom.

F. Biodiversity

19. The use of plant functional groups was demonstrated to be a useful concept for modelling vegetation dynamics. The functional groups could be, when successfully modelled, further divided to individual species, including Red List or other rare or "signature" species.

20. The Joint Expert Group noted that the terms and concepts used when dealing with biodiversity were inconsistently defined, and recommended that a common vocabulary be developed.

21. The Joint Expert Group applauded the efforts of ICP Waters in putting together a 30-year time series of invertebrate data from seven countries across Europe. It urged that the trends/patterns identified in that unique database be assessed against the trends/patterns in chemistry data from the same sites. This database can form the basis for dynamic modelling of biodiversity in surface waters and for setting relevant biological targets.

[1] See http://goldschmidt.info/2013/abstracts/finalPDFs/2334.pdf.

G. Ozone

22. The Joint Expert Group urged that ICP Vegetation be represented at the next meeting to assist with the dynamic modelling of ozone and nitrogen interactions. It also felt that the ICP Forests level 2 data could be more effectively used by the dynamic modelling community for testing and calibration of models, and would welcome experts from ICP Forests at its next meeting.

H. Progress in dynamic modelling of climate change/air pollution interactions

23. Base lines and reference conditions are — with respect to biology — changing due to irreversible impacts of air pollution, such as soil acidification and soil N enrichment as well as other changing environmental factors, namely climate.

I. Further development of the Guidelines on Reporting of Monitoring and Modelling of Air Pollution Effects

24. Ecosystem effects are a good basis for illustrating the benefits of reduced air pollution. Dynamic modelling of ecosystems uniquely provides the time scales of expected changes.

25. The revised Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (Gothenburg Protocol) sets 2020 as the target year for full implementation of its provisions. The Joint Expert Group urged continued work on dynamic modelling so that the outputs could support any future protocol. It reiterated that the time to recovery should be incorporated in any future negotiation on emission reduction and that target loads derived from dynamic modelling were available to undertake that.

26. Under the European Union Thematic Strategy for Air Pollution[2] the Joint Expert Group emphasized the use of dynamic modelling, critical loads and other ecosystem effects indicators in formulating policy.

27. The Joint Expert Group noted some inconsistency in approaches used in the implementation of the European Union Water Framework Directive[3] and the Convention within individual countries. It urged that efforts be made to ensure, as far as possible, that consistent targets and thresholds were developed, and agreed to revisit the issue at its next meeting.

J. Future of the Joint Expert Group

28. The Joint Expert Group agreed that a further meeting in 2013 would be beneficial to review progress with regard to: nitrogen as a nutrient in terrestrial and freshwater systems; interactions between nitrogen, carbon and phosphorus; biological responses and targets; heavy metals; base cations; ozone; and dynamic global vegetation models.

29. The Joint Expert Group also agreed that dynamic model outputs could provide input to assessment of ecosystem services and that it should consider the ecosystems services

[2] See http://europa.eu/legislation_summaries/environment/air_pollution/l28159_en.htm.

[3] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. See http://ec.europa.eu/environment/water/water-framework/.

approach and possible links between ecosystems services and dynamic modelling at its next meeting. The next Joint Expert Group meeting will also aim to consider the issue of consistency in approach under different international policies and conventions, such as the Water Framework Directive, the Convention on Biological Diversity and the Air Convention.