Did Fires in Russia cause a UK Particulate Pollution Episode in May 2006?

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Introduction

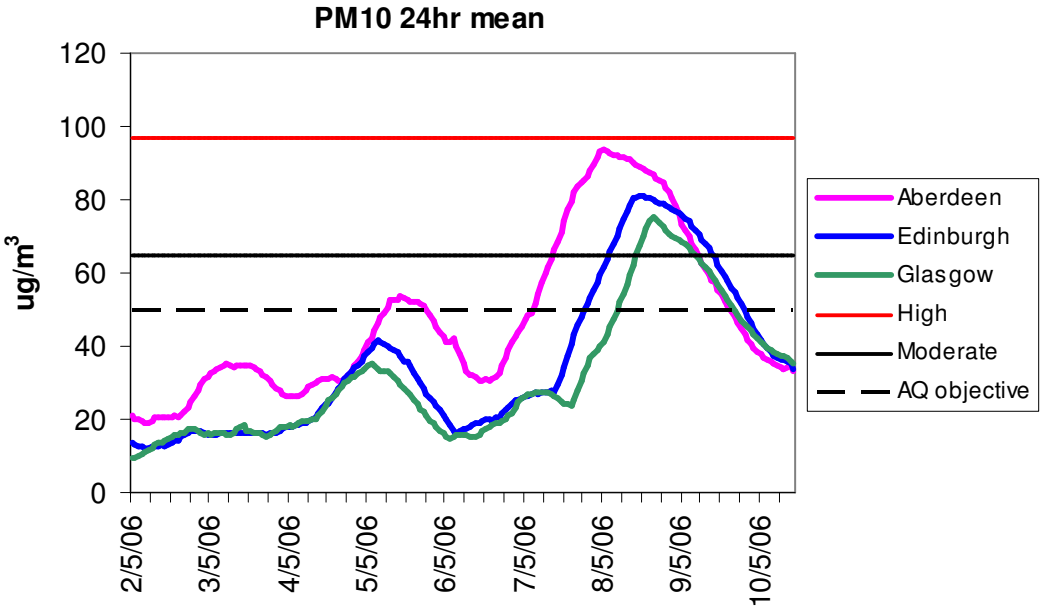
- Moderate to High levels of air pollution were recorded in Scotland and England from 7-10 May 2006
- Air transport during this time was from the east
- Elevated levels of PM_{10} also observed over NW Europe
- Near-critical fire situation in western Russia reported by Russian news agency on 5 May

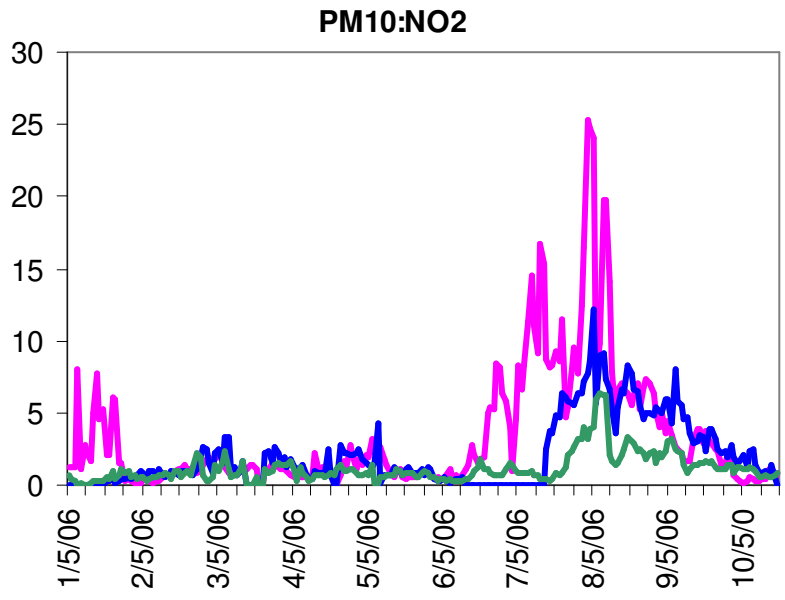
Band	Index	24hr Mean µg/m^3
Low	1	0-21
	2	22-42
	3	43-64
Moderate	4	65-74
	5	75-86
	6	87-96
High	7	97-107
	8	108-118
	9	119-129
Very High	10	130+

UK PM_{10} AQ levels

AURN Observations

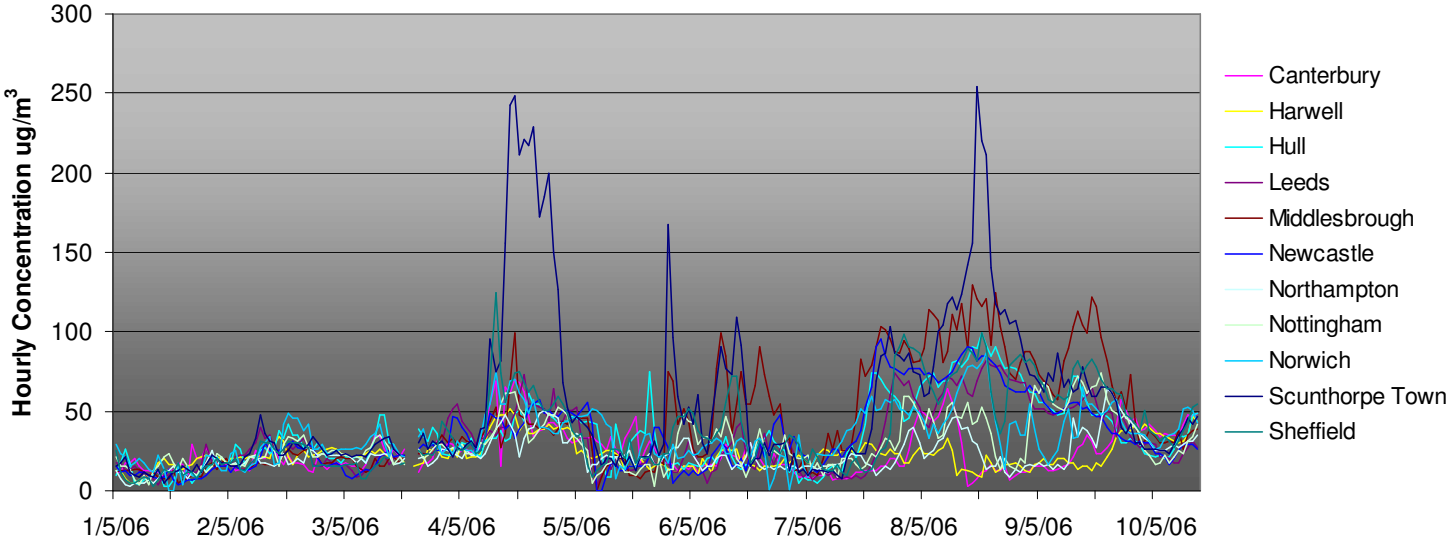
- Unusually high levels of PM_{10} recorded at 19 sites
- Max hourly concentrations of 101 µg/m^3 in Aberdeen, >160 µg/m^3 at Glasgow kerbside and >250 µg/m^3 in Scunthorpe
- Timing of episode later further SW
- Time of max 24-hour mean peak lags behind max hourly values
- Levels of other anthropogenically emitted species not elevated



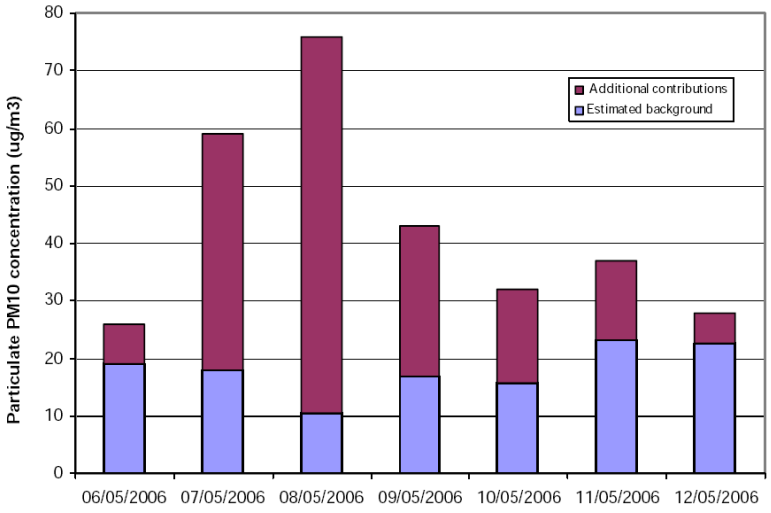


Observations

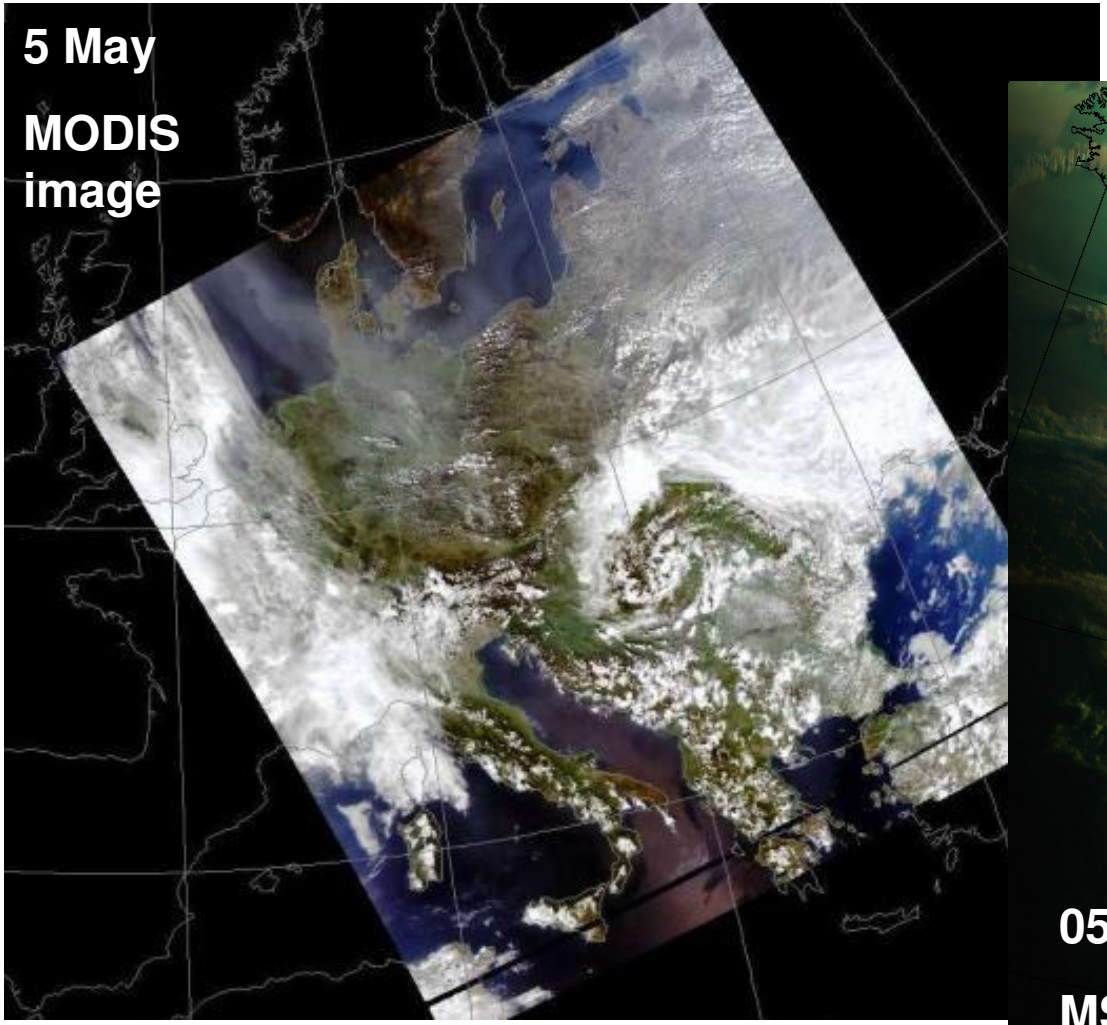
English AURN sites

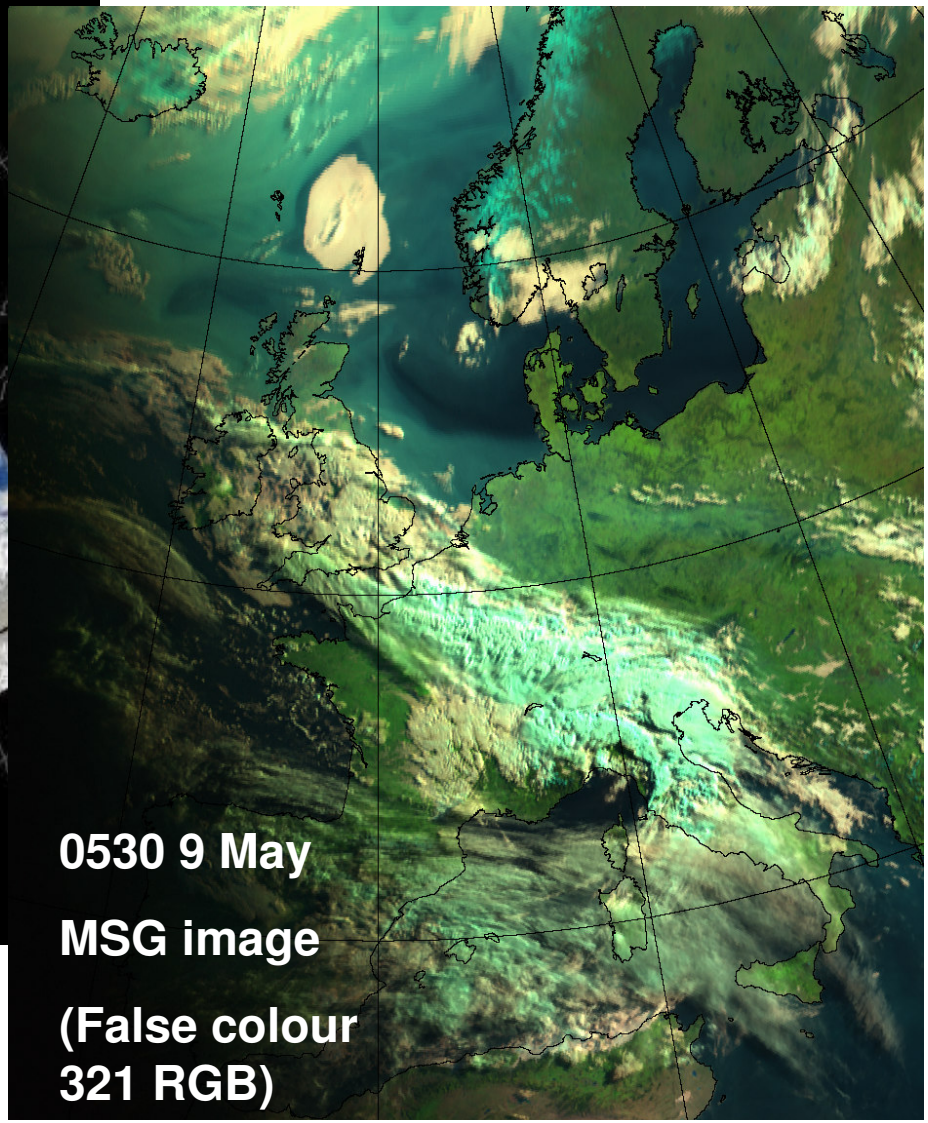


Estimated additional contributions of PM_{10} at Edinburgh St Leonards



Satellite Images of Haze

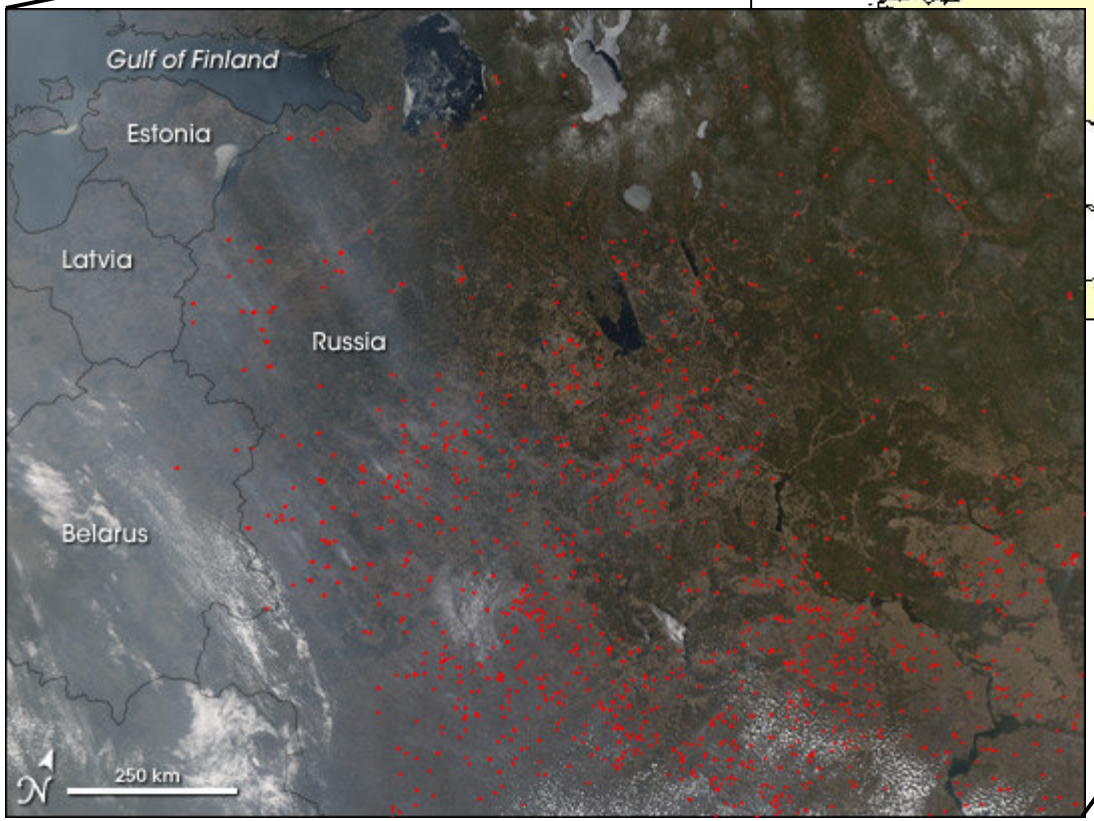


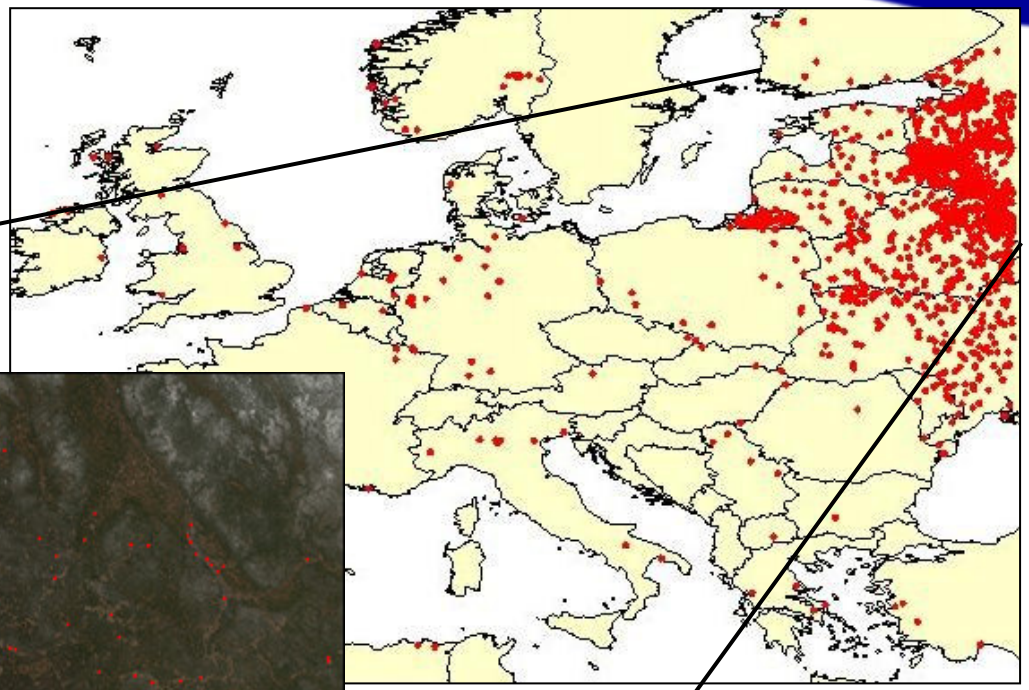


Satellite Images of Fire Region

MODIS Fire Detection Images (NASA)

1 May

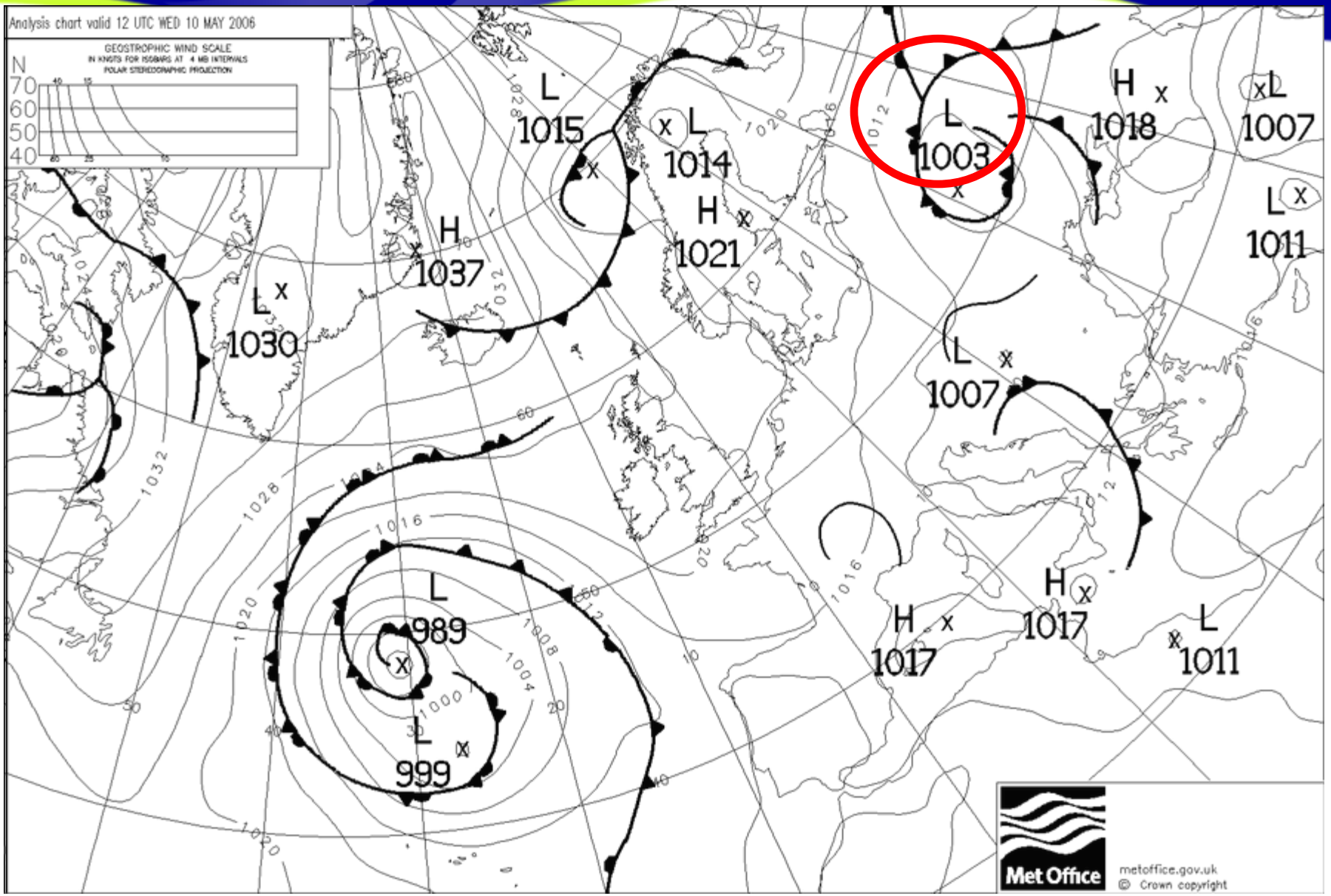




1-10 May composite

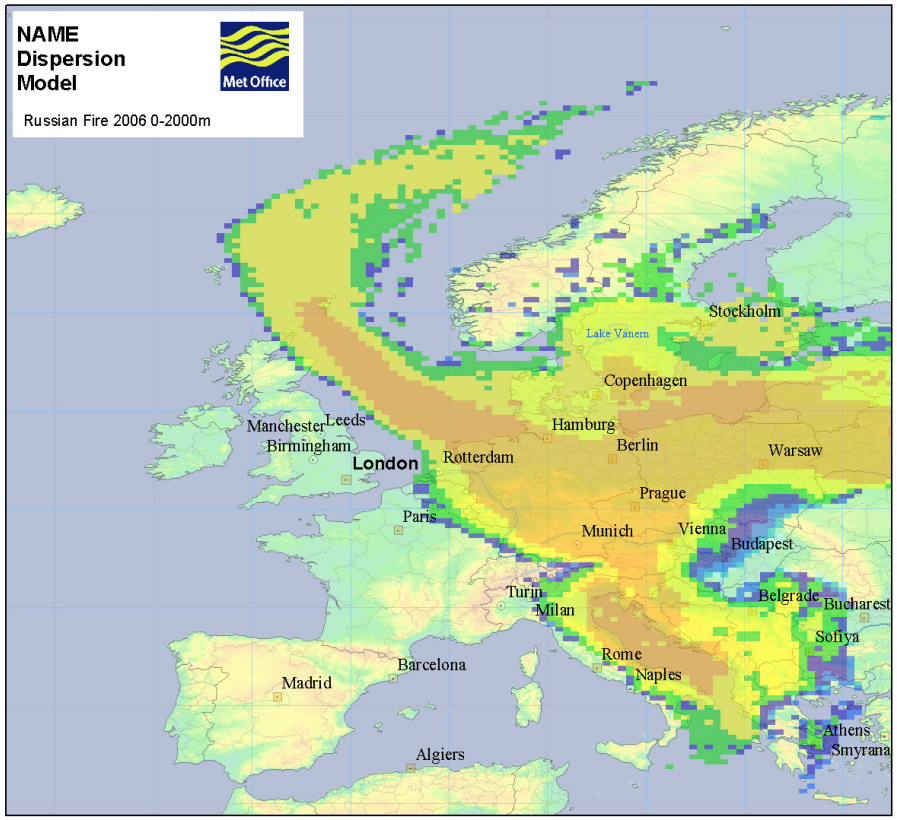
(Original image from Web Fire Mapper http://maps.geog.umd.edu/default.asp)

Synoptic Weather Situation



Modelling the Episode

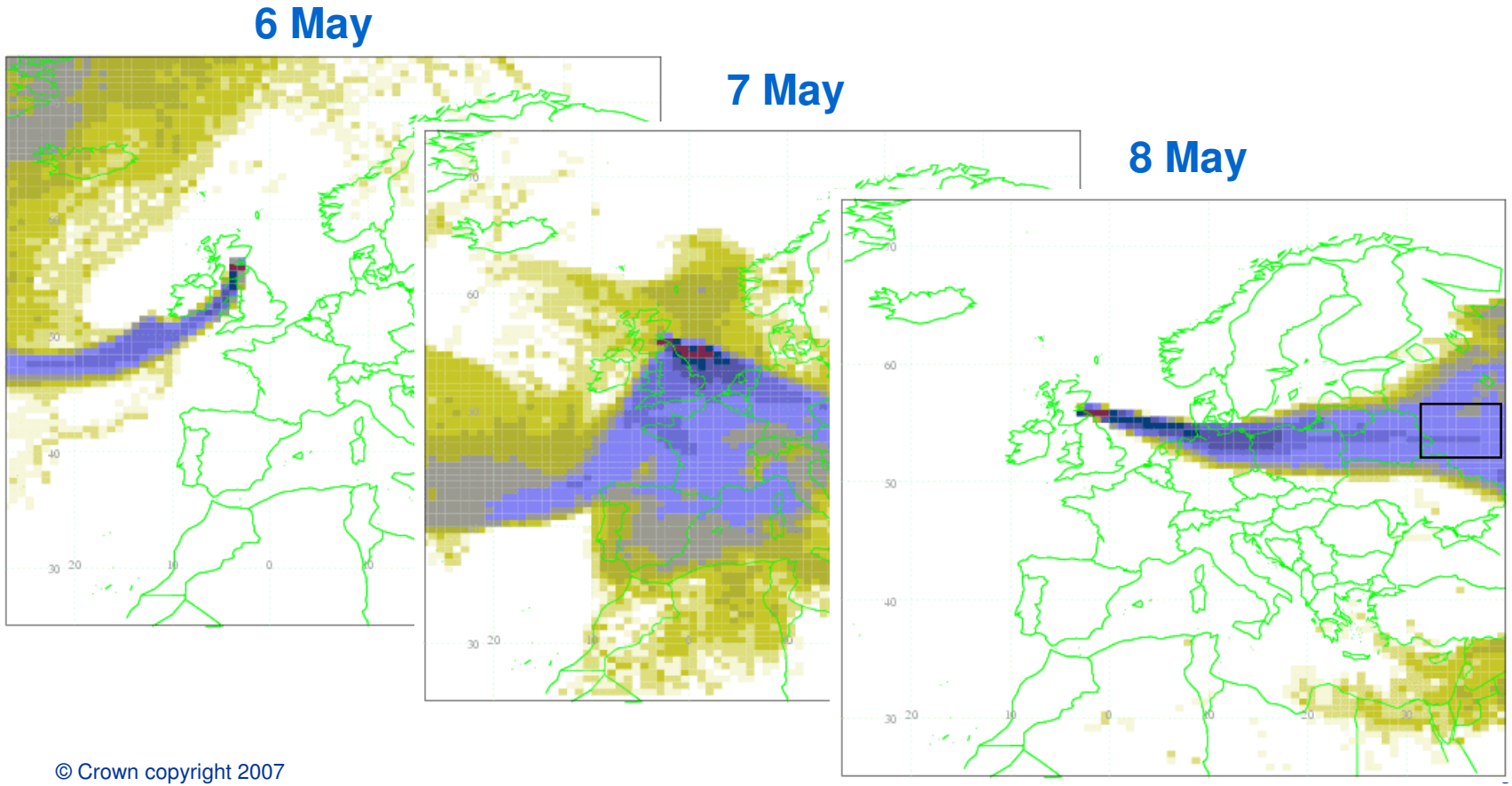
- Routine daily back-trajectories implied air source was to the east
- Further analyses conducted by Met Office using the NAME dispersion model:
  - Lagrangian particle model
  - Driven by 3D met data from Met Office NWP model (40 km res)
  - Predicts air concentrations and surface deposition
  - Run in forwards and backwards modes



Back-maps

NAME was run backwards from observation sites to identify potential source areas

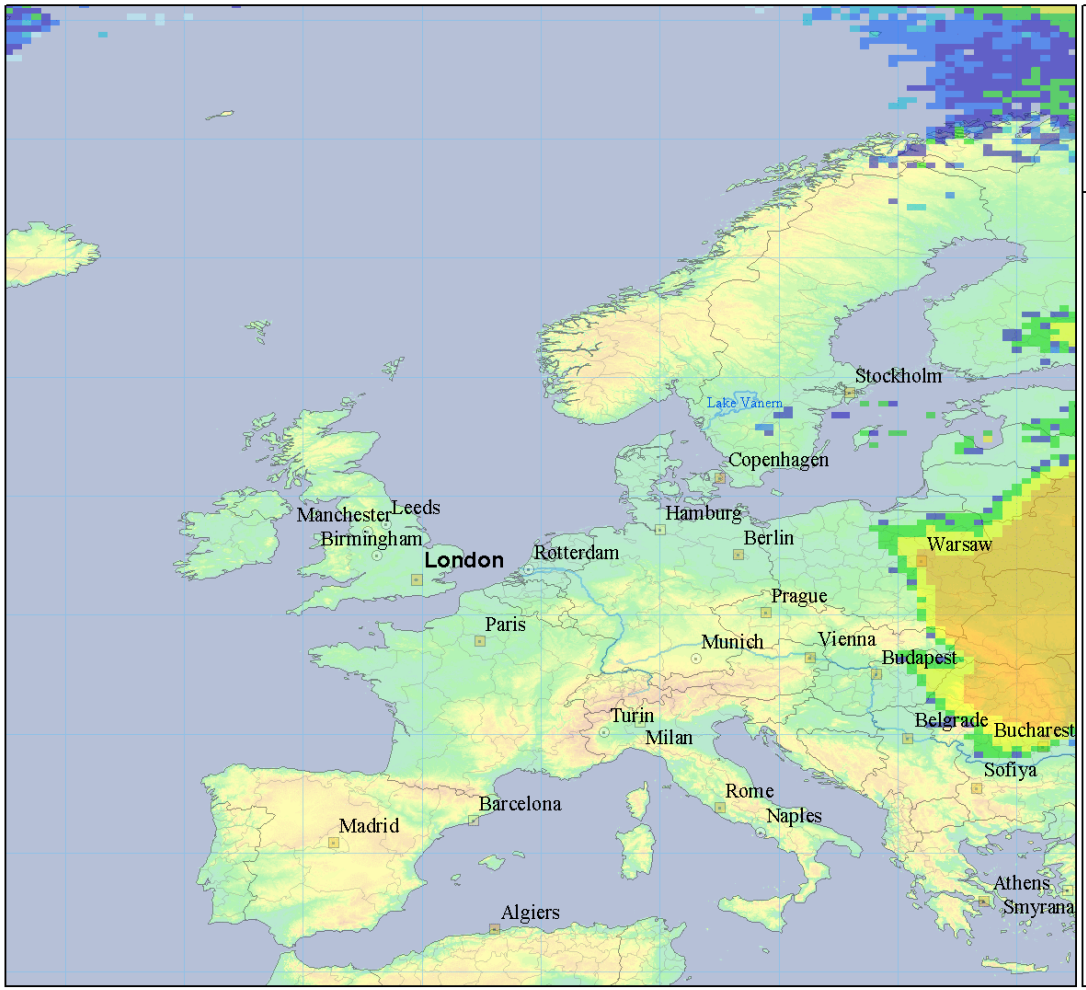
Edinburgh 0000-0300 UTC



Forward Modelling of Smoke Transport

- Uncertainty in the scale and type of fires required assumptions:
  - Location and size of burn area roughly estimated from satellite images
  - A constant unit release rate was used
  - Model was run forwards from 1 May 2006
  - Top of smoke plume estimated from other burn data
- Sensitivity tests were performed for release height and start time
- Wet and dry deposition accounted for

Forward Modelling Results



NAME Dispersion Model

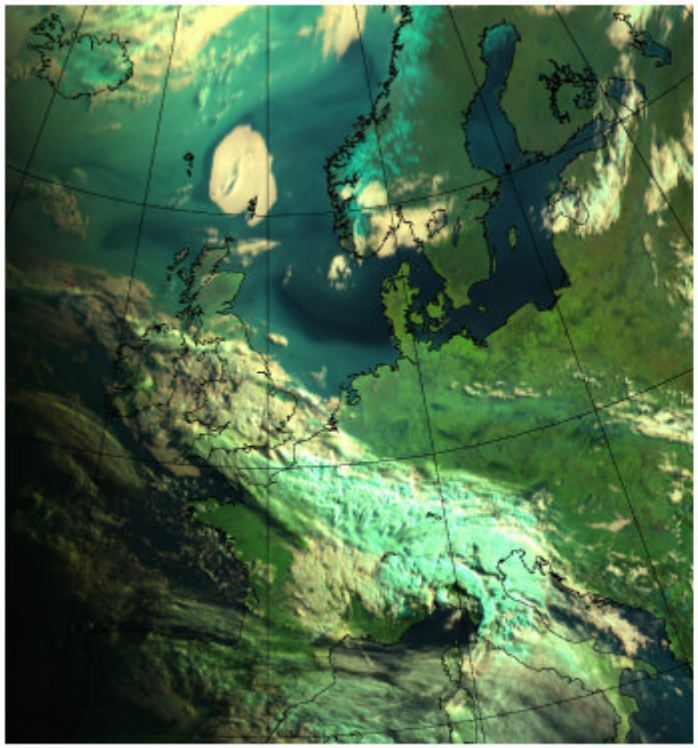
Russian Fire 2006 0-2000m

Model Version	: NAME version 815
Run Name	: Russian_Fire_May2006_
Run Time	: 1030UTC 09/08/2006
Met Data	: Regional
Release location	: multiple sources
Start of release	: 5/1/2006
End of release	: 3/9/1960 9:46:00 AM
Release rate	: multiple sources
Release height	: 0 to 2000m agl
Species	: TRACER
Averaging Period	: 001 hr time averaged
Field	: Air concentration
Vertical limits	: Boundary layer
Time ending	: 5/4/2006 6:00:00 PM
Units	: g/m3

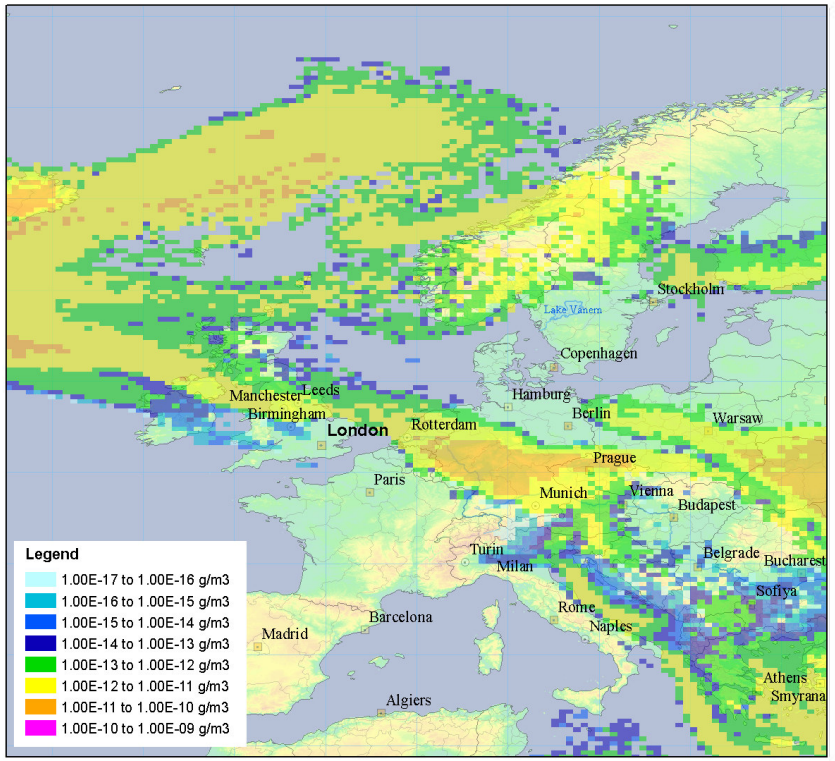
Legend

- 1.00E-17 to 1.00E-16 g/m3
- 1.00E-16 to 1.00E-15 g/m3
- 1.00E-15 to 1.00E-14 g/m3
- 1.00E-14 to 1.00E-13 g/m3
- 1.00E-13 to 1.00E-12 g/m3
- 1.00E-12 to 1.00E-11 g/m3
- 1.00E-11 to 1.00E-10 g/m3
- 1.00E-10 to 1.00E-09 g/m3

Comparison to Satellite Data



Meteosat 8 321 RGB image taken at 0530 UTC on 9 May 2006

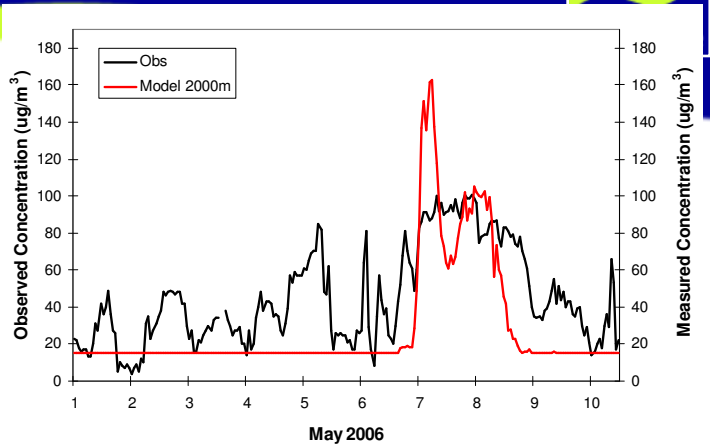


NAME modelled boundary layer air concentration for 0600 UTC on 9 May 2006

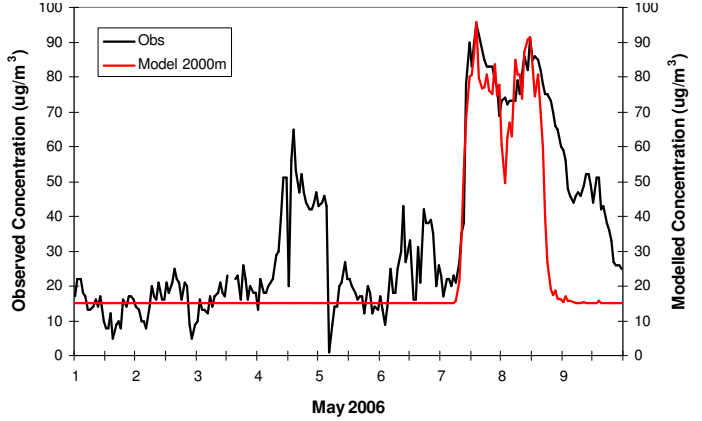
Comparison to Observations

- Good agreement between timing and relative peak magnitudes
- Model does not predict elevated levels at sites where PM_{10} was normal
- Scaling up suggests approx 0.5 Mtonnes per day would need to have been burnt

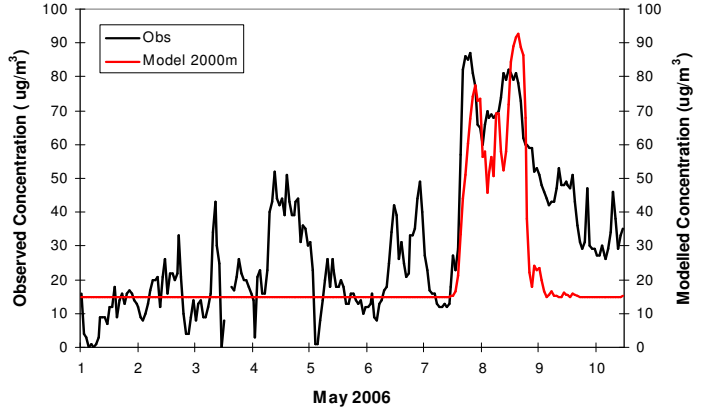
Aberdeen



Edinburgh

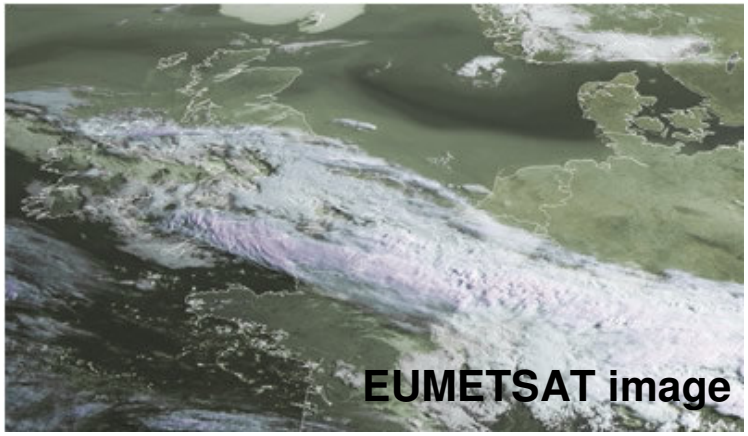


Glasgow

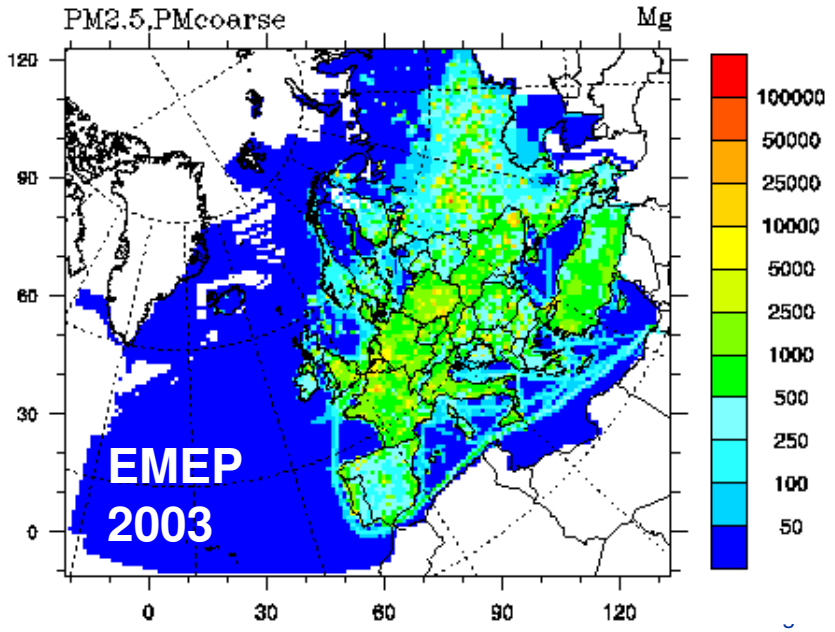


Other Possible Sources

- Pollen?
  - Reports of yellow dust
  - Unusually large pollen releases in NW Europe
  - Large particle size makes it less likely culprit



- Anthropogenic primary and secondary PM_{10}?
  - European pollution
  - Some contribution likely

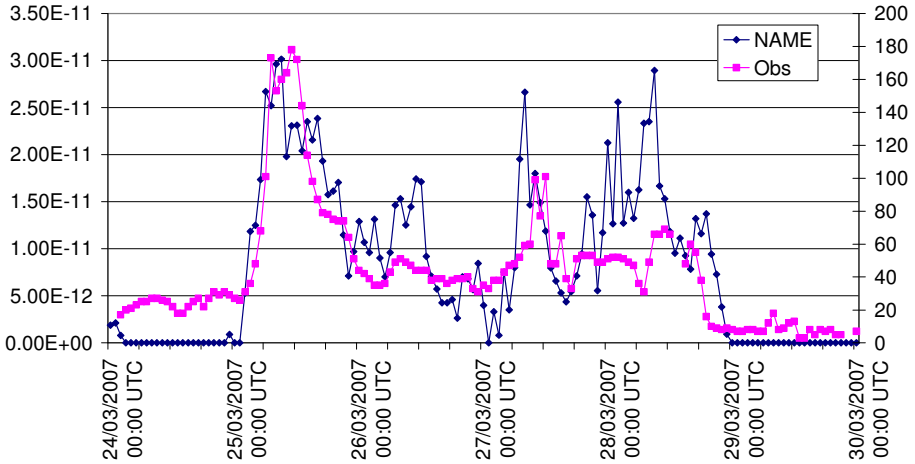


Post-event Analysis of Filters

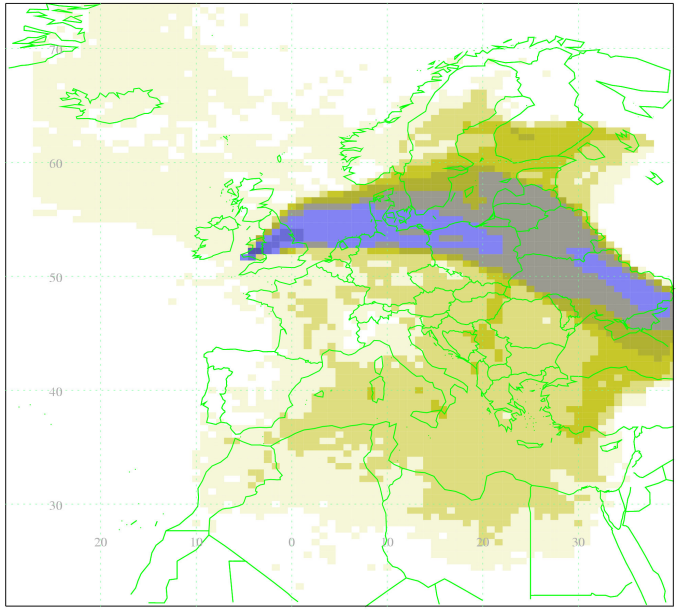
- Daily filters from Forfar from 1-14 May analysed
- X-ray fluorescence spectroscopy showed no consistent variation in particle composition for metals or sulphur
- Optical and scanning electron microscopy (SEM) showed only a few pollen particles over the whole period
- Most particles were inorganic or carbonaceous (particularly on the 7th)

Other Examples of Fire Pollution

- Biomass burning typically occurs in the spring and autumn in Eastern Europe and Russia
- Other identified related UK AQ incidents:
  - September 2002
  - March 2007



Obs and model prediction for Narberth March 2007



NAME back-map for Narberth 25 March 2007

Implications

- Evidence that fires in W. Russia/E. Europe have affected UK air quality at least 3 times since 2000
  - Sep 2002, ? 2003 (Muller et al., 2005), May 2006, Mar 2007
- Without changes in current burning practice such events are likely to occur again
  - Little UK can do about such long-range pollution
  - Pollution may reach HIGH levels with implications for health
- For EU reporting it is important that these “natural” pollution episodes are correctly identified

Conclusions

- PM_{10} levels at 19 AURN sites exceeded current UK AQ objectives in May 2006
- Arrival times and locations of the elevated levels were controlled by the synoptic conditions
  - Under different met conditions more of the UK is at risk (as demonstrated in March 2007)
- Modelling and satellite evidence suggests that primary cause was Russian biomass burning
- NAME model was key for confirming the source of the pollution
- Similar cross-boundary pollution in the future has implications for UK air quality