Remote Sensing Techniques for Urban Air Quality Monitoring

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- Project Innovations – novel technologies/applications
- Technology Transfer Potential
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Motivations

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- **Clean air is considered to be a basic requirement of human health (WHO)**
- **Pollution reduces life expectancy in UK on average by 7-8 months**
- **£15bn p.a. cost to UK**
- **Requirement for global solution management.**

Urban-scale air quality from orbit

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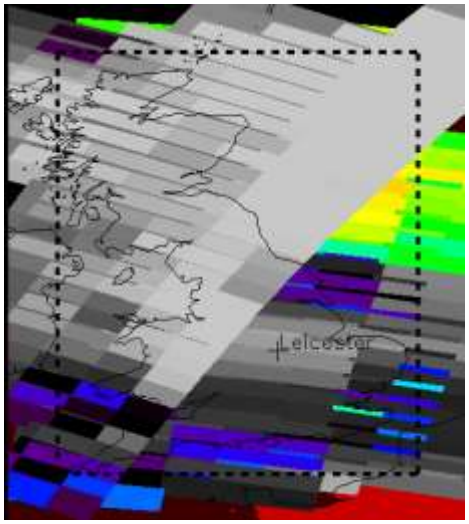
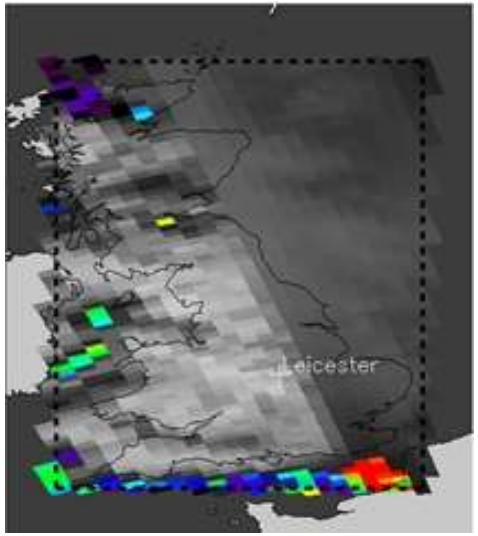
09:00

13:00

23:00



GOME 2



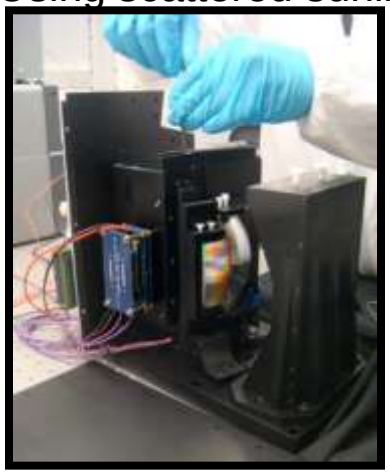
OMI

Challenges of Air Quality monitoring from space.

- Cloud Cover
- Horizontal resolution (23x12km:7x7km)
- Vertical resolution (Trop/Strat)
- Temporal sampling (once daily)
- “NRT” = 3 hour delay

CityScan – the NO_2 scanner

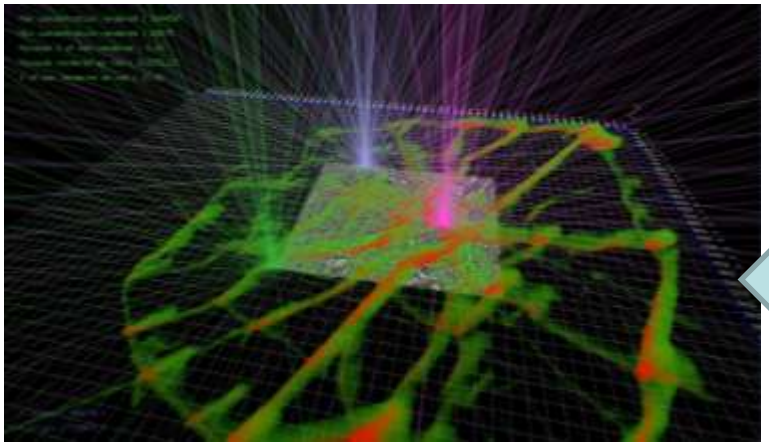
A novel imaging spectrometer
Using scattered sunlight

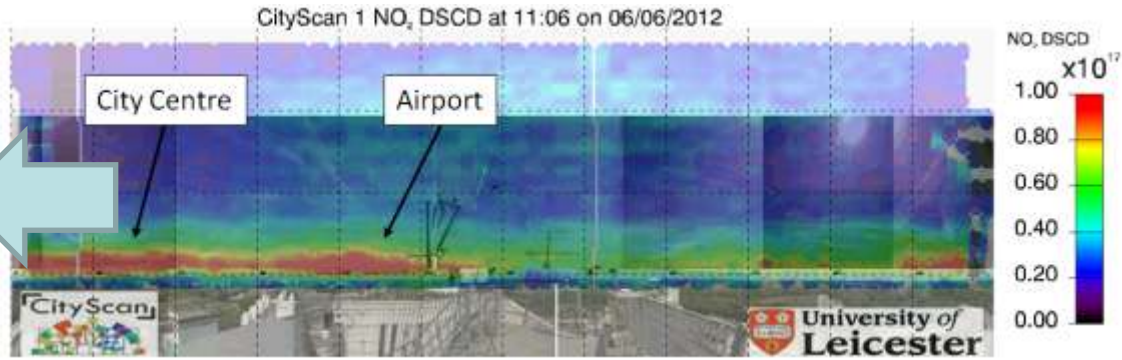


Placed in a housing looking over a city for NO_2 retrievals

Produces Panoramas of NO_2

Multiple rotating instruments for tomography





CityScan – the NO_2 scanner

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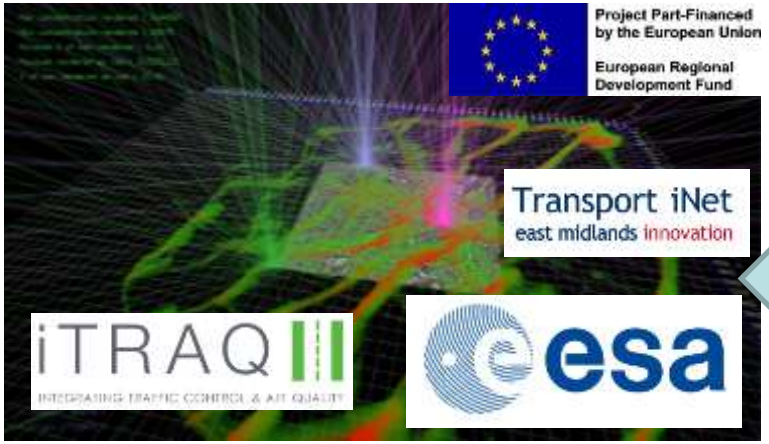
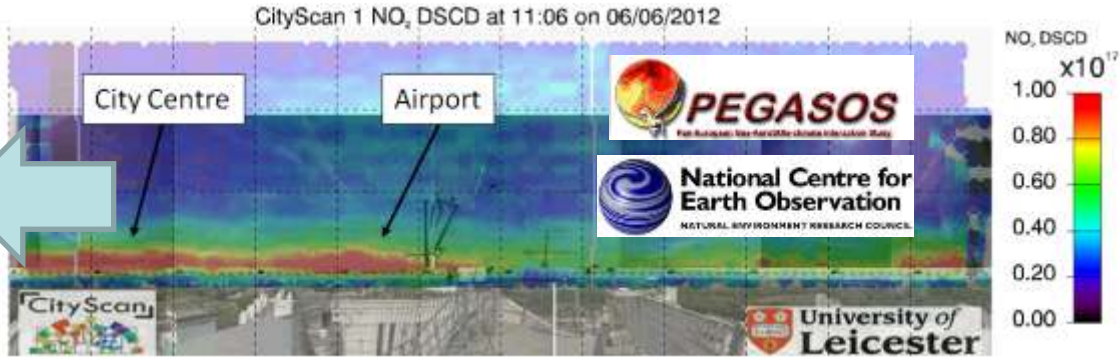


Produces Panoramas of NO_2



2 seedcorn studies.

UCAM: The Ultra-Compact Air quality Mapper.

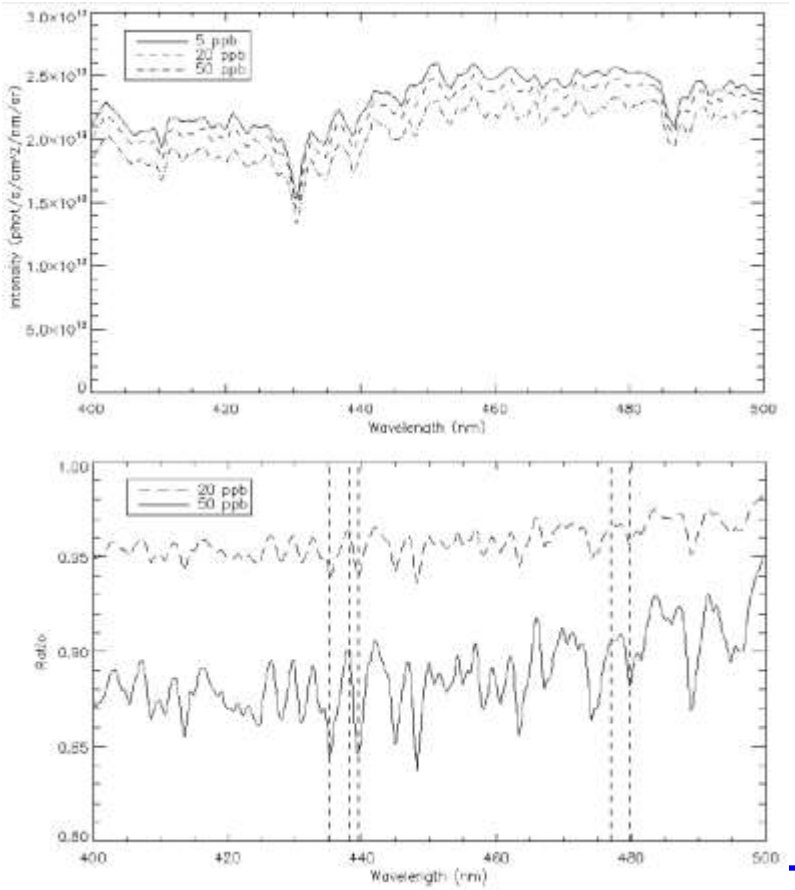
A discrete wavelength approach to NO_2 remote sensing.

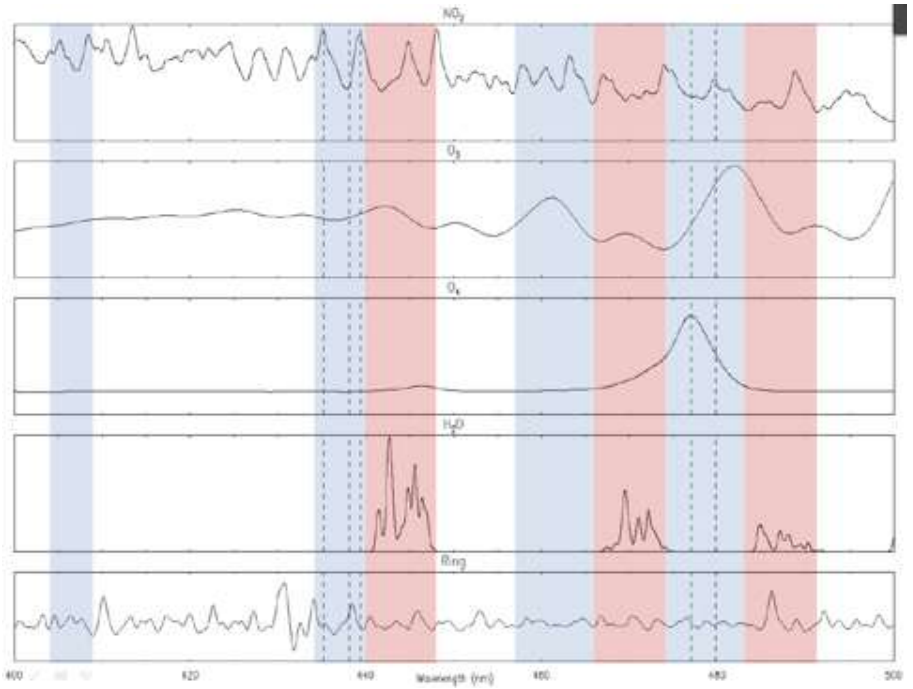
AAQM: The Airborne Air Quality Mapper.

A flight-demonstrator for novel air quality instrumentation.

The UCAM Question

Can a “discrete wavelength” technique produce an NO_2 retrieval of sufficient accuracy and precision for urban air quality mapping?





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SURREY SATELLITE TECHNOLOGY LTD

University of Leicester

WP1 – Management
Dr. Roland Leigh
University of Leicester

WP3 – Optical Design
Mark Chang
SSTL

WP2 – Retrieval Algorithm Development
Dr. James Lawrence
University of Leicester

CEOI CASE studentship

Radiometry modelling
Jasdeep Anand
University of Leicester

External variables

- Solar Zenith Angle
- Solar Azimuth Angle
- Field of view

Atmos. composition variables

- Cloud cover
- Aerosol
- Water vapour
- Ozone
- Nitrogen dioxide

Instrumental properties

- Lines sampled
- Line shape
- Line fidelity
- Signal to noise
- Detector bias or drift

Dataset of predicted instrumental data

Inputs

Points sampled

Outputs

Nitrogen dioxide

Train Neural Network

- Assess accuracy
- Prune nodes

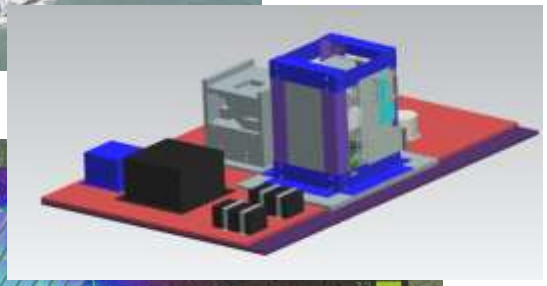
(remove lines with low NO_2 information content)

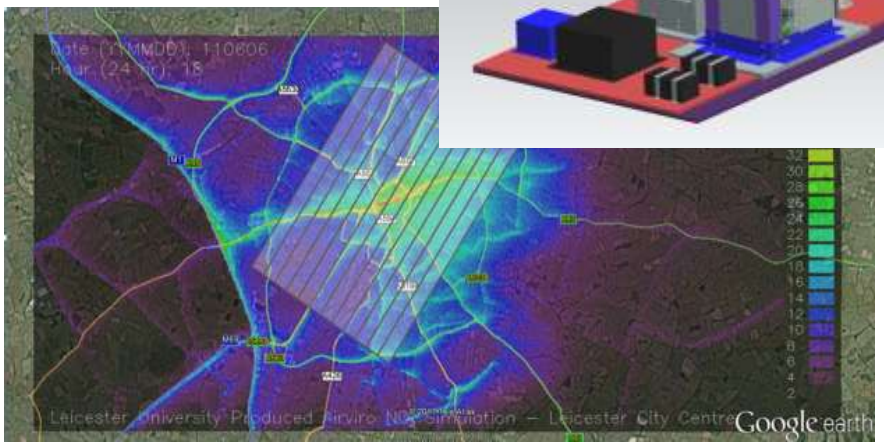
Derive instrument requirements

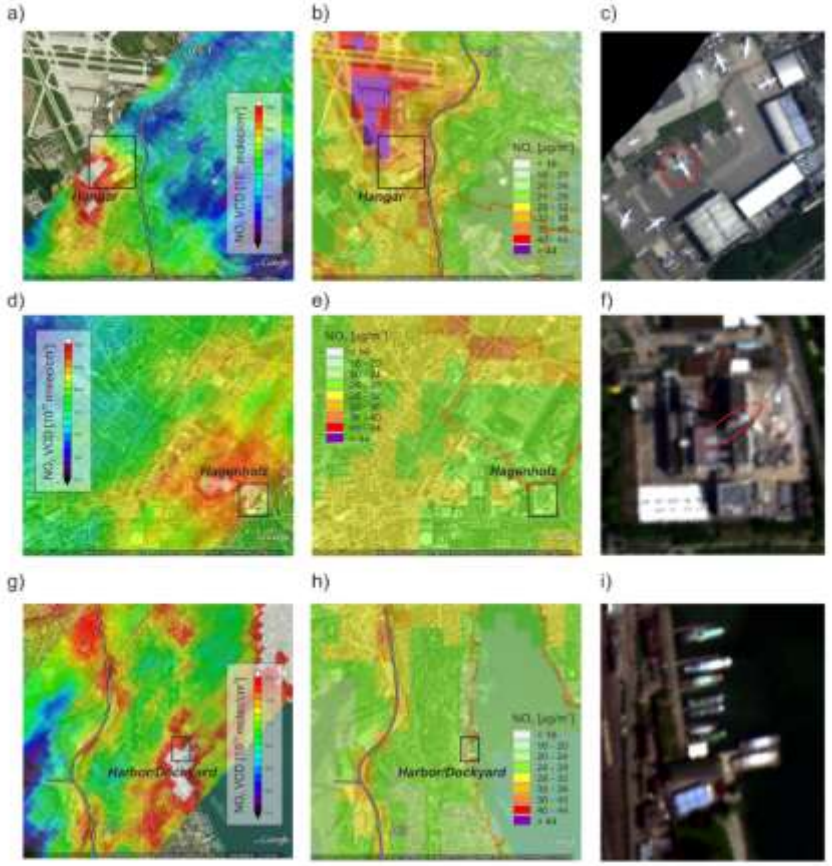
- Possible line combinations
- Instrument performance thresholds

<5% errors possible with achievable SNR and only 8 discrete wavelengths

The Airborne AQ mapper







First flights over Leicester: Early Feb 2013

Popp et al. AMT, Sep 2012

Applications

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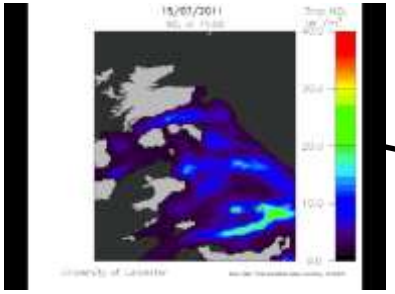
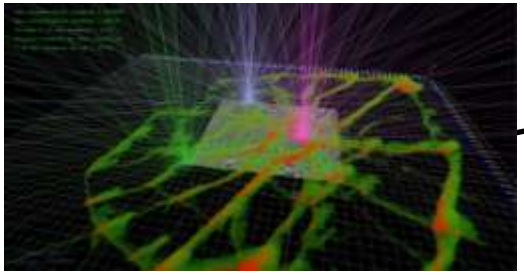
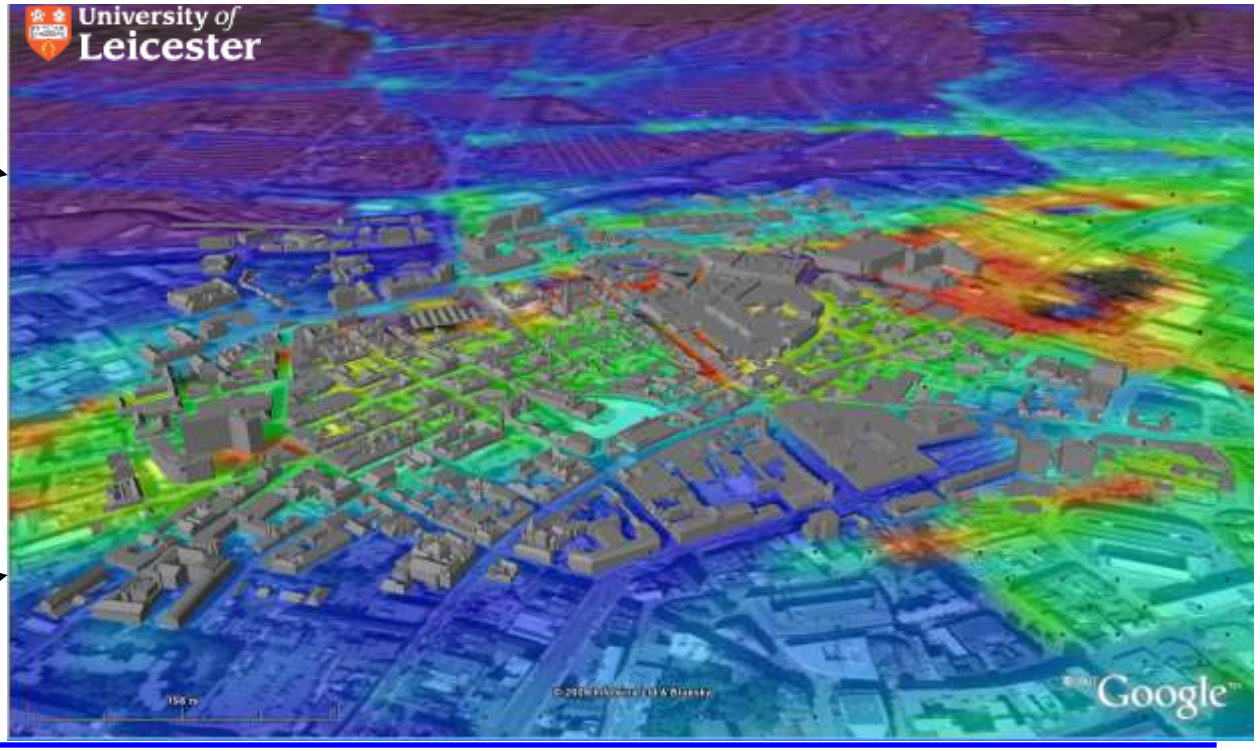
iTRAQ – An integrated traffic and air quality management tool.

Earth Observation Data



AQ measurement and modelling





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Project Innovations

- Novel technologies
- The CompAQS spectrometer.
- CityScan – the air quality scanner.
- The Airborne Air Quality Mapper
- The Ultra-Compact Air Quality Mapper.
- Novel applications
- Hemispherical air quality scanning.
- Remote sensing of air quality for operational urban management.
- Remote sensing of air quality for environmental management.

Technology Needs & Technology Transfer Potential

- **Who can use these instruments?**
  - Scientists
  - Environmental consultancies
  - Airborne Survey companies
  - Air quality monitoring companies
  - Airport/harbour authorities
  - Local authority air quality teams.
  - And others….

- **Benefits**
  - Remote monitoring of emissions across broad areas.
  - Potential for substantial improvement in knowledge of emissions and downwind exposure.
  - Unique.

Overview/Team

- Roland Leigh, University of Leicester
  - (R.J.Leigh@leicester.ac.uk)
  - General, CityScan, iTRAQ, AAQM.
- James Lawrence, University of Leicester
  - (JL110@leicester.ac.uk)
  - UCAM, Air Quality Visualisations.
- Mark Chang, Mike Cutter, SSTL
  - (M.Chang@sstl.co.uk)
  - Optical designs and small satellites.
- Paul Monks, University of Leicester
  - (P.S.Monks@leicester.ac.uk)
  - Everything (else).

To find out more
Go to our website:
www.leos.le.ac.uk/AQ

Follow us on Twitter:
@AirQualityULeic

Thank you for your attention