# More Frequency, More Coverage, More Emissions Monitoring

Doubling our measurement capacity to six satellites in 2022 was transformational in many ways. With increased coverage and more frequent revisits, our proven technology measured more emissions in 2022 than the previous 5 years combined, uncovering opportunities for industrial methane emissions reduction.

We've also perfected our offshore monitoring expertise, measured numerous world-first emission events with high-resolution sensors, partnered with organizations such as IMEO, IEA and S&P Global to open our data insights, and made more data available on SPECTRA, our emission intelligence platform.

This report gives perspective on our 2022 high-resolution satellite data and industry insights.

Total methane emissions detected in 2022

179 MTCO₂e
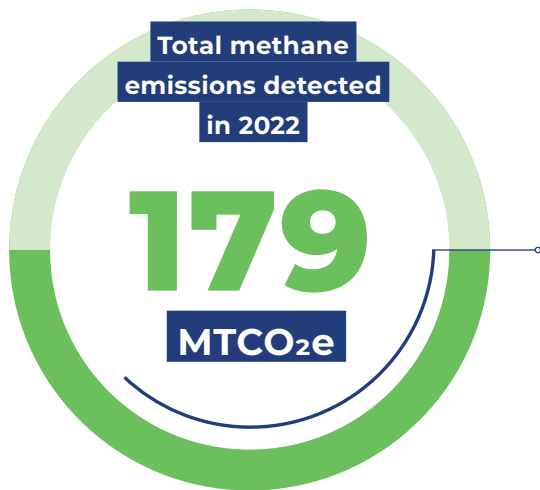
38.6M
Emissions measured equate to 38,654,743 cars driving on the road for a year
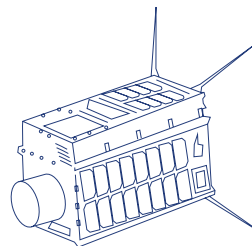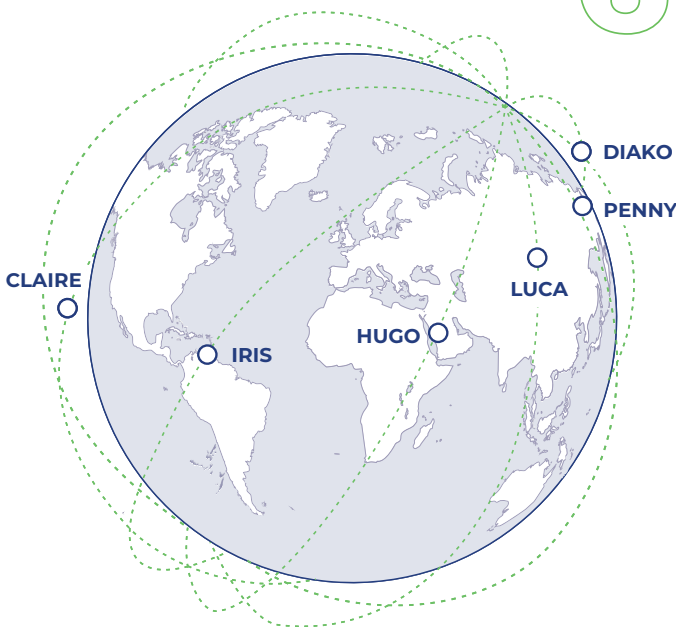
+25%
increase on 2021

2022 **2023**

6+6

In May 2022, our three new satellites GHGSat-C3 "Luca", GHGSat-C4 "Penny" and GHGSat-C5 "Diako" reached orbit and enabled our constellation to target industrial facilities every two to three days anywhere in the world.
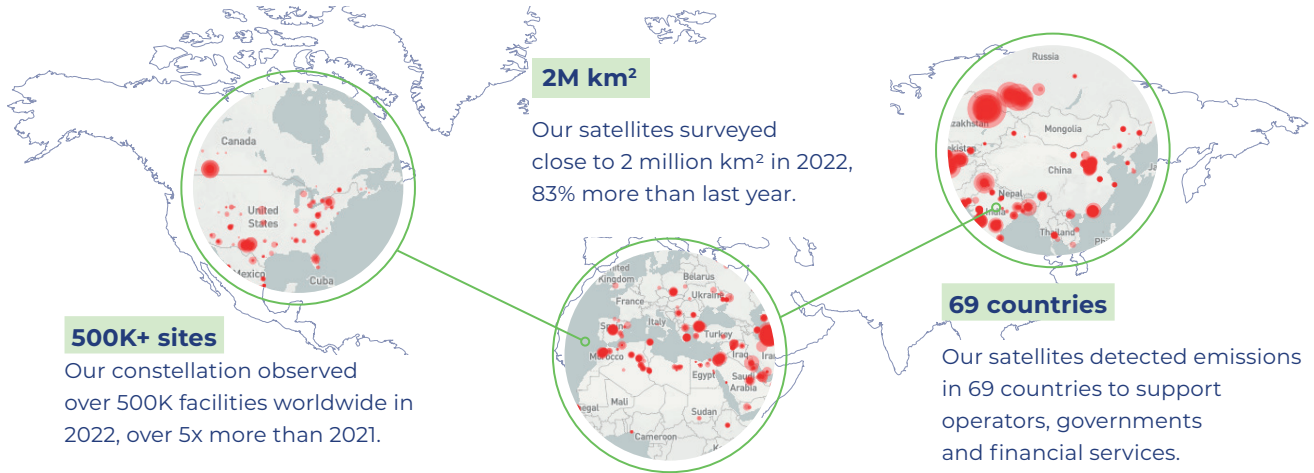
In 2023, we will launch an additional five sensors dedicated to methane and one for CO₂. Demand for accurate emissions data is growing. Frequent, timely and precise data enables tangible action towards measurable reductions in emissions.
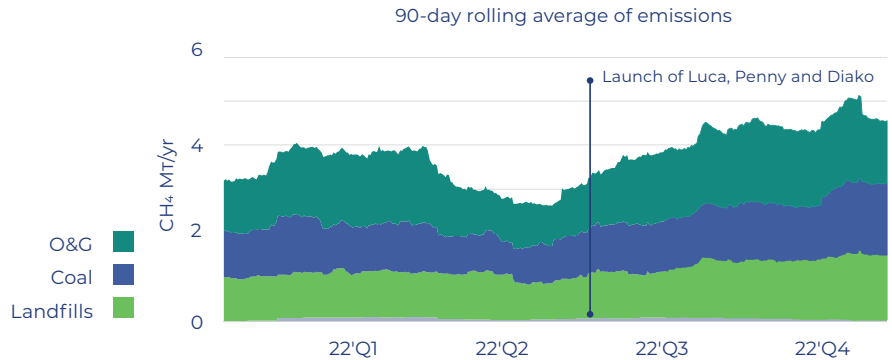
DIAKO
PENNY
LUCA
CLAIRE
IRIS
HUGO

Worldwide Monitoring

2M km²

Our satellites surveyed close to 2 million km² in 2022, 83% more than last year.

500K+ sites

Our constellation observed over 500K facilities worldwide in 2022, over 5x more than 2021.

69 countries

Our satellites detected emissions in 69 countries to support operators, governments and financial services.
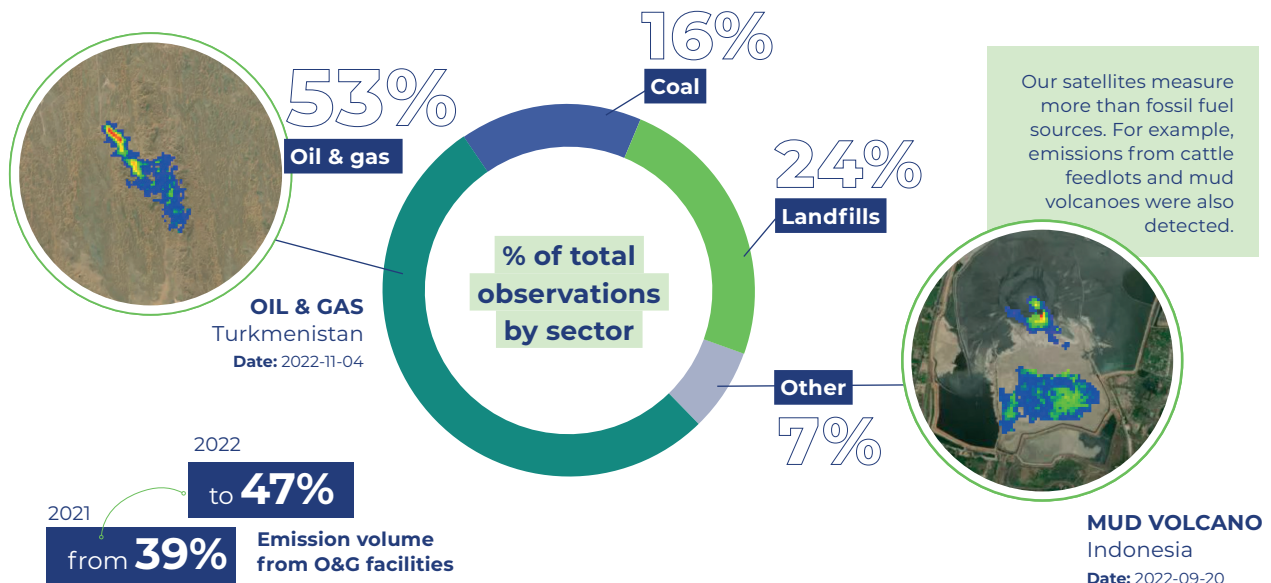
Increased monitoring across industries

With three more satellites successfully launched in May 2022, GHGSat's unparalleled capacity to monitor sites globally delivered a marked increase.

90-day rolling average of emissions

Launch of Luca, Penny and Diako

CH_4 MT/yr

- O&G
- Coal
- Landfills

22'Q1 22'Q2 22'Q3 22'Q4

69% from fossil fuels

Oil & gas accounted for over half of all emissions observations in 2022 and 47% of the volume of emissions measured in 2022, up from 39% in 2021.
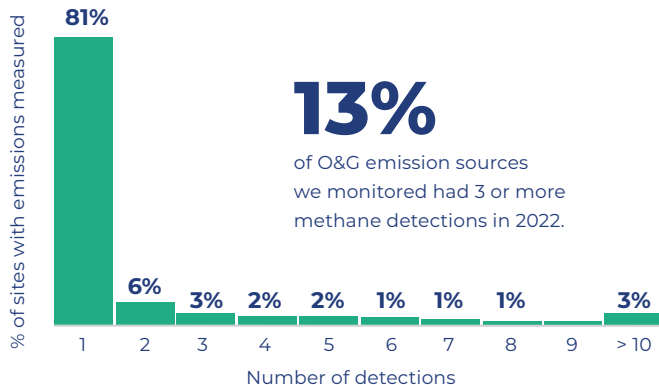
53%
Oil & gas

16%
Coal

24%
Landfills

7%
Other

% of total observations by sector

OIL & GAS
Turkmenistan
Date: 2022-11-04

Our satellites measure more than fossil fuel sources. For example, emissions from cattle feedlots and mud volcanoes were also detected.

MUD VOLCANO
Indonesia
Date: 2022-09-20

2022
to **47%**

2021
from **39%**

Emission volume from O&G facilities

Oil & Gas 2022 Trends
2.8 MT/yr CH₄ 69.5 MT/yr CO₂e

Persistence of oil & gas facilities' emissions

% of sites with emissions measured

- 81% — 1
- 6% — 2
- 3% — 3
- 2% — 4
- 2% — 5
- 1% — 6
- 1% — 7
- 1% — 8
- — 9
- 3% — > 10

Number of detections

13%
of O&G emission sources we monitored had 3 or more methane detections in 2022.

Emissions from O&G facilities can often be intermittent. Determining the persistence of emissions sources provides valuable information into LDAR priorities. Frequent site revisit capabilities enable prompt action on emission mitigation.

GHGSat's expanding constellation continues to provide the coverage and capacity required to accurately detect and quantify emissions from the O&G sector.

What leaks?
Different types of O&G emission sources were identified by our high-resolution satellite data like **flare stacks, compressor stations, storage tanks, and also blowdowns** as part of scheduled maintenance.

More observations with emissions

The percentage of observations with emissions grew in Russia from Q1 to Q2.

% of observations with emissions

Legend:
- United States
- Russia

Quarters: Q1'22, Q2'22, Q3'22, Q4'22
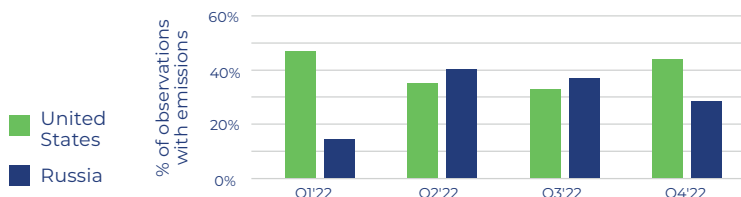
More in the Permian

3x
Emission detections in the Permian increased by nearly 3 times compared to 2021 data.

56%
Observations with emissions have also risen from 43% in 2021 to 56% in 2022.

More than half of O&G emissions measured in the US were in the Permian basin. Our satellites have detected emissions in all major US basins including the Marcellus, Uinta and DJ basins.
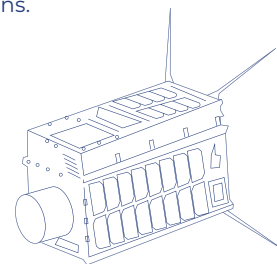
Remote-sensing and EPA's Proposed Rules

The US Environmental Protection Agency has issued a supplemental proposed rule for the oil and natural gas sector, listing standards of performance for new, reconstructed, and modified sources as well as emissions guidelines for existing sources. **GHGSat is in support of the use of alternative technology, such as satellite remote-sensing,** for periodic screening and acknowledged the creation of the super-emitter response program. GHGSat agrees that these changes could provide the basis for a strategic and affordable measure to tackle the methane emissions problem.

100
kg/h super emitter

EPA proposes to define a super emitter to be over 100 kg/hr. Our satellites meet this threshold.

10
kg/h threshold

Our airborne sensors meet the new proposed 10 kg/h and 30 kg/h threshold tiers at the required frequencies. They are regularly deployed in all North American basins and internationally.

Offshore Oil & Gas Monitoring Breakthrough

- **30% of global O&G production** occurs offshore so tracking emissions here is critical for company reporting.

- On 13th August 2022, GHGSat detected the smallest offshore emission ever measured from space: approximately 1500 kg/hr of fugitive methane leaking from a facility off the coast of Louisiana. Since then, our satellites have measured even smaller emissions.

- The breakthrough was the result of a pioneering study exploring the feasibility of monitoring offshore methane emissions from space using controlled releases.

OIL & GAS
Offshore Gulf of Mexico
Date: 2022-09-30

OIL & GAS
Offshore Nord Stream
Date: 2022-09-13
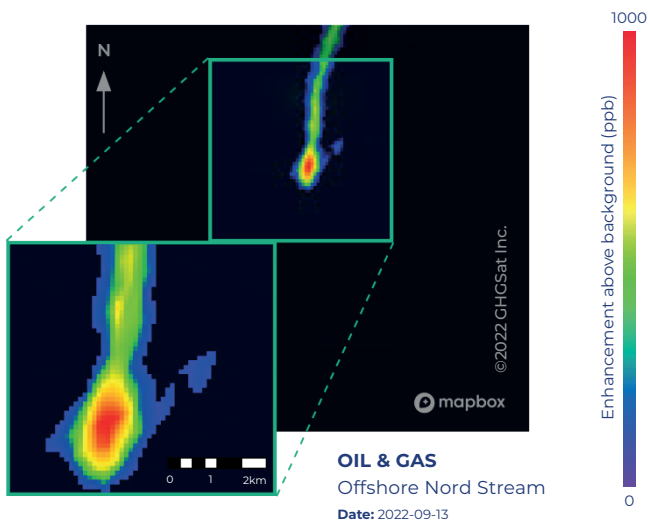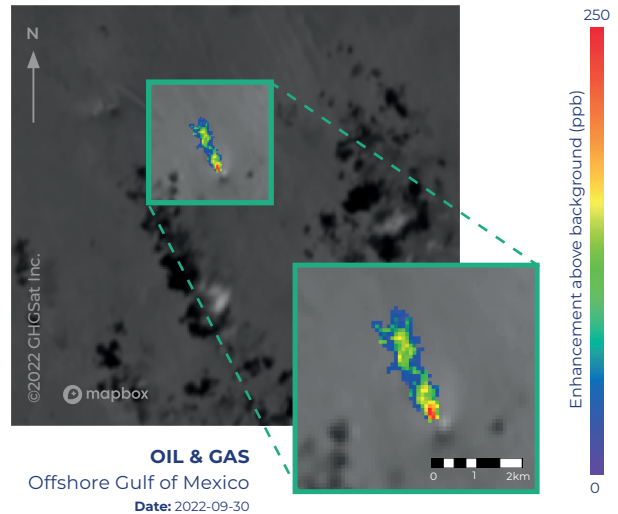
79,000 kg/h

equivalent to 2M pounds of coal burned every hour

Our offshore measurement capability was further validated in September 2022 when GHGSat's constellation was the first system to observe gas streaming from the Nord Stream 2 pipeline in high-resolution. We calculated the emission rate to be **79,000 kg/h** – the highest single one ever detected.
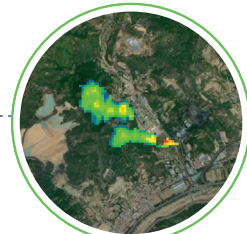
2022 Coal Mine Emissions
2.1 MT/yr CH₄ 52.5 MT/yr CO2e

China tops coal emission measurements in 2022

COAL MINE
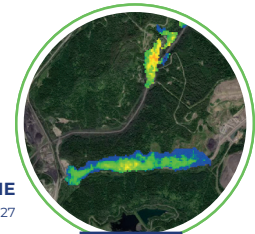**Date:** 2022-05-27
Russia

22%

33%

of GHGSat coal mine methane emissions were in China with 22% over Russia, in 2022.

Our sensors have monitored open pit and underground facilities worldwide. Higher emissions rates can be indicative of increased activity at a mine.
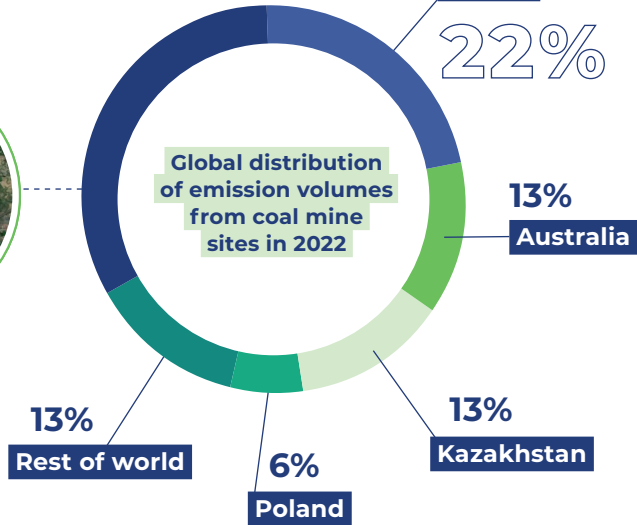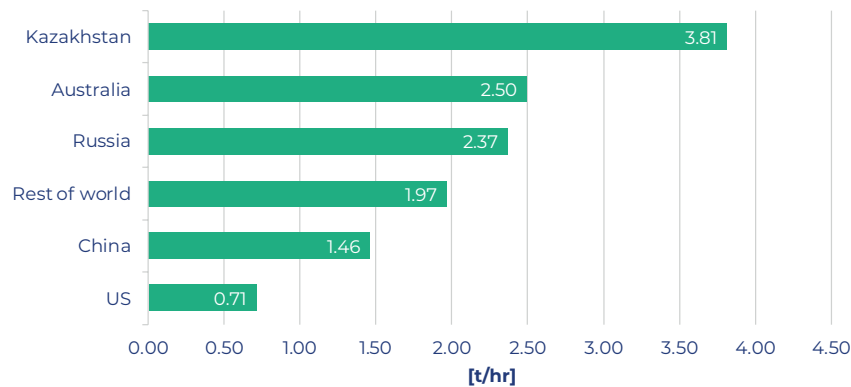
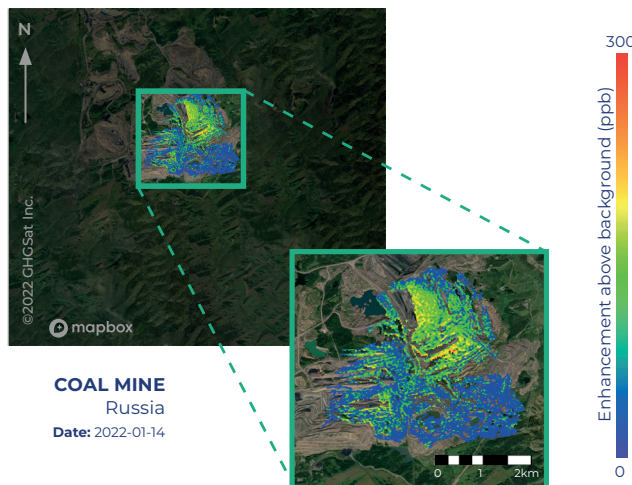**China**
COAL MINE
Date: 2022-06-16

Global distribution of emission volumes from coal mine sites in 2022

13%
Australia

13%
Rest of world

6%
Poland

13%
Kazakhstan

Average emission rate [t/hr] from coal mines globally

Country	[t/hr]
Kazakhstan	3.81
Australia	2.50
Russia	2.37
Rest of world	1.97
China	1.46
US	0.71

[t/hr]

The IEA explained that many Kazakh coal mines can have high emissions because of their age and relative inefficiency. The IEA's Coal 2022 report also stated that Kazakh coal production increased in 2022.
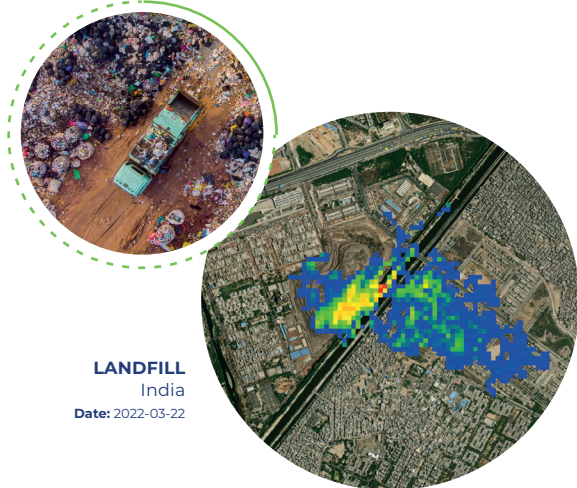
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mapbox

COAL MINE
Russia
Date: 2022-01-14

Enhancement above background (ppb)

300

0

0   1   2km

Towards the end of 2022, GHGSat observed some of the highest average emission rates from coal mines over Russia.

2022 Waste Management Global Trends

2.17 MT/yr CH$_4$ **54.3 MTCO2e**

LANDFILL
India
Date: 2022-03-22

2x GHGSat expanded coverage of landfills globally in 2022, performing over 1100 observations, nearly 2 times more than in 2021.

### India tops observations and emission volumes for landfills

160 landfill emissions measured in 2022.

India was the nation with the most individual emissions detected by GHGSat satellites as well as the largest estimated volume of CH$_4$ emissions coming from landfills.

Top 5 highest average landfill emission rates in 2022 per country

Country	Average emission size (t/hr)
Argentina	10.98
Hong Kong	6.25
Turkey	4.58
Jordan	4.37
Greece	3.27
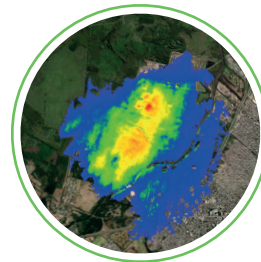
LANDFILL
Argentina
Date: 2022-08-13

Argentinian landfills top average emission rates table with

10.98 **t/hr**

GHGSat partners in major landfill emissions study

In 2022, a study from SRON demonstrated that large landfill emissions could be detected and characterized by combining TROPOMI with GHGSat satellite data.

Last November, SRON and GHGSat embarked on a demonstration project together with the Global Methane Hub to look at landfills around the world, aiming to drive impact at these facilities with high resolution satellite data.

Satellite-detected urban and landfill methane emissions

● TROPOMI Urban Hot Spots
· GHGSat-detected Landfills

SRON   GHGSAT
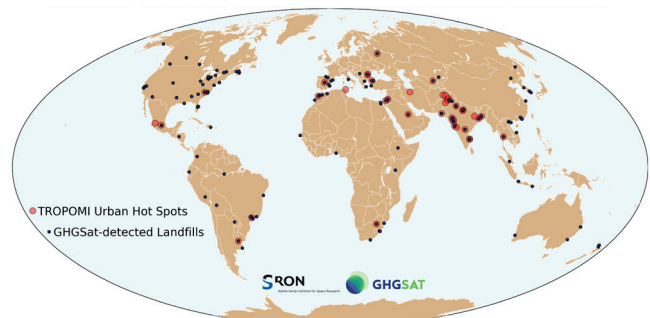
SPECTRA
GHGSAT

New free subscription on emissions intelligence platform

Everyone can explore higher temporal resolution of methane concentrations globally with a gallery of featured high-resolution emissions measurements around the world.

You can activate your SPECTRA account today for free, here.
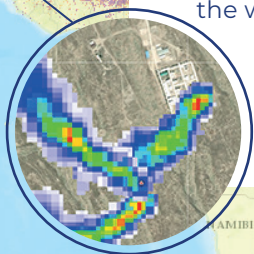
CO₂ Sensor for 2023

"Over the past seven years, we have shown there is demand – from the industry and the public sector – for accurate, independent, high-resolution emissions data from space. Our work has helped to change the conversation around methane, moving a greenhouse gas that was out of sight and out of mind, to the top of the climate agenda. When GHGSat-C10 launches later in 2023, we hope to revitalize the discussion around CO₂ as well, providing industry and government with tools to help them address this global issue, down to the facility level."

- *Stephane Germain, CEO at GHGSat*

Satellite Data Programs with NASA and ESA Take Off in 2022

ESA awarded GHGSat "Third Party Mission" status last May. The company also entered into a Commercial Small Satellite Data Acquisition Agreement with NASA.
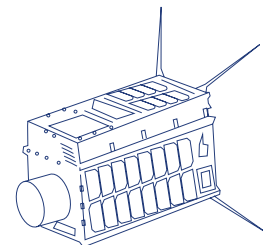
About **GHGSat**

GHGSat uses its own satellites and aircraft-based sensors to measure greenhouse gas emissions directly from industrial sites, providing actionable insights to businesses, governments, and regulators.

With proprietary and patented remote-sensing and analytics technology, GHGSat enables strategic decision-making through its monitoring and analytics services, with better accuracy and increased frequency at a fraction of the cost of other technologies.

Scientific validation

High-resolution monitoring expertise

GHGSat's satellite technology performance and accuracy is best in class.

PUBLISHED

Single-blind validation of space-based point source methane emission detection and quantification

Collaboration is essential and all monitoring systems are complementary in the fight against climate change.

PUBLISHED

Using satellites to uncover large methane emissions from landfills

Methods — GHGSat satellites measure methane concentrations using a patented method described in this peer-reviewed overview. Emissions are detected using algorithms and verified by human operators. Emission rates are estimated for each detected emission using peer-reviewed methods. Emissions per quarter are then estimated by aggregating emission rates for persistent and intermittent sources.

GHGSAT™

2022 REPORT