Ozone modelling (CTM)

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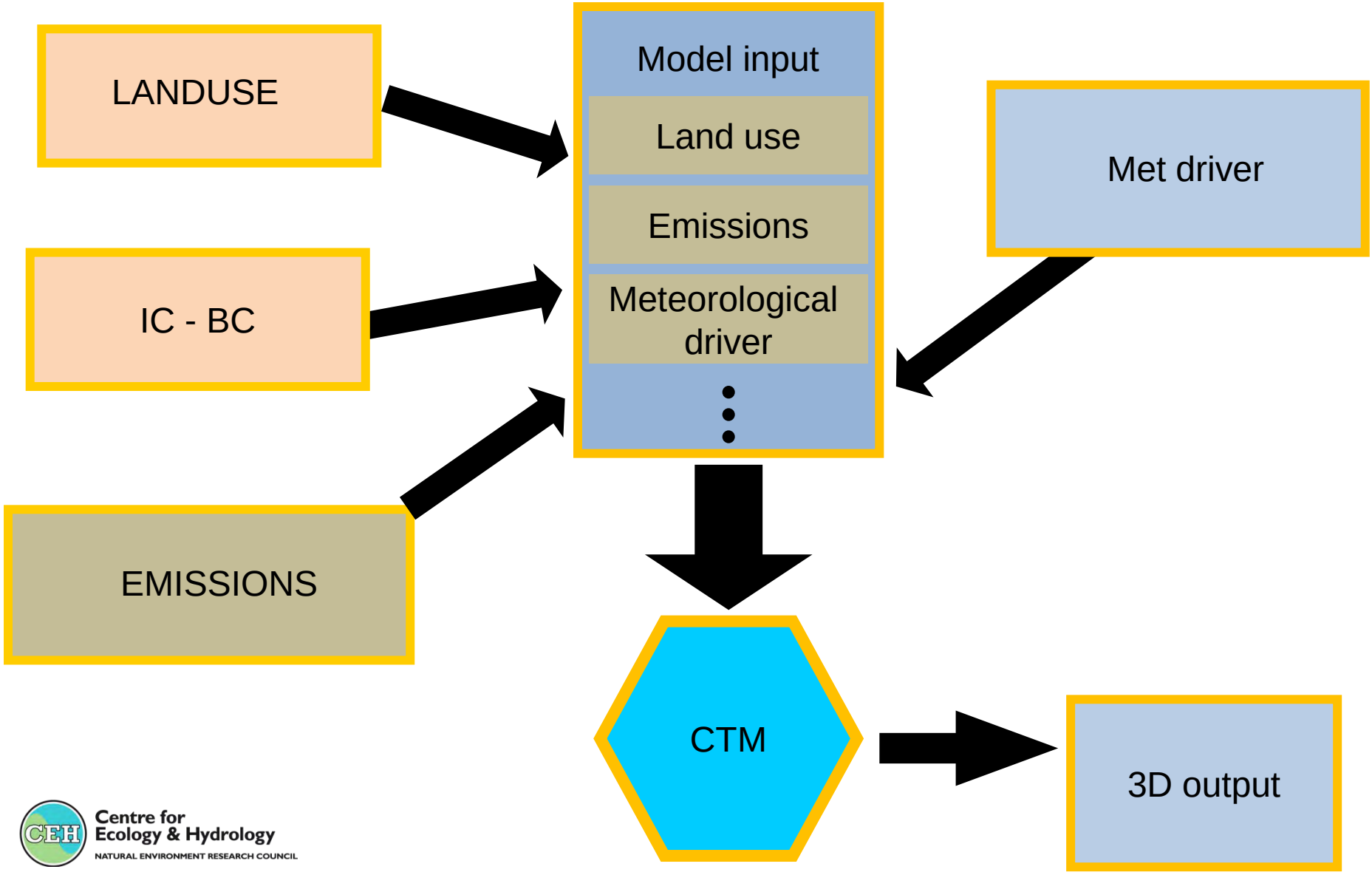
Chemistry transport model



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What is important for modelling ozone…

- Meteorology
- Chemistry
- Emission
- Surface exchange processes
- Model resolution

Example of how good the main met variables?

Weather Research and Forecast model (WRF 3.1)

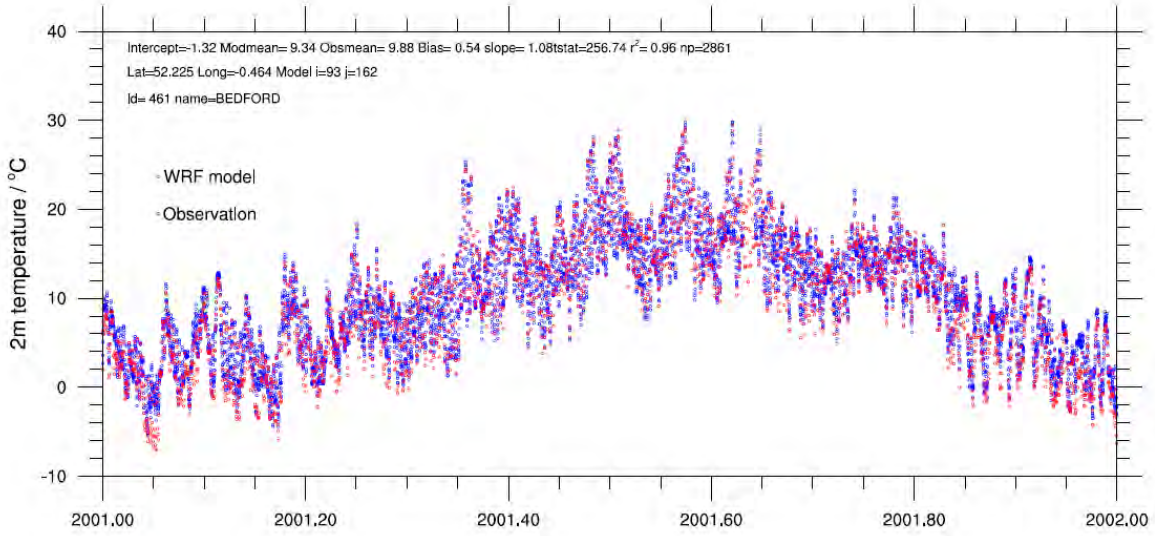
- Temperature seems to be ok

- Wind speed and direction ok-ish

- Precipitation timing ok but problem with magnitude - also some issues on fine domain

Temperature vs. UK AWS MIDAS

Example of 2001 3-hourly WRF calculated surface temperature for Bedford



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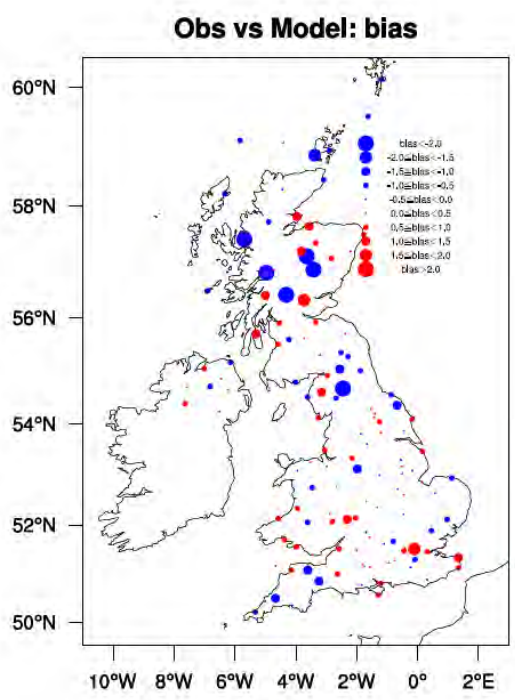
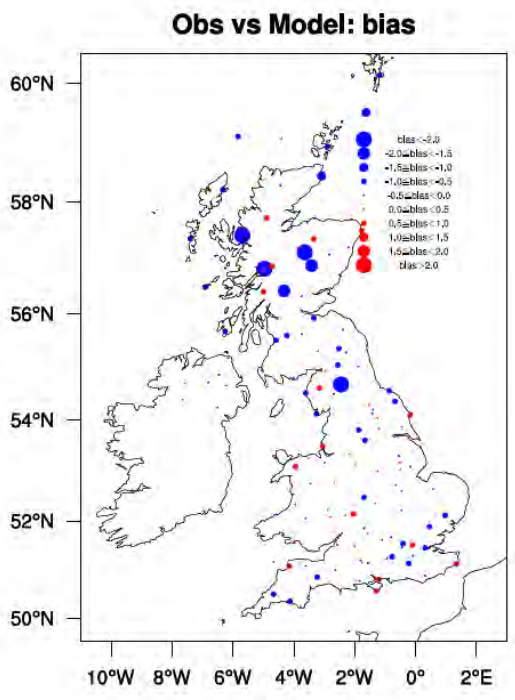
Does high res help with elevated sites?

- WRF 3-hourly Meteorology
  - 2 months of computing time 80 processors
- Meteorology – UK analysis (MIDAS 190 UK sites)

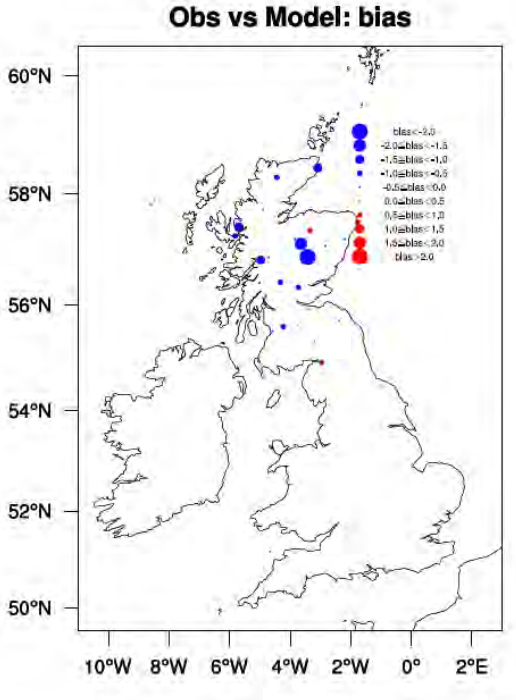
50 km^2 Europe



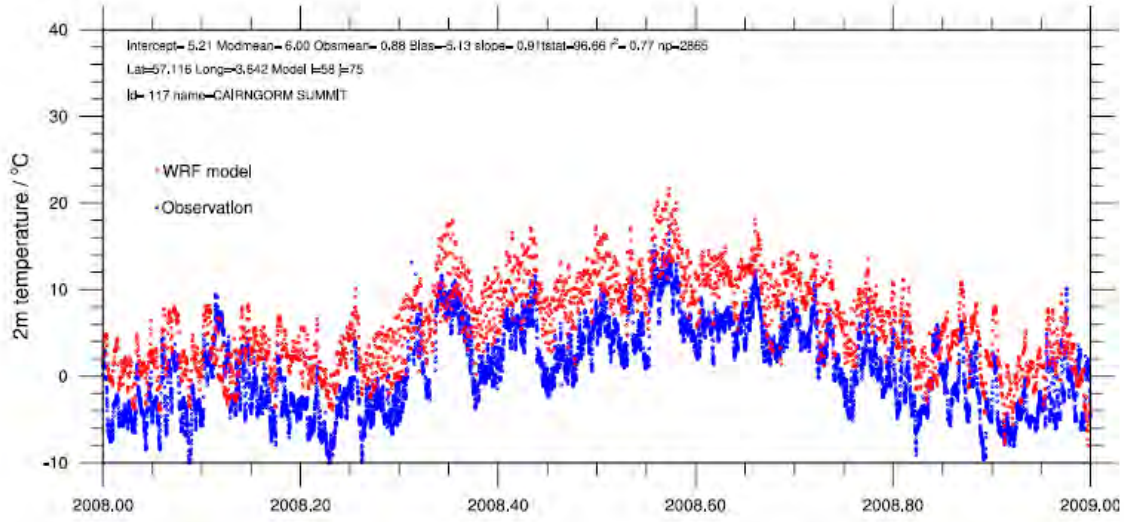
5 km^2 UK



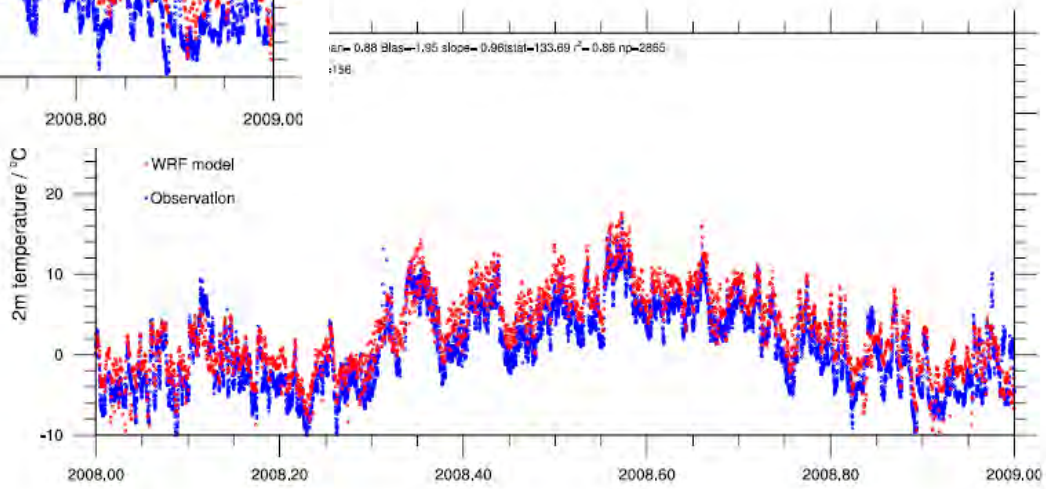
1 km^2 Scotland



Way to improves....higher resolution
CAIRNGORM SUMMIT 1245 m



50 km^2 grid



1 km^2 grid

Grid size	Model WRF	Obs MIDAS	Bias	Slope	R^2
50 km^2	6	0.9	-5.1	0.91	0.8
5 km^2	3.5	0.9	-2.6	0.94	0.9
1 km2	2.8	0.9	-1.9	0.95	0.9

Wind speed - direction

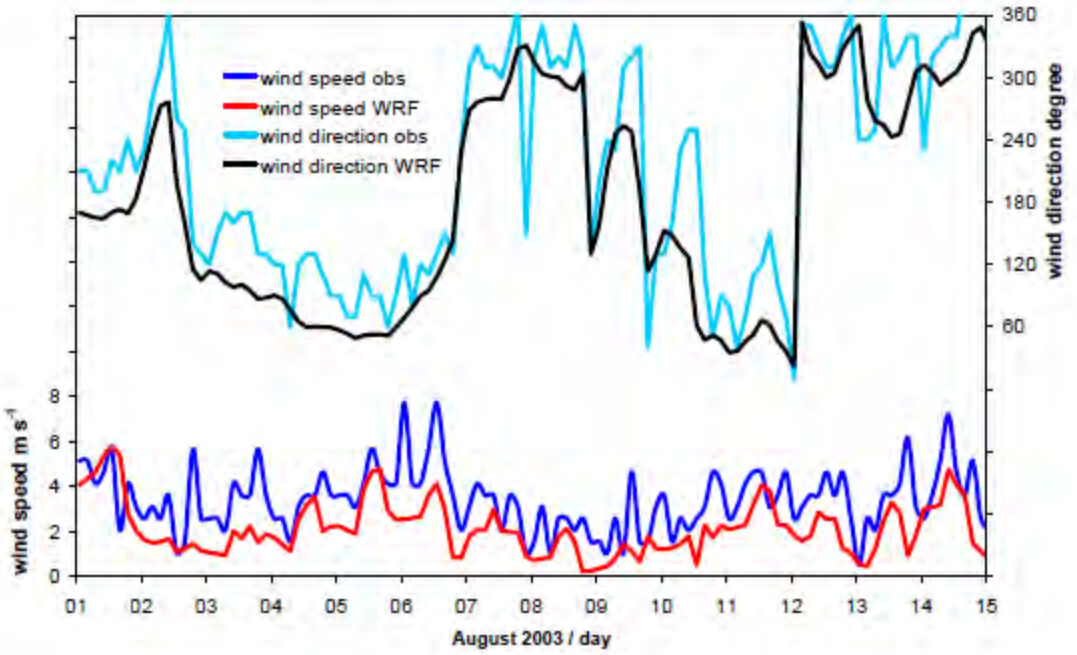
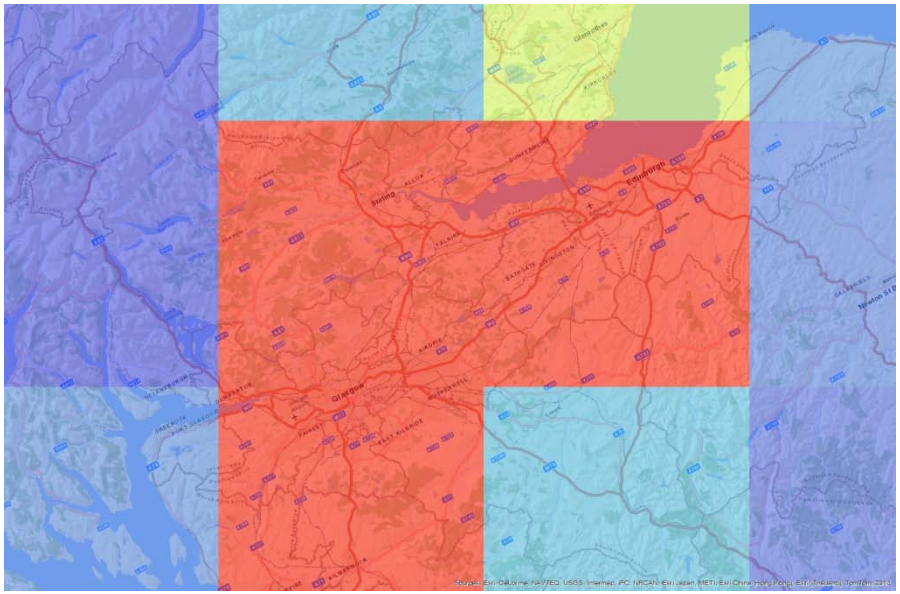
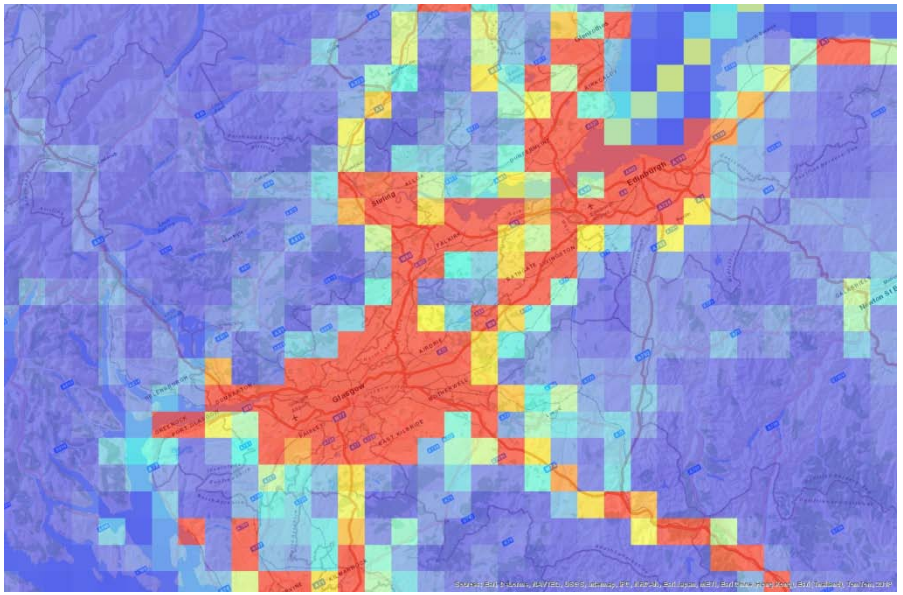
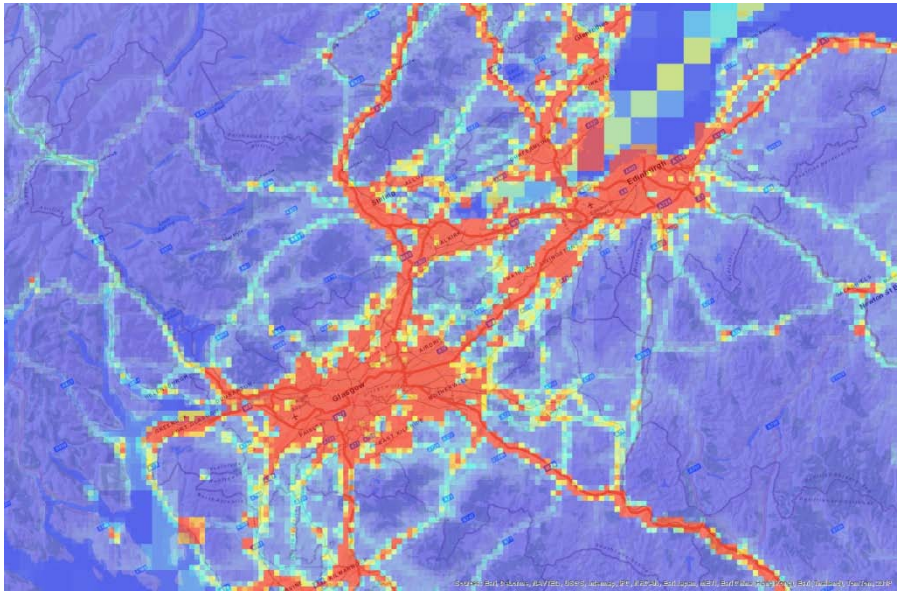


Fig. 2. Time series of hourly modelled (red, black) and observed (blue, pale blue) 10 m wind speed (bottom, m s^{-1}) and 10 m wind direction (top, degrees) at Wattisham.

Lets focus on a smaller area – Edinburgh







Model resolution issues:
50, 5 and 1km^2 NO_x emissions

Data from EMEP, NAEI, ENTEC

NO_x emissions mgm^2

60000

0

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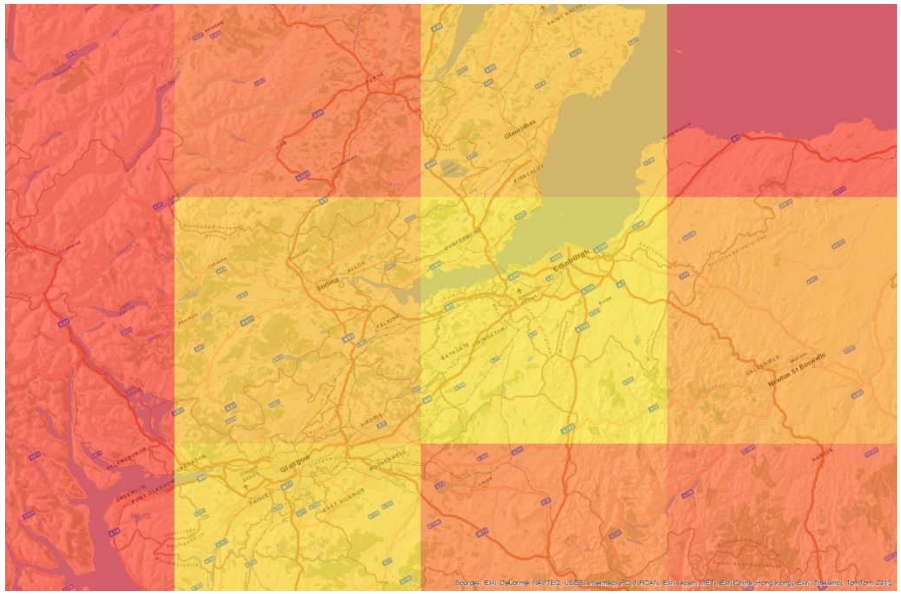
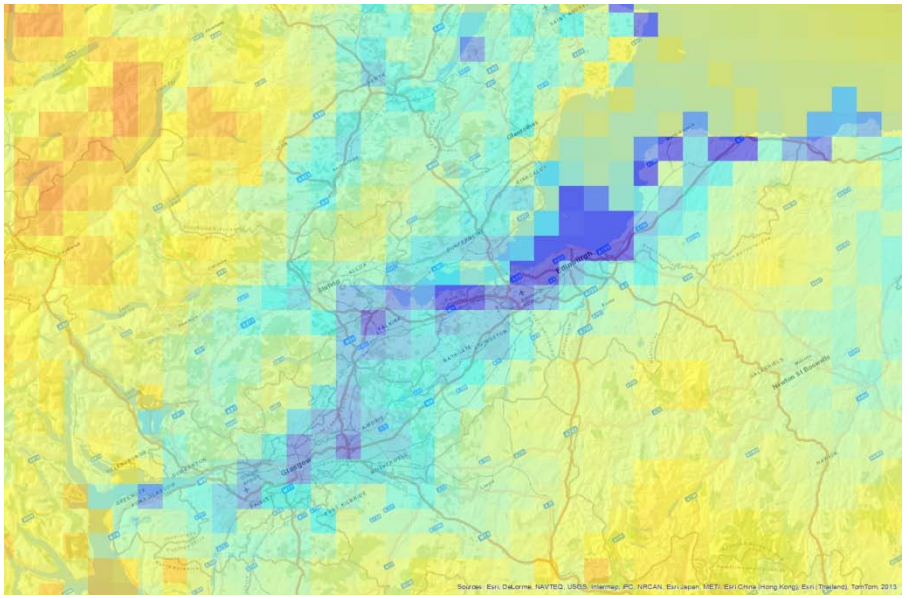
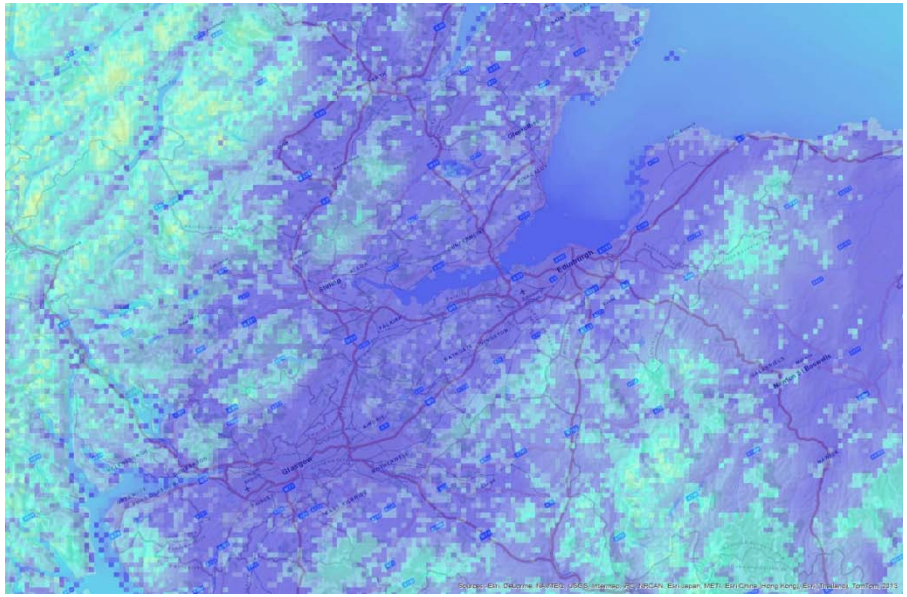
The implication for calculated surface ozone...



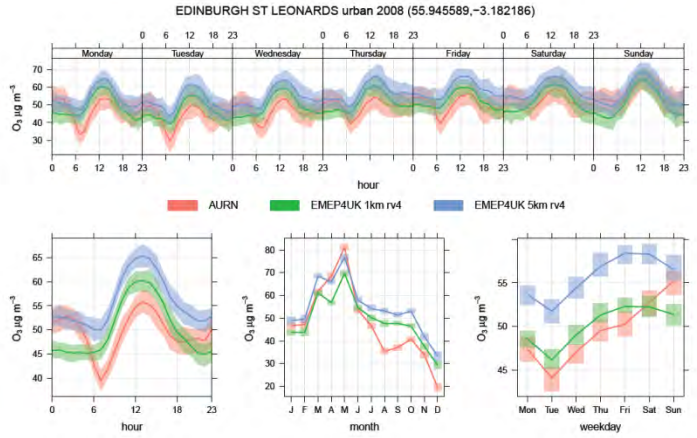




O_3 surface concentration µg m^{-3}

70

50



UK initiatives – Defra model inter-comparison

Phase 1 results are published in the Defra website

(http://uk-air.defra.gov.uk/reports/cat20/1105091514_RegionalFinal.pdf)

EMEP, CMAQ, OSRM, AQUM, NAME, WRF-Chem, …. (regional models)

All participated to a UK model inter-comparison focused on surface ozone and NO_2

-No attempt was made to normalise the model inputs-

- Large differences between models and even between same model (used by different group)
- Input to the model important (emissions and landuse)
- Now Phase2 looking at emissions reductions (report soon available)

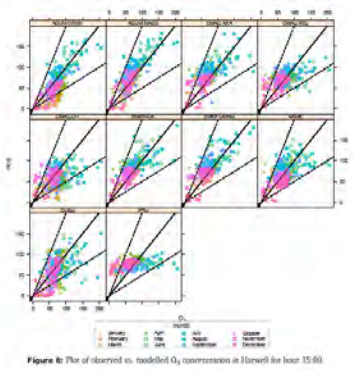


Figure 6: Plot of observed vs. modelled O_3 concentration at Harwell for hour 15:00.

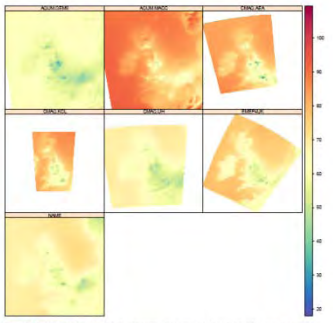


Figure 62: Surface annual mean O_3 concentrations predicted by each model over the same geographic area.

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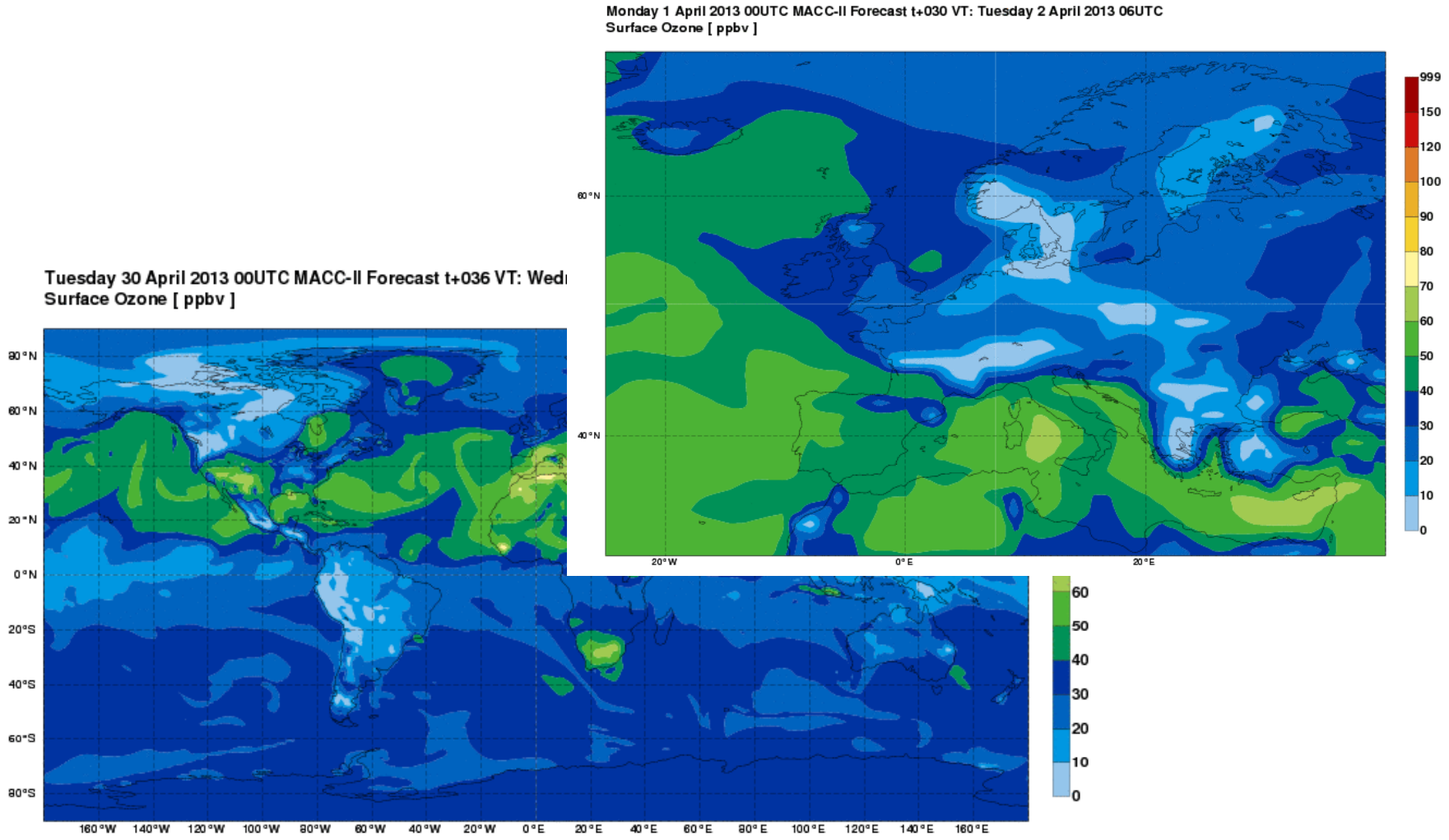
European modelling – ozone forecast



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MOZART Forecasts, from MACC II project

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EMEP global to local

Global lat/long 0.2 x 0.2 -> Regional -> Local

Using a single CTM

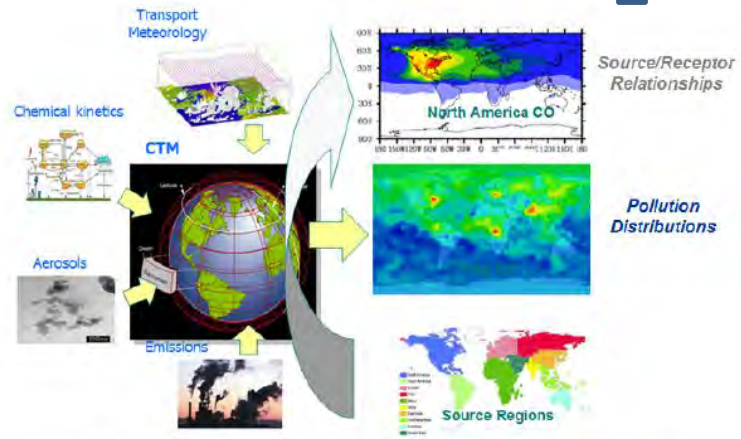

Figure 4.1. Schematic of the Eulerian forward modelling approach. The model represents various processes that impact pollutant transport, chemistry and removal of pollutants. These models can be applied in S/R and source attribution studies, where emissions from specific source regions are followed through the atmosphere.