Space Based ADS-B

Presentation to APANPIRG 29

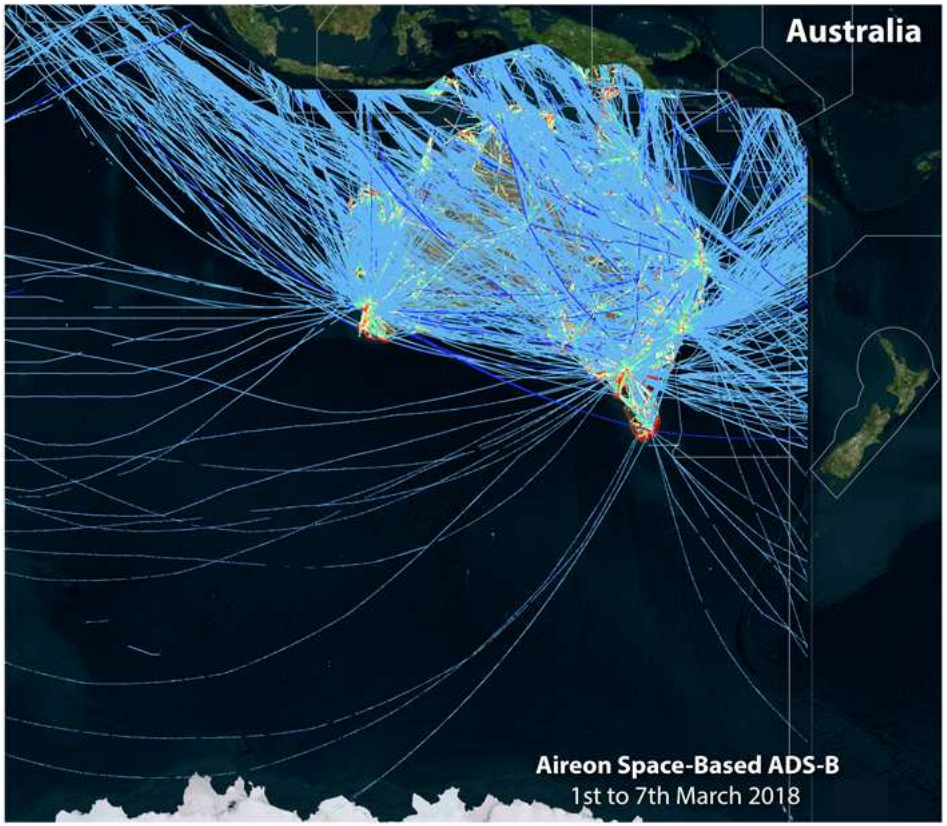
Greg Dunstone, representing ICCAIA (& Aireon LLC)

- See WP/19

September 2018

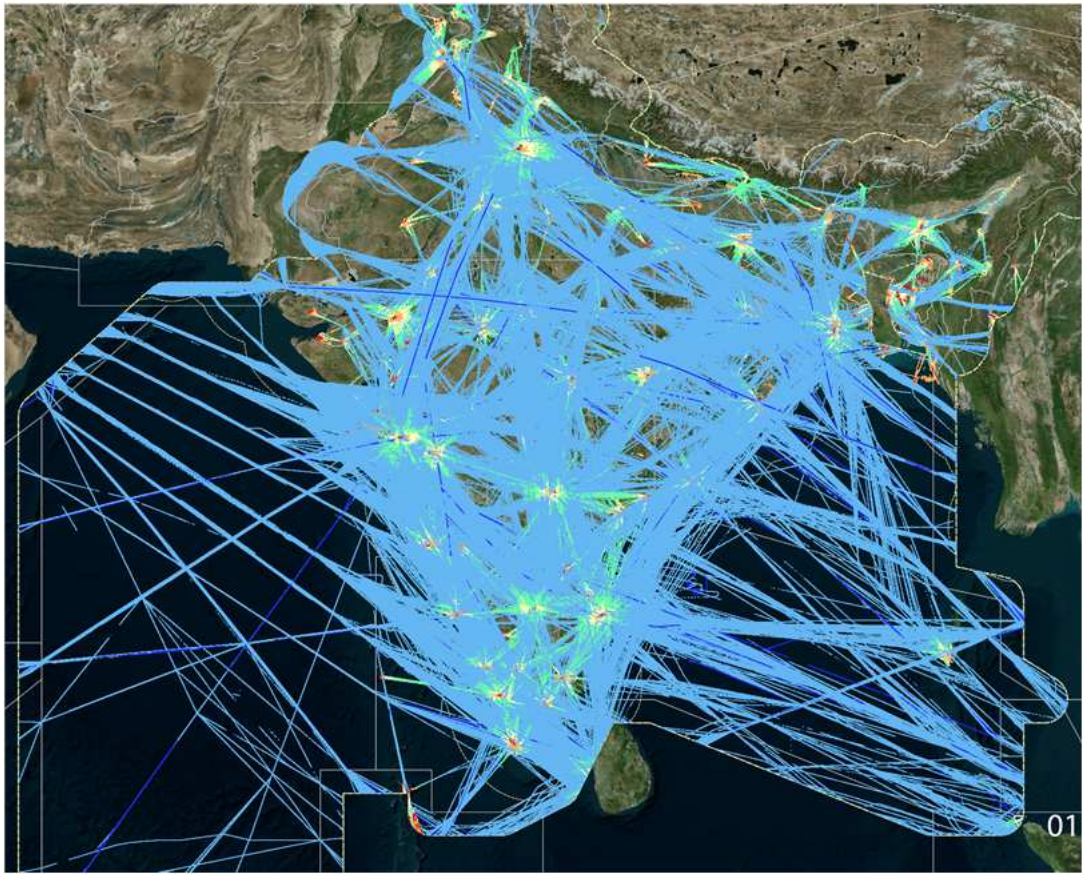
ADS-B Surveillance brings Capacity/Efficiency

- Reduced separation & reduced workload
  - ✈ compared to procedural ATC
- More preferred flight levels
- Removal of stepped climbs
- Gap filling holes in terrestrial surveillance
  - ✈ reduce ATC conservatism
- Improved flow management
- Reduction in ADS-C costs (Airline & ANSP)
- Backup existing surveillance network
  - ✈ Space based unaffected by local weather
- Reduced need for some radars
- Low capital cost & can be service based



ADS-B Surveillance brings Safety benefits

- ATC Situational awareness
- Safety alerts
  - RAM,CLAM, STCA, DAIW, MSAW
- FIR boundary safety
  - Eg: Detection of co-ordination failure
- Improved management in adverse weather
- Reduced workload
  - Eg: Due less voice & data communication
- GADSS & better SAR
- Analysis/ Statistics/ Safety reviews
  - where are aircraft really?



Safety benefits of surveillance

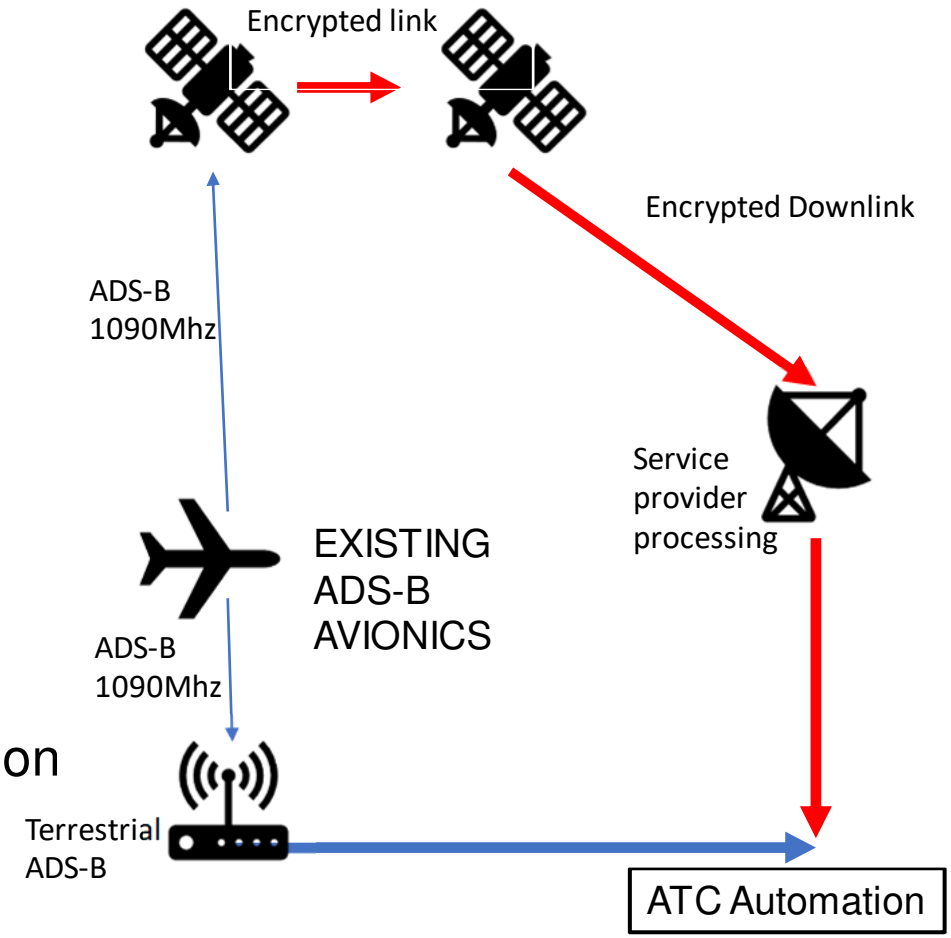
Applies equally to Terrestrial ADS-B & Space based ADS-B

- Safety benefits are real!
  - ✈ Safety nets, situational awareness and SAR
- Safety benefits traditionally hard to quantify
  - ✈ Worth little before the adverse event
  - ✈ Worth everything after the adverse event
- Increasing traffic density and more demanding community safety expectations
- Would the average passenger think it reasonable to be without surveillance when it is now possible everywhere?

See https://flightsafety.org/wp-content/uploads/2016/10/ADS-B-report-June-2016-1.pdf

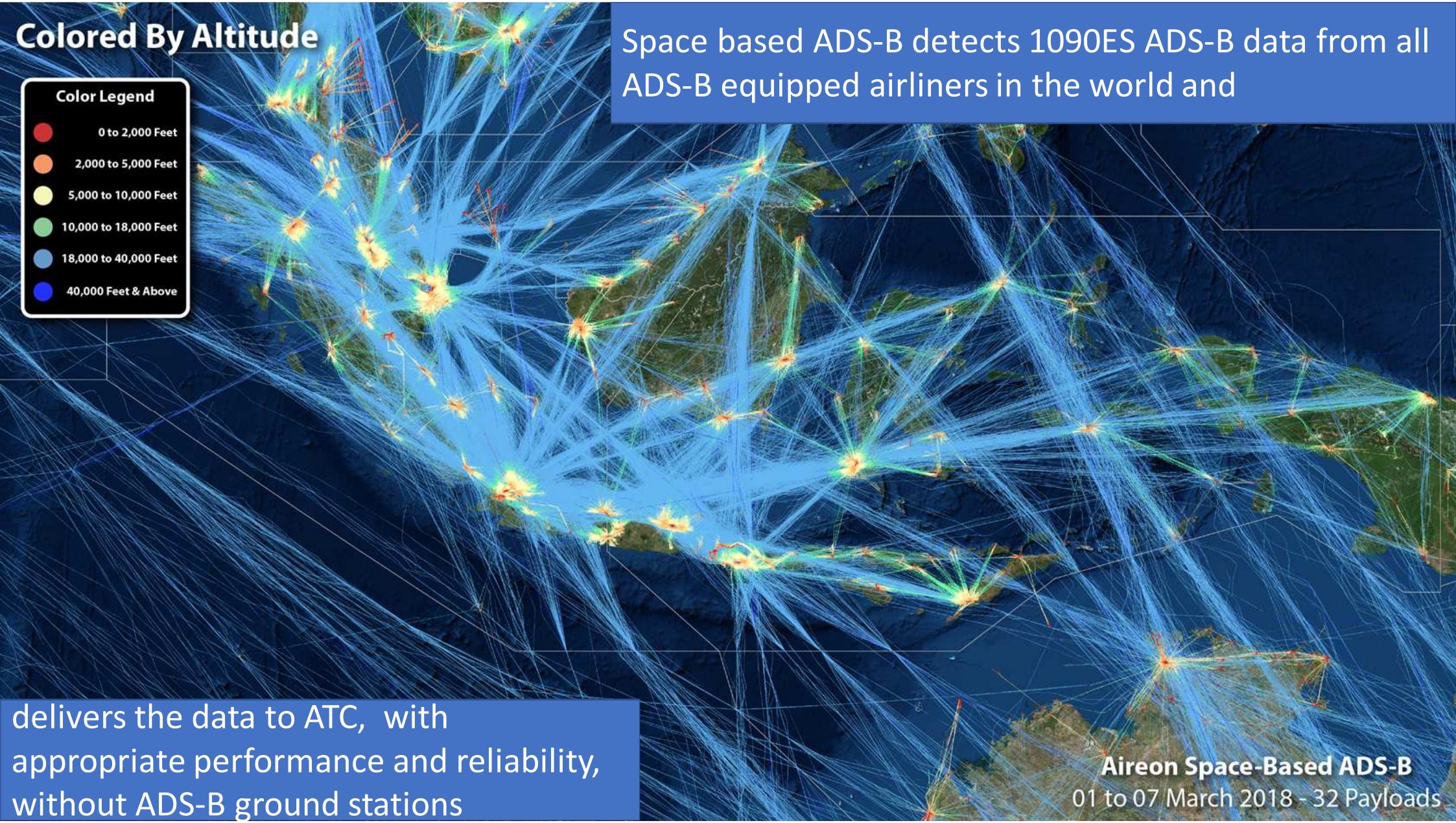
Space-based ADS-B is just ADS-B

- Many states have deployed ADS-B
  - ADS-B into ATC automation
  - Regulations
  - ATC procedures
  - Operational use
- They have already done the difficult part
  - Space based ADS-B is an easy addition
- Its like a “super capable” – extra ADS-B ground station
  - That covers the whole world (or your part of it)



Space based ADS-B is already providing data

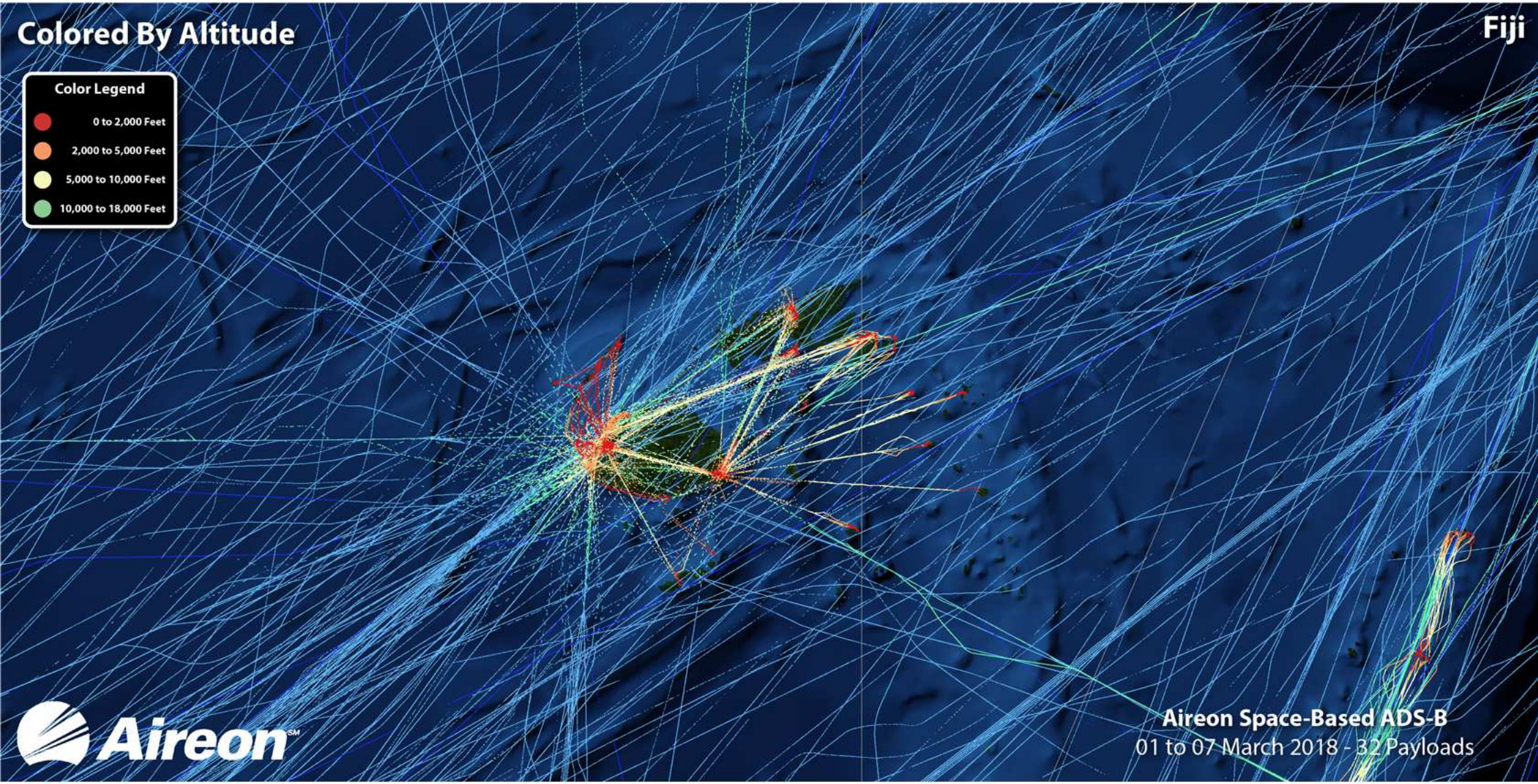
- Examples in following slides
  - ✈ Without complete constellation
  - ✈ Data flow temporarily constrained by old satellites
- Can provide ATC surveillance over the Ocean
- Can provide ATC surveillance over continents in terminal area and enroute
- Can provide ATC surveillance at all flight levels
- Can support Long Range Flow
  - ✈ Data on all aircraft travelling to your FIR
  - ✈ Wherever they are in the world



Space based ADS-B detects 1090ES ADS-B data from all ADS-B equipped airliners in the world and

delivers the data to ATC, with appropriate performance and reliability, without ADS-B ground stations


Aireon
SM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Fiji
Aireon
Aireon Space-Based ADS-B
01 to 07 March 2018 - 32 Payloads


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Aireon
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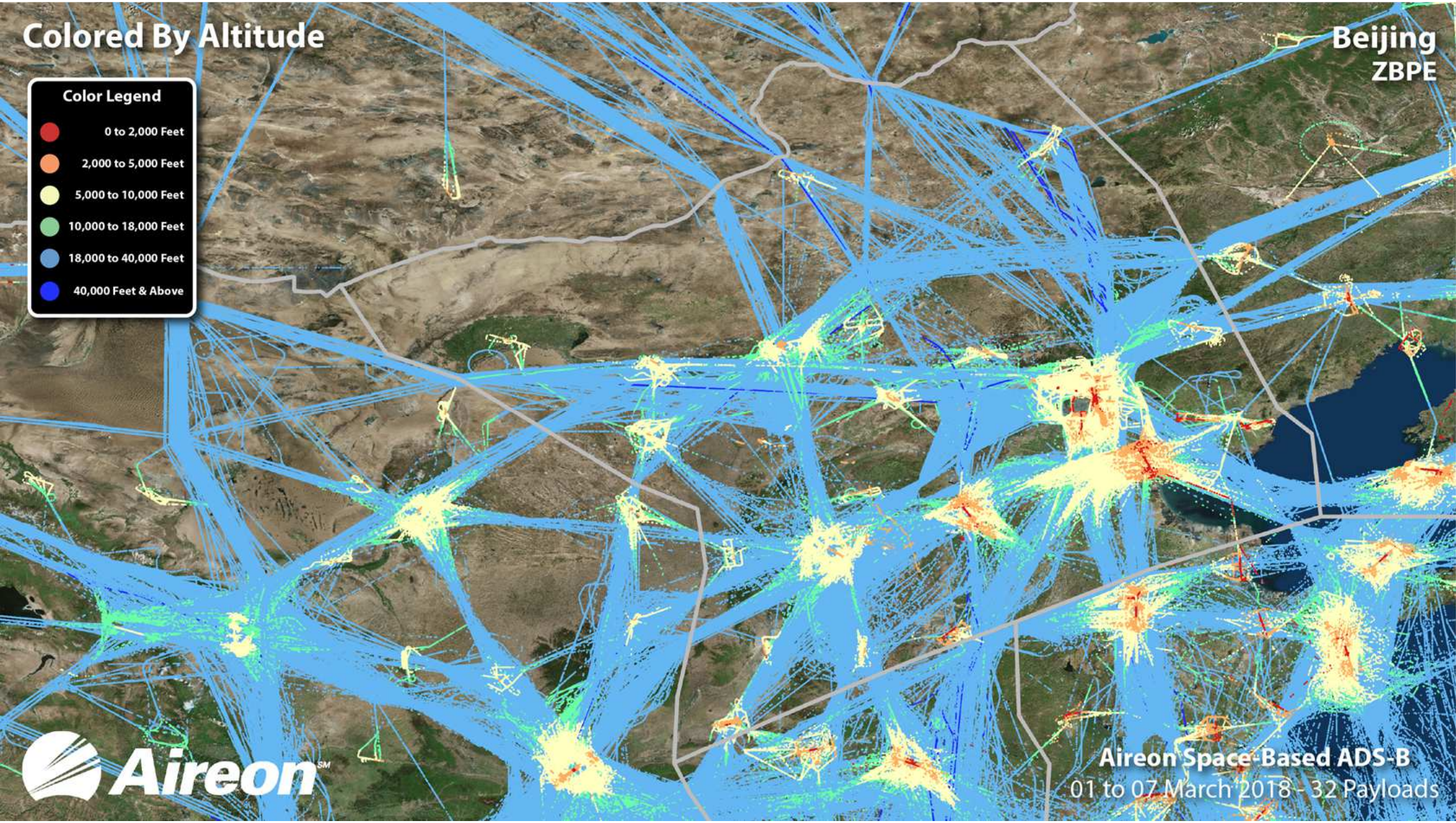
01 to 07 March 2018 - 34 Payloads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Beijing
ZBPE
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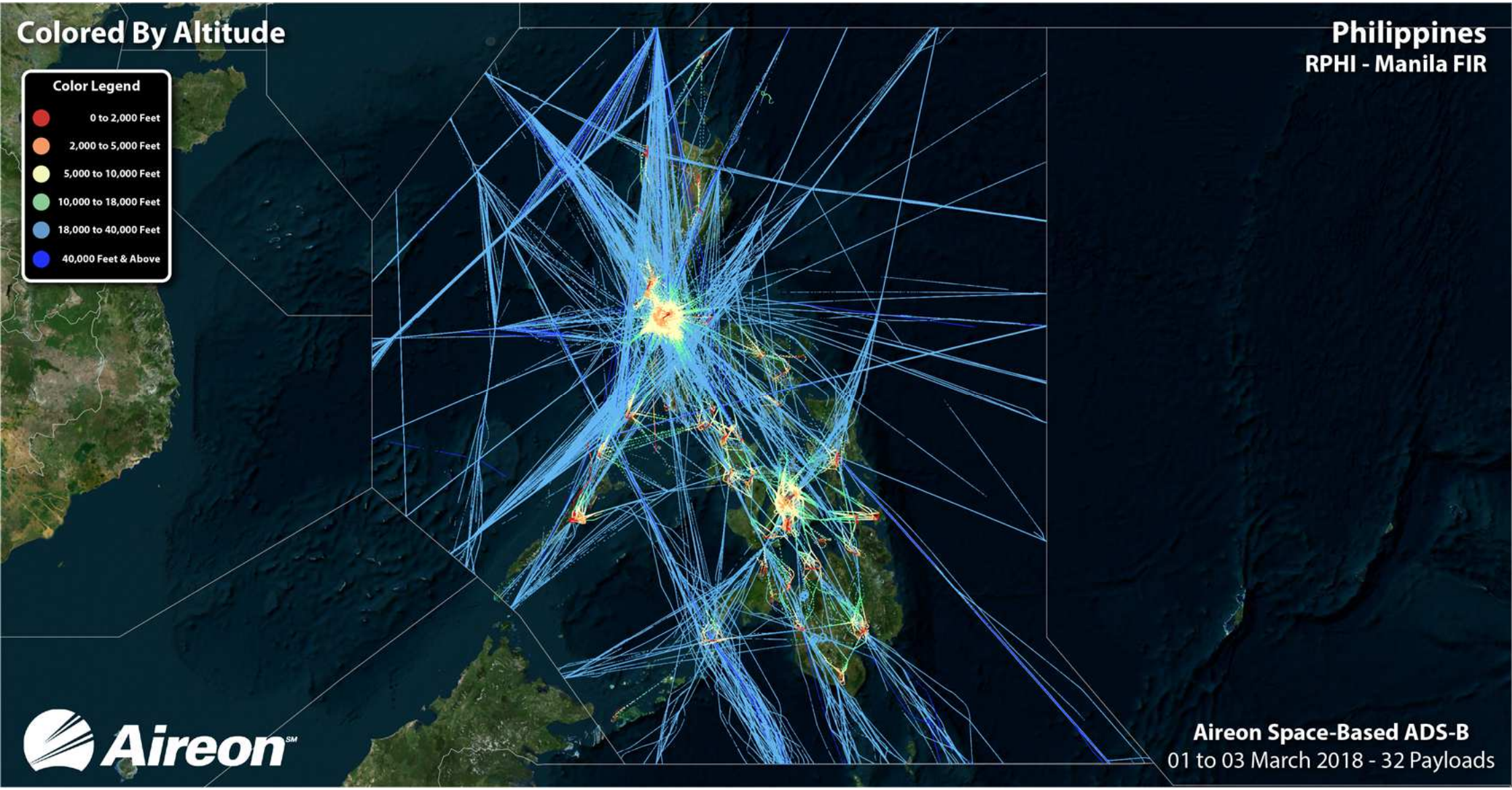
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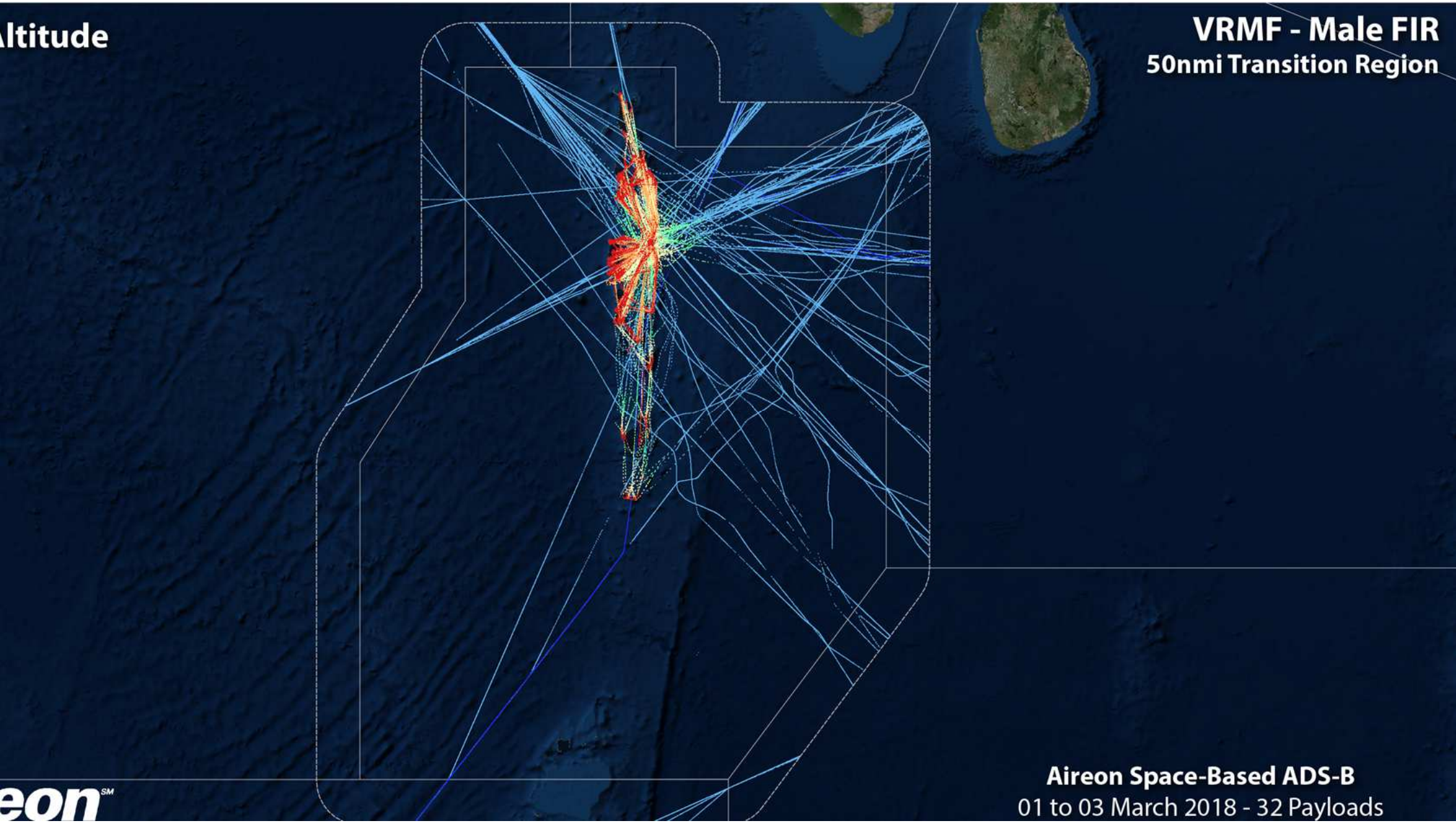
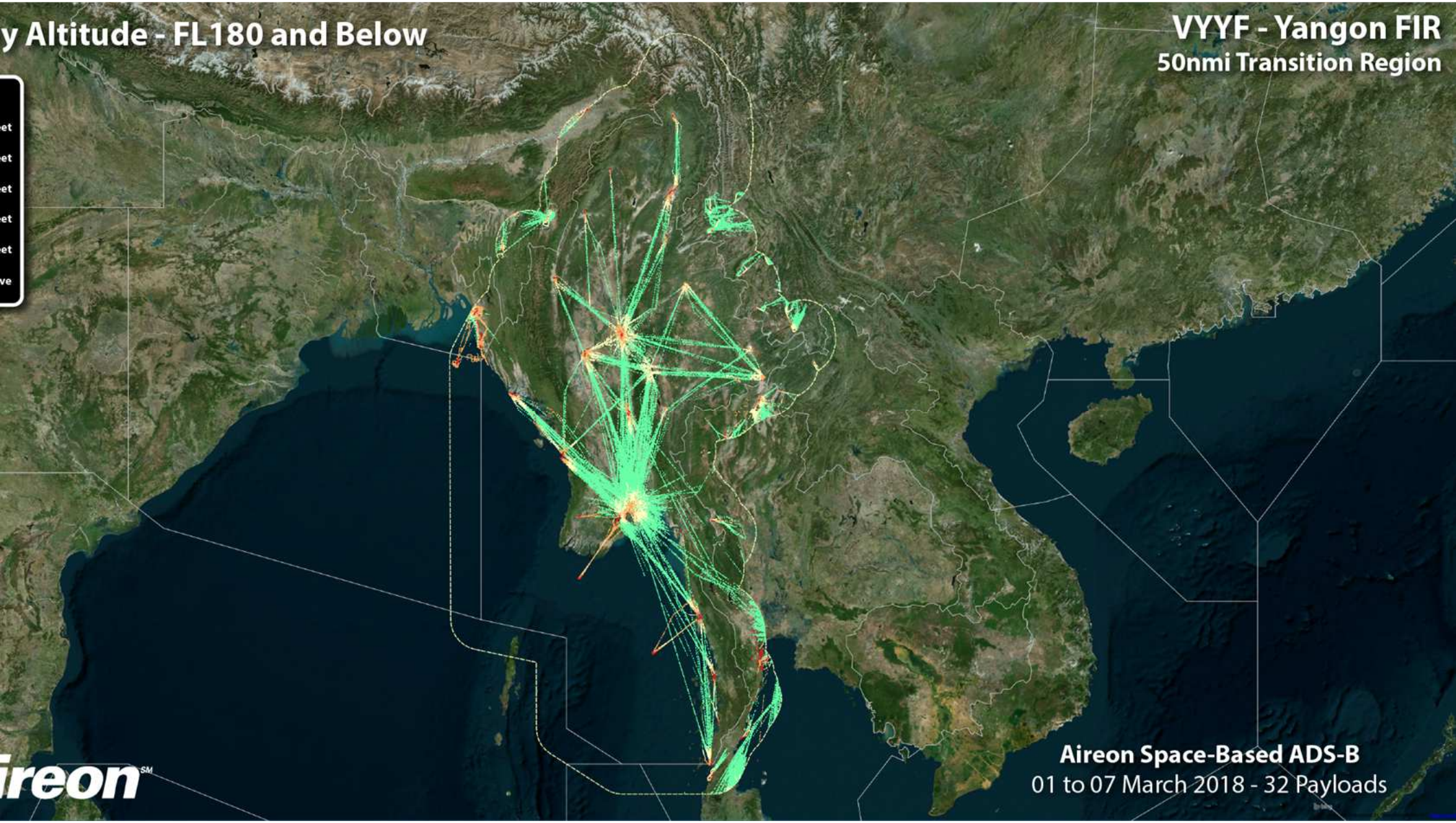
Philippines
RPHI - Manila FIR
Aireon
Aireon Space-Based ADS-B
01 to 03 March 2018 - 32 Payloads


ltitude
VRMF - Male FIR
50nmi Transition Region
Aireon Space-Based ADS-B
01 to 03 March 2018 - 32 Payloads


y Altitude - FL180 and Below
VYYF - Yangon FIR
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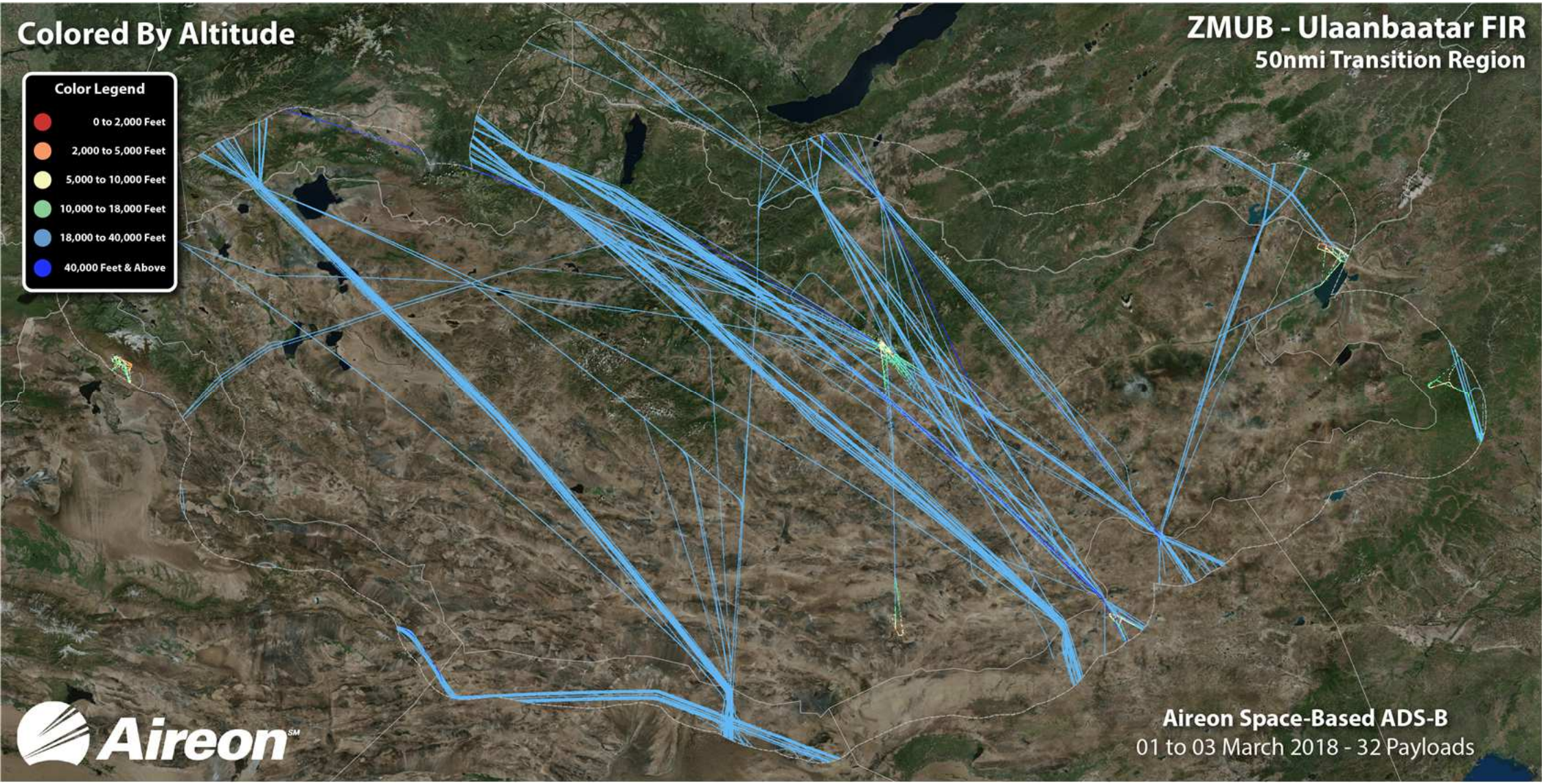
Aireon Space-Based ADS-B
01 to 07 March 2018 - 32 Payloads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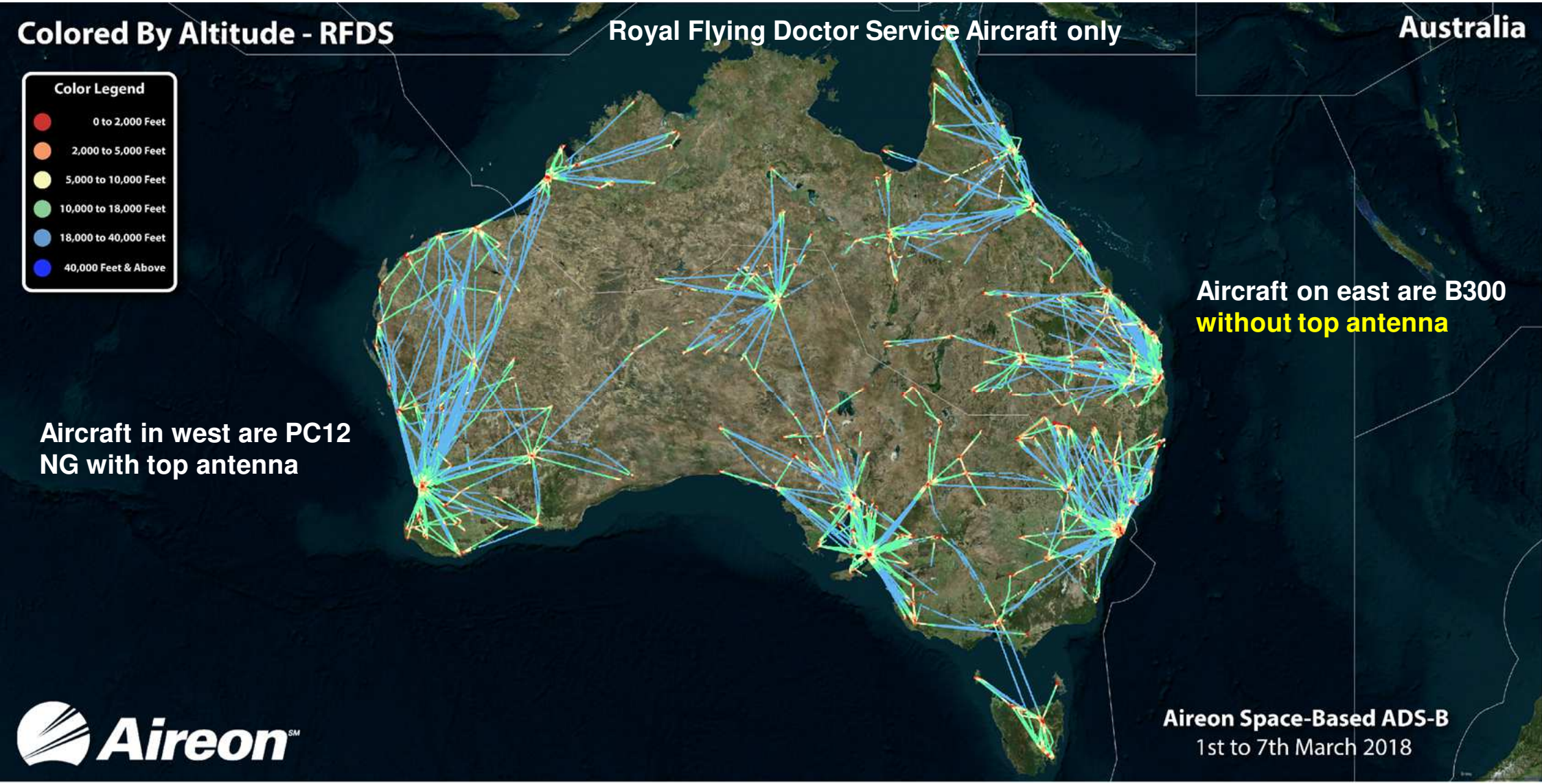
18,000 to 40,000 Feet
40,000 Feet & Above
ZMUB - Ulaanbaatar FIR
50nmi Transition Region
Aireon
Aireon Space-Based ADS-B
01 to 03 March 2018 - 32 Payloads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Royal Flying Doctor Service Aircraft only
Australia
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10,000 to 18,000 Feet
18,000 to 40,000 Feet
40,000 Feet & Above
Aircraft on east are B300
without top antenna
Aircraft in west are PC12
NG with top antenna
Aireon
Aireon Space-Based ADS-B
1st to 7th March 2018


Colored By Altitude - S92
Australia
Color Legend
0 to 2,000 Feet
2,000 to 5,000 Feet
5,000 to 10,000 Feet
10,000 to 18,000 Feet
18,000 to 40,000 Feet
40,000 Feet & Above
Helicopters to gas platforms (bottom antenna only)
Aireon
Aireon Space-Based ADS-B
1st to 7th March 2018


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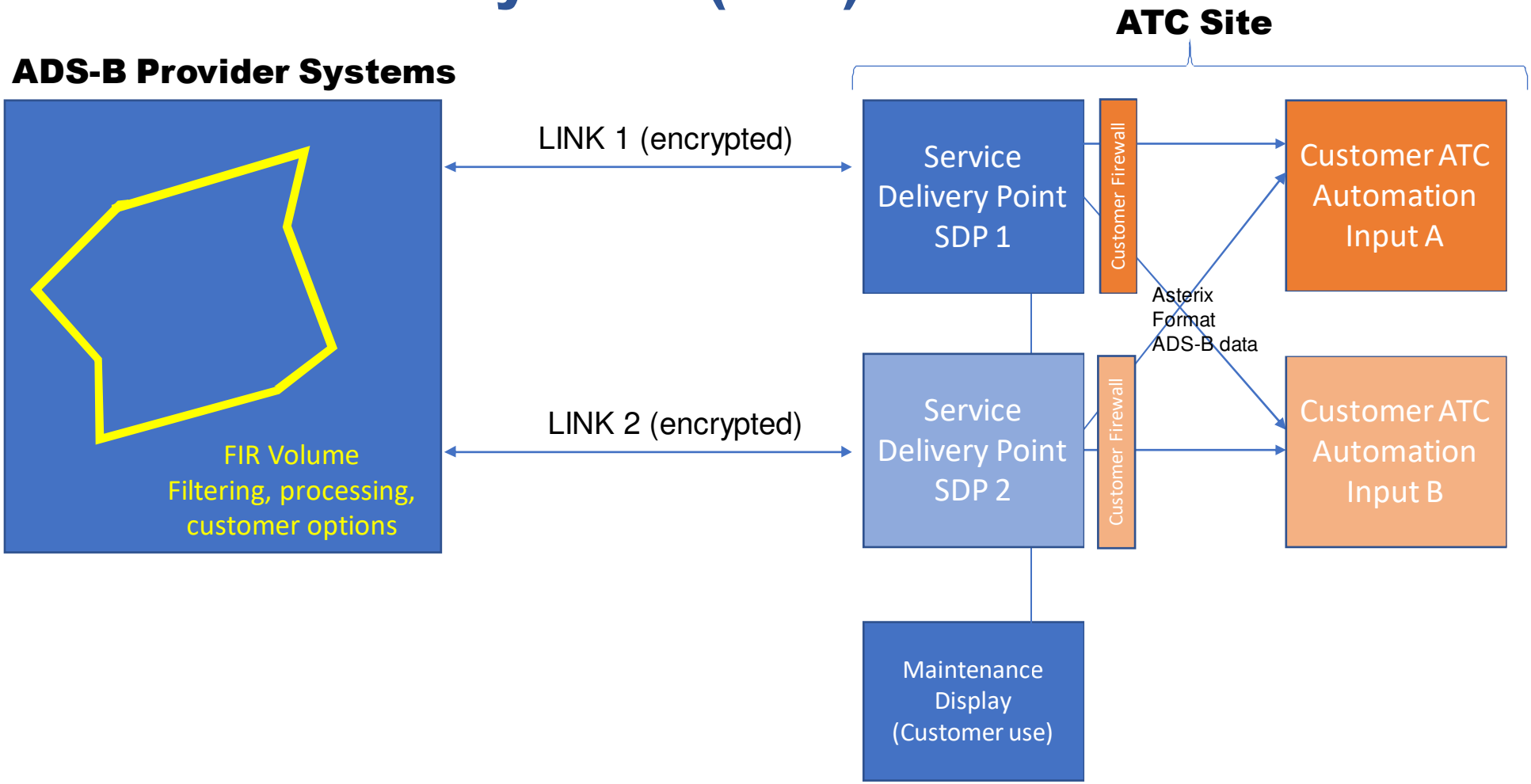
10,000 to 18,000 Feet
18,000 to 40,000 Feet
40,000 Feet & Above
Australia - Meekatharra
Low Altitude Filter - 30 Aircraft
Terminal area at remote airport
Aireon
Aireon Space-Based ADS-B
16 to 19 March 2018 - 34 Payloads

ADS-B : Service provider concept

- Service provider delivers ADS-B reports to ATC centre
- Regular service fee
- Guaranteed performance
  - ✈ Eg : Availability, latency, update rate
- Little capital outlay, No maintenance cost uncertainty
- Aireon owned by a number of ANSPs

Aireon Hosted payload centre

Space-based ADS-B is typically delivered from a Service Delivery Point (SDP)



Aireon status (See IP/10)

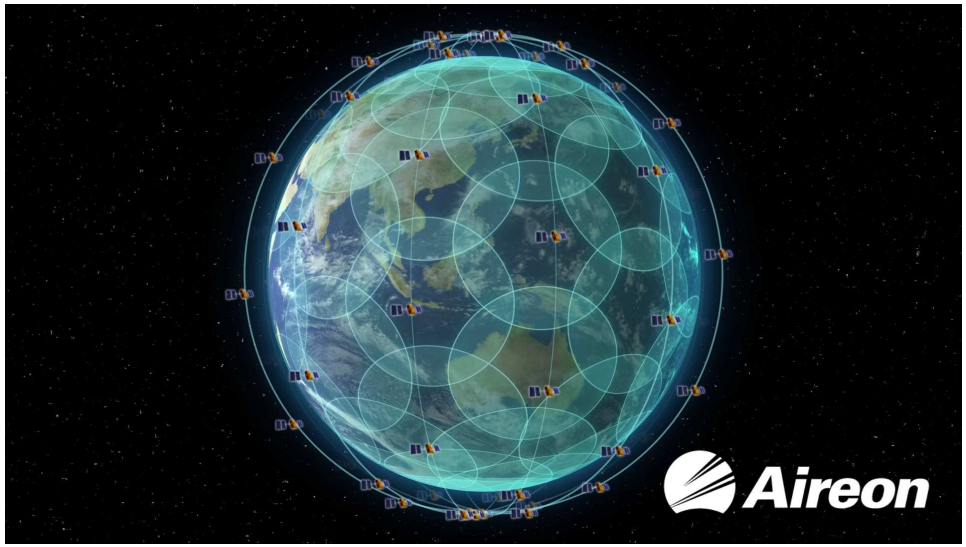
- The system has been providing test data for more than a year and performance has exceeded expectations

- Another SpaceX launch in Q4 2018 will complete the constellation.

- NAV CANADA : operational trials in late 2018. Other ANSP's in 2019.

Space based ADS-B : Surveillance everywhere

- Global coverage
- Uses existing ADS-B avionics



See https://Aireon.com/benefits/

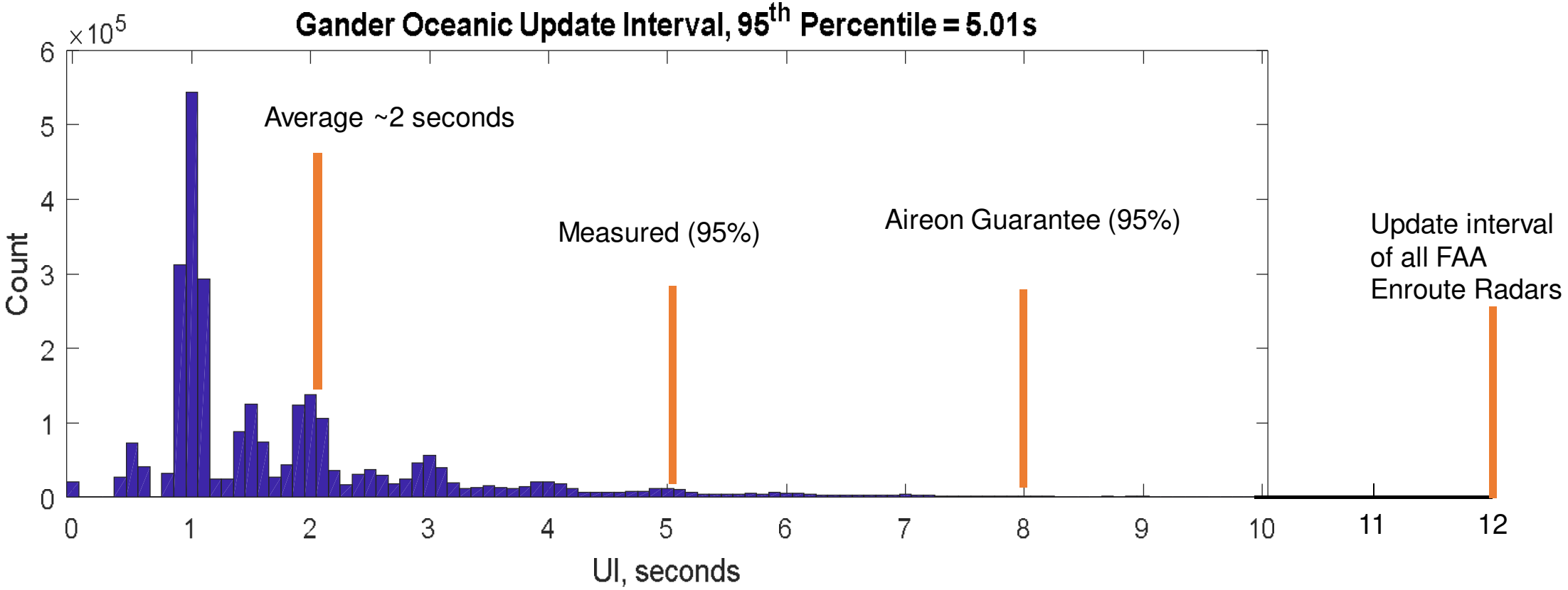
Service will be operating this year

- Aireon has
  - ✈65 satellites now in space
  - ✈75 satellites are planned to be deployed
    - 66 will be in orbit and operational
    - 9 in-orbit spares
    - 6 ground spares
  - ✈Performance continues to look good

- Aireon has contracts with ANSPs :

  - ✈ ASECNA: Agency for the Safety of Air Navigation in Africa and Madagascar
  - ✈ ATNS: South Africa
  - ✈ CAAS: Singapore
  - ✈ eNAV: Italy
  - ✈ NAV CANADA
  - ✈ Naviair: Denmark
  - ✈ Dutch Caribbean
  - ✈ UK NATS
  - ✈ Irish Aviation Authority (IAA)
  - ✈ Seychelles CAA
  - ✈ Isavia: Iceland

Measured Performance
Update Interval (in seconds)



30/ minute	15/ minute	7.5/ minute	5/ minute

* Using 44 out of 66 payloads and pre-operational constraints. Expected to further improve

Aireon Safety certification

- Aireon organisation designed with safety in mind. Its majority owners are ANSPs!

- Aireon internal safety management system

- EASA Regulator certification as surveillance service provider

- EASA Regulator ongoing oversight of
  - ✈System &
  - ✈Organisational and functional aspects
    - Financial, Management, Safety management
    - Methods, Procedures, Competency
    - Software assurance and system verification
    - Contingency, reporting, ICAO standards

EASA
European Aviation Safety Agency

Summary : Space based ADS-B contributes to safety

- **ADS-B is mature and in operational use for separation for more than a decade**
  - ✈ Higher performance surveillance at lower cost

- **Space based ADS-B is working – will be available to customers within 6 months**
  - ✈ Can be used for 5 NM separation with VHF > just like terrestrial ADS-B
  - ✈ ICAO SASP have finalized separation standards for ADS-B and RCP240 (15/14 NM)

- **Space-based ADS-B is easy to add on to ATC systems with ADS-B**
  - ✈ Technically, operationally, and for stakeholders
  - ✈ Builds benefit on airline avionics investment

- **Surveillance brings higher safety**
  - ✈ ANSPs can question – is it wise to operate without surveillance - when it is available everywhere ?
  - ✈ And allows leapfrog of legacy technology for some

WP/19

- **Invites the meeting to adopt the following :**

As global ATS surveillance capability will be operational and certificated early in 2019,

States should ***consider*** *implementation of this technology*

to improve safety and efficiency in airspace currently without continuous and seamless surveillance.

This technology enables some States to leapfrog legacy surveillance capabilities and helps ensure that 'no State is left behind'.


Space-based ADS-B will be Operational This Year
Questions?
NAV CANADA
iridium Everywhere
enav
NATS
IAA
NAVIAIR
Aireon
AIREON LLC PROPRIETARY INFORMATION

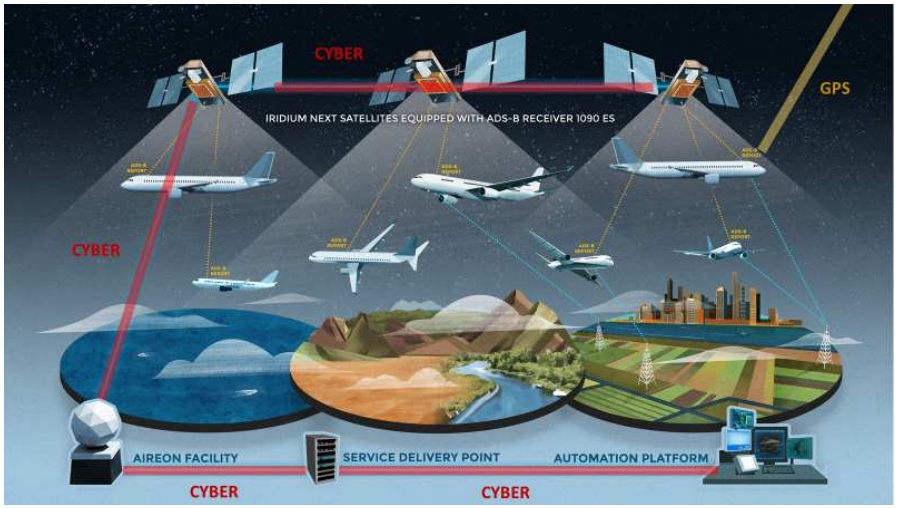
Spares

Issue : Security

- **Aireon Security policy, systems and processes**
  - Specification & performance designed with Security a key objective
  - Ongoing security monitoring and management is an important part of the role of the Aireon 24/7 operational centres

- **All interfaces controlled and managed**
  - Protected against network threats

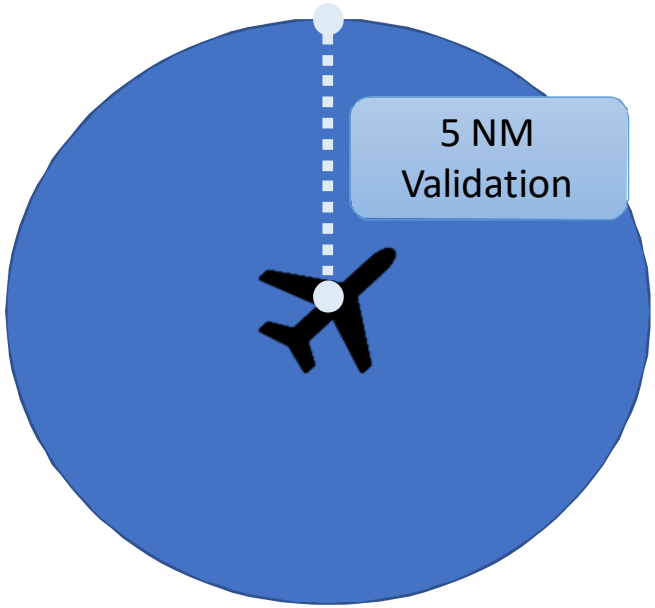
Aireon Service Management System (ASMS)



Issue : Position Validation

- **Validation of position is part of the design**
  - Applying all available pragmatic techniques
    - ✈Eg: Kinematic tests

- **Time Difference of Arrival (TDOA)**
  - ✈TDOA at multiple space receivers
  - ✈Aireon will initially flag any reports that are inconsistent by 5 miles
  - ✈Additional values being researched and validated
    - A more detailed review of this capability is planned to be shared during the Enhanced Solutions for Aircraft and Vehicle Surveillance Applications (ESAVS) conference in Berlin in October 2018



Aireon ALERT – (Free Service)

- **Aireon Aircraft Locating and Emergency Response Tracking (Aireon ALERT)** is the aviation industry's first and only **FREE**, global, real-time emergency aircraft location service.
- Aireon will provide the global, real-time, ADS-B air traffic surveillance coverage for the Aireon ALERT service.
- The Irish Aviation Authority (IAA) will operate the 24/7/365 Aireon ALERT service center and the Aireon ALERT registration system.
  - ✈https://aireonalert.com/ & https://aireon.com/2018/08/22/aireon-alert-now-open-pre-registration/
  - ✈Aireon ALERT will only be able to provide data in an emergency situations to preregistered stakeholders

Aireon + IAA = Aireon ALERT

What information is available to me from Aireon ALERT?

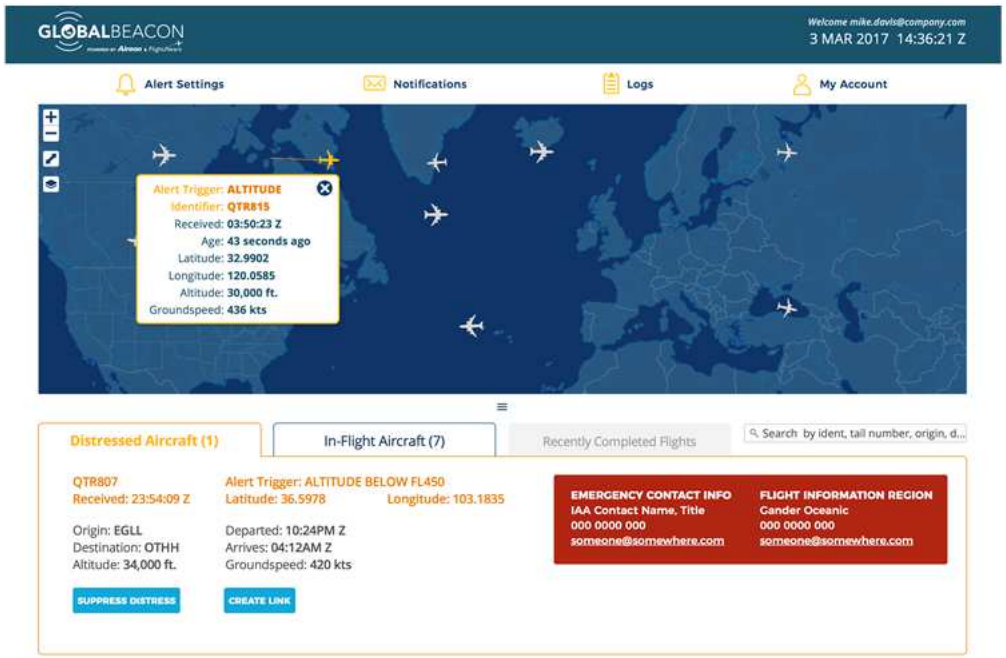
- Once the emergency request has been received by Aireon ALERT the operator will execute a search query.

- If the aircraft is found, a 4-dimensional report will be verbally provided:
  - Latitude
  - Longitude
  - Altitude
  - Time

- A package will then be produced that goes to the Aireon ALERT technical support team and the requester.
  - It will include a map of the last 15 minutes of flight, with one plot per minute and the 4-dimensional report information.

GlobalBeacon – Helping Airlines w/ GADSS Compliance

- GlobalBeacon was created by Aireon and FlightAware for GADSS requirements
- GADSS using FlightAware's web interface and with Aireon's space-based ADS-B data
- With configurable alerts, for abnormal events.
  - ✈ Eg Deviate from its intended flight path, the airline operations center will be notified



- More information : https://globalbeacon.aero/
  https://www.youtube.com/watch?v=4KKKh0gljz0

The FlightAware System