



# Ground-Based and Airborne Imaging of NO<sub>2</sub>

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Monks**

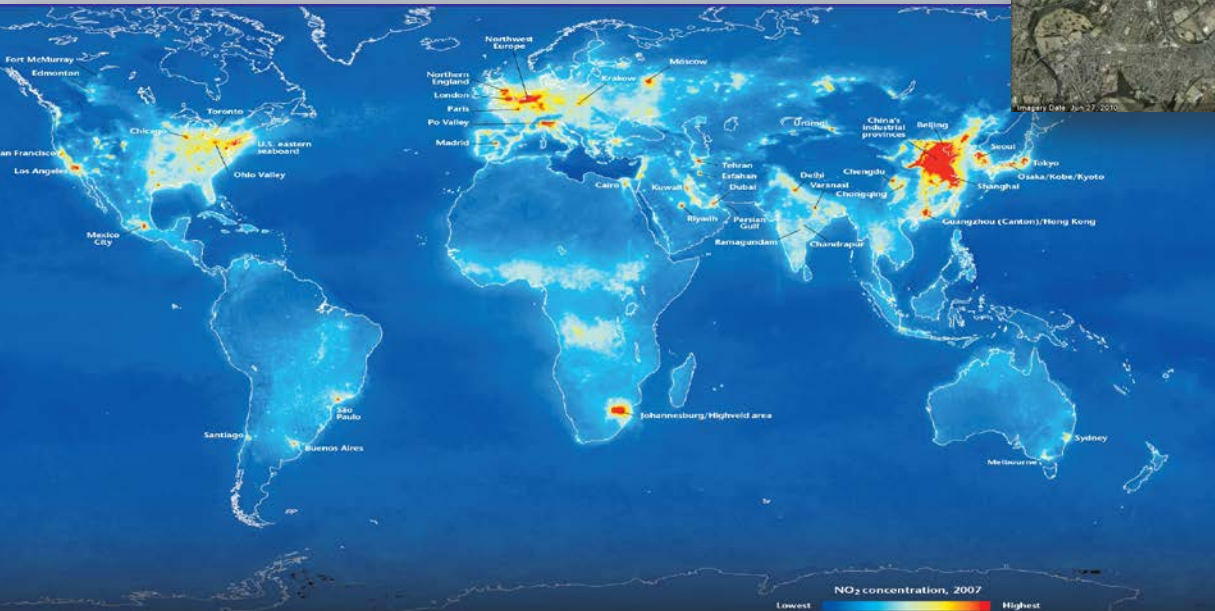
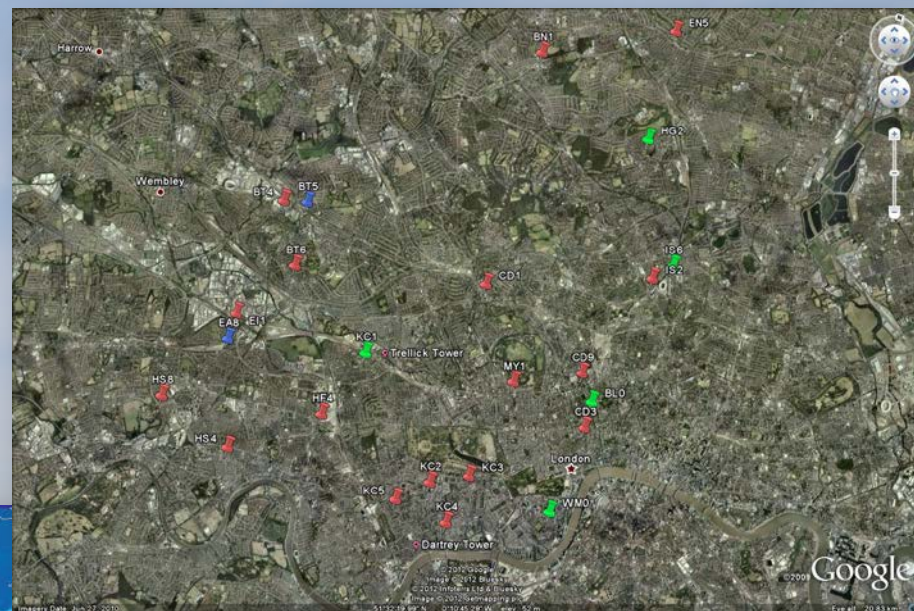
NCEO/CEOI-ST annual conference 24<sup>th</sup>-27<sup>th</sup> June 2014, Sheffield





# Motivations

- The total health-related costs of air pollution for the whole of Europe were €803 billion in the year 2000 and are estimated to fall to €537 billion in the year 2020 (Brandt et.al 2013).
- Defra consider NO<sub>2</sub> to be “one of the best indicators of air quality”.
- NO<sub>2</sub> plays an important role in the production of tropospheric ozone, which can act as a greenhouse gas and have adverse effects on human health.



## Spatial Information

- CompAQS bridges the gap between point measurements and satellite measurements in terms of spatial resolution.
- Providing information on air quality over an entire urban environment.





### Poster 'absorbs 20 cars' worth of pollution' in Sheffield

19 May 2014 Last updated at 13:31 BST

A giant poster has been put up in Sheffield to help remove pollution from the air.

Researchers say the banner removes harmful nitric oxide from the air, absorbing the pollution from around 20 cars a day.

### Pollution from Ikea in Sheffield 'will cause deaths'



by Chris Burn  
chris.burn@thestar.co.uk

More premature deaths from heart attacks and strokes could be caused by extra air pollution caused by a new Ikea store in Sheffield, a report says.

The report recommending plans for the store in Tinsley are approved said the store will have a negative impact on the area's 'already poor air quality' and cause a 'small number' of additional premature deaths.

But the report also states the store will have health benefits by creating jobs and training opportunities.

Concerns were raised by campaigner Neil Parry from the East End.

Published on the

19 June 2014 11:53

Tweet

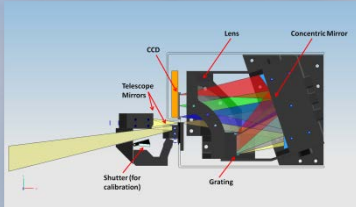
8+1 0

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# Project Heritage



CompAQS phase  
2, Imaging  
entrance  
optics



Design and  
Development  
of 2/3 CityScan  
instruments



CityScan  
deployments  
ClearLo and  
PEGASOS

Development  
of a  
hyperspectral  
suite for 3D  
retrievals

D.Lobb ,  
Applied  
Optics  
1994

'94

'07

'08

'09

'10

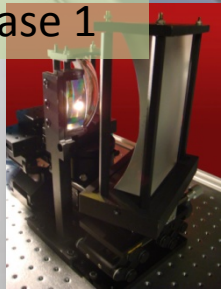
'11

'12

'13

'14

CompAQS  
phase 1

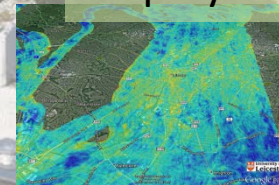


CEOI

PhD funded by  
NCEO and the Env  
Agency,  
Exploitation of the  
CompAQS  
spectrometer-  
CityScan

First CityScan  
Deployments

First AAQM  
Deployment



CEOI AAQM

CEOI-ST

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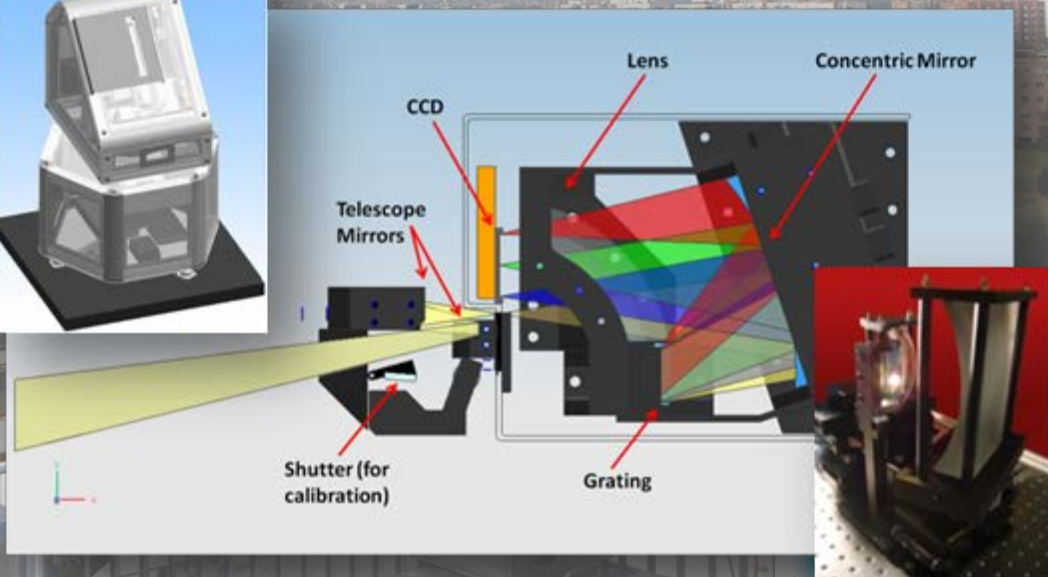
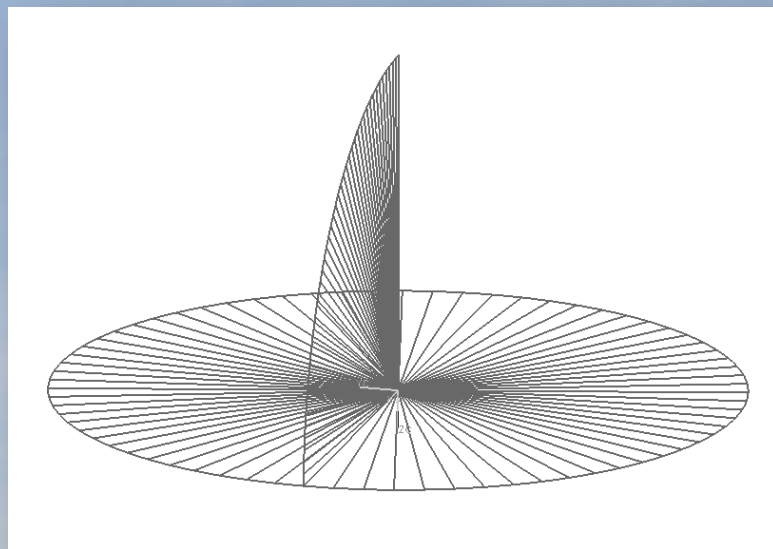
# Ground-Based Instrumentation



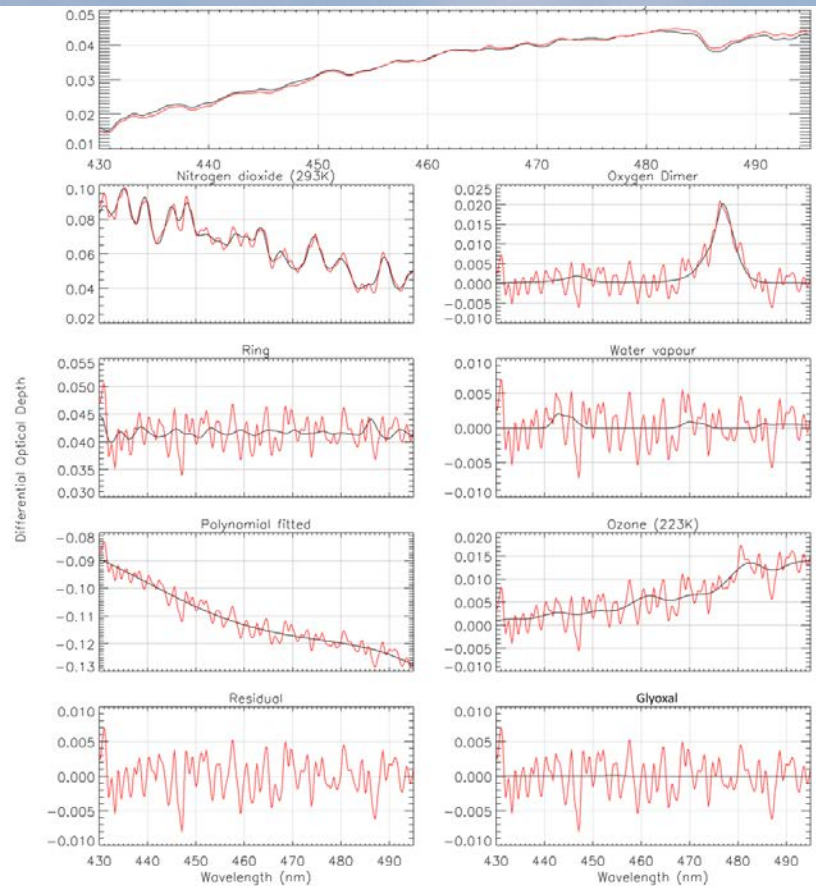


# CityScan

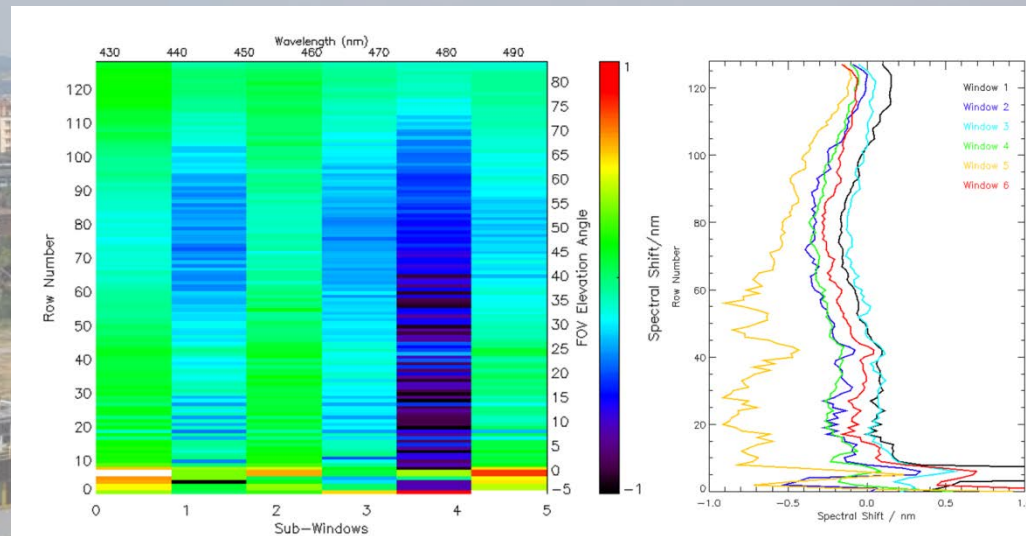
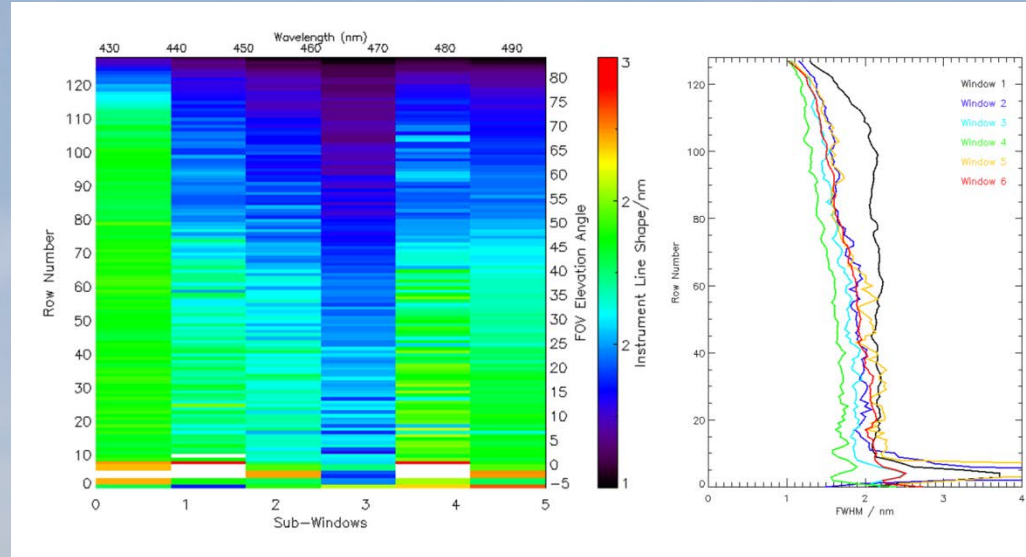
- A scanning imaging DOAS system with a wavelength range from 420-630nm.
- Scans in 360° with 1° resolution.
- Field of view from zenith to 5° below the horizon with 128 resolved elements.
- Providing over 45,000 spectra every 6 minutes.
- From these spectra we can calculate NO<sub>2</sub> columns.
- The DOAS technique removes broadband features in the spectra, which represent the extinction processes that occur in the atmosphere and absorption by some trace gases, in order to isolate the uniquely narrow trace gas absorptions of interest.





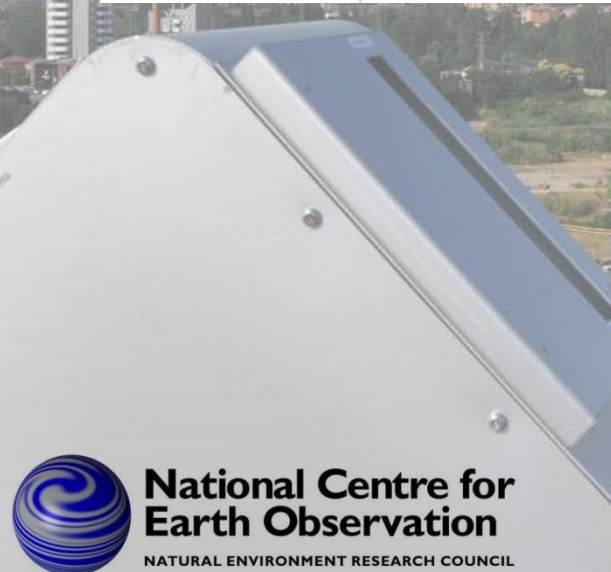
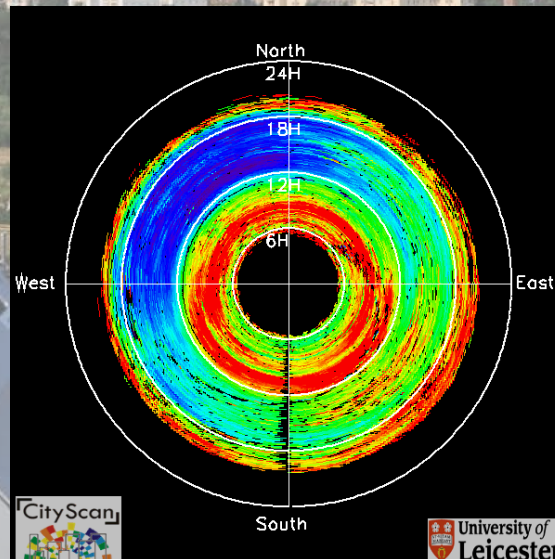
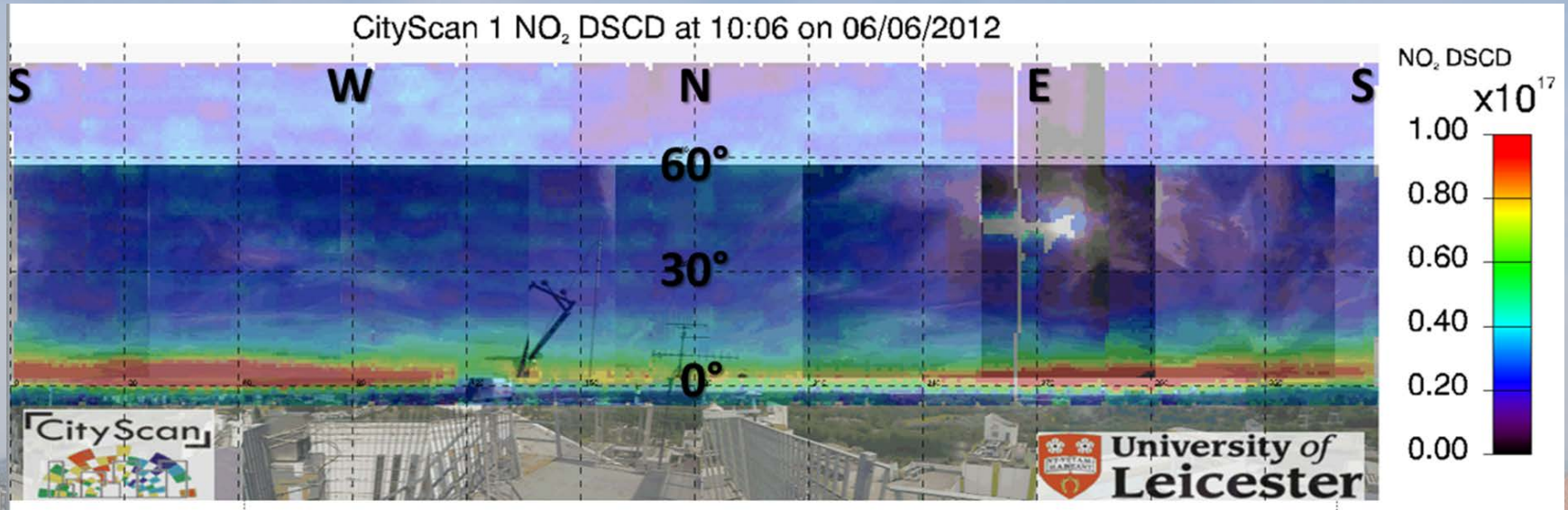


$\text{NO}_2$  SCD retrieved is  $1.62 \pm 0.043 \times 10^{17}$  mol cm<sup>2</sup> with an RMS on the fit of  $2.59 \times 10^{-3}$

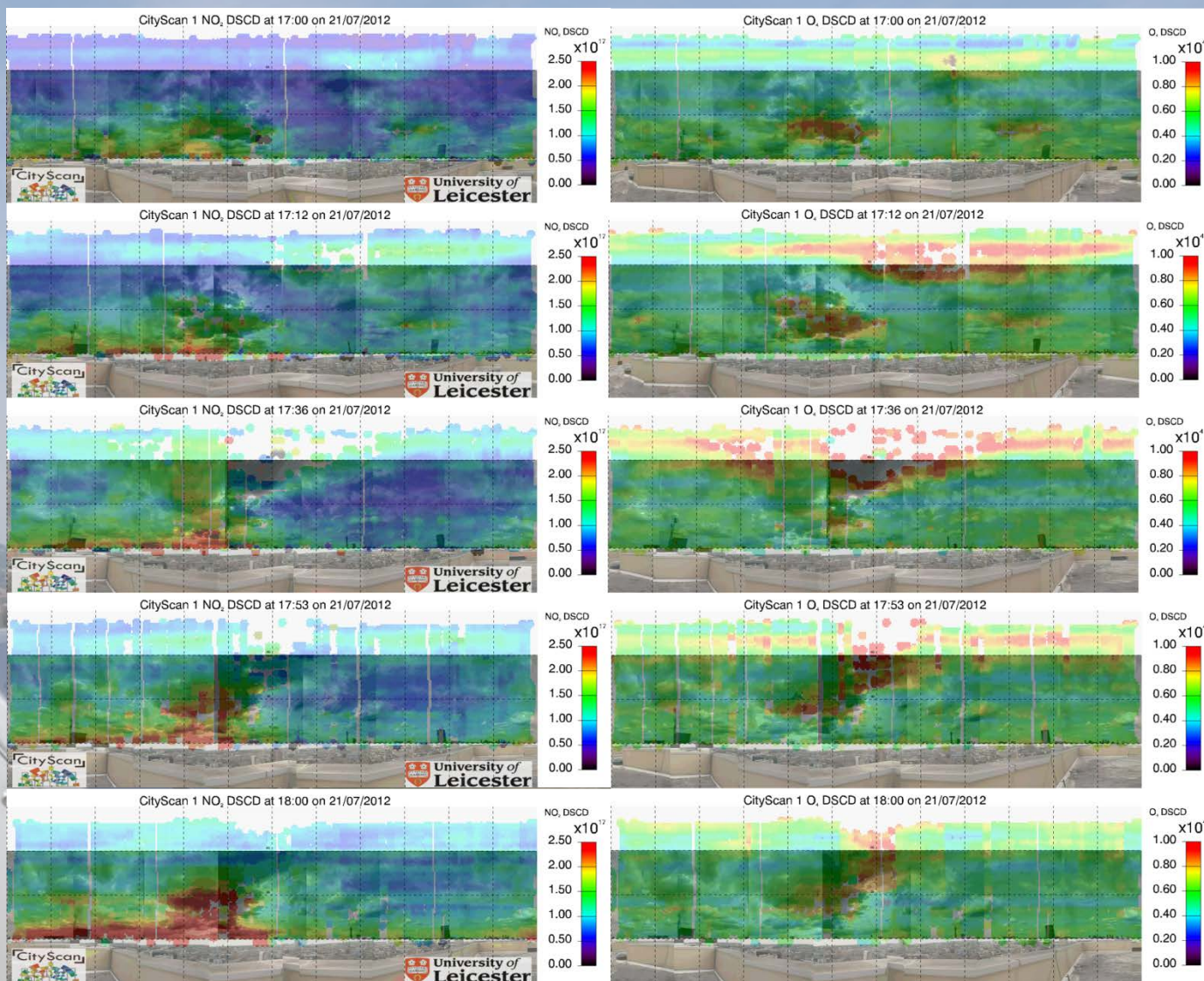




# Example CityScan Data

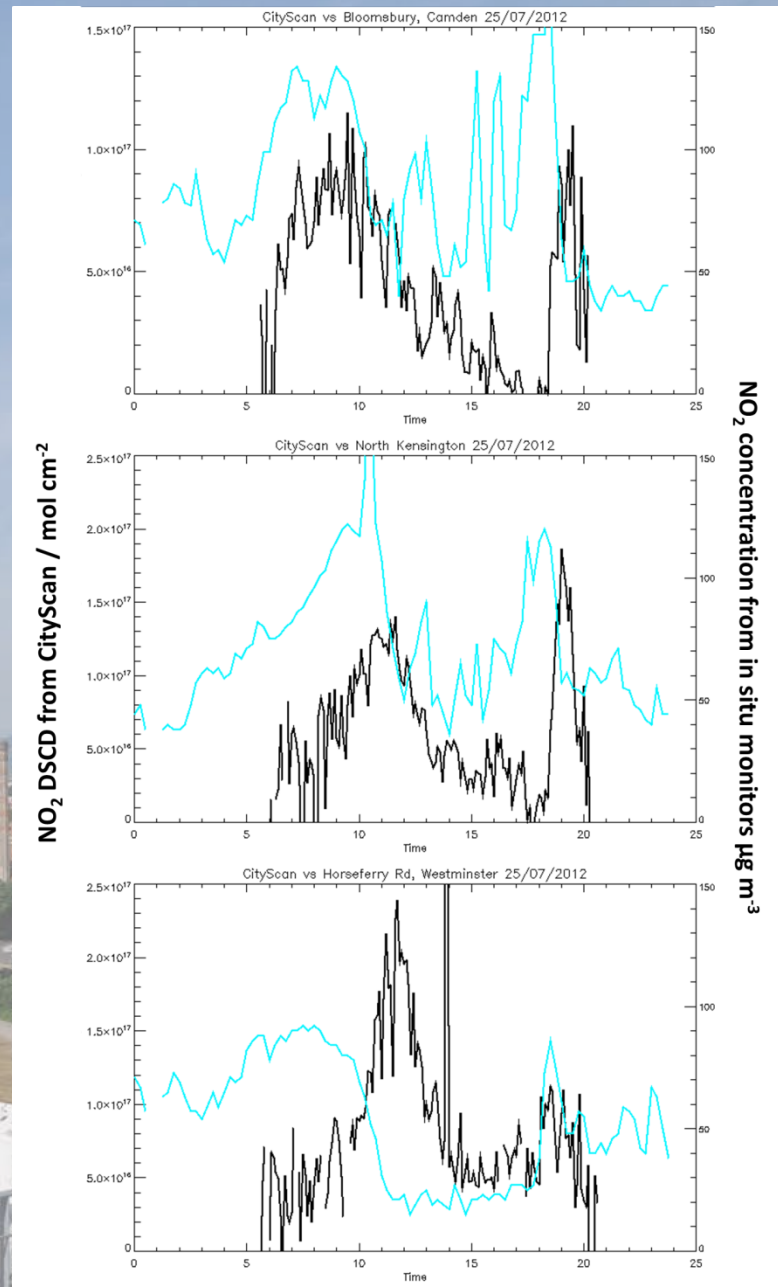
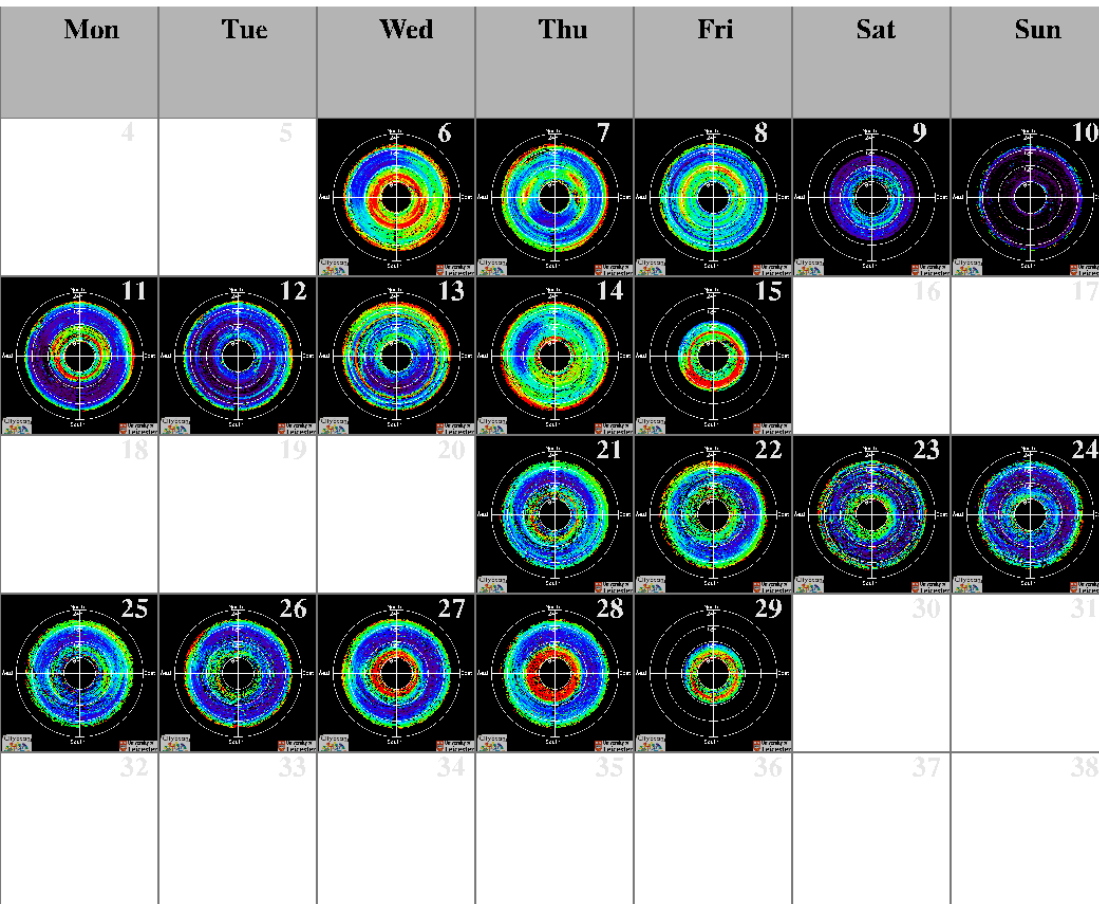








## Monthly data from Cityscan unit 1 for 06/2012







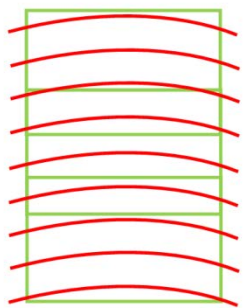
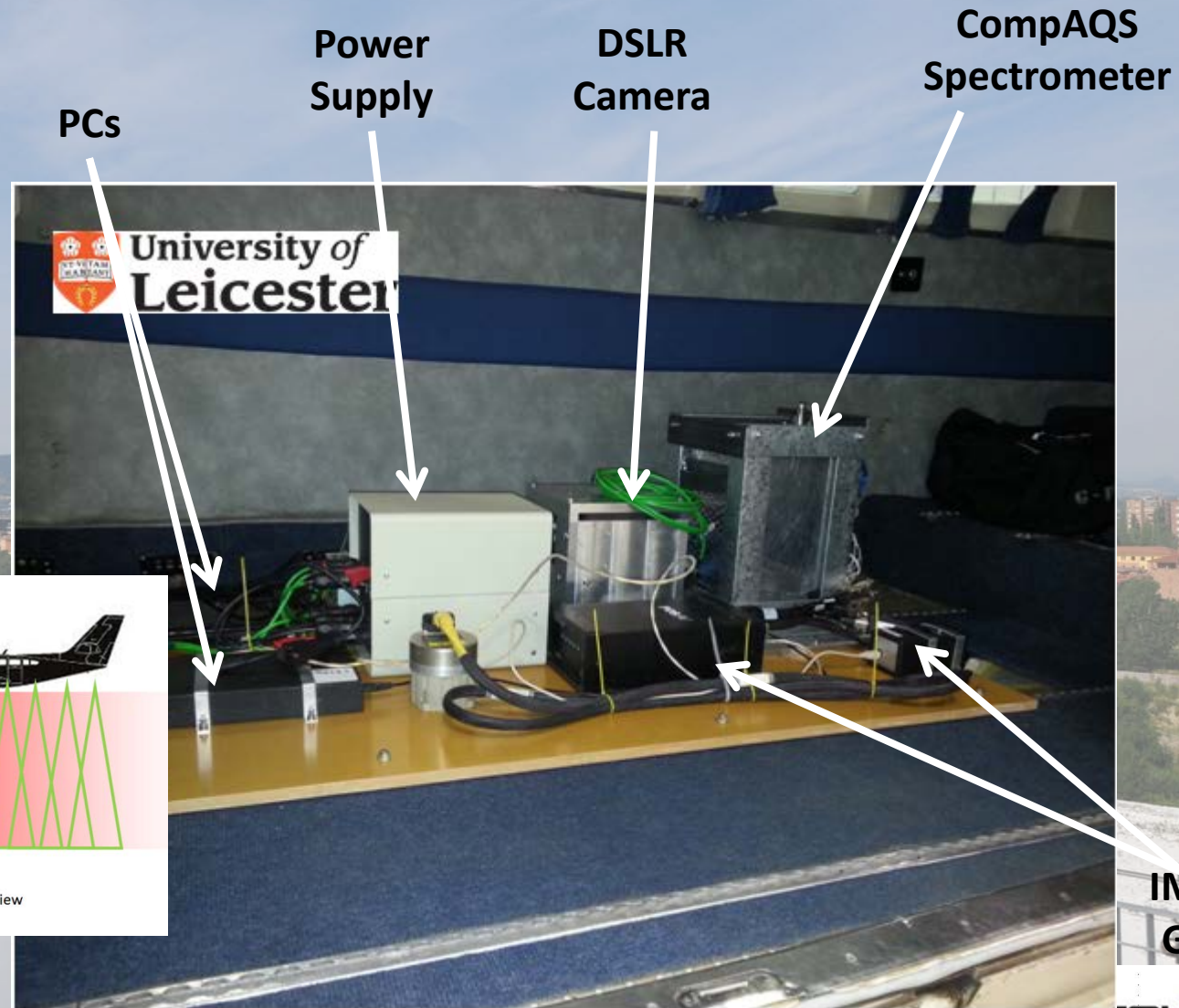
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# ANDI- The Airborne Nitrogen Dioxide Imager

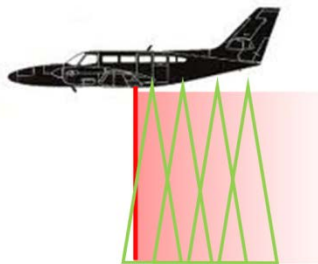


# Instrument Modifications and Design

- Optical mounts were modified for the new spectrometer orientation
- Detector was changed to frame transfer mode, therefore the shutter could be removed

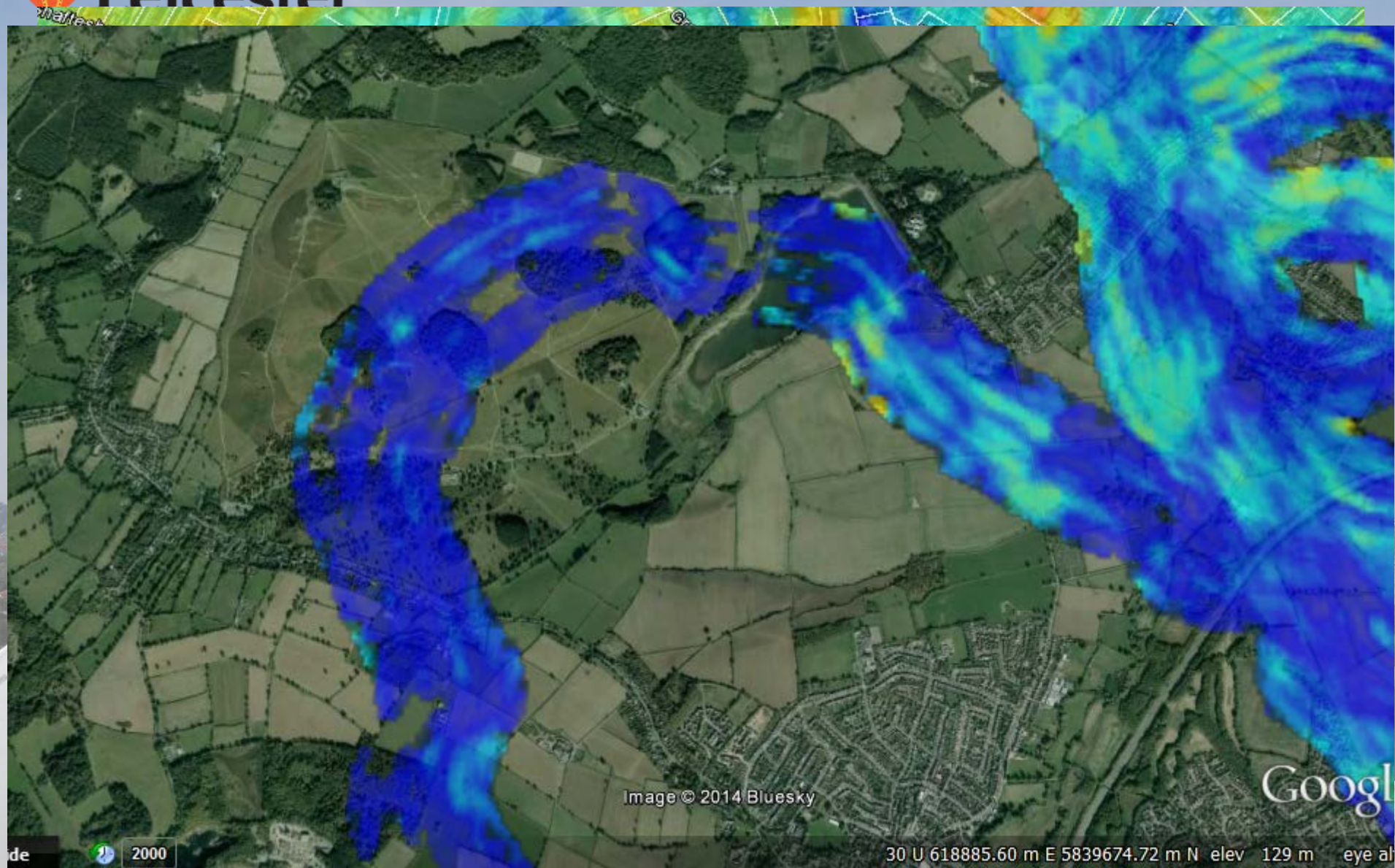


Top View



Side View









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# Future Work





# CEOI-ST Project

- Six month pathfinder grant

## Aims and objectives:

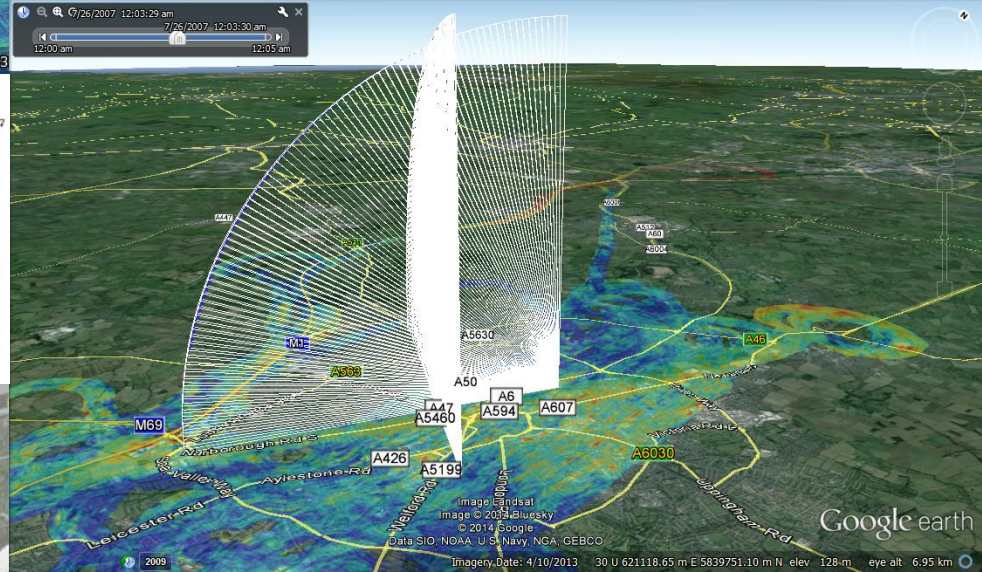
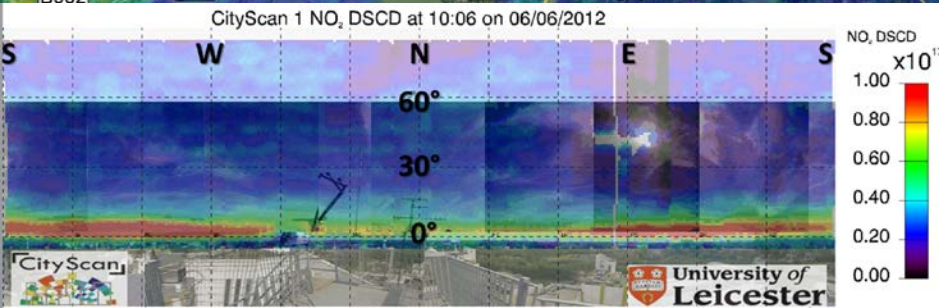
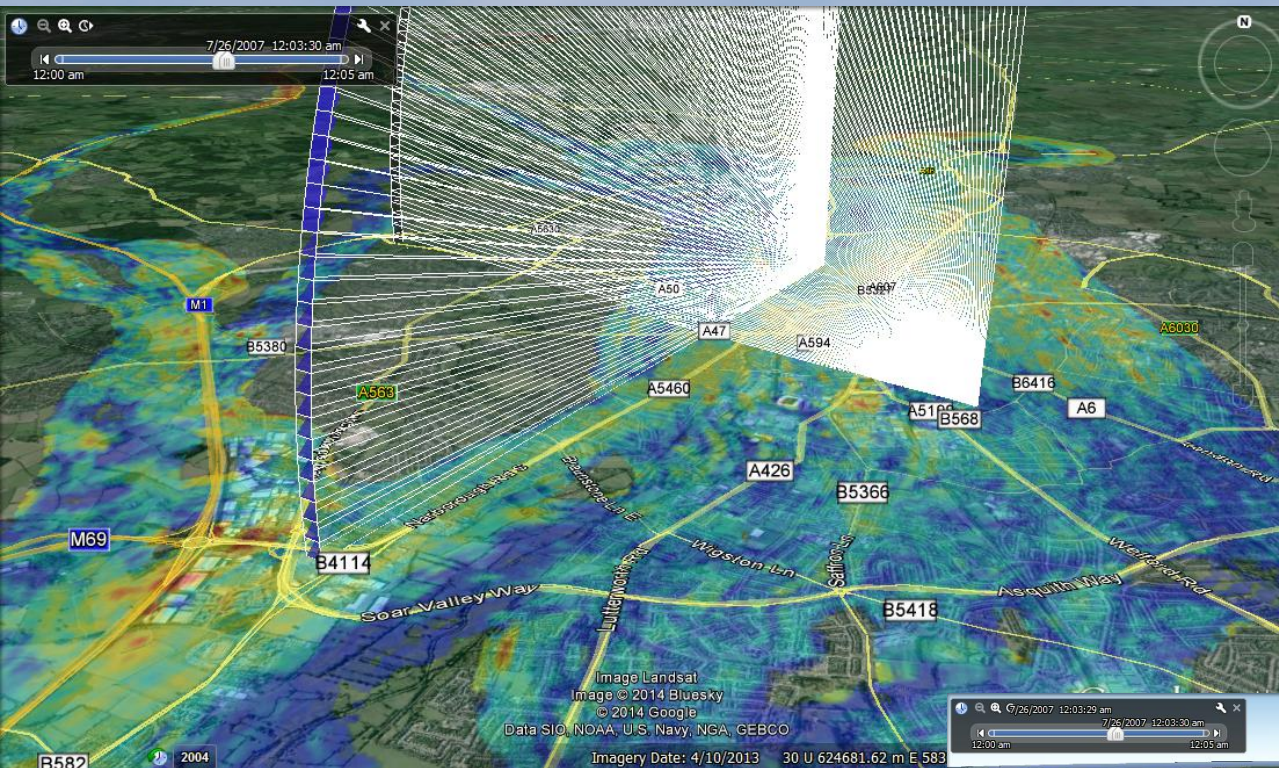
- Instrument optimisation
  - Optimisation of optics bench- including replacement of entrance slit
  - Refinement of focal plane resulting in improved resolution and SNR
  - Radiometric calibration of CompAQS pre-flight
- Deployment of a coordinated ground-based and airborne system
  - Flight of optimised CompAQS
  - Installation of two CityScan instruments on the ground
- Retrieval development
  - Development of tomographic retrieval to analyse the 3D dataset produced





# The Experiment

- 2 x CityScan installed during a flight of ANDI
- With Ground-based in situ sensors installed across the city







# Conclusions

- The CompAQS spectrometer has been shown to be a valuable tool for remote sensing of air quality on the ground and the air.
- Further work is planned to optimise the instrument.
- CEOI-ST has funded a 6 month project to deploy the ground-based and airborne systems side by side.



# Acknowledgements

- Colleagues in the Air Quality Group at the University of Leicester
  - Phil Peterson
  - Kirsty Grant
  - Rob Garner
- Funding bodies
  - NCEO
  - CEOI
  - Open Knowledge Foundation