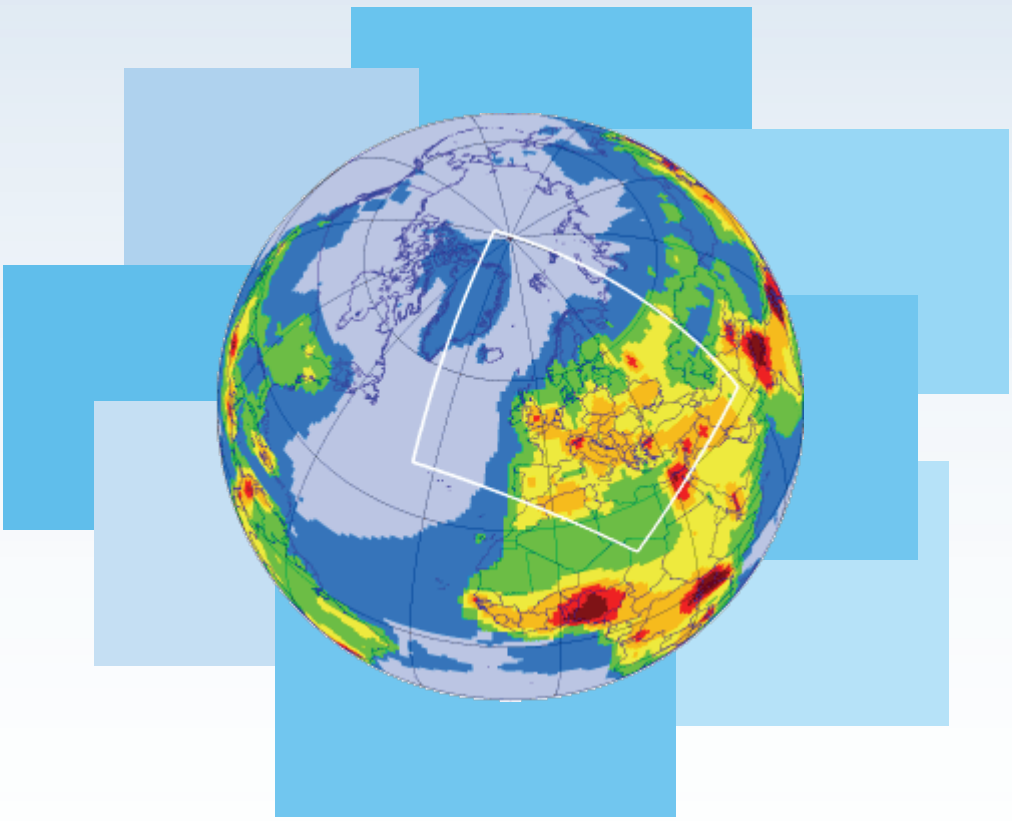
emep

Co-operative programme for monitoring and evaluation of the long-range transmission of air pollutants in Europe

Information on scientific cooperation between EMEP and UNEP

(Minamata Convention on Mercury and Stockholm Convention on POPs)



MSC-E
МСЦ-В

Meteorological Synthesizing Centre – East, 2014

I. Simulations of Hg on a global scale

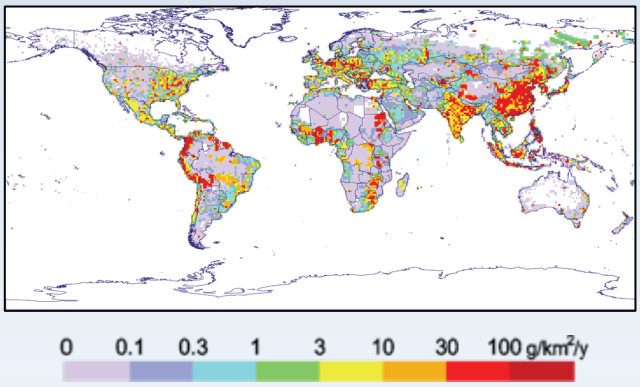
EMEP participates in various activities aimed at scientific support of international efforts to abate mercury pollution on global and regional scales. In particular, EMEP/MSC-E took part in preparation of the Global Mercury Assessment 2013 for negotiations of the Minamata Convention on Mercury.

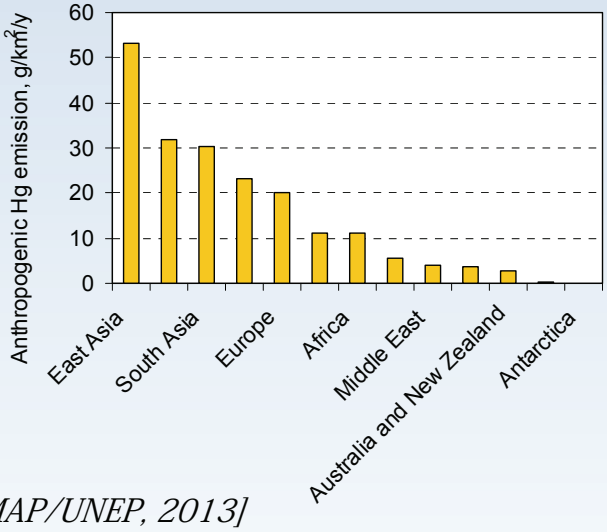
Estimates of Hg pollution on a global scale were recently updated by the Centre. Levels of Hg air concentration and deposition in different terrestrial and aquatic regions of the globe were assessed for present conditions by means of the Global EMEP Multi-media Modeling System (GLEMOS) model. Particular attention was paid to evaluation of Hg deposition to major fishing areas of the ocean keeping in mind the primary role of the fish consumption in human health exposure to mercury.

The work was partly funded by the EU FP7-ENV-2010 project “Global Mercury Observation System” (GMOS, Grant Agreement N 265113). Results of the study were used to support the Task Force on Hemispheric Transport of Air Pollution (TF HTAP) activities on mercury and presented at the Diplomatic Conference for the Minamata Convention (Japan, October 2013).

Emissions

The simulations are based on the new Hg anthropogenic emissions inventory for 2010 [*AMAP/UNEP*, 2013]. The dataset consists of gridded emission data with spatial resolution 0.5°×0.5° for three Hg species – gaseous elemental mercury (GEM), gaseous oxidized mercury (GOM), particle bound mercury (PBM).

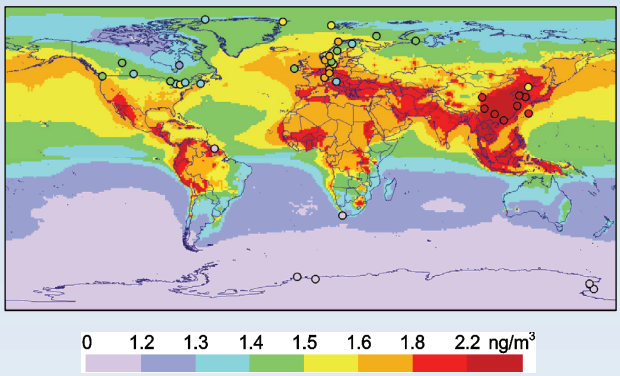


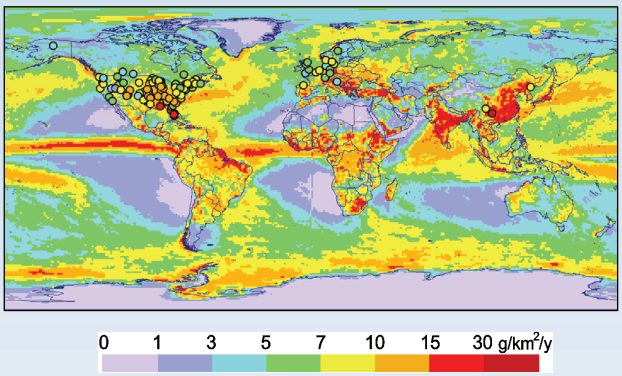


Hg anthropogenic emission in 2010 [AMAP/UNEP, 2013]

Spatial patterns of Hg concentration and deposition

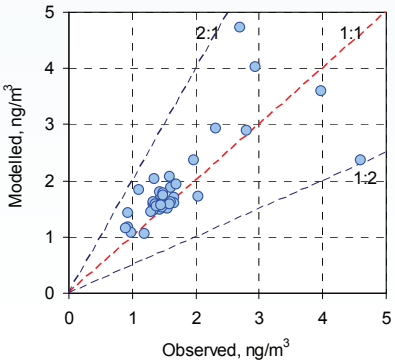
Model simulations of mercury atmospheric dispersion on a global scale were performed for 2010. Two-years model spin-up was performed to fill up the atmosphere with mercury. Simulated spatial distributions of GEM concentration in ambient air and mercury wet deposition fluxes are shown below.



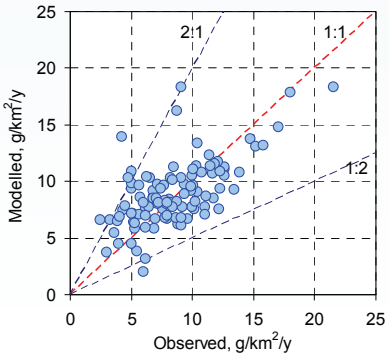


Global distribution of mean annual GEM concentration in ambient air and wet deposition in 2010. Circles present long-term observations

The simulation results were evaluated against long-term observations. Deviation of simulated GEM concentrations from observed values is mostly within ±20%, whereas for wet deposition it does not exceed a factor of 2. The Pearson's correlation coefficient between the simulated and measured pairs exceeds 0.7 for both GEM concentration and wet deposition.



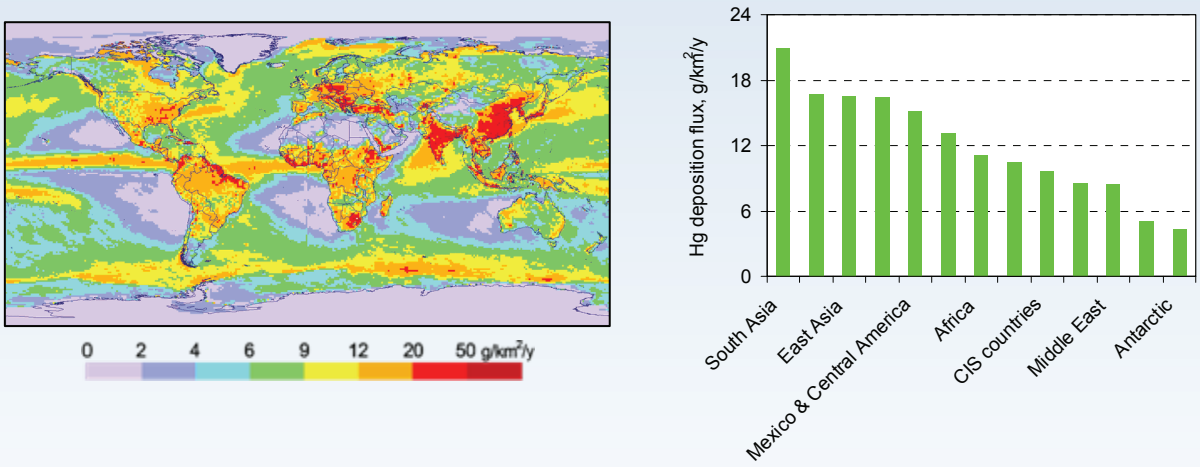
Model-to-measurement comparison for mean annual GEM concentration in 2010



Model-to-measurement comparison for annual wet deposition flux in 2010

Mercury deposition to terrestrial regions

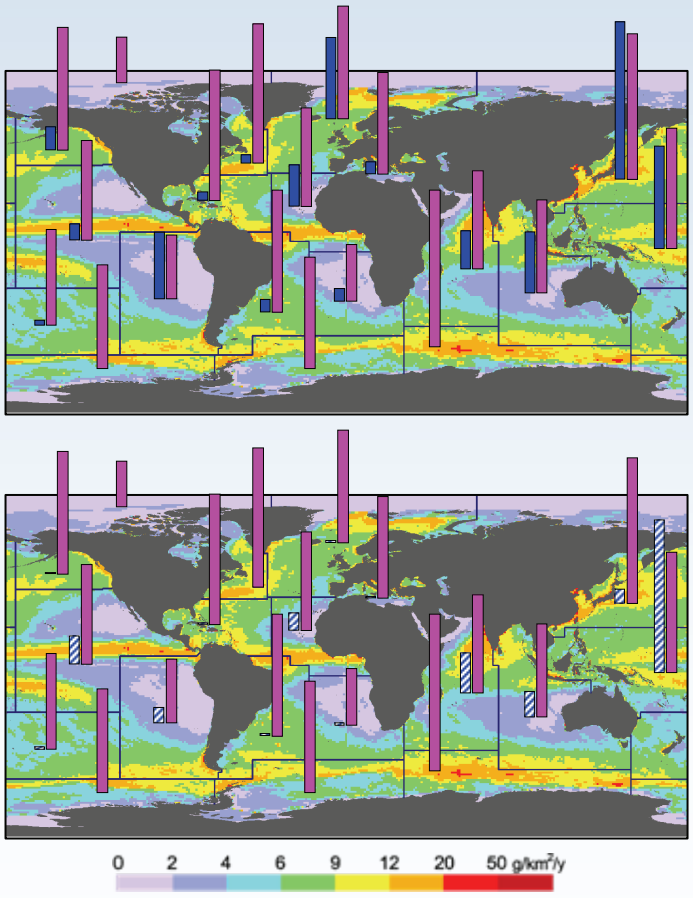
Mercury deposition in different regions of the world differs significantly depending on geographical location of the region with respect to emission sources and local environmental conditions (oxidation ability of the atmosphere, precipitation etc.) The highest fluxes are characteristics of South, Southeast and East Asia. Somewhat lower deposition is in Europe, Central and South America. Almost twice as lower deposition is estimated in Middle East, Australia and New Zealand. The lowest average deposition fluxes are over the polar regions even taking into account locally significant depositions over the AMDEs areas.



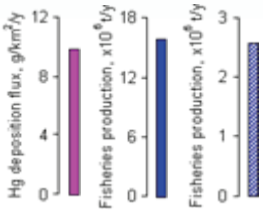
Spatial distribution of Hg total deposition and average deposition flux over various regions in 2010

Mercury deposition to the ocean

In regions not impacted by industrial point sources of contamination, most human exposure to Hg is through fish consumption. Mercury coming to freshwater and marine ecosystems from atmospheric deposition and other sources is converted by biotic and/or abiotic processes to methylmercury (MeHg), which is biomagnifies in aquatic food webs. To estimate Hg loads to different aquatic regions and potential accumulation in fish we calculated Hg deposition to the major fishing areas according to classification by Food and Agriculture Organization [*FAO*, 2013a].

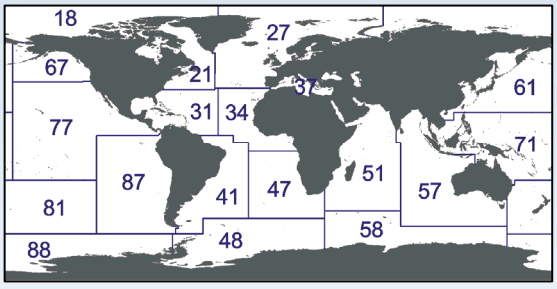


Annual Hg deposition to the FAO major fishing areas and marine capture fisheries production [FAO, 2013b] in 2010



- Hg deposition flux
- Total marine capture fisheries production [*FAO*, 2013]
- Tuna capture fisheries production [*FAO*, 2013]

FAO fishing areas [*FAO*, 2013a]



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

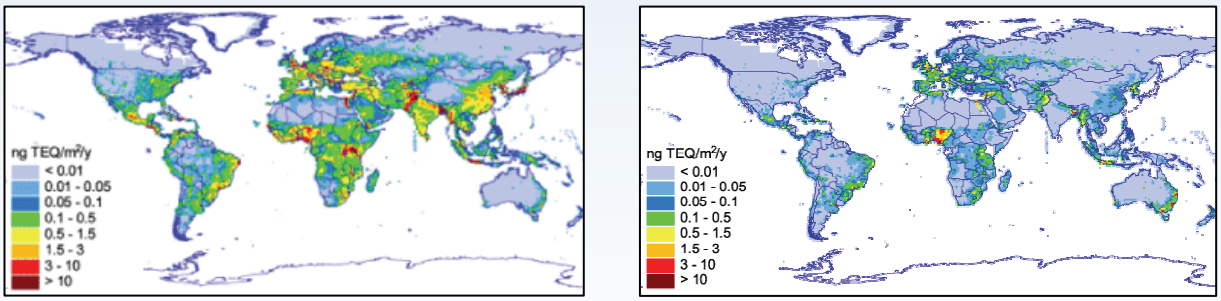
According to FAO statistics for 2010 [*FAO*, 2013b], total capture production takes place in the Northwest Pacific, Western Central Pacific and Northeast Atlantic. These areas are also characterised by significant average Hg deposition. It is particularly important that the highest deposition fluxes within the Northwest Pacific are estimated over the off-shore sea areas and marginal seas of East Asia (Yellow Sea, East and South China Seas, Sea of Japan), where intensive capture fisheries are expected.

Tuna fisheries production is dominated by fisheries in the Western Central Pacific [*FAO*, 2013b]. It is affected by high Hg deposition. Other regions of tuna fisheries with considerable Hg deposition include the Western Indian Ocean, Eastern Central Pacific, Eastern Indian Ocean and Eastern Central Atlantic.

II. Simulations of PCDD/Fs on a global scale

Cooperation between various subsidiary bodies under the Convention on Long-range Transboundary Air Pollution (CLRTAP) and the UNEP Stockholm Convention (SC) on POPs has already a long history. The recent session of the EMEP Steering Body (September 2013, Geneva) welcomed proposals of the UNEP SC Secretariat to enhance cooperation between the two Conventions and transfer of scientific knowledge and for capacity strengthening on a global level.

In support of these activities MSC-E carried out pilot modelling of global dispersion of PCDD/Fs using experimental emission scenario with application of global inventory compiled under the UNEP SC. Modelling results were presented at the special session of the DIOXIN Conference devoted to the 10th anniversary of the Stockholm Convention [*Gusev et al.*, 2014a].



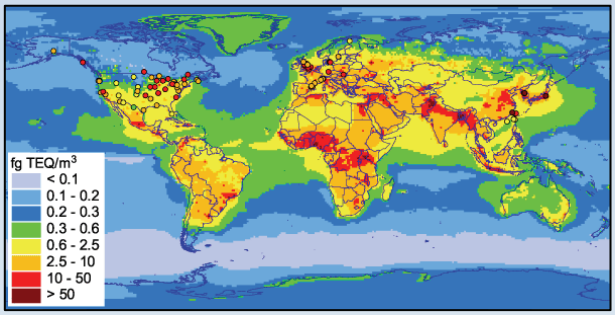
Annual PCDD/F emissions (ng TEQ/m^2/y) to the atmosphere (left) and to soil (right), constructed on the basis of UNEP SC global PCDD/F emission inventory

Model simulations took into account releases of PCDD/Fs to different media, particularly, to the atmosphere and land compartments.

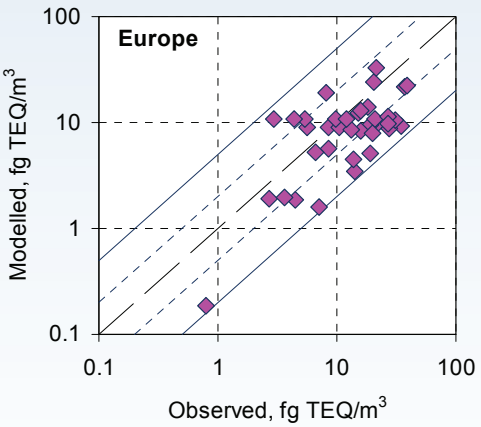
Modelled and measured pollution levels of PCDD/Fs

Global transport and fate of dioxins and furans was evaluated using the GLEMOS modeling system and PCDD/F emissions of the UNEP SC.

Elevated air concentrations were characteristic of Europe, Southern and Eastern Asia, and Africa, while relatively lower levels of pollution were indicated for North and South America and Australia.



Modelled PCDD/F air concentrations (fg TEQ/m^3) in comparison with measurements in rural and remote regions (market by the circle)



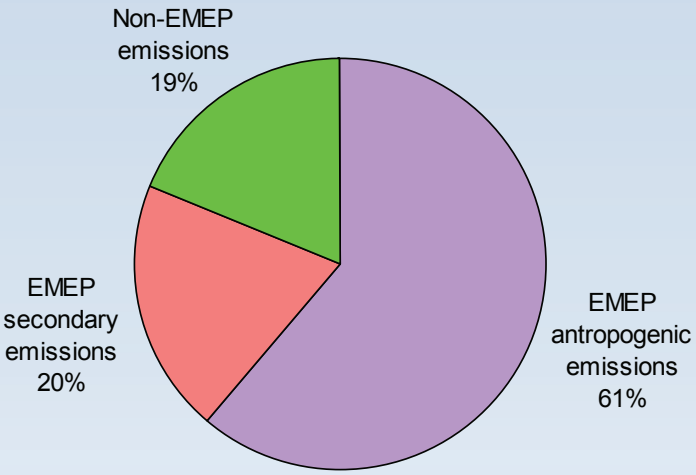
Comparison of modelled PCDD/F air concentrations (fg TEQ/m^3) with measurements in Europe

Modelling reasonably well reproduces observed levels of air PCDD/F concentrations in the European region, North America and Eastern Asia, which have been obtained from the UNEP SC GMP Data Warehouse [*Hůlek et al.*, 2013] and other sources [*Gusev et al.*, 2014b].

Pollution of the EMEP countries by PCDD/Fs

Global scale model simulations permit to characterize intercontinental transport of dioxins and furans and contribution of non-EMEP emission sources to the pollution of the EMEP countries.

Modelling results indicate noticable contribution of non-EMEP emission sources to pollution of the EMEP domain (about 20%).



Relative contributions of emissions of different source groups to the pollution of the EMEP region

However, evaluation of PCDD/F pollution levels is still a subject of essential uncertainties associated with incomplete knowledge of anthropogenic and secondary emissions of PCDD/Fs.

For further progress in the assessment of PCDD/F pollution levels in the EMEP countries and on global scale it is important to continue refinement of national PCDD/F emission inventories and to strengthen collaboration with the UNEP SC in the field of evaluation of PCDD/F emissions.

References

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