Testing an automated enclosure system for a ground-based greenhouse gas remote sensing spectrometer

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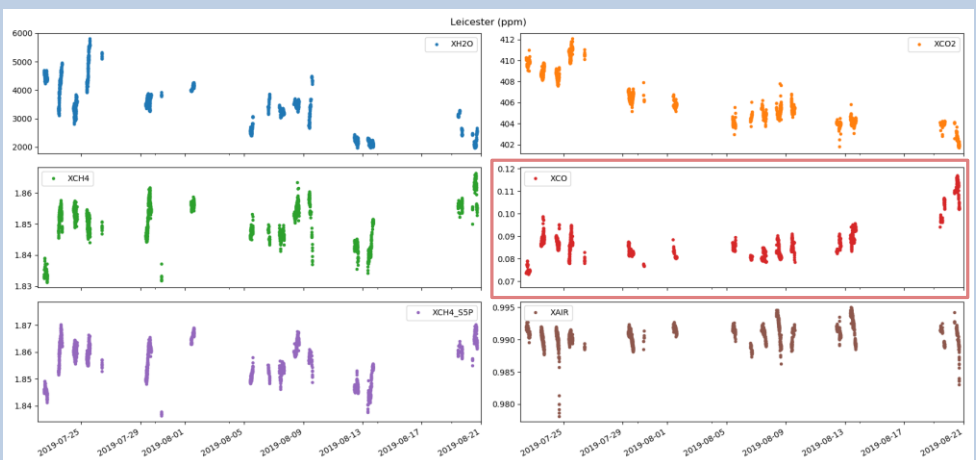
- *Bruker **EM27/SUN** Fourier transform spectrometer designed to observe **total atmospheric column concentrations** of the greenhouse gases (GHGs) carbon dioxide and methane, along with other gases including water vapour and carbon monoxide*
- *High resolution (0.5 cm^{-1}) near- to shortwave infrared spectra using the sun as the light source*
- *Provide **frequent observations** over a location of interest, **complementary to satellite observations** (e.g. TROPOMI, OCO-2/3, GOSAT(-2), TANSAT)*
- ***Portability:** EM27/SUNs can be used to **fill gaps in ground-based validation networks** in regions where the infrastructure isn't in place to support a more permanent deployment (Frey et al 2019) – **forthcoming deployment in Jinja, Uganda funded by NERC Global Methane project (MOYA)***
- *Also suitable for **short term campaigns**, where a network of EM27/SUNs are set up to quantify the emissions from an extended GHG source such as a city (Hase et al 2015, Chen et al 2016) – **NERC DARE-UK project plans to set up multiple EM27/SUNs around London***

EM27/SUN instrument and automated enclosure

- Fourier Transform spectrometer with 0.5 cm^{-1} resolution: standard operation takes average of 10 interferograms → 55 seconds per observation
- 5000 to 14500 cm-1 (0.69 to 2.0 µm): InGaAs detector
- 4000 to 5500 cm-1 (1.8 to 2.5 µm): for CO and CH_4, extended range InGaAs detector with Ge filter – **overlap with Sentinel 5P TROPOMI SWIR**
- Automatic solar tracker uses camera-based feedback system
- **Part of COCCON network** of over 30 EM27/SUNs operated worldwide and calibrated against Karlsruhe TCCON (Frey et al 2019)
- **Automated enclosure (Heinle and Chen 2018) developed by TU Munich** enables **continuous remote operation** and provides **environmental protection and stability**

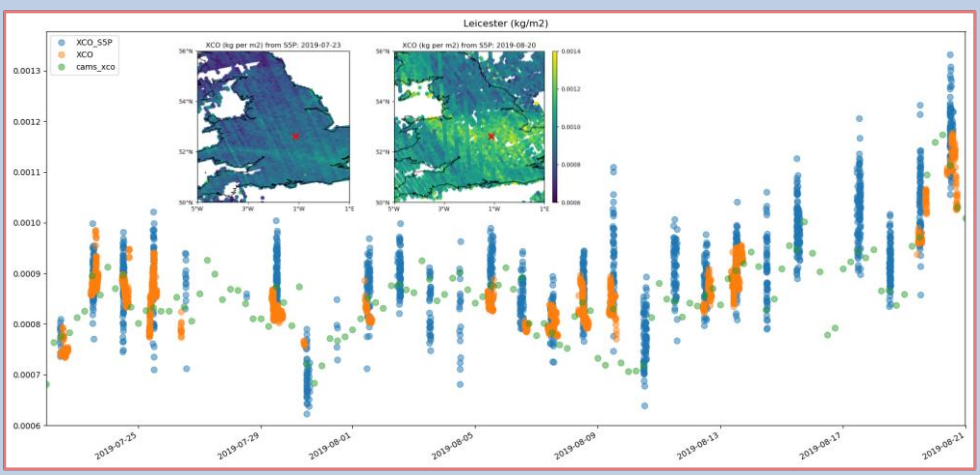
Testing in Leicester

- July 22nd to August 21st 2019
- 1959 measurements lead to successful total column retrievals (PROFFAST software)
- Spectral windows used:
  - H_2O: 1.182 – 1.197 µm
  - O_2 (X_{AIR}): 1.299 – 1.288 µm
  - CO_2: 1.565 – 1.620 µm
  - CH_4: 1.627 – 1.696 µm
  - CO/CH_4 (S5P): 2.316 – 2.376 µm
- **X_{AIR} is ratio of retrieved vs. measured surface pressure**, used as performance check



Preliminary results: CO

- Leicester EM27/SUN time series alongside Sentinel 5P TROPOMI and CAMS near-real-time data
- Good coverage provided by Sentinel 5P CO product (Landgraf et al 2016, s5phub.copernicus.eu)
- CAMS near-real-time data from apps.ecmwf.int/datasets
- Data from lat range [52.2, 53.0]; lon range [-1.4, -0.6]



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