National Aeronautics and Space Administration

EXPLORE EARTH

A Time of Change for Earth Science Research: B777-200ER

Derek Rutovic
NASA Airborne Science Program, Deputy Director
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Airborne Science at NASA, Why?

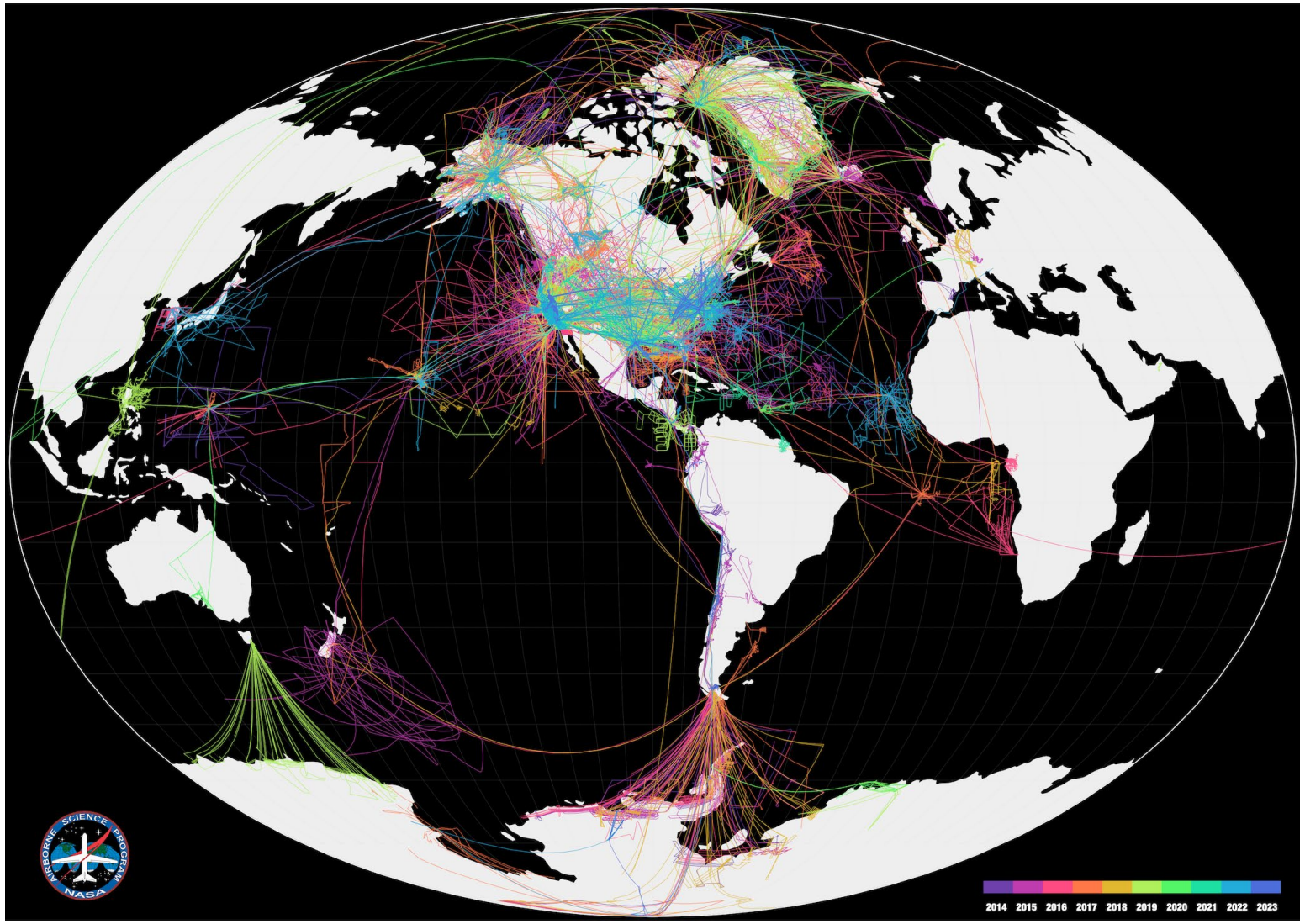
Scientific

- Make important scientific measurements not possible from satellite or surface-based platforms
- Calibration and validation of satellite remote sensing observations and models
- Develop new remote sensing and in-situ instruments

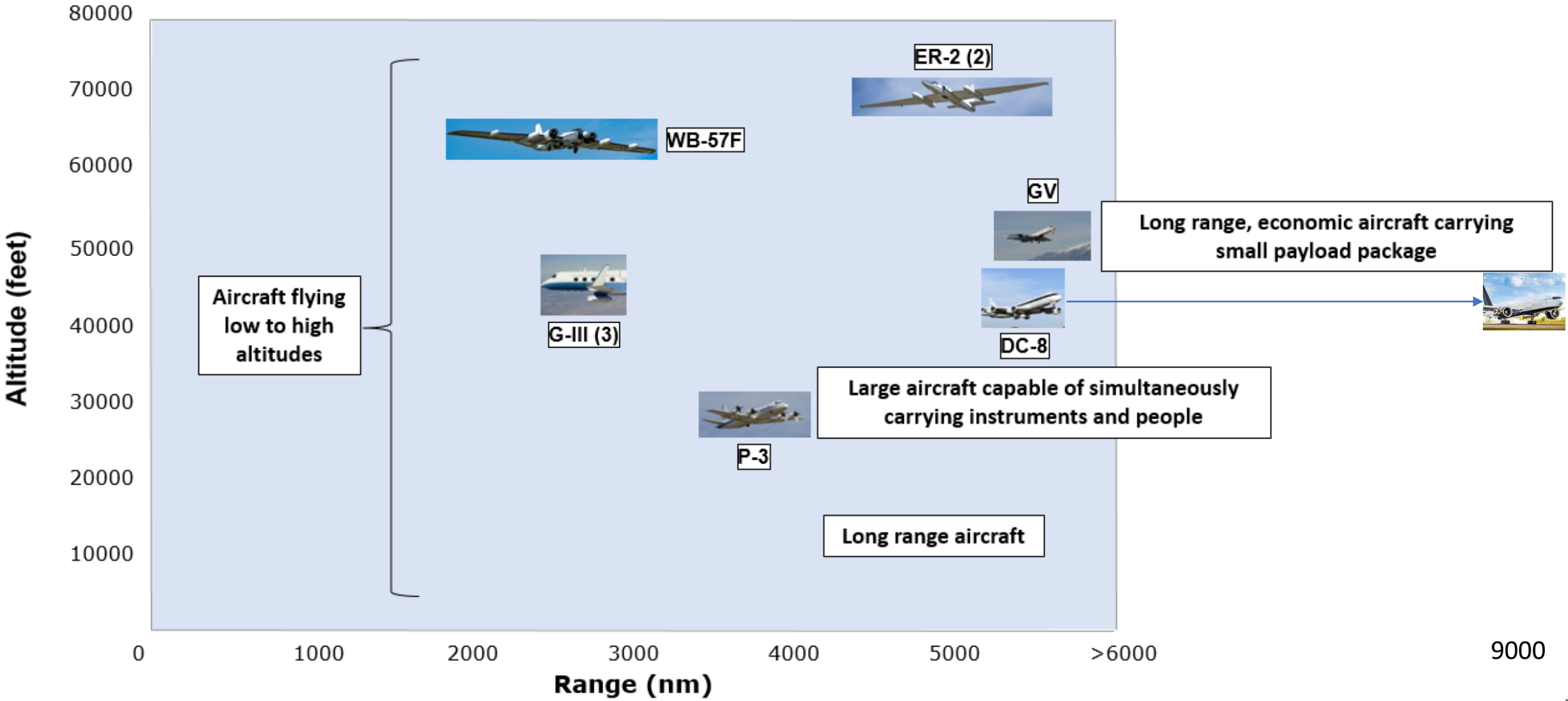
Programmatic

- Develop early career investigators
- Develop leadership skills in promising early and mid-career investigator

Mission Flight Tracks, 2014 - Present



Airborne Science, Core Platforms



Airborne Science, Core Platforms

DC-8 Historical Requirements

- DC-8 acquired to replace the CV 990
- Missions have relied on the DC-8 for the following requirements
  - Heavy Lift – enables multiple payloads to provide coincident measurements most often for atmospheric chemistry, weather, and instrument inter-comparisons (ASCENDS)
  - Long range – enables measurements across regions/basins to enable process studies over large regions
  - Vertical profiling – the long endurance capability enables sampling from the surface to 12km with repeat profiles at various altitudes
  - Onboard operators – the ability to host instrument operators allows for adjusting instruments during a mission in addition to enabling science collaboration in real time, backbone support for SARP

So, Why Replace the DC-8?

- With few pilot simulators available and limited spare parts, NASA's Armstrong Flight Research Center suggested that the DC-8 would end operations in 2025
  - Fuel probes, brakes, tires, emergency door slides
- Market research showed viable, affordable, vibrant used aircraft market

How Do You Replace the DC-8?

Independent Analysis of Platform Alternatives
NASA Langley Research Center and Analytical Mechanics Associates
2017 - 2018

Large commercial aircraft
Military aircraft
Fleet of GVs
Cost per payload pound per mile

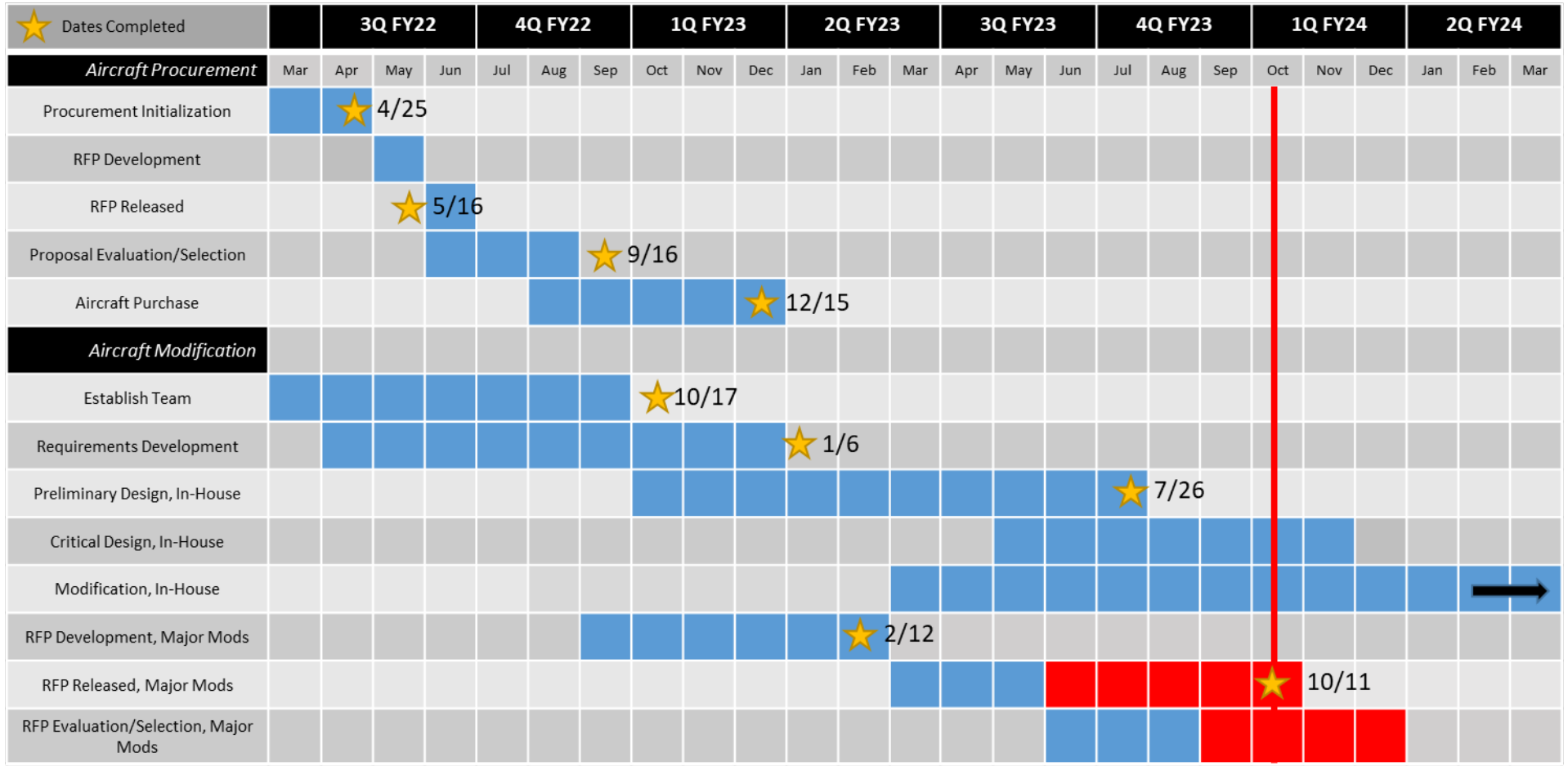
Best Replacement Option:
B767-200ER

National Academies of Science Study Assessed Long Term Need for Long Range Aircraft
2019-2021

"NASA should acquire, maintain, and operate a large aircraft … to address priority questions developed for the 2017 Earth Science … Decadal Survey."

Budget Approved
2022

B777 Replacement Schedule



B777 Replacement Schedule

	3Q FY24			4Q FY24			1Q FY25			2Q FY25			3Q FY25			4Q FY25			1Q FY26			2Q FY26		
Aircraft Modification (cont.)	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Modification, In-House	■	■	■	■																				
Modification, Major Mods					■	■	■	■	■	■	■	■												
Major Scheduled Maintenance					■	■	■	■	■	■	■	■												
Aircraft Paint												■	■											

Aircraft Procurement

- B767 vs B777 and the Amazon Prime Air market effect
- Selected a Japan Airlines B777-200ER that was a summer 2020 COVID casualty
  - 4 months from RFP release to contract award
  - 3 months to bring aircraft out of preservation
- Delivered to NASA LaRC on December 15th, 2022

Aircraft Delivery

Aircraft Design and Modification

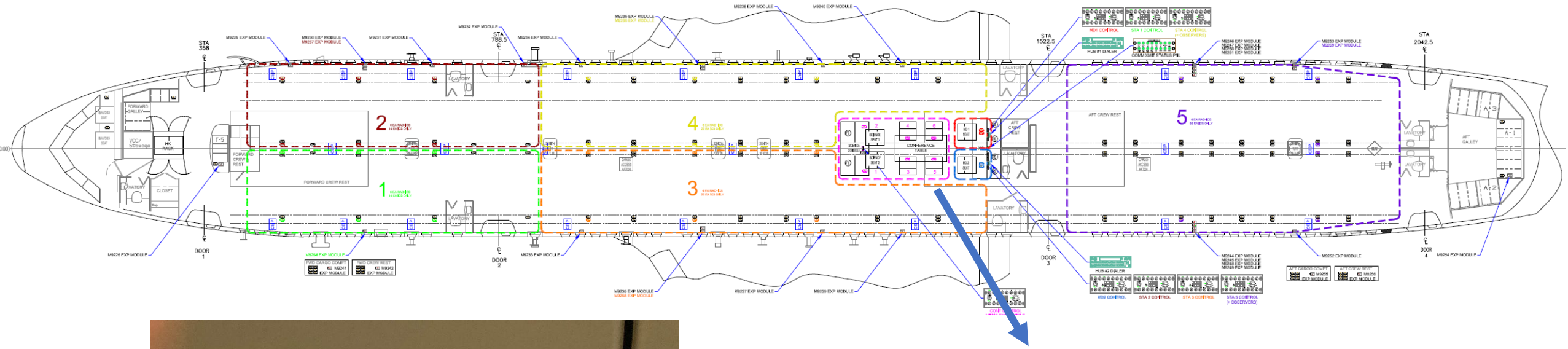
- Engineering design, analysis, and modification efforts were commencing in parallel with the aircraft procurement process
  - Engineering “Dream Team” assembled from across the Agency to complete “in-house” modifications
    - 4 participating Centers
    - New model of ASP HQ-driven team interleafing with Center airworthiness
  - Modification broken up into two phases
    - “In-House”
    - Vendor modification for structural portals

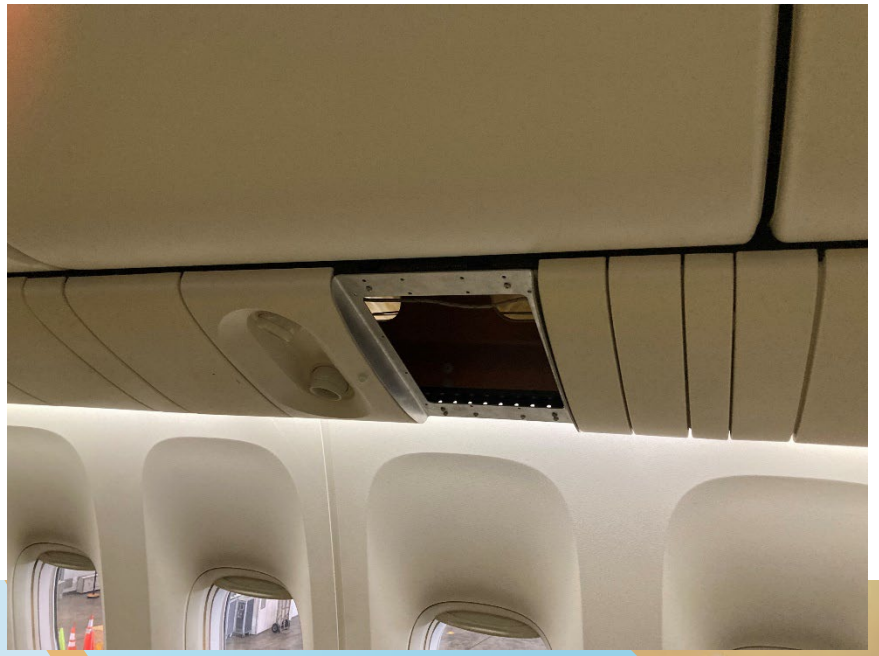
  - SRR completed January 2023
  - PDRs completed July 2023
  - CDRs ongoing
    - Network and research power completed: modification work is ongoing

Airborne Research Support Capabilities

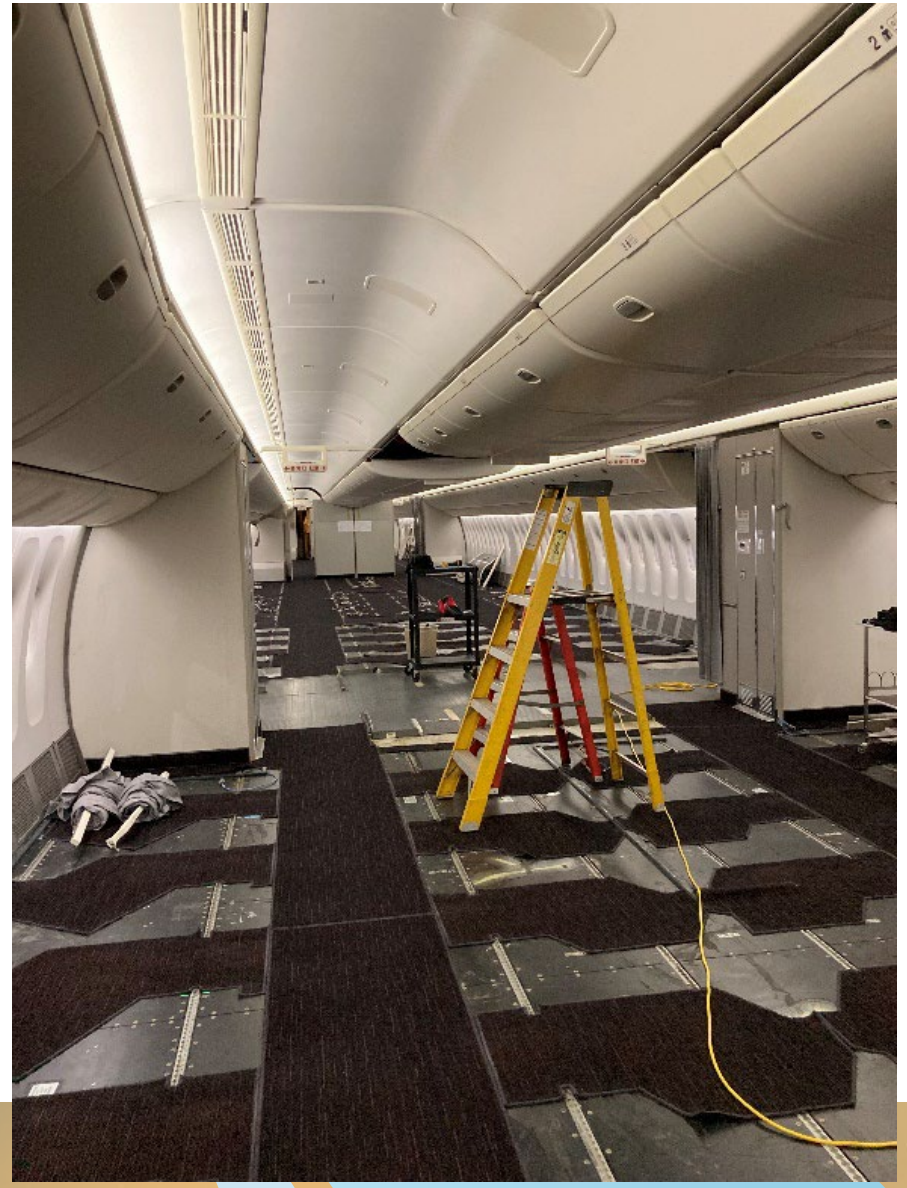
- 100K lbs of total payload
- 100 scientists and researchers
- Up to 7 nadir portals, 10 window portals, and 2 zenith portals
- Power
  - No break power transfer
  - 115 VAC, 400 Hz single/three phase: 83 kVA maximum
  - 115 VAC, 60 Hz single phase: 70 kVA maximum
  - 28 VDC: 7.8 kW maximum
- 200+ individual Intercom endpoints in the cabin, 6 private chat loops
- RD/NRD-41 dropsonde / AXCTD sonobuoy launcher
- Mission control center
- Network and SatCom, Iridium Certus
  - Planning for Starlink
- Standard suite of DC-8 “state parameters”

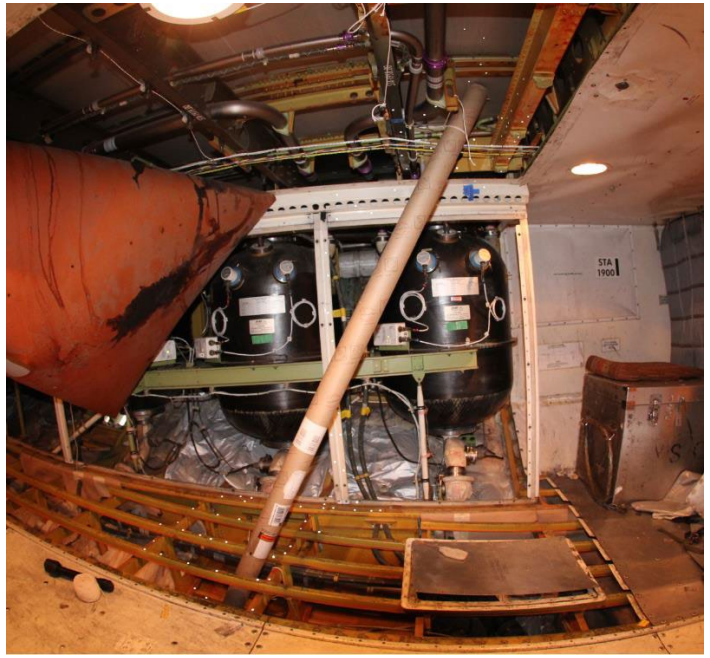
Aircraft Design and Modification





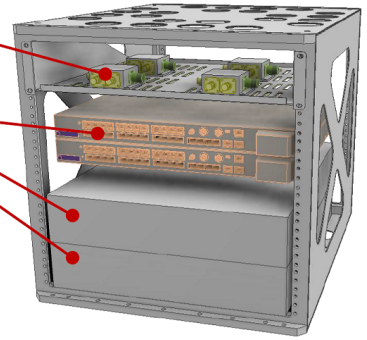
Aircraft Design and Modification





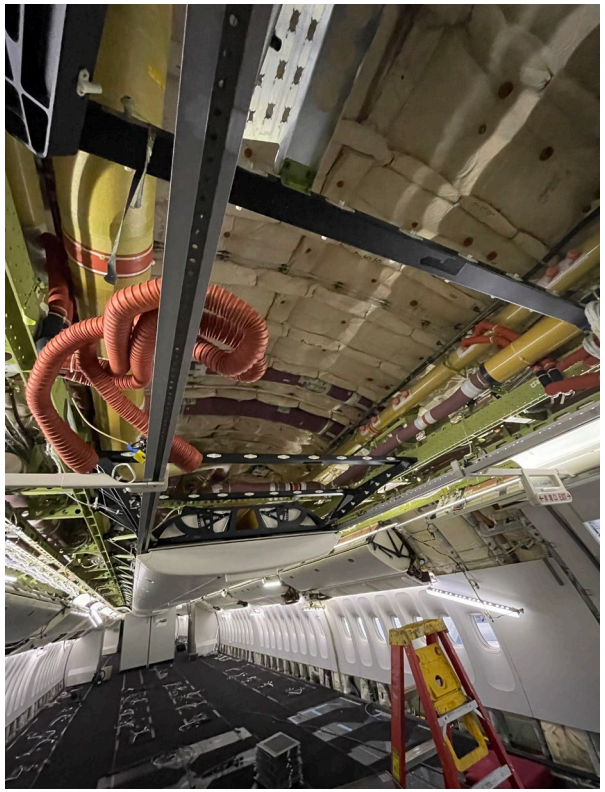
Network Rack

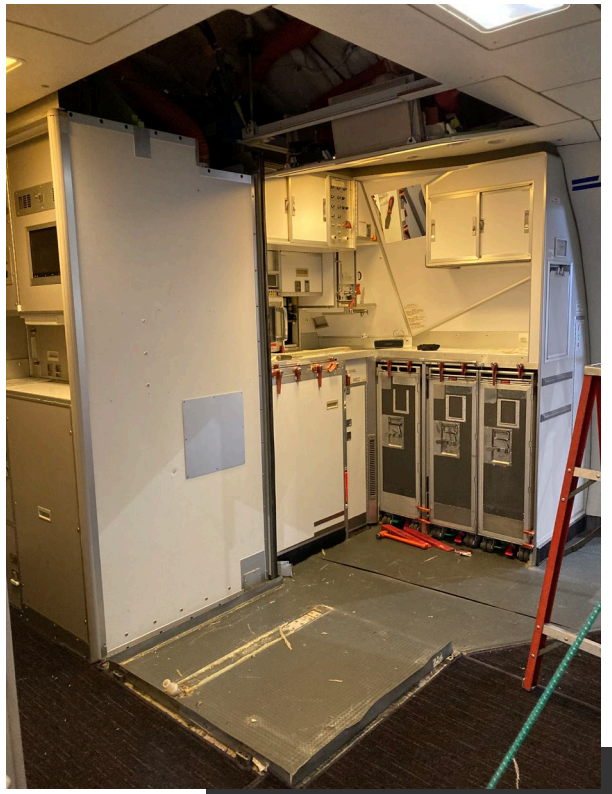
- Equipment at each rack includes:
  - 4X GPS splitter + tray
    - GPS Source MS14
    - 0.624 lb ea + mounting provisions = 1.5 lb (ea)
  - 2X Cisco 9300 network switch (**"Distribution Switches"**) = 15 lb (ea)
  - 1X Falcon ED4-2400RM-3/1-6-M UPS = 45 lb
  - 1X Falcon EDBR-1SH-M UPS battery bank = 60 lb
- Rack design:
  - Standard 19" rack, 24" depth
  - Welch Mechanical Designs (WMD) Lightweight Rugged Electronics Rack (L-RER), 10U height
  - Weight = 21.14 lb
  - Rack is aviation certified and used extensively by LaRC on various aircraft
- Total weight ~**175 lb**

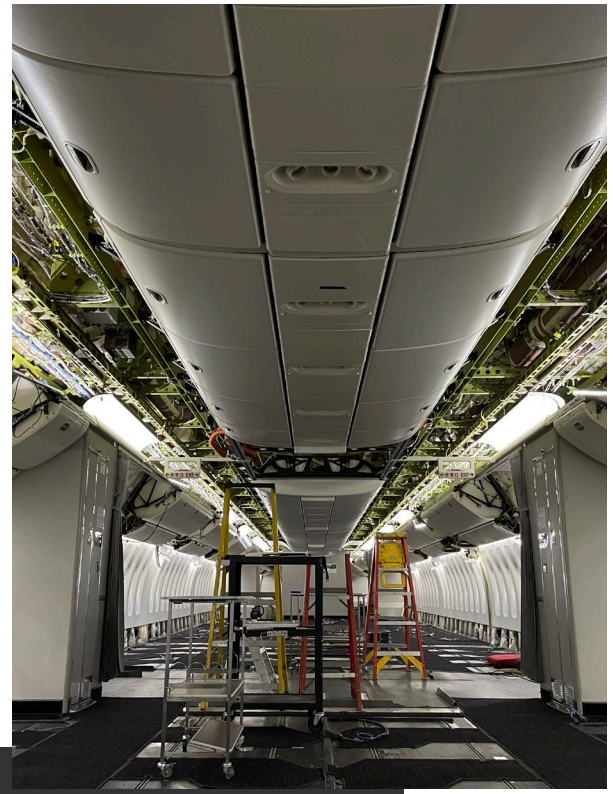


*Generic components shown, final components similar in size & weight
*WMD L-RER 10U shown

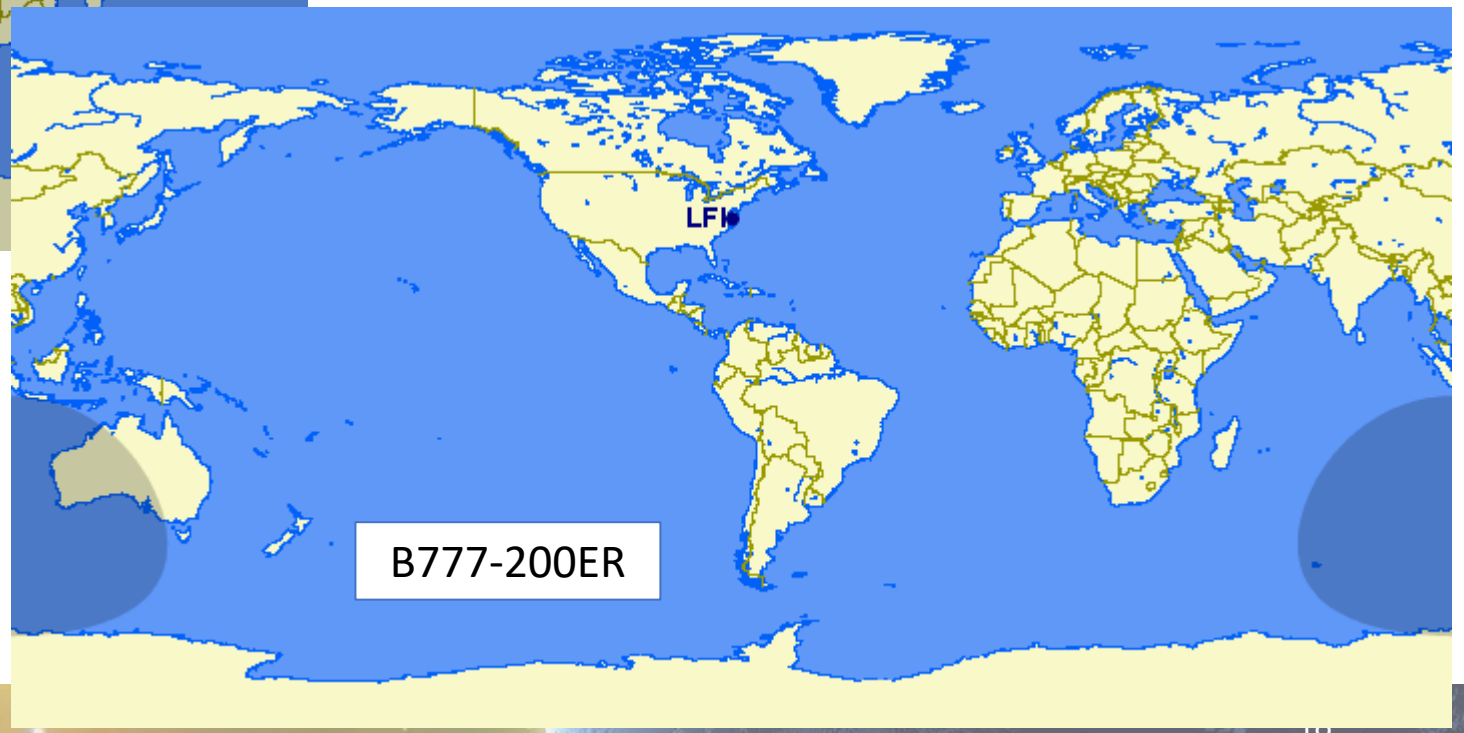
Aircraft Design and Modification







B777-200ER Performance



B777-200ER Performance

Aircraft	Payload Weight (lbs)	Fuel Load (%)	Range (nmi)	Endurance (hr)
DC-8	50,000*	100	~5000	11
B777-200ER	50,000	55	5400	11.7
	50,000	100	9000	19
	100,000	85	7400	15.6

*Approximate ATom-4 payload weight: instruments, passengers, etc.

- B777-200ER will have unmatched payload and range capability for the airborne research community for decade to come unlocking possibilities that were never achievable before
  - True polar, worldwide platform
  - Can overfly large geographic regions where basing aircraft has been difficult in the past
  - Increased collaboration with international partners with increased payload capacity


Questions?