13th CMAS Conference

Evaluation of reactants for the oxidation of mercury using high-res speciated observations

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GMOS Global Mercury Observation System

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Overview

- An Introduction to the GMOS project
- Overview of the model system
- Atmospheric mercury concentrations
- Mercury deposition
- Vertical profiles
- Discussion

Mercury: Global Cycle and Accumulation

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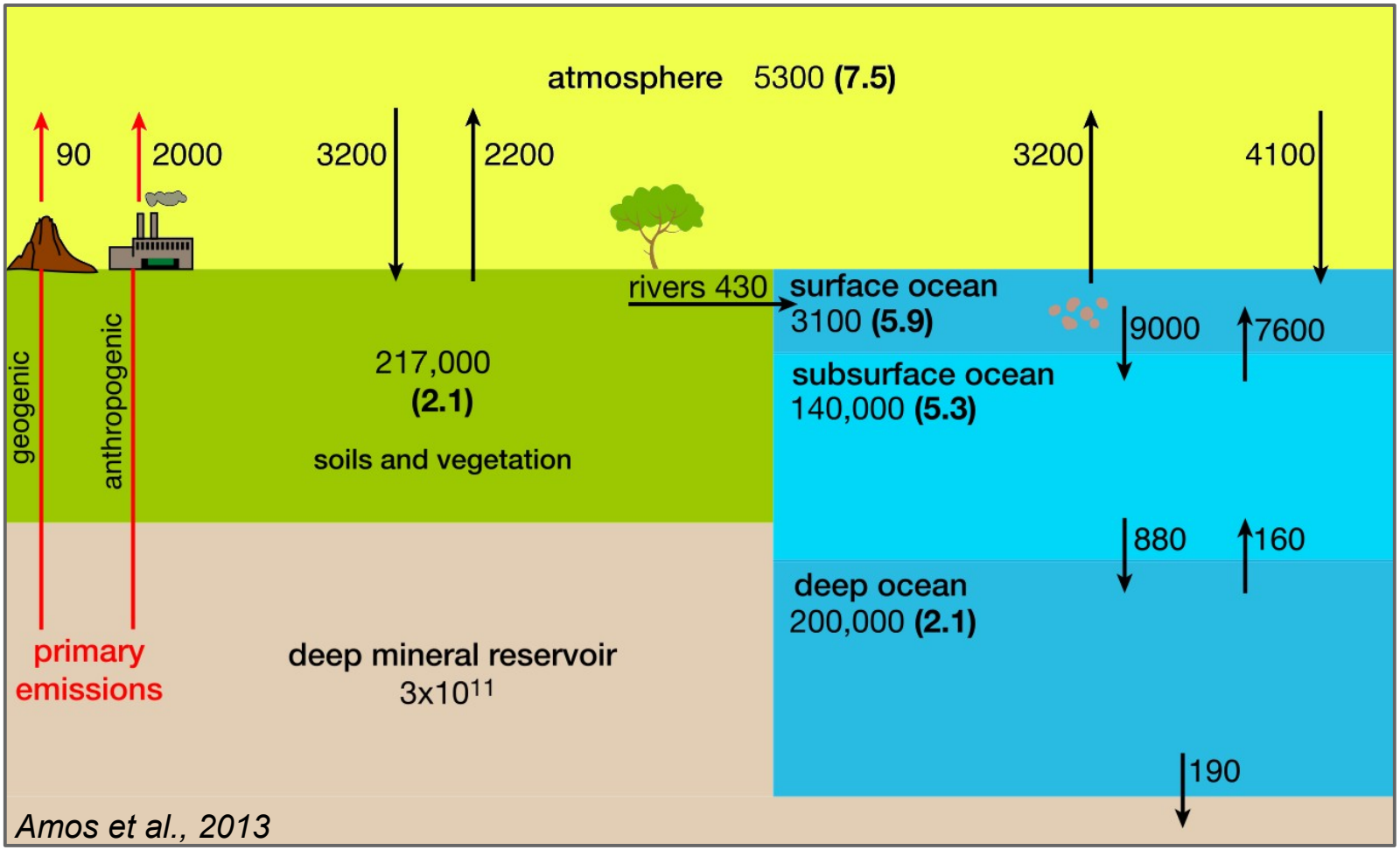
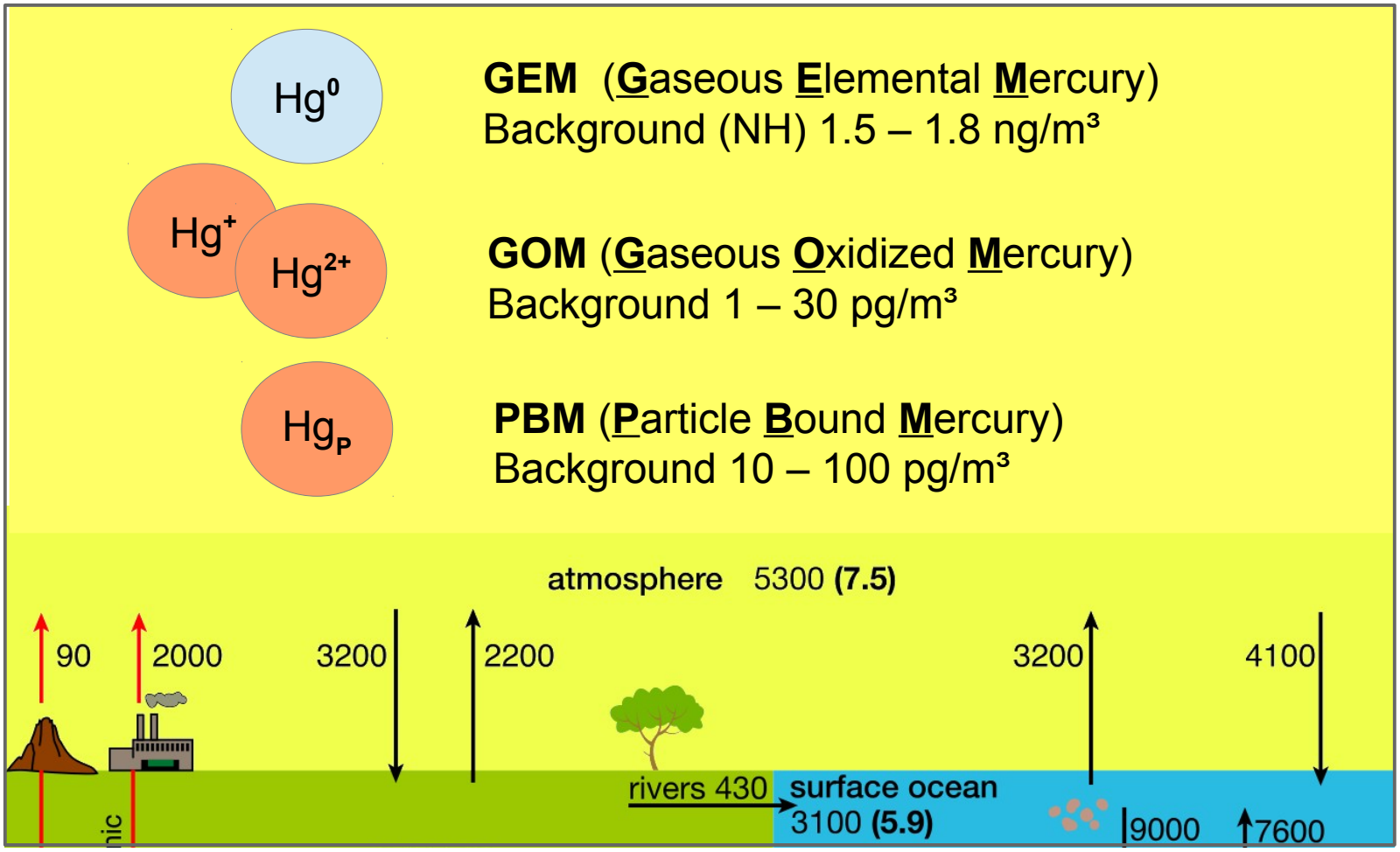
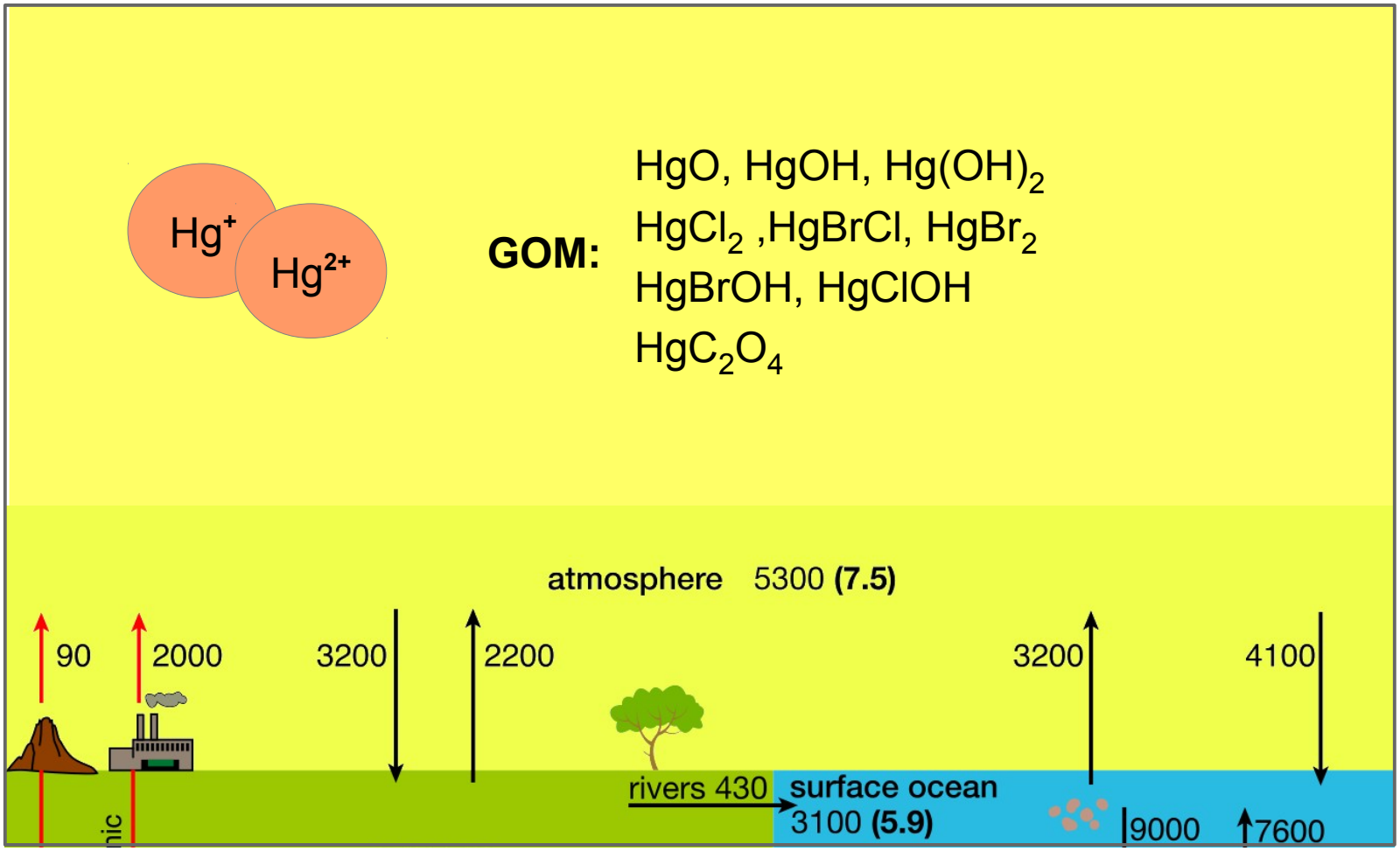


Emission, Chemistry, Transport, Deposition

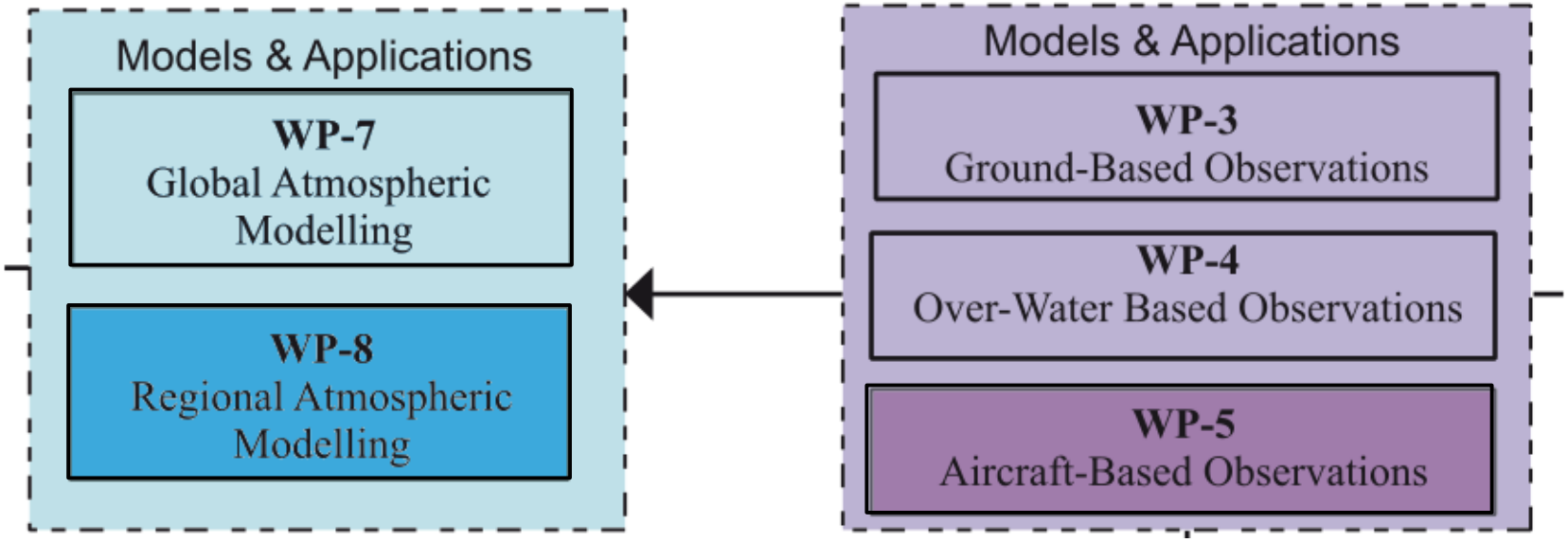


What is GOM?


Hg^+
Hg^{2+}
GOM:
HgO, HgOH, $Hg(OH)_2$
$HgCl_2$,HgBrCl, $HgBr_2$
HgBrOH, HgClOH
HgC_2O_4
atmosphere 5300 (7.5)
90
2000
3200
2200
3200
4100
rivers 430
surface ocean
3100 (5.9)
9000
7600

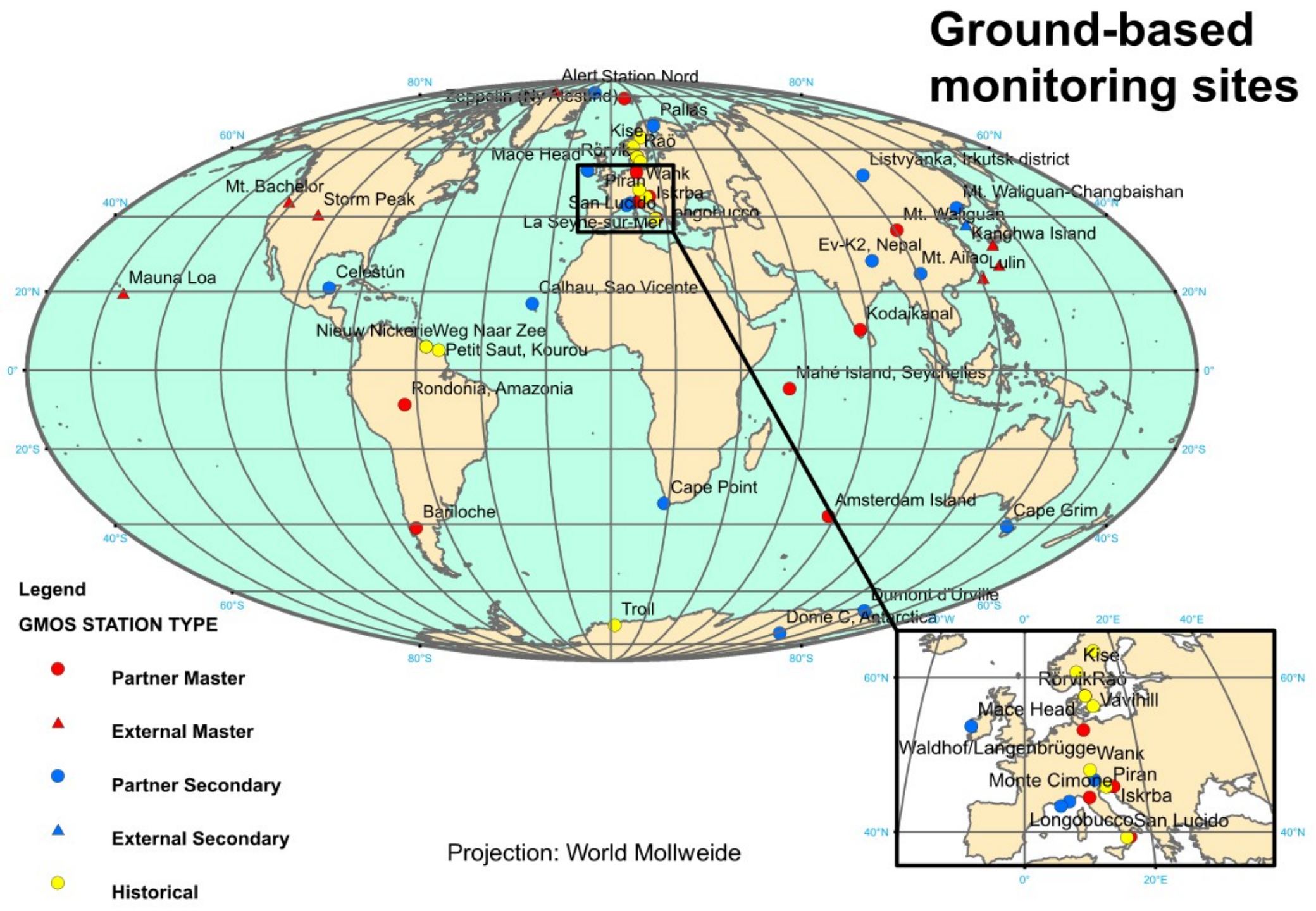
GMOS: Global Mercury Observation System

GMOS: Measurements and Models

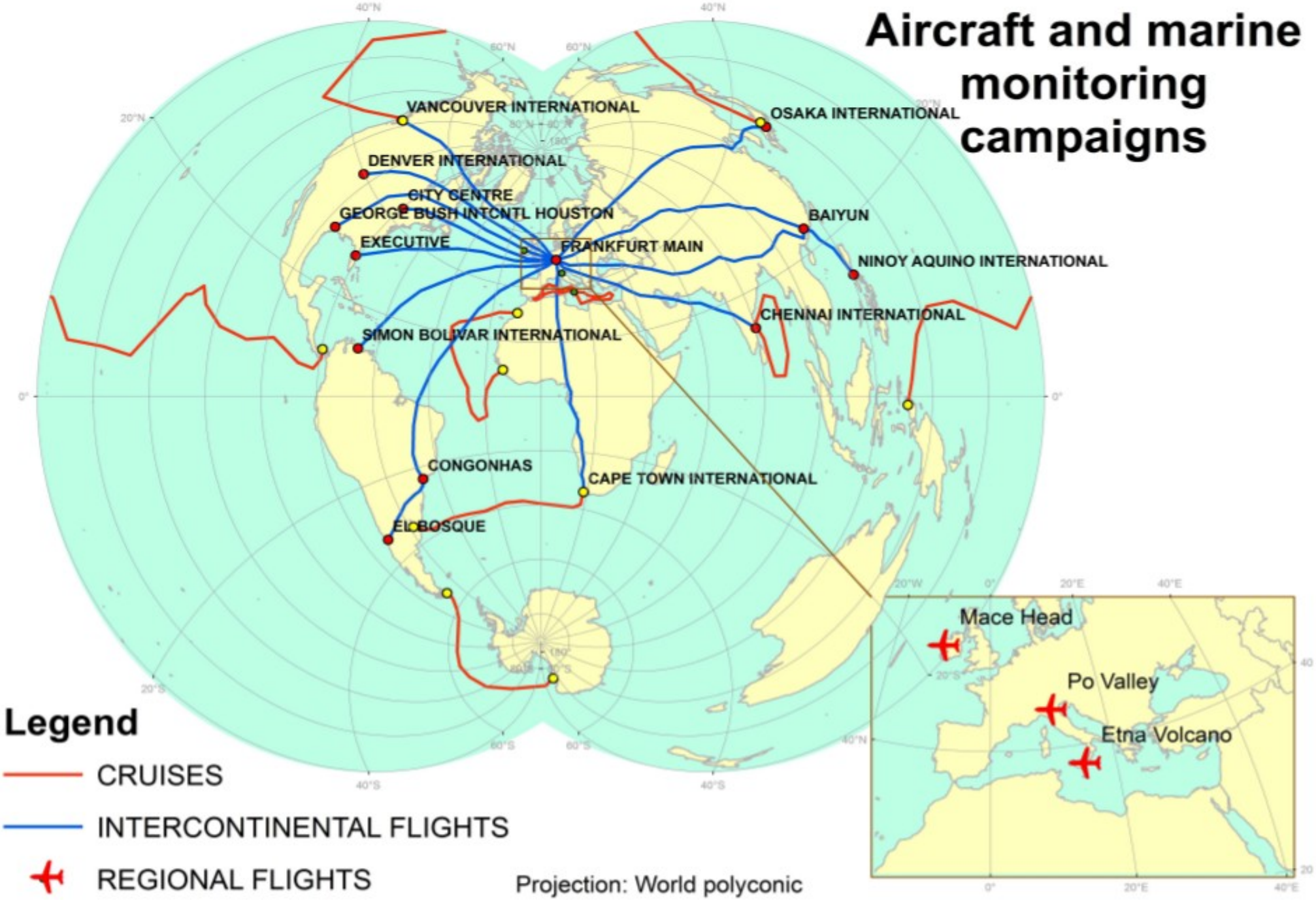


GMOS data will be used to test regional and global scale atmospheric mercury models, which can then be used for determining the current state of atmospheric mercury contamination, and its deposition to ecosystems. This will enable the development of policies to minimise ecosystem risk from mercury pollution.

Ground-based monitoring sites



Aircraft and marine monitoring campaigns



GMOS: Air craft based measurement campaigns

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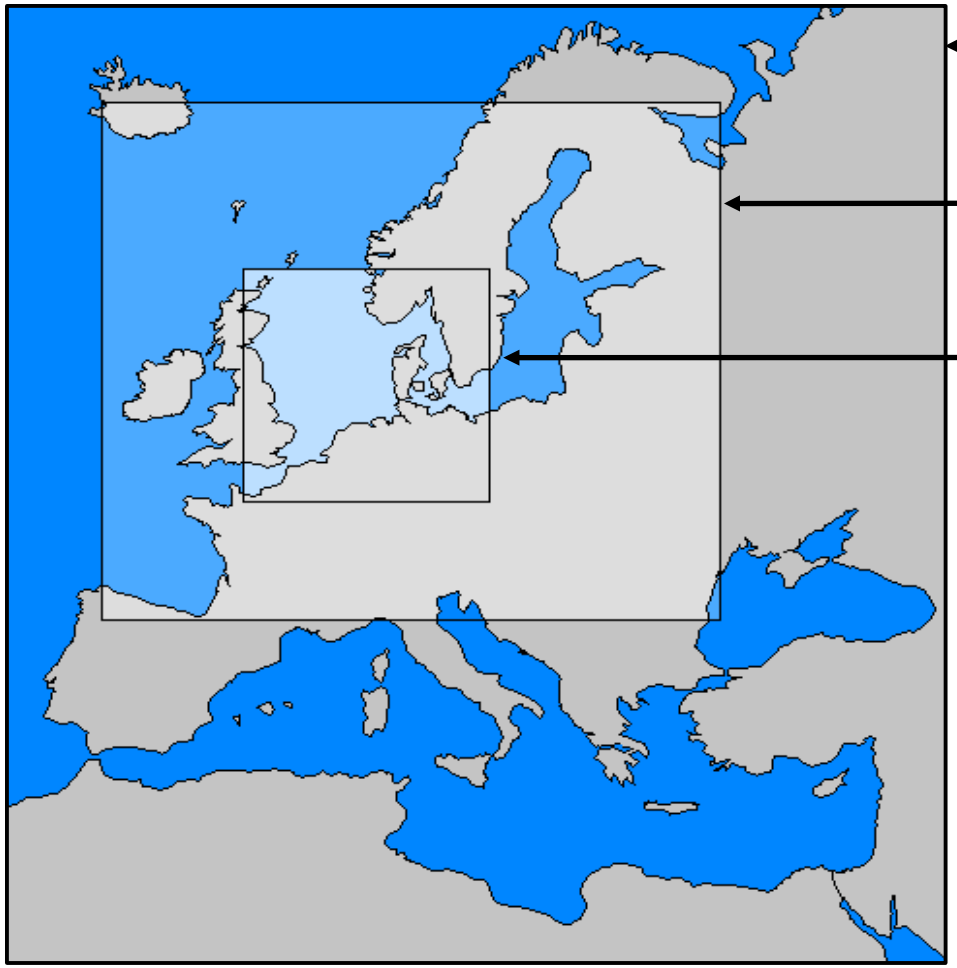
Model domain

CMAQ 5.0.1



72 km x 72 km

24 km x 24 km

6 km x 6 km

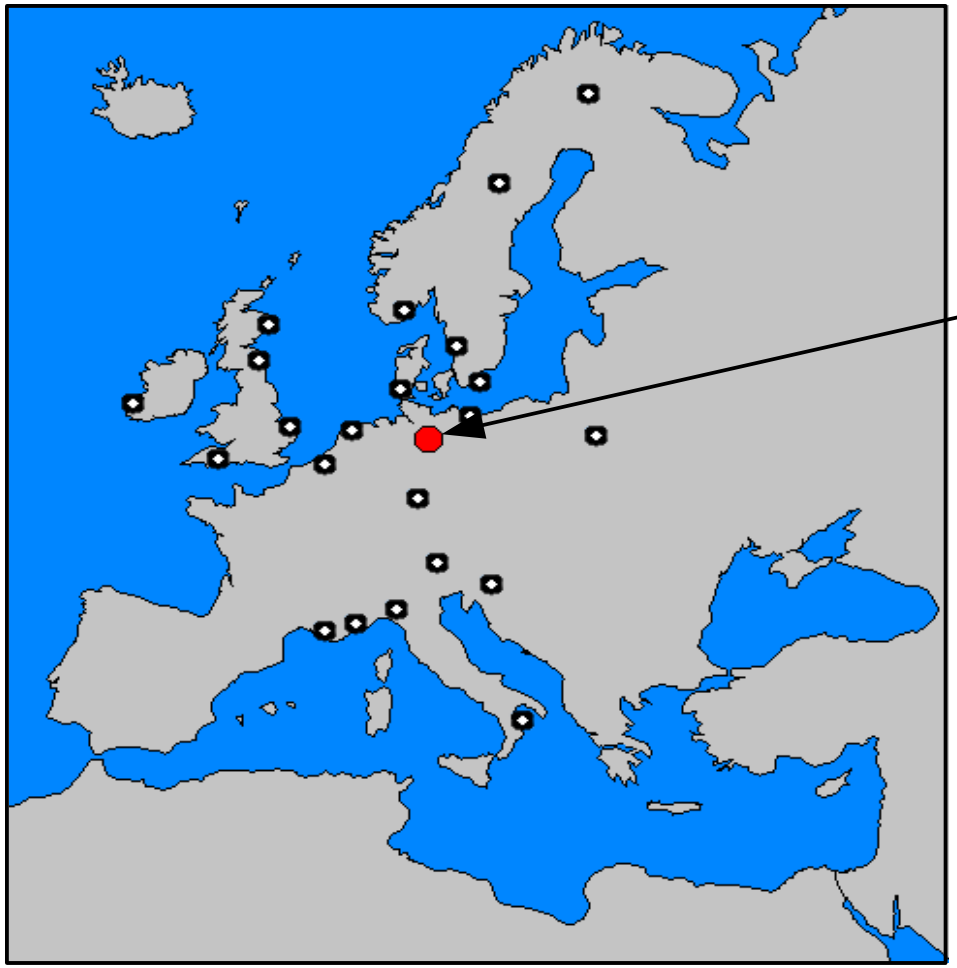
30 sigma layers up to 100 hPa

BC: GLEMOS, ECHMERIT

Meteorology: CCLM, WRF

Emissions: SMOKE-EU, AMAP

Measurement stations



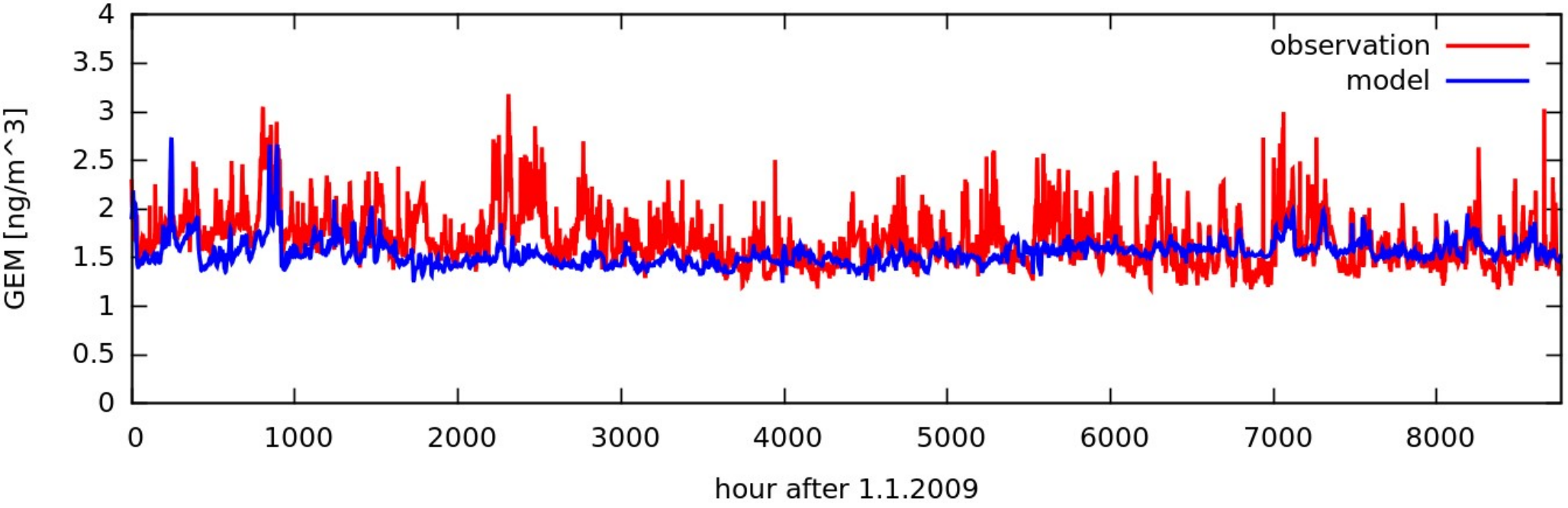
Station DE02: Waldhof (2009-present)

- hourly **GEM**
- 3 hourly **GOM** and **PBM**$_{PM2.5}$
- weekly **Hg** wet only deposition
- daily precipitation

Secondary parameters:

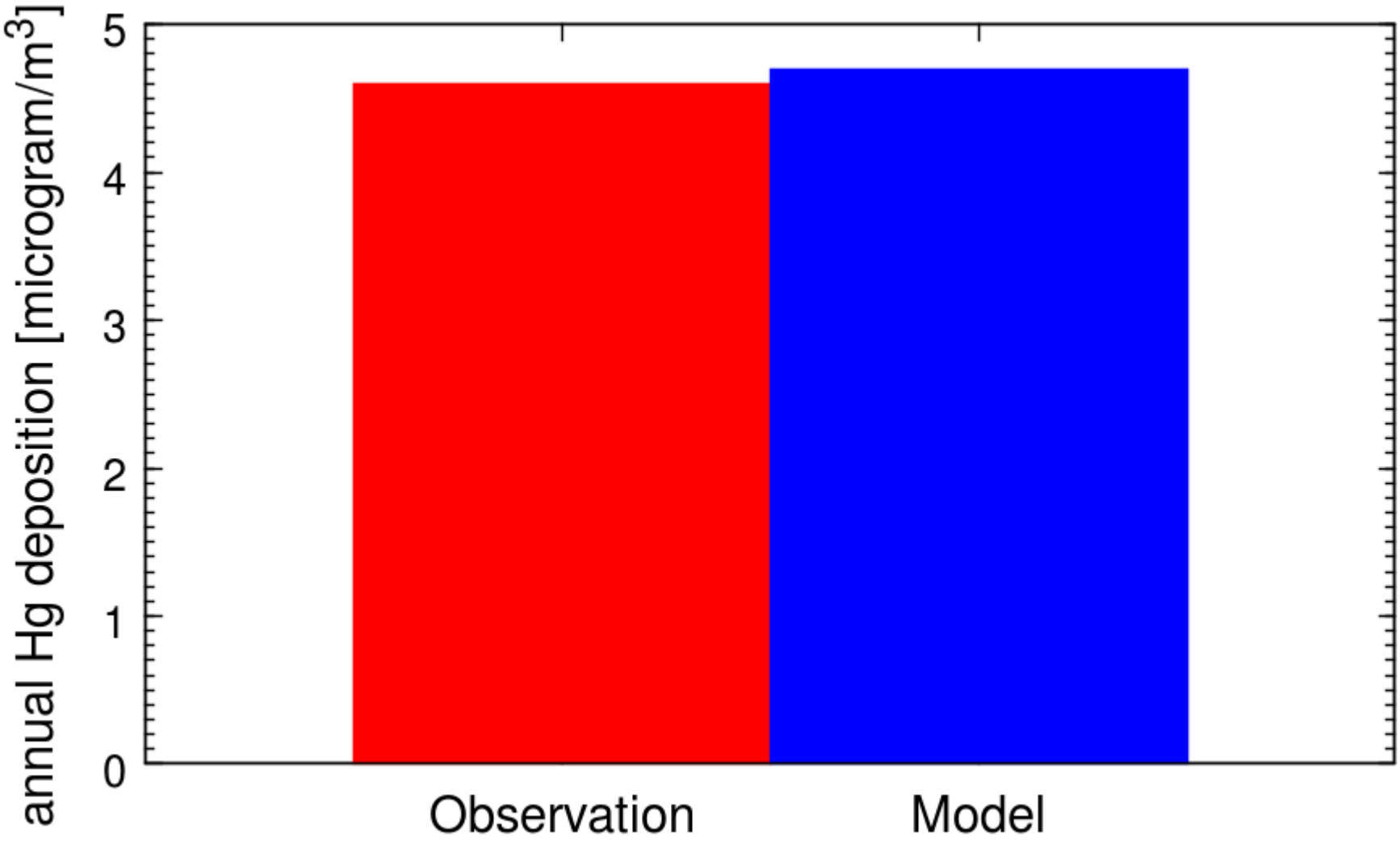
- ozone, SO_2, SO_4, NO_X, NO_3, NH_4, CO, PM2.5

GEM: Comparison to observations



MNB	MNE	R
-0.06	0.12	0.33

Annual mercury wet deposition at Waldhof



The End

Weekly mercury wet deposition at Waldhof

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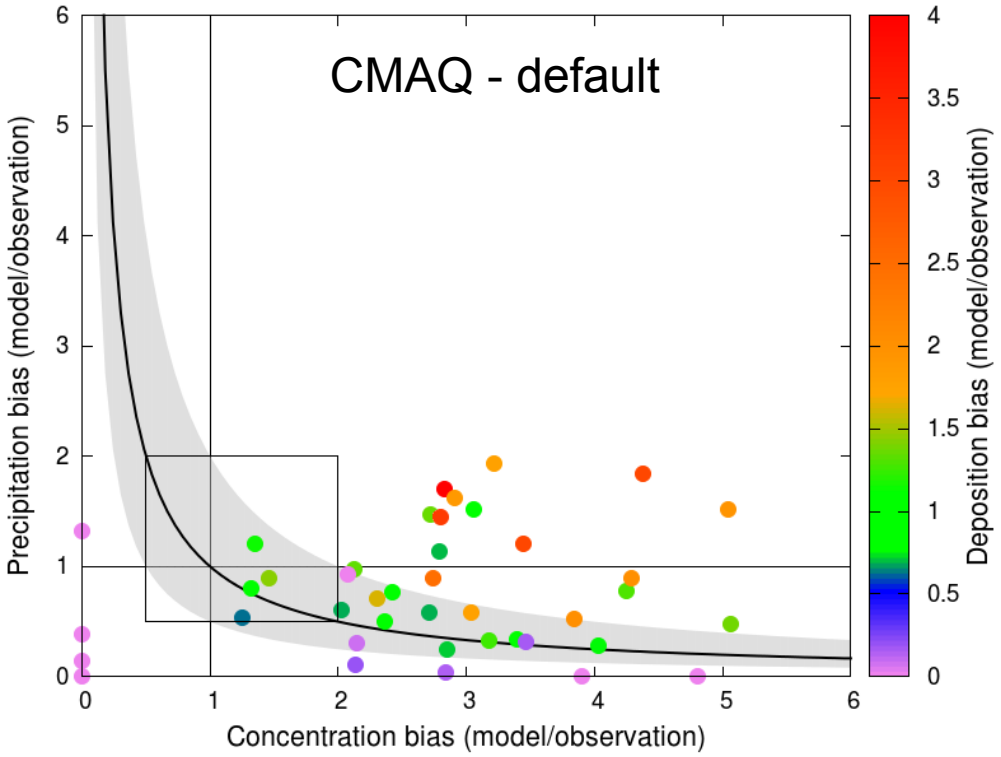
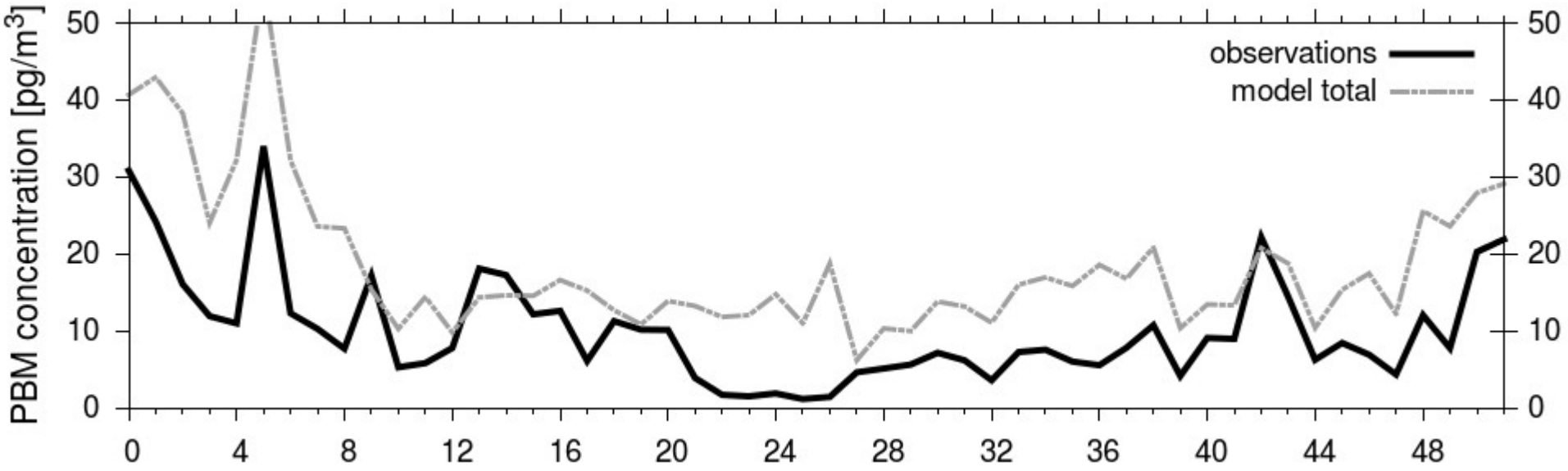


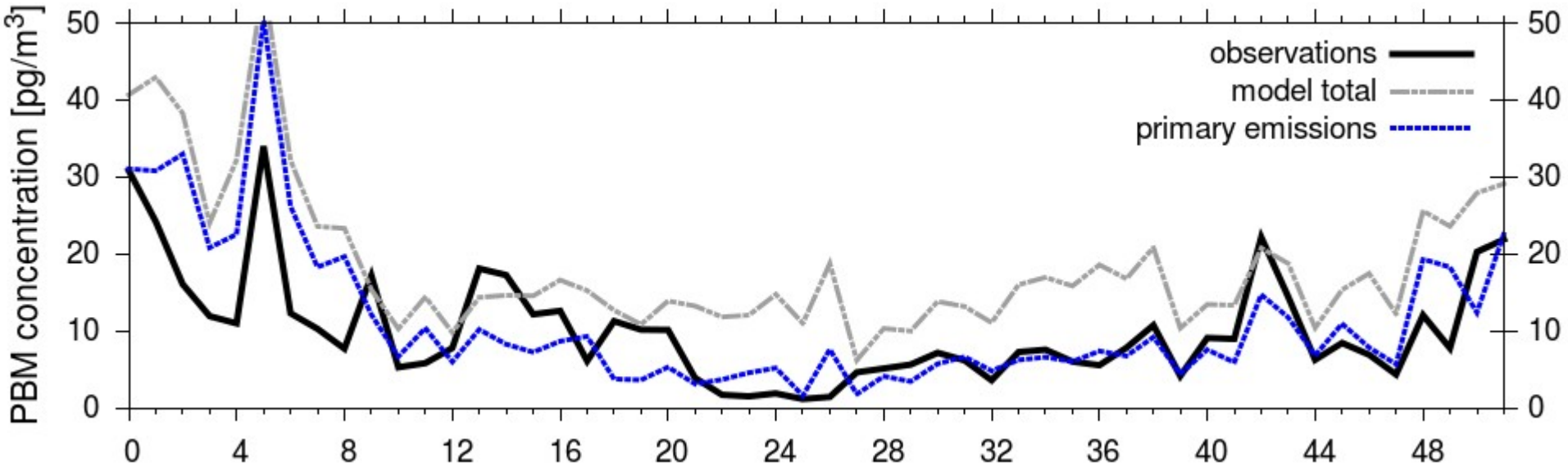
MNB = 0.4
MNE = 0.6
(4.7 µg/m²)

PBM: Comparison to observations



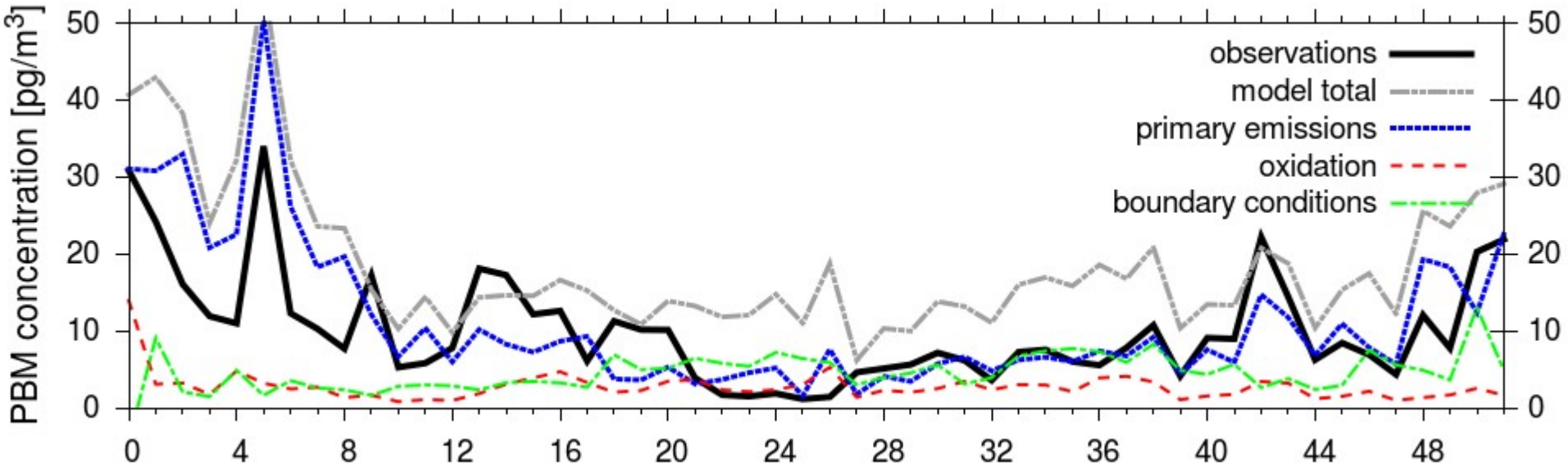
MNB	MNE	R
1.6	1.7	0.77

PBM: Sensitivity analysis



MNB		MNE		R	
0.3	1.6	0.6	1.7	0.77	0.77

PBM: Sensitivity analysis



MNB			MNE			R		
0.3	1.6	-0.5	0.6	1.7	0.7	0.77	0.77	0.21

PBM: Diurnal variability

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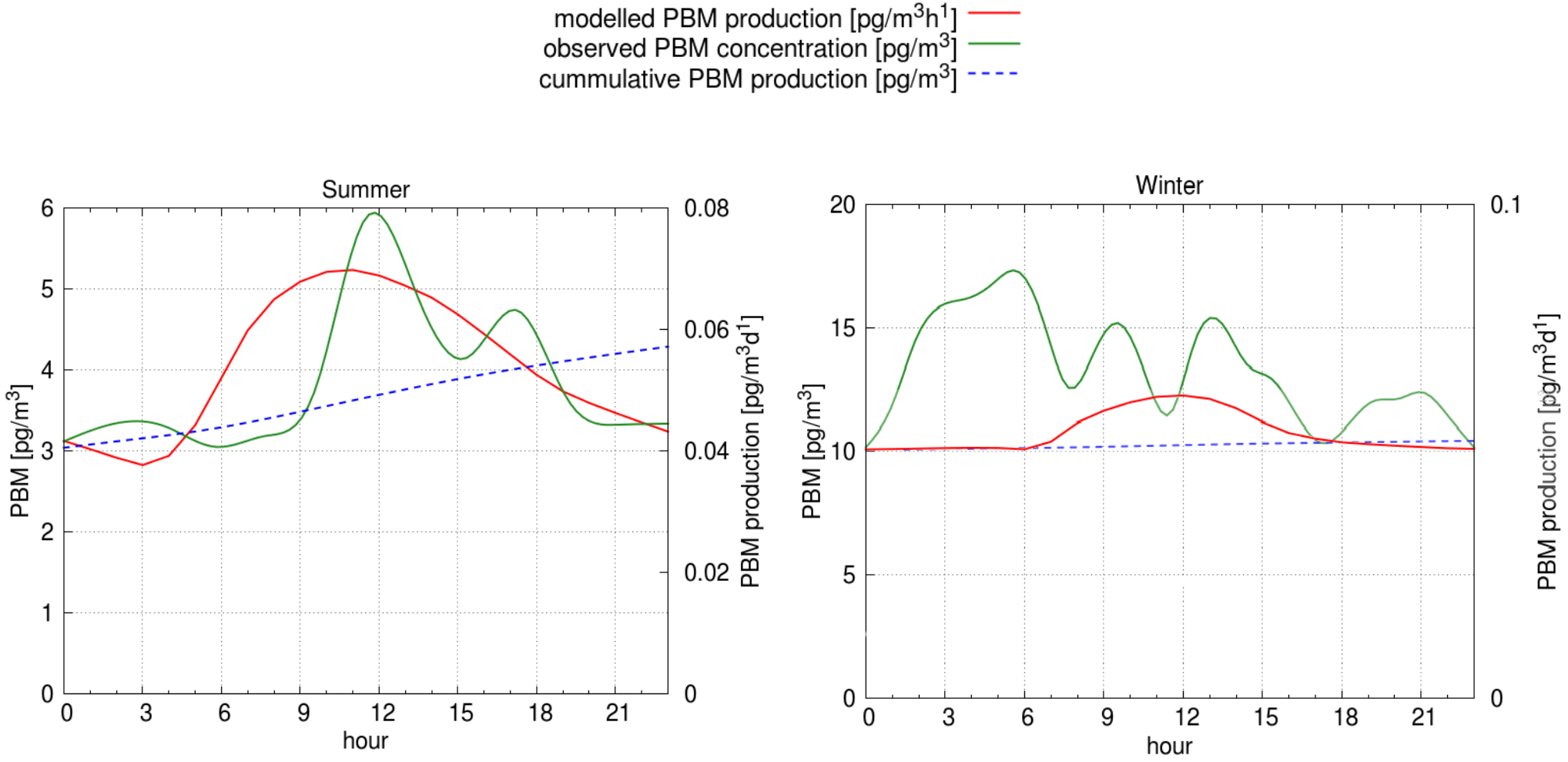


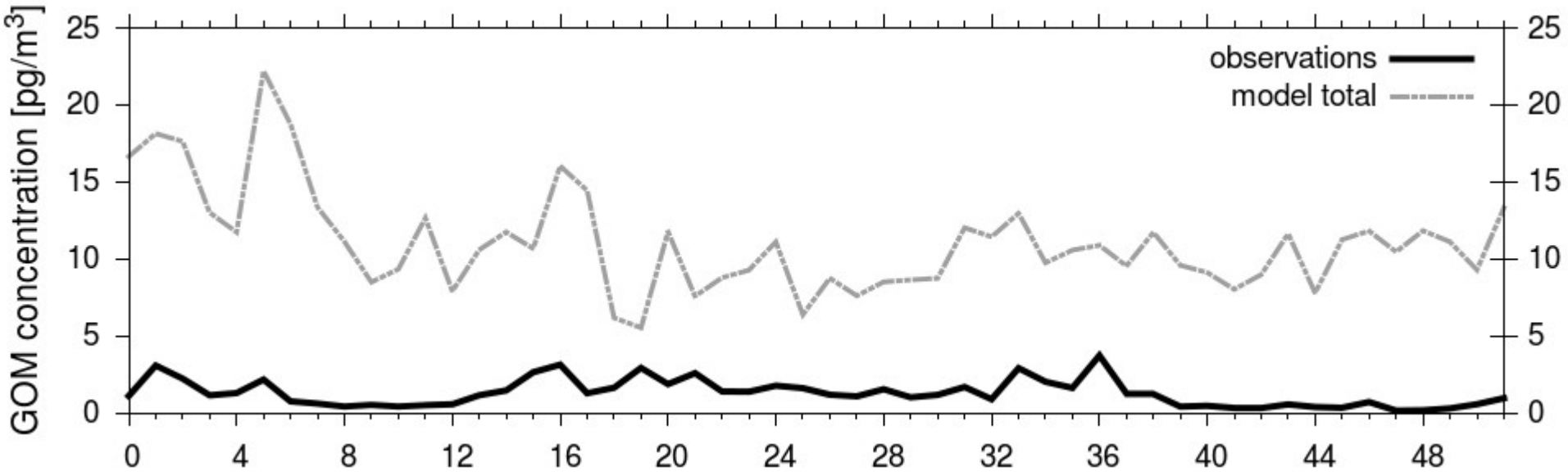
PBM: Conclusions

PBM concentrations can be explained by

- primary emissions
- particle conversion
- transport

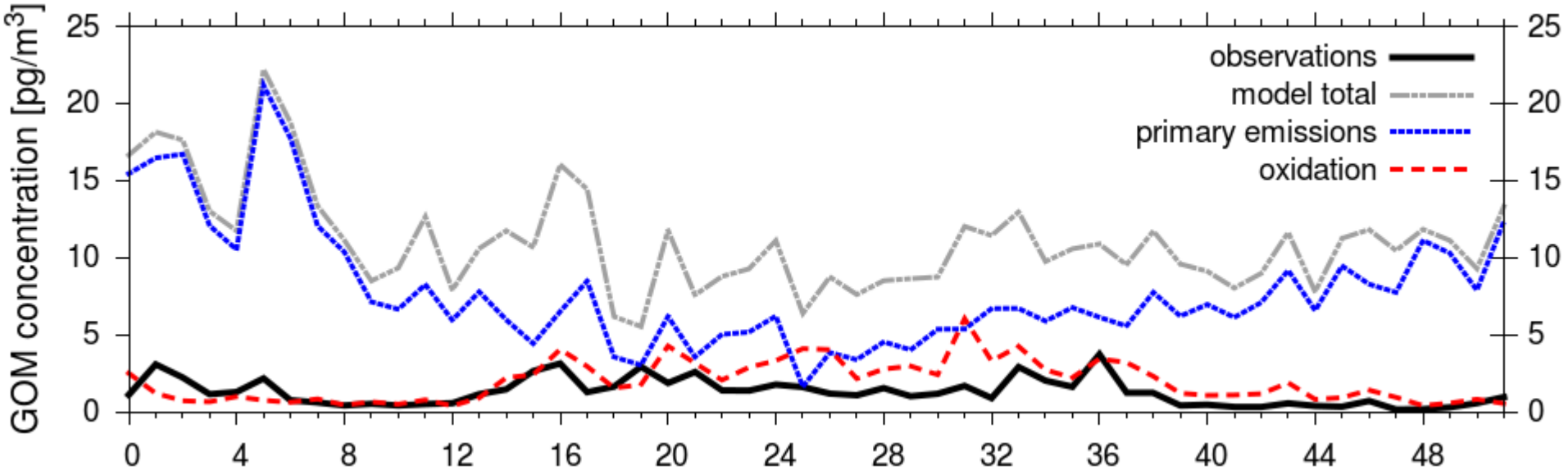
The annual and diurnal variability of PBM indicate that it is not directly produced by oxidation

GOM: Comparison to observations



MNB	MNE	R
14.0	14.0	0.2

GOM: Sensitivity runs



MNB	MNE	R
9.0	9.0	-0.1
14.0	14.0	0.2
0.9	1.0	0.54

PBM: Diurnal variability

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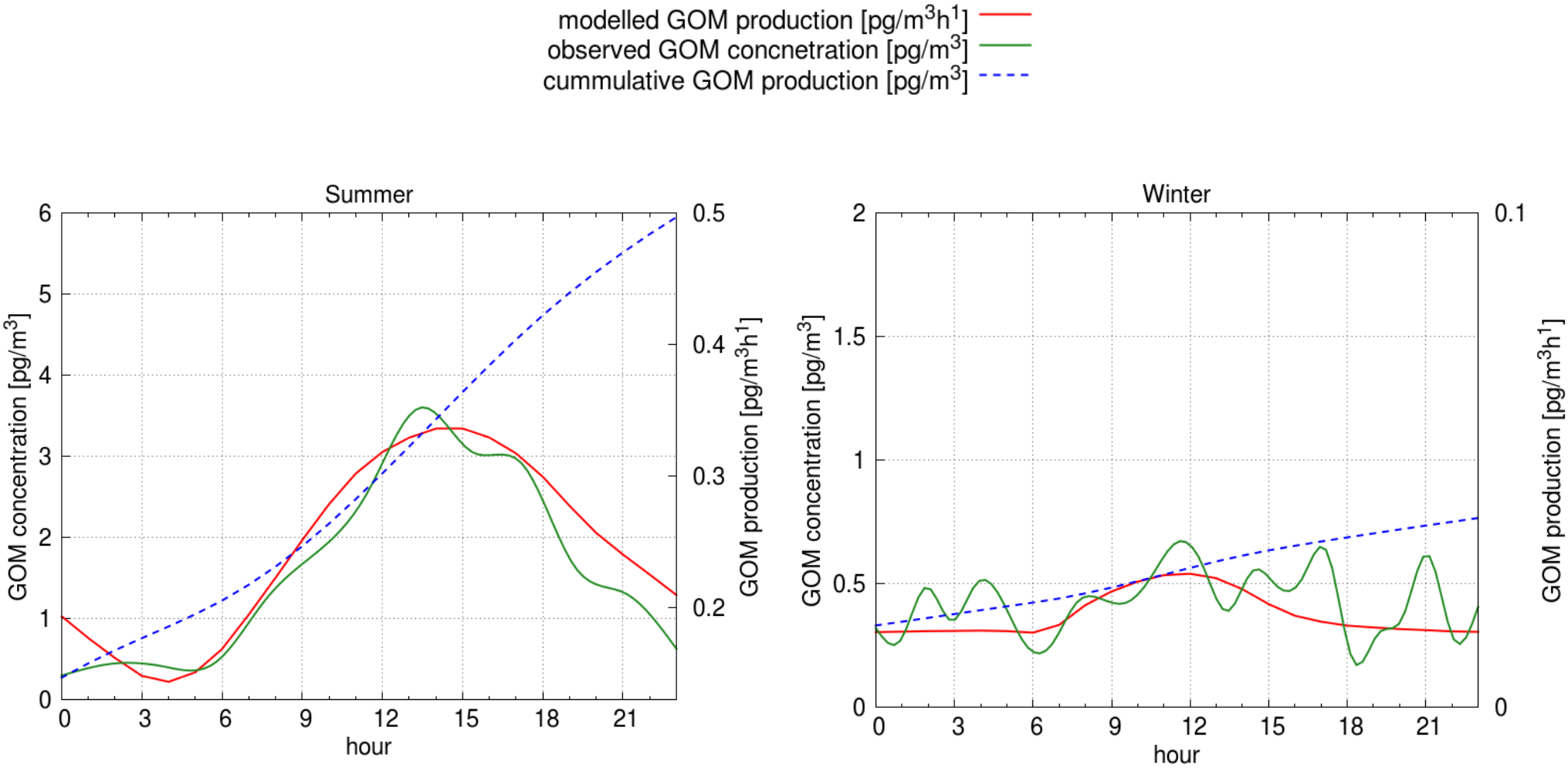
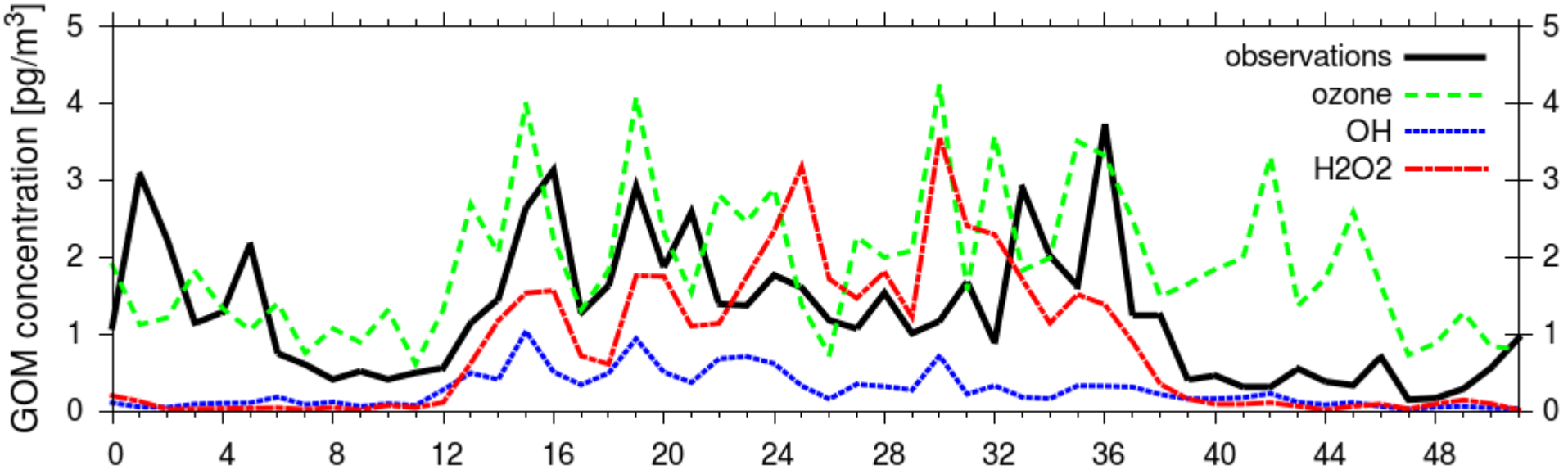
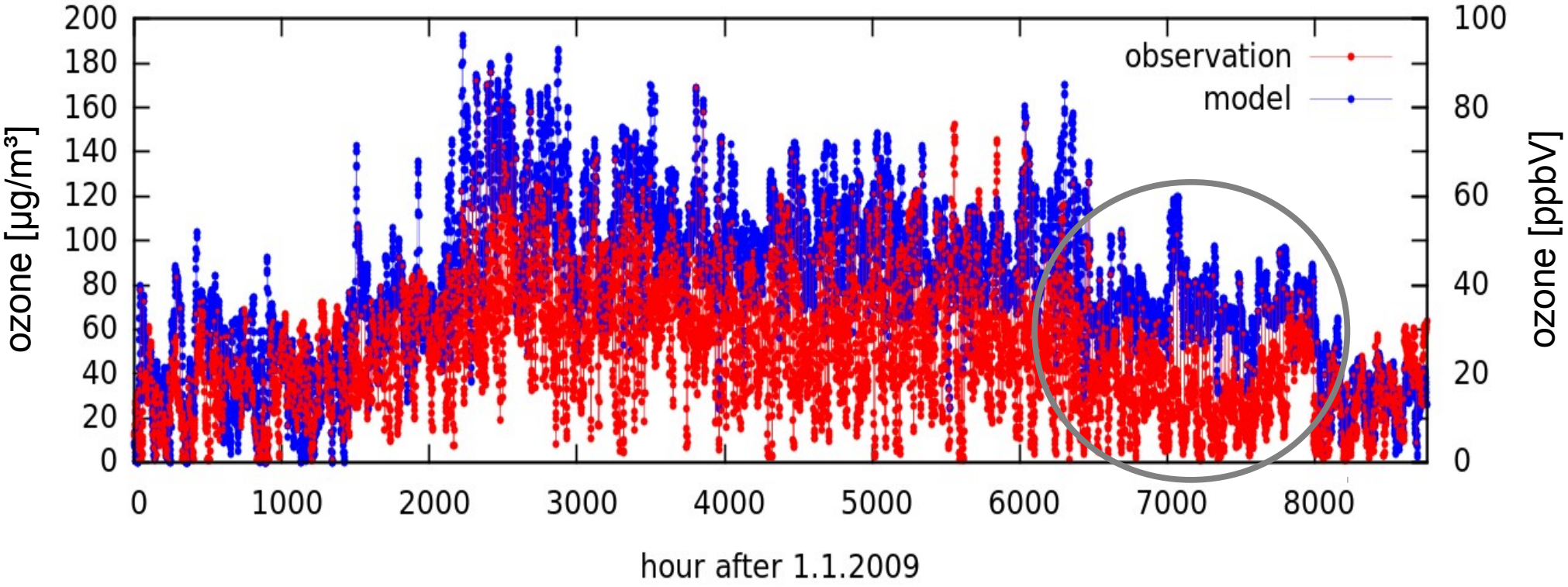


GOM: Different oxidants



MNB			MNE			R		
1.3	-0.8	-0.3	1.4	0.8	0.6	0.52	0.54	0.49

Ozone


ozone [µg/m³]
ozone [ppbV]
observation
model
hour after 1.1.2009
0
20
40
60
80
100
120
140
160
180
200
0
1000
2000
3000
4000
5000
6000
7000
8000

GOM: Conclusions

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The diurnal variability of GOM indicates that it is related to photochemistry

Production during summer could not be attributed to a certain reaction

Production of GOM during winter can be explained by ozone reaction

New Hg emission split: 89% GEM, 10% PBM, 1% GOM

Weekly mercury wet deposition at Waldhof

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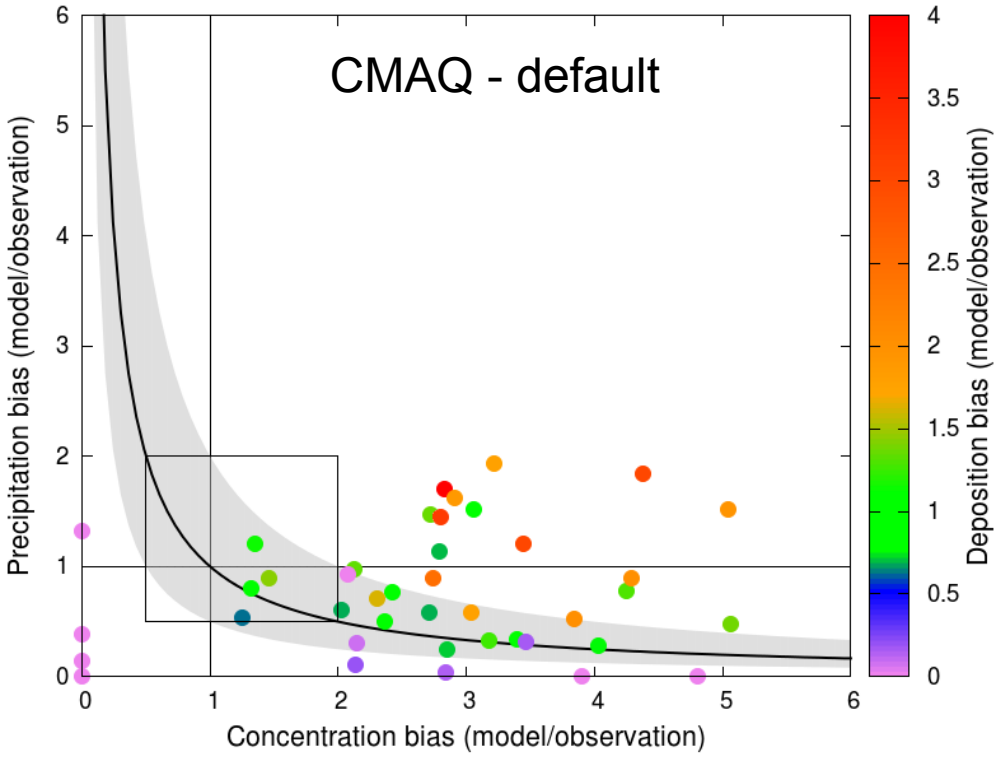
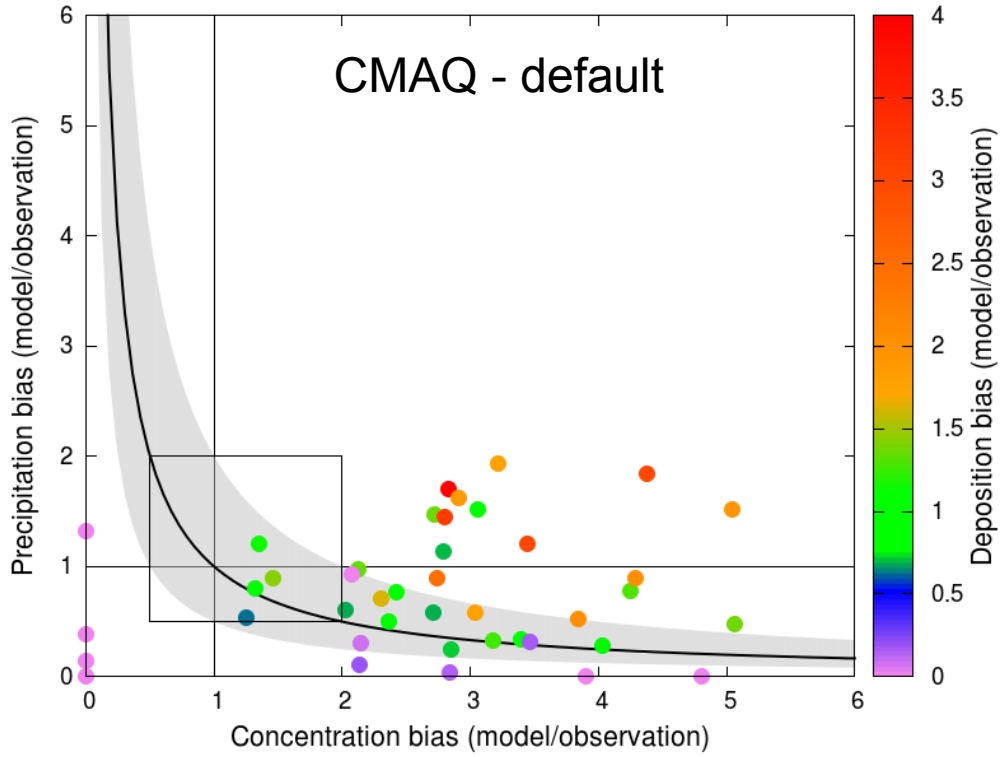
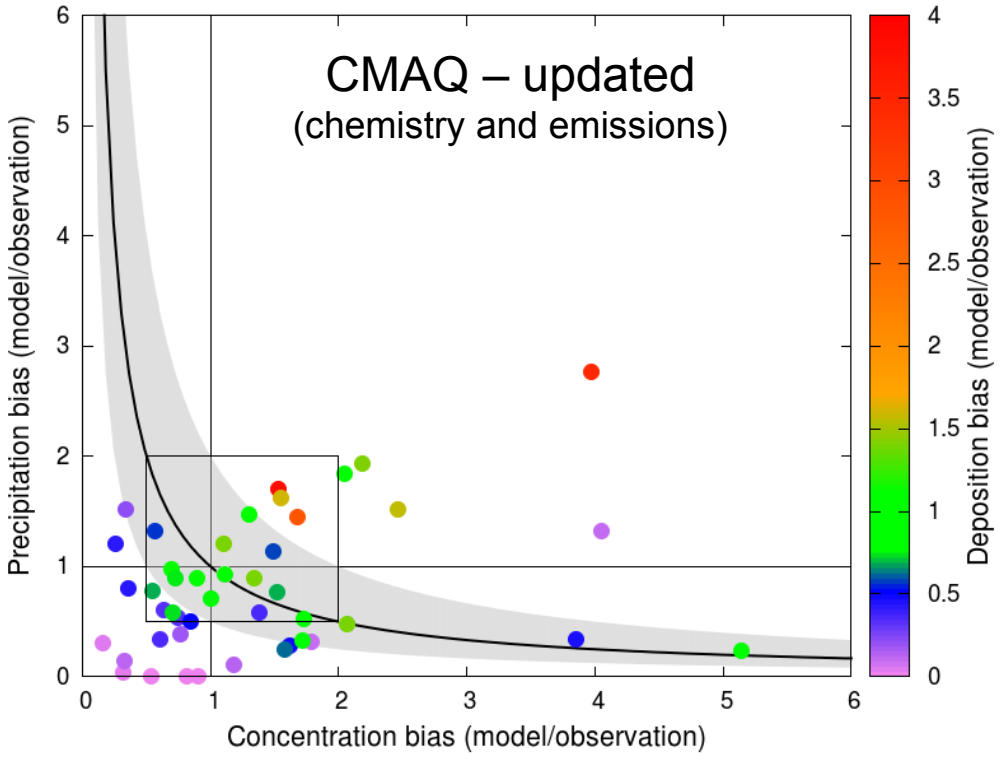


MNB = 0.4
MNE = 0.6
(4.7 µg/m²)

Sensitivity runs: Wet deposition



MNB = 0.4
MNE = 0.6
(4.7 µg/m²)



MNB = -0.01
MNE = 0.3
(3.2 µg/m²)

Sensitivity runs: mercury deposition

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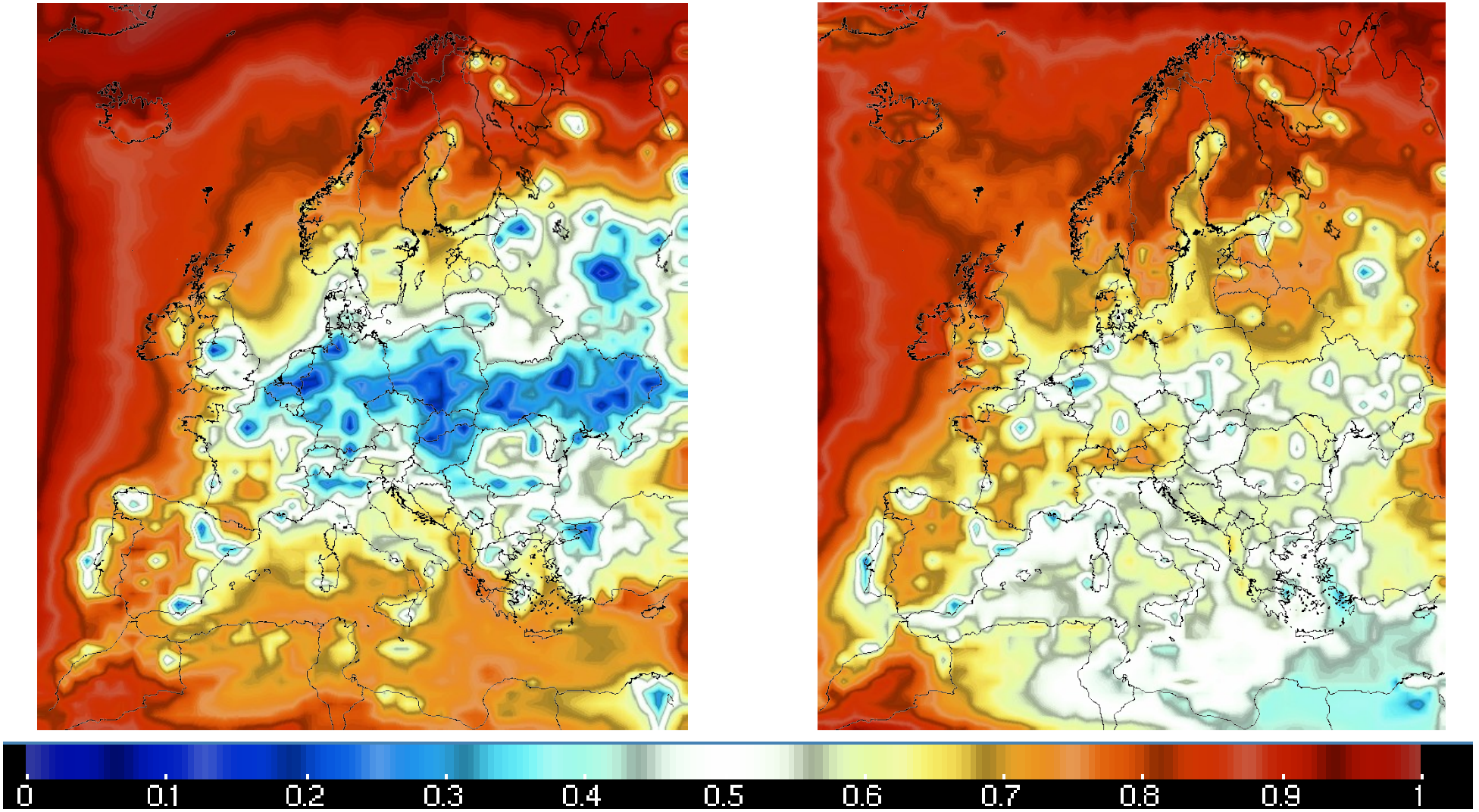
winter

summer



Vertical profiles (GEM)

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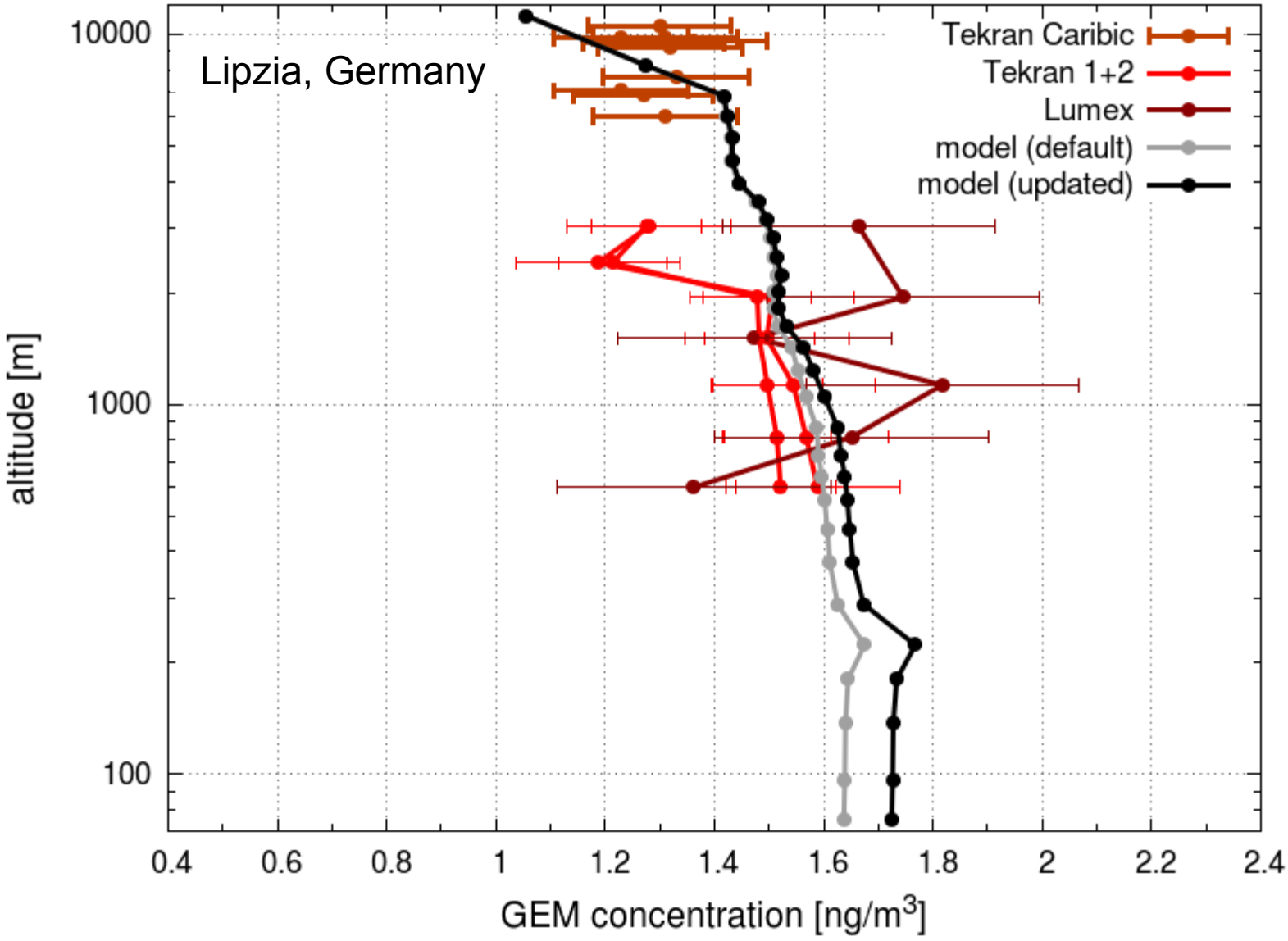

Vertical profiles (GEM)

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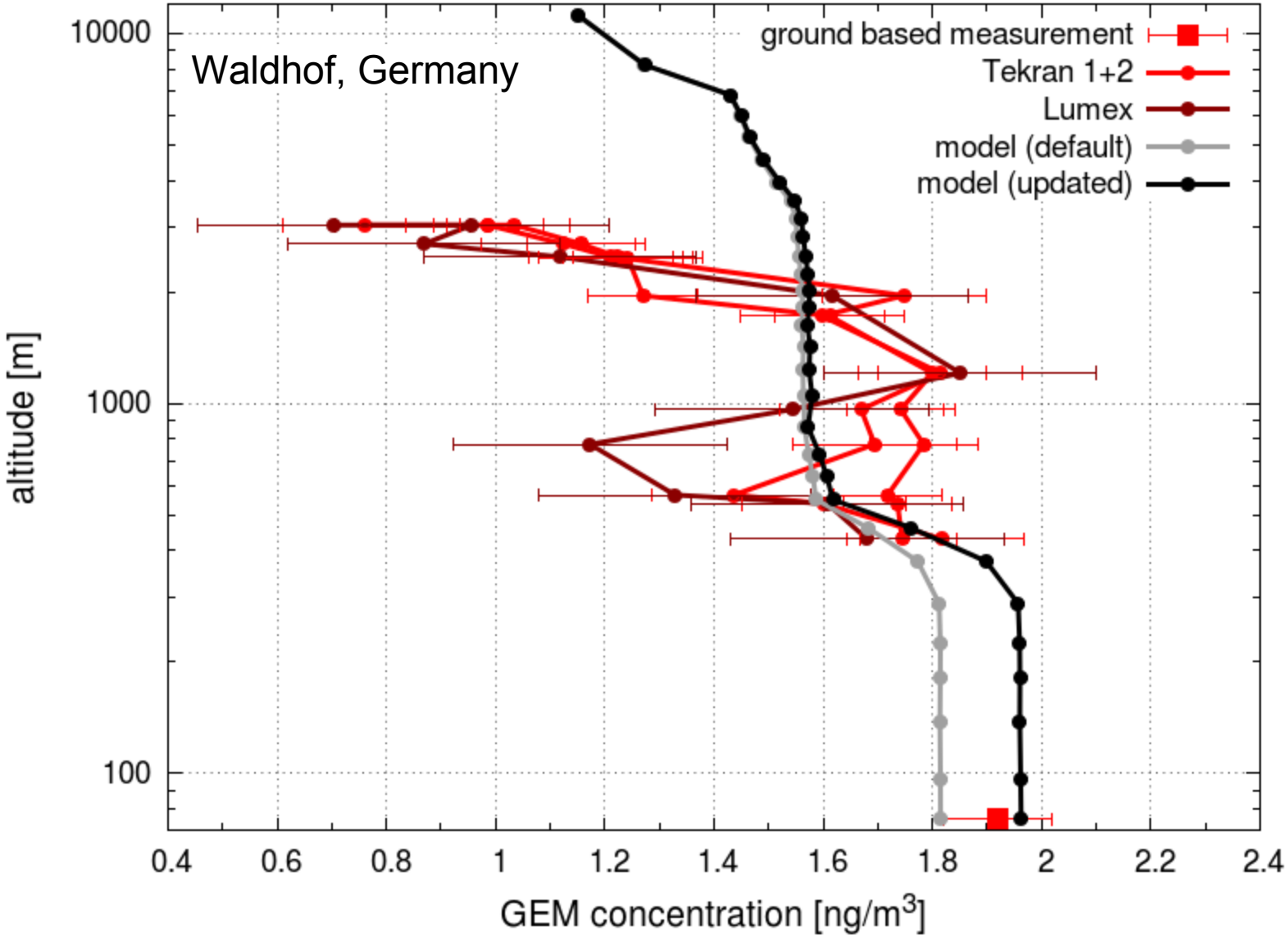

Vertical profiles (GOM)

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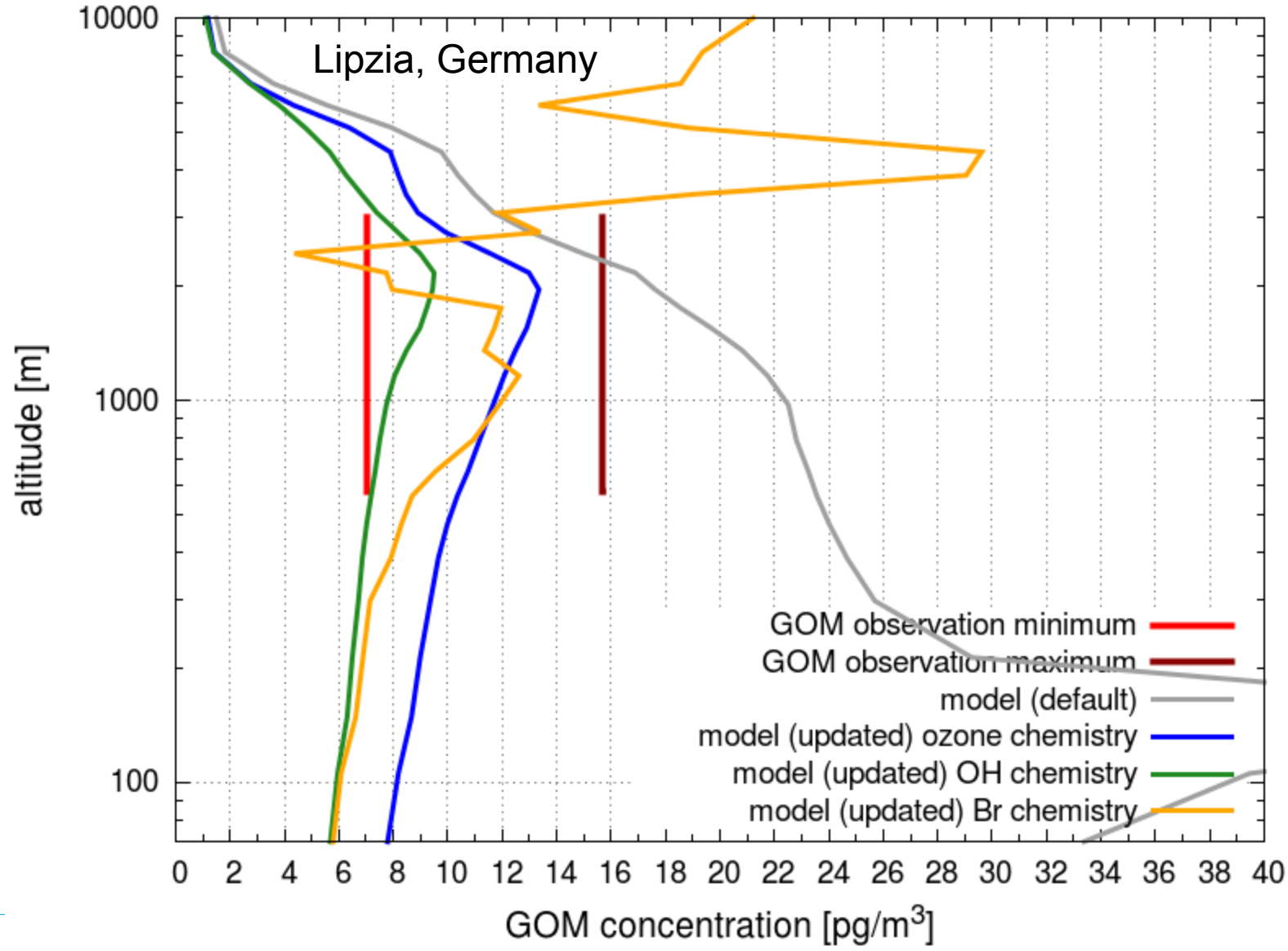

Vertical profiles (GOM)

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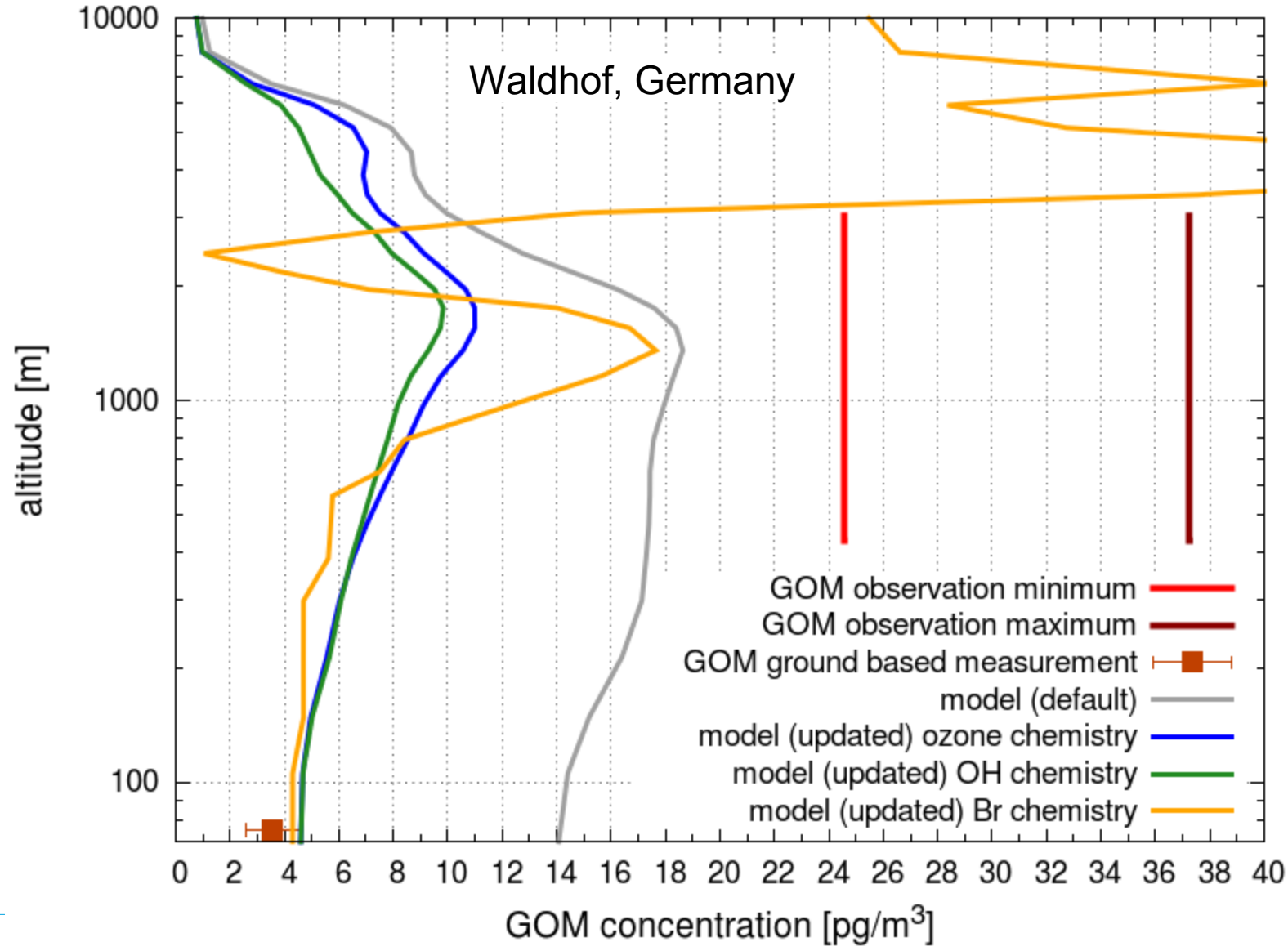
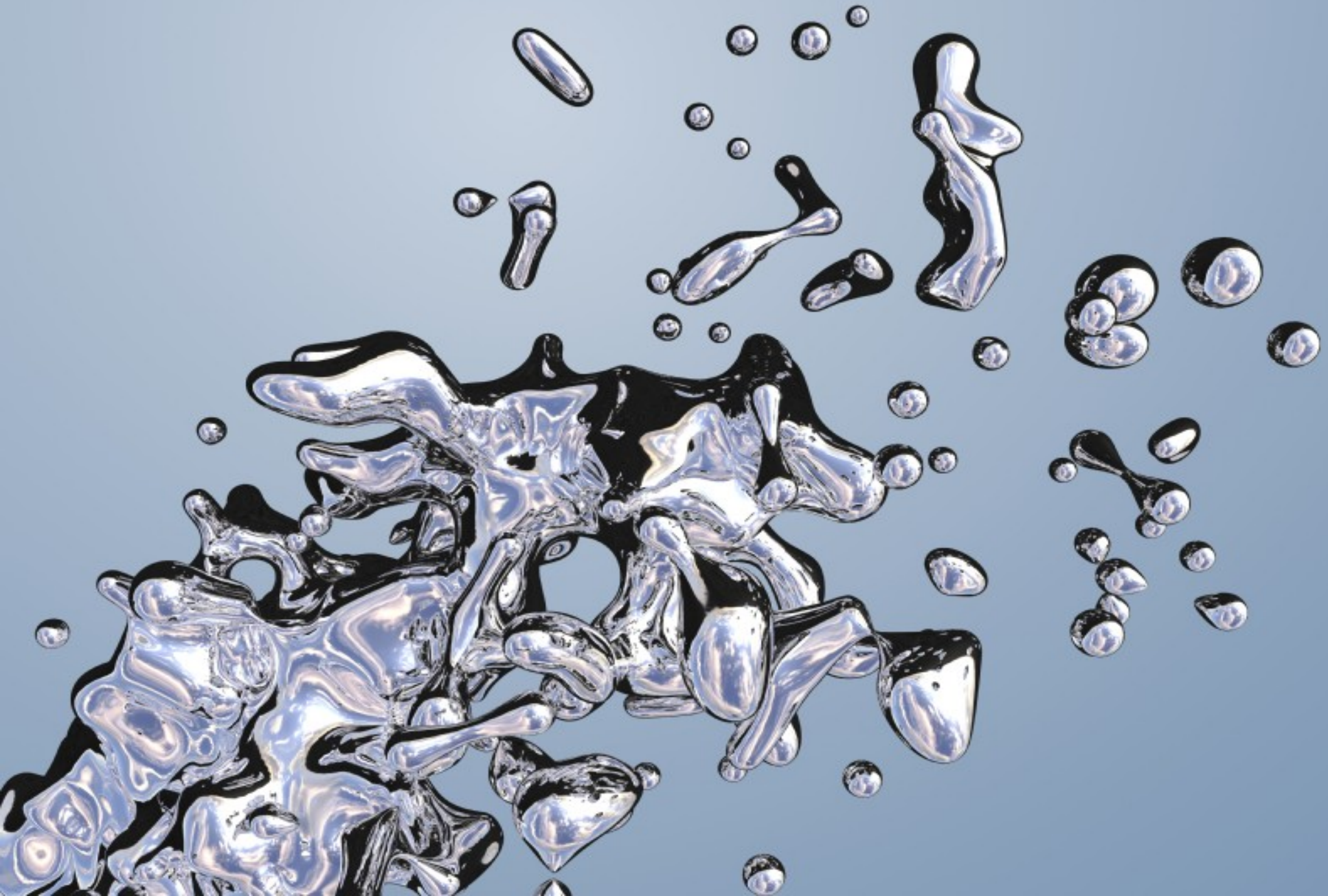


Conclusions & Outlook

- New insights into mechanics of PBM and GOM formation
- Improvement of emission speciation
- Additional measurements will be available soon and allow to scrutinize these assumptions
- Analysis of additional air craft based observations
- Implementation of bromine emission and chemistry
- Additional regions (e.g.: asia, tropics, southern hemisphere)



Concentrations with default mechanism

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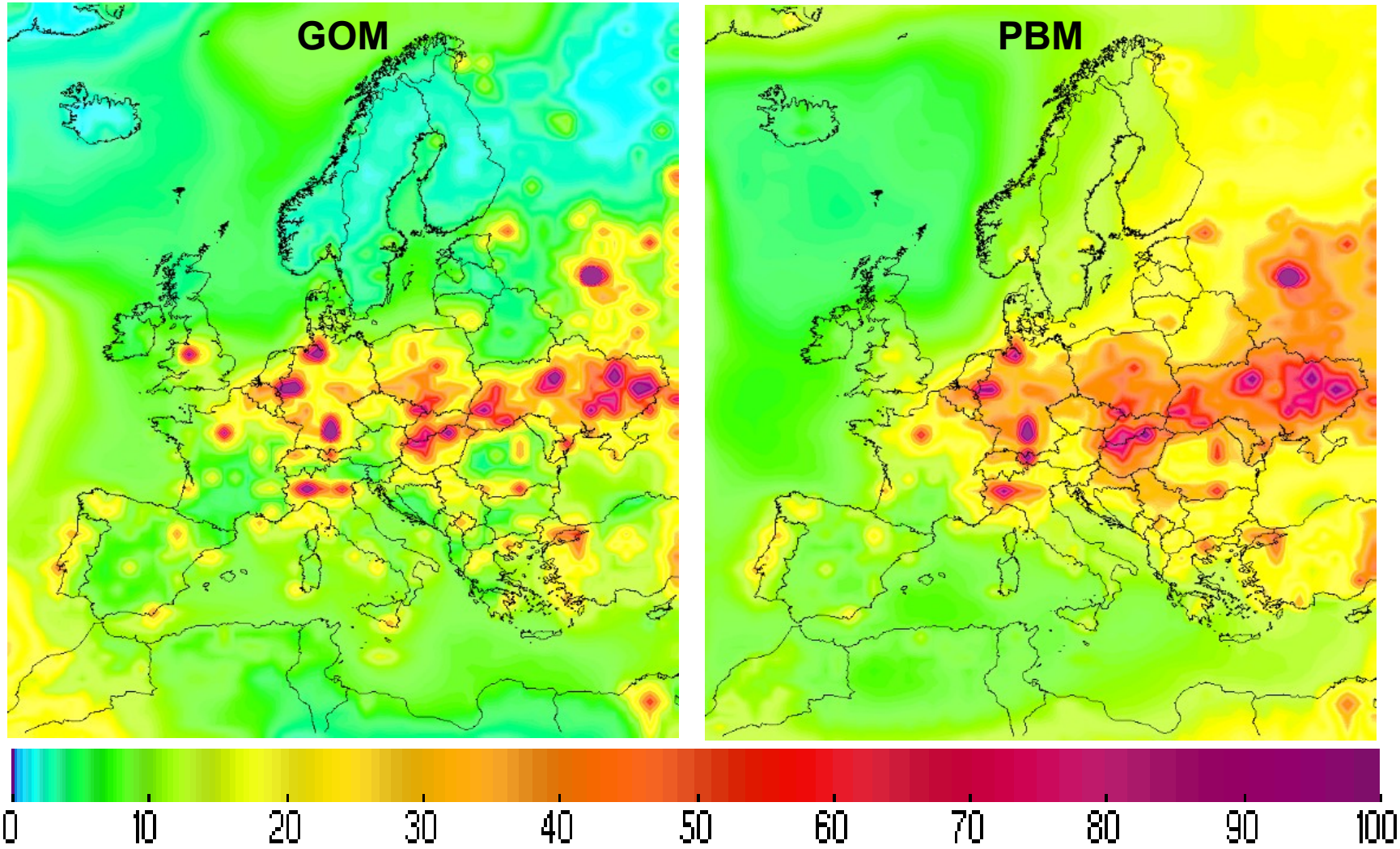

Frequency distribution of precipitation at Waldhof

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