### \* AUDIOVISUAL SERVICES \* PROVIDED BY

### METRUNET

### \* THIS SESSION \* IS SPONSORED BY





## **★ DAMAGE PREVENTION** ★ TRAINING CONFERENCE

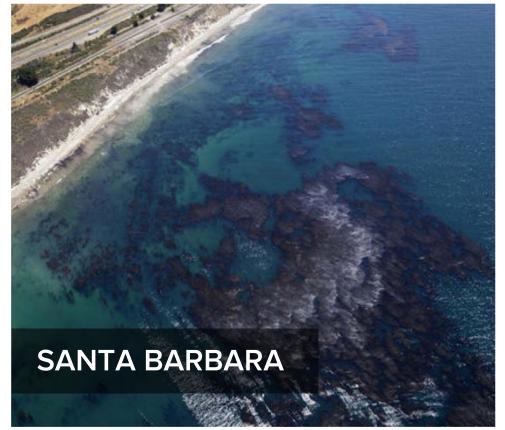
### LAUNCHED! MONITORING SOLUTIONS FOR INFRASTRUCTURE OPERATORS FROM THE SPACE ECONOMY

Thursday November 11, 2021
Session Block 1
10:10 – 11:00 am
French Lick, Indiana



R. Peter Weaver peter@orbitalsidekick.com (985) 237-3306

# Pipelines Are Everywhere, and They're Aging









# Energy Infrastructure Monitoring has been Hovering in the Past



#### **SUBJECTIVE MONITORING**

What the pilot might see:



#### **COMPLIANCE REPORTING**

What the operator might get:

Date	Observation Report	Method	Time	Reported To:
1/1/2019	No previously unreported activity.	Phone	12:08 PM	Name
1/8/2019	No previously unreported activity.	Phone	11:53 AM	Name
1/15/2019	No previously unreported activity.	Phone	10:30 AM	Name
1/22/2019	No previously unreported activity.	Phone	2:11 PM	Name
1/29/2019	No previously unreported activity.	Phone	1:17 PM	Name
2/5/2019	No previously unreported activity.	Phone	12:30 PM	Name
2/12/2019	No previously unreported activity.	Phone	11:31 AM	Name
2/19/2019	No previously unreported activity.	Phone	11:27 AM	Name
2/26/2019	No previously unreported activity.	Phone	2:17 PM	Name
3/5/2019	No previously unreported activity.	Phone	11:27 AM	Name





# Global Persistent Monitoring With Hyperspectral Satellites



#### **GHOSt SYSTEM**

HSI Satellite Constellation Daily Monitoring

#### SPECTRAL INTELLIGENCE<sup>TM</sup>

Proprietary Chemical Fingerprinting





RGB Image No Hydrocarbon Detected

Hyperspectral Image
Hydrocarbon Detected

#### SIGMA<sup>TM</sup> USER PLATFORM

Global Monitoring Application

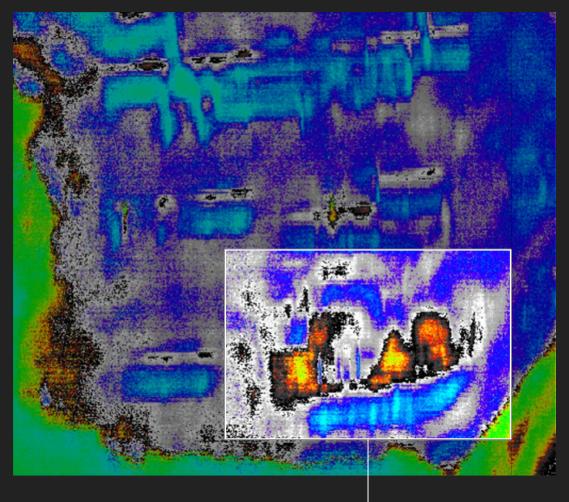




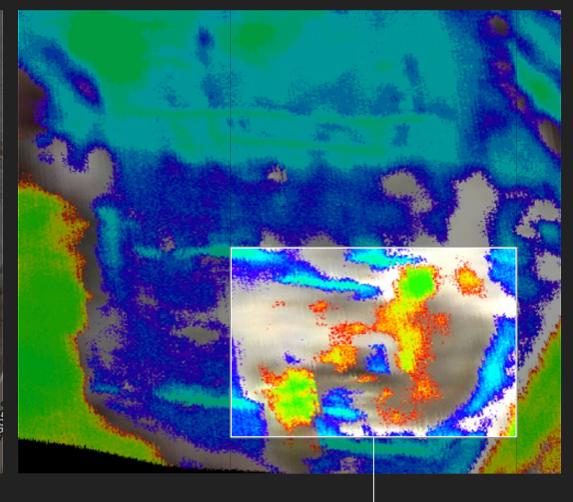


### Underground Gas Leak

### CHANGE DETECTION AND SOIL DISTURBANCE







Issue detected

Issue is not visible in standard view

View after repair







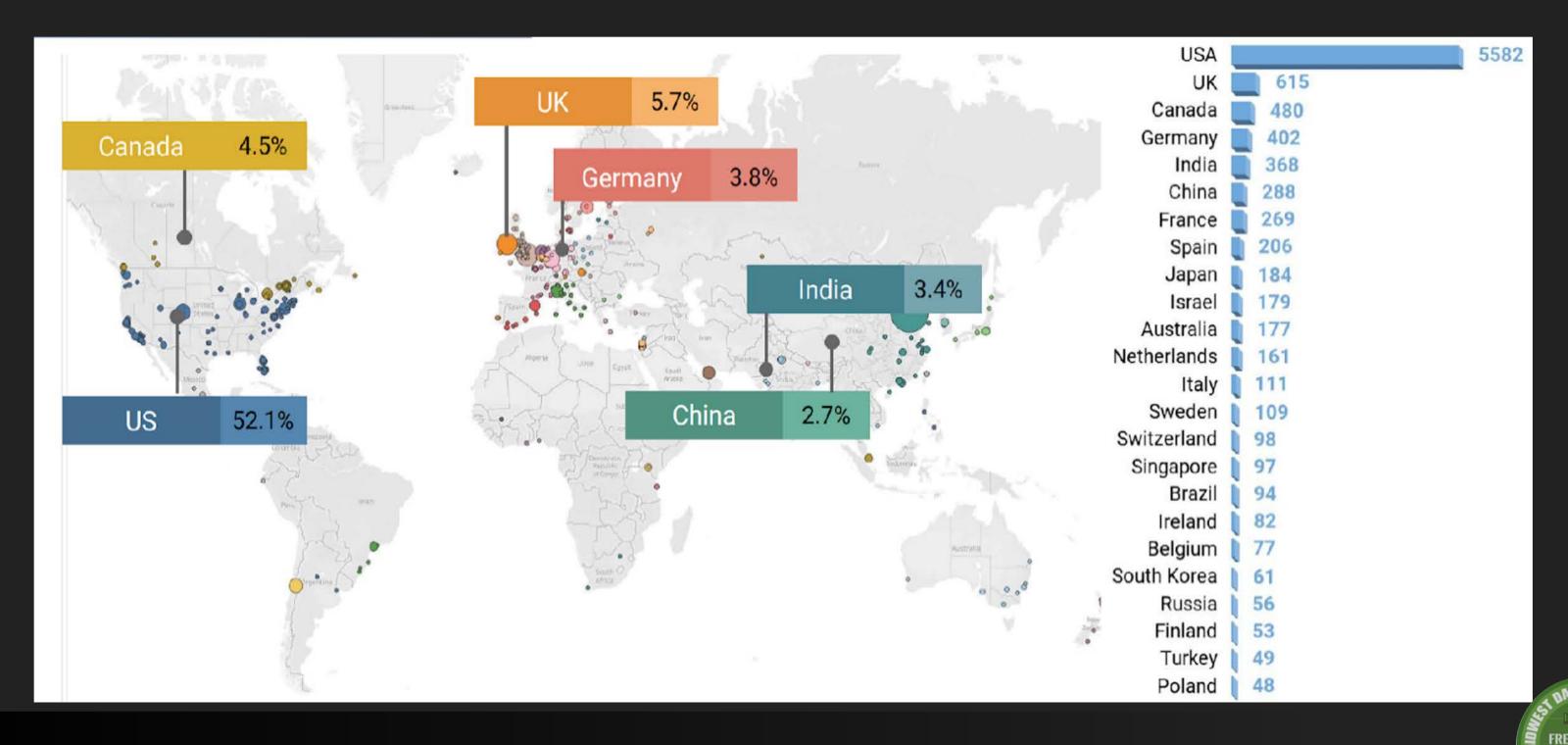
Today's
SpaceTech
Ecosystem
Represents
>\$4 Trillion

Governmental Organizations - 130 Global SpaceTech Ecosystem Landscape Overview 2021 / Q2 R&D Hubs and Associations - 150 Navigation & Mapping Companies - 10 000 Investors - 5 000 **Natural Resourses** Space Travel & Exploration **Education & Training** Spacecraft Development **Cloud Solutions** Security & Defence **Data Solutions** Companies Al Solutions Investors **Hubs and R&D Centres Governmental Organizations** Science & Engineering Manufacturing Robotics & UAV **5G Communications** Software & Hardware Service & Consulting SpaceTech **Analytics** Material & Product Supply Satellite Communication

https://www.spacetech.global/mindma



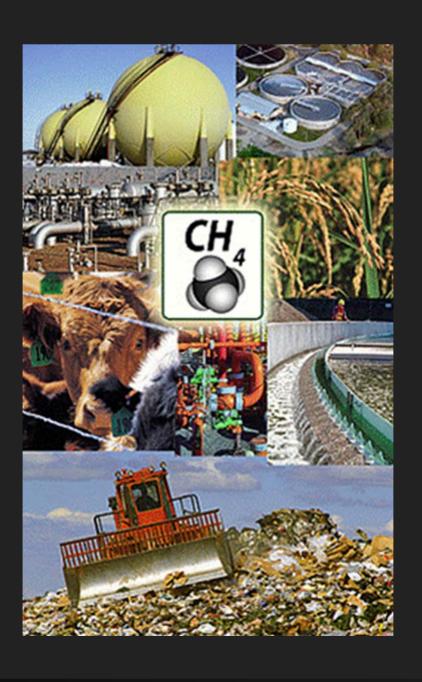
### Regional Distribution of Satellite Companies 2021 (by no. companies)





### What are the implications for managing how I do my job?









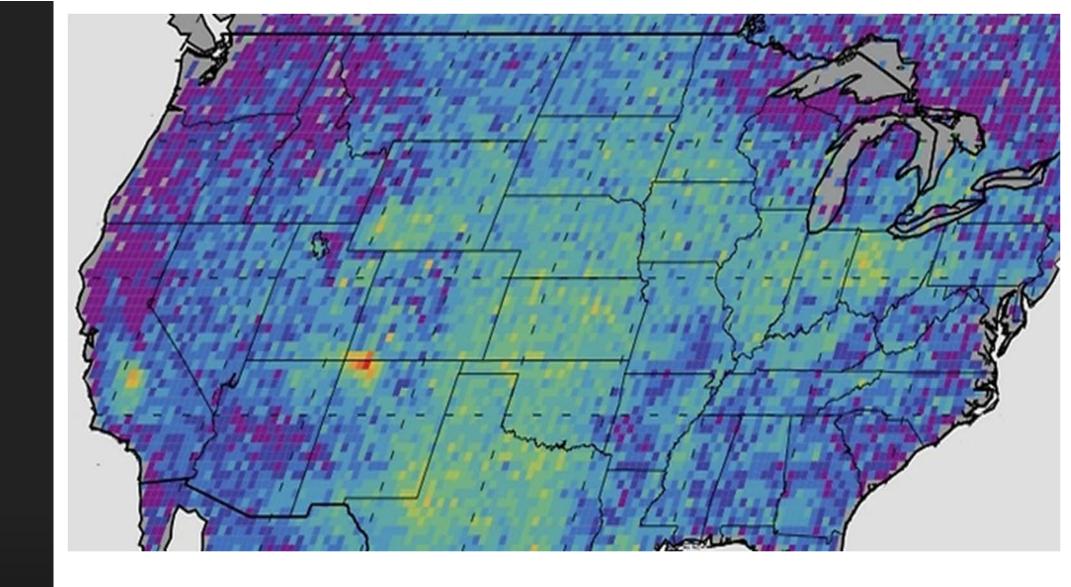




### Four Corners: (Reported 2012)

### The First & Largest Methane Anomaly Detected from Space

- ESA SCIAMACHY Sensor
- 2003 2009 Collection,
   results averaged
- 30 km x 60 km pixel

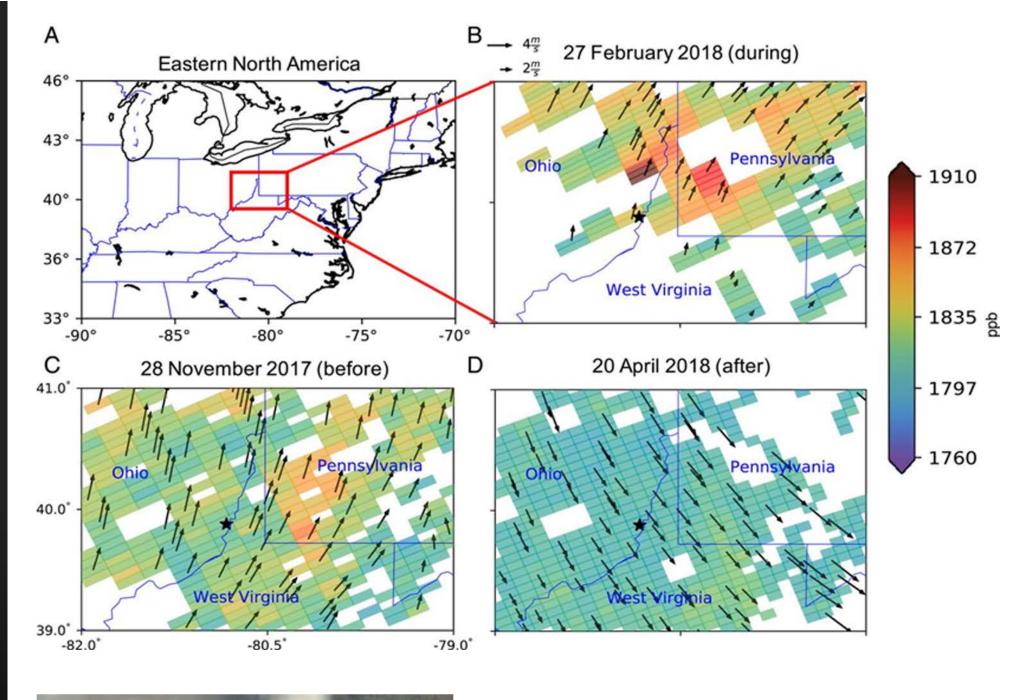






### Belmont County, OH (Feb. 2018)

- ESA Sentinel-5P Sensor
- Wellhead blowout, 120 tph for 20 days
- Detection by a single observation
- 7 km pixel



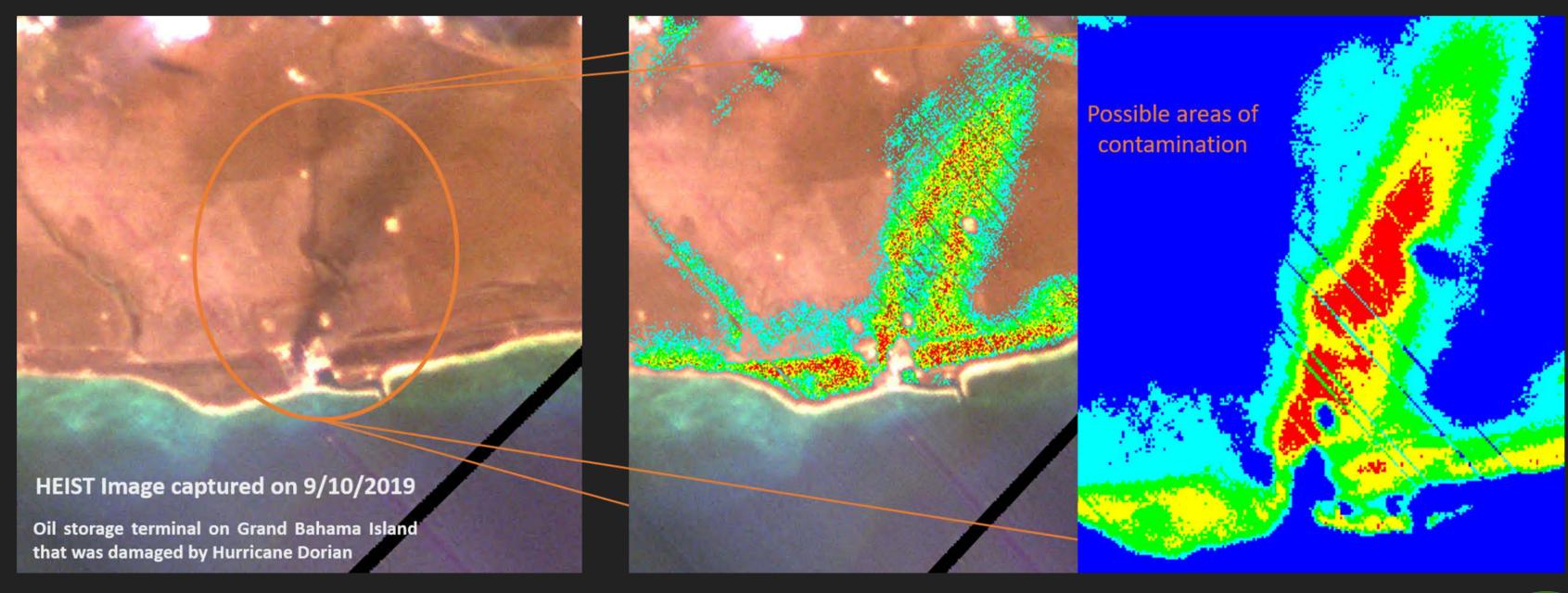






### Grand Bahama Island, Hurricane Dorian (Sep. 2019)

### **ISS-HEIST**

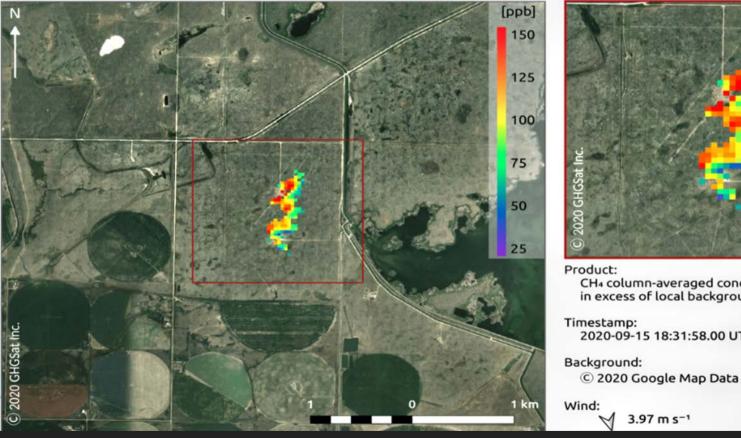


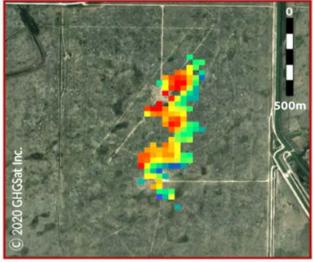






#### Controlled Release, Alberta - Canada GHGSat-C1 - CH4 Measurement





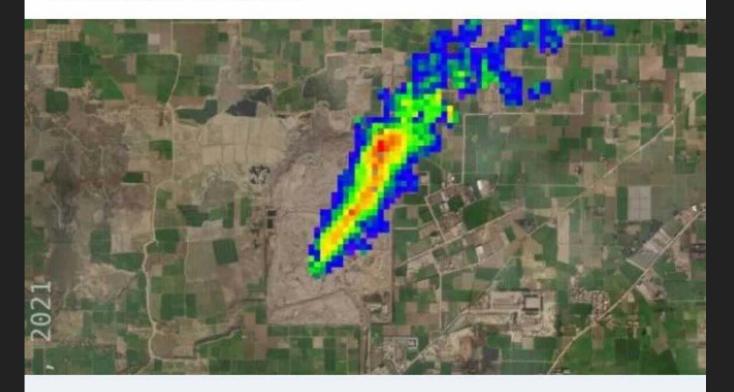
CH<sub>4</sub> column-averaged concentration in excess of local background level

2020-09-15 18:31:58.00 UTC



+ Follow

"Following Maasakkers' work, geoanalytics firm GHGSat, which offers higher resolution detection, captured a large methane plume on July 1 from Lakhodair landfill. 🦬 The rate of release was about 4 tons per hour, which GHGSat captured using its own commercial satellites."



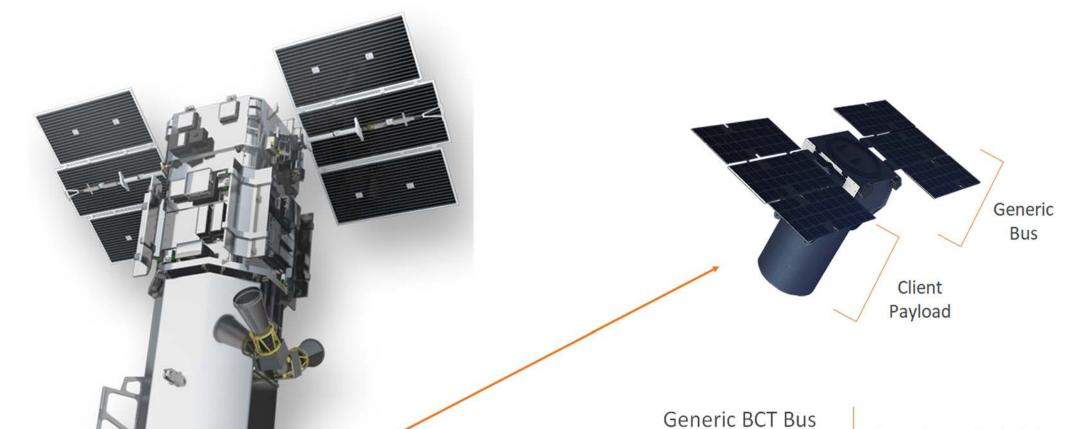
### Methane Plumes in Pakistan Put Landfills in the Spotlight - BNN Bloomberg

bnnbloomberg.ca 6 · 3 min read





# The Future of Earth Observation Satellites



World View 3

Commercial Custom Satellite

Weight: 2800 kg

Cost: \$680M

Launched: 2014

Planned Mission Life: 7.25 years

Commoditized Satellite

Weight: upto 250 kg

Cost: <\$5M

Launched: 2019

Planned Mission Life:

2-5 years

Can swap with any number of payloads (Systems of Systems approach)

- High resolution panchromatic
- Multispectral
- SAR
- Hyperspectral
- Thormal





### SPACEX

#### **Transporter-2 Deployments** PACE-1 17. Third ICEYE Satellite NewSat-19 18. LINCS-1 19. Mandrake-2 Able First ICEYE Satellite **TROPICS Pathfinder** 20. Fourth ICEYE Satellite 21. First SpaceBEE Cluster **GNOMES-2** 22. Second SpaceBEE Cluster Tyvak-0173 Second ICEYE Satellite 23. D2/AltaCom-1 Tyvak-0211 24. LEMUR Number 1 YAM-3 25. NewSat-22 10. TUBIN 26. YAM-2 11. UmbraSAR 27. LEMUR Number 2 12. ION Satellite Carrier 28. Mandrake-2 Baker 29. Sherpa-FX2 13. LINCS-2 14. NewSat-20 30. Sherpa-LTE1 15. NewSat-21 31. Starlink 16. Capella SAR Satellite 537 T+00:56:45 STAGE 2 TELEMETRY ► ► I ■ • LIVE ● □ 棒 # >





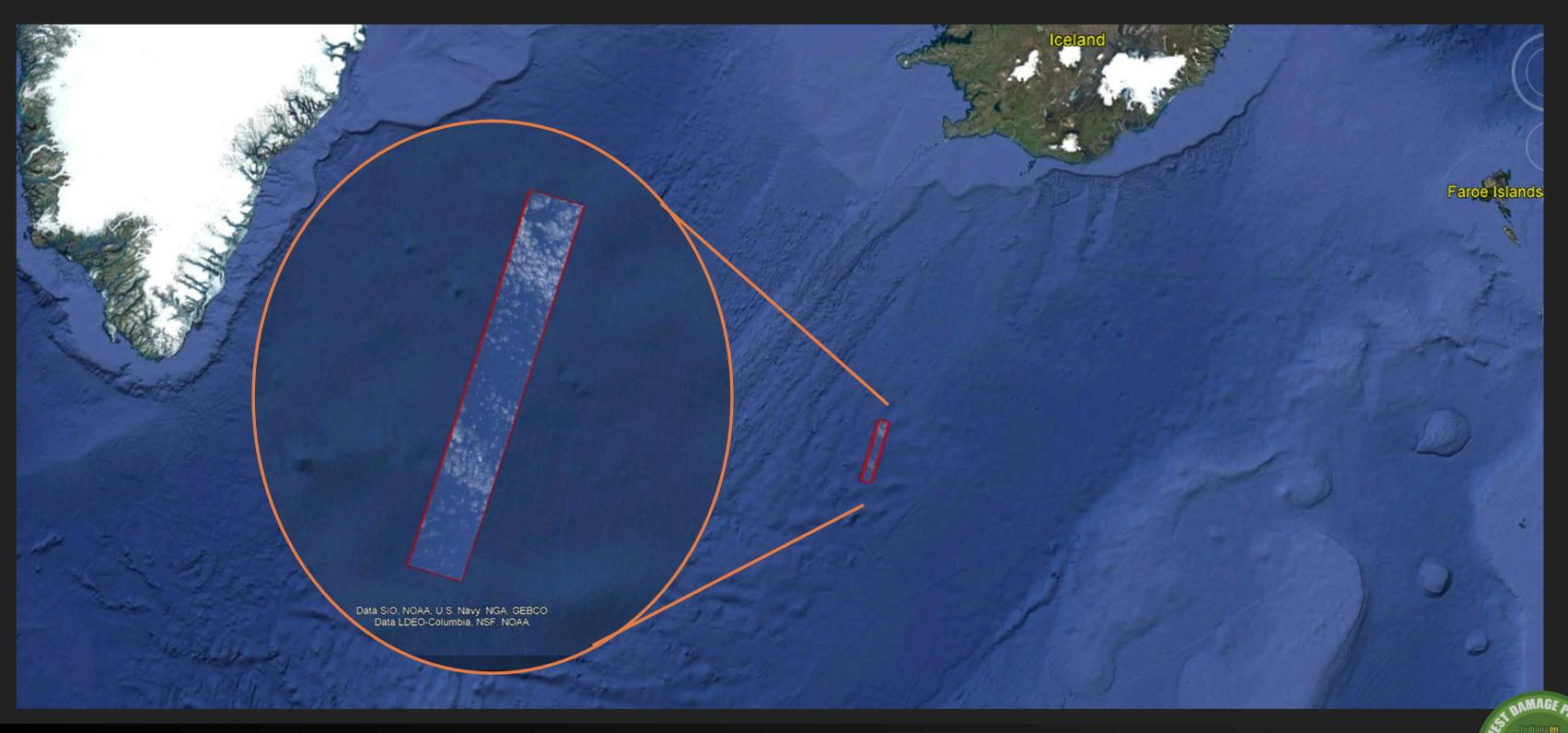
### Sherpa LTE-1 (aka. OSK "Aurora"), 30 June 2021



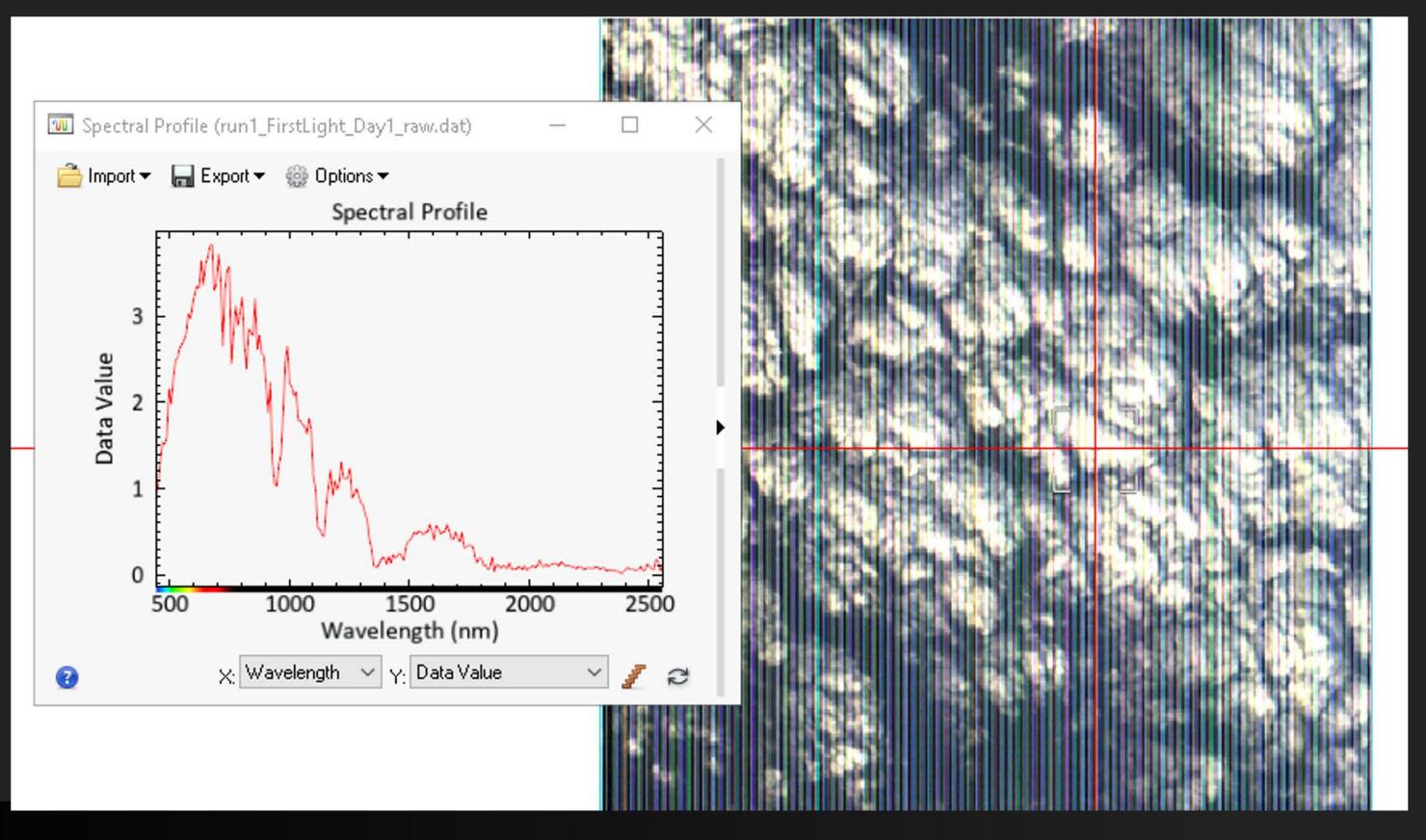




### OSK Aurora "First Light" – 17 October 2021

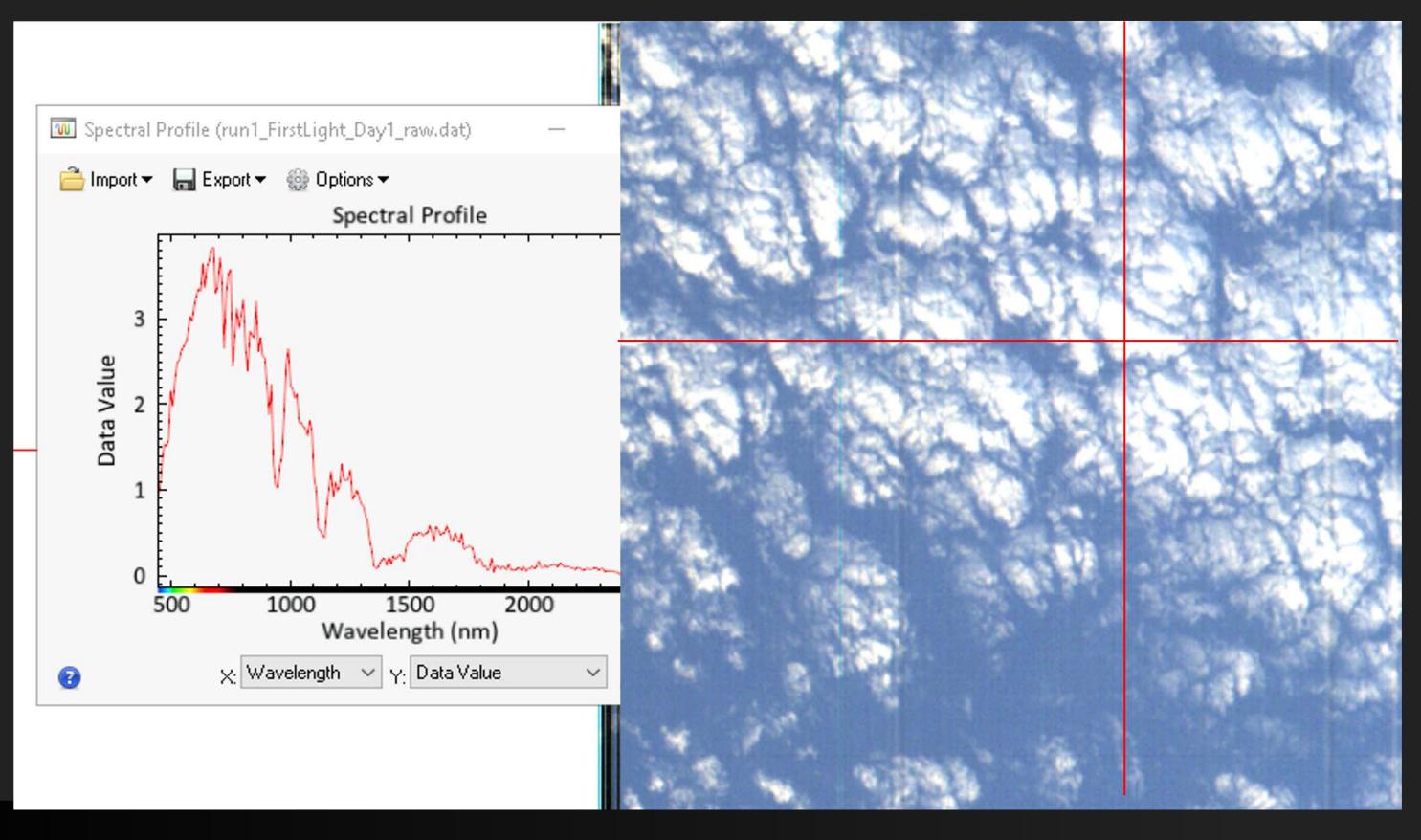






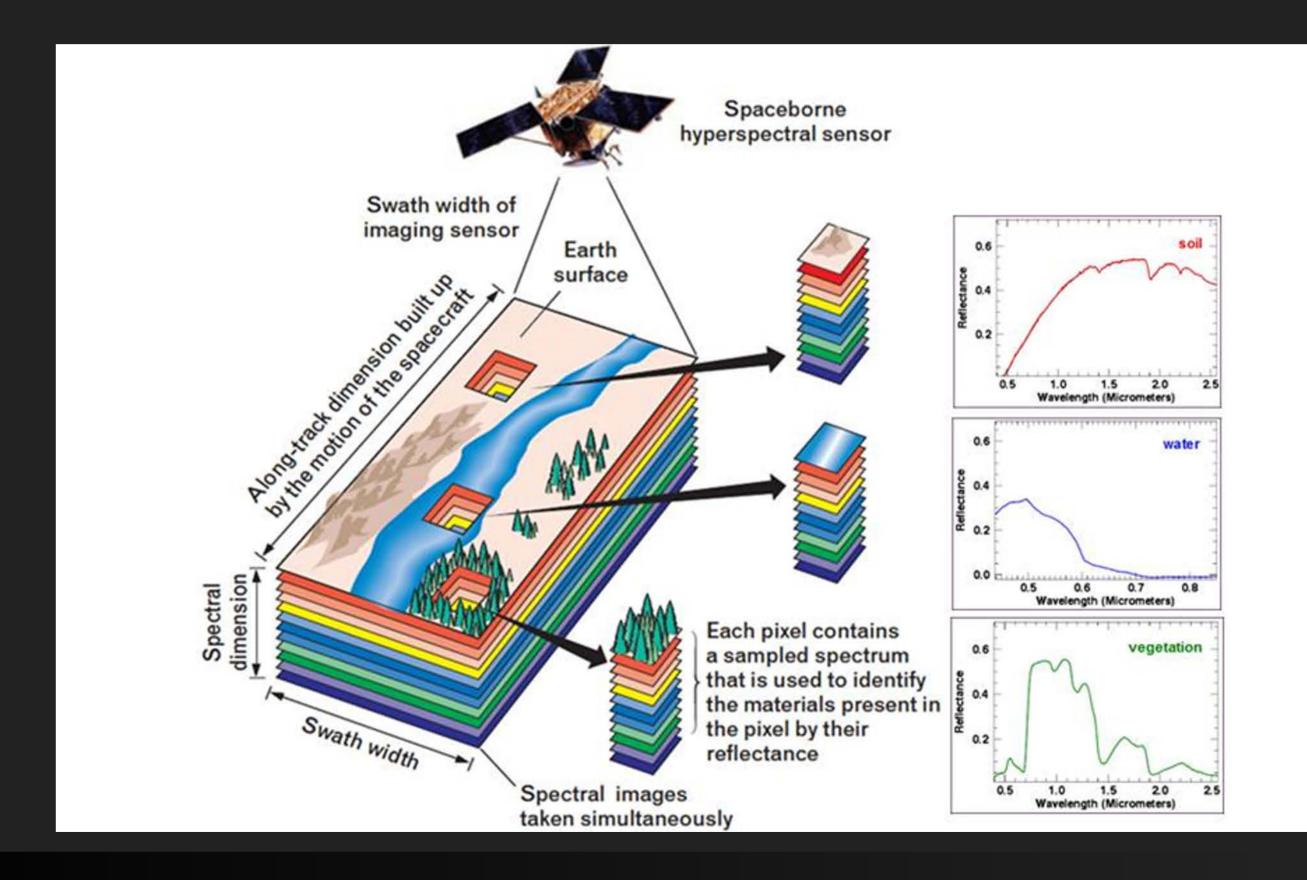






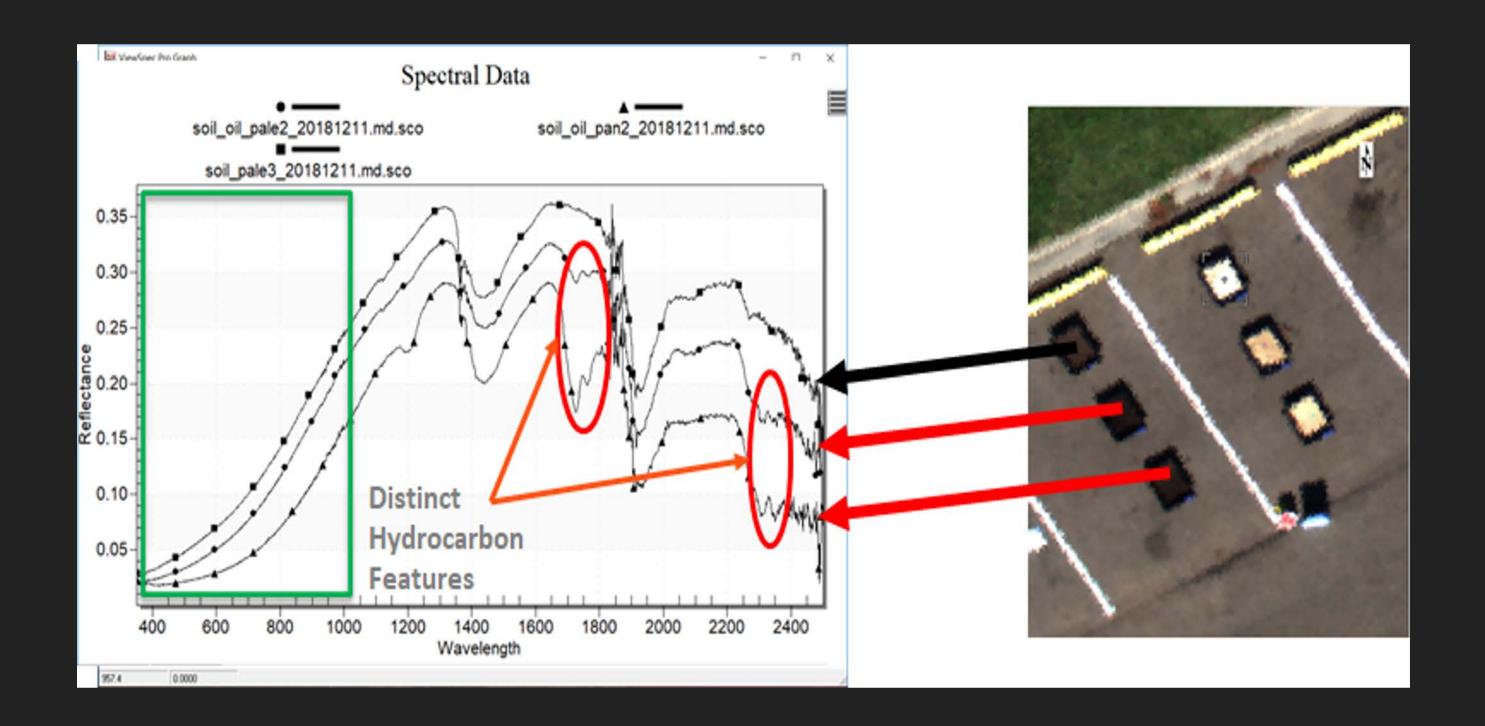






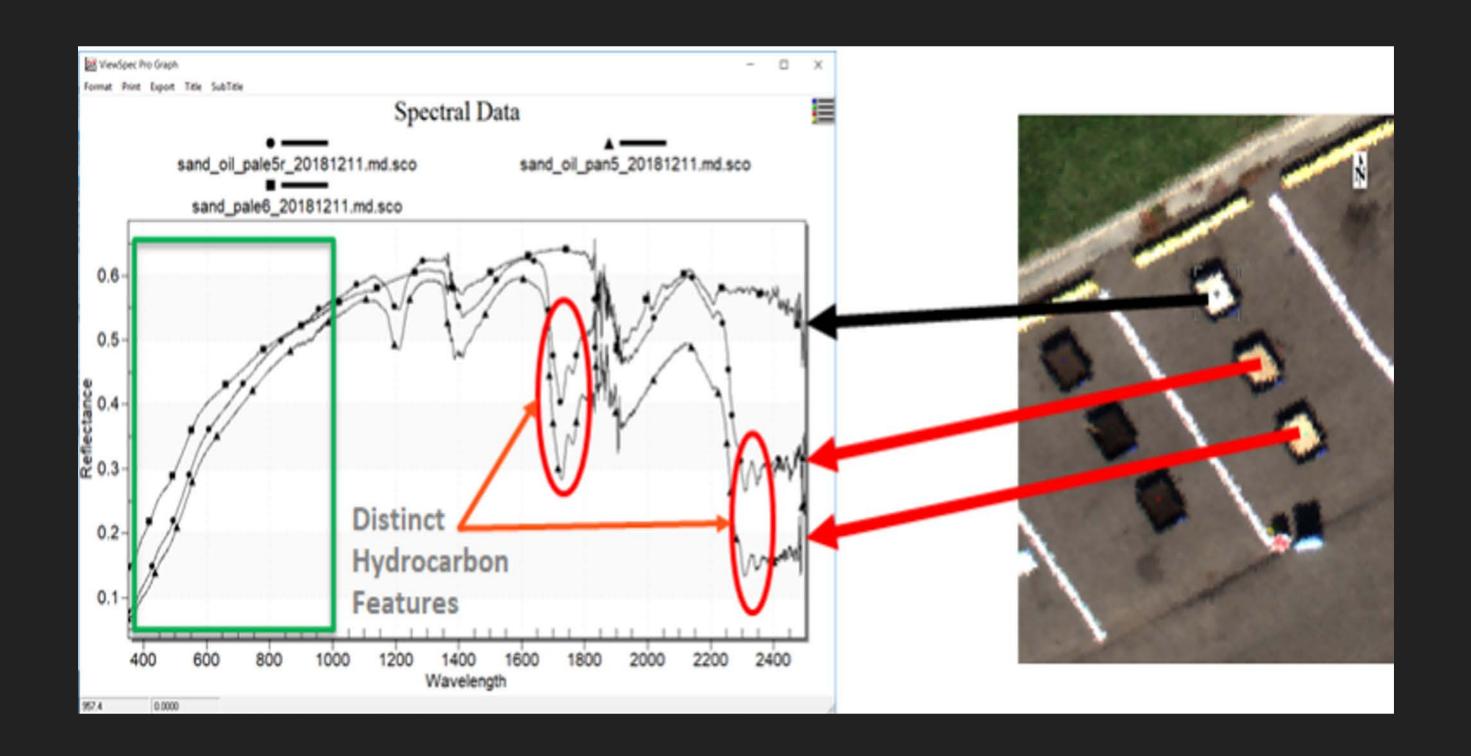








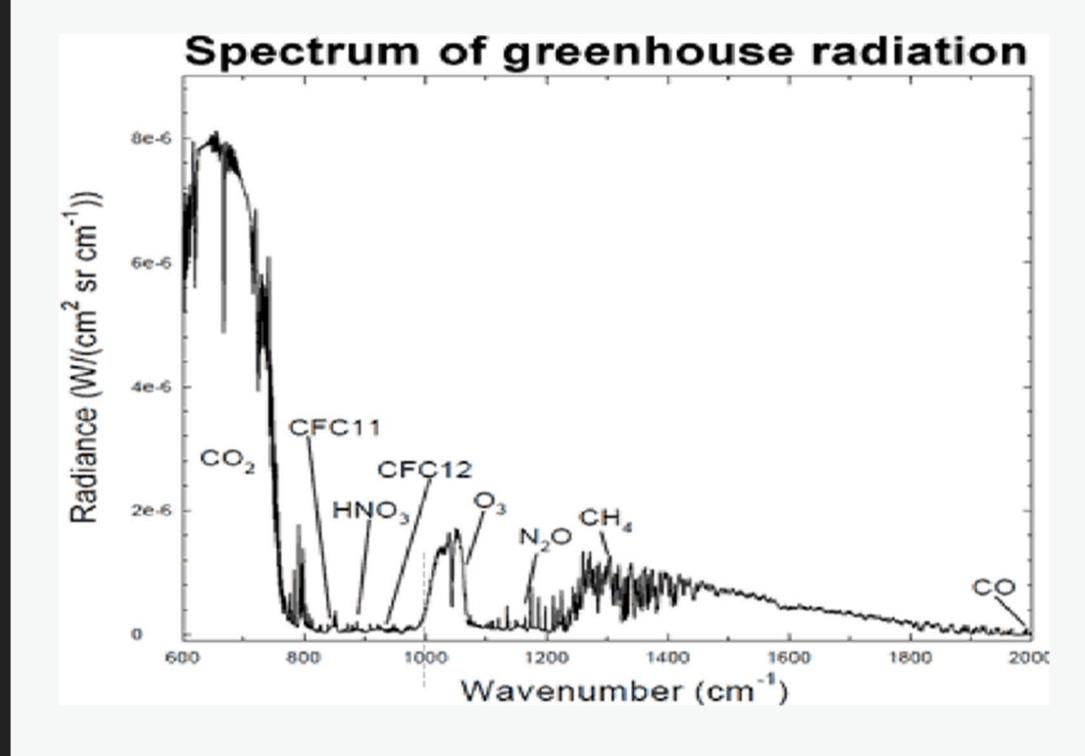








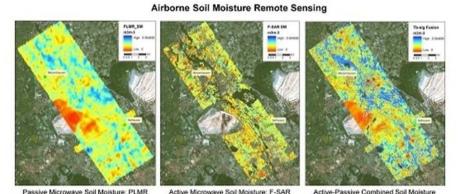
### Emission Absorption Features in the V-SWIR Region







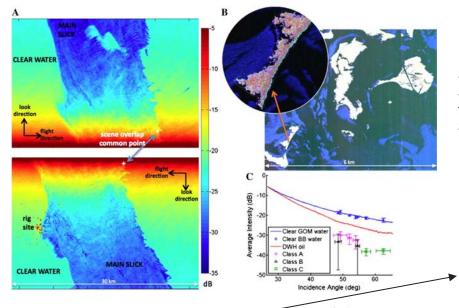
### HYPERSPECTRAL APPLICATIONS



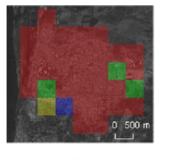
Lausch, A. et. al, Linking Remote Sensing and Geodiversity and Their Traits Relevant to Biodiversity—Part I: Soil Characteristics. Remote Sens. 2019, 11, 2356.

Agriculture Soil Mapping

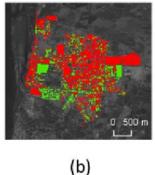
Chemical Detection

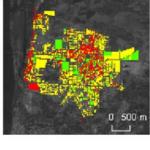


I. Leifer *et. al.*, "State of the Art Satellite and Airborne Marine Oil Spill Remote Sensing: Application to the BP Deepwater Horizon Oil Spill," Remote Sens. Environ. **124**, 185 (2012).



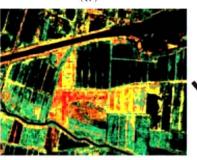
(a)



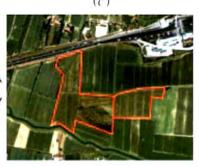


Disaster Recovery Hyperspectral reveals targets according to their molecular structure. Each "color" is a unique signature that allows us to discriminate between targets and their phenomena

Hazardous Waste Monitoring



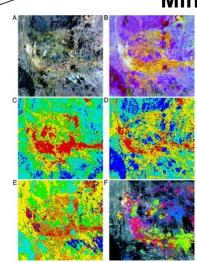




T. Slonecker et. al., "Visible and Infrared Remote Imaging of Hazardous Waste: A Review," Remote Sens. 2, 2474 (2010).

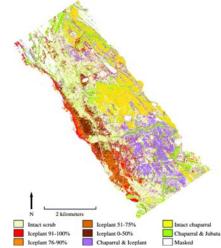
Dell'Acqua, Fabio & Gamba, Paolo. (2012). Remote Sensing and Earthquake Damage Assessment: Experiences, Limits, and Perspectives. Proceedings of the IEEE. 100. 2876-2890.

#### **Mineral Exploration**



F. Sabins, Remote sensing for mineral exploration, Ore Geology Reviews, Volume 14, Issues 3–4, 1999, Pages 157-183,

#### **Vegetation Speciation**



E. Underwood, S. Ustin, D. DiPietro, Mapping nonnative plants using hyperspectral imagery, Remote Sensing of Environment, Volume 86, Issue 2, 2003, Pages 150-161

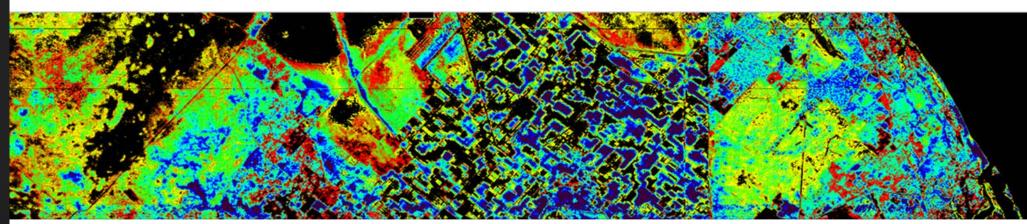


### OSK Hyperspectral Fire Risk Tool

#### FIGHTING WILDFIRES

Fire risk assessment tool developed for utilities and emergency services





Uses various vegetation indices to calculate Fire Risk; including live fuel moisture content, greenness, canopy water content, and dry or senescent carbon content.

- Blue values indicate least fuel
- Red values indicate most fuel





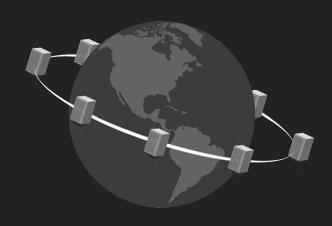


Insert Know What's Above Video



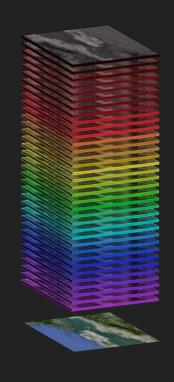


### The OSK Model: Global Monitoring with Hyperspectral Satellites



Global HSI Satellite constellation (GHOSt<sup>TM</sup>)

Daily Monitoring



Hyperspectral Analysis
Proprietary Chemical
Fingerprinting



Accessible User Platform
Spectral Intelligence Global
Monitoring Application (SIGMA<sup>TM</sup>)







Enabling sustainable operations with the most robust remote sensing and analytics capability in existence

R. Peter Weaver peter@orbitalsidekick.com (985) 237-3306



