Activities on monitoring and modelling of acidification, eutrophication and photo-oxidants

Highlights

Hilde Fagerli, David Simpson, Svetlana Tsyro + many more

1st joint session of steering body to EMP & WGE, Geneva 14-18th September, 2015

Outline

- Status for air pollution in Europe, 2013, including fine resolution results and preliminary 2014 runs
- The new EC emissions – model results
- Condensables – how does the issue affect model results?
- Improved modelling of aerosols
- Trends in historic depositions

New material available on web

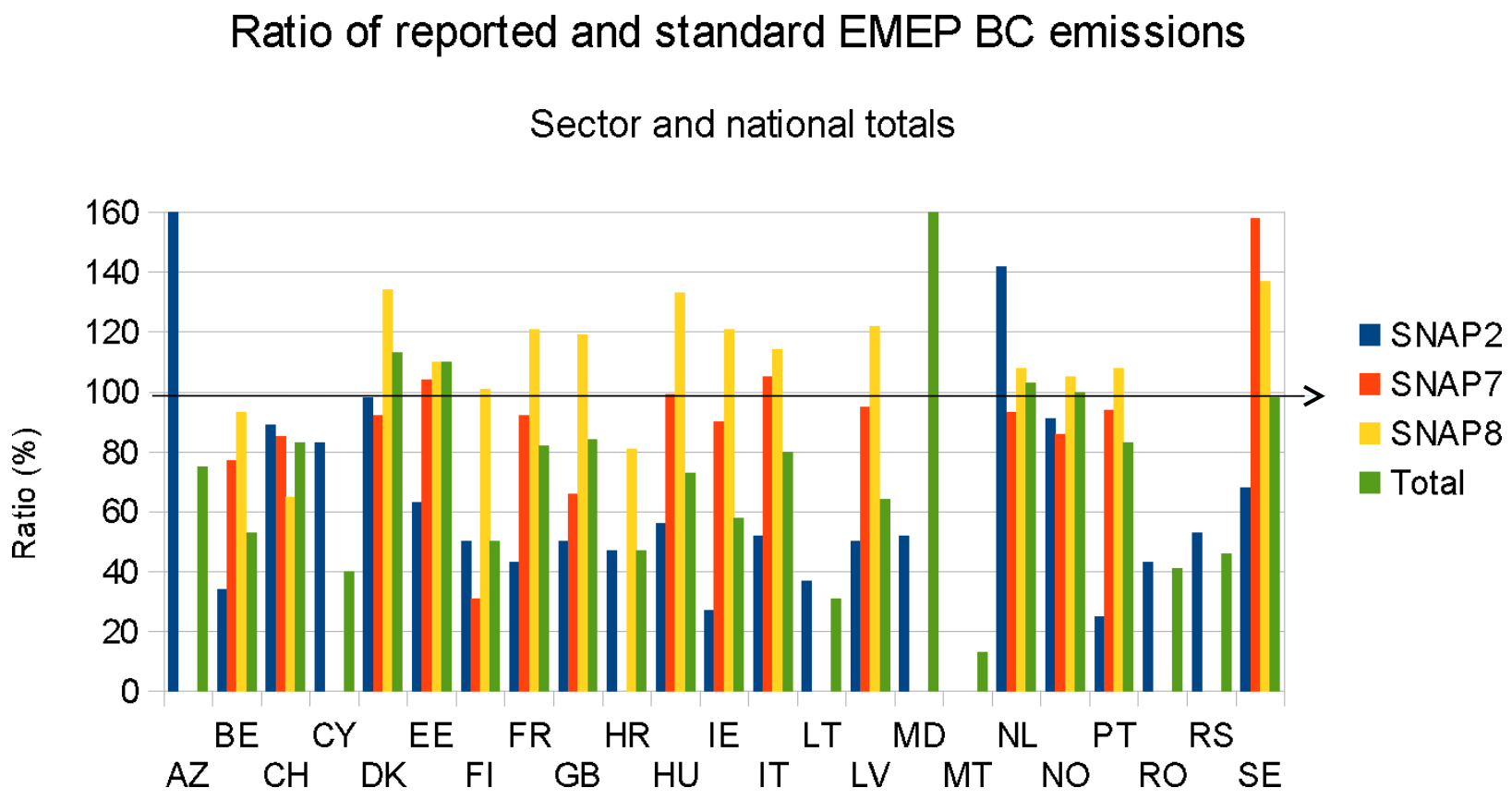
- EMEP Status Report 1/2015, *Transboundary particulate matter, photo-oxidants, acidifying and eutrophying components*
- Model evaluation report
- Country reports
- Data:
  - 50km×50km (2013 + 2014)+ 0.1°×0.1°
  - Re-run 2000-> with updated (latest re-reported emissions)

The new EC emissions – a first model evaluation

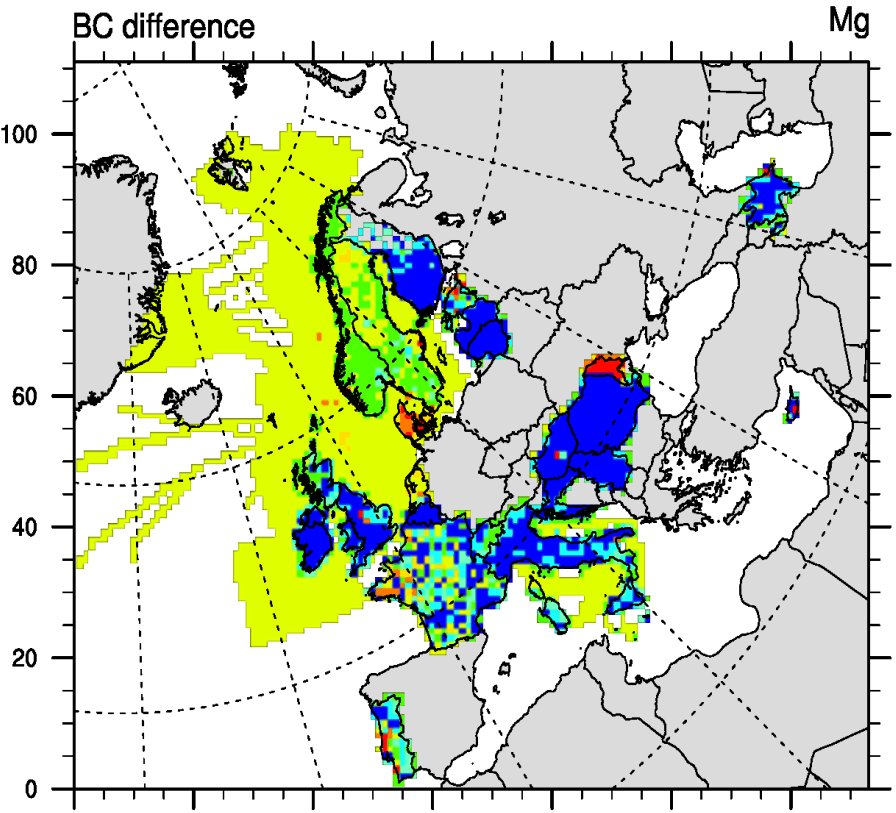
- Aim: use the new EC emissions reported to EMEP in model calculation and evaluate with EC observations and aerosol absorption data
- What did we do before we had these EC data from the countries?
  - EC as fractions of PPM2.5 (per country and sector)
- Compare 'new results' to results using our ‘standard’ EC emissions

How to use the new emissions?

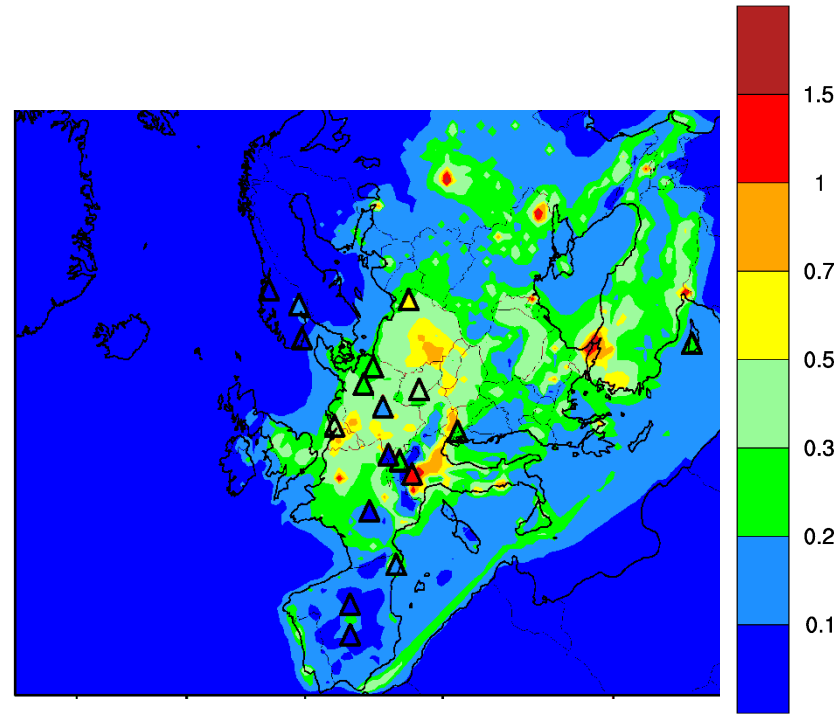
- Challenges (*solutions*):
  - 28 countries reported data (national and sector), but only one country submitted gridded data (*grid per PM sector/split*)
  - Some countries did not report data for all relevant sectors (*gap-fill*)
  - Consistency checks showed that for 6 countries, EC was higher than PPM2.5 for some sectors(*restrict to PPM*)


Ratio of reported and standard EMEP BC emissions
Sector and national totals
Ratio (%)
160
140
120
100
80
60
40
20
0
AZ
BE
CH
CY
DK
EE
FI
FR
GB
HR
HU
IE
IT
LT
LV
MD
MT
NL
NO
PT
RO
RS
SE
SNAP2
SNAP7
SNAP8
Total

Model vs. measurements, EC concentrations

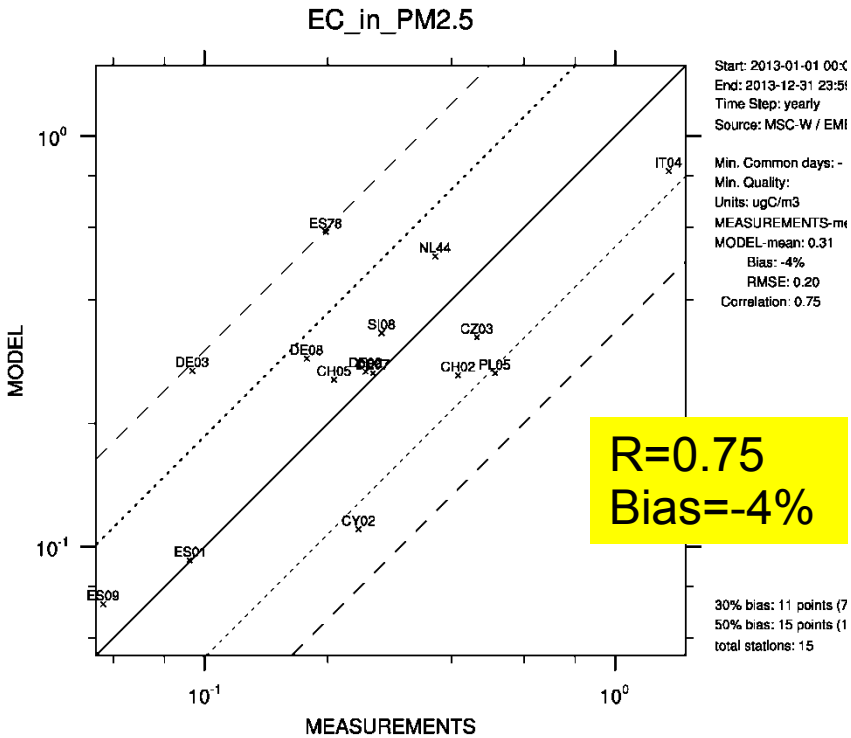


Difference in emissions, ‘standard’ - reported

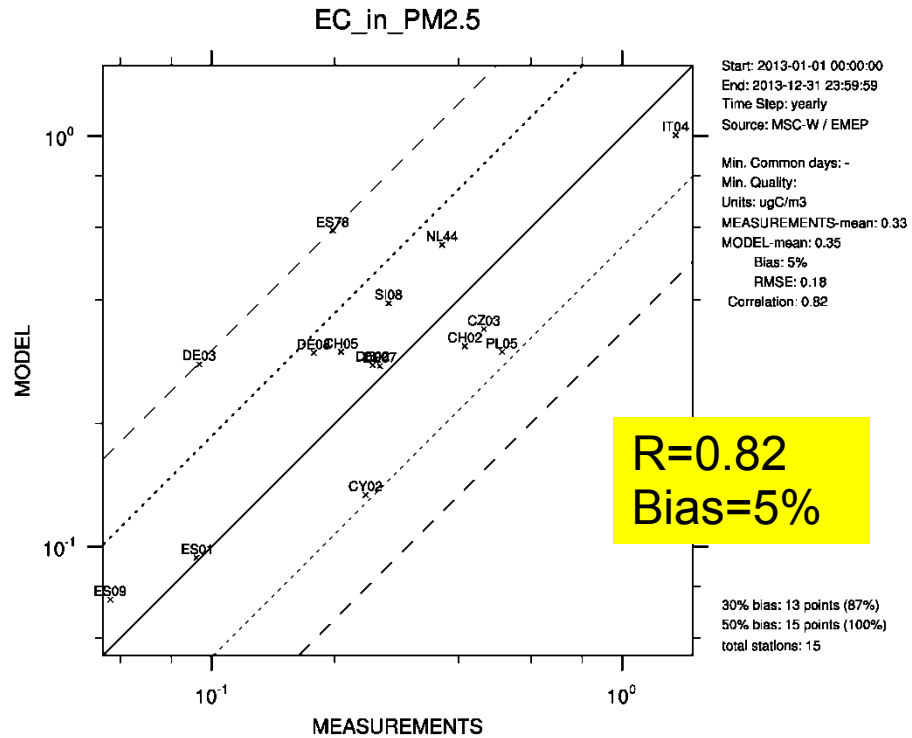


EC concentrations (field) with measurements on top(triangles)

Most of the countries where EC was measured in 2013 did not submit data (e.g. important emitters as Germany, Austria, Spain)



Reported EC emissions



'Standard' EMEP

- Model results (using reported EC emissions) reproduce observed levels of EC reasonably well
- Agreement with observations is slightly worse than when using 'standard EMEP setup'
- Note that observations are mostly NOT in countries which did not report EC emissions

Condensables – how important are they?

Missing condensables in the PM (and NMVOC) emission inventories leads to e.g. underestimation of aerosol concentrations

1. Reported PM2.5 emissions are generally based upon inconsistent emission factors (depend on methods), for most countries not including SVOC
2. NMVOC inventories do not include IVOC
   - IVOC readily oxidized to SVOC

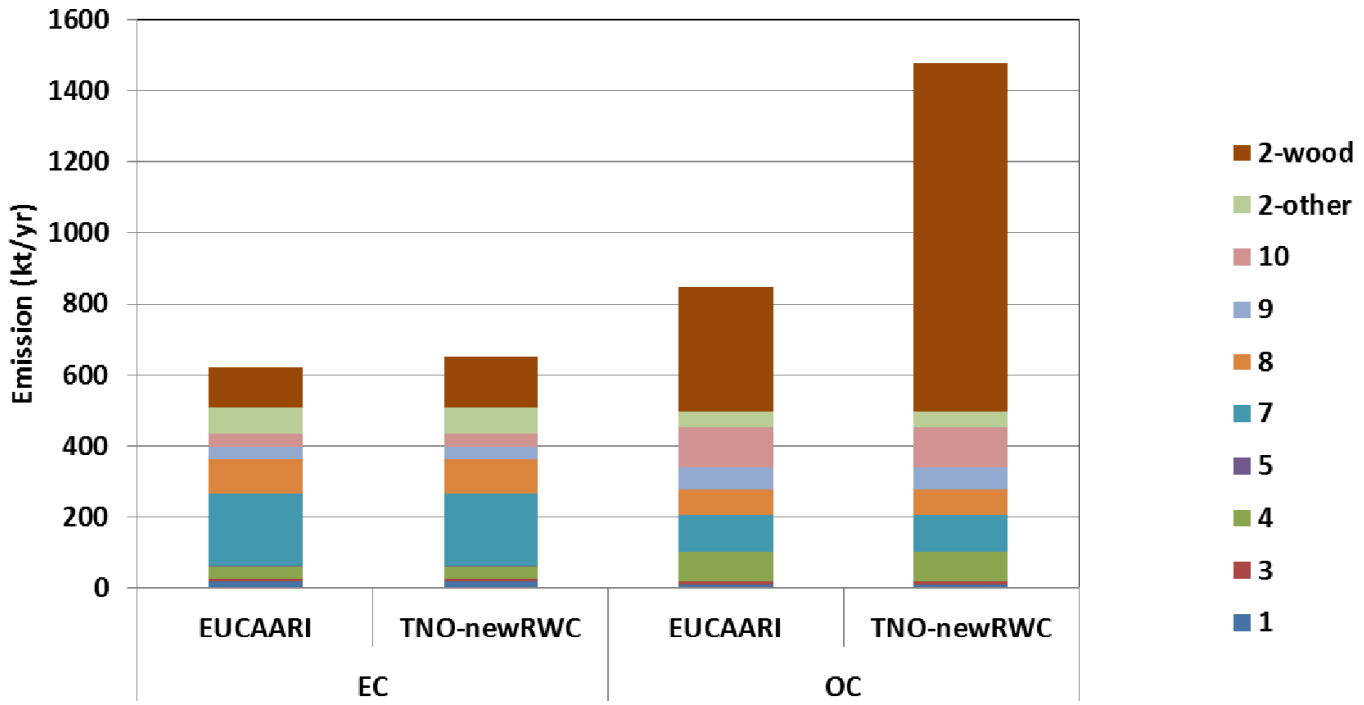
How important is this? A model study considering residential wood combustion(RWC)

- RWC large source of organic aerosols in Europe
- EMEP model study using 'Standard emissions': underestimation of organic aerosols in winter – especially in regions dominated by RWC

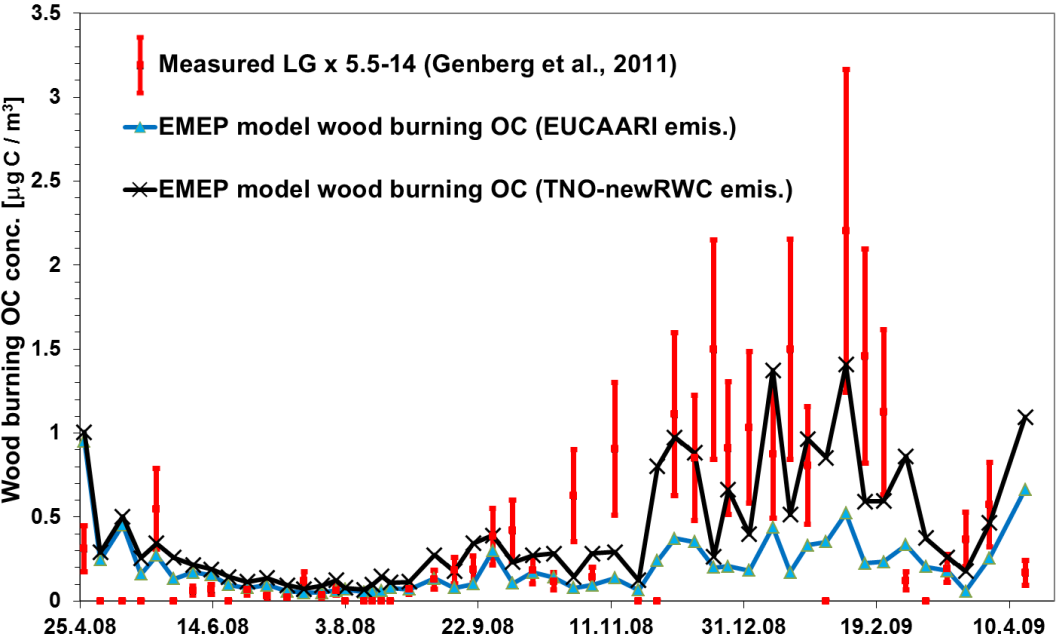
Denier et al.,2015, Simpson, 2015 (Chapter 6. in EMEP Status Report 1/2015)

RWC emissions

- New bottom-up emission inventory for RWC constructed (TNO) using emission factors that includes the 'condensables' (total OA emissions increase almost by a factor of 2, total PM2.5 emissions by 20%)

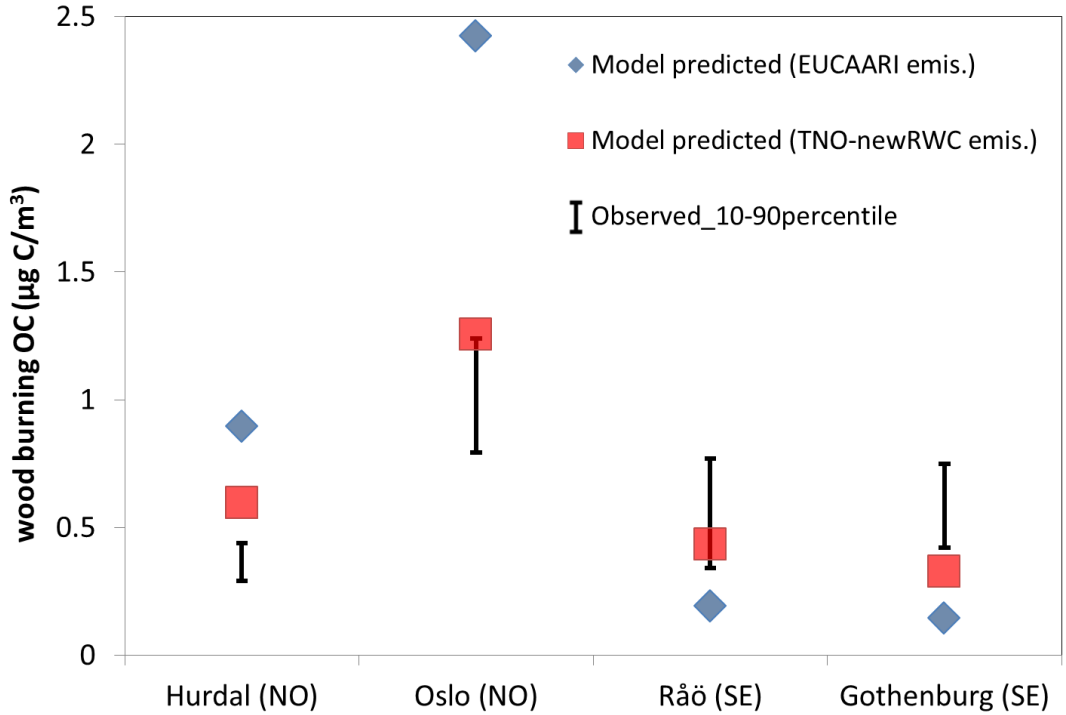


PM2.5 EC and OC emissions for Europe in 2005 for each source sector



Comparison of EMEP/MSC-W model results for biomass burning OC and biomass burning OC estimated from Levoglucosan at Vavihill

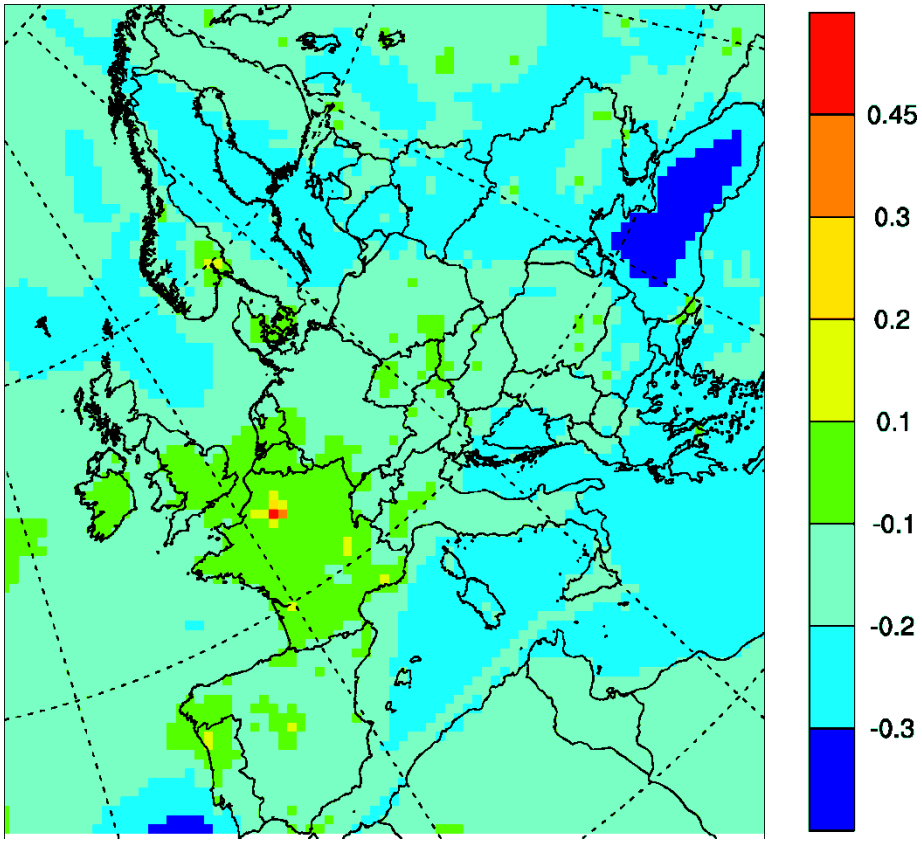
Comparison of EMEP/MSC-W model results for biomass burning OC and source apportionment data during winter



How do we handle POA in the EMEP model?

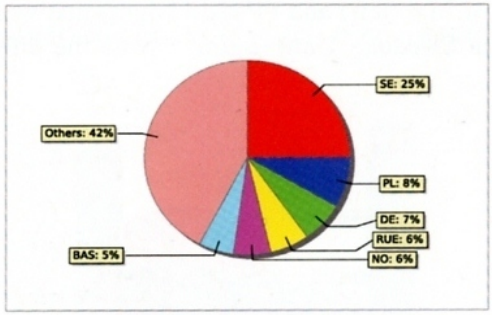
- Different VBS Schemes:
  - ‘Official’ version, where POA is assumed inert
  - Research versions, treating POA (and re-lated emissions of SVOC and IVOC) as components of varying volatility.
  - Also introduces IVOC/SVOC that are supposed to not be accounted for in official inventories (often IVOC/SVOC=1.5×POM)

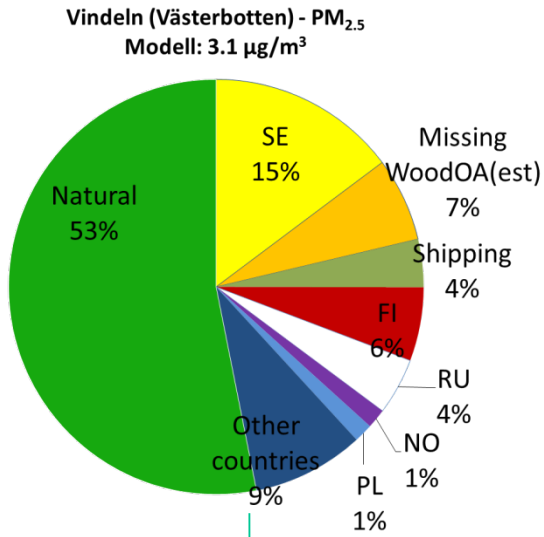
Magnitude of the effect of missing 'condensables'

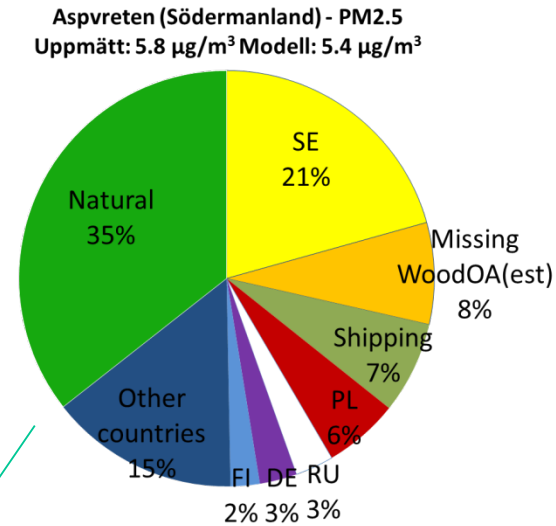


Relative difference in fine organic aerosol concentrations

Sources at Swedish EMEP sites (according to the EMEP/MSC-W model)







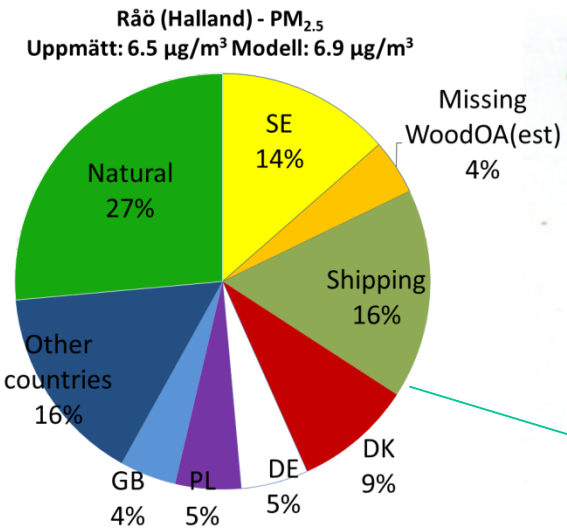
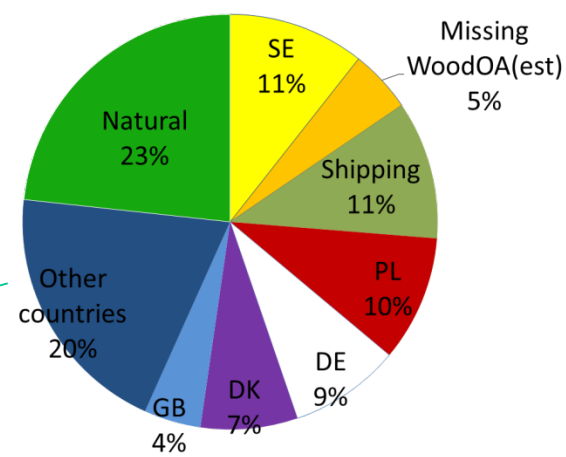


Figure 27: Location of stations in Sweden.



Courtesy R. Bergström

What next?

- Cross-cutting TFMM&TFEIP&TFIAM activity (including the centres)
- Workshop?

Improved modelling of aerosols

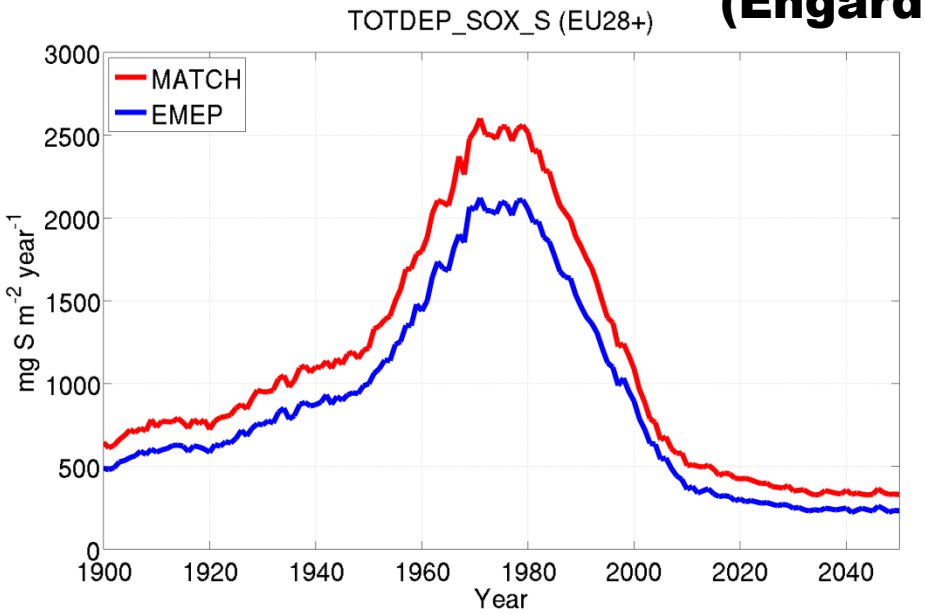
- Dust (using EIMP)
- Aerosol uptake rates/N2O5 hydrolysis
- SOA from biotic stress (bugs)

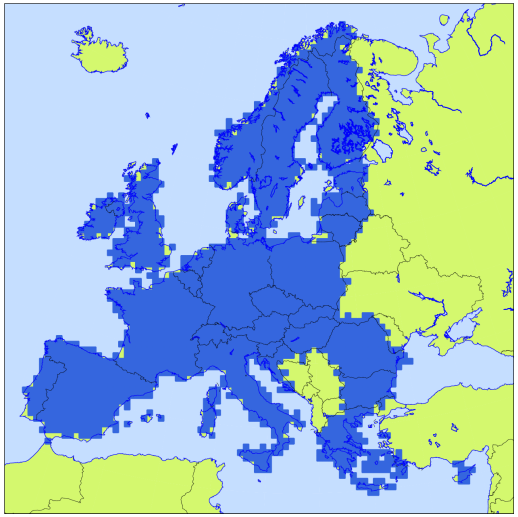
How important is mitigation of ammonia emissions for PM?

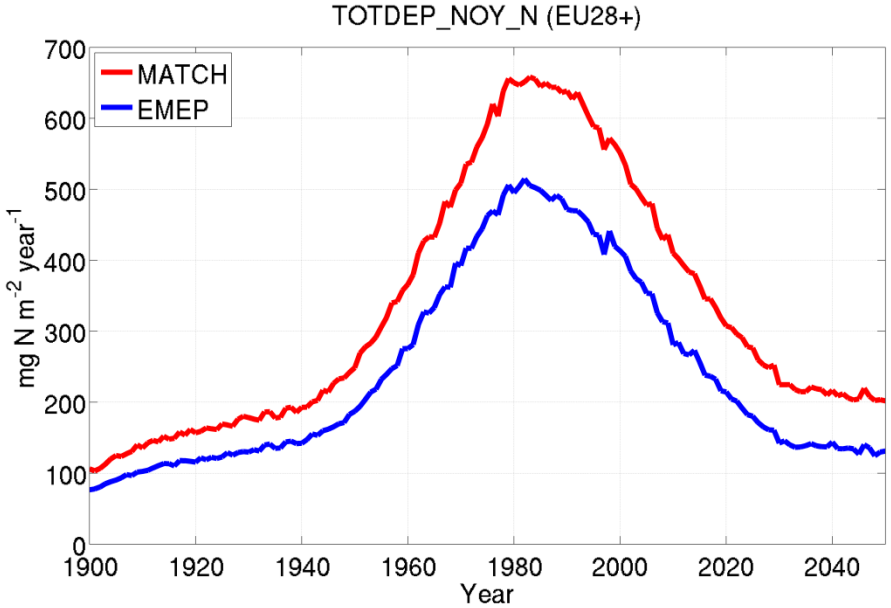
- Several studies points to the importance of NH3 for PM2.5
- Complex NH3-SO42-,HNO3,NO3- interactions
- Efficiency of ammonium aerosol formation depends on the chemical regime (and how well the different components and the chemical interactions are modelled)
- Efforts to do a ‘better job’ for NH3 (and nitrate)
- Through the FP7 project ECLAIRE, there is now a
  - Module/data for dynamic NH3 emissions
  - Module/data for bidirectional exchange
- Plan:
  - finalize implementation and tests
  - Sensitivity study on the importance of NH3 emissions for PM (now and in the future) – could also be a TFMM multi-model study

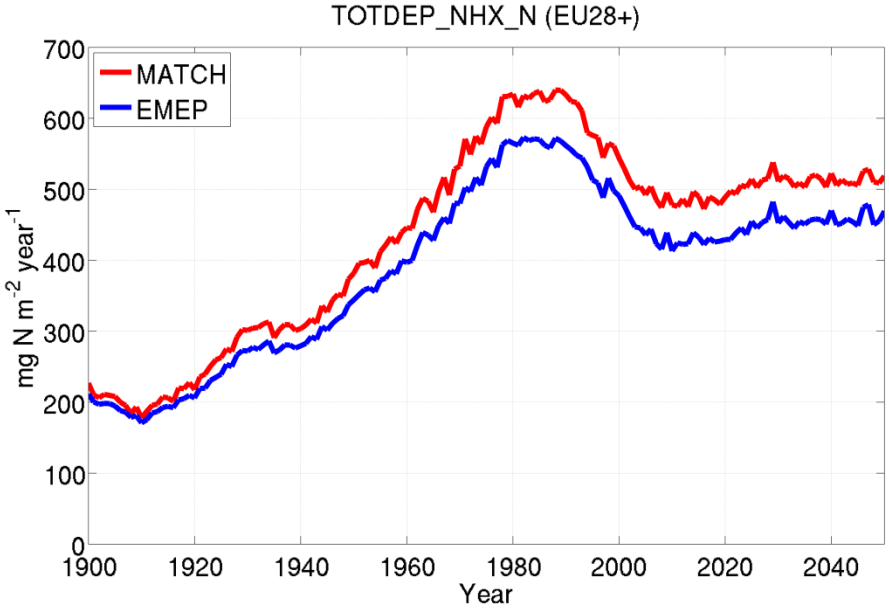
Temporal trend (1900-2050) of sulphur and nitrogen deposition to EU28+

(Engardt+Simpson)





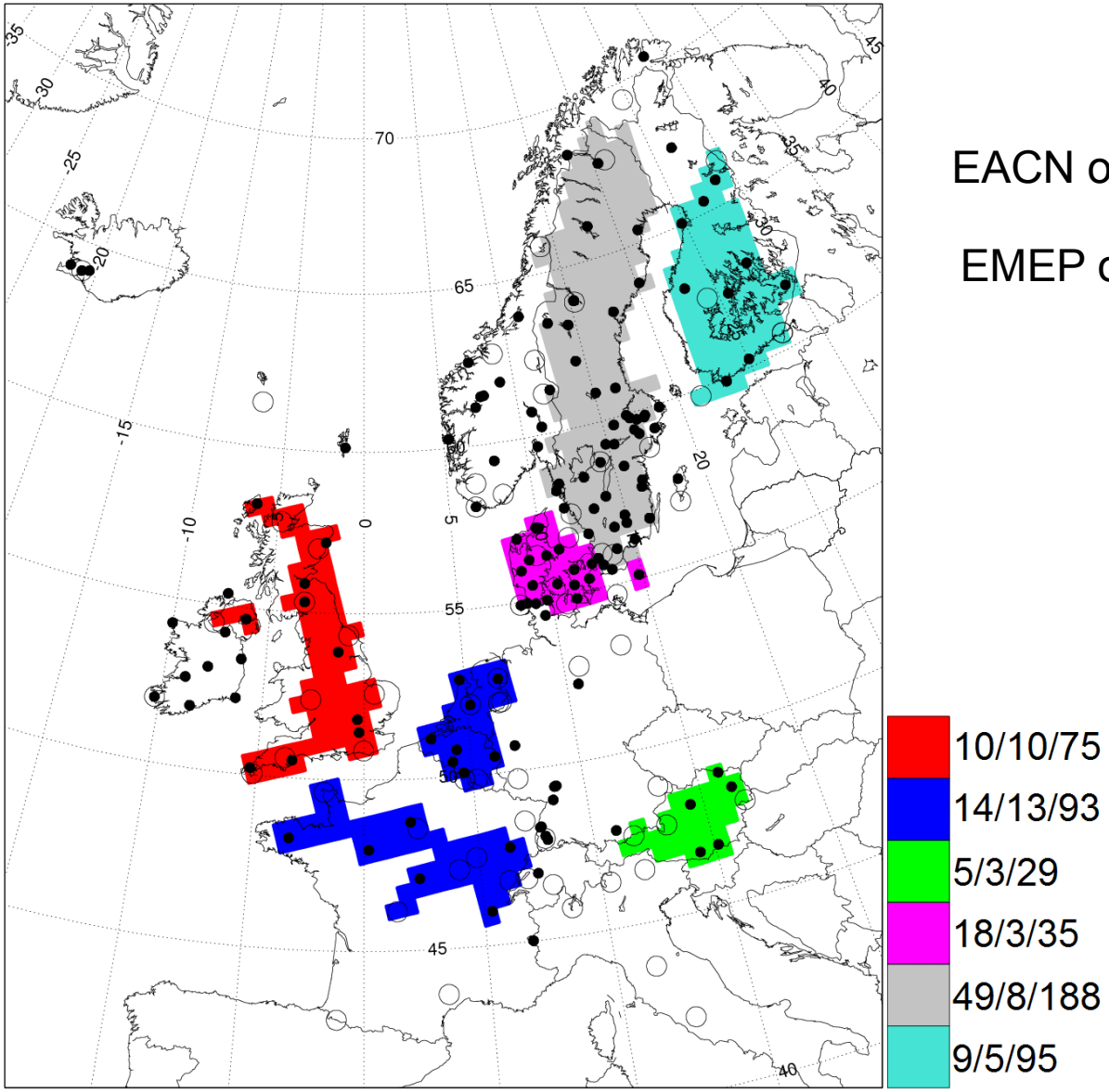




Historic depositions of N and S (1900-20150)

- Historical emissions are based on Lamarque et al. (2010), but scaled…
- SMHI climate-model simulations (RCA3)
- EU FP7 project ECLAIRE
- Comparison to EMEP, EACN, historic data, ice core data..
- Data can be made available to EMEP/WGE

Stations utilised in this study



EACN observations 1958-1966

EMEP observations 1983-1990

10/10/75

14/13/93

5/3/29

18/3/35

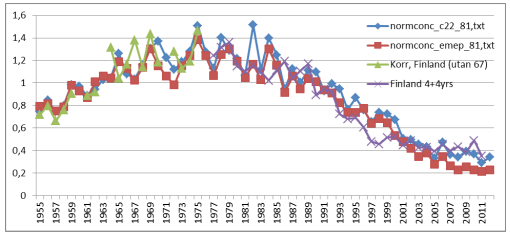
49/8/188

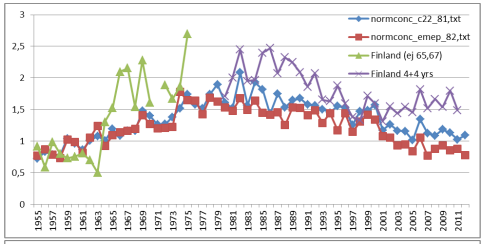
9/5/95

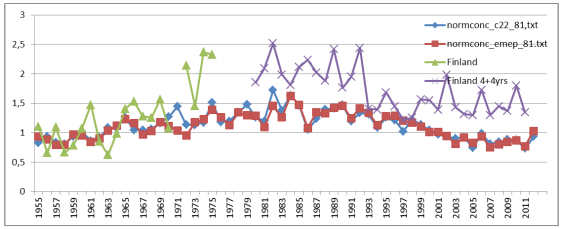
obs 58-66 / obs 83-90 / model grids

ECLAIRE,
Courtesy
M. Engardt

ECLAIRE, Courtesy M. Engardt







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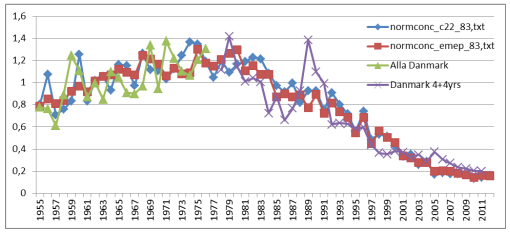
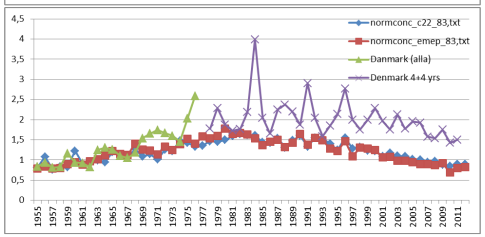
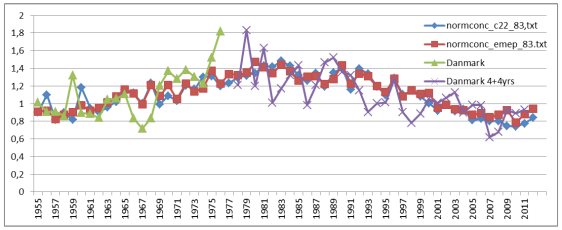
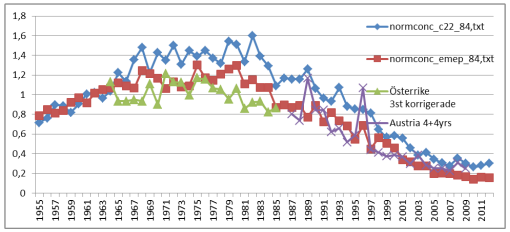
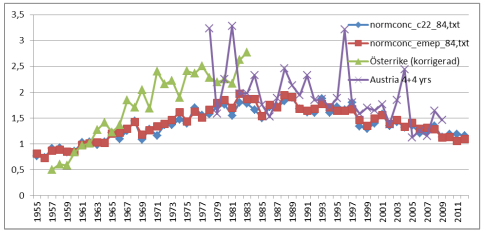


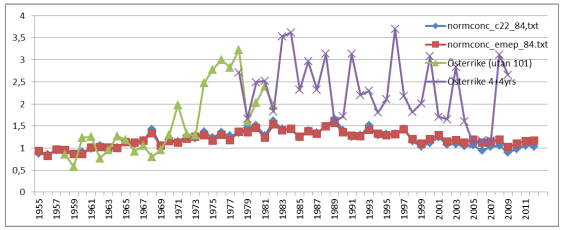




DK







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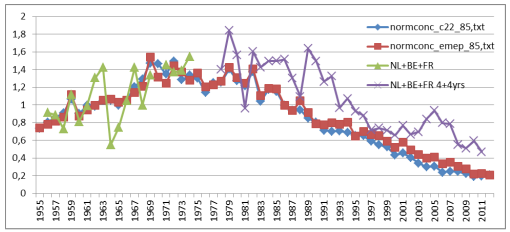
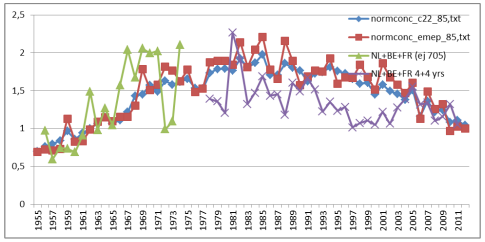
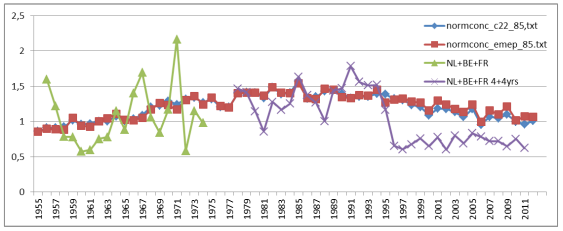
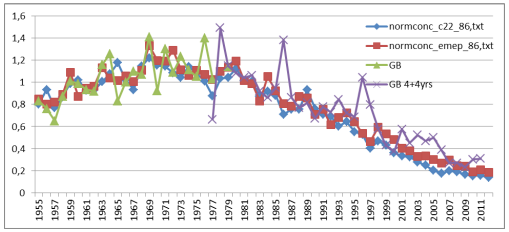
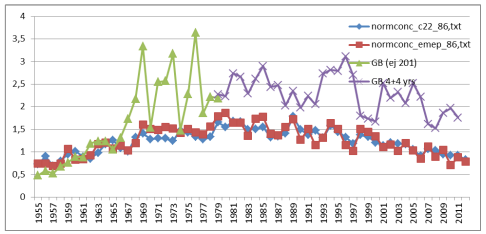


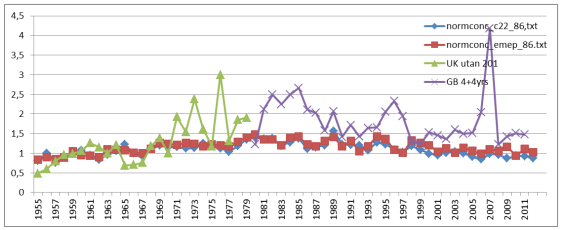




NL+BE+FR





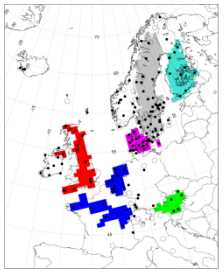


GB

Sulphate

Nitrate

Ammonia



Other work

- CLRTAP Assessment report:
  - MSC-W hosted the 'Oslo Workshop' on the CLRTAP Assessment report

- TFMM Trend analysis: EMEP model runs and analysis
- EMEP/MSC-W model training course 13-14th of October in Oslo
  - Open for 2-3 more participants (18 registered)

The end

Summary

- Model calculations using reported EC inventories gives results in reasonable agreement with observations, but the inventories for some countries are inconsistent and incomplete
- Lack of ‘condensables’ in the emission inventories may give modelled PM2.5 concentrations in the order of 5-10%(?) too low (can be substantially higher/lower depending on season, location,..)
- A evaluated historic (1900->) modelled data set for depositions is available

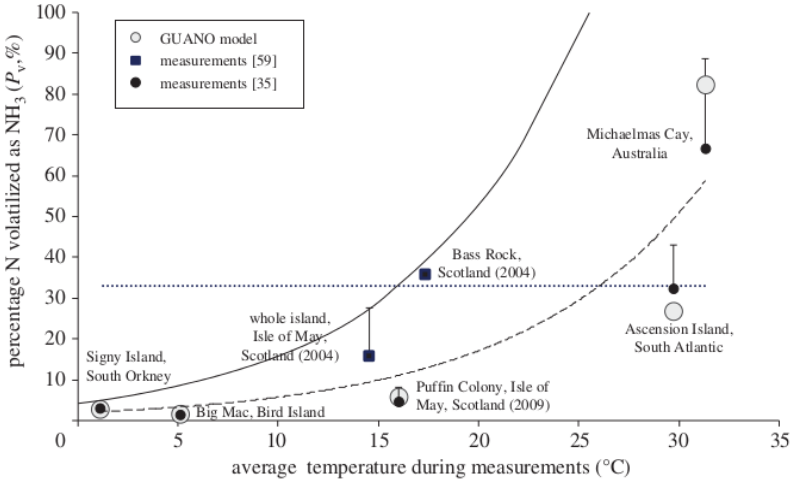
EMEP/ECLAIRE –- in progress

* * Bi-directional NH3 exchange

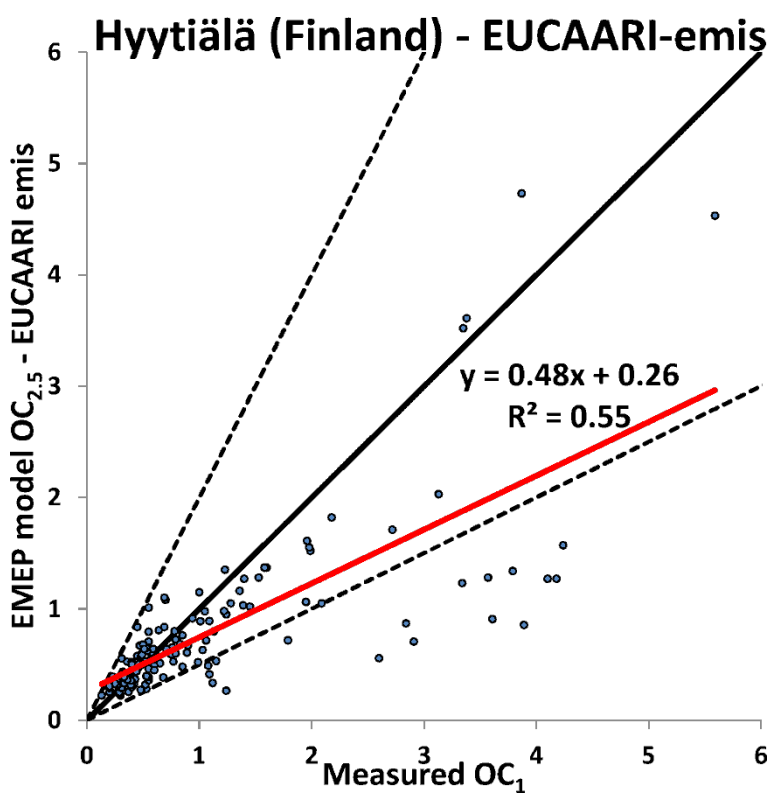
  - INRA will provide European maps of 'Gamma' factors – to drive emissions from agricultural areas, dependent on temperature and other meteorology
  - Plus results of meta-models to capture short-term emissions (e.g. slurry application) in forms appropriate for EMEP
  - Long-term implementation would require activity data within EMEP system
  - Implications for EMEP emissions – who calculates what?

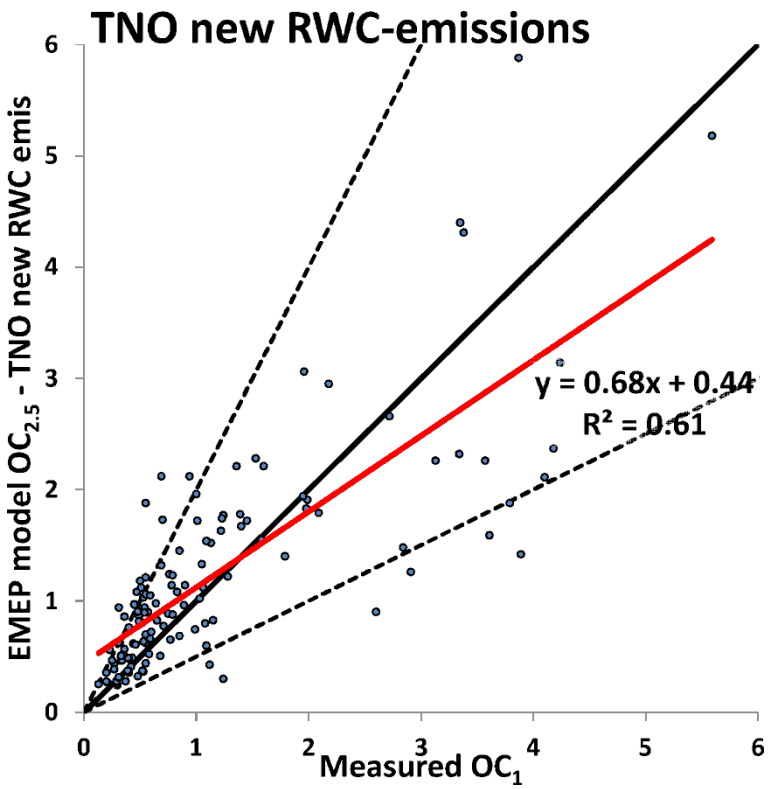
Dynamic NH3 in EMEP? (ECLAIRE/EnsClim)

- New developments:
  - Sutton et al. - “Towards a climate-dependent paradigm” (Phil. Trans. R.Soc., 2013)
  - Suggests that climate change may increase NH3 emissions substantially (ca. 28-67% for 5C warming)
  - [2015 update – likely less than 40%, but still significant]
  - Stresses need for activity-based emissions, responsive to temperature and other meteorology



EMEP Model results





Example of improved model performance:
Organic carbon in fine particulate matter at Hyytiala