HTAP 2010 Assessment Report

Overview of Part C: Persistent Organic Pollutants

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HTAP 2010 Assessment Report

Part C: Persistent Organic Pollutants (~200 pages, 35 experts)

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Common Topics in Chapters C1-C5

- Physical-chemical properties of POPs
- Main processes of POPs behaviour in environmental compartments
- Legacy and new POPs
- Climate change and POPs
- Integrated approach

Chapter C1. Conceptual Overview

- Purpose of the HTAP 2010 assessment on POPs
- Properties of POPs (legacy and new POPs)
- International policy on POPs
- Integrated aproach
- Interactions between climate and POPs
- F & R

Purpose of the HTAP 2010 Assessment on POPs

- to provide the current state of knowledge and understanding on POPs
- to identify key findings and recommendations for further work.

State of the art:

Our understanding of POPs has greatly improved in recent years.

Physical-Chemical Properties

Persistent organic pollutants (POPs) are chemicals that persist in the environment, can resist degradation, bioaccumulate through the foodchain, may be toxic and cause adverse health effects in humans, wildlife and the environment and can be transported to regions where they have never been used or produced.

Main processes

POPs are multimedia chemicals meaning that they partition to air, water, soil, sediment, snow/ice, aerosols and other environmental compartments according to their key physical-chemical properties

Accumulation in environmental media and subsequent re-emission, and transport in ocean currents play an important role in determining levels in locations remote from sources.

Driving Forces (International policy on POPs)

Findings

Past research on POPs highlighted their inherent properties that make them a threat to human health and the environment. This has driven international and national policy and regulation of POPs under frameworks such as:

International

- the Stockholm Convention on POPs
- Basel and Rotterdam Conventions
- the LRTAP Convention
- OSPAR, HELCOM, MAP
- . . .

(the Stockholm Convention and the Basel and Rotterdam Conventions: Global (~170 countries); the LRTAP Convention and OSPAR, HELCOM, MAP: Regional)

National

- Canadian Environment Protection Act (1999)
- EU Regulation REACH (2007)
- . . .

EU Regulation REACH (~ 2000 substances)

In accordance with the EU Regulation REACH (2007) on production and use of chemicals in the European Union the industry should submit the following information:

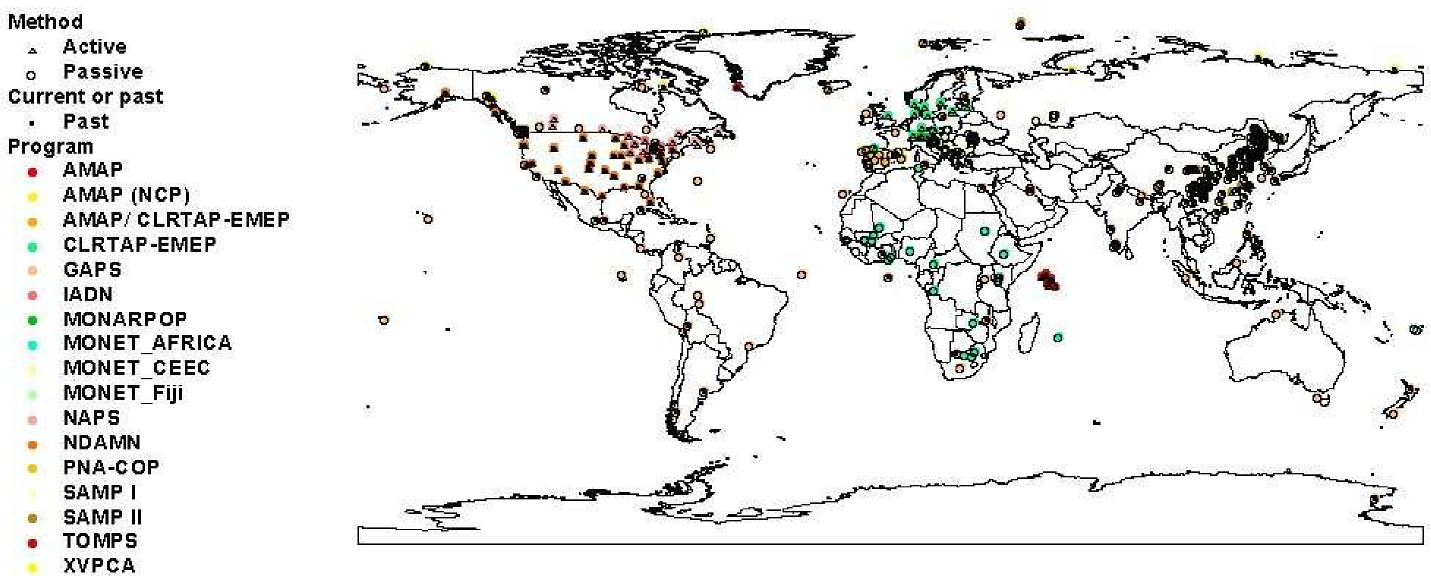
- on physical-chemical properties of a substance
- its environmental fate properties
- toxicological and ecotoxicological properties
- possible harmful effects on human health and the environment
- emission estimates
- monitoring data for substances of very high concern.

Chapter C2. Observations and Capabilities

- Atmospheric observation
- Oceanic observation
- Air-Surface Interaction
- Chemical Tracers
- Effectiveness of Control Measures
- Effects of Climate Variations
- F & R

State of the art:

This chapter summarizes recent observations and measurements of POPs in various environmental media from which a better understanding of POPs transport on a regional, intercontinental or global scale can be derived (Appendix A,B).



Long/short-term and process studies monitoring networks around the globe

Findings

Atmospheric monitoring programs provide good spatial coverage of atmospheric concentration of most POPs.

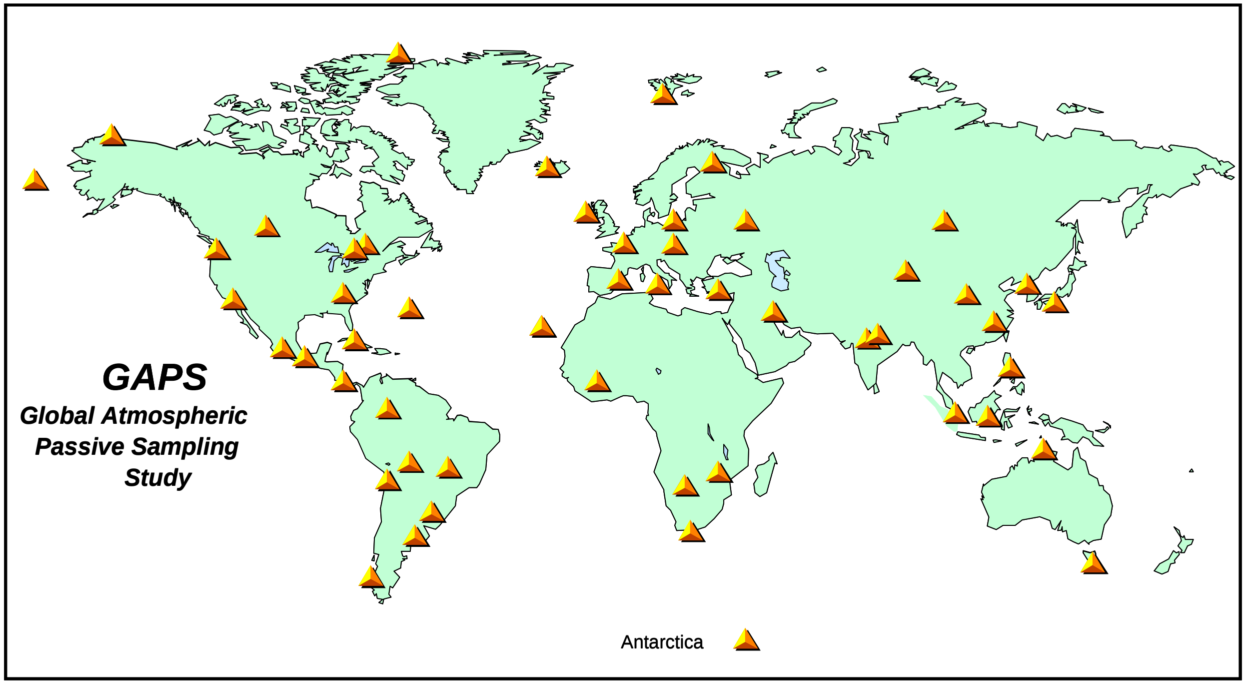
Long-term air monitoring programs provide temporal trends with a time span of approximately 15 years.

In some cases, declining time trends of some substances, e.g. technical HCH, responded to international controls.

However, some POPs showed slow or no significant decline in air in response to control.

Findings

Spatial resolution for air measurements have increased considerably due to the adoption of passive air sampling methods.



UNEP GAPS monitoring sites

Findings

There are limited measurements and few organised monitoring of POPs concentrations in media other than air, e.g. precipitation, dry deposition, ocean, snow, soil and vegetation, etc.

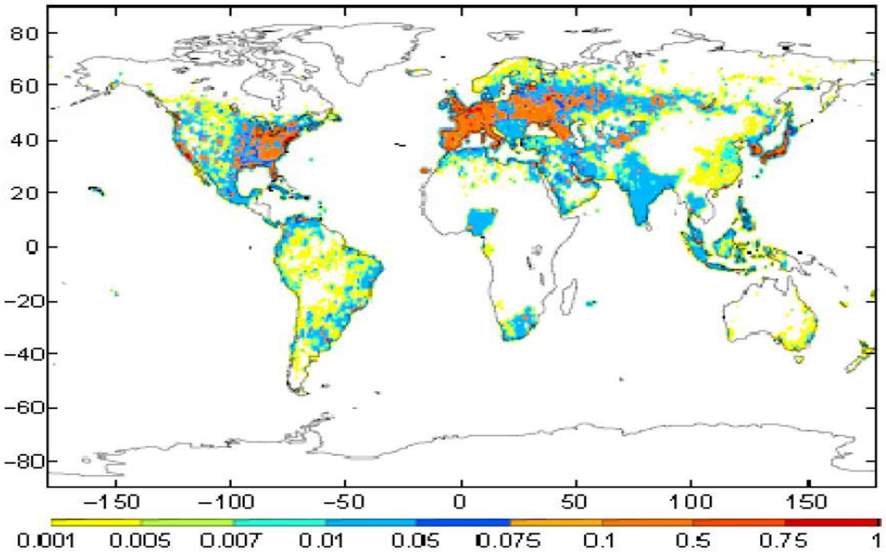
Chiral analysis is useful for distinguishing primary versus secondary emission.

C3. Emissions

- Emission inventories
- Uncertainties and verification of emission inventories
- Emission projections
- F & R

State of the art

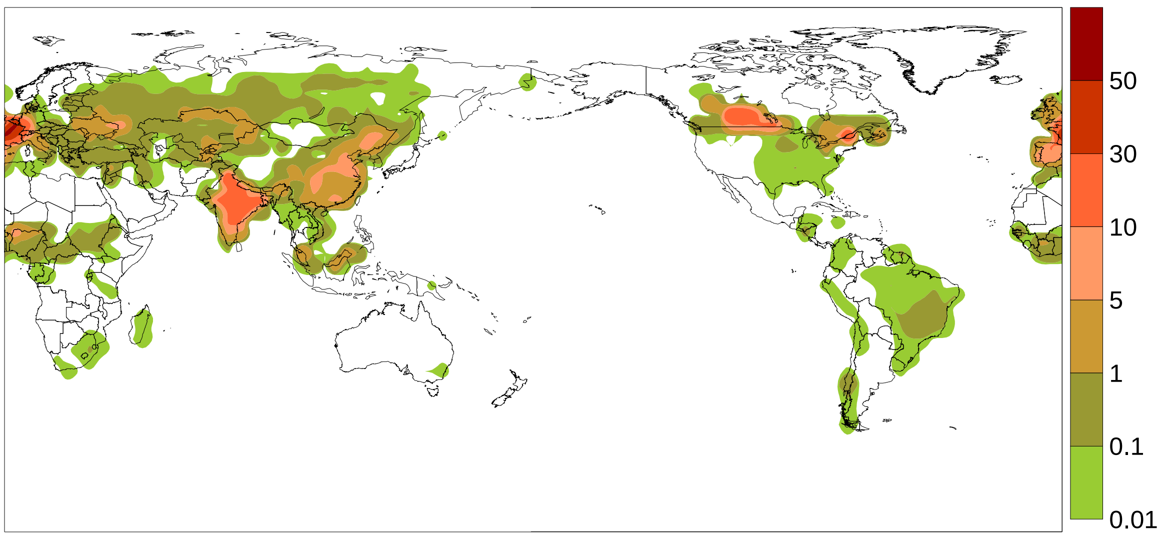
Significant advances have been made with respect to the development of emission inventories for some POPs on a global scale. in the last decades (DDT, HCB, HCHs, PAHs, PCBs, PCDD/Fs, and PFOS).



Spatial distribution of global atmospheric emissions of PCB(22) for the year 2004 in metric t/y [map by Sabine Eckhardt, based on data in *Breivik et al.*, 2007]

Findings

POP emission inventories quantify primary emissions only. The emitted POPs tend to accumulate in environmental reservoirs, such as soil and water bodies, and re-emit to the atmosphere forming the secondary emissions, which in future may supersede eventually the primary emissions.



Gridded global γ-HCH soil residues (t cell-1) in 2005 with 1°×1° latitude/longitude resolution

Findings

Evaluation of the re-emission can be subject of essential uncertainties as it depends on the historical emissions.

Any future projection of POPs emissions without considering the second emissions will not be complete, or misleading in some cases.

Emission inventories of all POPs are affected with high uncertainties concerning the applied emission factors.

There are still essential spatial and temporal gaps in information on emission sources.

C4. Global and Regional Modelling

- Modelling approaches for the evaluation of POP transport
- Evaluation of POP long-range transport on global and regional scales
- Intercomparison of POP intercontinental transport modelling
- Integrated approach
- F & R

State of the art

This chapter describes modelling approaches for quantification of environmental exposure to Persistent Organic Pollutants (POPs), reviews applications of models in conjunction with emissions information and monitoring data, and presents results of model comparison exercises aimed at quantifying inter-continental source-receptor relationships.

Modelling approaches

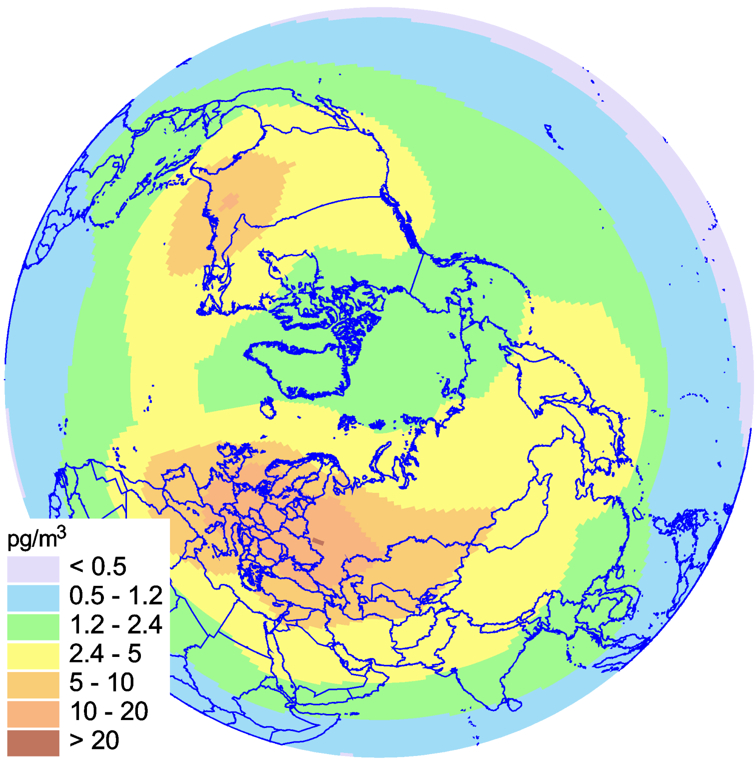
At present, there exist a set of POP fate models that describe the system of chemical and environment with widely varying levels of detail. These include multimedia box models, trajectory models, and spatially resolved multicompartment chemistry transport models.

The different models reflect different design decisions and different applications − from screening of a large number of substances with respect to their long-range transport potential and environmental persistence to the detailed evaluation of pollution levels and trends and source-receptor relationships.

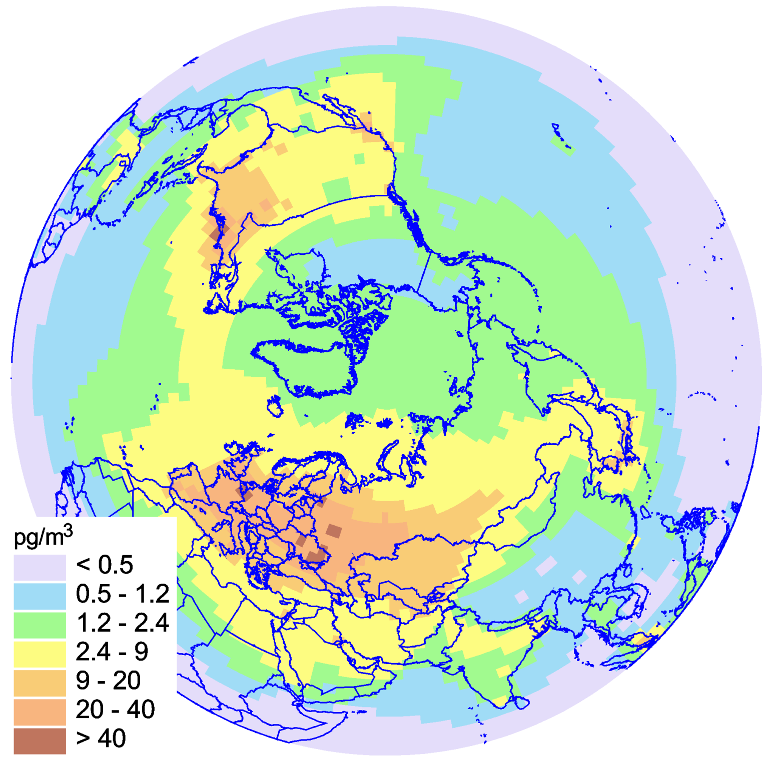
Long-range transport on the global scale

Modelling studies of POP long-range transport at global (intercontinental transport) and regional (transboundary transport) scales have been performed for a subset of legacy POPs (PAHs, PCBs, PCDD/Fs, HCHs, DDT) and new POPs (brominated flame retardants and fluorinated acids).

Long-range transport on the global scale



BETR-Global (BG)



MSCE-POP (MP)

Spatial distribution of modelled annual mean air concentrations of PCB-28 (pg/m^3), 2001

Long-range transport on the global scale

Findings

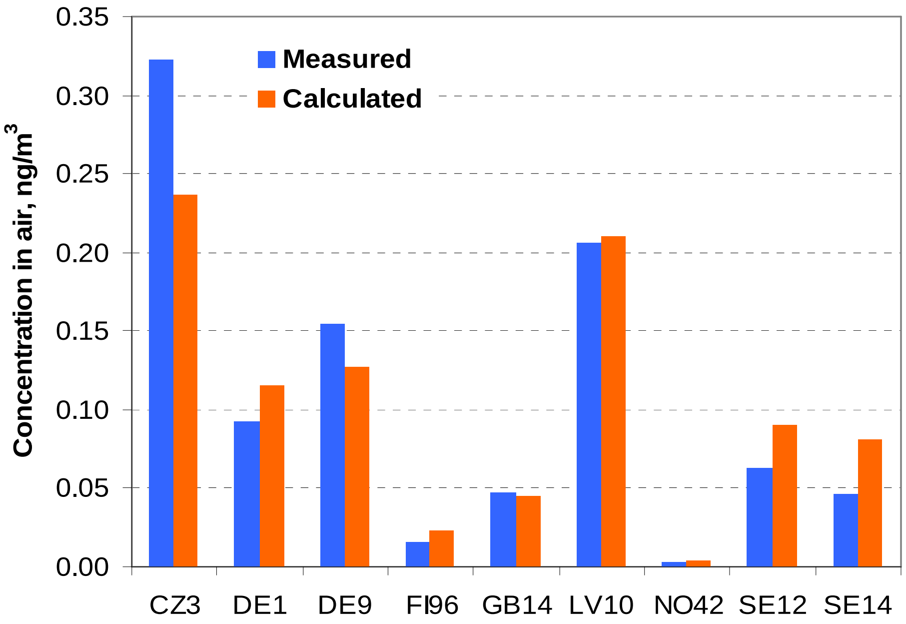
Model simulations performed for the selected POPs showed that contribution of intercontinental transport to the pollution levels in the receptor regions can reach almost 30%.

Both mass balance models and multicompartment chemistry transport models can be used to support the evaluation of environmental hazard associated with new substances.

Evaluation of model results

Findings

Evaluation of modeling results reveals reasonable agreement between available measurements and model predictions of POP concentrations in the atmosphere. Deviations between the modeled and observed concentrations for most of the studied POPs are typically within a factor of three to four.

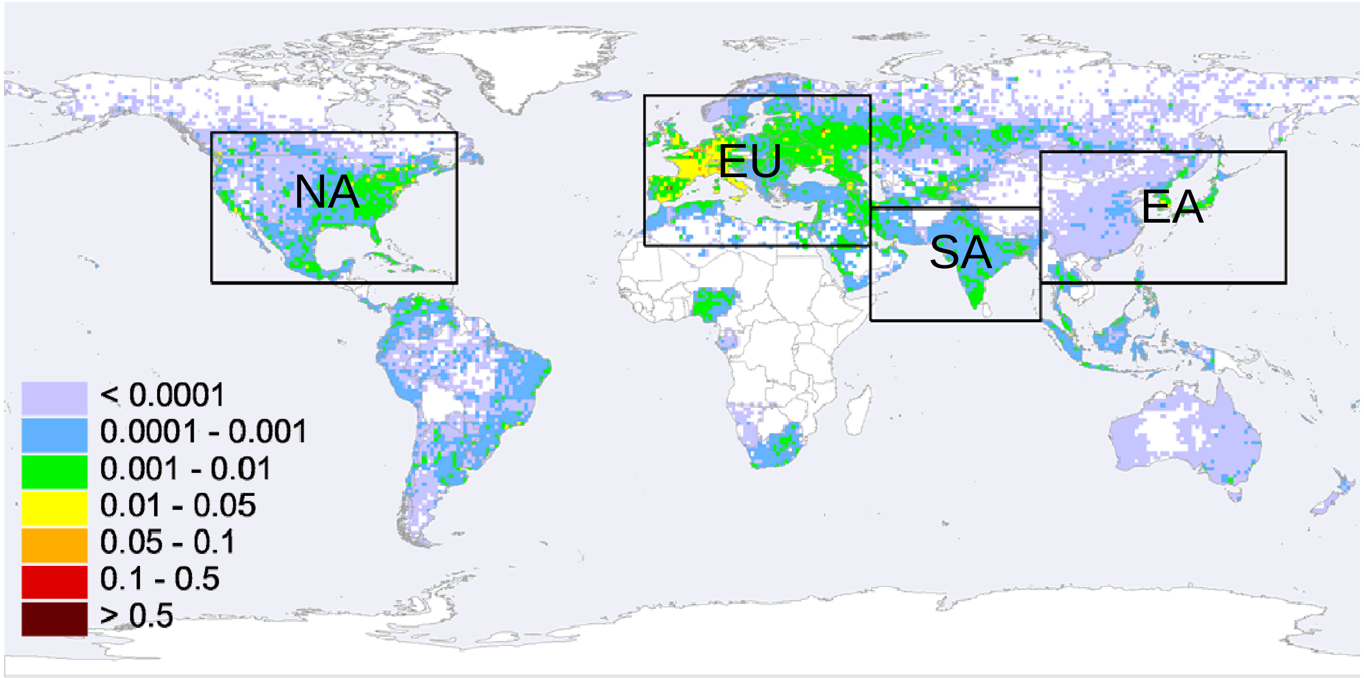


Comparison of measured and calculated annual mean air concentrations of B(a)P for 2007, ng/m^3.

Source-receptor relationships

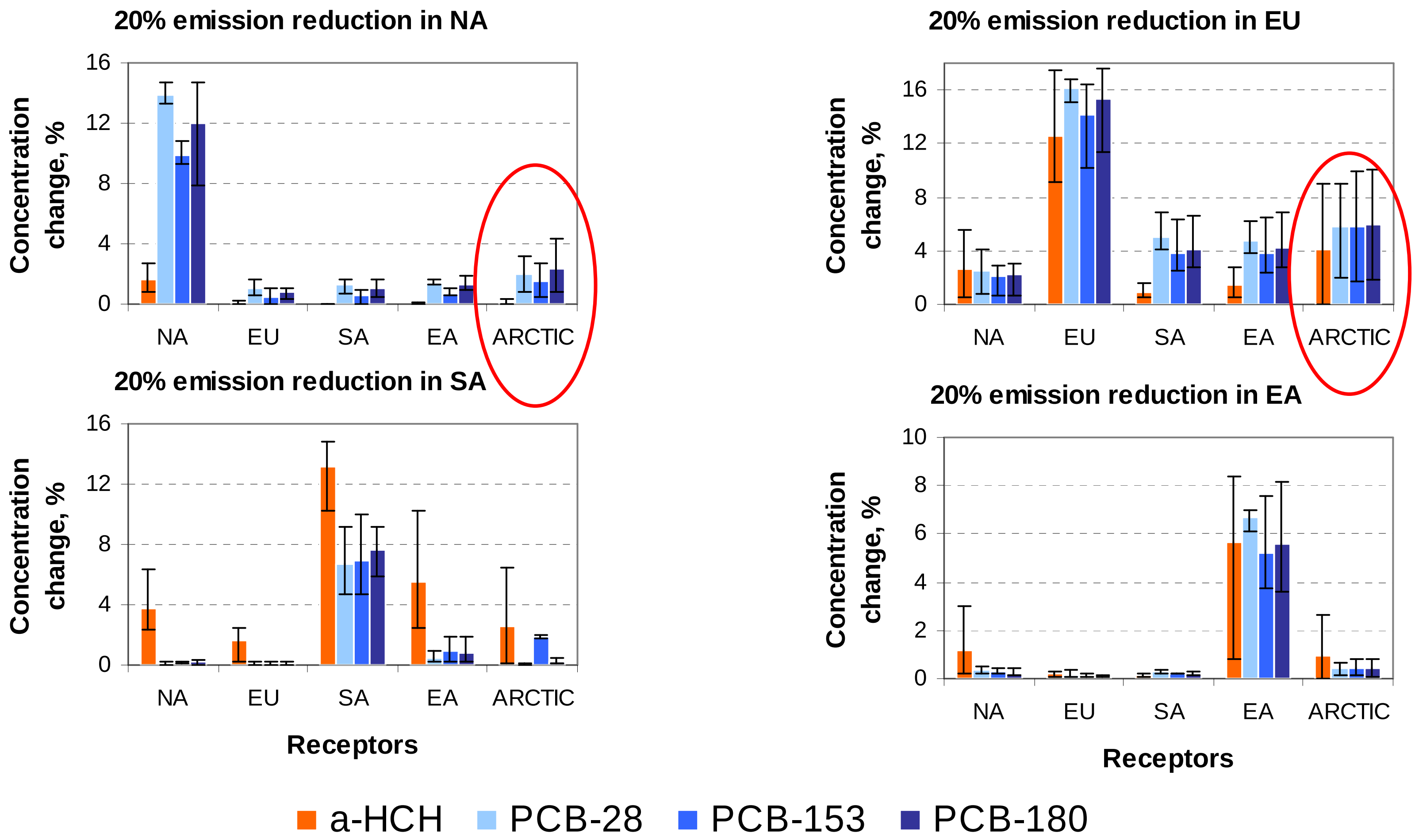
Findings

The TF HTAP model intercomparison designed to evaluate and quantify POP intercontinental transport showed concentrations and deposition to be sensitive to **20%** changes in POP emissions on the global scale.



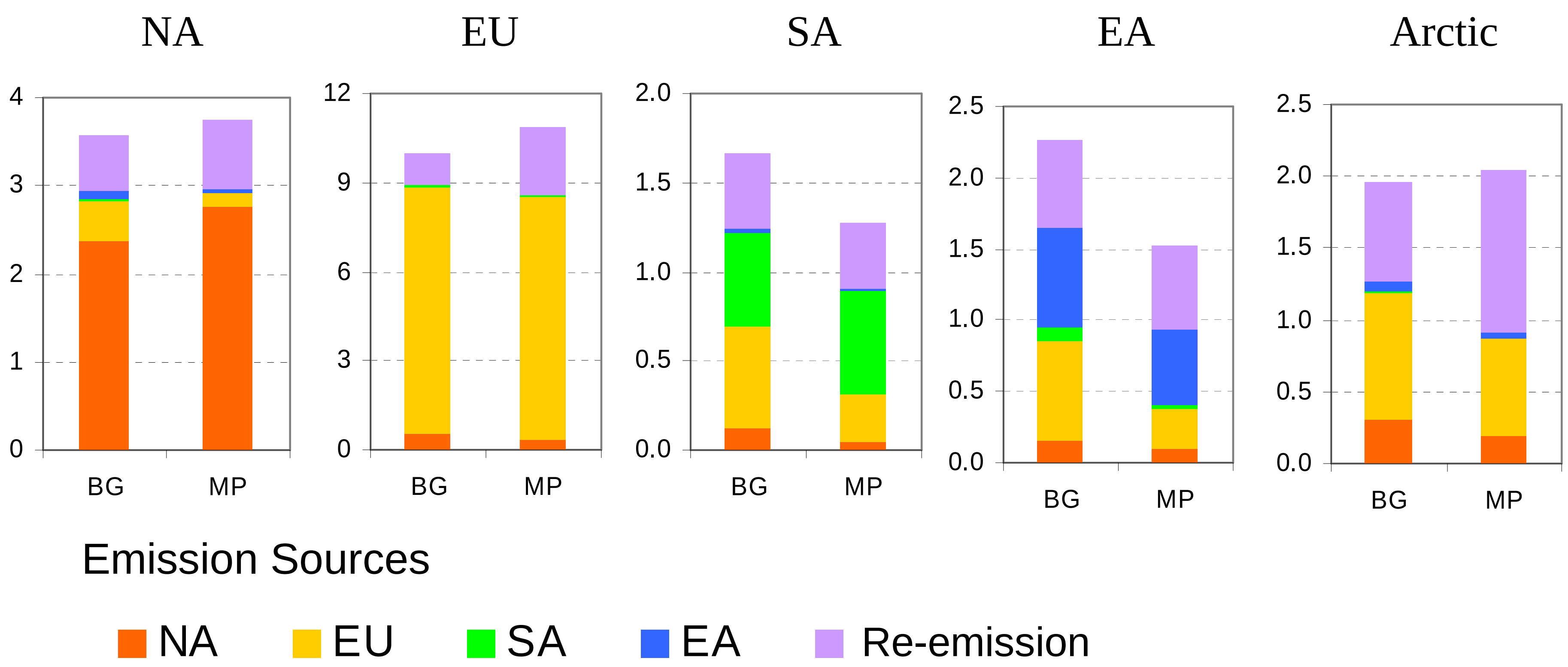
Source-receptor relationships

Findings



Relative decreases (in %) of annual mean surface air concentrations in the receptor regions due to 20% emission reductions in four HTAP regions.

Source attribution



Estimates of contributions of different emission source regions to annual mean surface air concentrations (pg/m^3) of PCB-28 over five receptors (NA, EU, SA, EA, and the Arctic)

(Other sources: emission in other regions and secondary emissions)

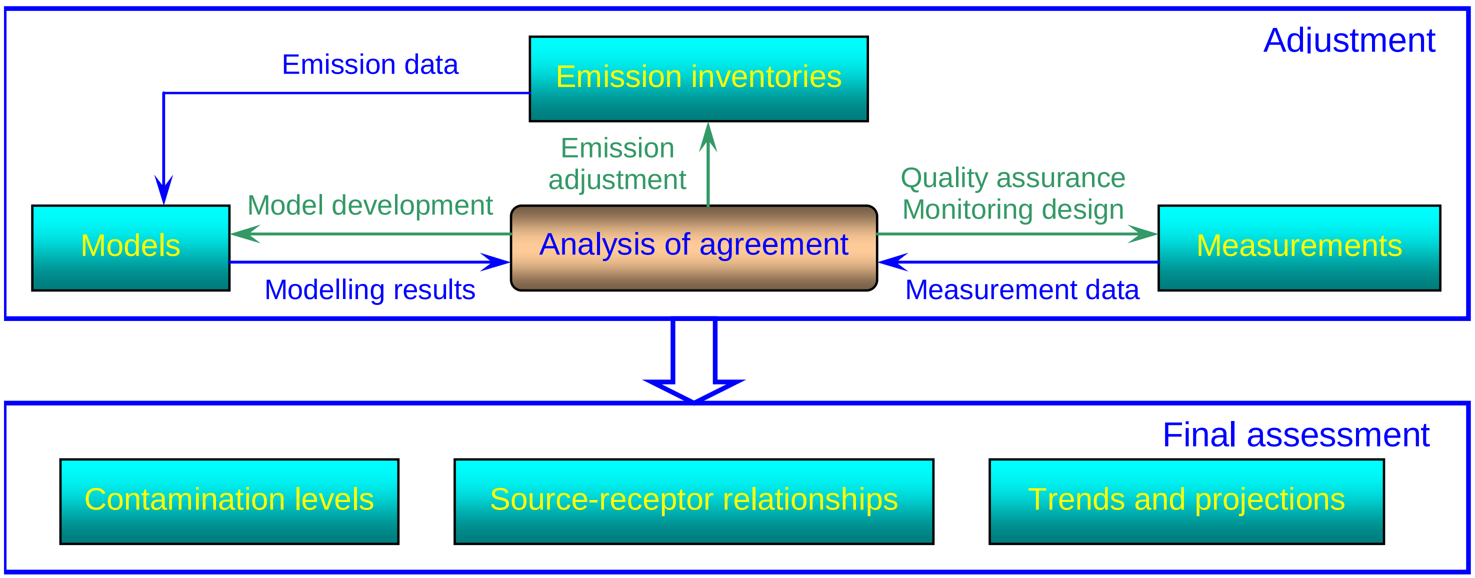
Source-receptor relationships

Findings

Evaluation of the source-receptor relationships for POPs is more difficult than for other air pollutants, because of the significance of the secondary emission sources (re-emission).

Integrated approach

To better understand long-range transport, fate and impact of POPs in the environment integrated use and analysis of monitoring, emission, and modelling data for evaluation of POP contamination is required.



Integrated approach is an iterative process that may require re-evaluation of one or more of the components to achieve agreement.

C5. Impacts

- Overview of impacts of POPs
- Impact of POPs on ecosystems
- Impact of POPs on human health
- Monitoring in human media
- Implications of HTAP analysis

State of the art

POPs can negatively impact the health of humans and animals. The toxicity of many POPs has been well established, while some POPs are also known or suspected carcinogens.

POPs	IARC classification
2,3,7,8-TCDD	1 = carcinogenic to humans
Benzo[a]pyrene	1 = carcinogenic to humans
PCBs	2A = probably carcinogenic to humans
Toxaphene	2B = possibly carcinogenic to humans
Chlordane	2B = possibly carcinogenic to humans
Heptachlor	2B = possibly carcinogenic to humans
……	…..

Findings

The main ways in which people can be exposed to POPs are through food 90 % [*Liem et al.*, 2001].

The concentrations of POPs in animals are often greater than the concentration of POPs in the animal's nearby environment or the animal's food. The processes by which this occurs are called bioconcentration, bioaccumulation, and biomagnification.

Findings

The Joint WHO/Convention TF on the Health Aspects of Air Pollution report (2003) highlighted several POPs that are of concern or are potentially of concern with respect to long-range transport, especially DDT, HCH, dioxins, and PCBs.

The AMAP 2009 assessment of human health in the Arctic concluded that current human exposure to contaminants negatively influences human health. Since most of the POPs in the Arctic are the result of long-range transport, it can be concluded that most of the health effects from POPs in the Arctic are also due to long-range transport.

New substances

Findings

New or emerging substances (PBDEs, PFOS…) have been detected in the Arctic. Assessments have cited the lack of information on health effects and long-range transport of these substances.

Uncertainties in physical chemical properties of some POPs and the lack of such measurements for new and emerging chemicals create difficulties in the understanding of air-surface exchange processes.

In many cases, these ‘new’ POPs behave differently compared to their ‘legacy’ counterparts.

‘New’ POPs continue to be identified through risk assessment activities and listed under international agreements.

Climate

Findings

Information on climate effects on POPs is increasingly recognized as a key consideration and should also be integrated into the assessment framework / process.

There is evidence that climate change phenomena, e.g. elevated temperatures and sea-ice reduction, and extreme climate events, such as forest fires, flooding and glacial melting, will remobilize POPs previously deposited in sinks, e.g. forest soils and vegetation, ocean and lake sediments and glaciers.

Climate-related changes may also result in altered exposure pathways and increased vulnerability for the biotic environment and related health impacts.

Recommendations

It is an obligation and a priority to continue to improve our understanding of the fate and transport of POPs through continued efforts in monitoring and process research, modelling, and emissions estimation.

Existing air monitoring efforts should be continued to generate long-term trends to assess the effectiveness of international control initiatives. Proper interpretation of temporal trends requires an understanding of these influencing factors which can be estimated using appropriate transport models.

Observations

Recommendations

Integrated monitoring of various media within the same vicinity is essential for understanding partitioning processes that influence transport and estimating flux for model validation and parameterization.

It is important to develop an inventory of POPs in sinks, such as soil and ocean water, in order to assess secondary emissions and subsequent transport, especially for legacy POPs that are showing a shift from primary to secondary sources.

Observations

Recommendations

Passive air sampling programs should be sustained to ensure the ability to develop temporal trends and can be expanded to cover regions where measurements are currently not available.

Long-term sustained monitoring in human media, such as blood and breast milk, is needed for an understanding of how POPs impact human health.

Emissions

Recommendations

Developing and improvement of gridded emission and soil residue inventories for POPs with both certain temporal and spatial resolutions on a global scale is crucial for assessing intercontinental transport.

Further development of global emission data sets should focus on the improvement of methodological approaches and reporting requirements of POP emission inventories and data parameters on a global scale.

Modelling

Recommendations

Further work on the development and improvement of model parameterization of gaseous exchange between the atmosphere and underlying surface and improving information about degradation in all the environmental media is needed.

Further studies revealing the role of the secondary sources and quantifying their contribution to the long-range transport and pollution levels are required for better description of the source-receptor relationships for POPs.

Modelling

Recommendations

Model parameterisation of POP distribution and behaviour in soil, snow and seawater is very uncertain and need further research. The same is true for biodegradation.

Uncertainties in physical chemical properties (e.g. Henry's Law constants, vapour pressures, octanol-water and octanol-air partition coefficients) of some POP should be further studied.

New POPs

Recommendations

There is a need to conduct process-research and adapt measurement and analytical techniques to target ‘new’ POPs. Transport models will need to be parameterized for these chemicals and new emission inventories developed.

There is also a need to continue screening efforts (based on monitoring/modelling activities) and research to identify new chemicals with POP-like characteristics for further consideration (PBDE, PFOS, PCP, SCCP …).

Climate

Recommendations

To understand how climate change and variations affect the transport and behaviour of POPs in the environment, measurements in environmental media, including air, must be continued to provide temporal trends spanning over similar time-scales as climate change observations, i.e. over decades.

Climate interactions on POPs and the connection between climate and variable meteorology should be considered in the collection and interpretation of data sets to assess spatial and temporal trends for POPs and source-receptor relationships.

Integrated approach

Recommendations

To improve understanding of temporal and spatial trends and intercontinental transport of POPs, it is essential to adopt an integrated approach that assimilates information from observations, model outputs and emission estimates.

An integrated approach to POPs assessment requires cooperation and congregation of experts from different backgrounds. The TF HTAP should continue to move in this direction and promote collaboration between these groups of experts and related programs.

POPs present global-scale risks that require the TF HTAP to consider broadening its scope and membership to include regions outside of the UN-ECE.

Thank you