

**Scientific review of the models used at MNP for air quality  
assessment, held at 1-2 December 2005**

**Final Report**

A.A.M. Holtslag  
L. Tarrasón  
P. Grennfelt

## **1. Introduction**

This report describes the review of the methods used for assessment of air pollution, and constitutes the first step of the full review of MNP. The review of the air quality models took place 1 and 2 December 2005, through a visit of the review committee to MNP. The review committee consisted of the following members:

- Prof. Dr. A.A.M. Holtslag (chair review committee), Professor of Meteorology and Air Quality, Wageningen University and Research Centre.
- Dr. L. Tarrasón, Head Air Pollution Section at the Research Department of the Norwegian Meteorological Institute, and Project leader of the EMEP Meteorological Synthesizing Centre-West under the UN-ECE Convention on Long-range Transboundary Air Pollution.
- Prof. P. Grennfelt, Scientific Director of the Swedish Environmental Research Institute (IVL), and Associate Professor in "Atmospheric chemistry and air pollution control strategies" at the Department of Inorganic Chemistry, University of Gothenborg.

Prior to their visit, the review committee was provided with a set of documents. This set consisted of general information about MNP, the MNP modelling strategy, documents describing the scientific approach of the models used, and several reports to show examples of how the models are used for policy assessments (see reference list).

## 2. Background

In 2004 the supervisory committee of the National Institute of Public Health and the Environment (RIVM) has requested the review of the scientific performance of RIVM, including that of the Netherlands Environmental Assessment Agency (MNP). In response to this request, a scientific review of MNP has been organised, which is being held in the period 2005-2007. This report describes the review of the methods used for assessment of air pollution, and constitutes the first step of the full review of MNP. The results of the first scientific review (held in 2000) of the integrated environmental policy assessment function of RIVM, the 'predecessor' of MNP, are described in the report 'Scientific Audit of Integrated Environmental Policy Assessment, Final Report' (Bourdeau et al., 2001). The overall judgement of that first scientific review was very positive, and several recommendations were given on various issues such as independence, modelling and treatment of uncertainties.

The present review concentrated on the three models that are employed at MNP for air pollution assessment and policy support at the national and continental scale:

1. The integrated assessment model RAINS-NL. This model will be used for integrated assessment studies at the national level, i.e., studies into the effects of alternative emission control policies on future air quality and the effects of it on human and ecosystem health, paying attention to the cost-effectiveness of the various control policies.
2. The atmospheric chemistry transport model OPS. By default, OPS is used to calculate long-term average concentrations and deposition in the Netherlands, for all components other than ozone or POPs (see Lotos/Euros).
3. The atmospheric chemistry transport model Lotos/Euros. This model is used for components that have non-linear chemistry (ozone); or when output is needed for the European domain; or for components that exhibit re-emission, such as POPs; or when a time resolution is needed of less than one month.

The questions that were provided to the review committee are given below. In addition to these aspects, the review committee has also addressed the independence of MNP and the access to monitoring data.

1) *What is your opinion on the MNP strategy regarding models? In particular:*

- *What is your opinion on the balance between models of different levels of detail and scope?*
- *What is your opinion on the choice of the partners in the network?*
- *How do you judge the amount of expertise necessary at MNP for model development, maintenance and actual computations?*

2) *Are the models suited for their purpose? In particular:*

- *What is your opinion on the scientific approach followed in the models?*
- *Are conclusions drawn from the results of model calculations scientifically sound?*
- *Are the models suitable to answer the policy questions, as addressed in environment policy evaluations and outlooks?*
- *Do these policy questions demand the models employed at MNP?*

3) *What is your opinion on how MNP is dealing with uncertainties related to the models/methods used?*

- *Is MNP aware of all relevant uncertainties that influence the policy conclusions?*
- *What is your opinion on how MNP should deal with uncertainties?*
- *What is your opinion on the communication about uncertainties by MNP?*
- *How much uncertainty is acceptable.*

4) *What is your opinion on the way forward for MNP for the next few years regarding modelling air quality aspects?*

### **3. Findings of the review committee**

#### ***Overall Judgement of Environmental Assessments***

- **The overall judgement of MNP regarding air quality assessments is excellent, based on the material provided. MNP's assessments are timely, are on key issues, taking into account a wide number of aspects. MNP has very good ability to formulate policy relevant questions and finding answers.**

RIVM/MNP has a long tradition in systems analysis on environmental issues going back to the end of the 1980-ies (cf 'Concern for Tomorrow'). MNP has built on this tradition and further developed its concept based on models assessing environmental status and outlining possible pathways for the future. Recent publications ('Particulate matter: a closer look' and 'Consequences for the Netherlands of the EU thematic strategy on air pollution') are examples on how this tradition is taken further. Even though the reports are considering national problems and dimensions, the review committee welcomes the initiative to publish the material in English. The wide distribution of the reports may make them important for policy development outside the Netherlands.

#### ***Independence***

- **The formation of an independent assessment agency in the Netherlands is good. It is however not fully clear to the review committee for who MNP works. It is aimed at government, but its relation to other stakeholders is not fully clear. MNP should continue to reflect upon its independence and its position.**

Integrated assessments have the aim of forming a basis for policy decisions. Since the basis for them (within the framework of MNP) is pure scientific, it is important that they are produced within the context of an independent organisation, taking into account all relevant scientific findings without being influenced by various short term policy or scientific interests. Even though the independence was a basis for the formation of MNP, the review committee however felt some hesitation regarding its role vis-à-vis the government. For the review committee it appeared obvious that MNP should have a wider objective than working for the government. It's role is rather to be supportive to the society and its reports should therefore also be useful and reflect interests from other parts in the society than those normally considered by the government. Such interests could be local authorities, NGOs, farmers and industry. The review committee felt that MNP's work more strongly reflected requests from the government than from other stakeholders.

#### ***Strategy on models***

- **We endorse the MNP modelling strategy, which is a networking strategy. MNP could benefit from further collaboration with international institutes.**

MNP's working area is very broad, and it is not feasible nor desirable to do model development on all relevant areas in house. MNP has recognized this, and has developed a networking strategy to have access to the best available tools. The choice of partners in the Dutch network is good, as the institutions are competent and complementary. This choice of partners in the future could benefit from including more international institutes. In the past few years, co-operation with IIASA has been established on RAINS-NL, and MNP has fruitfully co-operated with EMEP, particularly on comparing results for the Netherlands.

- **The role of MNP staff should include continuous critical reviews of the models used to answer policy relevant questions. Therefore, it is necessary that MNP allocates sufficient funding for the maintenance of its own modelling expertise and for independent evaluations of air quality models.**

Presently, MNP's assessments are made with models that have been developed mainly by MNP itself (OPS), in co-operation with other institutes (LOTOS-EUROS), or that have been developed by other institutes and adapted by MNP to give more detailed results for the Netherlands (RAINS-NL). The review committee feels that it is important that MNP also shows a larger openness to other air quality models that are available, and that MNP continues to contribute to model developments and international model intercomparisons. In the past, the LOTOS-EUROS model has played an important role in checking the performance of European reference models. From this perspective, it is important that MNP allocates sufficient funding for independent evaluation of air quality models, as well as for the maintenance of own modelling expertise which is necessary to make a critical review of air quality models.

### ***Fitness for purpose of the models used for air quality assessments at MNP***

- **The OPS model has shown good performance for national purposes in the past. To explore the suitability of OPS for simulations of future concentrations and deposition, we strongly recommend to compare OPS with models that have more detailed treatment of transport, mixing and chemistry.**

The main task for which the OPS model is used is the assessment of long-term (yearly) average concentrations and deposition of air pollutants – with the exception of ozone – in the Netherlands, and the simulation of their changes with time. It has shown good agreement with air pollution concentrations (trends and spatial distribution) as measured by the Dutch national air quality monitoring network over the past 10-20 years.

The applicability of OPS for this purpose is to some degree constrained by the formulation of transport, mixing and chemistry. As in many models, attention should be given to upgrade the dispersion formulations for light wind conditions (see also Dabberdt et al, 2006). The chemical parameterisation in OPS is based on conversion rates of air pollutants, rather than on more explicit (non-linear) chemical schemes. Some non-linearities have been taken into account in OPS, for example to simulate the conversion of ammonia to ammonium: the yearly conversion rate of ammonia to ammonium depends on the ambient concentrations of ammonia, sulphur dioxide and nitrogen oxides.

While for species other than ammonia, conversion rates are assumed linear within OPS, in reality, conversion rates depend on the actual mixture of air pollutants and meteorological parameters (e.g., temperature, UV actinic flux). As the (average) mixture of gases changes over the years, the conversion rates may also change over time. This imposes, in principle, a limitation to the use of the OPS model for simulating long-term trends spanning multiple decades. Nevertheless, in practice, it has been shown that OPS is very well capable of reproducing trends of air pollutant concentrations with the Netherlands despite the changes in the chemical regime (and conversion rates) over this period. To explore the suitability of OPS for simulations of future concentrations and deposition, we recommend to compare OPS with models that have more detailed treatment of chemistry, such as the Lotos-Euros model.

- **The development of the RAINS-NL model for the Netherlands is a good initiative, and allows a deeper insight in future development and control options in relation to EU strategies.**

It is becoming increasingly evident that European air pollution policy requests control measures on different levels, from European legislation to control measures on a local scale. Assessments with European-wide integrated assessment models (RAINS) therefore need to be complemented with assessments on national and local levels. A further development of the RAINS model to cover smaller regions is therefore welcomed. The RAINS-NL model is designed to fill the gap between the European and national level.

- **For further applications of the RAINS-NL model, MNP should consider the use of source-receptor matrices derived from models that account for non-linear chemistry. However, before deciding on changing the source-receptor matrices used within RAINS-NL, MNP should carefully investigate how a change may influence the outcome of the model.**

Atmospheric chemistry involves a large number of non-linear processes that have been identified and investigated throughout the last 5-10 years. These processes have been shown to severely influence source-receptor relationships and make it impossible to use simple proportional relations when assessing the outcome of future control scenarios and developing cost-effective control strategies for Europe. Since the source-receptor matrices in RAINS-NL are based on the OPS model, which not fully can take into account the non-linear processes, we see a problem in using the OPS model for the development of future control scenarios.

The review committee therefore recommends continuing to compare the source-receptor relationships calculated with OPS with those calculated with models that include non-linear chemistry. The result of such comparisons may eventually lead to a replacement of the source-receptor relationships used within RAINS-NL. However, before deciding on changing the source-receptor relationships used within RAINS-NL, MNP should carefully investigate the effect on the policy advice.

### ***Uncertainties***

- **It is positive that MNP has put uncertainties on the agenda and that the topic is a subject for a systematic thinking and that MNP attempts to find a structure of uncertainty management.**

Uncertainty has become an area of increasing interest in the development and application of models aimed to support policy development. Even if uncertainty analysis has been widely used as a scientific tool, its use in the context of policy development is far from well developed. If uncertainty analysis will have a meaning in policy development, it is not only important to analyse uncertainty properly in the policy context but it is also necessary to develop methods to communicate uncertainties to policy makers in a way that is understandable and useful for them. The framework developed in connection with the RAINS-NL model is a valuable step forward but needs further consideration in order to be useful.

- **We welcome the initiative to employ the MNP uncertainty management guidelines to applications of the RAINS-NL model. However it needs further consideration regarding communication with stakeholders.**

If uncertainty analysis should have a meaning for a stakeholder or a policymaker, it needs to be undertaken in the perspective of raised questions or of proposed decisions. Questions to be answered include: "How certain are we that calculated environmental benefits will be achieved given a certain emission reduction?", or "How sure are we that the proposed control measure is the most cost-effective?".

## ***Recommendations for the future***

- **For the long-term, MNP should consider making a feasibility study to explore tools necessary for Dutch policy support in 2020.**

MNP has a unique position in the European environmental society due to its long term task to assess environmental problems as an independent organisation. Since the advice obtained by MNP mainly is based on models, it is important to keep following the development of models and tools so MNP always can use state-of-the-art models and also focus on problems to be on the agenda in the future. From what we have seen, our impression is that, although being able to focus on relevant problems, there is a risk that models and tools are becoming out of date, which may cause problems in terms of credibility and legitimacy.

- **For the short-term, the focus should be on characterisation of assessment tools. It is important to have a quality control of the tools.**

It is important that MNP continues to contribute to model developments and international model intercomparisons. The criteria for the quality testing should be based on international cooperation and standards. In the past, the LOTOS-EUROS model has played an important role in checking the performance of European reference models. It is important that MNP allocates sufficient funding for independent evaluation of air quality models, as well as for the maintenance of own modelling expertise which is necessary to make a critical review.

- **There is a need to continuously follow the development of different policy agendas (NEC review, climate policy, CAP reform, transport policy, renewable energy) and assess how these policies may affect the requirements for the modelling tools.**

One of the most important challenges for MNP is to have assessment models ready and applied when the policy questions are raised. The assessments that were provided to the review committee showed that at present this is one of the strong points of MNP. Maintaining this good performance means that MNP should allocate sufficient resources to follow the policy processes in particular within the European Commission, but also in relation to other bodies (UNFCCC, CLRTAP) as well as national policy development.

## ***Air quality monitoring***

- MNP should be fully aware that access to air quality monitoring data is essential for assessments and model validation.

As a result of the institutional separation of RIVM, MNP does no longer perform operational air quality measurements itself. The review committee feels that this poses a risk to the ability of MNP to perform model validations and properly use monitored data for their assessments. Also, there may be a risk that MNP will rely in the future more on models rather than on measured data. MNP should be aware of this risk and make sure not only that model outputs continue to be in line with measurements but also that the models and measurements continue to have a sound scientific basis. The review committee therefore feels that it is important that MNP has a manner to steer the monitoring such that the amount and quality of monitored data is sufficient for model validation and air quality assessments.

## **References**

- Aben JMM, Hettelingh J-P and Schoepp W (2005) RAINS-NL: An Integrated Assessment Model to support Dutch air quality policy making In: Hrebicek J. and Racek J., eds., Proceedings of the 19th International Conference Informatics for Environmental Protection, Brno, 7-9 September 2005, pp 513-517.
- Bourdeau Ph et al. (2001) Scientific Audit of the Integrated Environmental Policy Assessment (Milieuplanbureau), RIVM, Bilthoven.
- Buijsman E et al. (2005) Particulate matter: a closer look – The state of affairs in the particulate matter dossier from a Dutch perspective, MNP/RIVM, Bilthoven.
- Dabberdt WF et al. (2006) USWRP workshop on air quality forecasting, BAMS, pp. 215-221.
- Folkert R et al. (2005) Consequences for the Netherlands of the EU thematic strategy on air pollution, MNP report 500034002.
- MNP, The Netherlands Environmental Assessment Agency – Introduction, unpublished document.
- MNP, The 2<sup>nd</sup> International scientific audit of the Netherlands Environmental Assessment Agency at RIVM, to be held in five separate steps, from 2005-2007, unpublished document.
- MNP, Outline of general principles for modeling at MNP, unpublished document.
- MNP, Scientific audit file for OPS, unpublished document.
- MNP, Scientific audit file for RAINS-NL, unpublished document.
- MNP, Scientific audit file for LOTOS/EUROS, unpublished document.
- Schaap M, Roemer M, Sauter F, Boersen G, Timmermans RMA, Builtjes PJH (2005) TNO report B&O 2005/297.
- Schaap, M, Sauter F, Timmermans RMA, Roemer M, Velders G, Beck J and Builtjes PJH (2005) The LOTOS-EUROS model: description, validation and latest developments (submitted).
- Van Jaarsveld JA (2004) The Operational Priority Substances model; Description and validation of OPS-Pro 4.1. RIVM rapport 500045001.
- Van Pul A, Van Jaarsveld H, Van der Meulen T, Velders G (2004) Ammonia concentrations in the Netherlands: spatially detailed measurements and model calculations, Atmospheric Environment 38, 4045-4055.
- Velders G et al. (2003) The RIVM-MNP contribution to the evaluation of the EMEP Unified (Eulerian) model, RIVM report 500037002.
- Van Velze K and Aben JMM, An empirical model for deriving NO<sub>2</sub> and O<sub>3</sub> concentrations from NO<sub>x</sub> concentrations, unpublished document.