Paul Scherrer Institut

LABOR FÜR ATMOSPHÄREN-CHEMIE

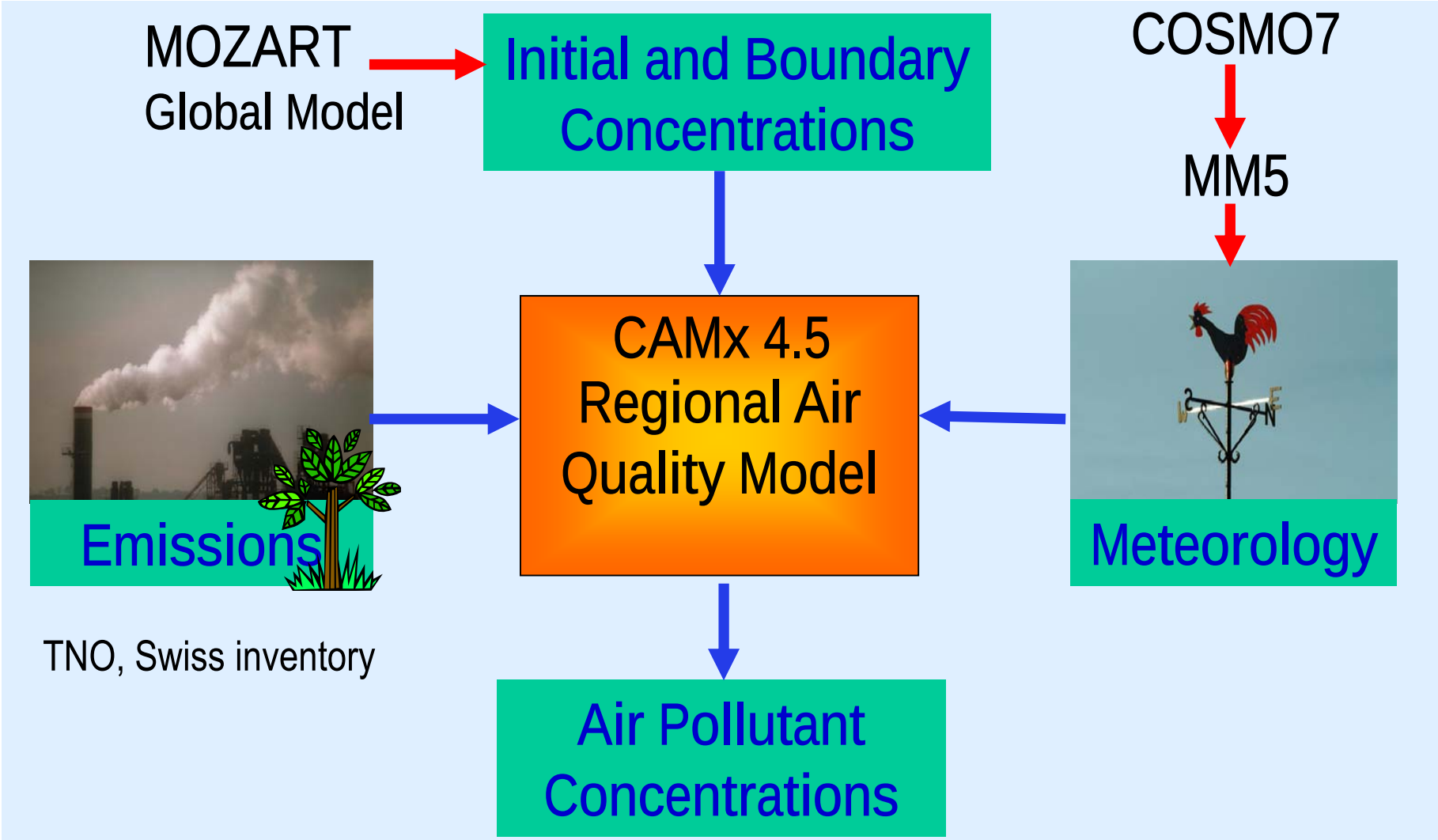
Sensitivity of Ozone and Aerosols to Precursor Emissions in Europe

Ş. Aksoyoğlu, J. Keller, D. Oderbolz, I. Barmpadimos, A.S.H. Prévôt, U. Baltensperger

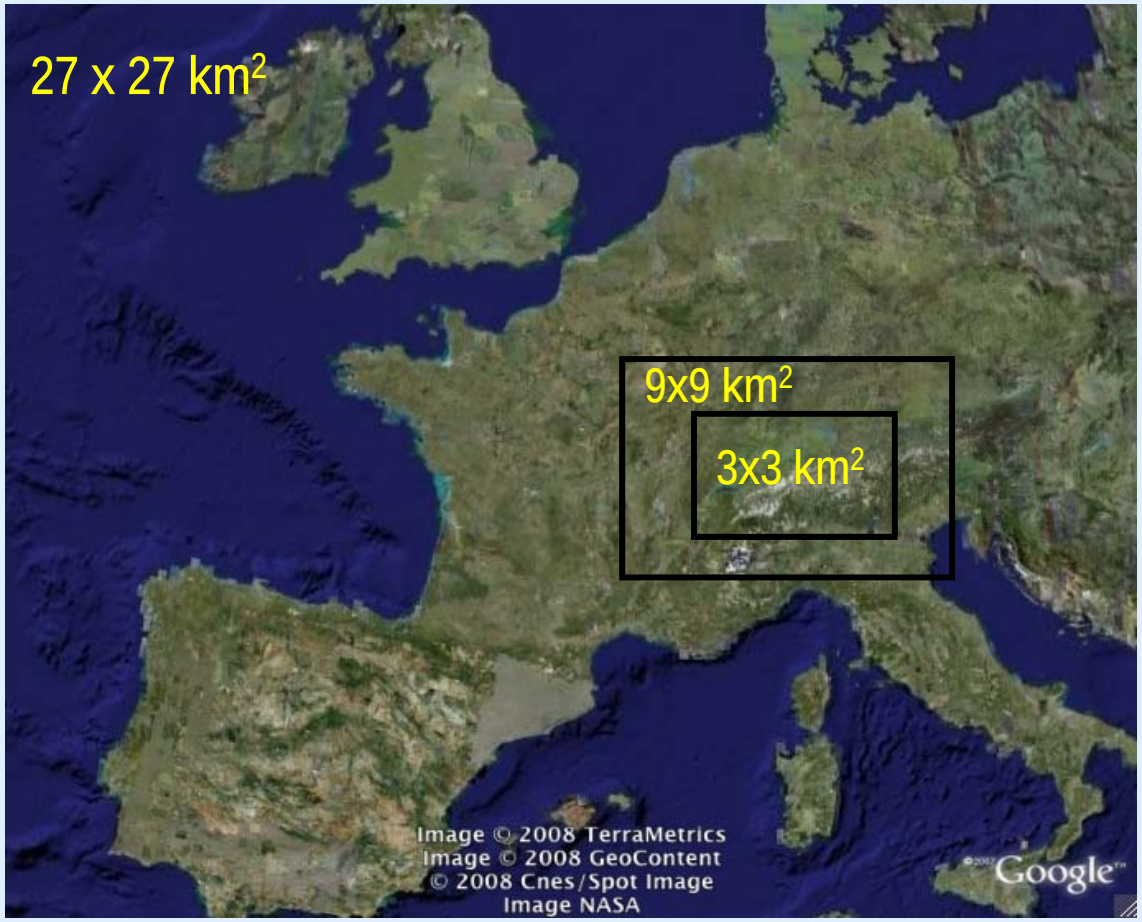
Laboratory of Atmospheric Chemistry (LAC)
Paul Scherrer Institute, Switzerland
http://lac.web.psi.ch

HARMO14, Kos, 2-6 October 2011

Model system



Model Domains



- Lambert Conic Conformal
- 14 layers in CAMx
- CB05 gas-phase mechanism
- RADM aqueous chemistry
- ISORROPIA
- SOAP aerosol module (7 SOA)
- Oligomerization
- PM2.5
- January, June 2006

Sensitivity tests

Isoprene:

ozone and secondary organic aerosols (SOA)

high uncertainty in emissions (factor of 3-5)

increased emissions in summer by a factor of 4

NO_x and VOC :

ozone

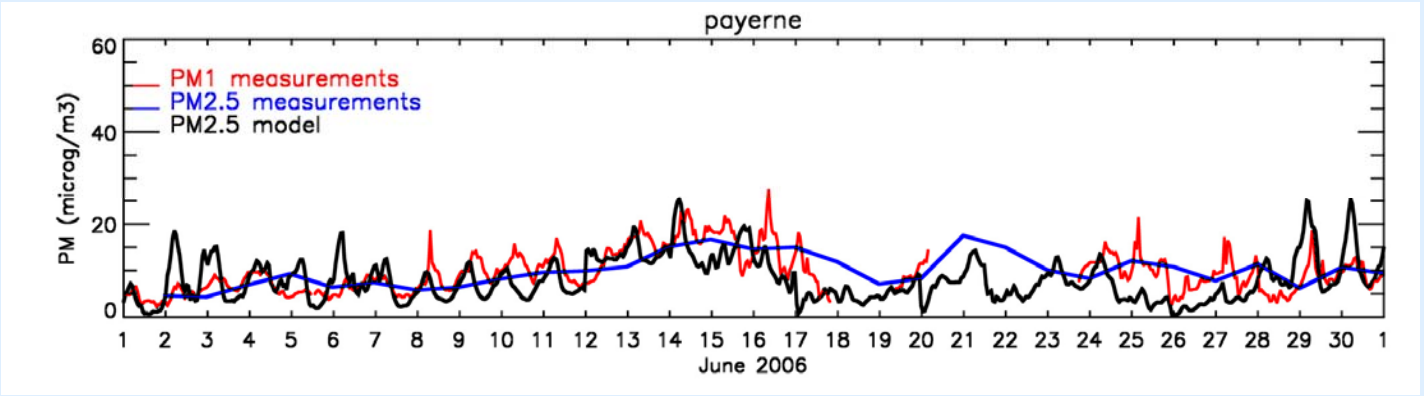
reduced emissions in summer by 30%

NO_x and NH_3 :

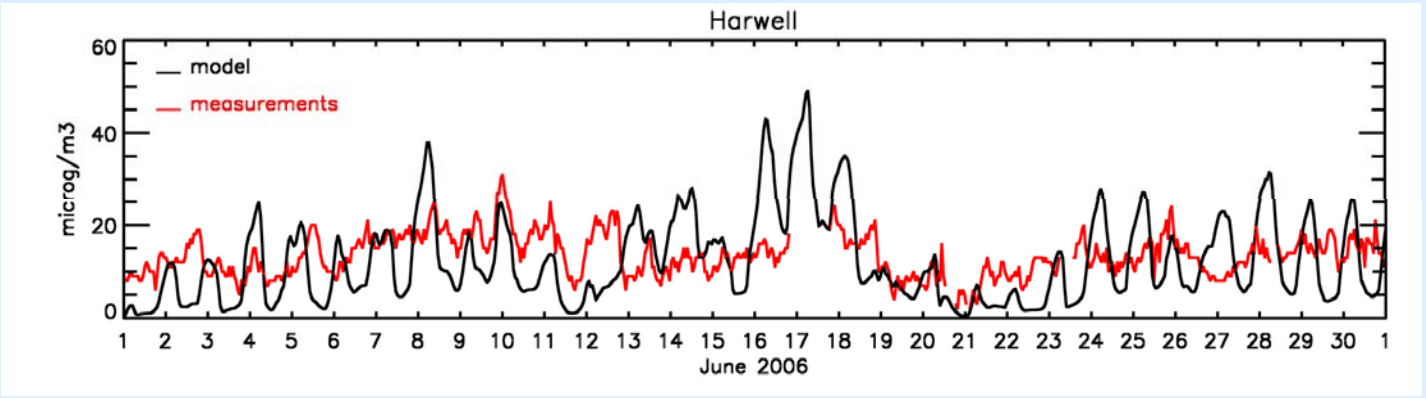
inorganic aerosols, NO_x ..... $\rightarrow$ HNO_3 (g) + NH_3 (g) $\rightarrow$ NH_4NO_3 (s)

Reduced emissions in winter and summer by 15%

PM2.5 : Comparison with measurements (summer)



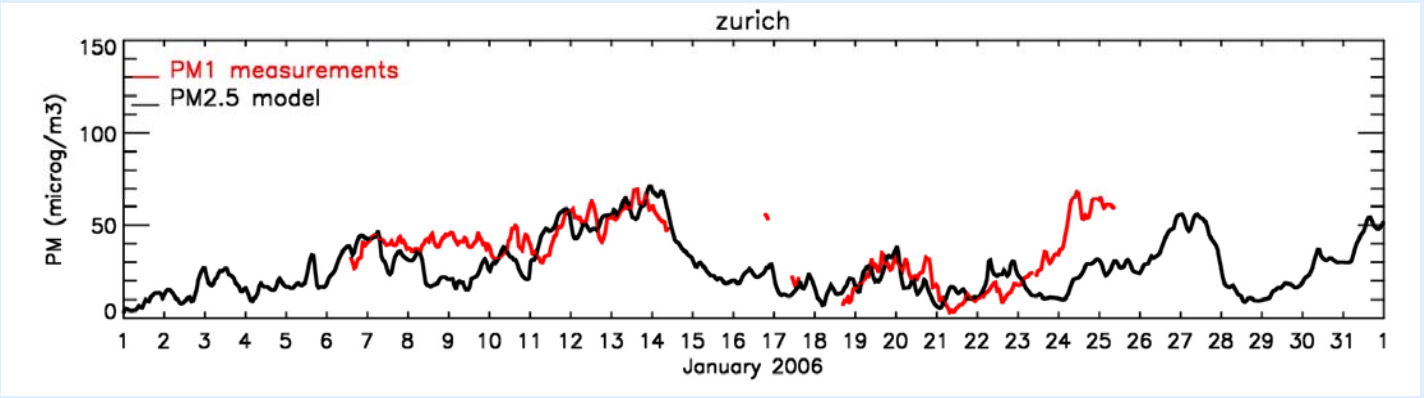
high-resolution domain (3 km x 3 km)



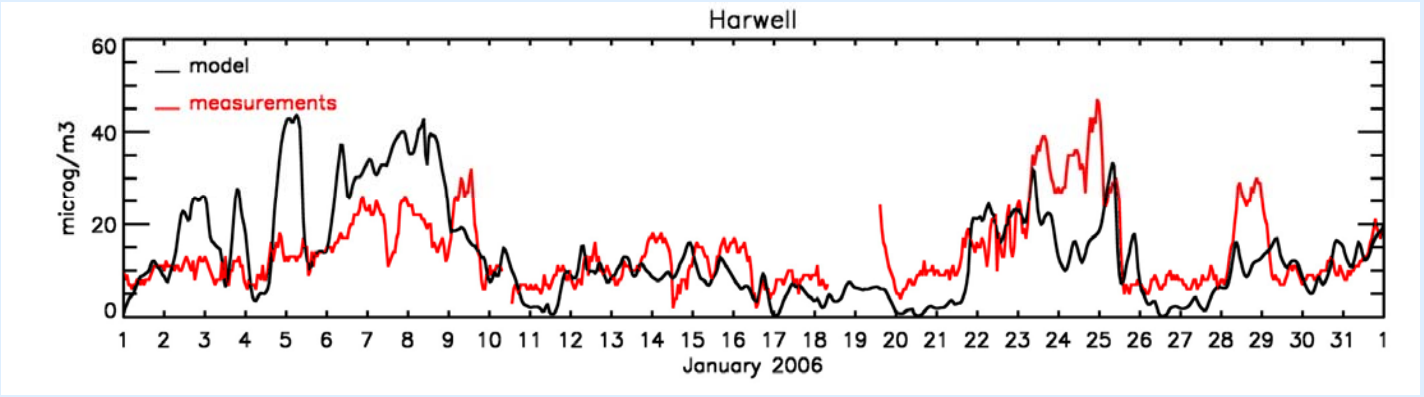
low-resolution domain (27 km x 27 km)

(Aksoyoglu et al., ACP, 2011)

PM2.5 : Comparison with measurements (winter)



high-resolution domain (3 km x 3 km)

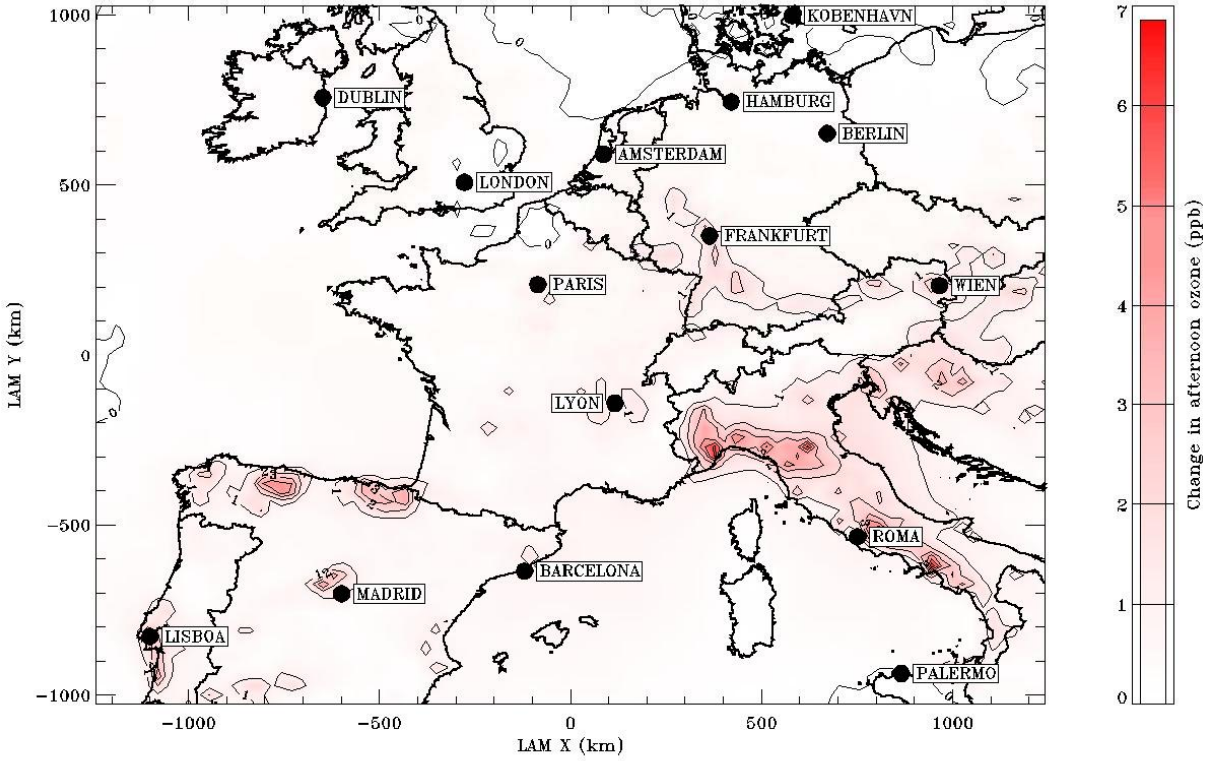


low-resolution domain (27 km x 27 km)

(Aksoyoglu et al., ACP, 2011)

Ozone : Sensitivity to isoprene emissions

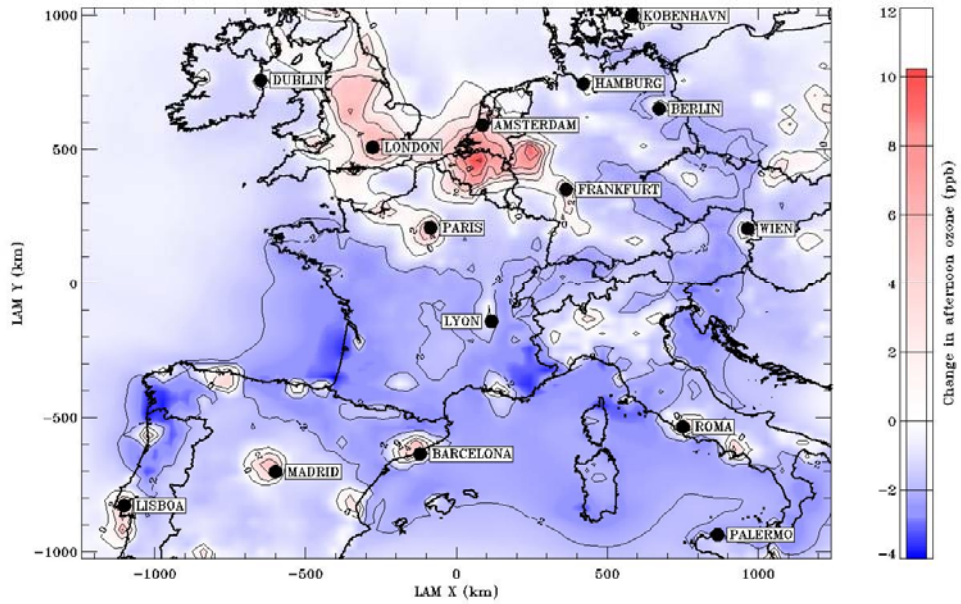
effect of increased emissions on the afternoon ozone concentrations in June 2006



(max. 10%)

Ozone : Sensitivity to NO_x and VOC emissions

effect of reduced emissions on the afternoon ozone concentrations



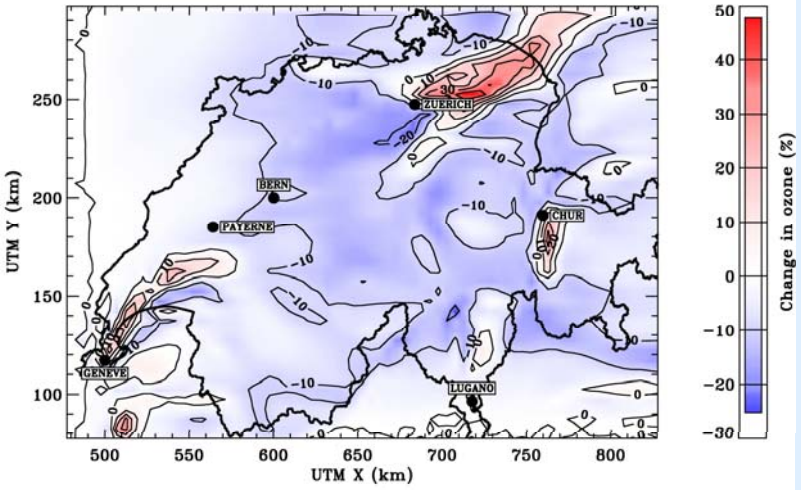
$$(\Delta O_{3\ (BC - VOC)}) - (\Delta O_{3\ (BC - NOx)})$$

red : VOC - sensitive blue : NO_x- sensitive

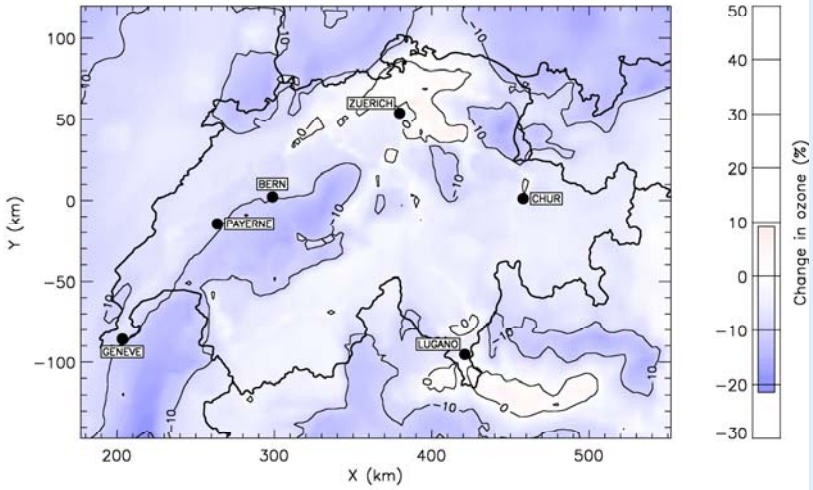
Ozone : change in sensitivity between 1993 and 2006

effect of reduced emissions on the afternoon ozone concentrations

1993



2006



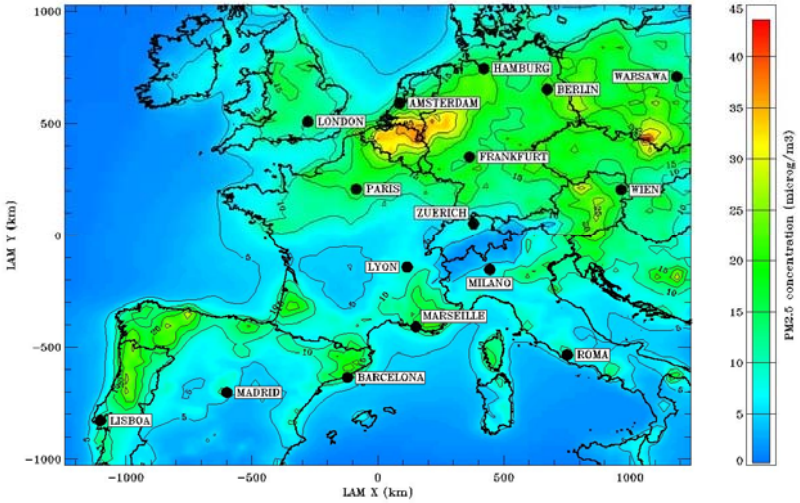
$(\Delta O_{3\ (BC - VOC)}) - (\Delta O_{3\ (BC - NOx)})$

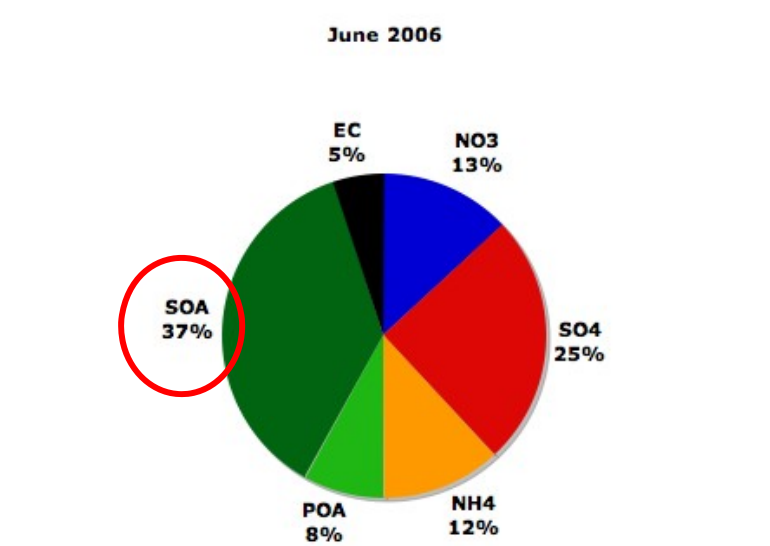
red : VOC - sensitive blue : NO_x- sensitive

SOA : Sensitivity to isoprene emissions

PM2.5 Monthly average (µg/m³)

June 2006



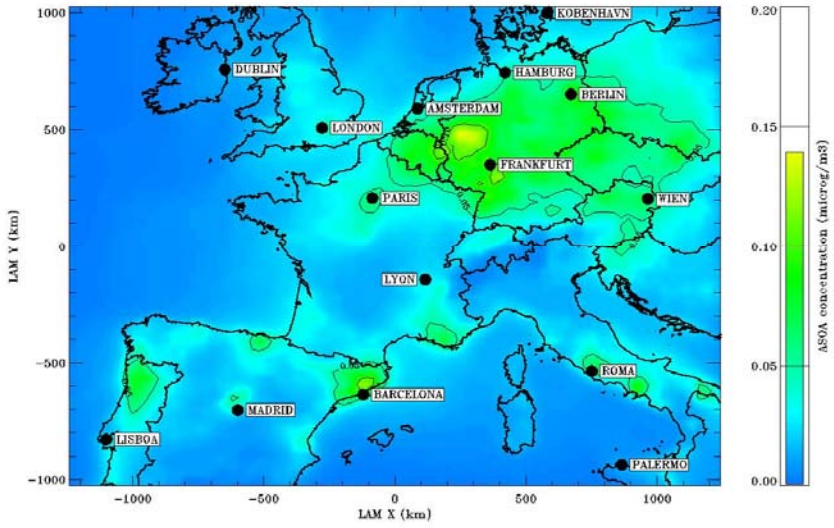


SOA : Sensitivity to isoprene emissions

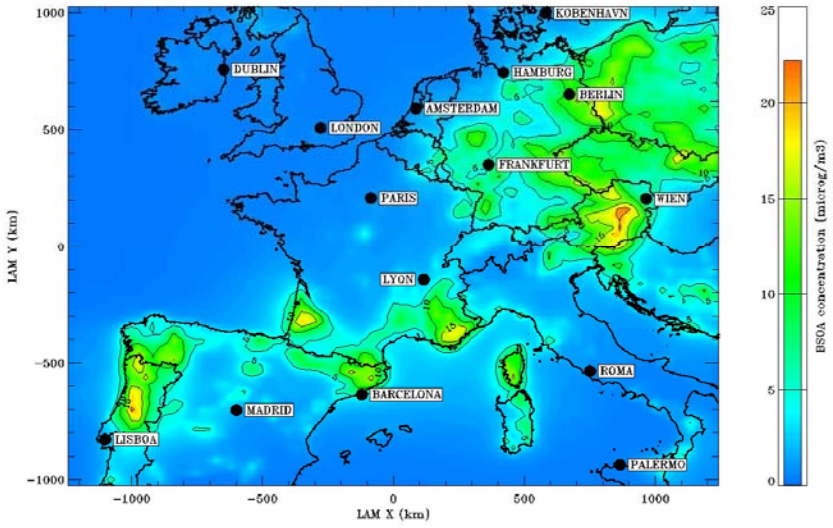
Anthropogenic versus biogenic SOA in June 2006

Monthly averages (µg/m³)

ASOA



BSOA

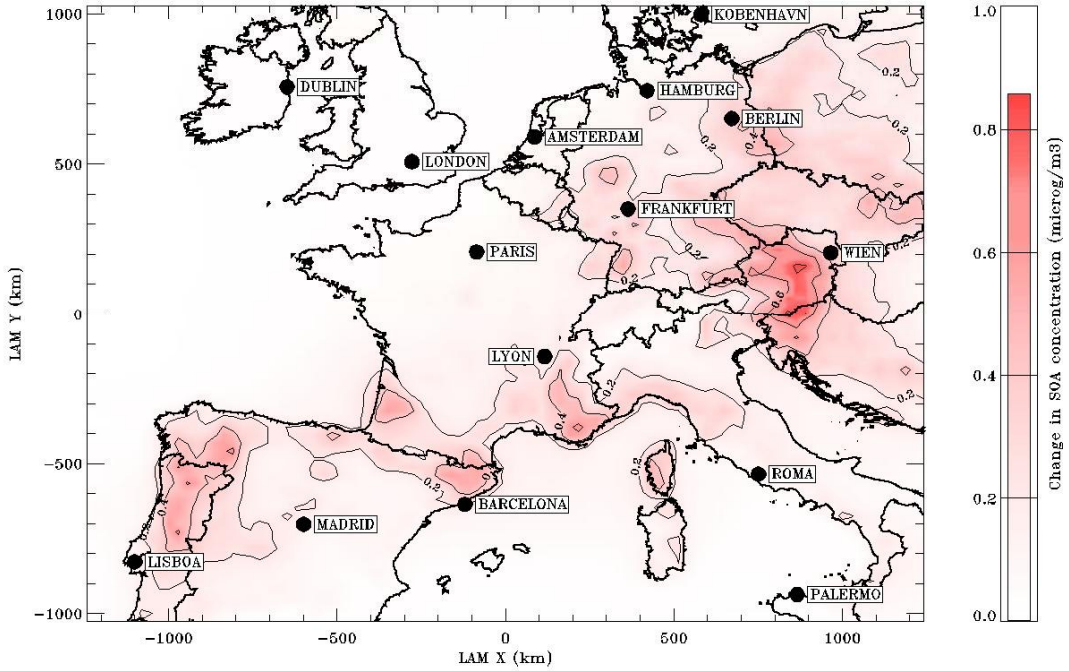


SOA is produced mainly from *biogenic precursors* in summer

SOA : Sensitivity to isoprene emissions

effect of increased isoprene emissions on the monthly average SOA concentrations (June 2006)

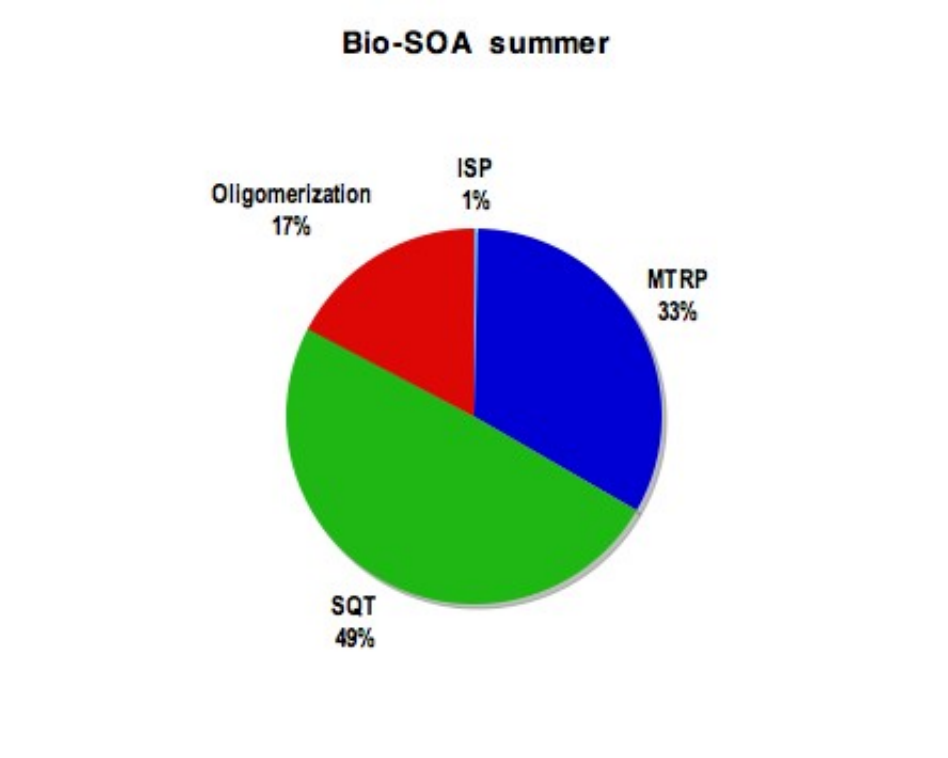
change in SOA



(< 4%)

BSOA : Fractional Composition

produced mainly from mono- and sesquiterpenes as well as oligomerization



Attention:

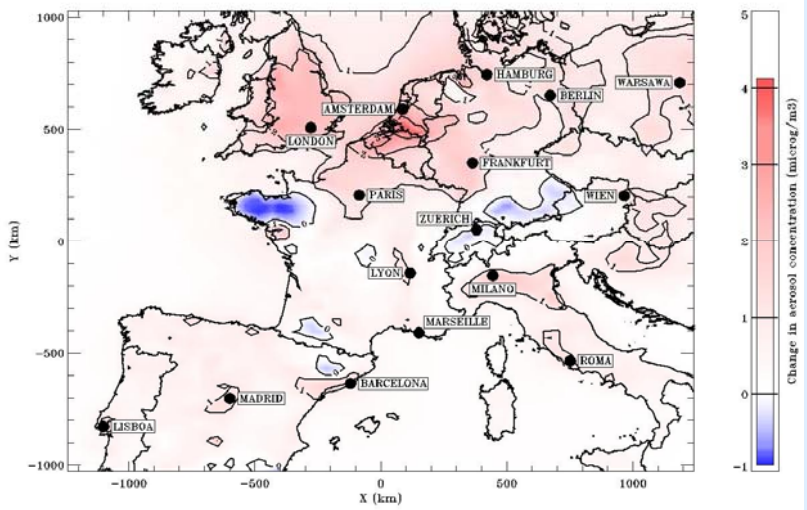
Sesquiterpene emissions might be too high.

BSOA fractions might change significantly with lower SQT emissions.

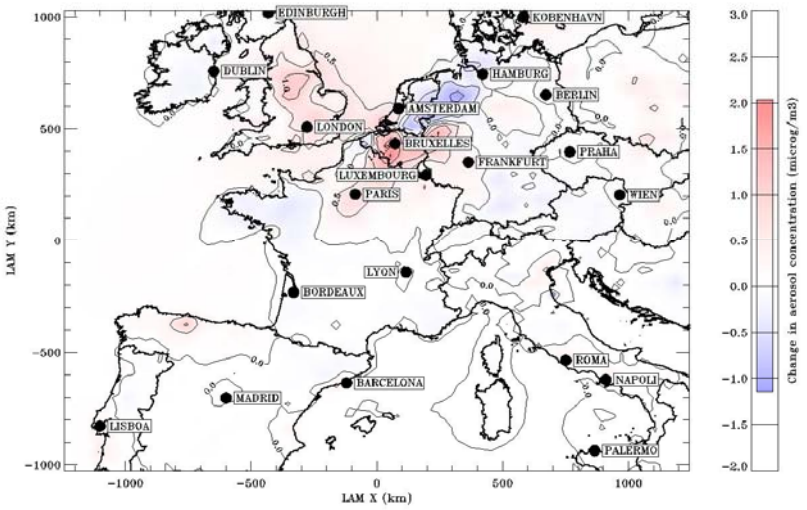
Inorganic Aerosols : Sensitivity to NO_x and NH_3 emissions

effect of decreased emissions on aerosol concentrations

January 2006



June 2006



$(\Delta PM_{(BC - NH3)}) - (\Delta PM_{(BC - NOx)})$

red : NH_3 - sensitive blue : NO_x- sensitive

Conclusions

- The effect of increased isoprene emissions (within the uncertainty range) on afternoon ozone in summer is predicted to be up to 10%.

- Ozone formation in Europe is mainly sensitive to NO_x emissions except some urban areas. The sensitivity to precursor emissions has likely become weaker during the last 2 decades due to large emission reductions.

- SOA in summer was predicted to come mainly from biogenic sources. However, contribution of isoprene was small (due to low yields). Monoterpenes, sesquiterpenes and oligomerization are the main sources of SOA in this study. Updating biogenic emissions is going on.

- Inorganic aerosol mass is more sensitive to ammonia emissions in a large part of Europe. Sensitivity to ammonia is weaker in summer due to higher emissions and lower ammonium nitrate concentrations.

Acknowledgements

Swiss Federal Office of Environment (FOEN)

ENVIRON Inc.

TNO

ECMWF, M. Schultz

EMPA/NABEL

INFRAS

MeteoSwiss

Meteotest

ACCENT