Air Pollution Forecasting: A UK Particulate Episode from 16th September to 17th September 2006.

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SUMMARY

Over the period Saturday 16th September to Sunday 17th September 2006 twelve sites in the UK Automatic Urban and Rural monitoring network (AURN) measured levels of PM_{10} particulate matter at air pollution index 4 (MODERATE), one site reached index 5 (mid-MODERATE band).

The cause of this PM_{10} particulate episode was likely to have been a build up of particulate matter, sourced from Europe, behind a weather front which had remained relatively stationary over the UK over that two day period.

Of the sites measuring PM_{10} in the MODERATE band, seven were located in the London area, three in the Yorkshire and Humberside zone, two in the North East zone, one in the East Midlands and roadside sites in Glasgow and Manchester.

The majority of these sites measured MODERATE as a result of local pollution sources combined with the additional long-range transport component. Five of these sites were roadside or kerbside, seven were urban–designated, two were urban-industrial and one was an airport site.

INTRODUCTION

Within this short paper we will attempt to:

- Quantify the magnitude of the episode by analysing automatic air pollution monitoring data.
- Identify the source of the pollution by examining:
  - simple air mass back-trajectory analyses available to the forecasters in real-time during the event,
- Track and understand how the pollution spread across the UK by examination of satellite images over the period of interest.

MONITORING RESULTS

Figure 1a shows hourly-averaged PM_{10} measurements at two London sites, two sites in central-northern England, one roadside site in the Manchester area and in central Glasgow and two rural sites as references: Lough Navar in Northern Ireland and Rochester in South East England. Figure 1b shows hourly averaged PM_{10} and $PM_{2.5}$ (TEOM) measurements taken at Rochester. Figure 1c shows hourly-averaged $PM_{2.5}$ (TEOM) measurements at four sites in the south east of England.

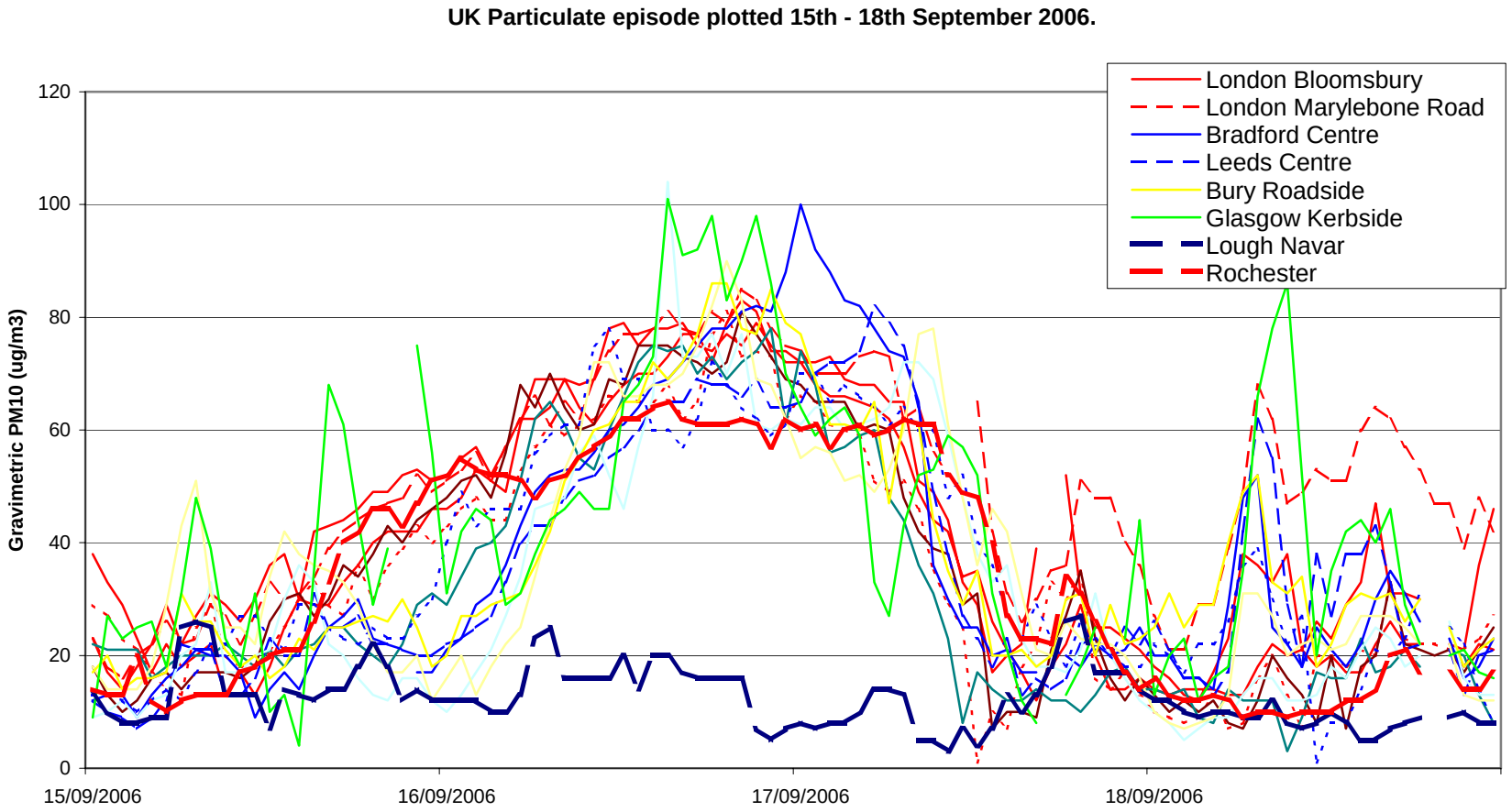

Figure 1a: Hourly mean PM_{10} measurements at selected UK sites, September 15th to 18th 2006.

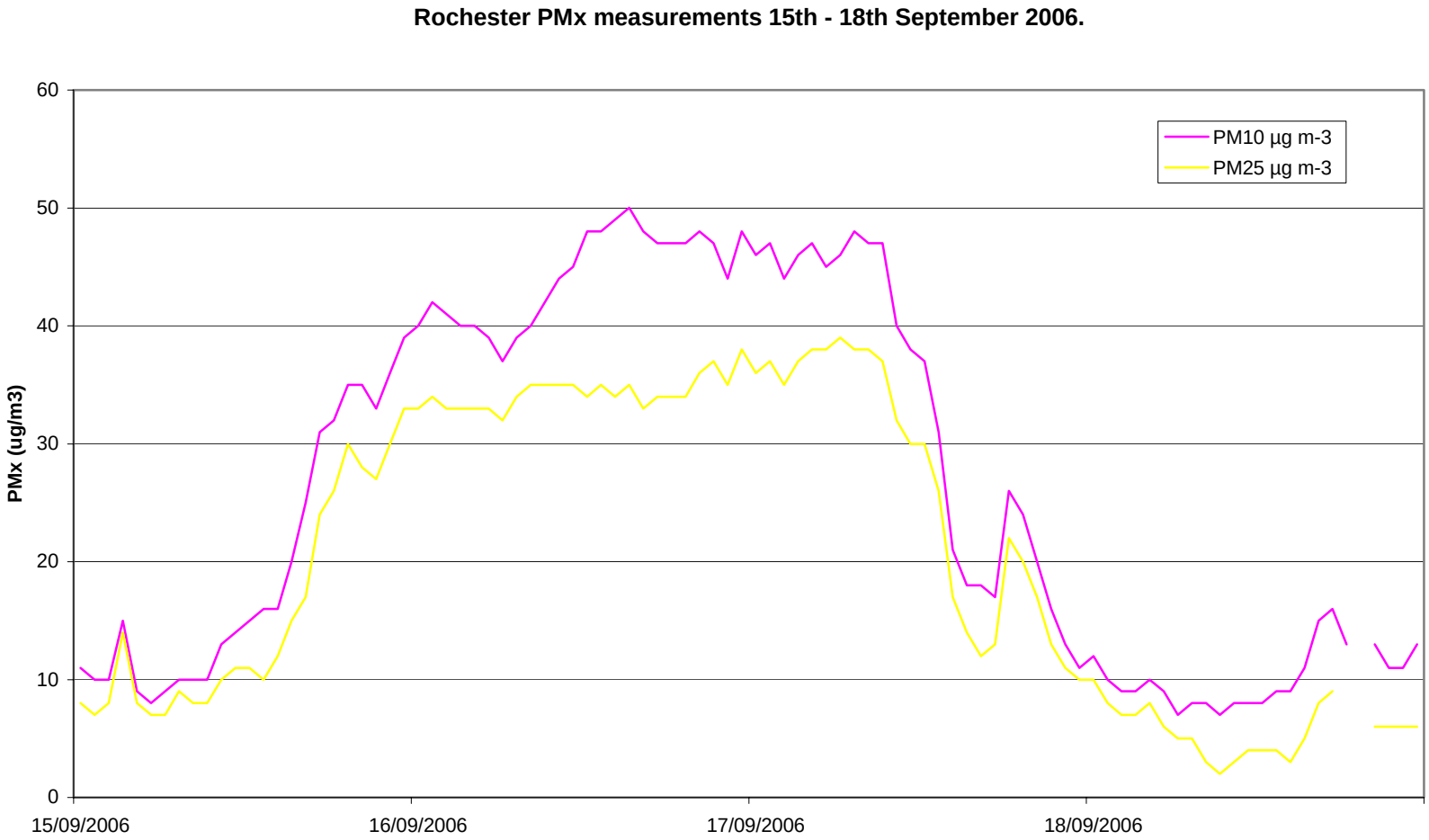

Figure 1b: Hourly mean PM_{10} and $PM_{2.5}$ (TEOM) measurements at Rochester, September 15th to 18th 2006.

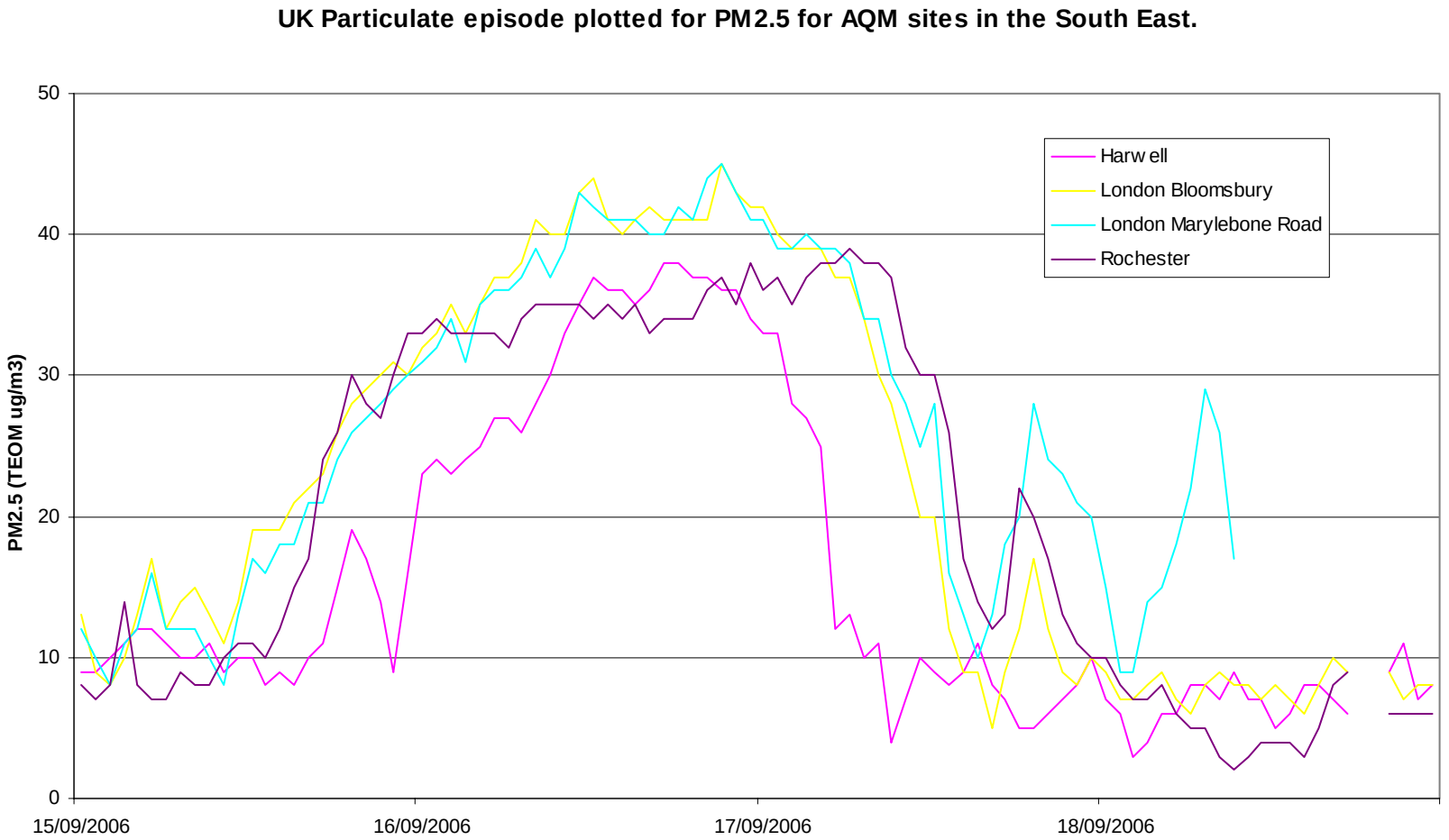

Figure 1c: Hourly mean $PM_{2.5}$ measurements at Rochester, Harwell, London Bloomsbury and Marylebone Road, September 15th to 18th

DESCRIBING THE EPISODE

A general build up in particulate concentrations occurred from the afternoon of Friday 15th to late in the evening on Saturday 16th. Levels dropped during the morning of Sunday 17th , returning back to pre-episode levels by the early afternoon. PM_{10} and $PM_{2.5}$ measurements made at Rochester indicate that 80% of the particulates measured at ground level were composed of 80 % the finer fraction $PM_{2.5}$ by mass-volume, a particle size usually associated with secondary particles and anthropogenic sources such as combustion processes.

LIKELY SOURCES OF THE POLLUTION

Simple 1000mB 96-hour forecast air mass back-trajectory data are provided by the Met Office to the Netcen air pollution forecasting team each day. These data illustrated that the air arriving in most of the UK, particularly in the east of England on the first day of the episode (16th September) had traveled from a south-easterly direction, from continental Europe and countries such as Germany (see figures 2a and 2b for the progression of the sampling direction on the Friday and Saturday). Figures 2c and 2d show the progression back to westerly sampling of clean Atlantic air on the Sunday and Monday.

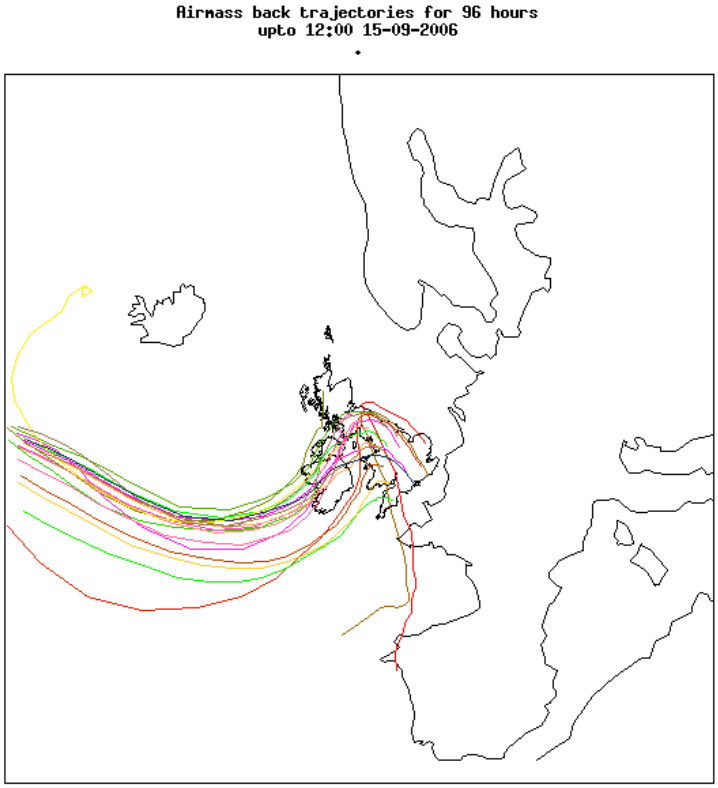

Figure 2a: Air mass back-trajectories for Friday 15th September

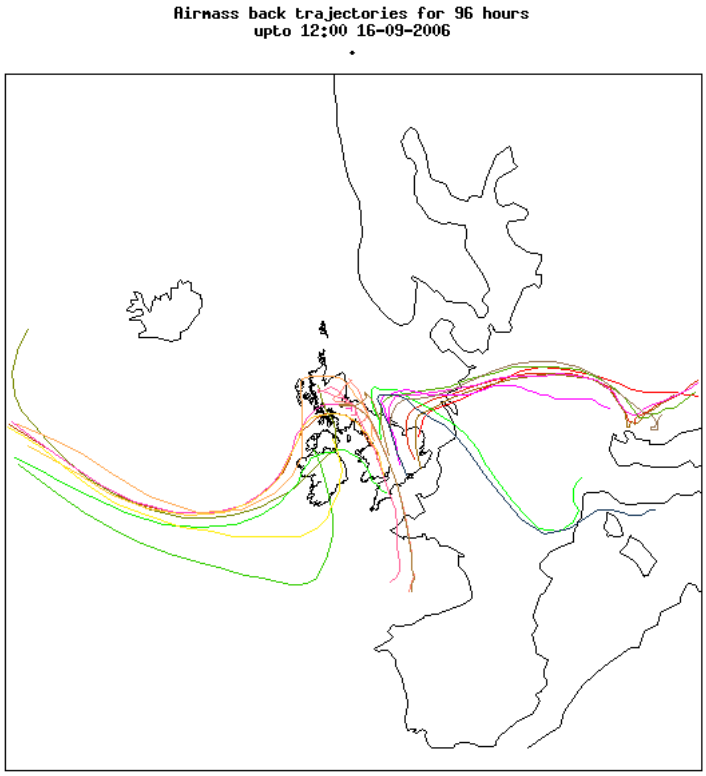

Figure 2b: Air mass back-trajectories for Saturday 16th September

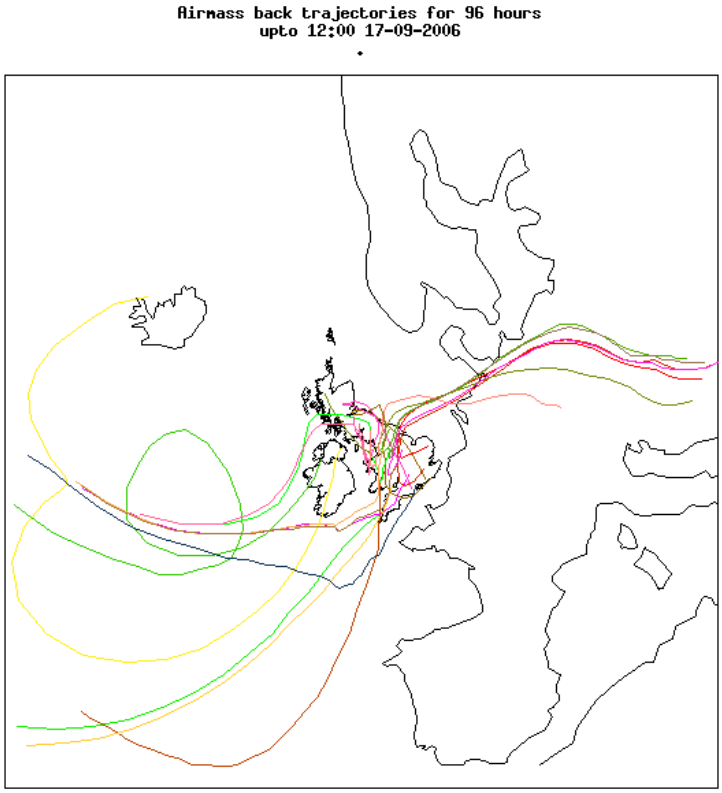

Figure 2c: Air mass back-trajectories for Sunday 17th September

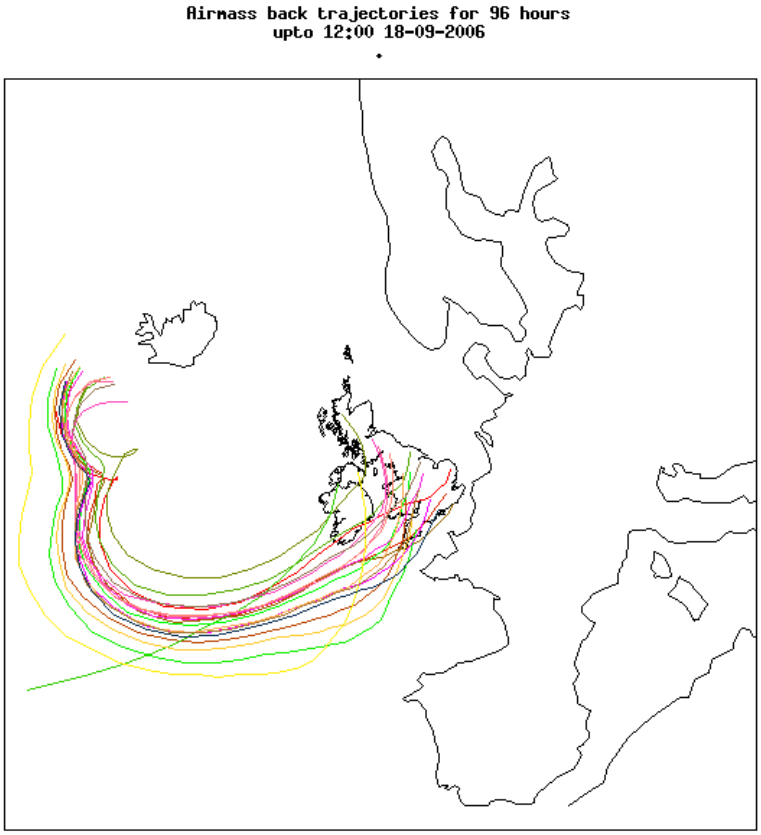

Figure 2d: Air mass back-trajectories for Monday 18th September

TRACKING THE EPISODE FROM SATELLITE IMAGES

Please note that many of the high resolution colour images which follow have been sourced from a MODIS satellite.

On Friday 15th September, the afternoon on which particulate concentrations began to increase, a haze could be seen issuing from Europe, from the vicinity of Germany, with some indication that particulates were already building over the North Sea (ie the purple haze which can be seen in figure 3).

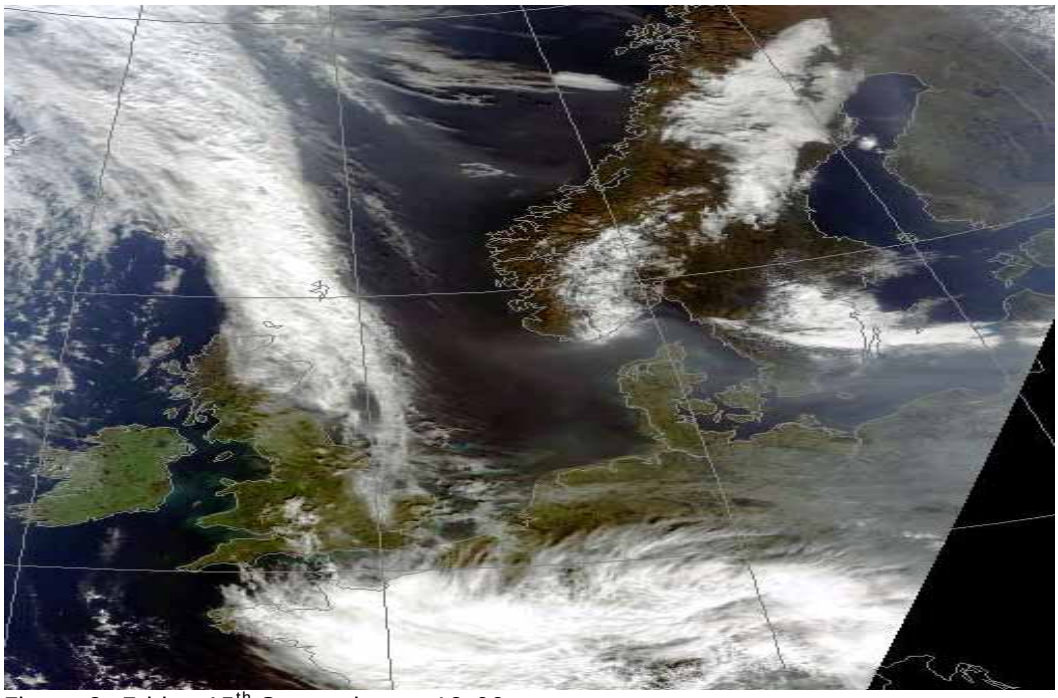

Figure 3: Friday 15th September at 12:00.

By Saturday afternoon a conglomeration of haze could be seen over much of the eastern half of the UK, mingling with a broad band of cloud. More haze can be seen arriving from the east, as seen in figure 4. Many of the sites which reached the MODERATE band during the episode had reached index 4 (MODERATE) by this stage.

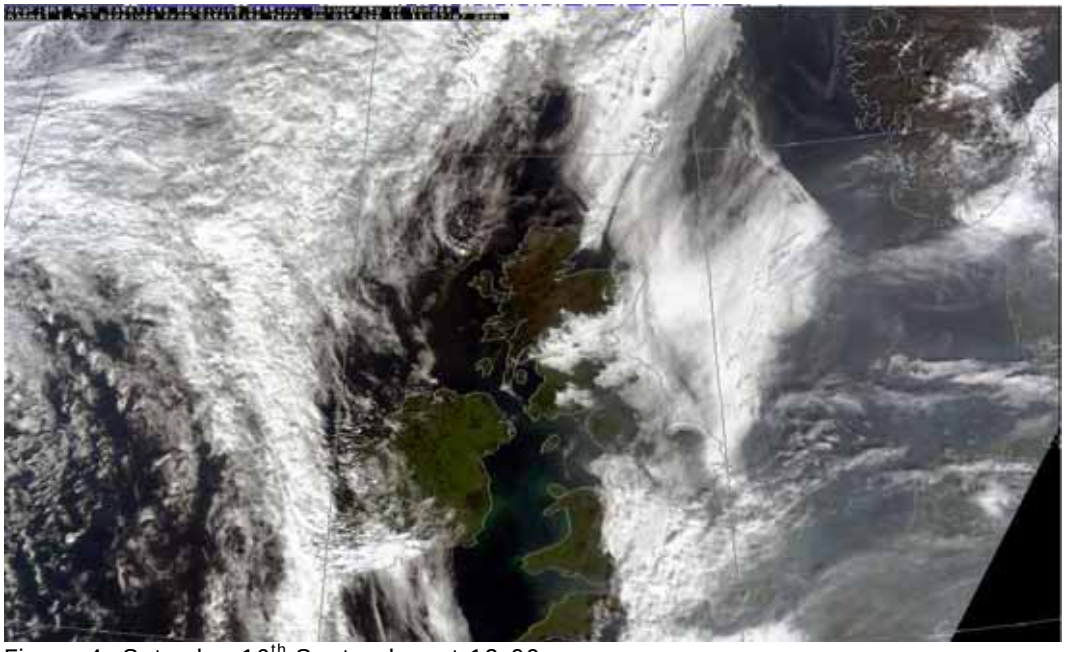

Figure 4: Saturday 16th September at 12:00.

A second satellite image taken at the same time, with a larger field of view, shows that behind the concentrated haze reaching the UK from the east the air over Europe was relatively clear of further cloud and haze. This can be seen in figure 5.

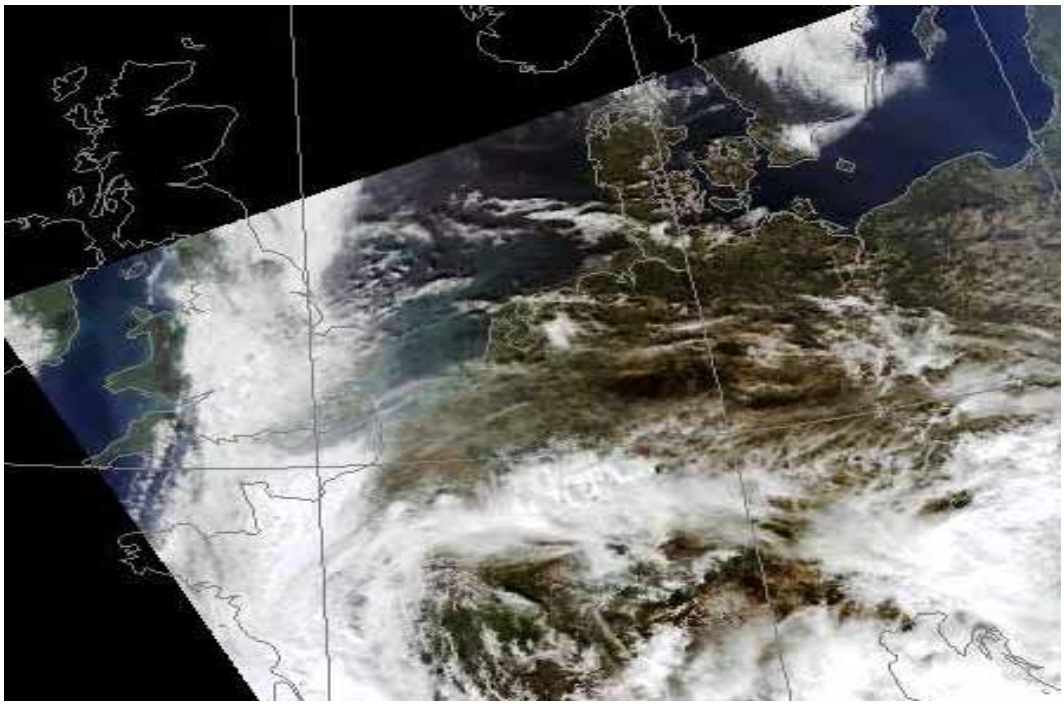

Figure 5: Saturday 16th September at 12:00, image of the UK and Europe.

By midday on Sunday a separate band of cloud had formed to the west of the first band, leaving the eastern side of the UK clear of any cloud or haze. The particulate haze is likely to have passed away to the south east of the UK at this stage or had remained within the band of cloud which had been drawn eastwards away from the UK and over the North Sea, as shown in figure 6.

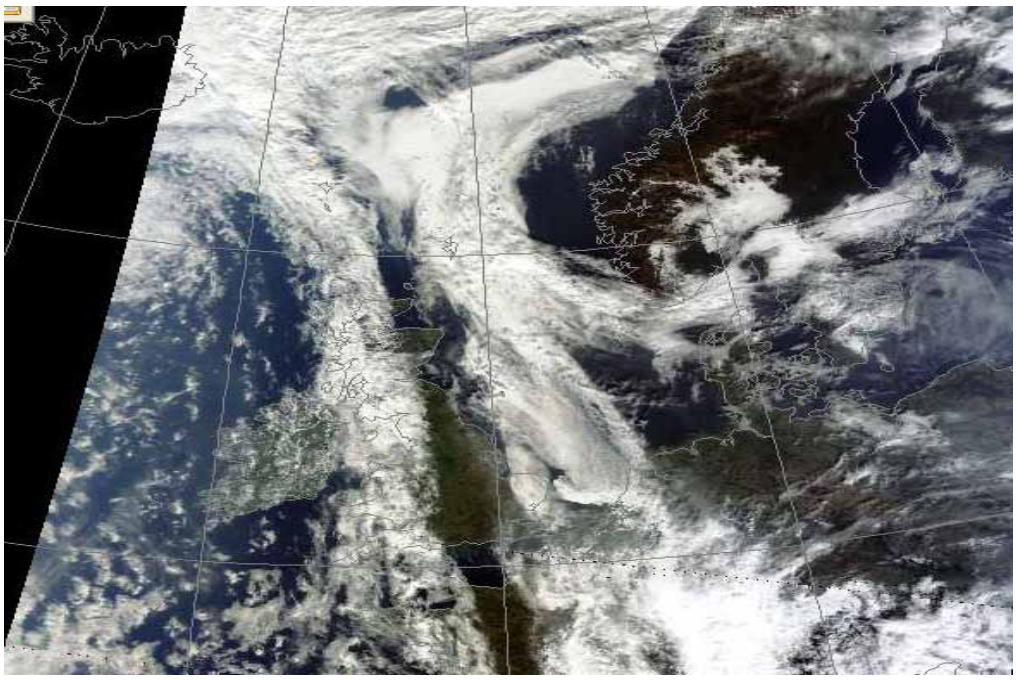

Figure 6: Sunday 17th September at 12:00.

By Monday satellite imagery suggest that any haze is likely to have passed away over the Atlantic, probably to the south-west of the UK, within the spiral arm of a low pressure front. Clean Atlantic air reached all UK areas from Monday onwards. Measurements taken at Lough Navar and other air quality monitoring sites in Northern Ireland show that particulate levels remained at normal background levels in Northern Ireland throughout the episode period. Possibly a dispersed portion of the haze passed over Northern Ireland on the Sunday evening (see figure 1a). Figure 7 shows the cloud and haze to the west of the UK.

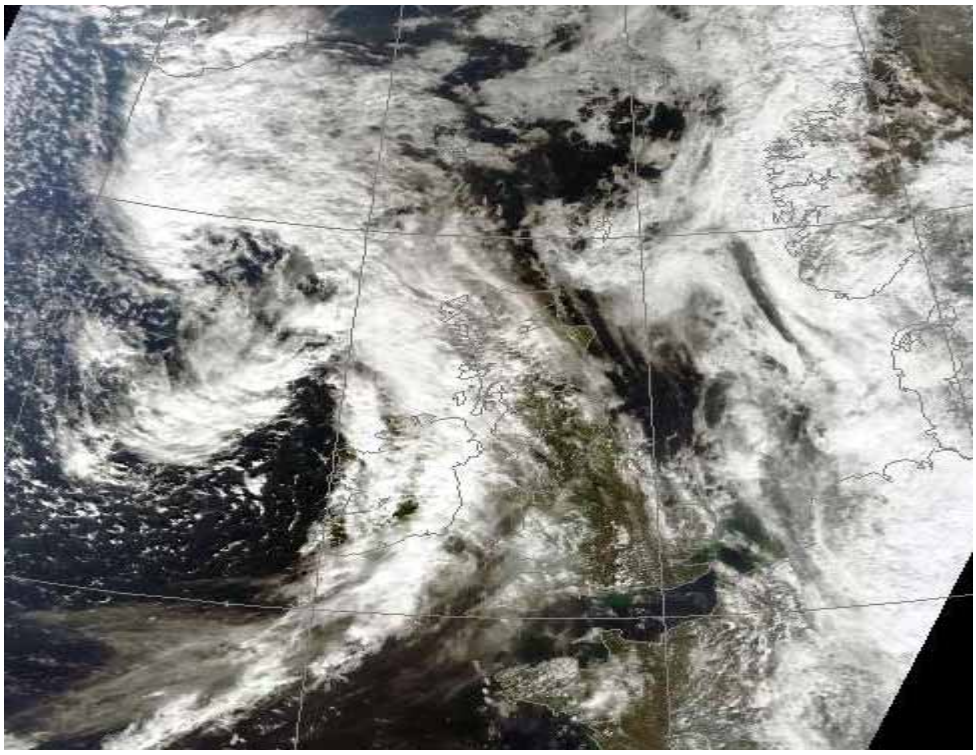

Figure 7: Monday 18th September at 12:00.

CONCLUSIONS

The main features of the mid September 2006 particulate episode may be summarised as follows:

A particulate haze, which was likely to have originated from Europe, travelled to the UK during a period of easterly air trajectories, during the weekend of the 16th and 17th September 2006. Secondary pollution effects in the UK from Europe are usually at their highest at the end of any working week, exacerbating any build up of particulates at weekends in the UK. The haze built up behind and within a band of cloud which settled over the UK during that weekend. The onset of low pressure air arriving in the UK from the west on the Sunday and Monday dispersed the haze which had been measured at index 4 (MODERATE band) at thirteen AURN air quality monitoring sites in the UK on Saturday 16th. Measurements made at air quality monitoring sites in Northern Ireland indicate that Northern Ireland had not been effected.