



Space Operations—CDM General Session





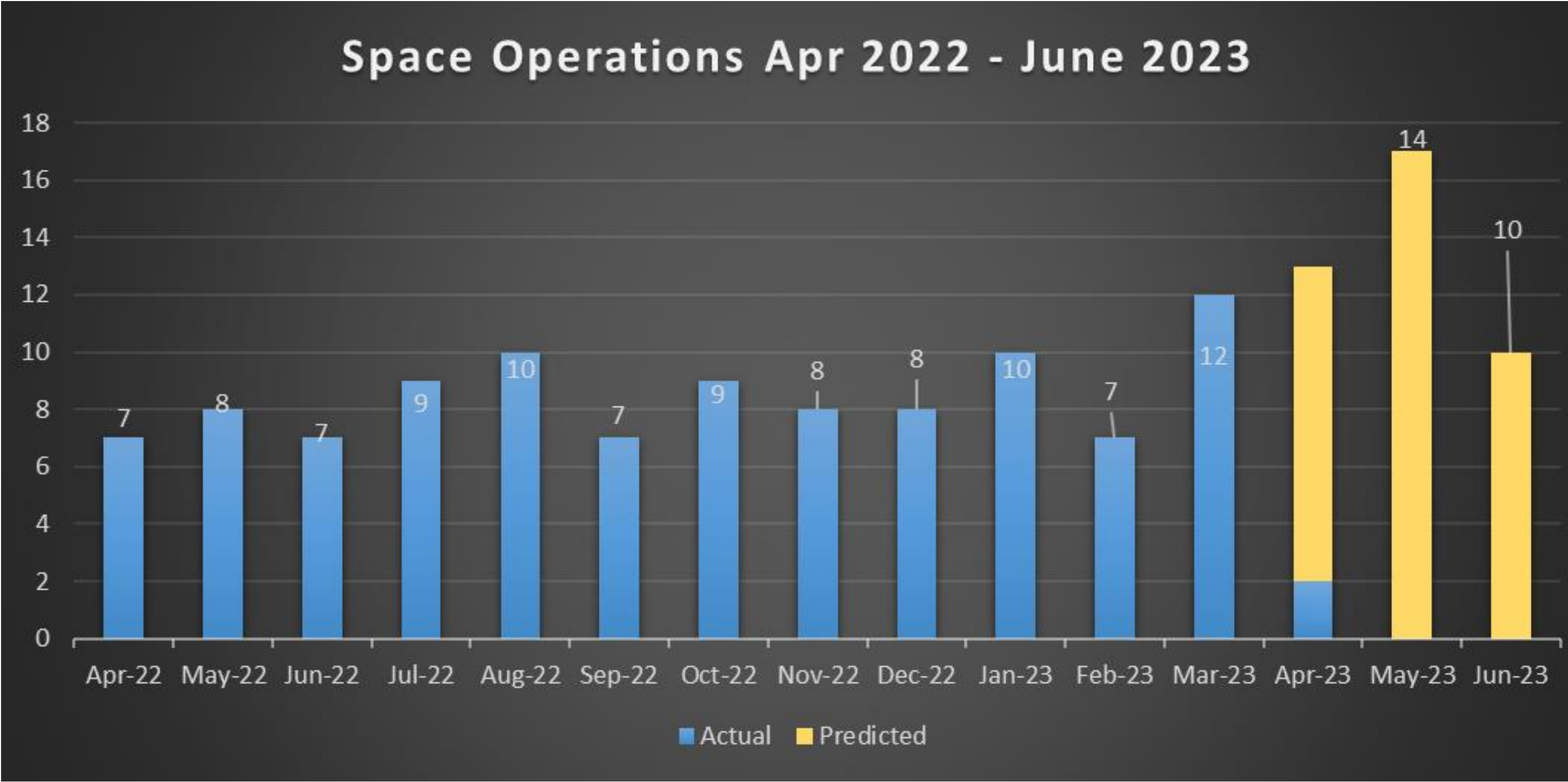
NAS Efficiency

Launch Cadence

Space Operations per Calendar Year

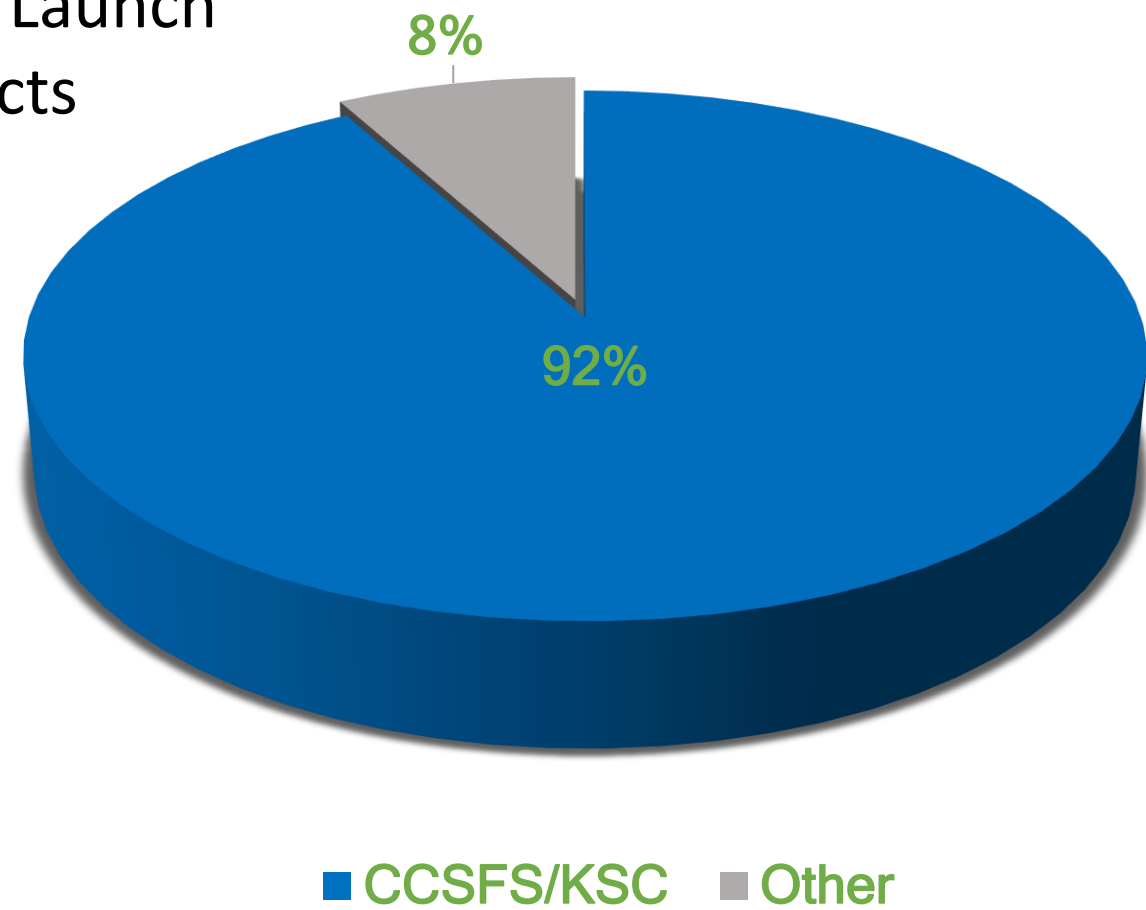


Launch Cadence



Focus on Florida

2022 Launch Impacts



CCSFS/KSC Initiatives

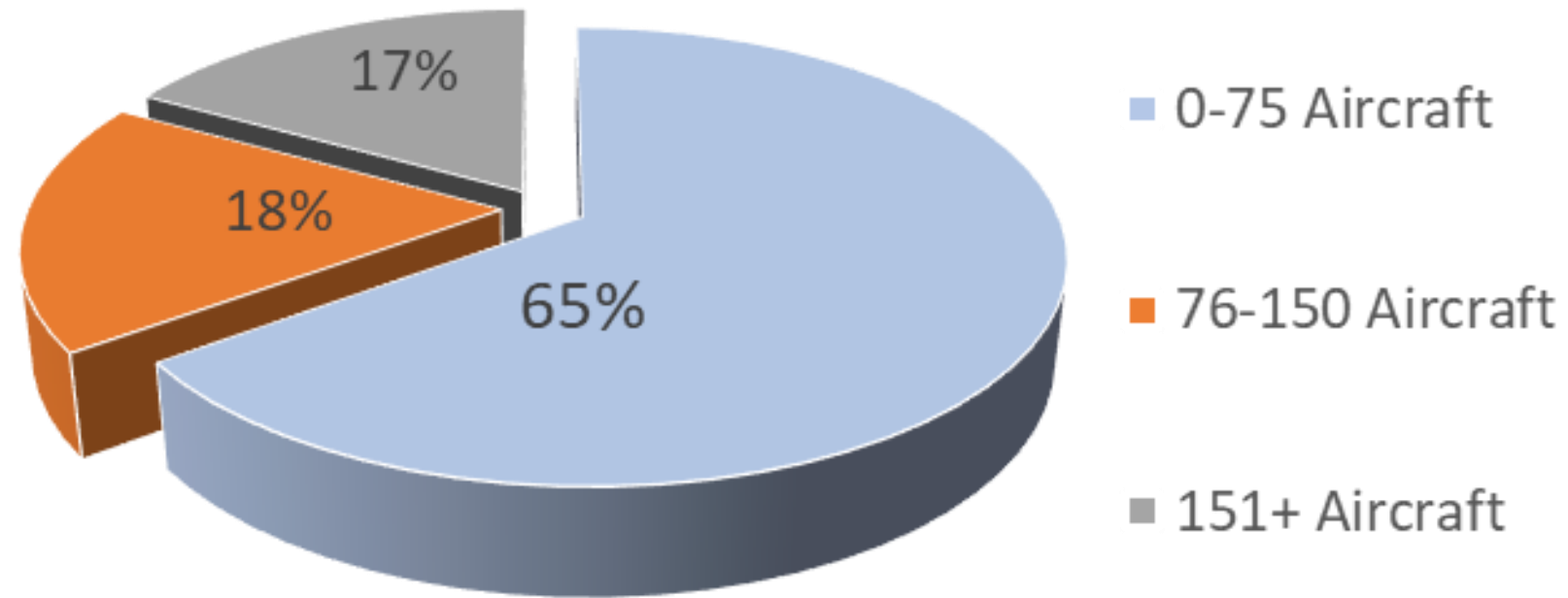
- Time Based Launch Procedures (TBLP)
- Dynamic Launch and Reentry Windows (DLRW)
- CCSFS/KSC Playbook Routes
- Critical Decision Windows (CDW)

Special Use Airspace (SUA) Management

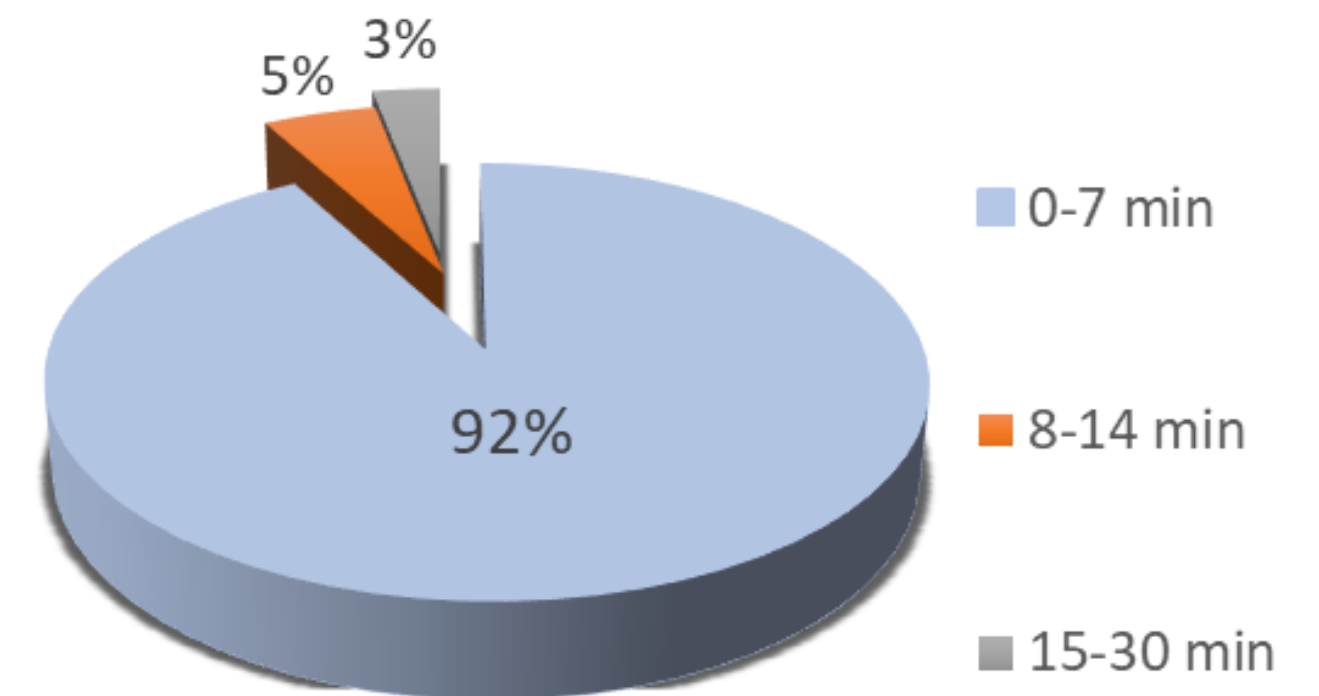


2022 Launch and Reentry Review

2022 Projected Number of Aircraft Impacted/Launch



2022 Projected Average Minutes of Delay/Launch

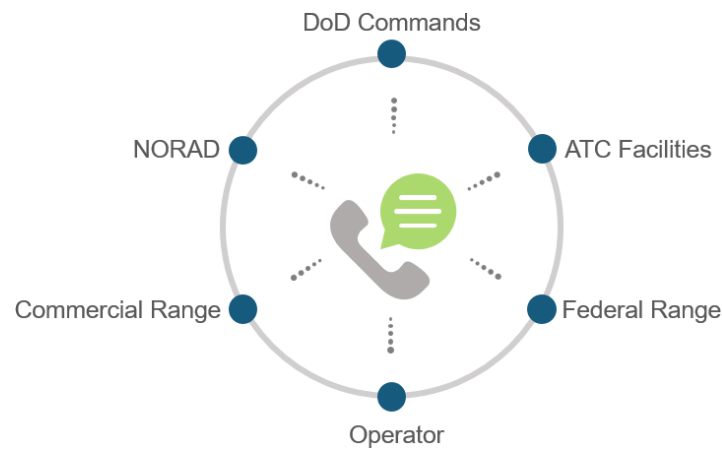


LAUNCH EFFICIENCY EFFORTS



- ✓ Real time release of hazard area airspace (2018)
- ✓ Time Based Launch Procedures (2020)
- ✓ Dynamic Launch and Reentry Windows (2020)
- ✓ Space Data Integrator (2021)
- ✓ Collaborative Mission Planning (2021)
- ✓ Critical Decision Windows (2022)
- ✓ Cape Canaveral/Kennedy Space Center Playbook Routes (2022)
- ✓ Hazard Area Calculation Improvements (2022)
- ✓ Airspace Management (2023)

REAL TIME RELEASE OF HAZARD AREA AIRSPACE



Goal: Gain efficiency through real time situational awareness

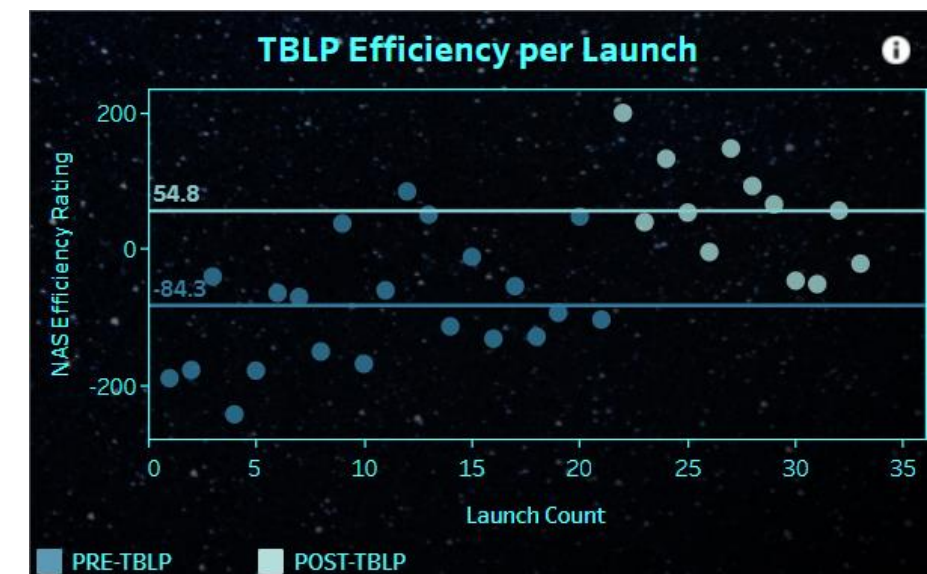
- 2019 Hotlines introduced at all launch locations
- Real time situational awareness between ranges, operators and ATC facilities **shaved hours off airspace closure**

DYNAMIC LAUNCH AND REENTRY WINDOWS

Goal: Leverage operator mission triggers to reduce airspace closure

- 2020 DLRW introduced at all launch locations
- Leverages operator mission triggers to dynamically manage hazard airspace and TMIs
- Average annual **3600+ minutes airspace closure reduction**

DLRW Minutes Saved
4,630



TIME BASED LAUNCH PROCEDURES

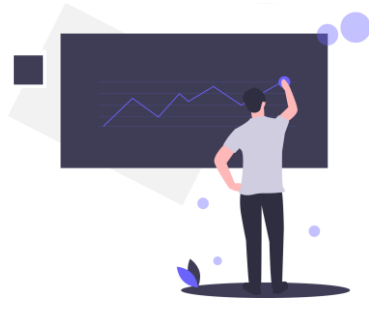
Goal: Reduce impacts through time based management

- 2018 analysis indicated that 65% of all NAS impacts were due to missions from CCSFS/KSC with Atlantic Route closure
- 2020 TBLP introduced at CCSFS/KSC launches with Atlantic Route closure
- TBLP has **saved avg 139+ minutes** of AR closure for these missions

COLLABORATIVE MISSION PLANNING

Goal: Leverage data metrics to facilitate better operator decision making

- 2020 Data driven analysis used in operators mission planning process to mitigate impacts
- Hazard area windows and adjusted to mitigate NAS impacts



CRITICAL DECISION WINDOWS

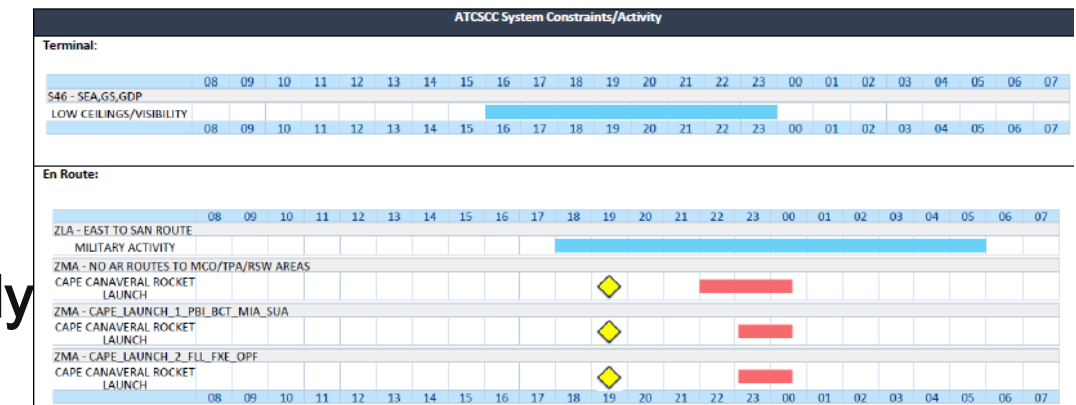
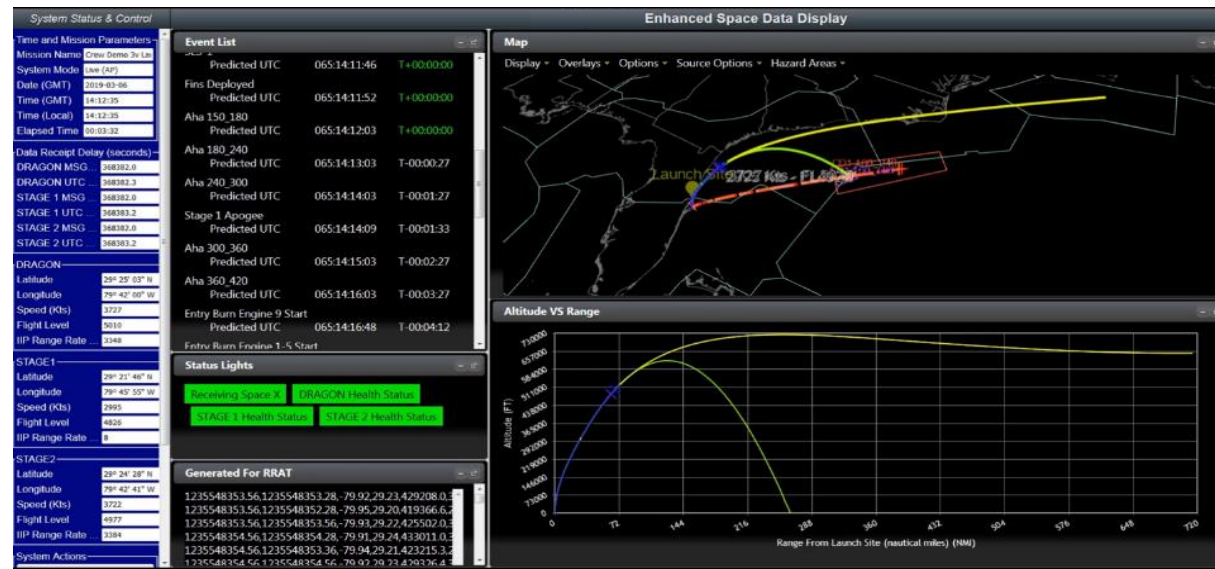
Goal: Eliminate lost capacity due to scrubs

- 2021 CDWs introduced at Pacific Spaceport Complex Alaska to encourage scrub decisions prior to PACOTS route structure publication
- 2022 CDWs introduced at all launch locations
- 1 scrub at CCSFS/KSC since Feb 20, 2022

SPACE DATA INTEGRATOR

Goal: Utilize real time telemetry to dynamically manage airspace

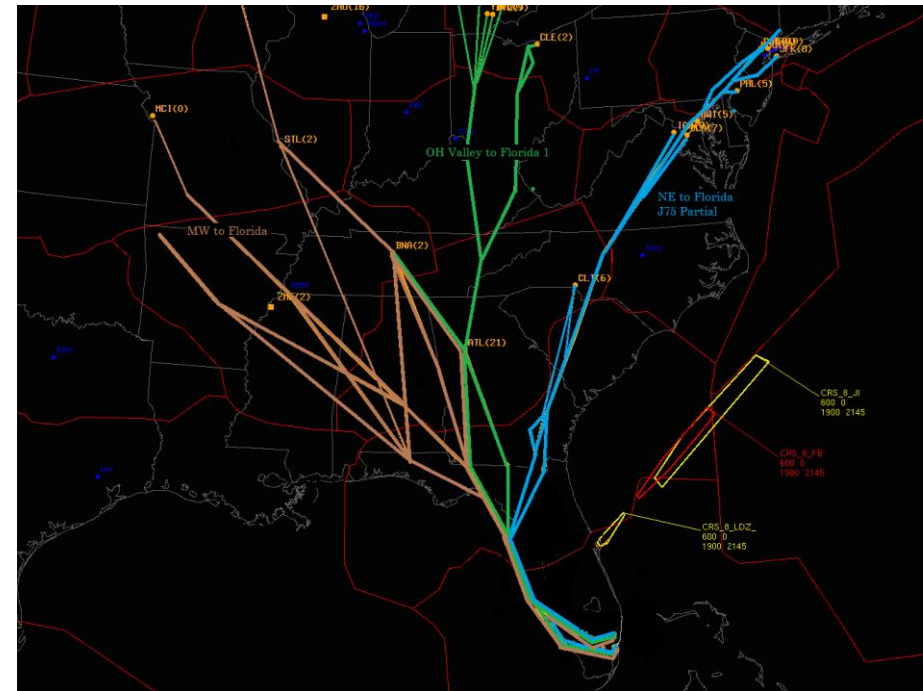
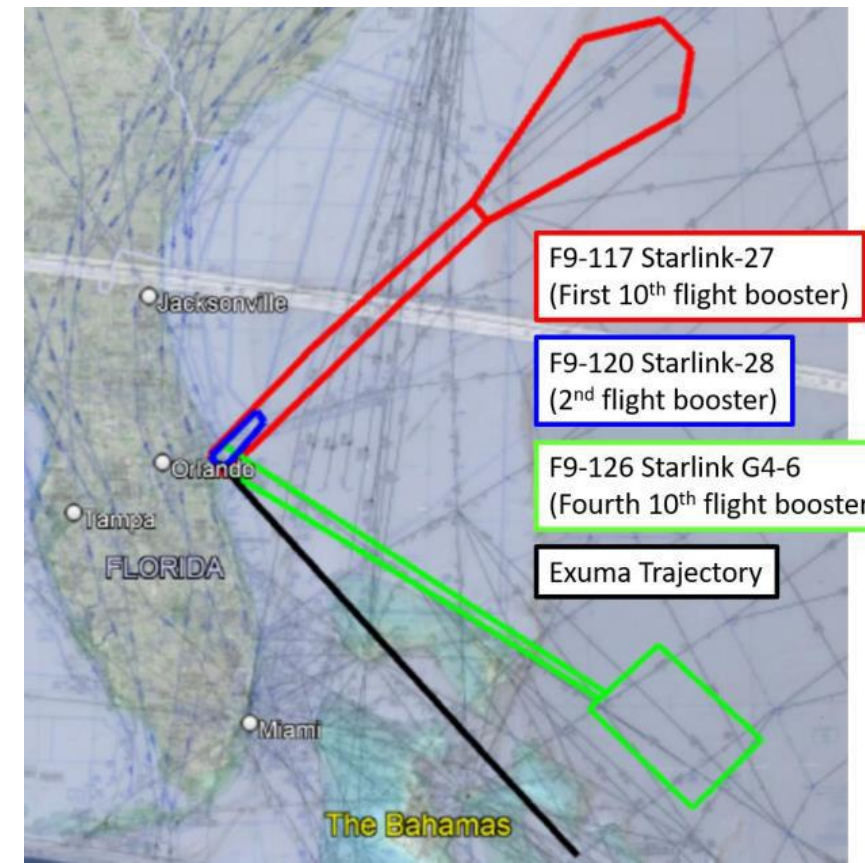
- 2020 SDI was fielded as an operational test demonstration system
- Allows for **real time decision making** from the Challenger Room based on vehicle telemetry
- **Facilitates Debris Response Areas** allowing ATC to respond in real time to a vehicle anomaly



HAZARD AREA CALCULATION IMPROVEMENTS

Goal: Improve and where possible reduce hazard area size

- Hazard areas naturally shrink with flight proven vehicles
- **2022** Decoupling of HAs from Special Use Airspace (SUA)
- **2022** Hazard Area reductions implemented for “life leading” (reusable) boosters



CAPE CANAVERAL/KENNEDY SPACE CENTER PLAYBOOK ROUTING

Goal: Develop repeatable procedures for launch missions from CCSFS/KSC

- **2022** Playbook routings implemented for CCSFS/KSC mission



ATCSCC System Constraints/Activity

Terminal:

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07
S46 - SEA,GS,GDP																								
LOW CEILINGS/VISIBILITY																								

En Route:

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07
ZLA - EAST TO SAN ROUTE																								
MILITARY ACTIVITY																								
ZMA - NO AR ROUTES TO MCO/TPA/RSW AREAS																								
CAPE CANAVERAL ROCKET LAUNCH																								
ZMA - CAPE_LAUNCH_1_PBI_BCT_MIA_SUA																								
CAPE CANAVERAL ROCKET LAUNCH																								
ZMA - CAPE_LAUNCH_2_FLL_FXE_OPF																								
CAPE CANAVERAL ROCKET LAUNCH																								

CRITICAL DECISION WINDOWS

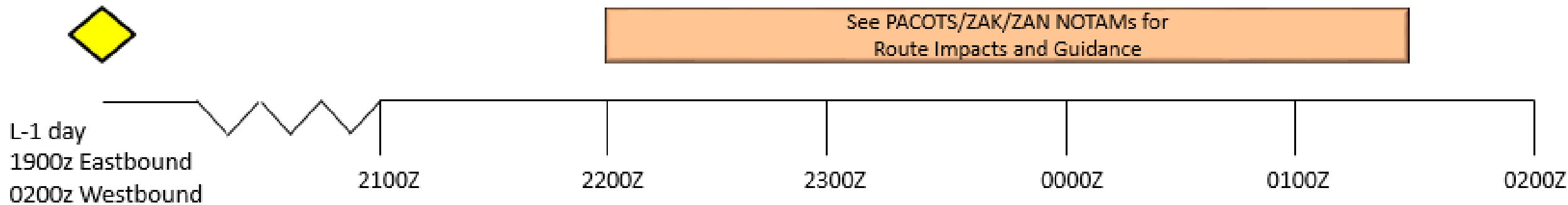
Goal: Eliminate lost capacity due to scrubs

- 2021 CDWs introduced at Pacific Spaceport Complex Alaska to encourage scrub decisions prior to PACOTS route structure publication
- 2022 CDWs introduced at all launch locations

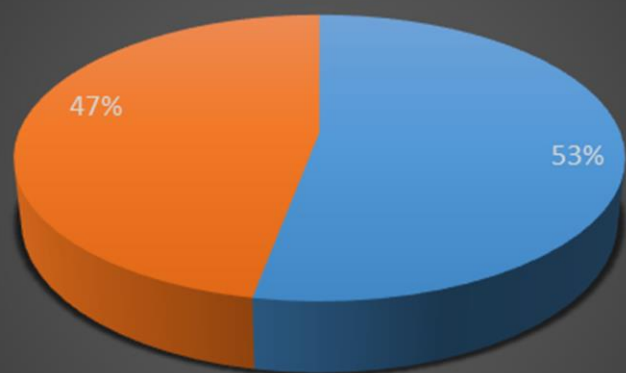
Aircraft Hazard Area



TMIs

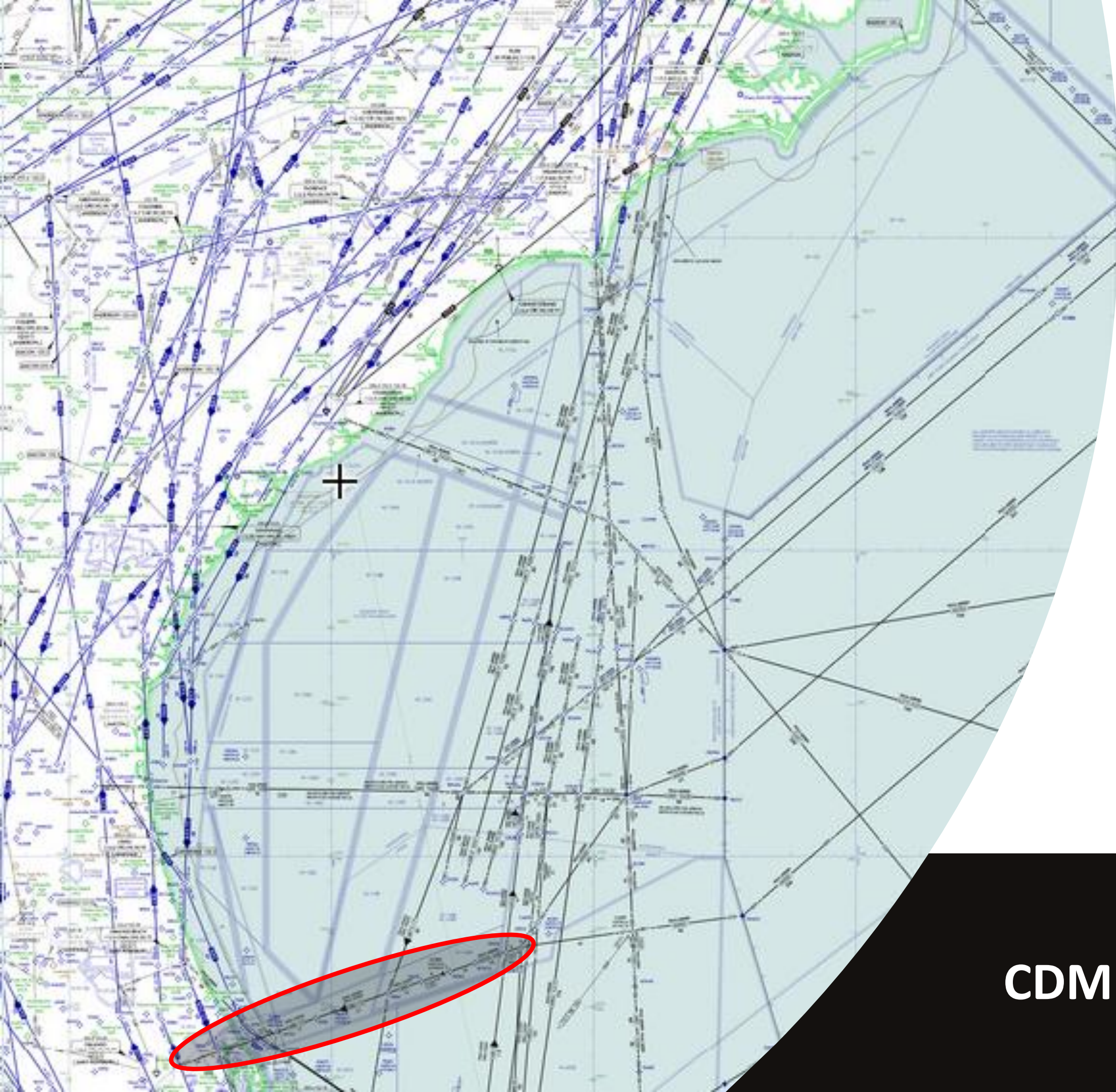


Scrubs Prior to CDW in 2023



Before CDW After CDW





Focus on Florida

CCSFS/KSC Special Use
Airspace Management

CDM General Session



CFR 91.143 surface to FL180 at T-30

R2934 SFC to unlimited T-30

CAPE ATCAA (CAPE A) surface to FL180 for weather support aircraft at T-60

CAPE ATCAA (CAPE B) surface to FL180 for weather support aircraft at T-30

Notional Aircraft Hazard Area (AHA)

Restricted Area R-2933 5000 to unlimited at T-30

W-497A west of 80 degrees surface to 5000 MSL at T-60





- Revised airspace management will apply to missions on easterly to southerly trajectories (84% of missions since 11/1/2022)
- R2934 SFC to 6000'
- Partial clamshell (91.143 TFR) in an effort to **leave AR6-15 open**
- W497 West of 080
- Will not request Cape ATCAA B



Focus on Florida

Overview

- 10-12 aircraft per hour
- 5-10 minutes extra flying time per flight
- 25-50 extra miles flown per flight

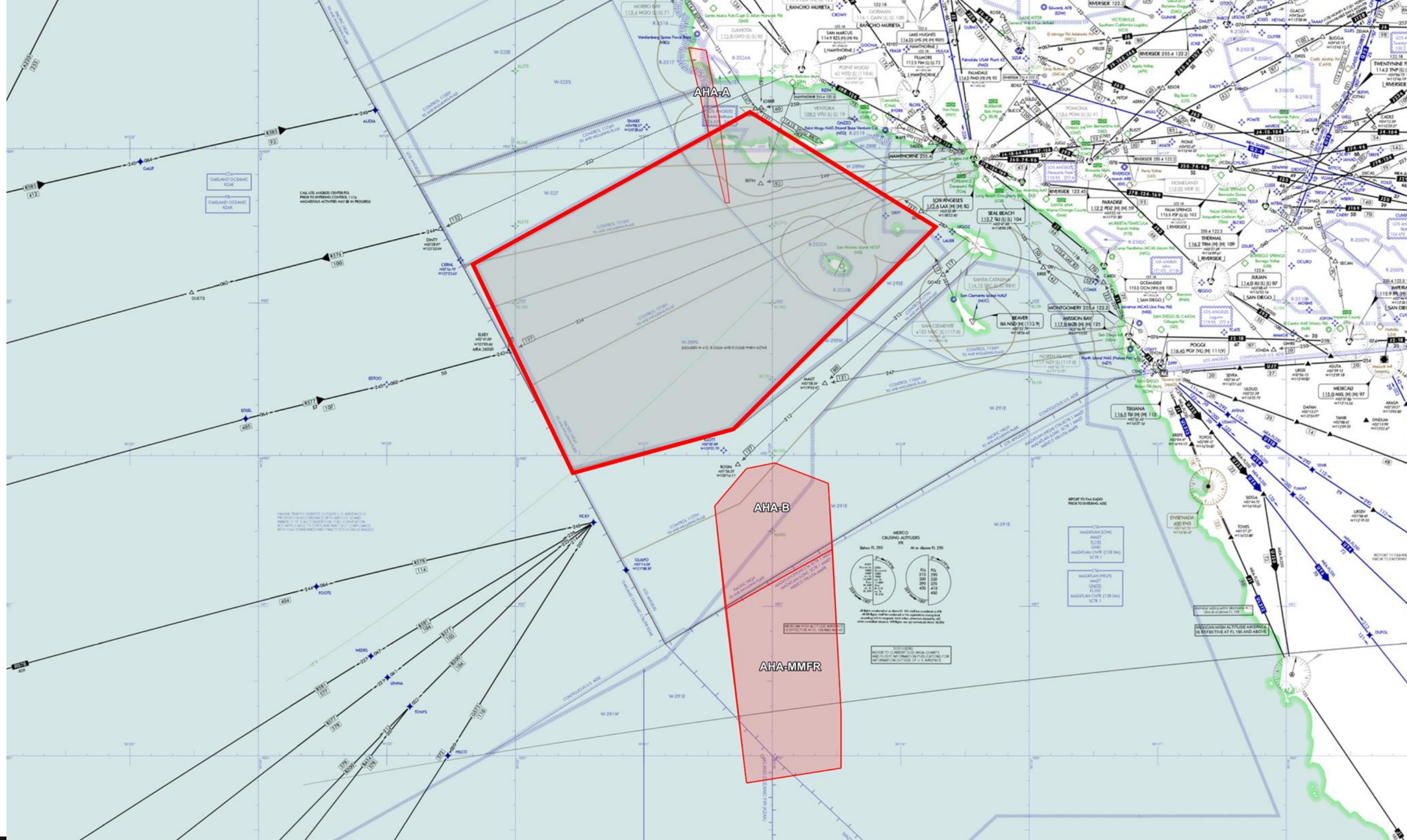
3 hour window impacts

- Number of aircraft: 30-36
- Extra minutes flown: 150-300 extra minutes flown
- Extra miles flown: 750-1500 extra miles flown
- Passengers impacted: 3,600-4300

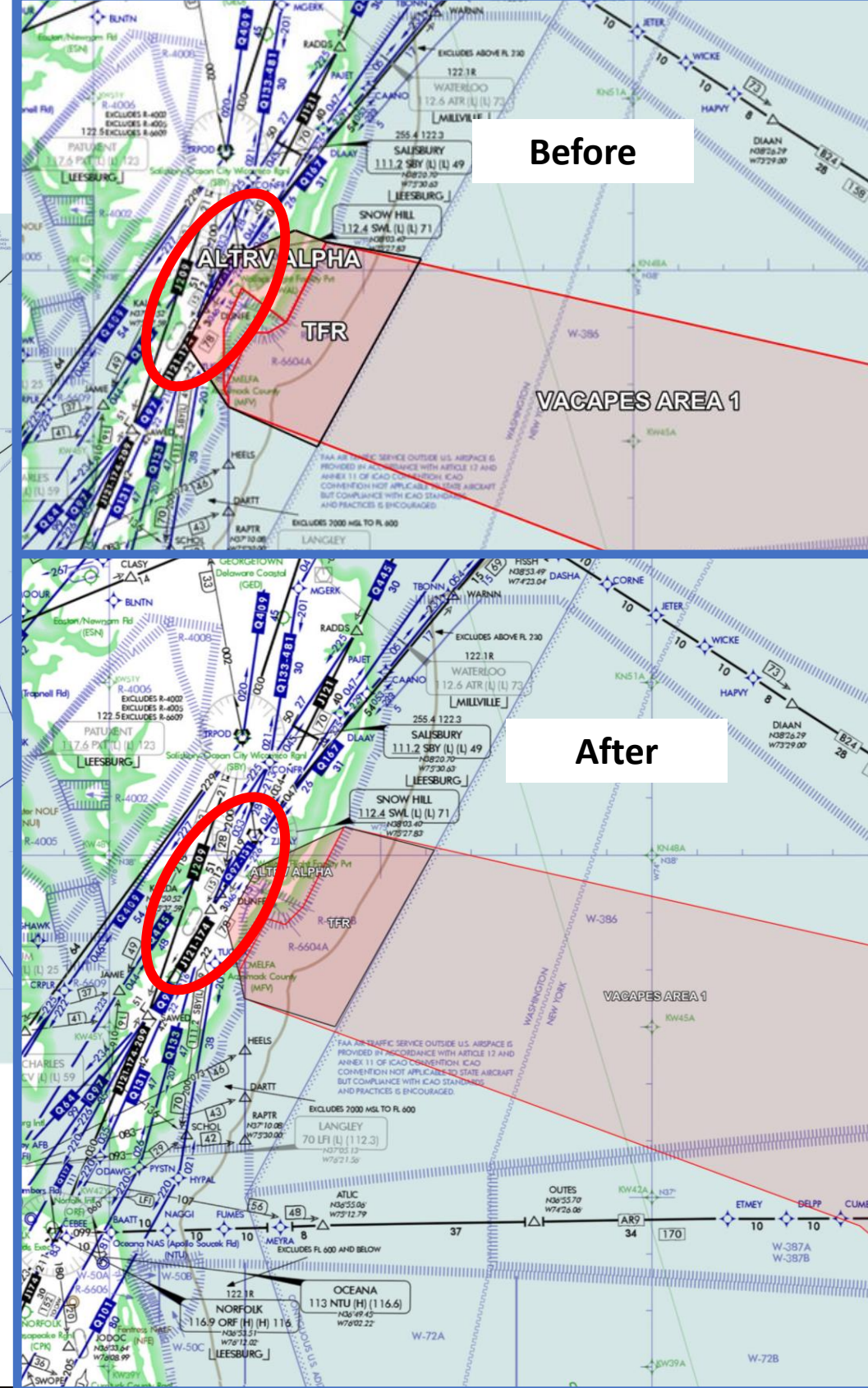
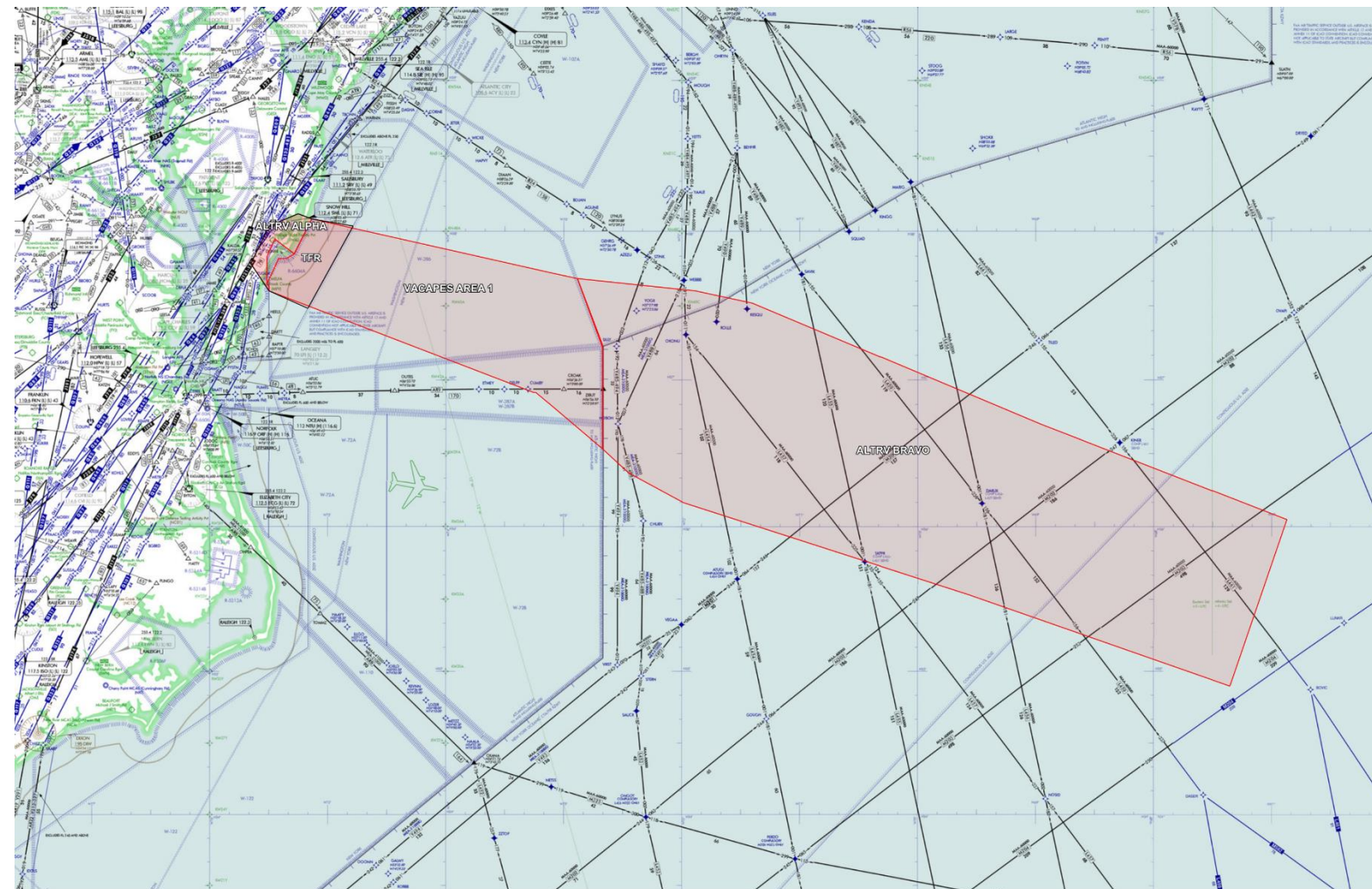
Additional Impacts

- These flights must now flow on congested overland routes causing additional departure and en-route delays

Airspace Management VBG



Airspace Management Wallops Island



≡ Demo 10-28-2022

≡ Time: 15:58:52
Start: 15:59:12
Count: T-00:00:20

**CURRENT TIME
START (T-0)
COUNTDOWN**

PT

SDC

STAGE1
0

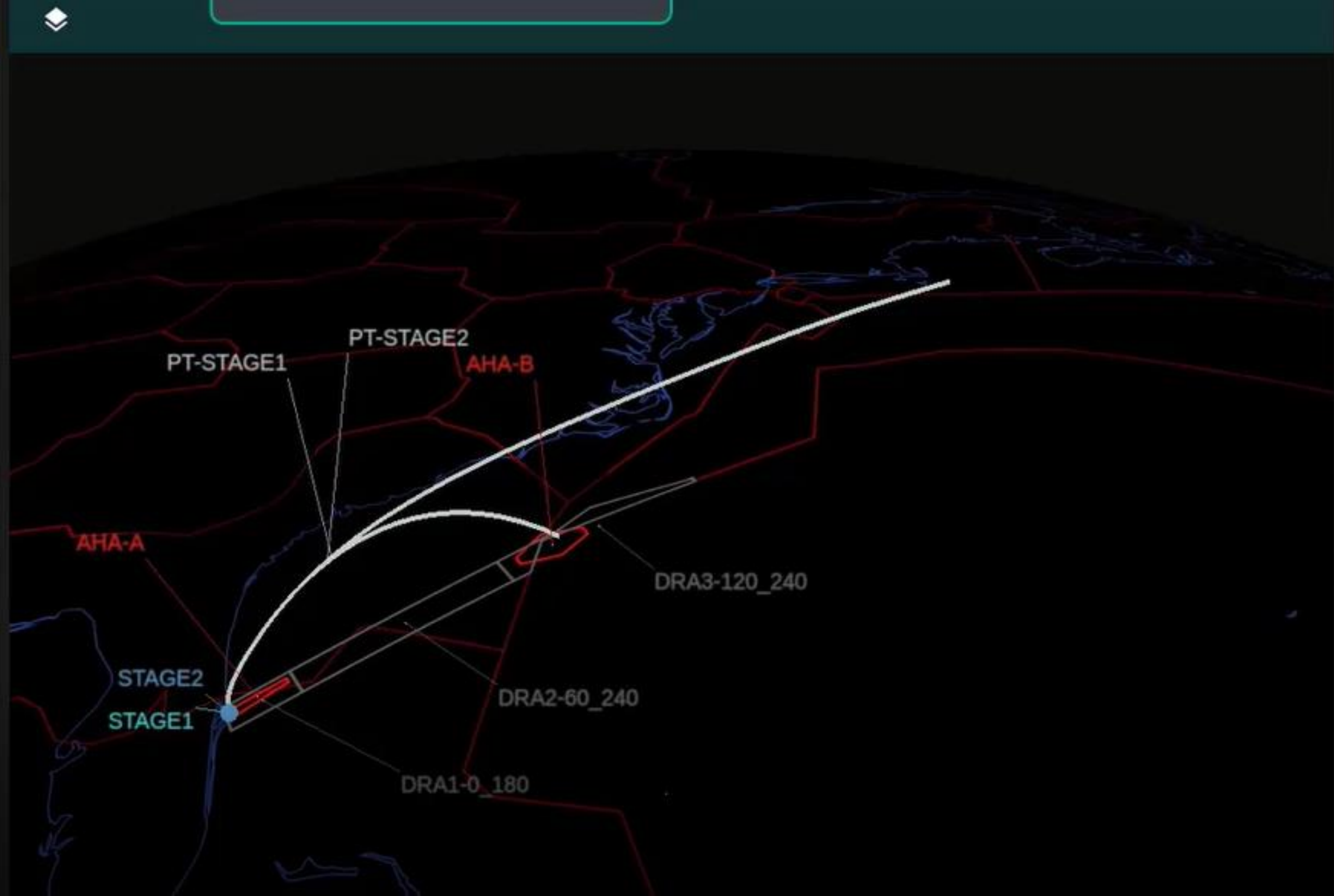
STAGE2
0

MALFUNCTION

Events ×

Event	Time	Count
Liftoff	15:59:12	-00:00:20
Initial Pitch Kick	15:59:22	-00:00:30
Max-Q	16:00:12	-00:01:20
Stage 1 MECO-1	16:01:50	-00:02:58
Stage Separation	16:01:52	-00:03:00
Stage 2 SES-1	16:02:02	-00:03:10
IIP Vanish	16:08:02	-00:09:10

Map ×



Alt vs Ran

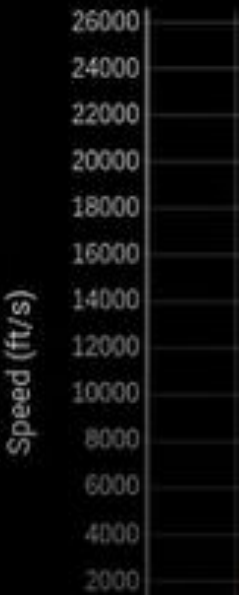


XHA ×

AHA/THA	Start	End
AHA-A	15:45:00	20:45:00
AHA-B	15:45:00	20:45:00

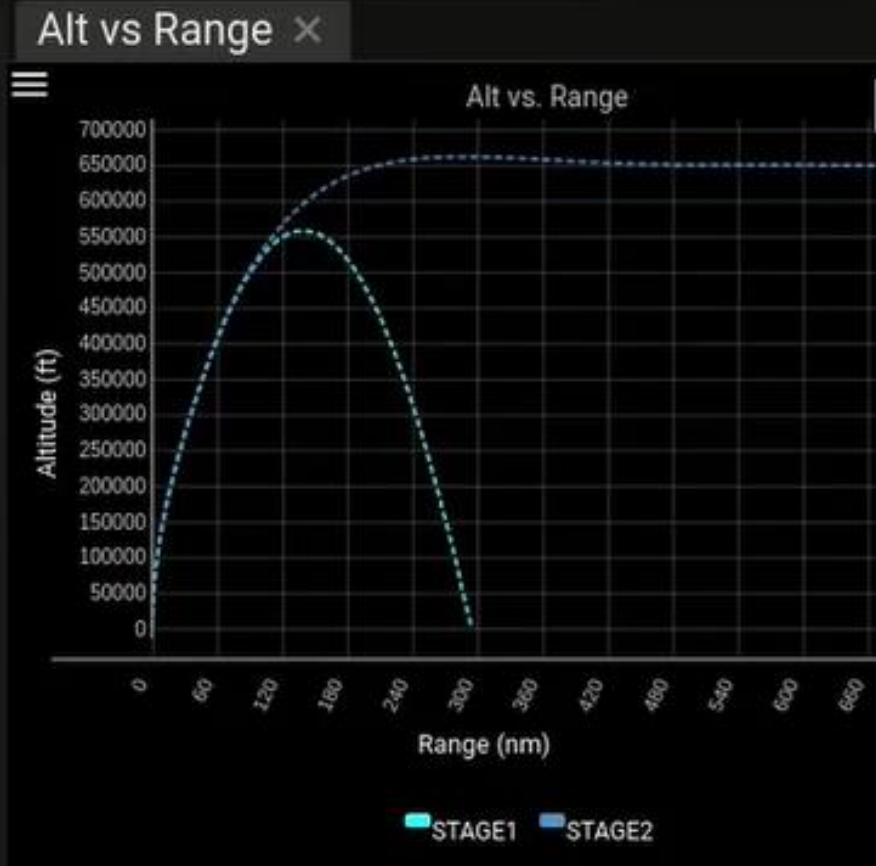
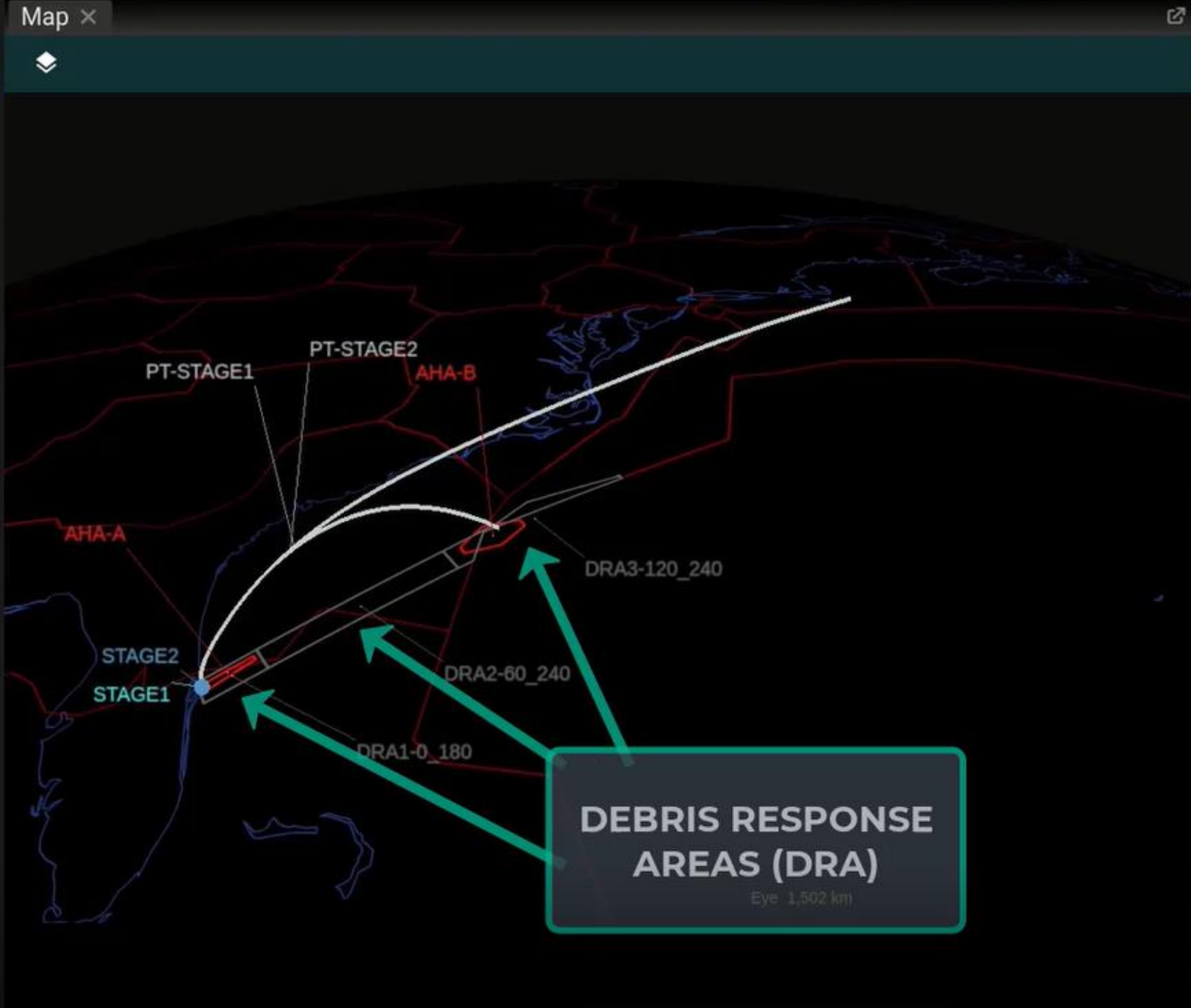
DRA	Relevant Start	Relevant End
DRA1-0_180	15:59:12	16:02:12
DRA2-60_240	16:00:12	16:03:12
DRA3-120_240	16:01:12	16:03:12

Speed vs



Events ×

Event	Time	Count
Liftoff	15:59:12	-00:00:12
Initial Pitch Kick	15:59:22	-00:00:22
Max-Q	16:00:12	-00:01:12
Stage 1 MECO-1	16:01:50	-00:02:50
Stage Separation	16:01:52	-00:02:52
Stage 2 SES-1	16:02:02	-00:03:02
IIP Vanish	16:08:02	-00:09:02



XHA ×

AHA/THA	Start	End
AHA-A	15:45:00	20:45:00
AHA-B	15:45:00	20:45:00

DRA	Relevant Start	Relevant End
DRA1-0_180	15:59:12	16:02:12
DRA2-60_240	16:00:12	16:03:12
DRA3-120_240	16:01:12	16:03:12



Year in Review

To view this video, please
click **HERE.**





Year in Review

Year in Review





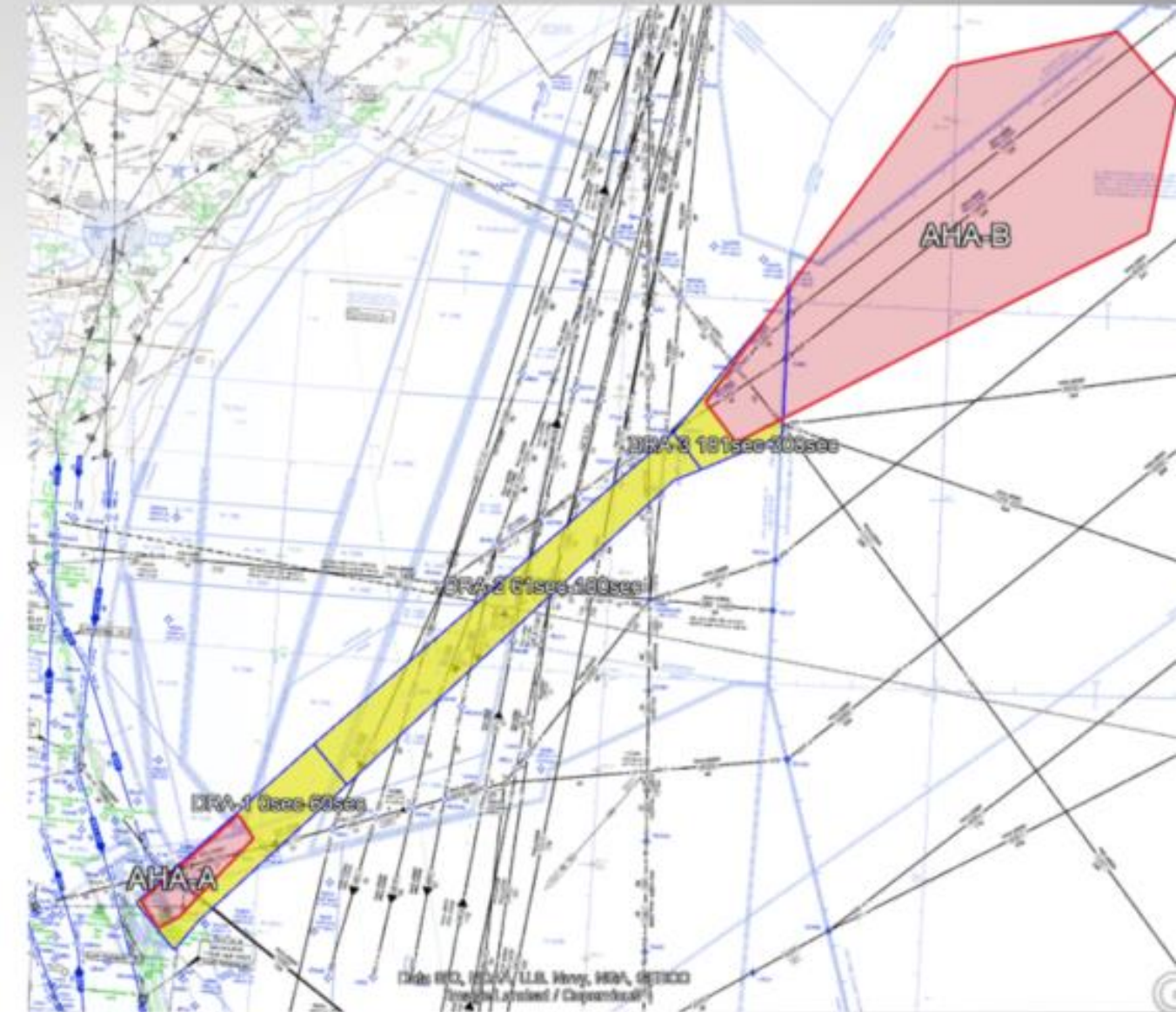
Year in Review
Space Collaborative
Decision Making



Year in Review Debris Response Areas

New Procedures - Debris Response Areas (DRAs)

- Angular crossing restrictions no longer required.
- Real-time ATO response to a debris generating event:
 - Appropriate DRA will be activated based on time of the vehicle malfunction.
 - DRA will be evacuated and remain sterile until all debris has fallen to earth.
 - DRA durations are pre-calculated and known prior to launch.
 - Applied in radar controlled airspace only.



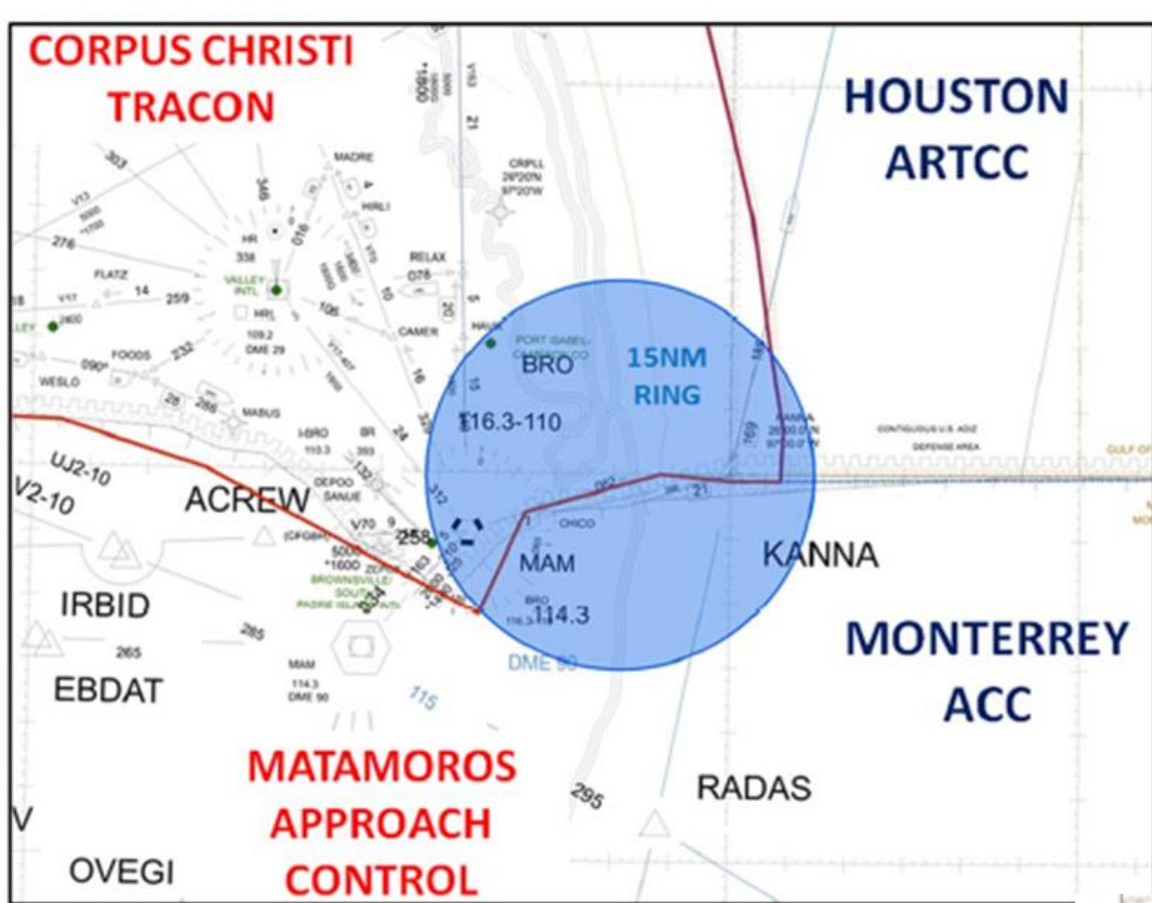


Year in Review Crewed Missions



Looking Forward the Year Ahead



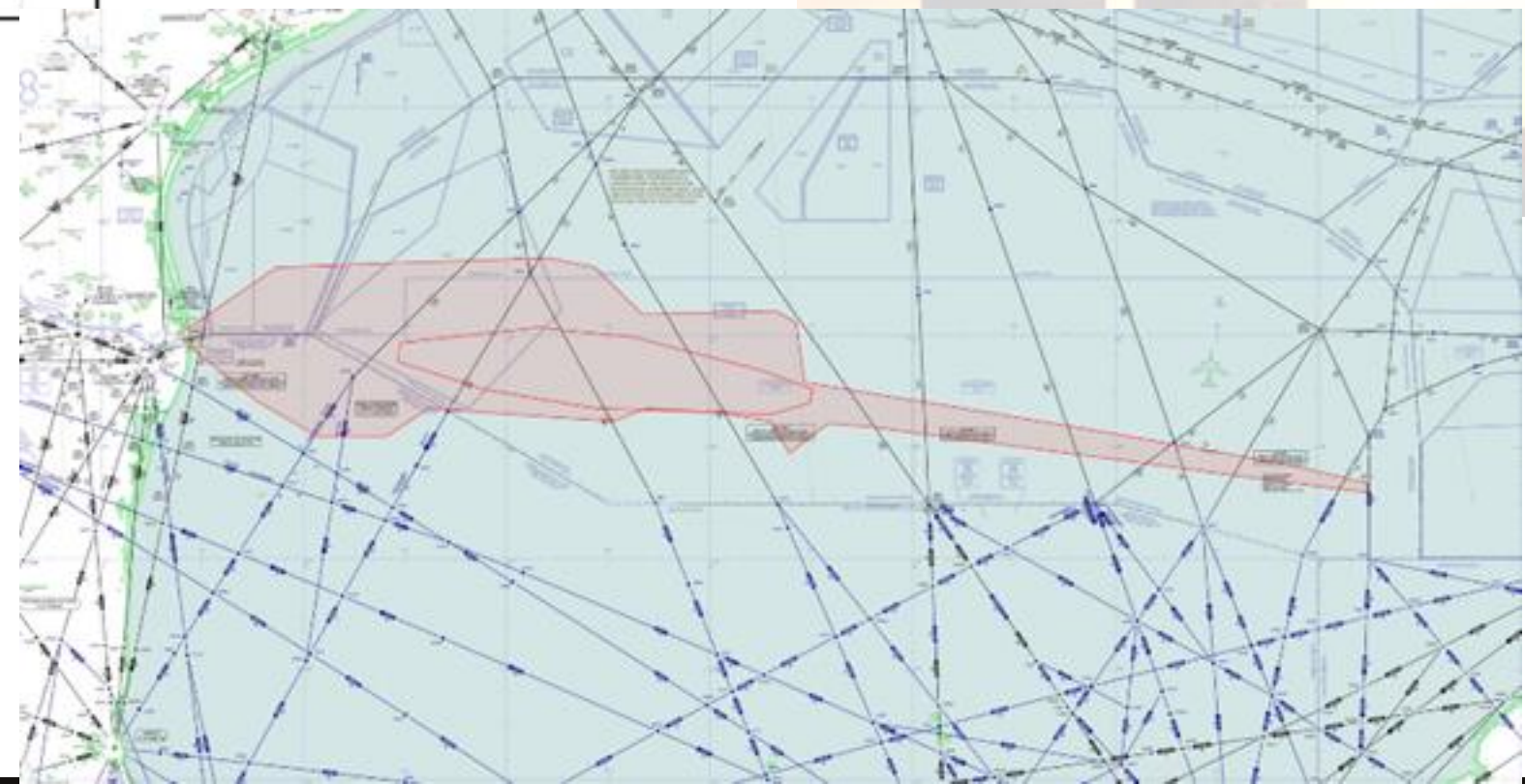


Starship Super Heavy CONOPs

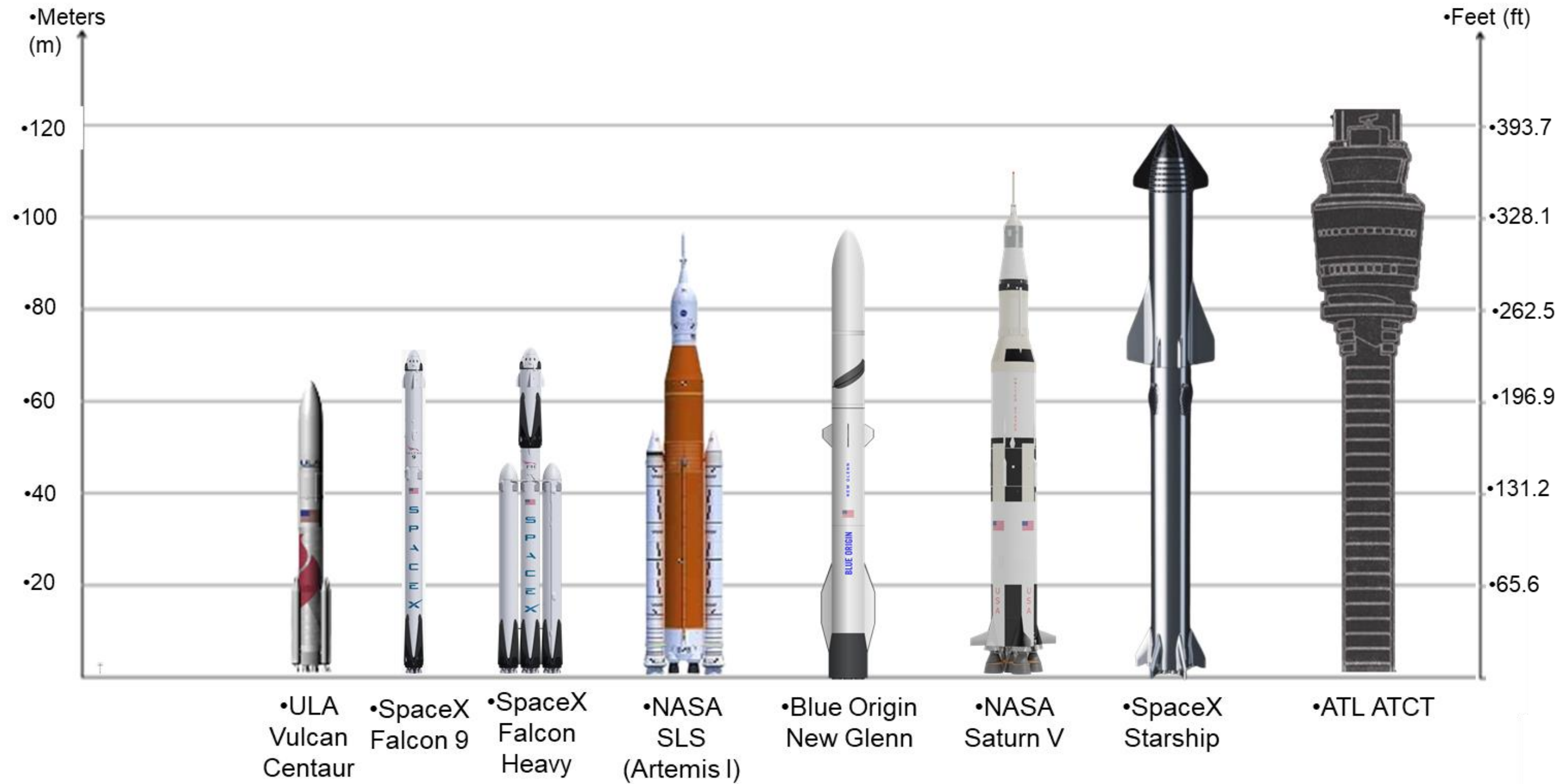
- Launch from “Starbase” @ Boca Chica, TX
- After stage separation, first stage booster returns conducting a soft-water landing off Boca Chica coast
- Starship continues to orbital insertion followed by de-orbit burn to return to earth
- Starship conduct soft-water landing north of Hawaii
- Total flight time ≈90 minutes



SpaceX Starship



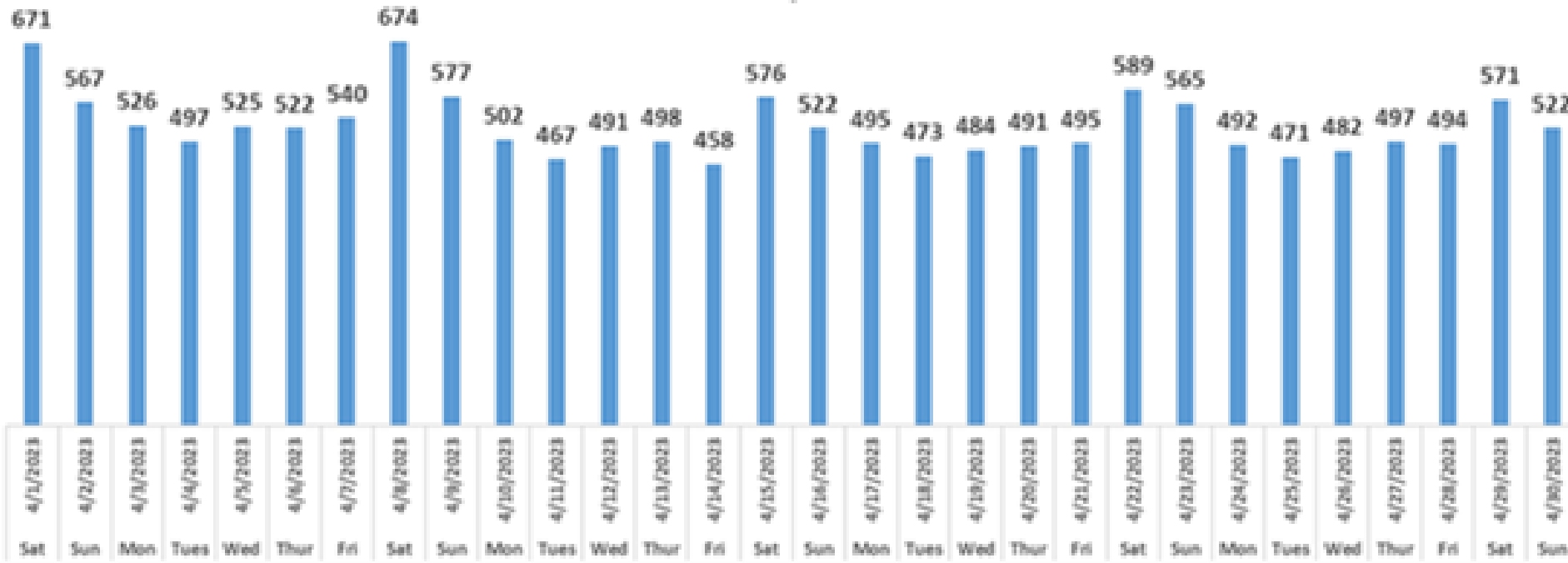
SpaceX Starship



SpaceX Starship

Hourly	04/01/2022 Fri	04/02/2022 Sat	04/03/2022 Sun	04/04/2022 Mon	04/05/2022 Tue	04/06/2022 Wed	04/07/2022 Thu	04/08/2022 Fri	04/09/2022 Sat	04/10/2022 Sun	04/11/2022 Mon	04/12/2022 Tue	04/13/2022 Wed	04/14/2022 Thu	04/15/2022 Fri	04/16/2022 Sat	04/17/2022 Sun	04/18/2022 Mon	04/19/2022 Tue	04/20/2022 Wed	04/21/2022 Thu	04/22/2022 Fri	04/23/2022 Sat	04/24/2022 Sun	04/25/2022 Mon	04/26/2022 Tue	04/27/2022 Wed	04/28/2022 Thu	04/29/2022 Fri	04/30/2022 Sat	Total
00h	23	33	41	29	14	25	33	26	20	36	24	23	30	30	39	19	28	18	20	33	14	20	17	29	19	14	19	17	23	24	688
01h	11	12	21	13	14	9	13	18	12	16	11	20	9	13	19	18	20	19	20	14	16	15	14	18	13	14	18	15	12	16	469
02h	18	14	17	11	18	9	10	15	12	15	10	10	12	11	13	14	13	16	11	16	13	13	17	14	9	10	12	12	12	391	
03h	9	13	7	5	9	11	9	12	7	6	8	7	11	9	8	5	7	9	6	14	7	8	6	11	14	13	10	9	11	289	
04h	5	7	9	6	4	4	6	4	3	5	4	3	5	4	10	5	4	3	3	5	2	6	6	3	2	6	3	5	5	2	138
05h	6	4	2	6	4	5	8	5	7	5	10	5	3	5	8	7	4	7	6	4	6	5	3	6	7	5	4	4	5	5	161
06h	4	3	7	11	3	5	5	4	7	5	3	1	6	5	1	5	7	5	5	8	5	3	5	6	7	6	4	4	7	3	150
07h	3	8	9	5	7	12	10	6	8	8	10	6	8	6	7	6	9	11	7	9	10	12	9	8	6	9	5	11	6	9	218
08h	10	10	7	9	7	5	7	8	7	6	8	9	4	9	6	10	7	5	8	5	7	5	4	7	8	7	8	10	7	7	217
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10h	4	7	6	7	4	6	2	4	5	2	5	4	1	3	5	3	4	7	6	4	3	3	3	4	6	3	7	4	3	128	
11h	7	2	5	5	2	4	3	1	2	2	3	5	1	3	3	3	5	4	4	4	3	4	4	3	4	6	2	4	3	104	
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14h	29	28	9	23	14	21	19	21	24	23	14	14	14	18	20	18	18	21	19	17	15	17	24	20	17	19	25	23	21	621	
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17h	85	57	27	48	33	41	45	41	54	42	42	37	37	36	34	41	44	40	35	37	42	36	31	40	38	35	37	35	38	54	1200
18h	44	48	36	41	36	34	37	42	68	57	38	32	31	36	39	51	49	44	36	46	48	48	59	54	41	41	42	47	46	56	1334
19h	43	49	31	46	32	39	40	42	53	40	41	24	24	31	40	42	33	37	29	27	33	35	47	32	35	28	31	33	34	43	1095
20h	42	46	40	40	34	43	38	41	59	45	37	37	41	41	45	52	37	41	48	52	51	46	62	54	39	48	49	41	44	58	1370
21h	40	66	28	35	30	40	34	43	54	44	37	24	29	31	32	45	31	37	29	24	21	28	41	35	20	32	26	30	40	48	1095
22h	33	35	31	39	28	29	28	35	49	31	29	30	25	28	35	30	33	30	34	32	34	42	36	19	31	30	31	33	41	994	
23h	25	38	29	22	24	22	14	18	32	29	21	18	18	17	23	20	22	15	19	21	21	24	29	26	20	21	18	22	25	29	688
Total	514	619	662	520	426	478	478	512	651	548	483	418	421	457	504	575	526	491	477	480	488	512	596	542	451	471	468	488	510	576	15185

Estimated Number of Aircraft Entering Starship AHA April 2023



Operating procedures:

- Starting Mon 4/17 daily Mon -Fri opportunities with 2+30 (3+05 AHA) windows. AHA time includes debris fall time in the event of a launch malfunction
- Critical Decision Windows established at 8pm the night prior to launch attempt.
- SpaceX will be limited to 3 attempts per week. An attempt will be defined as a scrub after the CDW or an actual launch. Example: A scrub inside the CDW for a Monday attempt will leave 2 attempts through Fri. NOTAMs will be published for all week days and drawn back when it is determined which days will come off the schedule. The goal here is to not close the Gulf of Mexico route structure for more than 3 days in a week.

Year Ahead New operators

Global
Small Satellite
Market

OPPORTUNITIES AND FORECASTS,
2019-2026

Small Satellite Market is
expected to reach
\$15,686.3 Million by 2026.

Growing at a **CAGR of 20.1%**
(2019-2026)



Relativity

