ICAO FSMP – WG/6

Mexico City, Mexico

February 12th, 2018

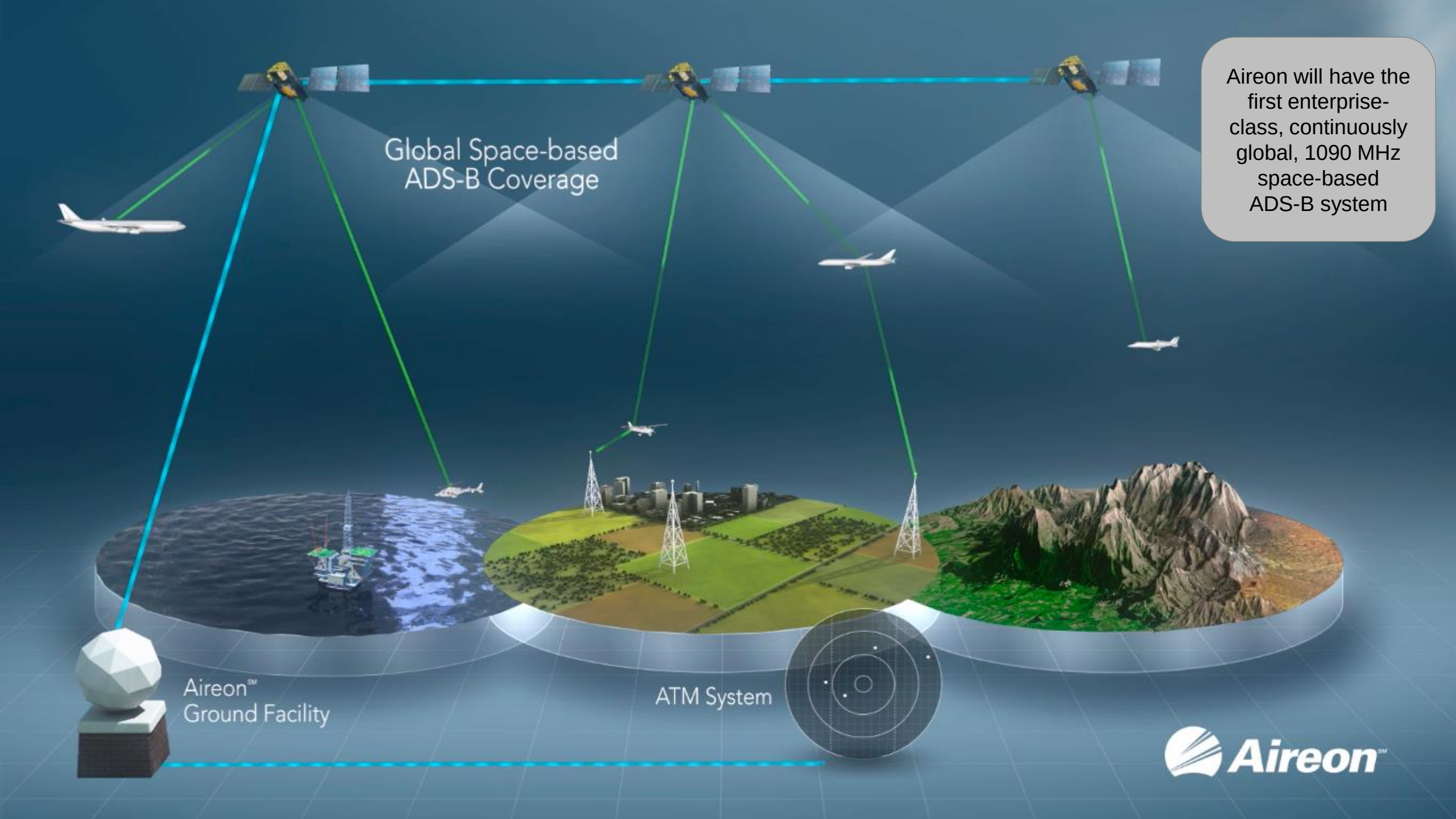
Dr. Michael Garcia

Aireon℠

Agenda

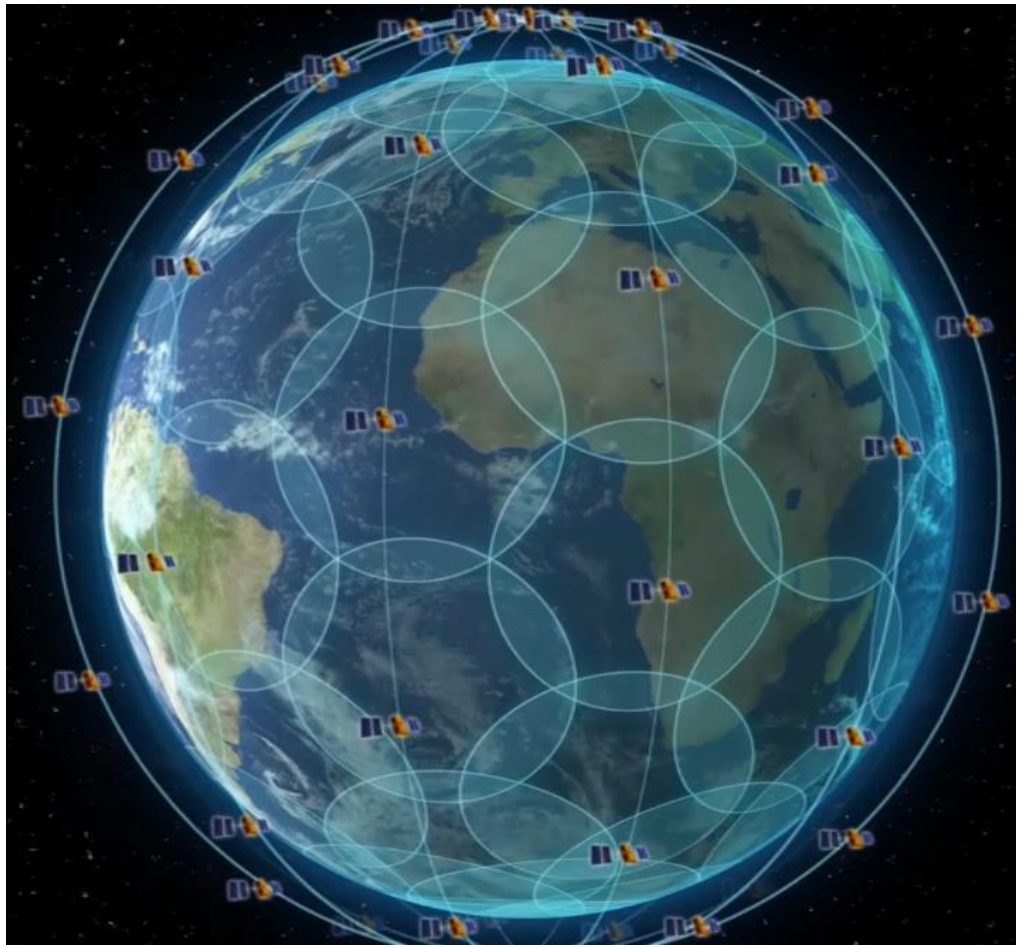
- Aireon Overview
- On-Orbit Acceptance Test (OOAT) Performance Results
- Other Interesting Data Proof Points
- Closing Q&A

Aireon Overview

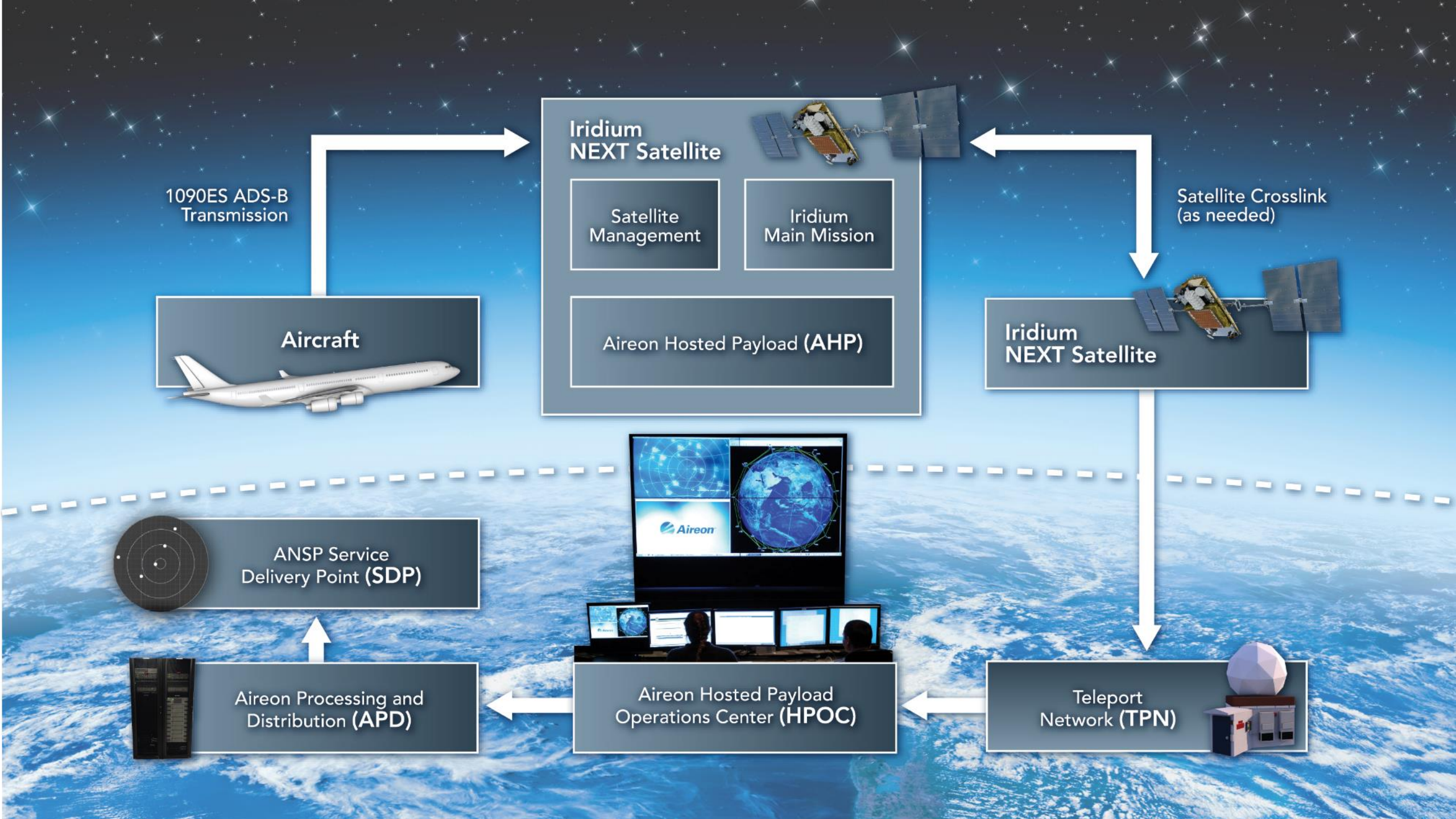

Global Space-based
ADS-B Coverage
Aireon will have the first enterprise-class, continuously global, 1090 MHz space-based ADS-B system
Aireon℠
Ground Facility
ATM System
Aireon℠

Constellation Overview

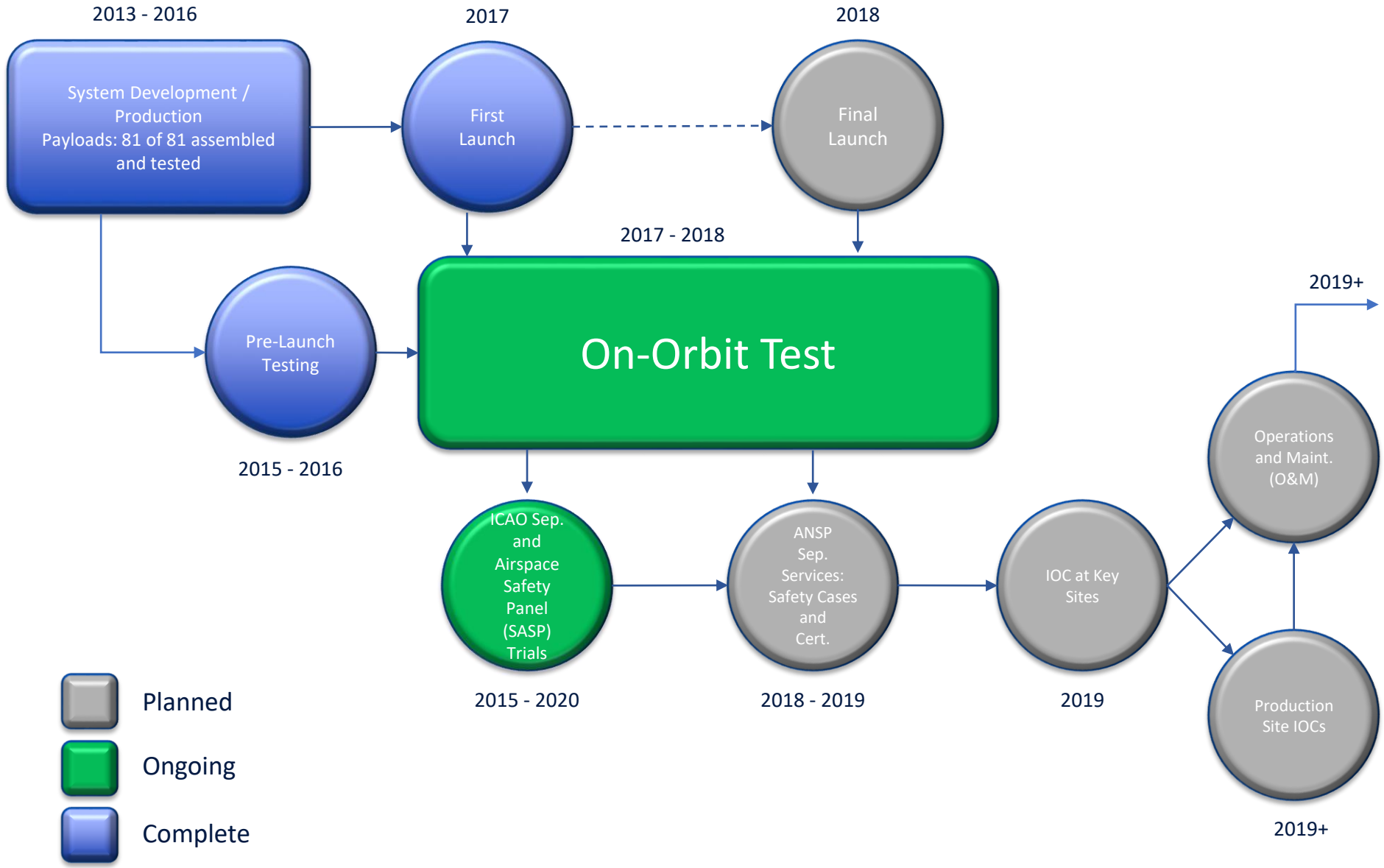
- Satellites in orbit: 66
  - 11 satellites per plane
  - Plus 9 in-orbit spare satellites and 6 ground spare satellites
- Orbital Planes: 6
- Operational altitude: 780 km
- Availability: ≥ 0.999



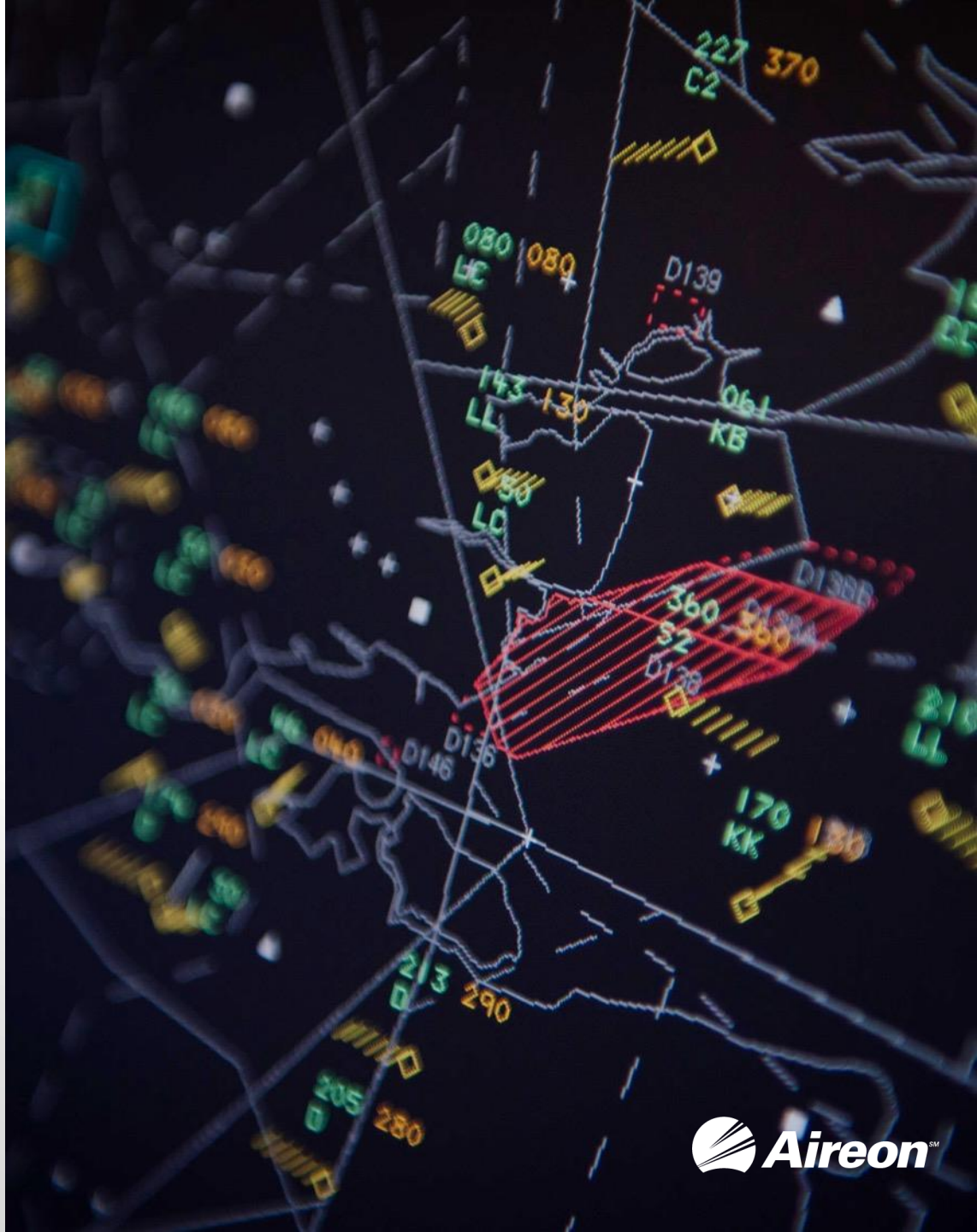

Aireon Hosted Payload
Main Mission
Antenna L-band


Iridium
NEXT Satellite
Satellite
Management
Iridium
Main Mission
Aireon Hosted Payload (AHP)
1090ES ADS-B
Transmission
Aircraft
Satellite Crosslink
(as needed)
Iridium
NEXT Satellite
Aireon
ANSP Service
Delivery Point (SDP)
Aireon Processing and
Distribution (APD)
Aireon Hosted Payload
Operations Center (HPOC)
Teleport
Network (TPN)

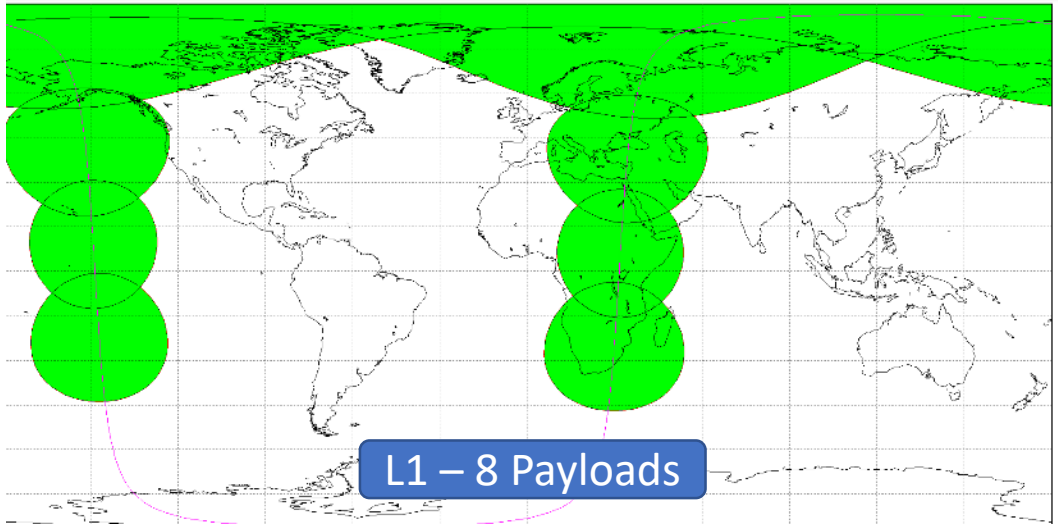
Program Schedule

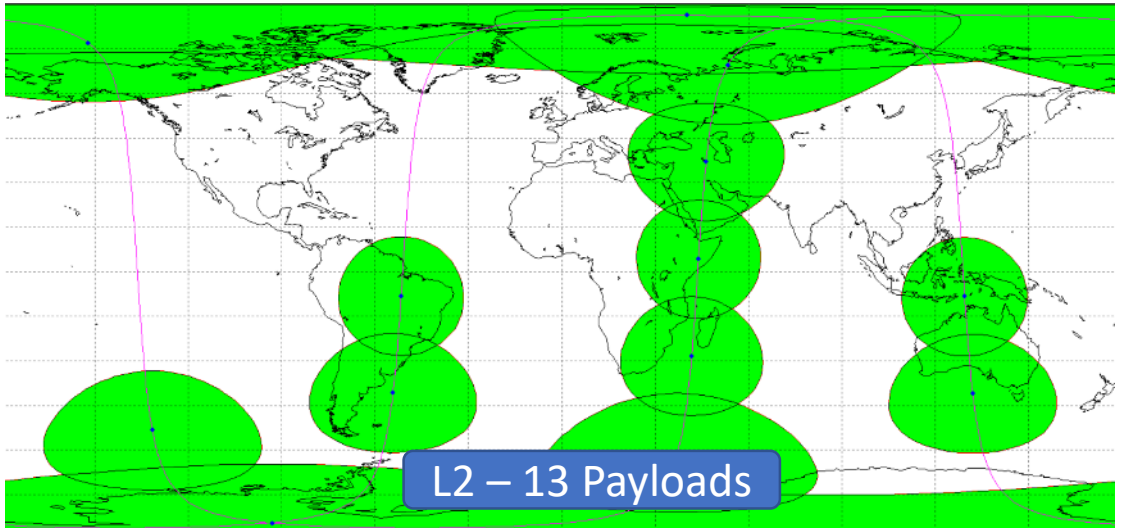


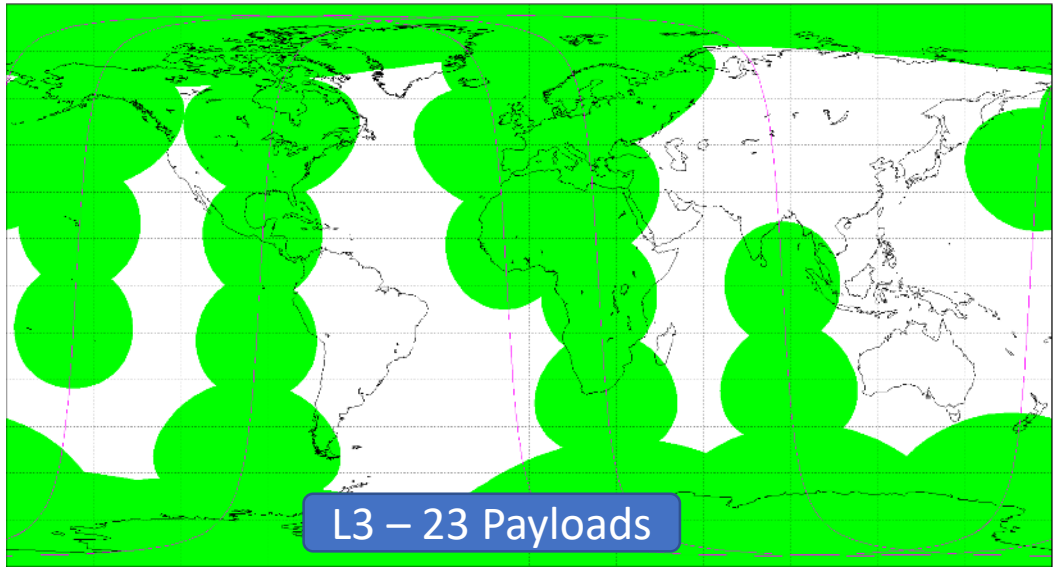
Launch Status, Planning and Projected Coverage

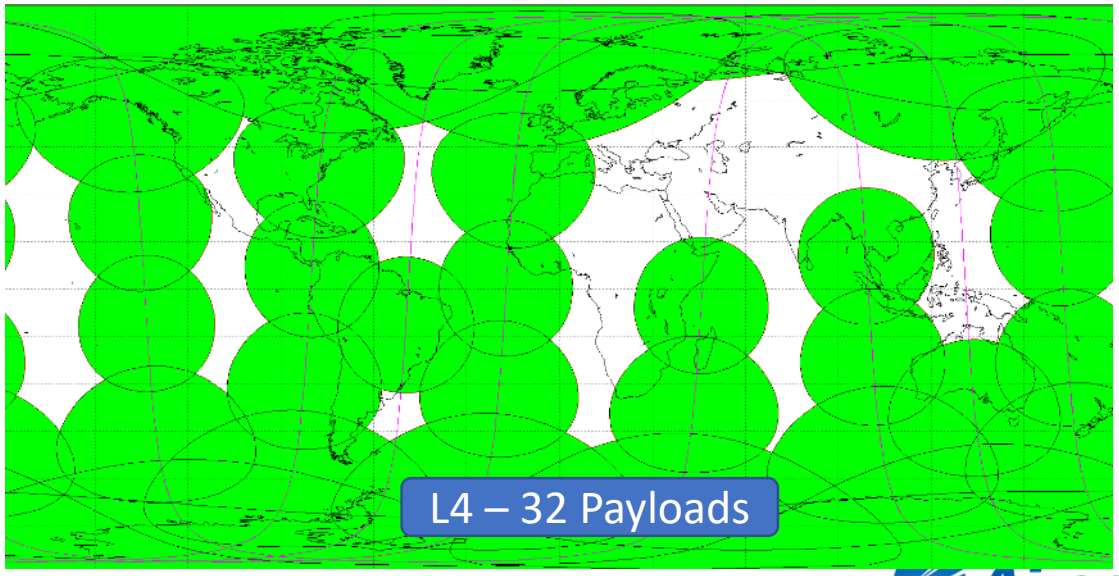


Launch 1-4 Coverage

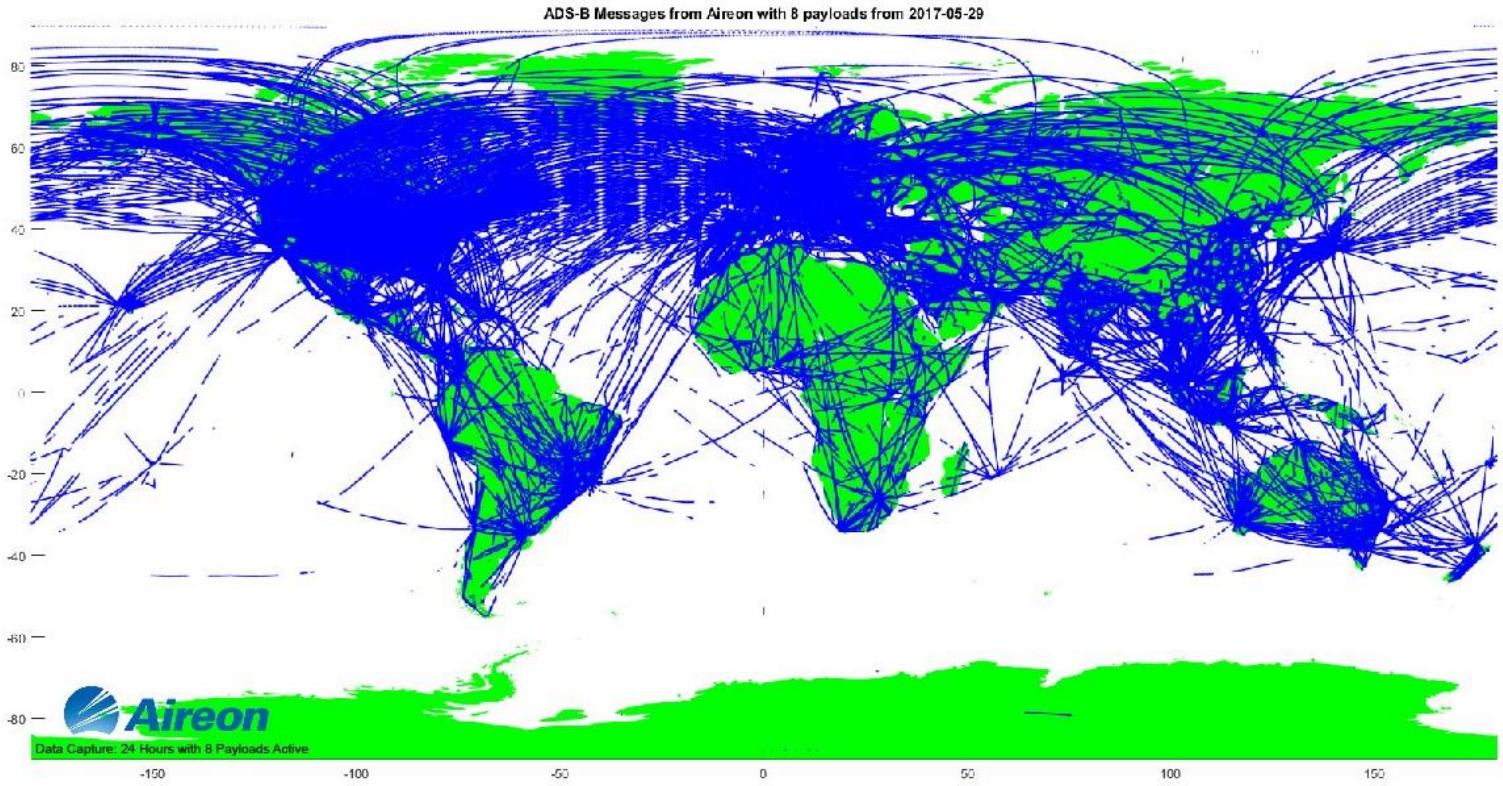


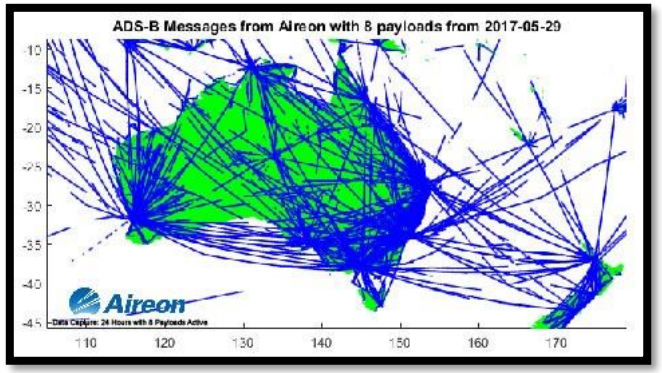


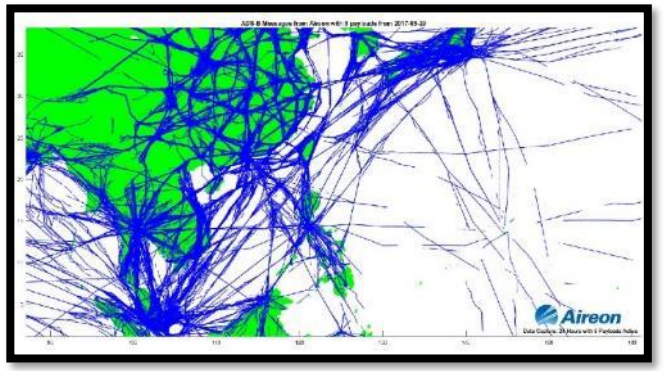




Launch 1 Coverage – 8 Payloads

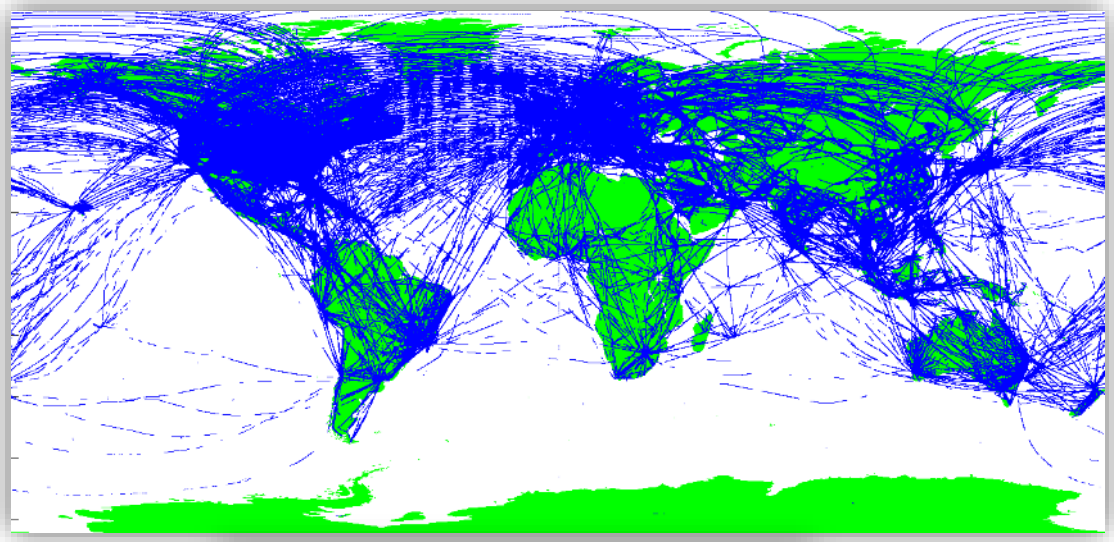




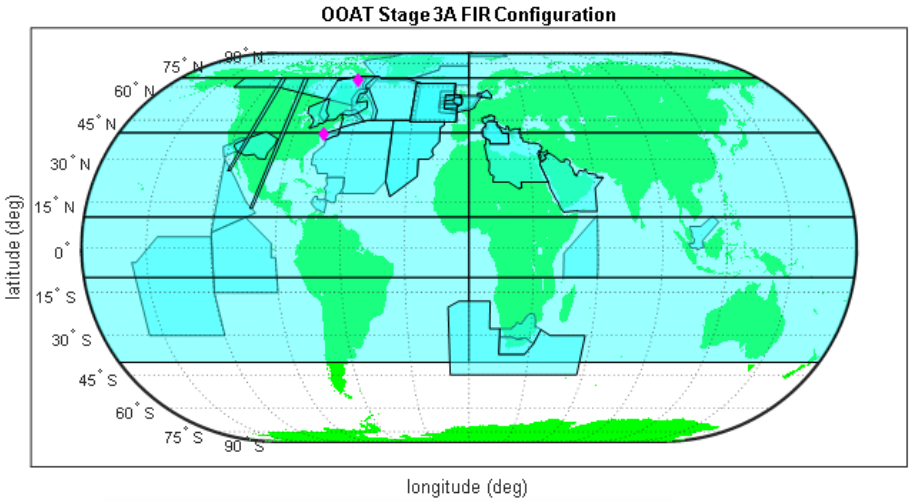


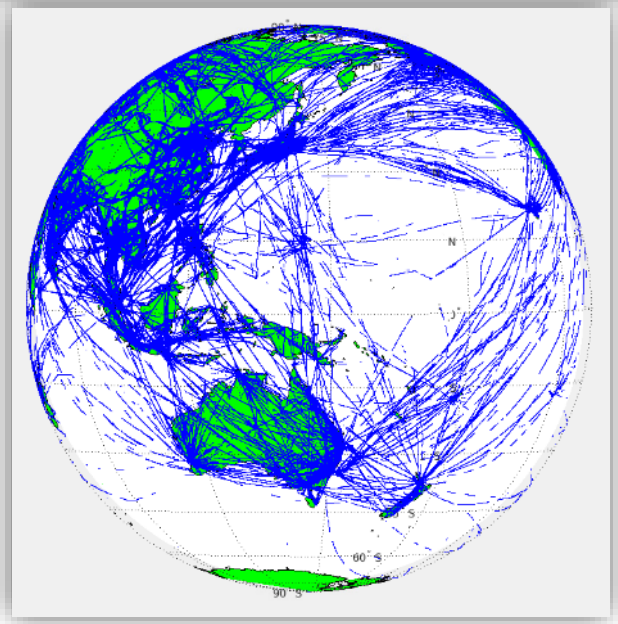
8 Payloads Stitched Over 24 Hours on May 29

Launch 2 Coverage – 13 Payloads

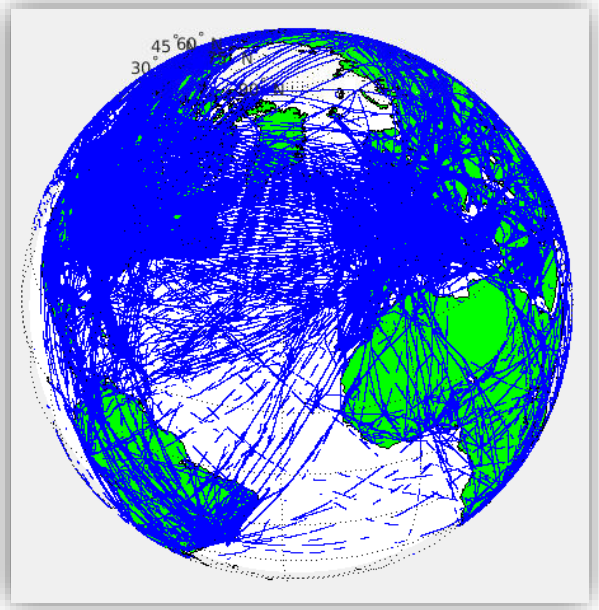


Stage 3A Service Volumes

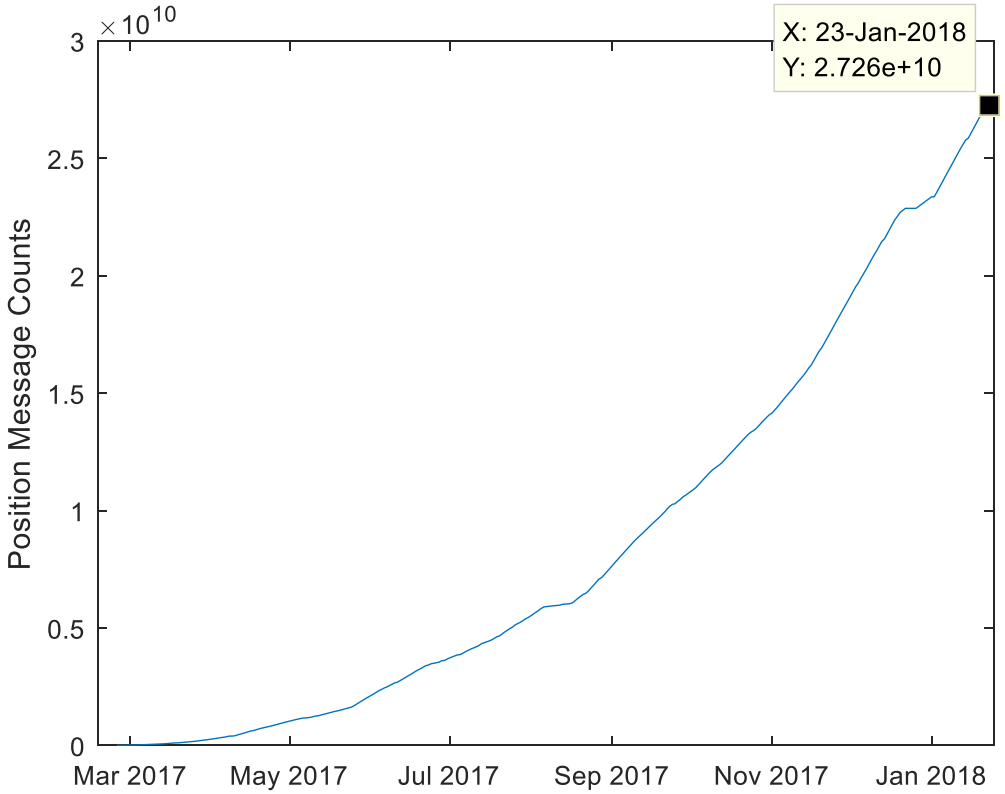


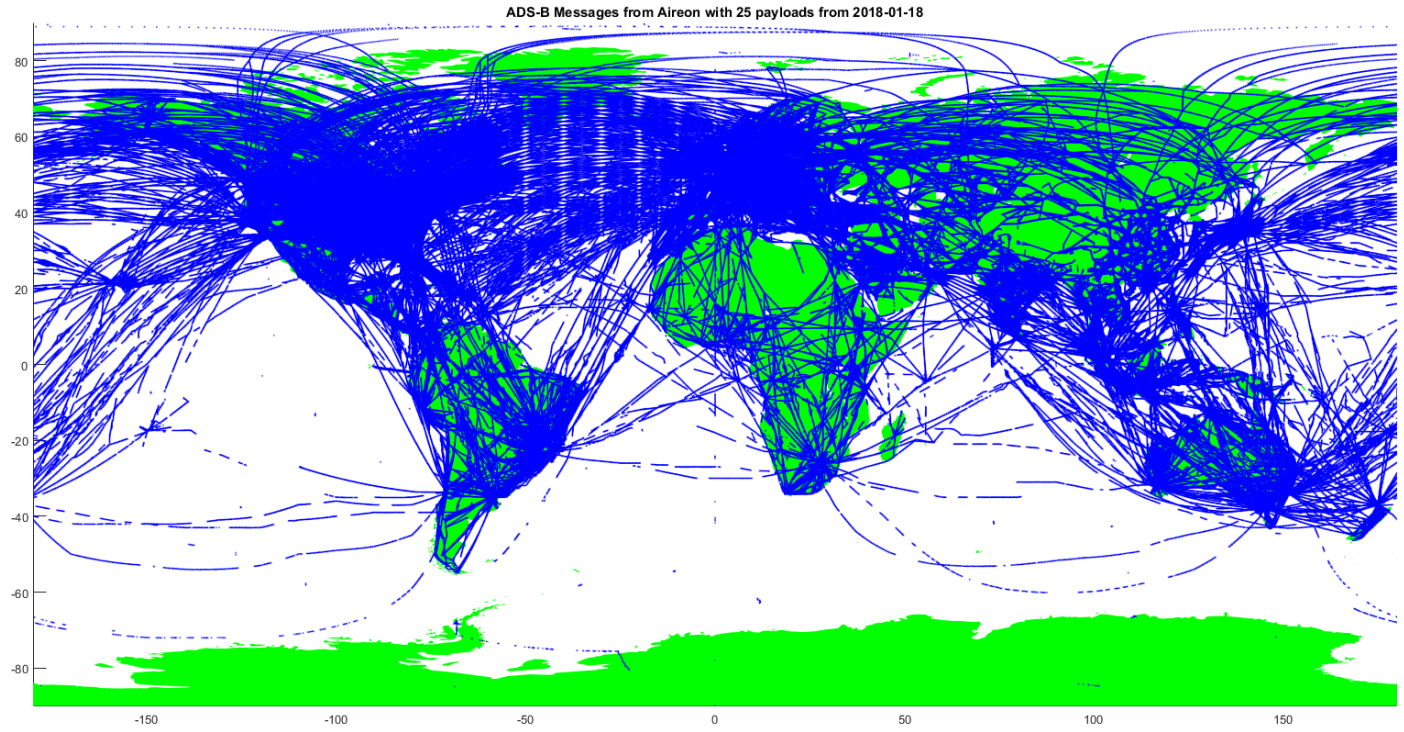


13 Payloads Stitched
Over 24 Hours on 7/26
w/ Stage 3A



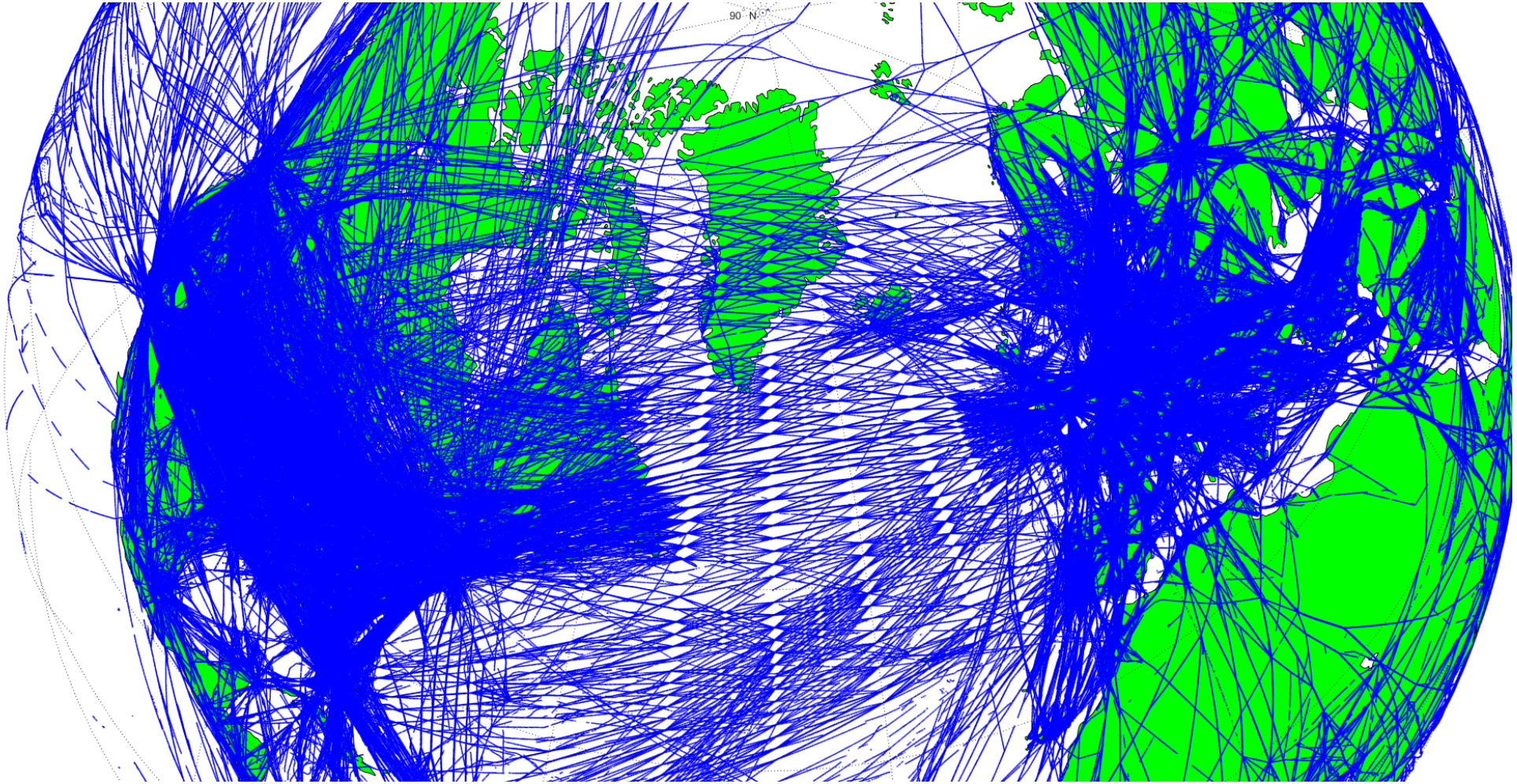
Hamburger Counter and Coverage Overview



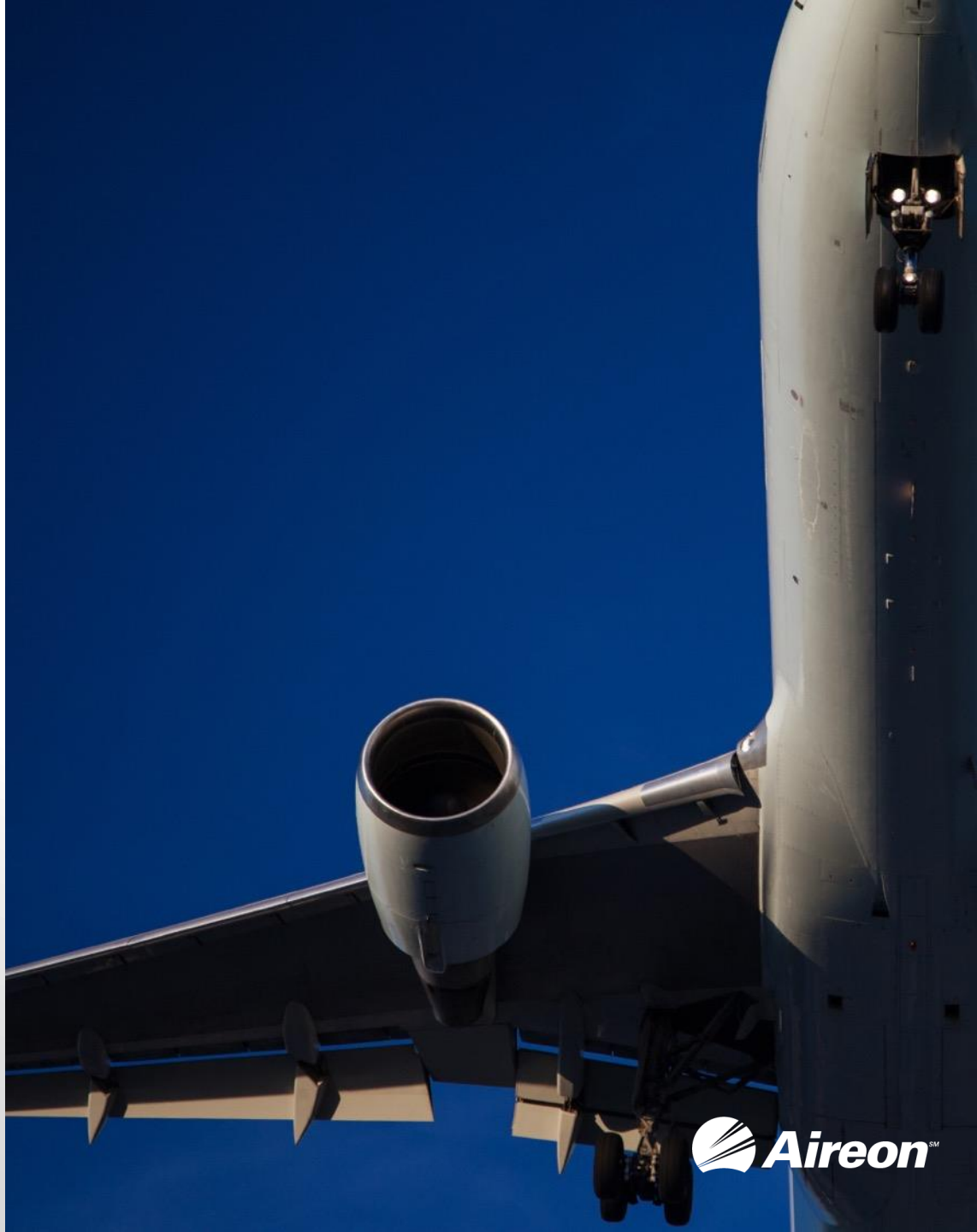


As of Jan 2018, Aireon receives over 6 billion ADS-B position messages per month!

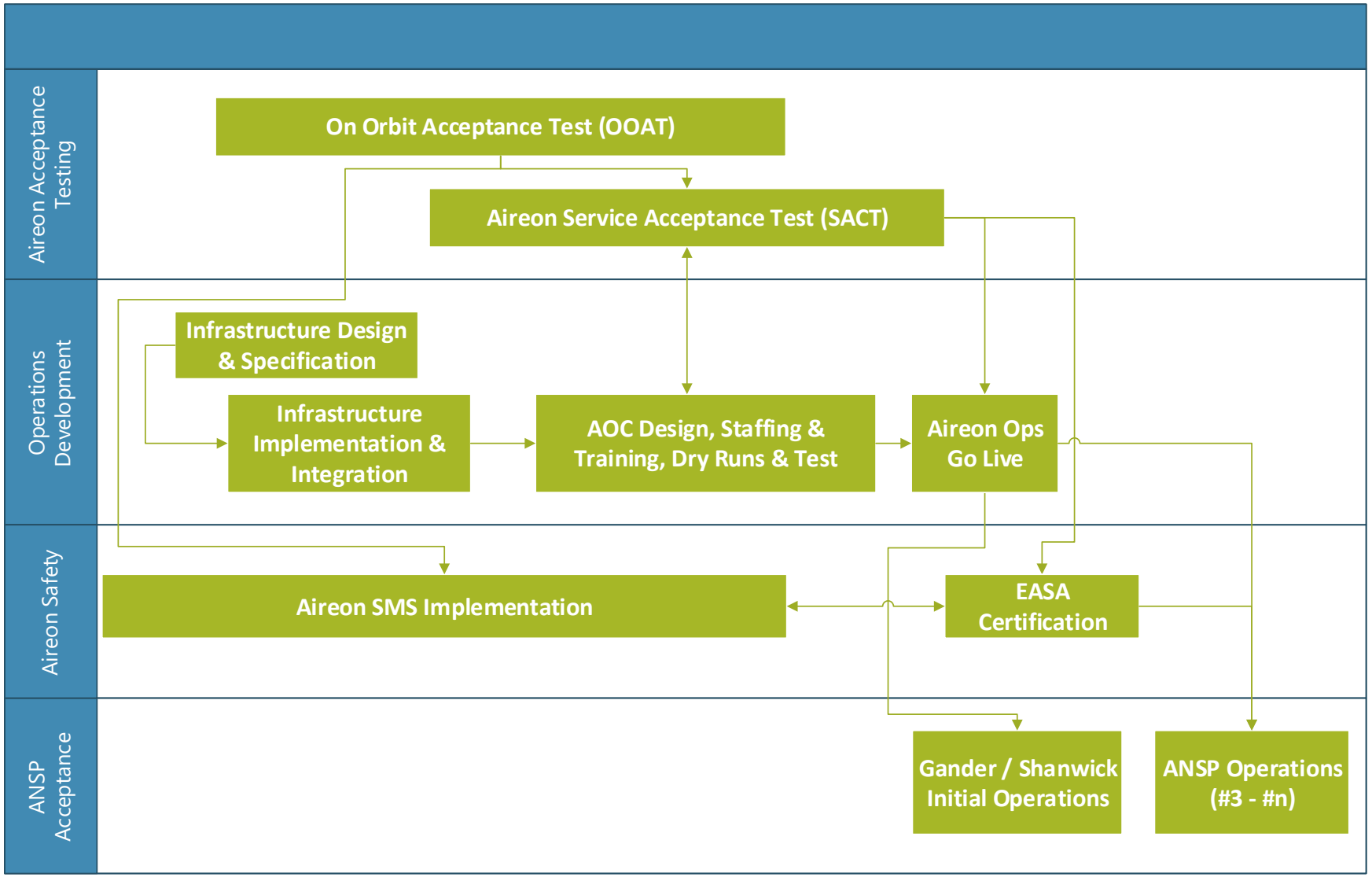
Atlantic



On Orbit Test Results



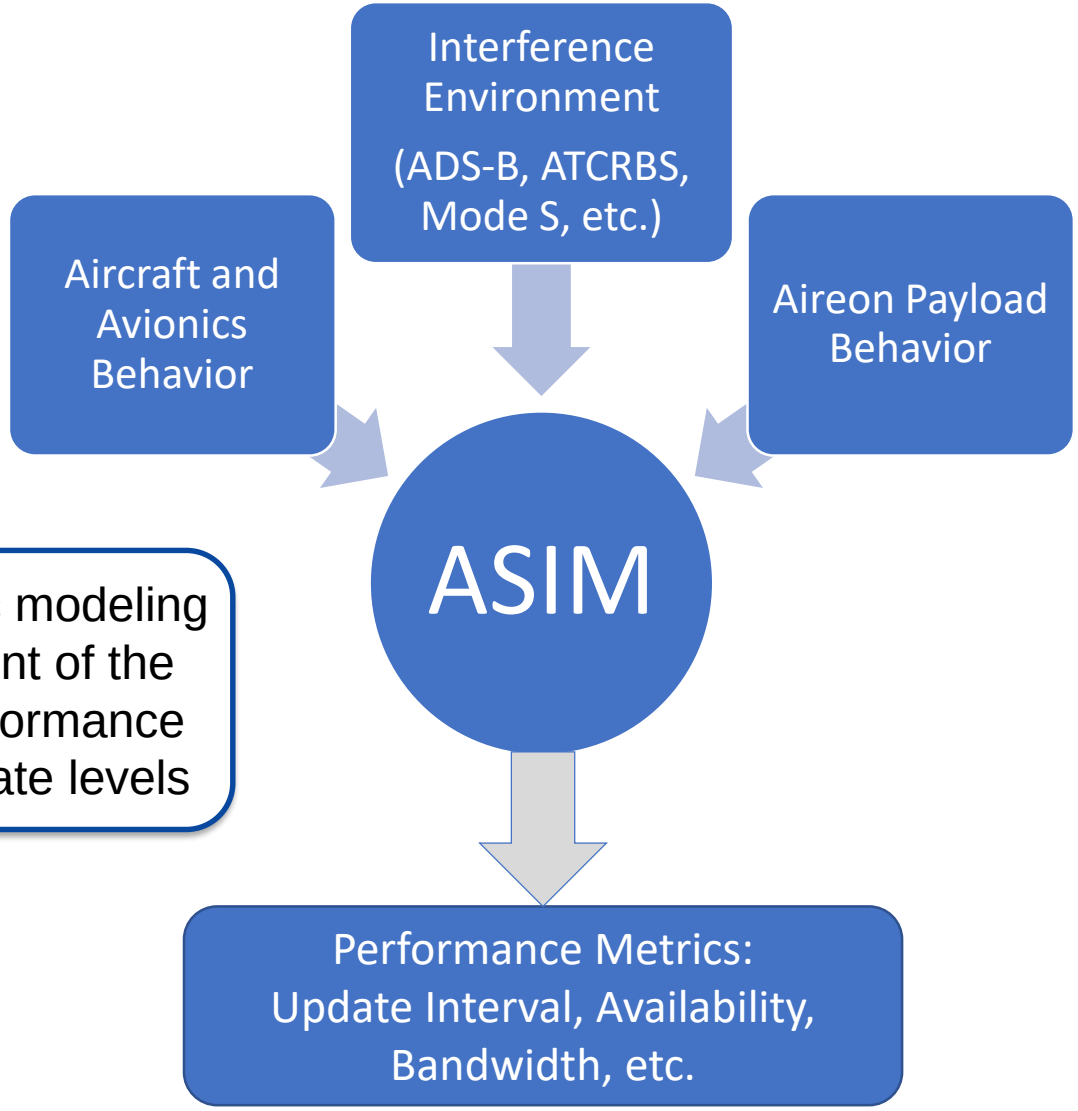
Activities to Operations



Aireon's Key OOAT Test Cases

Test Case	Description
PVTC-11	Low-power target performance
PVTC-12	Track A/C in high-FRUIT regions
PVTC-14	Pattern measurement with transmitters

Aireon's Simulation (& Analysis) Tool: ASIM



ASIM uses a stochastic modeling process for each element of the system to estimate performance at granular and aggregate levels

OOAT PVTC11

Low Power Target Performance

Flight Tests

NAV CANADA
Test Flight
12/5 - 12/6/2017

125W

Polaris Flight Systems
Test Flight
12/5-12/8/2017

200W

FAA
Test Flight
Dec 6th, 2017

125W

Pattern Record/Recognition Process

Measured

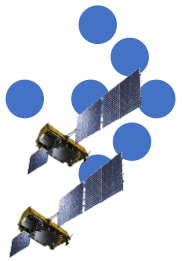
•Mission Data

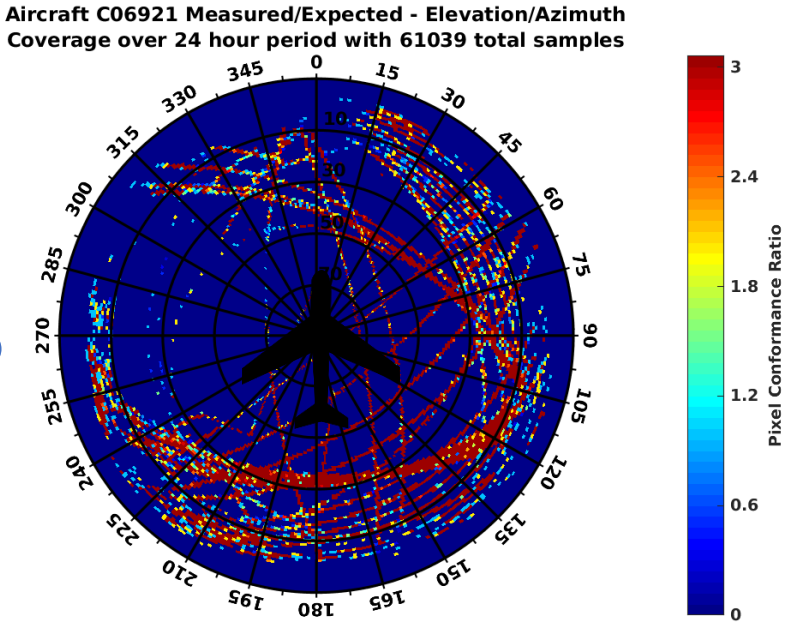
Expected

•Remixed Tracks

Recreated Satellite Coverage

Pattern Rec

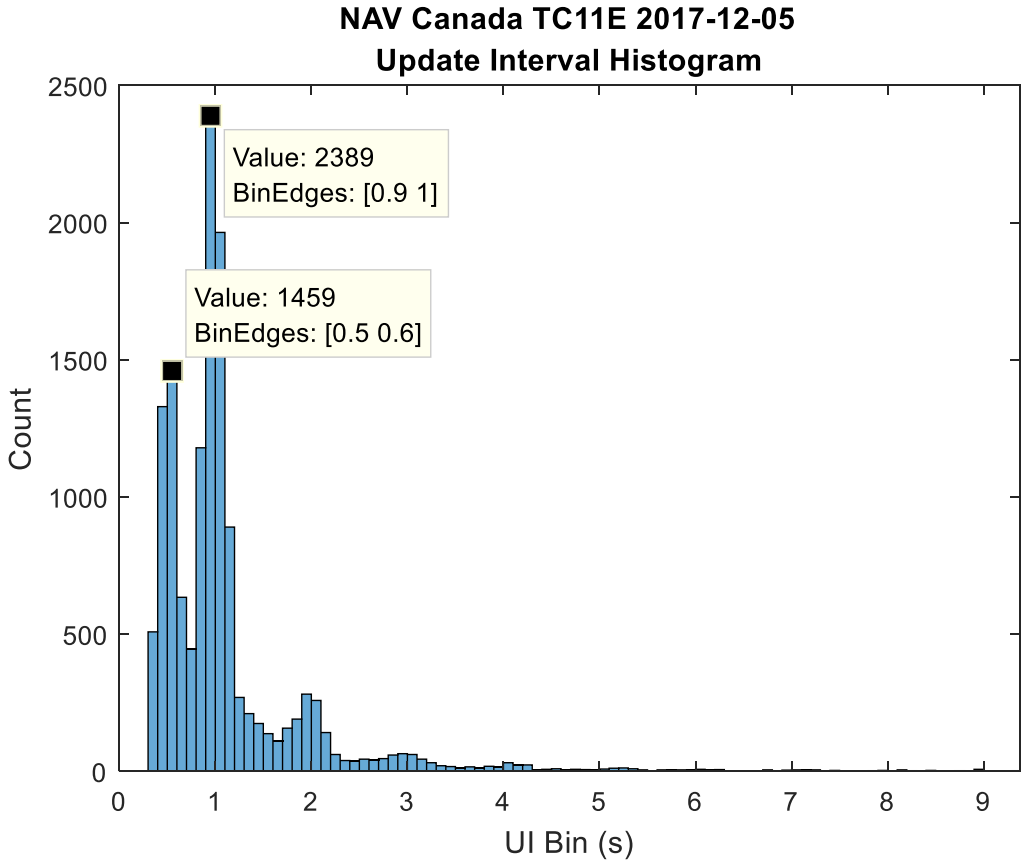




Conformance = Measured/Expected

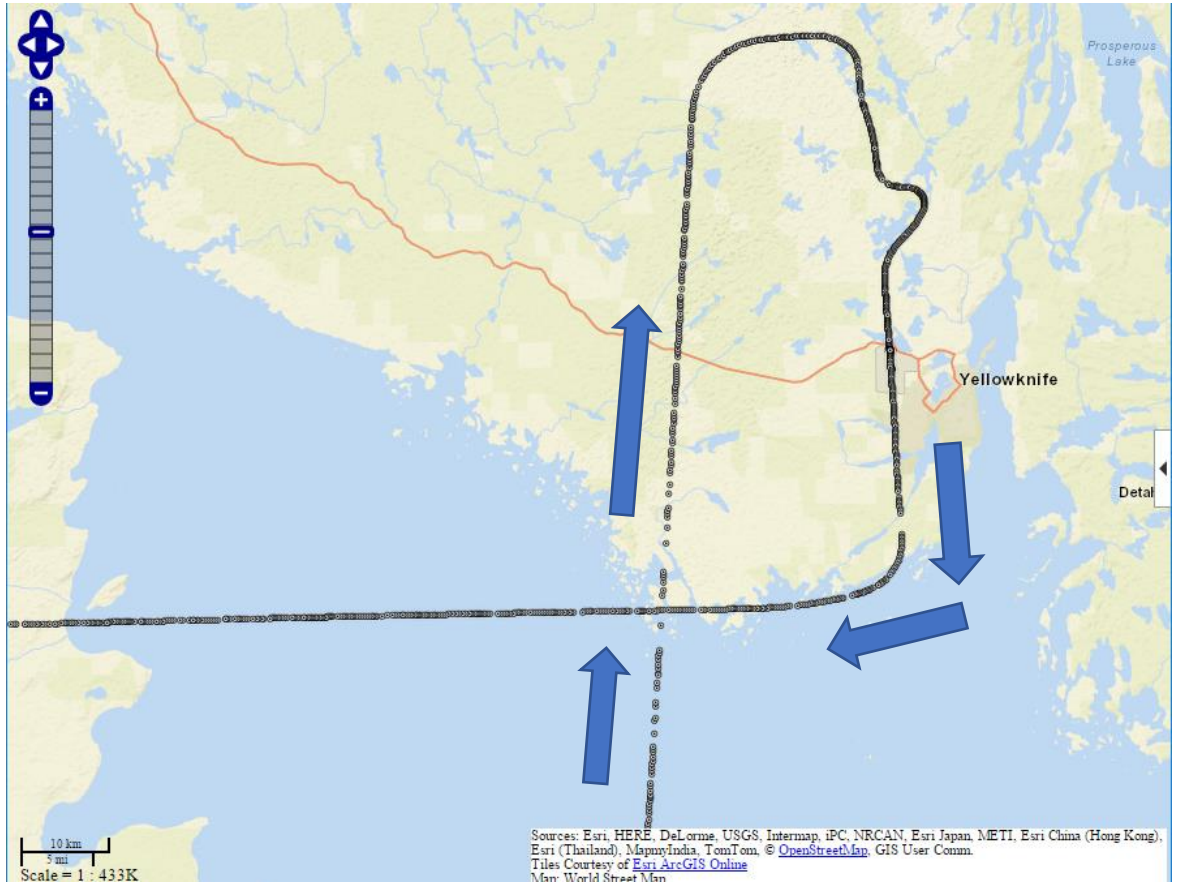
Success Criteria:
"Sweet Spot" ≥ 0.85

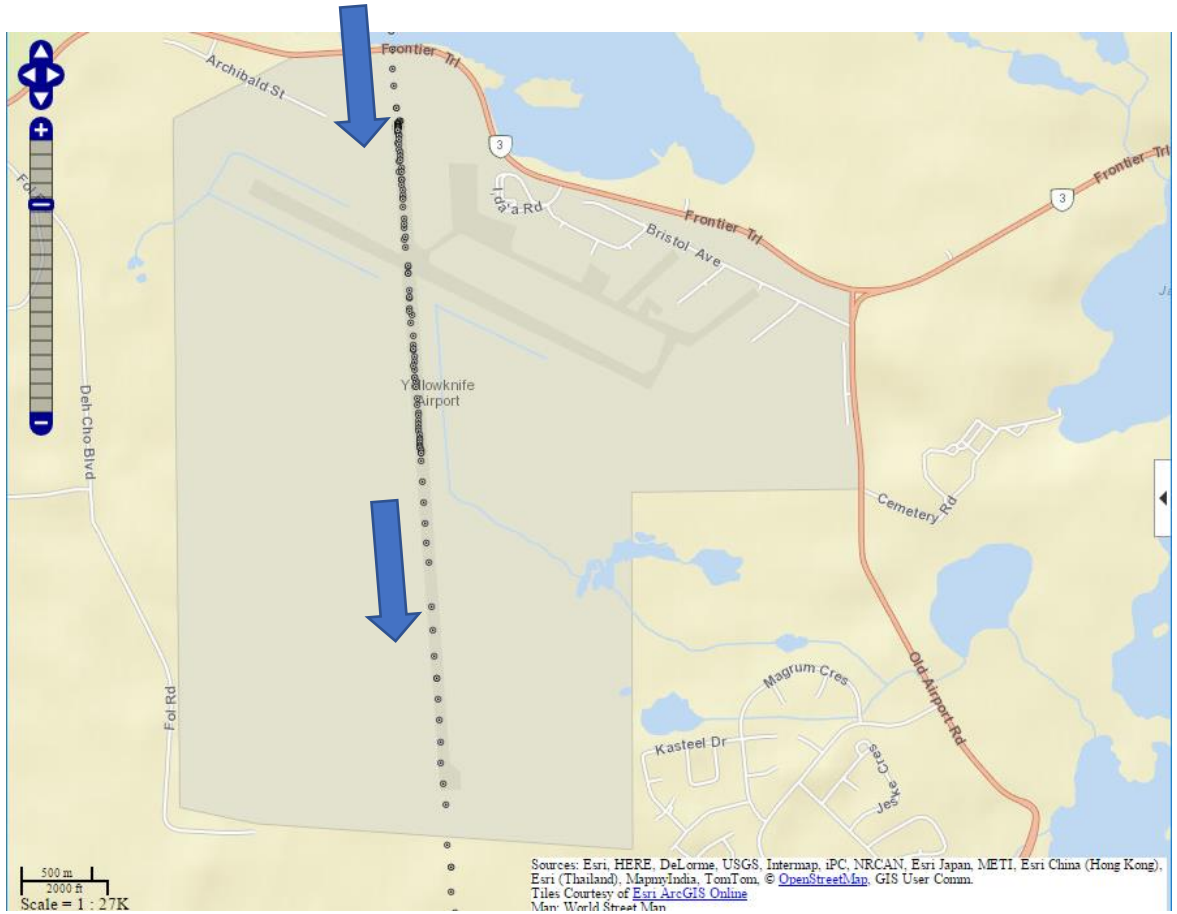
Aireon Data Observation Overview



95th Percentile UI = 2.88s

Landing and Takeoff at Yellowknife





OOAT PVTC12

Interference Model Validation Test Case

Polaris Flight Plan 11/16/2017

N9476S

LANDED OVER A WEEK AGO

NOT YOUR FLIGHT? N9476S flight schedule

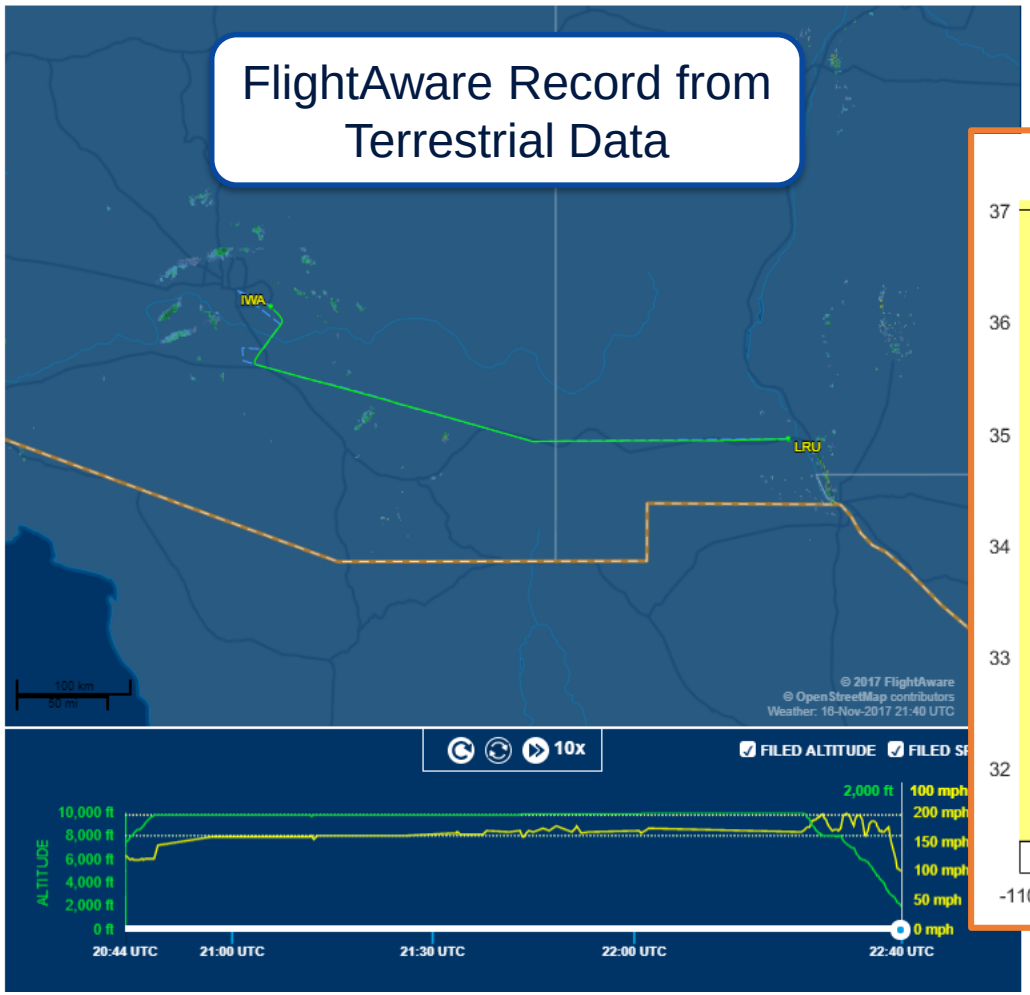
LRU
LAS CRUCES, NM
THURSDAY 16-NOV-2017
20:44 UTC

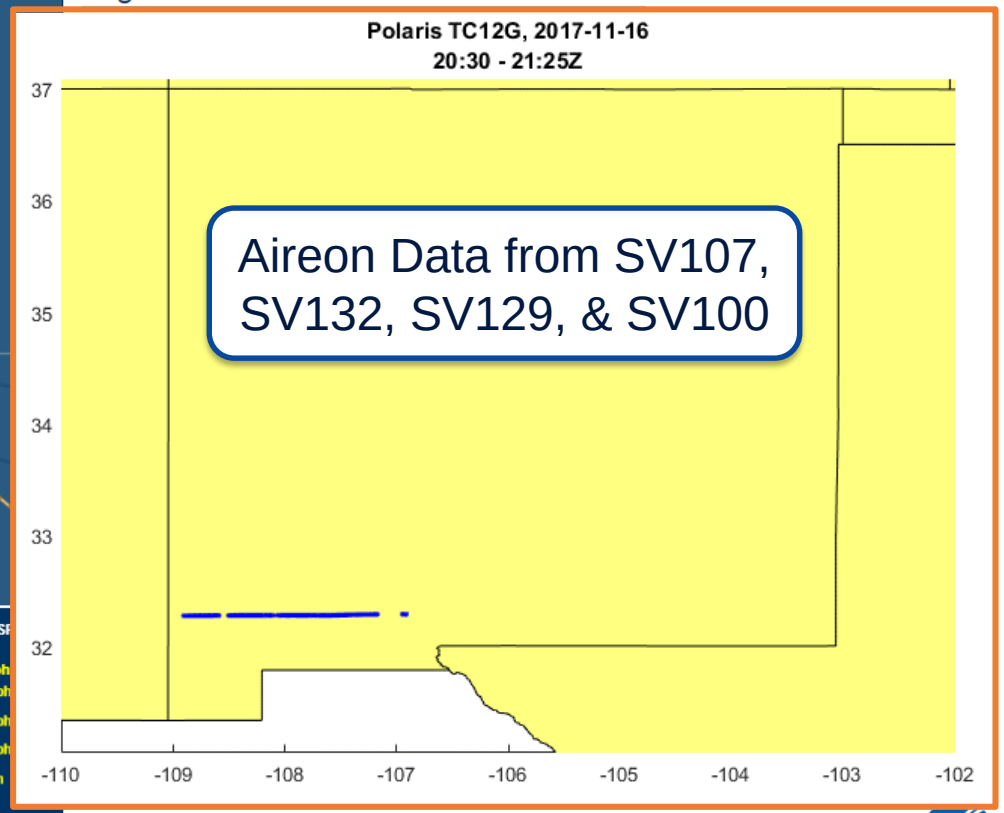
IWA
PHOENIX, AZ
THURSDAY 16-NOV-2017
22:40 UTC

1h 56m total flight time

Get Notifications

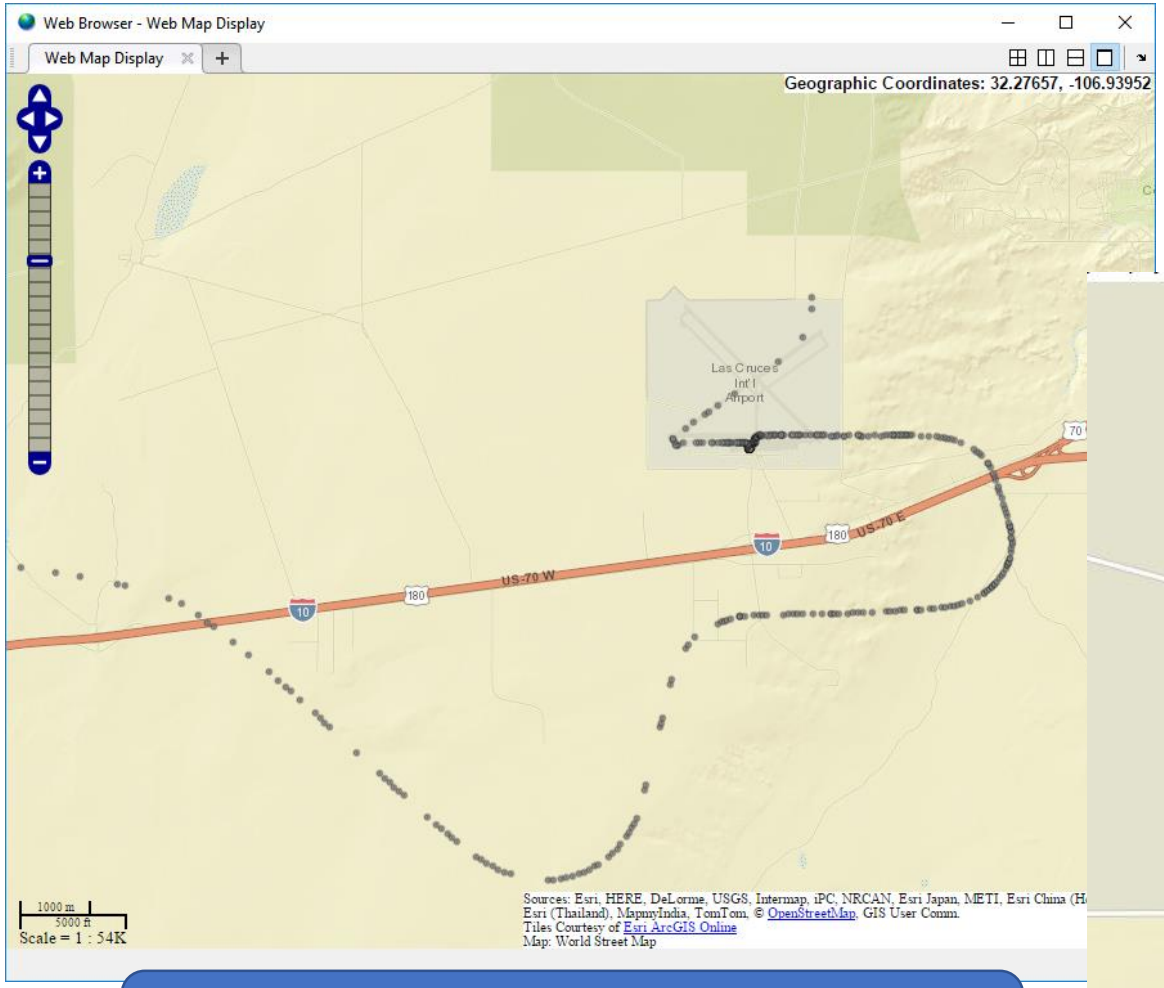
Flight Details



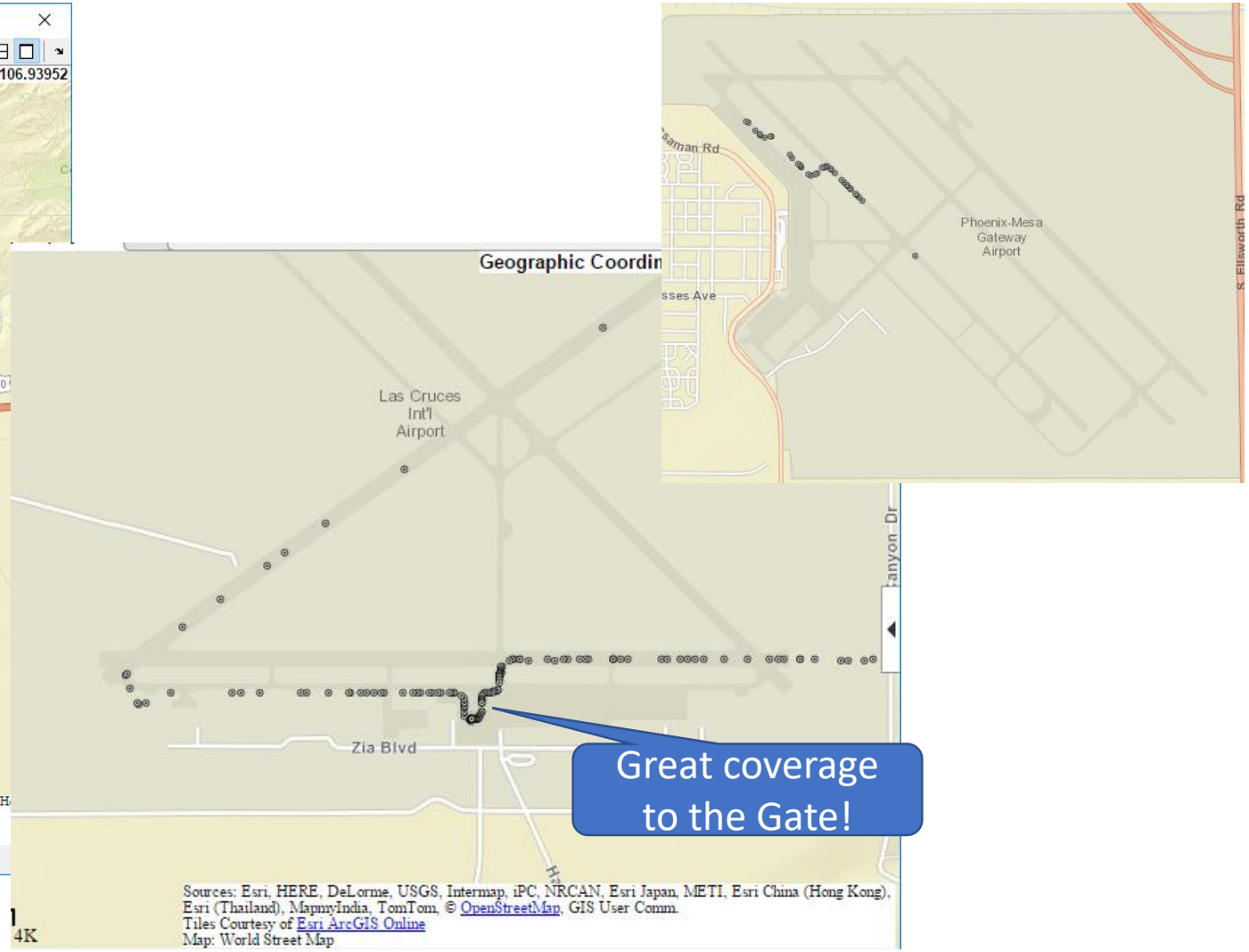


Aireon

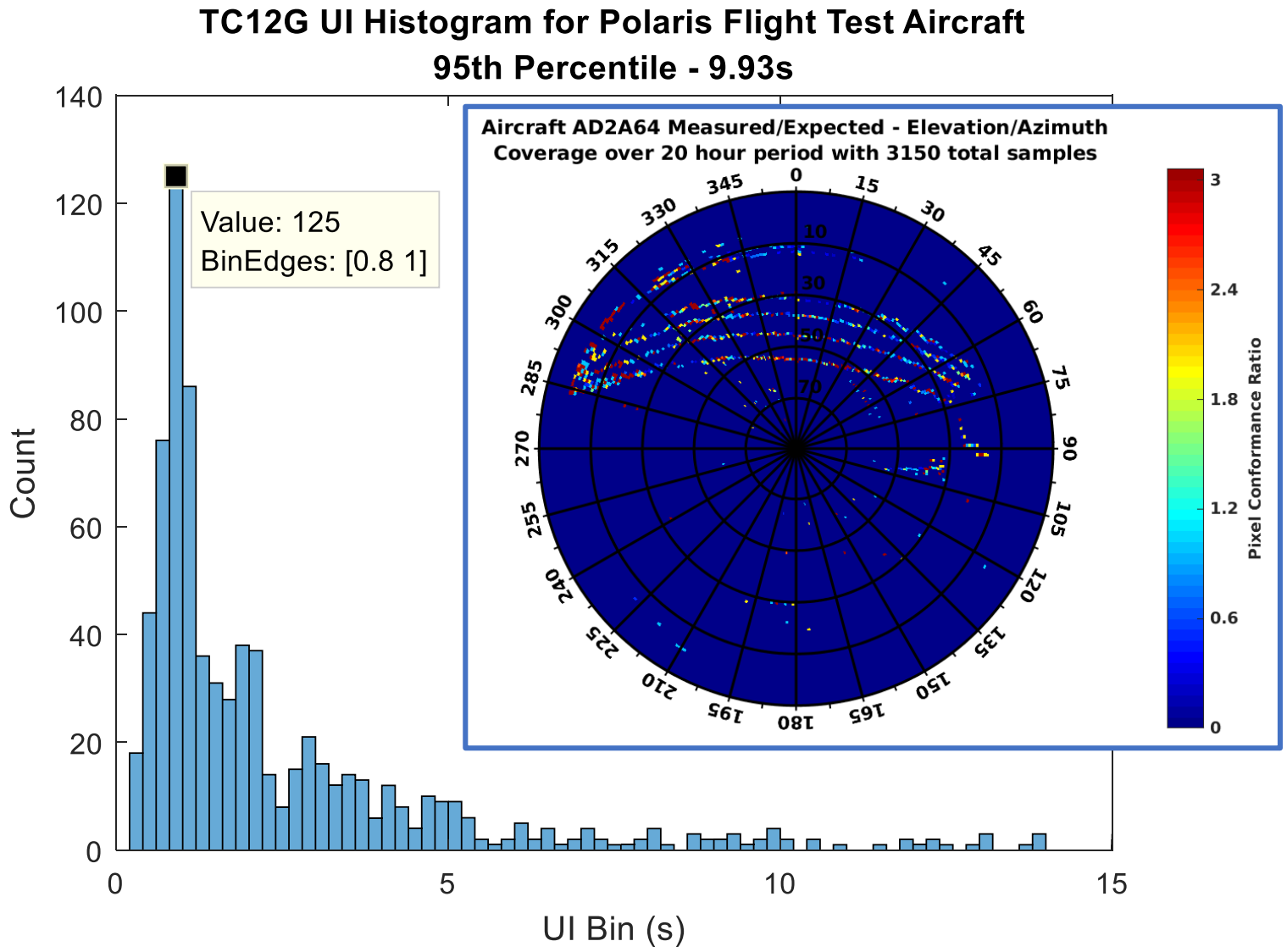
Observations at Las Cruces and PHX Airports



Aireon Observed Landing and Takeoff at Las Cruces Airport (18:40 and 20:12Z)



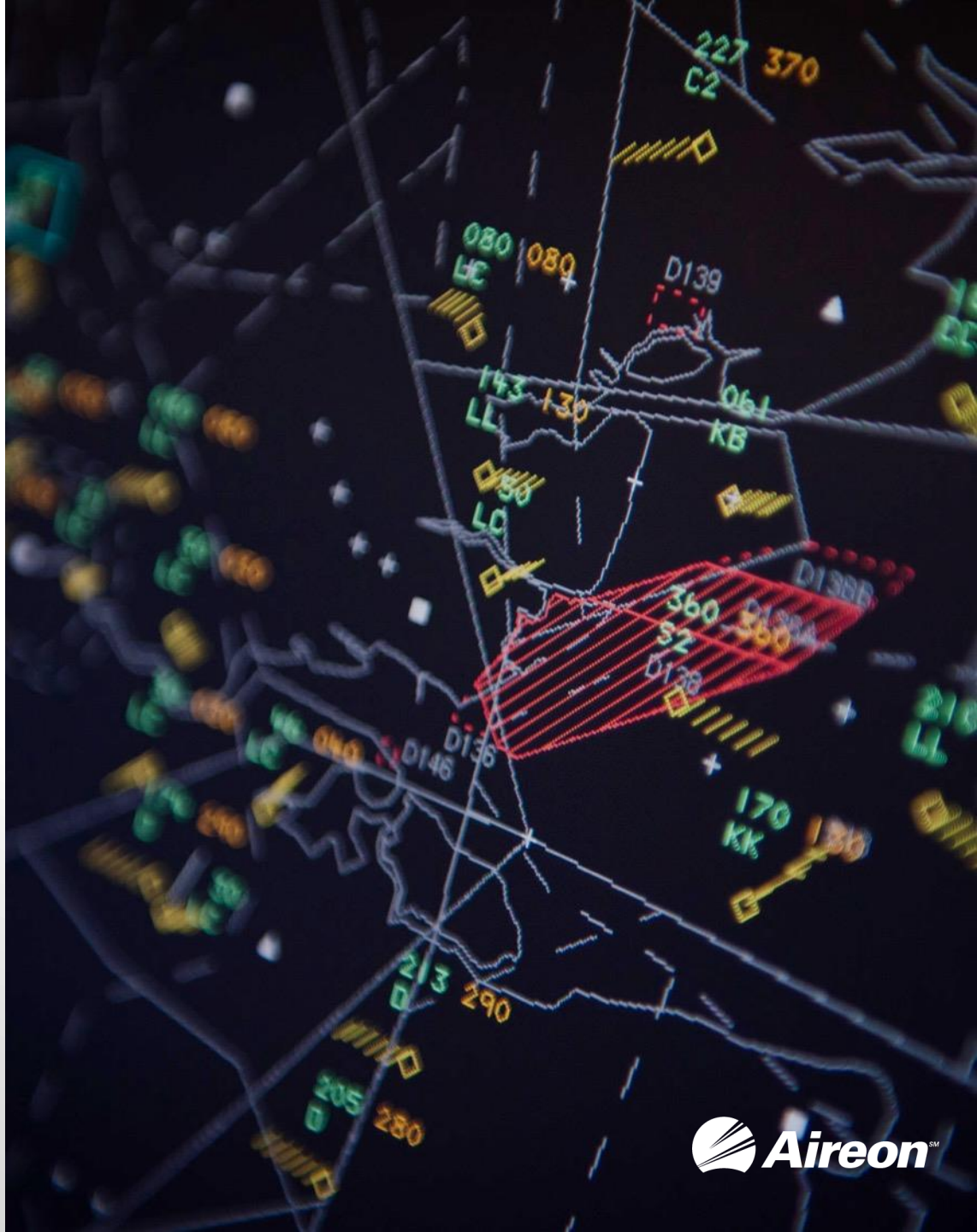
Polaris Flight Test Results



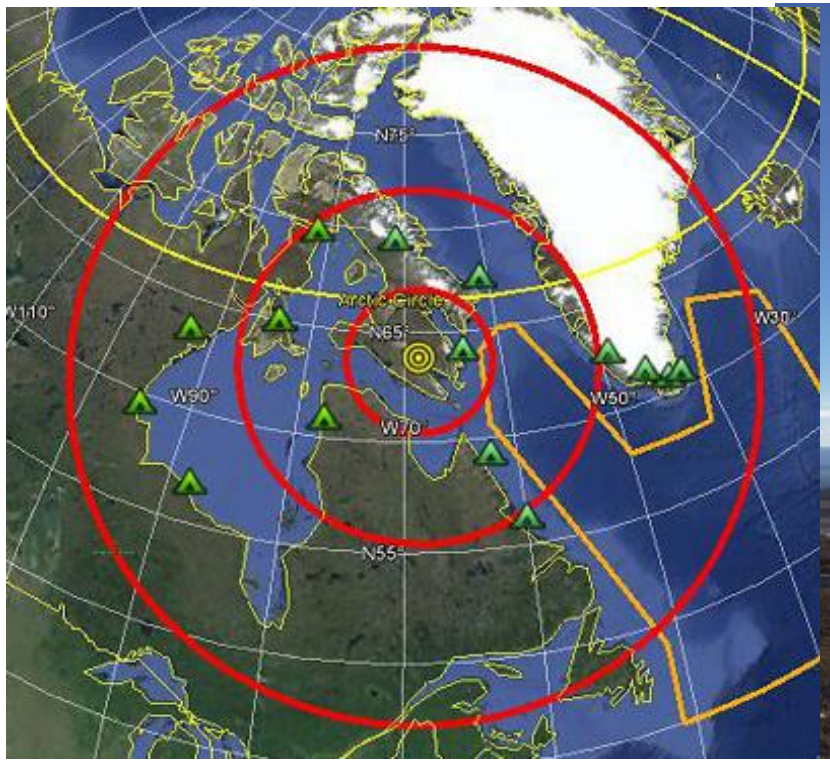
Payload Performance Data

OOAT PVTC14

AHP Beam Characterization/Validation

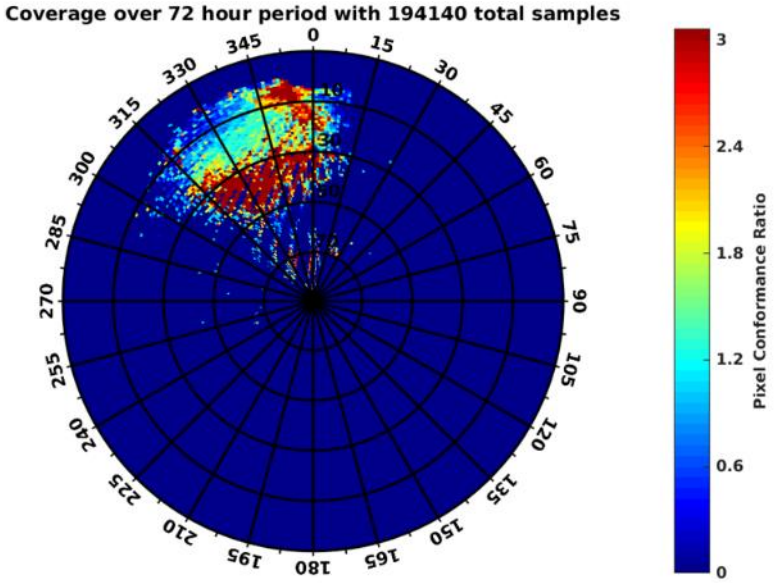


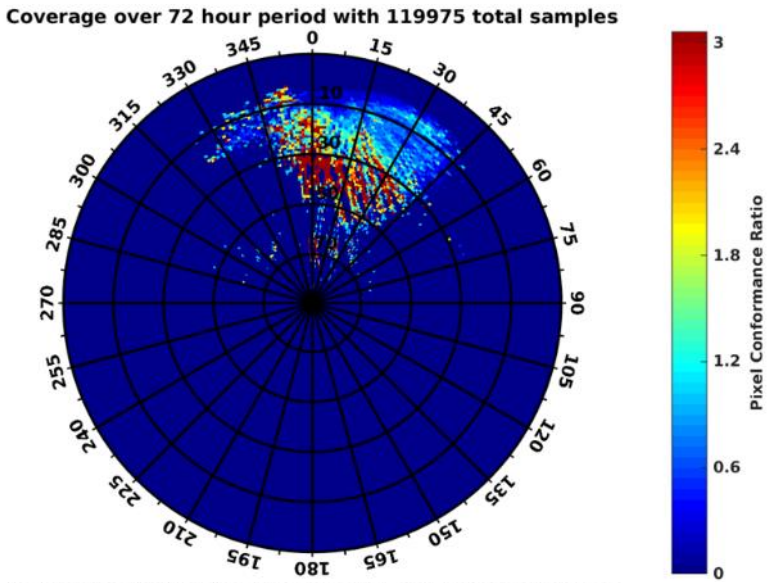
Iqaluit Ground Based Reference Transmitter (GBRT)

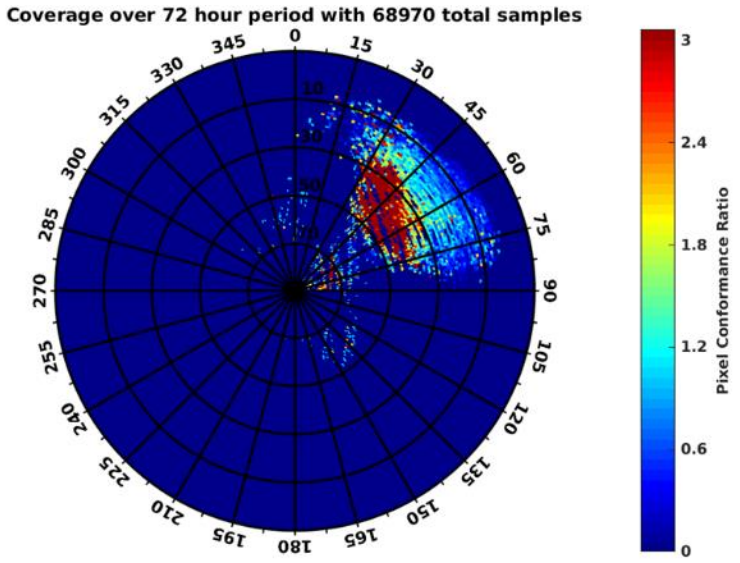


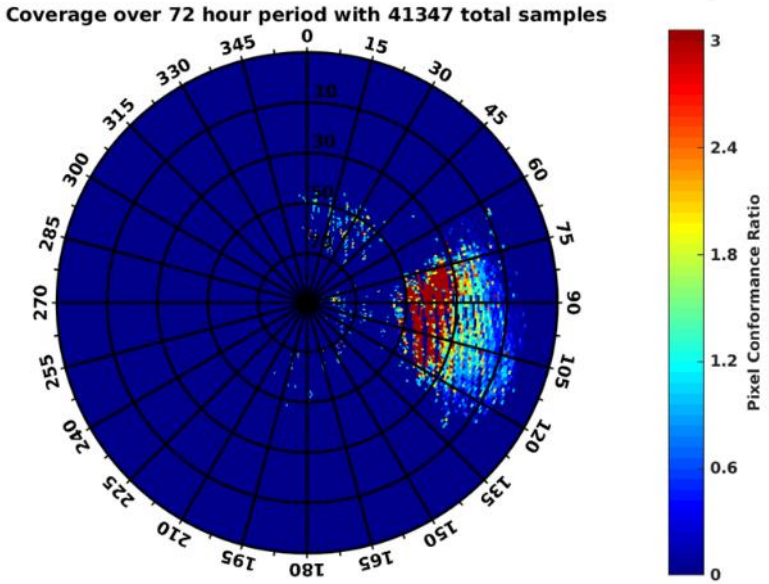
Uses a 4-Channel Reference Transmitter

GBRT Conformance Patterns

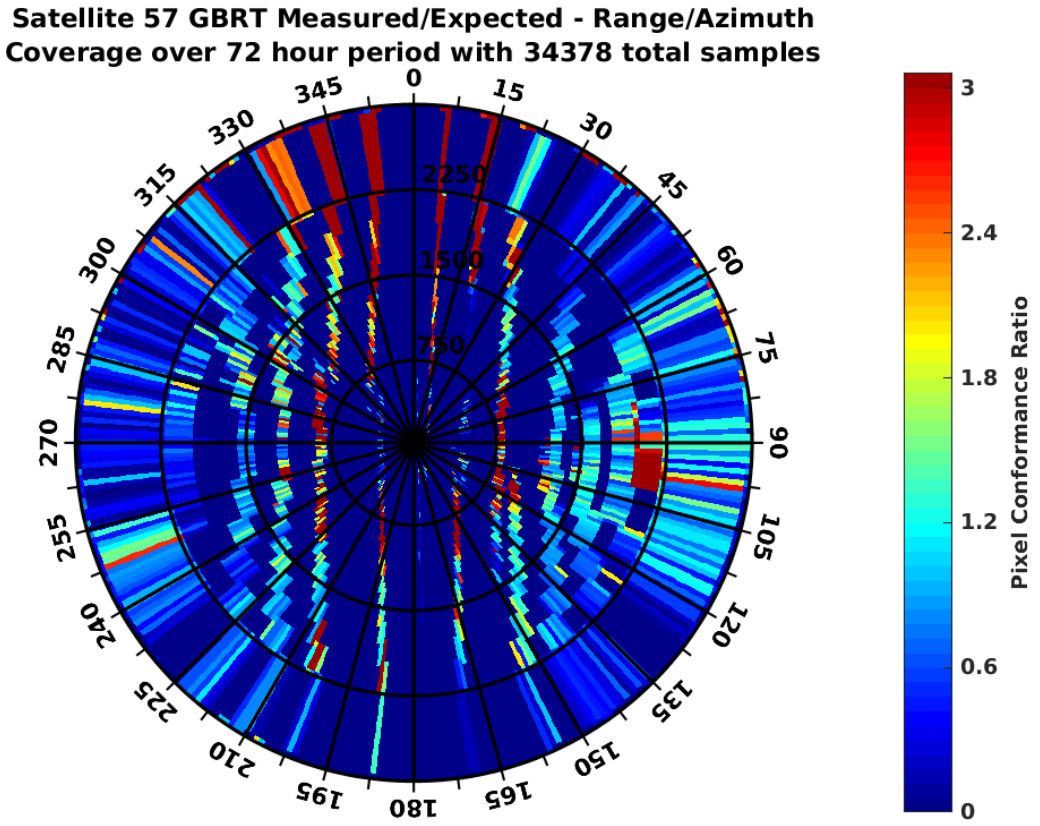


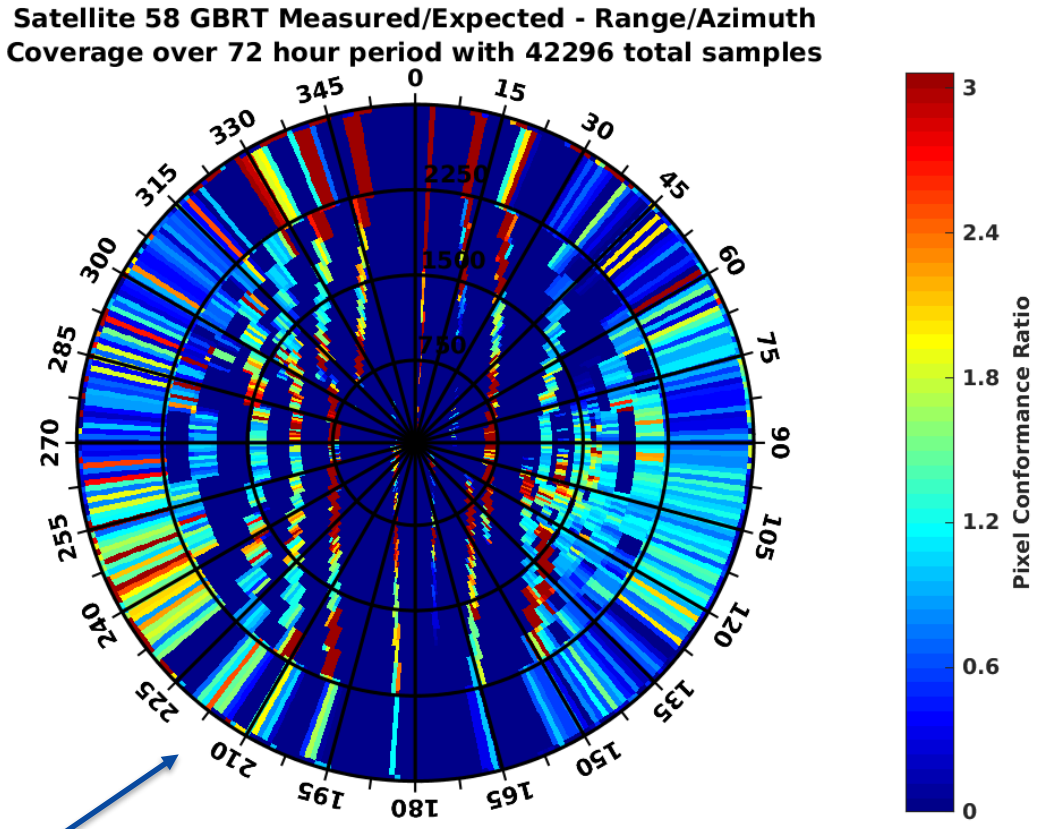






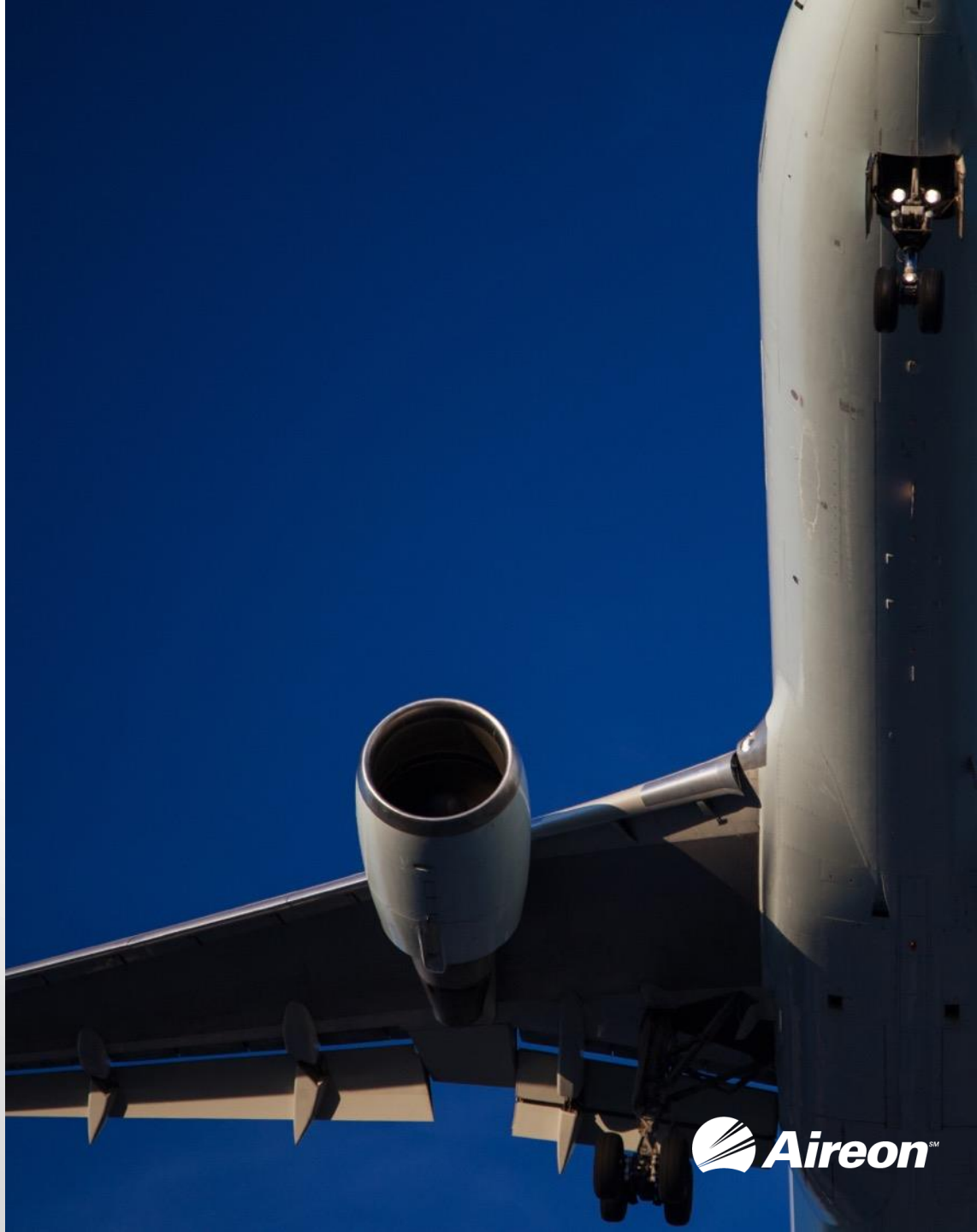
SV112 and SV104 Performance Comparison



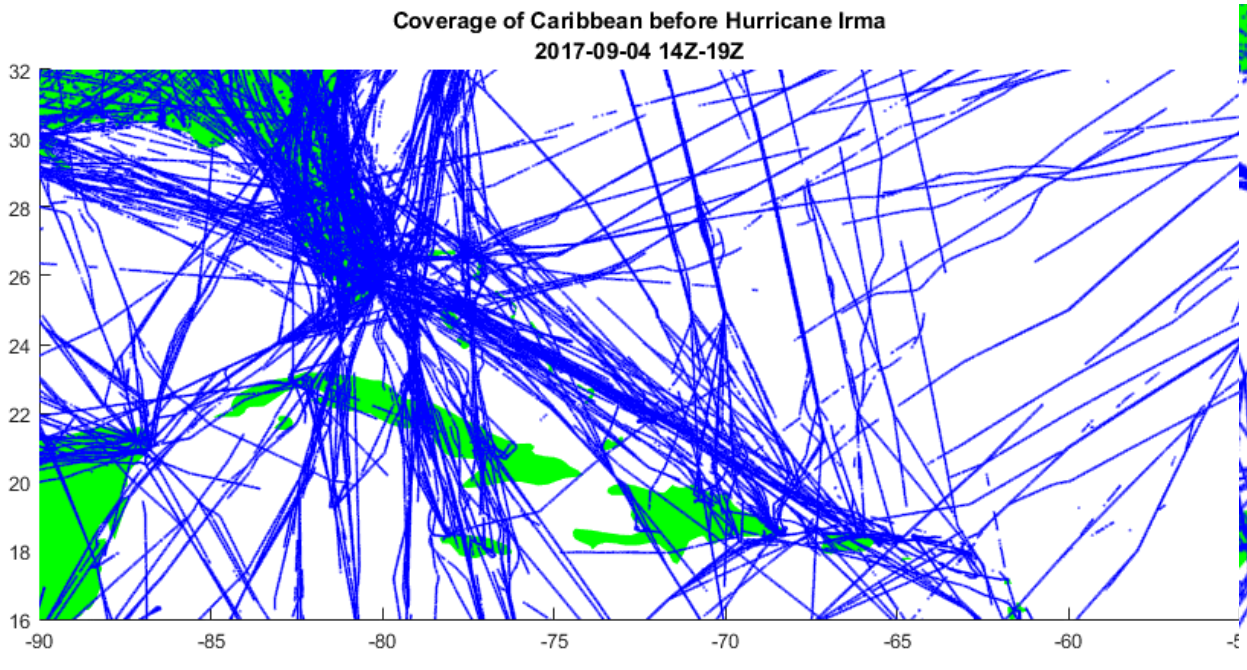


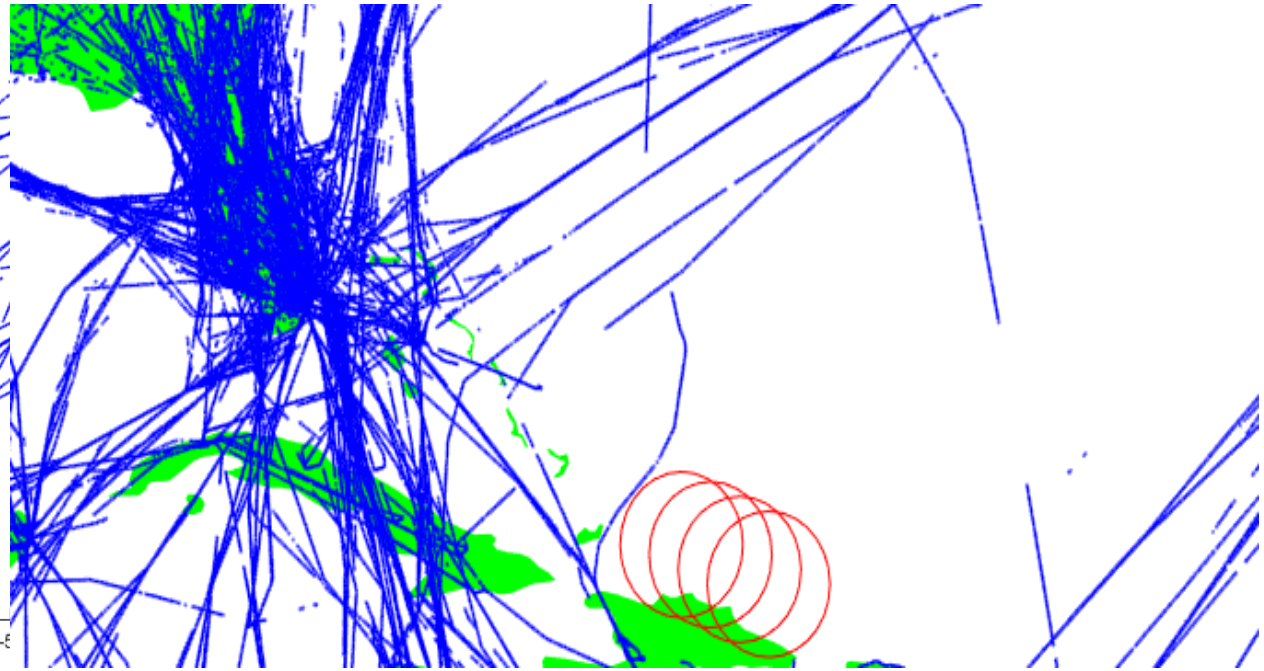
SV104 currently has a bandwidth allocation 5x higher than SV112

Other Interesting Observations from OOAT



ADS-B Aircraft Tracks in Caribbean from Aireon before and during Hurricane Irma

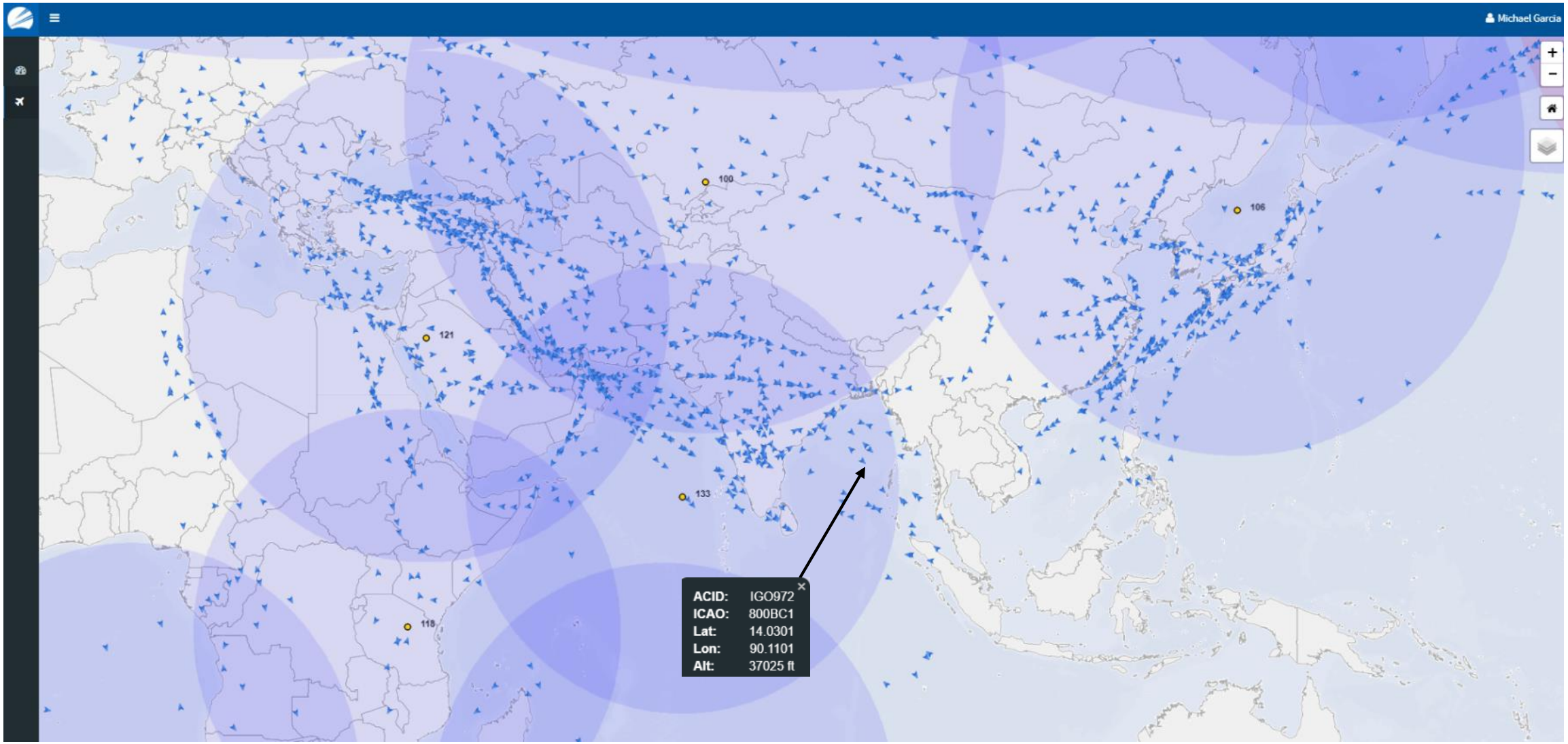




Our satellites are in the same approximate position about every 3 days. So this is the coverage from September 4th, 2017

Flight operations in the Caribbean changed significantly as a result of Hurricane Irma from September 7th, 2017

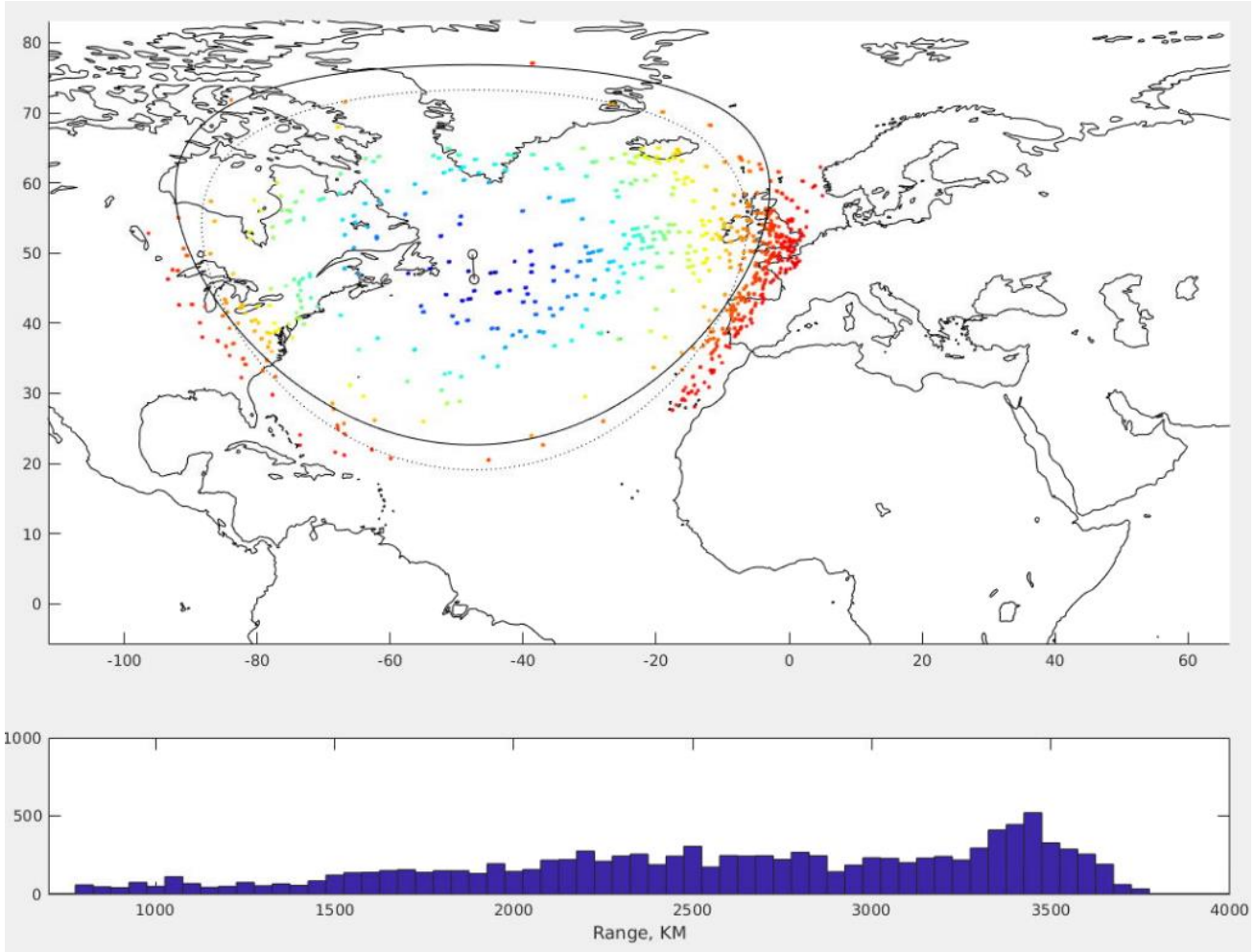
Aireon Dashboard Web Application



01:55Z 1/29/2018

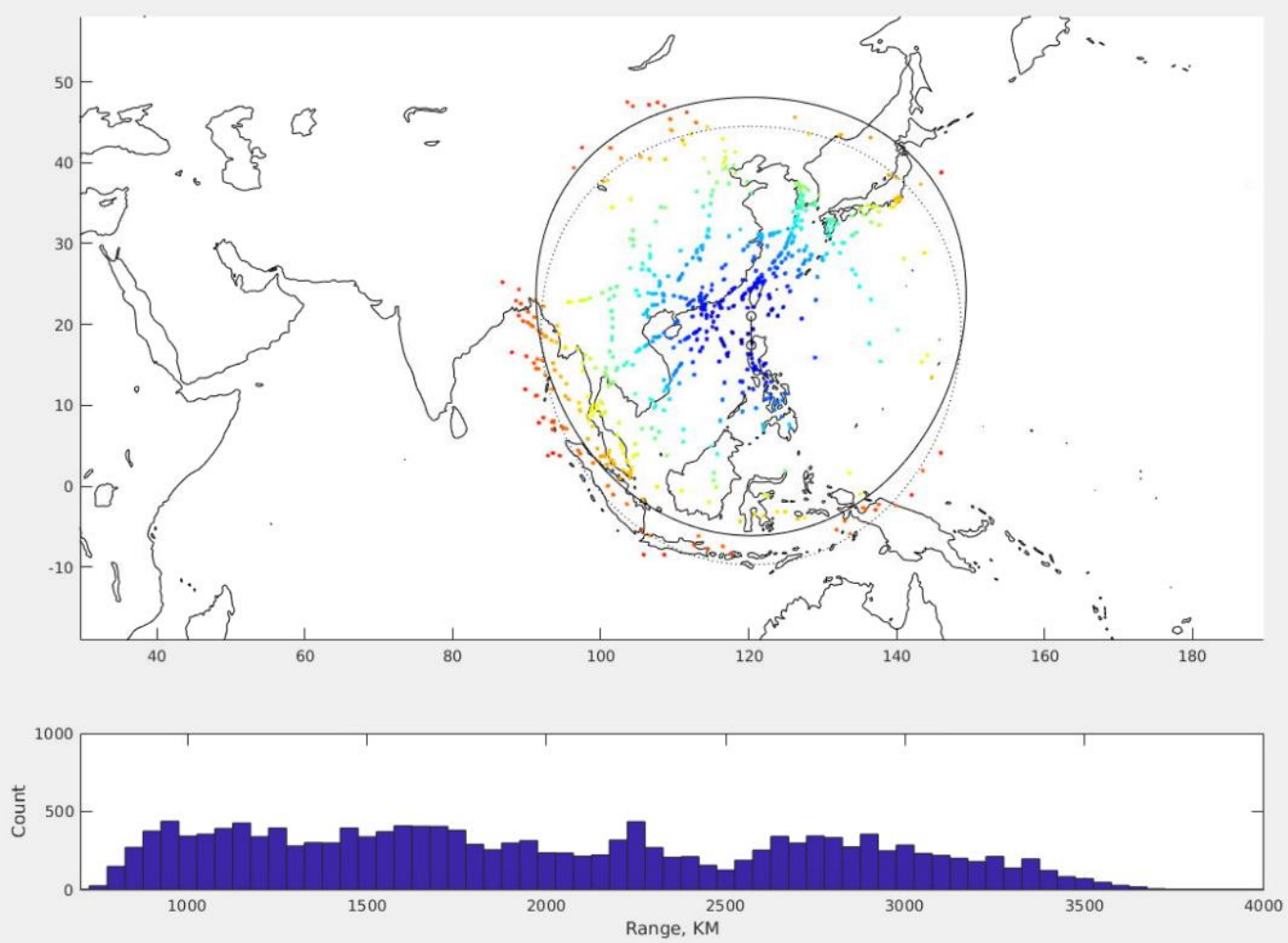
Satellite Coverage Analysis (1)

SV103
2017-11-19 08:08Z
Max Range = 3783 km
Min Elev = -4.6°
Aircraft Count = 697

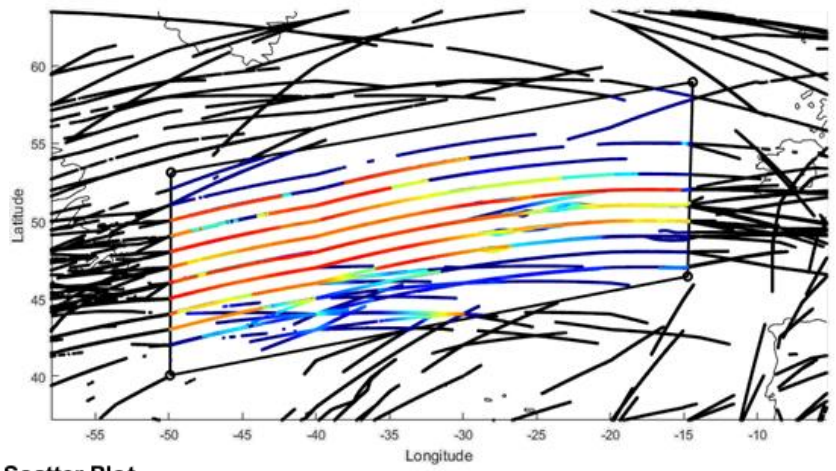


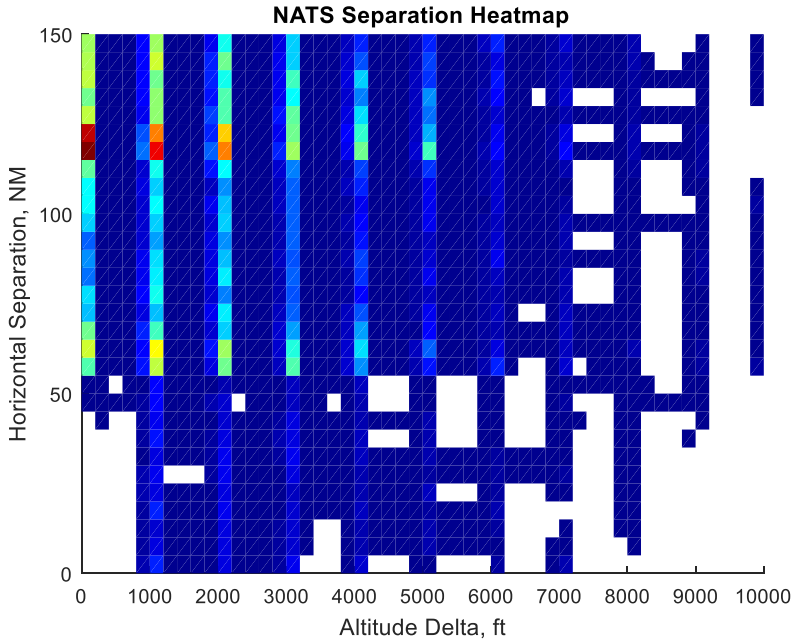
Satellite Coverage Analysis (2)

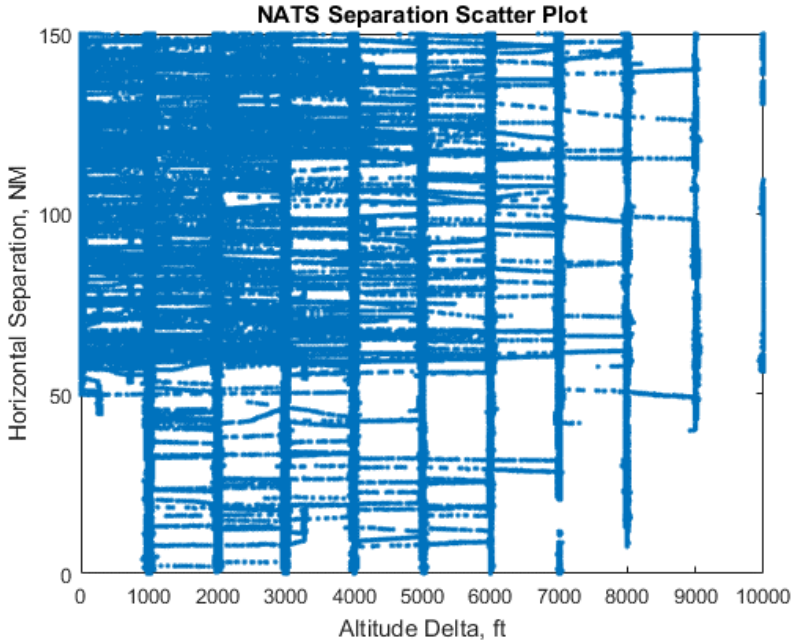
SV104
2017-11-16 21:21Z
Max Range = 3750 km
Min Elev = -4.4°
Aircraft Count = 797



Atlantic Traffic Separation







Data captured over the Atlantic shows how targets are being separated in oceanic airspace
This two hour sample shows peaks at 60 and 120NM of horizontal separation and 0-2000ft vertical separation

Aireon℠

OOAT Summary

- The On Orbit Test campaign has successfully evaluated the Aireon system with
  - Flight Tests
  - Reference Transmitters
  - Commercial Aircraft
  - Data Analytics

- Each Additional Launch further improves our confidence in the capabilities of the system with continuous improvement of our knowledge, tools, and techniques

References

1. Garcia, M.A., J. Dolan, A. Hoag. “Aireon’s Initial On-Orbit Performance Analysis of Space Based ADS-B”. IEEE/ICNS Conference 2017
2. Garcia, M.A. (2016). “Aireon Space Based ADS-B Compatibility and Performance Analysis”. ESAVS Conference 2016.
3. Garcia, M.A., J. Stafford, J. Minnix, J. Dolan. (2015). “Aireon Space Based ADS-B Performance Model”. IEEE/ICNS. 2015: C2-1 – C2-10.


Thank you for your time!
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