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Aerosol Modelling with CAMx4 and PMCAMx

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Outline

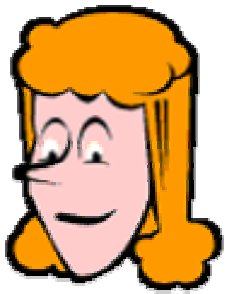
- aim of this study
- overview of CAMx4 and PMCAMx
- application 1 : Northern Italy, 1998
- application 2 : Switzerland, 2003
- conclusions

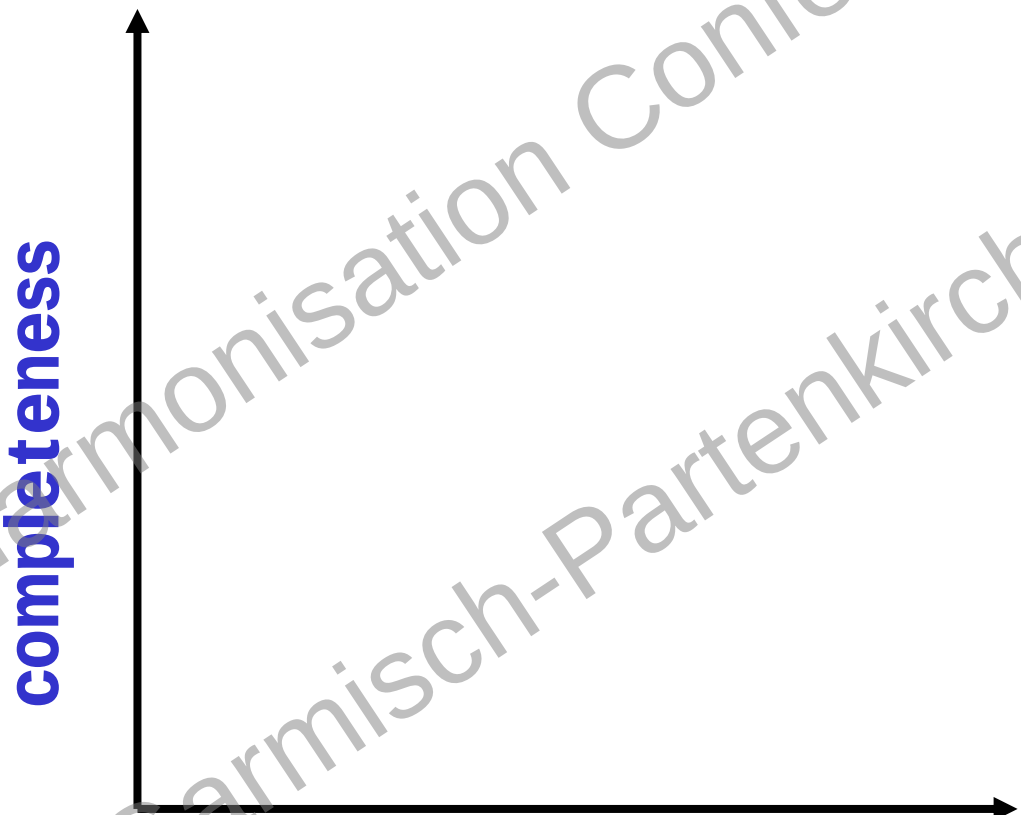
Aerosol Modelling

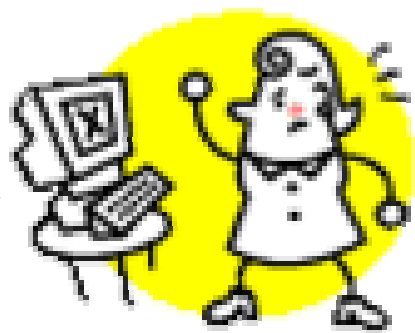
most of air quality models include aerosols with different complexity

- aerosol dynamics
- particle size distribution
  - fine/coarse
  - modal
  - sectional
- inorganic aerosols
- SOA formation
- aqueous chemistry

Aerosol Models







Question

How much complexity is really needed in our three-dimensional air quality modelling studies?

Comparison of CAMx Models

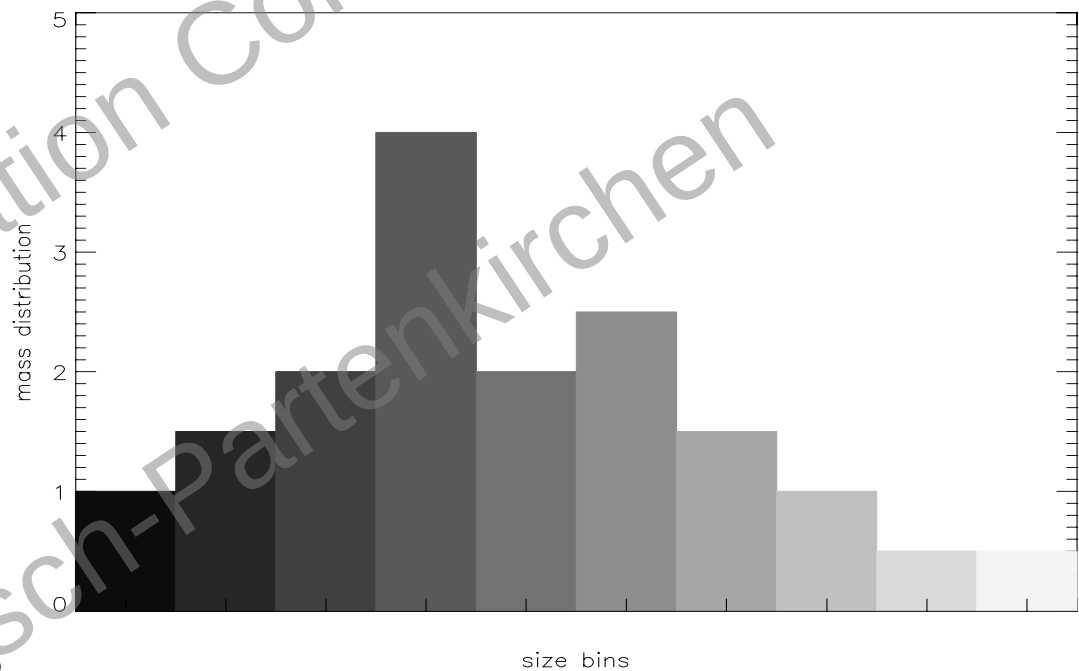
	CAMx4	PMCAMx
approach	one-atmosphere	full-science PM model
gas-phase	CBM-IV/SAPRC99	CBM-IV/SAPRC99
inor. aerosols	ISORROPIA	ISORROPIA
org. aerosols	SOAP	SOAP
aq. chemistry	RADM-AQ	VSRM
particle size	fine/coarse	10-sectional
cpu time rel.	1	3

Size distribution

CAMx4

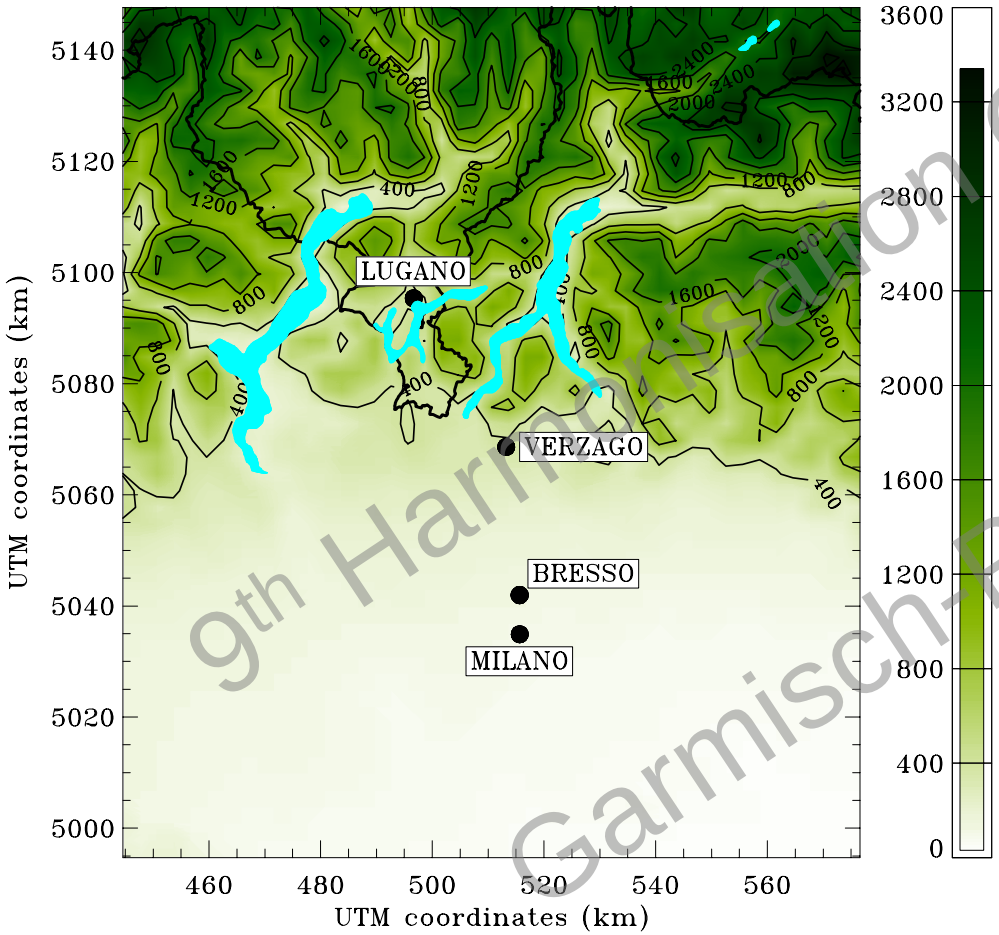
- primary PM coarse and/or fine
  - crustal
  - EC and OC
  - sea salt
  - other primary
- secondary PM is fine
  - NH_4, NO_3, SO_4
  - anthropogenic organics (SOA1, SOA2, SOA3)
  - biogenic organics (SOA4)

PMCAMx



10 size bins = 0.04-40 μm

Application 1, northern Italy



May 11-13,1998

CAMx4, PM2.5

PMCAMx, 10 sections

3km x 3km

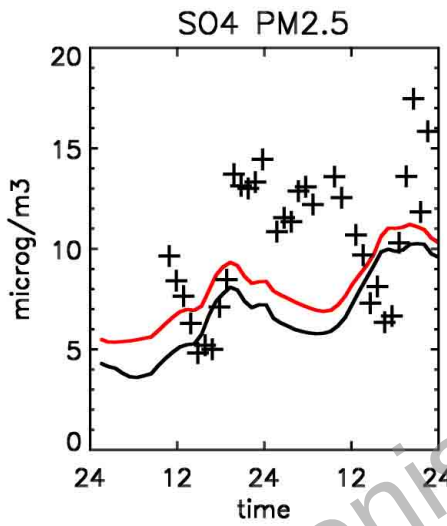
8 layers

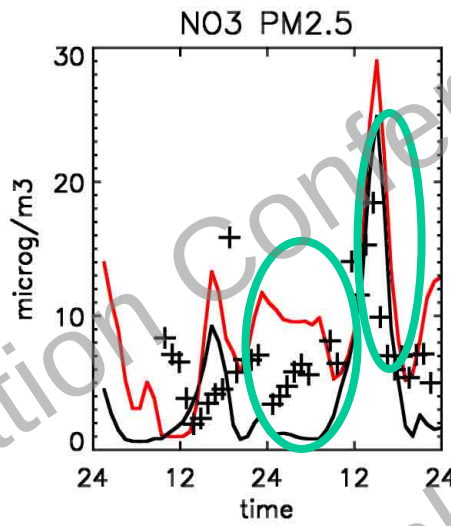
SAIMM meteo-model

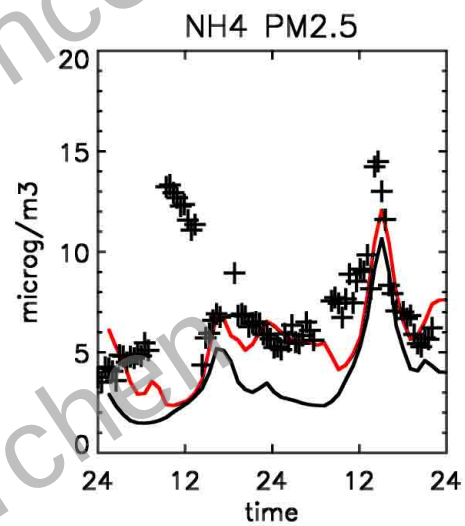
Andreani-Aksoyoglu et al., JGR, 109,2004

Inorganic aerosols

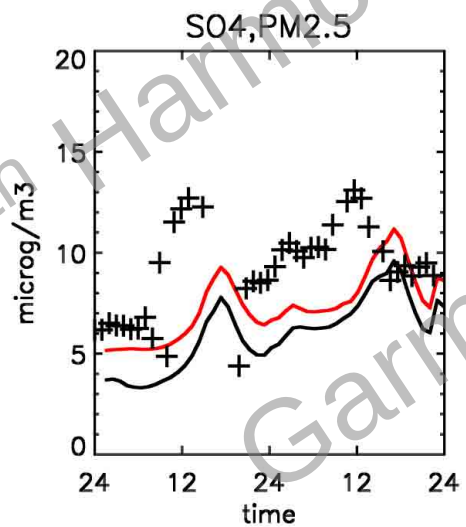
Verzago (rural)

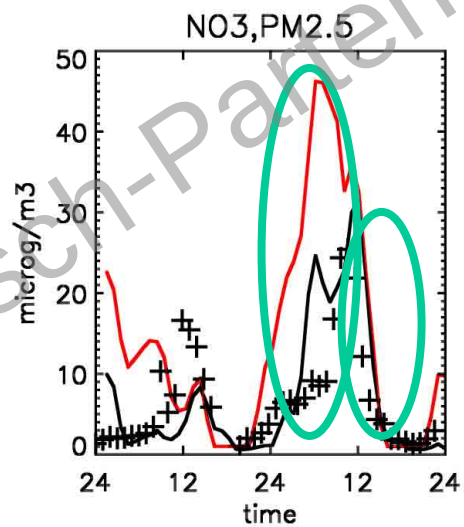


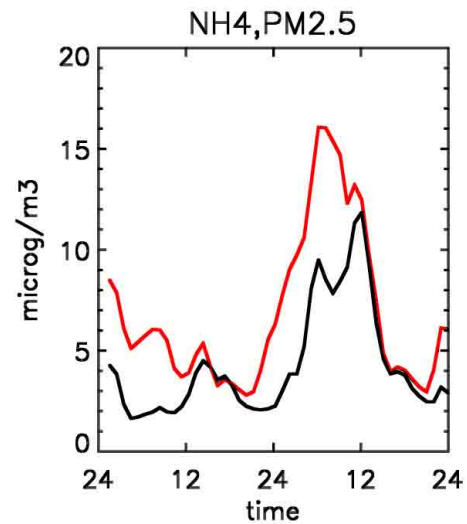




Bresso (urban)



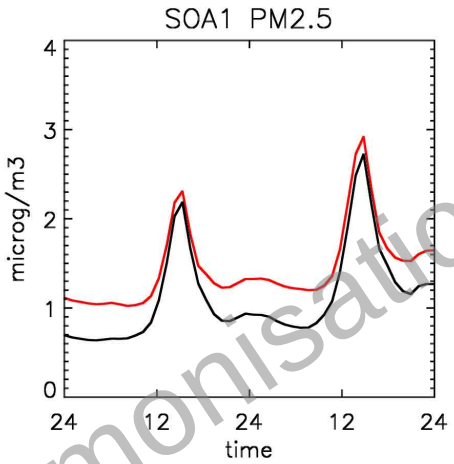


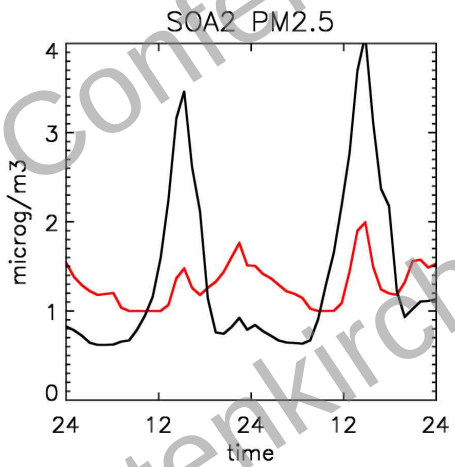


+++ measurements ____ CAMx4 ____ PMCAMx

Organic aerosols
Verzago

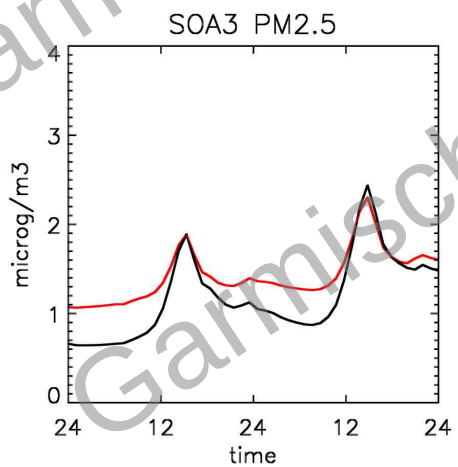
SOA1 precursors
TOL, XYL

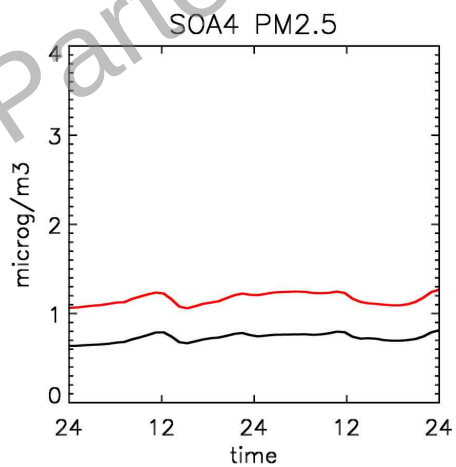




SOA2 precursors
TOL, XYL

SOA3 precursors
PAR,OLE,CRES

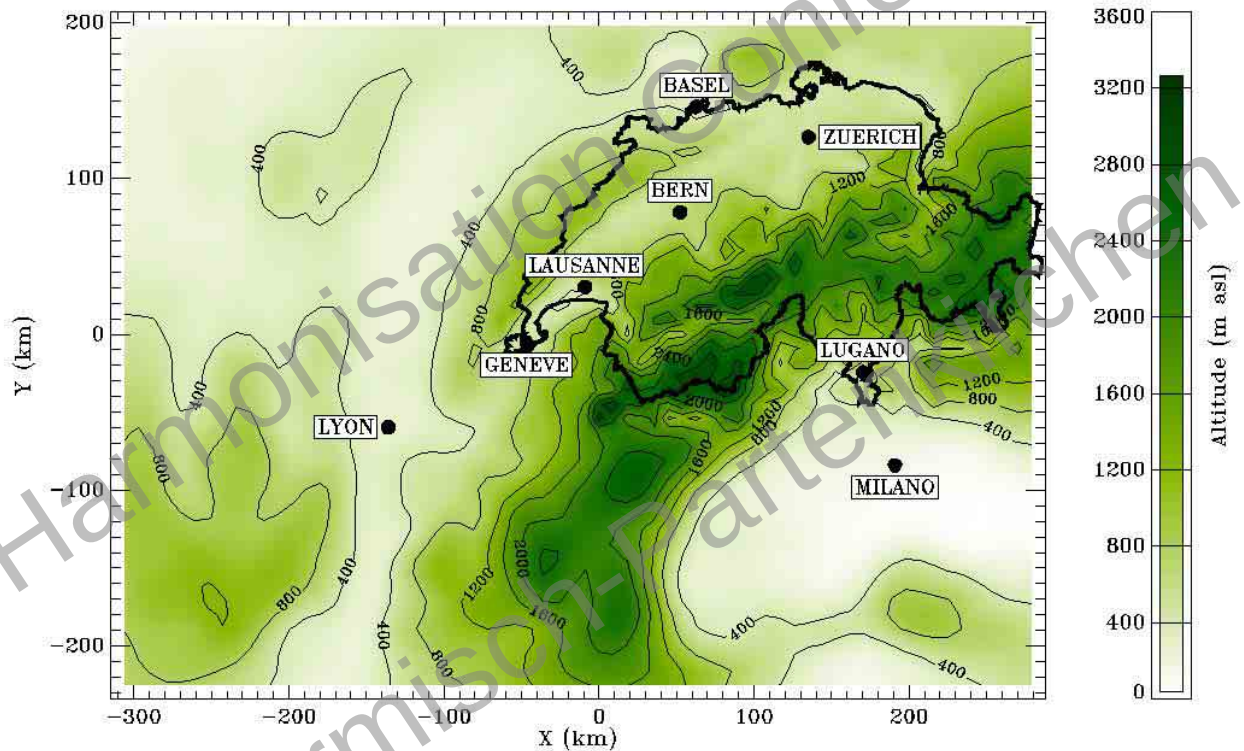




SOA4 precursors
monoterpenes

CAMx4 **PMCAMx**

Application 2, Switzerland



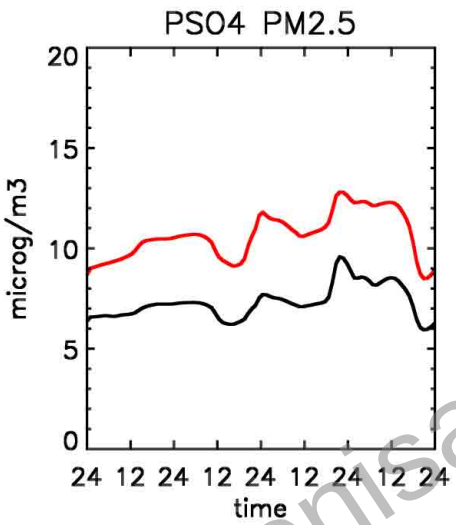
August 4-7, 2003

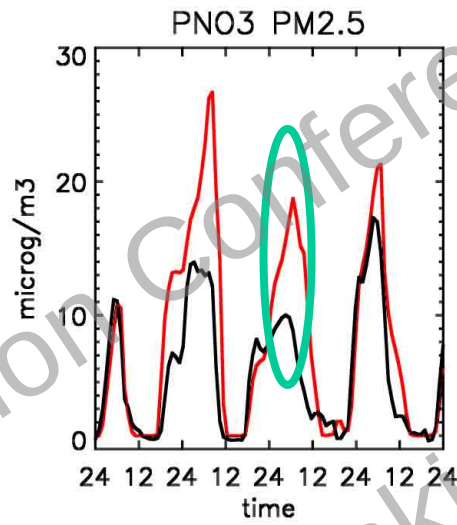
CAMx4, PM2.5 **PMCAMx 10 sections**

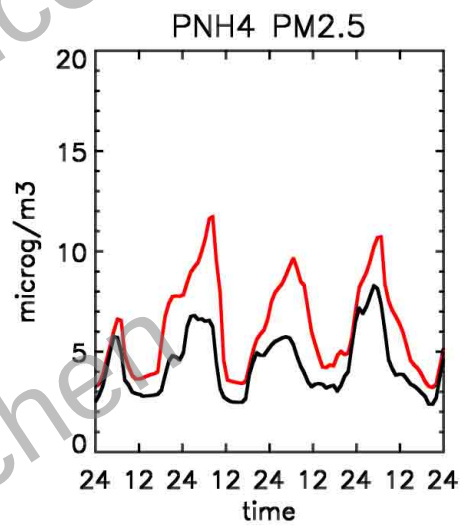
9km x 9km, 10 layers, MM5 meteorological model

Inorganic aerosols

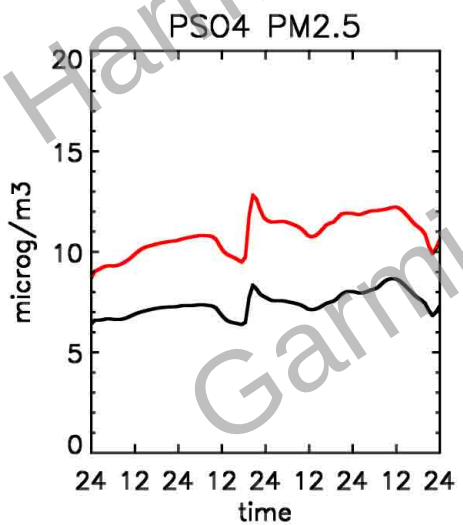
Taenikon (rural)

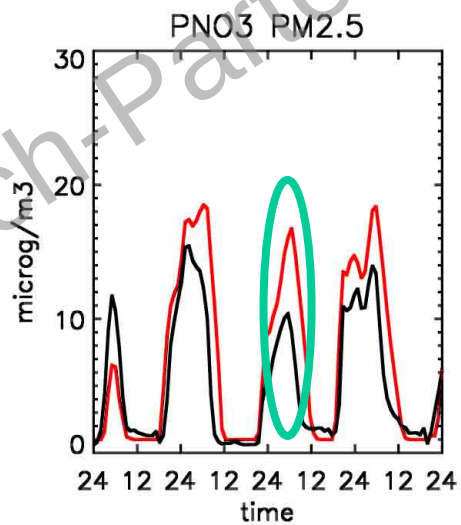


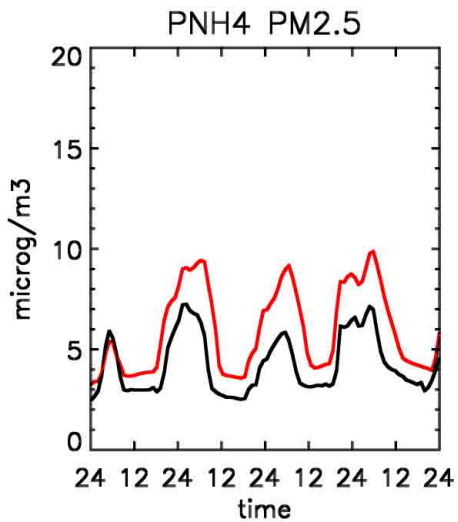




Zurich (urban)



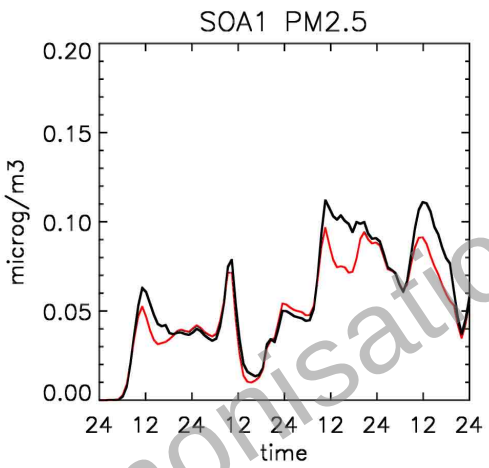


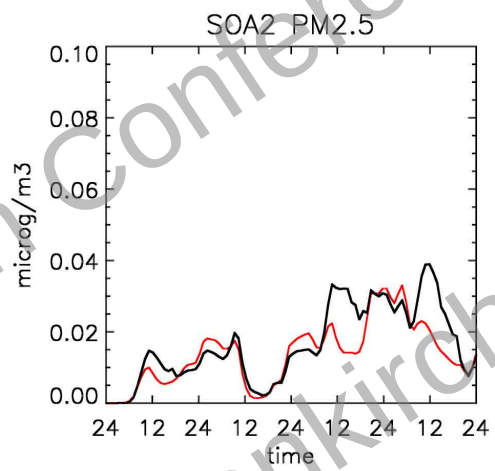


_____ CAMx4 _____ PMCAMx

Zurich, August 4-7, 2003

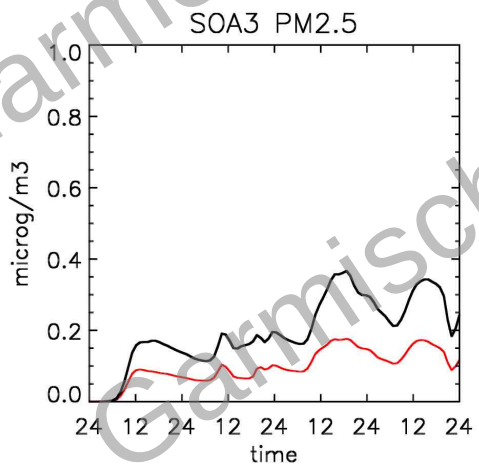
precursors
TOL, XYL

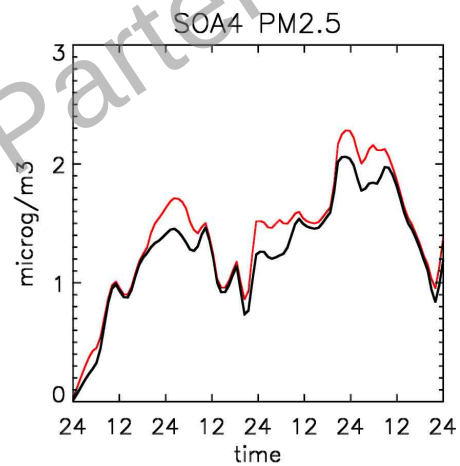




precursors
TOL, XYL

precursors
PAR,OLE,CRES

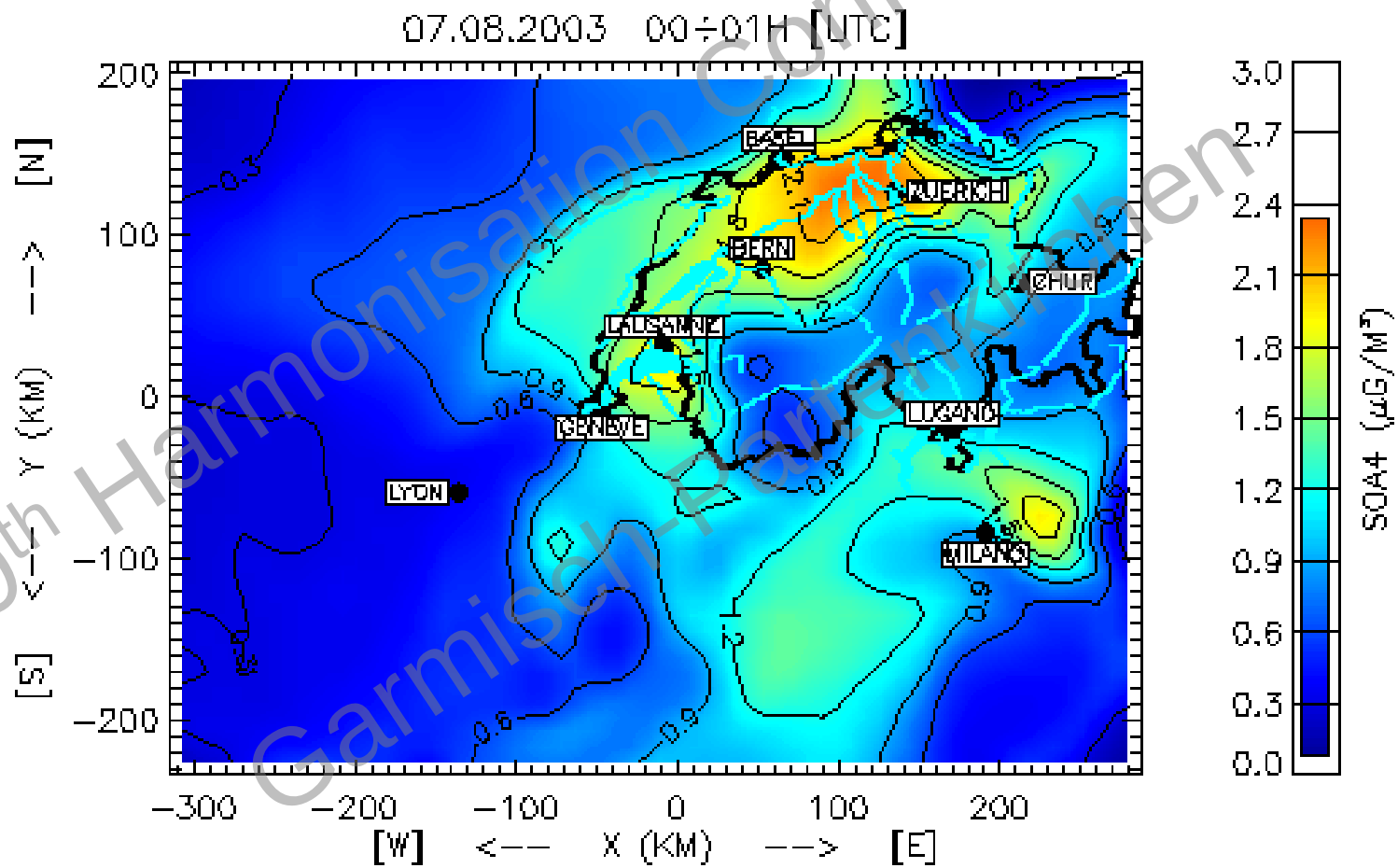




precursors
monoterpenes

____ CAMx4 **____ PMCAMx**

Biogenic SOA (PM2.5)



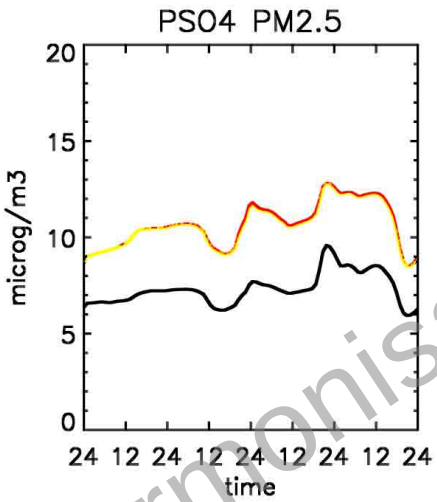
Differences between CAMx4 and PMCAMx which may lead to different results

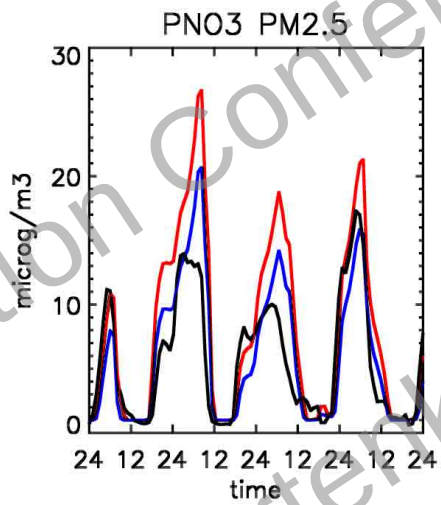
- **difference in aqueous chemistry RADM (CAMx4) vs VSRM (PMCAMx)**
  - **coarse and fine droplets may have different pH effects on aqueous-phase sulfate formation**

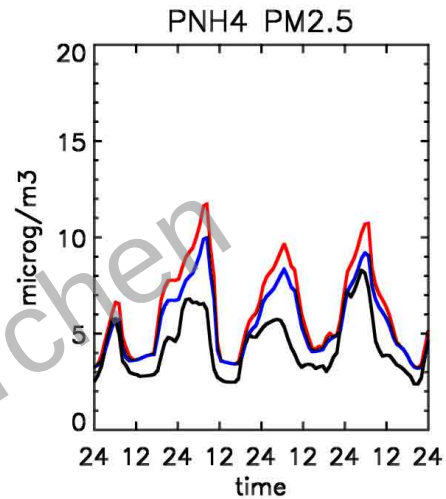
- **all nitrate is fine (CAMx4) vs nitrate represented by 10 sections (PMCAMx)**
  - **PMCAMx grows NO_3 into coarser sections where it dry deposits faster than CAMx4 NO_3 that is assumed to be fine.**

How significant is the difference between CAMx4 and PMCAMx ?

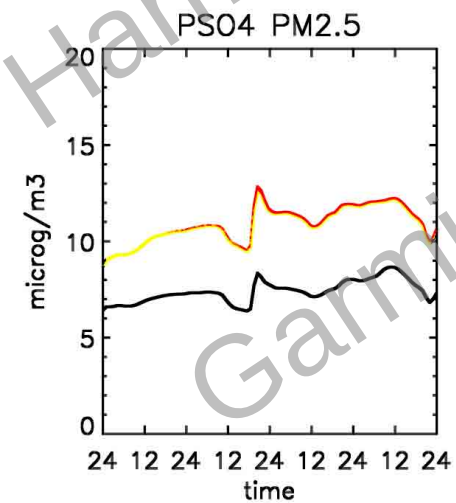
Taenikon (rural)

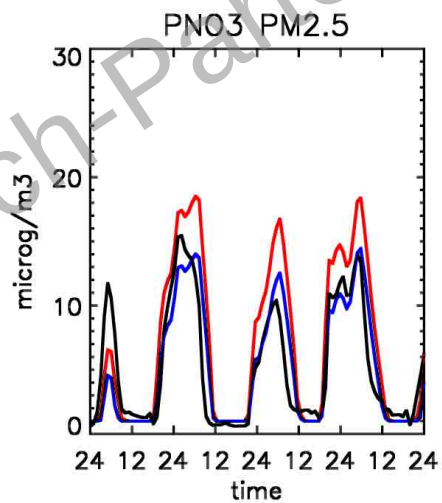


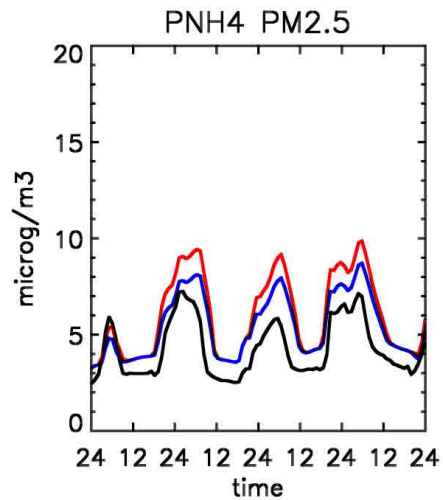




Zurich (urban)







___ PMCAMx ___ CAMx4 ___ CAMx4 80% SO_2 ___ CAMx4 80% NH_3

Conclusions

- Models give consistent results in both domains.
- Assuming all nitrate as fine in CAMx4, leads to overestimation of particulate nitrate. However, the difference between CAMx4 and PMCAMx wrt nitrate is in the same range of uncertainties in NH_3 emissions.
- Difference between the SO_4 results of two models cannot be attributed only to the uncertainties in SO_2 emissions. One of the reasons is probably size sensitive pH effects considered in PMCAMx.
- PMCAMx is more demanding than CAMx4.
- As long as there are no speciated aerosol measurements available for validation, CAMx4 is still good enough for 3-dimensional aerosol modeling.

Acknowledgements

- BUWAL, MeteoSwiss, INFRAS
- Freie Universität Berlin
- TNO
- LOOP community

Thank you

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