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Item 4 (g) of the provisional agenda

**Steering Body to the Cooperative Programme for Monitoring and Evaluation
of the Long-range Transmission for Air Pollution in Europe (EMEP)**

(Twenty-eighth session, Geneva, 6-8 September 2004)

Item 4 (a) of the provisional agenda

**WORKSHOP ON THE EMISSIONS, TRANSPORT, DEPOSITION AND EFFECTS OF
BASE CATIONS IN RELATION TO ACIDIFICATION**

Report prepared by the workshop organizers with the assistance of the secretariat

Introduction

1. The workshop on the emissions, transport, deposition and effects of base cations in relation to acidification took place on 26-28 November 2003 in Gothenburg (Sweden). It was organized by the Swedish Environmental Research Institute (IVL) and the Swedish Research Programme on International and National Abatement Strategies for Transboundary Air Pollution (ASTA).

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2. The workshop was attended by 23 experts from the following Parties to the Convention: Czech Republic, Estonia, Finland, Germany, Italy, Latvia, Netherlands, Norway, Sweden and United Kingdom. The International Cooperative Programme (ICP) on Modelling and Mapping, the Joint Expert Group on Dynamic Modelling, the EMEP Meteorological Synthesizing Centre - West (MSC-W) and the secretariat were also represented.

I. AIMS OF THE WORKSHOP

3. The aim of the workshop was to:

(a) Summarize knowledge on the state of the art in the large-scale monitoring and modelling of base cation deposition in Europe;

(b) Strengthen cooperation between effects-oriented research, the Working Group on Effects and EMEP on the issue of base cation deposition;

(c) Make recommendations for shorter- and longer-term approaches to obtain quantified data on base cation deposition;

(d) Explicitly address the needs of critical loads calculations and the requirements of dynamic models used in integrated assessment models.

4. The workshop was opened by Ms. Gun Lövblad (Sweden) and Mr. Peringe Grennfelt (Sweden). They briefly presented the background and the main aims of the workshop.

II. CONCLUSIONS

5. The workshop agreed that the definition of base cations for effects-oriented air pollution research referred to the ions calcium (Ca^{2+}), magnesium (Mg^{2+}), potassium (K^+) and sodium (Na^+). In addition, chloride (Cl^-) was often used to estimate co-leaching with cations, and as tracer for the sea-salt correction. In general, effects work required total (wet plus dry) base cation deposition input from outside the ecosystem considered. However, various fractions were needed for different purposes. For example, the base cation depositions used in critical load calculations should exclude sea salt and anthropogenic contributions while dynamic modelling included them.

6. Total base cation deposition rates were important for the calculation of critical loads, dynamic modelling and other ecosystem effect assessments. They were usually comparable to base cation weathering and net uptake by vegetation, although this strongly depended on the region and ecosystem.

7. Bulk deposition, for which there were many data available, captured wet deposition and an unknown part of the dry deposition. However, the relation between the bulk and wet-only deposition varied over Europe, as demonstrated by various national studies. The bulk collector gave neither the wet-only fraction nor the total deposition.
8. Wet deposition of base cations over Europe was only moderately well known.
9. Dry deposition comprised a large fraction of the total base cation deposition in Europe. There were almost no measurements of dry deposition and only few data on air concentrations that could be used in connection with inferential models (dry deposition velocities for different land covers) to estimate dry deposition amounts. Throughfall data, which were more readily available, could be used in combination with canopy budget models to assess site-specific total deposition rates.
10. The dry deposition fraction was considerably affected by land cover and consequently the land-use classification, which should characterize the ecosystem properties important for deposition processes. Therefore, the mapping of dry and total deposition always required appropriate land cover data.
11. The reliability of wet base cation deposition was relatively high, while for dry deposition there were large uncertainties.
12. ICP Mapping and Modelling, as well as its national focal centres (NFCs) and the Coordination Center for Effects (CCE), would benefit from a European total (ecosystem-specific) base cation deposition map based on joint data and evaluation by experts working under the Working Group on Effects and the EMEP Steering Body. Such a "default" map should preferably have the same geographical resolution as the other data in the effects-oriented work. For mapping critical loads, recent long-term meteorological data (e.g. 3–5 years) would be better than a single year's data to avoid potential biases from annual meteorological variations. There was no need anticipated for shorter time periods than one year, except for validation purposes.
13. The work of EMEP to provide a first ad hoc EMEP map of total base cation deposition over Europe for effects-oriented work was highly welcome (see recommendations).
14. There was a need for historical base cation deposition estimates for dynamic modelling. The Joint Expert Group on Dynamic Modelling had asked EMEP for such data; however, no data

had yet been provided. There were methods to support any (modelled) estimates to acquire relative historical changes, such as tree ring analyses or lake sediment data.

15. The workshop considered that the particulate matter emission inventory and modelling work carried out by MSC-W provided a good framework for base cation deposition modelling. The base cation element contents could be incorporated into the chemical composition scheme for anthropogenic particulate matter emissions. However, there had been no official requests to create an inventory of natural (mainly sea salt and soil erosion) emissions yet.

16. The preliminary results from comparing EMEP modelled deposition with throughfall measured at ICP Forests level II (intensive monitoring) sites showed good agreement for ecosystem-specific total sulphur deposition and for nitrogen wet deposition. This method could be promising for base cation deposition assessment as well, provided that canopy budget models were valid on a European scale.

17. For the validation of modelled wet deposition, the wet deposition fraction of measured bulk deposition should be estimated. Bulk deposition always contained some dry deposition. The validation could be done, for example, by using parallel measurements from specific sites and apply those results region by region.

18. For the validation of modelled dry deposition, independent direct measurements of air concentrations and of dry deposition were needed.

19. Generally decreasing trends in base cation deposition in Europe over the past 30 years were shown by several presentations at the workshop. The periods for the largest decreases varied in different regions; however, it was assumed that the anthropogenic fraction had decreased sharply in recent decades.

20. There was no clear information on the relative contributions from natural and anthropogenic emissions to present total base cation deposition. However, the workshop considered natural emissions to be roughly the same as anthropogenic emissions, with large regional variations. In Northern Europe, the contribution of soil erosion to base cation deposition may be relatively small. There was a need for more information on natural emissions (mainly wind-blown dust from soil erosion).

21. The workshop considered it important to have modelled base cation deposition maps available within the next year for comparison with monitored data. However, it was acknowledged that the emission data might not be fully ready and evaluated with this time frame.

22. The workshop concluded that the forthcoming activities should be grouped in short-medium- and long-term goals, presented in more detail in the recommendations.

III. RECOMMENDATIONS

23. The workshop recommended that the providers and users of base cation deposition should always clearly define the type of base cation deposition that they provided, used or required (for example, wet-only or bulk as monthly or yearly averages).

24. The workshop categorized the needs of base cation deposition map data as short-medium- and long-term, depending on the current availability of data and possibilities for including new findings.

25. The workshop recommended that the effects work community should be provided with one commonly agreed "default" European total base cation deposition map. The most straightforward approach for a quickly producible map was believed to be to use existing data with minimum extra work. The following steps could be taken at short notice to prepare a map in early 2004:

(a) Develop a basic wet-only base cation deposition map using EMEP Chemical Coordinating Centre (CCC) monitoring data. The map should be derived for the year 2000 (likely to be the reference year for the Protocol's forthcoming revision) or a multi-year average around it, and to provide feasibly interpolated element-specific (Ca, Mg, Na, K, Cl) data at the same geographical resolution as the EMEP 50 km × 50 km grid, preferably with and without sea-salt correction. If the above data were not immediately available, a 1996 map could be used as a proxy, although its data coverage may not fully meet current requirements;

(b) Estimate the regionalized land-use-specific ratio of dry to wet deposition using the particulate matter (PM) deposition results obtained with the EMEP unified model. The study should be concurrent with wet deposition data, that is, the year 2000 with element- and ecosystem-specific data in a 50 km × 50 km grid, and PM size segregated (2.5 and 10 µm), if relevant;

(c) Invite the participants of the workshop to examine the method and the results, preferably before the end of 2003 or as soon as possible. The workshop felt that a positive response was necessary for further circulation to the relevant bodies of the Working Group on Effects, that is, NFCs for mapping critical loads and the Joint Expert Group on Dynamic Modelling;

(d) CCE could make the data available to NFCs by circulating the map, with clear documentation attached to explain what the data were and how they could be used;

(e) NFCs may then compare the Europe-wide data with national maps derived, for example, from national monitoring networks. They might also use the map for calculations if no other appropriate data were available for a country;

(f) NFCs might make an assessment of the "default" map against their national data and report to CCE or the Task Force at its meeting and workshop in 2004.

26. As the above-mentioned approach did not fulfil the needs of the Joint Expert Group on Dynamic Modelling, which had not met to discuss this, a possible approach towards historical depositions would be similar maps based on CCC data from past years, for example, in 5-year intervals from as early as the data were available (1980s). To reach estimates for earlier years surrogate methods could be employed. These included, inter alia, guidance from EMEP experts based on historical measurements, or relative, historical changes in sulphur deposition being made available by CCE and the Centre for Integrated Assessment Modelling (CIAM). However, these approaches should be agreed jointly by the Working Group on Effects and EMEP.

27. The above-mentioned results should be considered as an ad hoc solution and used with caution. They would be updated with expected new findings during 2004. On a longer timescale, the "default" total base cation deposition map would be revised with new research findings.

28. MSC-W could deliver the sea-salt deposition (calculated within the EMEP unified model) if these data were found to be useful in the effects work. The users of these data should be identified before they were made available.

29. Research on soil dust base cation deposition should have priority and should preferably take the form of a Europe-wide assessment. This could be possible with the EMEP unified model, as a proposed task for MSC-W in 2004.

30. Anthropogenic base cation emissions could be quantified and included in the current particulate matter emission inventory, possibly in a manner comparable to the soil dust component. The workshop stressed that countries should submit data on the base cation element contents in their sectoral particulate matter emissions, including the size distribution.

31. The base cation emission data should be compiled and used with the atmospheric dispersion models. The resulting modelled depositions should be compared with monitored data, such as the EMEP precipitation and air concentration data, and the data collected by ICP Forests,

ICP Integrated Monitoring and ICP Modelling and Mapping. It is expected that the discrepancies between modelled and measured total depositions would be higher in Southern and South-Eastern Europe than elsewhere, mainly due to the influence of Saharan dust.

32. The need for size-segregated measurements should be re-evaluated. It was possible to rely on the filter-pack data from the EMEP monitoring network. There were some data from Europe on particle size ranges including their chemical speciation. Large particles were expected to play a role; however, it was currently not easy to evaluate their contribution over Europe.

33. There was a need to further compile and evaluate dry deposition velocity data at national and international levels.

34. It was considered important that countries should follow the EMEP recommendation to report to EMEP the base cation contents from filter-pack measurements.

35. There was a need to develop additional methods for validation. These included the use of surrogate surfaces. This could be applied largely in Europe at sites where base cation air concentrations were measured, and with models that allowed the use of throughfall measurements. Potential sites included many ICP Forests and ICP Integrated Monitoring sites. More research on methods was needed.

36. The land cover had to be taken into account when mapping deposition, since the spatial variability of total deposition varied considerably with land cover. Land cover data should be identical to, or compatible with, those used in effects-oriented work under the Convention. This has been underlined by ICP Modelling and Mapping, which recommended the use of the CORINE land cover (or compatible national) database for spatial allocation and the EUNIS classification for receptor definition. The workshop noted that European land-cover data should be made freely available to the Parties for the work under the Convention.

37. Historical and future depositions (1860–2100) of both acidifying and neutralizing compounds were required for dynamic modelling. If the necessary data could not be delivered in the short to medium term, appropriate guidelines to fulfil the needs of dynamic model inputs should be provided by EMEP as soon as possible.