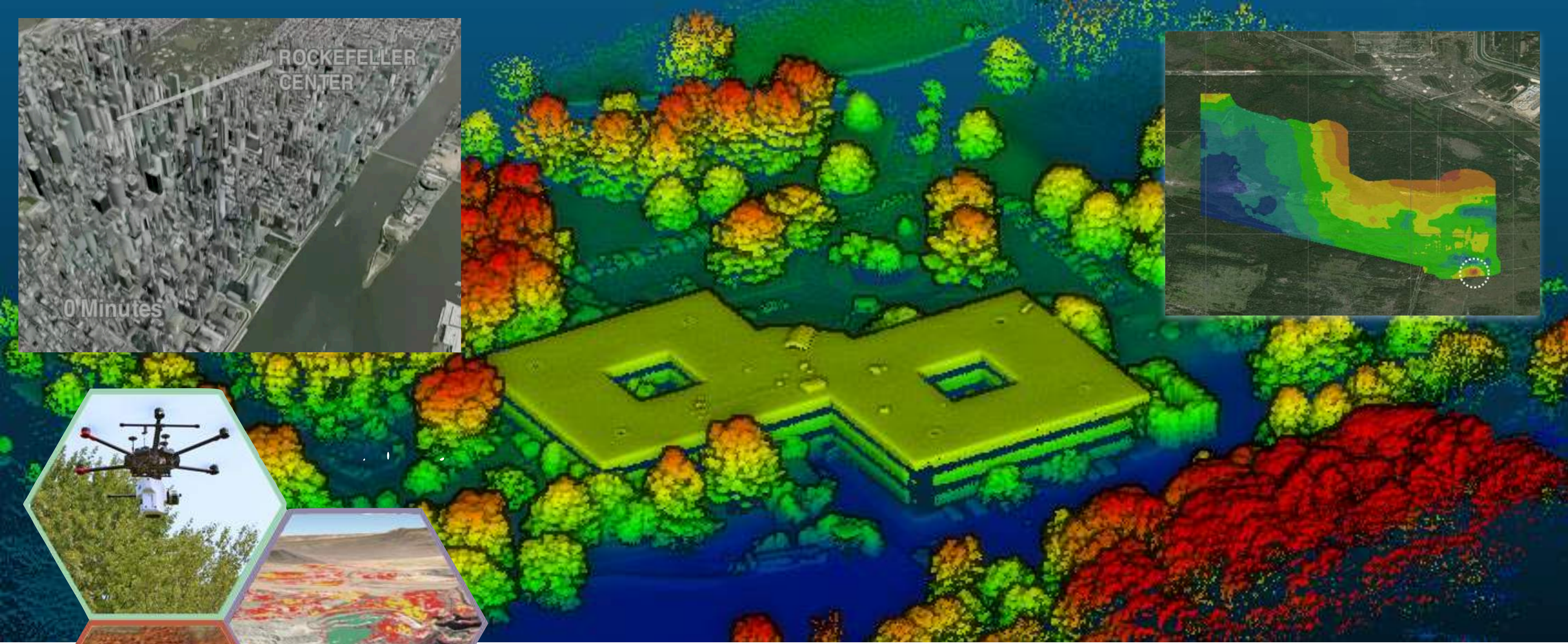
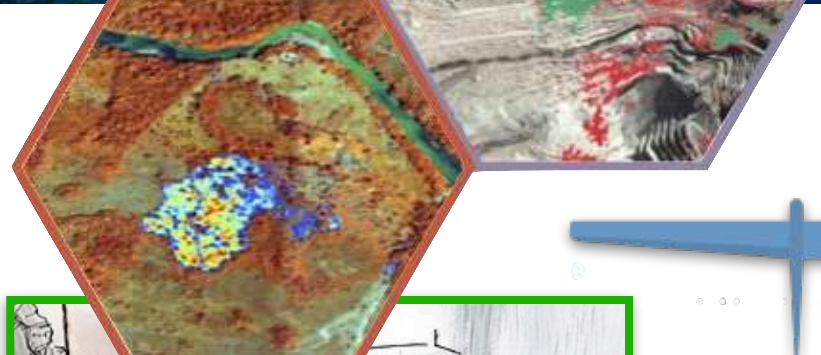
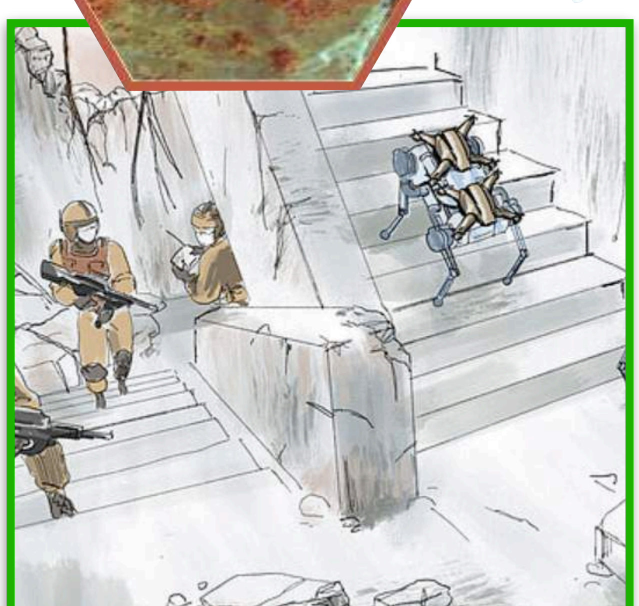
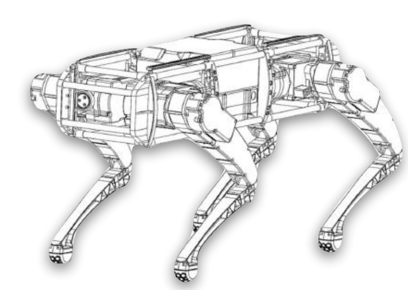




Synergistic Robots for Safety Surveys (ROSS)

Hanson Center for Space Sciences
University of Texas at Dallas
Prof. David J. Lary





What? To provide a capability for **preemptive force protection** focussed on **ports** that does not currently exist

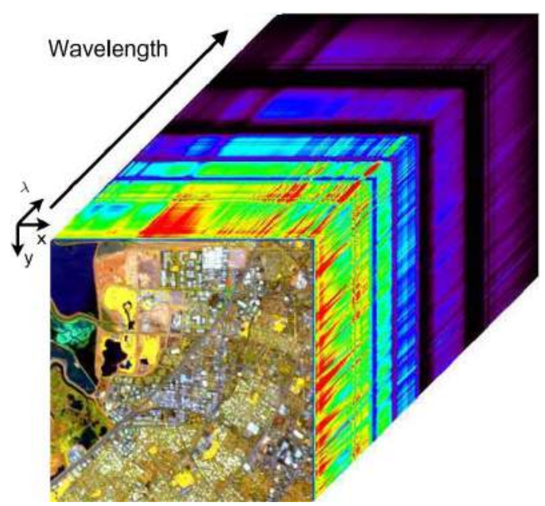
Coordinated robots with comprehensive environmental sensing capabilities and onboard machine learning that **can learn new environments in realtime and provide realtime processing of sensor feeds** to help answer the questions:

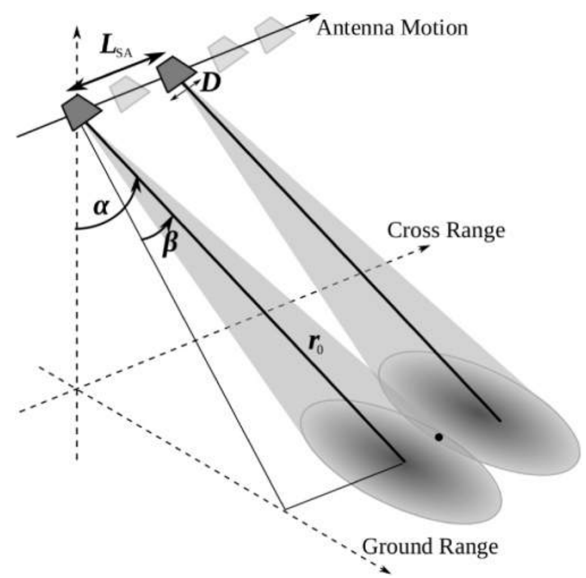
1. Is the area safe?
2. What survey patterns are best to use?
3. Is the water safe (to enter/to drink)?
4. What protective clothing maybe needed?

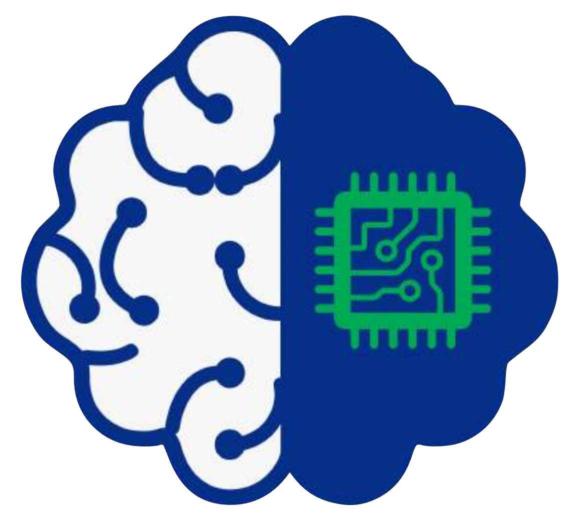
UAV with 350-2,500 nm hyperspectral imager

UAV with SAR

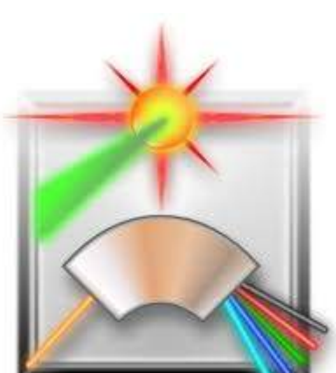
Machine Learning

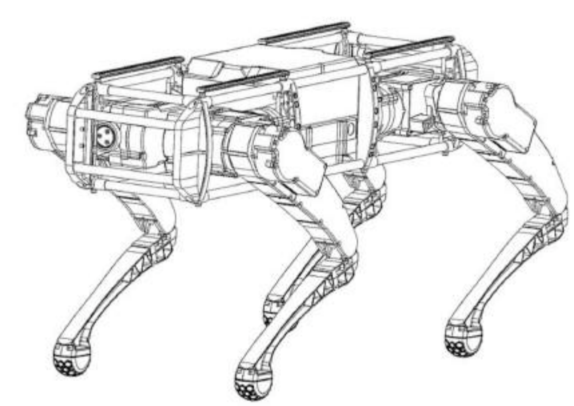






Mass Spectrometer

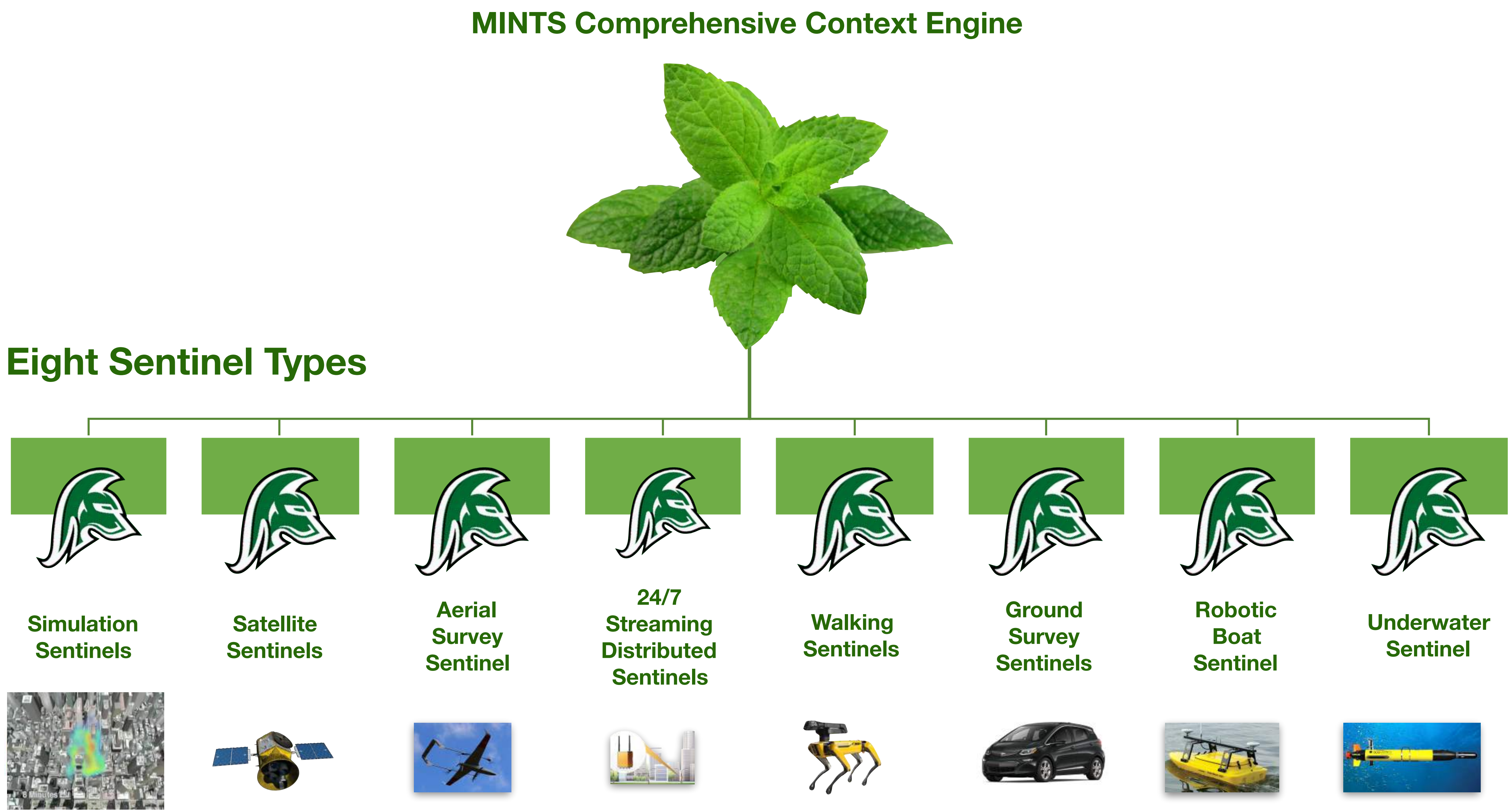




MINTS Context Engine

Multi-scale Integrated Interactive Intelligent Sensing and Simulation

CBRN (Chemical Biological Radiological Nuclear) Sentinels For Actionable Insights



Why?

- **30% of Global Population living in Mega Cities by 2020.**

$\frac{8}{10}$

- **Eight out of ten of the largest megacities in the world are located by the coast.**

- **Ports are strategically important for the movement of personnel and materiel, currently this capability does not exist.**

- **Characterizing the safety of the land and aquatic environment is of growing significance, e.g. with increasing hurricane frequency & terrorism.**

TEXAS NATIONAL SECURITY NETWORK

Why?

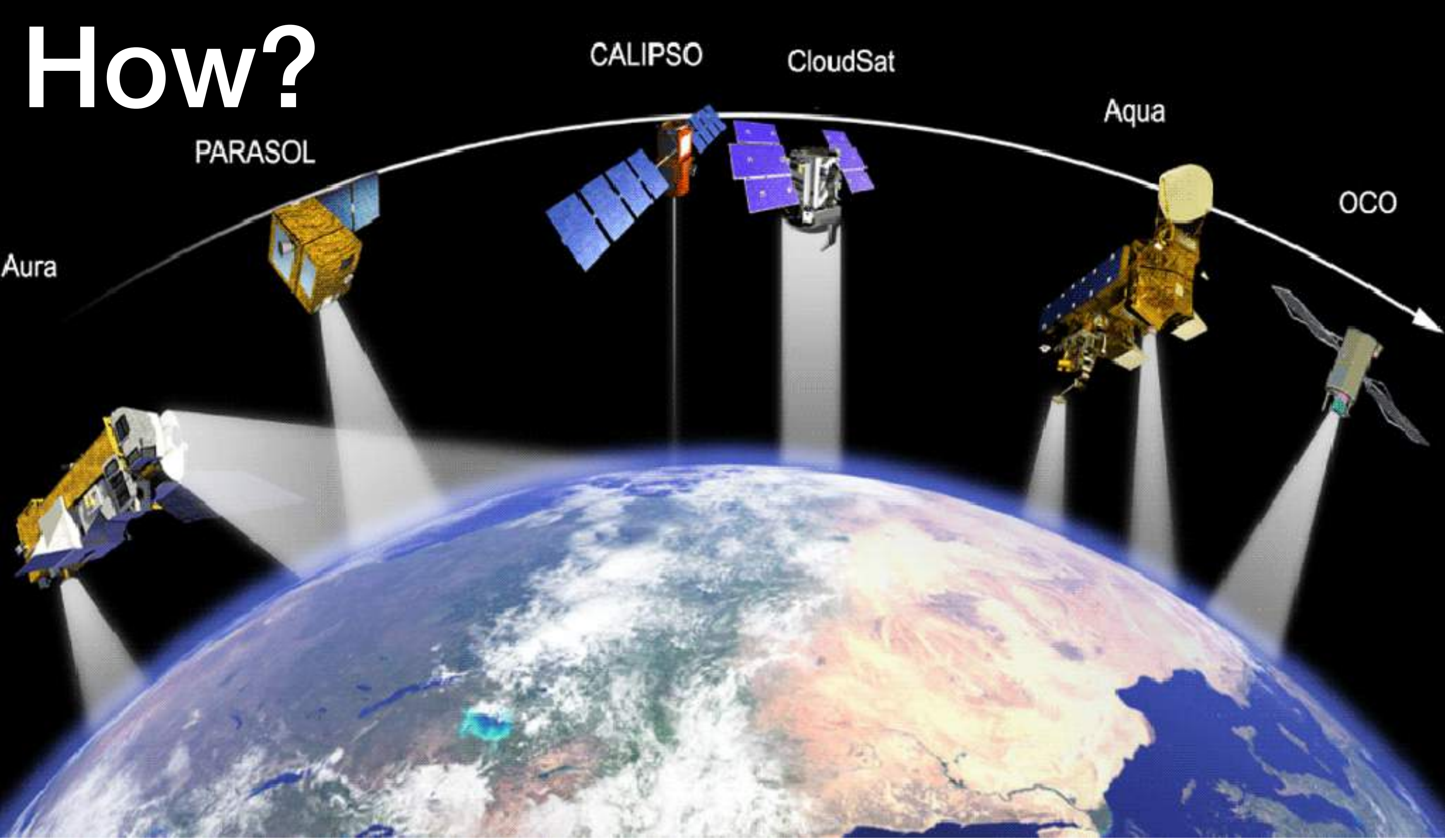
Ports are strategically important for the movement of personnel and materiel

Currently this capability does <u>not</u> exist.

How it Works?

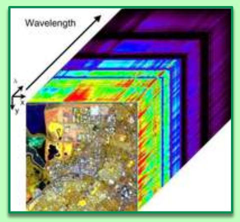
Machine Learning Modes of Operation

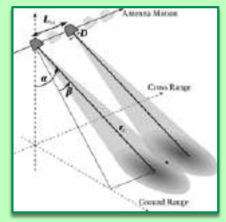
How?



Build on the heritage of established Earth Observing Systems

How? Mode 1: Coordinated robots using onboard Machine Learning for <u>specific</u> data products

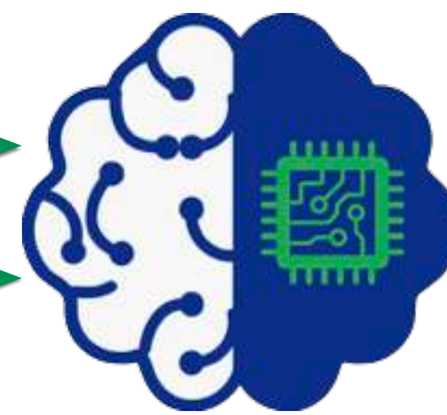




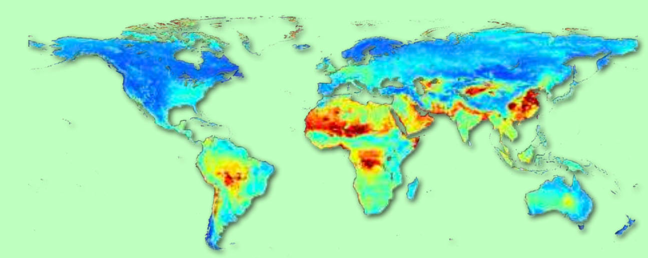
Remotely Sensed Hyperspectral and Synthetic Aperture RADAR Imagery

Rapid Large Area Capability

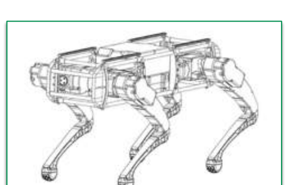
Learn specific signatures



Supervised Machine Learning



Large Area Data Products Provided by Machine Learning

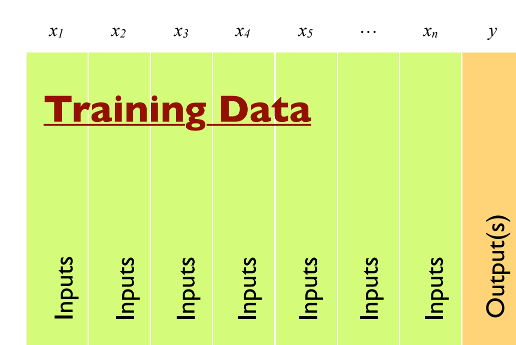


In-situ accurate sensing using mass spectrometers, fluorometers, radiation sensors, etc.

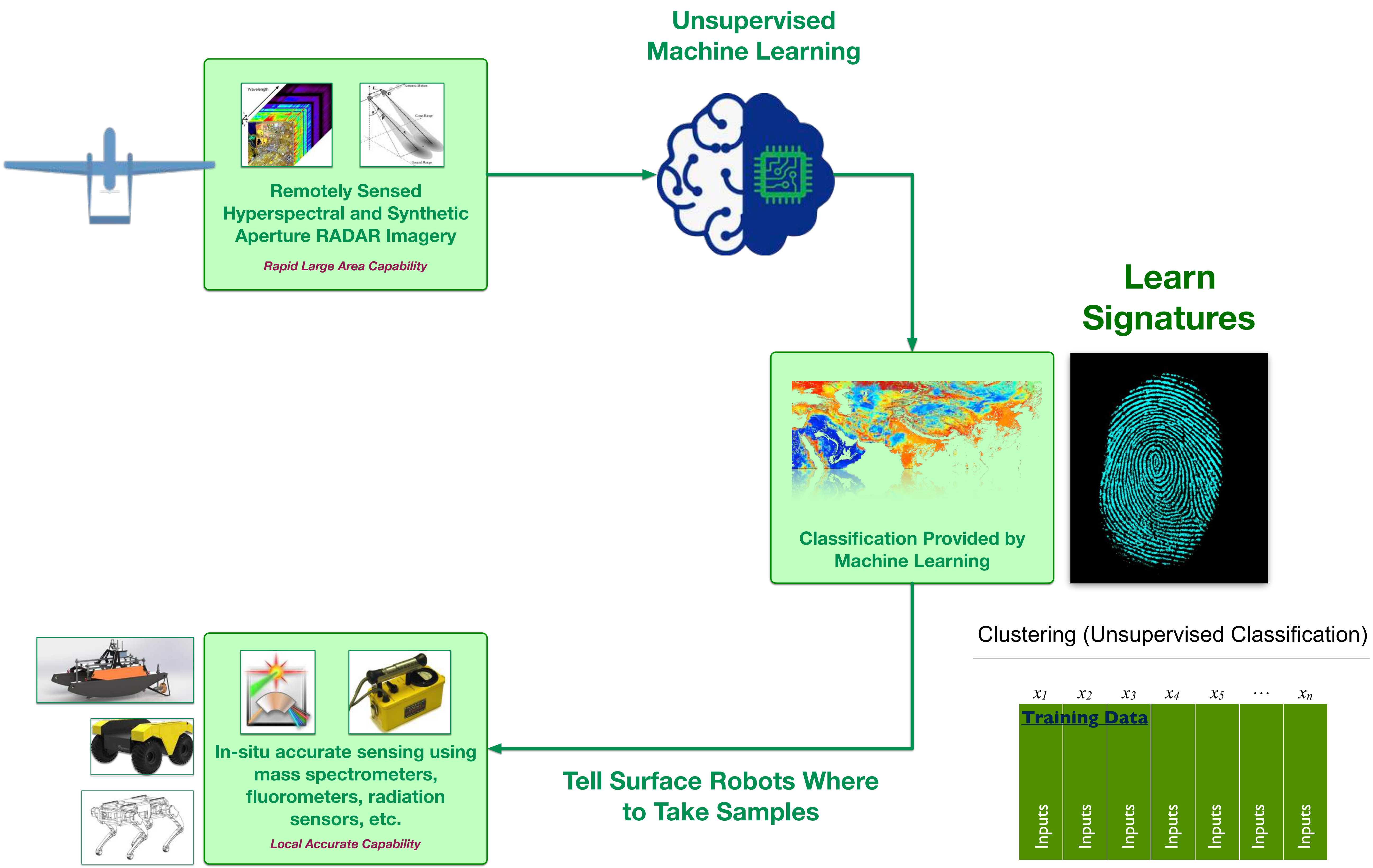
Local Accurate Capability

Multi-Variate Regression

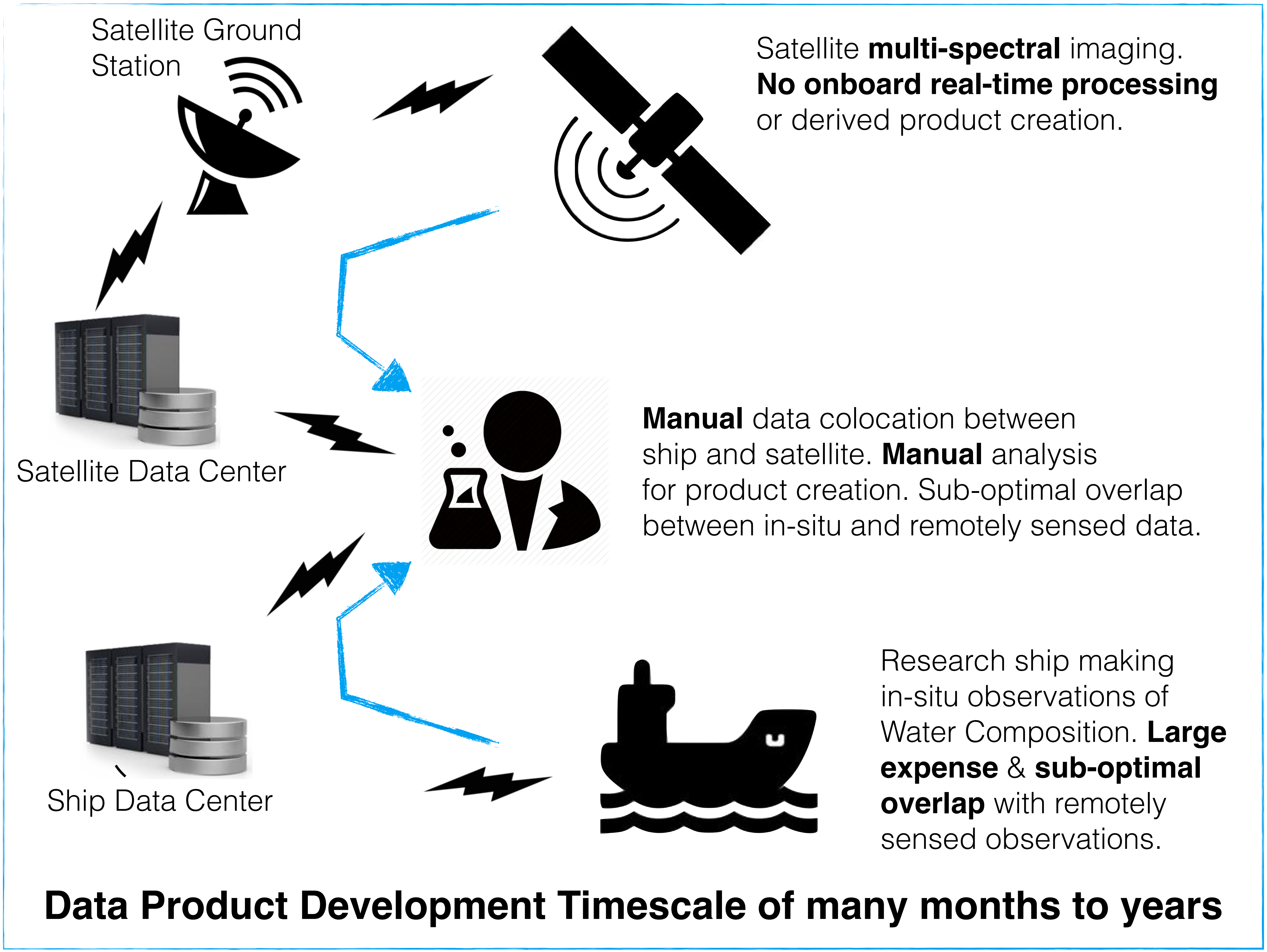
$$y = f(x_1, x_2, x_3, x_4, x_5, \ldots x_n)$$



How? Mode 2: Use remote sensing signatures to suggest optimum sampling patterns

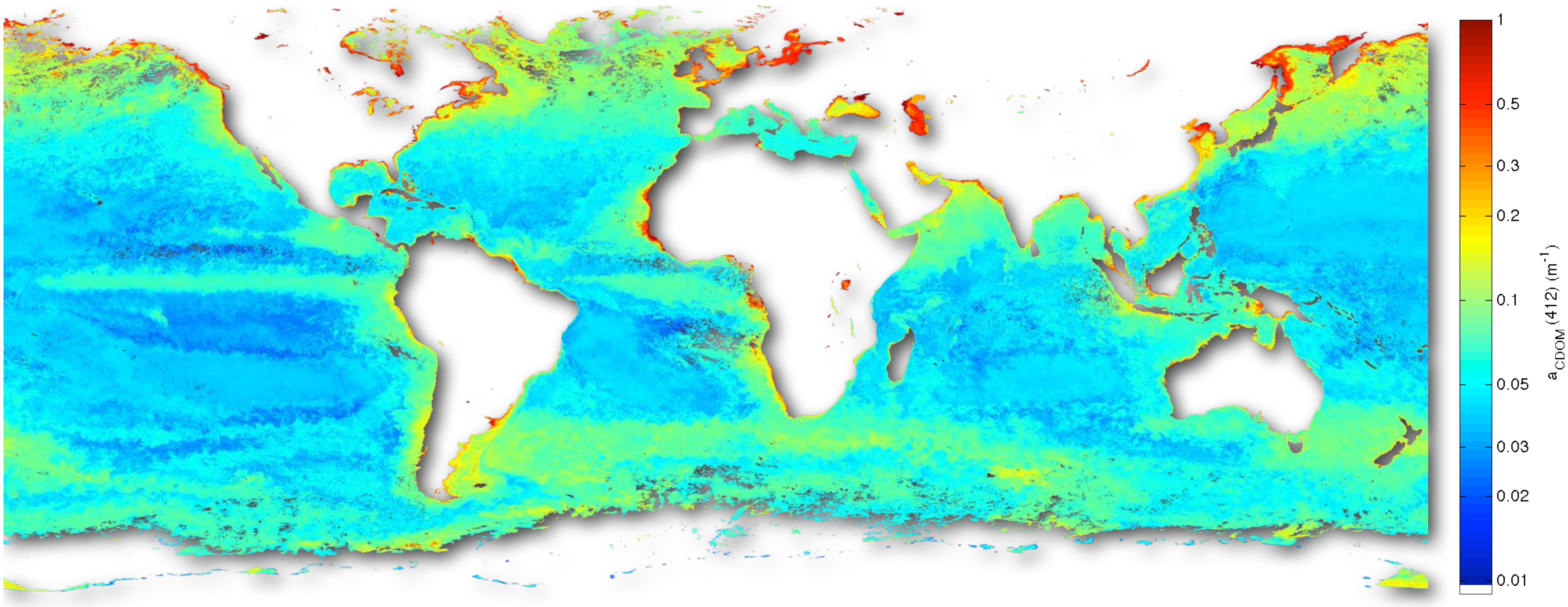


Traditional Remote Sensing Product Development



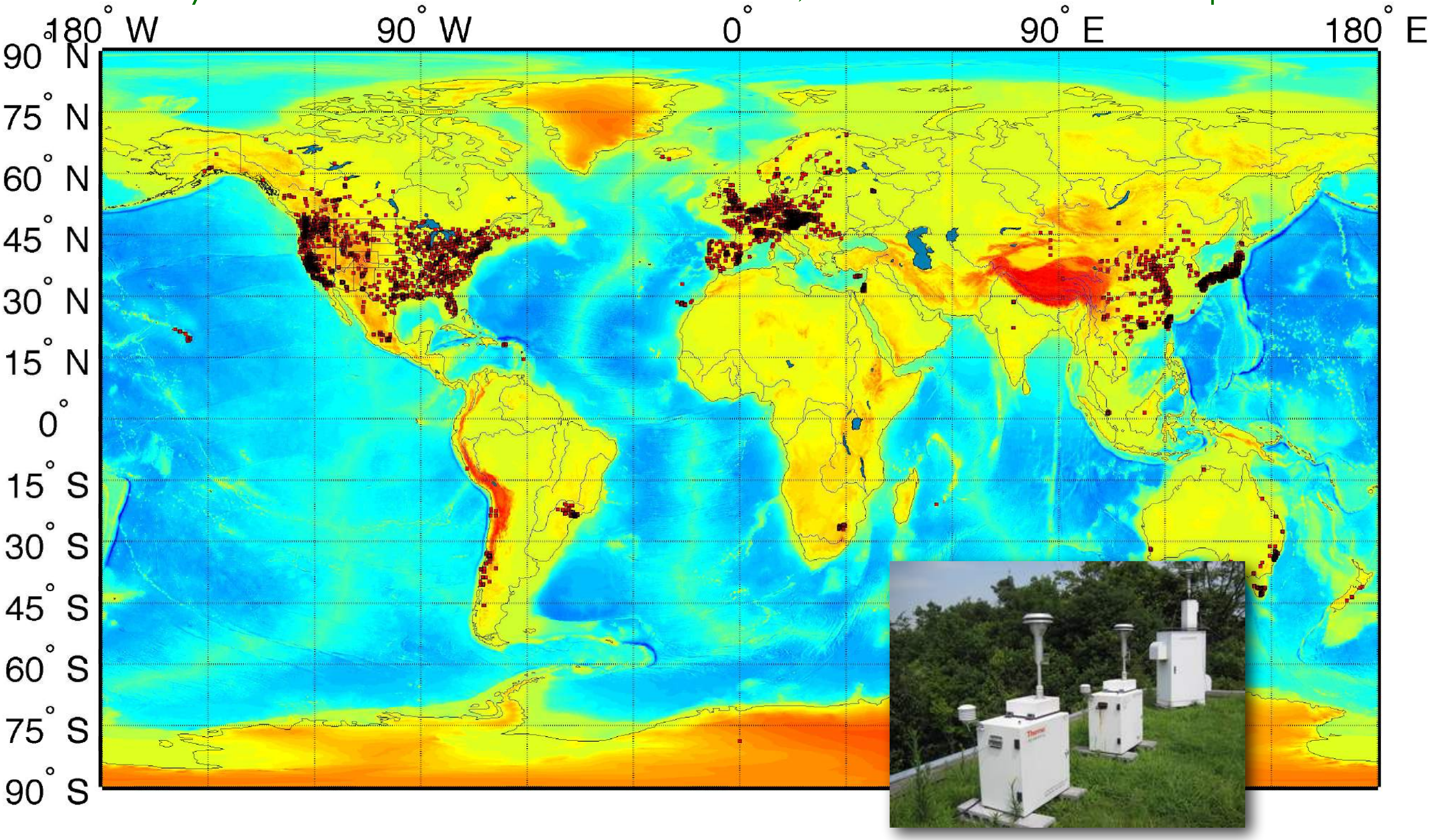
Satellite Examples

Using Machine Learning to Estimate Chromophoric Dissolved Organic Material (CDOM) Absorption



Satellite Examples

Hourly Measurements from 55 countries and more than 8,000 measurement sites from 1997-present



Sensing Assets

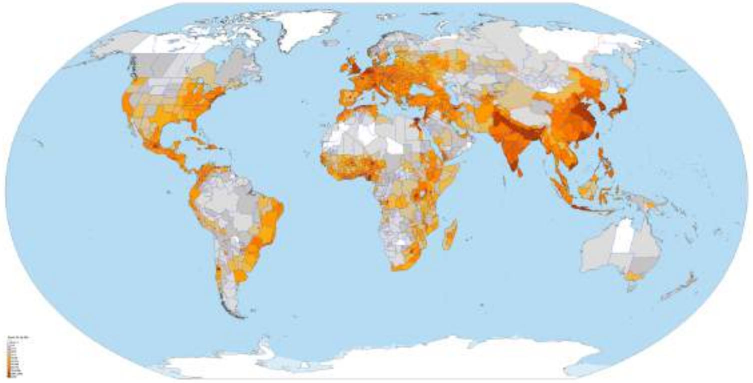
Clouds and Aerosols

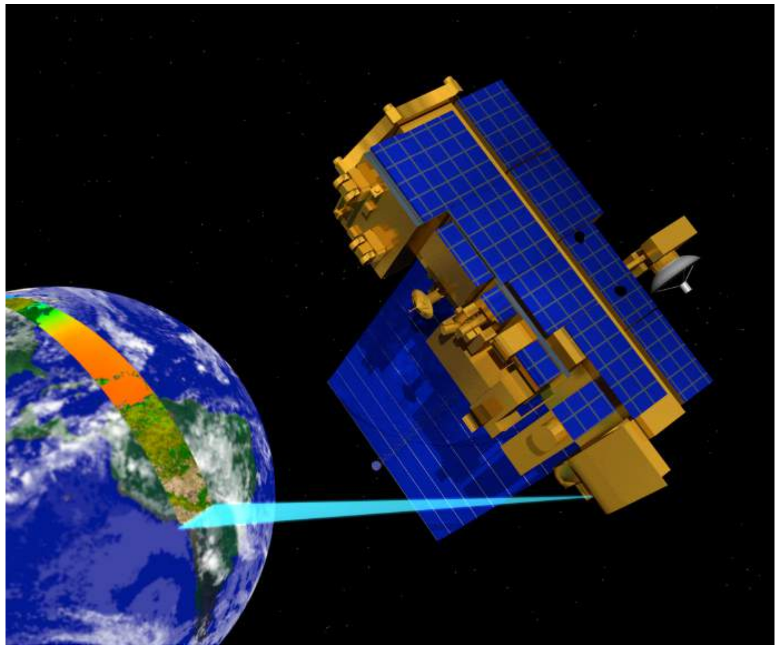
Earth's water cycle

Atmospheric Chemistry

Aqua DeepBlue

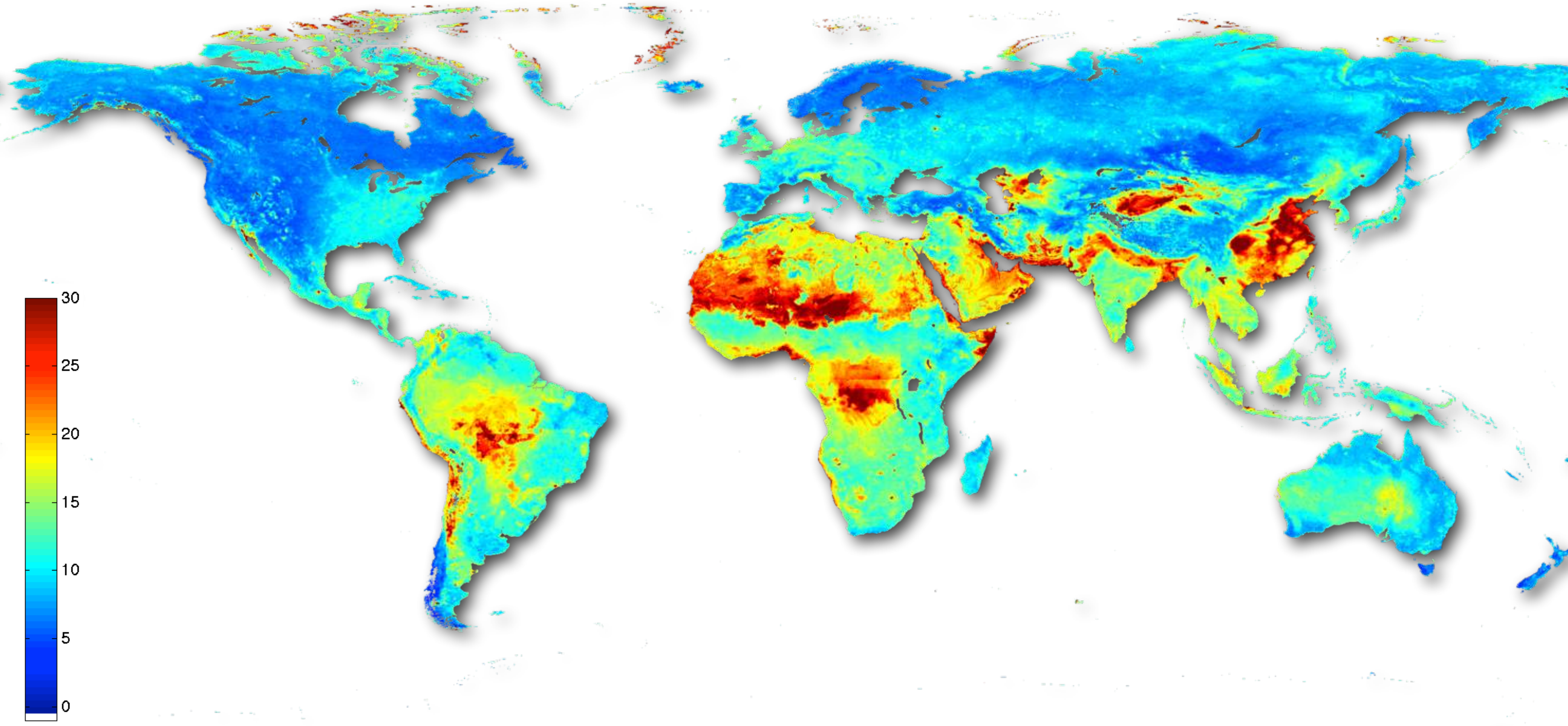
Rank	Source	Variable	Type
1	Satellite Product	Tropospheric NO_2 Column	Input
2	Satellite Product	Solar Azimuth	Input
3	Meteorological Analyses	Air Density at Surface	Input
4	Satellite Product	Sensor Zenith	Input
5	Satellite Product	White-sky Albedo at 470 nm	Input
6		Population Density	Input
7	Satellite Product	Deep Blue Surface Reflectance 470 nm	Input
8	Meteorological Analyses	Surface Air Temperature	Input
9	Meteorological Analyses	Surface Ventilation Velocity	Input
10	Meteorological Analyses	Surface Wind Speed	Input
11	Satellite Product	White-sky Albedo at 858 nm	Input
12	Satellite Product	White-sky Albedo at 2,130 nm	Input
13	Satellite Product	Solar Zenith	Input
14	Meteorological Analyses	Surface Layer Height	Input
15	Satellite Product	White-sky Albedo at 1,240 nm	Input
16	Satellite Product	Deep Blue Surface Reflectance 660 nm	Input
17	Satellite Product	Deep Blue Surface Reflectance 412 nm	Input
18	Satellite Product	White-sky Albedo at 1,640 nm	Input
19	Satellite Product	Sensor Azimuth	Input
20	Satellite Product	Scattering Angle	Input
21	Meteorological Analyses	Surface Velocity Scale	Input
22	Satellite Product	Cloud Mask Qa	Input
23	Satellite Product	White-sky Albedo at 555 nm	Input
24	Satellite Product	Deep Blue Aerosol Optical Depth 550 nm	Input
25	Satellite Product	Deep Blue Aerosol Optical Depth 660 nm	Input
26	Satellite Product	Deep Blue Aerosol Optical Depth 412 nm	Input
27	Meteorological Analyses	Total Precipitation	Input
28	Satellite Product	White-sky Albedo at 648 nm	Input
29	Satellite Product	Deep Blue Aerosol Optical Depth 470 nm	Input
30	Satellite Product	Deep Blue Angstrom Exponent Land	Input
31	Meteorological Analyses	Surface Specific Humidity	Input
32	Satellite Product	Cloud Fraction Land	Input
	In-situ Observation	**$PM_{2.5}$**	**Target**



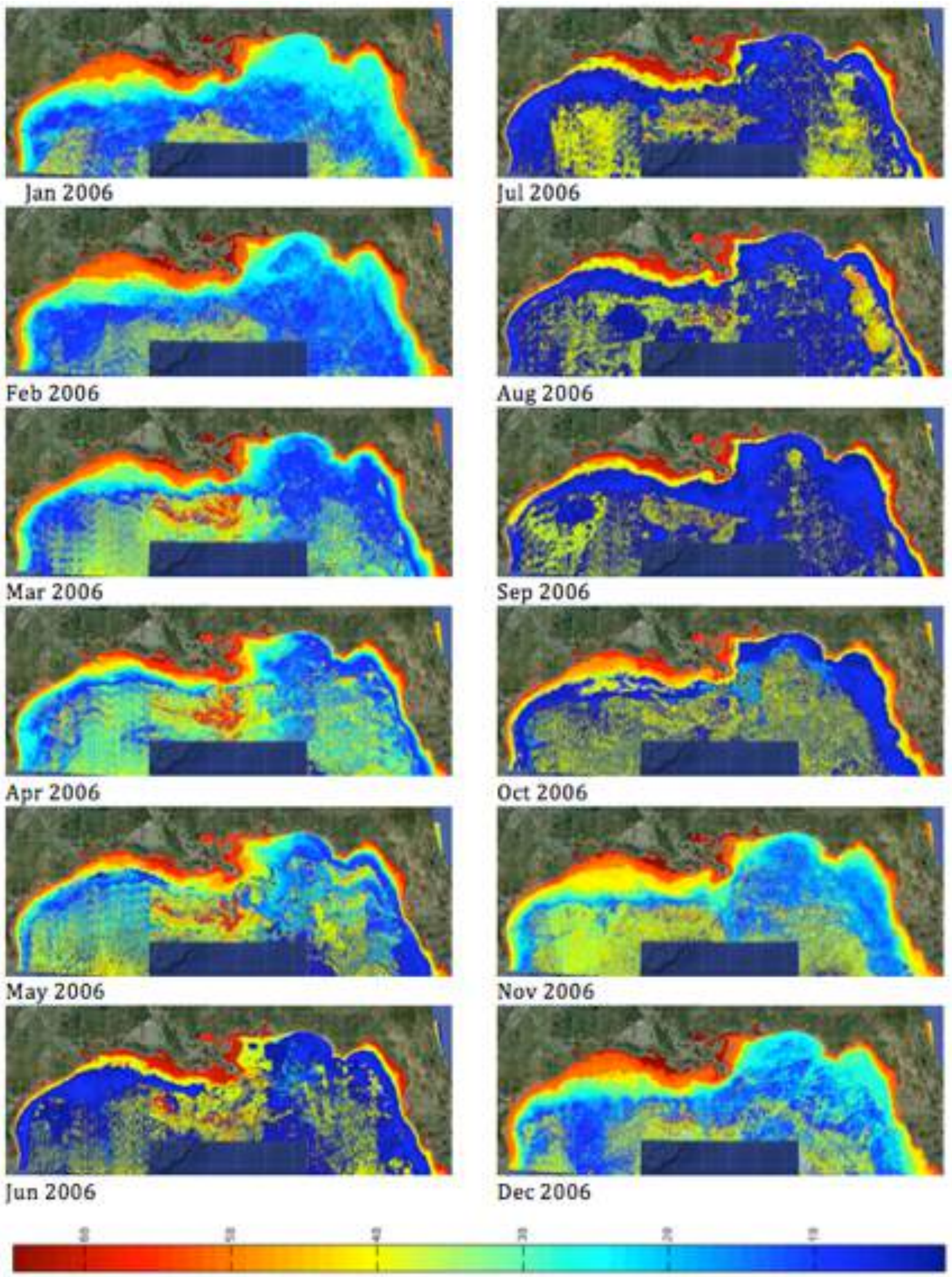


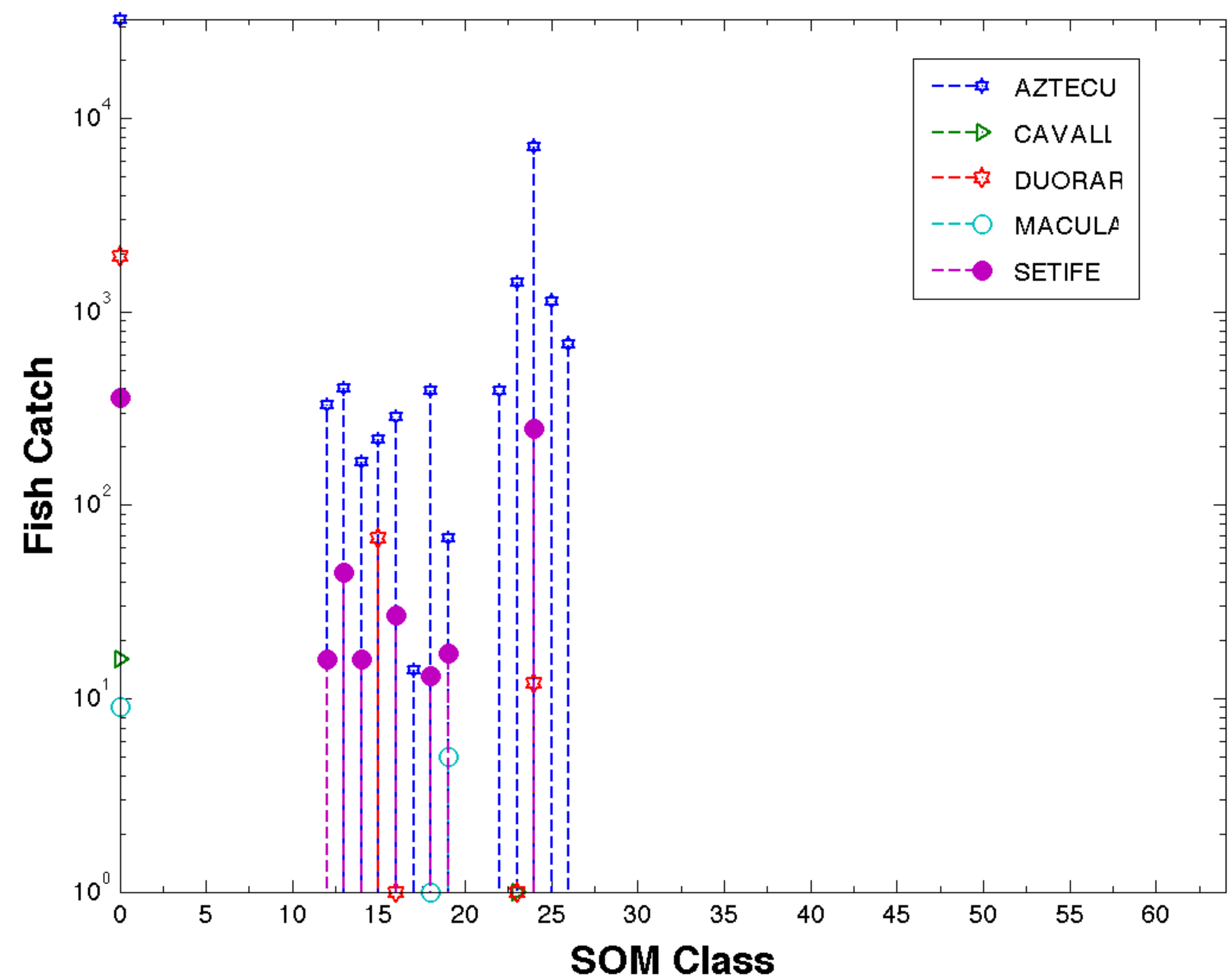
Air Quality: Long-Term Average 1997-present

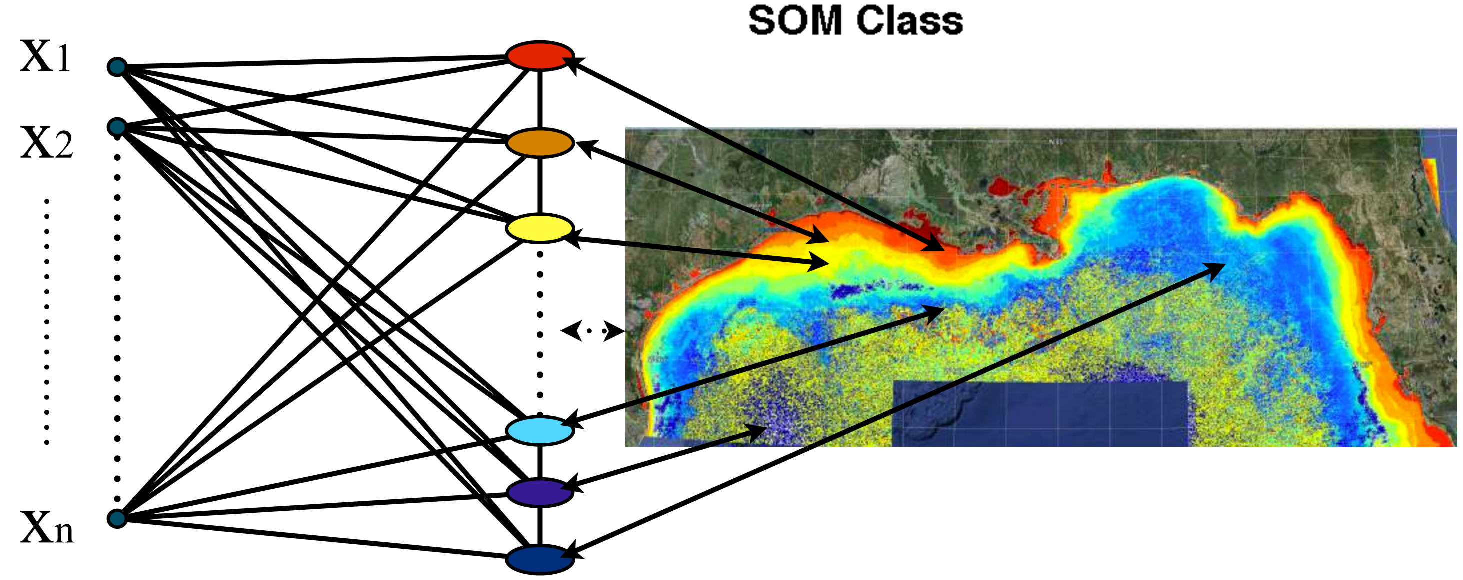
Used around 40 TB of different BigData sets from satellites, meteorology, demographics, in-situ sensors and scraped web-sites and social media to estimate $PM_{2.5}$.

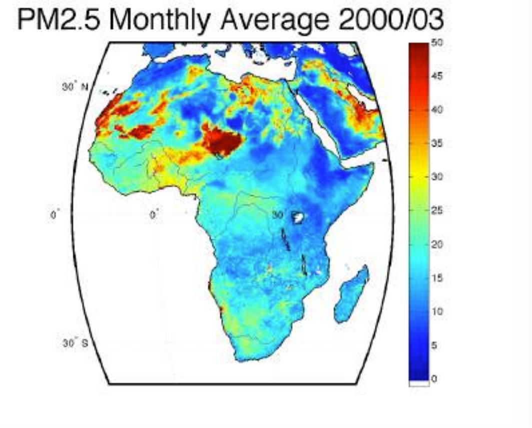


Aquatic Zones





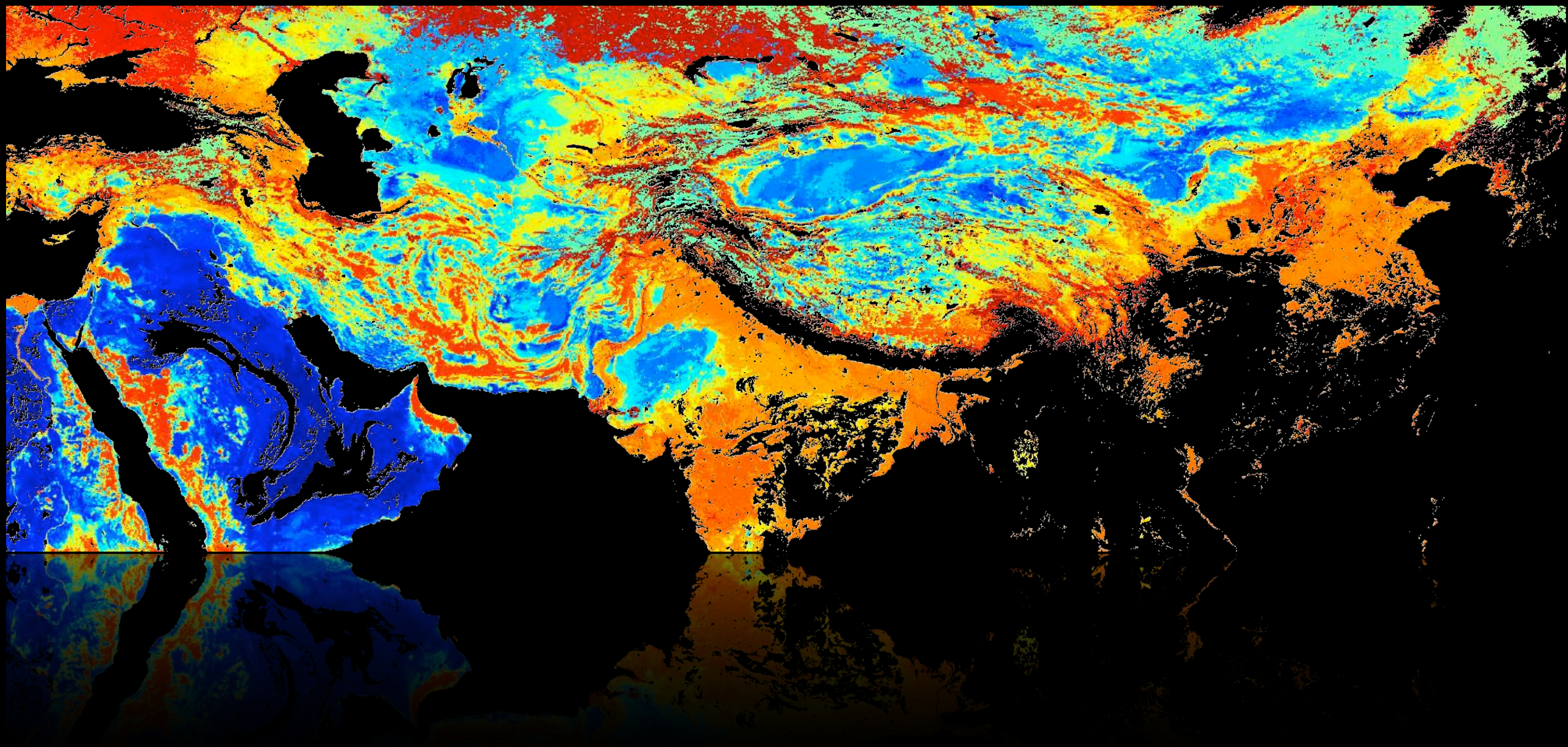




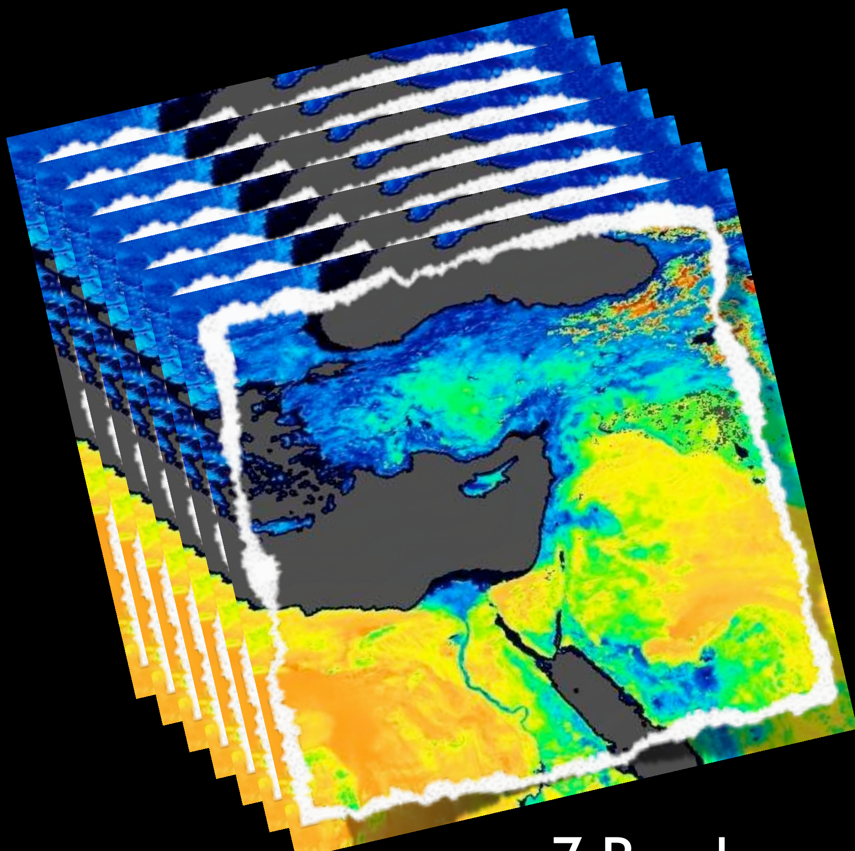
Remote Sensing & Machine Learning

Identifying at High Resolution Global Dust Sources

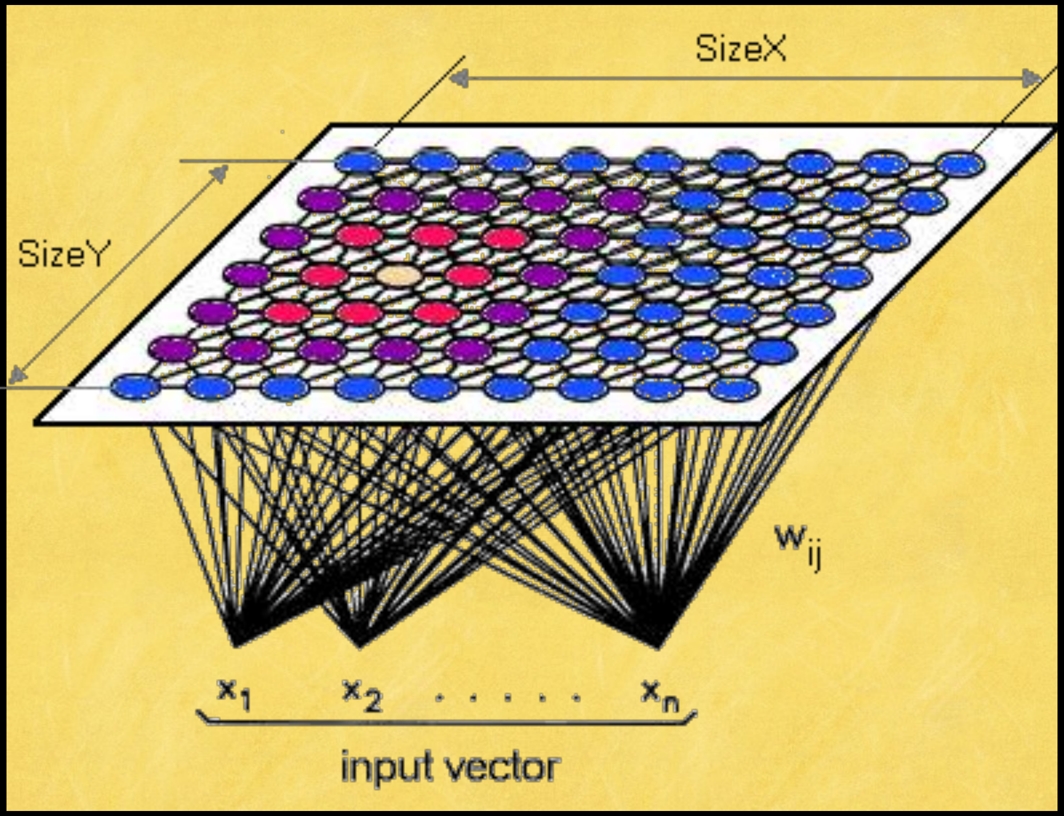
Detecting Dust Sources

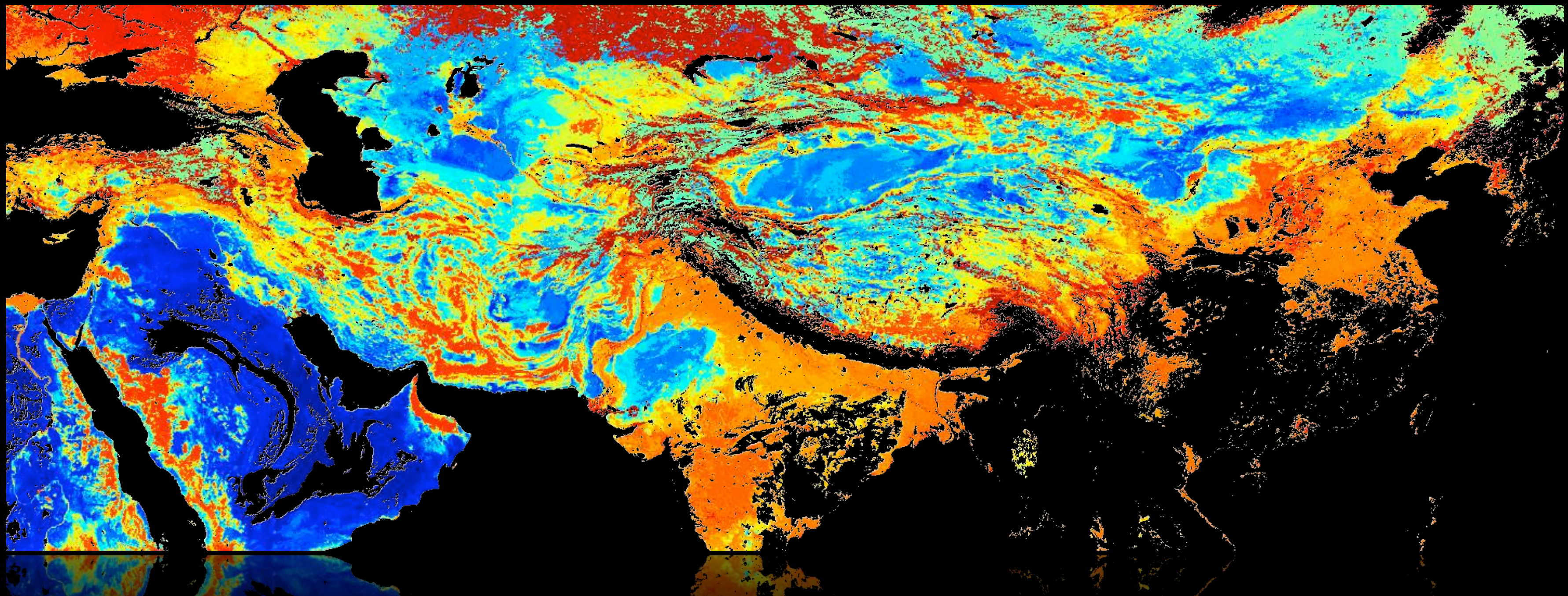


Self Organizing Map Classification



7 Bands
MODIS MCD43C3
bihemispherical reflectance



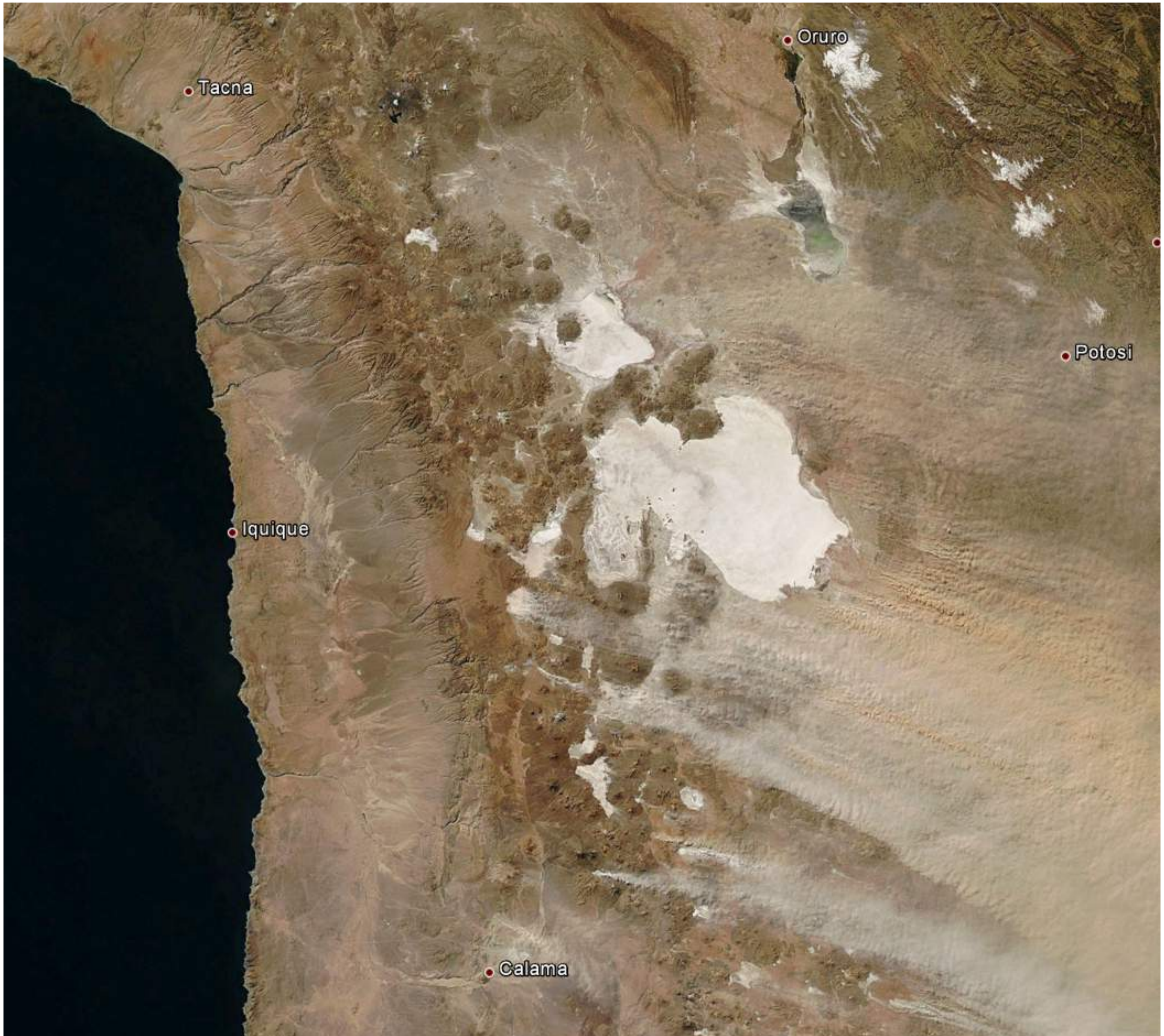


A Haboob (Arabic: هَبوب "strong wind", or "blowing furiously.")

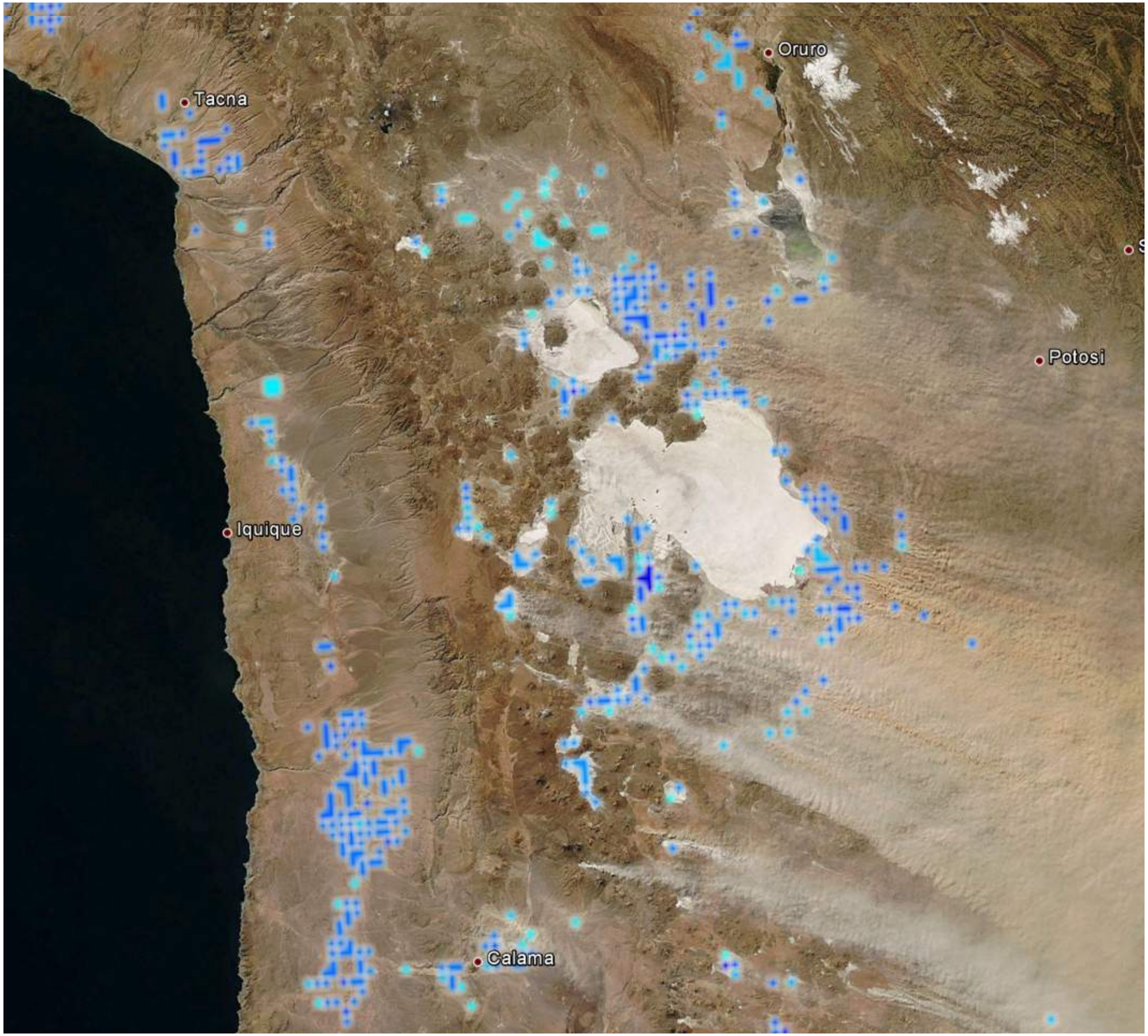
Midday

South America: Bolivia and Chile

July 18, 2010 MODIS Terra True Color



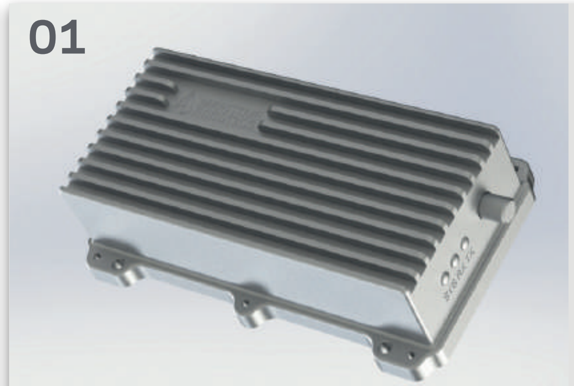
Optimum Sampling Patterns/Locations for a Given Locale



The Robots

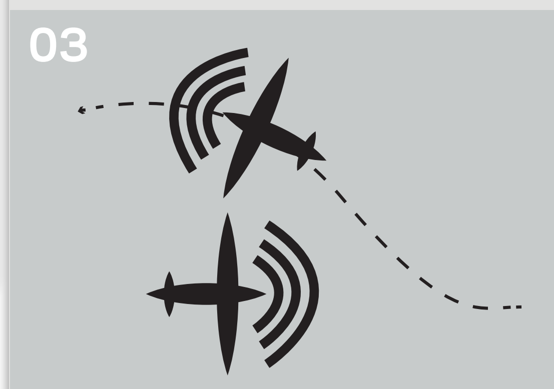
VTOL UAV PX-31

Flight time (battery):	1.5hr
Flight time (hybrid):	10-12hr
Empty weight:	15.0kg
Max Payload weight:	7.0kg
MTOW:	22.0kg
Max climb rate:	1200fpm
Operational ceiling:	20000ft.
Dimensions (wing/length):	3.2m
Vcruise:	25m/s
Vmax	40m/s
Vstall	14m/s



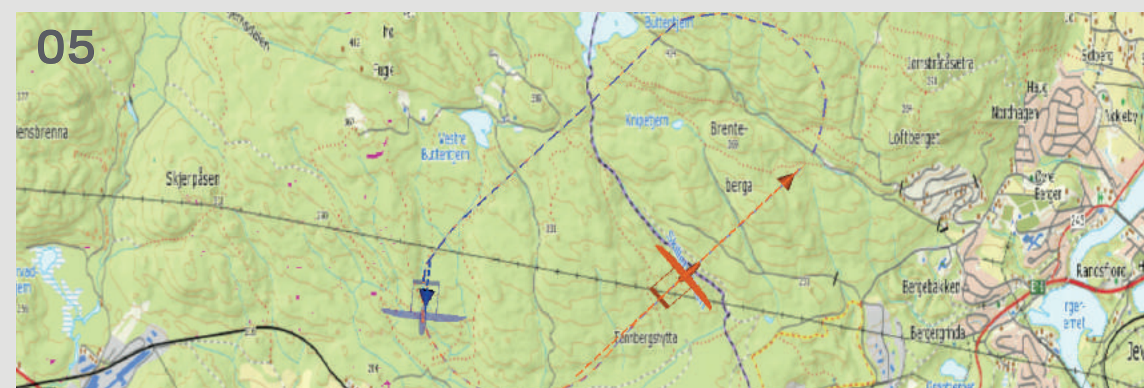
LONG RANGE VHF

STANDARDIZED CONNECTIONS AND SETUP



AIR SAFETY

VEHICLE CONTROL STATION



PROVEN UNDER DUAL UAS OPERATION

MARITIME ROBOTICS

Maritime Robotics Otter

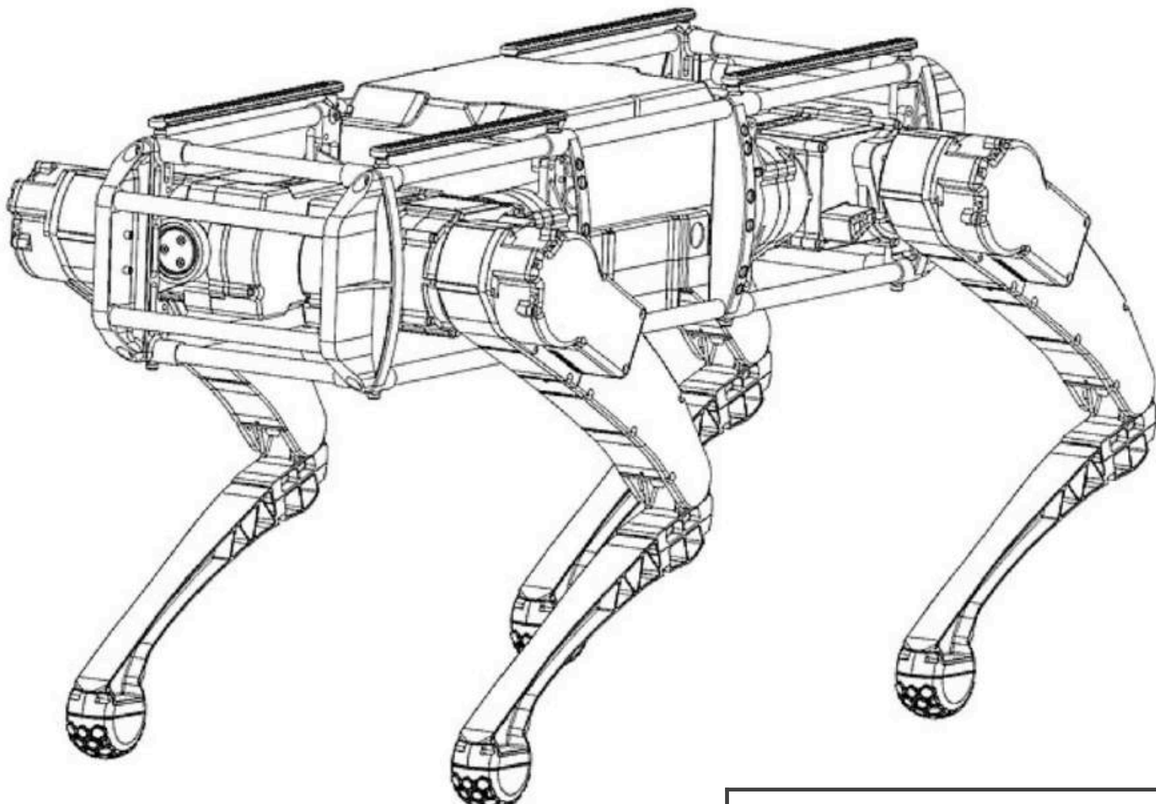
TEXAS
NATIONAL SECURITY NETWORK

MARITIME ROBOTICS

WARTHOG™

AMPHIBIOUS UNMANNED GROUND VEHICLE

Ghost Robotics Vision 60



Long Endurance. 8 - 10 hrs. mixed use and 21 hrs. standby. Travel 7.5+ miles in 3.5 hrs. on single charge

Any Terrain. Traverse a range of unstructured terrains and substrates, and even stairs

Unstoppable. Designed to self-right from any immobilization, and even operate when inverted

Robot Design	All weather electric Q-UGV with exoskeleton and quick-change sub-assembly design constructed from aluminum, CF and PLA. MIL-STD-1913 rails for multi-point sensor & electronics mounting throughout
Ingress Rating	Sealed IP-67 sub-assemblies: actuation/leg, computing, battery, and fore, aft and side sensor heads *
General MTBF	TBD *
Key Dimensions cm (in.)	L: 83 cm (33) | W leg-2-leg: 53 cm (21) | H stand: 38-76 cm (15-30)
Core Electronics | Compute | Sensors & Comms	Ghost electronics | NVIDIA Xavier | 3rd party integrated & external
Actuation, Legs & Toes	3-DOF, 340º degree articulation w/ various replaceable toe options
Sensor & Comms I/O | Power	IP/Ethernet, USB 3.0 , M.2, MIPI CSI-2 | 37-43, 15V
Mass kg (lbs.)	Tare: 30kg (66) | w/ 2x Battery: 37kg (82)
Available Payload@ kg (lbs.)	Max: 14 kg (31) | w/ 2x Battery: 7 kg (15)
Endurance @ 2x Battery (avg. sensor config.)	Standby: 21 | Mixed Use: 8 -10 | Continuous Walk: 3.5 *

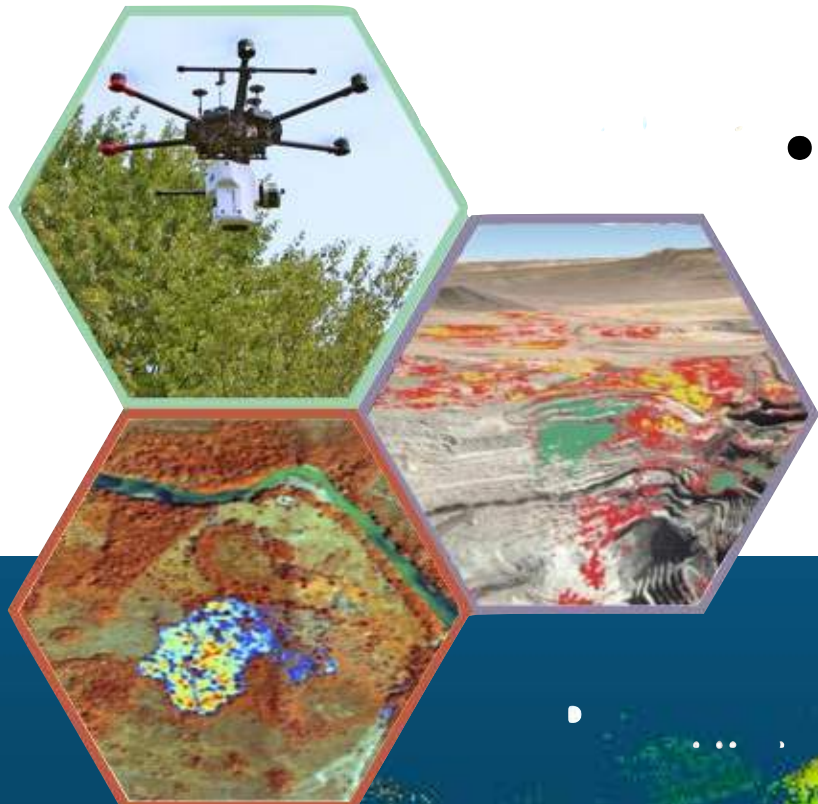
The Sensors

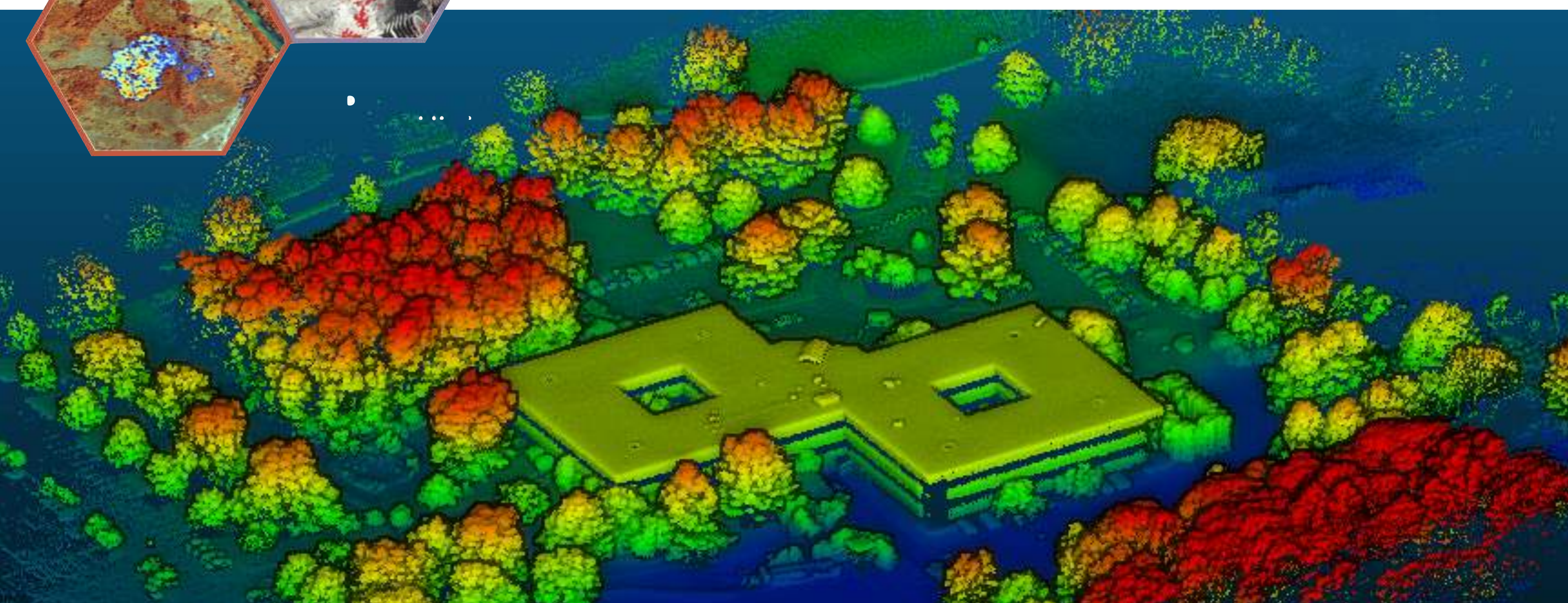
Robot Sensor Payloads

Robot	Sensors
VTOL UAV 1	Hyperspectral Imager, Thermal Imager, Onboard Machine Learning
VTOL UAV 2	SAR, LIDAR, Airborne Particulate Spectrometer, Ionizing Radiation
Robotic Boat	Camera System, Sonar, Fluorometers, Ion Sensors, pH, T, Turbidity, Salinity, Sediment Concentration, Mass Spectrometer for Air & Water, Airborne Particulate Spectrometer, Ionizing Radiation, ….
UGV - Wheels	Camera system, LIDAR, Thermal Camera, Meteorology, Mass Spectrometer for Air & Soil, Airborne Particulate Spectrometer, Ionizing Radiation
UGV - Walking	Camera System, Ionizing Radiation, Airborne Particulate Spectrometer, Some Gases

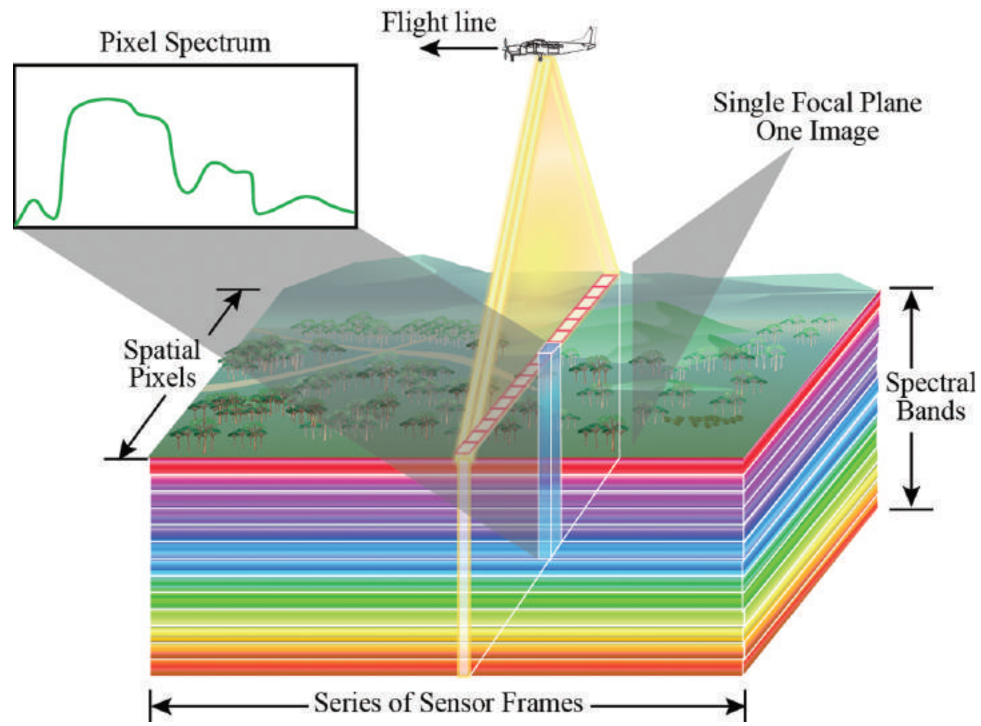
Capture Context

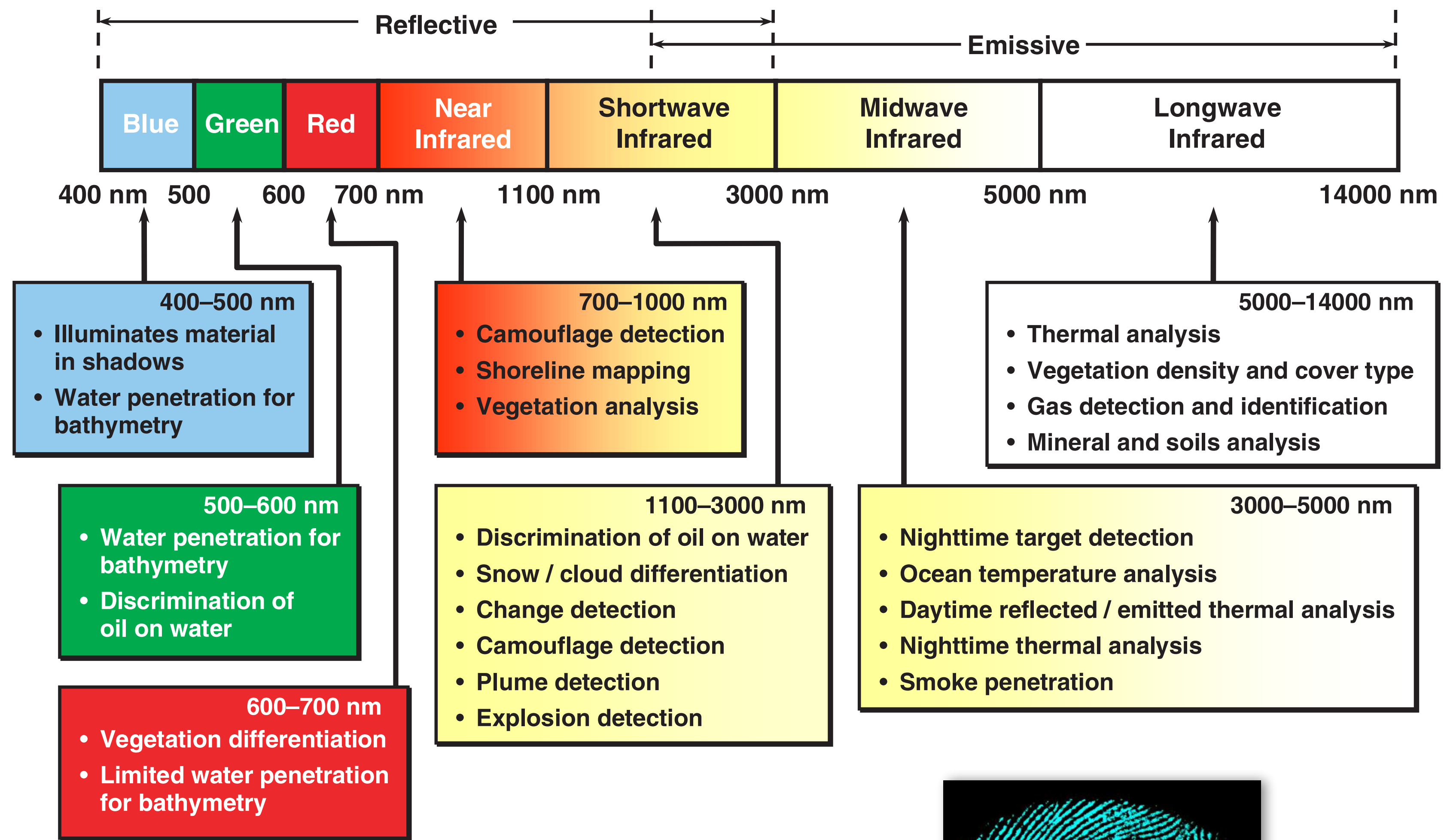
- Exact topography that guides air flow.
- Hyperspectral & LiDAR are complementary sensors giving the precise terrain and a full spectrum for every pixel within the field of view. Helpful in characterizing release sources and characteristics.

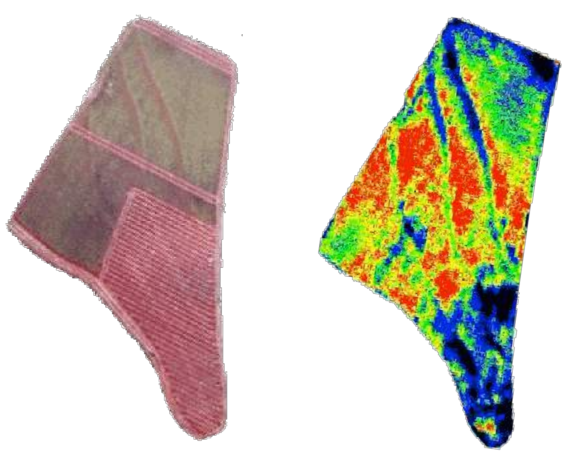


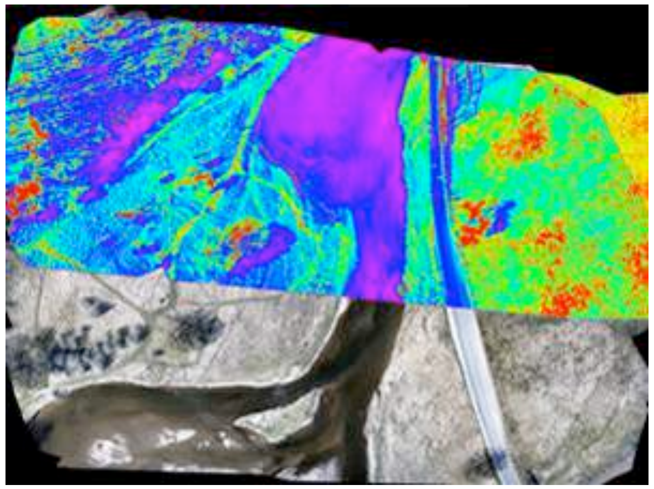


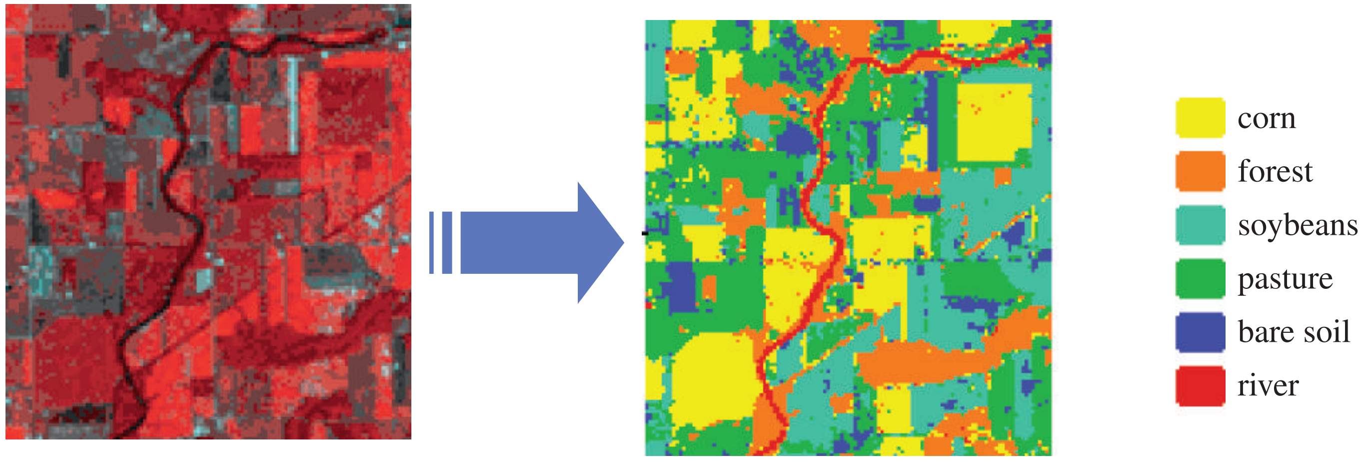
Hyper-spectral Imaging



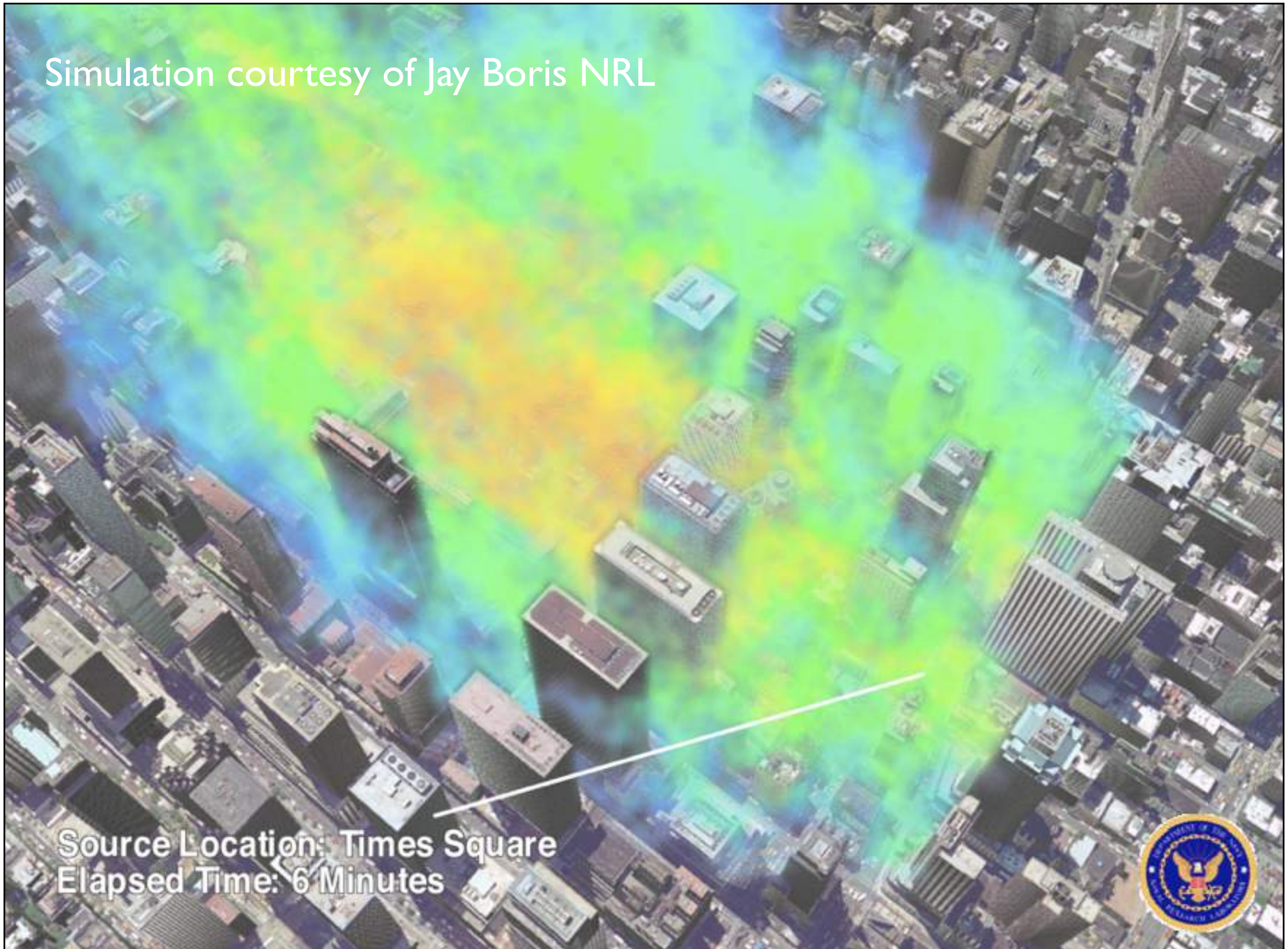




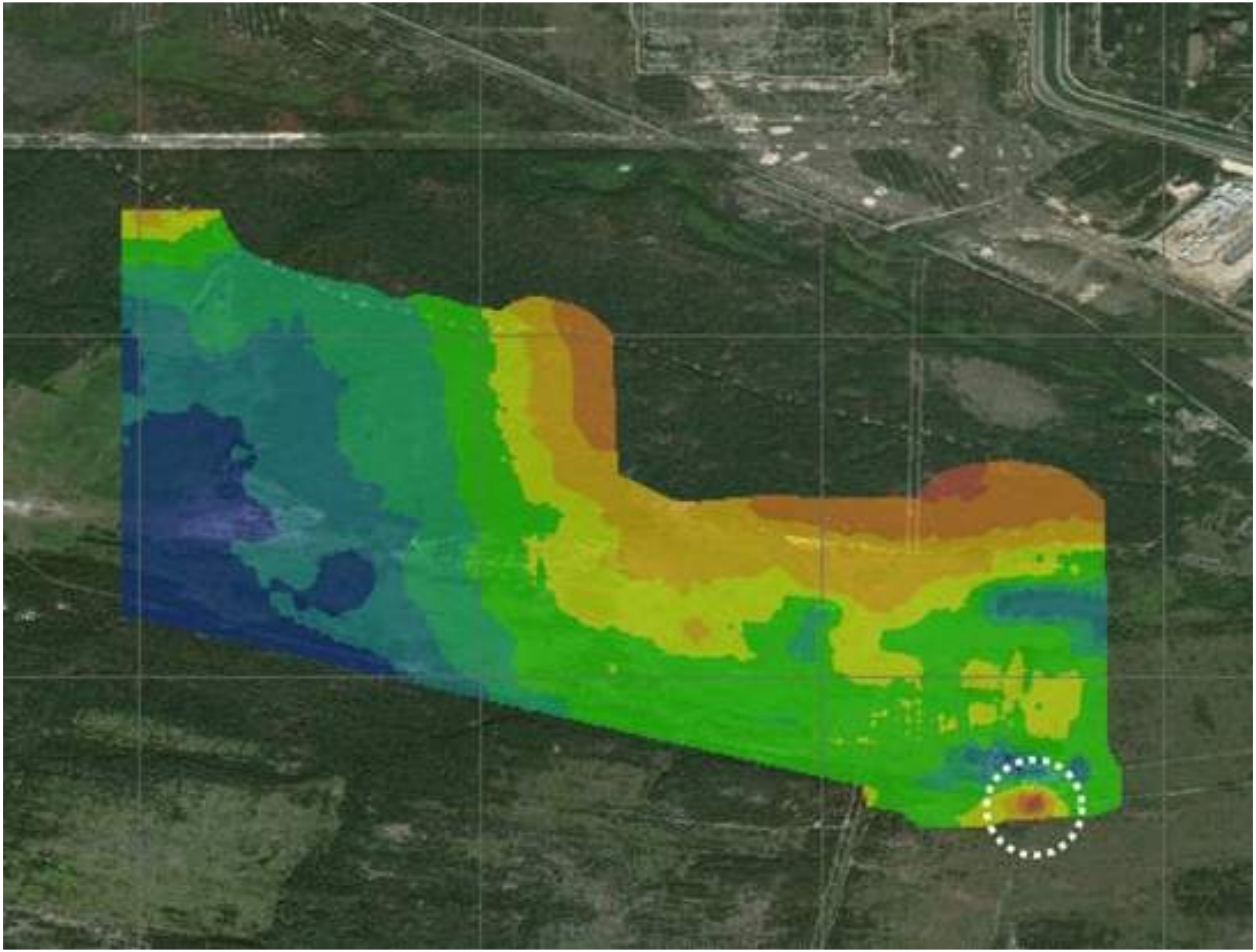




Sensing and Simulation of detailed micro environments. Optimum evacuation routes.

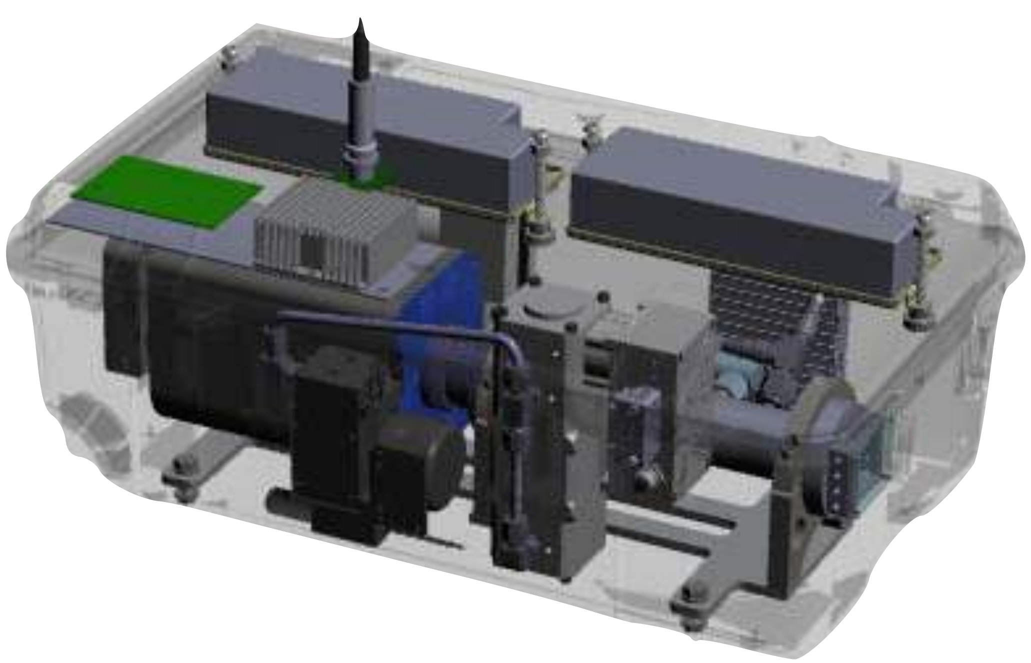


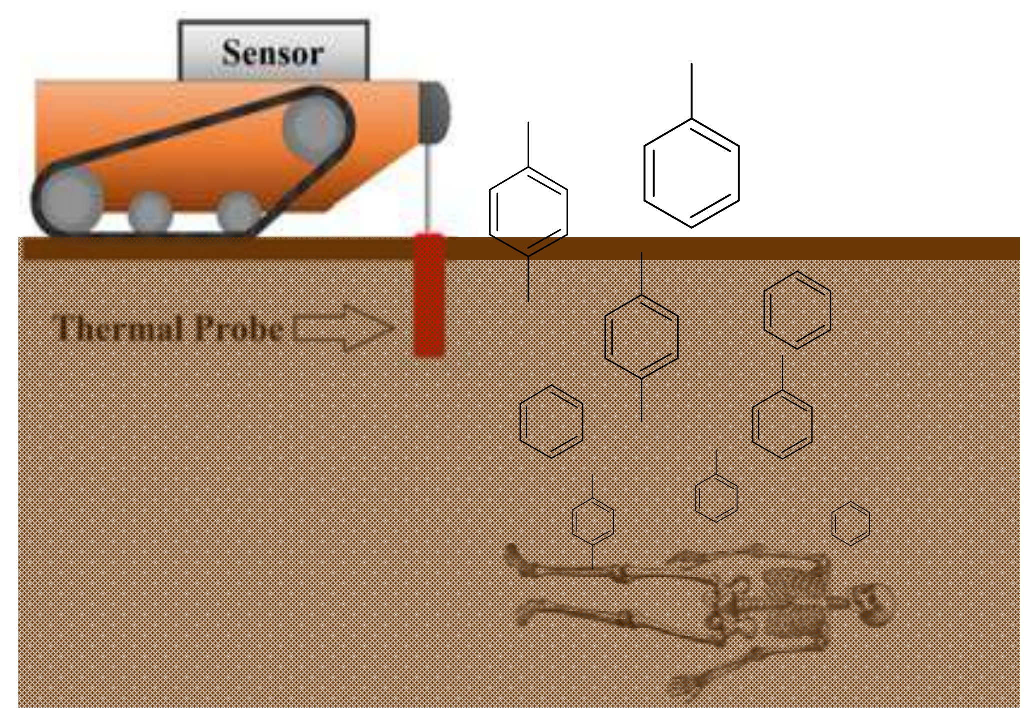
Chernobyl's "Red Forest" - one of the most radioactive locations on Earth - has just been surveyed using a suite of drones. The survey detected some unexpected hotspots to the south of the Red Forest.



https://www.ncnr.org.uk/research-areas/uav-based-site-monitoring

Can Also Detect Mass Graves





What? To provide a capability for **preemptive force protection** focussed on **ports** that does not currently exist

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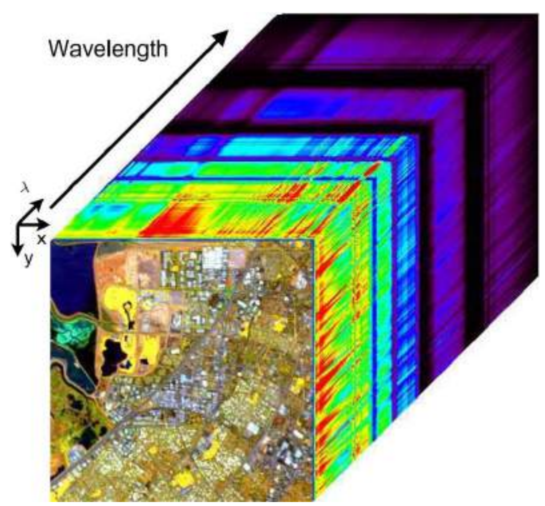
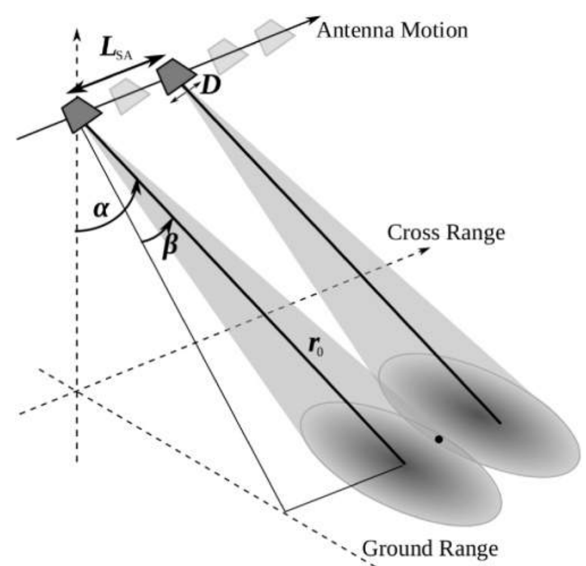
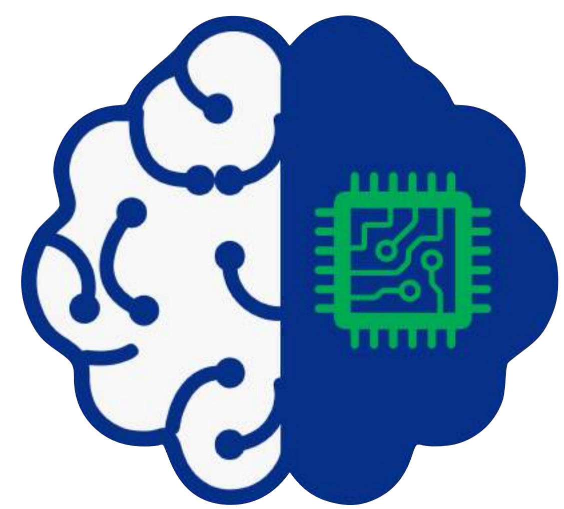
UAV with 350-2,500 nm hyperspectral imager



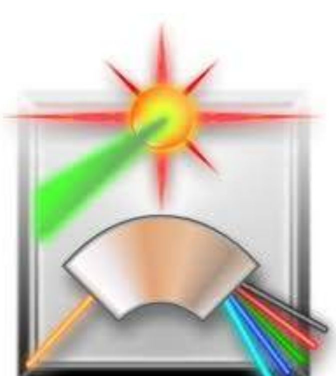
UAV with SAR

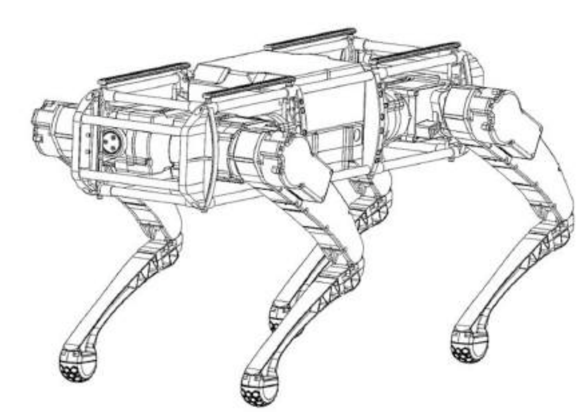


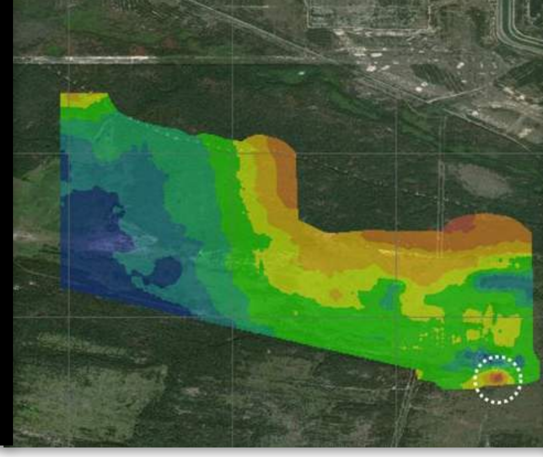
Machine Learning

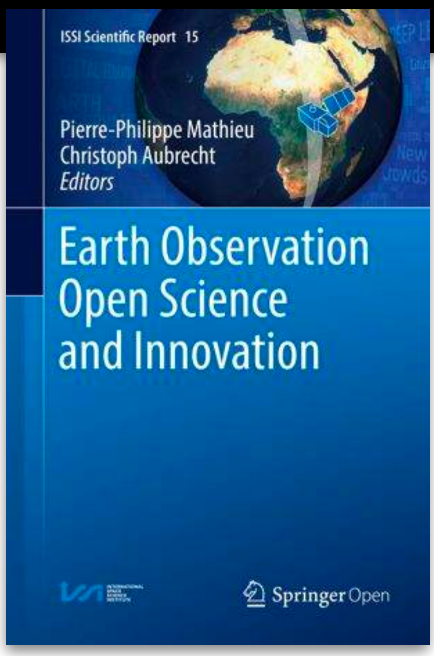


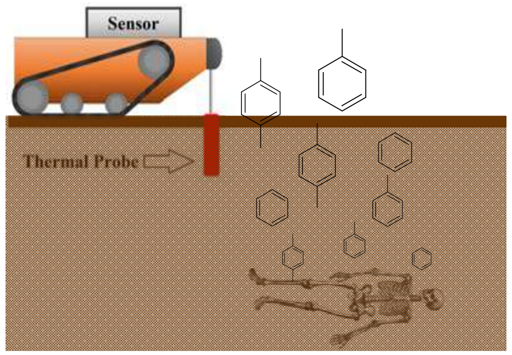
Mass Spectrometer







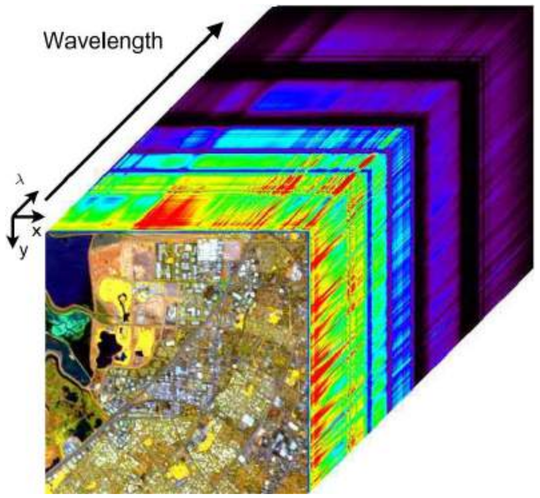


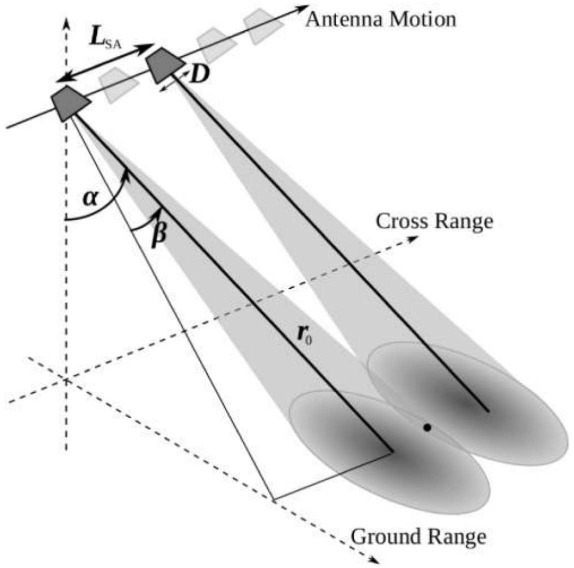


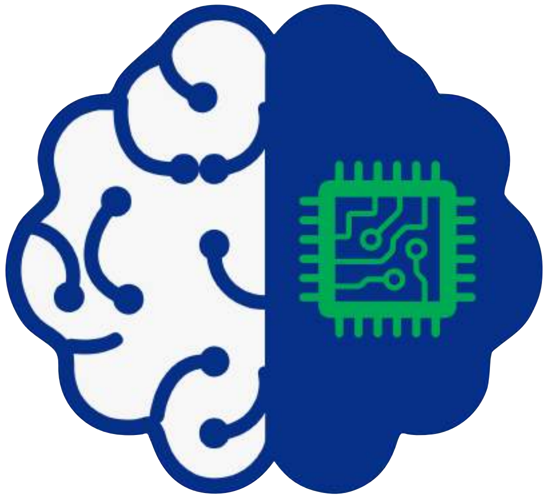
UAV with 350-2,500 nm hyperspectral imager

UAV with SAR

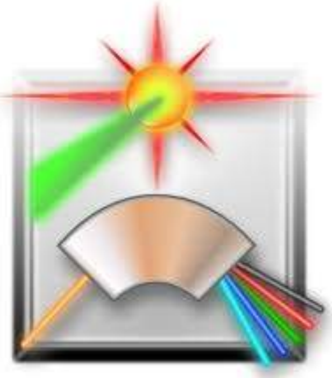
Machine Learning

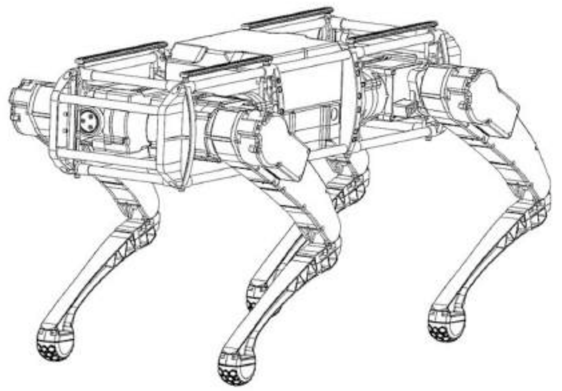






Mass Spectrometer





Flying Cell Towers

Kamesh Namuduri
Electrical Engineering, University of North Texas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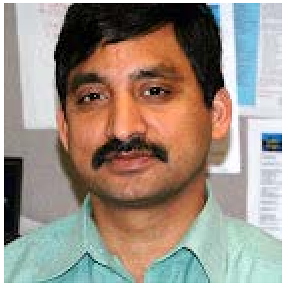


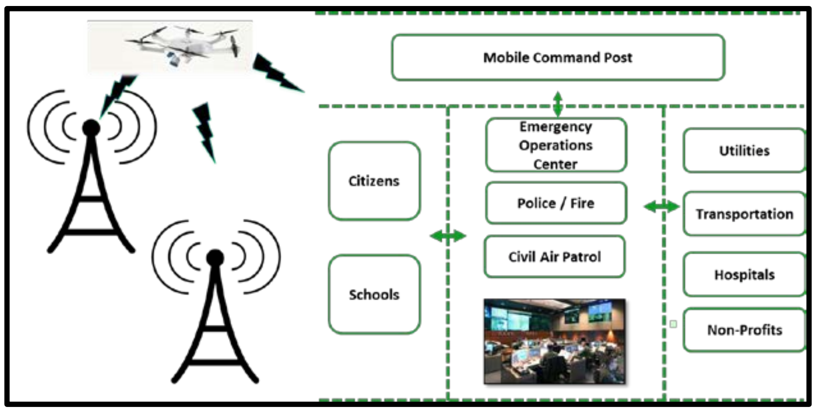
Kamesh Namuduri, Professor

Department of Electrical Engineering

Director, Autonomous Systems Laboratory

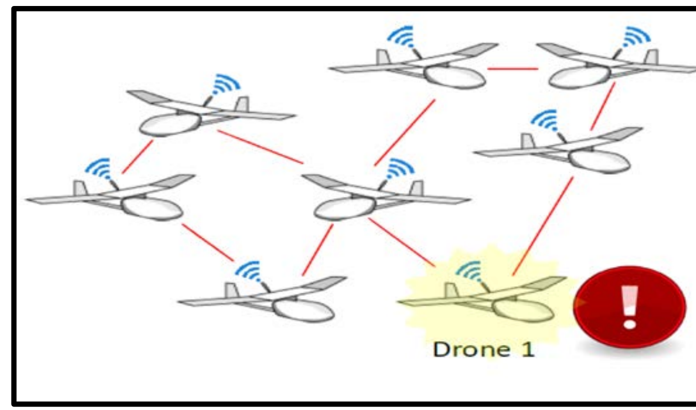
Research Interests: Emergency Communications, Airborne Networks, and Image and Video Communications

Flying Cell Towers for Emergency Response



Principal Investigator, “Networked Aerial Base Stations for Enabling Emergency Communications During Disaster Recovery”

Aerial Communications and Networks



Chair, IEEE P1920.1 Working Group, Standards for Aerial Communications and Networks

Chair, Ad hoc Committee on Drones, IEEE Vehicular Technology Society

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Civil Air Patrol
Denton, Texas

Nighthawk
Composite Squadron

City of Denton, Fire department

PennState

Virtual Network Communications

UNMANNED EXPERTS

AIRROBOT®

Mutualink

IoT+ LTE Consulting Group

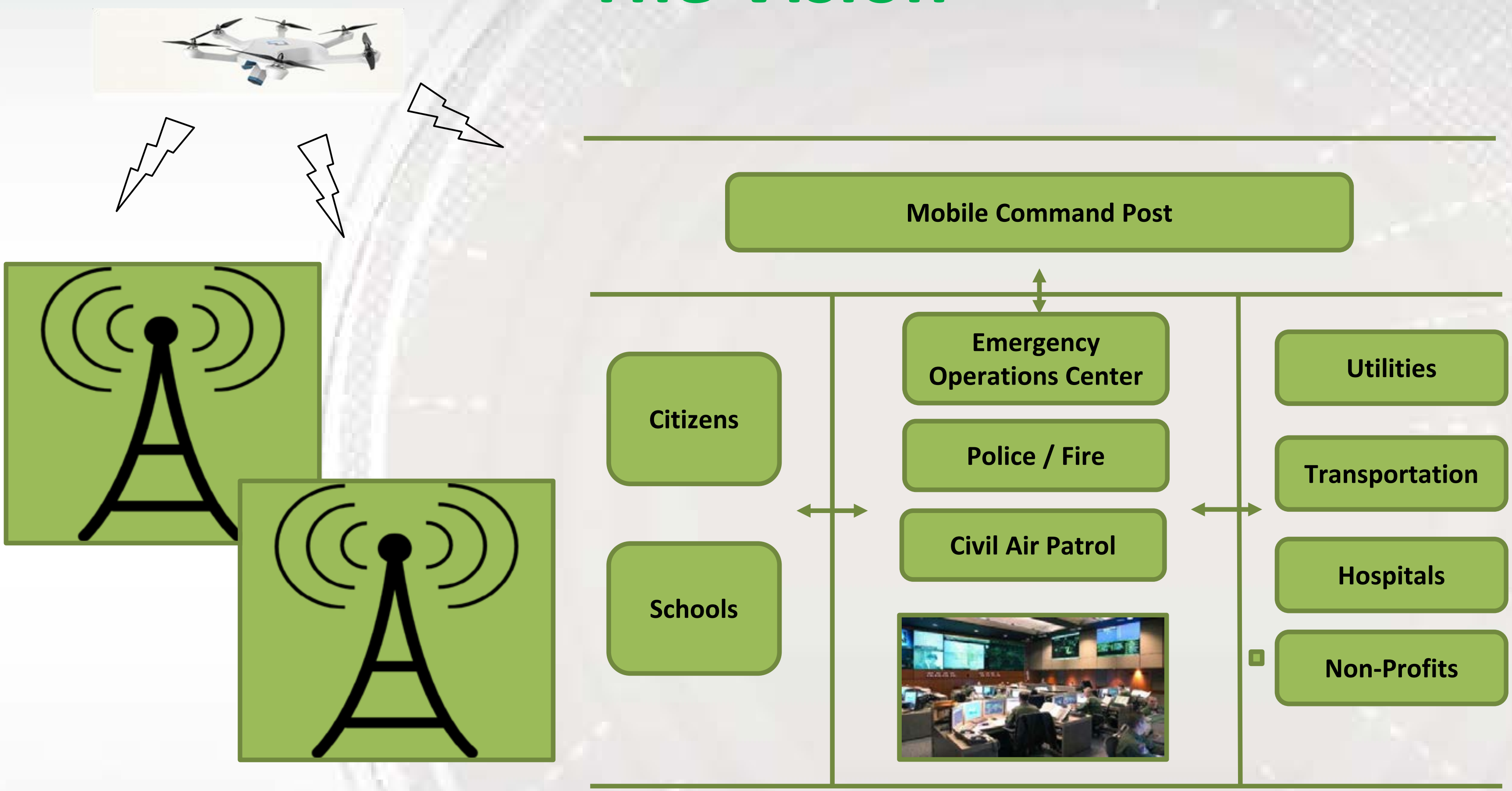
Fundamental Research

- Exploring the dynamics of human interactions during disaster recovery
- Identifying critical inter-organizational communication channels
- Identifying communication requirements and protocols between emergency management and civilian population

Fundamental Research

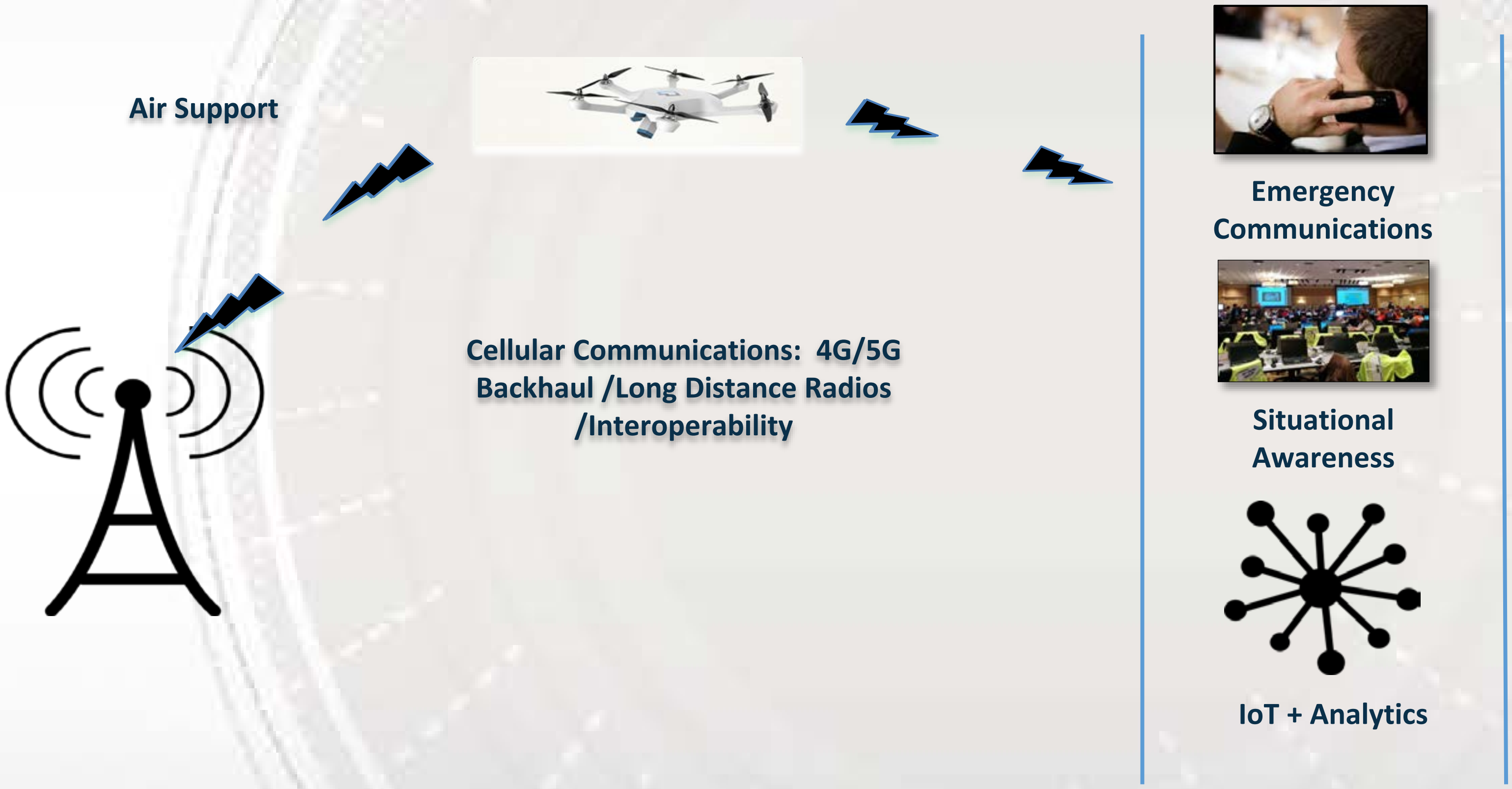
- Study of complex human interactions that take place on the ground immediately after a disaster
- Strategies for enhancing the efficiency of relief operations, decision-making, and resource allocation through technological innovations.
- Foundations for innovation- and research-driven ecosystem for emergency preparedness.

The Vision



Mobile Command Post
Citizens
Schools
Emergency Operations Center
Police / Fire
Civil Air Patrol
Utilities
Transportation
Hospitals
Non-Profits

Deployable Communications, Situational Awareness and Incident Management



Building Blocks for Public Safety & Disaster Relief Operations

- Deployable Communications (UAS, LTE eNB, EPC, Long Distance Radios)
- Sensor Data Aggregation (Edge Computing and Analytics)
- Incident Command system (GIS based Dashboard + Chatroom)
- Situational Assessment (Cloud Analytics)
- Decision Making (Actionable Information for Incident Commanders)

Aerial Deployable Communications Systems

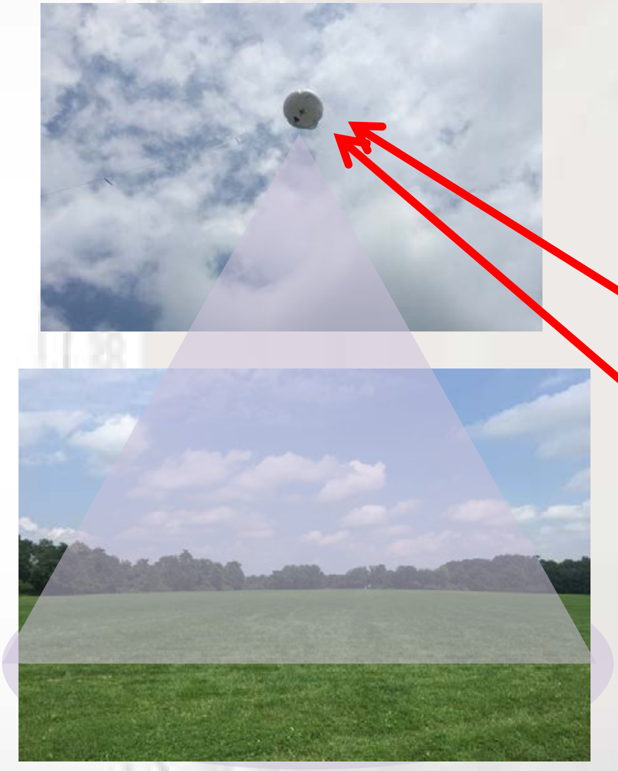
LTE eNB

UAS

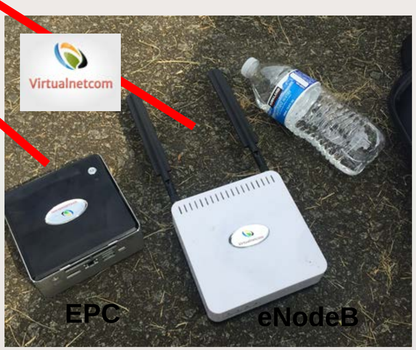
Situational Assessment and Decision Making Tools

Edge Analytics

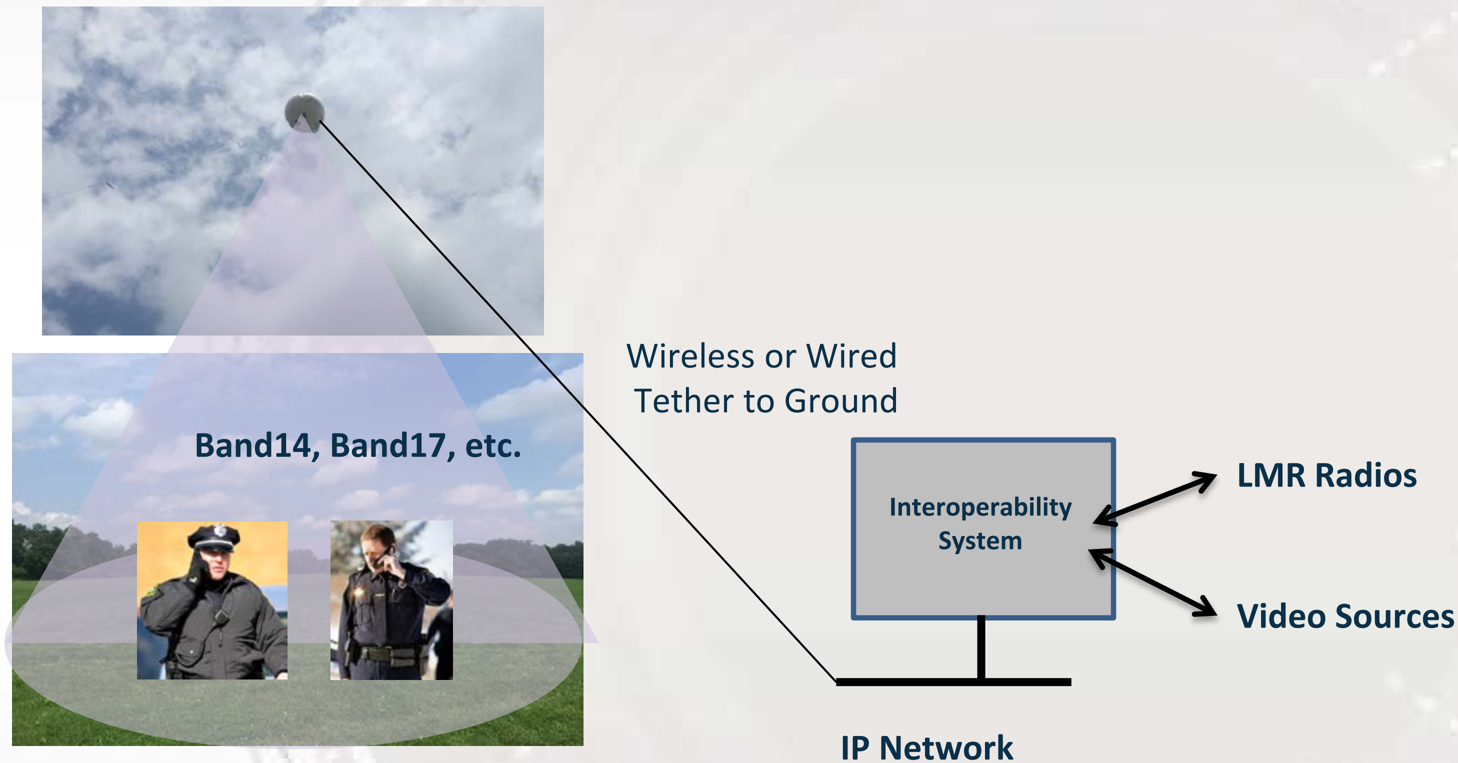
Flying Cell Towers



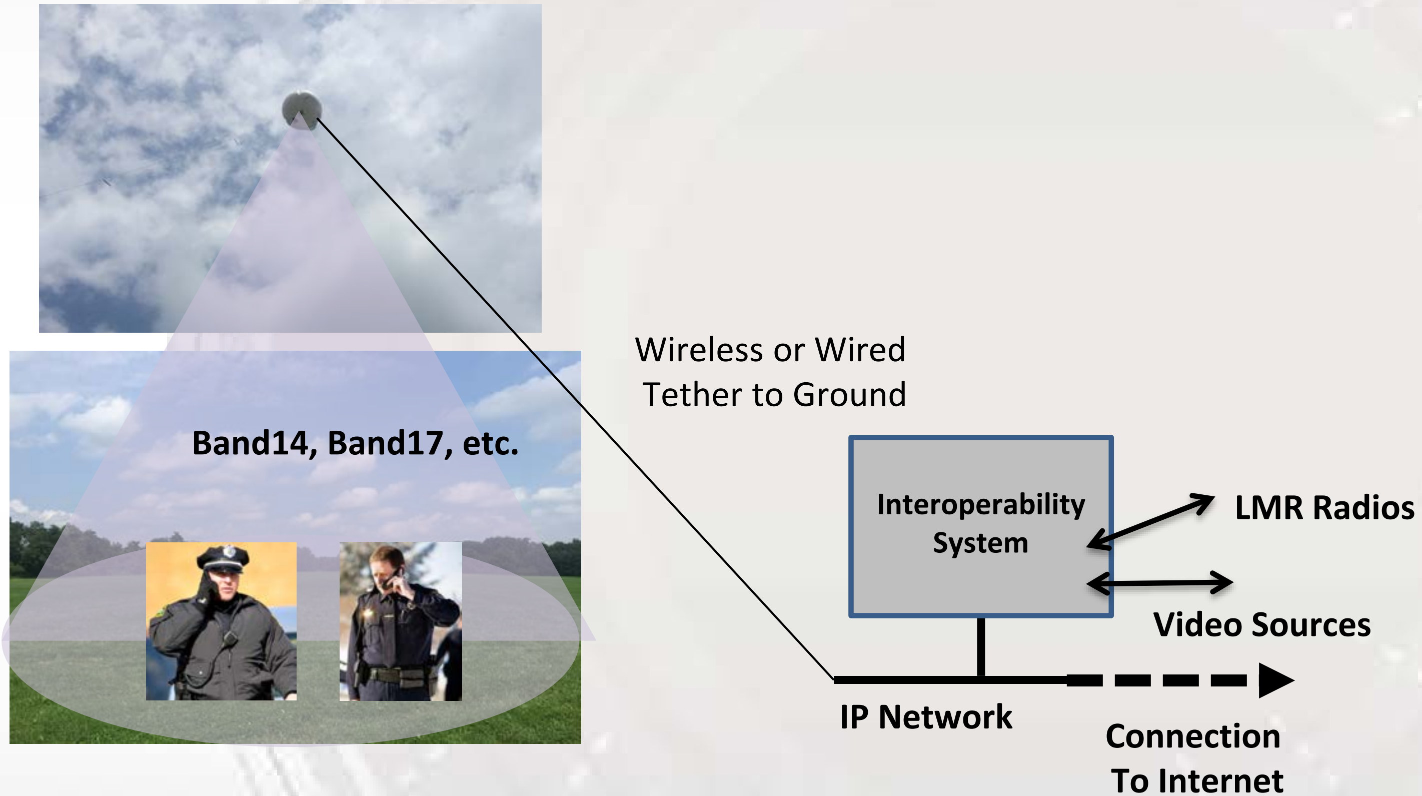
(Drone, Balloon, Aerostat, etc.)



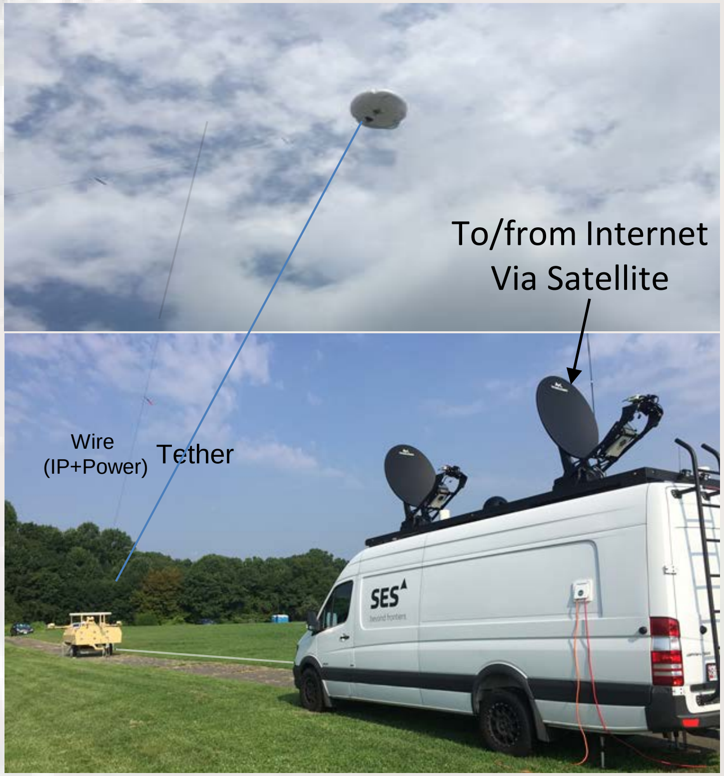
Ground-based Interoperability Services



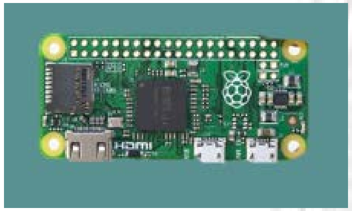
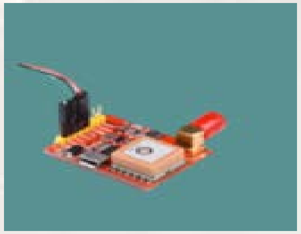
Integration with Nationwide Secure Emergency Network and Other Services

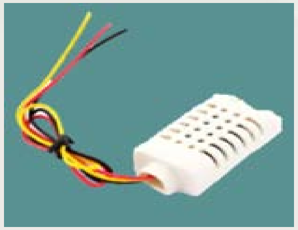
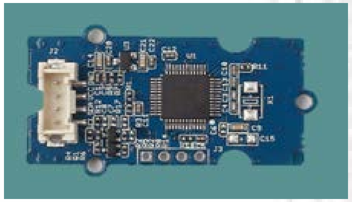
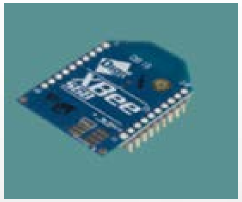


A Possible Deployment



The Ecosystem of Public Safety Data Acquisition, Analysis, and Dissemination in Real-Time

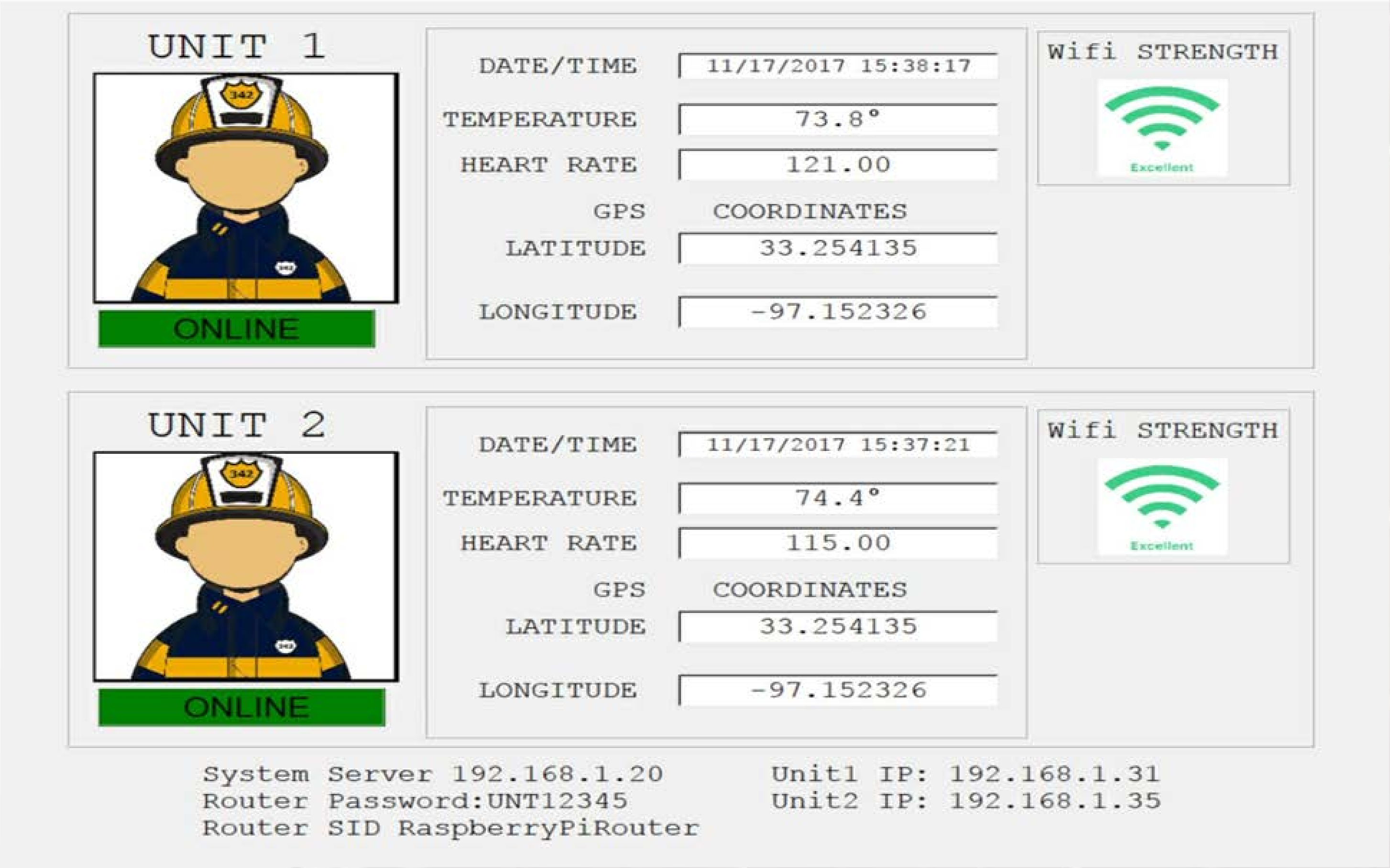



Safety gadgets for firefighters
Smart phone apps for sharing information
Situational awareness applications
Edge analytics

UNT Emergency Exercise Friday, May 5th, 2017 at Apogee Stadium, UNT

Data Collected from the Safety Gadgets for Firefighters

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UAS
unmanned aircraft systems
Marketing | Advertising | Publicity | Outreach

Unmanned Aircraft Systems

[*The Project*]

- Purpose
- Goals and Objectives
- Audiences
- UAS Workshops
- General UAS Education
- Approach + Tone
- Standard Messaging
- Outreach Tactics
- Advertising Options
- Evaluation

Unmanned Aircraft Systems

[*Draft Schedule*]

- Draft Communications Plan – Education and PA Task Force: May 1, 2019
- Draft Communications Plan – UAS Safety and Integration Task Force: May 28, 2019
- Final Communications Plan – Education and PA Task Force: June, 2019
- Final Communications Plan – UAS Safety and Integration Task Force: July, 2019
- Launch campaign messaging and announce 1st Workshop via partners & COG Social Media: August 2019

Unmanned Aircraft Systems

[***Purpose***]

- Rules and Regulations (General Public + Operators)
- Career Opportunities
- Best practices

Unmanned Aircraft Systems

[***Goal and Objectives***]

- Create awareness of UAS and their corresponding rules/regulations
- Increase safety for North Texans and make them feel comfortable with seeing UAS devices
- Make public aware of best places to fly UAS
- Encourage public engagement with UAS Task Force
- Host successful/well-attended UAS workshops

Unmanned Aircraft Systems

[***Goals and Objectives Cont.***]

- Increase in Part 107 Licenses by ______% by 2022
- Decrease in Regional UAS crashes/incidents by ______% by 2022
- Increase in UAS school curriculum by ______ % by 2022
- Reach near capacity at Regional UAS workshops
- Increase in web traffic by 25% (pending new standalone website)

Unmanned Aircraft Systems

[***Audiences***]

- General public
- UAS operators
- Geographical regions situated near local airports and military installations
- Career-seeking public

Unmanned Aircraft Systems

[***UAS Workshops***]

- 12 workshops over two years
- Located all over North Texas
- Audience is 16 and up
- Opportunity to learn from UAS pros and see equipment
- Develop brochures, fact sheets, and postcard mailer
- Sponsorship opportunities for UAS Partners

Unmanned Aircraft Systems

[***UAS Workshops Cont.***]

- Marketing via:
  - Print and electronic newsletters
  - Partner publications
  - Public meetings

- Advertising via:
  - Radio
  - Social Media
  - TV
  - Billboards

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[***General UAS Education***]

- Communications Approach
  - Social Media Messaging
  - Press Releases
  - Partner Videos
  - Launch Campaign Initiative

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[***General UAS Education Cont.***]

- Tone
  - Written
  - Visual
- Key/Standard Messaging
  - Develop standard messaging for all partners to use
  - Content for General Public, Operators, and Educators

Unmanned Aircraft Systems

[***Outreach Tactics***]

- Develop shared calendar with UAS Partners
- Work to develop partnerships with non-profit organizations
- Regularly attend outreach events w/coordinated effort among partners
- Specific outreach to young audience about careers
- Utilizing Speakers Bureau

Unmanned Aircraft Systems

[***Outreach Tactics Cont.***]

- Develop standalone website
  - Purchase unique URL
  - Create a platform for web traffic to learn more
- Partner websites
  - Use standard content on partner webpages

Unmanned Aircraft Systems

[*Advertising Options*]

- **Workshop Advertising**
  - Multiple levels ($15k, $30k, and $45k)
  - Multiple mediums
    - Radio, Social Media, TV
  - 1 year duration

- **General UAS Campaign**
  - Multiple levels ($20k, $40k, and $60k)
  - Multiple mediums
    - Radio, Social Media, TV, Billboard, Transit
  - Six month duration

Unmanned Aircraft Systems

[*Evaluation*]

- Determine effectiveness based on:
  - Attendance at workshops
  - Increase in Part 107
  - Decrease in UAS Incidents
  - Website traffic
  - Media attention

Unmanned Aircraft Systems

[*Contact Information*]

Kenny Bergstrom

Communications Coordinator

NCTCOG – Marketing

817-704-5643

kbergstrom@nctcog.org

Mindy Mize

Program Manager

NCTCOG – Marketing

817-608-2346

mmize@nctcog.org

UAS Legislative Update

NICK ALLEN
UAS SAFETY AND INTEGRATION TASKFORCE
NORTH CENTRAL TEXAS COUNCIL OF GOVERNMENTS
MAY 28, 2019

Texas Legislature - UAS Legislation

UAS Study

HB 2340 (Dominguez) Creates a study for emergency and disaster management, response and recovery

- **Sent to Governor**

Operations

HB 3082 (Murphy) - Adds ‘criminal negligence’ to code

- Language to add military installations to the list of critical infrastructure was amended into the bill
- **Set on House Items Eligible Calendar on 5/23/19**

New FAA Rulemaking Guidelines

Provides notice of how individuals can operate recreational unmanned aircraft and FAA's implementation plan.

Includes eight statutory conditions and provides guidance.

- Fly for recreational purposes
- Follow current safety guidelines
- Fly within visual line of sight or communication with observer
- Do not interfere and give way to manned aircraft
- Obtain prior FAA authorization
- Fly under 400 feet; comply with airspace restrictions
- Pass safety test; register with FAA

Questions and Comments

Amanda Wilson
Program Manager
(817) 695-9284
awilson@nctcog.org

Rebekah Hernandez
Communications Supervisor
(682) 433-0477
rhernandez@nctcog.org

Nick Allen
Communications Coordinator
(817) 704-5699
nallen@nctcog.org

Kyle Roy
Communications Coordinator
(817) 704-5610
kroy@nctcog.org

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