Hazards31

The application of GHGSat data to improve the detection of methane leaks and the integration opportunities with plant sensor data

Presenters:

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GHGSat Inc.

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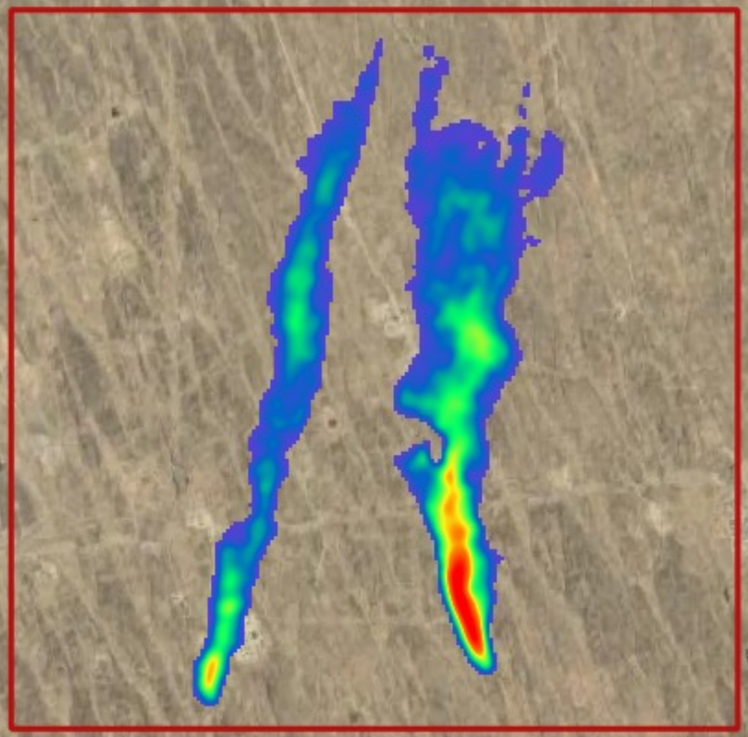


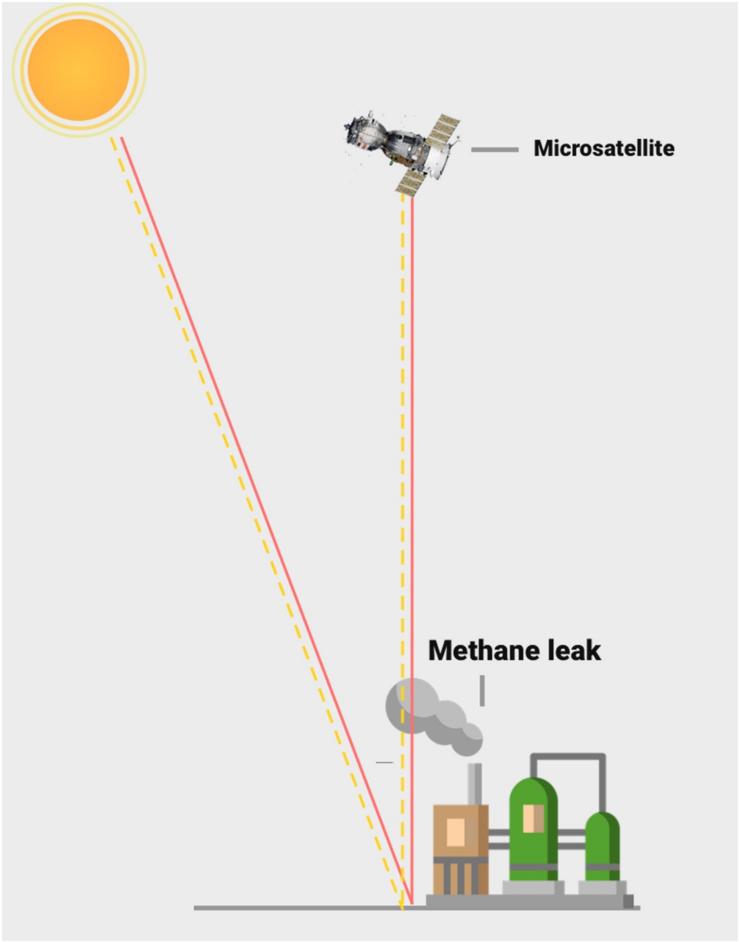
Agenda

1. Introduction

2. Greenhouse Gas Emissions (Methane) Monitoring from Space

3. Real world examples of Methane Leak Detection

4. Integrating Satellite data with plant data



Why Methane Matters

1. Methane has a great impact on climate change
2. Methane is hazardous (Explosion & Asphyxiation)
3. Abundant in Nature, present in landfills and sewage treatment works
4. Main component of Liquefied Natural Gas (LNG) and Compressed Natural Gas (CNG
5. Business as usual = methane leaks can go undetected for hours, days… and months

'Record methane levels pose new threat to Paris Climate accord'
Leslie Hook, Financial Times, 2019

Ingredient for high potential incidents

1. June 9, 2009, **4 workers killed** and **sixty seven (67) others injured** in natural gas explosion, ConAgra Foods Slim JimTM processing facility, Garner, North Carolina. (CSB, 2009)

2. February 7, 2010, **6 workers killed** and at least **fifty (50) others injured** in natural gas explosion at the Kleen Energy power plant , Middletown, Connecticut. (CSB, 2010)

3. April 20, 2010, **11 workers died** on the Macondo Platform when a methane gas release triggered a deadly explosion (ISBN: 978-0-16-087371-3)

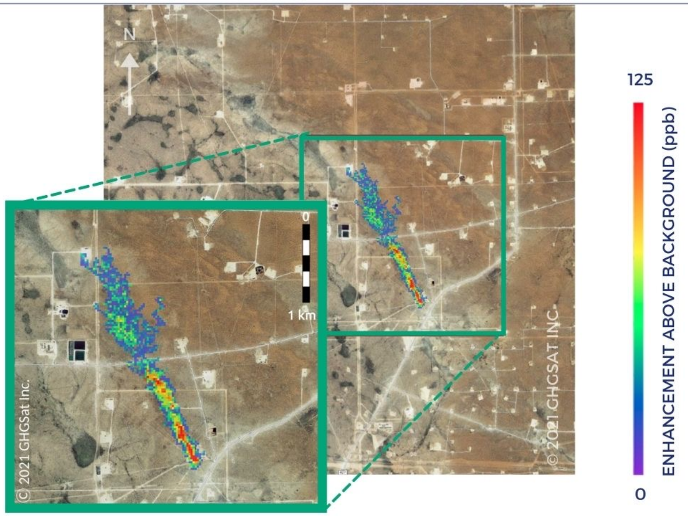
4. February, 2018, The New York Times reported a gas-well accident at an Ohio **fracking site** and claimed that it resulted in one of the **largest methane leaks ever recorded** in the United States (Hiroko, 2019), a claim supported by satellite measurements of the incident (Pandey, 2019).

5. September, 2021, The Chemical Engineer, reported **high methane emissions** from the **coal-mining** Boen Basin in Australia with an average methane release of 1.6 m t/y in 2019 and 2020, equivalent to 134m t/y of CO_2. (TCE, 2021)

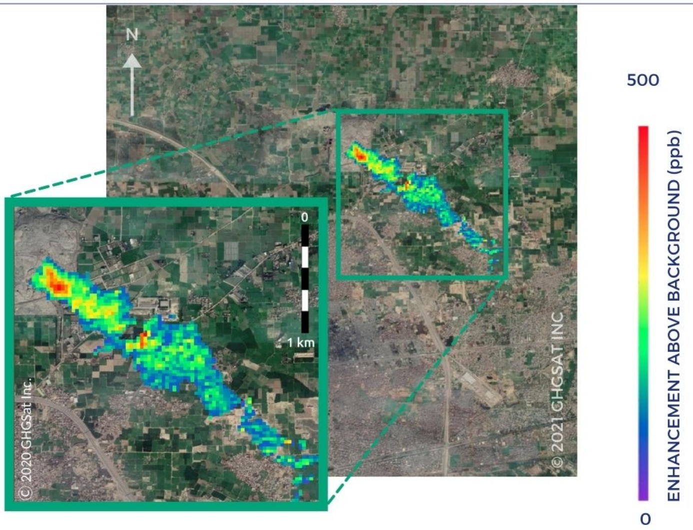
Global Emissions Monitoring

GHGSat operates its own satellites and aircraft to detect and quantify methane emissions from industrial facilities around the world

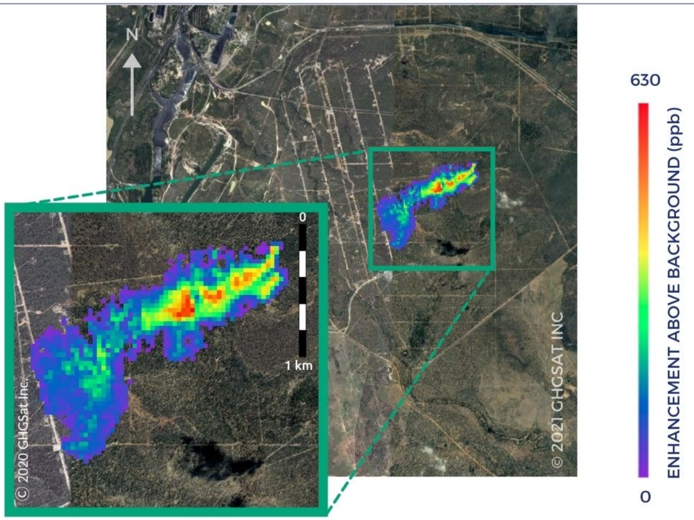
O&G - USA
CH_4 Measurement



Landfill - Asia
CH_4 Measurement

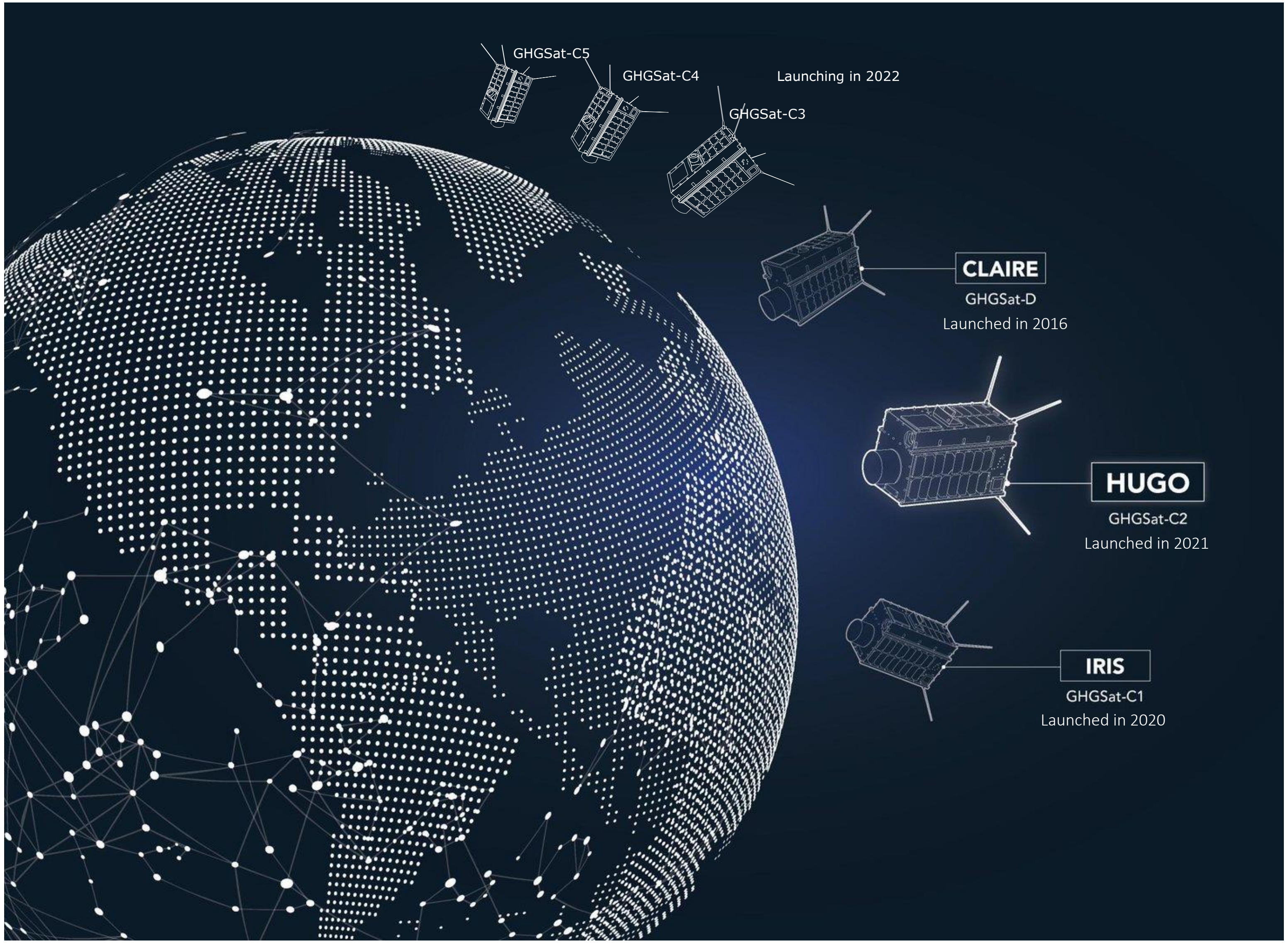


Coal Mine - Australia
CH_4 Measurement



Growing satellite fleet

- "Claire" demonstrator
  - GHGSat-D launched 2016
- First commercial satellites
  - Iris, launched Sept 2020
  - Hugo, launched Jan 2021
- Next batch being built
  - Three satellites launch 2022
  - GHGSat-C3, C4 and C5
- Total 10 satellites in 2023

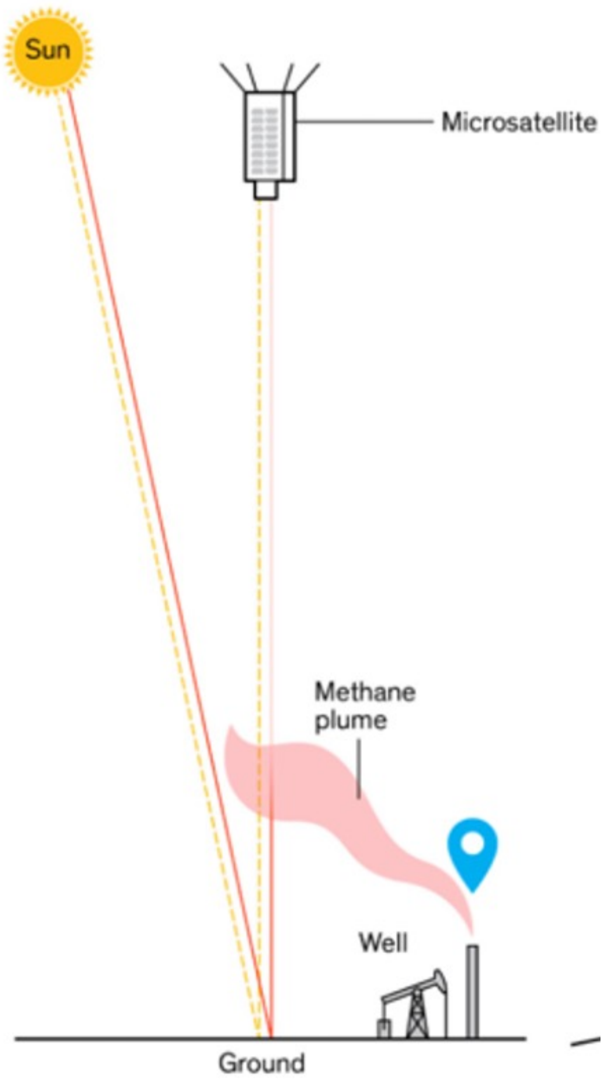


Why measure methane from space?

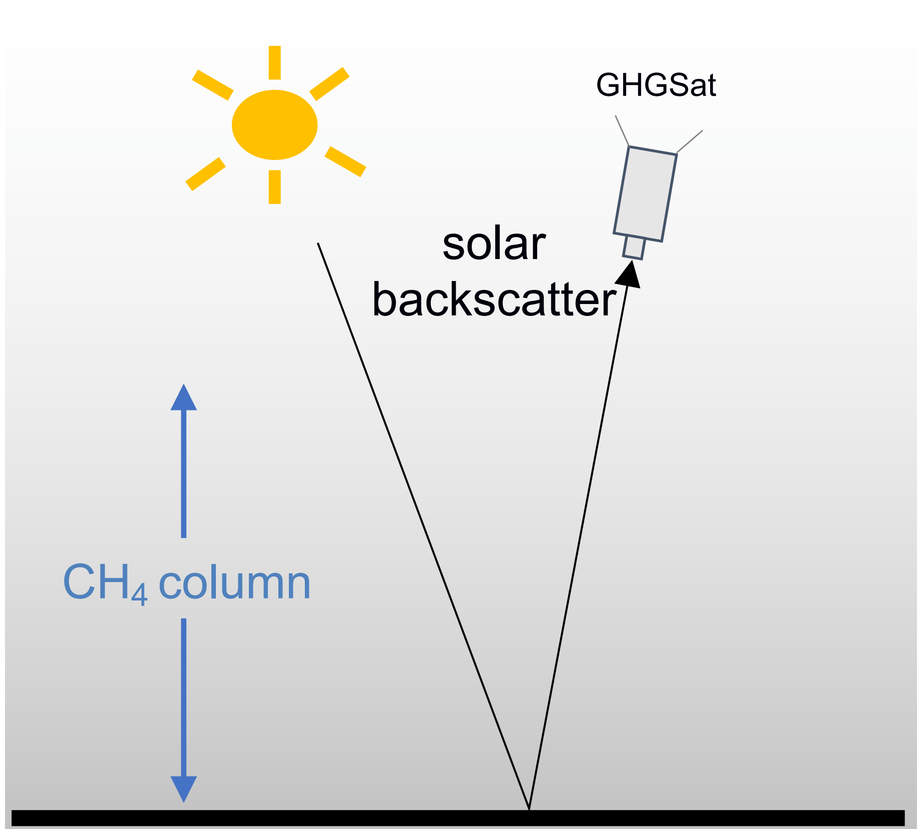
1. Rapidly available with minimal delay and no need to be on site

2. Comparable measurements anywhere worldwide able to detect large leaks fast

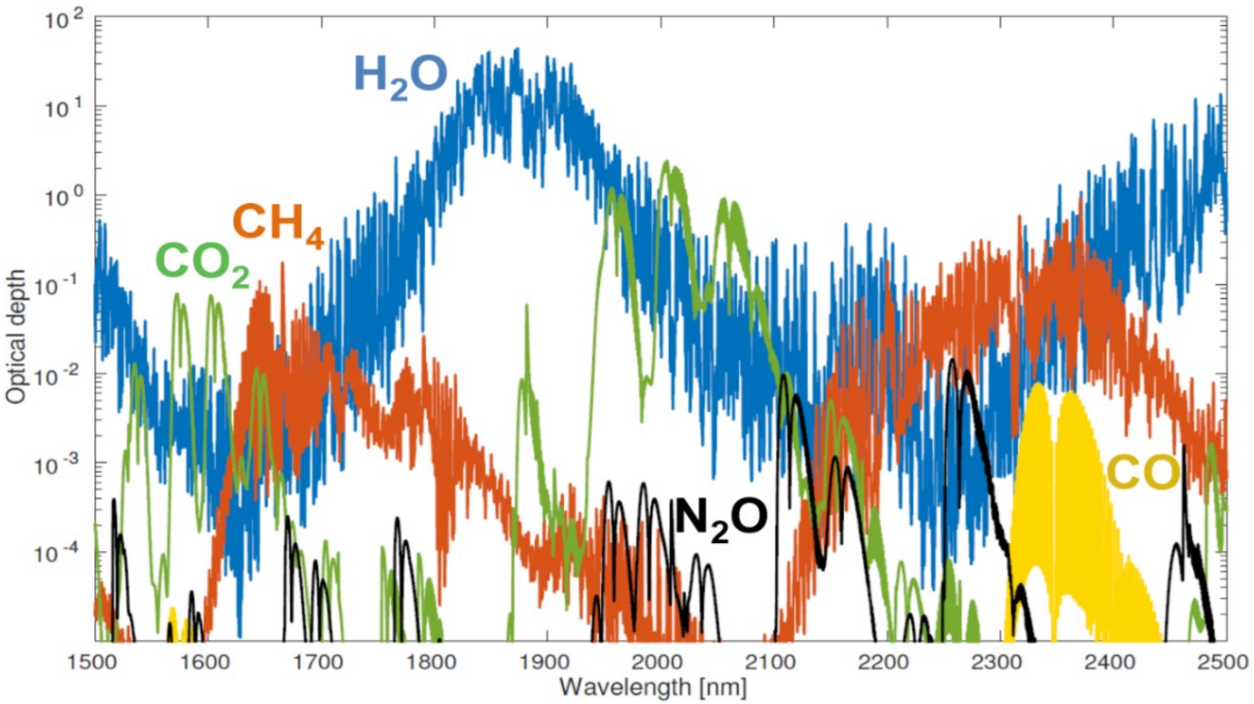
3. Enables regular and sustained monitoring at an affordable cost



Methane Imaging in Short-wave Infrared (SWIR)



Measure absorption by methane column between sensor and ground



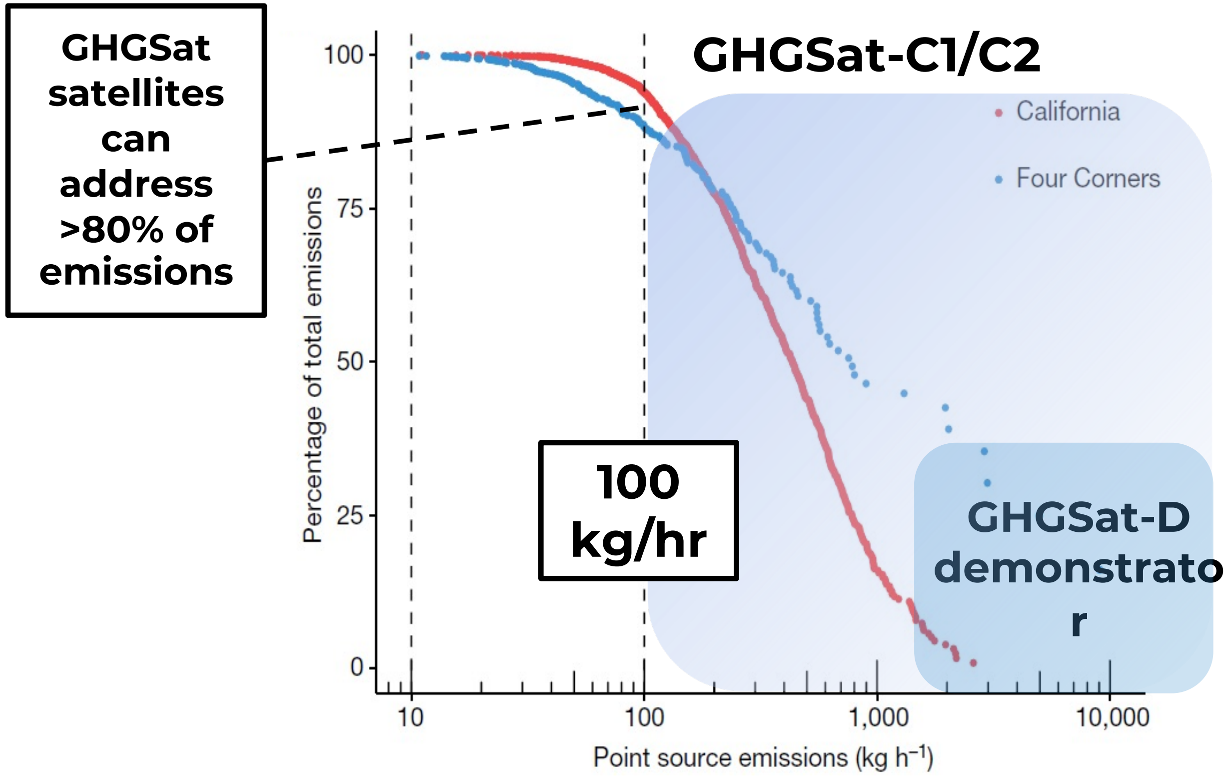
GHGSat Sentinel 2

Jacob et al., ACP 2016

TROPOMI Sentinel 2

Relevance of satellite methane measurements

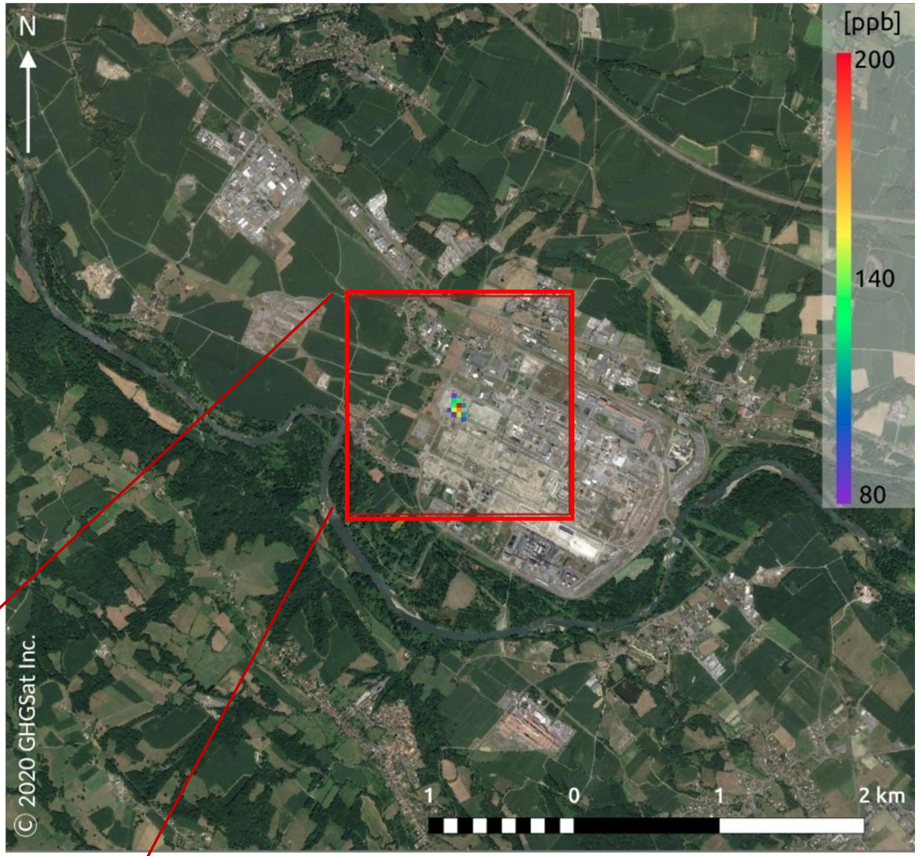
- “Super emitters” drive total emissions
  - Majority of methane emissions from relatively few larger sources
  - Satellite detections can address significant proportion of all emissions
- Satellite view of point sources
  - Detection threshold >100 kgCH4/hr
  - High spatial resolution (25 m) enables source attribution
- Aircraft sensor extends insights
  - Detection threshold >10 kgCH4/hr
  - Very high resolution (better than 1 metre)

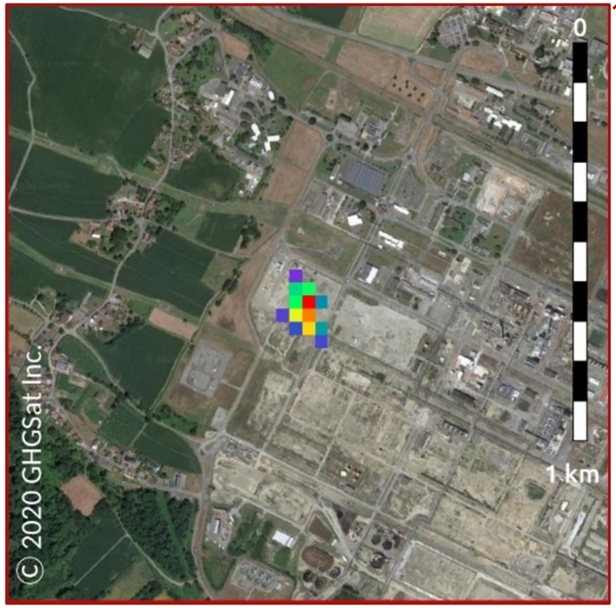


Plot from Duren, R. M. *et al.* California’s methane super-emitters. *Nature* 575, 180–184 (2019). GHGSat annotations.

Case study – Blind controlled release

“In developing the technical solutions of tomorrow to monitor methane emissions, TotalEnergies uses its TADI facility to validate emerging technologies on the market, notably those selected by OGCI Climate Investments.”





Blind controlled release in partnership with TotalEnergies in France (October 2020).

GHGSat had no knowledge of release rate or position

- Our retrieval: 250 ± 140 kg/hr
- Ground truth: 234 kg/hr
- Wind 1.6 m/s

TotalEnergies

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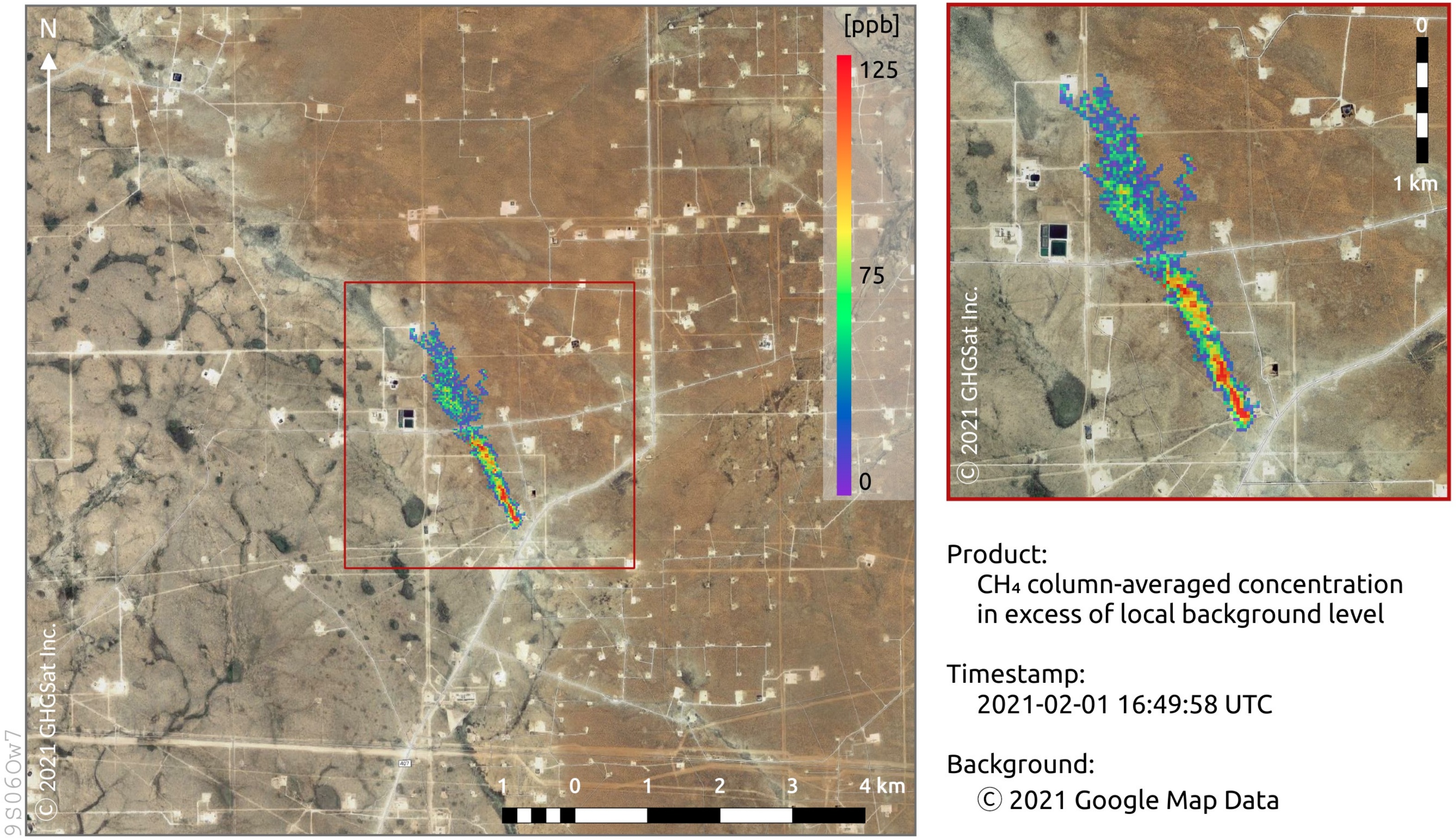
Oil and gas facility – Permian Basin, USA

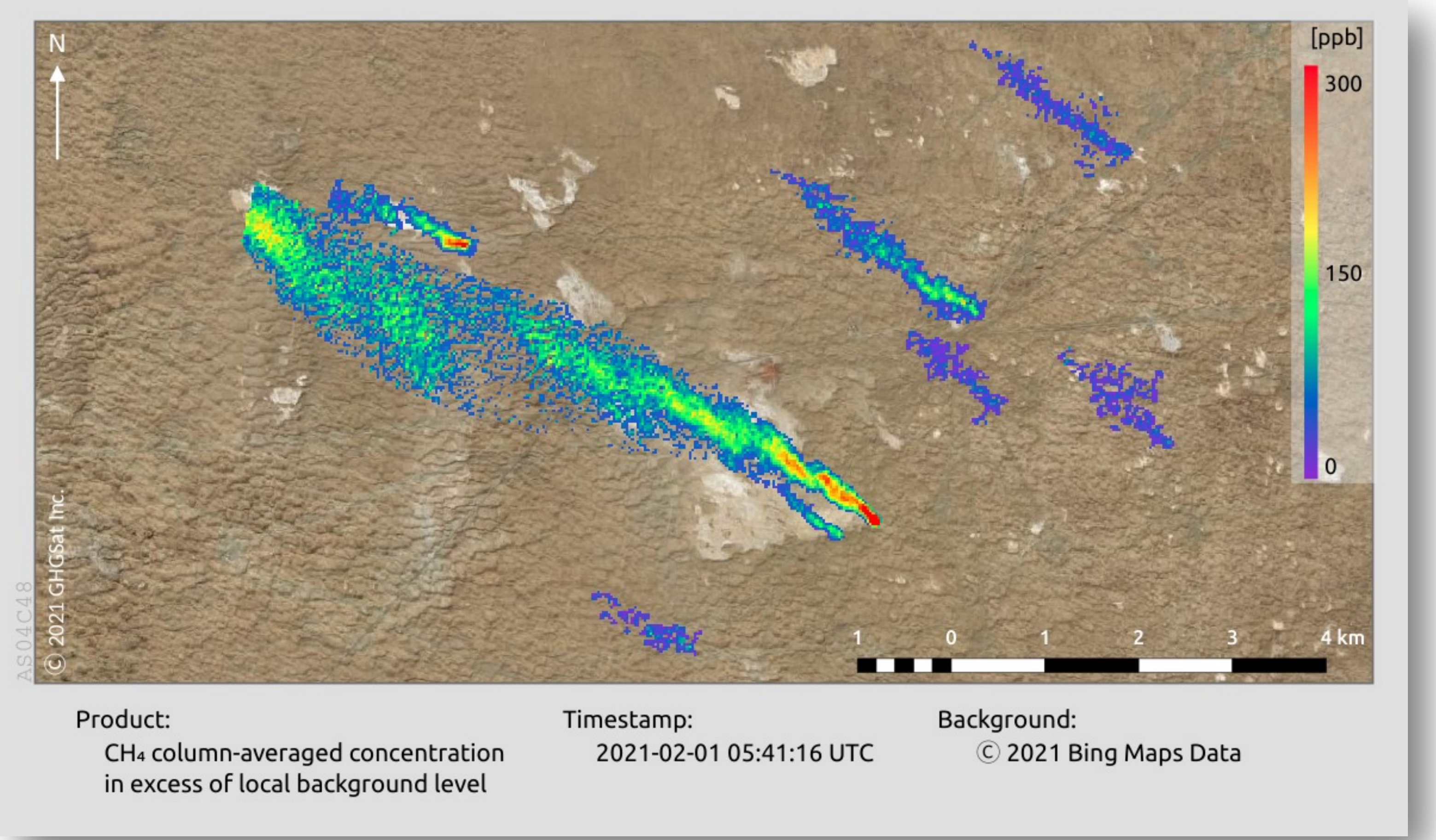


Product:
CH4 column-averaged concentration in excess of local background level

Timestamp:
2021-02-01 16:49:58 UTC

Background:
© 2021 Google Map Data

Pipelines & unlit flares – Central Asia



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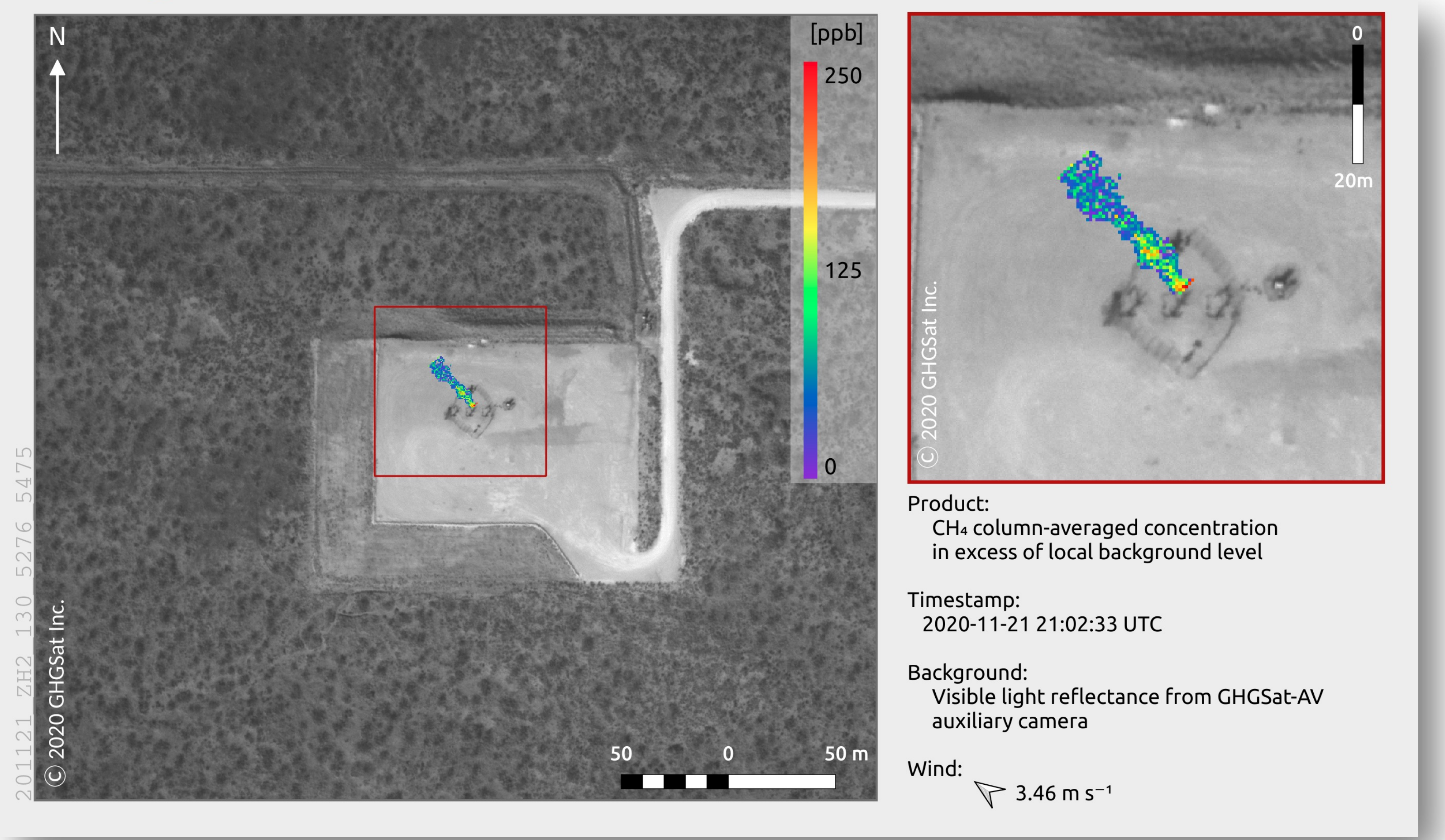
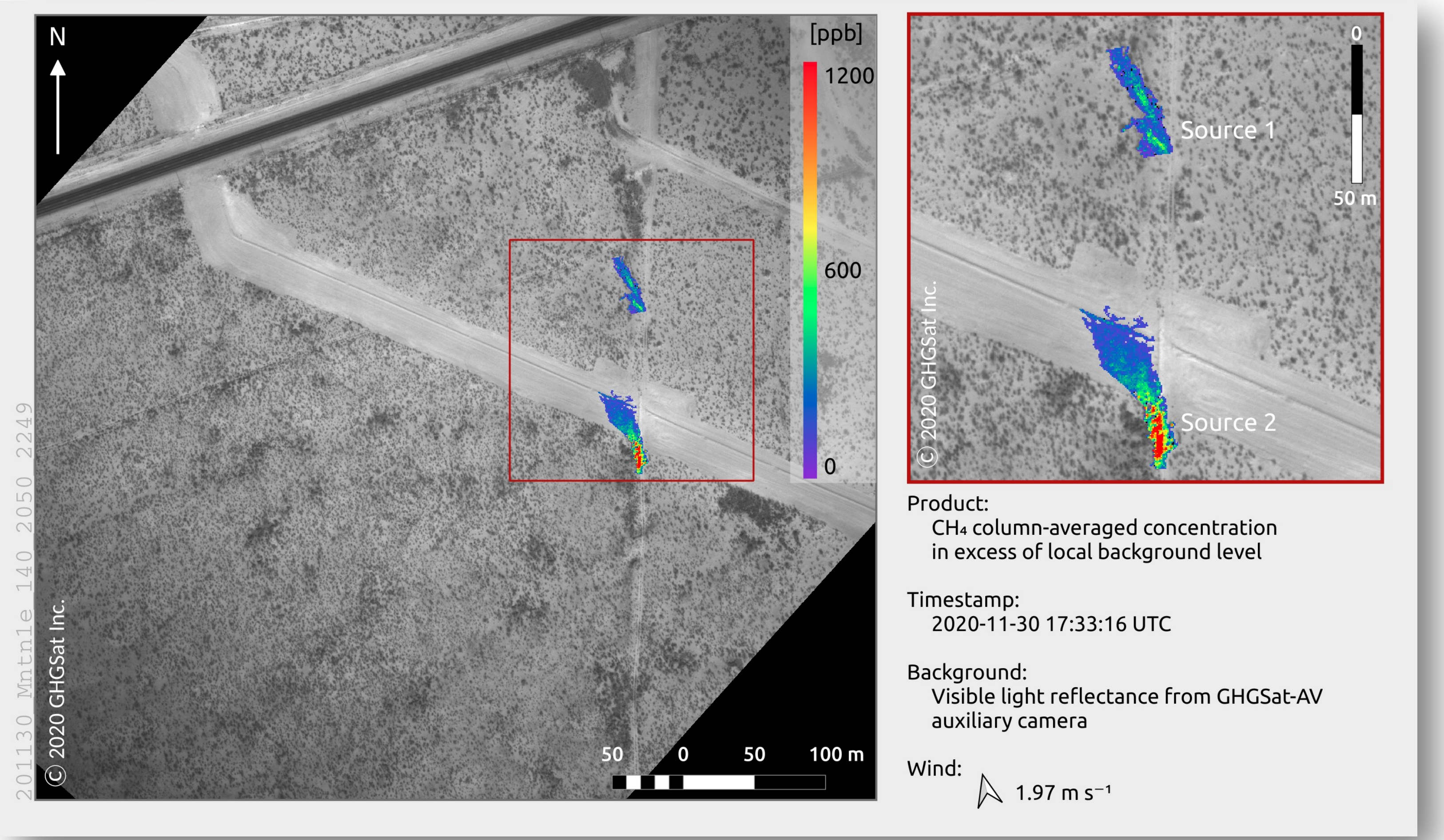
https://www.bloomberg.com/news/articles/2021-02-12/new-climate-satellite-spotted-giant-methane-leak-as-it-happened

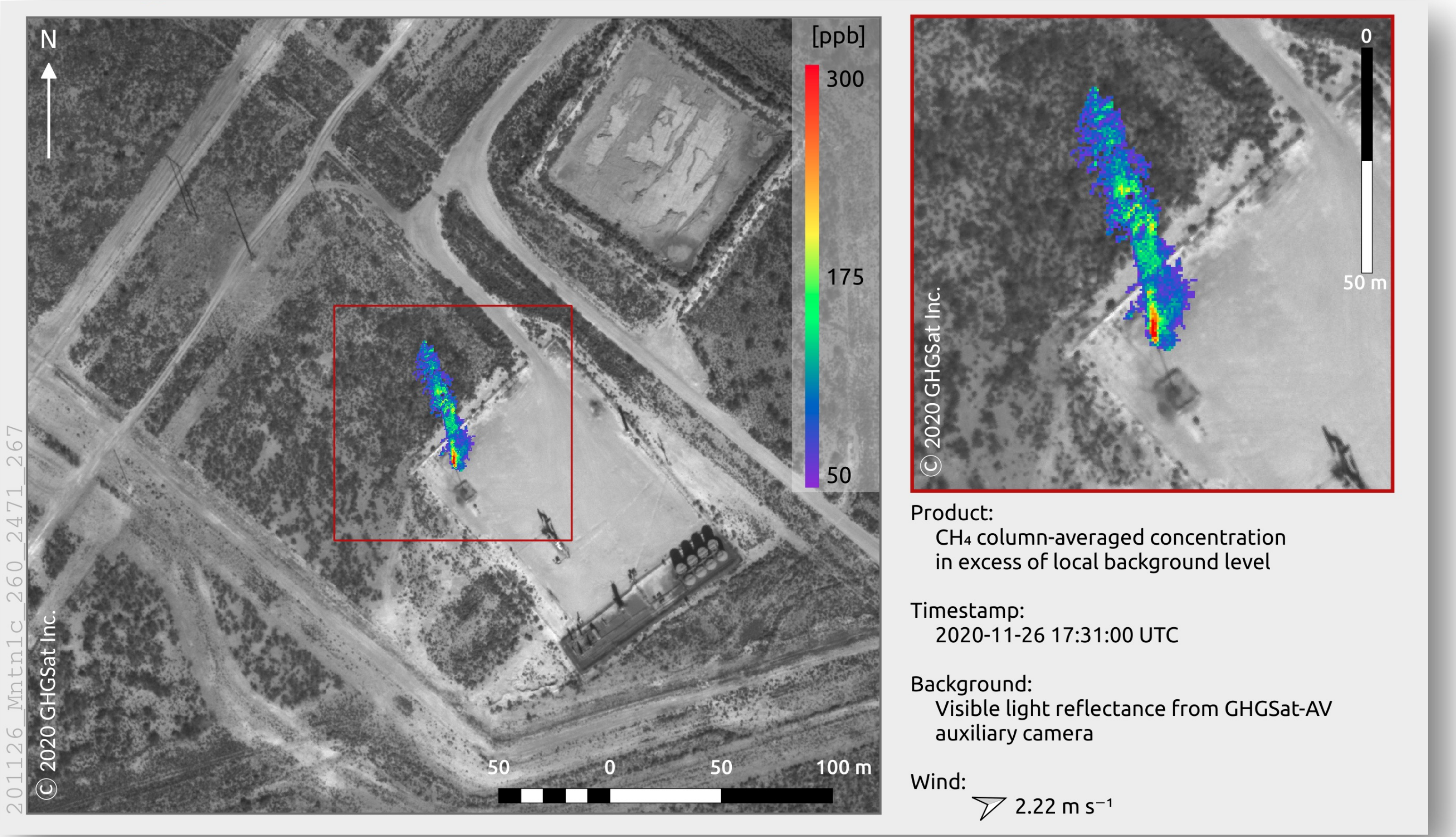
Well head – Delaware Basin, USA



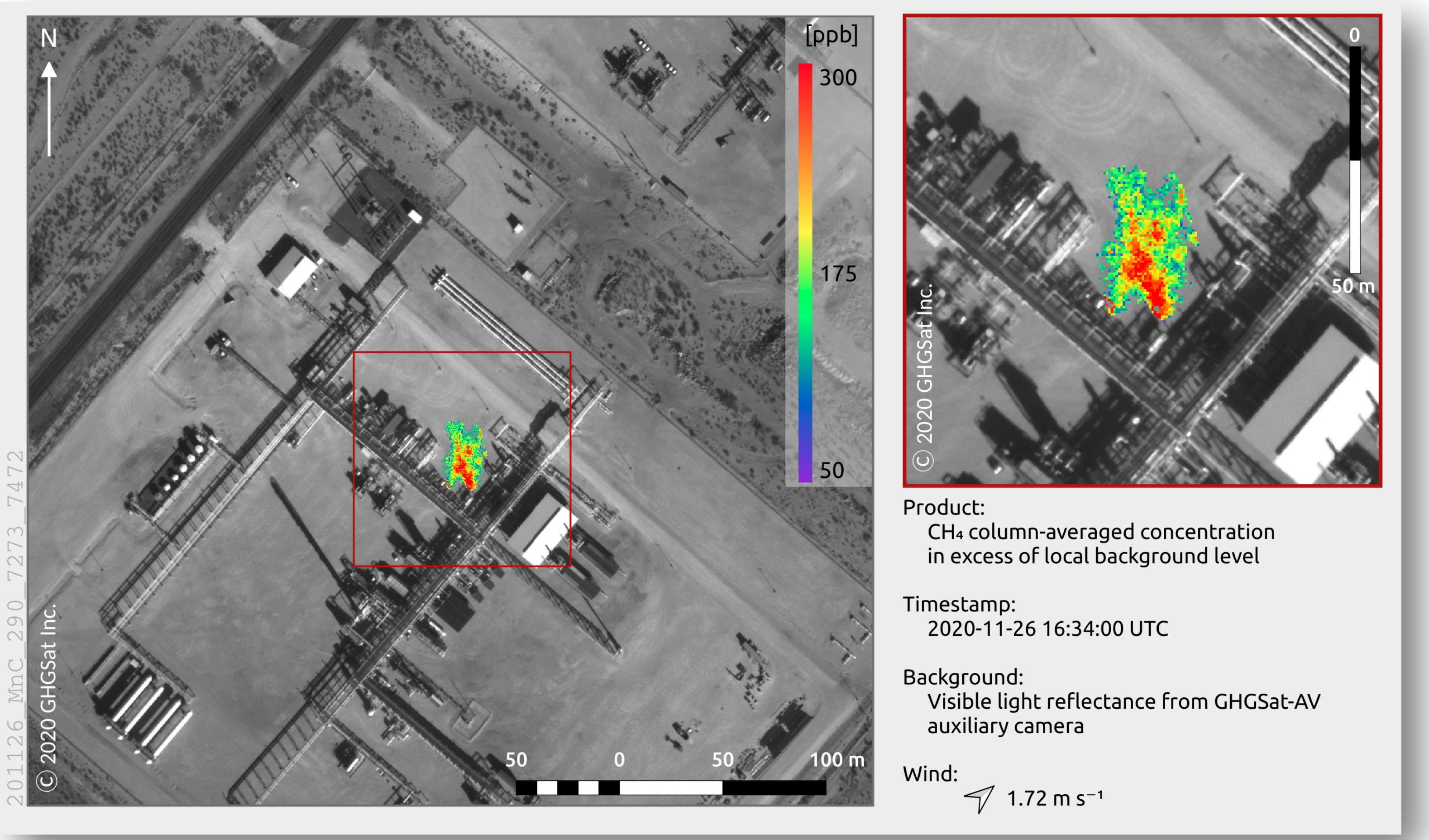
Gathering line – Delaware Basin, USA



Flare stack – Delaware Basin, USA



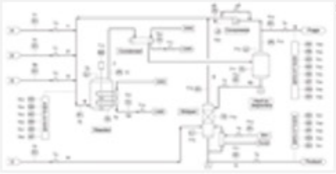
Gas plant – Delaware Basin, USA



Integrating Plant Data With Space Data

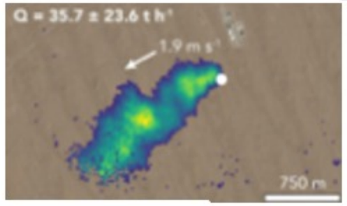
Data Sources

PLANT DATA
Plant Historians



WEATHER DATA FEED

GHGSat and Sentinel Open Data
feed for METHANE and Leak Identification and PLUME OBSERVATIONS



GOAL: Explore the opportunity for technology solutions to reduce the cost, reduce the time, and increase the accuracy of detecting Methane & GHG leaks.

Seeq

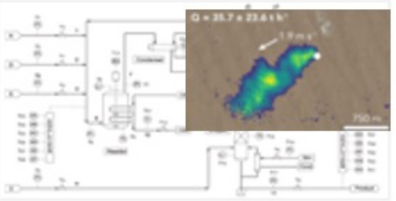
Explore how to predict and prevent Methane and GHG releases

Protect the environment
Protect People, Plant and profit
Protect Company's Brand

Use Cases / Outcomes

1) Enhanced Identification of methane / GHG leak events

2) Enhanced quantification of Leak Events by cross referencing plant data with Satellite Observations



3) EARLIER WARNING & Predictive analytics of METHANE / GHG LEAK EVENTS

Methane Plume Events from Simulated GHGSat data

Observation ID	File Basename	Country	Acquisition time [UTC]	WGS-84 Latitude [∞]	WGS-84 Longitude [∞]	UTM Easting [m]	UTM Northing [m]	UTM Zone	Q-IME [kg/hr]	Q-IME Error [%]	Source # Varon 2019	Event Varon 2019
1BEVxRS	GDSW1_SON1BEVxRS200717_CON161128002S_COLN01_TIFF	Canada	22/02/2018 18:10	53.911944	-117.2750095	481935	5973759	11 N	9100	100%+		
1D17F1K	GDSW1_SON1D17F1K200717_CON0018000445_COLN01_TIFF	Turkmenistan	19/06/2018 06:29	38.49391	54.19763	255596	4264340	40 N	11600	76%	1	a
1DwXF1K	GDSW1_SON1DwXF1K200717_CON0018000445_COLN01_TIFF	Turkmenistan	15/08/2018 06:29	38.49391	54.19763	255596	4264340	40 N	9900	69%	1	b
1ED4F1K	GDSW1_SON1ED4F1K200717_CON0018000445_COLN01_TIFF	Turkmenistan	03/09/2018 06:28	38.49391	54.19763	255596	4264340	40 N	43300	27%	1	c
1EXXk1K	GDSW1_SON1EXXk1K200717_CON0018000445_COLN01_TIFF	Turkmenistan	22/09/2018 06:27	38.49391	54.19763	255596	4264340	40 N	33400	48%	1	d
1FGXF1K	GDSW1_SON1FGXF1K200717_CON0018000445_COLN01_TIFF	Turkmenistan	08/11/2018 06:30	38.49391	54.19763	255596	4264340	40 N	30450	84%	1	e
1G0Xk1K	GDSW1_SON1G0Xk1K200717_CON0018000445_COLN01_TIFF	Turkmenistan	13/01/2019 06:26	38.49391	54.19763	255596	4264340	40 N	25450	62%	1	g
1G0Xk1K	GDSW1_SON1G0Xk1K200717_CON0018000445_COLN01_TIFF	Turkmenistan	13/01/2019 06:26	38.4992	54.2174	257339	4264874	40 N	33600	61%	2	g
2GWXk1K	GDSW1_SON2GWXk1K200717_CON0018000445_COLN01_TIFF	Turkmenistan	27/01/2019 06:27	38.49391	54.19763	255596	4264340	40 N	37850	48%	1	f
2GWXk1K	GDSW1_SON2GWXk1K200717_CON0018000445_COLN01_TIFF	Turkmenistan	27/01/2019 06:27	38.55947	54.20253	256245	4271603	40 N	2700	67%	3	h
1Dz0Xvv	GDSW1_SON1Dz0Xvv200717_CON0018000483_COLN01_TIFF	USA	17/08/2018 16:53	31.687004	-103.7251805	620825	3506449	13 N	1750	66%		

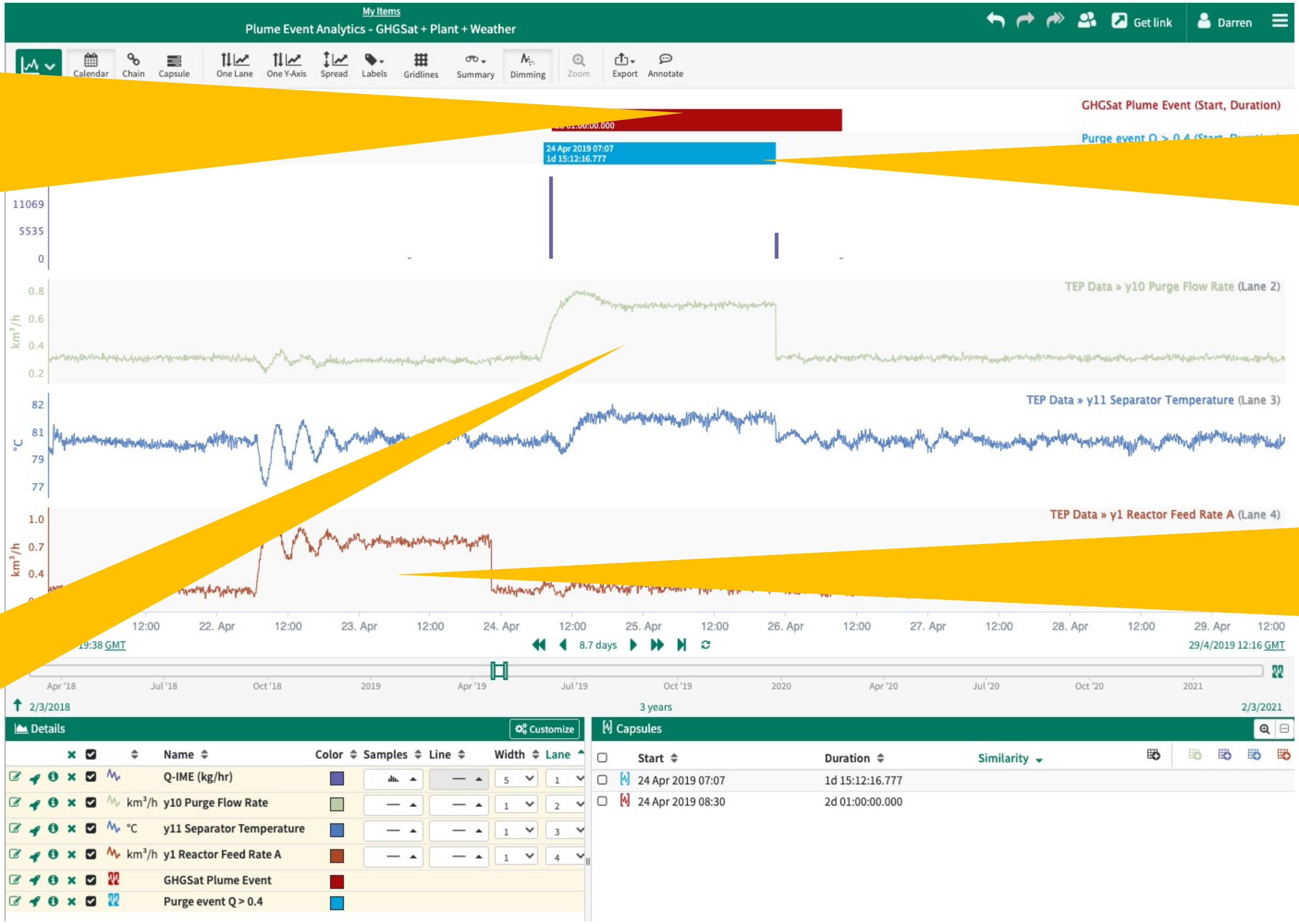
Q: Source Rate
IME: Integrated Mass Enhancement

Observation Timestamp

Estimated Methane release rate at observation timestamp (and error)

Validating Methane Plume Observations with Plant Data

1) GHGSat "Snapshot" derived Methane even capsule. Observation can be prone to error.



3) Plant data derived Methane event capsule.

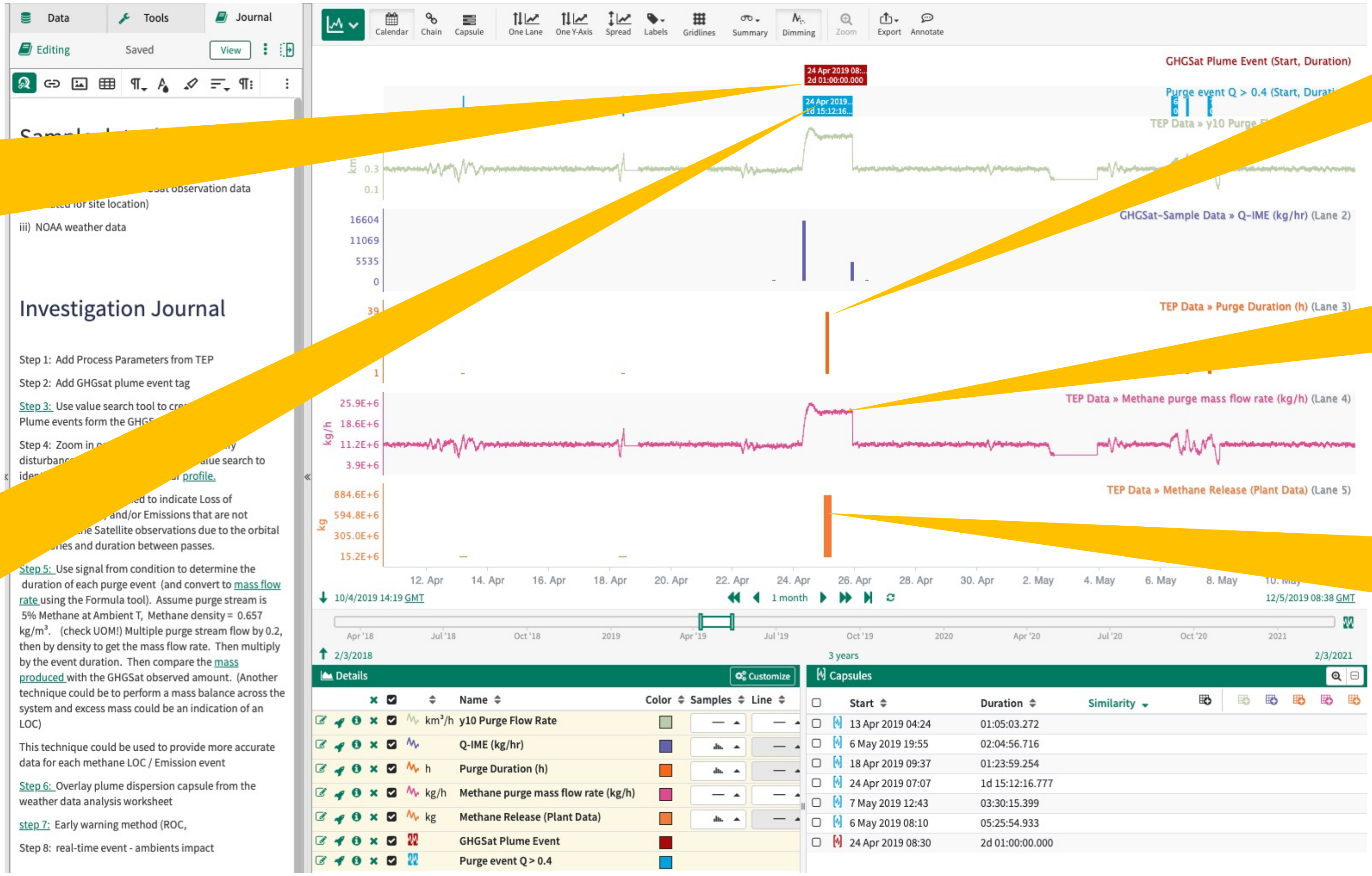
2) Cross reference Plant data with observation, Step Change noted in purge stream.

4 Plant disturbance prior to methane plume event capsule.

Creating Soft Sensors for Methane Emissions

1) GHGSat "Snapshot" derived methane Plume event

2) Plant data validation of LOC / Emission incident (Rule Based)



3) Derive event duration (rule based)

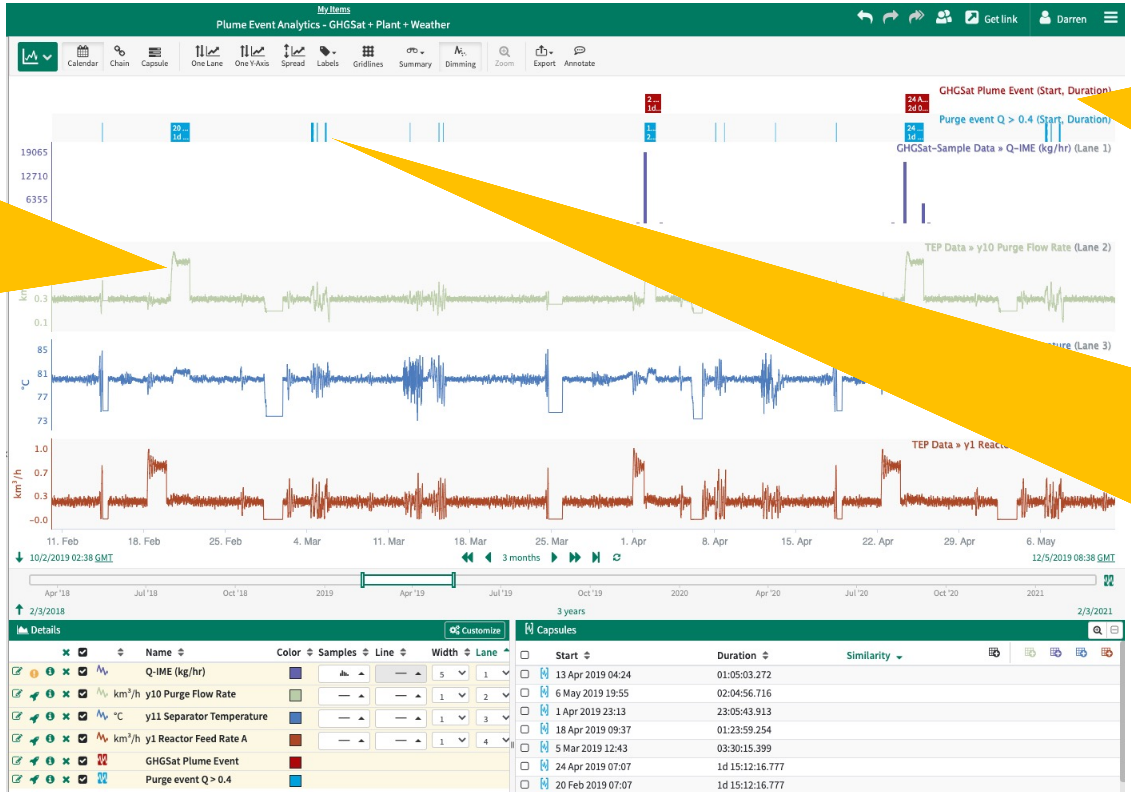
4) Convert to mass flow rate (Soft Sensor)

5) Derive actual mass released (Soft Sensor).

Pattern based identification of potential methane releases

1) The plant step change event is used to identify similar events in the plant history (and current real-time data).

Not detected from space!



2) Needs to be validated using real world plant data where several methane emissions have been observed. …

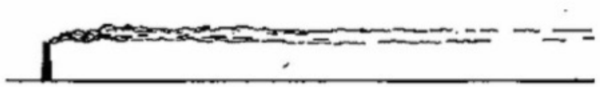
3) This method could also potentially identify transient methane emissions that cannot be detected by satellite observations due to frequency of observations

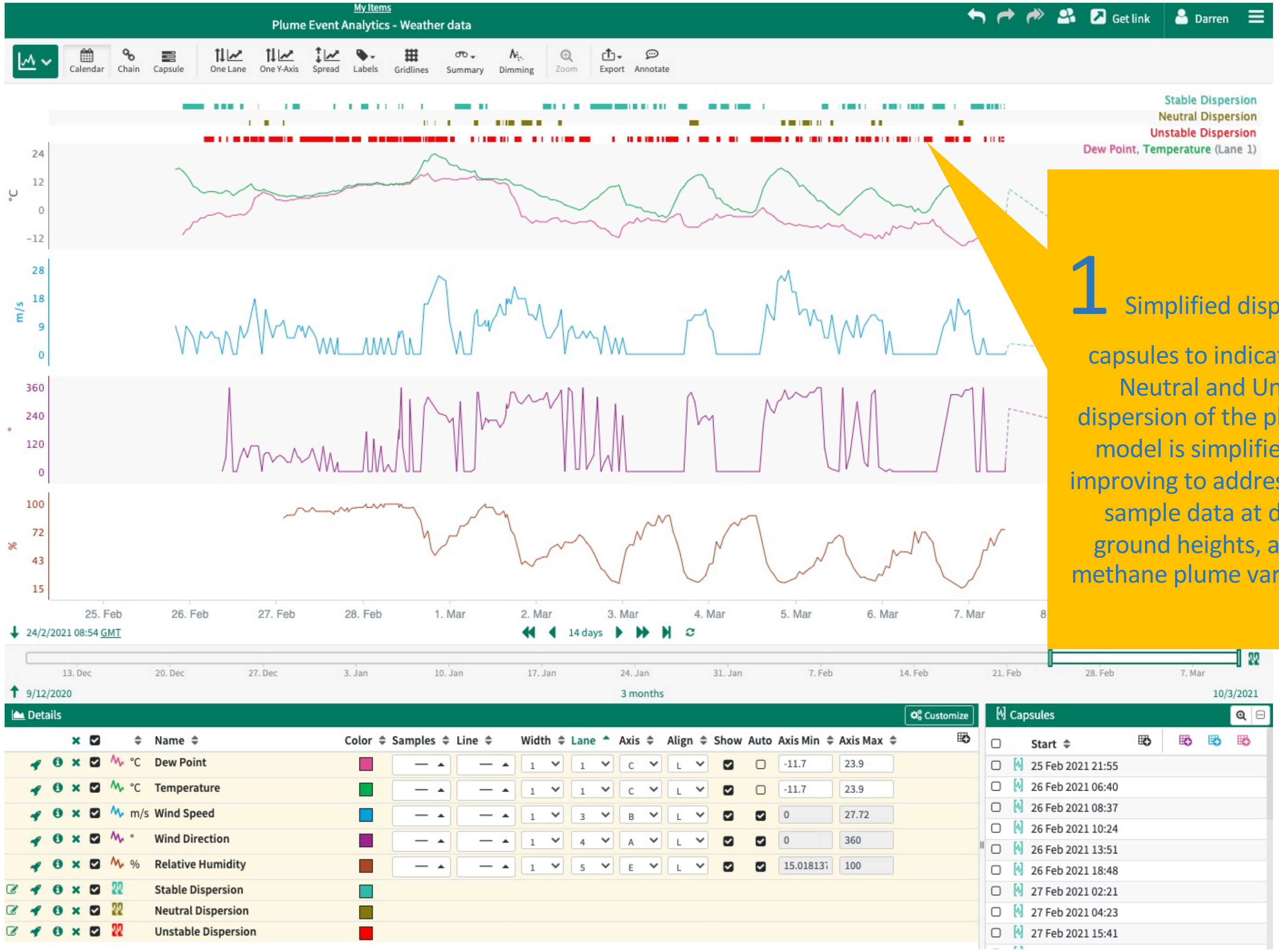
Plume Dispersion types derived from integrating NOAA Weather Data

Unstable

Neutral (Coning)

Stable (Fanning)



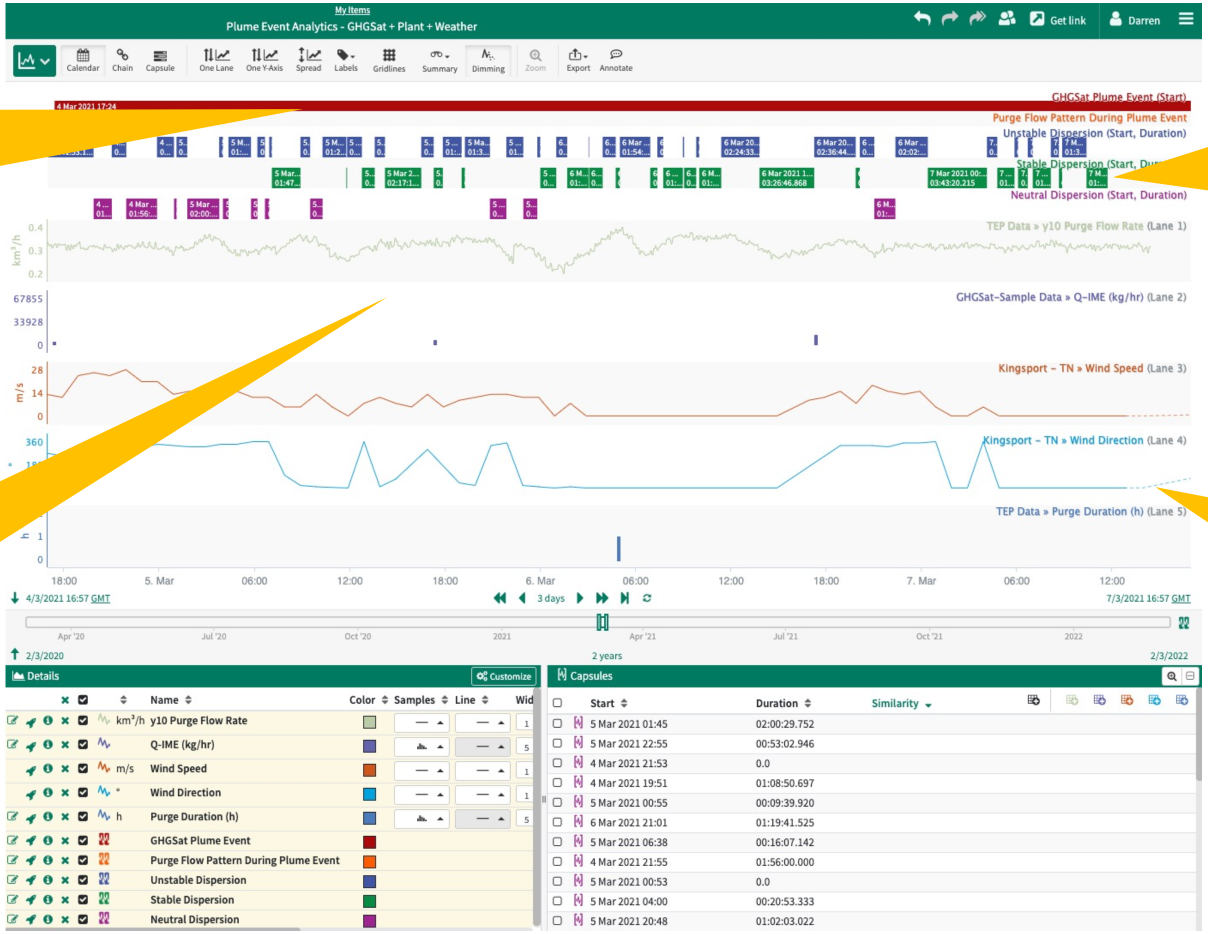


1 Simplified dispersion type capsules to indicate Stable, Neutral and Unstable dispersion of the plume. The model is simplified, needs improving to address weather sample data at different ground heights, and other methane plume variables etc..

Methane Plume Event with Predicted Dispersion Model

1 Current (ongoing) methane plume event capsule

2 Real-time Weather data feed (+/- 7 days)



3 Simplified dispersion type capsules to indicate Stable, Neutral and Unstable dispersion

4) predict the future plume dispersion behavior!

Summary

- More action on Methane is needed
- Space Data provides a viable method for detection of methane leaks.
- More satellites are needed with appropriate resolutions and higher frequency of observations
- Emergency response to methane leaks requires near real-time detection if early warning methods are not available
- Opportunity to apply analytics on integrated data sets to mitigate future leaks, but needs further research with “real-world” data to prove and validate the approach described herein.

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