Air Quality Monitoring from Space – New instruments and applications

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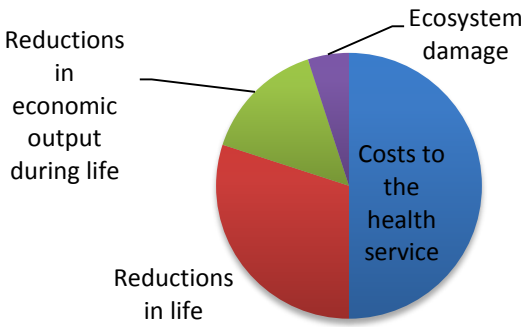
3rd December 2015

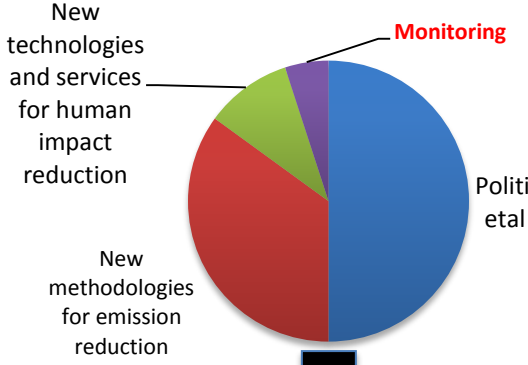
Measuring Air Quality from Space – how much should we spend on this?

Annual costs of poor Air Quality (£1Tn)



nb. Climate costs not included

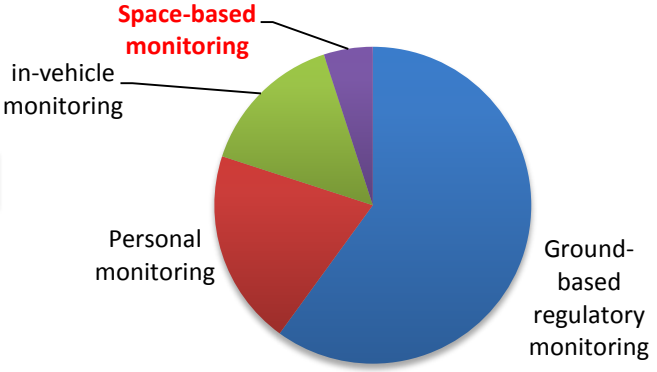
Budget to reduce cost of air quality problems



Includes understanding, prioritisation, and protocol verification

% of problem cost spent on solution	% of solution spent on space	Annual global Budget for Space Air Quality monitoring
5%	5%	£2.5bn
1%	1%	£100M

Solutions for monitoring

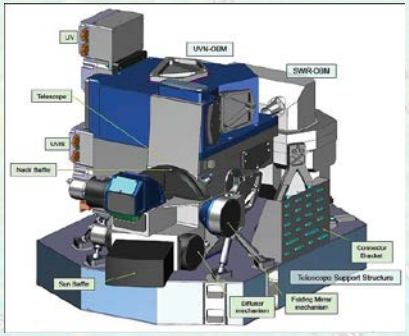


Lowest — Highest

ThalesAlenia Space | Science & Technology Facilities Council UK Astronomy Technology Centre | CEOI-ST | SURREY SATELLITE TECHNOLOGY LTD | bluesky | University of Leicester

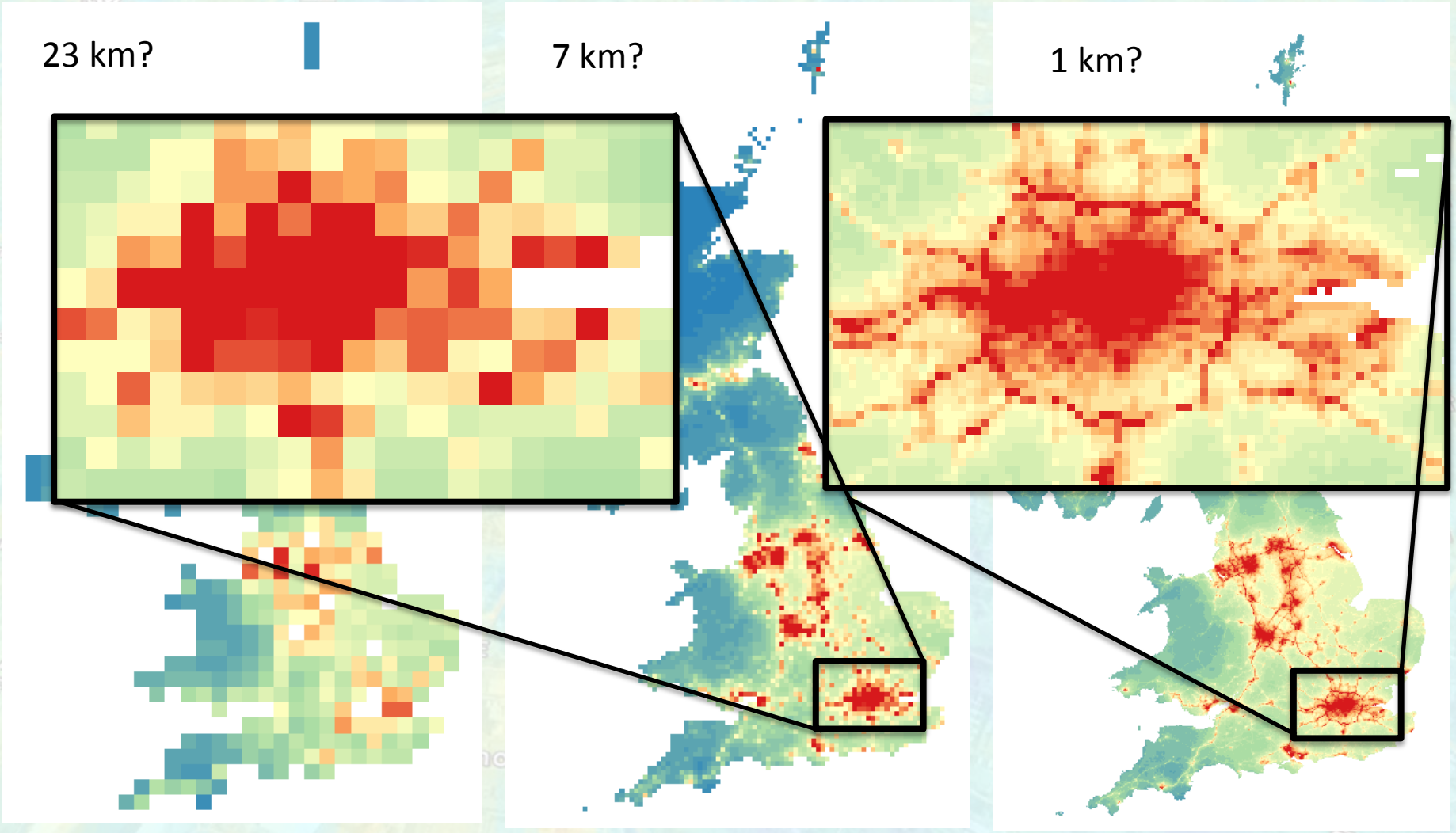
Key forthcoming air quality (NO_2) missions

Sentinel 5 Pre-cursor (LEO - 7x7 km, 2016 – followed by Sentinel 5)

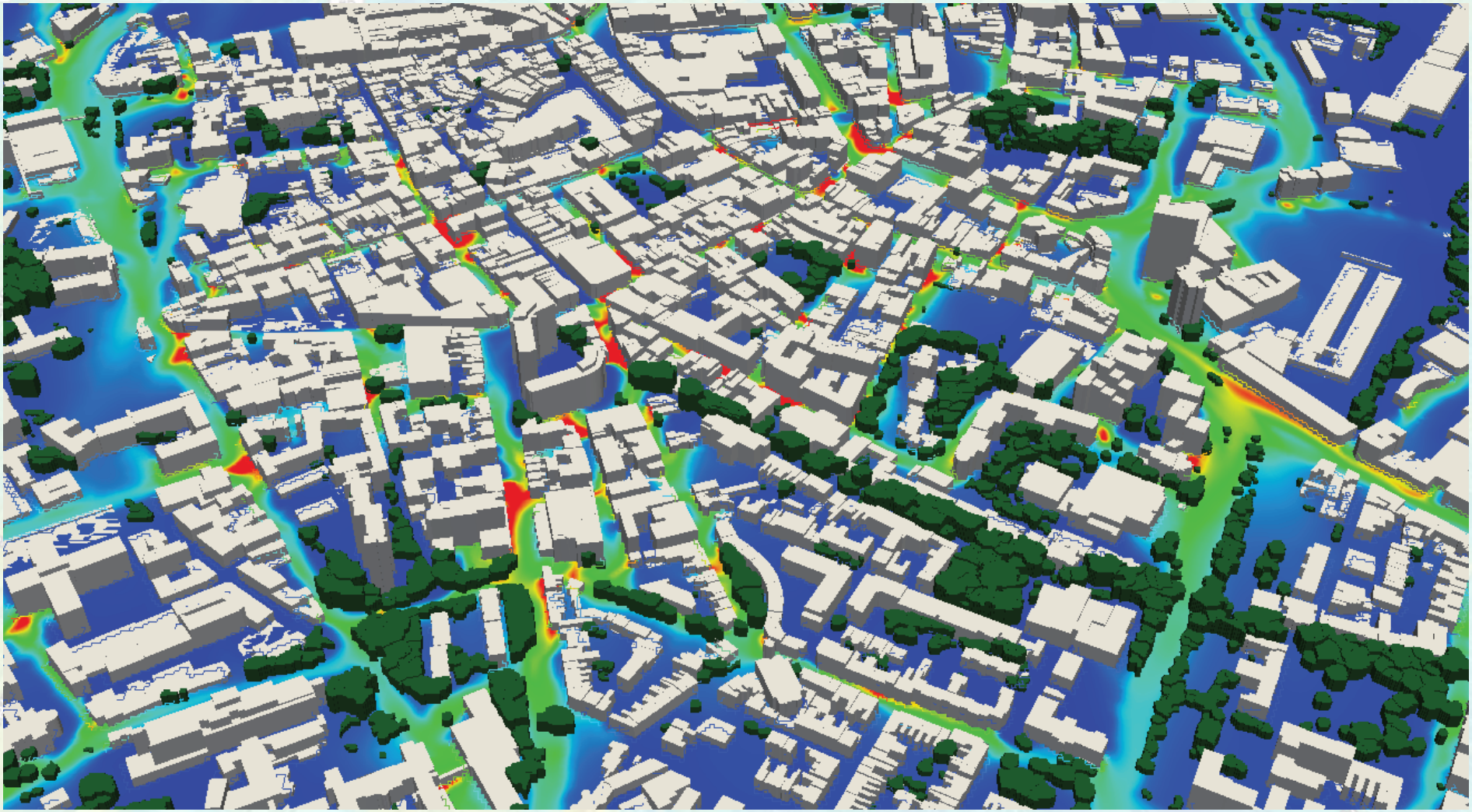


Sentinel 4 (GEO, 7x7 km, 2020(?), in addition to TEMPO and GEMS)

What spatial resolution is useful?



PCM, Ricardo AEA, DEFRA



FluidAir Model, University of Leicester

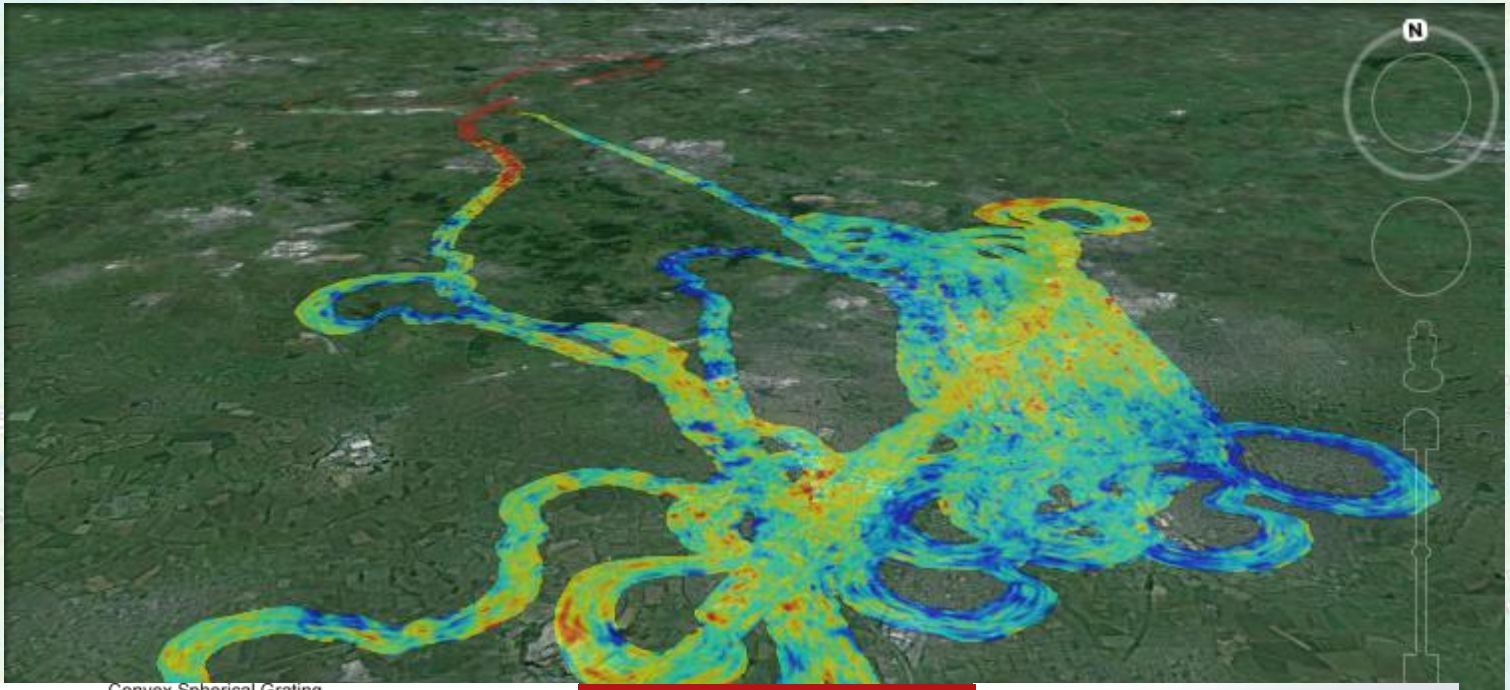
2 Upstream projects

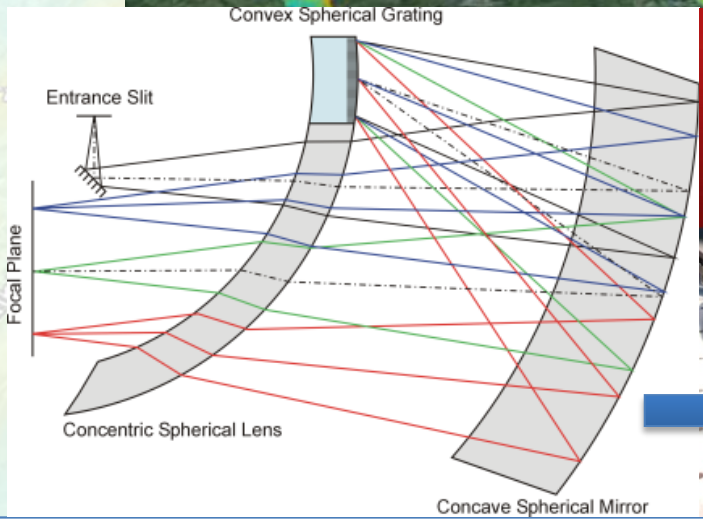
- CompAQS – The Compact Air Quality Spectrometer
  - Innovative, but strong foundations in traditional disciplines.
  - TRL raising of key components
- HAPI – The High-resolution Anthropogenic Pollution Imager
  - Potentially disruptive innovation, but yet to be fully proven.
  - From concept to airborne demonstrator

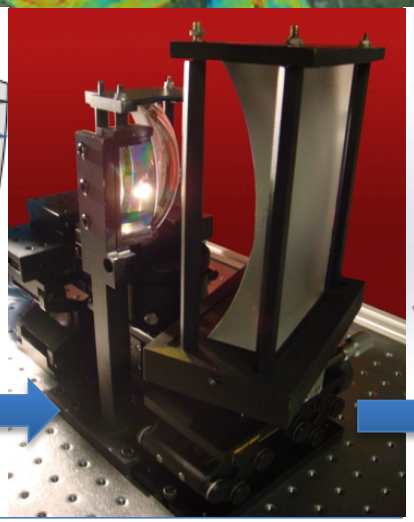
2 Downstream projects

- uTRAQ – ESA IAP, Traffic and Air Quality
- The Hot Spot Mapper - SSGP

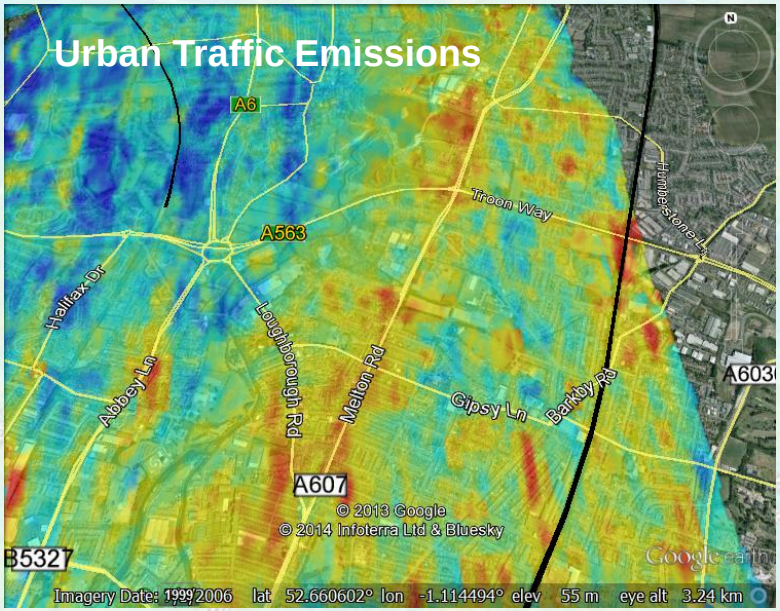
CompAQS: Breadboard and field demonstrator

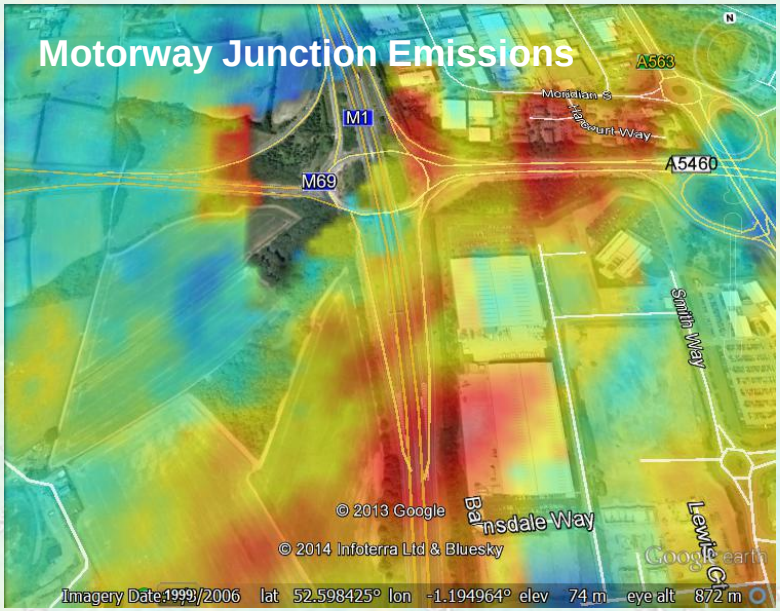


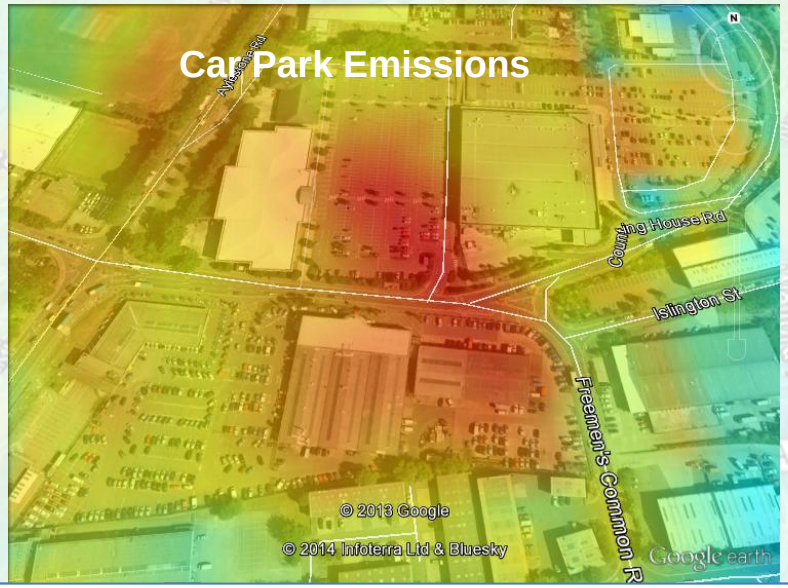


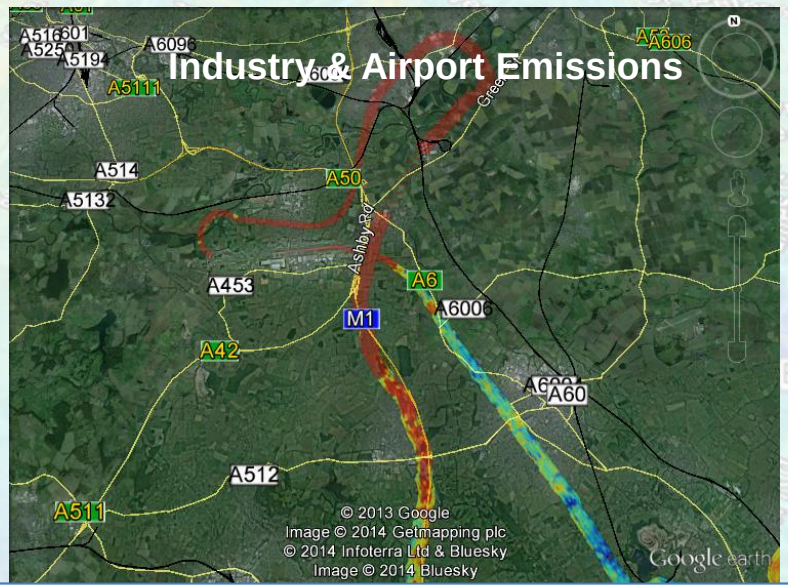


What features can we see?









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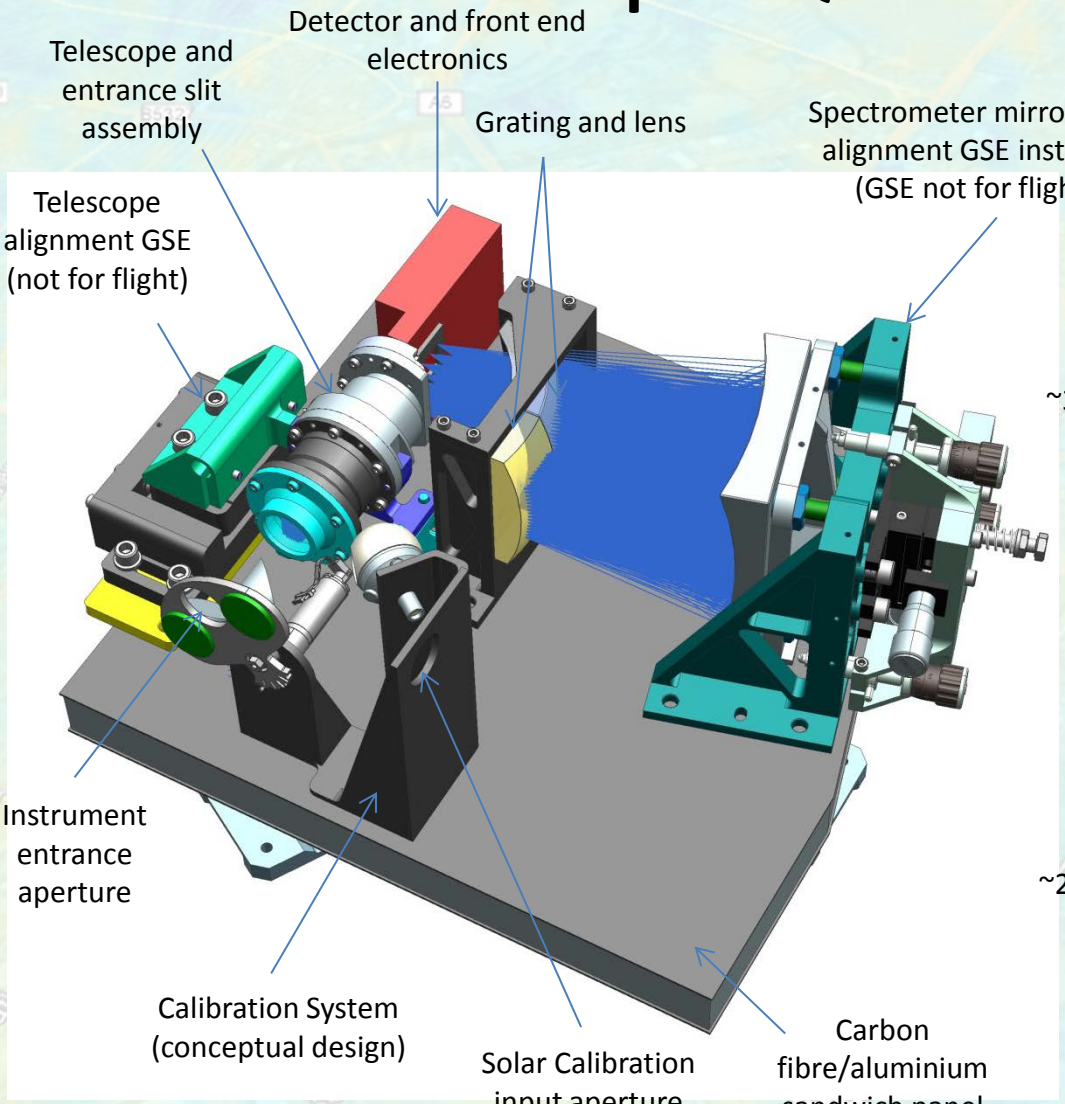
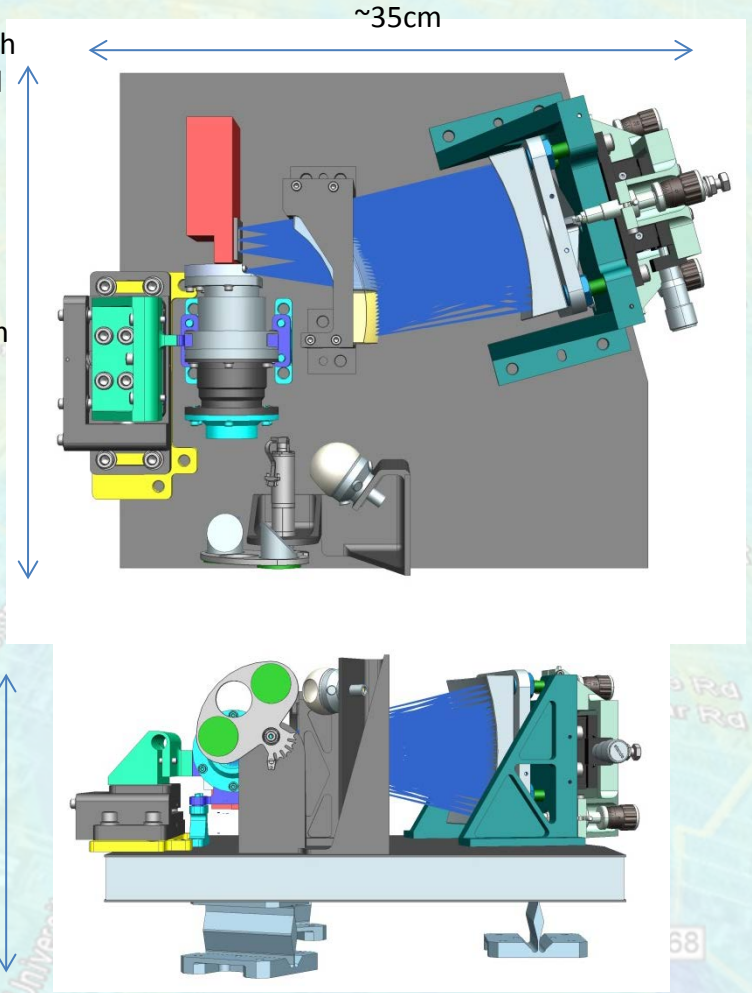
CompAQS: TRL raising



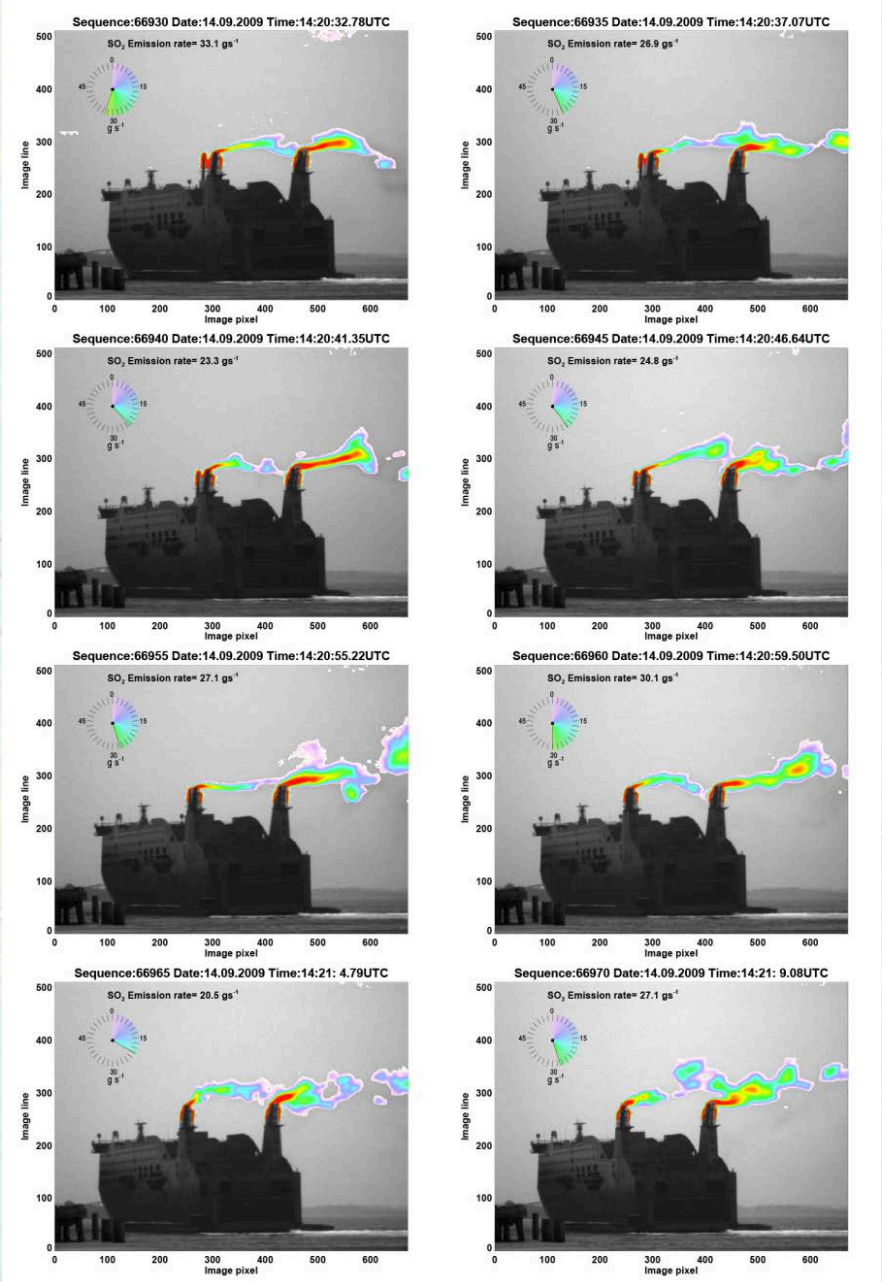
CompAQS Main System Components



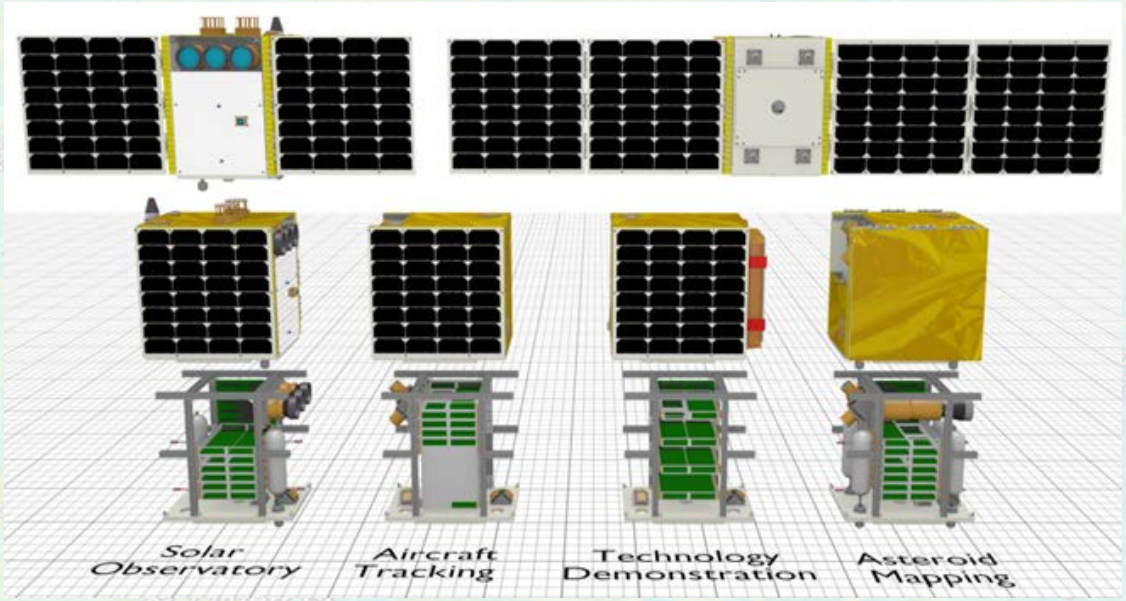
Instrument size
(not including back end electronics module)

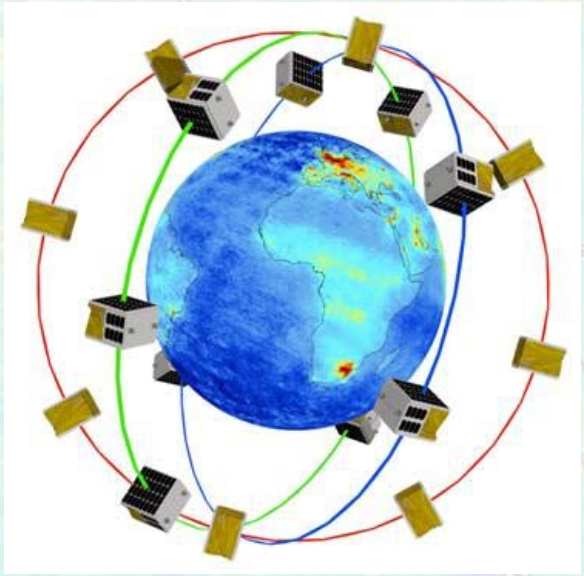
HAPI – The High-resolution Anthropogenic Pollution Imager

- Multispectral gas imaging
- Has been demonstrated for SO_2 and O_3 in the UV.
- Has never been demonstrated for NO_2
- Previous CEOI studies by the University of Leicester have demonstrated capability
- A consortium of Thales Alenia Space UK Ltd, ATC and the University of Leicester recently won an ESA sysnova study with this concept.
- Now a flagship CEOI-ST (NSTP) project.



HAPI on OMNISAT – Agile mapping of NO_2

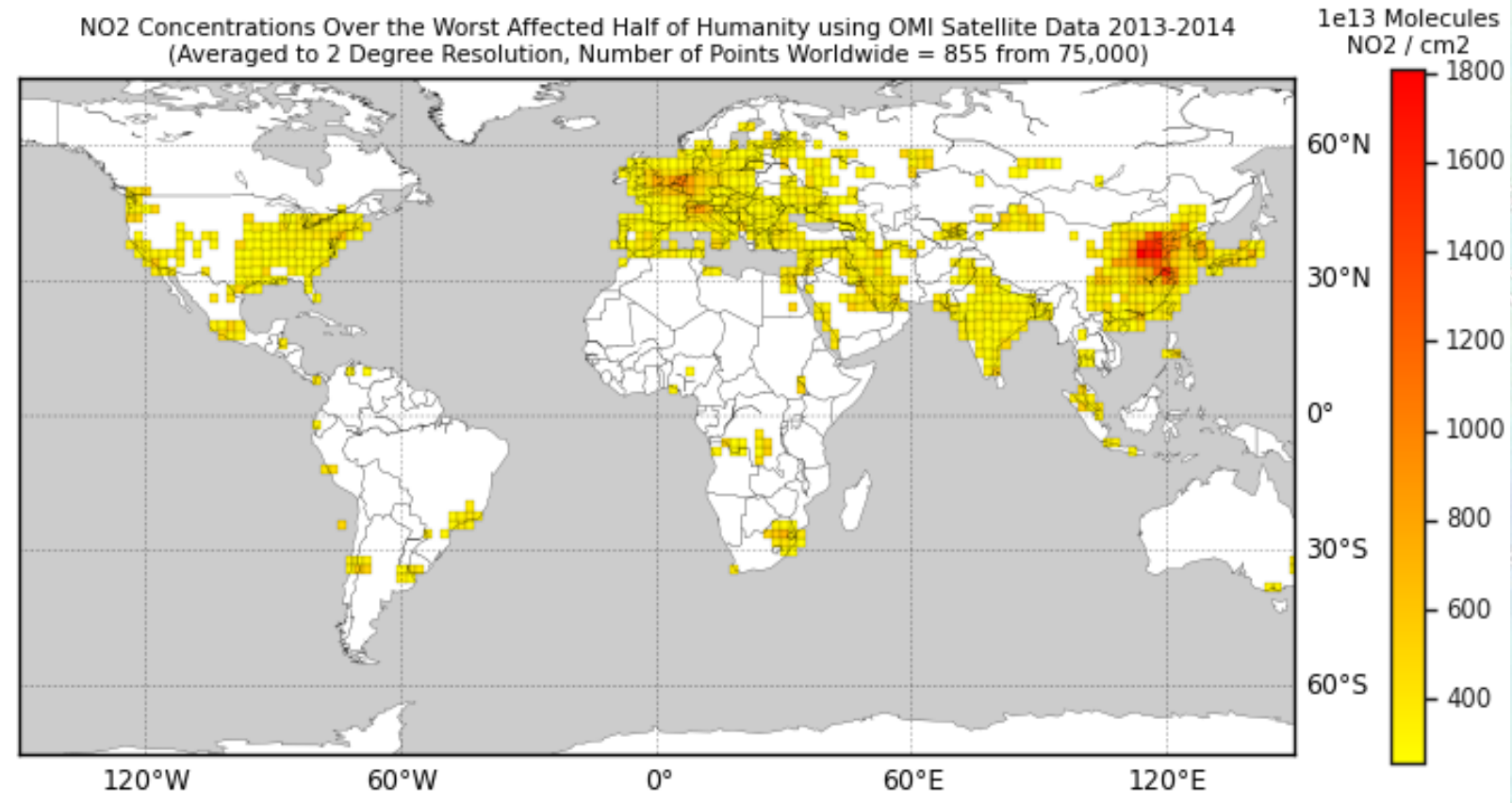


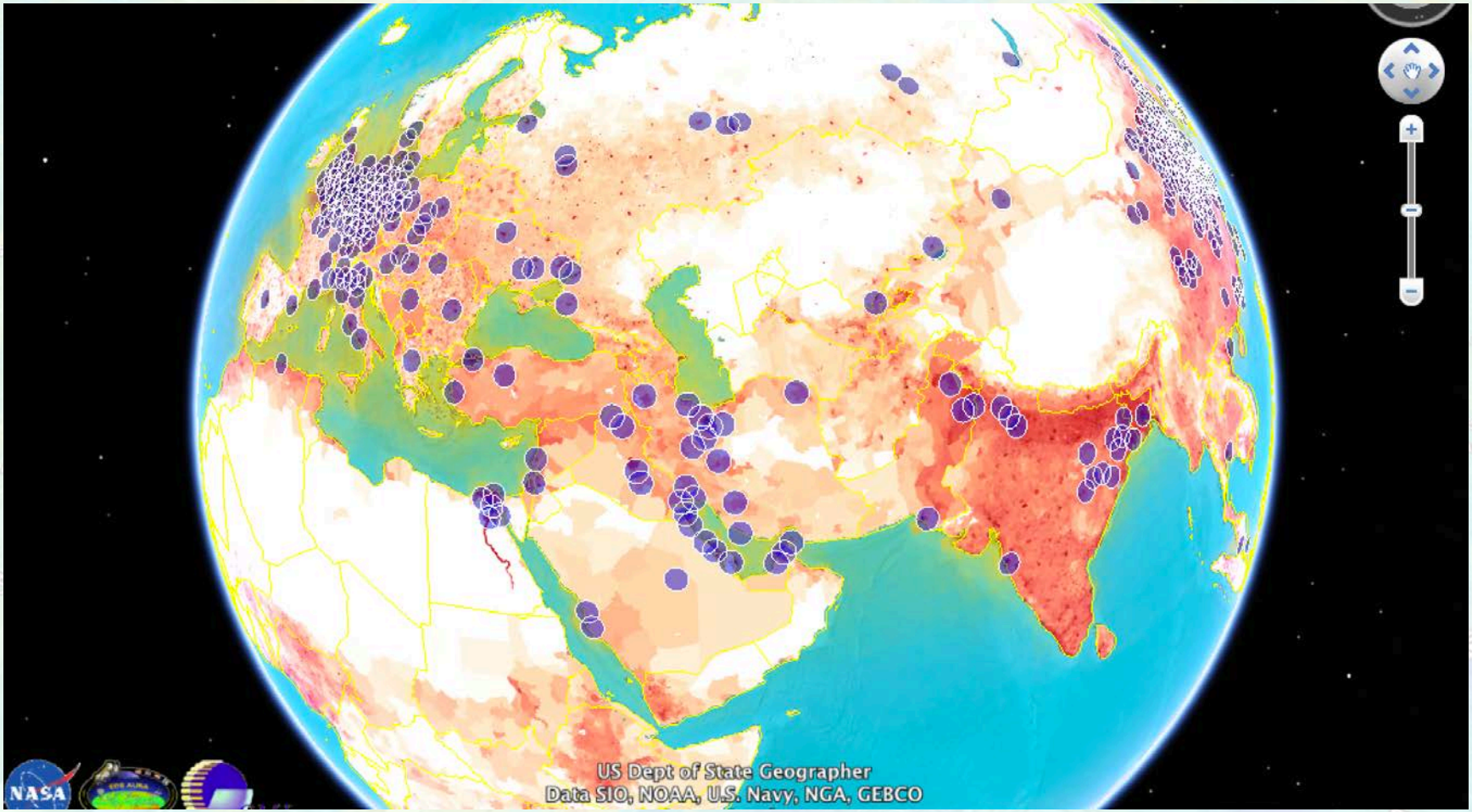


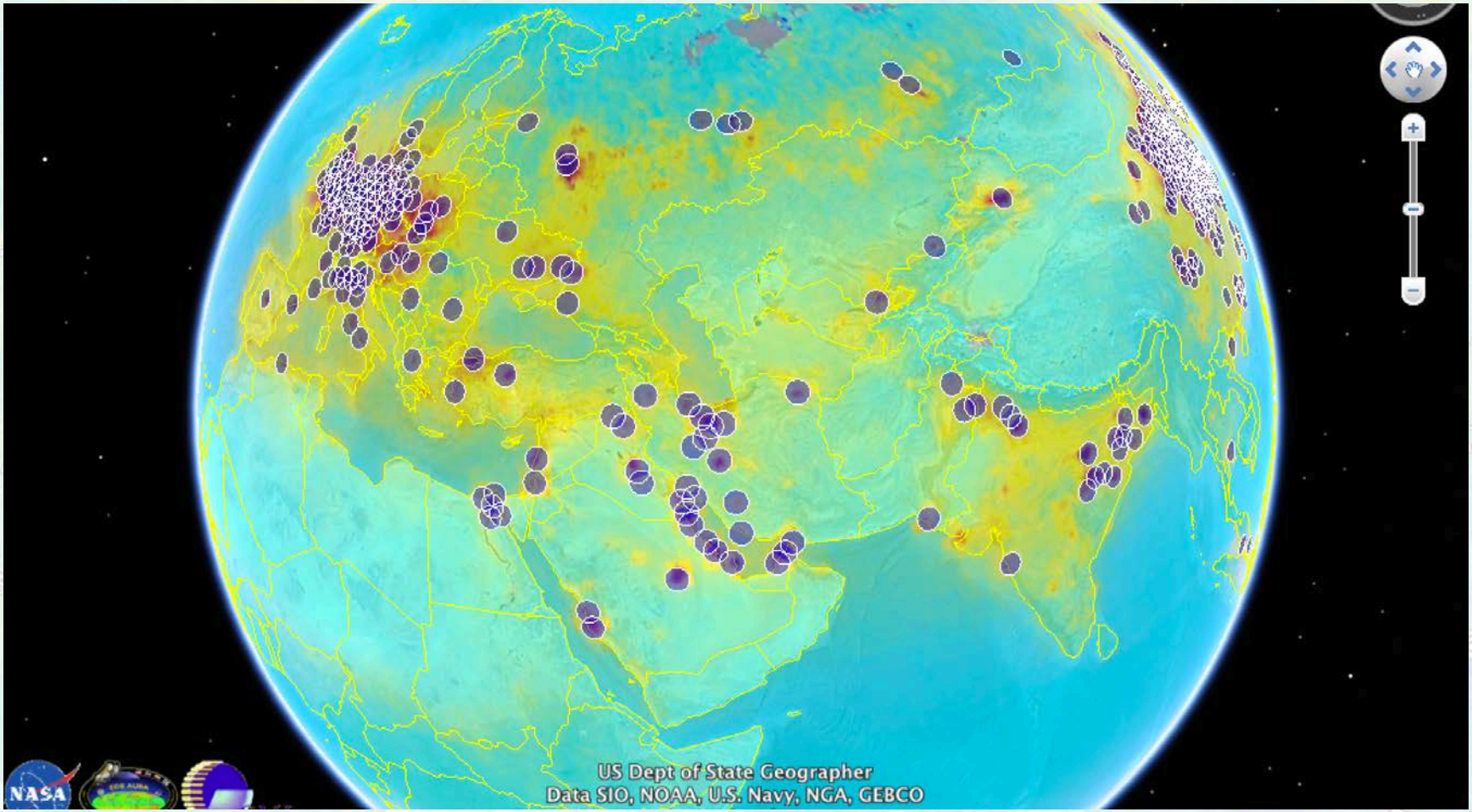
- A constellation of small agile satellites.
- Providing revisit times of approximately 2 hours for most targets
- Providing data latency of less than 2 hours for most targets.
- 600 metre ground-based resolution
- Relatively inexpensive for a global monitoring solution.

Locating NO_2 emission hotspots

- NO_2 concentrations over the most polluted half of humanity
- Approximately 8% of the Earth's total surface




US Dept of State Geographer
Data SIO, NOAA, U.S. Navy, NGA, GEBCO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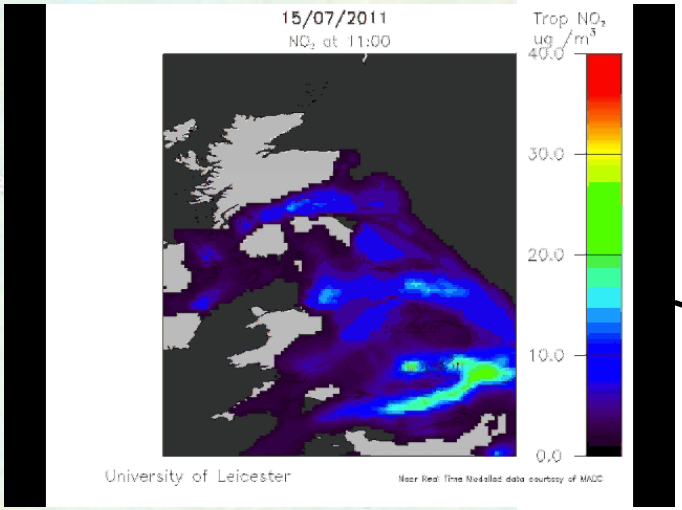
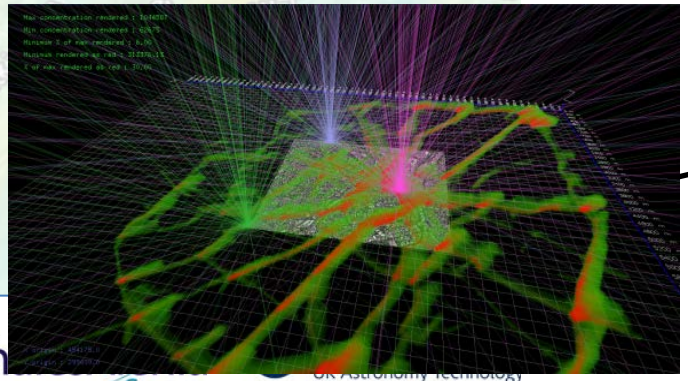
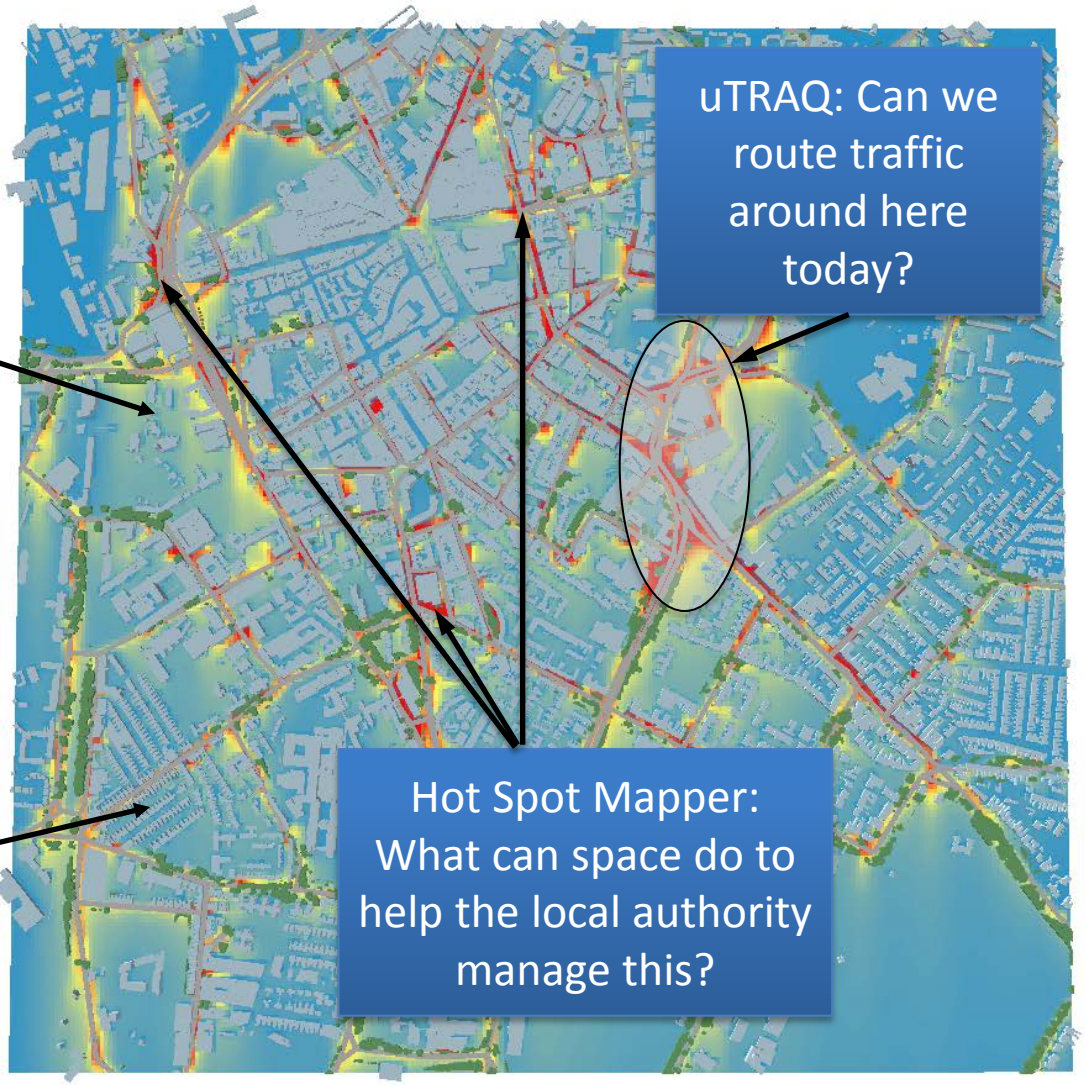
University of Leicester

Earth Observation Data
(Meteorology and Air Quality)



AQ measurement and modelling





Space

Summary

- A strong justification can be made for significant expenditure on climate monitoring from space, particularly in the area of Air Quality.
- We are not yet delivering the spatial resolution required for the majority of applications.
- 2 key air quality missions being developed at the University of Leicester and partner institutions.
    - CompAQS – 1km resolution, innovative spectrometer with traditional methodologies
    - HAPI – 500m resolution, innovative instrument and methodology within an EO small-sat constellation
- Downstream services also being developed in unison, under ESA IAP and SSGP.

Acknowledgements

- University of Leicester: Paul Monks, Mark Sims, Piyal Samara-Ratna, Paul Drumm, Jon Sykes, Gillian Butcher, Sam Grocock, Martin Thompson
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