Chapter 1
Introduction

Current emissions create pollution levels that exceed air quality standards and other environmental objectives at many locations throughout the Northern Hemisphere. While local or regional emissions and environmental conditions are responsible for most of these problems, air quality and pollutant deposition is also influenced by emissions, transport, and transformation processes at the intercontinental and global scales. There is well-documented evidence for the intercontinental transport of ozone, fine particles, and their precursors, as well as mercury and some persistent organic pollutants. The significance of this intercontinental influence for the design of air pollution control policies, however, has not been well understood.

This interim report summarizes the current state of understanding of the significance of intercontinental transport and hemispheric pollution on ozone and fine particle concentrations and sulfur and nitrogen deposition in the Northern Hemisphere. The report was produced by the Task Force on Hemispheric Transport of Air Pollution (TF HTAP) organized under the auspices of the 1979 Convention on Long-range Transboundary Air Pollution (LRTAP Convention) primarily for purposes of informing the review of the 1999 Gothenburg Protocol to Abate Ground-level Ozone, Acidification, and Eutrophication.

1.1 The LRTAP Convention and TF HTAP

The LRTAP Convention, which is administered under the United Nations Economic Commission for Europe, presently has a total of 51 parties, covering all of Europe, most of North America, and extending into Central Asia. Under the Convention, eight protocols have been developed and have all entered into force. One protocol addresses long-term funding for air pollution monitoring and modeling activities. The other protocols comprise air pollution reduction targets which address sulphur, nitrogen oxides, ammonia, volatile organic compounds, mercury, lead, cadmium, and persistent organic pollutants (see http://www.unece.org/env/lrtap). The most recent protocol, the 1999 Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone, identified the issue of intercontinental transport of air pollution as potentially relevant for research and the review that is to take place after the entry into force of the protocol.

TF HTAP was created by the Executive Body of LRTAP Convention in December 2004 to “plan and conduct the technical work necessary to develop a fuller understanding of the hemispheric transport of air pollution ...[and] estimate the hemispheric transport of specific air pollutants for the use in reviews of protocols to the Convention ….” [*UNECE*, 2004]

TF HTAP reports to the European Modeling and Evaluation Programme (EMEP) Steering Body, the atmospheric monitoring and analysis arm of the LRTAP Convention, and cooperates with other LRTAP Convention bodies. The United States and the European Community were designated the lead parties of TF HTAP. TF HTAP members are experts nominated by national governments, experts from intergovernmental or accredited non-governmental organizations, and experts invited by the Chairs. With encouragement of the Executive Body, the TF HTAP chairs encourage the participation of experts from countries outside the LRTAP Convention and the UNECE region.

TF HTAP serves as a forum for international scientific communication and collaboration to integrate national and international research efforts at the regional, hemispheric, and global scales to better understand air pollution transport across the Northern Hemisphere and inform the development of international air pollution policy.

TF HTAP met for the first time in Brussels in June 2005. The participating experts agreed to focus the efforts of the TF HTAP on a series of policy-relevant science questions (see Box 1) and began to lay out a plan for producing an assessment of intercontinental transport of air pollutants in the Northern Hemisphere by 2009.

In December 2005, the Executive Body of the LRTAP Convention began a review of the obligations of the 1999 Gothenburg Protocol to be completed by December 2007. The Executive Body charged all of the bodies under the Convention to contribute information to the review. The TF HTAP was specifically asked to contribute information on the significance of intercontinental transport and hemispheric pollution for the achievement of the objectives of the Protocol, including impacts on ground-level ozone, fine particles, and deposition of sulphur and nitrogen.

1.2 Purpose and Organization of This Report

This interim report has two purposes. The first purpose is to inform the review of the Gothenburg Protocol. For this purpose, the findings of the report have been summarized in the Executive Summary, which has been submitted to the LRTAP Convention's secretariat for incorporation into the protocol review.

The second purpose of this interim report is to provide an initial assessment upon which to build a more comprehensive 2009 assessment. In addition to addressing ozone, fine particles, sulphur and nitrogen deposition, the 2009 assessment will also address mercury and persistent organic pollutants, which are also the subject of protocols under the LRTAP Convention.

The report builds on experts' written contributions in chapters addressing important aspect of assessment of intercontinental transport of air pollution. The authors of the report were drawn from a roster of experts set up through a general invitation on the internet to nominate authors. More than 50 experts were invited by the Co-Chairs of the TF HTAP to contribute to the different chapters. The draft chapters were posted on the website of the TF HTAP (see http://www.htap.org) with a general invitation for comments on the draft. The different chapters were updated after the comments and the revised draft presented to the TF HTAP at the annual spring meeting held 30 May to 1 June 2007 in Reading. At that meeting, the TF HTAP accepted the report and adopted the Executive Summary.

The rest of the report begins with a conceptual overview of hemispheric and intercontinental transport of ozone and fine particles in the Northern Hemisphere presented in Chapter 2. Chapter 3 summarizes the observational evidence from surface sites and networks, aircraft and field campaigns, and satellite instruments for hemispheric and intercontinental transport and discusses the current state of observational systems for characterizing intercontinental transport. The status and implications of available inventories and future projections for anthropogenic and natural emissions are discussed in Chapter 4. Chapter 5 describes different approaches for characterizing hemispheric pollution and intercontinental transport using models and summarizes available modeling results for ozone and fine particles and deposition, including the initial results of the on-going model intercomparison and evaluation effort organized under the TF HTAP. Each chapter includes a discussion of recommendations for future research and analysis. An overview of the activities of the TF HTAP between 2004 to summer 2007 is given in Chapter 6. The main conclusions of this interim assessment and key recommendations for future work are summarized in Chapter 7.

References

UNECE, United Nations Economic Commission for Europe (2004), Convention on Long-range Transboundary Air Pollution, Executive Body, Decision 2004/4, ECE/EB.AIR/83/Add.1, Annex IV.

Box 1: TF HTAP Policy-Relevant Science Questions

1. How does the intercontinental or hemispheric transport of air pollutants affect air pollution concentration or deposition levels in the Northern Hemisphere for ozone and its precursors; fine particles and their precursors; compounds that contribute to acidification and eutrophication; mercury; and persistent organic pollutants?
   - What evidence do we have of transport pathways and mechanisms from intensive field studies? From observations? From model predictions?
   - How do the transport pathways differ by pollutant? By source region? By season?
   - What processes need to be better understood to describe the relative significance of intercontinental transport?
   - How do processes at the intercontinental or hemispheric scale affect processes at the local or global scales? (Synoptic scale meteorological events/cycles; Hadley circulation; etc.)

2. More specifically, for each region in the Northern Hemisphere, can we define source-receptor relationships and the influence of intercontinental transport on the exceedance of established standards or policy objectives for the pollutants of interest?
   - What observational evidence exists for attributing pollutant concentrations or deposition levels to source regions or countries?
   - Using predictive chemical transport models, what are possible methods for calculating source-receptor relationships? At what spatial resolution (geographic region, individual countries) can such methods be applied reasonably?
   - How can models with different spatial resolutions be nested within one another to provide an appropriate level of spatial resolution for the entire hemisphere or globe?
   - What improvements are needed to global and regional transport models to better simulate atmospheric processes to enhance source-receptor predictions?

3. How confident are we of our ability to predict these source-receptor relationships? What is our best estimate of the quantitative uncertainty in our estimates of current source contributions or our predictions of the impacts of future emissions changes?
   - What metrics and techniques are most appropriate for evaluating global and regional model simulations with observations and for quantifying uncertainties?
   - Do we have a sufficient database of observed concentrations and deposition levels to evaluate the predictions of current models? How can this observational database be improved for the purposes of evaluating models? Should we develop a set of standard observational platforms and measurements to enhance data consistency globally?
   - Do we have sufficient observational data bases to track long term progress and change in transport and deposition patterns?
   - Do we have sufficient data on emissions and the trends in driving forces needed for making reasonable future projections? How can this data be improved?
   - What physical or chemical processes must be better understood to improve our confidence in our estimates of source-receptor relationships? What is the minimum level of certainty in our understanding of these processes that must be attained before reasonable/useful estimates can be made?

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4. For each country in the Northern Hemisphere, how will changes in emissions in each of the other countries in the Northern Hemisphere change pollutant concentrations or deposition levels and the exceedance of established standards or policy objectives for the pollutants of interest?
   - Is there a simple relationship between changes in emissions and changes in pollutant concentrations and deposition levels?
   - How is the predicted relationship affected by the spatial resolution of the model?

5. How will these source-receptor relationships change due to expected changes in emissions over the next 20 to 50 years?
   - How might emission quantities and spatial distributions change over the next 20 to 50 years?
   - How should future emission scenarios be constructed?

6. How will these source-receptor relationships be affected by changes in climate or climate variability?
   - How will meteorological changes predicted by climate modeling studies affect major transport or chemical processes?
   - Are there significant feedbacks between the transported air pollutants and regional climate and meteorology?
   - Are there significant feedbacks between transported air pollution and potential changes in land use, vegetation, or ecosystems, especially with respect to natural emission sources?
   - Are there predictive relationships between climate system indices that can be used to estimate the impact of changing climates on hemispheric transport of air pollutants?

7. What efforts need to be undertaken to develop an integrated system of observational data sources and predictive models that address the questions above and leverages the best attributes of all components?