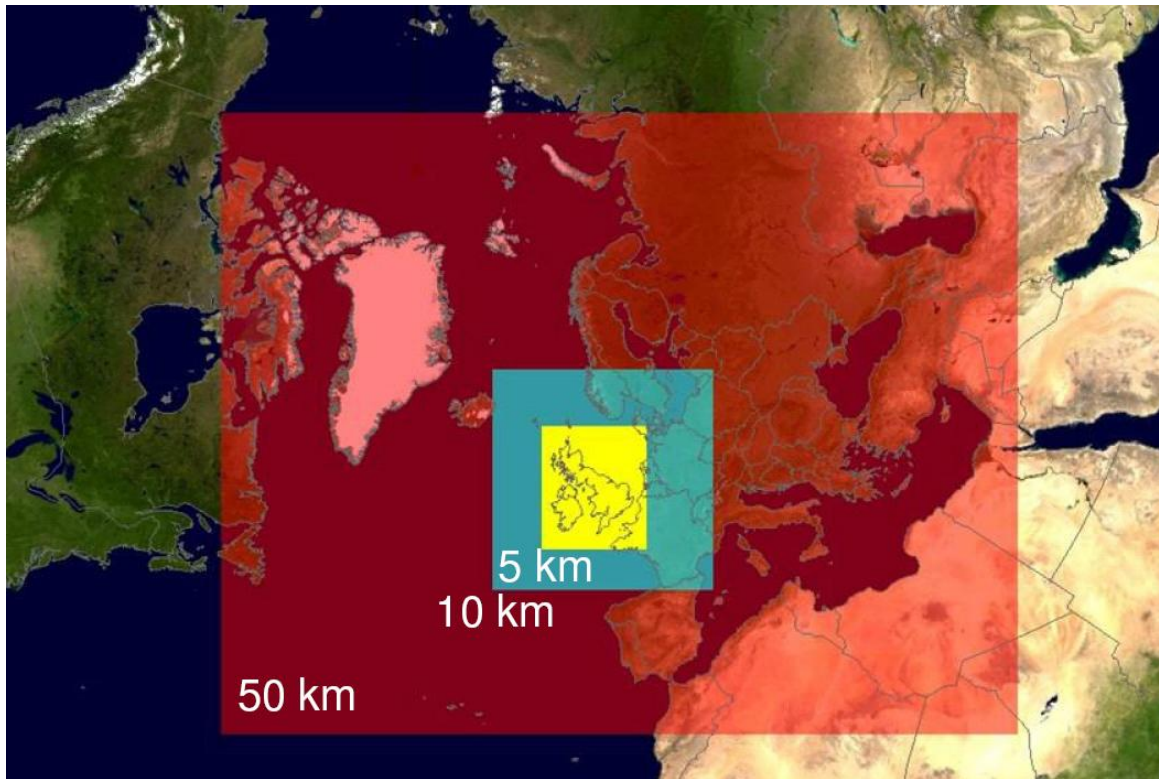


Eulerian modelling of TORCH: EMEP4UK simulations of surface ozone during the 2003 heat-wave

*M. Vieno, A.J. Dore, D.S. Stevenson,
R. Doherty, M. Heal, S. Reis, S. Hallsworth,
L. Tarrasón, P. Wind, D. Fowler,
D. Simpson, and M.A. Sutton*

EMEP4UK model



Meteorology:

From WRF using NCEP/NCAR re-analysis and 6 h nudging

Horizontal resolution:

5 km x 5 km over UK, nested within EMEP domain

Vertical resolution:

20 layers up to ~16 km. Surface layer depth 90 m

Chemistry:

As for EMEP UM

Emissions:

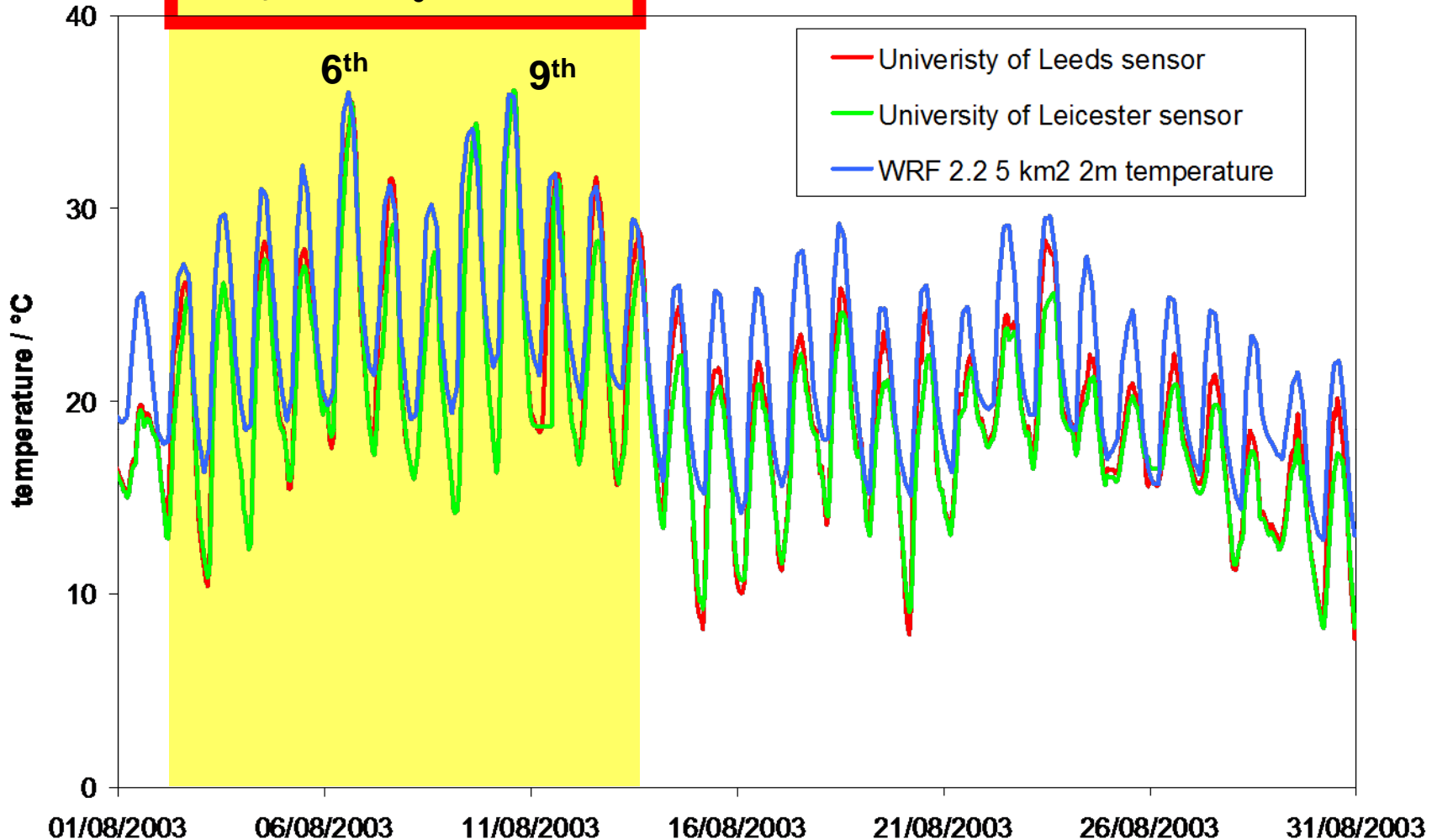
Outer uses 50 km x 50 km EMEP UM; inner uses NAEI 1 km x 1 km aggregated to 5 km x 5 km, except BVOC is for EMEP UM.

Deposition:

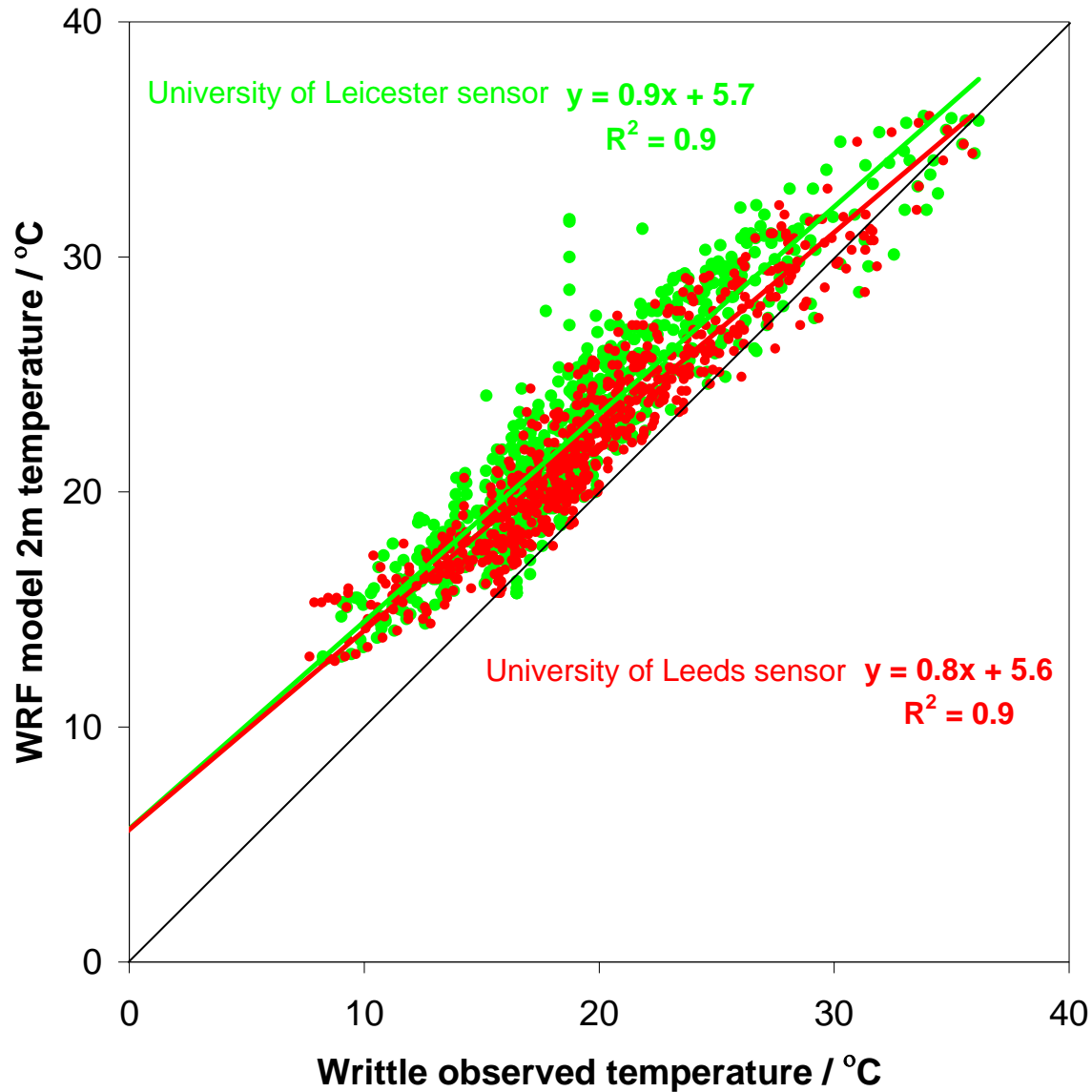
dry – resistance analogy, wet – scavenging coeffs with 3D rainfall

Surface temperature (August, Writtle)

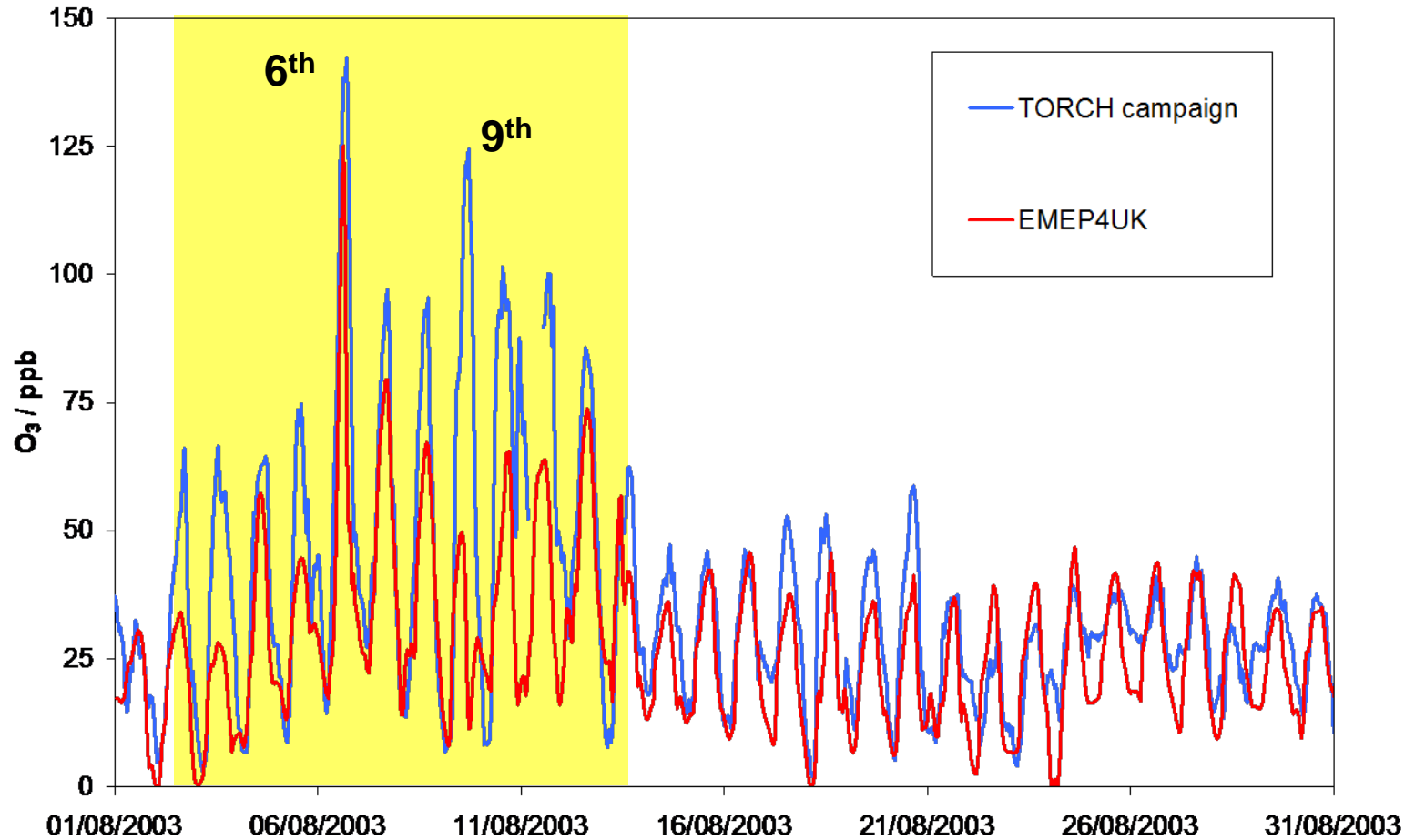
Heat-wave: 2-13th Aug
Daily max T_0 ~27-35°C



Surface temperature: Model vs Obs



Hourly Ozone, Writtle (TORCH), August 2003



Ozone - August 2003

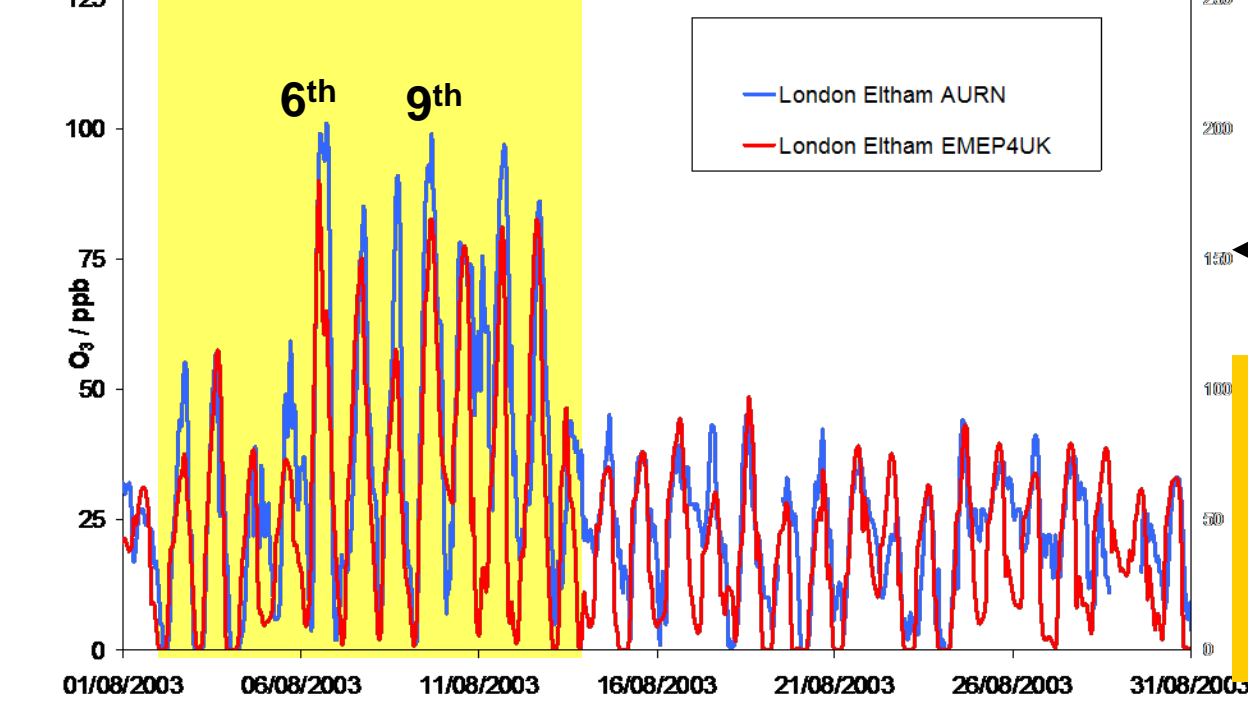
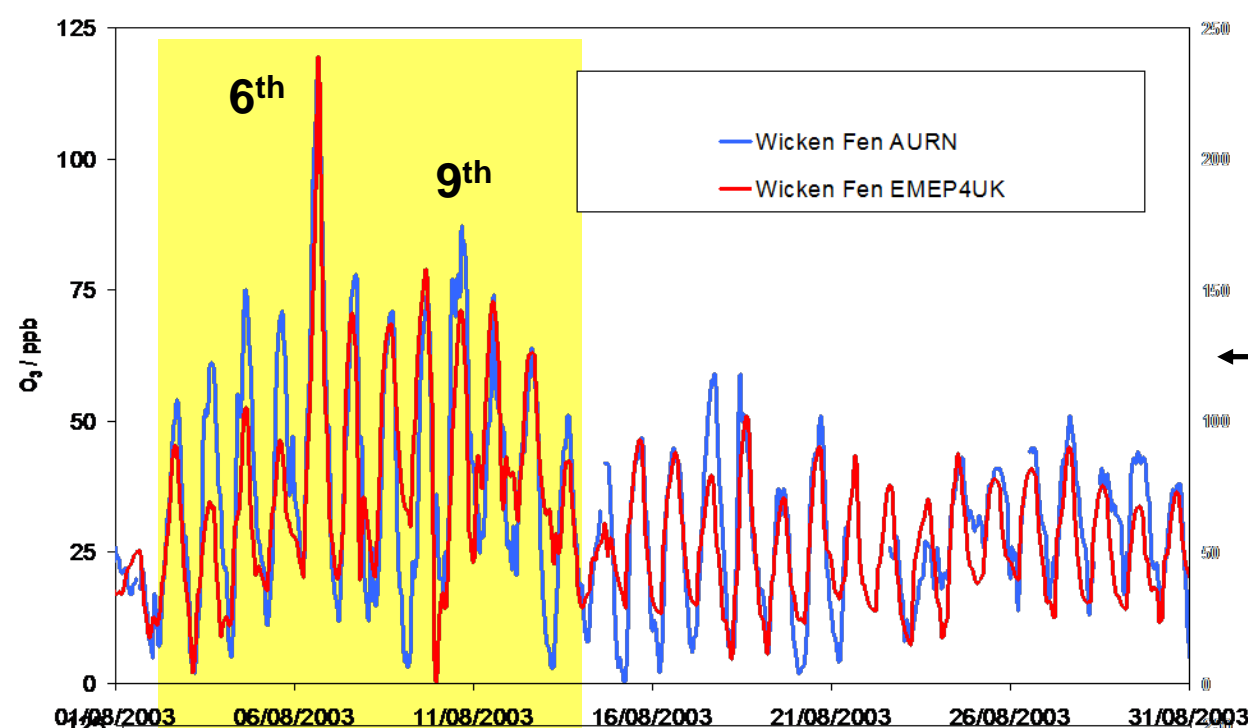
← Wicken Fen

Model does better during the heat-wave at these sites compared to Writtle –

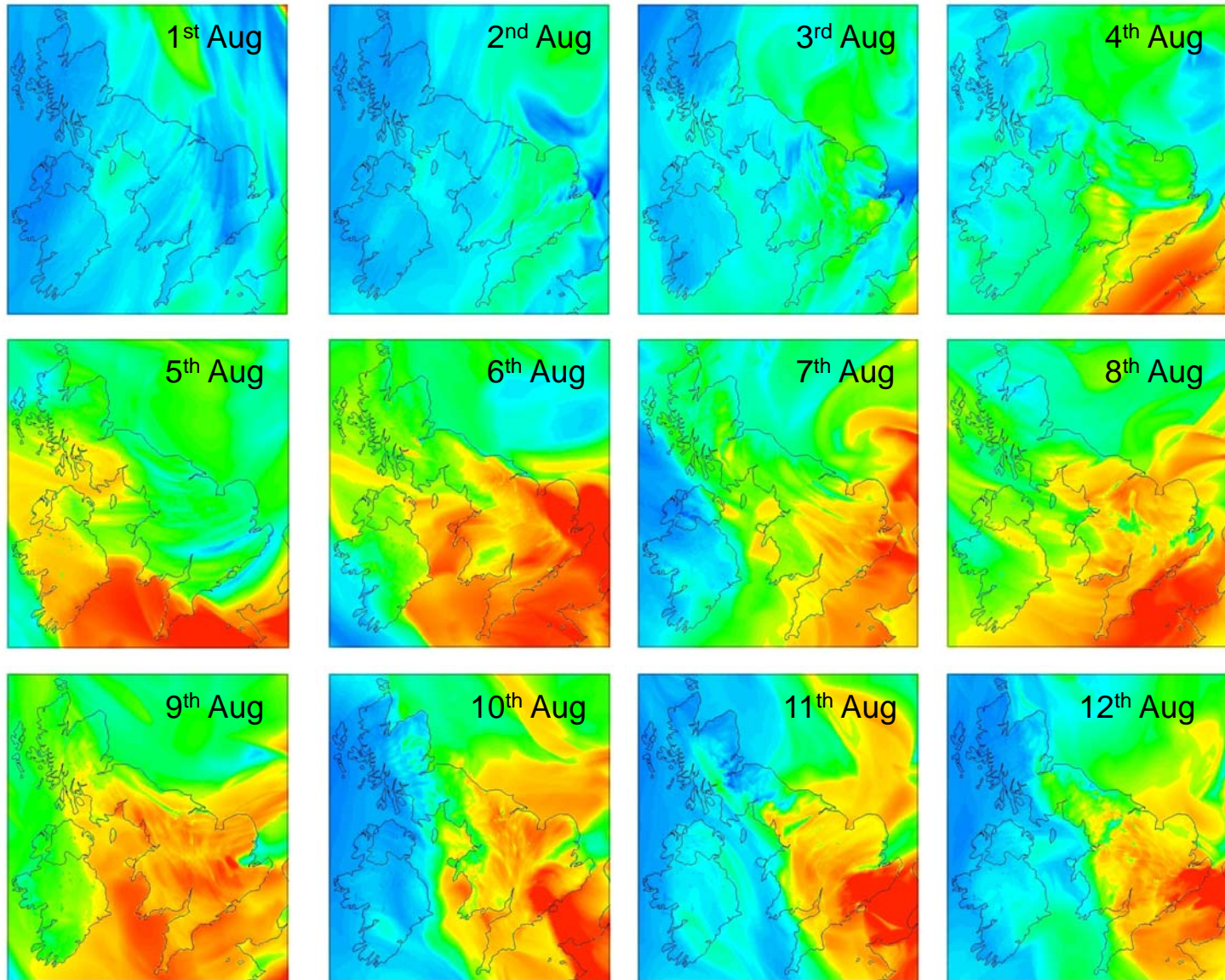
Indicates importance of local factors in getting O₃ correct at Writtle

← London Eltham

EMEP4UK has ability to simulate O₃ over SE England, rural & urban

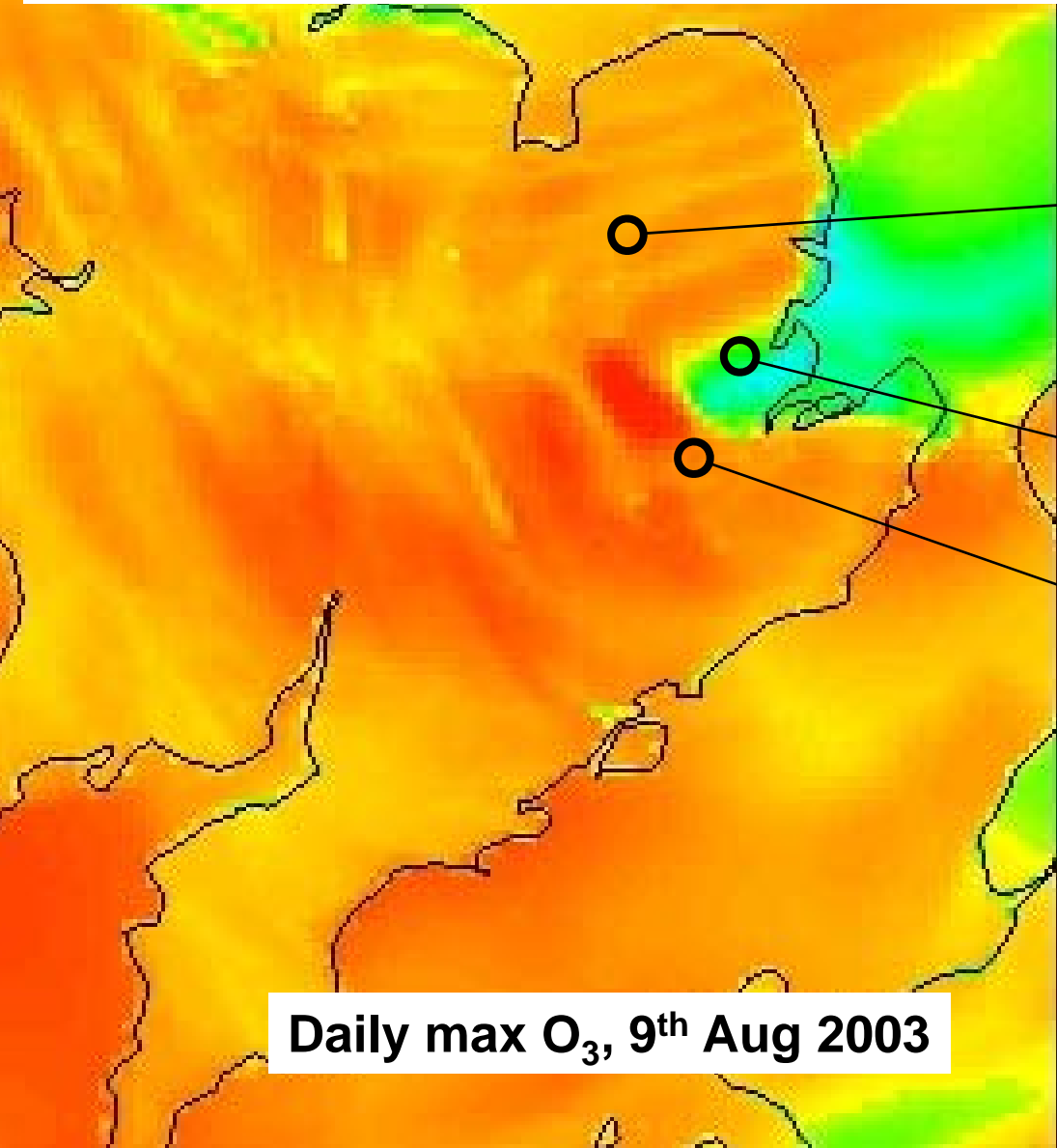


Surface daily (1-h) maximum ozone 1st-12th August 2003



0 ppb  100 ppb

9th August: Why are Wicken Fen and London O₃ OK, but Writtle not?



Wicken Fen

Writtle

Eltham

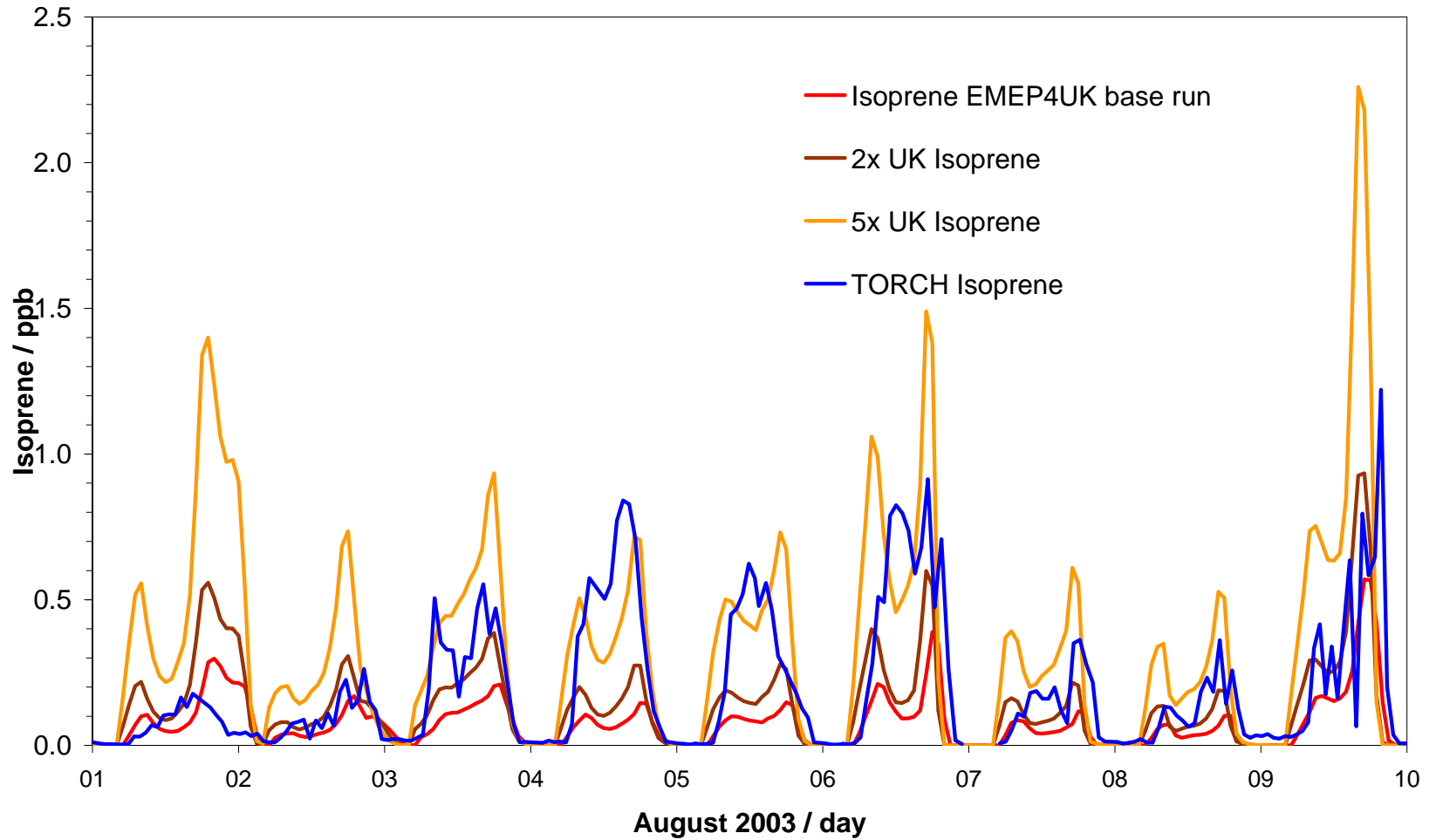
Local sea-breeze or BL effects crucial!

Daily max O₃, 9th Aug 2003

Attribution of ozone during August 2003

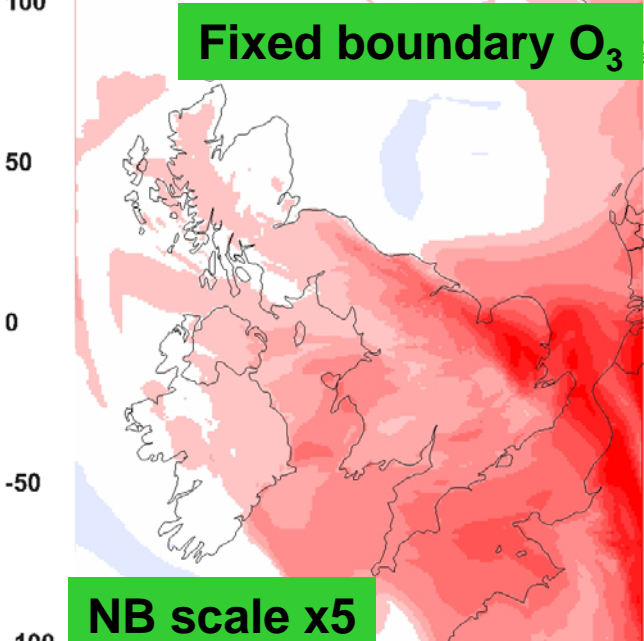
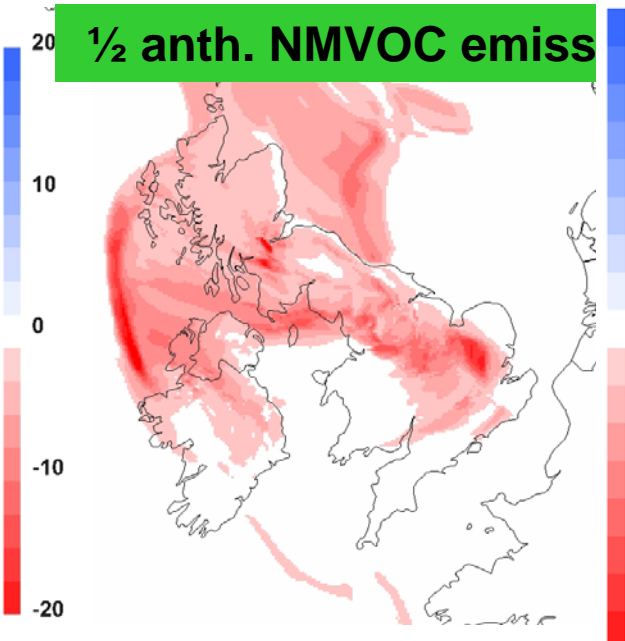
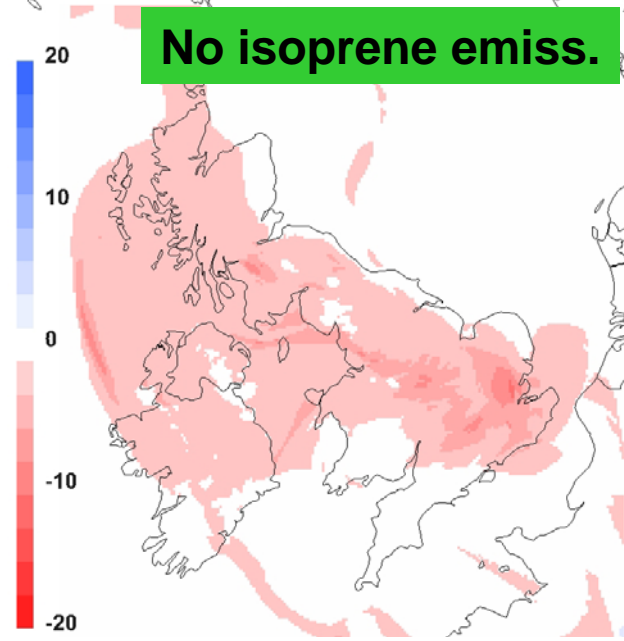
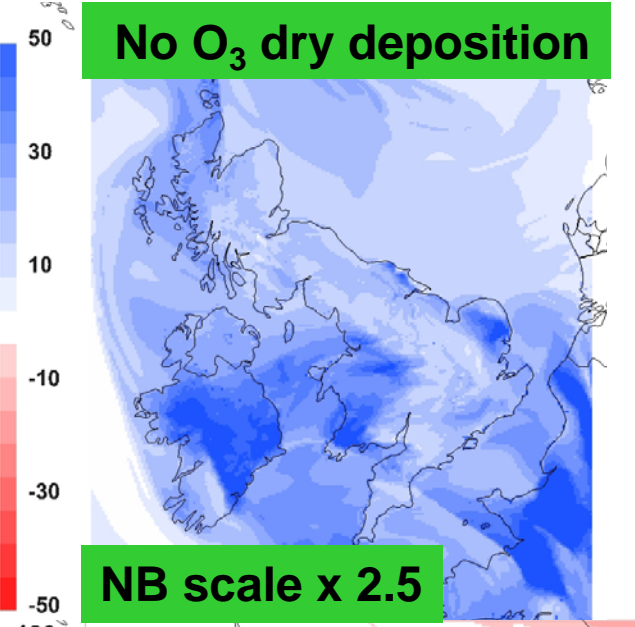
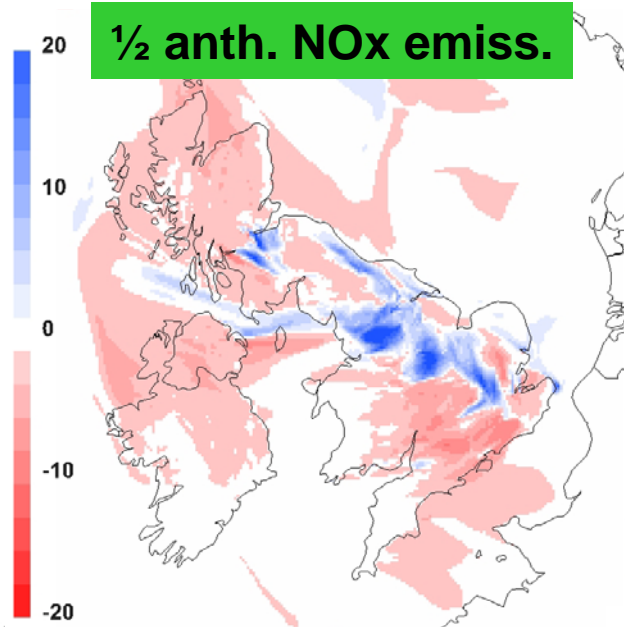
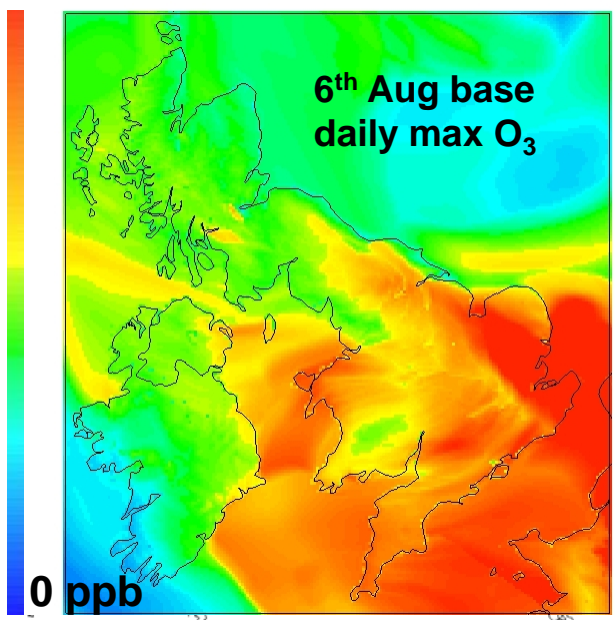
- Series of variants of base run to explore sensitivity to:
 - UK biogenic isoprene emissions (off, x2, x5)
 - UK anthropogenic NO_x emissions (x $\frac{1}{2}$)
 - UK anthropogenic NMVOC emissions (x $\frac{1}{2}$)
 - Import of O₃ from outside 5 km domain (fix O₃ at boundary to climatology)
 - Dry deposition (off)

Isoprene, Writtle (TORCH) August 2003

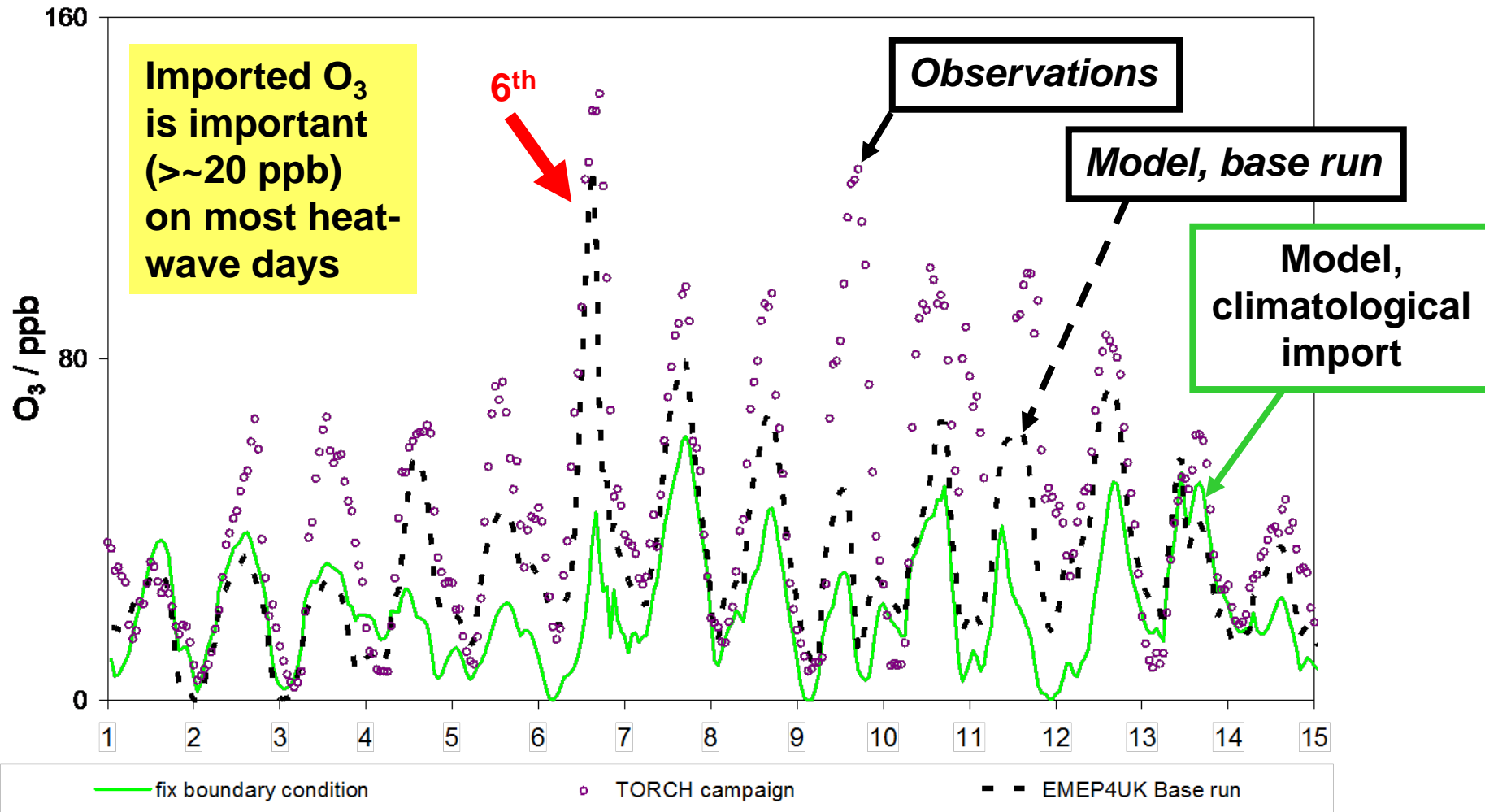


Change in daily maximum O₃ 6th Aug relative to base

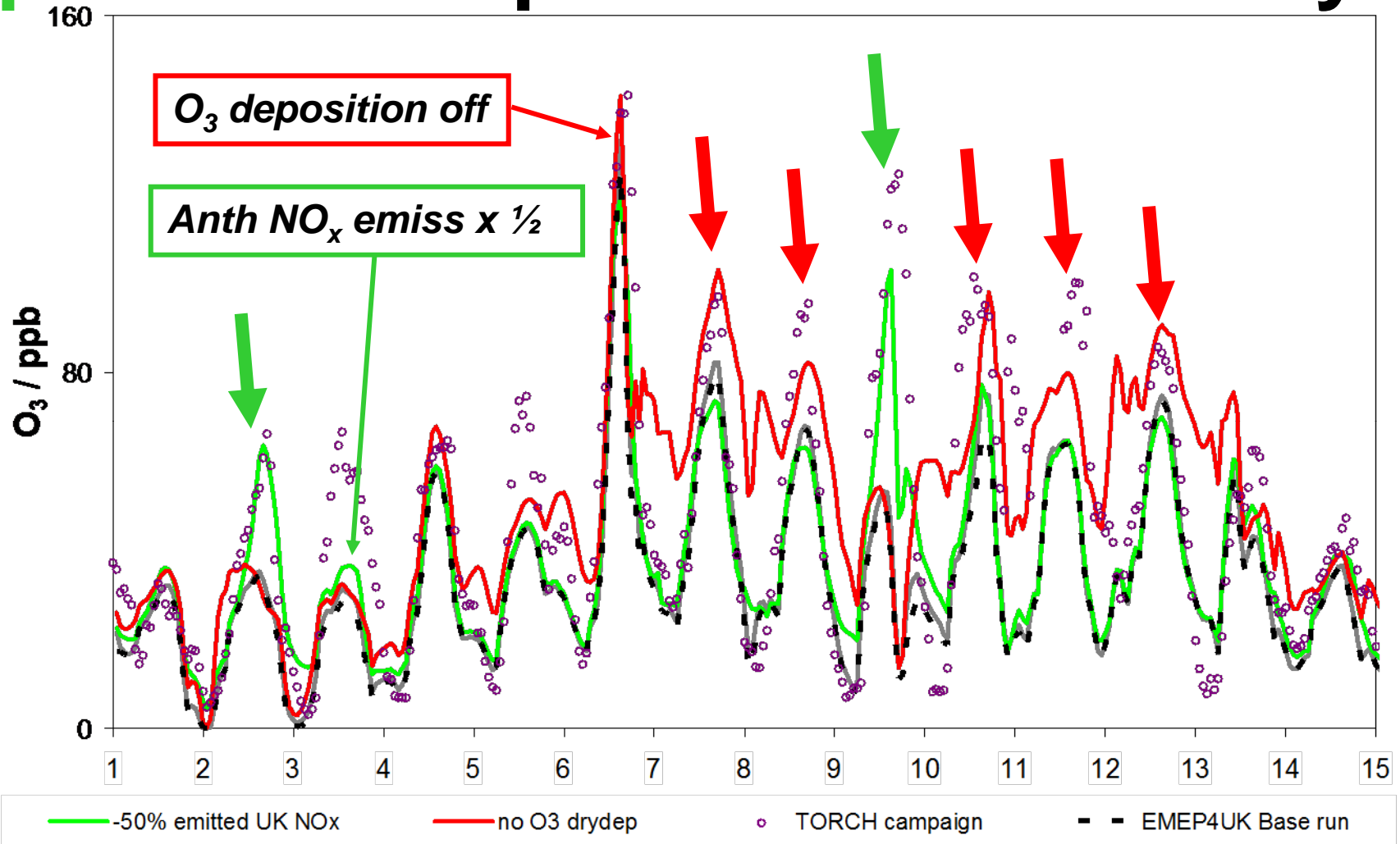
100 ppb



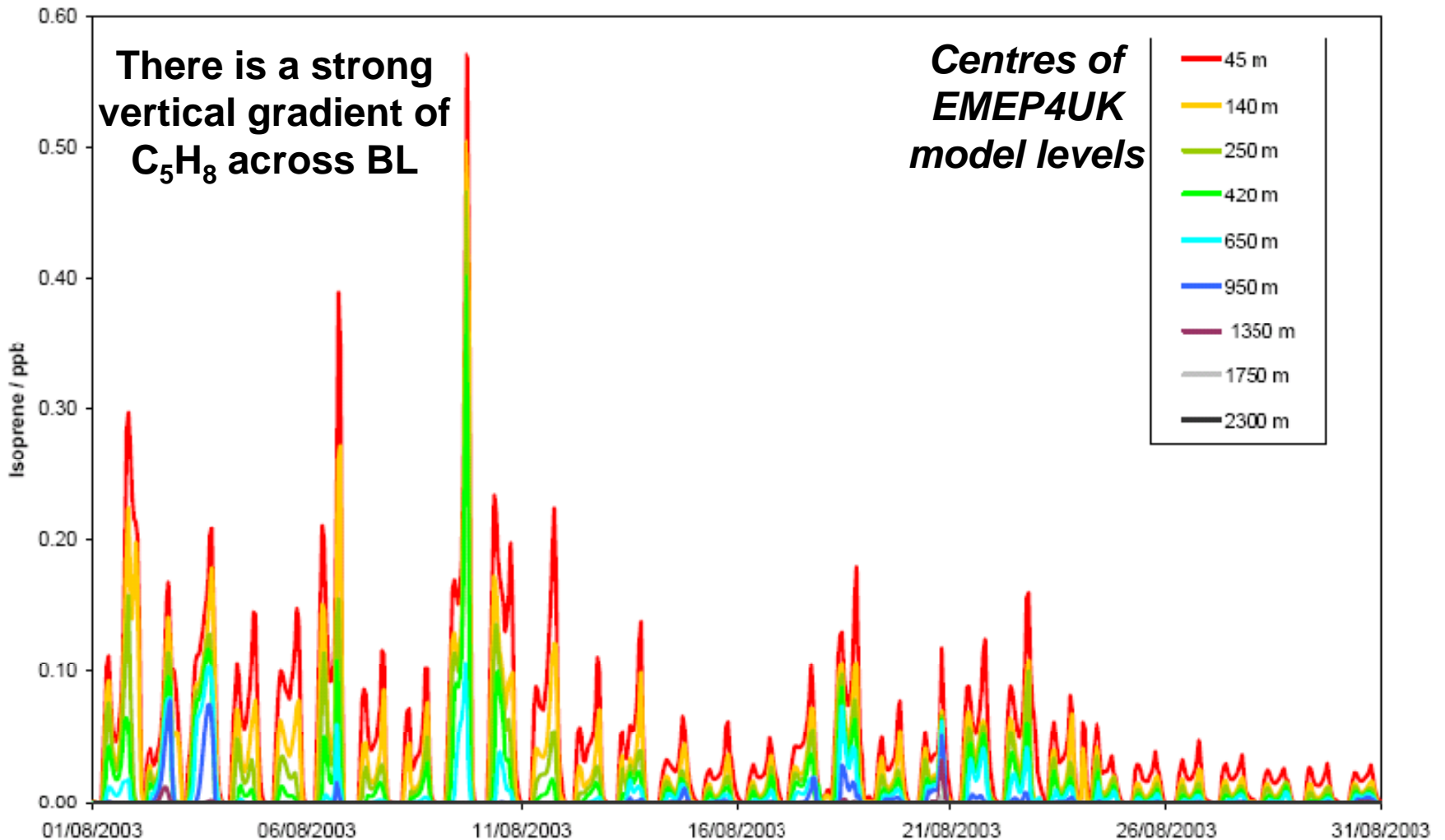
Most of the O₃ at Writtle on 6th Aug was imported from EU



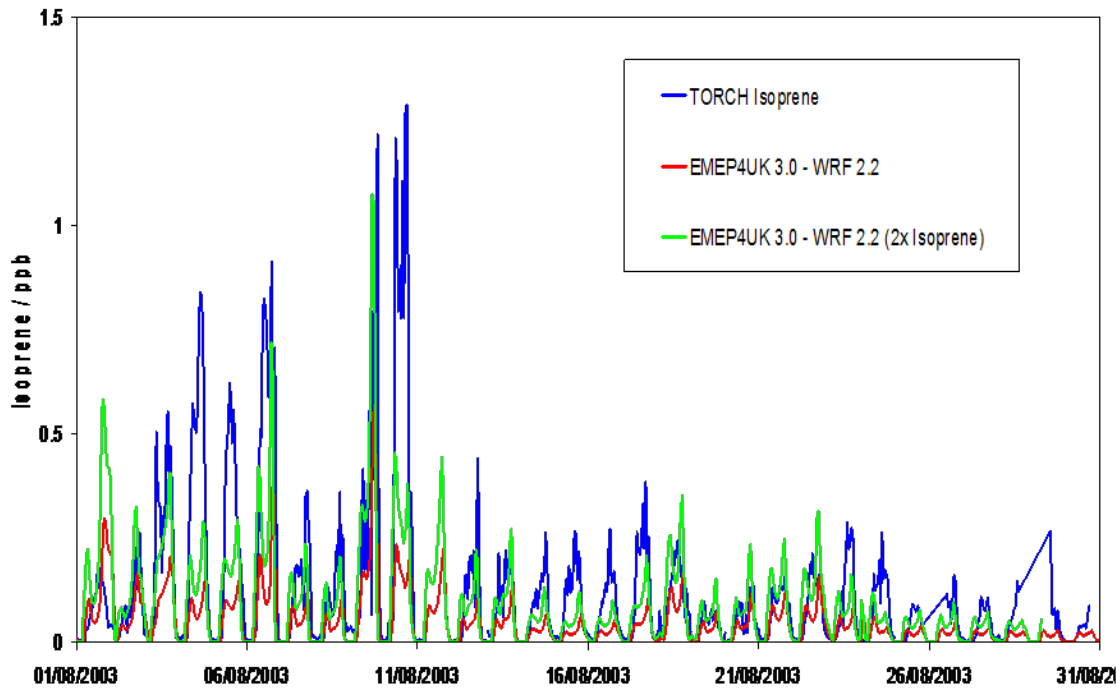
O₃ dry deposition and **NO_x plume positions** important on other days



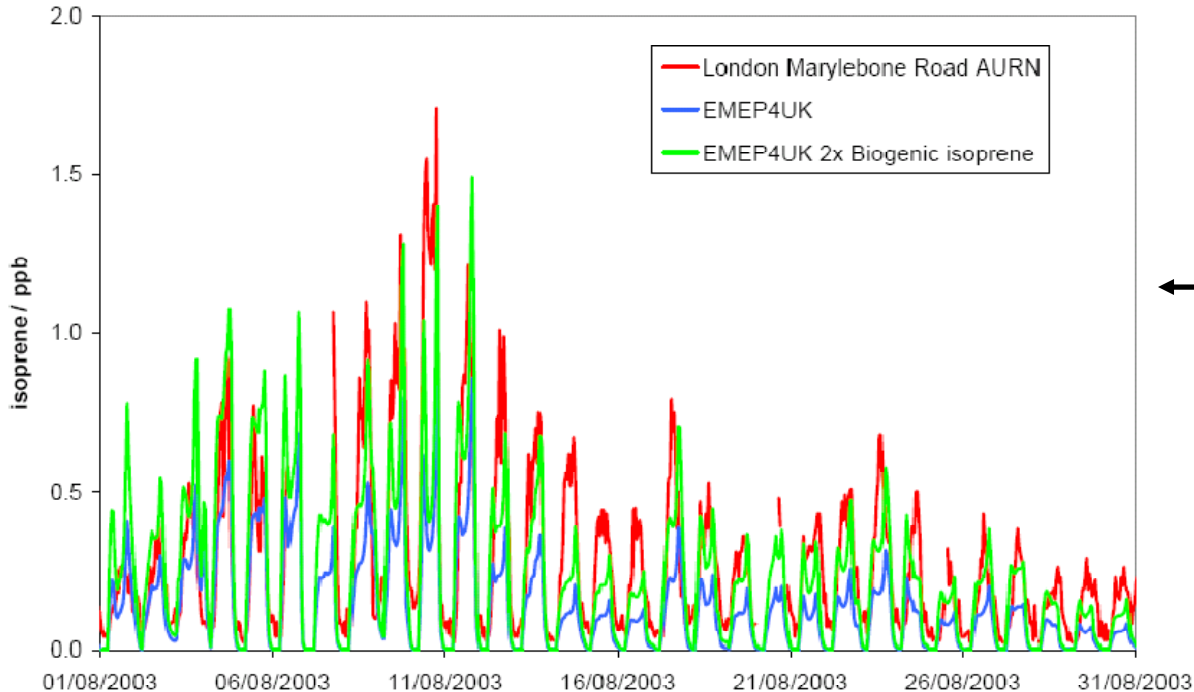
EMEP4UK vertical profile of isoprene, Writtle (TORCH) August 2003



Isoprene - August 2003



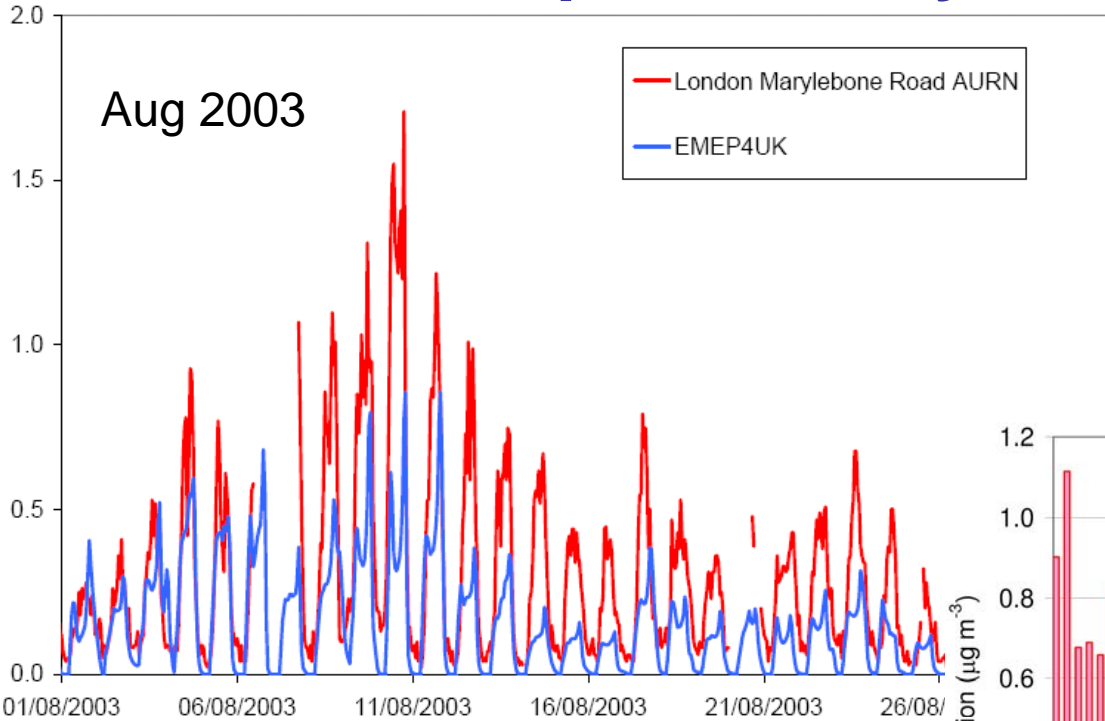
← Writtle (TORCH)



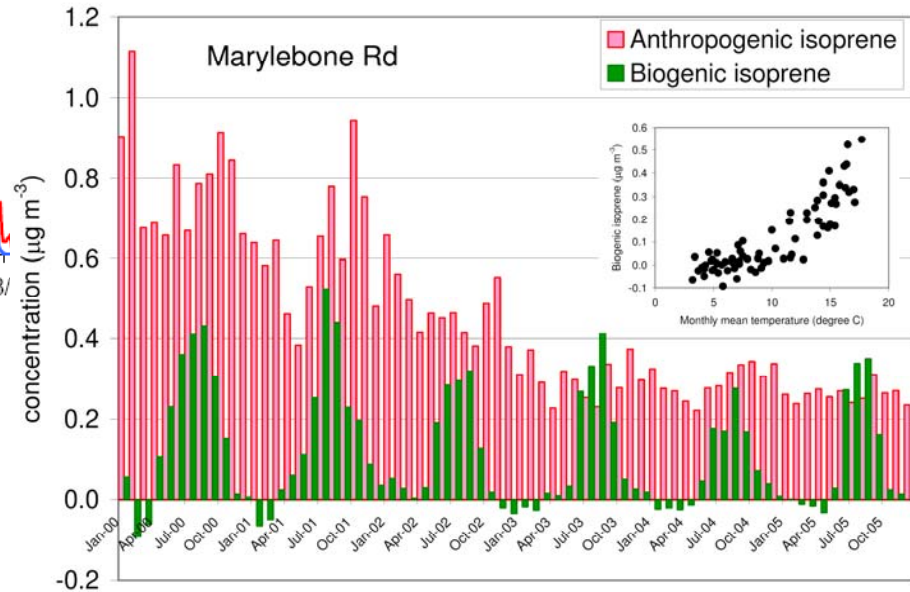
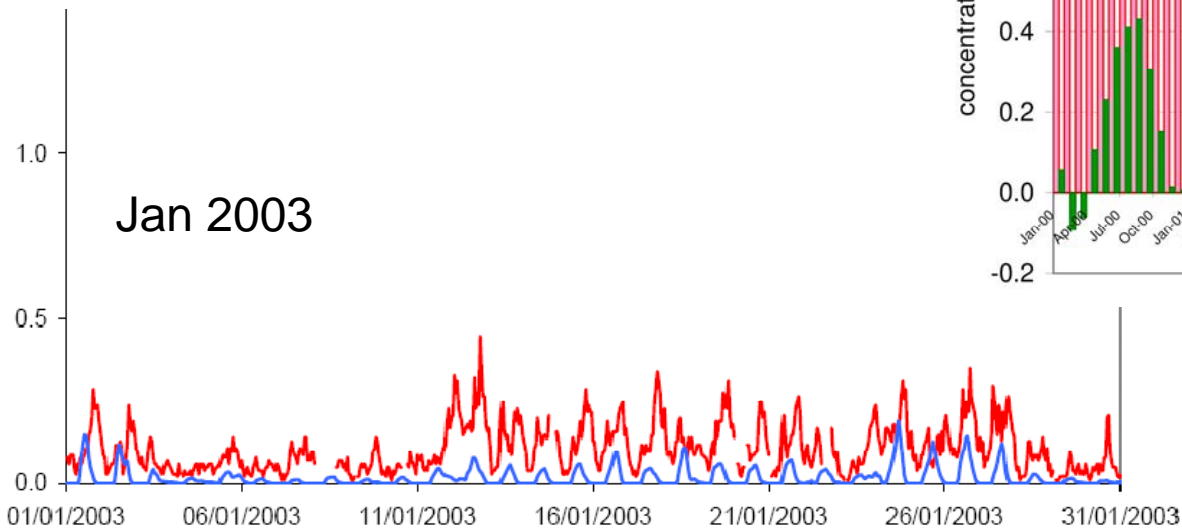
← Marylebone Road

Modelled C_5H_8 in London also reasonable; 2x emissions better

Isoprene, Marylebone Road



Anthropogenic isoprene at MR of $\sim 0.3 \mu\text{g m}^{-3}$ (0.1 ppb) not included in EMEP



(Also no T-dependence on anthropogenic VOCs in EMEP4UK)

1 $\mu\text{g m}^{-3}$ isoprene = 0.35 ppb

Conclusions(1)

- Ozone during the 2003 heat-wave
 - EMEP4UK reproduces observed O_3 at several sites in SE England ‘quite well’
 - Major source: import from continental Europe
 - Different days have different dominant controls on maximum ozone.
 - Import ($> \sim 20$ ppb of O_3) on most days
 - Dry deposition influences O_3 at ~ 10 -20 ppb level
 - Position of NO_x plumes on specific days crucial
 - Isoprene produces ~ 0 -10 ppb O_3

Conclusions (2)

- Isoprene
 - EMEP4UK with current emissions simulates C_5H_8 (Writtle & London) to within a factor of ~ 2
 - Some evidence that emissions should be higher (factor $\sim 2-3$)
 - Vertical profile in BL significant (may be relevant for trajectory models?)
 - Anthropogenic component not included in model; also no T-dependence of anth. VOC emissions
 - Model simulates shape of diurnal variation OK (suggests model C_5H_8 oxidation chemistry \sim OK?)