Preliminary analysis of the impact of airport closures due to the 2010 Eyjafallajokull volcanic eruptions on local air quality

We have received many enquiries asking what the effects of the closure of UK airspace will have on air quality surrounding major airports. In response we have made an initial analysis of NO_X and NO_2 concentrations surrounding Gatwick and Heathrow airports during the first three days of closure – Thursday 15th to Saturday 17th April 2010. This period was chosen due to the stable weather conditions with light north easterly winds, allowing a cross-sectional analysis upwind and downwind of the airports.

This period of unprecedented closure during unexceptional weather conditions has allowed us to demonstrate that the airports do have a clear measurable effect on NO_2 concentrations and that this effect dropped almost to zero during the period of closure, leading to a temporary but significant fall in pollutant concentrations adjacent to the airport perimeters.

Concentrations recorded by a monitoring site arise from a mix of pollution sources both local and distant affecting that specific location. In order to separate and quantify the affects of a particular local source, such as emissions from an airport, a control dataset is required. In this case pairs of monitoring sites were used located either side of each airport. The upwind monitors provided the control data. By subtracting hourly mean concentrations recorded by the upwind site from those recorded by the downwind site, an estimation of emissions from the airport could be made – termed 'local' concentrations.

Reigate and Banstead Borough Council operate three continuous monitoring sites close to the perimeter of Gatwick airport, two of which were well placed to make such a cross-sectional assessment, as shown in Figure 1. Poles Lane ('RG3') is situated in a rural location approximately 0.5 km to the south west of the runway. This site provided downwind concentrations during north easterly winds. Horley ('RG1') is in a suburban location approximately 2.5 km to the north east of the runway and therefore provided upwind concentrations. Both sites continuously monitor NO_X and have been in operation since 2005 and 2000 respectively.

Figure 1 Location of RG1 and RG3 close to Gatwick.

Figure 2 shows the relationship between wind direction (polar axis), wind speed (radial axis) and 'local' NO_X concentrations (colour scale) at RG3 using a polar plot. During winds from most directions the difference between upwind and downwind concentrations is zero or less, i.e., concentrations at RG3 are the same or less than those at RG1 (dark blue colours). However, the influence of emissions from the airport is clear during northerly and north easterly winds. The construction and use of polar plots in assessing airport emissions is discussed in detail by Carslaw et al (2006)[1].

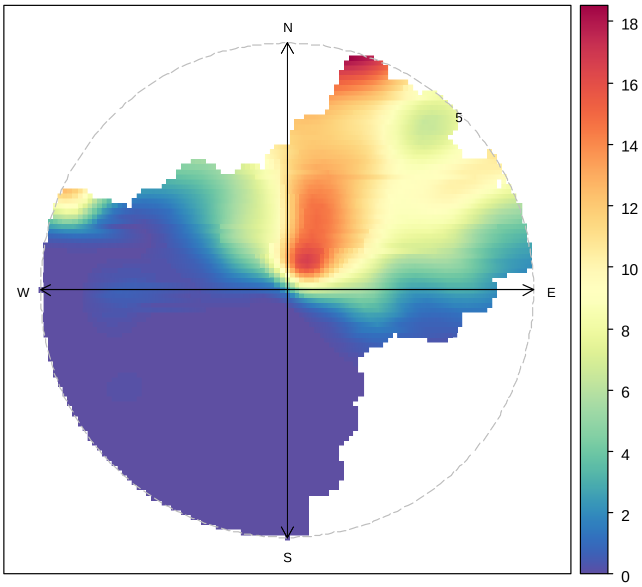

Figure 2: The relationship between 'local' NO_X concentrations and wind conditions at RG3, 2005-2009.

In order to assess the impact of the airport closure on NO_X and NO_2 concentrations, hourly mean 'local' NO_X and NO_2 concentrations at RG3 were calculated from April 2005 up to the date of closure (15th April 2010 12:00) using the cross sectional method described above. This process was then repeated for the closure days (15th April 2010 12:00 to 19th April 2010 00:00). Local wind data were taken from the RG1 and RG3 monitoring sites. This dataset was then filtered to only include data recorded during wind directions between 0 and 90 degrees; the direction of the RG1 to RG3 cross section.

Figure 3 shows filtered daily diurnal mean 'local' NO_X concentrations for the 'open' and 'closed' periods. The yellow shaded areas indicate hours where filtered data were available during the closure period, i.e., winds were from the north or north east. This chart shows that during normal operating conditions 'local' NO_X concentrations increase during the day peaking at around 22 to 25 µg m^{-3} on average. During the period of closure (15th to 17th April 2010) 'local' mean NO_X concentrations were zero most of the time, with a short peak of 4 µg m^{-3} on Saturday at 10am.

The analysis was repeated for NO_2, with similar results. 'Local' mean NO_2 concentrations dropped from a mean of 8 µg m^{-3} (peak of 13 µg m^{-3}) during normal operation (06:00 to 22:00) to zero during

[1] Carslaw D.C., Beevers S.D, Ropkins K., Bell M.C., 2006. Detecting and quantifying aircraft and other on-airport contributions to ambient nitrogen oxides in the vicinity of a large international airport. Atmospheric Environment. 40(28):5424-5434.

most hours of closure (maximum of 1 µg m^{-3} on Friday at 01:00). The annual mean NO_2 concentration measured at RG3, to the south west of the airport, during 2009 would decrease from 18 µg m^{-3} to approximately 16 µg m^{-3} in the absence of airport emissions. The impact of the airport is likely to be greater in the populated areas to the north east of the airport (Horley) due to prevailing winds from the south west.

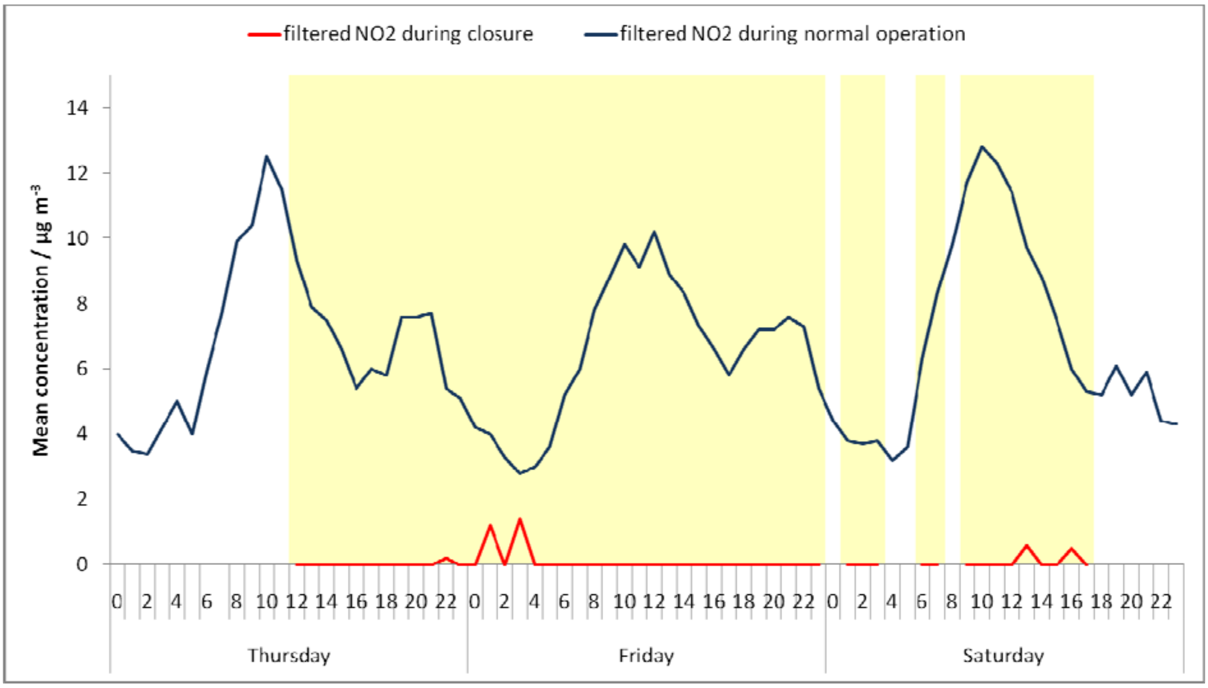

Figure 3: Comparison of diurnal variation in filtered 'local' NO_X concentrations during normal operation and airport closure.

Heathrow

A similar analysis was carried out using a NE/SW cross-section pair of monitoring sites surrounding Heathrow airport. The downwind site, Oaks Road ('LH7') was located approximately 0.6 km south of Heathrow's southern runway as shown in Figure 4 . At the time of analysis the closest north easterly site with available data was in Southall ('EA7') approximately 4.5 km from the airport. This was used as the upwind site for the cross section. The data periods and filtered wind directions were the same as the Gatwick analysis. Due to slightly different wind patterns and an earlier change in wind direction, the analysis could only be carried out on Thursday and Friday 15th and 16th April.

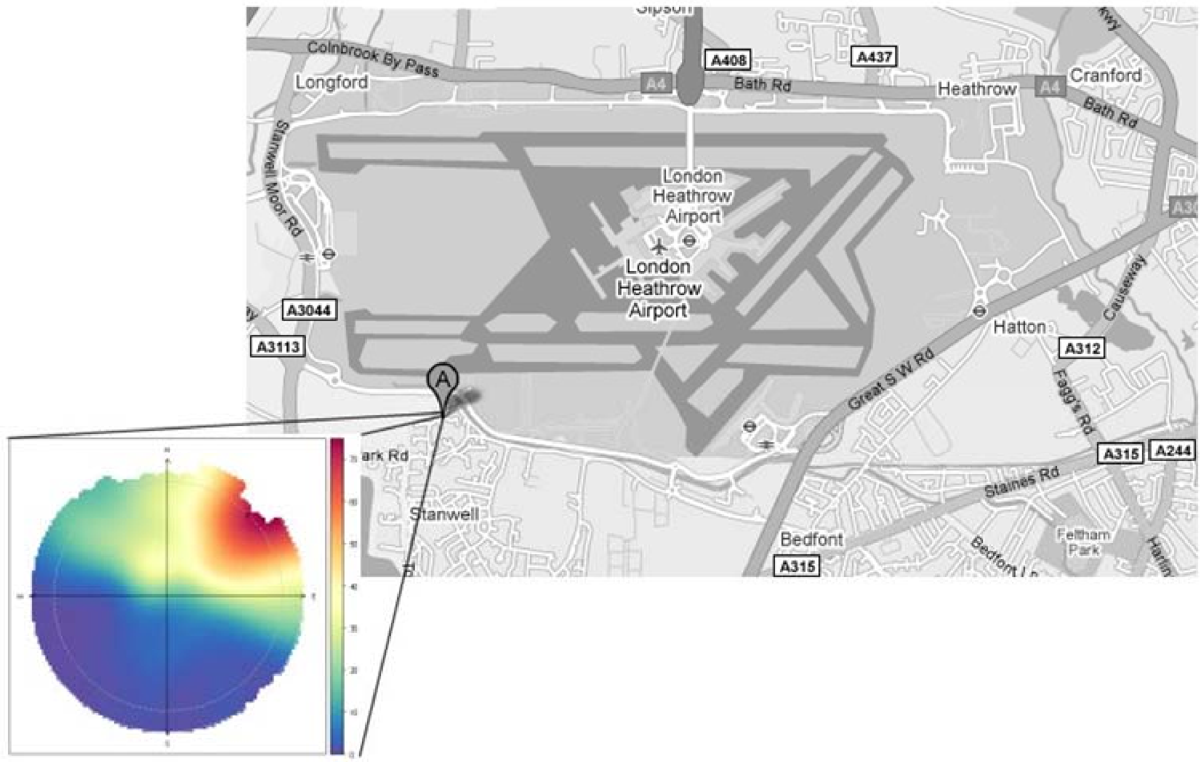

Figure 4 Location of LH7, Oaks Road, close to Heathrow. The inset shows relationship between 'local' NO_X concentrations and wind conditions at the site.

During normal operating conditions the LH7 site recorded mean 'local' NO_X concentrations of 64 µg m^{-3}(06:00 to 22:00), far higher than those recorded at the Gatwick site. This dropped to 10 µg m^{-3} during the closure period. 'Local' NO_2 concentrations were also higher, dropping from 27 µg m^{-3} to 8 µg m^{-3}. In the absence of airport emissions, the annual mean NO2 concentration recorded at LH7 during 2009 would decrease from as 33 µg m-3 to approximately 30 µg m-3. As with Gatwick, the impact of airport emissions is likely be greater to the north east of the airport over a full year.

This exceptional closure has allowed us to demonstrate the impacts of airport emissions on their immediate neighbourhood. The evidence from this preliminary analysis can be extended to quantify the impacts of Gatwick and Heathrow airport on their neighbourhoods during normal operation.

This preliminary study did not consider the impact of decreased traffic flows on airport feeder roads. Decreased flows are likely to have a significant effect on concentrations of vehicle-related pollutants close to such roads. Unfortunately, we do not have sufficient traffic data to carry out this additional analysis at this time.

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