GHGSat
GLOBAL EMISSIONS MONITORING

Measuring Methane Emissions using Satellite and Airborne Instruments

Toward a Tiered Observation System

EnviroTech 2019 • Calgary, AB • 25 April 2019

GHGSat uses its own satellites to monitor greenhouse gas (GHG) emissions from industrial facilities, anywhere in the world

WHY A SATELLITE?

ECONOMIES OF SCALE

Each satellite can measure any site in the world, every two weeks

EASE OF DEPLOYMENT

Can measure any site within a few days of request, as many times as needed, with no deployment cost

PERFORMANCE

Can detect and quantify emissions more precisely and at lower cost than many existing methods

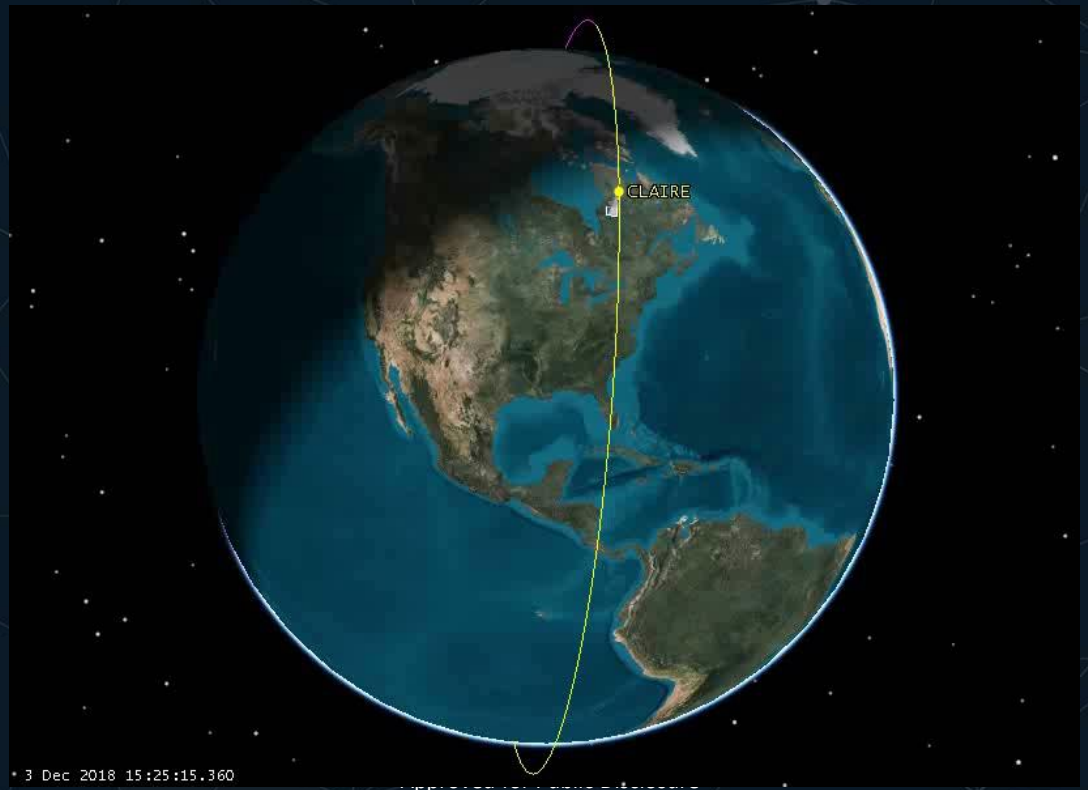
CONSISTENCY, TRANSPARENCY

Same method used for all sites, everywhere, for anyone

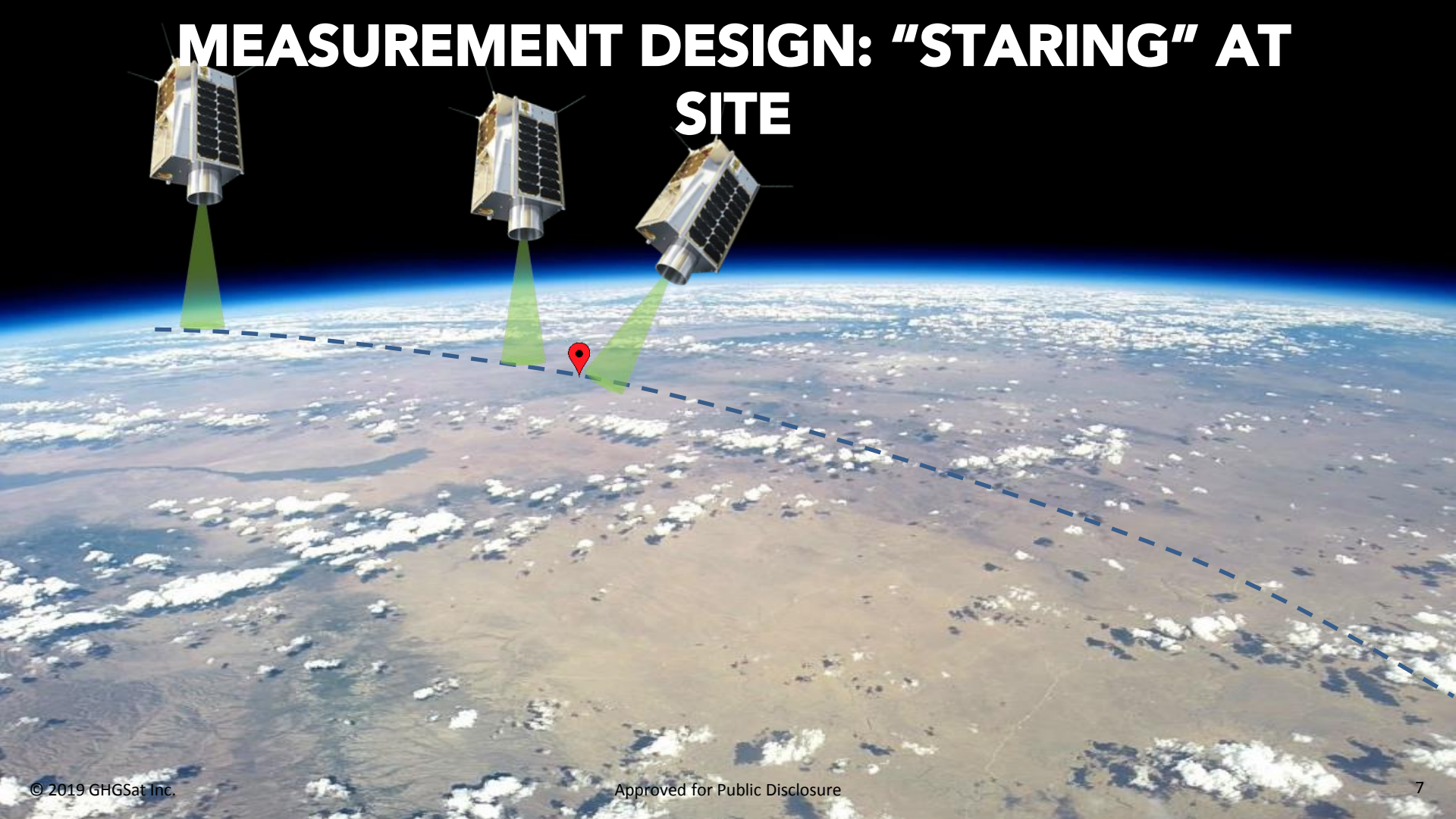
DEMONSTRATION SATELLITE: GHGSAT-D ("CLAIRE")

Launched in June 2016

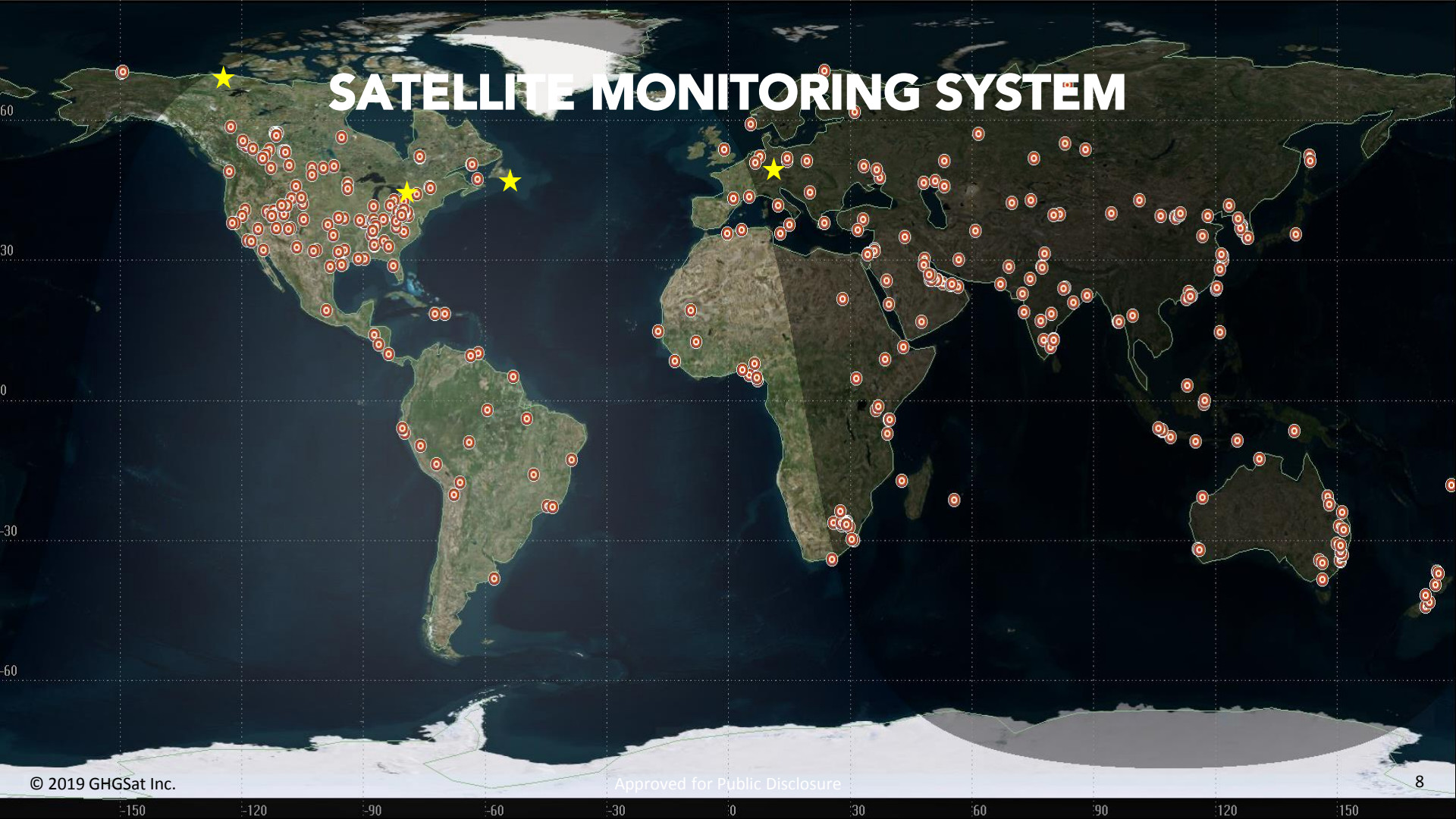
ORBIT DESIGN: EACH SATELLITE CAN MEASURE ANY SITE EVERY TWO WEEKS



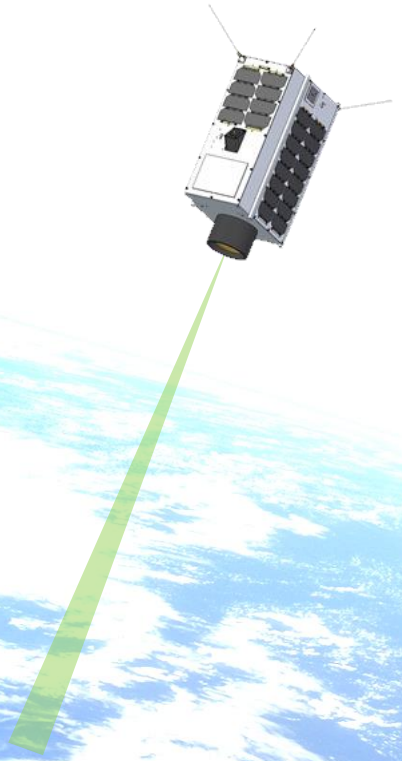
MEASUREMENT DESIGN: "STARING" AT SITE

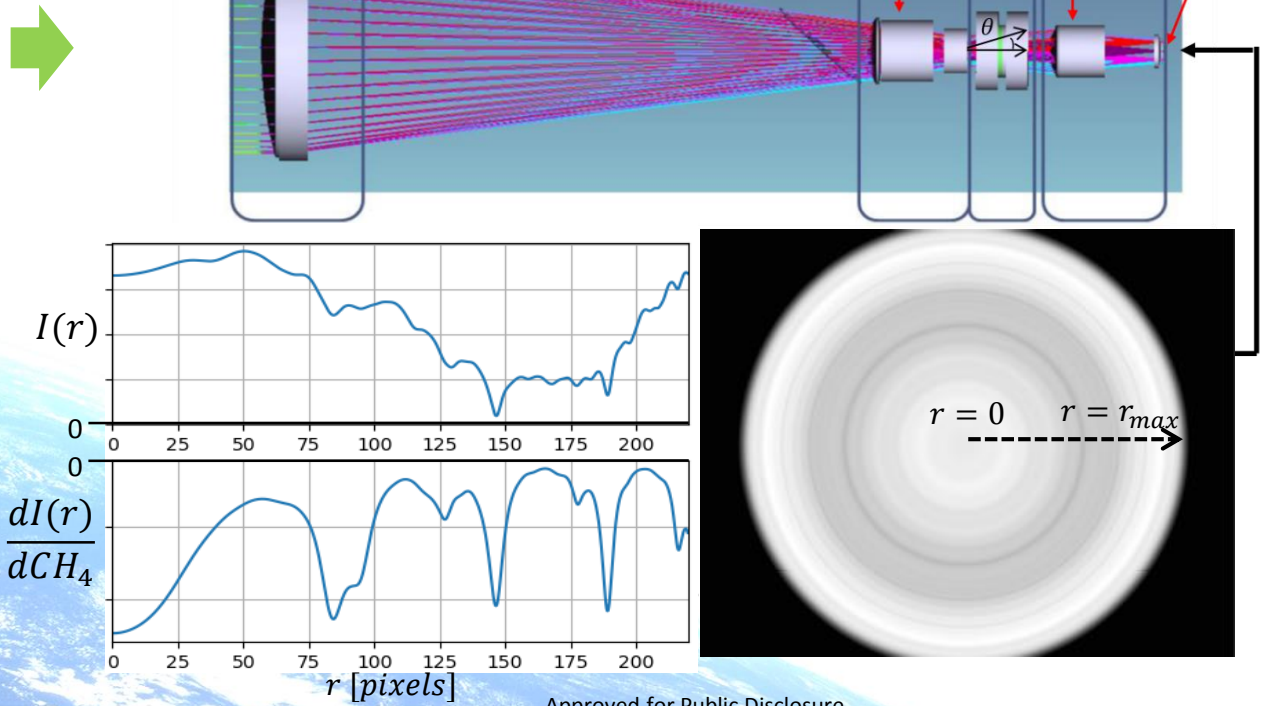


SATELLITE MONITORING SYSTEM



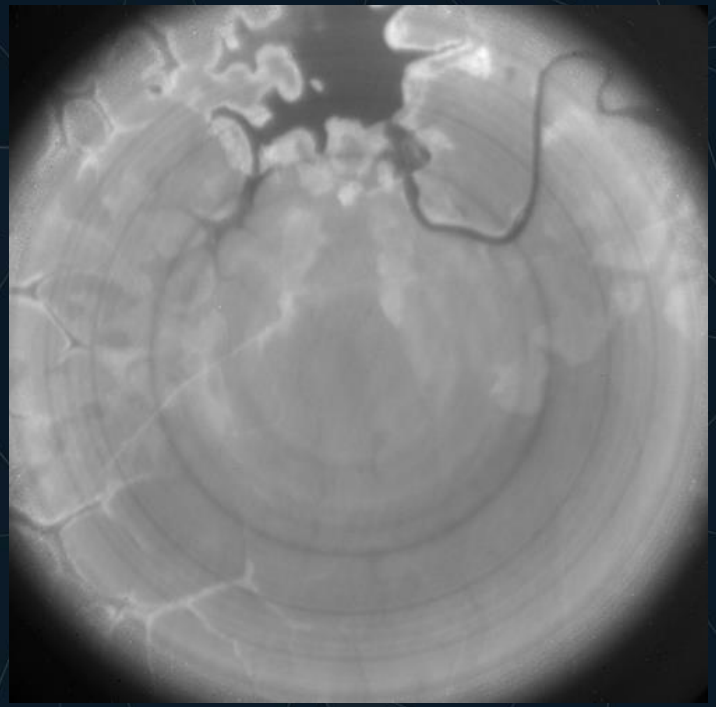
SPECTROMETER MEASUREMENT CONCEPT



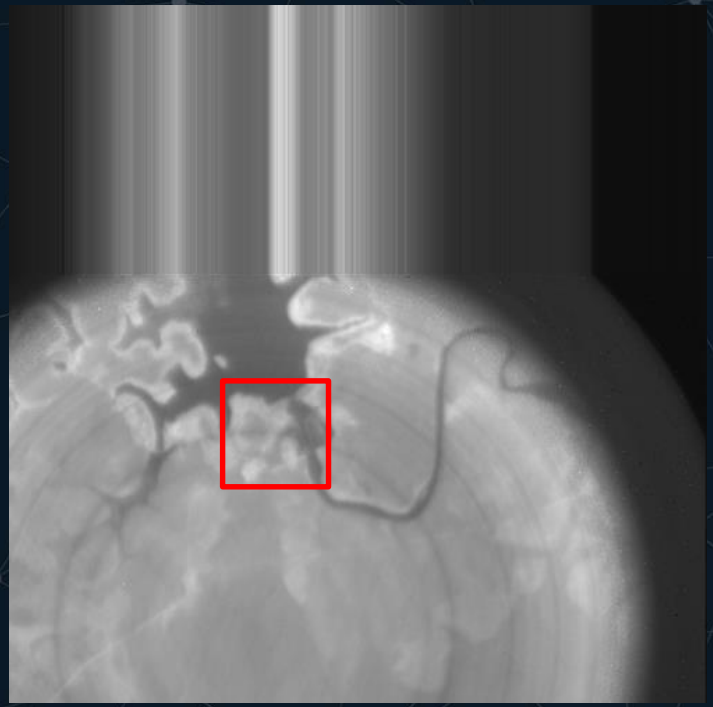


SAMPLE IMAGING SEQUENCE

IMAGE FRAME: WHAT CLAIRE SEES



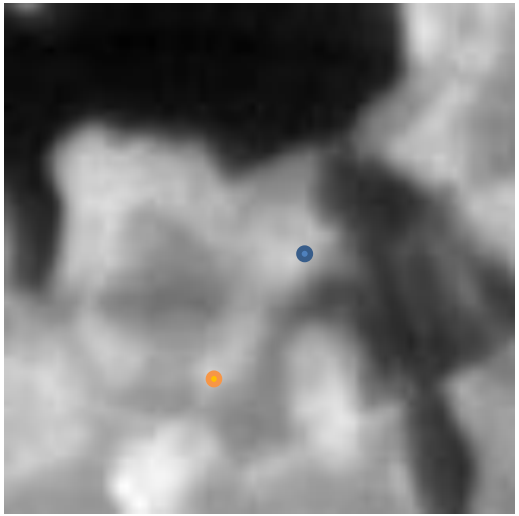
GROUND FRAME: WHAT WE NEED



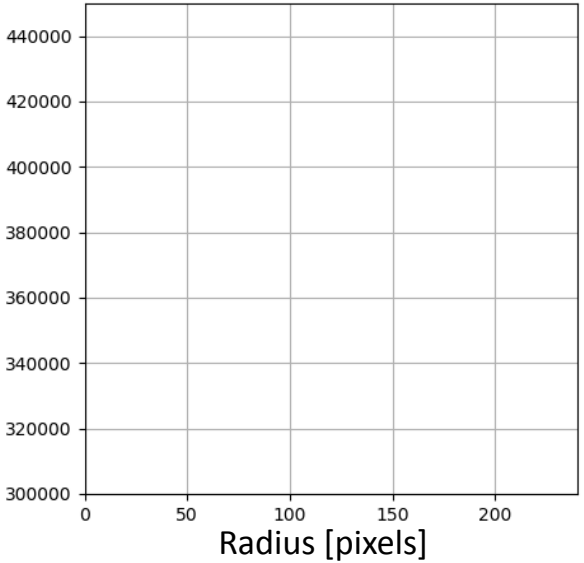
SAMPLE IMAGING SEQUENCE

GROUND FRAME: ZOOM

$2\ km$

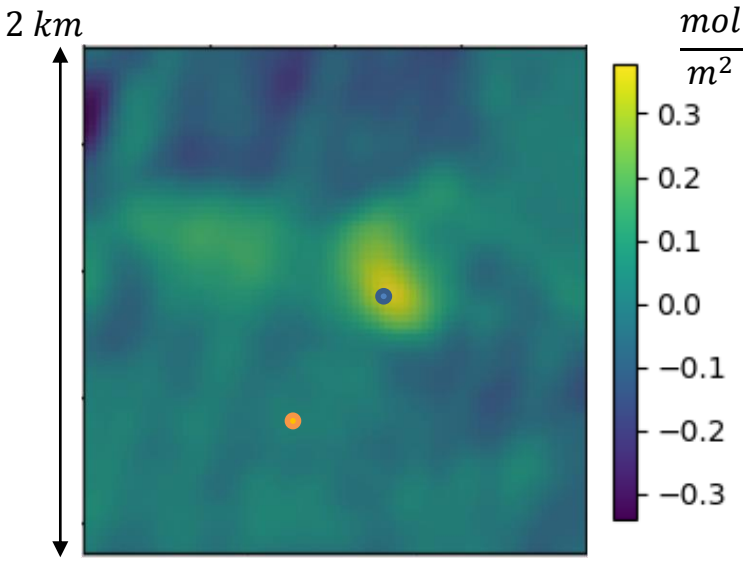


GROUND TRACE



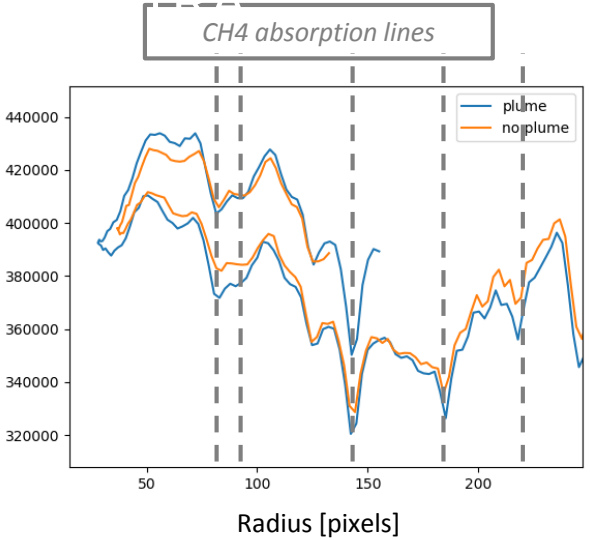
SAMPLE IMAGING SEQUENCE

RETRIEVED CH4



Nominal CH4 VCD: $0.62\ mol/m^2$

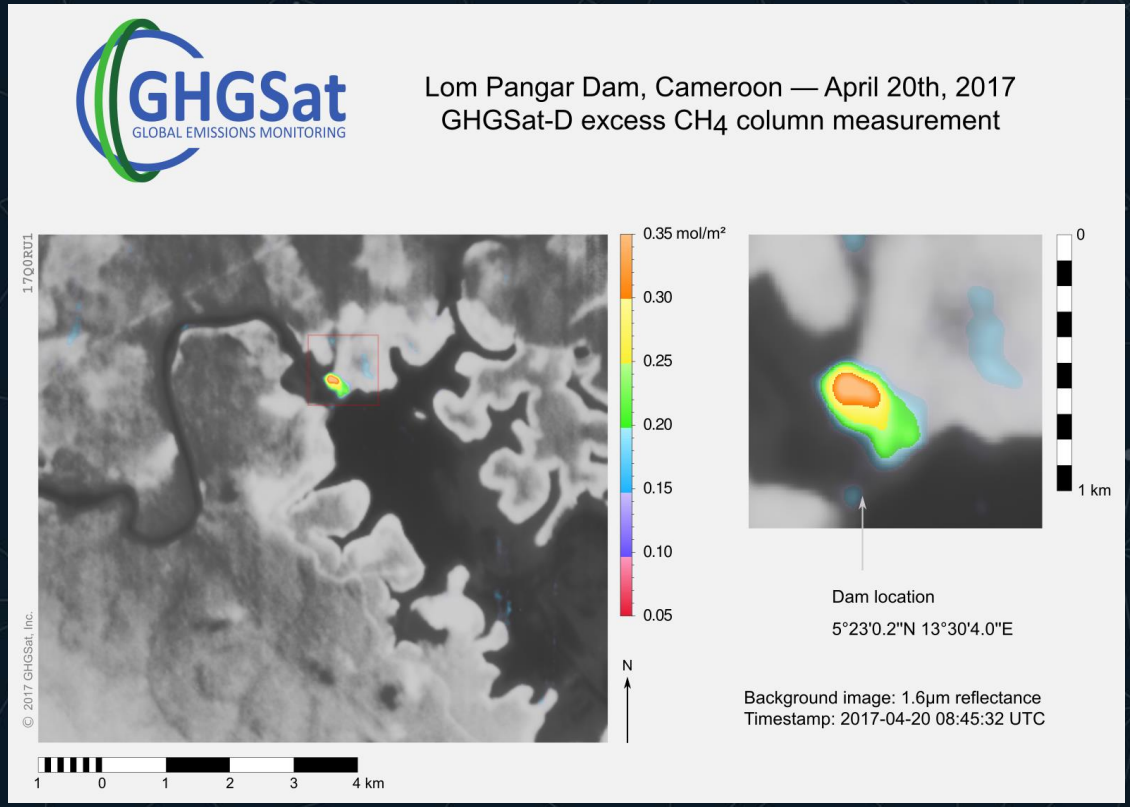
HIGH RESOLUTION CH4



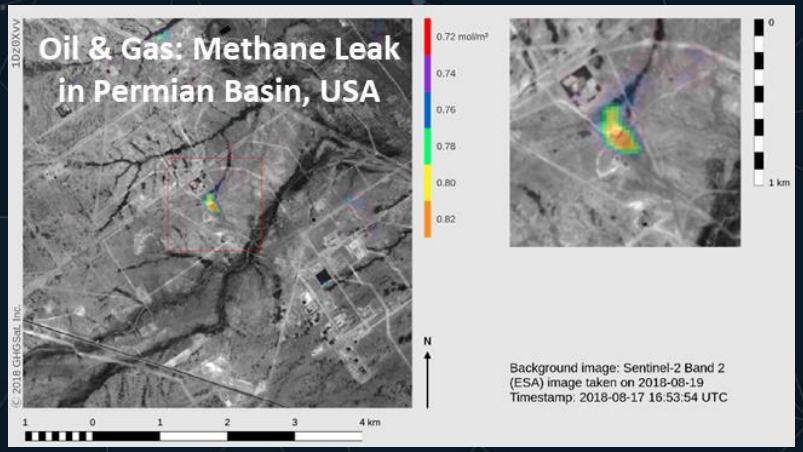
We fit ~200,000 such traces for each site observation

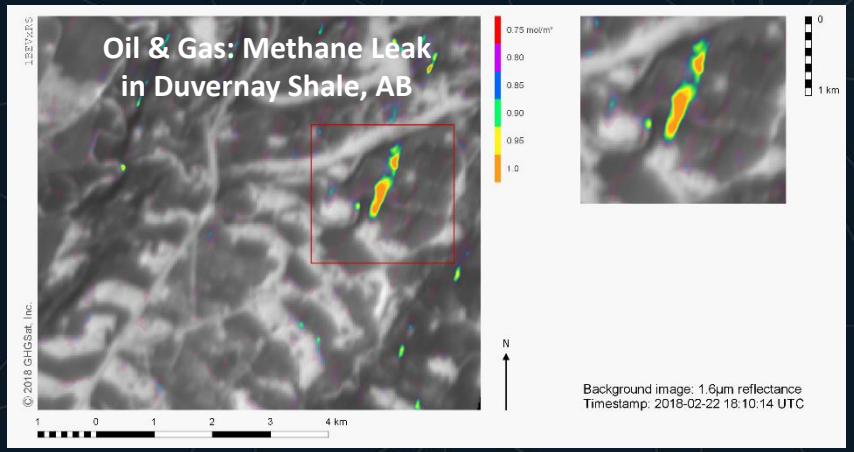
TARGETED FACILITIES: SAMPLE MEASUREMENTS

View of water flow from Lom Pangar hydroelectric dam



AREA SURVEY: SAMPLE MEASUREMENT





Typical midstream facility in Permian Basin

Typical well in Duvernay Shale

TIERED OBSERVATION SYSTEM

TIERED OBSERVATION SYSTEM ⟶ Alternative LDAR/FEMP

Objective is to detect big leaks, fast (Largest 5% of leaks = 50% of methane leaked by volume)

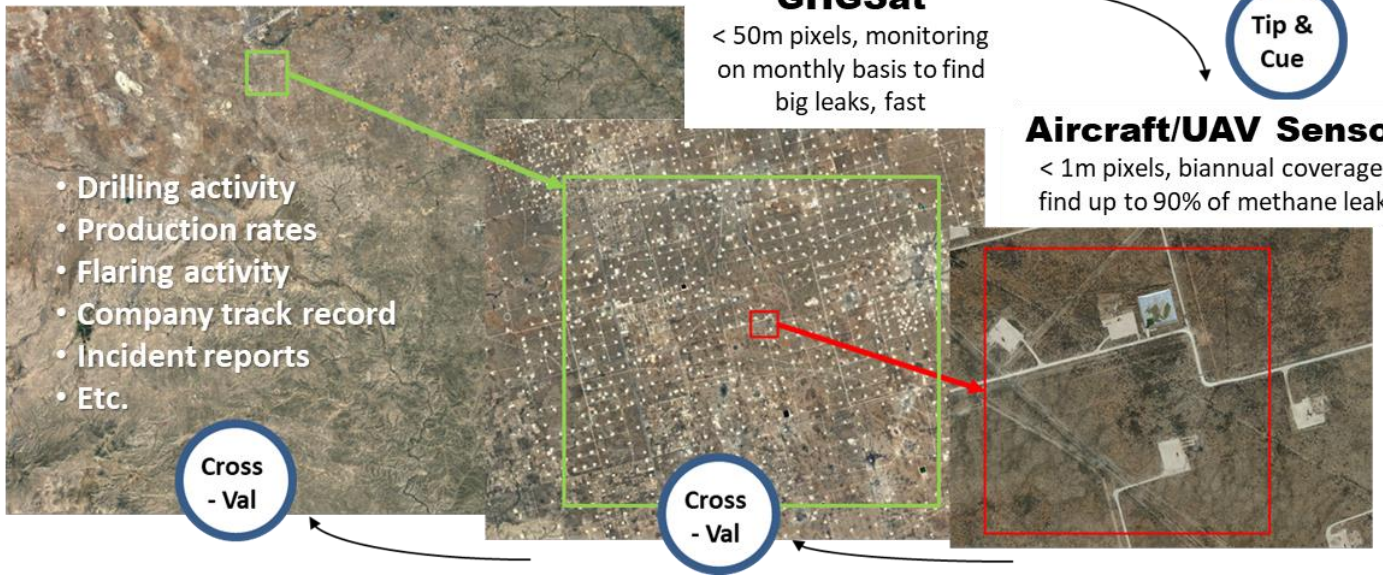
Analytics
AI with data from GHGSat and third-parties to predict areas at higher risk of emissions

Tip & Cue

GHGSat
< 50m pixels, monitoring on monthly basis to find big leaks, fast

Tip & Cue

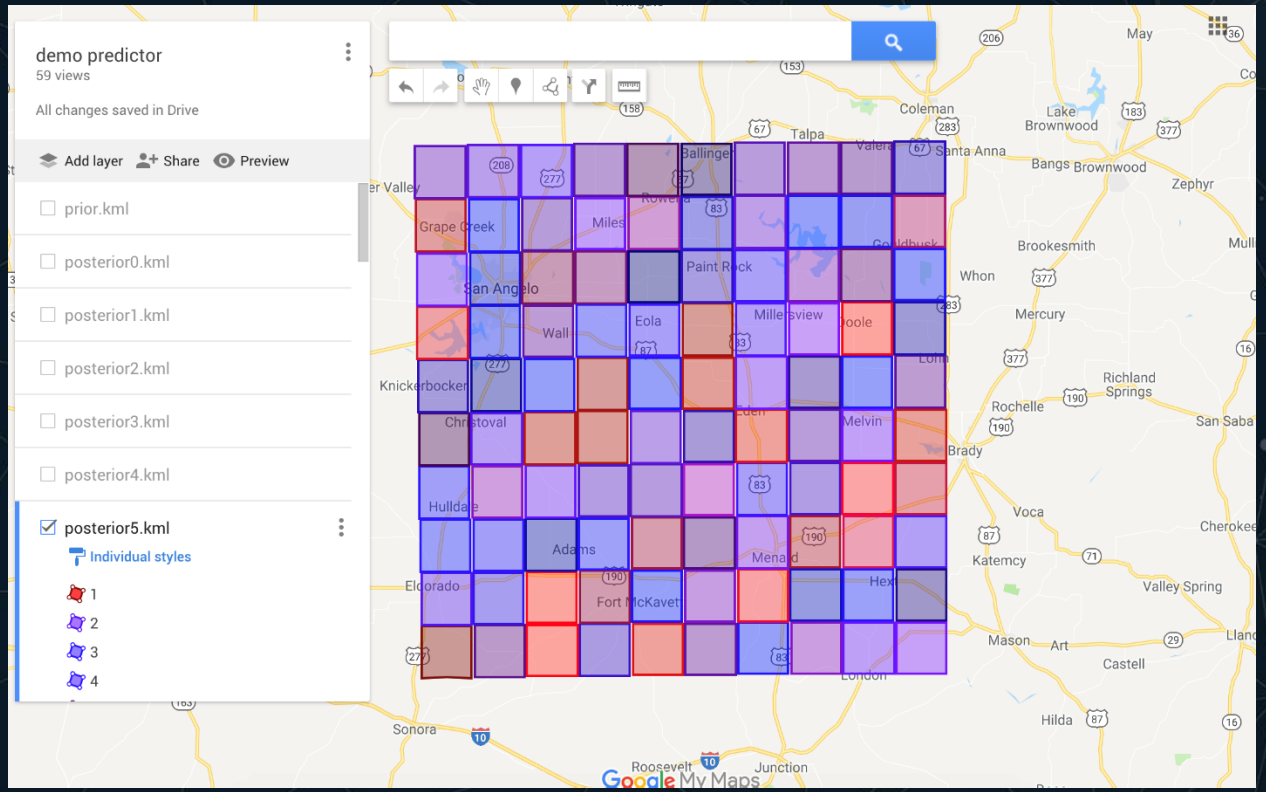
Aircraft/UAV Sensors
< 1m pixels, biannual coverage to find up to 90% of methane leaked



Truck Dispatch
Find last 10% and perform repairs as needed

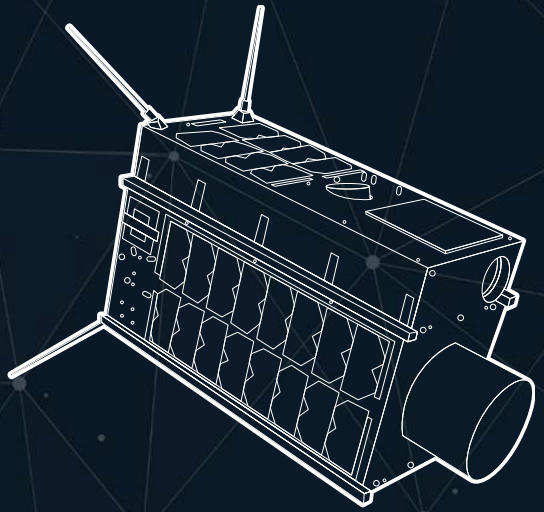
AREA SURVEYS: PREDICTIVE ANALYTICS

- AI with data from GHGSat and third-parties to predict areas at higher risk of emissions
- Example
  - 10x10 GHGSat observations
  - Red = high risk
  - Blue = low risk
  - Probability changes as AI learns

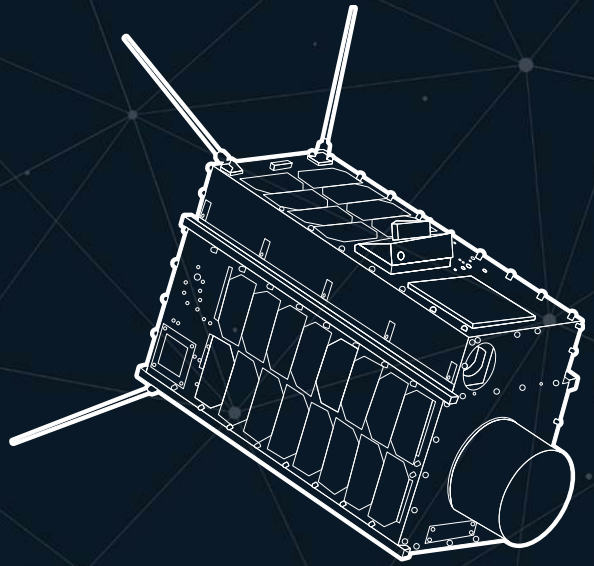


Approved for Public Disclosure

NEXT SATELLITES: **BUILDING ON LESSONS LEARNED**



GHGSat-D

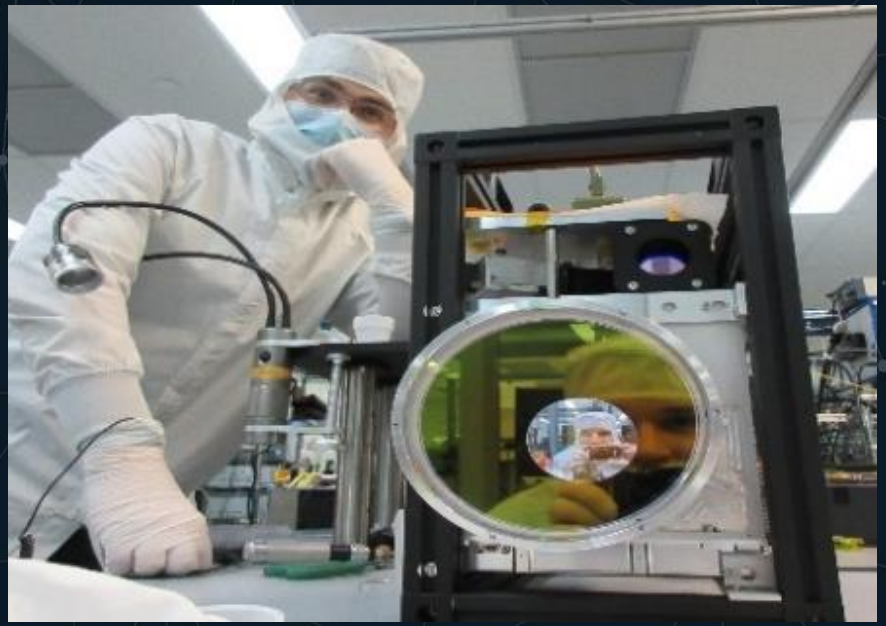


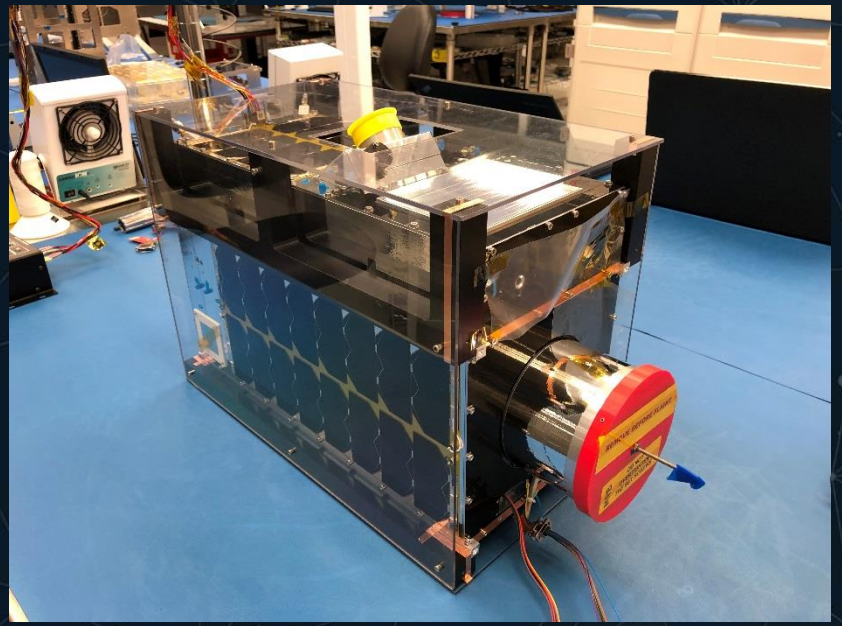
GHGSat-C1

Targeting Order of Magnitude Performance Improvement (detection threshold and precision):

- Optimized spectroscopy
- Onboard calibration
- Optical design improvements
- Radiation shielding improvements

INTRODUCING: GHGSAT-C1 (“IRIS”)

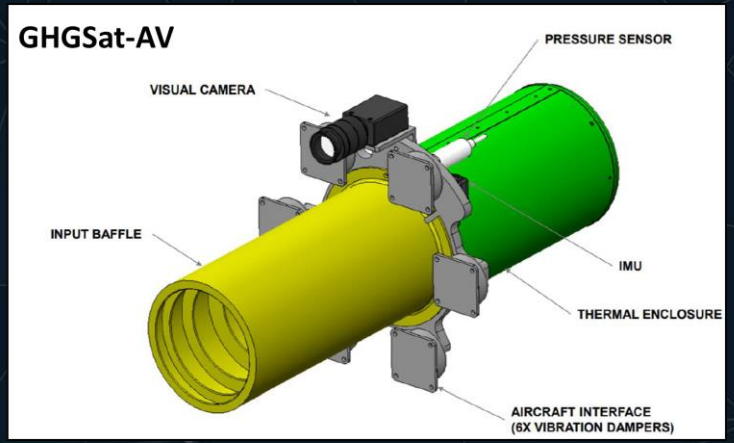


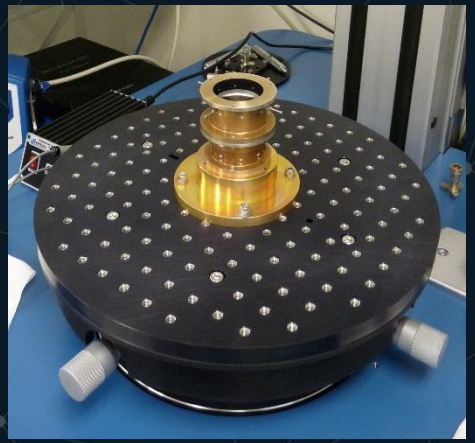


Launching in August 2019

AIRBORNE VARIANT INSTRUMENT: **GHGSAT-AV**

Same instrument concept as satellites, adapted for airborne operations



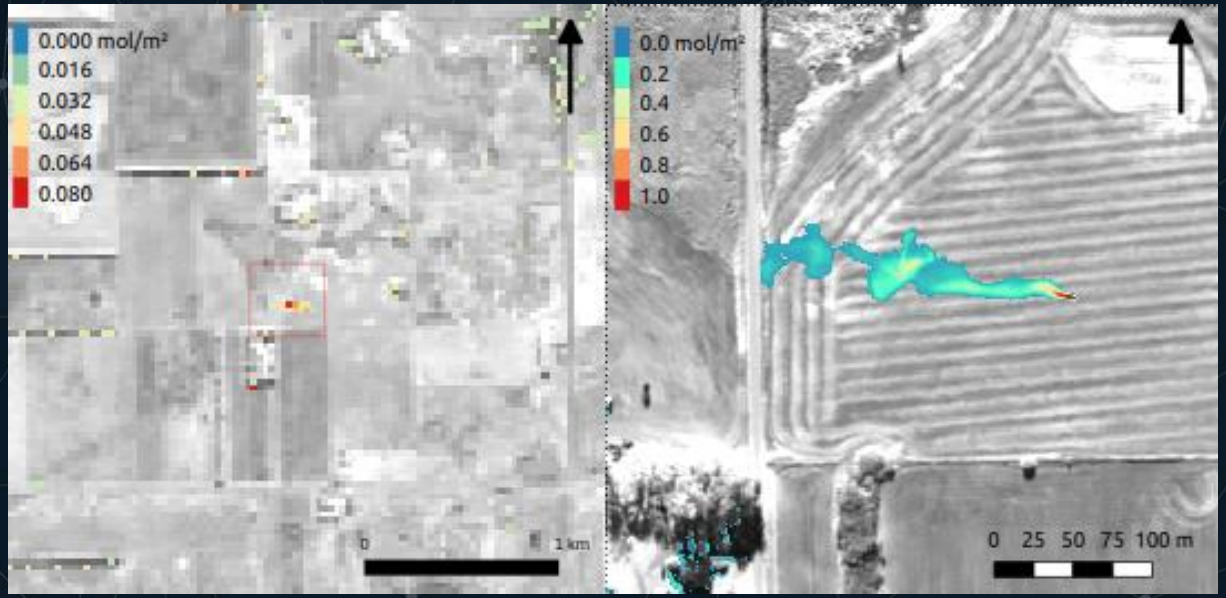


- Optimized for methane
- Custom fore-optics with wide angular FOV
- Stray light control including input baffle
- Vibration isolation for airborne environment

- Prototype designed for fixed-wing airplane
- Design can be adapted for drone operations

AIRBORNE VARIANT INSTRUMENT: **GHGSAT-AV**

Targeting an order of magnitude lower detection threshold than C1 satellite



Simulated plume as seen by C1 Satellite (left) and Airborne Instrument (right)

Airborne Operations

- 120 knots
- 10,000 ft AGL altitude
- over 500 m swath width
- spatial resolution < 1 m

TIMELINE FOR NEXT INSTRUMENTS: GHGSAT-AV, C1, C2

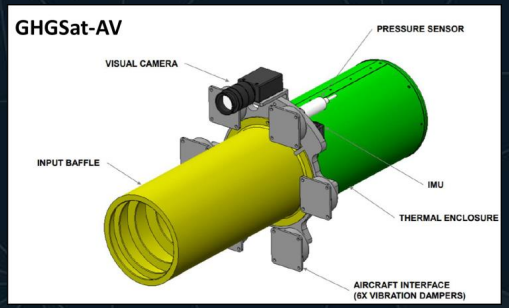
Aug ’19
Launch GHGSat-C1

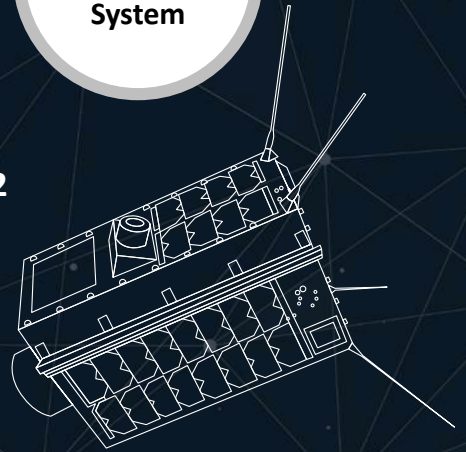
Demonstration of the Satellite - Aircraft hybrid system (C1 / AV)

Tiered Observation System

Q3’19
GHGSat-AV ready for flights

H1’20
Launch GHGSat-C2





Concluding Remarks

Actionable data enables industrial operators to better measure, control, and ultimately reduce emissions

Satellites are an excellent platform for emissions monitoring

- Global coverage
- Fast revisit times
- No ground deployment risks/costs

GHGSat well positioned to continue pioneering role in satellite emission monitoring

- Expanding capacity with a constellation of satellites
- Tiered observation system: satellites + airborne instruments + analytics

Thank you

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