365 Days
in the Stratosphere

Aerostar Stratospheric Platforms

AEROSTAR

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Agenda

1. **Aerostar and Thunderhead Overview**
2. **What have we been up to lately?**
   - Continuous Flight and Navigational Improvements
   - Active ISR Support for Government Partners
   - Multi-Spectral Imaging for Methane Monitoring
3. **What's next?**
4. **Questions**

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Aerostar Overview

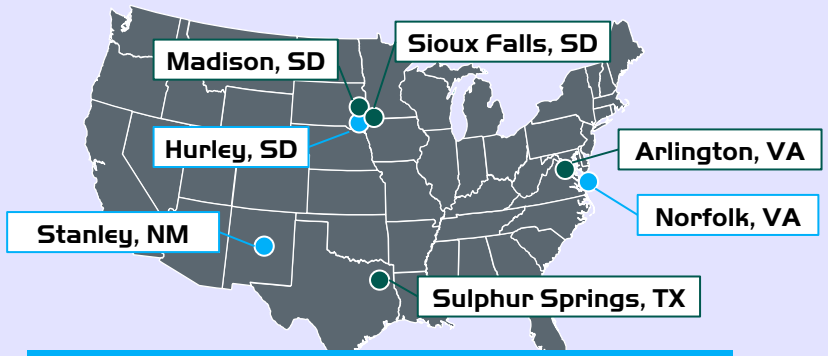
Who Are We?

>2M Flight Hours in Stratosphere

>10,000 Operational Flights

>200 Technology Patents

>65 Years Building Balloons



We connect, protect, and save lives.

1956: Raven founded as manufacturer of high-altitude research balloons

1956: USAF projects Manhigh and Excelsior utilize balloon systems for space and high-altitude flight tests

1986: Aerostar International is founded as a subsidiary of Raven

2010: Hi Sentinel successful sustained, powered stratospheric airship flight

2012: Project Loon initiated with Google X to provide high-speed Internet to Rural Areas using balloons

2018: DARPA ALTA program selects Thunderhead system as sole platform

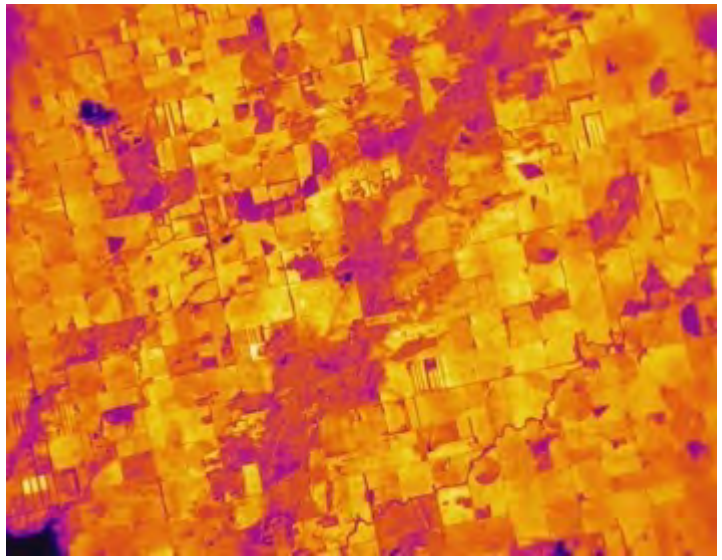
2018 Cyclone Balloon System selected for NASA "Flight Opportunities" program

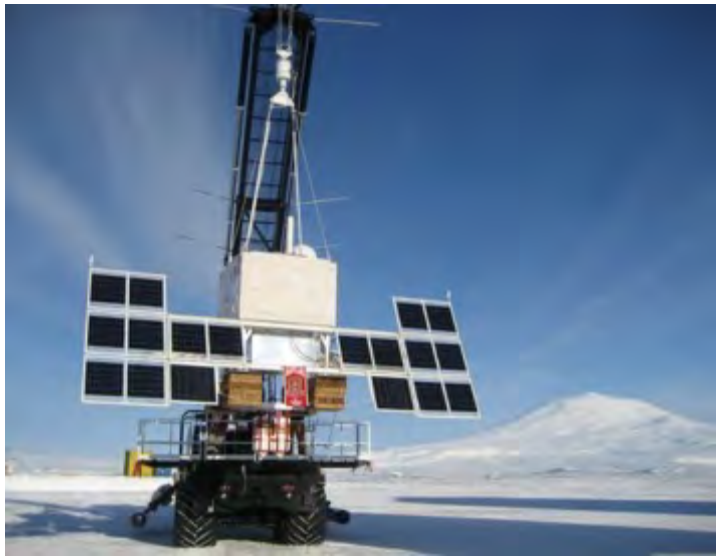
2021: Aerostar launches 18 flights across 6 sites for 5 programs in 2 wks

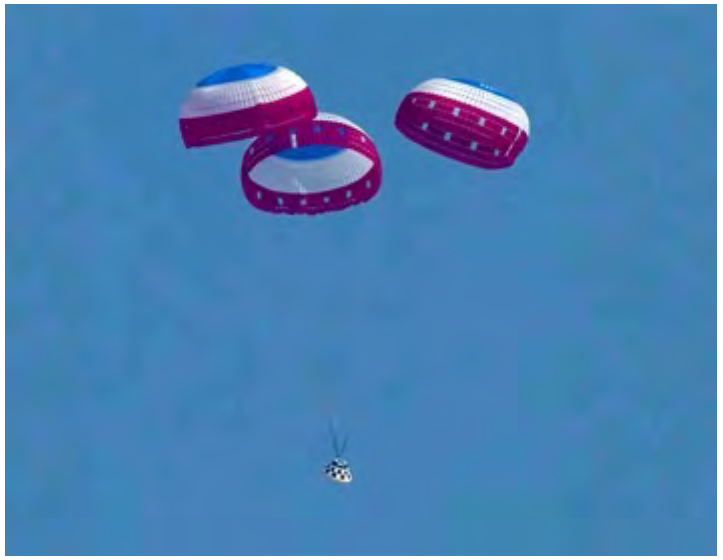
2022: Thunderhead system duration record with >150 days aloft

2022: Aerostar International separates from Raven, becomes stand-alone entity held by TCOM Holdings

1956 — 2010 — 2015 — 2020 — 2022







Stratospheric Balloon Applications

- **Defense:** Intelligence, surveillance, and reconnaissance, long-range communications
- **Disaster Relief**: Reconstituting Cellular Networks, Real-time Imagery
- **Earth Science**: Atmospheric Testing, Crop Health Assessment, Wildfire Monitoring
- **Space Science**: Particle and Physics Studies, Telescopes, Electromagnetics
- **Satellite Testing**: Recoverable, Near-Space Qualifications of Instruments and Sensors
- **Space Systems Testing**: Parachutes, Descent Vehicles, Test and Qualification

Thunderhead Balloon Constellation

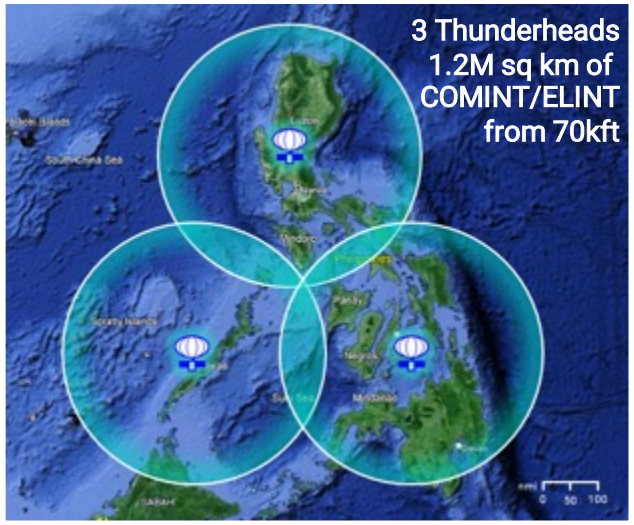
networked ELINT,COMINT and Cyber to support deep sensing, targeting and effects

System Description:

- **Platform:** Expendable, persistent, low observability, expeditionary, low cost
- **Sensors:** Multi-platform, deep sensing, low bandwidth, autonomous cross cueing
- **Integrated:** Intel solutions for targeting, fires, EW, cyber, mission cmd systems
- **Data Transport:** Reliable, resilient, secure, interoperable, from the tactical edge
- **PED:** All echelon access, autonomous processing, timely delivery

Capabilities:

- **Persistent, Autonomous, Attritable ISR Swarm** 90 days+
- **Networked Integrated COMINT/ELINT and RF Cyber Ops**
- **Long Range Sensing** over A2/AD environments
- **Command and Control** from any location
- **Networks** secure ingest into NSANET, JWICS, SIPR, others



Backhaul
Secure Data Transfer
via LEO or GEO Satellite

Navigation
Altitude Change-Based Steering
15-30 km | Above Typical Airspace

Downlink/PED
Directly into
National Infrastructure

Downlink/PED
Division Headquarters via
IPR/JWICS/NSANET

Field Launch
35x65ft Pad | 5 Crew
3 Hours' Notice

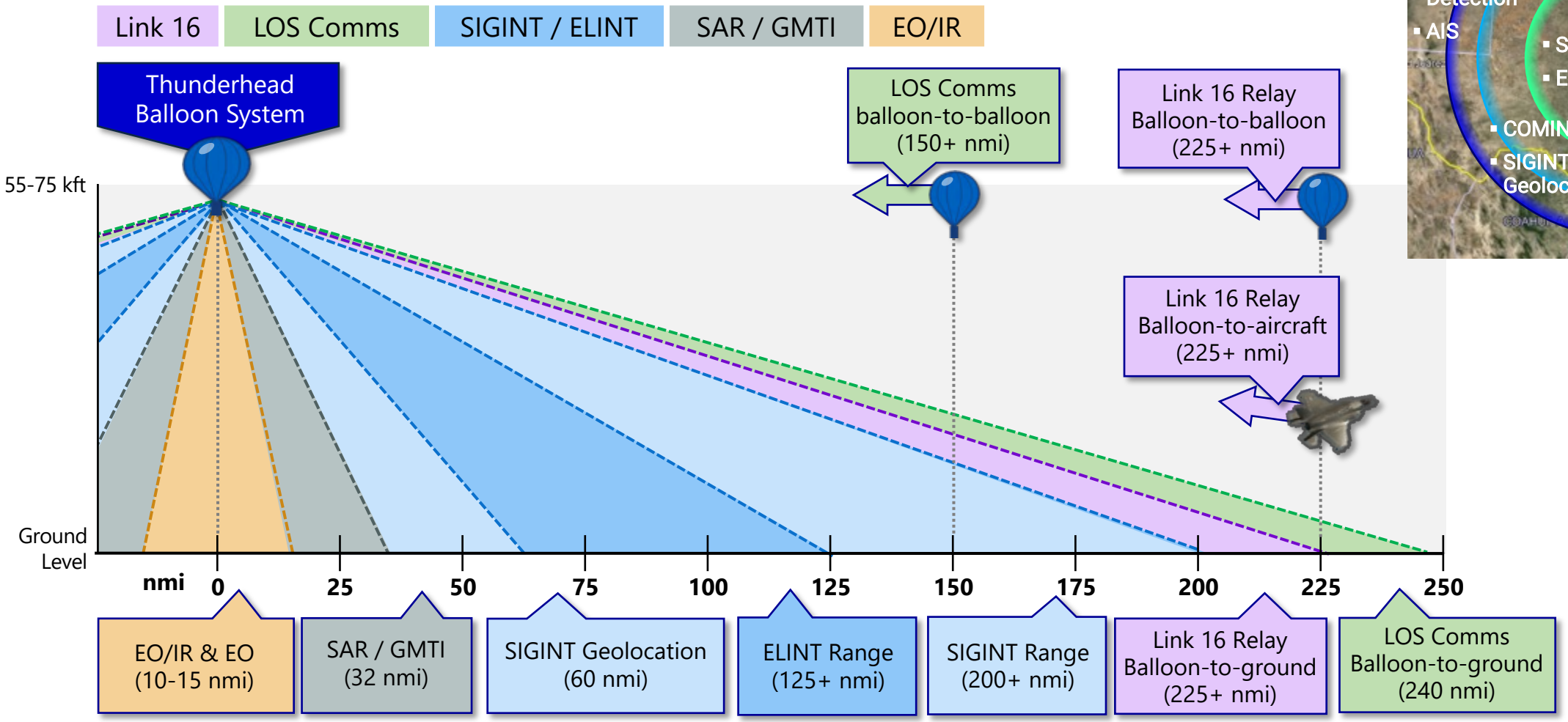
Fixed Base Launch
Simpler Logistics | Longer
Transit Time | 2 Hours' Notice

Persistence
Months On-Station with
ELINT/SIGINT Capabilities

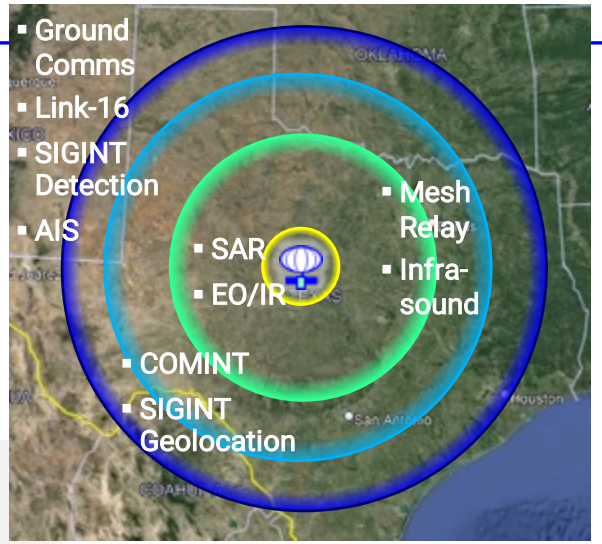
1,100 km

Thunderhead Payload Capability

Demonstrated Results during Customer Operations



Representative Coverage



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Thunderhead Operations Overview

Navigation Example

Test Area #1	
Station Seeking Duration	21.0 days
Time on Station	90%

Launch: Baltic, SD

Recovery: Greencastle, IN

Test Area #2	
Station Seeking Duration	10.4 days
Time on Station	100%

Overall Stats	
Flight Length	93.8 days
Time on Station	52.5 days
Time in Loopback	4.2 days
Time in Transit	37.1 days
Distance Travelled	18,550 nmi

Test Area #3	
Station Seeking Duration	15.8 days
Time on Station	87%*

Note: Several exits of Test Area #3 were forced by airspace constraints.

Test Area #4	
Station Seeking Duration	16.8 days
Time on Station	100%*

Note: Intentionally deviated off station to avoid cold clouds caused by Hurricane Eta.

100 nmi

74.4 kft

0 200 400 NM

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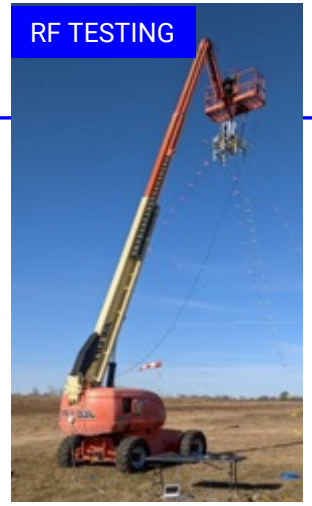
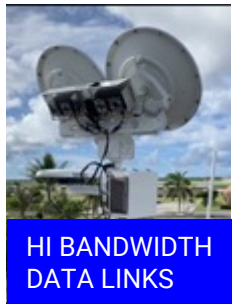
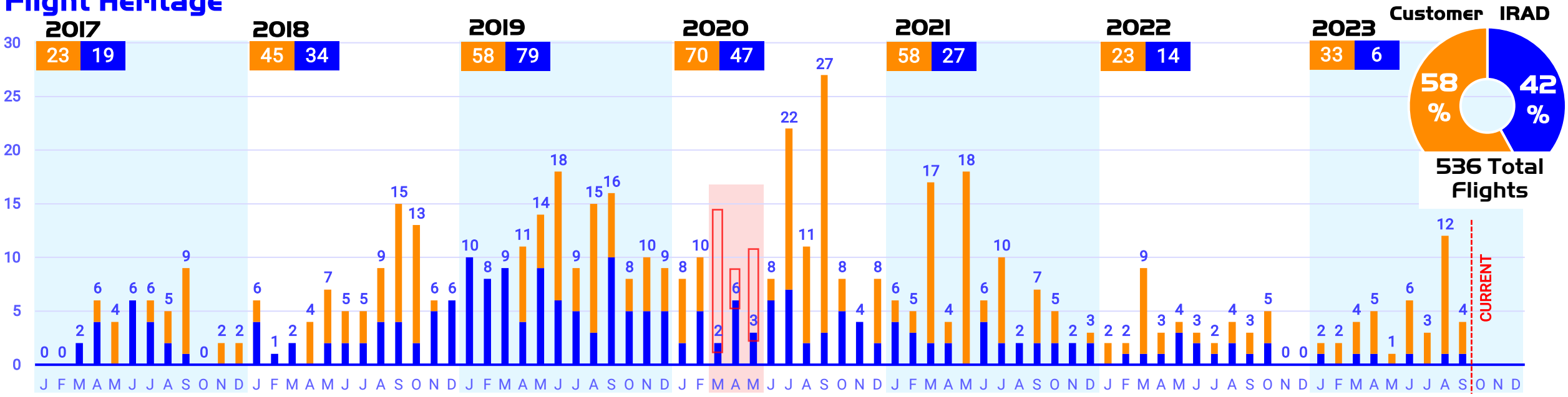
Our Capabilities

- High TRL Platforms
  - 500+ Thunderhead Flights
  - 3000+ Flight Days
- Enabling Access to the Stratosphere
  - Ground Testing Capability
  - Engineering and Integration
  - Flight Planning and Services





Flight Heritage



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Recent Accomplishments

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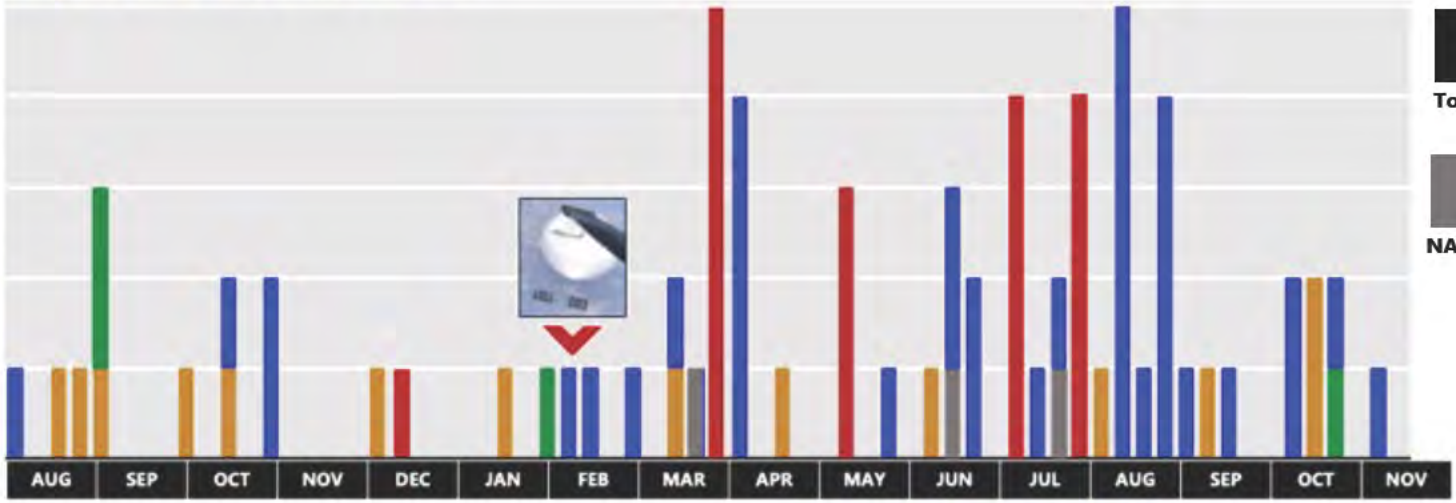
A Year in Flight!

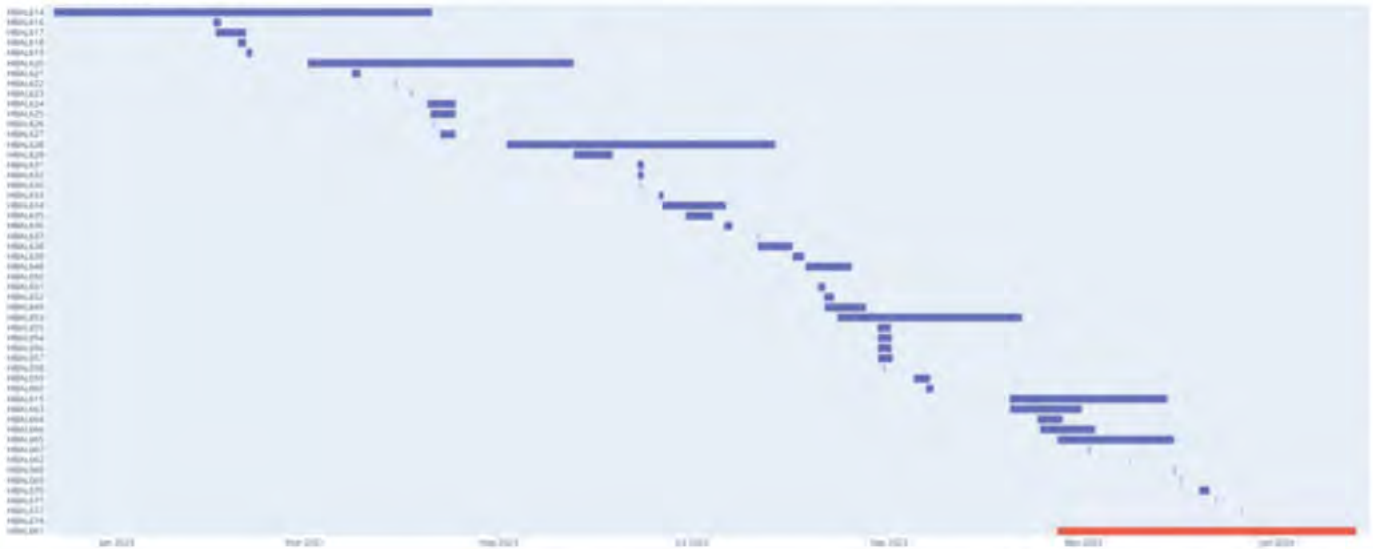
- Aloft Past 450+ Days to Mar 2024
- Over Airspace of all 7 Continents (including NASA flights)
- Could've Done More! (Re: China Incident)

Flights over the Prior Year:

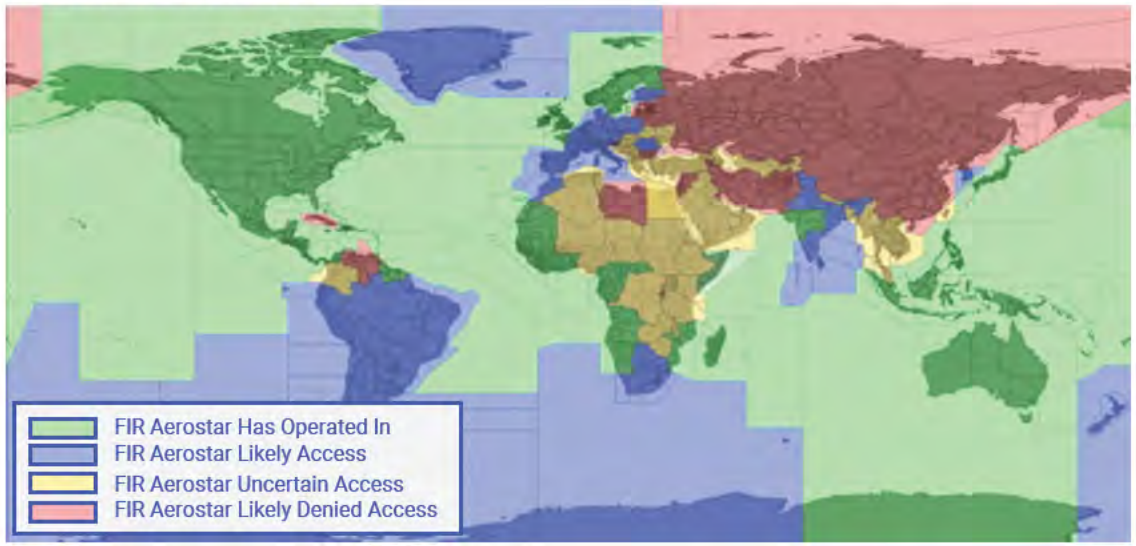


56	35	14
Total Launches	DoD Launches	Aerostar funded IRAD Flights
3	**3**	**17**
NASA Launches	Commercial Launches	Campaign Authorization Not Received

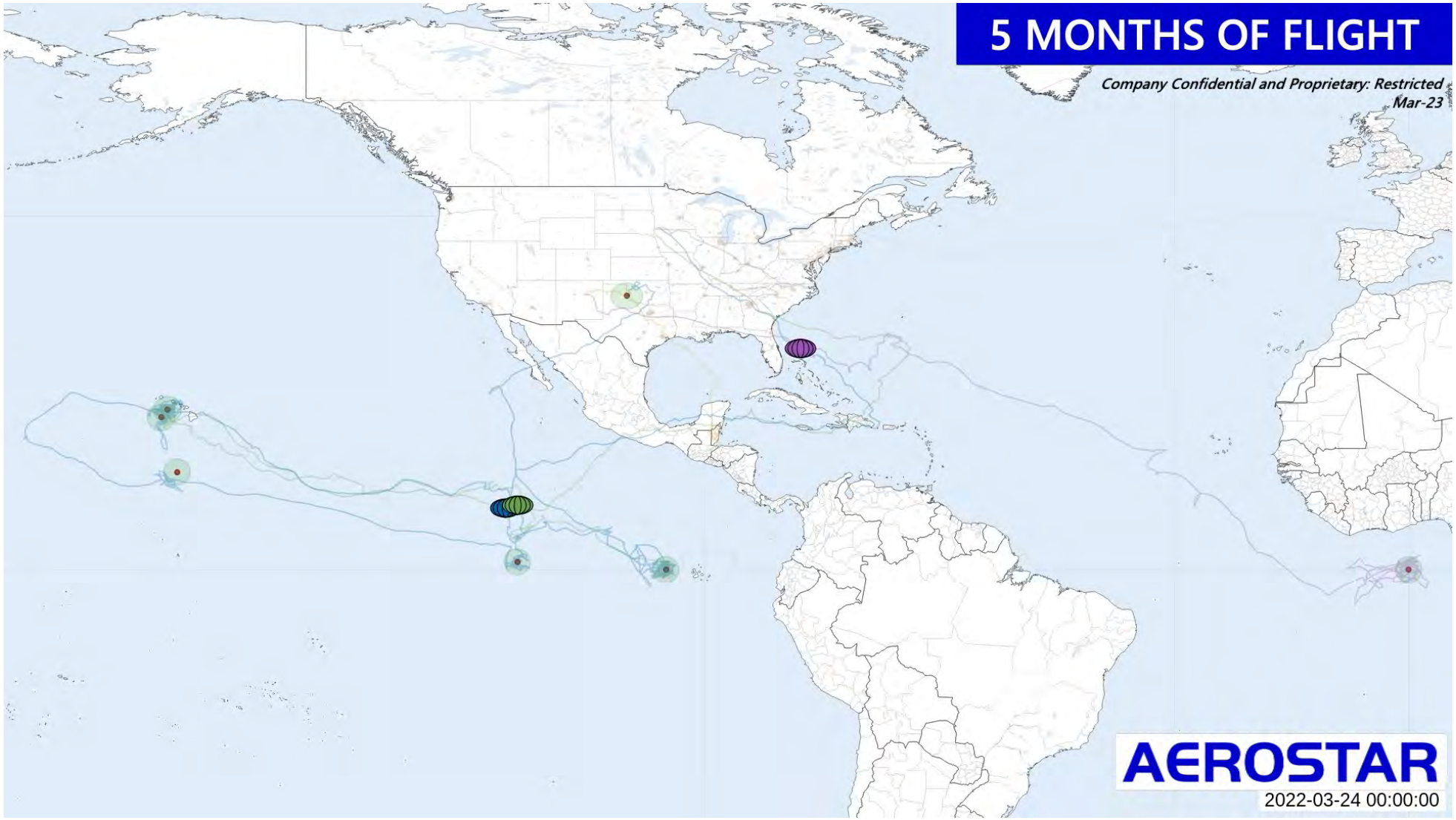
Flight Timelines:



Where in the World?!

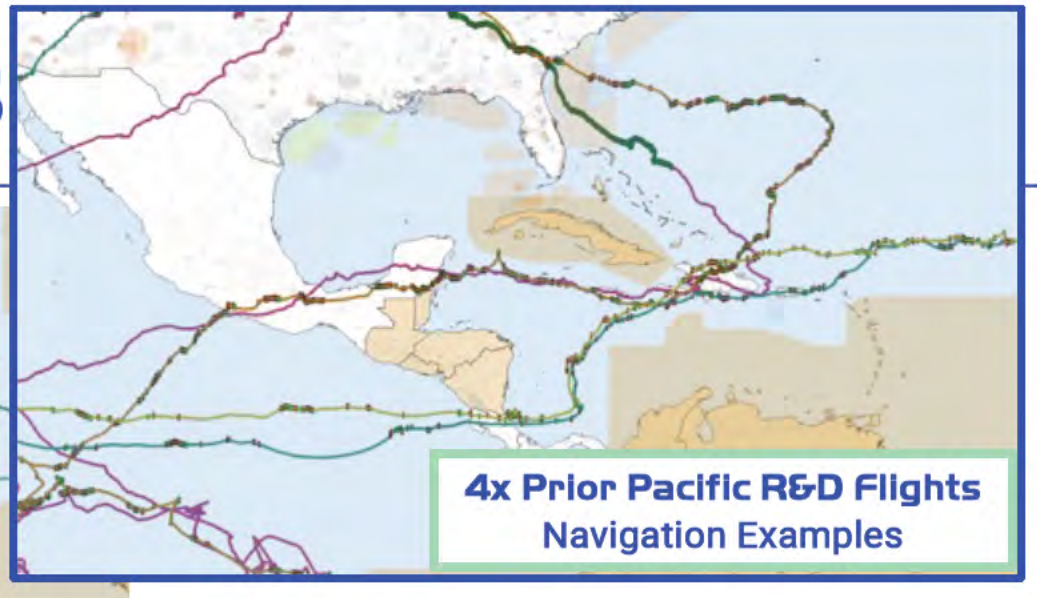


Long Duration Flight Video

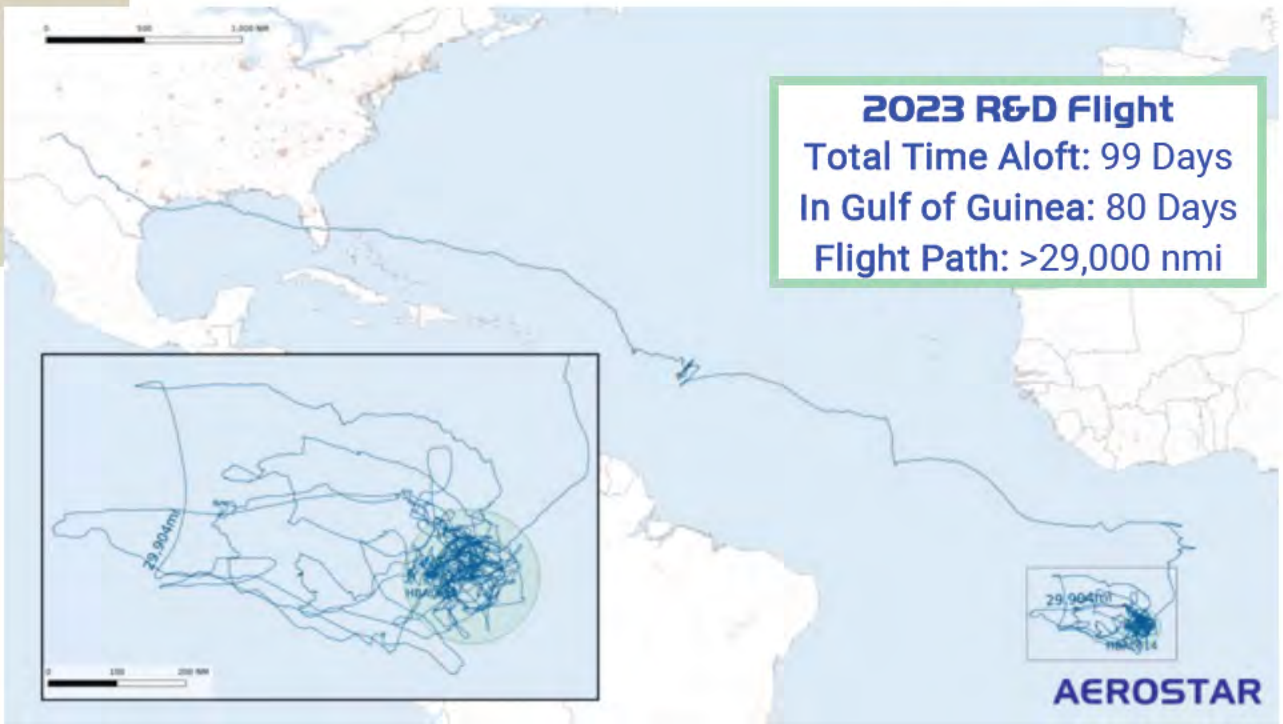


Yet More Flight Paths

Recent R&D Flight (Last Month)
Total Time Aloft: 95 Days
In South Pacific: ~80 Days



4x Prior Pacific R&D Flights
Navigation Examples



2023 R&D Flight
Total Time Aloft: 99 Days
In Gulf of Guinea: 80 Days
Flight Path: >29,000 nmi

ExxonMobil

Monitoring at ~60,000 feet in the sky

Designed, patented and architected by

SCEPTER™

ExxonMobil

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Sensors

LEO:

HAPs:

Aircraft:

Drone & UAV:

Terrestrial:

Monitoring

Aggregation

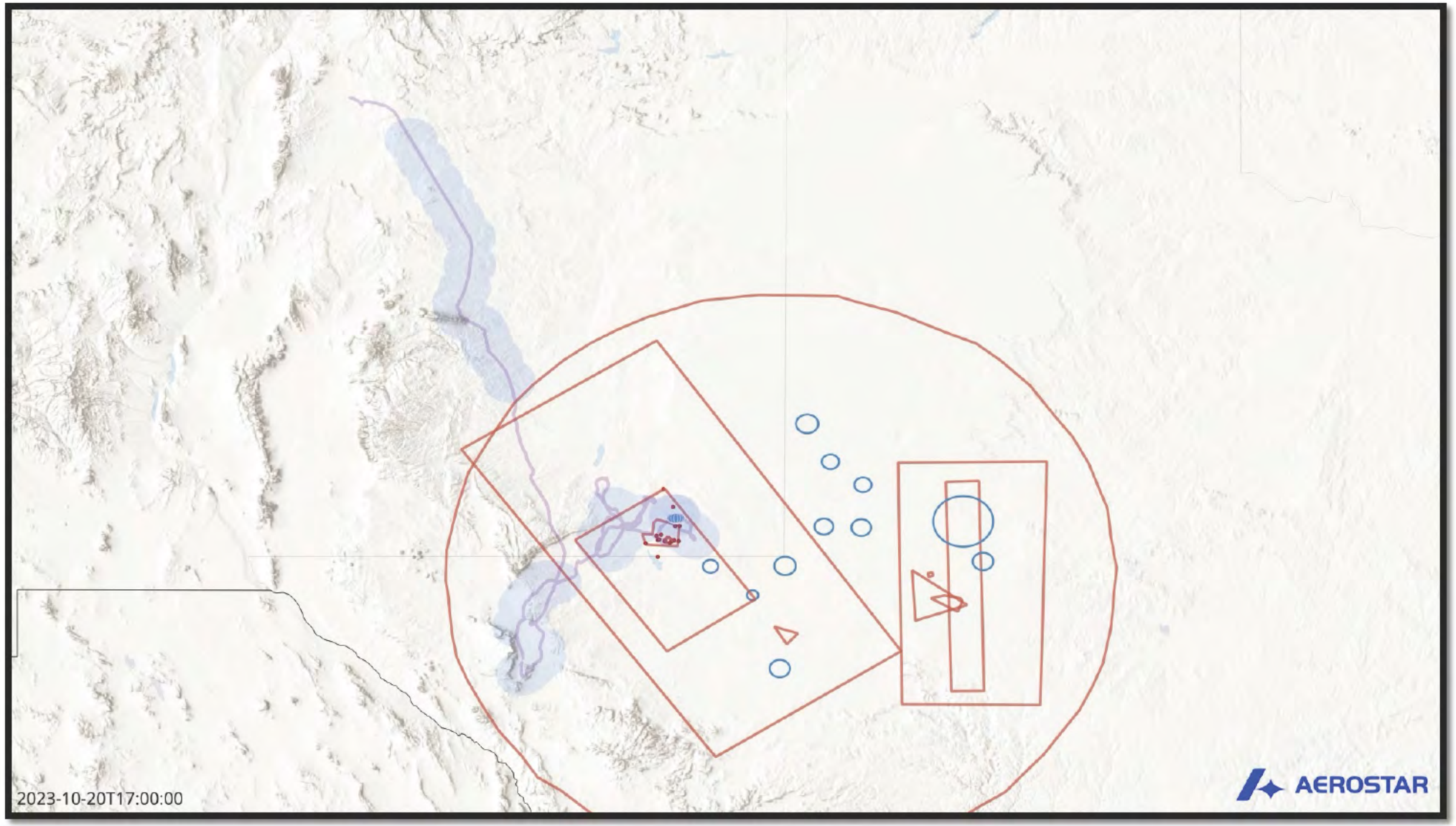
Data Fusion

Analytics

Visualization

Actionable Information

Methane Detection Flight Path



What's Next?

- **USFS/NASA Collaboration for Wildland Fire Support**
- **Platform Improvements**
  - Looking to roughly double Thunderhead size, weight, and power availability
  - Target early 2025 for broad system production
- **Continued Refinement of CONOPs**
  - Expect increased op-tempo 2024-2025 as we scale up in-theater demonstrations
  - Hoping for broad and persistent deployment of systems by 2026
- **Industry Alignment:**

  PSA for HAPS Alliance and Defense Working Group

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