



HTAP Model Experiments: Relevant activities on Hg and POPs

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GMOS/HTAP simulations program for Hg

- 1. Model studies of Hg atmospheric processes and evaluation vs. field campaign measurements (HTAP WP3.10)
- Assessment of present-day and historical deposition levels (HTAP WP3.10)
- 3. Source-receptor analysis and evaluation of global sources contribution to Hg deposition in Europe (HTAP WP2.4)
- 4. Forecasting future Hg pollution levels for 2030

	20	12		20	13		20	14		20	15	
1. Process studies												
2. Present-day levels												
3. Source-receptor												
4. Future scenarios												

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	2012		2013			20	14	2015					
1. Process studies													
2. Present-day levels												141	
3. Source-receptor												1.1	
4. Future scenarios													

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1. Process studies												
2. Present-day levels									11		141	
3. Source-receptor											1.1	
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EMEP simulations program for POPs

- 1. Assessment of long-term changes in POP pollution levels, evaluation vs. EMEP and GMP SC measurements (HTAP WP3.11)
- 2. Source-receptor model simulations using HTAP regions, evaluation of contribution of secondary emissions (HTAP WP2.4)
- 3. Evaluation of future changes of POP pollution levels

	20	12		20	13		20	14		20	15	
1. Long-term trends			1									
2. Source-receptor												
3. Future scenarios						5.000						



Hg process studies in CBL



Model experiments: Sensitivity runs with selected oxidation processes

Measurements: Speciated Hg (Hg⁰, Hg(II)_{gas}, Hg(II)_{part}), Hg wet deposition, O₃, PM, ...

Site: Waldhof, Northern Germany, flatland

Simulations of different Hg oxidation processes at Waldhof (2009)



Mechanism	Regression	R _{corr}
$Hg^0 + O_3$	0.93	0.64
Hg ⁰ + OH	3.2	0.6
Hg ⁰ + Br	2.6	0.57



Hg process studies in UT/LS



Civil Aircraft for the Regular Investigation of the atmosphere Based on an Instrument Container

Model experiments: Sensitivity runs with selected oxidation processes

Measurements: Total gaseous Hg (Hg⁰+Hg(II)_{gas}), O₃, aerosol, CO, CO₂, NO, NO_y, oxygenated organic compounds, ...

Location: Lufthansa intercontinental flights



Simulations of selected CARIBIC flights (2009)





Future process studies

GMOS Mercury Modelling Task Force (GMOS MMTF)

Objectives:

- Multi-model studies of Hg atmospheric and other processes making use of the extensive GMOS measurement data
- Multi-model assessment of Hg pollution levels in selected regions and over the globe
- Enhancement of co-operation between GMOS and other international programmes and organizations (TF HTAP, UNEP, AMAP etc.)

Timeline:

• Kick-off meeting (February or April, to be fixed)

The program of model simulations will be coordinated with the on-going activities within TF HTAP

HTAP2 relevant simulations

Current Hg and POP modeling activities:

- Simulations of present-day Hg deposition levels and historical trends (GMOS)
- Model evaluation of source-receptor relationships for Hg deposition (GMOS/EMEP)
- Model evaluation of source-receptor relationships for PCB-153 air concentration (EMEP)

Definition of source/receptor regions





Hg and POP emissions data

Emission inventories:

- Global Hg emissions inventory for 2010 (AMAP/UNEP, 2013)
- Global PCB emissions inventory for 1930-2100 (Breivick, 2007)
- Global PCDD/F emissions inventory based on UNEP Toolkit, 1999-2009 (Fiedler et al., 2007, 2012)
- Application of inverse modelling (regional-scale) to estimate POP emissions (Gasic et al. 2009; Moeckel et al., 2010)



PCB-153 anthropogenic emission in 2010



Hg and POP measurement data

Monitoring networks and programs:

- Regional Hg networks (EMEP, AMAP, MDN, AMNet, NAtChem, ...)
- GMOS global network for Hg (2012 ...)
- Regional POP networks (EMEP, AMAP, IADN, ...)
- Global and regional POP passive sampling programs (GAPS, MONET, PNA COP, ...) available through GMP of Stockholm Convention

Hg measurement networks





POP passive sampling programs



GMOS multi-model simulations

Participating models:

Model	Scale	Institution
GLEMOS	global/regional	EMEP/MSC-E
ICHMERIT	global	CNR-IIA (Italy)
GRAHM	global	Environment Canada
WRF-Chem	regional	CNR-IIA (Italy)
CMAQ-Hg	regional	HZG (Germany)



GMOS multi-model simulations

Current modelling activities:

- Simulations of present-day Hg concentration and deposition levels (2010)
- Evaluation of modelling results against observations (EMEP, MDN, GMOS ...)



Hg⁰ concentration (2010)



Intercontinental transport of Hg Source apportionment of Hg deposition (2010)



Source regions



Source/receptor regions:



Intercontinental transport of PCB-153 Source apportionment of PCB-153 air concentration (2010)

Simulated PCB-153 air concentration in 2010 (GLEMOS)



Source regions



Source/receptor regions:



Multi-media dispersion character requires source apportionment of secondary emissions over longer period

Hg deposition to the ocean

Source attribution of Hg deposition to fishing areas (2010)



8

4

- Hg deposition flux
- Total marine capture fisheries production (FAO, 2013)

FAO fishing areas



- 18 Arctic Sea
- 21 Northwest Atlantic
- 27 Northeast Atlantic
- 31 Western Central Atlantic
- 34 Eastern Central Atlantic
- 37 Mediterranean and Black Sea
- 41 Southwest Atlantic
- 47 Southeast Atlantic
- 48 Antarctic Atlantic
- 51 Western Indian Ocean
- 57 Eastern Indian Ocean
- 58 Antarctic Indian Ocean
- 61 Northwest Pacific
- 67 Northeast Pacific
- 71 Western Central Pacific
- 77 Eastern Central Pacific
- 81 Southwest Pacific
- 87 Southeast Pacific
- 88 Antarctic Pacific

Hg deposition to the ocean

Source attribution of Hg deposition to fishing areas (2010)

Sin ulat id Hg annual dep osition in 2010 (GLEMCS)



3

2

- Hg deposition flux
 - Tuna capture fisheries production (FAO, 2013)

FAO fishing areas



- 18 Arctic Sea
- 21 Northwest Atlantic
- 27 Northeast Atlantic
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- 47 Southeast Atlantic
- 48 Antarctic Atlantic
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Co-operation with UNEP

Minamata Convention on Mercury

 Adoption of the global legally binding instrument on Hg (Minamata Convention) (Geneva, January 2013)

> EMEP took part in preparation of the Global Mercury Assessment 2013 for the 5th session of the Intergovernmental Negotiation Committee (INC5)

 Diplomatic Conference on the Minamata Convention (Japan, October 2013)

EMEP was invited to update results of the Global Mercury Assessment with new model estimates of Hg global pollution

Global Atmospheric Mercury Transport:

Global Mercury Assessment 2013 update

he new global mercury emissions inventory produced for UNEP's *Global Mercury* Assessment 1013¹ is now being used by air transport modeller

Initial results for modelled air concentrations and mercury deposition show modified patterns compared to previous work. These reflect the improved information in the new inventory concerning the locations of industrial emission sources and emissions from key sectors, in particular artisanal and small-scale gold mining.











SAL

eviced model results using the 2010 mercury emissions inventory show that thropogenic mercury emissions in the largest source regions exceed total deposition. is means that mercury is exported from these regions to other regions by long range mogheric transport. The opposite is the case for regions with lower emissions (e.g., e Arctic), Natural and re-emission sources also increase atmospheric loads of mercury possited around the world.

Sraphics show preliminary results from GLEMOS model runs by Meteorological synthesising Centre-East and GRAHM model runs by Environment Canada; ensemble means for the two models.





Co-operation with UNEP

Stockholm Convention on POPs

 Recommendations of Saltsjöbaden V workshop in Gothenburg (Sweden, June 2013):

Enhance synergies and cooperation between the CLRTAP and SC and other conventions with regard to work on POPs.

 Information Note by the SC Secretariat for the 37th EMEP Steering Body meeting (Sep, 2013) proposed:

> Enhanced cooperation of SC with EMEP on air monitoring, emission inventories and long-range transport modelling of POPs



TF HTAP could be very useful for assessment of POP long-range transport, changes over time and effectiveness of abatement measures

Directions of further Hg and POP activities

- Source apportionment of Hg and POP pollution over longer periods (tagging of accumulation and media exchange)
- Evaluation of future scenarios of Hg and POP pollution
- Continue Hg process studies within the framework of GMOS MMTF
- Application of inverse modelling for reconstruction of regional and global POP emissions
- Focus of the assessment output on evaluation of Hg and POP impacts on human health and ecosystems
- Enhancement of co-operation with UNEP (Minamata and Stockholm Conventions)