EMEP and WRF (EMEP4UK)
Brief introduction

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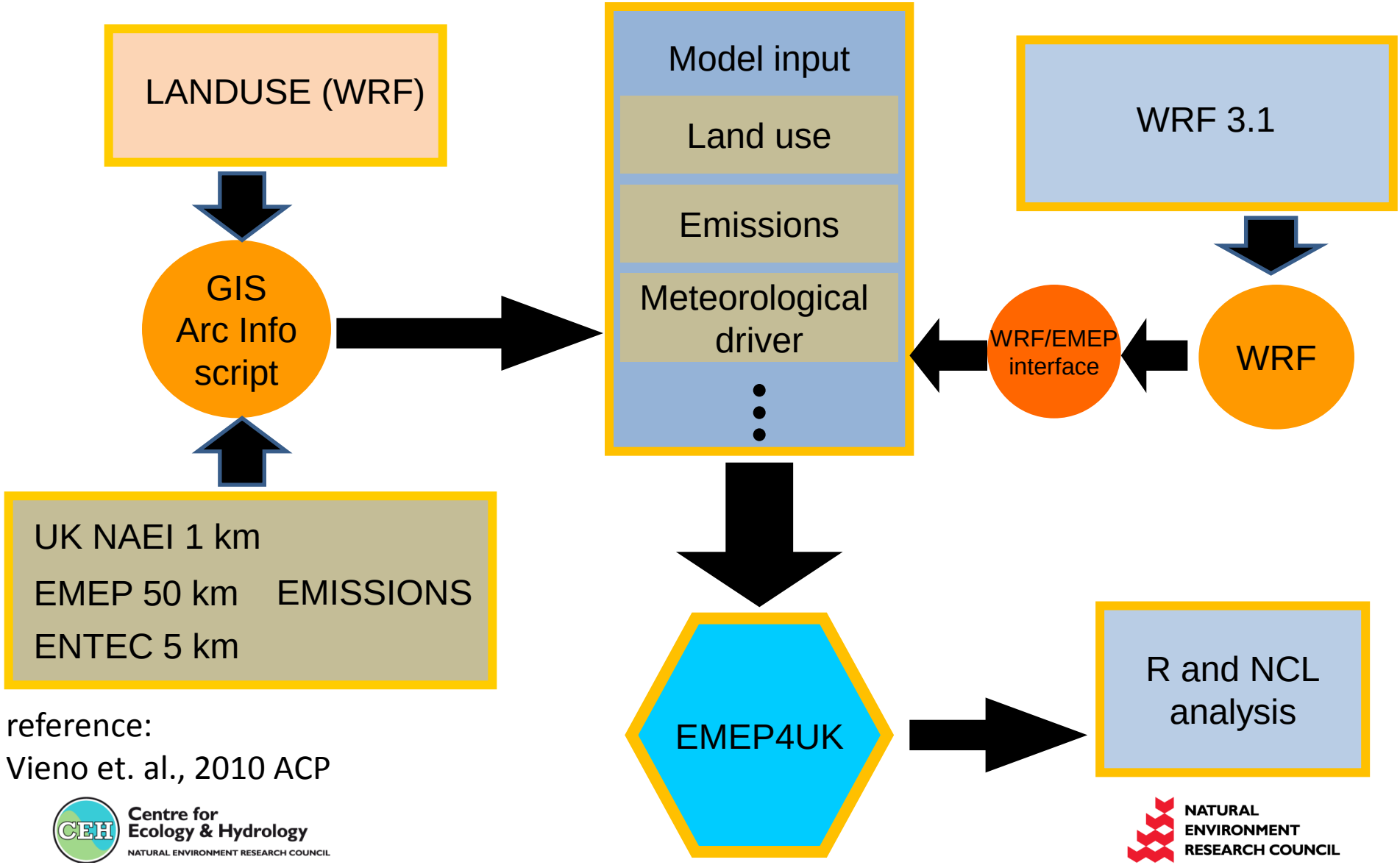
EMEP-WRF interface



reference:
Vieno et. al., 2010 ACP

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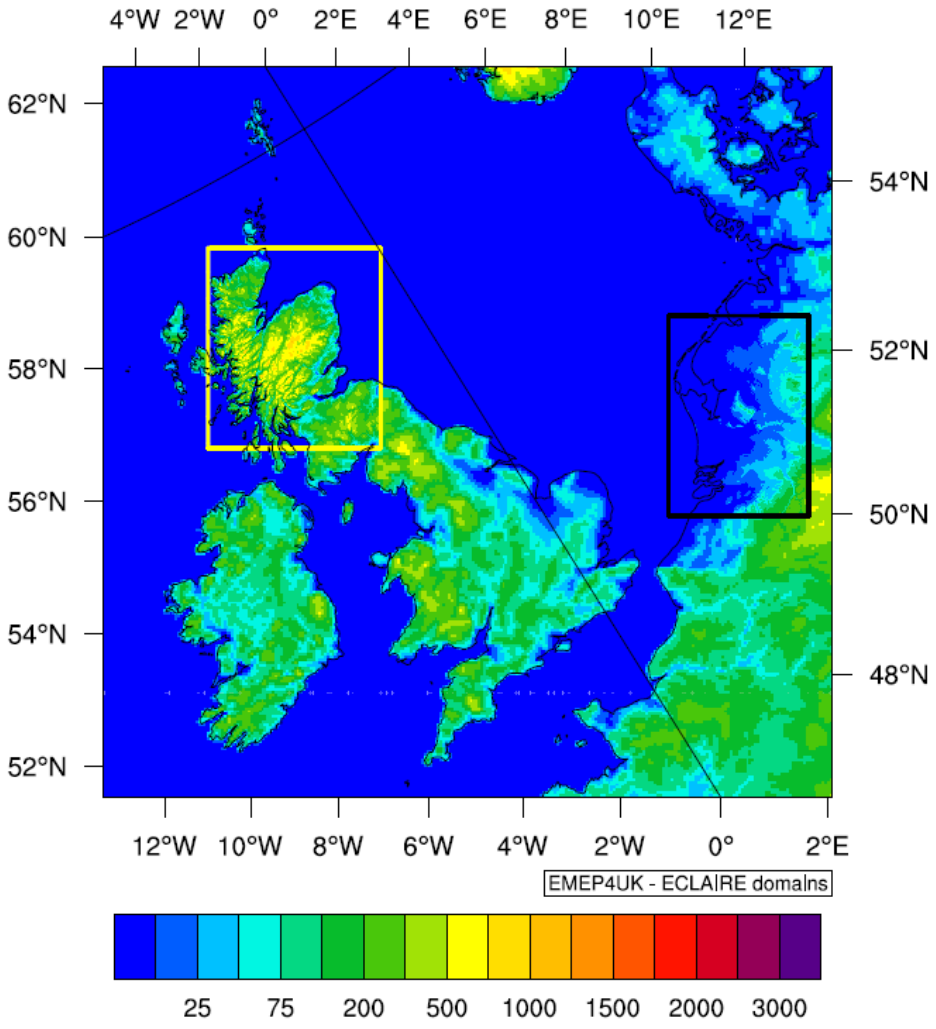
Variables needed by the EMEP model

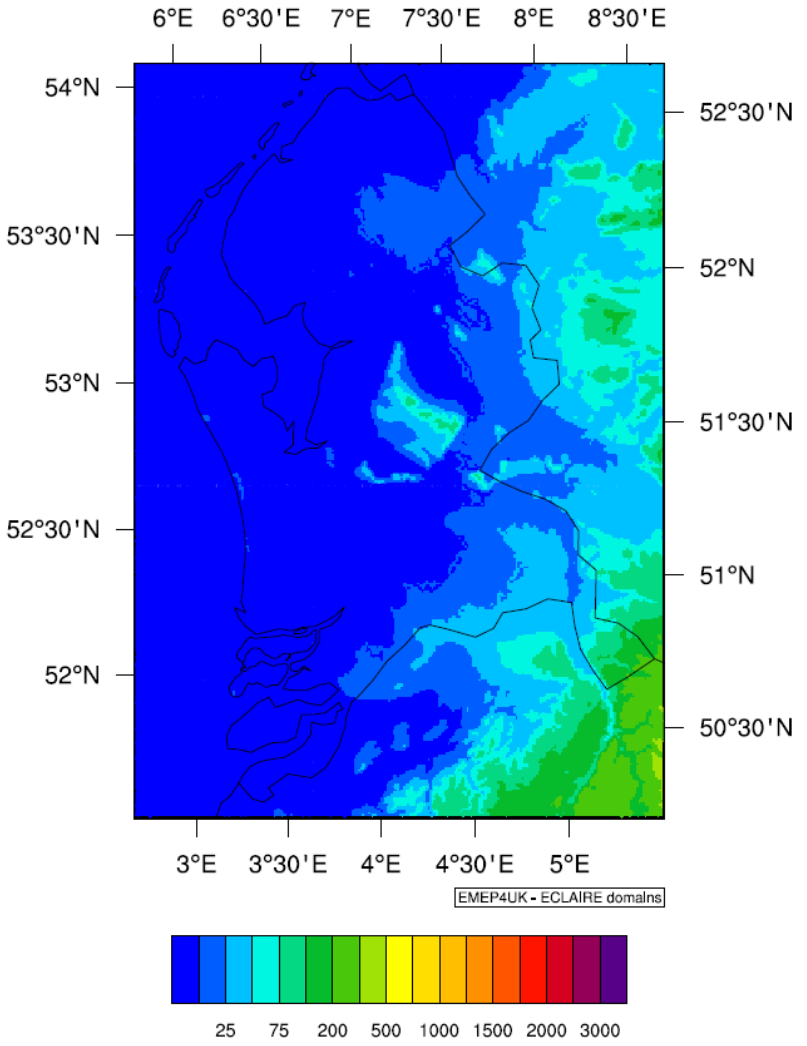
From the EMEP rv4.3 user guide

Table 2.2: Input meteorological data used in the EMEP/MSC-W Model

Parameter	Unit	Description
3D fields - for 20 σ levels		
u, v	m/s	Horizontal wind velocity components
q	$^{kg}/_{kg}$	Specific humidity
θ	K	Potential temperature
CW	$^{kg}/_{kg}$	Cloud water
CL	%	3D Cloud cover
$cnvuf$	$^{kg}/_{sm^2}$	Convective updraft flux
$cnvdf$	$^{kg}/_{sm^2}$	Convective downdraft flux
PR	mm	Precipitation
2D fields - for Surface		
PS	hPa	Surface pressure
$T2$	K	Temperature at 2m height
$Rh2$	%	Relative humidity at 2m height
SH	$^{W}/_{m^2}$	Surface flux of sensible heat
LH	$^{W}/_{m^2}$	Surface flux of latent heat
τ	$^{N}/_{m^2}$	Surface stress
SST	K	Sea surface temperature
SWC	$^{m^3}/_{m^3}$	Soil water content
lspr	m	Large scale precipitation
cpr	m	Convective precipitation
sdepth	m	Snow depth
ice	%	Fraction of ice
$SMI1$		Soil moisture index level 1
$SMI3$		Soil moisture index level 3
u10/v10	m/s	wind at 10 m height

How to setup a WRF domain for EMEP





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WRF setup to match the EMEP model domain

A 4 steps procedure to setup a new WRF domain:

Setting the domain and sub-domain GRID setup

```
&geogrid
 parent_id         = 1,1,2,3,3,
 parent_grid_ratio = 1,5,2,5,5,
 i_parent_start    = 1,65,25,40,210,
 j_parent_start    = 1,40,15,130,105,
 e_we          = 171,171,271,321,261,
 e_sn          = 134,161,271,371,371,
dx = 50000,
 dy = 50000,
 map_proj =  'polar',
 ref_lat   = 57,
 ref_lon   = 6,
 truelat1  = 60,
 truelat2  = 90,
 stand_lon = -32,
/
```

1. Define a model coarse domain and any nested domains – geogrid.exe

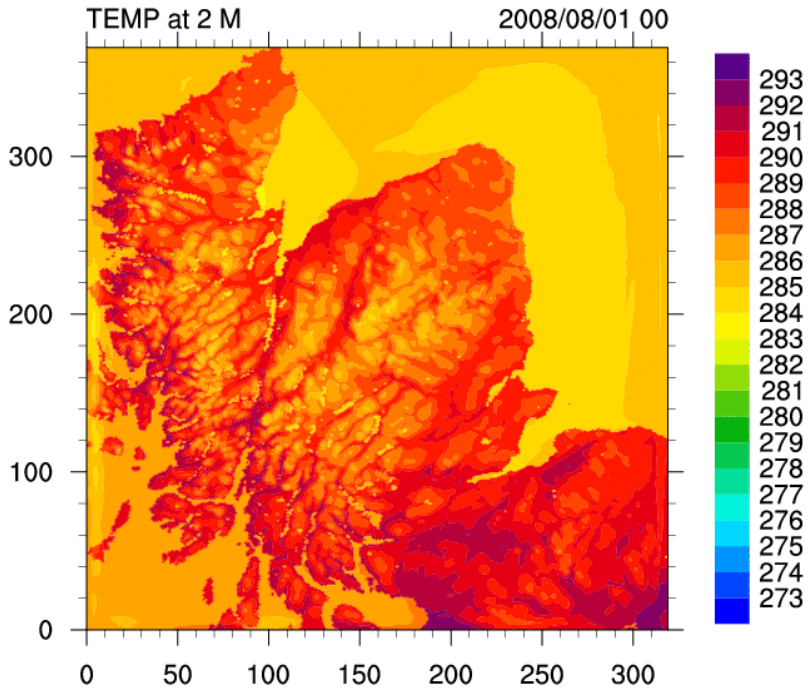
2. Extract meteorological fields from GRIB data sets (NCEP or ECMWF) – ungrib.exe

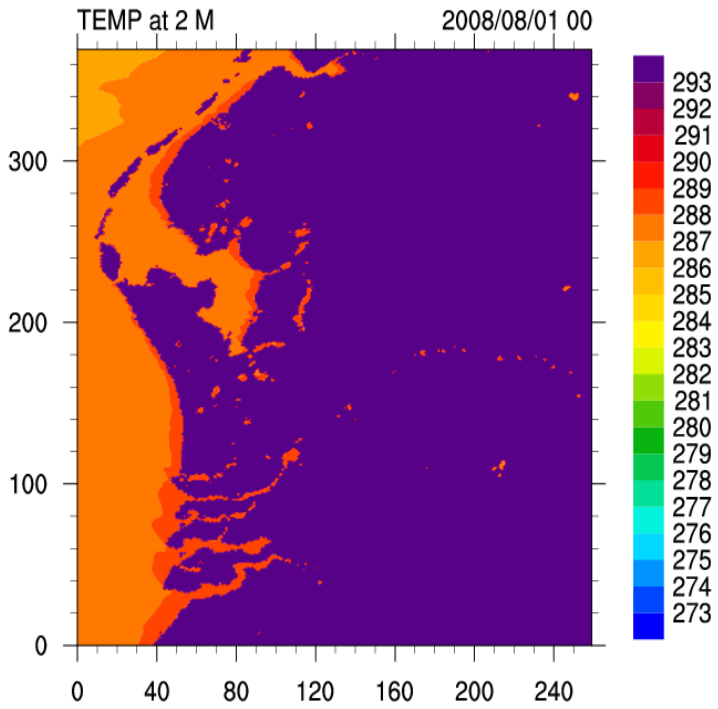
3. Horizontally interpolate meteorological fields to the model domains – metgrid.exe

4. Vertically interpolate the meteorological fields and if required setting the data for nudging – real.exe

...Running the WRF model... - wrf.exe

August 2008 – Scotland and Netherlands





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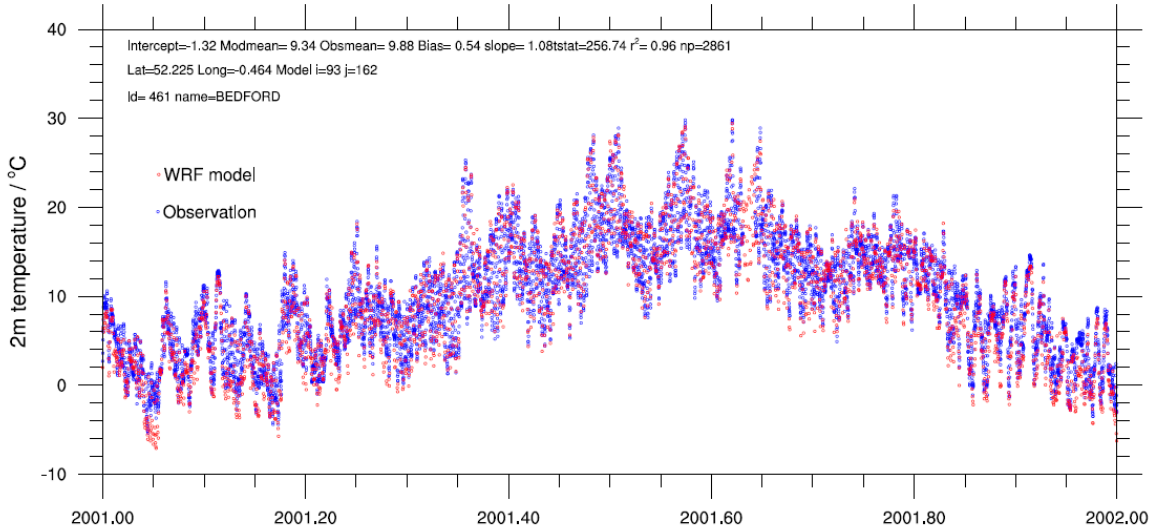
How good are the main met variables?

- 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

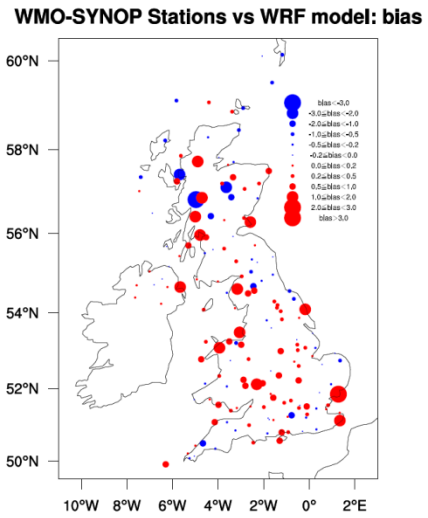
Example of 2001 3-hourly WRF calculated surface temperature for Bedford



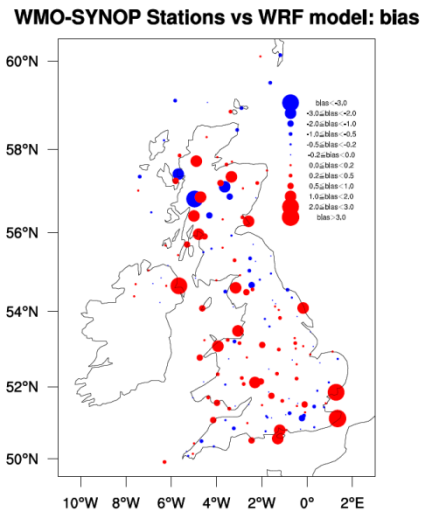
2m Temperature bias for all sites...

Model-observations annual average bias

2001

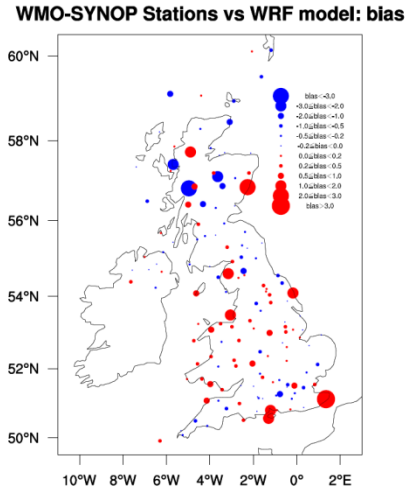


2002



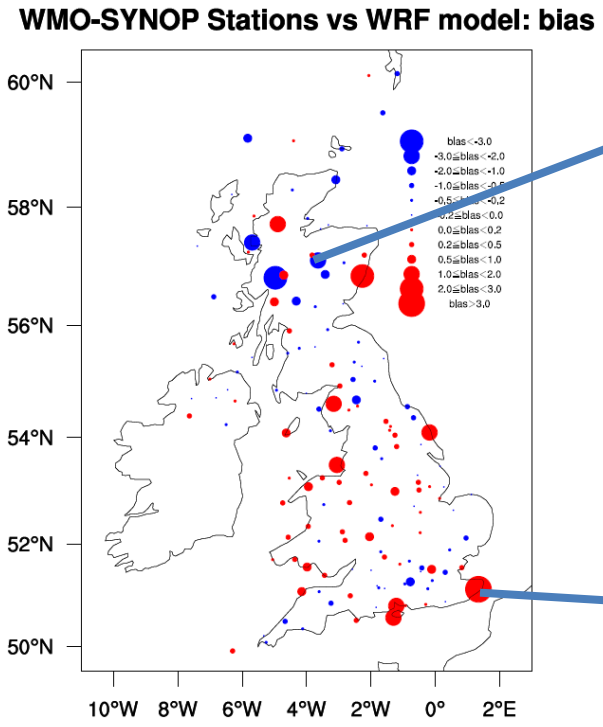
.....

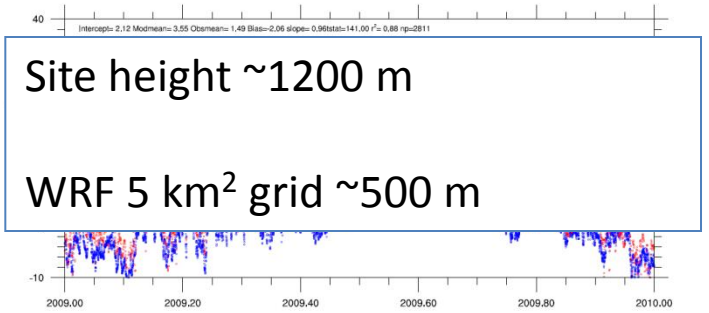
2009



Some sites are consistently underestimate or overestimate 2m temperature

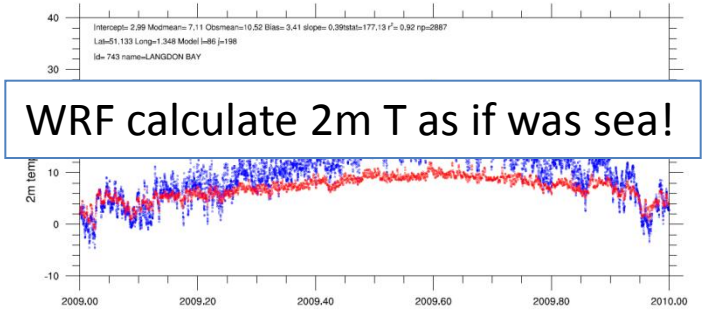
Temperature : WRF 3.1 – 2009
~200 sites across the UK





Site height ~1200 m

WRF 5 km^2 grid ~500 m



WRF calculate 2m T as if was sea!

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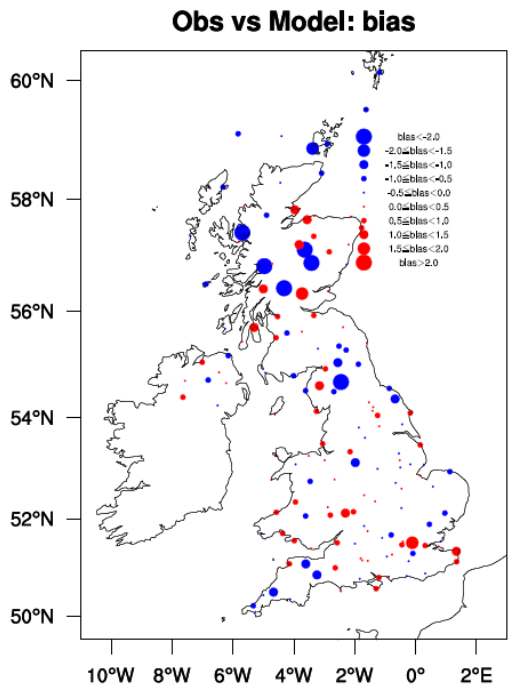
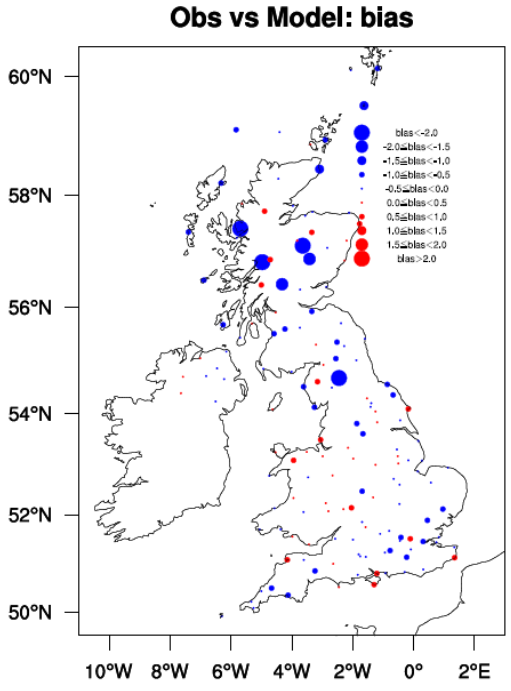
Does high res help with elevated sites?

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

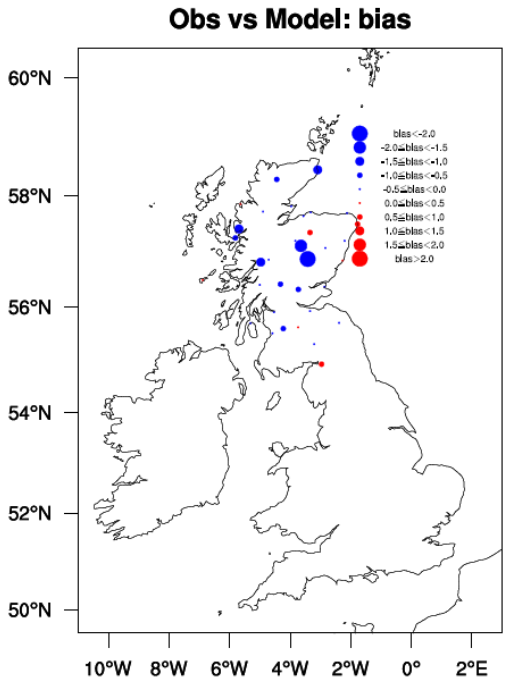
50 km^2 Europe



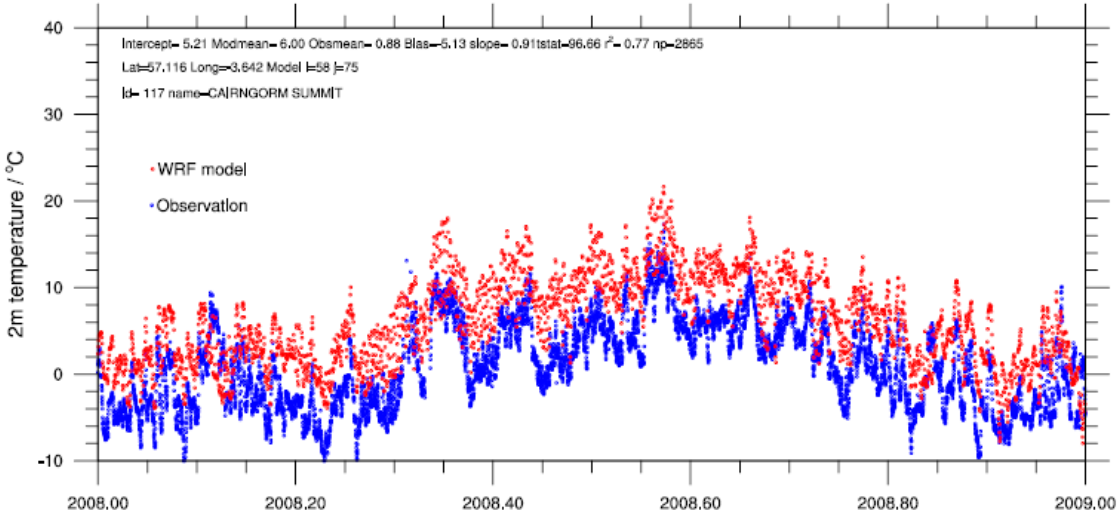
5 km^2 UK



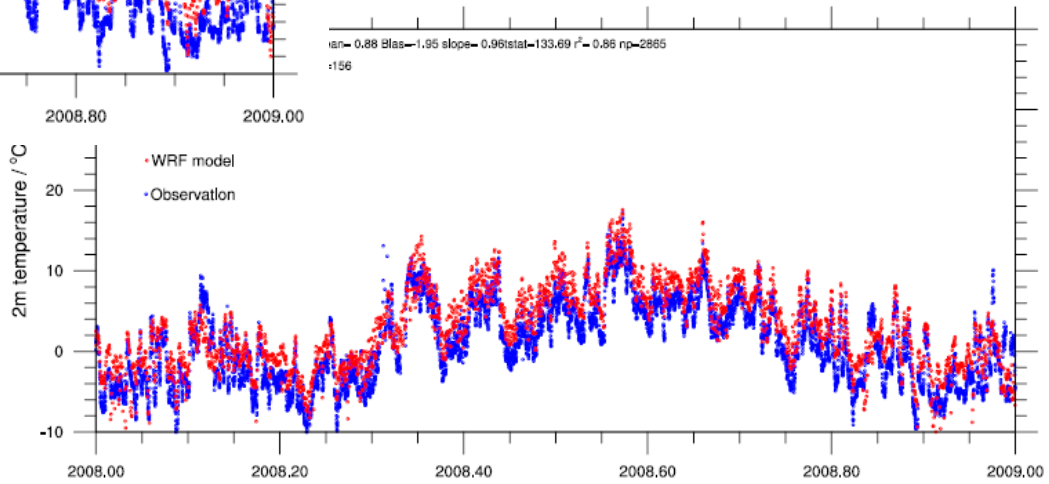
1 km^2 Scotland



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

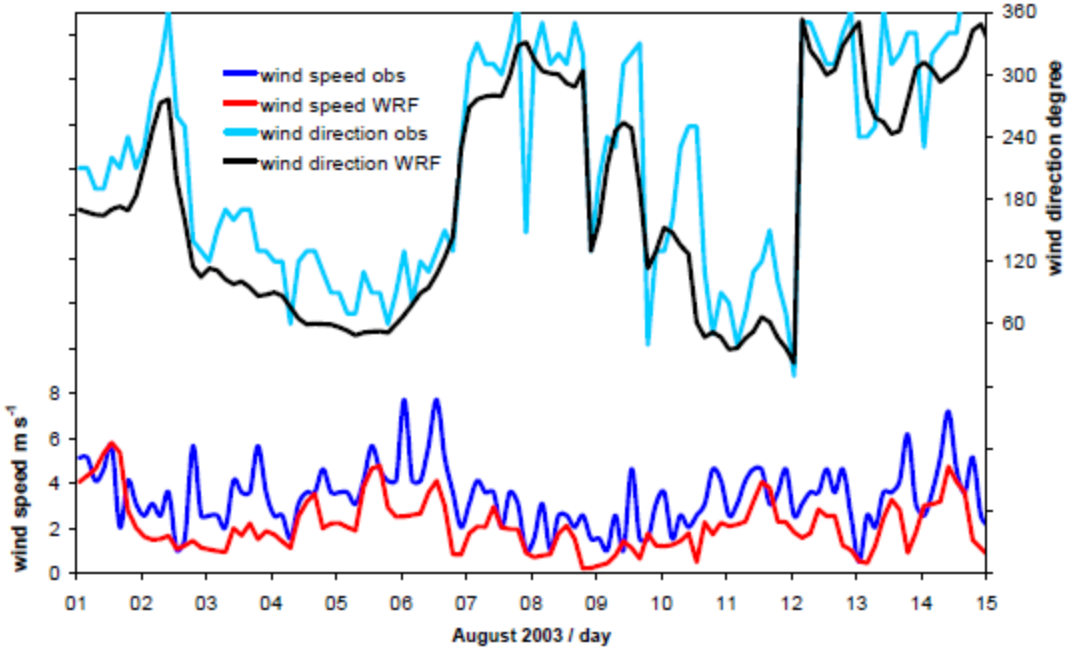
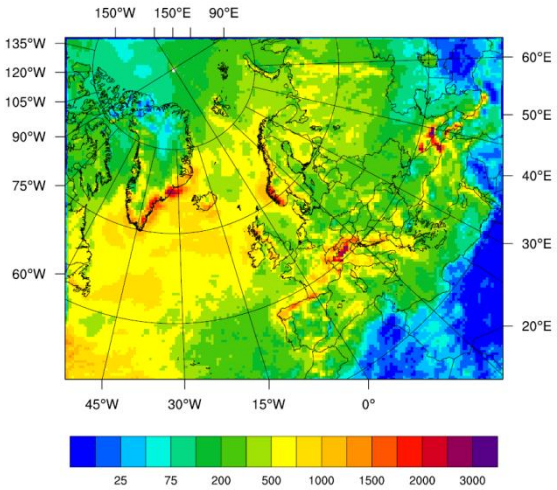


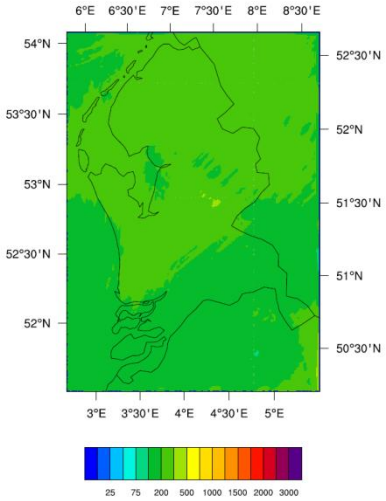
Fig. 2. Time series of hourly modelled (red, black) and observed (blue, pale blue) 10 m wind speed (bottom, $m\,s^{-1}$) and 10 m wind direction (top, degrees) at Wattisham.

Rainfall pattern

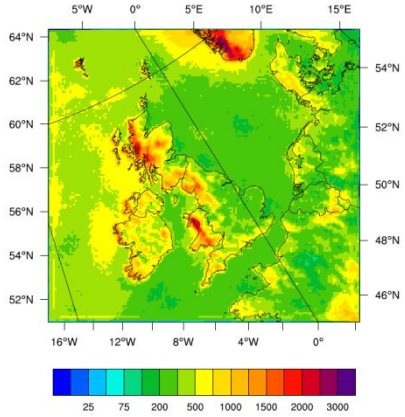
50 km^2



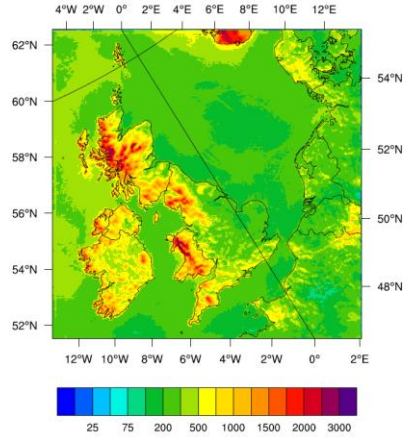
1 km^2



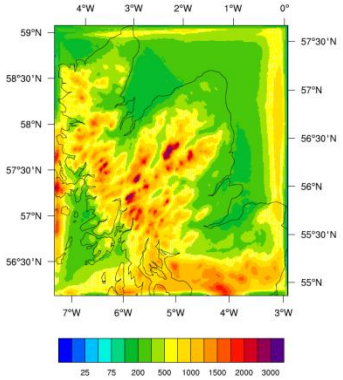
10 km^2



5 km^2



1 km^2



With a parent ratio of 5 the edge of the domain may have side effects

It is probably better to use a parent ratio of 3

Also the average total rainfall fo the UK is ½ the UK met office rainfall map

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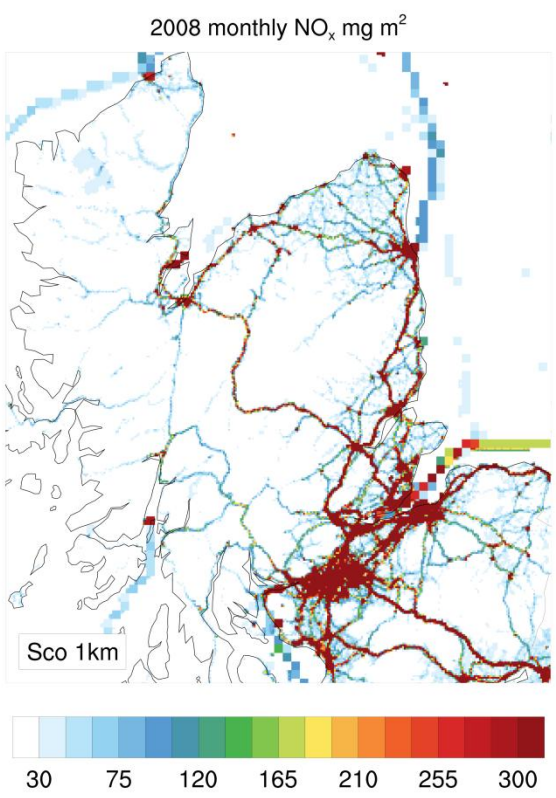
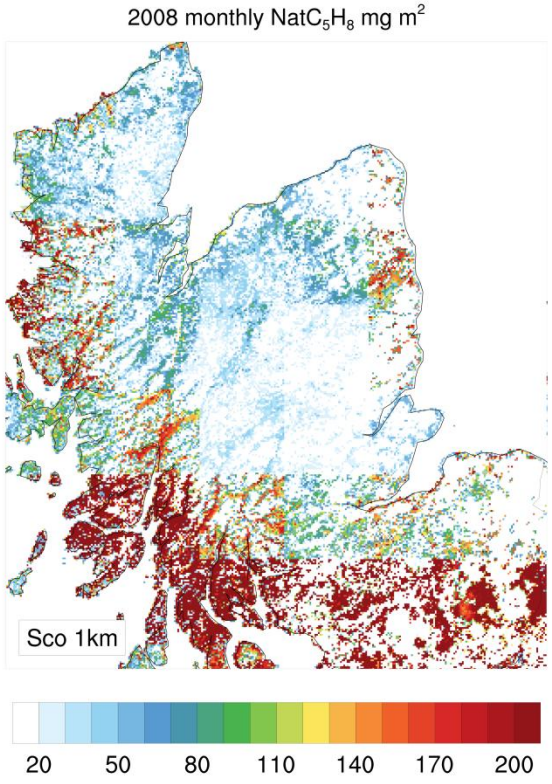
Non standard EMEP domain setup

- Creating the emissions for the relevant scale (<5 km^2)
- Re-projection of natural emissions (i.e. DMS)
- Default land cover (.nc) not fine enough for <5 km^2 domain – I use WRF-MODIS instead
  - Perhaps WRF MODIS derived land cover should always be use in EMEP-WRF

Emissions example





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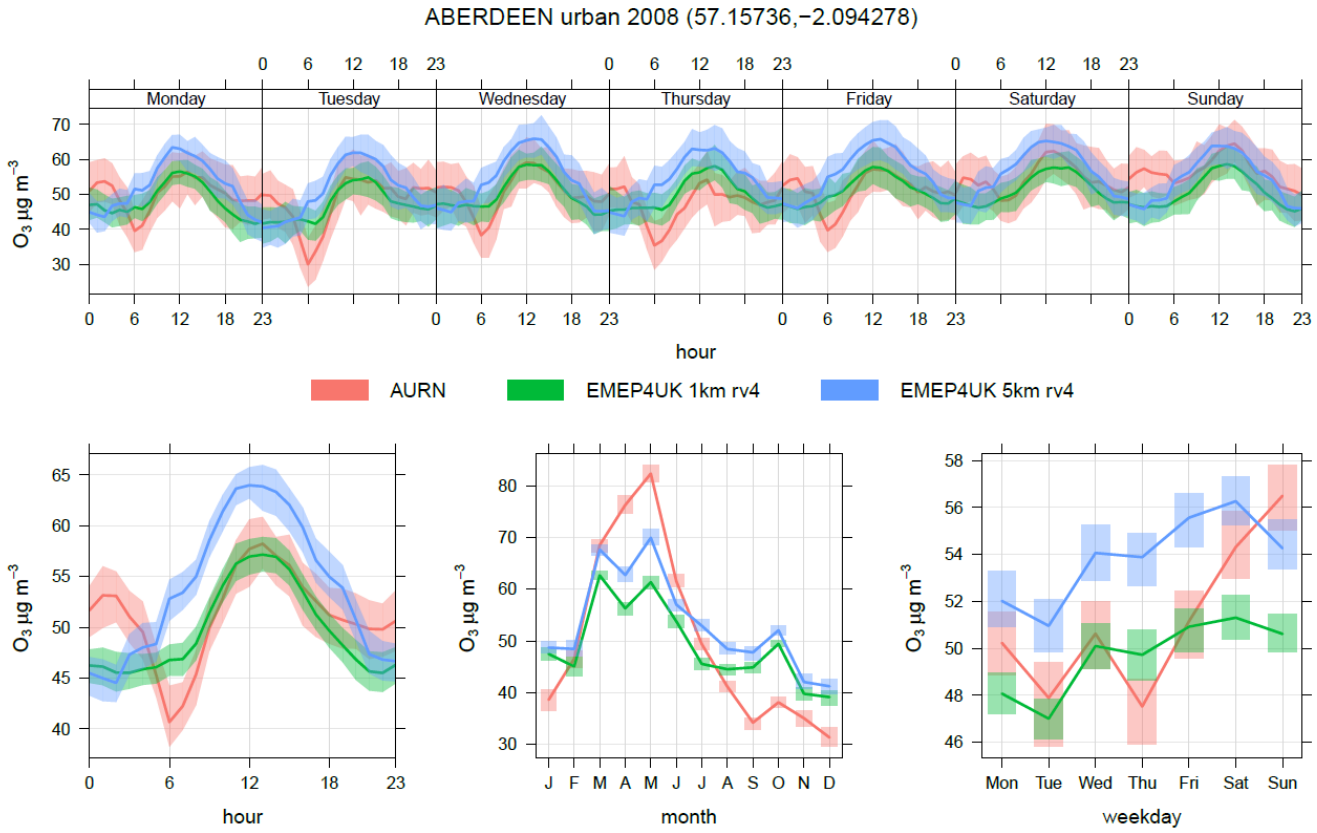
Model validation specific to the UK



AURN vs. EMEP4UK >90 sites across the UK for hourly ozone, NOx, SO2, PM25

Not all site measure everything

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