

First validation of high-resolution satellite-derived methane emissions from an active gas leak in the UK

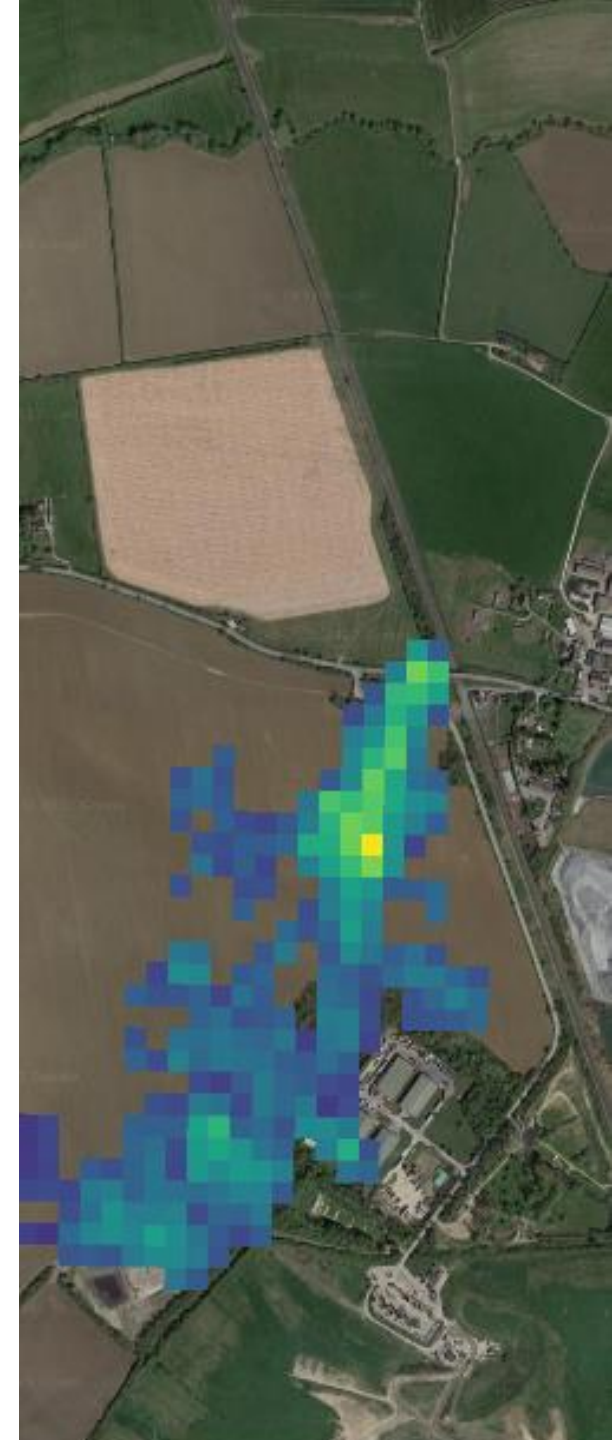
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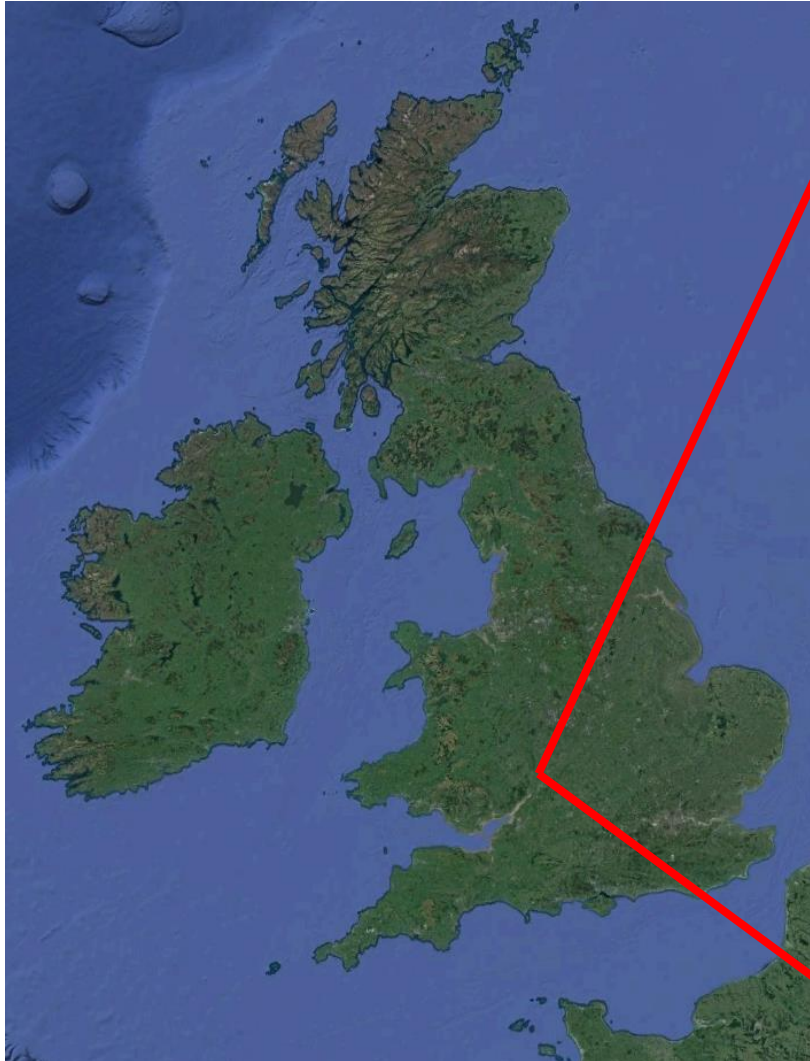
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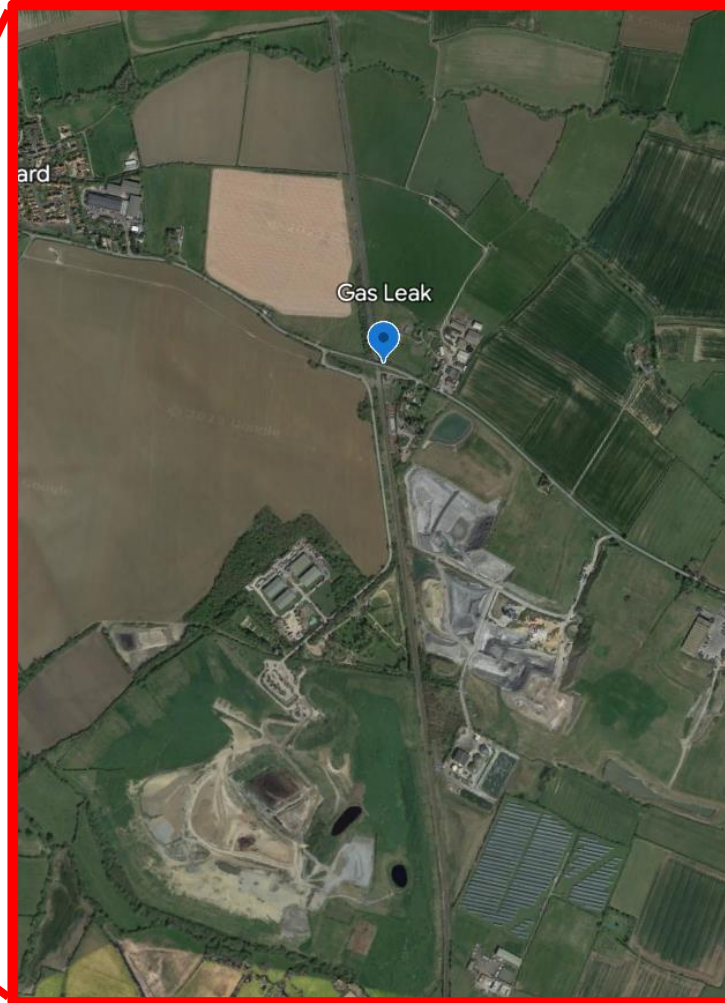
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5. School of Chemistry, University of Bristol, Bristol, UK
6. UK National Atmospheric Emissions Inventory, Ricardo Energy & Environment, Harwell, Oxon, UK
7. National Centre for Earth Observation, University of Leeds, Leeds, UK



Gas Leak Location – Bishops Cleeve, Cheltenham



Google Earth Image Landsat/Copernicus



Google Earth Image

- Leak was detected by GHGSat on 27th March 2023
- Leak is from a gas distribution pipe
- 5km north of Cheltenham
- Surrounded by agricultural land
- One farm ~70m to the east
- Two waste management sites <0.5km to south
- One road to south of location within 30m of leak

Natural Gas & UK Emission Inventories

- Natural gas is mostly composed of CH₄
- Fugitive emissions from oil and gas transportation in UK in 2020 were estimated to be 187 kilotonnes of CH₄
- Annual estimates of fugitive emissions of natural gas are provided by gas distribution network (GDN) operators and used in the National Atmospheric Emissions Inventory (NAEI)

Observations



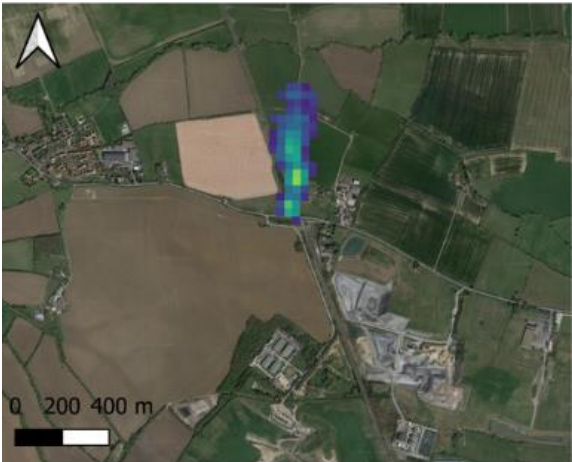
- Constellation of ~10 SmallSats
- Spatial resolution of 25m
- 12km x 12km field of view
- Capability of 1-2 day revisit time
- Detection limit 100 kg h⁻¹
- 6 observations were taken between March and June 2023
- Flux estimated using a mass enhancement method

Mobile Survey by Royal Holloway, University of London

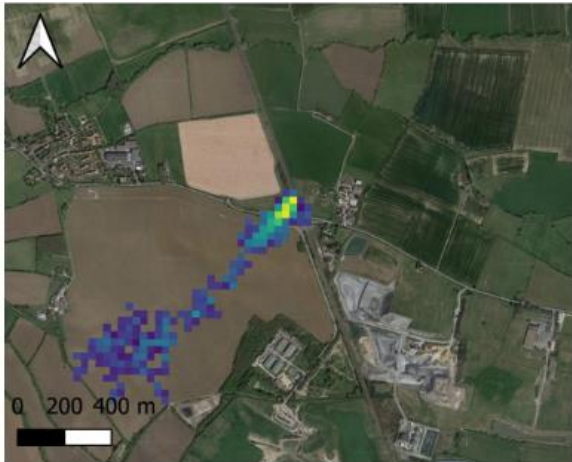
- Suite of cavity enhanced laser absorption spectrometers
- Measured CH₄, CO₂, C₂H₆ and CH₄ isotopes
- Car was driven on nearest road
- Mobile surveys were carried out on 26th May, 12th June and 22nd June 2023
- Flux estimated using Gaussian plume model

GHGSat Retrievals

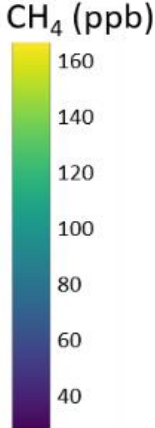
27/03/2023



20/04/2023



20/05/2023



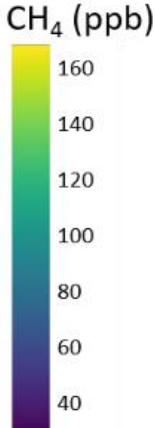
22/05/2023



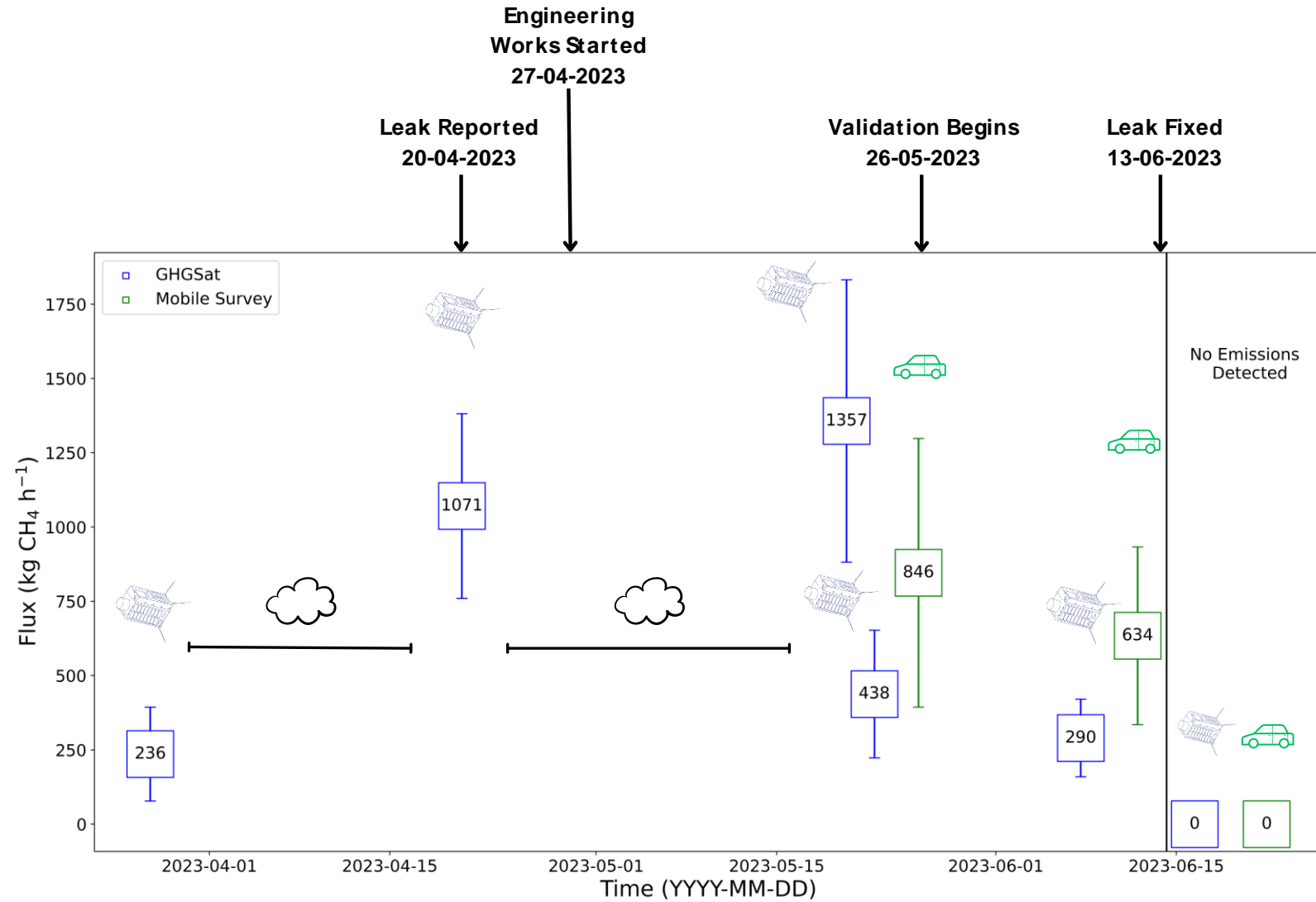
07/06/2023



16/06/2023



Timeline of Events



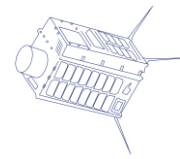
Site Images



Google Earth Image Airbus 2023

Numerical Atmospheric-dispersion Modelling Environment (NAME)

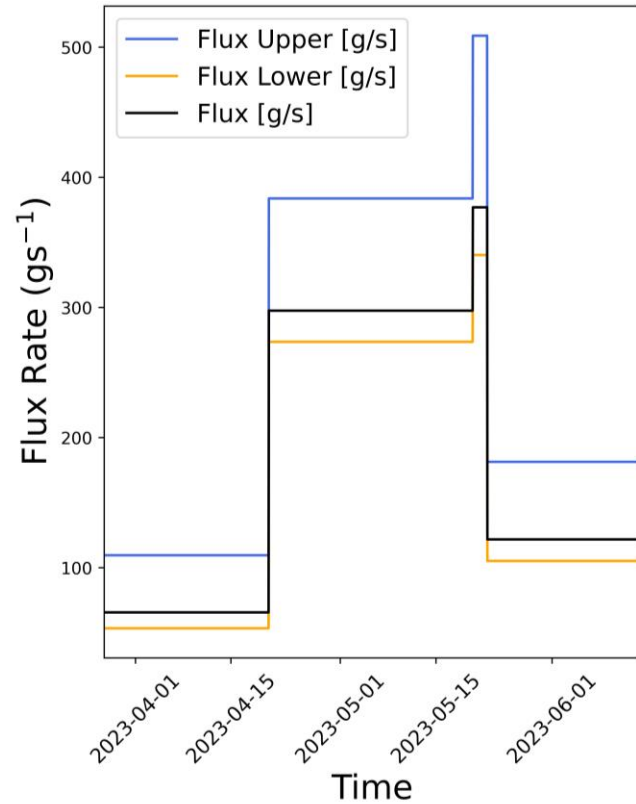
- Lagrangian dispersion model driven by Met Office's NWP meteorology UKV at 1.5km x 1.5km horizontal resolution
- Simulated the gas leak for 3 hours at 10m and 25m to estimate the flux in NAME



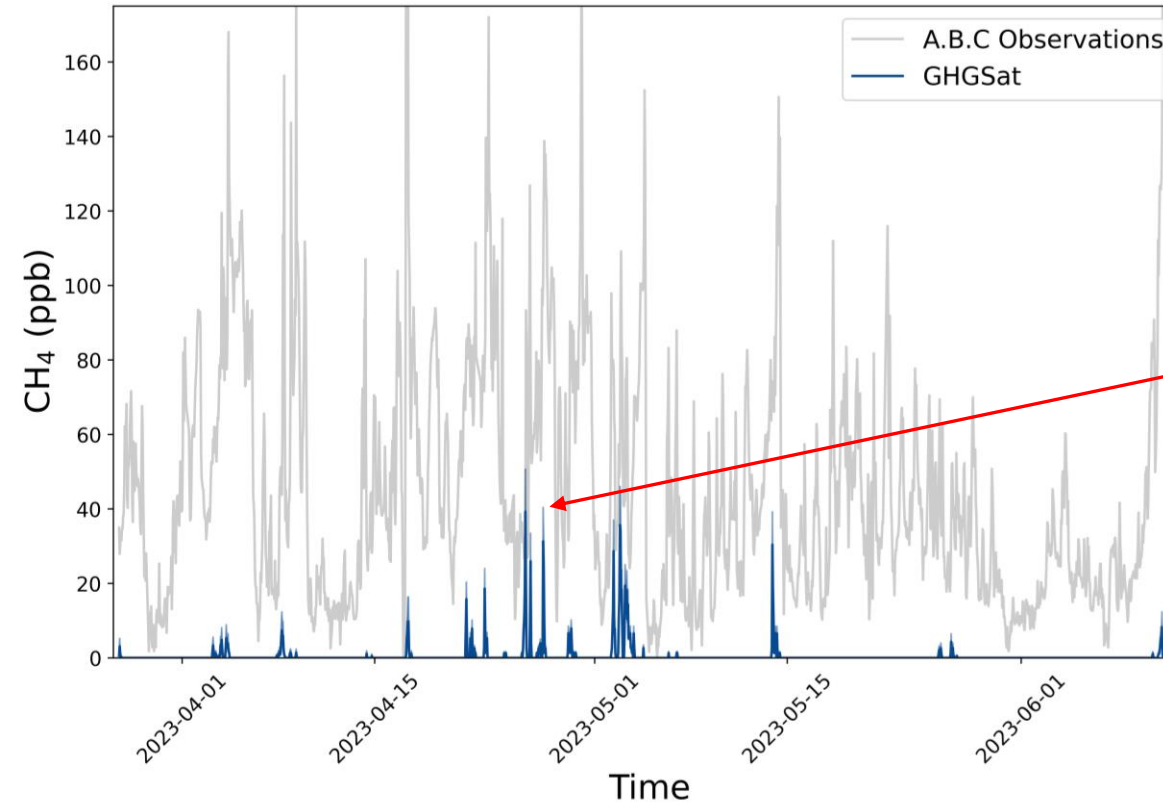
Date	Mobile Survey Flux (kg h ⁻¹)	NAME Derived Flux from MS Concentrations (kg h ⁻¹)	GHGSat Flux (kg h ⁻¹)	NAME Derived Flux from GHGSat Concentrations (kg h ⁻¹)
27/03/2023	-	-	236 ± 157	181 [133, 322]
20/04/2023	-	-	1071 ± 310	745 [539, 1376]
20/05/2023	-	-	1375 ± 481	1243 [931, 2322]
22/05/2023	-	-	438 ± 215	384 [173, 292]
26/05/2023	846 ± 453	406 [366, 680]	-	-
07/06/2023	-	-	290 ± 131	204 [77, 244]
12/06/2023	634 ± 299	512 [498, 681]	-	-

Contribution at Ridge Hill Tall Tower

Model Flux Variation in Time



Ridge Hill

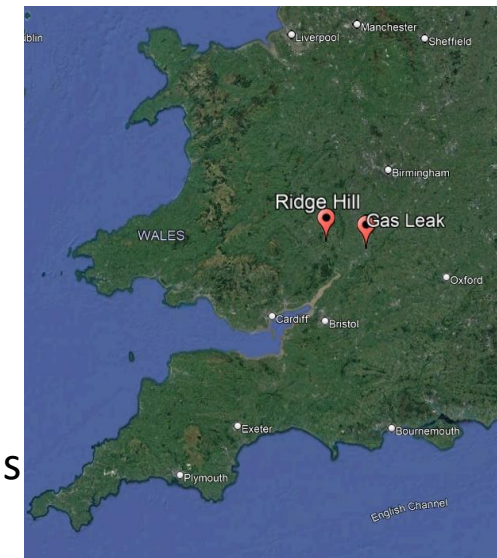


A.B.C: Above-Background Concentrations

Pollution Event on 25/04/2023

- Simulated NAME for 3 months at 2.5km horizontal resolution
- Flux held constant until next observation
- Time series output at Ridge Hill, compare with above-background observations
- Defined pollution events as $>2\sigma$ above-background and $> 90\%$ of above-background concentrations
- One pollution event at Ridge Hill over 3 months

Ridge Hill approx. 30km away



Google Earth Image Landsat/Copernicus

Conclusions

- Validated satellite data with mobile survey measurements
- Steps were taken to resolve the leak and this was confirmed by our measurements
- Satellite and mobile survey derived fluxes differ, likely due to:
 - Different flux estimation methods (wind speed estimates)
 - Work being done on the pipe during measurements
- Modelling shows that the tall tower site cannot be used to estimate the flux of the leak using inverse modelling techniques
- Incident specific emission estimates are not provided for the NAEI
- Demonstrates need for multi-scale observations to detect fugitive emissions
- The gas leaked over 11 week-period was equivalent to the annual electricity consumption of more than 7,500 average homes (EPA calculator).

With thanks to



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Major UK greenhouse gas leak spotted from space

The detection of methane by satellite raises hopes future leaks can be stopped more quickly.

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The actor says his letter of support for rape convict Danny Masterson was an "error in judgement".

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His situation is seen in small shops across the country, says the Federation of Independent Retailers.

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MailOnline Science & Tech

Major UK methane leak is spotted from space: Satellite discovers plumes of the greenhouse gas coming from a pipeline in Cheltenham - with enough released to power 7,500 homes for a year

- Scientists use satellites to detect leaked methane over the UK for the first time
- They blame ageing pipes, not sabotage, thought to be case with Nord Stream

Data for EMISSIONS REDUCTION COP28 UAE DAY 1

200 kg/h

Discovery of a methane pipe leak near Cheltenham, UK with GHGSat satellite data.

5 Methane measurements were taken showing emissions ranging from ~200 – 1,400 kg/hr.

REDUCTION ACTION

The operator was quickly informed and addressed the leak. Following satellite measurements recorded no further emissions.

GHGSAT

Every day, high-resolution satellite data supports mitigation action.

First validation of high-resolution satellite-derived methane emissions from an active gas leak in the UK

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