On-Going Mercury Research at IVL

Ingvar Wängberg Monday 19 May 2014

Content

Brief presentation of some earlier IVL research activities

- The Roof Project
- MeHg in runoff as a course of damage to soils caused by heavy machinery

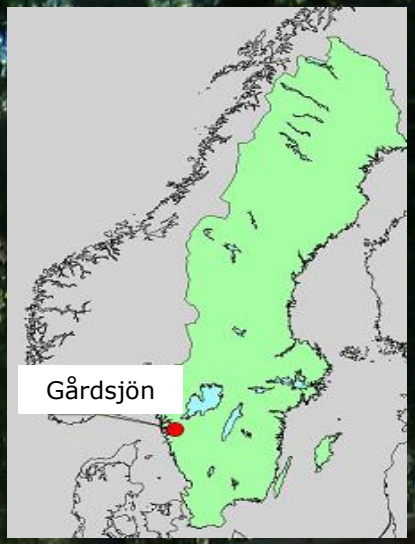
Global Mercury Observation System (The GMOS project)

- An annual study of mercury species in air at Rörvik/Råö
- Method for determining concentration of elemental mercury in surface water.

The Roof project in Gårdsjön

In operation between 1991 and 2001

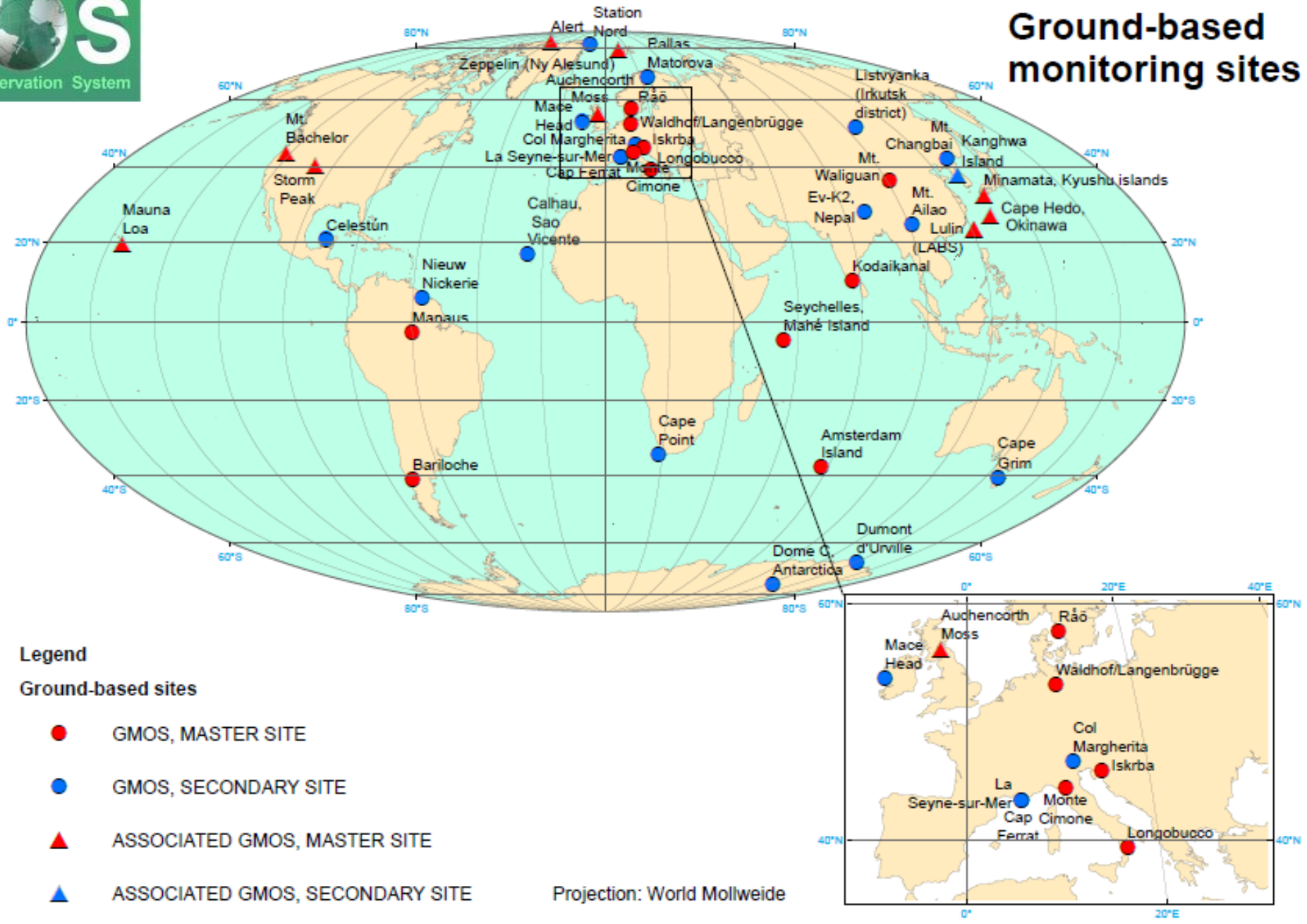
6000 m^2 large roof over a micro catchment



MeHg in runoff from the catchment area F1 in Gårdsjön as a course of damage to soils caused by heavy machinery during clear-cutting of an adjacent forest area

GMOS
Global Mercury Observation System

Ground-based monitoring sites



Legend

Ground-based sites

- GMOS, MASTER SITE
- GMOS, SECONDARY SITE
- ASSOCIATED GMOS, MASTER SITE
- ASSOCIATED GMOS, SECONDARY SITE

Projection: World Mollweide

An annual study of mercury species in air at Rörvik/Råö

Effects of long range transport

Rörvik/Råö

GMOS Master Station Rörvik/Råö
Coastal background site

Location: West-coast, Sweden
Height above sea level: 7m
Measuring period: 14/5 2012 – 14/5 2013

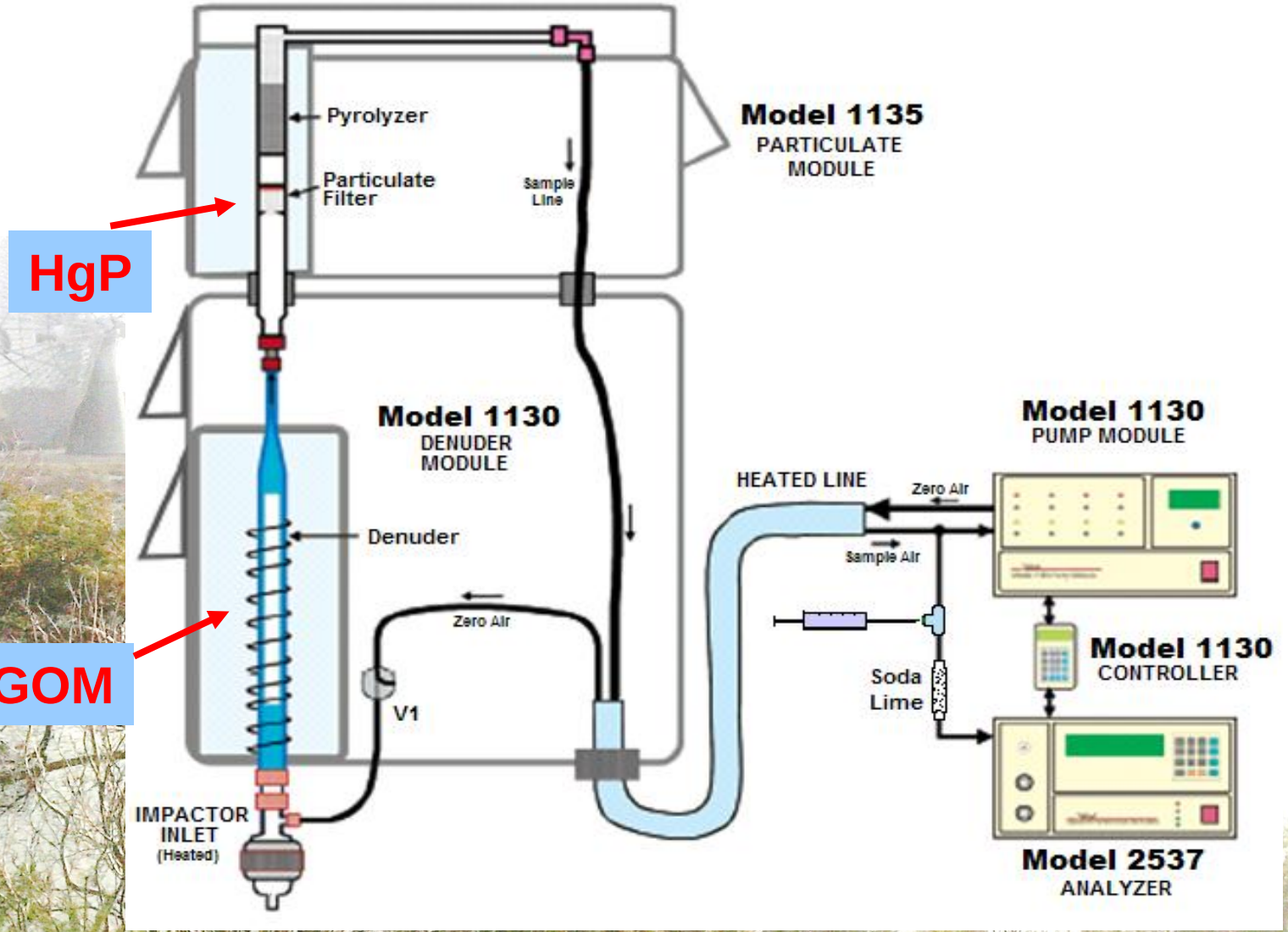
- **Measured Mercury species in air:**
  - Gaseous Elemental Mercury (GEM) Hg(0)
  - Gaseous Oxidized Mercury (GOM) Hg(II)
  - Particulate Bound Mercury (HgP) Hg(II)

IVL

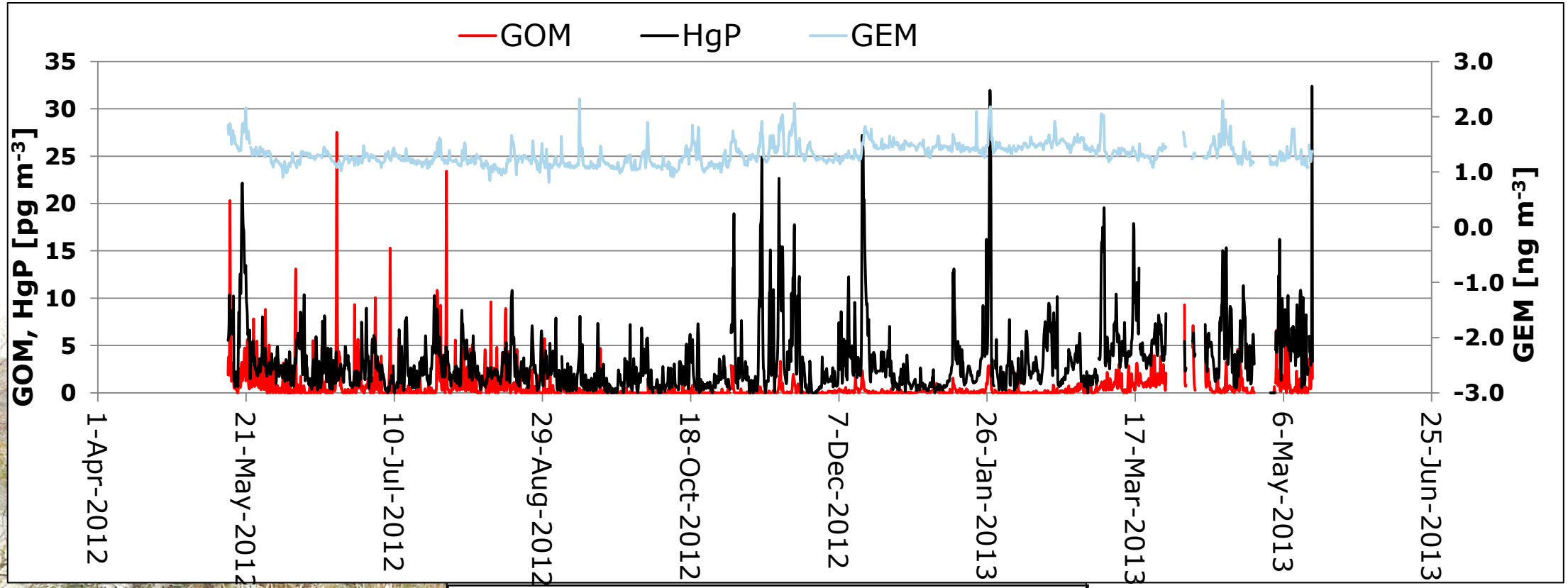
GMOS
Global Mercury Observation System

Measurements

GEM values – with 5 min time resolution
Hgp and GOM values – with 3 h min time resolution

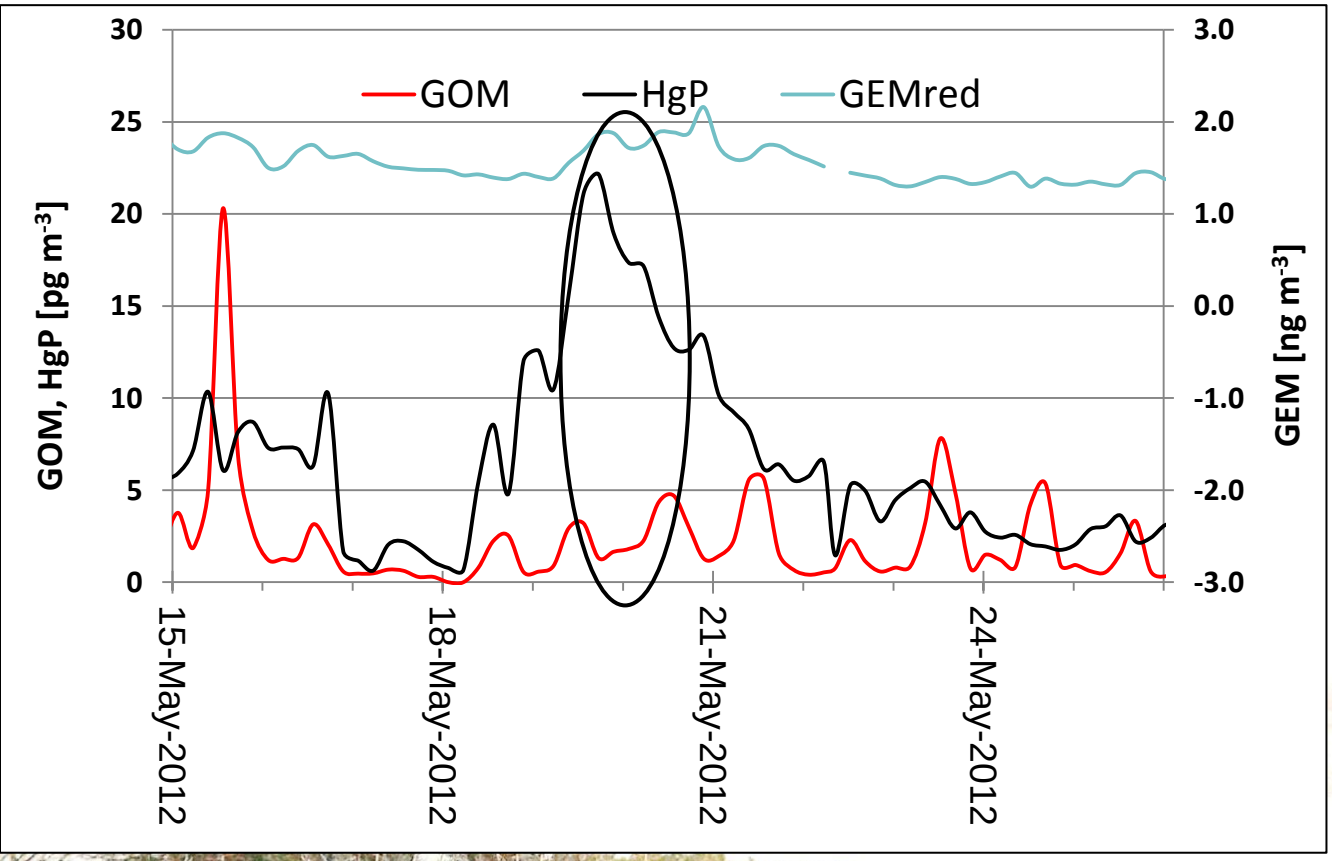


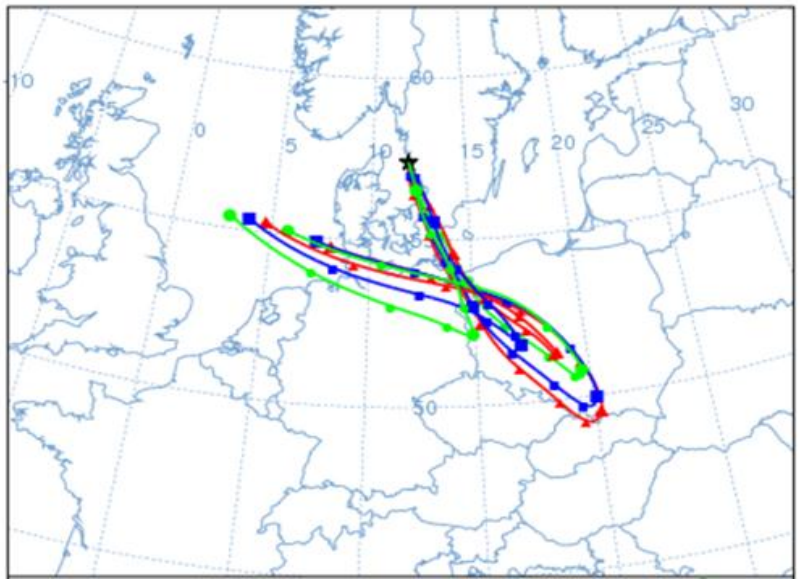
One year of Mercury Species data



Average values	GEM	GOM	HgP
May - August 2012	1.27	1.26	3.22
September - December 2012	1.34	0.17	3.29
January - April 2013	1.41	0.59	4.06
Yearly total averages:	*1.34*	*0.67*	*3.53*

Wind trajectories

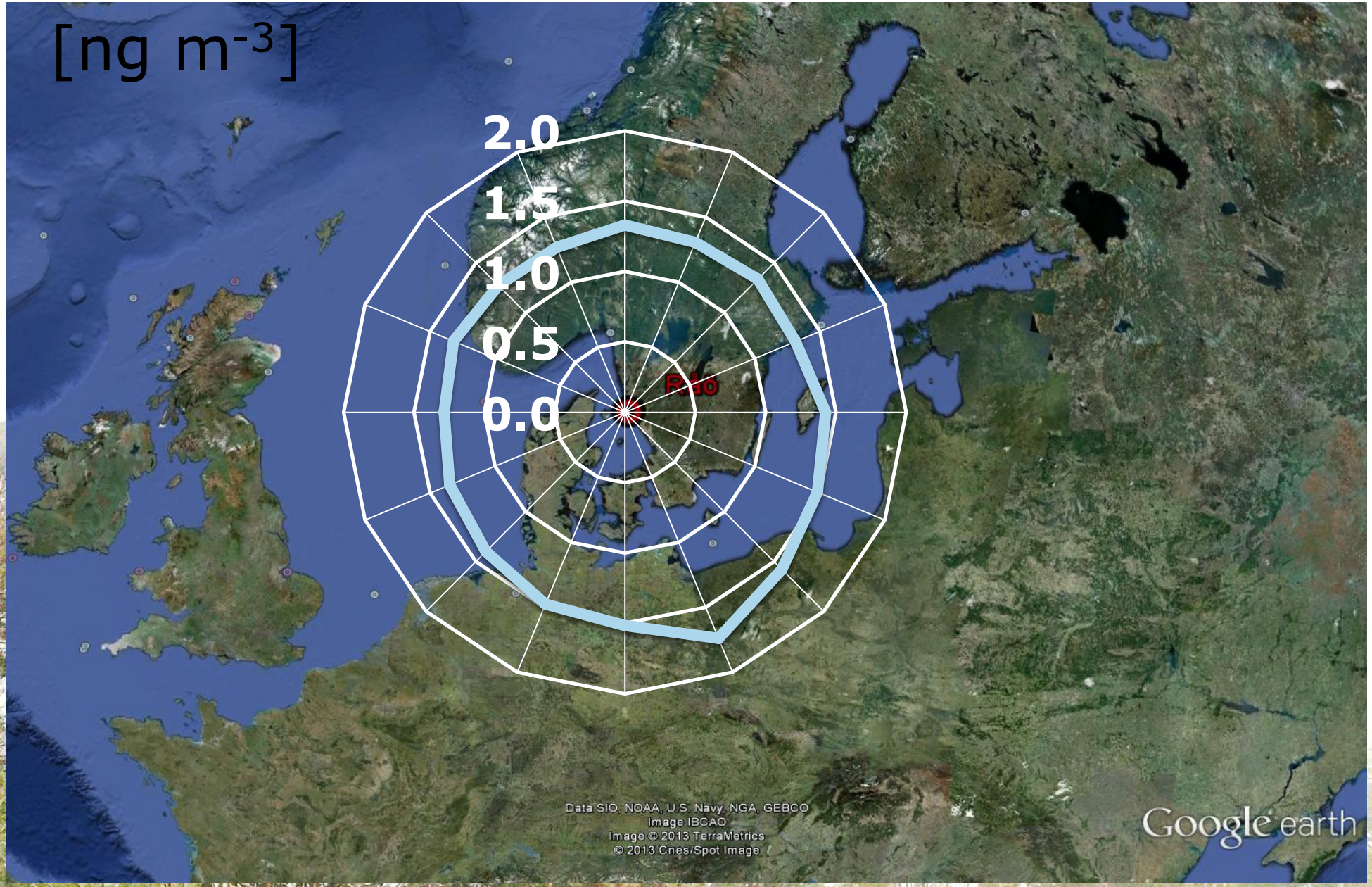




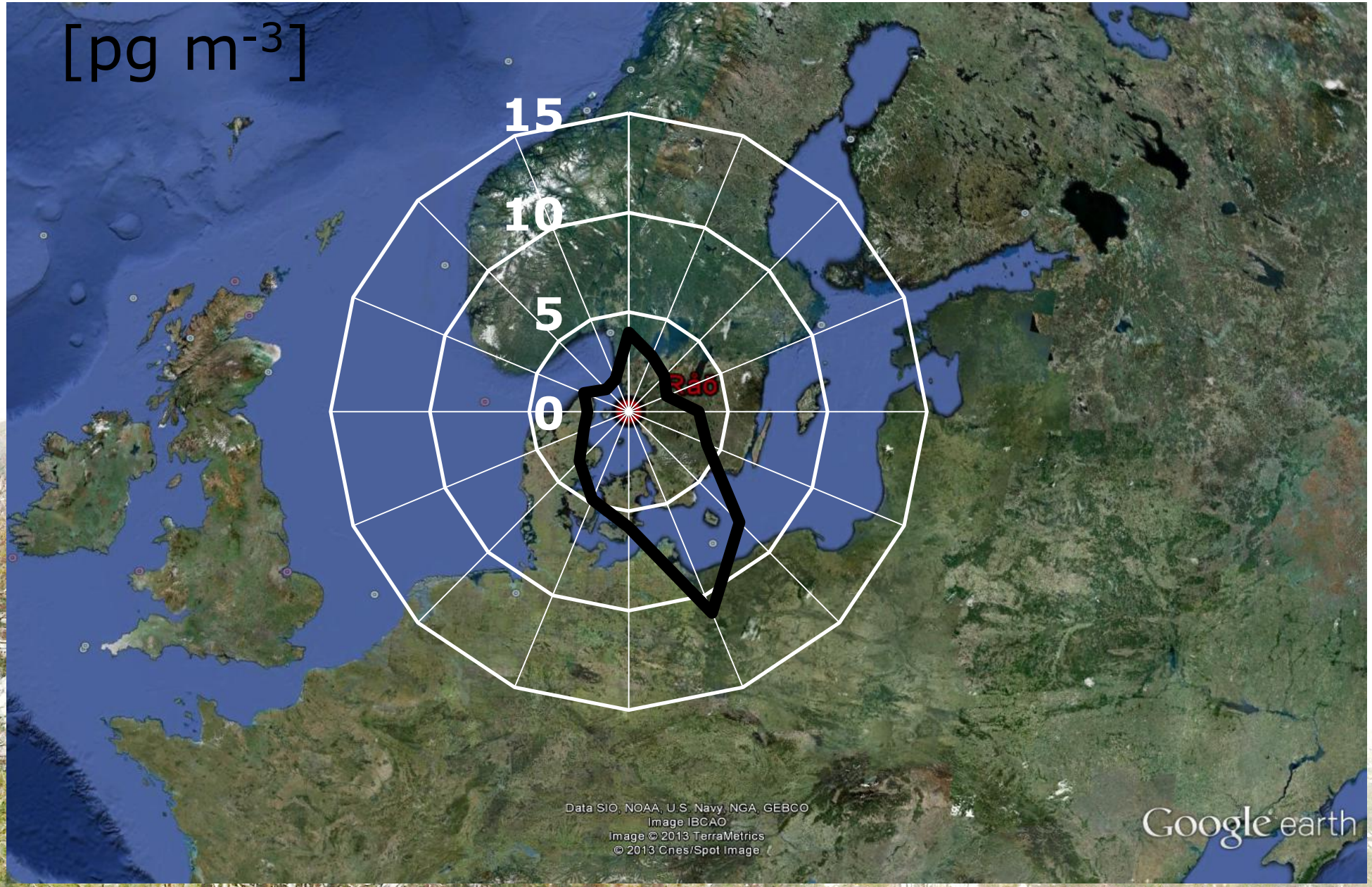
Wind trajectories 20-May-2012

Wind trajectories for 1year → *Effects of long range transport*

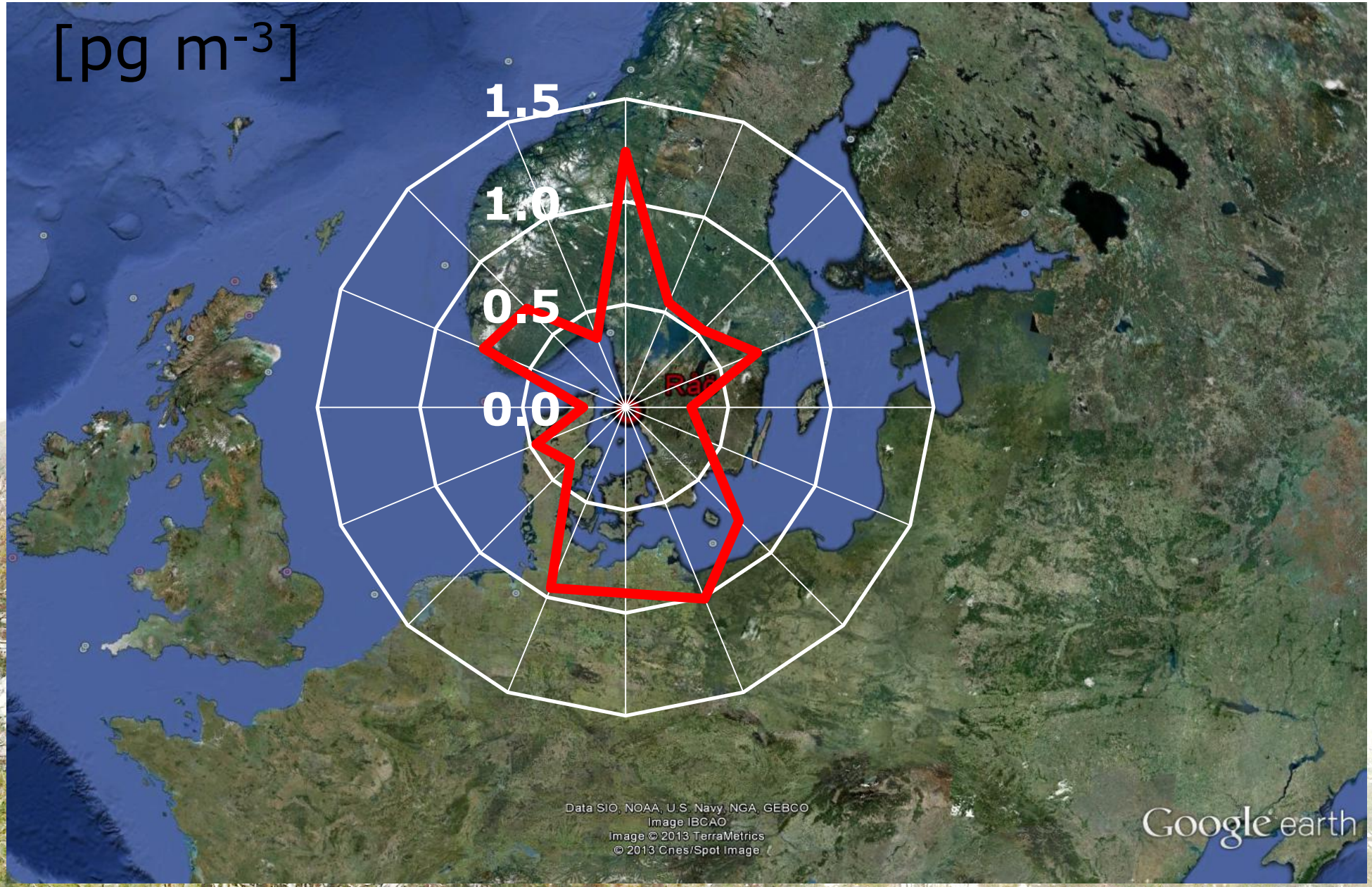
Gaseous Elemental Mercury (GEM)



Particulate Mercury (HgP)



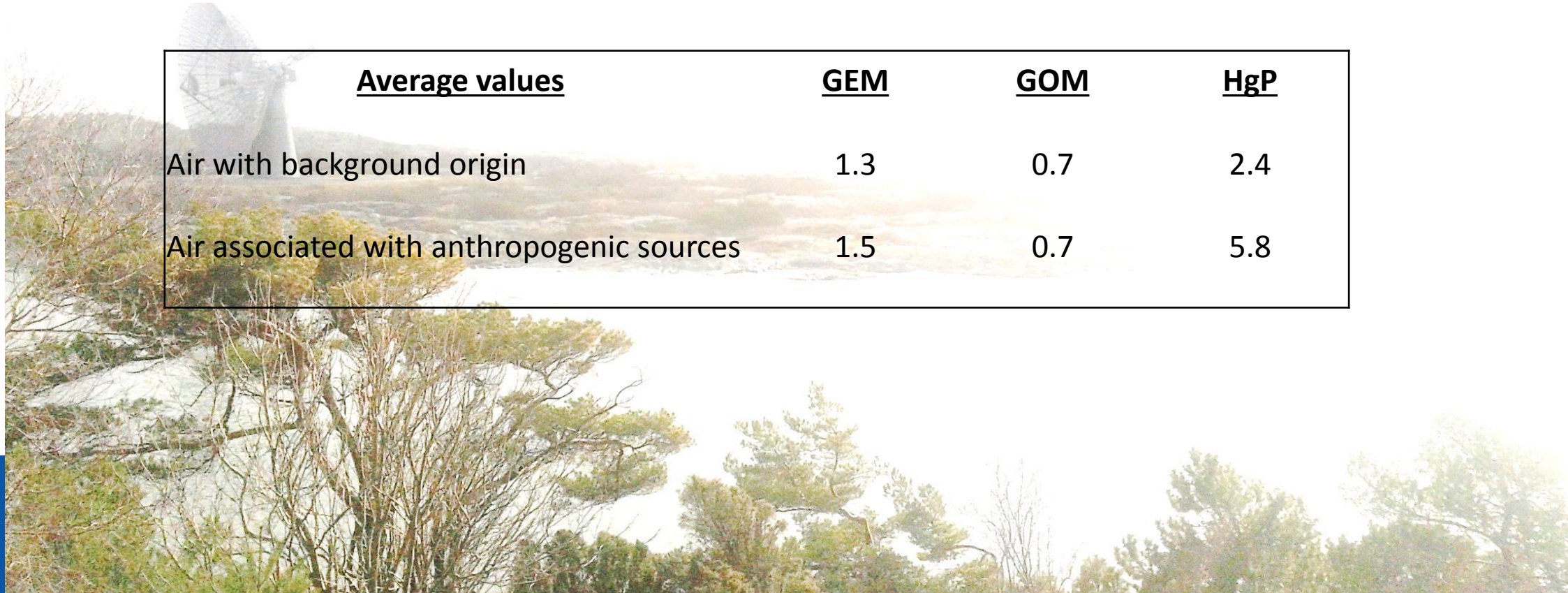
Gaseous Oxidized Mercury (GOM)



Conclusions

~60% of the air masses reaching the Rörvik/Råö site are of background origin

Average values	GEM	GOM	HgP
Air with background origin	1.3	0.7	2.4
Air associated with anthropogenic sources	1.5	0.7	5.8

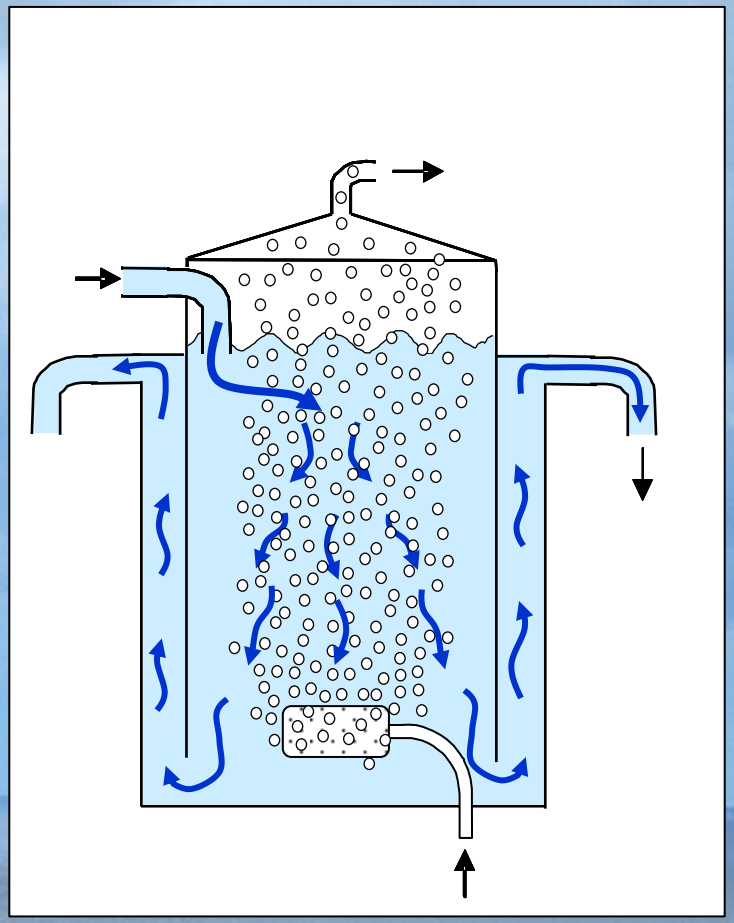


Continous determination of DGM in surface seawater

Ingvar Wängberg
ingvar.wangberg@ivl.se

[Title]
[Lecturer], [Date]

Opposite flow extractor for determination of Dissolved Gaseous Mercury (DGM)



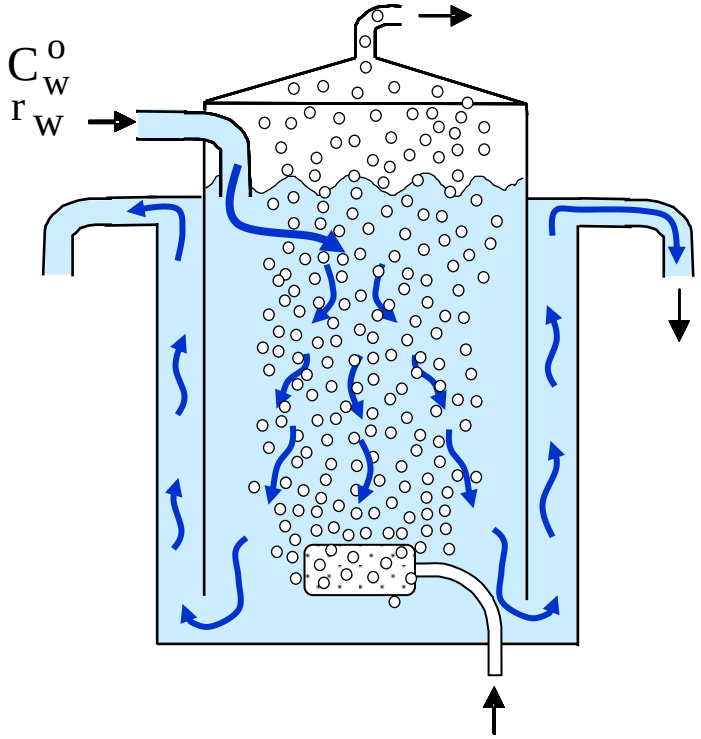
Parameters to consider:

- C^{o}_{w} = DGM (pg L^{-1})

r_{w} = water flow rate (L min^{-1})

Water from the ship bow water system

r_{w} = 10 – 12 L min^{-1}

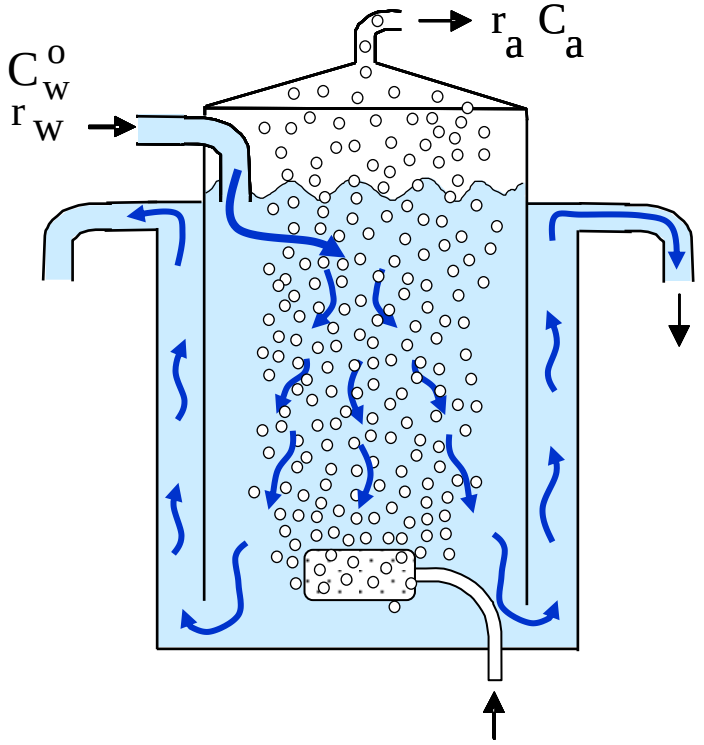


Parameters to consider:

- C_a = Hg^0 equilibrium concentration in the air leaving the extractor (pg L^{-1}) *(measured by a Tekran instr.)*

r_a = air volume flow rate (L min^{-1})

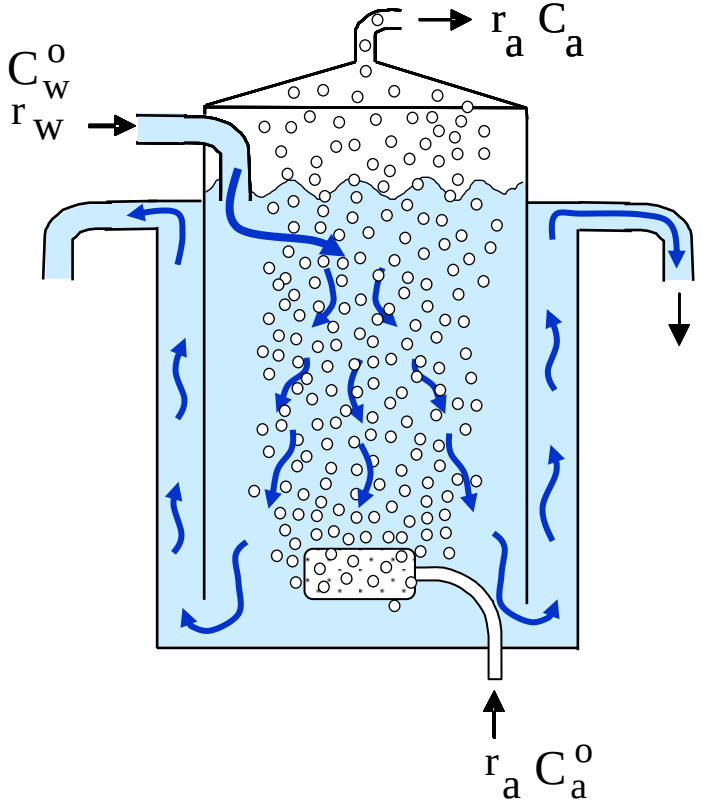
$r_a \approx 1.2$ L min^{-1}



Parameters to consider:

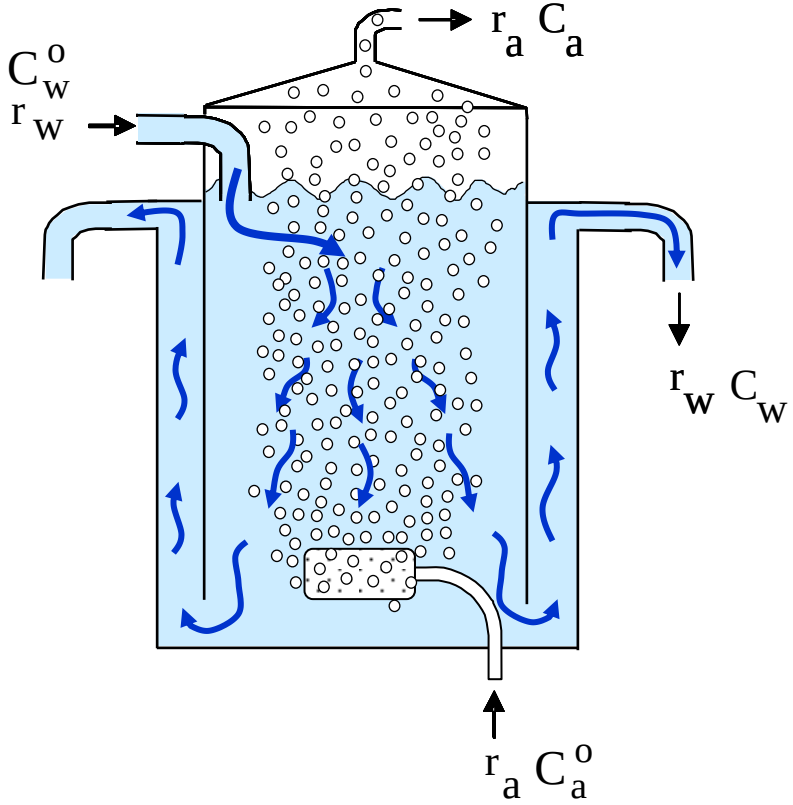
- C^o_a = Hg^0 concentration in the incoming air (pg L^{-1})

(ambient air can be used)



Parameters to consider:

- C_w = Hg^0 concentration in the water leaving the extractor (pg L^{-1})

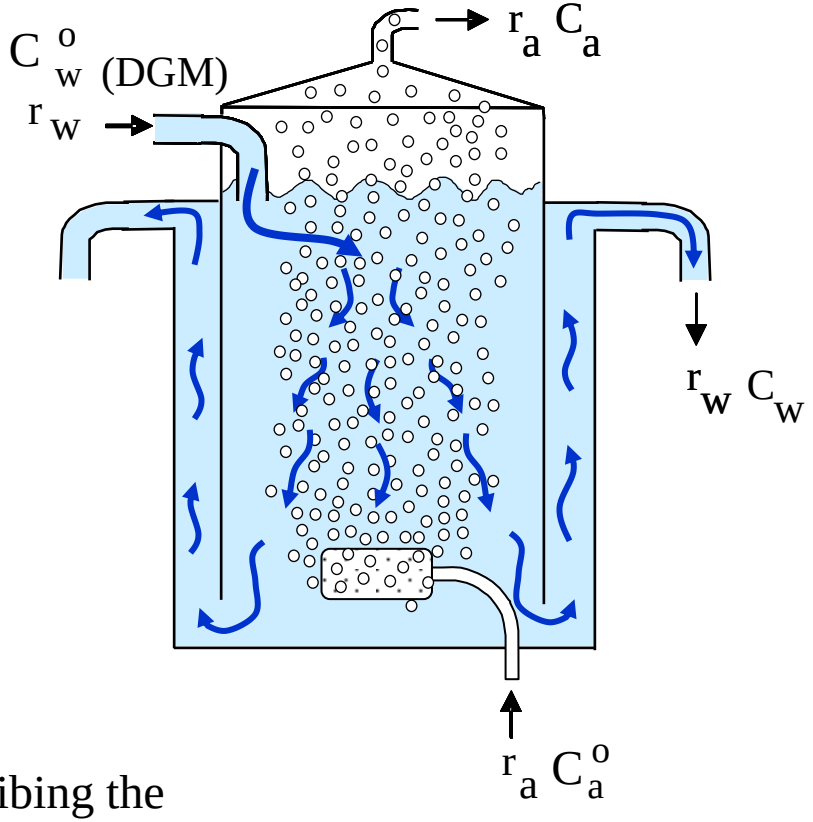


Calculation

$$\frac{dC_w}{dt} = \frac{r_w C_w^o + r_a C_a^o - r_w C_w - r_a C_a}{V} \qquad (1)$$

$$\text{Steady state}: \quad \frac{dC_w}{dt} = 0 \qquad (2)$$

$$C_w = \frac{C_a}{H'} \qquad \left(H' = \frac{C_a}{C_w}\right) \qquad (3)$$



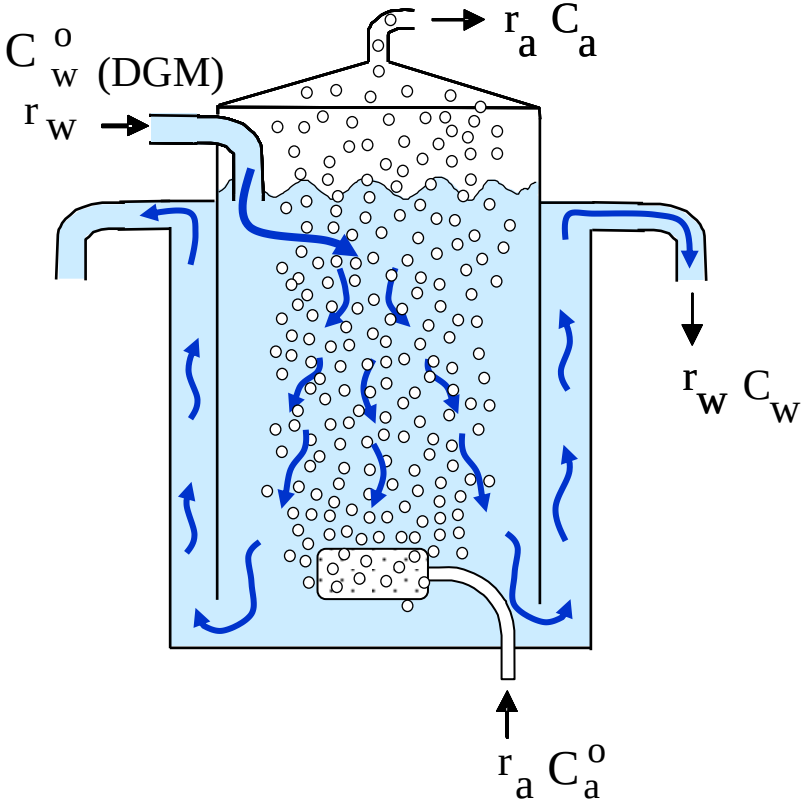
Where H' is the dimensionless Henry's Law coefficient describing the Hg^0 air/water partition

Calculation

Combining equation (1), (2) and (3) yields,

$$C_w^o = \frac{C_a}{H'} + (C_a - C_a^o)\frac{r_a}{r_w} \qquad (4)$$

$$\frac{1}{H'} = 2.7 - 6.6 \; ; \qquad \frac{r_a}{r_w} \approx 0.1$$



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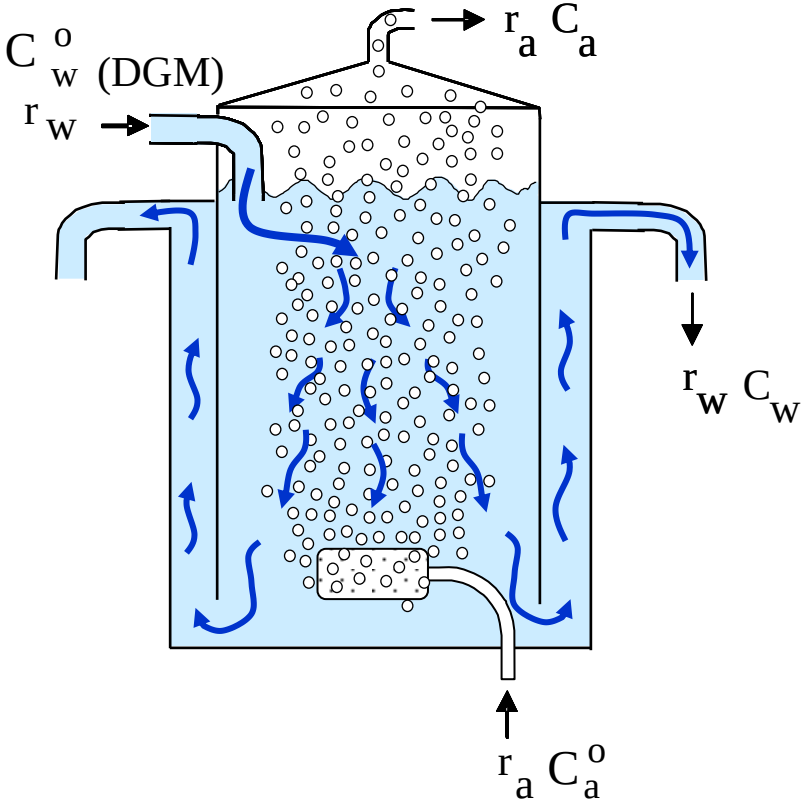

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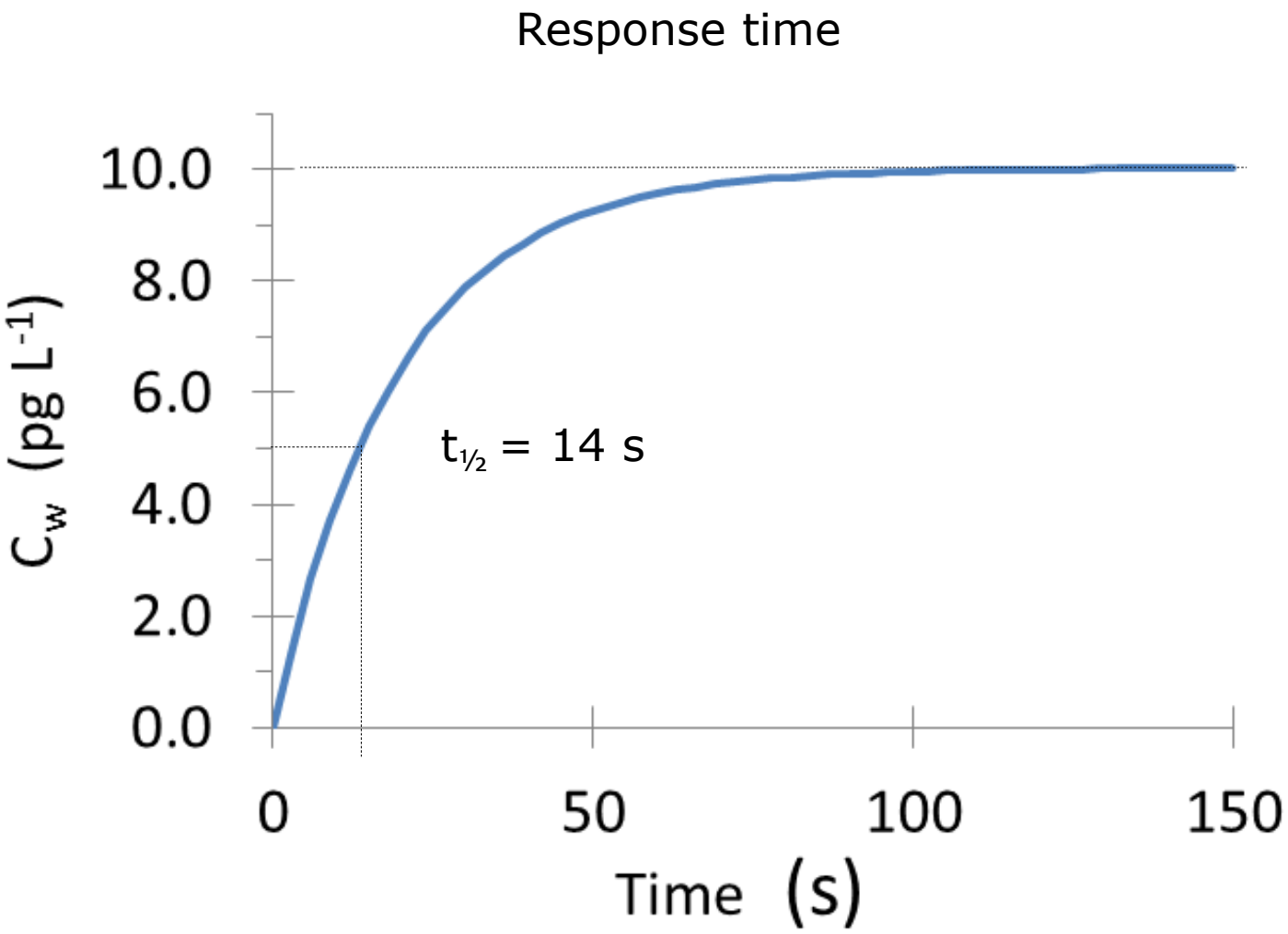

Conclusions

- The quick partition of Hg^0 between water and air allows determination of DGM by means of continuous extraction
- The system response time is fast in comparison to the expected DGM dynamic
- The performance of the extractor has been verified at oceanic cruises as well as in the Mediterranean Sea

Further work

Development of a standalone instrument for measurement on cargo ships or stationary measurements oil/gas platforms.