



Norwegian
Meteorological
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EMEP modelling of Organic Aerosol; issues with SVOC/IVOC

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02/05/18

Primary organic aerosol (POA) – what is it?

All particles (**cores**) thickly coated (80-90% mass shells) via condensation.

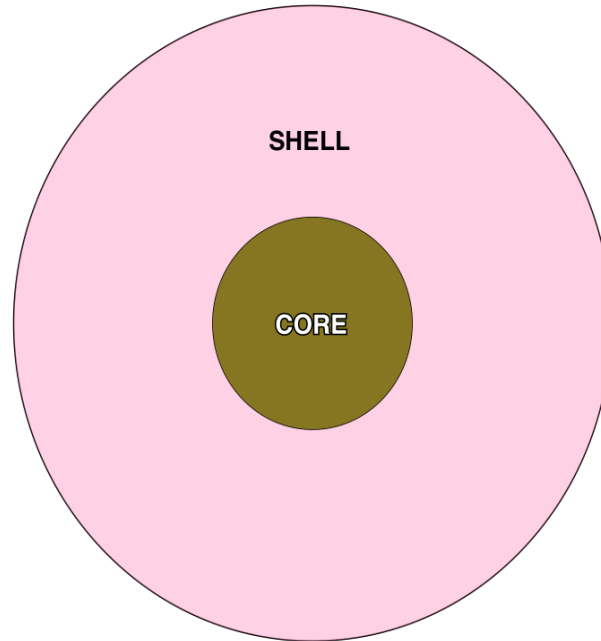


Fig from A. Robinson

- **Problem 1: what is in the emission inventory – core or whole (includes SVOC)?**

Primary organic aerosol (POA) – what is it?

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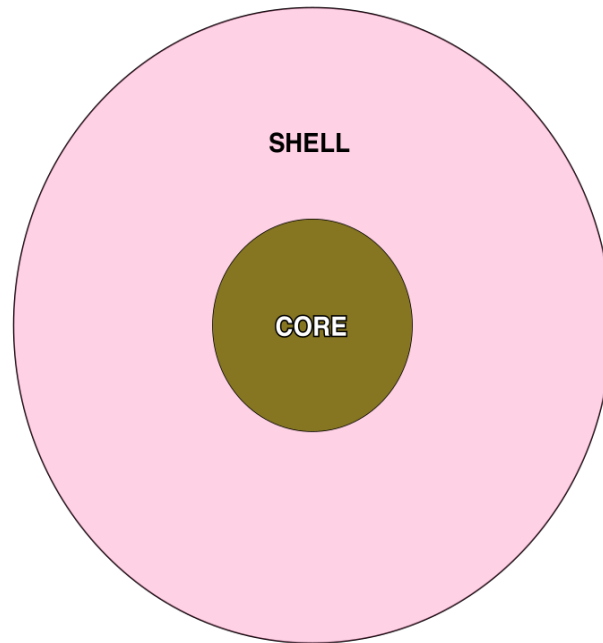


Fig from A. Robinson

- **Problem 2: the amount of SVOC in emission factor measurements overestimates what enters the atmosphere. Ca. 50% can evaporate!**

Semi, intermediate volatiles (SVOC, IVOC) also important!

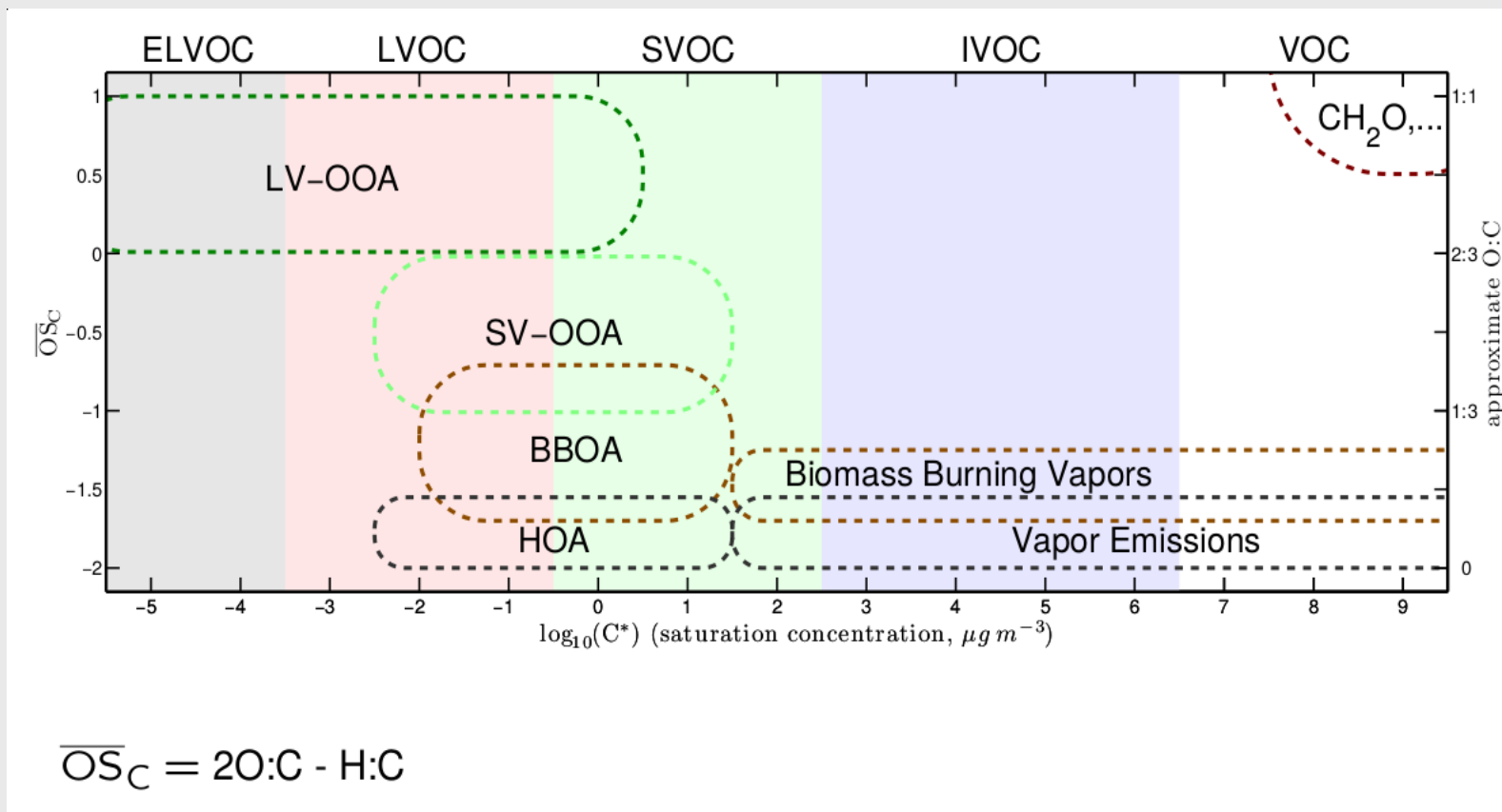
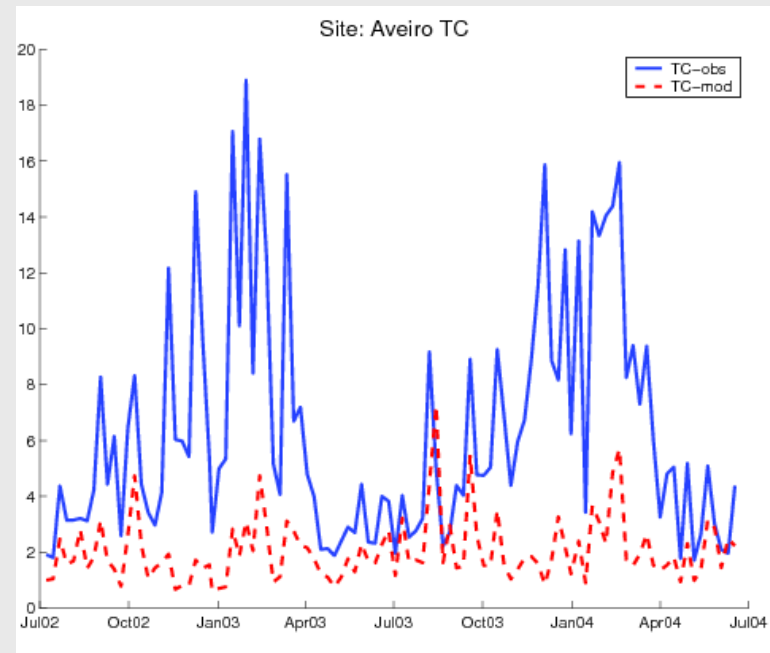
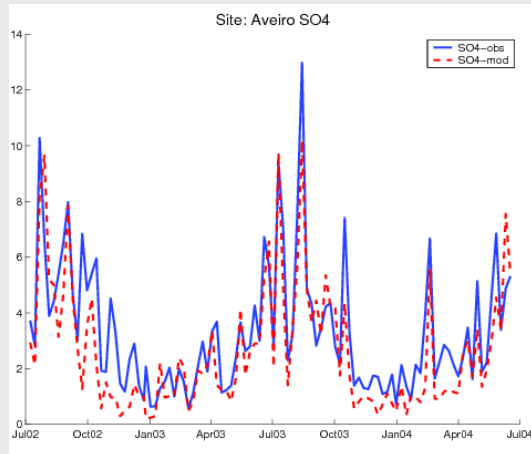


Fig from A. Robinson

- **Problem 3: Some SVOC and all IVOC are in gas-phase, but not the PM or the VOC inventory! Typically, modellers may add 150% extra to POA to account for this**

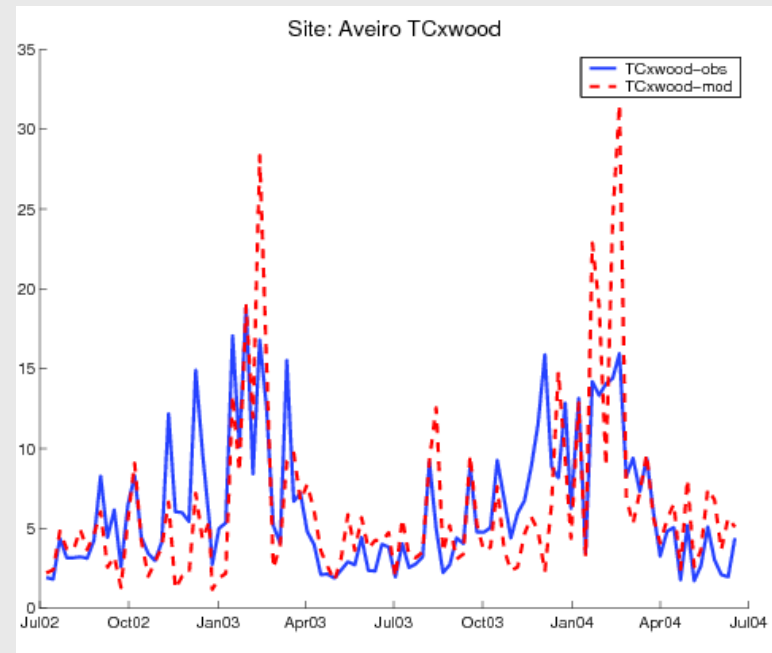
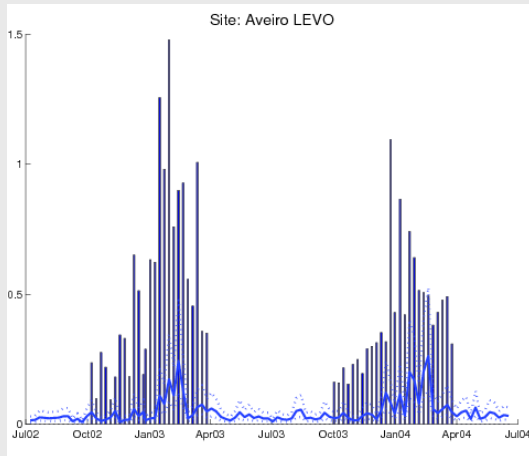
Early lessons in organic aerosol (CARBOSOL project)

- First OA results not promising, e.g. Aveiro (Simpson et al., 2007)
- Incorrect conclusion: problems with model



Early lessons in organic aerosol (CARBOSOL project)

- Aveiro revisited, after use of levoglucosan-scaling (Simpson et al., 2007)
- Correct conclusion: problems with inventory (or site-representativity)



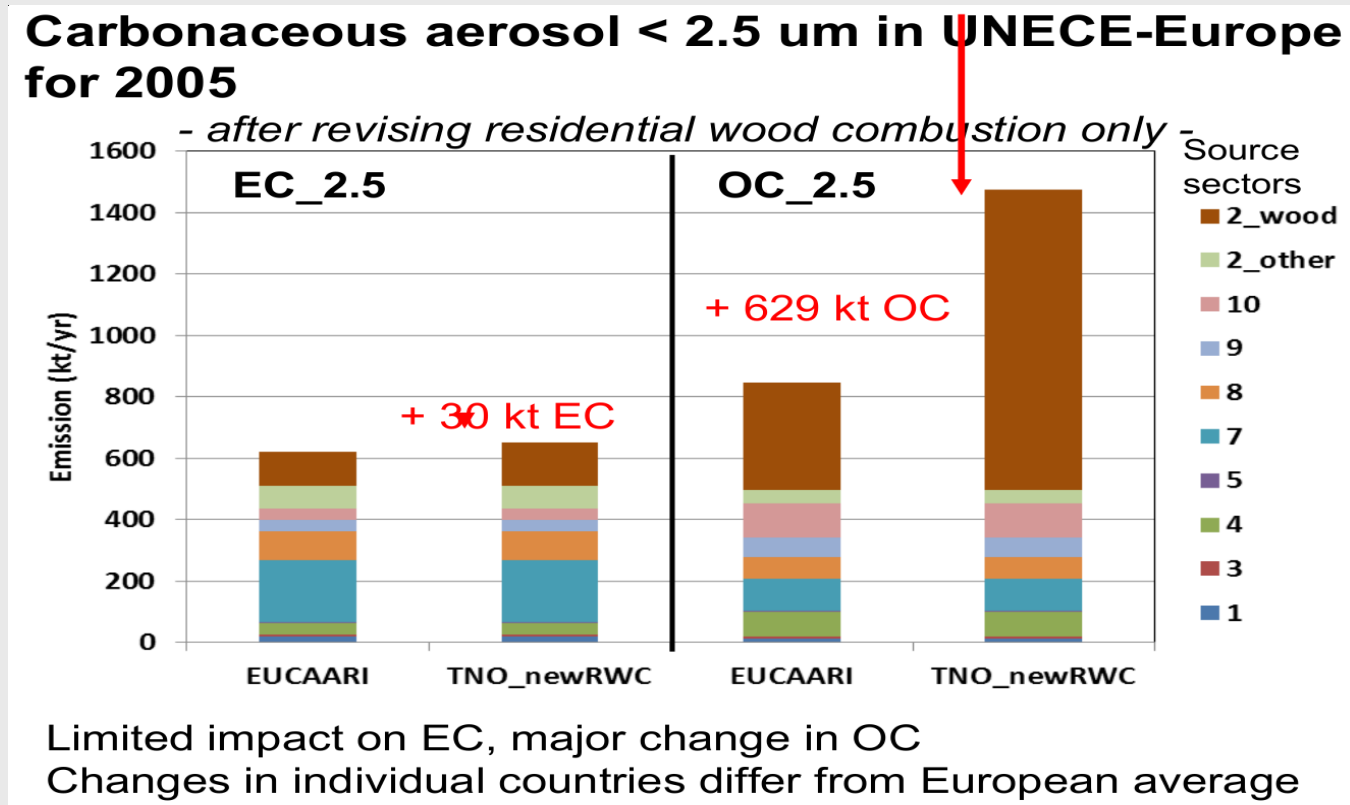


New emission inventory for residential biomass combustion (Denier van der Gon et al., 2015, Genberg et al, 2013)

- Emissions treated in a consistent way
- Emission factors based on dilution tunnel measurements
- Higher organic aerosol emissions than earlier inventories



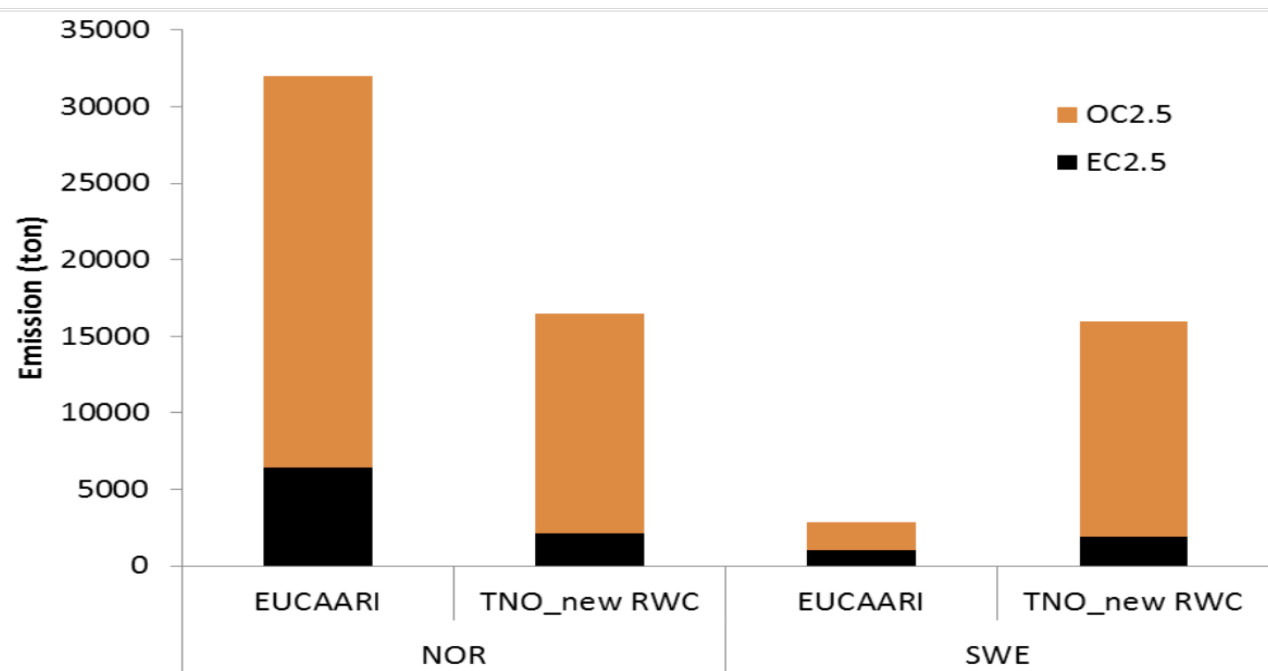
Denier van der Gon et al., 2015:



➤ See also Genberg et al, ACP, 2013

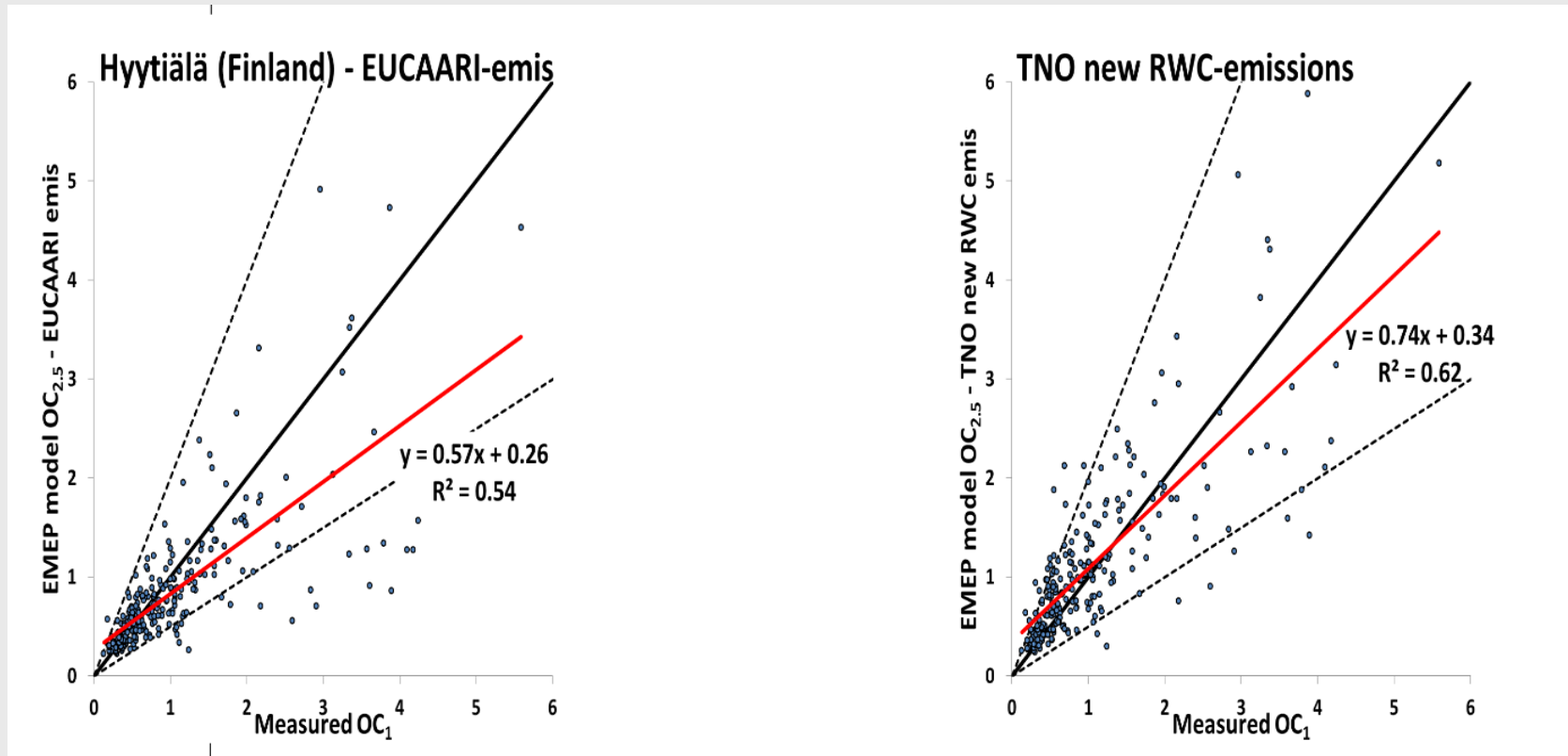
Denier van der Gon et al., 2015:

Norway & Sweden total RWC emissions 2005



➤ See also Genberg et al., 2013

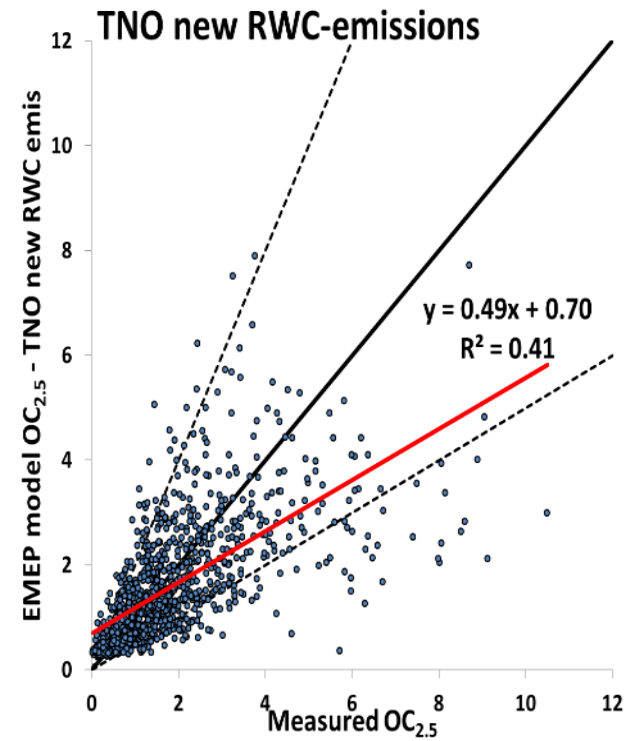
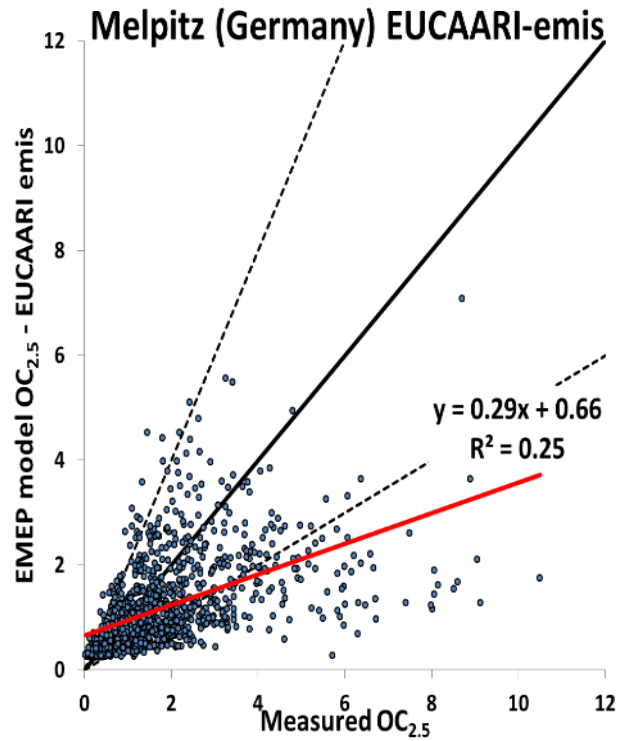
Denier van der Gon et al., 2015:



➤ COMPARISON OC1, Hyytiälä, Finland

➤ (Significant improvement at all sites)

Denier van der Gon et al., 2015:

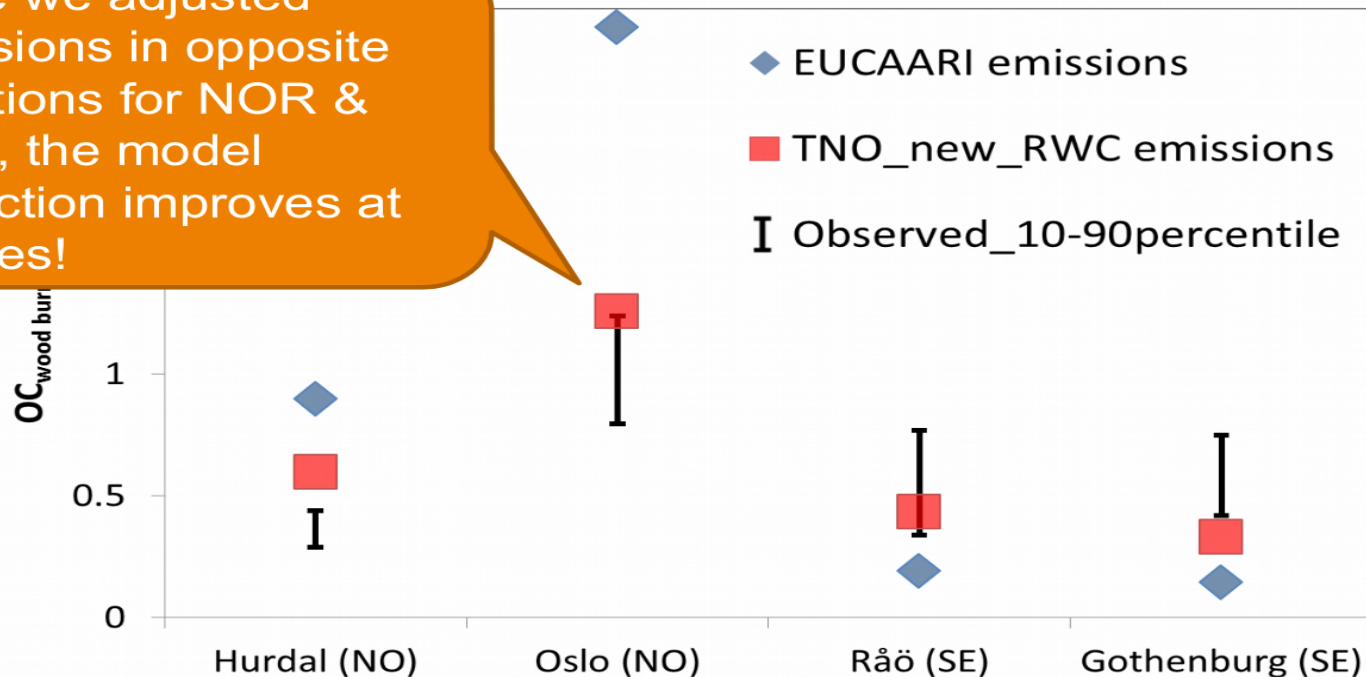


➤ COMPARISON OC1, Melpitz, Germany

Denier van der Gon et al., 2015:

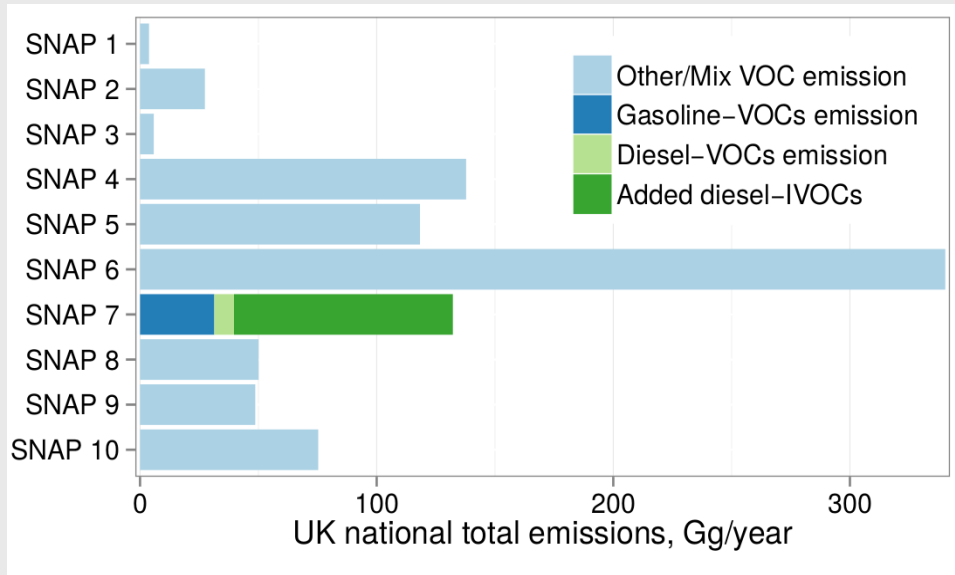
Wood Burning OC - source-apportionment studies Winter campaigns in Scandinavia

While we adjusted emissions in opposite directions for NOR & SWE, the model prediction improves at all sites!



Comparison of model calculated OC from wood burning to source-apportionment data from measurement campaigns during winter in Norway and Sweden

Emerging issues: diesel IVOC



- Dummore et al. (ACP, 2015) found major underpredictions in long-chain HC in London air, ca. factor 4 for C9, factor 70 for C12!
- These were estimated to have major impact on OH, O3
- Ots et al., 2016 (ACPD, 2016) used these data to estimate IVOC (fig. above), in proportion (10 x!) to VOC (not PM2.5) emissions....



Diesel IVOC cont., Ots et al (EMEP4UK) results

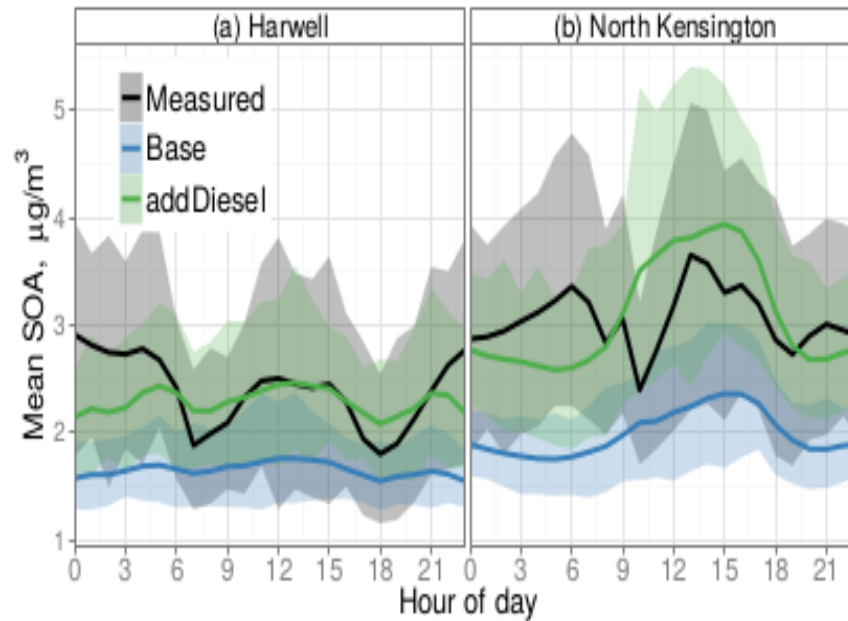
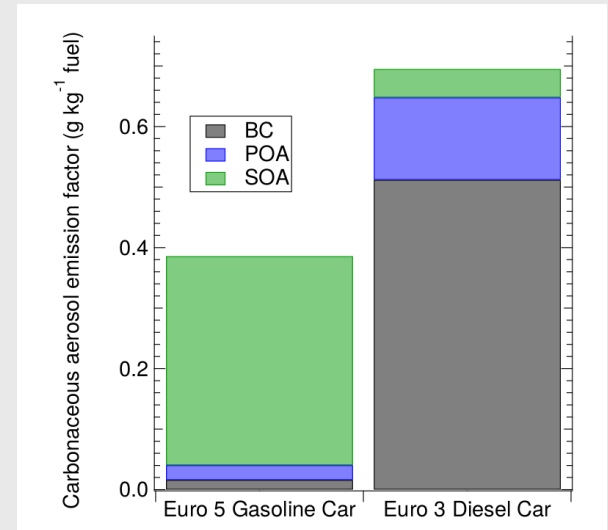


Figure 9. Average hourly profiles of modelled and measured SOA during the summer IOP. The shading is the 95% confidence interval.

- EMEP4UK setup. 5x5 km² resolution
- Inert POA + VBS for SVOC; IVOC

Gasoline? Newer diesel?

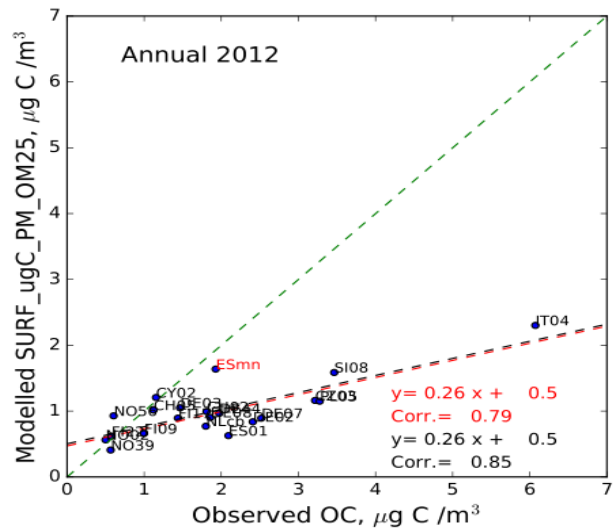


- Platt et al. ACP 2013 (PSI-chamber) suggested that gasoline cars had far higher SOA potential (via IVOC) than diesel.
- Why different to London for diesel? Seems to be related to technology – diesel here had oxidation catalyst and low NMVOC emissions.
- Recent American work suggesting IVOC ~ 20-25% NMVOC
- Conclusion? Existence of IVOC seems well established, with impacts on SOA, but quantification difficult.

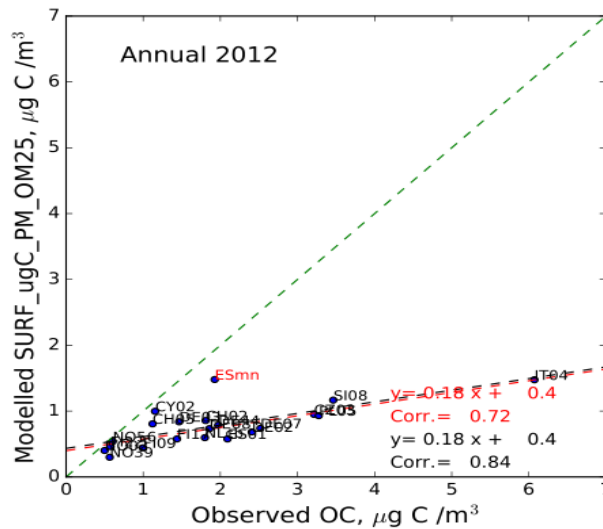
EMEP IVOC modelling, re-visited (Also with Robert Bergström and Hugo Denier van der Gon.)

- Tested 4 cases:
 - a) Ref1, Inert POA. Emissions of POA as given in inventory.
 - b) Ref1, volatile POA. (Total emis as Ref1, Inert)
 - c) As (b), but with CAMS-71 estimate of SVOC.
 - d) As (c), but with extra IVOC =
 - 3 x POA from SNAP-2
 - 0.25 x NMVOC from SNAP-7
- SVOC chemistry/VBS follows Bergström EMEP scheme
- IVOC uses Hodzic approach
- All VERY uncertain!

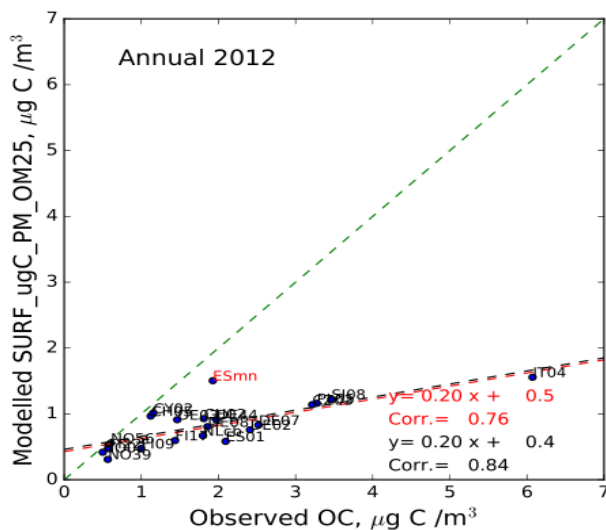
Impact of IVOC on EMEP calculations



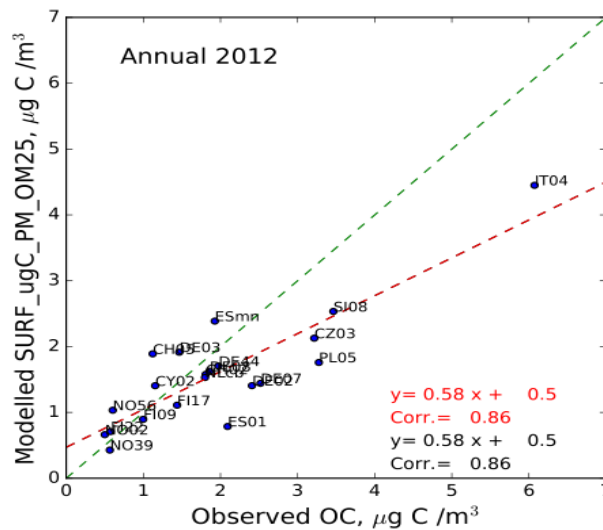
(a) Ref1, Inert POA



(b) Ref1, volatile POA



(c) Ref2, volatile POA



(d) Ref2, volatile POA + IVOC

POA/SVOC/IVOC: Conclusions

- The basic emissions factors (EFs) are likely the main source of errors in modelling POA and some SOA
 - and S/IVOC assumptions can have major impact on SOA
 - Large need for new measurements, in 'realistic' conditions -- these should account for volatility, S/IVOC, etc, as far as practical.
- In shorter term
 - PM inventories need to be harmonised
 - we need to know what we have!! (Apples or oranges?)
 - Emissions (eg IVOC) are changing very quickly
 - Should the 'modellers' be allowed to add these?
 - Task for TFEIP, Guidebook, EMEP