



# Assessment of regional effects using complex models

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Evaluation of complex models is difficult

Inter-comparisons are a good way of understanding model behaviour

Operational evaluation is not enough

Uncertainty can be averaged in integrated sectorial or domain aggregated assessments

Local uncertainties may be a problem particularly for a regulator

Sector changes v individual sources

Source attribution needs a model or AIRTRACK analysis

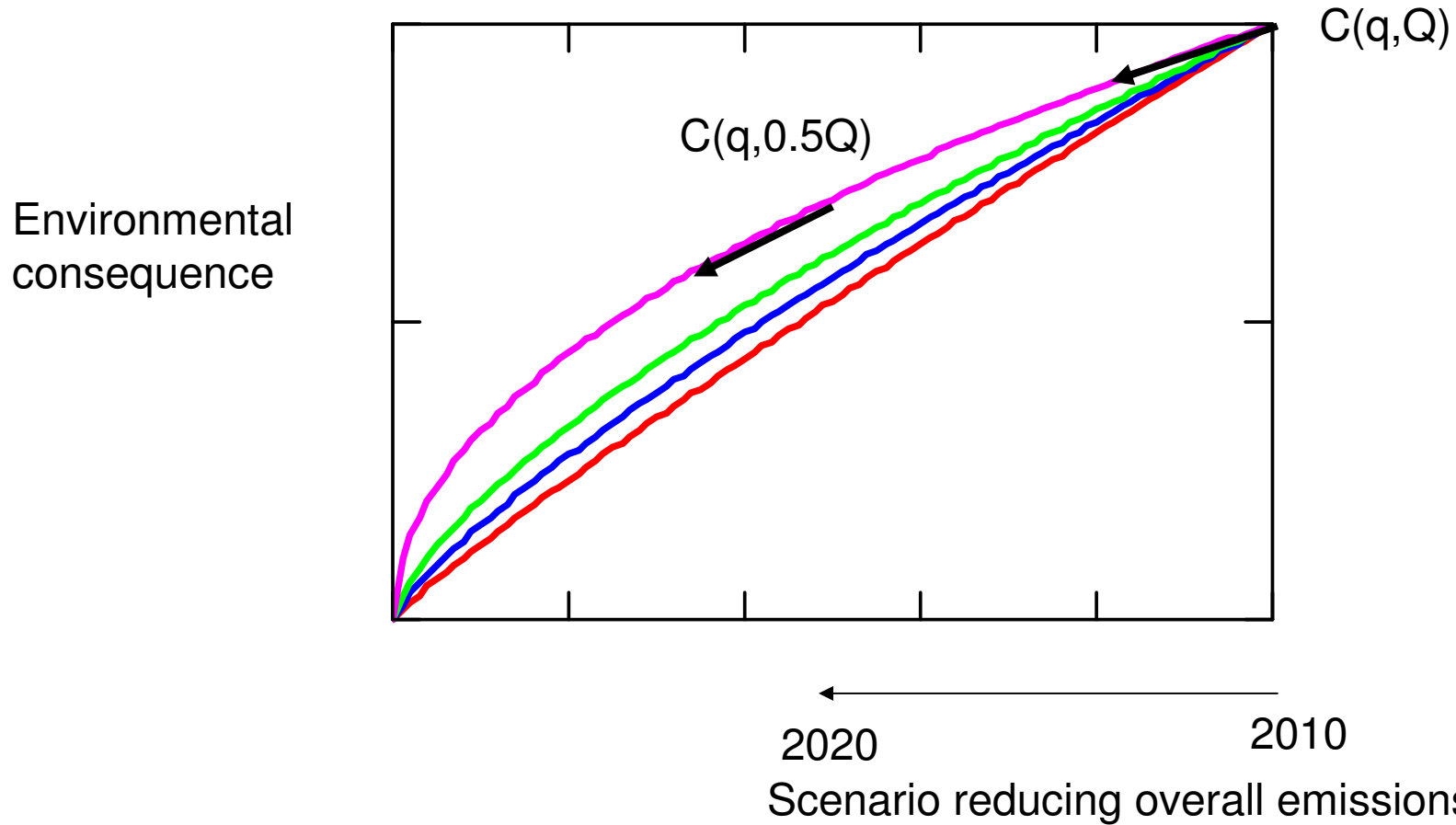
We have looked at footprints - regulatory and diagnostic value

Particularly for secondary pollutants such as ozone PM which are difficult to do any other way. One needs a chemical transport model

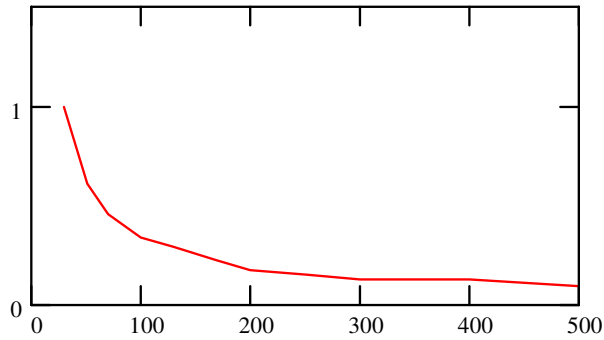
Capability of regulator's staff. Be practical.

Multiple policy options or sensitivity analysis.

Footprint  $C(q,Q)$   
where  $q$  is source strength  
 $Q$  background i.e. all the other sources

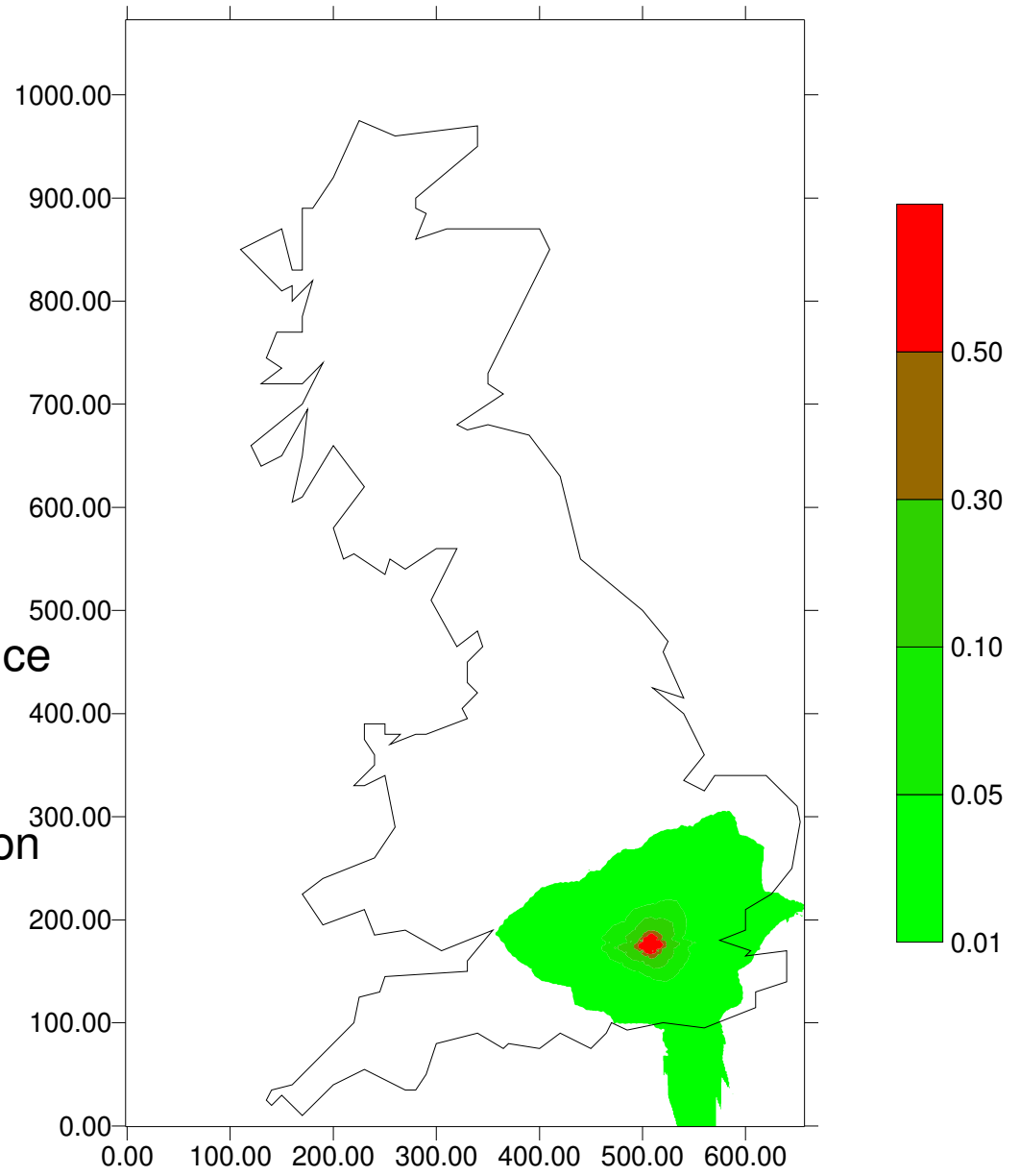


We have not done 2020 yet with CMAQ. Some systematic approximations may suffice.

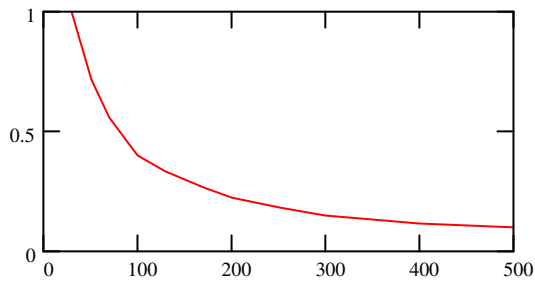


Average dependence on distance  
 $r$  along radial trajectory

Annual average NO<sub>2</sub> concentration  
from Heathrow in  $\mu\text{g m}^{-3}$   
CMAQv4.6 at 1km resolution

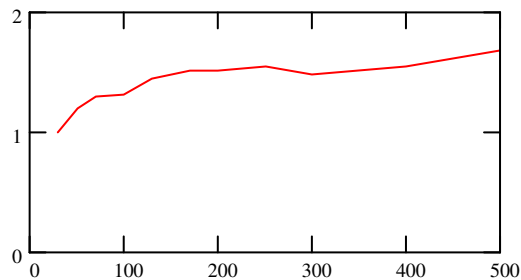


Example of the footprint from a stationary major point source e.g. power station. This is needed for regulation (1) response to change, (2) source apportionment (responsibility).

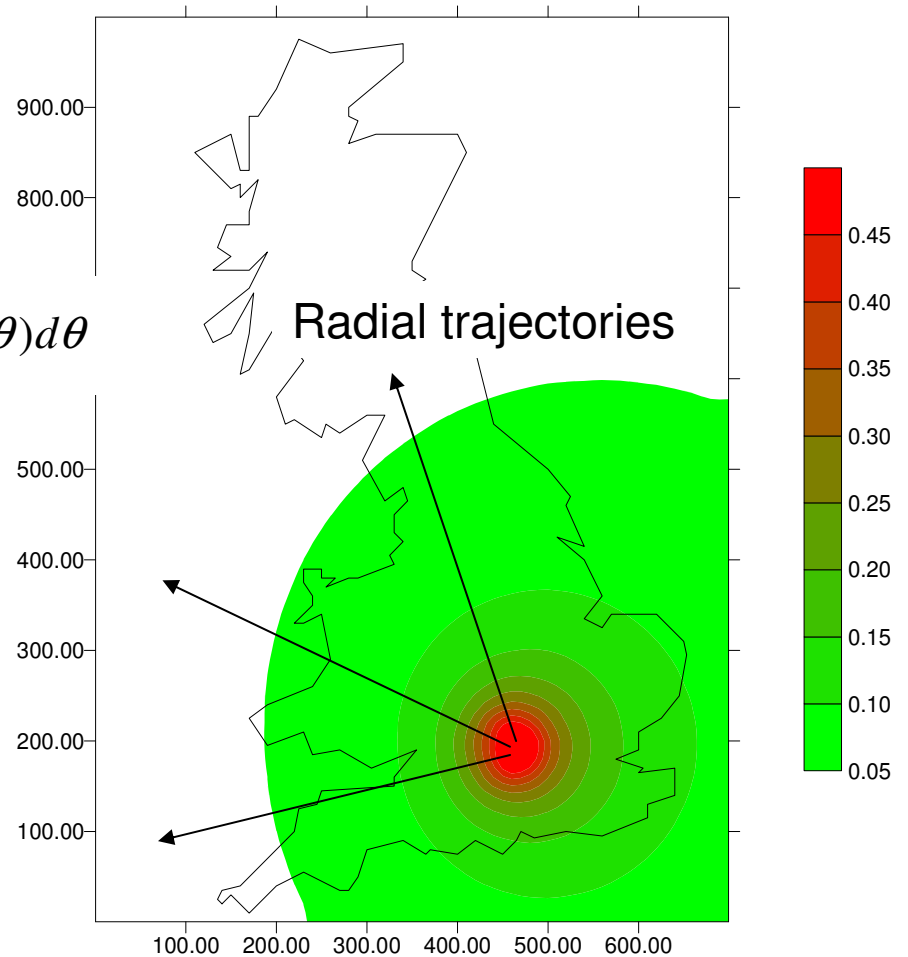


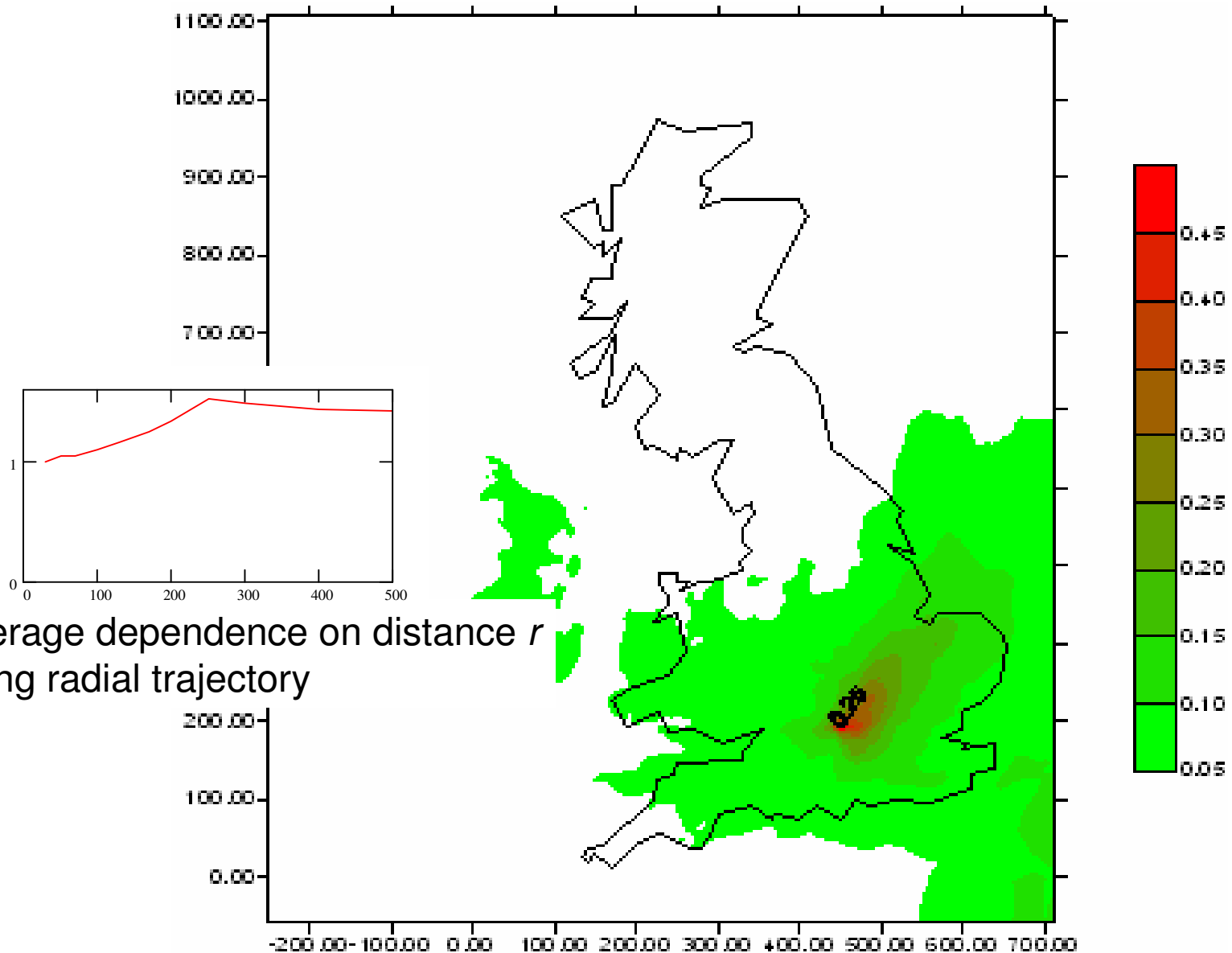
Average dependence on distance  $r$  from source

$$\frac{1}{2\pi} \int_0^{2\pi} C(r, \theta) d\theta$$



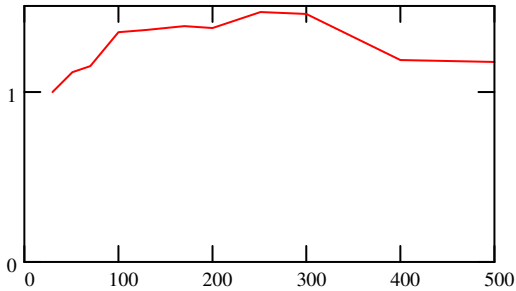
Average dependence on distance  $r$  along radial trajectory  $\frac{1}{2\pi} \int_0^{2\pi} rC(r, \theta) d\theta$



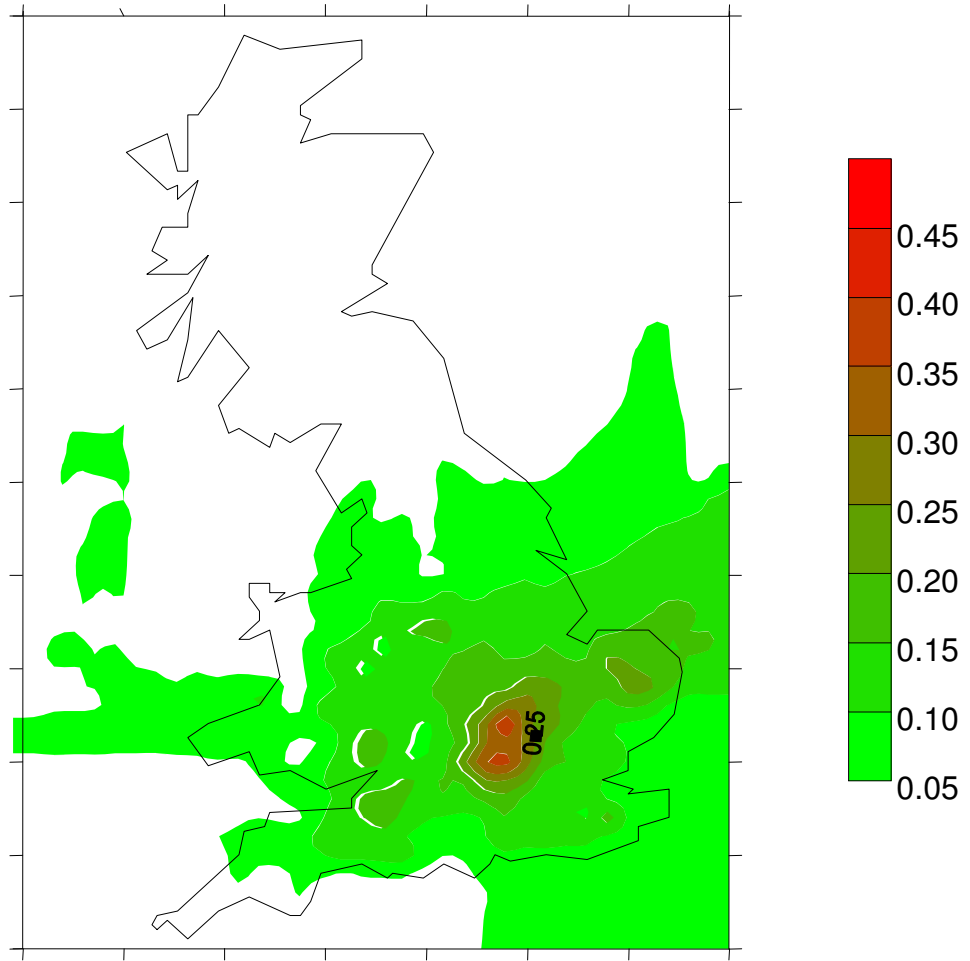


Average dependence on distance  $r$  along radial trajectory

Annual average PM10 concentration from power station in  $\mu\text{g m}^{-3}$   
CMAQ v4.6 at 5km resolution

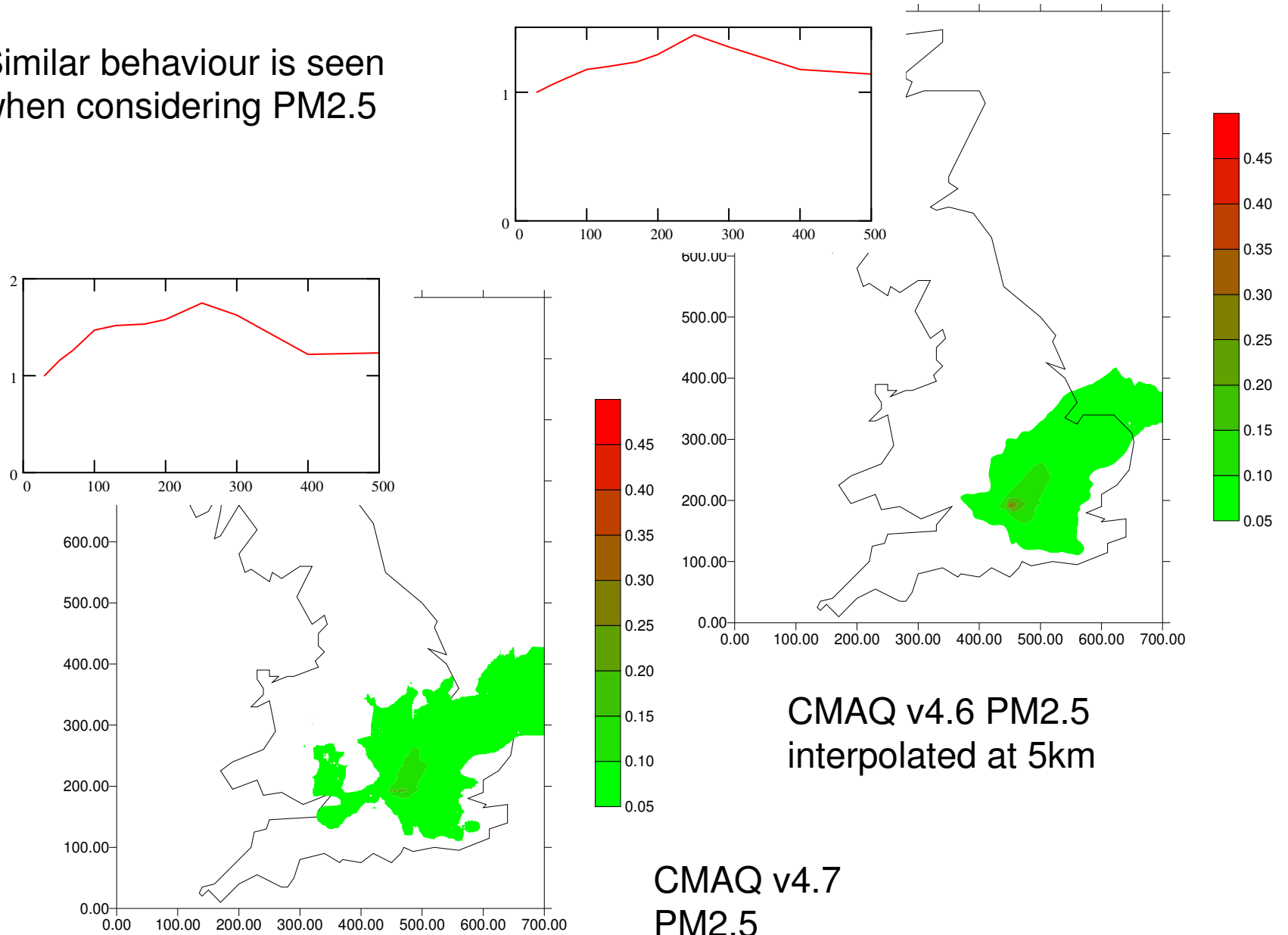


Average dependence on distance  $r$  along radial trajectory



Annual average PM10 concentration from power station in  $\mu\text{g m}^{-3}$   
CMAQ v4.7 at 5km resolution

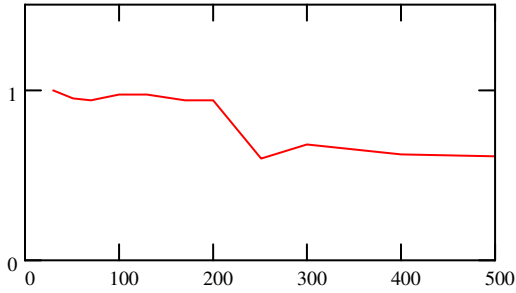
Similar behaviour is seen when considering PM2.5



CMAQ v4.6 PM2.5  
interpolated at 5km

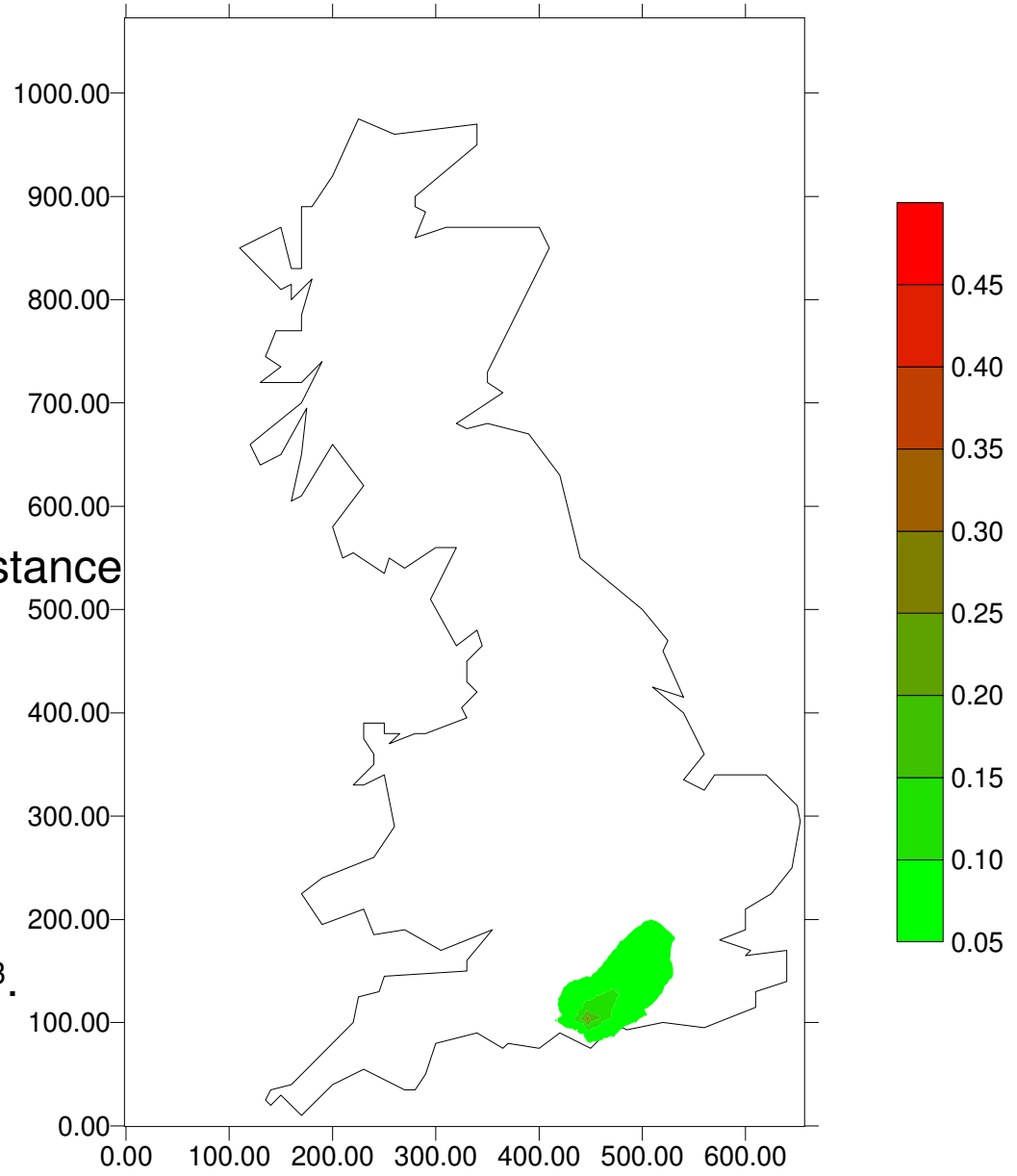
CMAQ v4.7  
PM2.5  
interpolated at 1km





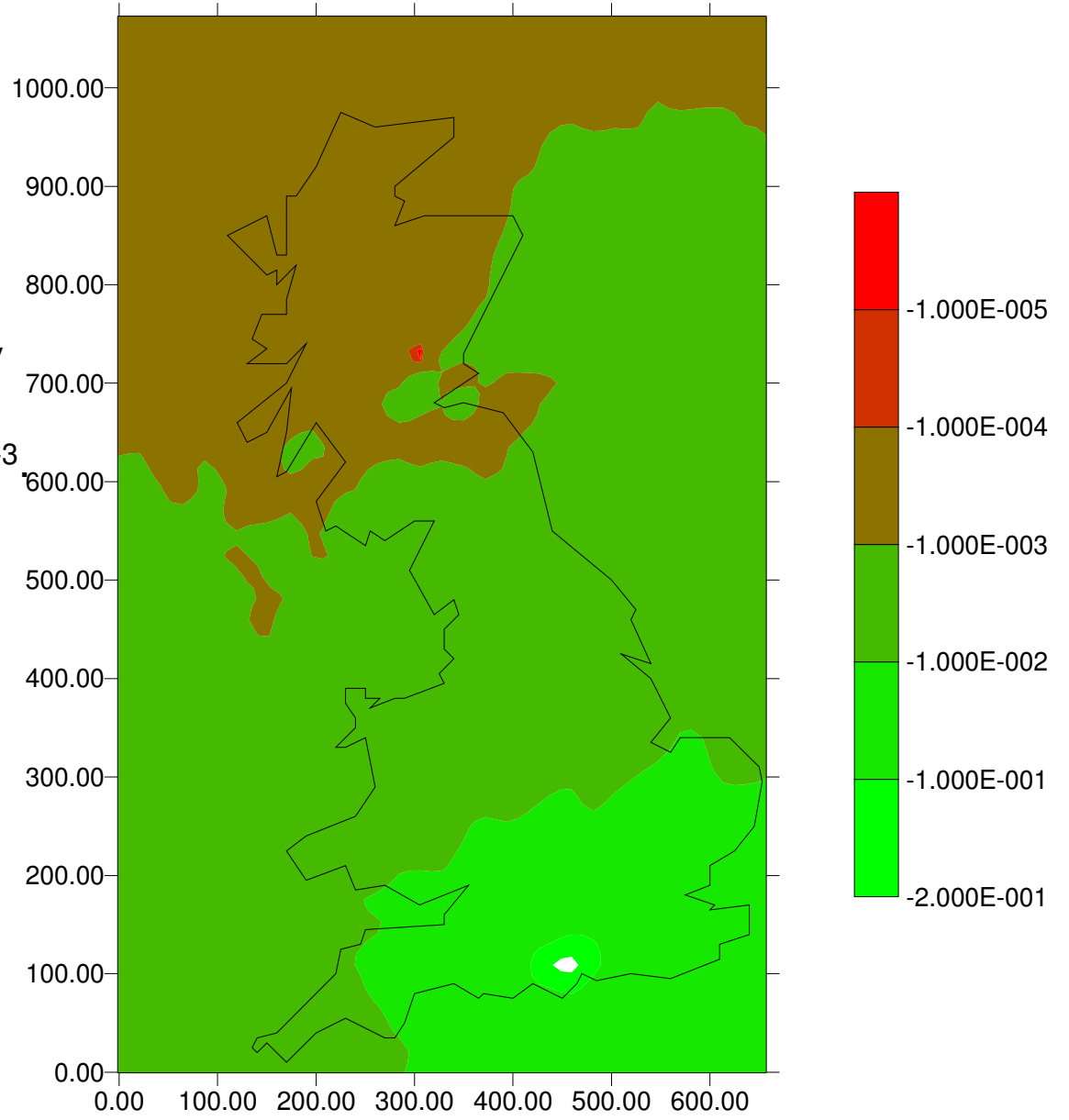
Average dependence on distance  $r$  along radial trajectory

Annual average PM<sub>2.5</sub> concentration from Fawley Refinery for 2003 using CMAQ v4.6 model in  $\mu\text{g m}^{-3}$ .



Annual average O<sub>3</sub> concentration from Fawley Refinery for 2003 using CMAQ v4.6 model in  $\mu\text{g m}^{-3}$

Appropriate metric?



## **Conclusions**

Messages for regulator

- (1) Danger of calculation without understanding
- (2) Uncertainty and sensitivity, robust decisions
- (3) Informed user or have guidance available
- (4) Role of assimilated/empirical models? When should they be used?
- (5) Regulatory metric may not be as useful as diagnostics
- (6) Justify both domain-wide assessment of policies and individual sources
- (7) Some way to go - does not require to much extra effort. Any USEPA data sets which are relevant.