UNIVERSITY OF LEICESTER

Earth Observation Science

Demonstrating multi-view spectroscopy for greenhouse gas remote sensing using the GHOST airborne spectrometer

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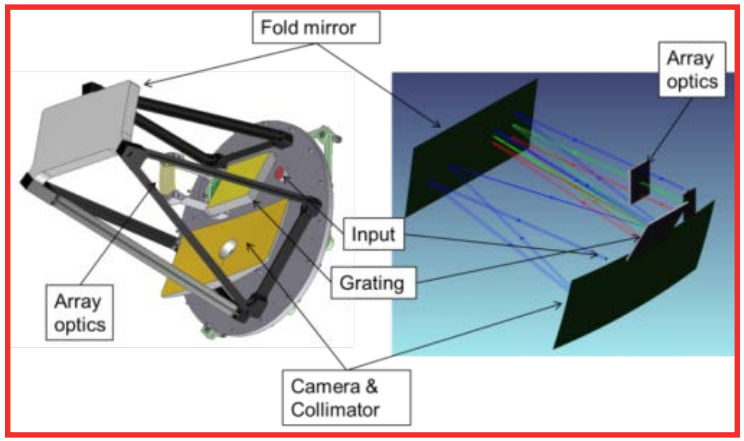
GHOST: GreenHouse gas Observations in the Stratosphere and Troposphere

- Novel UK-developed airborne shortwave infrared grating spectrometer for greenhouse gas remote sensing
- Four SWIR spectral bands observed using a single diffraction grating and detector array with spectral resolution between 0.1 and 0.3 nm (band dependent)
- In addition to GHG bands GHOST measures the 1.27 μm O_2 band to provide information about optical path of observation
- *Validation opportunities with **OCO-2**, **GOSAT** and **Sentinel-5P TROPOMI** – see table – as well as ground-based stations such as TCCON*

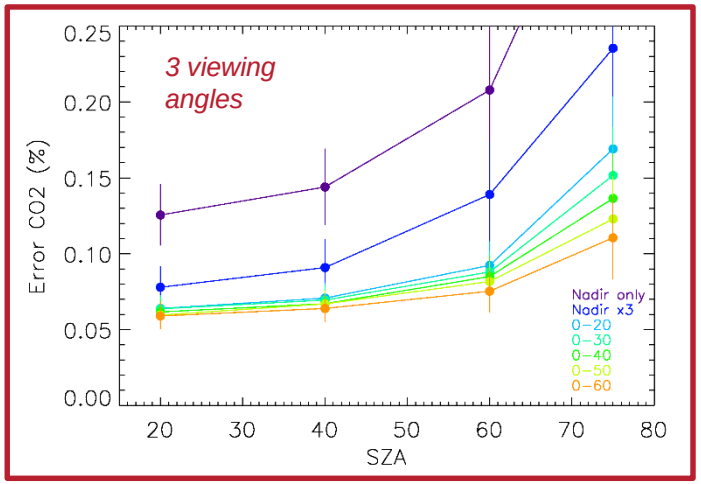


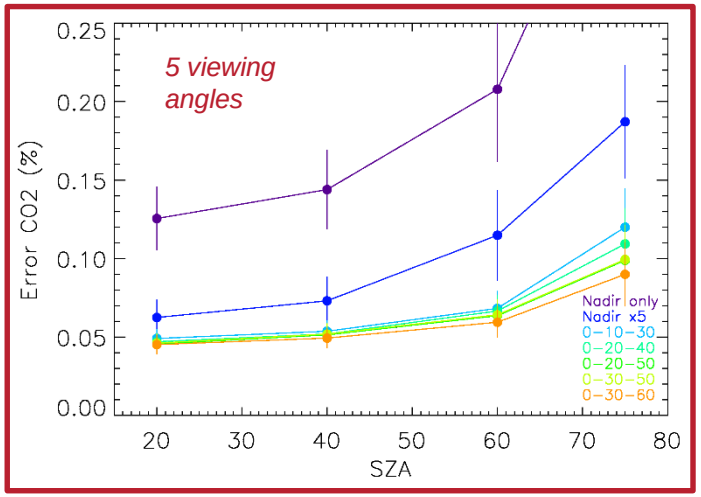
GHOST installed on the Global Hawk

Instrument/channel	Range (nm)	Resolution (nm)	Sampling (nm)	Target species
TROPOMI/SWIR	2305 – 2385	0.25	0.1	CH_4 CO H_2O HDO
OCO-2/WCO2	1590.6 – 1621.8	0.071 – 0.098	0.03	CO_2
OCO-2/SCO2	2043.1 – 2083.4	0.087 – 0.127	0.04	CO_2
GHOST/Band 2A	1594.0 – 1670.1	0.21 – 0.24	0.038	CO_2 CH_4
GHOST/Band 3	1993.4 – 2088.7	0.33 – 0.34	0.048	CO_2
GHOST/Band 4	2269.1 – 2378.1	0.26 – 0.28	0.055	CH_4 CO H_2O HDO

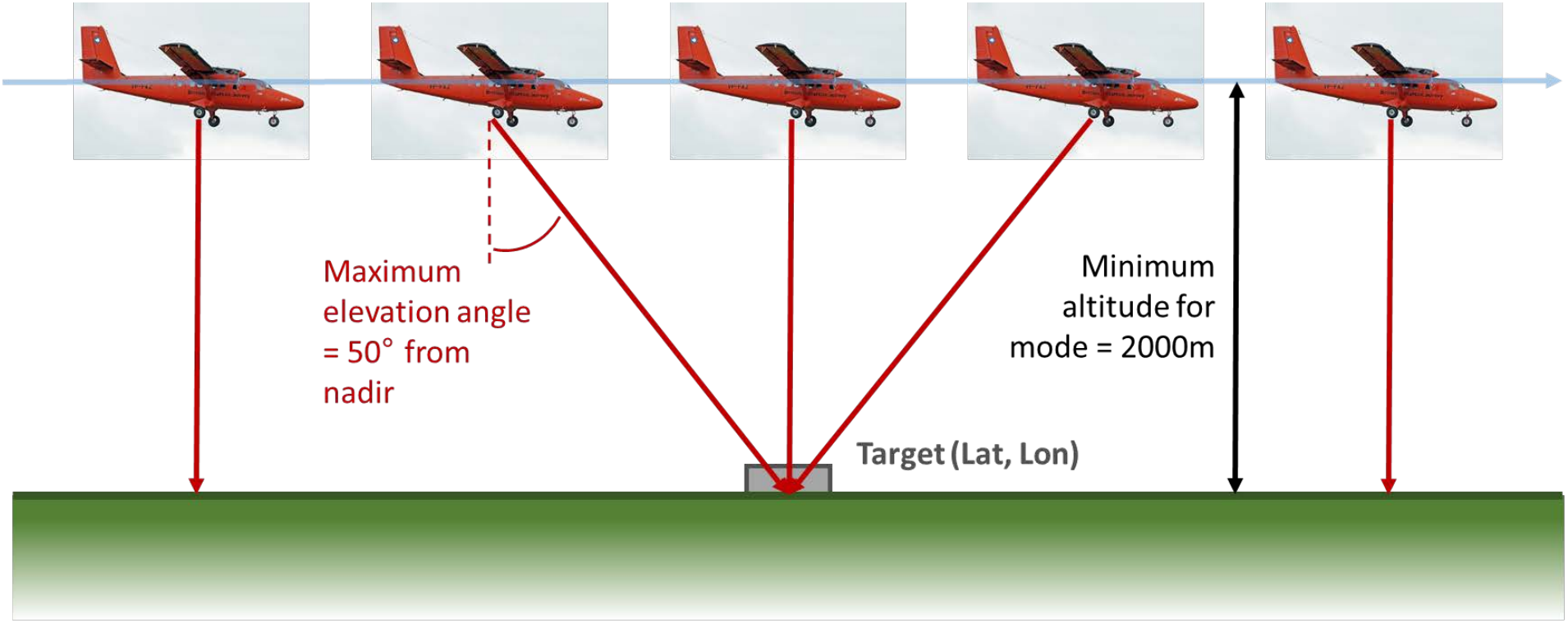
Motivation for multi-view spectroscopy

- Investigated as part of CEOI funded study supporting the Tropical Carbon Mission (a potential ESA Earth Explorer candidate)
- Viewing the same target from multiple angles allows for better characterisation of scattering effects in the atmosphere, e.g. from aerosols and cirrus
  - *Reduced errors in XCO_2 and XCH_4 retrievals*
  - *Improved quantification of emission sources*



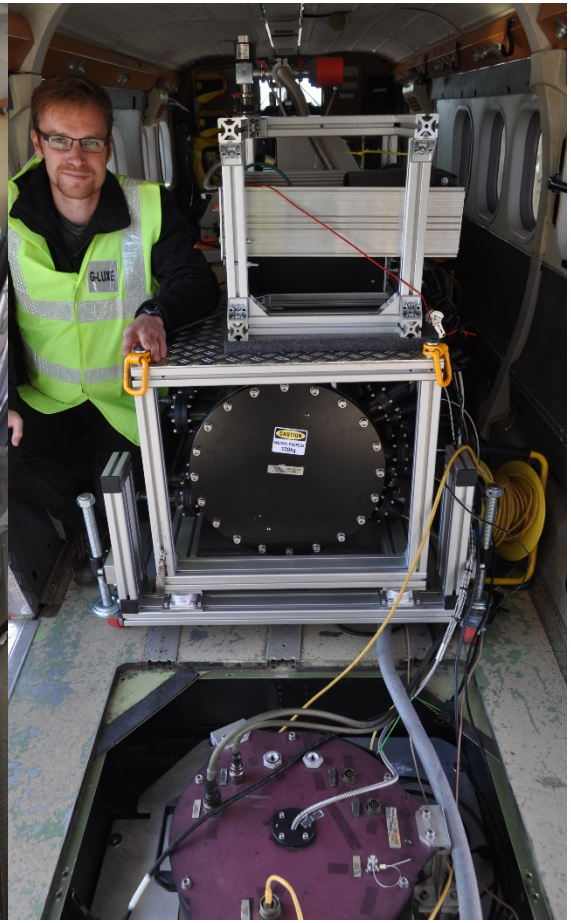


New target tracking mode to demonstrate multi-view observations



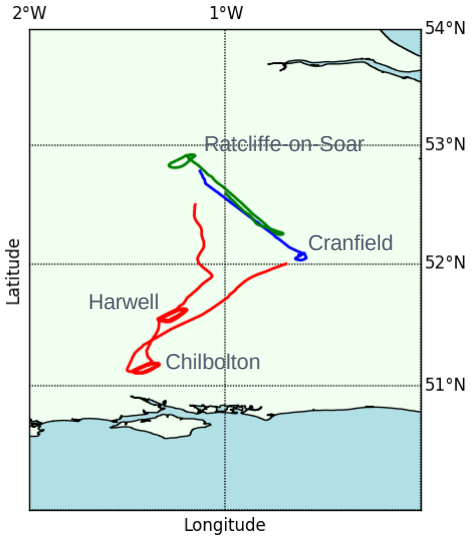
- When target co-ordinates are within the gimbal viewing geometry, gimbal continuously tracks the target
- Otherwise, gimbal reverts to nadir pointing

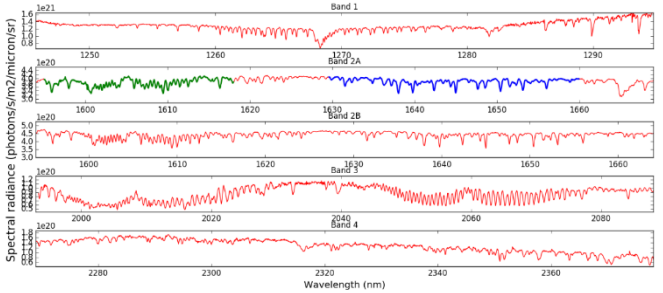
Installation of GHOST on the British Antarctic Survey Twin Otter

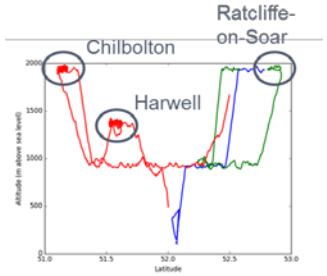


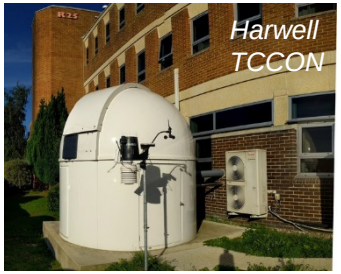
Twin Otter flights on 21st and 22nd June 2018

- June 21st:
  - Successfully surveyed over Chilbolton (around 1330 BST) and Harwell (around 1300 BST)
  - Ground observations (TCCON at Harwell, ceilometers and other instruments at Chilbolton) successful

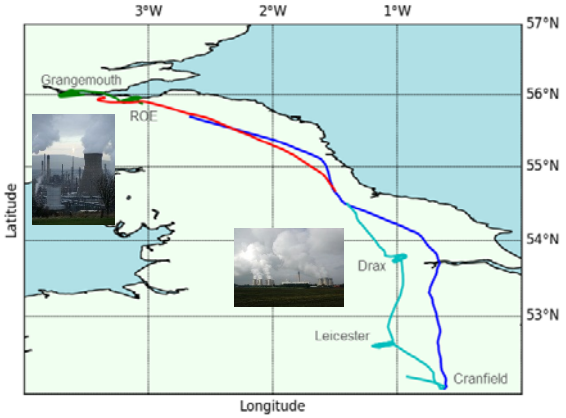


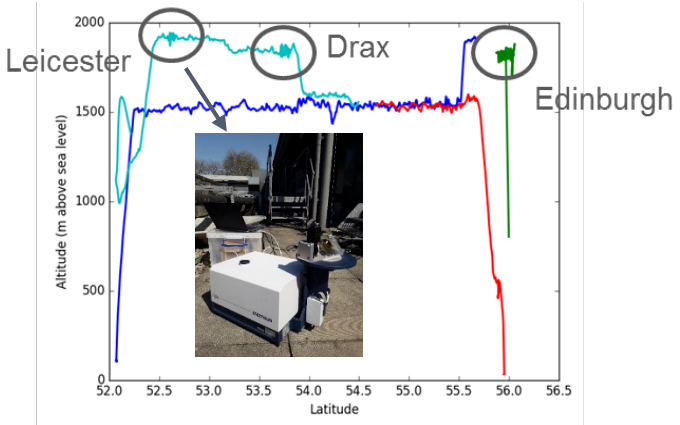






- June 22nd:
  - Successfully surveyed over Edinburgh (Royal Observatory and Grangemouth), Drax power station, and Leicester
  - Observations also taken during transits: north-south transects from 52N to 56N (nadir sounding)
  - Ground observations (laser heterodyne radiometers at Royal Observatory, EM27/SUN at Leicester) successful





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Summary

- GHOST instrument upgrade and re-calibration
  - New depolariser
  - Target tracking mode for multi-angle observations
- Installation on British Antarctic Survey Twin Otter
- Two successful science flights in June 2018
  - Surveyed over both ground instrumentation and significant emission sources
- Data processing and analysis ongoing

… see me at the poster session (tonight from 1700 to 1900 in the Great Hall) for more details!