First data from GEMINI-UK: the UK national network of ground-based greenhouse gas observing spectrometers

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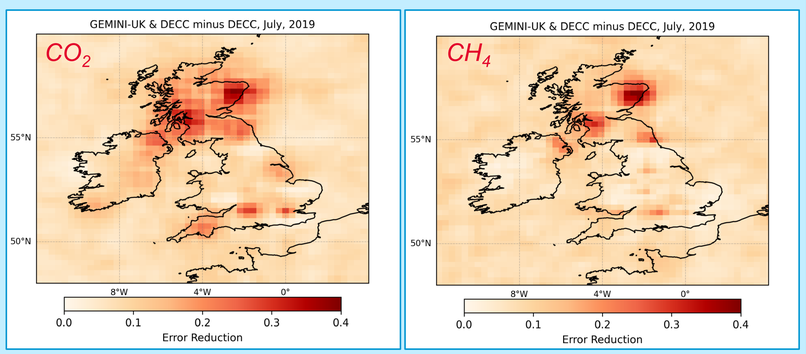
Ground-based greenhouse gas remote sensing observations in the UK

- **GEMINI-UK:** Greenhouse gas Emissions Monitoring network to Inform Net-zero Initiatives for the UK – *ten EM27/SUNs located around the UK* to help improve national and regional estimates of GHG emissions
- **TCCON Harwell:** operated by RAL Space, officially part of TCCON global GHG monitoring network since 2022
- **GEMINI+Edinburgh:** observational framework to determine long-term trends in GHG emissions from the city of Edinburgh, *including six EM27/SUNs – see poster by Will Morrison (X5.44)*

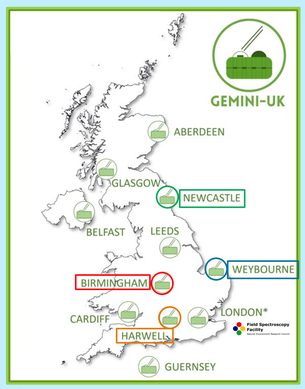
GEMINI-UK network design and anticipated impact on emissions estimates

- Combine emissions and atmospheric transport models, along with the EM27/SUN vertical sensitivity, to *estimate likely 'footprints' for candidate sites* – ensure that the ten sites are chosen to maximize sensitivity to UK GHG emissions, and are complementary to existing in-situ measurements – *see Kurganskiy et al (2025)[1]*
- Figures shows estimated *a posteriori* error reduction of *a priori* CO_2 and CH_4 flux uncertainties as a result of *simulated EM27/SUN observations*, relative to information already provided by existing tall tower in-situ network
- Greatest impact expected in summer months (more observations) and in parts of the UK where we have less in-situ data



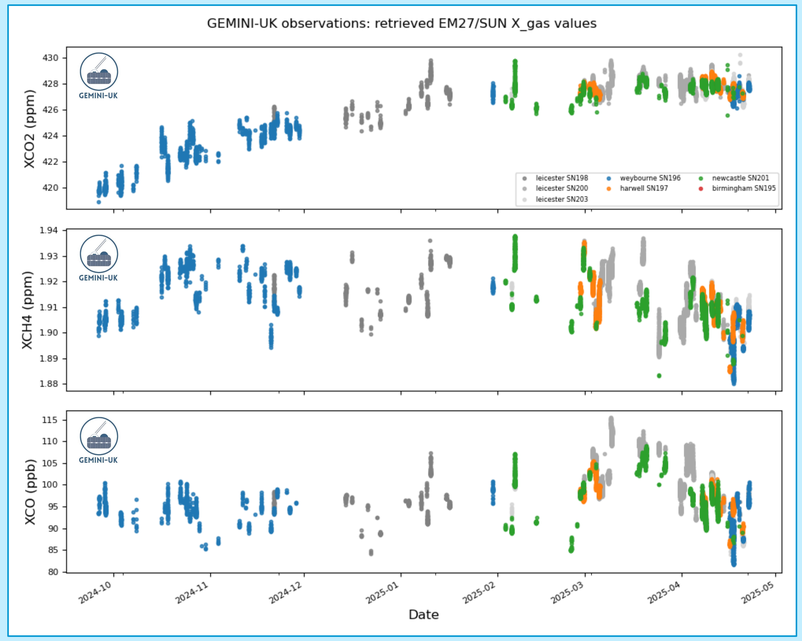
GEMINI-UK network status

- Funding from NERC through the NPL-lead *GEMMA* (Greenhouse gas Emissions Measurement Modelling Advancement) programme for *ten EM27/SUNs and weatherproof enclosures*
- One site *co-located with the Harwell TCCON site* for traceability to WMO approved scale – provide data for intercomparison of *TCCON* and *EM27/SUN* results and processing chains
- Two additional sites in London operated by the NERC Field Spectroscopy Facility (*fsf.nerc.ac.uk*) will contribute data
- Data processing using PROFFAST algorithm developed at KIT through the ESA COCCON project, with PROFFASTpylot Python wrapper – *see Feld et al (2024)[2]*
- Purpose-built weatherproof enclosures allow long term, continuous, remote observations – using Pyra automation software developed at TU Munich, *see Aigner et al (2023)[3]*



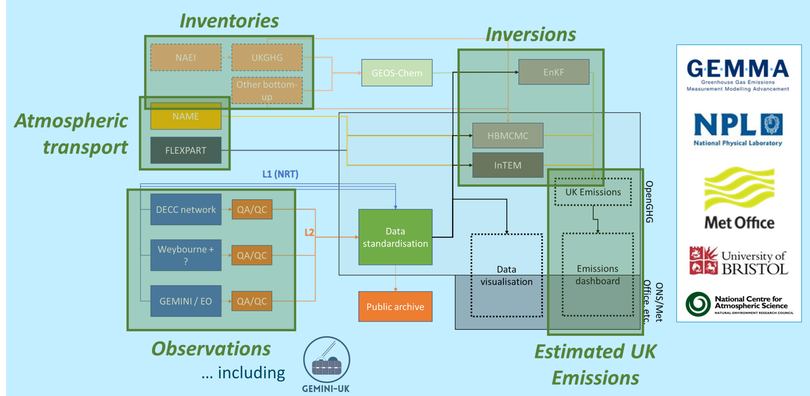
GEMINI-UK data so far

- Combined column concentration data from established sites (colours) and pre-deployment testing in Leicester (greyscale)



The GEMMA programme

NERC Programme led by NPL: inversions using new and existing observations, atmospheric transport models and inventories to produce UK GHG emissions estimates on a regular basis



1. Kurganskiy, A et al: The Greenhouse gas Emission Monitoring network to Inform Net-zero Initiatives UK (GEMINI-UK): network design, theoretical performance, and initial data, EGUsphere [preprint], https://doi.org/10.5194/egusphere-2025-94, 2025.
2. Feld et al., (2024). PROFFASTpylot: Running PROFFAST with Python. Journal of Open Source Software, 9(96), 6481, https://doi.org/10.21105/joss.06481
3. Aigner et al., (2023). Pyra: Automated EM27/SUN Greenhouse Gas Measurement Software. Journal of Open Source Software, 8(84), 5131, https://doi.org/10.21105/joss.05131