Ash cloud hits the UK

Ash is not a respiratory air quality problem – but it's left plenty to talk about finds Jack Pease

Air quality was thrown centre stage last month with the Icelandic volcano. An invisible plume of particles paralysed Europe– deadly to aero engines, but kind to the human lung.

The ash is generally larger than coarse PM_{10} so not strictly an air quality problem, the public were reassured that ash is not a direct human health issue despite copious deposits on their cars. But that didn't stop a massive focus (once again) on Met Office air quality modelling – as well as allowing a unique no flying period during which air quality could be studied near deserted airports.

Once the ash started billowing into the atmosphere, it was relatively easy for atmospheric modellers to plot the course of the plume. The Met Office use the Name model, a model derived from early military use as a means of tracking nuclear fall out – an event not dissimilar to the volcano.

Name has been in the air quality news before. Modelling is well known as a black art and subject to errors, Name was used to plot the Buncefield fallout (*AQB July 2006 p3*) and failed to predict plume grounding (which was eventually picked up by monitoring).

If Buncefield stretched Name, then the Icelandic Volcano was likely to stretch it even more, with stratified layers of ash apparently scattering across most of Europe. Airlines must heed the advice of aviation authorities, with aviation authorities being told by aero engine manufacturers that there was no safe level of ash, most of Europe was pronounced a no-fly zone.

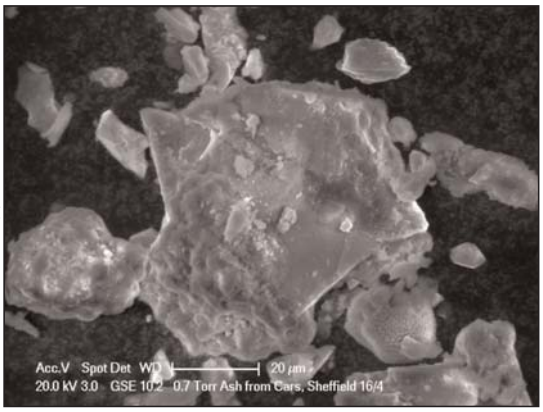
A few days of that started to make already cash-poor airlines squeal – and there was greater scrutiny of the advice from engine manufacturers. Airlines such as BA sent up their own planes into the plume and these arrived back safely, prompting engine manufacturers to agree a threshold of ash concentrations which should not cause a problem.

Modellers were then asked by governments and airlines what concentrations of ash there would be. This is really stretching Name to the limit – but even so the model was run with airspace being opened where concentrations were deemed to be low.

In the inevitable post mortem, the Met Office and its Name model have been criticised for being overcautious. But to be fair to the Met Office, it was asked 'where is the ash' and the Name model delivered its broadbrush prediction.

One expert told *AQB*: "Name has two jobs to do. The first is to predict the 3-D tracks of the ash. This does not require much understanding of the source, except for its position. Name will do this very well and as well as many other models because all you need are the basic
3-D wind fields.

"The second job for Name to do is to predict the concentrations along the path. This is where the difficulties really come in. You need to know a lot about the source, its magnitude, height and you need to know a lot about the nature of the ash, its particle size distribution and removal en route. Garbage in, garbage out. So as soon as the regime shifted from ash/no ash to how much ash? then all the models start to show their weaknesses. Name is no different in this regard."



Sheffield Hallam University analysed ash deposited on cars: it was volcanic

As *AQB* went to press, ash problems have re-emerged, and may do so over coming months. It is now inevitable that the Met Office will be asked to deliver concentration predictions – and atmospheric modelling may find itself once again in the spotlight.

As with Buncefield, modelling of the early volcanic plume spread was backed up with reports coming in from monitoring stations across the UK. As most ash is larger than 10 microns, there was little effect, although plenty of anecdotal reports of widespread and persistent dust appearing on cars.

Sheffield Hallam University was one of the earliest to report the analysis of deposited ash. Scientists from the University's Materials and Engineering Research Institute (MERI) collected samples of the ash and examined them in their laboratory.

Dr Hywel Jones said: "It was a curiosity factor for me to see if this dust was volcanic ash. We analysed the samples and found they contained silicon and oxygen, calcium, aluminium and sodium, which make up volcanic matter. It is essentially volcanic rock that has been melted and frozen in the atmosphere."

Kings College London ERG was characteristically also quick off the mark. Gary Fuller said: "Initially our analysis focused on looking for co-incident elevations of SO_2 and PM_{10} reflecting the likely composition in the volcanic plume.

"A series of SO_2 peaks have been measured in the areas covered by our networks. These have affected sites in east London at Greenwich and Bexley on Friday and sites in south Essex, at Castle Point and Thurrock on Saturday and Sunday. Elevated concentrations of NO_X have been associated with the SO_2 peaks (indicating a combustion source) and each of these events has shown an easterly progression with local wind direction. This is consistent with the normal pattern of plume grounding from industrial sources in the east Thames area.

"On Friday afternoon (16th April) a veering of wind direction from northeast towards southeast was linked to a sharp increase in PM_{10} concentrations at certain background sites. This increase of around 20µg/m³ appears to be mainly coarse PM (ie. $PM_{10-2.5}$) particles, with coarse PM comprising around 50% of background concentrations of total PM_{10} during Friday afternoon. Although this is a change in the nature of PM concentrations that prevailed earlier in the week, similar patterns of concentration changes have been measured before, for instance during a secondary PM_{10} episode in May 2009.

"Since Friday afternoon concentrations of volatile PM have been increasing steadily across south east England, consistent with increasing concentrations of secondary particulate. In addition, widespread moderate ozone was measured throughout south east England over the weekend with the greatest concentrations being measured on Sunday afternoon in Sussex, east Surrey and west Kent where concentrations of over 120µg/m³ were attained.

On Sunday afternoon, elevated concentrations of PM_{10} were measured at sites to the south of London, across Sussex, east Surrey and west Kent. PM_{10} concentrations of over 80µg/m³ were measured at roadside sites in Horsham, Chichester and Sevenoaks and at background sites in Sevenoaks, Eastbourne, Reigate and Banstead and Mole Valley. During Sunday afternoon PM_{10} concentrations at these sites exceeded those in London."

ERG said that the key to understanding the pollution events is to use back trajectory analysis to look at where air has travelled over before it reached the UK. Although the air present over the Sussex, east Surrey and

west Kent area on Sunday afternoon was over Iceland four days previously, this air also passed over parts of Germany, Belgium, the Netherlands and north France during the preceding 36 hours.

"The possibility of a minor contribution cannot be ruled out. Detection of PM from this source would require mineralogical analysis of collected PM samples. Such analysis is not routinely undertaken in the UK networks."

As is usual, AEA is less forthcoming. While it is the guardian of the national monitoring network, it is also under contract to to Defra and the regions and is thus muzzled by officialdom at the best of times. Being in the middle of election purdah made it even worse, but it did publish back trajectories that suggested air streams across the UK were coming via Iceland, but that there was no appreciable impact on network PM_{10} readings.

While the ash is generally in the coarser fraction above PM_{10}, there was still a need to reassure the public that there was little health risk.

Health Protection Scotland said: "No evidence has been identified from routine health surveillance resources which suggest any detectable impacts on public health in Scotland. Similarly routine air quality monitoring has not identified any significant increases in levels of pollutants such as particulates or gases such as sulphur dioxide potentially associated with the ash plume from the volcano.

"It is likely that there will be rain in various parts of the UK which might cause low concentrations of ash to be deposited. In wet weather the particles cannot be inhaled under these conditions, only very low concentrations of volcanic ash would be deposited in fields and towns. However, because small quantities of volcanic ash could float back up into the air in windy conditions, it would be sensible for people with existing respiratory conditions such as chronic bronchitis, emphysema and asthma to ensure they keep their inhalers or other medications with them."

AEA reported on it's Scottish air quality website some grounding of ash in Lerwick: "This was analysed by SEPA and verified to be from volcanic origin."

The particulate matter measured by SEPA was found to be between 15-85microns in diameter, far larger than the 10 micron cut off of PM_{10} analysers used in the networks.

The European Environment Agency (EEA) also followed the impacts of recent volcanic eruptions in Iceland, in particular assessing changes in ground-level air pollution. "According to preliminary monitoring data, ground-level air quality across Europe has not deteriorated significantly as a result of the volcanic activity. So far, monitoring stations in Europe have only detected a few episodes of ambient air concentrations of particulate matter and sulphur dioxide of volcanic origin, in particular at elevated mountainous locations, for example at Zugspitze in Germany (2659 m). The threat to public health in the European Union is therefore considered minimal."

AIRPORTS: A CLEAR MEASURABLE EFFECT

Closure of UK airspace for six days provided respite for those who suffer noise near airports – and an opportunity to see if there were any air quality improvements.

There are very few airports where air quality is a problem, Heathrow and Gatwick are the worst and have plenty of monitors dotted around the airport perimeter.

Kings College ERG said: "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.

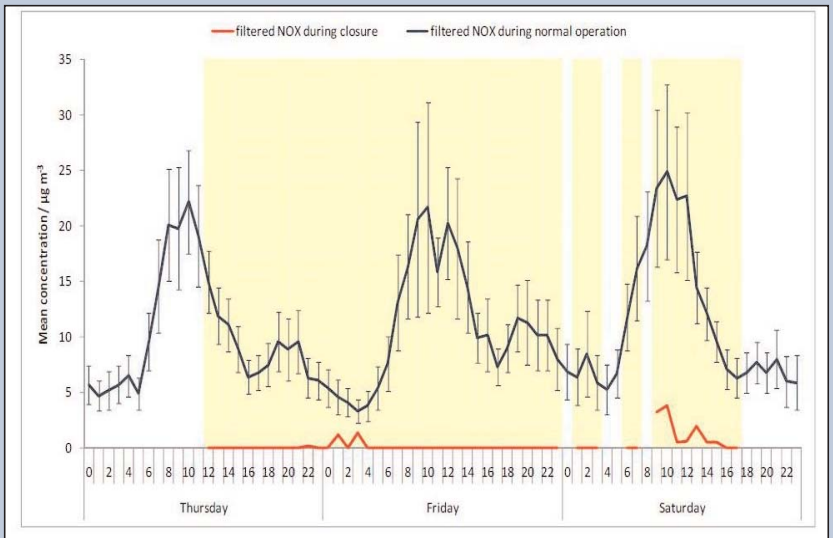
"This period of unprecedented closure during unexceptional weather conditions has allowed us to demonstrate that the airports have a clear measurable effect on NO_2 concentrations and that this effect disappeared entirely during the period of closure, leading to a temporary but significant fall in pollutant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

"Pairs of monitoring sites were used located either side of each airport with 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.

NO_x was found to drop dramatically (see box right), and the analysis was repeated for NO_2, with similar results. The annual mean NO_2 concentration measured to the south west Gatwick, during 2009 decreased from 18µg/m³ to approximately 16µg/m³ 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.

A similar analysis was carried out using a pair of monitoring sites surrounding Heathrow airport. 'Airport' NO_2 concentrations were higher than those at Gatwick and dropped from 27µg/m³ to 8µg/m³ during the closure period.

"This exceptional closure has allowed us to demonstrate the impacts of airport emissions on their immediate neighbourhood. 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."



The figure above shows daily diurnal mean 'airport' NOx concentrations for the 'open' and 'closed' periods at a monitoring site close to the perimeter of Gatwick airport.

The yellow shaded areas indicate hours where winds were from the north or north east during the closure period, i.e., the site was downwind of the airport runway. The chart shows that during normal operating conditions 'airport' NOx concentrations increase during the day peaking at around 22 to 25 µg/m³ on average. During the period of closure (15th to 17th April 2010) mean 'airport' NOx concentrations were zero most of the time.

All concentrations were well below the lower 95% confidence interval indicating that the difference from 'normal' operation was statistically significant.