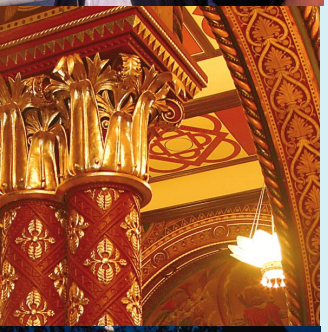

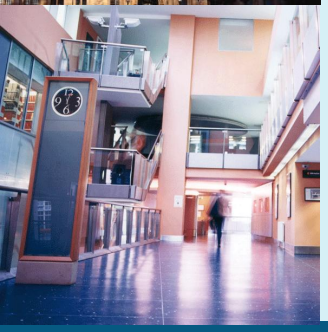

MRC Medical Research Council | Health Protection Agency

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KING'S College LONDON

Impact of the flight ban on air quality around airports

An initial analysis

(A quick note on detecting grounding of volcanic ash too)

BEN BARRATT, GARY FULLER, DAVID CARSLAW, MARTIN WILLIAMS, SEAN BEEVERS

KING'S COLLEGE LONDON

Air quality around airports

- Impacts of air pollution around airports is the subject of considerable controversy.

Photo: Evening Standard

- Issue is keenly felt at Heathrow (T5, 3rd runway, breaches of NO2 LV) and to a lesser extent at Gatwick and other airports.

Air quality around airports

- UK airspace was closed to all flights at noon on Thursday 15th April, 2010 for six days.

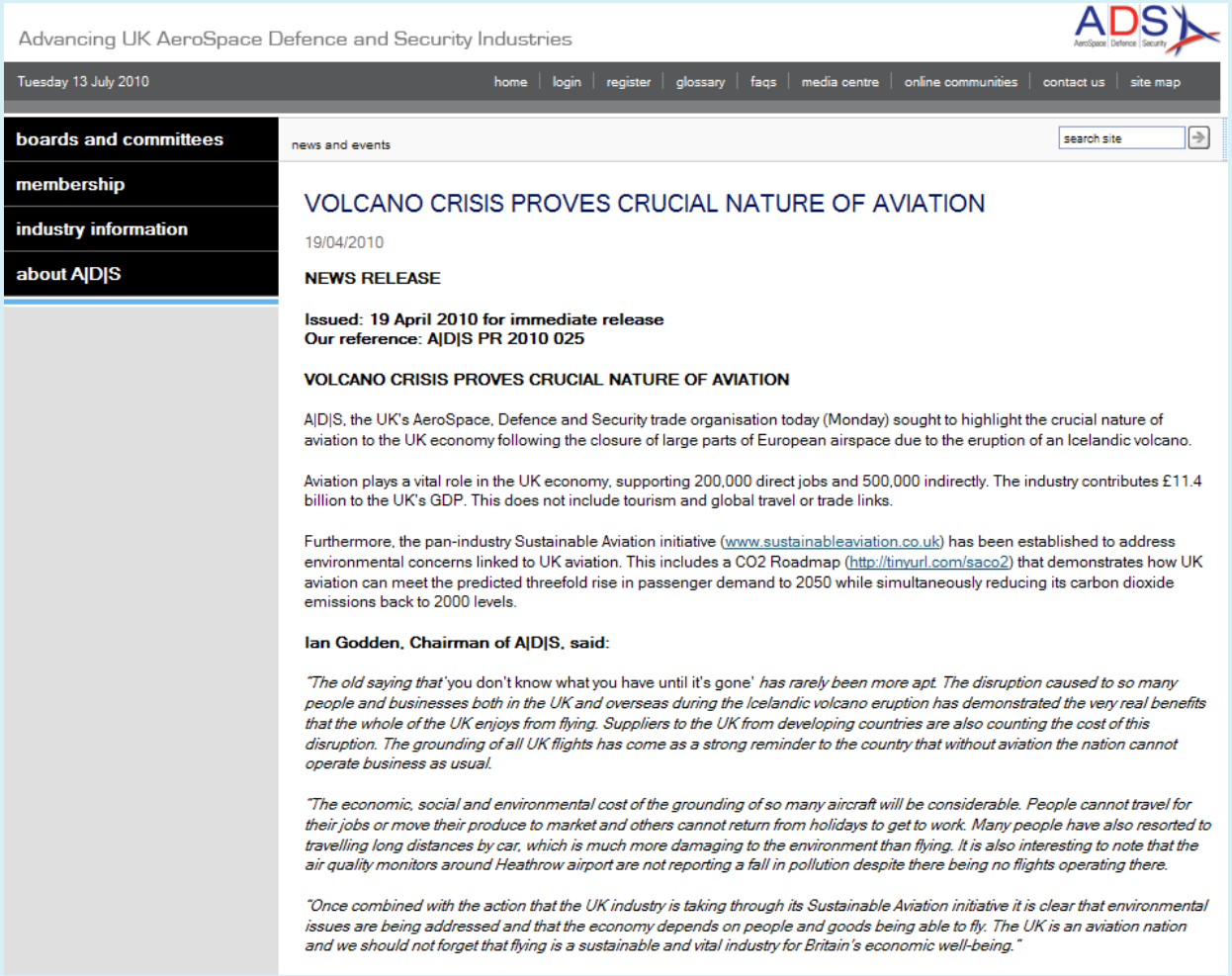
- A unique natural experiment providing an opportunity to quantify aircraft and airport-related emissions on air quality surrounding airports in the UK and across Europe.

Initial cross-sectional study

- Clearly demonstrate the impact of airports in a straightforward way without recourse to emission inventories and dispersion modelling

- Prelude to a more detailed analysis

- Independent of airport operators and other interest groups – this is very important



Advancing UK AeroSpace Defence and Security Industries

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Tuesday 13 July 2010

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VOLCANO CRISIS PROVES CRUCIAL NATURE OF AVIATION

19/04/2010

NEWS RELEASE

Issued: 19 April 2010 for immediate release
Our reference: A|D|S PR 2010 025

VOLCANO CRISIS PROVES CRUCIAL NATURE OF AVIATION

A|D|S, the UK's AeroSpace, Defence and Security trade organisation today (Monday) sought to highlight the crucial nature of aviation to the UK economy following the closure of large parts of European airspace due to the eruption of an Icelandic volcano.

Aviation plays a vital role in the UK economy, supporting 200,000 direct jobs and 500,000 indirectly. The industry contributes £11.4 billion to the UK's GDP. This does not include tourism and global travel or trade links.

Furthermore, the pan-industry Sustainable Aviation initiative (www.sustainableaviation.co.uk) has been established to address environmental concerns linked to UK aviation. This includes a CO2 Roadmap (http://tinyurl.com/saco2) that demonstrates how UK aviation can meet the predicted threefold rise in passenger demand to 2050 while simultaneously reducing its carbon dioxide emissions back to 2000 levels.

Ian Godden, Chairman of A|D|S, said:

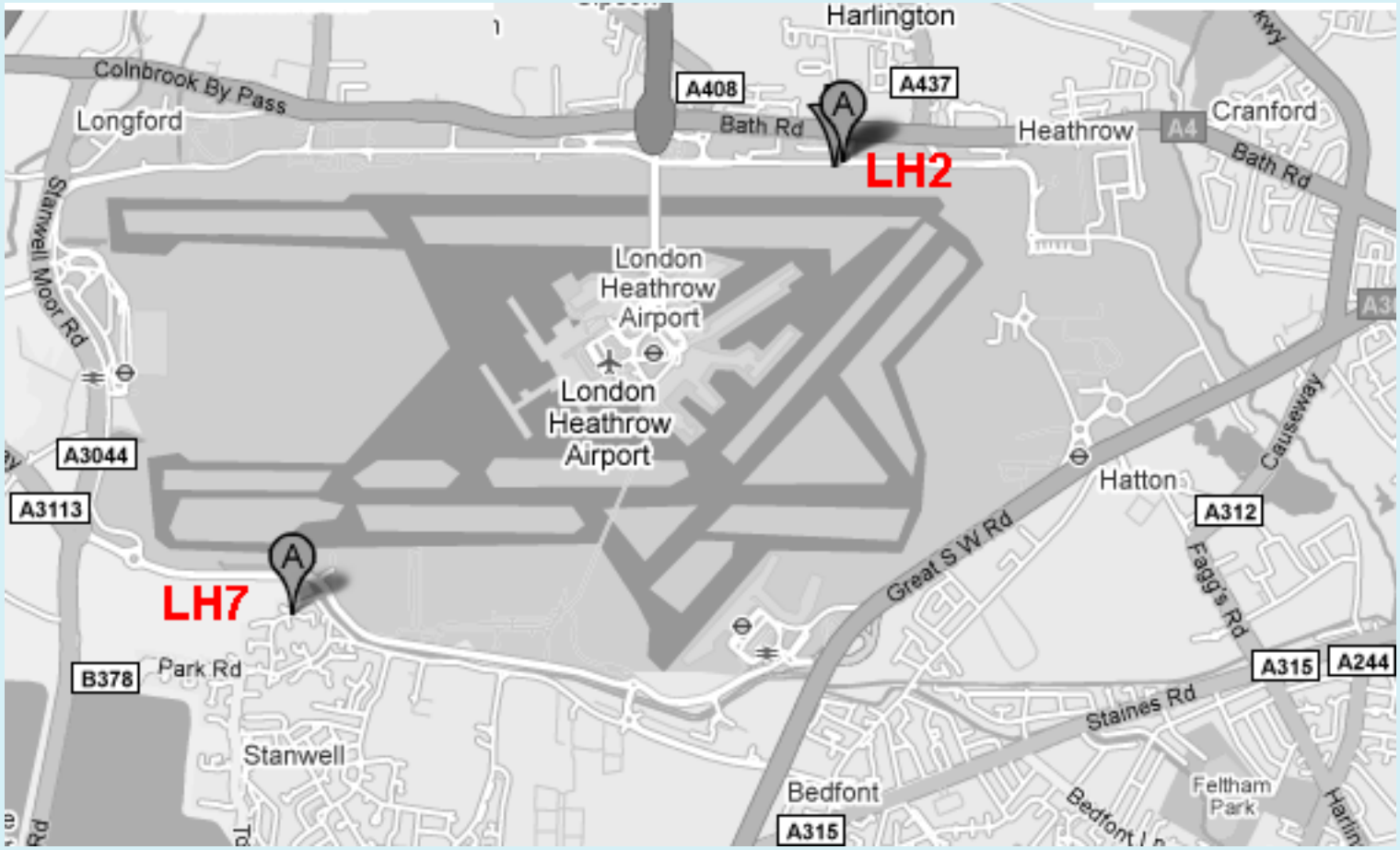
"The old saying that 'you don't know what you have until it's gone' *has rarely been more apt. The disruption caused to so many people and businesses both in the UK and overseas during the Icelandic volcano eruption has demonstrated the very real benefits that the whole of the UK enjoys from flying. Suppliers to the UK from developing countries are also counting the cost of this disruption. The grounding of all UK flights has come as a strong reminder to the country that without aviation the nation cannot operate business as usual.*

"The economic, social and environmental cost of the grounding of so many aircraft will be considerable. People cannot travel for their jobs or move their produce to market and others cannot return from holidays to get to work. Many people have also resorted to travelling long distances by car, which is much more damaging to the environment than flying. It is also interesting to note that the air quality monitors around Heathrow airport are not reporting a fall in pollution despite there being no flights operating there.

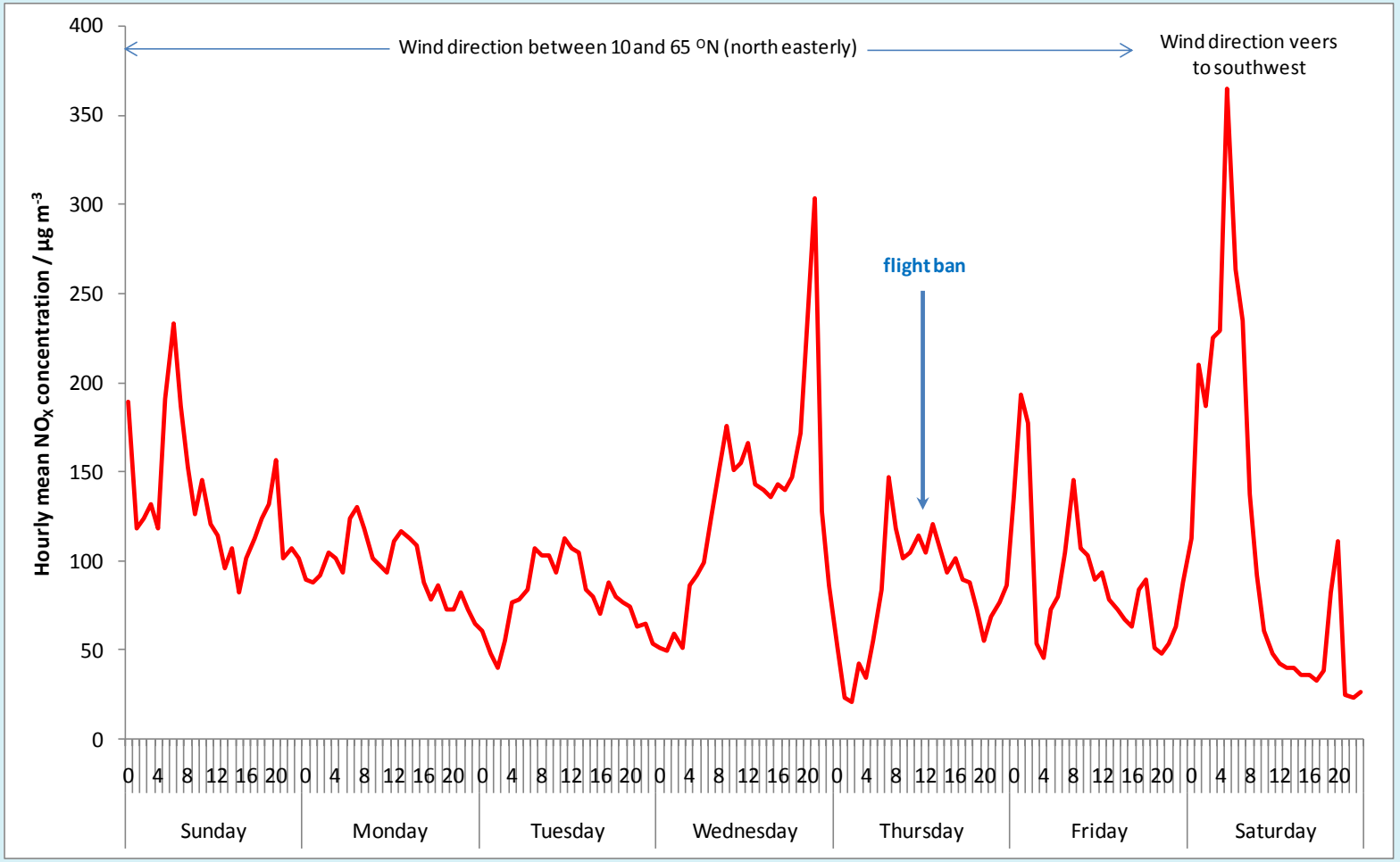
"Once combined with the action that the UK industry is taking through its Sustainable Aviation initiative it is clear that environmental issues are being addressed and that the economy depends on people and goods being able to fly. The UK is an aviation nation and we should not forget that flying is a sustainable and vital industry for Britain's economic well-being."

"It is … interesting to note that the air quality monitors around Heathrow airport are not reporting a fall in pollution despite there being no flights operating there." Ian Godden, Chairman of A|D|S, 19th April 2010.

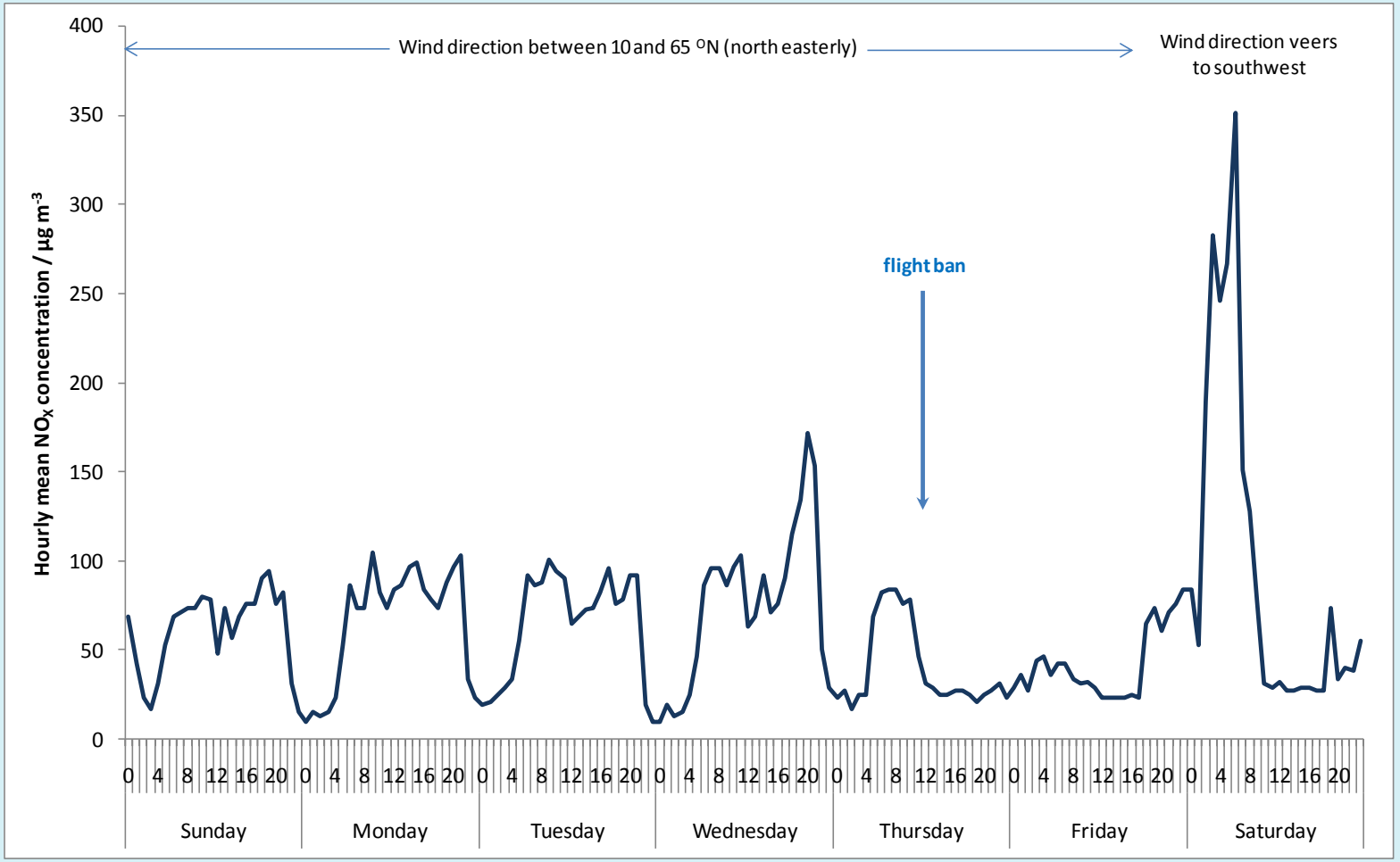
A quick look at some of the measurements…



Heathrow northern perimeter NO_X



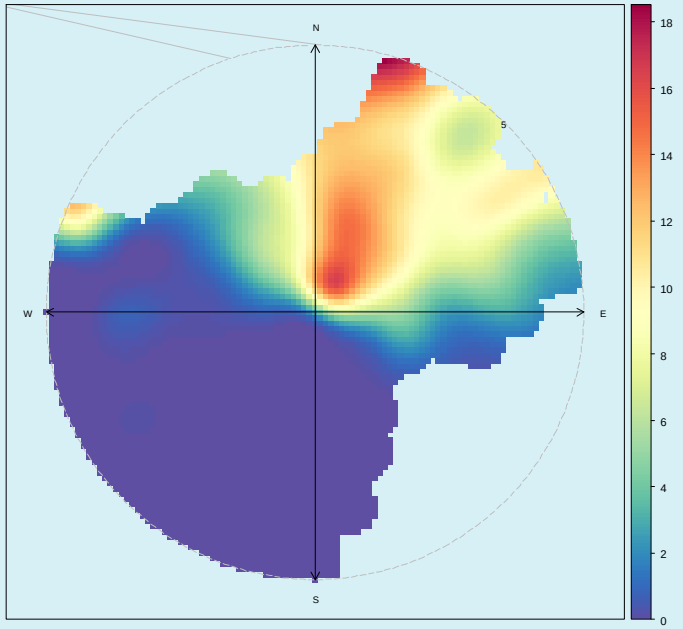
Heathrow southern perimeter NO_X



Initial cross-sectional study

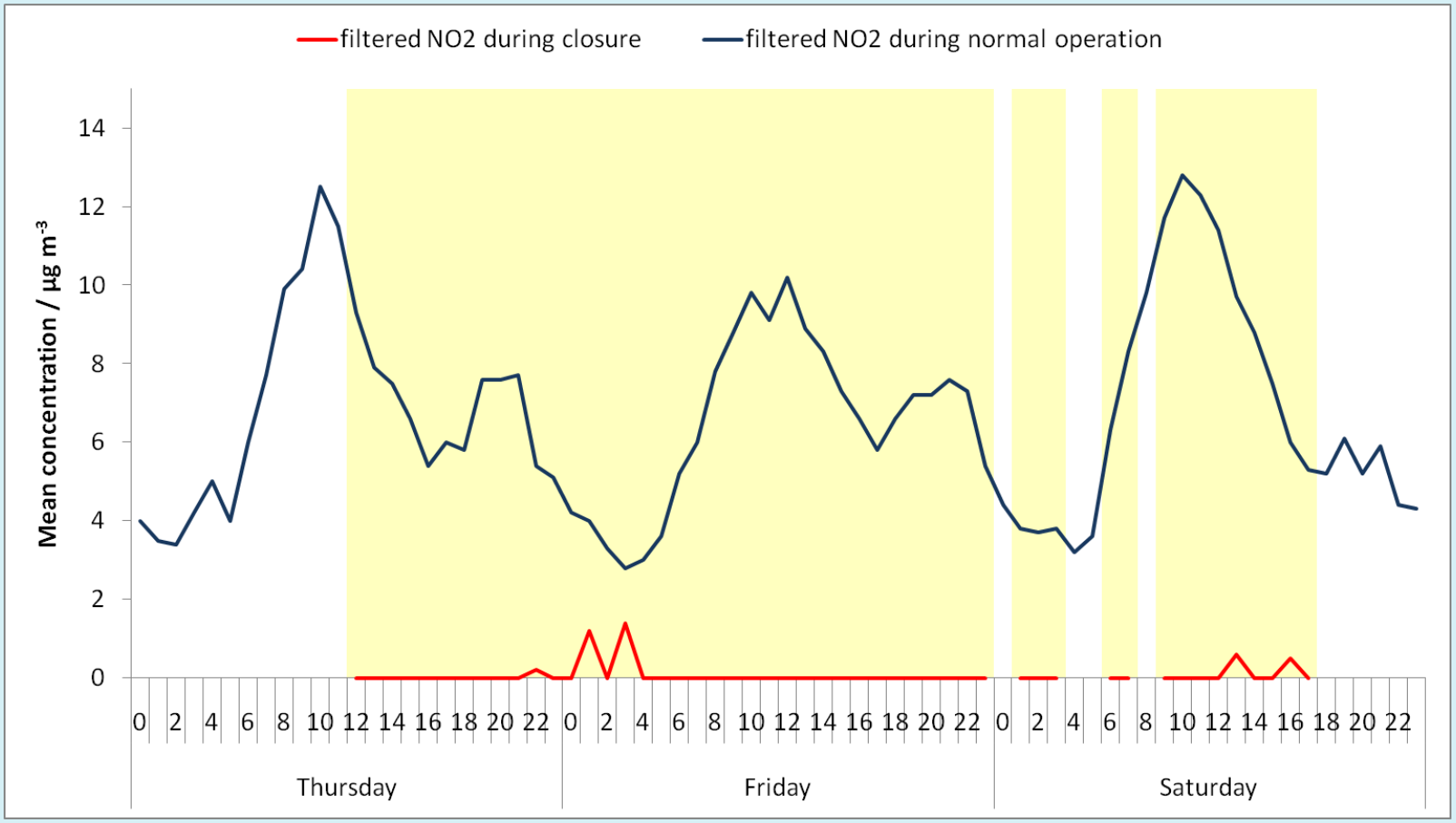
- Analysed NO_X and NO_2 concentrations surrounding Gatwick and Heathrow 15th to 17th April 2010.
- Method relies on:
  - Paired upwind and downwind sites
  - Stable wind direction
  - Long historical dataset
- Does not account for:
  - Changes in emissions outside of airport (traffic)
  - Meteorological conditions other than wind
  - Continued activities within the airport perimeter

Air quality around airports - Gatwick

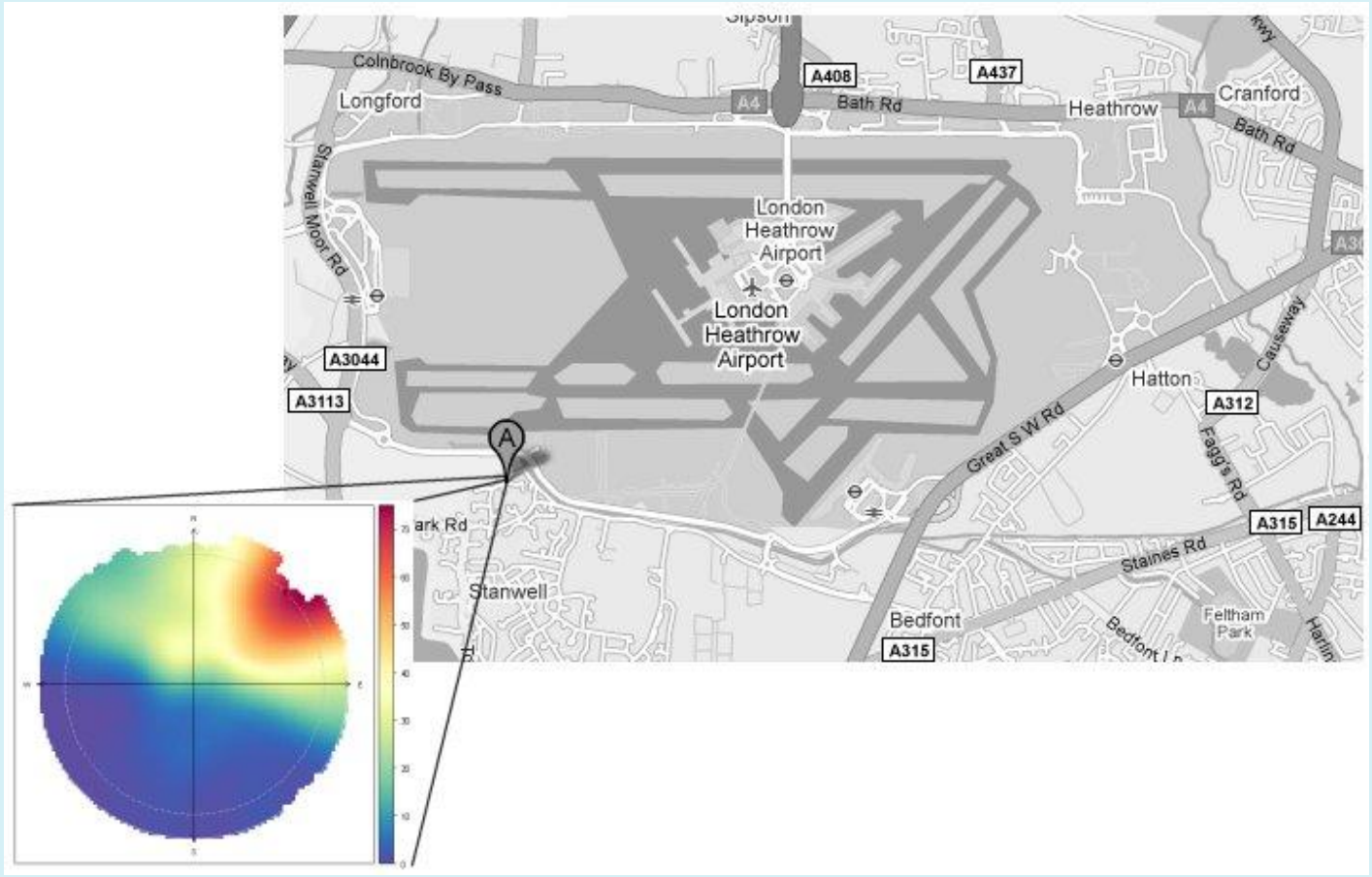


Air quality around airports – Gatwick

0600 to 2200 wind direction filtered



Air quality around airports - Heathrow



Air quality without the airports

- Measured annual mean NO_2 (2009) to the south west:
  - Gatwick - would decrease from 18 µg m^{-3} to approximately 16 µg m^{-3}.
  - Heathrow – would decrease from 33 µg m^{-3} to approximately 30 µg m^{-3}.
  - Greater effects to the north west due to wind frequency.

More detailed analysis

- Use and develop several techniques that King's has available specifically for this type of analysis:
  - Airport transect analysis.
  - Other airports in UK and Europe.
  - Accounting for meteorology when assessing trends using statistical models.
  - The use of King's College/University of Leeds openair tools (www.openair-project.org) to characterise the changes e.g. polar plots.

More detailed analysis

(boosted regression trees, Carslaw and Taylor 2009)

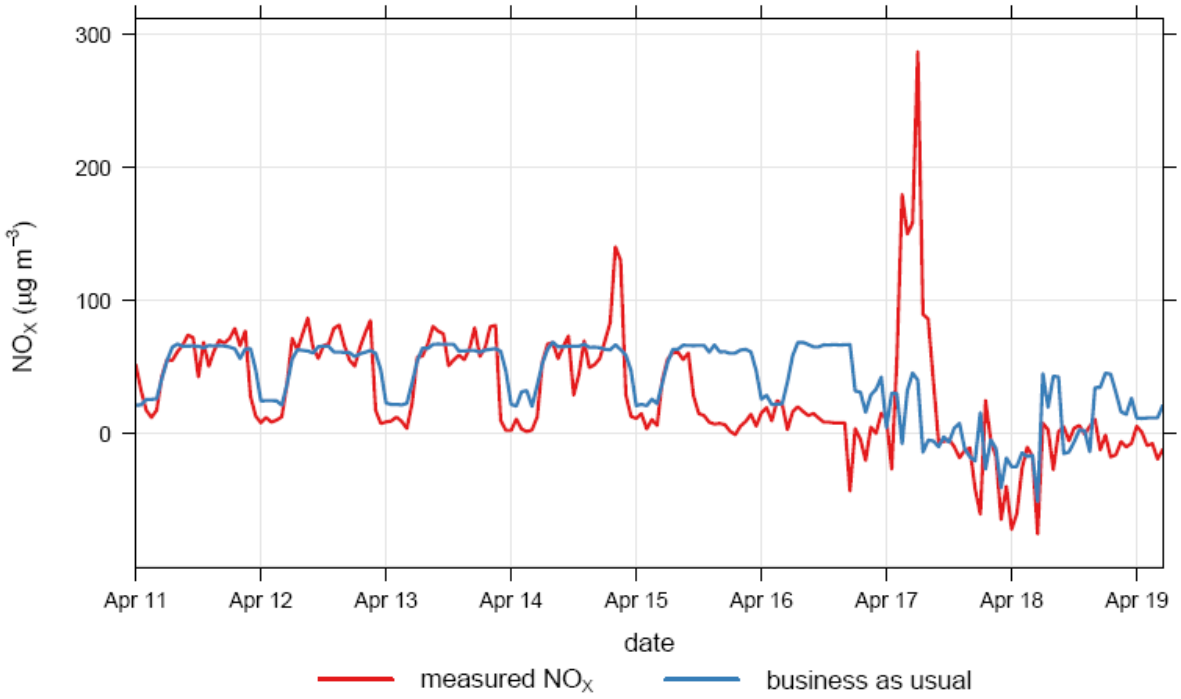


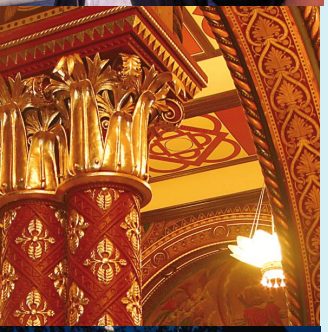
Figure 2: Increment of NO_X above background at Oaks Road before and during the flight ban. The measured NO_X shows what actually happened to concentrations of NO_X and the "business as usual" shows the predicted concentrations if activity had continued as normal.

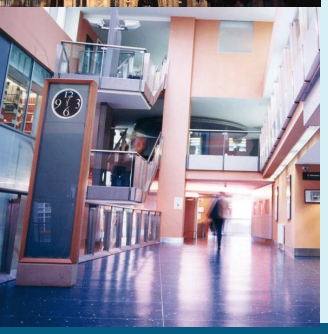
Key questions for detailed analysis

- Quantitatively, what was the effect of the ban on the estimated contribution to concentrations of NO_X/NO_2/PM by source type e.g. aircraft/airport activities/road transport?
- Spatially, where can the flight ban be detected?
- What would be the effect of a flight ban expressed as annual means?
- Is it possible to comment on the nature of aviation emissions/dispersion that have hitherto been impossible e.g. plume dispersion, jet buoyancy effects?
- Do these answers agree with or contradict existing knowledge with respect to the main source contributions, and what are the air quality management implications?

Conclusions

- The flight ban did have an identifiable effect on air quality surrounding airports.
- More detailed analysis is required for policy advice.
- Timely but simple analysis outputs can generate a huge amount of media interest.
- Outputs must be independent, robust and show their limitations.





Medical Research Council | Health Protection Agency

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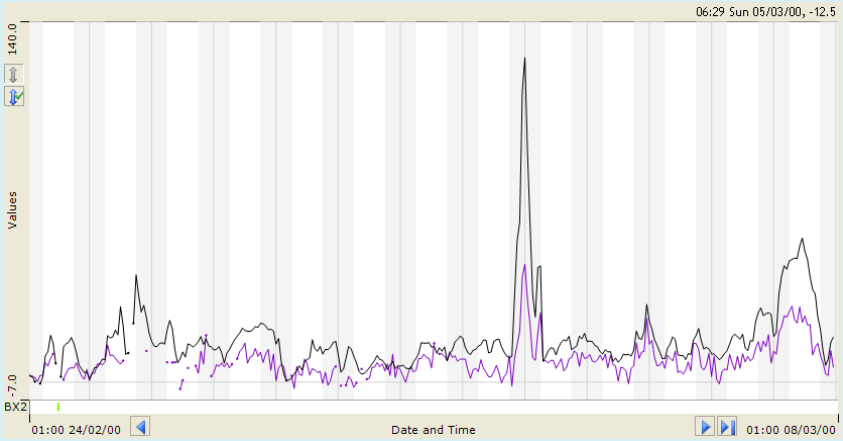
KING'S College LONDON

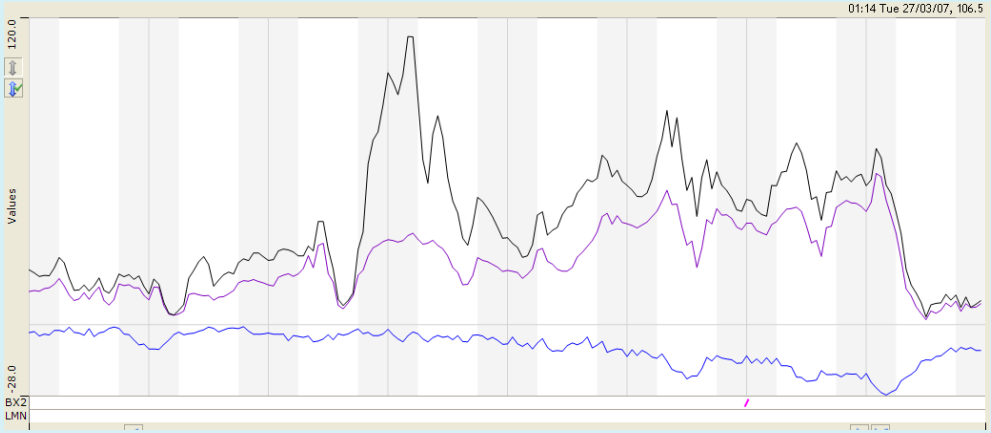
A quick note on detecting the grounding of volcanic ash

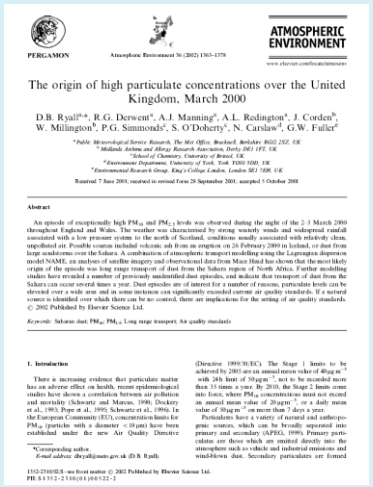
GARY FULLER, BEN BARRATT,
KING'S COLLEGE LONDON

Saharan and Ukrainian dust storms clearly seen

Bexley Belevdere, south east London
(black = PM10, Purple = PM2.5, Blue = volatile PM10)







PERGAMON

Atmospheric Environment 36 (2002) 1363–1378

ATMOSPHERIC ENVIRONMENT

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The origin of high particulate concentrations over the United Kingdom, March 2000

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Received 7 June 2001; received in revised form 28 September 2001; accepted 5 October 2001

Abstract

An episode of exceptionally high PM_{10} and $PM_{2.5}$ levels was observed during the night of the 2–3 March 2000 throughout England and Wales. The weather was characterised by strong westerly winds and widespread rainfall associated with a low pressure system to the north of Scotland, conditions usually associated with relatively clean, unpolluted air. Possible sources included volcanic ash from an eruption on 26 February 2000 in Iceland, or dust from large smokestorms over the Sahara. A combination of atmospheric transport modelling using the Lagrangian dispersion model NAME, an analysis of satellite imagery and observational data from Mace Head has shown that the most likely origin of the episode was long range transport of dust from the Sahara region of North Africa. Further modelling studies have revealed a number of previously unidentified dust episodes, and indicate that transport of dust from the Sahara can occur several times a year. Dust episodes are of interest for a number of reasons; particulate levels can be elevated over a wide area and in some instances can significantly exceeded current air quality standards. If a natural source is identified over which there can be no control, there are implications for the setting of air quality standards.

Keywords: Saharan dust; PM_{10}; $PM_{2.5}$; Long range transport; Air quality standards

1. Introduction

There is increasing evidence that particulate matter has an adverse effect on health, recent epidemiological studies have shown a correlation between air pollution and mortality (Schwartz and Marcus, 1990; Dockery et al., 1993; Pope et al., 1995; Schwartz et al., 1996). In the European Community (EU), concentration limits for PM_{10} (particles with a diameter $< 10\,\mu m$) have been established under the new Air Quality Directive (Directive 1999/30/EC). The Stage 1 limits to be achieved by 2005 are an annual mean value of $40\,\mu g\,m^{-3}$ with 24h limit of $50\,\mu g\,m^{-3}$, not to be exceeded more than 35 times a year. By 2010, the Stage 2 limits come into force, where PM_{10} concentrations must not exceed an annual mean value of $20\,\mu g\,m^{-3}$, or a daily mean value of $50\,\mu g\,m^{-3}$ on more than 7 days a year.

Particulates have a variety of natural and anthropogenic sources, which can be broadly separated into primary and secondary (APEG, 1998). Primary particulates are those which are emitted directly into the atmosphere such as vehicle and industrial emissions and wind-blown dust. Secondary particulates are formed

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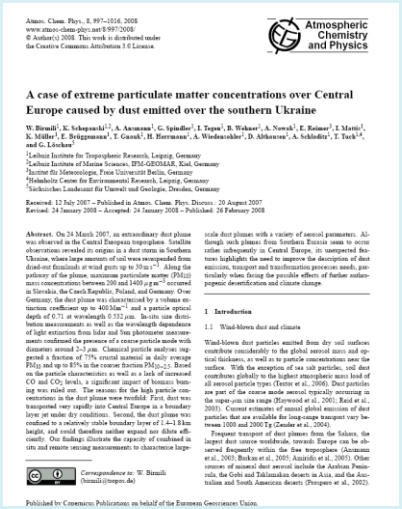

Atmos. Chem. Phys., 8, 997–1016, 2008
www.atmos-chem-phys.net/8/997/2008/

Atmospheric Chemistry and Physics

A case of extreme particulate matter concentrations over Central Europe caused by dust emitted over the southern Ukraine

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Revised: 24 January 2008 – Accepted: 24 January 2008 – Published: 26 February 2008

Abstract. On 24 March 2007, an extraordinary dust plume was observed in the Central European troposphere. Satellite observations revealed its origins in a dust storm in Southern Ukraine, where large amounts of coal were resuspended from dried-out floodlands at wind gusts up to $30\,m\,s^{-1}$. Along the pathway of the plume, maximum particulate matter (PM_{10}) mass concentrations between 200 and $1400\,\mu g\,m^{-3}$ occurred in Slovakia, the Czech Republic, Poland, and Germany. Over Germany, the dust plume was characterized by a volume extinction coefficient up to $400\,Mm^{-1}$ and a particle optical depth of 0.71 at wavelength $0.532\,\mu m$. In-situ size distribution measurements as well as the wavelength dependence of light extinction from lidar and Sun photometer measurements confirmed the presence of a coarse particle mode with diameters around $2–3\,\mu m$. Chemical particle analyses suggested a fraction of 75% crustal material in daily average PM_{10} and up to 85% in the coarse fraction $PM_{10-2.5}$. Based on the particle characteristics as well as a lack of increased CO and CO_2 levels, a significant impact of biomass burning was ruled out. The reasons for the high particle concentrations in the dust plume were twofold. First, dust was transported very rapidly into Central Europe in a boundary layer jet under dry conditions. Second, the dust plume was confined to a relatively stable boundary layer of 1.4–1.8 km height, and could therefore neither expand nor dilute efficiently. Our findings illustrate the capacity of combined in-situ and remote sensing measurements to characterize large-scale dust plumes with a variety of aerosol parameters. Although such plumes from Southern Eurasia seem to occur rather infrequently in Central Europe, its unexpected features highlights the need to improve the description of dust emission, transport and transformation processes used, particularly when facing the possible effects of further anthropogenic desertification and climate change.

1 Introduction

1.1 Wind-blown dust and climate

Wind-blown dust particles emitted from dry soil surfaces contribute considerably to the global aerosol mass and optical thickness, as well as to particle concentrations near the surface. With the exception of sea salt particles, soil dust contributes globally to the highest atmospheric mass load of all aerosol particle types (Textor et al., 2006). Dust particles are part of the coarse mode aerosol typically occurring in the super-μm size range (Heywood et al., 2001; Reid et al., 2003). Current estimates of annual global emissions of dust particles that are available for long-range transport vary between 1000 and 2000 Tg (Zender et al., 2004).

Frequent transport of dust plumes from the Sahara, the largest dust source worldwide, towards Europe can be observed frequently within the free troposphere (Ansmann et al., 2003; Bitcan et al., 2005; Amiridis et al., 2005). Other sources of mineral dust aerosol include the Arabian Peninsula, the Gobi and Taklamakan deserts in Asia, and the Australian and South American deserts (Prospero et al., 2002).

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Volcanic PM10 and SO2 detected in Swiss Alps

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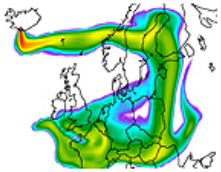
EMPA
Materials Science & Technology

Empa - a Research Institute of the ETH Domain

You are here: empa.ch > Departments > Support > Communication > News > News 2010

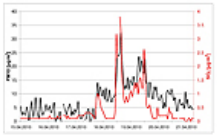
Empa measures concentration of volcanic ash on Jungfraujoch **23 April 2010**

From emission source investigations to forecasting



Empa continuously monitors the make-up of the air on Switzerland's Jungfraujoch and has been able to provide important information about changes in the concentration of harmful substances caused by the volcano Eyjafjalloekull. Empa researchers normally use their data in atmospheric transport models to investigate emissions that occurred in the past. If, however, weather forecasting data is fed into the computer simulations, this allows predictions regarding how the clouds of Icelandic volcanic ash are likely to make their way across Europe during the days following their emission.

Since the evening of the 17 April, Empa's Jungfraujoch-based measuring equipment has recorded several marked increases in the level of sulphur dioxide (SO2) in the atmosphere and in the amount of micro-particles – so-called PM10 particles. Normally, the question to be asked in such cases is: Where have these substances come from? On this occasion, however, the origin of the substances was clear: they have been carried into Switzerland's mountains in clouds of ash emitted by the volcano Eyjafjallajoekull in Iceland.
Empa scientists, working together with the FOEN (the Swiss Federal Office for the Environment), have been able to glean valuable information from the data recorded, particularly about the concentration and composition of the volcanic ash. The highest levels of PM10 particulate matter (particles with a diameter of less than 10 micrometres) recorded on Jungfraujoch over the recent days amounted to some 30 micrograms per cubic metre of air. Empa's researchers are planning to investigate the chemical content of the volcanic ash over the next few days.



Measurements of PM10 and sulphur dioxide taken by Empa in the alpine research station on Jungfraujoch: the values increase on 18 April and fall back again on 19 April.

- Media release (PDF-File, 133 K
- News-Archiv
- Mediacorner

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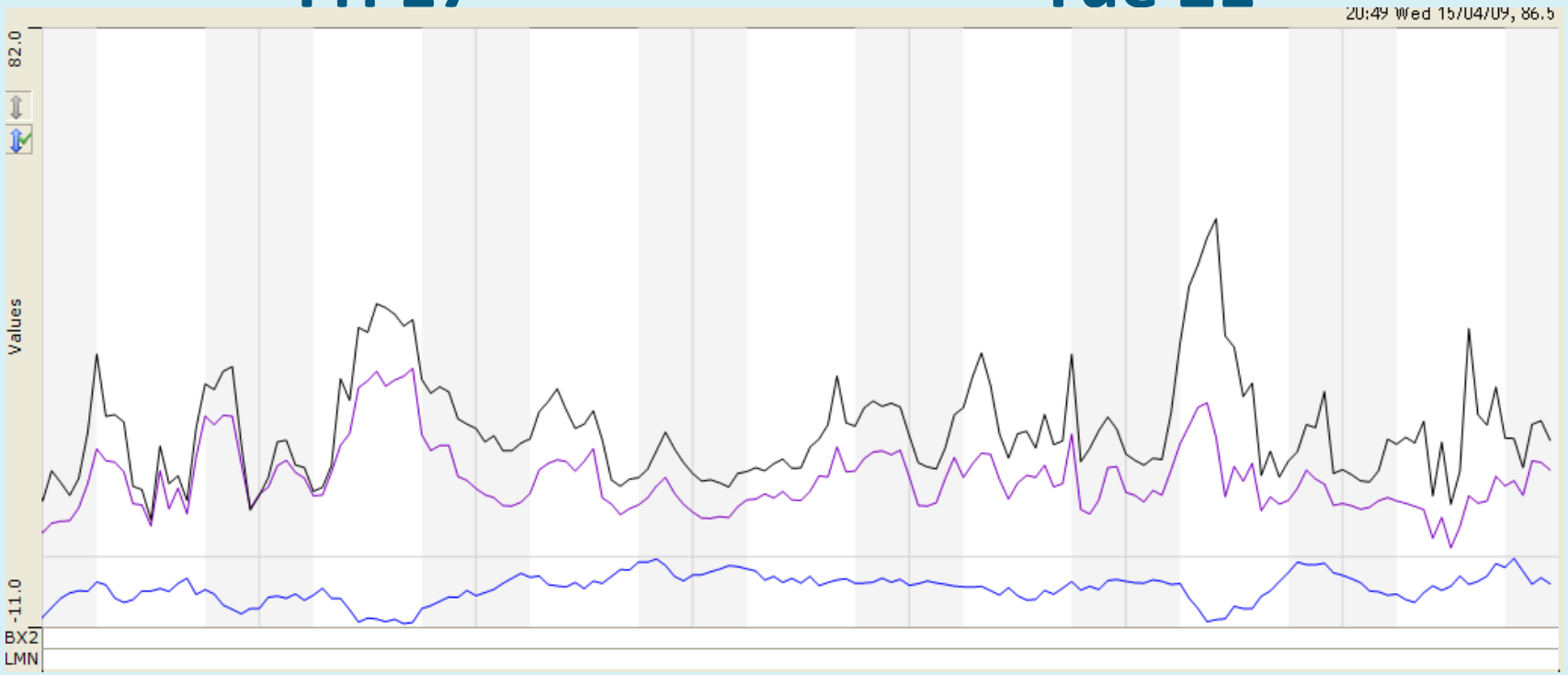
Volcanic ash? (probably not)

Bexley Belevdere, south east London.
(black = PM10, Purple = PM2.5, Blue = volatile PM10)

Fri 17th **Tue 21st**

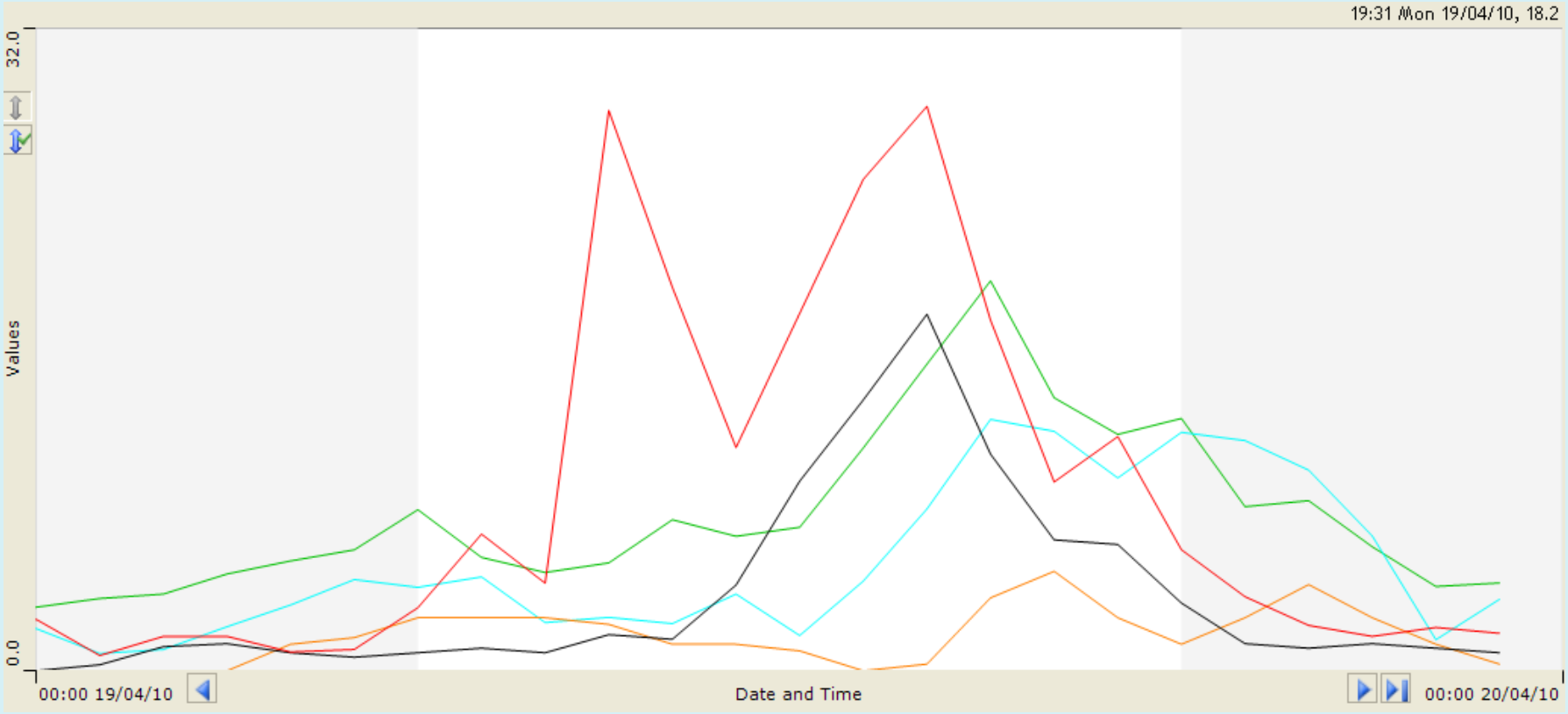


Volcanic ash? (not)

SO2 across London.

Red = Bexley, Black = Greenwich, Green = Westminster, Blue = Kens & Chelsea, Orange = Ealing

Sun 19th



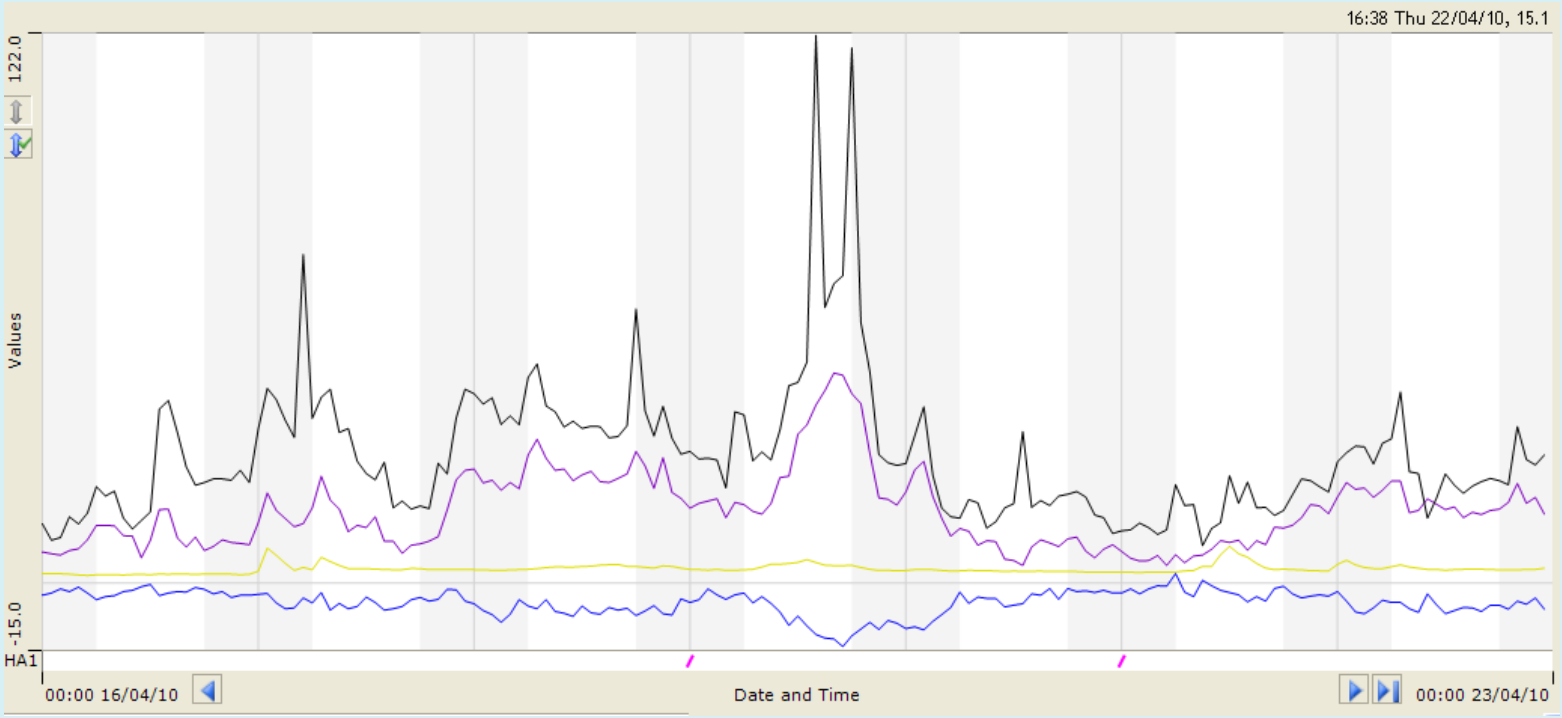
Volcanic ash?

Harwell Ox

No known local events - thanks to Paul Willis AEA for investigating.

(black = PM10, Purple = PM2.5, Blue = volatile PM10)

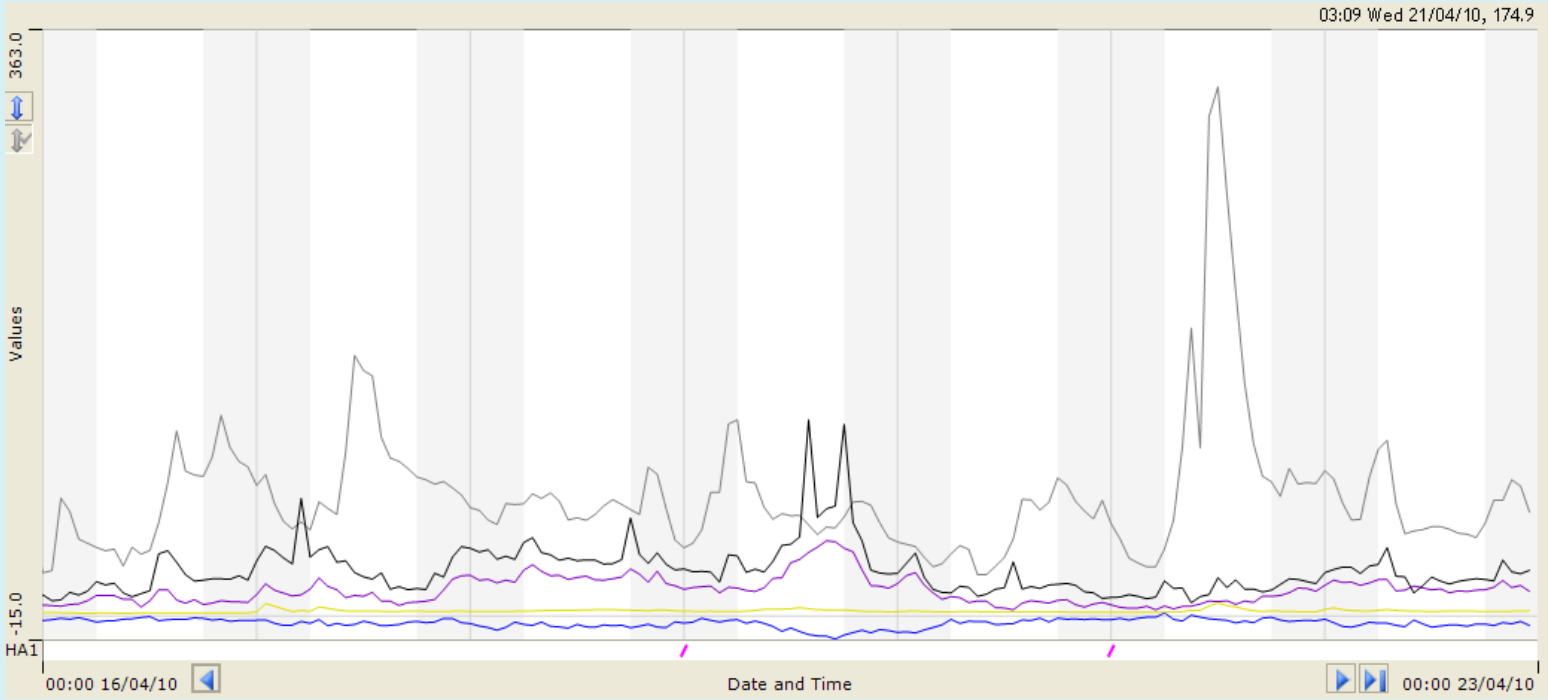
Mon 19th



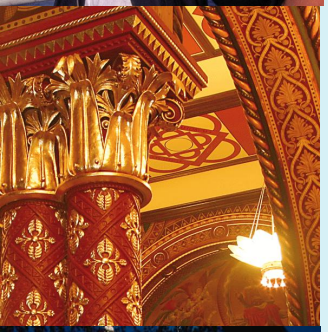
Volcanic ash?

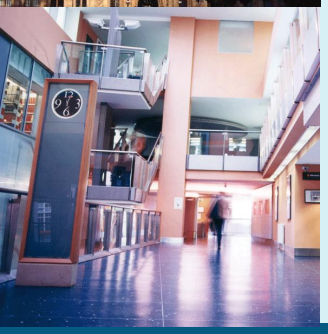
Harwell Ox
(black = PM10, Purple = PM2.5, Blue = volatile PM10 and CPC particle number concentrations (grey p cm-1 *0.01)

Mon 19th



Also elevated PM_{10} at Lough Navar on 17th April max 54 ug m^{-3} (spotted by Alan Jones – Birmingham). Sadly no SO_2 measurements at this site



KING'S College LONDON

Thank you

gary.fuller@kcl.ac.uk