Organization of Course

INTRODUCTION

1. Course overview
2. Air Toxics overview
3. HYSPLIT overview

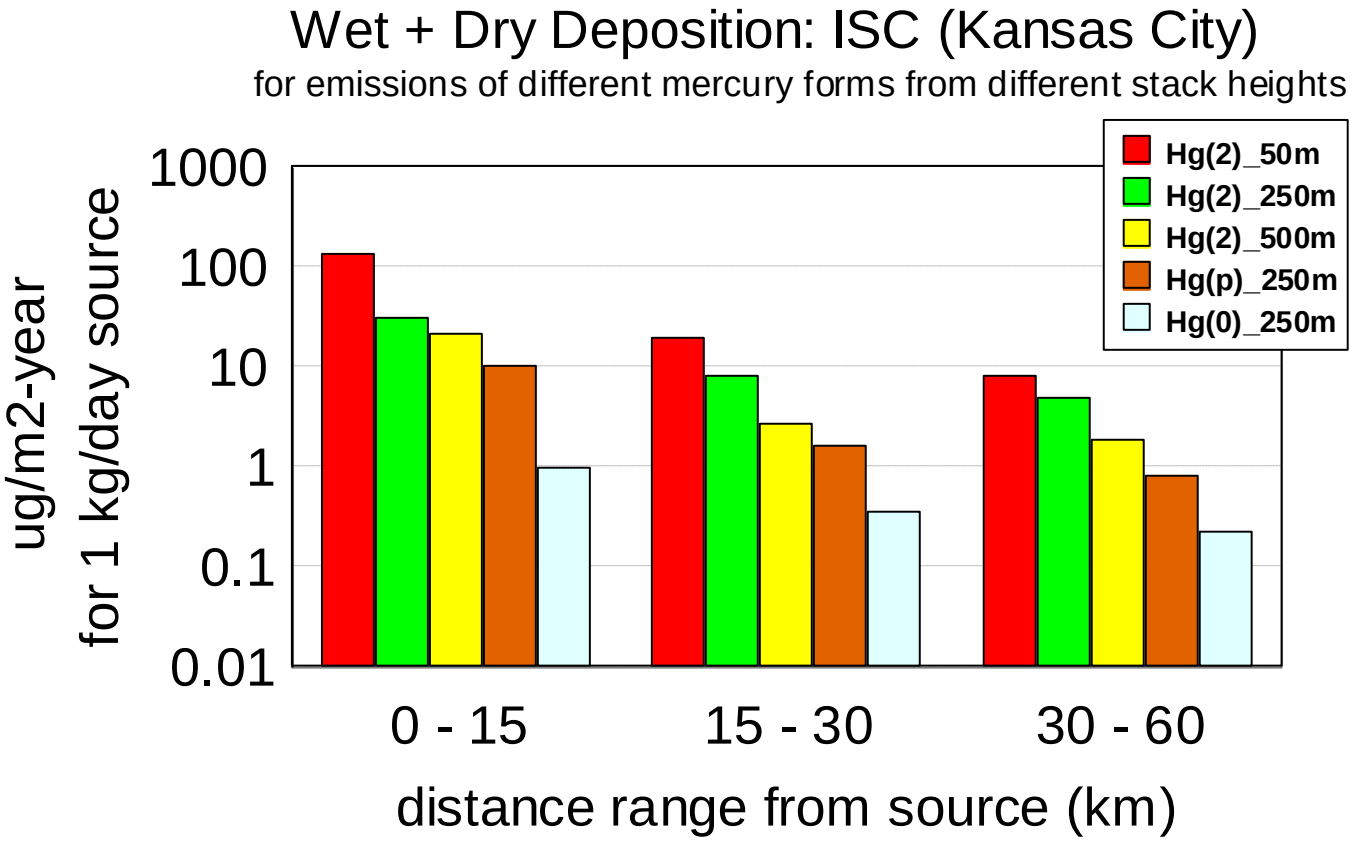
HYSPLIT Theory and Practice

4. Meteorology
5. Back Trajectories
6. Concentrations / Deposition
7. HYSPLIT-SV for semivolatiles (e.g, PCDD/F)
8. HYSPLIT-HG for mercury

Overall Project Issues & Examples

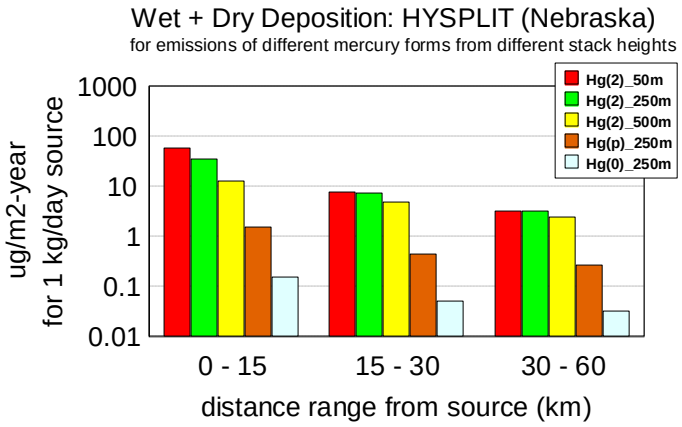
9. Emissions Inventories
10. Source-Receptor Post-Processing
11. Source-Attribution for Deposition
12. Model Evaluation
13. **Model Intercomparison**
14. Collaboration Possibilities

So how good are current models, and how do they compare with one another?



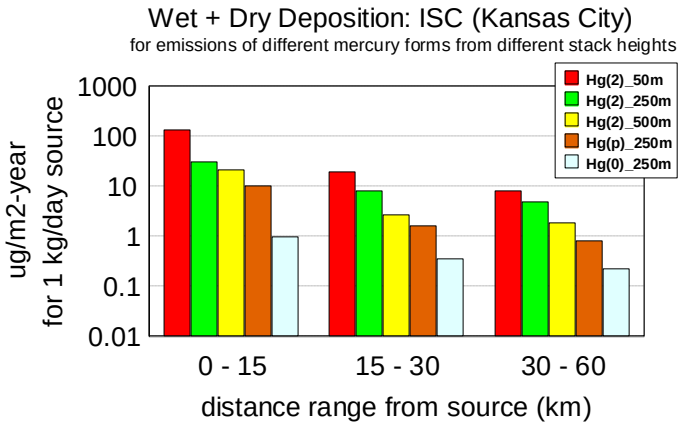
Calculated from data used to produce Appendix A of USEPA (2005): Clean Air Mercury Rule (CAMR) Technical Support Document: Methodology Used to Generate Deposition, Fish Tissue Methylmercury Concentrations, and Exposure for Determining Effectiveness of Utility Emissions Controls: Analysis of Mercury from Electricity Generating Units

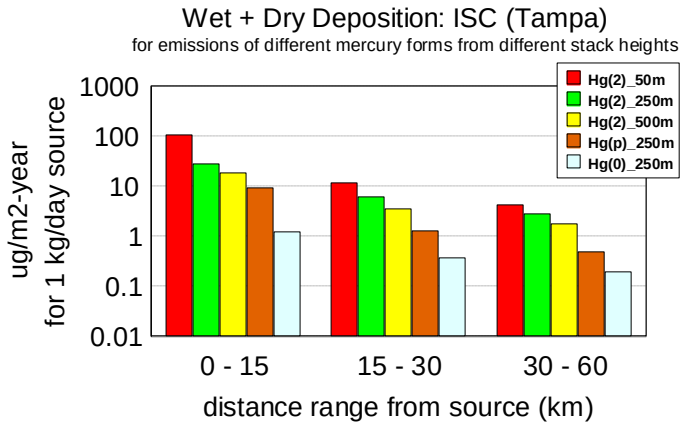
HYSPLIT 1996

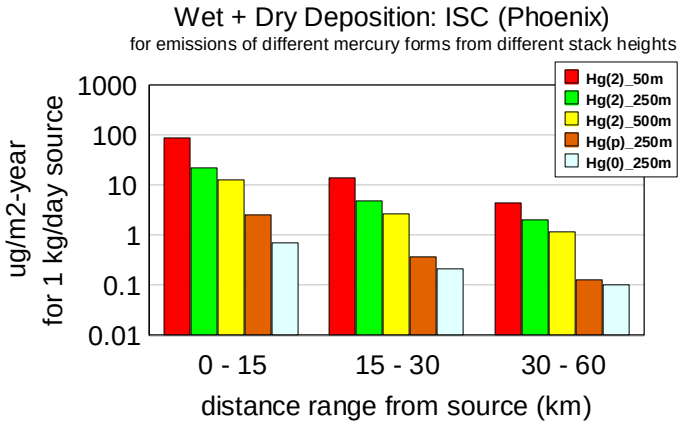


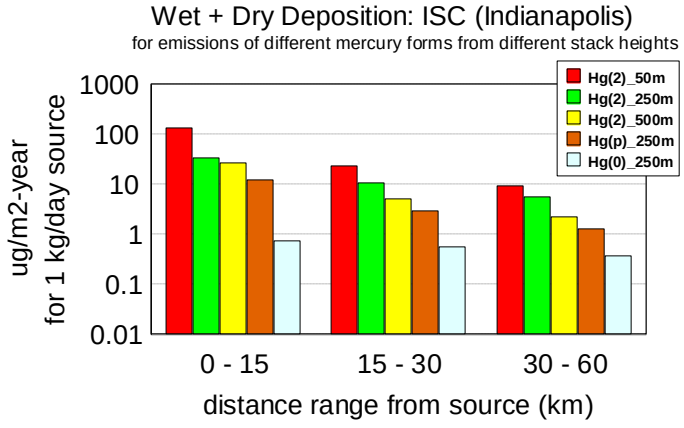
Different Time Periods and Locations, but Similar Results

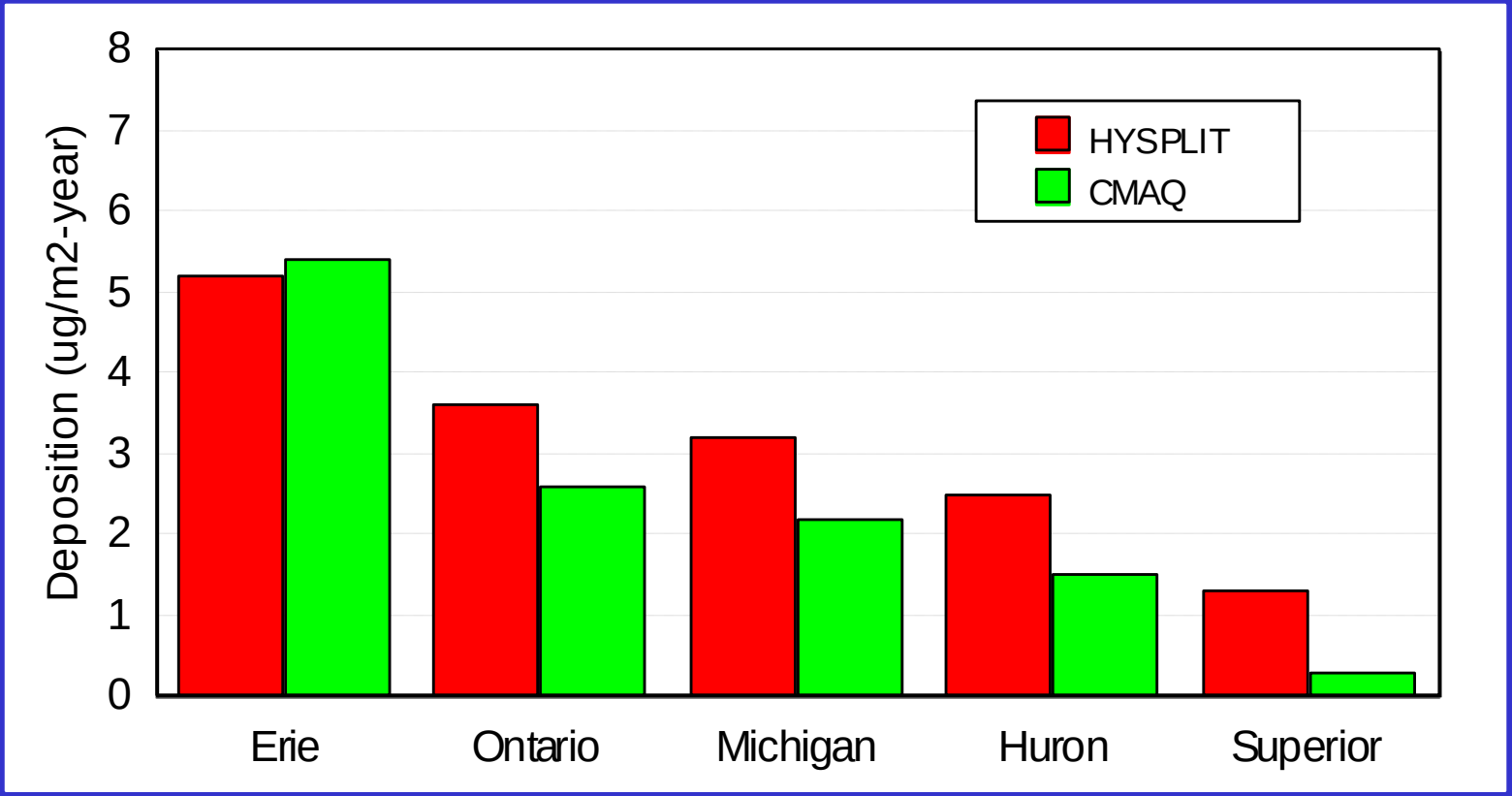
ISC: 1990-1994



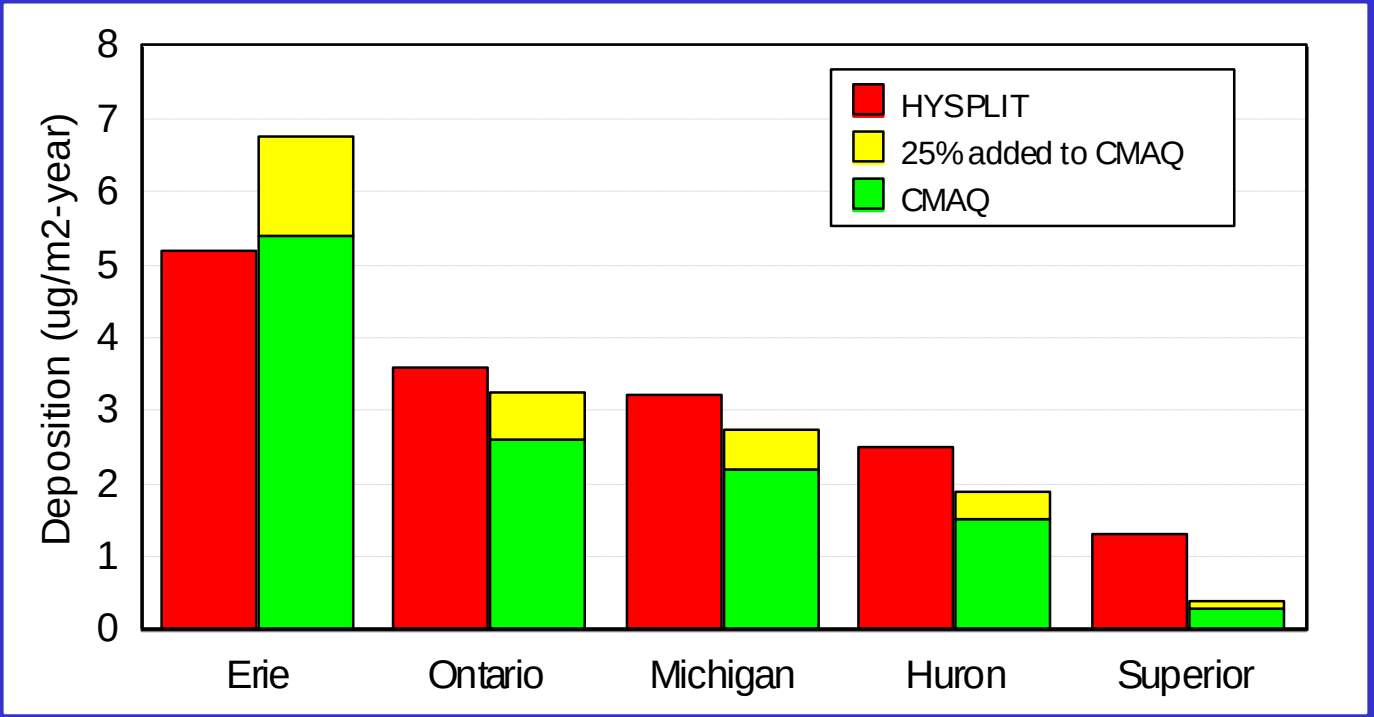








Model-estimated U.S. utility atmospheric mercury deposition contribution to the Great Lakes: HYSPLIT-Hg (1996 meteorology, 1999 emissions) vs. CMAQ-HG (2001 meteorology, 2001 emissions).



- Model-estimated U.S. utility atmospheric mercury deposition contribution to the Great Lakes: HYSPLIT-Hg (1996 meteorology, 1999 emissions) vs. CMAQ-Hg (2001 meteorology, 2001 emissions).

- This figure also shows an added component of the CMAQ-Hg estimates -- corresponding to 25% of the CMAQ-Hg results – in an attempt to adjust the CMAQ-Hg results to account for the deposition underprediction found in the CMAQ-Hg model evaluation.

EMEP Intercomparison Study of Numerical Models for Long-Range Atmospheric Transport of Mercury

EMEP/TFMM
Workshop on the Review
of the MSC-E Models
on HMs and POPs
Oct 13-14, 2005
Hotel Mir, Moscow Russia

Summary presented
by Mark Cohen,
NOAA Air Resources
Laboratory,
Silver Spring,
MD, USA

Participants

D. Syrakov ..... **Bulgaria**....**NIMH**

A. Dastoor, D. Davignon ..... **Canada**..... **MSC-Can**

J. Christensen ..... **Denmark**...**NERI**

G. Petersen, R. Ebinghaus ..... **Germany**...**GKSS**

J. Pacyna ..... **Norway**.....**NILU**

J. Munthe, I. Wängberg ..... **Sweden**..... **IVL**

R. Bullock .....**USA**.....**EPA**

M. Cohen, R. Artz, R. Draxler ..... **USA**.....**NOAA**

C. Seigneur, K. Lohman .....**USA**..... **AER/EPRI**

A. Ryaboshapko, I. Ilyin, O.Travnikov...**EMEP**.....**MSC-E**

Intercomparison Conducted in 3 Stages

I. Comparison of chemical schemes for a cloud environment

II. Air Concentrations in Short Term Episodes

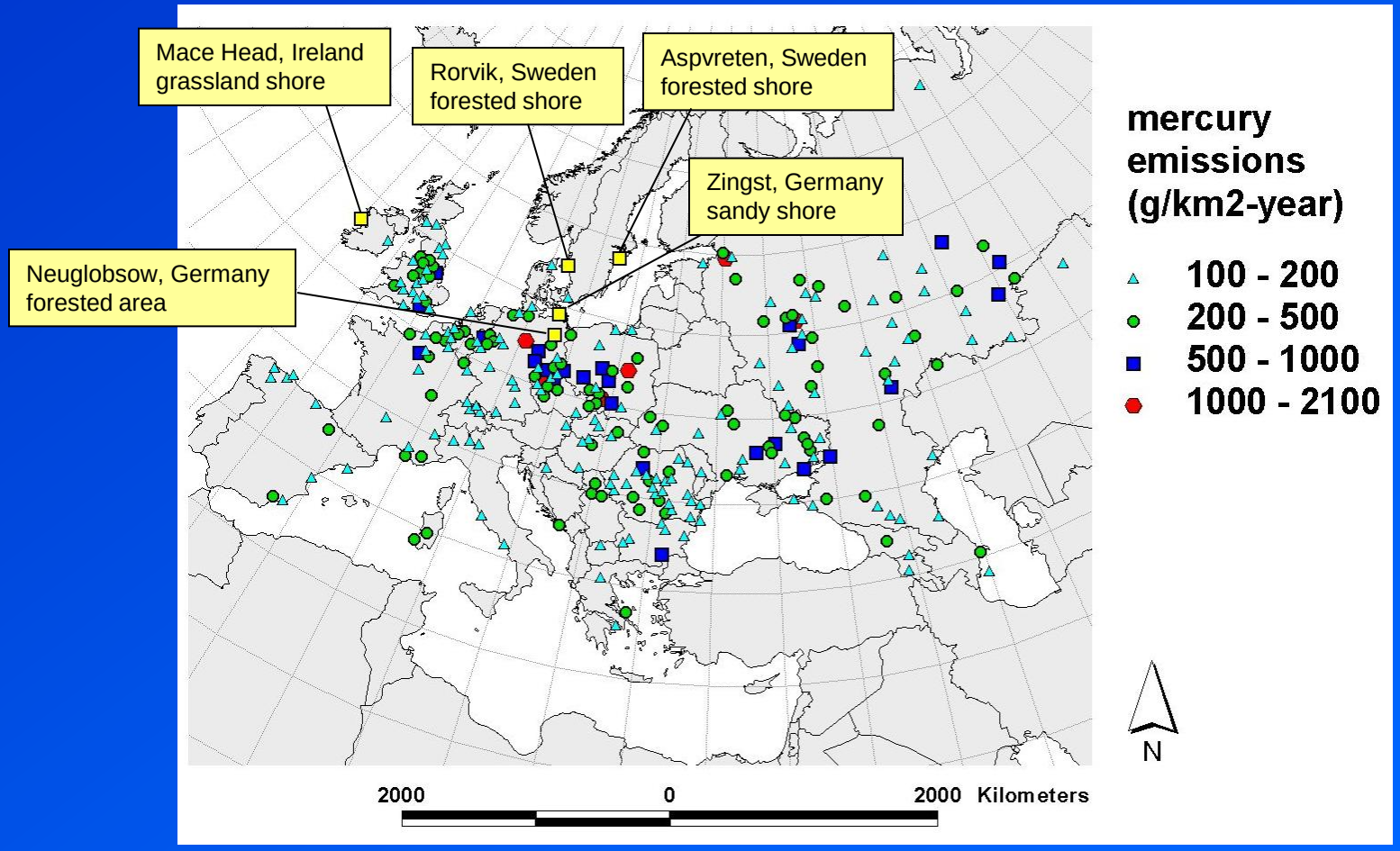
III. Long-Term Deposition and Source-Receptor Budgets

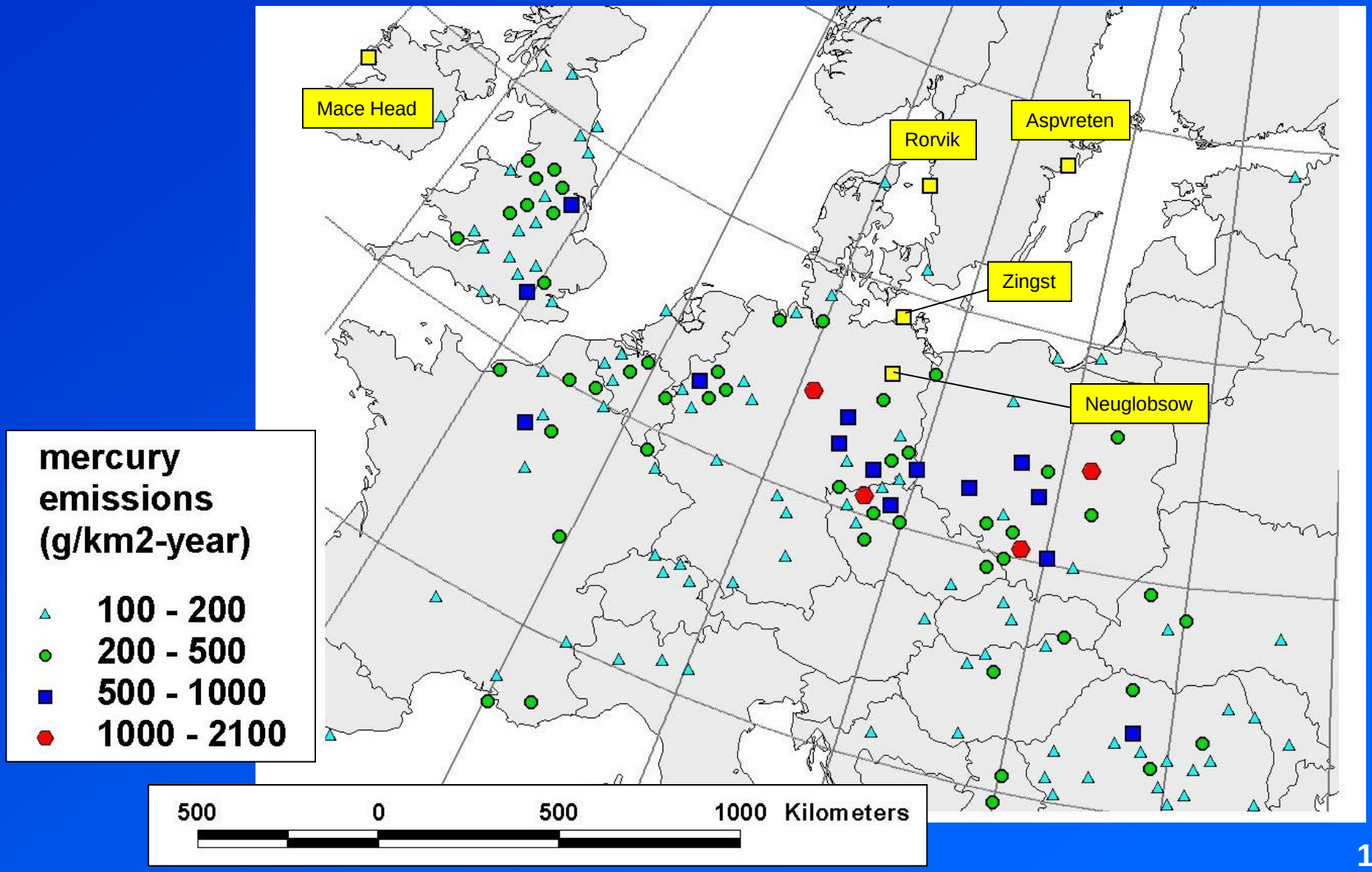
Participating Models

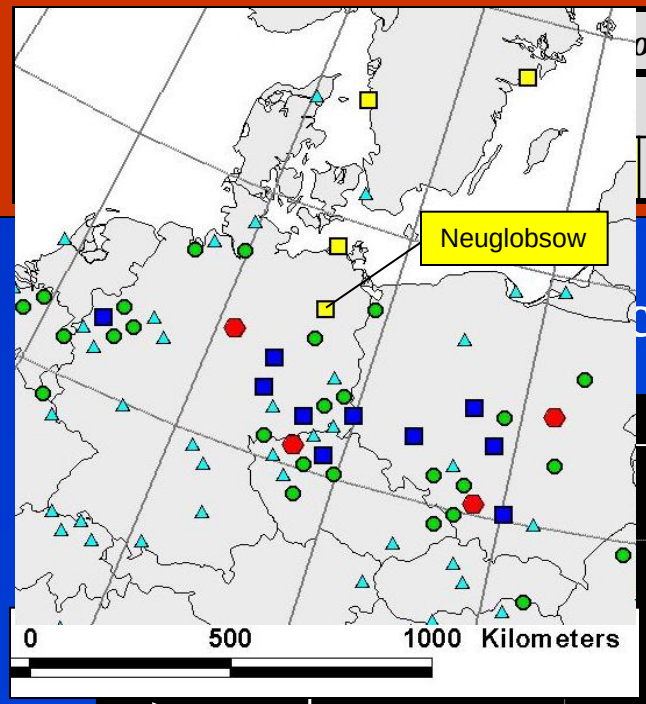
Model Acronym	***Model Name* and Institution**	**Stage**		
		I	**II**	**III**
CAM	*Chemistry of Atmos. Mercury model*, Environmental Institute, Sweden			
MCM	*Mercury Chemistry Model*, Atmos. & Environmental Research, USA			
CMAQ	*Community Multi-Scale Air Quality model*, US EPA			
ADOM	*Acid Deposition and Oxidants Model*, GKSS Research Center, Germany			
MSCE-HM	*MSC-E heavy metal regional model*, EMEP MSC-E			
GRAHM	*Global/Regional Atmospheric Heavy Metal model*, Environment Canada			
EMAP	*Eulerian Model for Air Pollution*, Bulgarian Meteo-service			
DEHM	*Danish Eulerian Hemispheric Model*, National Environmental Institute			
HYSPLIT	*Hybrid Single Particle Lagrangian Integrated Trajectory model*, US NOAA			
MSCE-HM-Hem	*MSC-E heavy metal hemispheric model*, EMEP MSC-E			

Anthropogenic Mercury Emissions Inventory and Monitoring Sites for Phase II

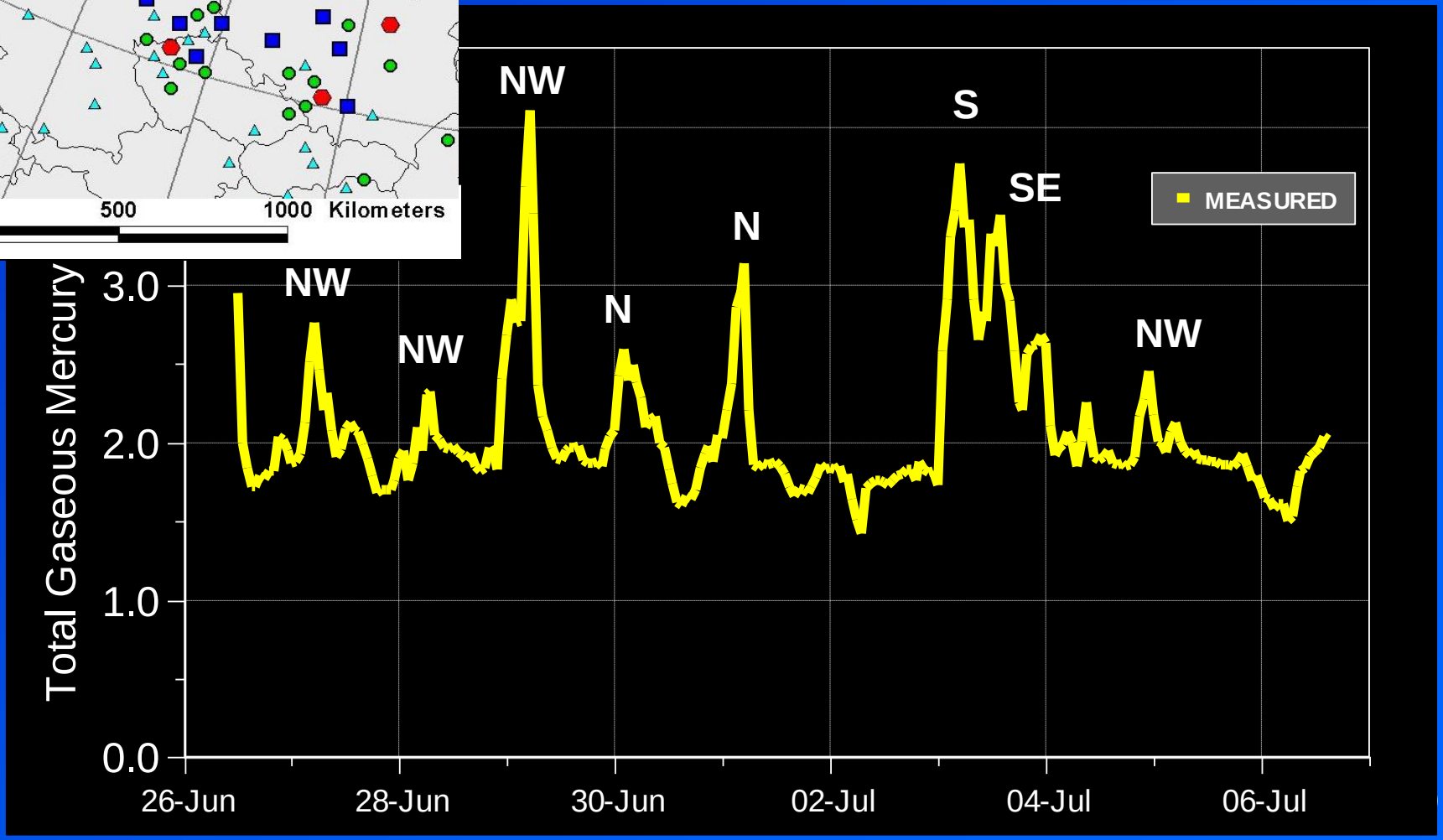
(note: only showing largest emitting grid cells)



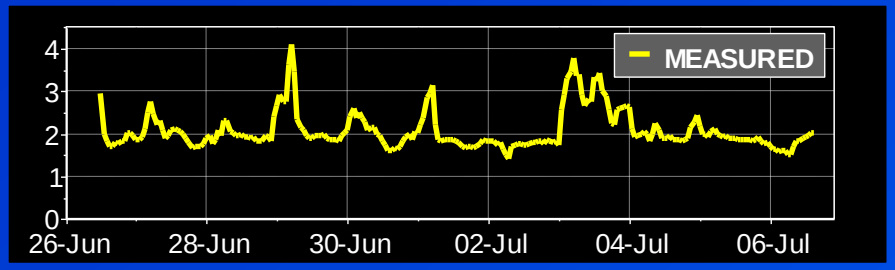

Mace Head
Rorvik
Aspvreten
Zingst
Neuglobsow
mercury emissions (g/km2-year)
100 - 200
200 - 500
500 - 1000
1000 - 2100
500 0 500 1000 Kilometers

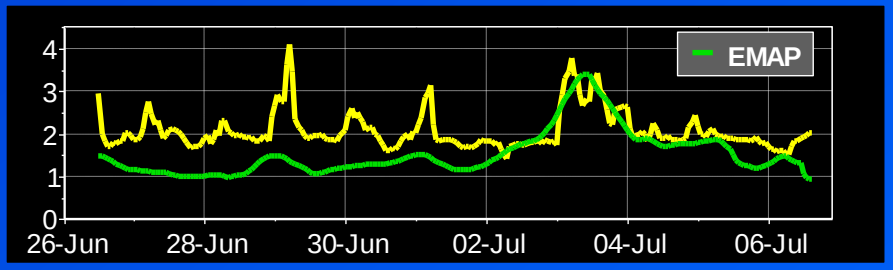


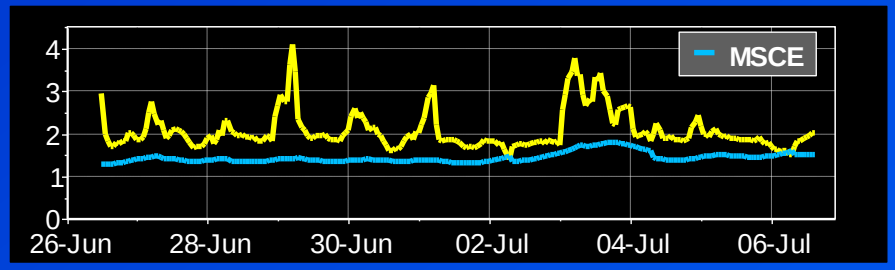
cury at Neuglobsow: June 26 – July 6, 1995

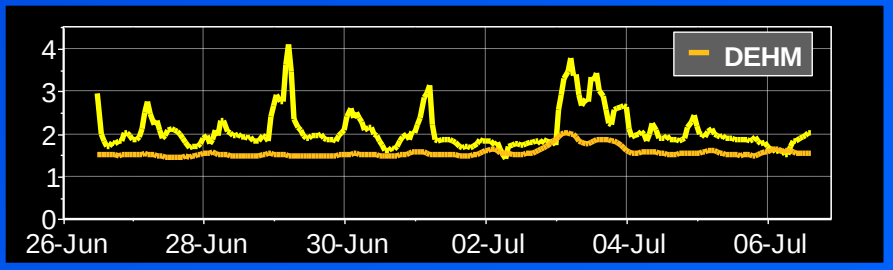


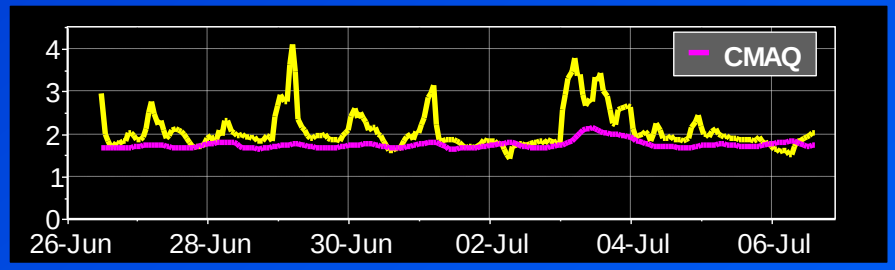
Total Gaseous Mercury (ng/m^3) at Neuglobsow: June 26 – July 6, 1995

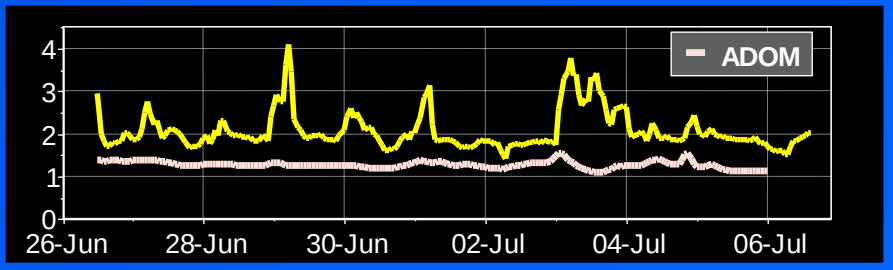


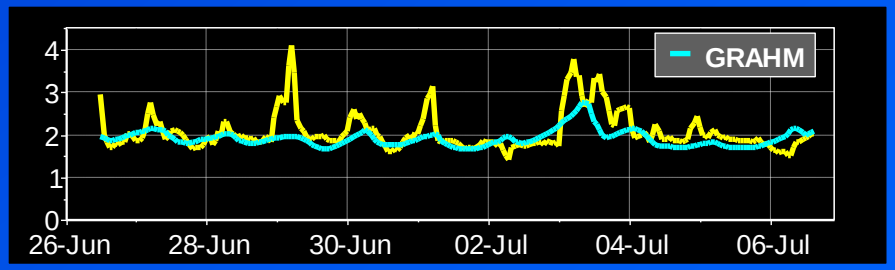


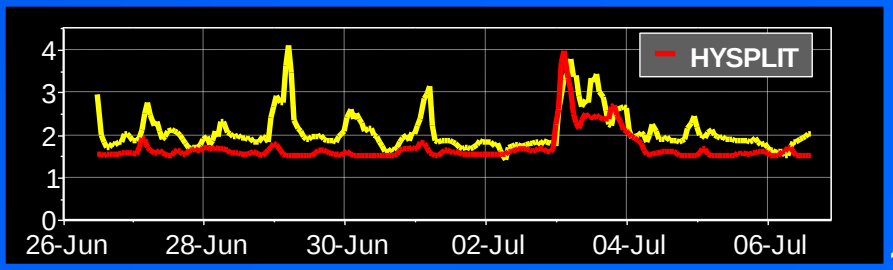




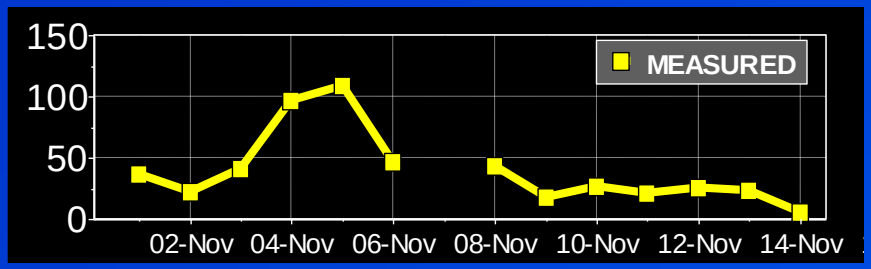


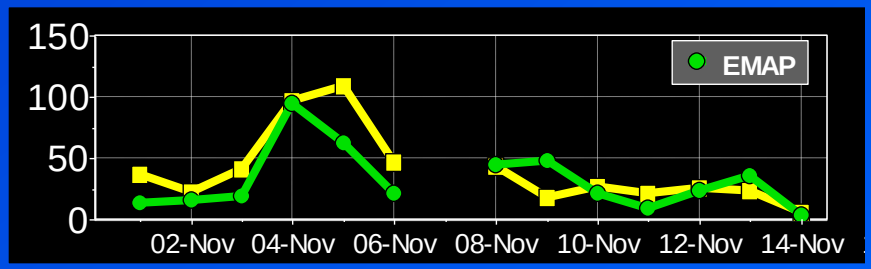


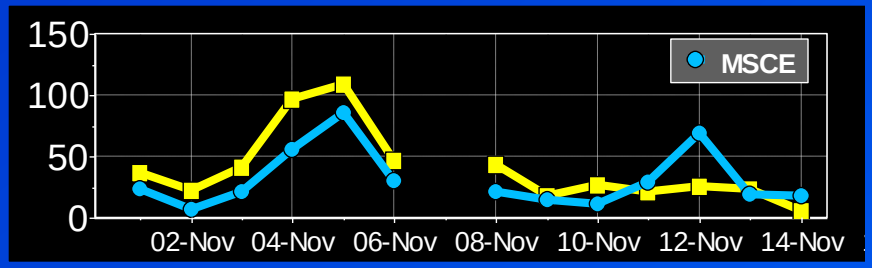


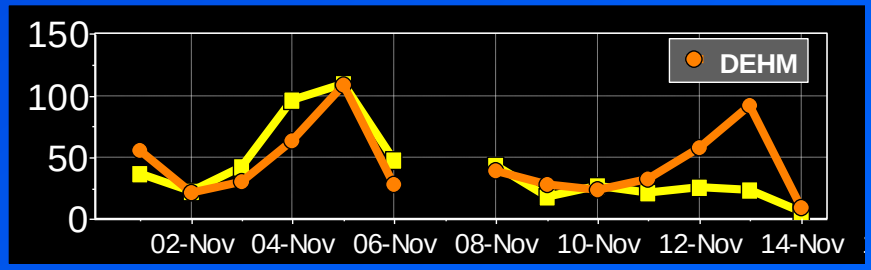


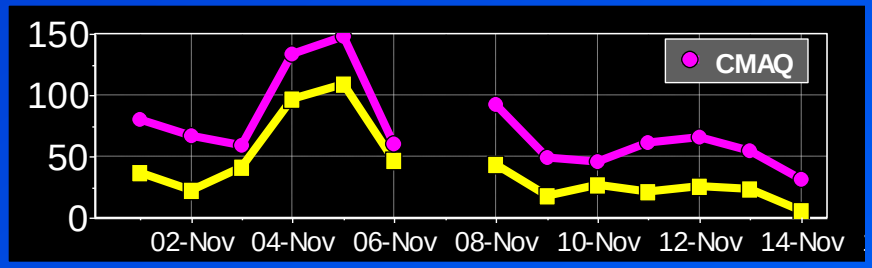
Total *Particulate* Mercury (pg/m^3) at Neuglobsow, Nov 1-14, 1999

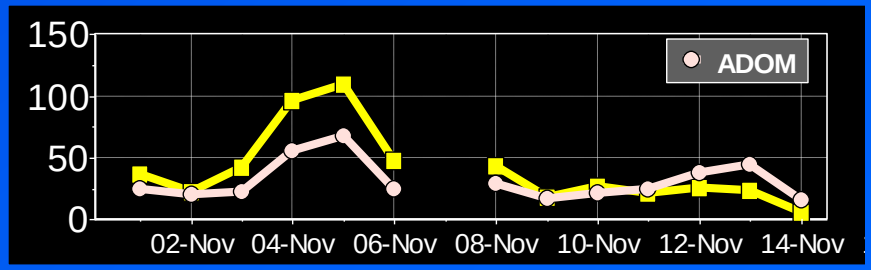


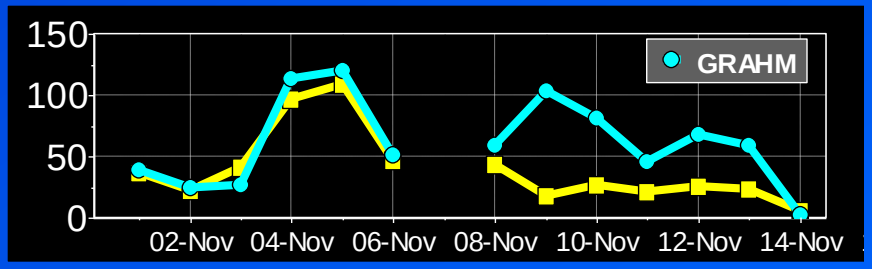


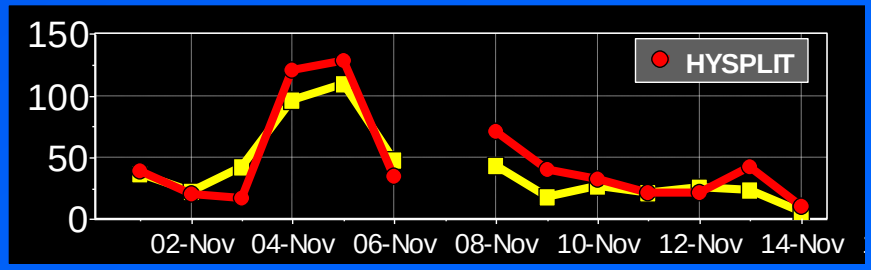




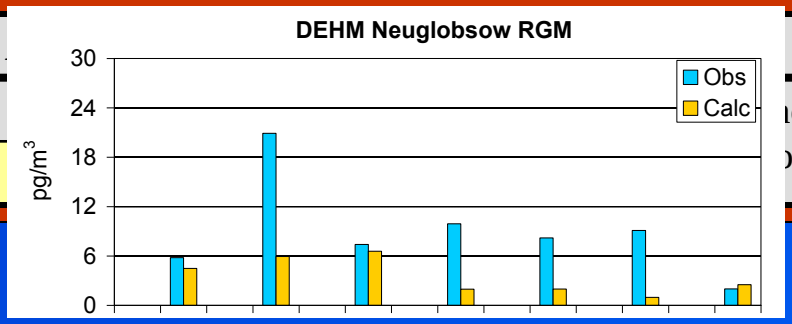


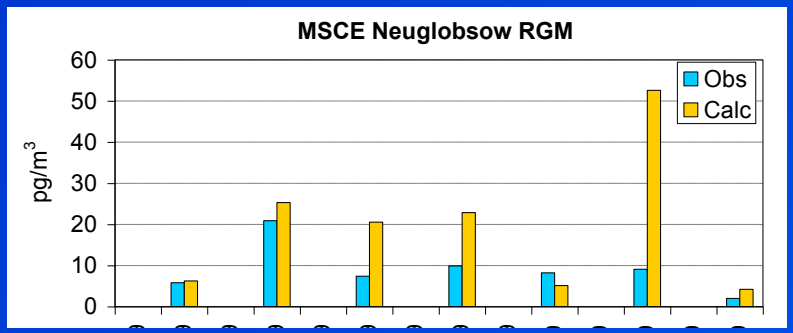


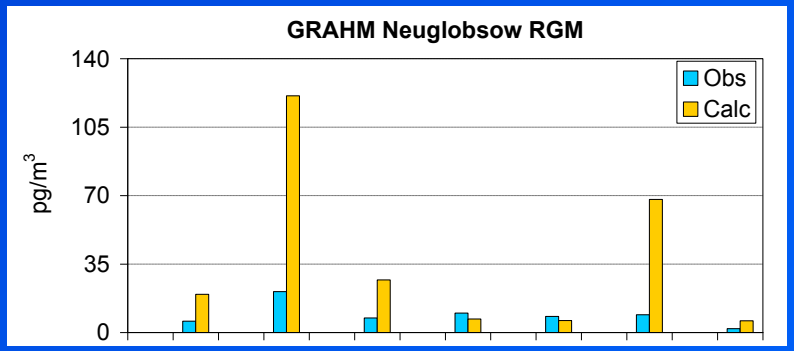


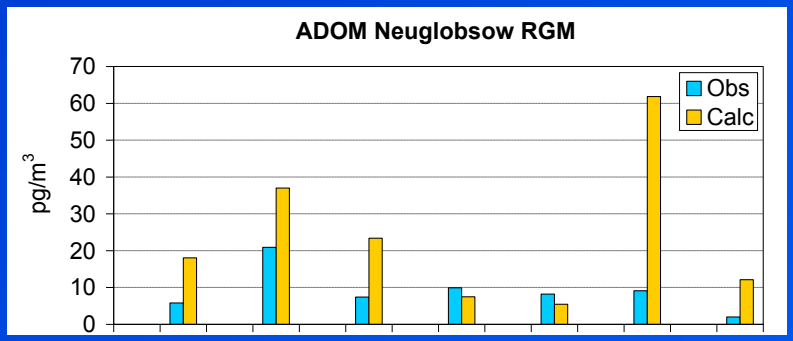


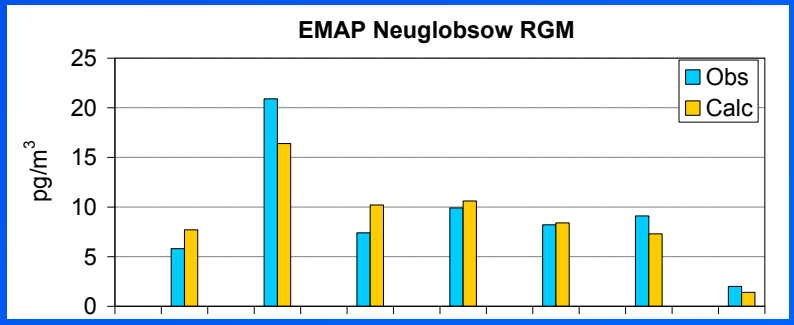
Reactive Gaseous Mercury at Neuglobsow, Nov 1-14, 1999

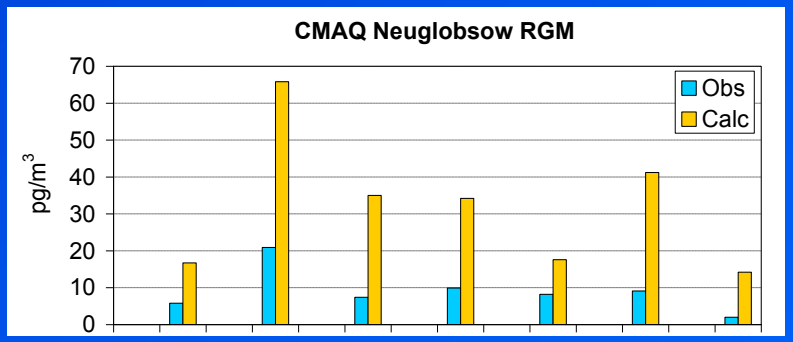


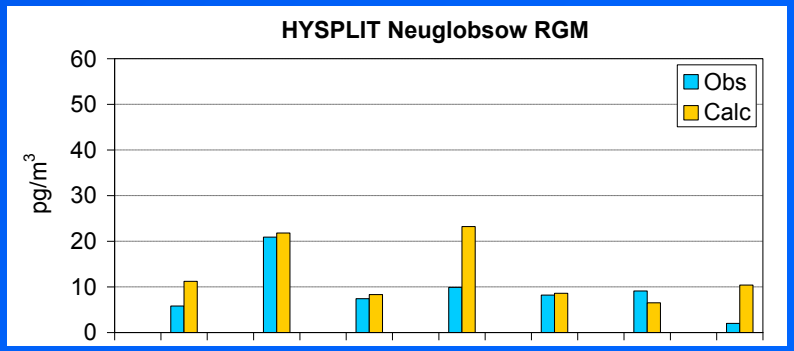








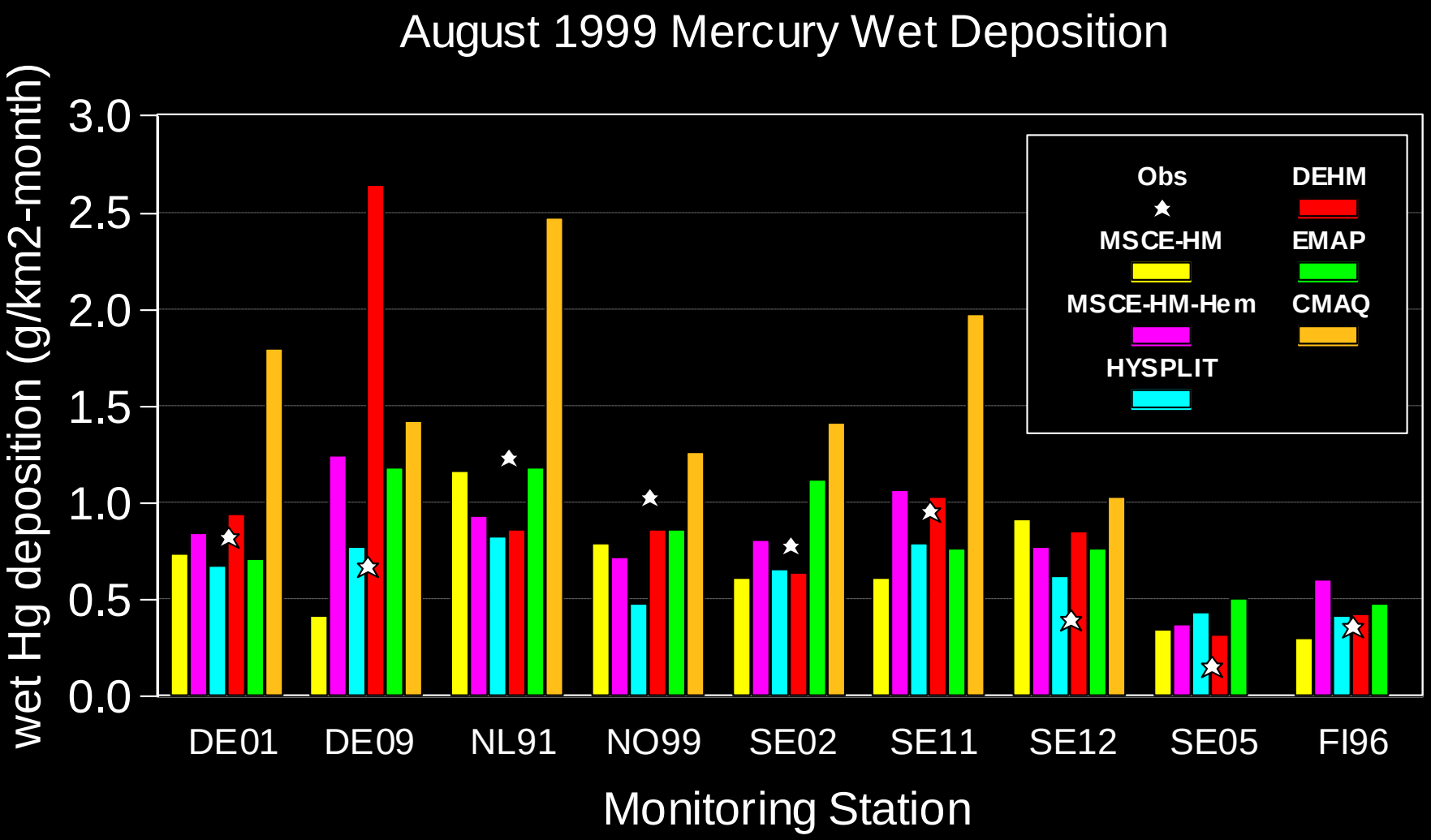




Stage II Publications:

2003 Ryaboshapko, A., Artz, R., Bullock, R., Christensen, J., Cohen, M., Dastoor, A., Davignon, D., Draxler, R., Ebinghaus, R., Ilyin, I., Munthe, J., Petersen, G., Syrakov, D. *Intercomparison Study of Numerical Models for Long Range Atmospheric Transport of Mercury.* ***Stage II. Comparisons of Modeling Results with Observations Obtained During Short Term Measuring Campaigns***. Meteorological Synthesizing Centre – East, Moscow, Russia.

2005 Ryaboshapko, A., Bullock, R., Christensen, J., Cohen, M., Dastoor, A., Ilyin, I., Petersen, G., Syrakov, D., Artz, R., Davignon, D., Draxler, R., and Munthe, J. *Intercomparison Study of Atmospheric Mercury Models*. ***Phase II. Comparison of Models with Short-Term Measurements***. Submitted to Atmospheric Environment.


August 1999 Mercury Wet Deposition
wet Hg deposition (g/km2-month)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Obs
DEHM
MSCE-HM
EMAP
MSCE-HM-Hem
CMAQ
HYSPLIT
DE01
DE09
NL91
NO99
SE02
SE11
SE12
SE05
FI96
Monitoring Station

Stage III Publication:

2005 Ryaboshapko, A., Artz, R., Bullock, R., Christensen, J., Cohen, M., Draxler, R., Ilyin, I., Munthe, J., Pacyna, J., Petersen, G., Syrakov, D., Travnikov, O. *Intercomparison Study of Numerical Models for Long Range Atmospheric Transport of Mercury.* ***Stage III. Comparison of Modelling Results with Long-Term Observations and Comparison of Calculated Items of Regional Balances***. Meteorological Synthesizing Centre – East, Moscow, Russia.

Conclusions: Uncertainties in Mercury Modeling

- Elemental Hg in air - factor of **1.2**
- Particulate Hg in air - factor of **1.5**
- Oxidized gaseous Hg in air - factor of **5**
- Total Hg in precipitation - factor of **1.5**
- Wet deposition - factor of **2.0**
- Dry deposition - factor of **2.5**
- Balances for countries - factor of **2**