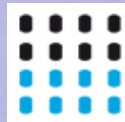
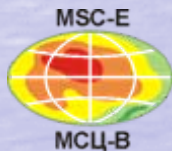


# Hg attribution & long-term simulations:

Program of numerical experiments on Hg within HTAP

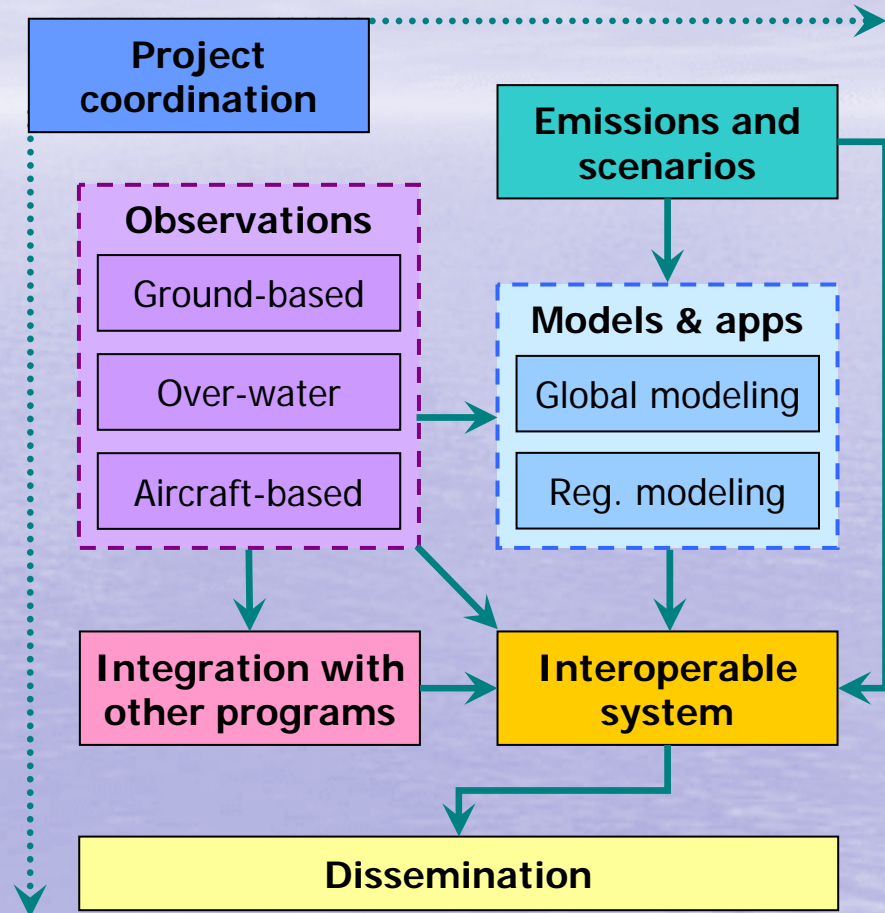
Oleg Travnikov, Ian Hedgecock, Volker Matthias,  
Ashu Dastoor, Jerry Lin, Pruek Pongprueksa



# GMOS: Global Hg observation system

## Major project components:

- Global monitoring system for Hg (land-based, over-water and aircraft observations)
- Updates of Hg emissions inventory and future scenarios
- Development and application of global and regional scale models
- Interoperable system for collection and dissemination of the project data



# Hg models involved in GMOS/HTAP

<i>Model</i>	<i>Scale</i>	<i>Type</i>	<i>Institution</i>
<b>ICHMERIT</b>	global	atmospheric	CNR-IIA (Italy)
<b>GLEMOS</b>	global	partly M-M	EMEP/MSC-E
<b>GRAHM</b>	global	partly M-M	Environment Canada
<b>DEHM</b>	hem.	partly M-M	Aarhus Univ. (Denmark)
<b>CMAQ-Hg</b>	hem.	atmospheric	Lamar University (USA)
<b>WRF-Chem</b>	regional	atmospheric	CNR-IIA (Italy)
<b>CMAQ-Hg</b>	regional	atmospheric	HZG (Germany)
<b>GEOS-Chem</b>	global	multi-media	Harvard Univ. (USA)
<b>CMAQ-Hg</b>	regional	partly M-M	US EPA (USA)
<b>HYSPLIT</b>	global	atmospheric	NOAA (USA)



# Proposals for numerical experiments program

1. Simulation of short-term observational episodes (2012)
2. Long-term simulations and evaluation against monitoring networks data (2012-2013)
3. Hindcast of historical trends (2013)
4. Source apportionment for different source types (contemporary anthropogenic, natural, legacy) (2013-2014)
5. Evaluation of future emission and climate scenarios (2014-2015)

# 1. Simulation of short-term episodes

**Objective:** Detailed evaluation of model parameterizations in different atmospheric environments

**Method:** Simulation of Hg concentration and air-surface exchange fluxes for particular measurement episodes and comparison with detailed observations

**Measurements:** Intensive land-based, aircraft and over-water measurements of Hg species (Hg<sup>0</sup>/TGM, RGM, HgP) and various ancillary parameters.

**Models:** Global/hemispheric, regional models

# 1. Simulation of short-term episodes

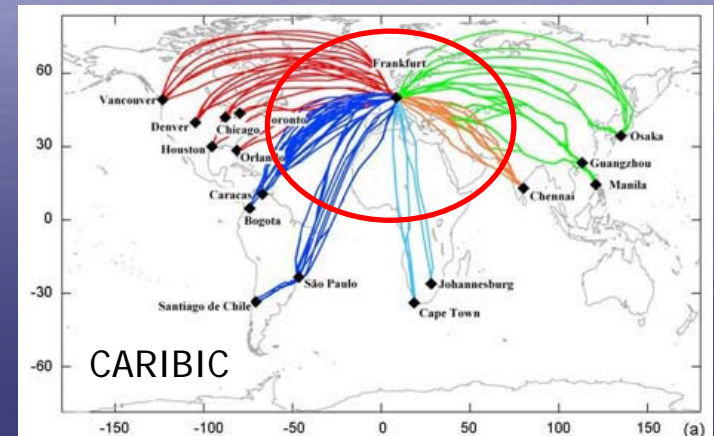
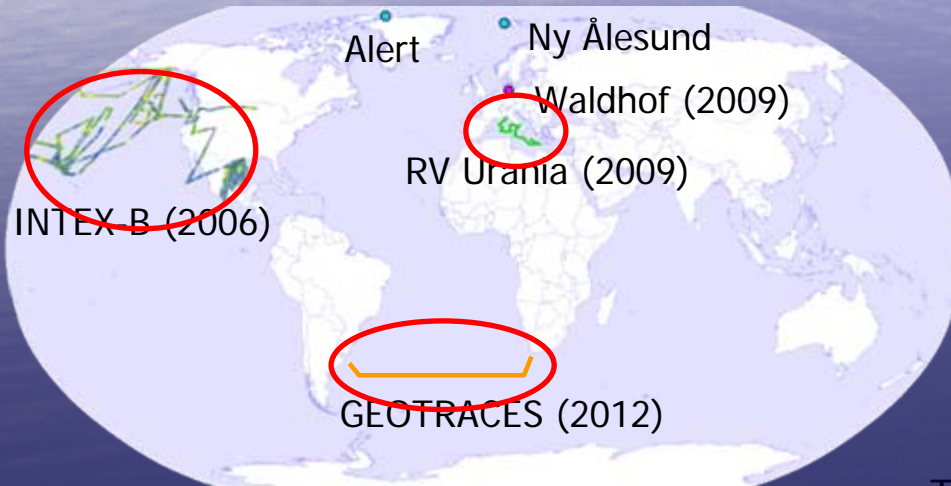
## Intensive field campaigns in different environments

### *Marine boundary layer*

- **RV Urania** cruise (Mediterranean Sea, June 2009)
- **GEOTRACES** cruise (Southern Atlantic, Jan-Feb 2012)

### *Free troposphere and UT/LS*

- **INTEX-B** campaign (North America/Northern Pacific, 2006, 2008)
- **CARIBIC** project (Europe/global, 2009)





# 1. Simulation of short-term episodes

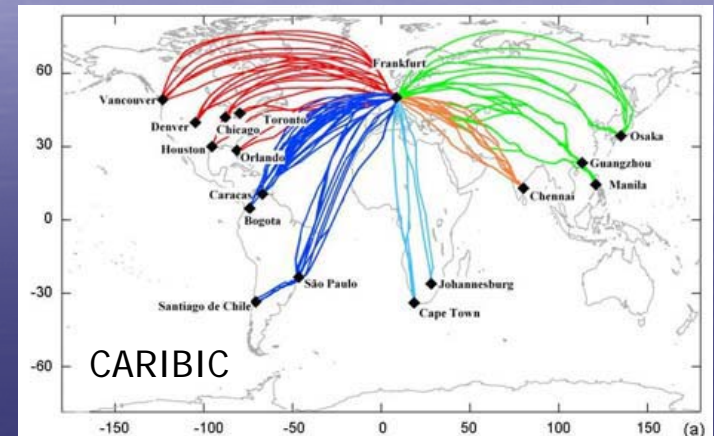
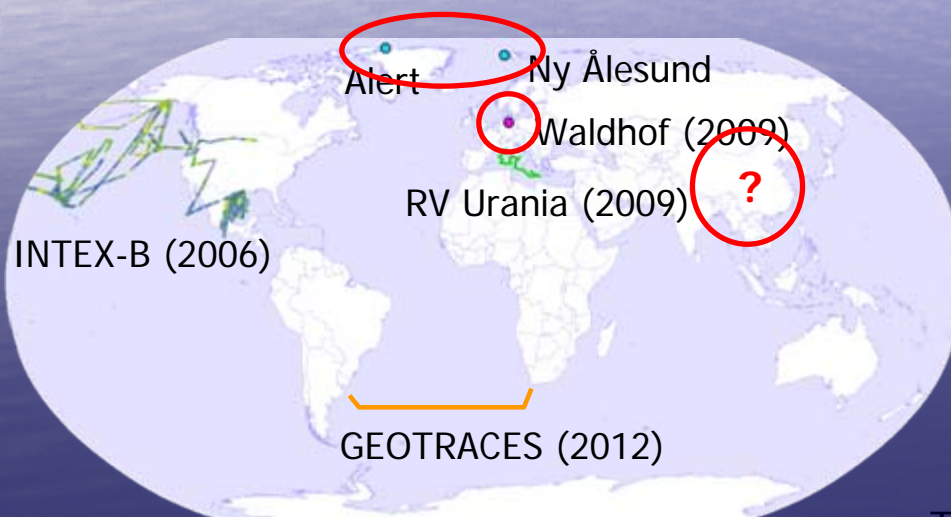
## Intensive field campaigns in different environments

### Continental boundary layer

- EMEP measurements at site Waldhof (Germany, 2009)
- Field campaigns in Asia (CBL, depending on availability of data)

### Polar regions

- CAMNet and/or EMEP measurements in the Arctic (AMDEs, 2009)



## 2. Evaluation vs. long-term measurements

**Objective:** Reproduce observed **spatial gradients** and **temporal variation** of Hg levels and evaluate different **physical** and **chemical mechanisms**

**Method:** Annual model runs (**2009**) to simulate air concentrations of Hg species and wet deposition fluxes over the globe and comparison with **long-term ground-based observations** from monitoring networks.

**Measurements:** Ground-level **air concentration** of Hg species (Hg<sup>0</sup>/TGM, RGM, HgP) and **wet deposition fluxes** from existing networks (EMEP, AMNet, CAMNet, AMAP, NADP/MDN, etc.)

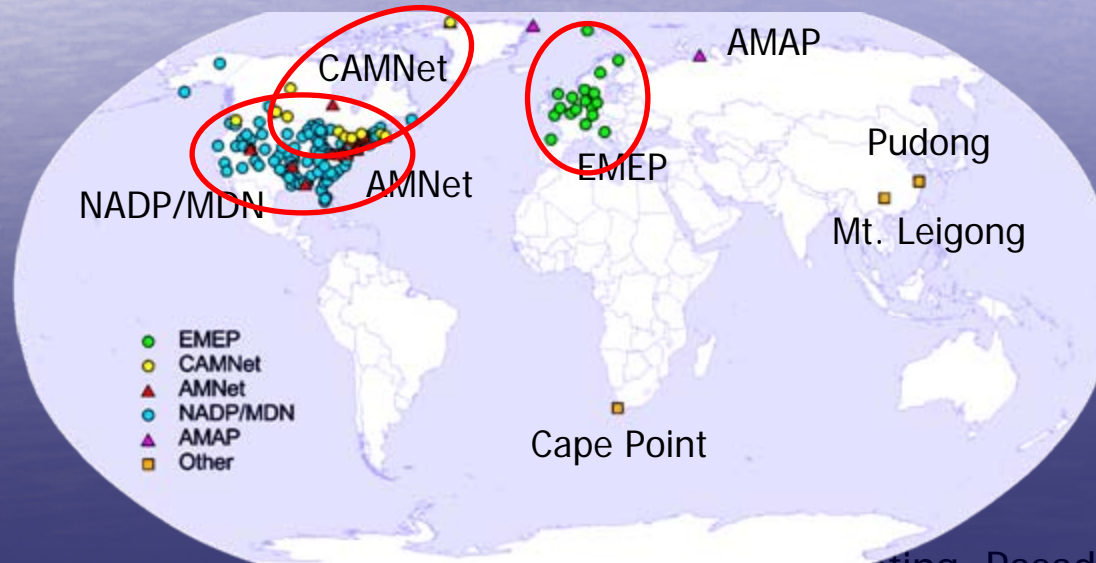
**Models:** Global/hemispheric, regional models



## 2. Evaluation vs. long-term measurements

### Monitoring networks:

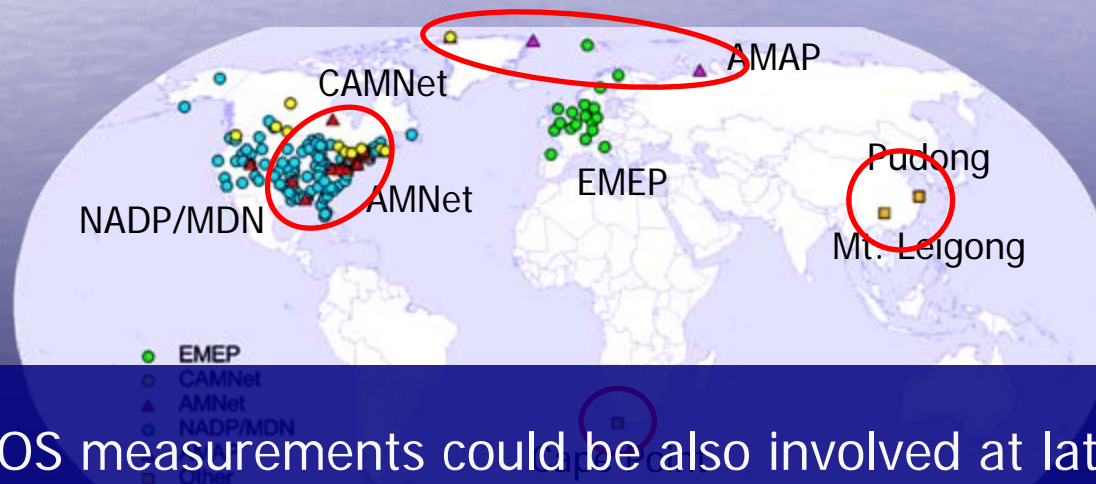
- **EMEP** network (Europe, 17 sites, Hg<sup>0</sup>/TGM, RGM, HgP, wet deposition)
- **NADP/MDN** network (North America, 90 sites, wet deposition)
- **CAMNet** network (Canada/Arctic, 11 sites, Hg<sup>0</sup>/TGM)



## 2. Evaluation vs. long-term measurements

### Monitoring networks:

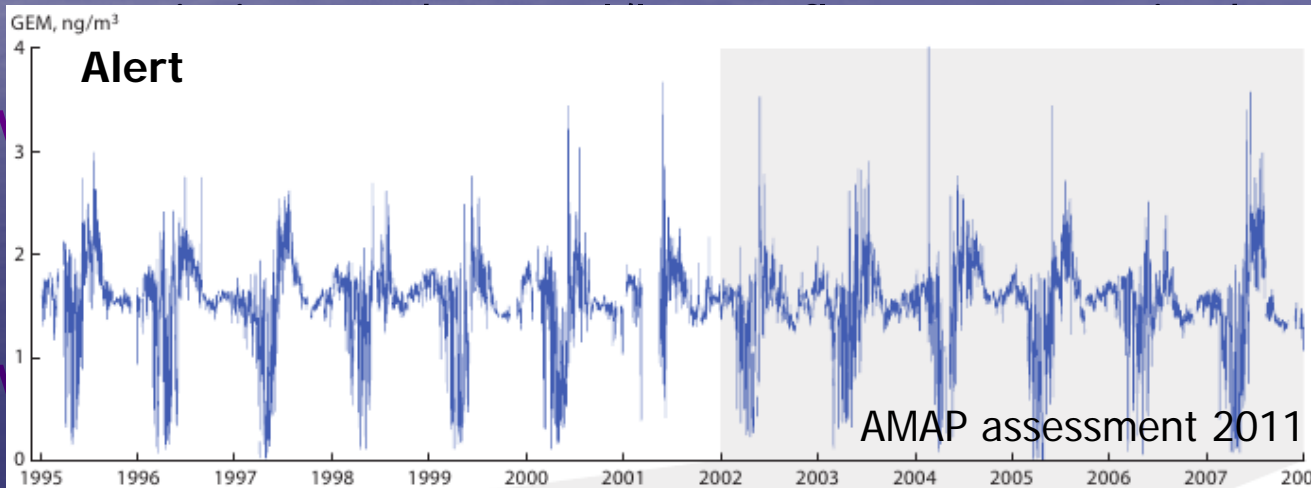
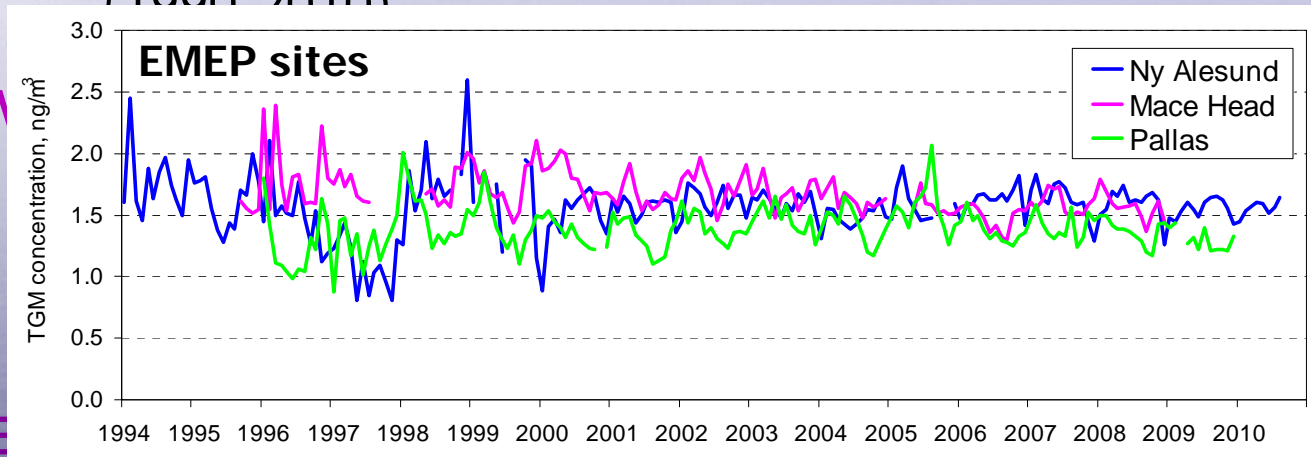
- **AMNet** network (USA/Canada, 21 sites, Hg<sup>0</sup>/TGM)
- **AMAP** network (Arctic, 4 sites, Hg<sup>0</sup>)
- Cape Point (South Africa, 1 site, Hg<sup>0</sup>)
- Mt. Leigong (China, 1 site, Hg<sup>0</sup>, wet deposition)
- Pudong, Shanghai (China, 1 site, TGM)



New GMOS measurements could be also involved at later stages

# 3. Hindcast of historical trends

**Objective:** Reconstruct long-term changes of Hg pollution levels in different parts of the world during last 20 years (1990-2010)



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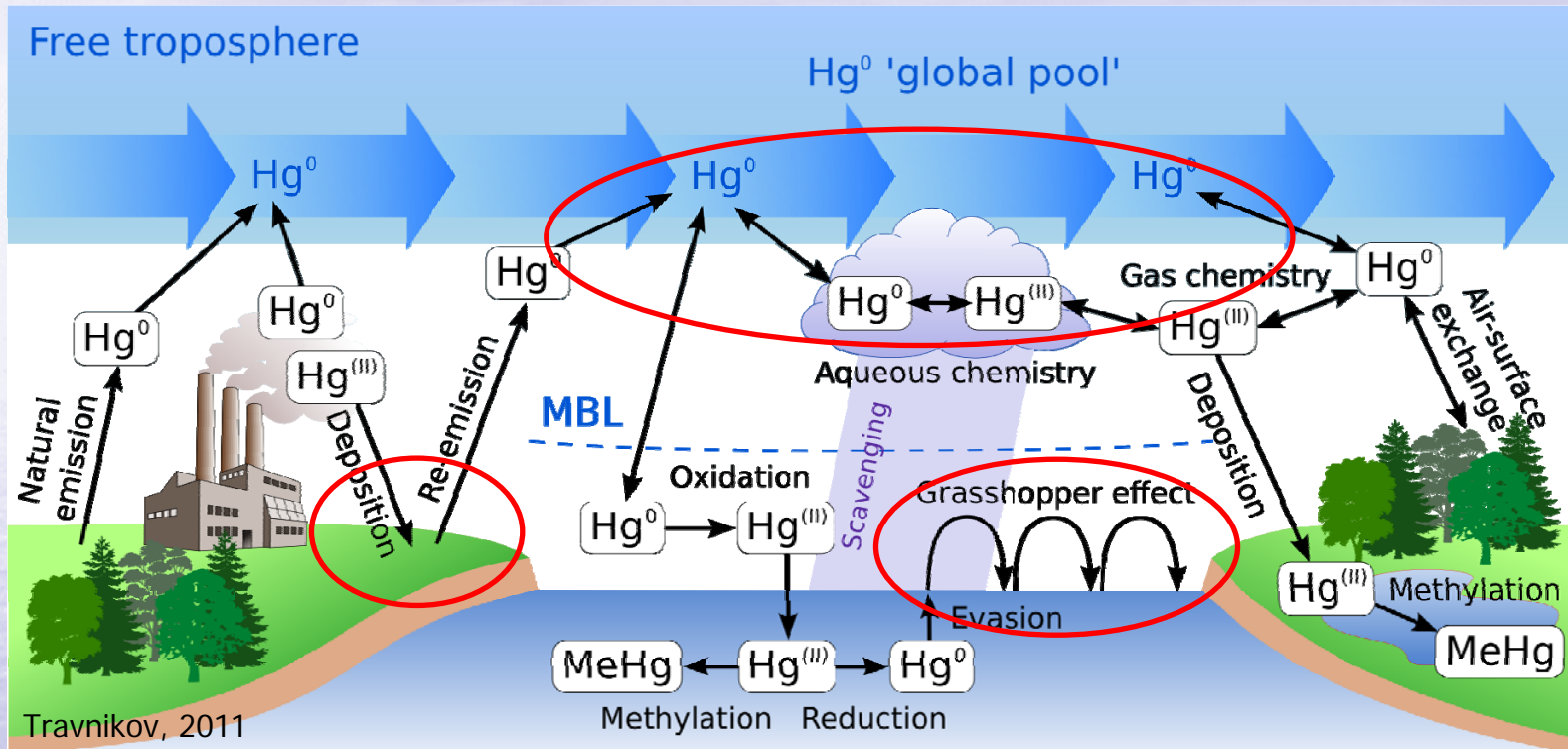
ons at  
AMNet

California, 2012



# 4. Source apportionment

## Hg intercontinental transport



**HTAP Assessment 2010:** Multi-media aspect is principal for Hg long-term cycling on a global scale

# 4. Source apportionment

**Objective:** Evaluate source apportionment of Hg concentration and deposition over the globe taking into account **multi-media character** of Hg dispersion in the environment

**Method:**

- Base 3-year run (e.g. **2008-2010**) and a number of perturbation runs to evaluate source apportionment
- **Source types** – contemporary anthropogenic, natural, legacy
- **Initial conditions** for “natural/legacy sources” defined as Hg concentration in soil and ocean or as pre-defined net exchange fluxes constrained on observations
- **Multi-year spinup** to get steady state at the beginning of the main simulation period

**Models:** Global/hemispheric **atmospheric** and **multi-media** models

# 5. Future scenarios

**Objective:** Evaluate **change in Hg pollution levels** and source apportionment as a result of expected air pollution abatement efforts or climate change

**Method:**

- “**Snapshots**” of Hg future cycling in the environment for selected periods (e.g. around 2030 and 2050)
- **Initial conditions** based on application of multi-media simulations for long period (e.g. 2010-2050) or use of present-day conditions
- Separate consideration of the effects of **emissions reduction** and **climate change**

**Emissions:** Future scenarios for 2030 and 2050 are required

**Meteorology:** Climate simulations based on IPCC scenarios

**Models:** Global/hemispheric **atmospheric** and **multi-media** models