Regional OC/SOA and EMEP
- Background for NMR project

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Outline:

- Where do we start?
- What do the models suggest?
- What do SOA models have in common with string theory?
- What do the measurements tell us?
- The NMR project

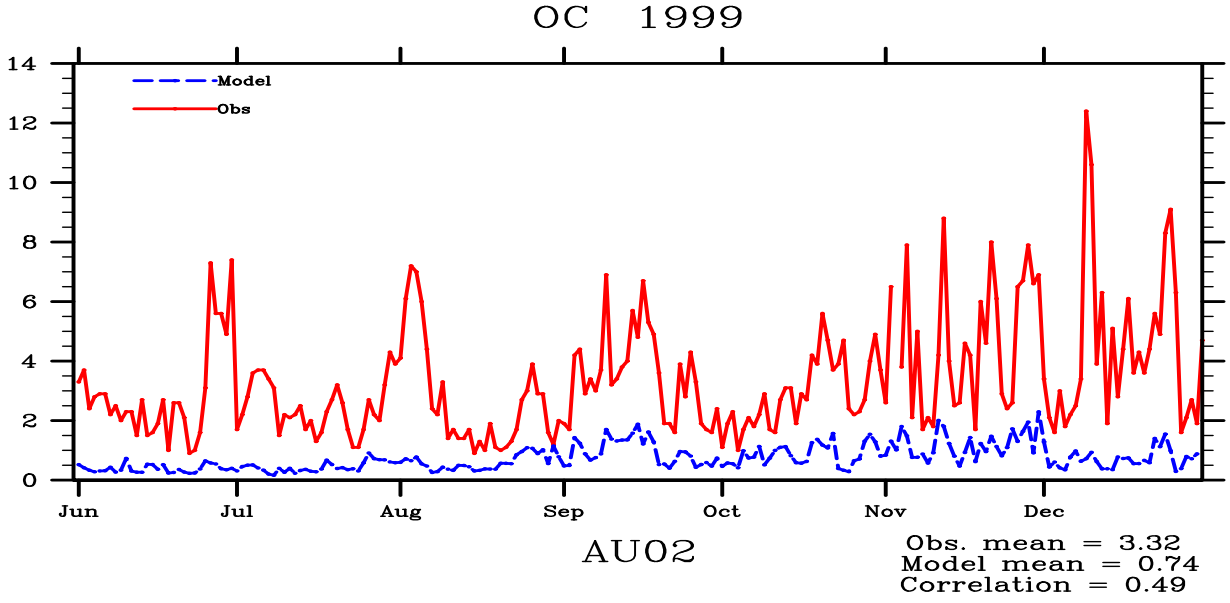
EMEP models

- ACID model - Simple chemistry - PMx mass
- OZONE model - full photochemistry - PMx mass
- AERO model - - Simple chemistry - aerosol dynamics

Where do we start?

- Basic EMEP models include primary OC (POC) and EC

  These consistently underpredict OC:



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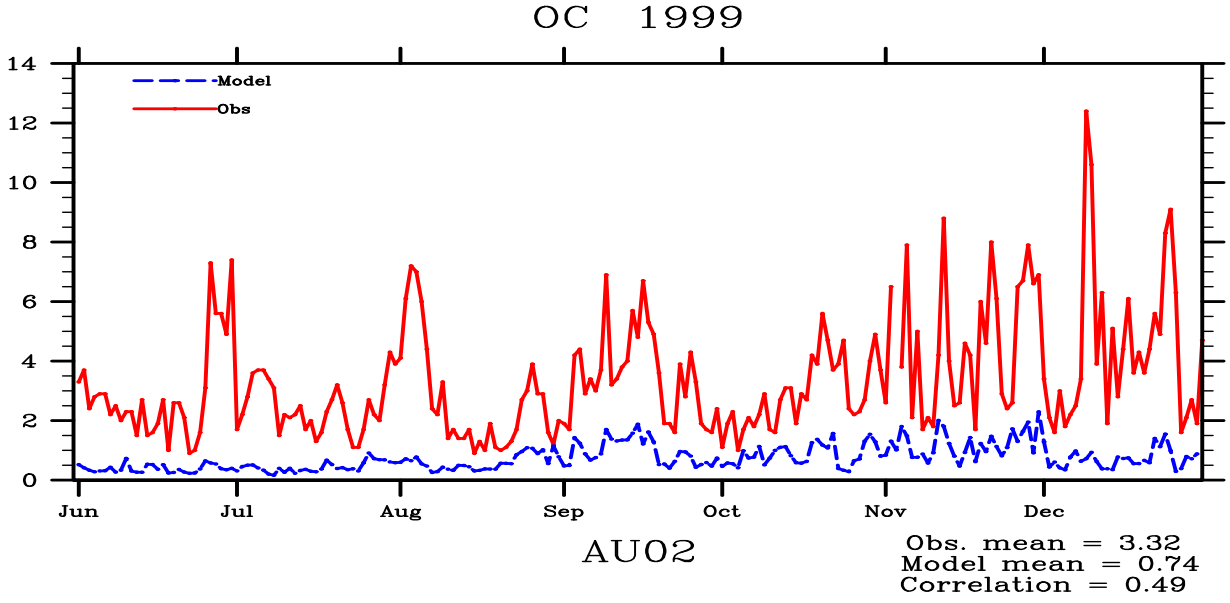
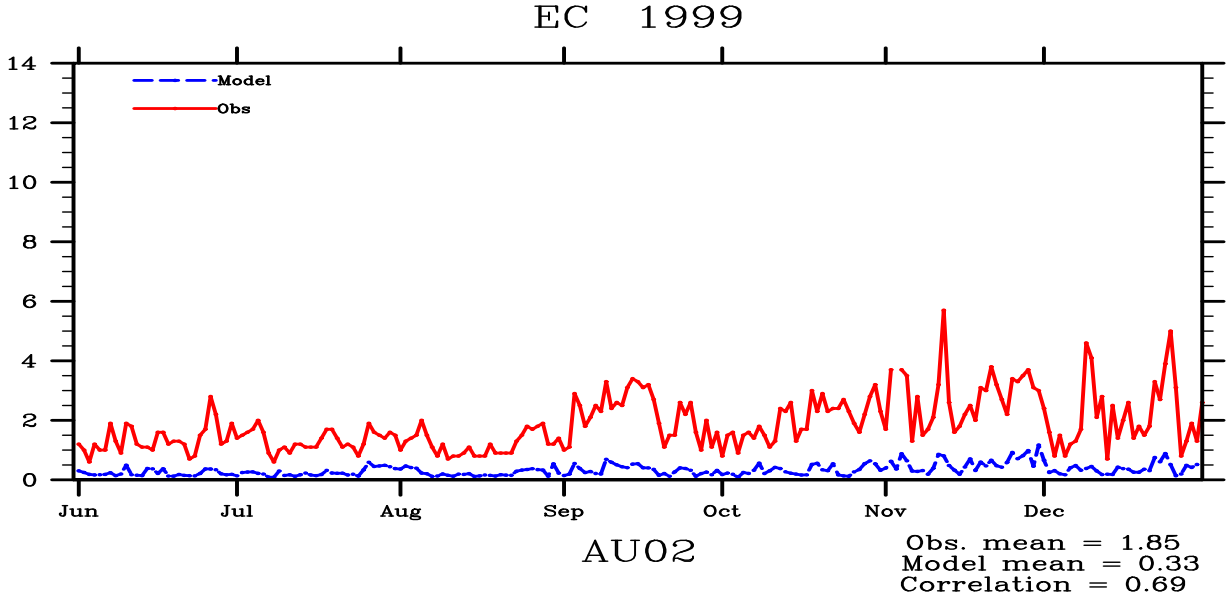


- Could it be SOA?

But ....

- We also underestimate EC!



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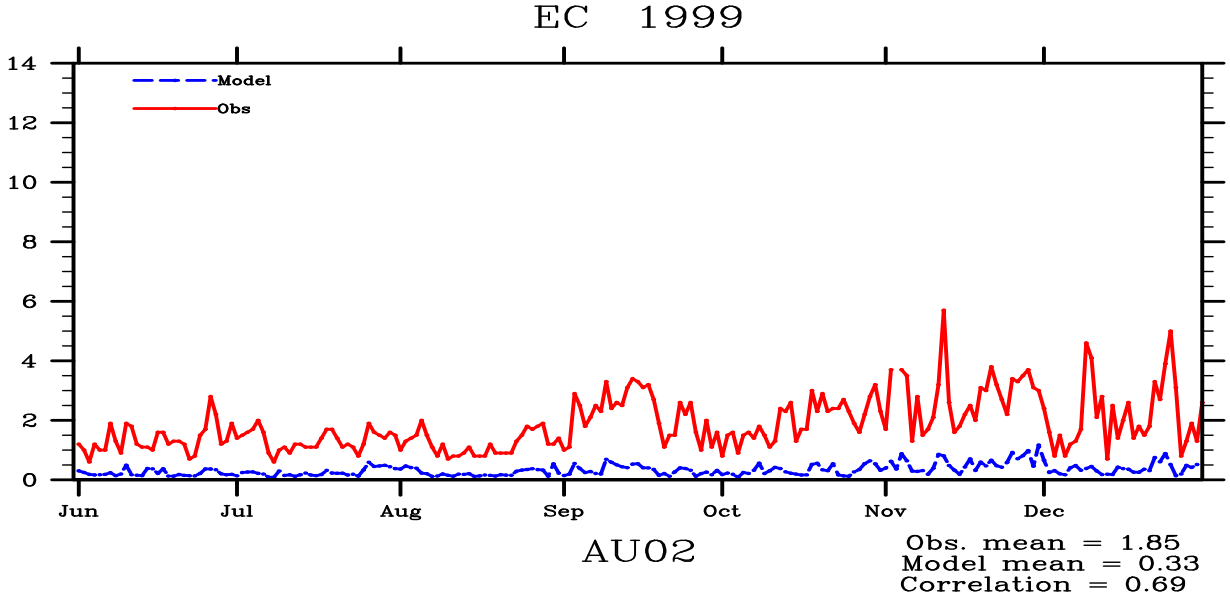


- The first major problem is then to reconcile emissions of primary EC with measured values

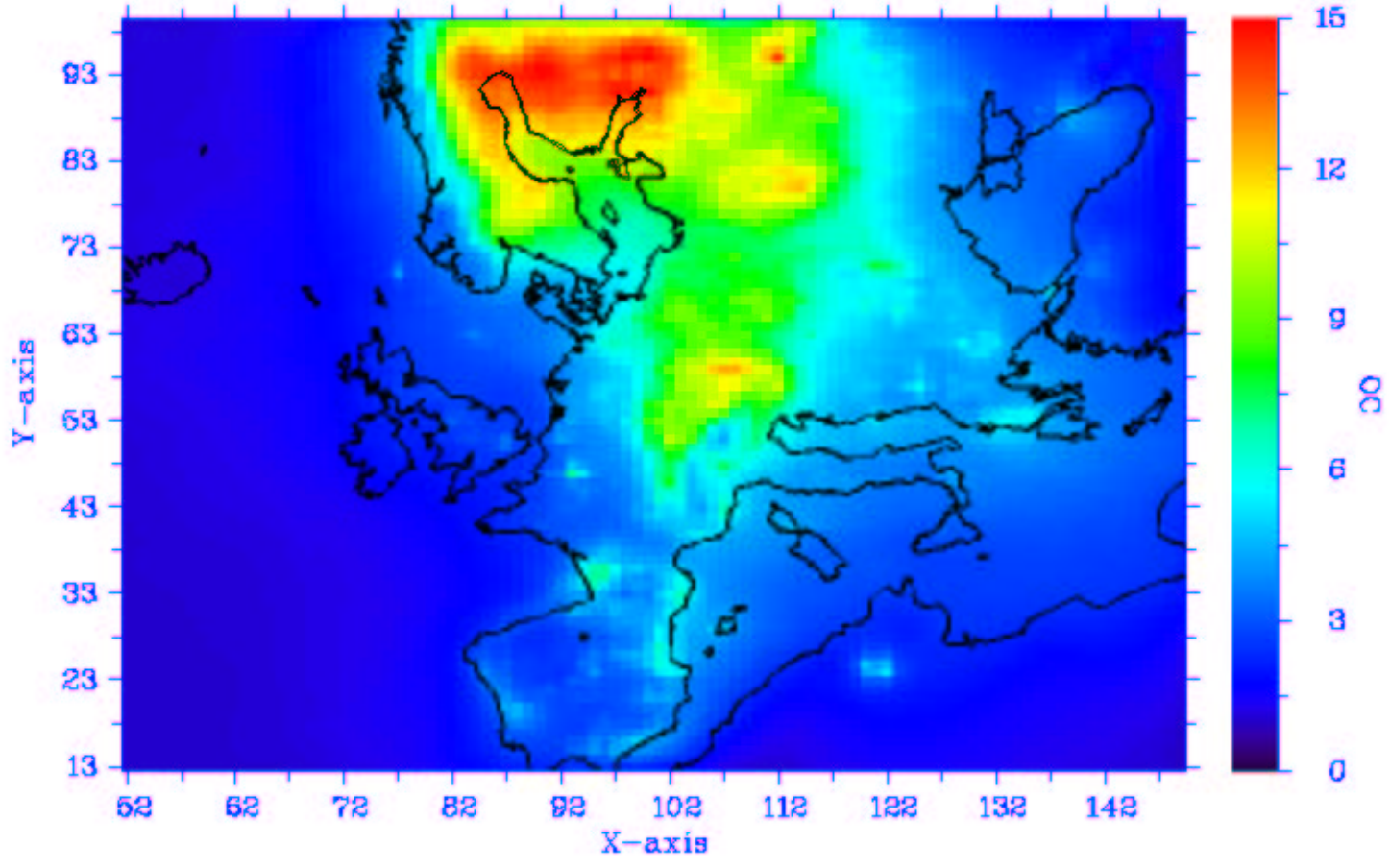
The EMEP SOA model

- Emissions characterised as:
  - 'Oil': Fossil-fuel combustion emissions
  - 'Wood': Residential combustion
- Existing and Secondary OC as:
  - ASOA: Anthropogenic SOA (from aromatics)
  - BSOA: Biogenic SOA (from terpenes)
  - BGND: Background OC (mixture oil/wood type)
- Gas/Particle partitioning (Pankow-type approach - see Andersson-Sköld and Simpson, 2001)

NOTE: the 'wood' category is clearly a gross exaggeration, but the aim here is to look at seasonal cycles rather than absolute levels.

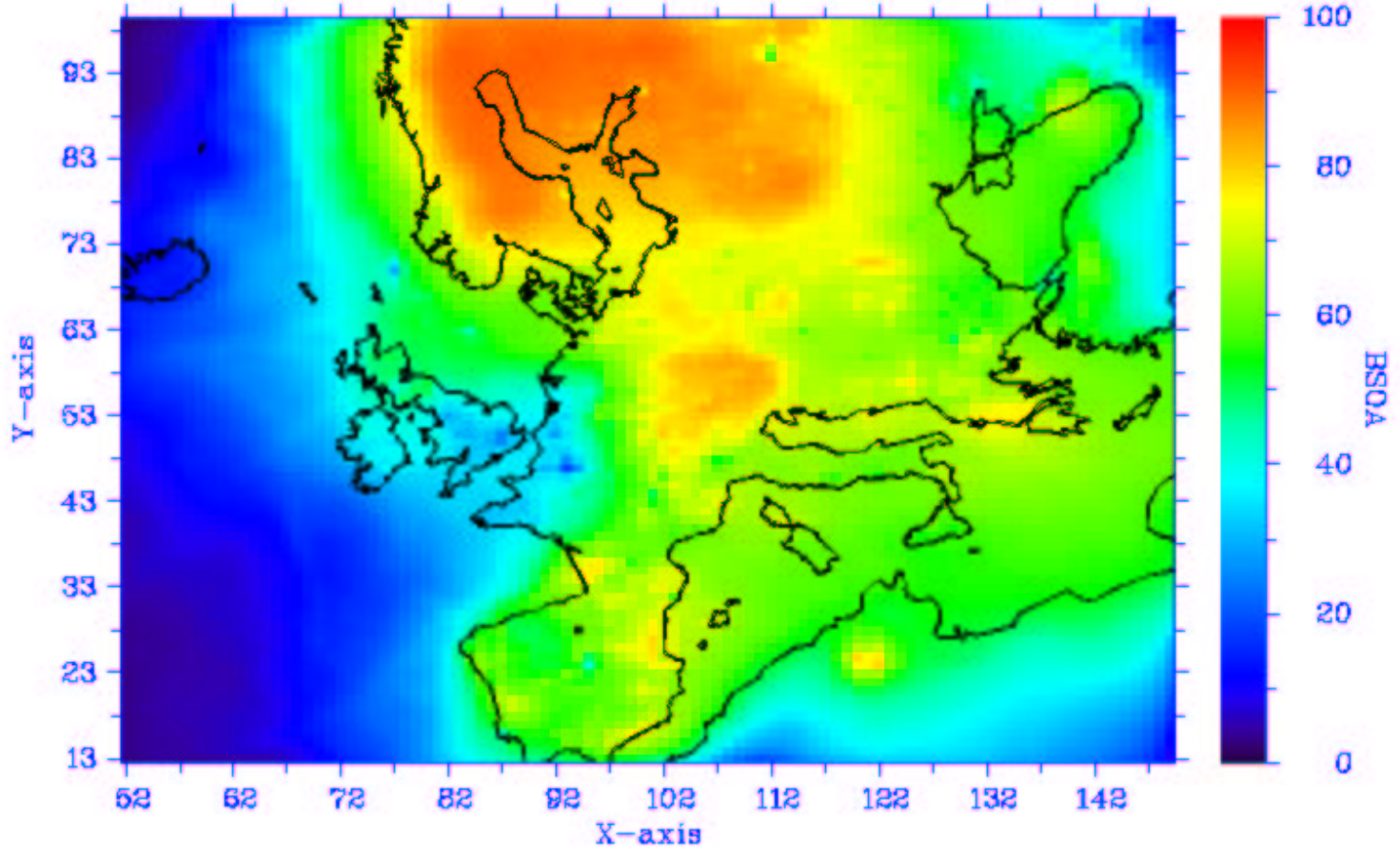
EMEP SOA Model:

Results: Annual Average OC, year 2001 (ug/m3)



BVOC Contribution

Results: Contribution of BVOC to OC (%)



AVOC Contribution

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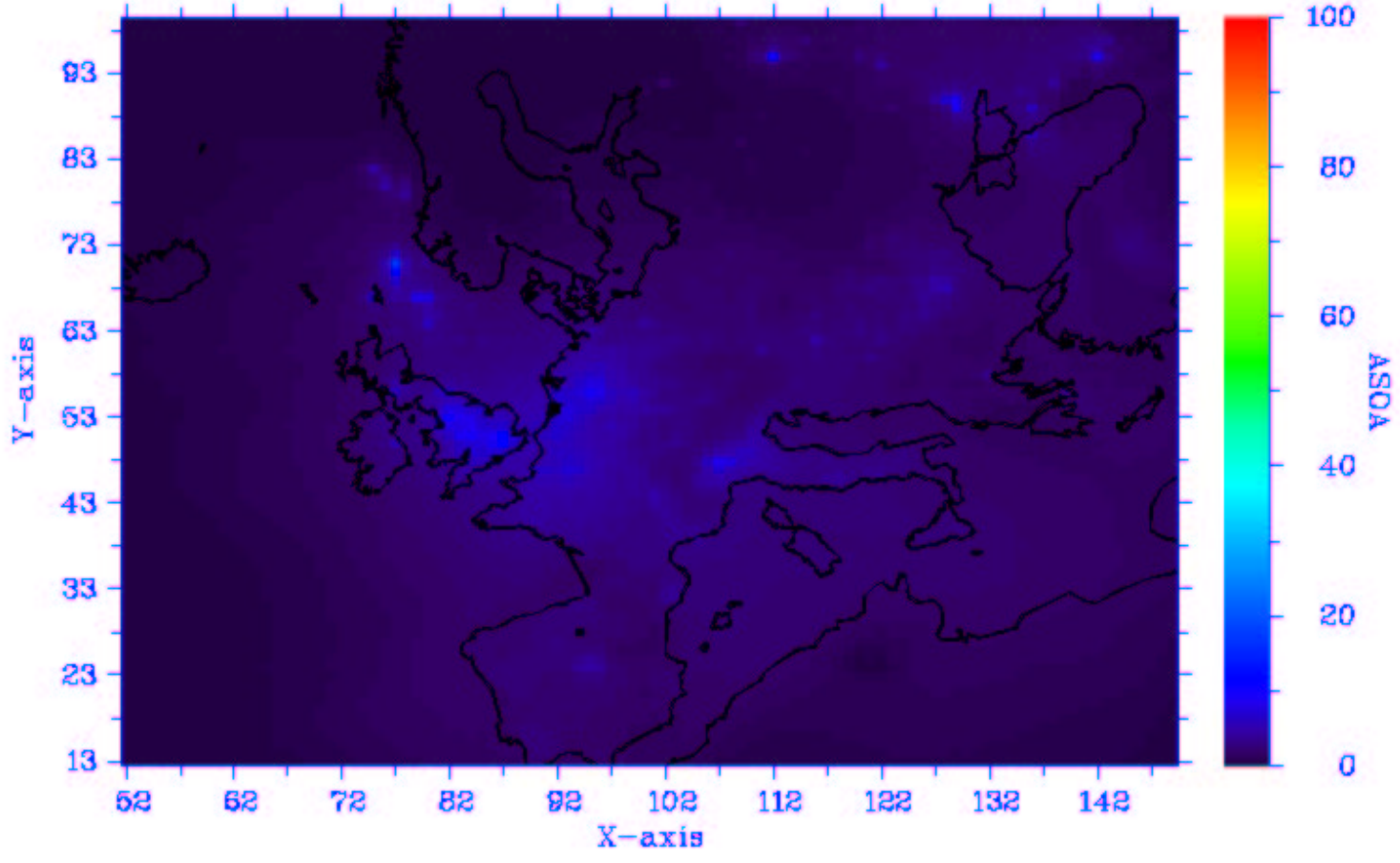
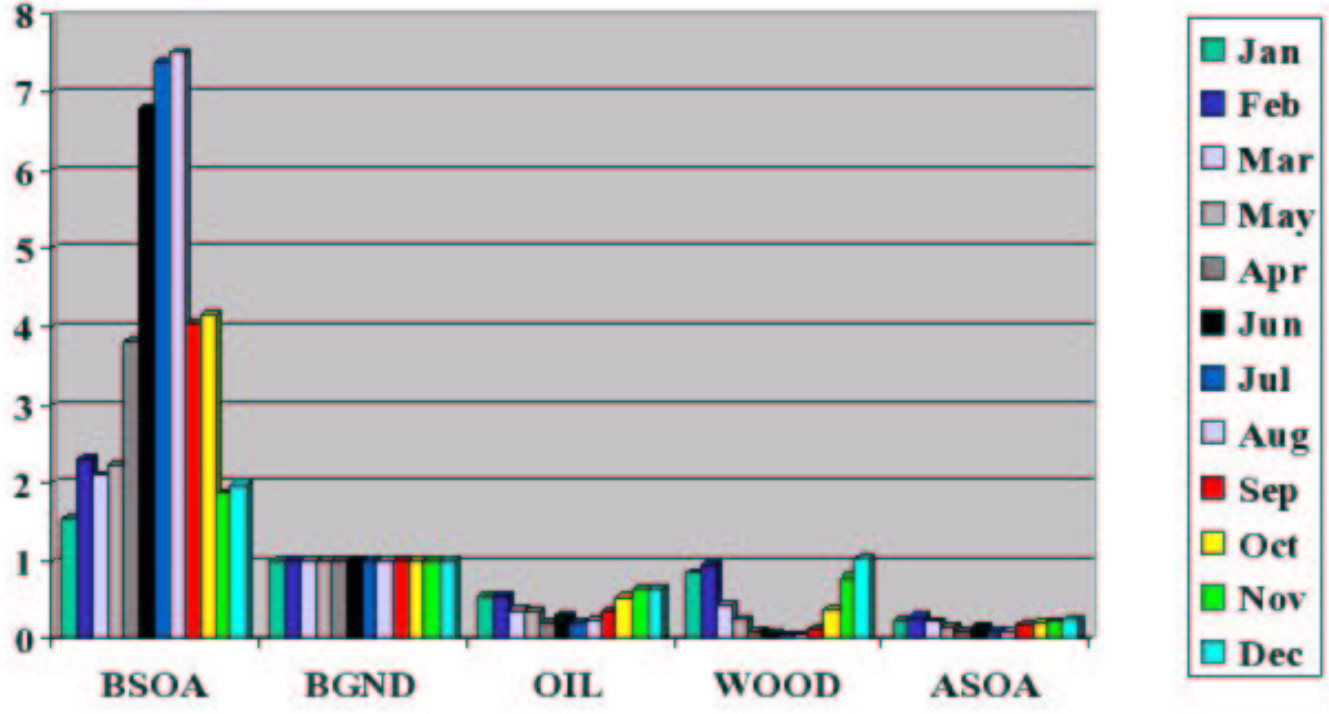


Seasonal Variation:

K-Puzsta, Hungary:



Note: The BGND contribution is held fixed in the model.

Model results suggest:

- A summer maxima in SOA caused by biogenics
- Anthropogenic contributions have winter maxima, but are much smaller
- Maximum OC location coincides with maximum BSOA, in Northern Europe

State of SOA Modelling

- Model theories change every year!
- Over last 10 years we have seen:
  - Fixed-yield theories
  - Need to exceed P^{sat}
  - Gas-Particle partioning (α-K) - succesful for smog-chambers
- Possible reactions within the aerosol invalidate most current theories!
- Increasing evidence for polymerisation and other reactions within aerosol

String theory?

What do SOA models have in common with string theory?

- Easy for modellers to produce ’pretty plots’ and numbers for SOA

String theory?

What do SOA models have in common with string theory?

- Easy for modellers to produce ’pretty plots’ and numbers for SOA
- But impossible to prove them wrong - there are insufficient measurements!

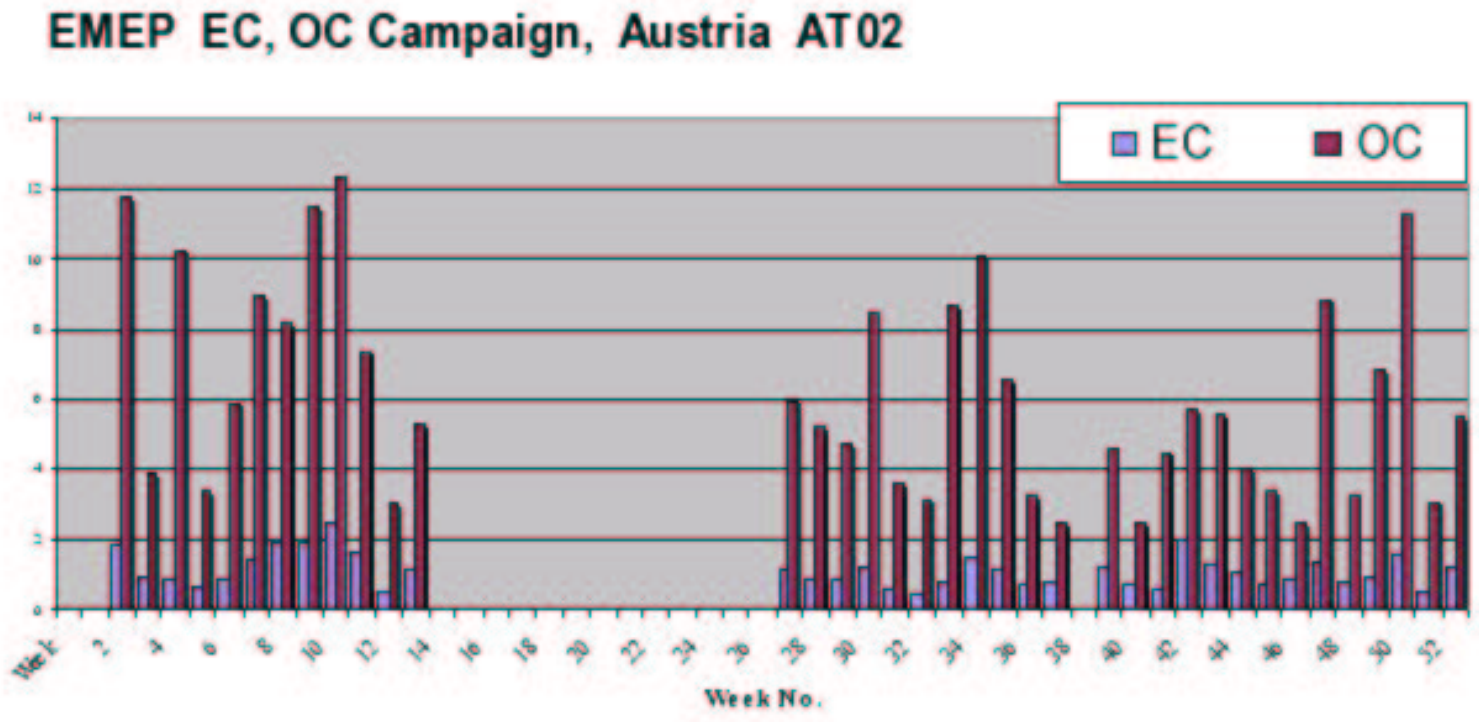
Measurements?

Sources of Data:

- NILU EC/OC Campaign, 2002-2003 - 24h sample of EC/OC once per week
- Austrian AUPHEP sites - daily EC/OC
- CARBOSOL (EU Project) - weekly EC/OC

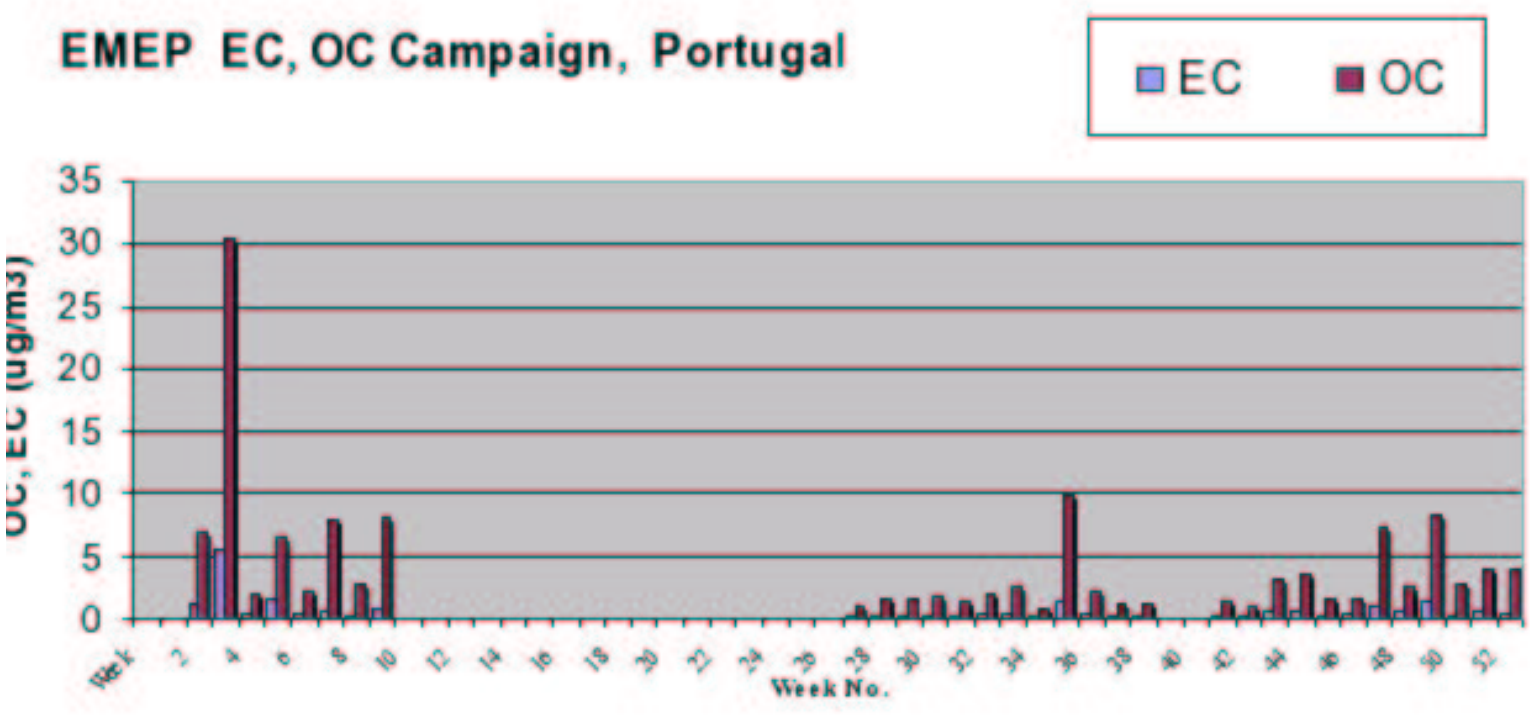
Investigation only just started - focus on OC/EC ratios

Seasonal variation?



Comment: winter concentrations similar to summer

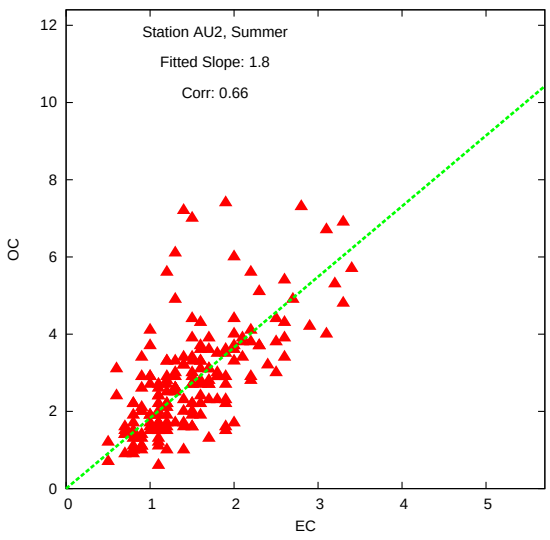
Seasonal variation?

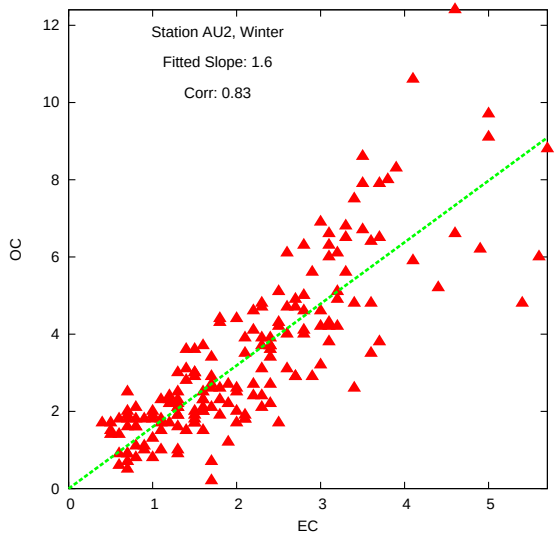


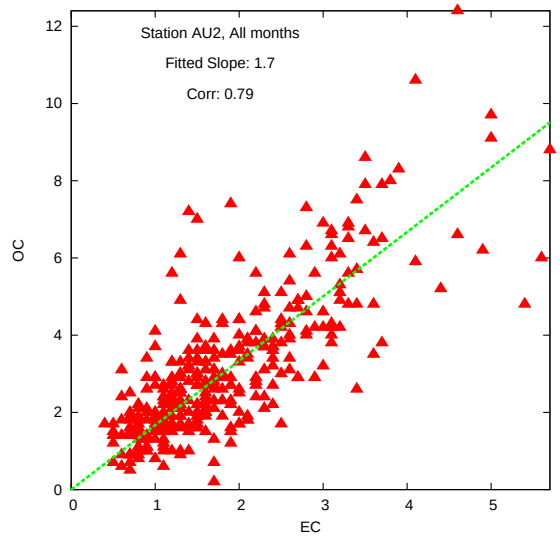
Comment: winter concentrations $\geq$ summer

OC/EC, Austria AU02

AUPHEP site - Daily data:



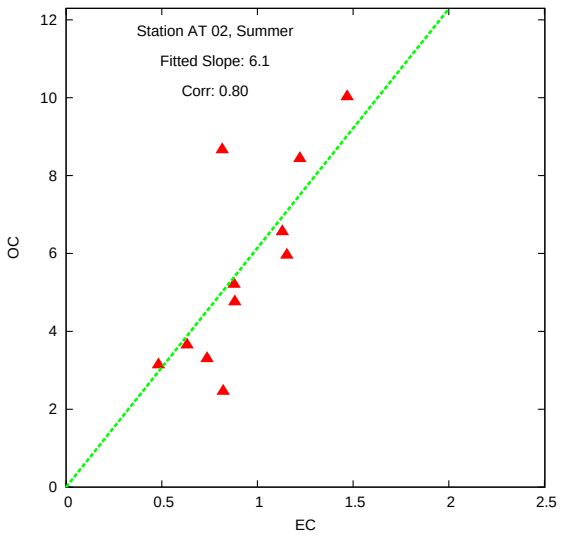


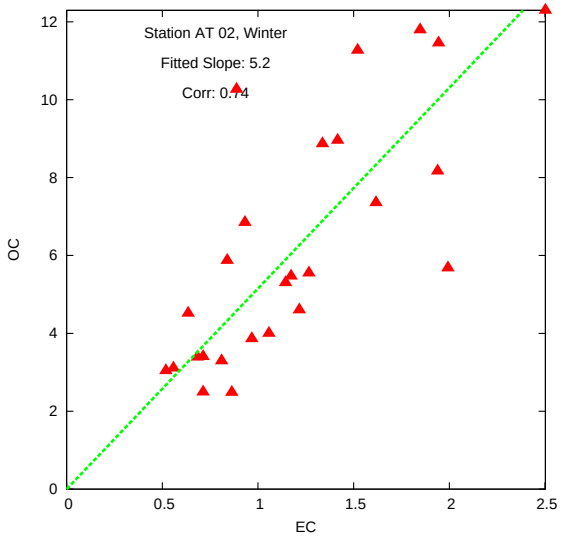


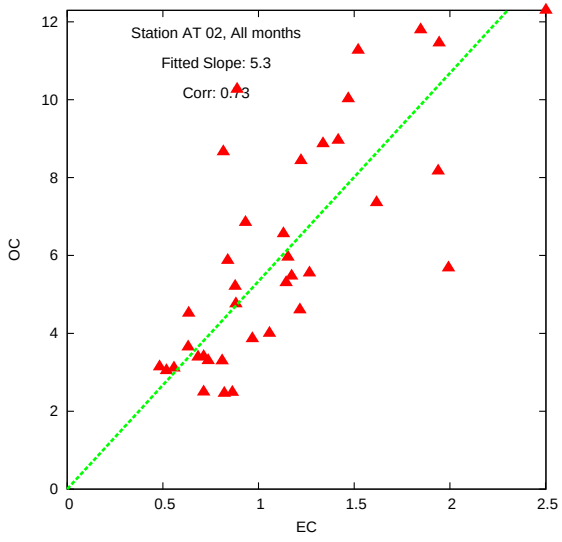
NOTE: slope very similar in all seasons, but scatter larger in summer.

OC/EC, Austria AT02

NILU EC/OC site - 24h data, once per week: (Illmitz)





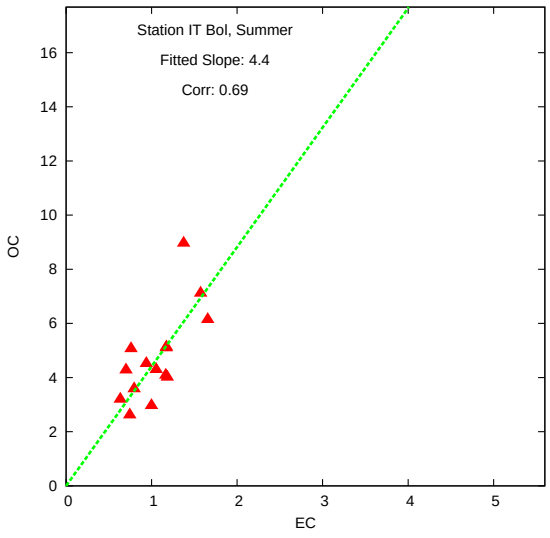


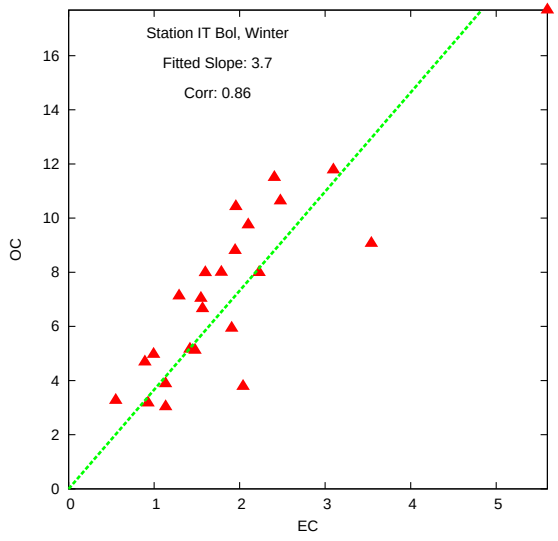
NOTE: slope much larger than from AUPHEP site. Why?!

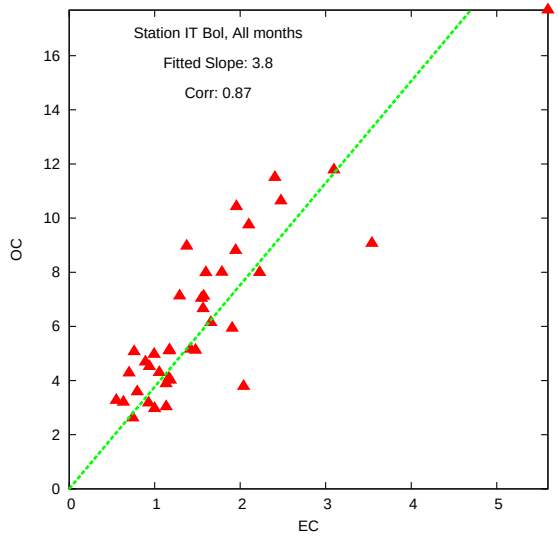
(Different methods?)

OC/EC, Italy

NILU EC/OC site - 24h data, once per week: (Belogna)



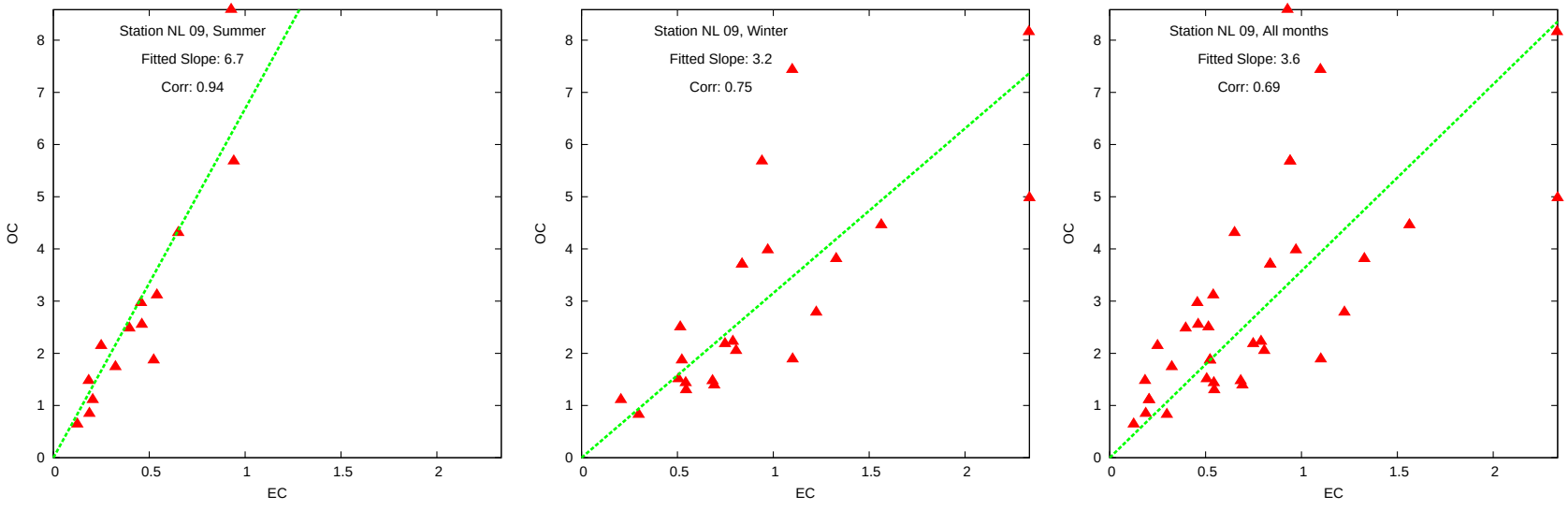




NOTE: slope very similar in all seasons.

OC/EC, Netherlands

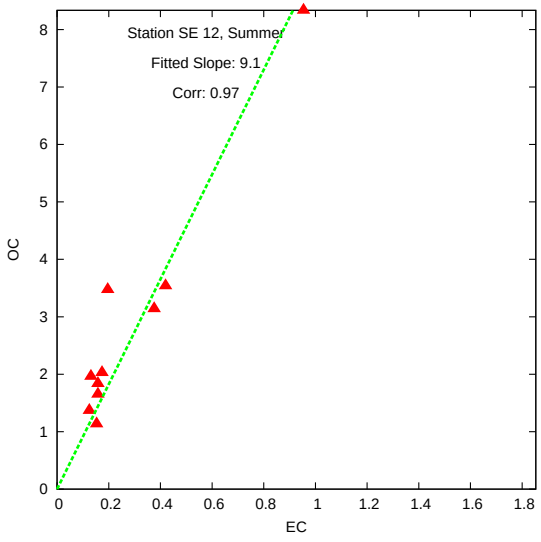
NILU EC/OC site - 24h data, once per week: (Kollumerward)

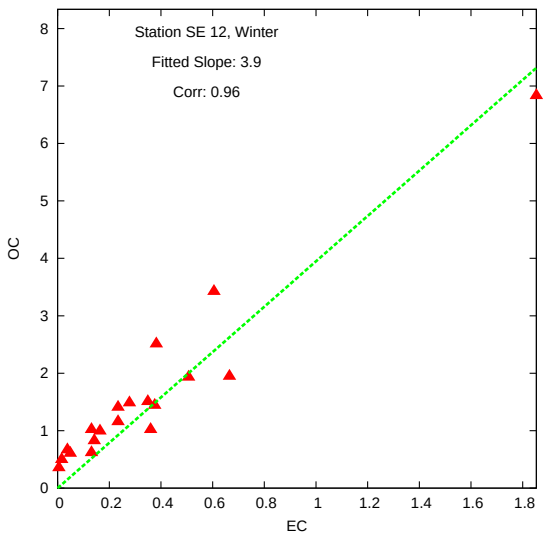


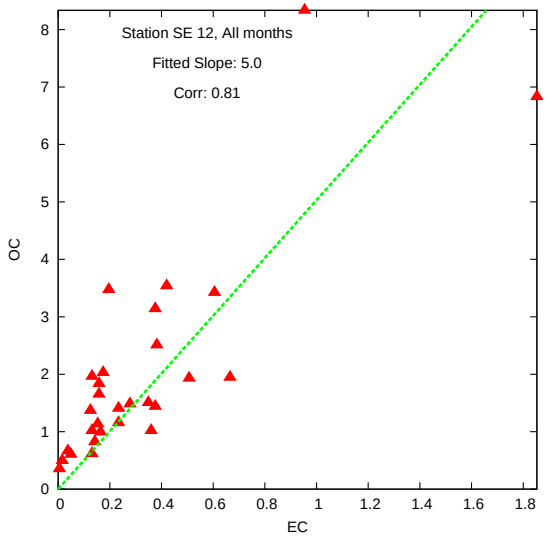
NOTE: slope very different! Why?

OC/EC, Sweden

NILU EC/OC site - 24h data, once per week: (Aspvreten)







NOTE: slope very different! Why?

Summary of OC/EC

OC/EC Ratios from NILU Campaign:
(Sorted by increasing summer-winter ratio, given in last column)

		Summer (S)	Winter (W)	All months	Ratio W/S (S/W)
Belgium	Ghent	1.9	2.4	2.2	0.79
Italy	IT04	4.2	4.5	4.4	0.93
Portugal	PT01	5.4	5.3	5.3	1.0
Austria	AT02	6.1	5.2	5.3	1.2
Italy	IT	4.4	3.7	3.8	1.2
UK	Peniciuk	3.2	2.2	2.4	1.5
Germany	DE02	10.1	6.0	6.5	1.7
Netherlands	NL09	6.7	3.2	3.6	2.1
Sweden	SE12	9.1	3.9	5.0	2.3
Finland	FI17	10.7	4.0	5.5	2.7

Comments on OC/EC

- For many sites there is hardly any difference in summer/winter OC/EC ratios
- Sites in warmer locations show small differences, e.g. AT, IT, PT - this does not directly support ideas of a large biogenic contribution
- Greatest differences in "cold" regions? Why?
  - Greater biogenic SOA in Northern Europe?
  - More primary biogenic OC in Northern Europe?
  - Greater condensation?
  - Artefacts in remote regions? (e.g. absorption on quartz filters?)

NMR Project

- Model predictions of summertime maxima in OC, due to BSOA, are not consistent with measurements at many sites
- SOA modelling is very immature
- Neither measurements nor modelling are currently good enough to explain OC levels.

NMR Project cont.

Aims to use both:

- Look for correlations between measured OC and:
  - Modelled primary EC and/or OC from different sources
    - e.g. fossil-fuel, wood, forest-fires
  - Modelled SOA from different sources
    - e.g. ASOA, BSOA
  - Modelled fields of precursors
    - e.g. AVOC (aromatics), BVOC (terpenes)
- i.e. a semi-empirical approach