Mission Status for Earth Science Constellation MOWG Meeting @ Gilbert, AZ

December 4, 2019

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Topics

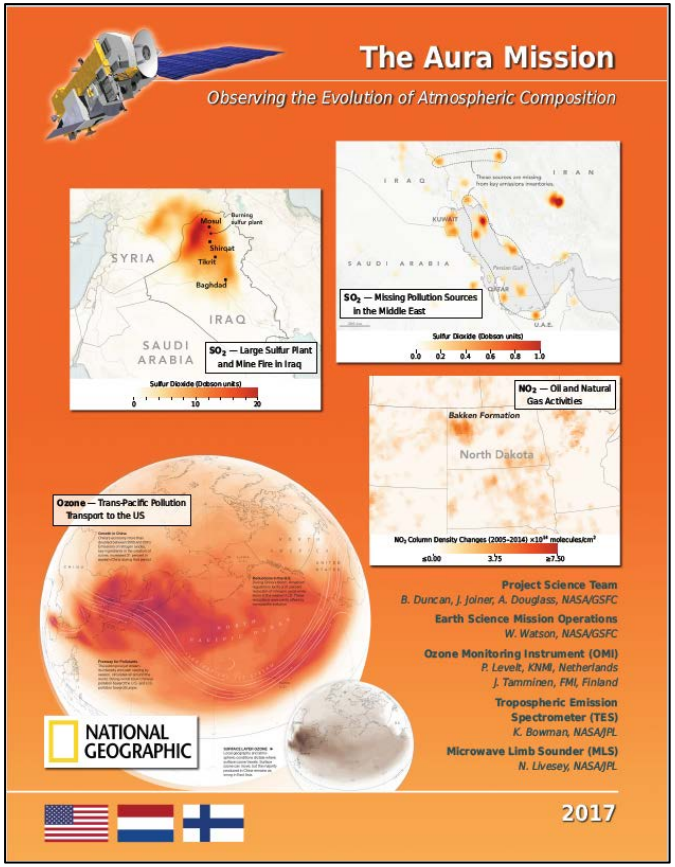
- **Mission Summary**
- **Spacecraft Subsystems Summary**
- **Recent Activities**
- **Planned Activities**
- **Propellant Usage & Lifetime Estimates**
- **Overall Summary**

- **Additional Slides:**
  - **Spacecraft Maneuvers & Ground Track History**
  - **Conjunction Assessment**
  - **Data Capture & Ops Error Statistics**
  - **Extended Mission Plans**

EOS Aura Mission Summary

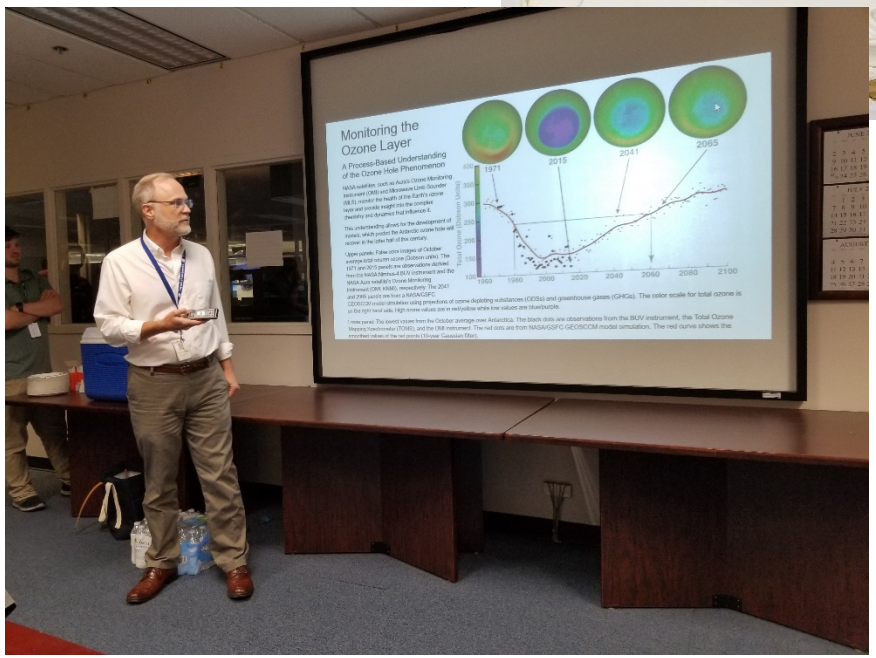
(Updates since June 2019 MOWG @ Toulouse, FR)

- 07/15/04: Launch
  - 6-Year Design Life
- 09/30/10: End of Prime Mission Review
- 09/18/15: 2015 Mission Extension Senior Review Proposal Panel Report
- 03/03/17: Senior Review Proposal #5
  - Reliability Estimates thru 2022
  - Consumables through 2022
- 06/22/17: NASA Earth Science Senior Review Subcommittee Report
  - High Utility, Excellent science merit
- 12/21/17: Received NASA HQ Guidance
- 01/31/18: TES Decommissioning
- 03/30/18: Updated Aura Phase F Plan
- 04/02/19: ESMO Annual Review #12
- 07/15/19: Aura 15-Year Anniversary

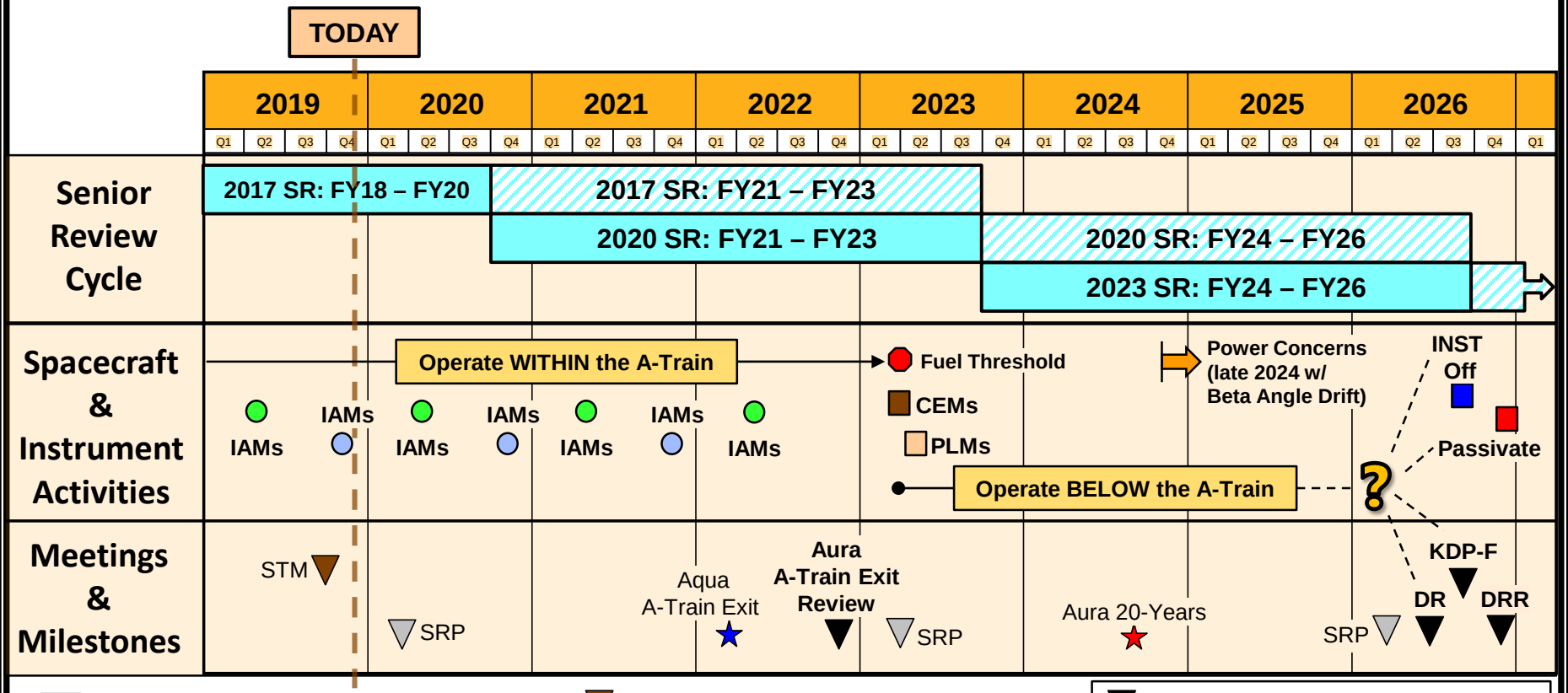


Aura's 15th Anniversary!

Launch Date:
July 15, 2004



Aura Extended Mission Timeline



- Senior Review Funding (Approved)
- Senior Review Funding (Preliminary Guideline)
- **IAMs** – Spring Inclination Adjust Maneuvers
- **IAMs** – Fall Inclination Adjust Maneuvers
- **CEMs** – Constellation Exit Maneuvers
- **PLMs** – Perigee Lowering Maneuvers
- **STM** – Aura Science Team Meeting (2019)
- **SRP** – Senior Review Proposal
- A-Train Exit Review (~late 2022)
- ? Activity & Milestone dates dependent on spacecraft ability to generate sufficient power
- **DR** – Decommissioning Review
- **KDP-F** – HQ Key Decision Point to proceed with Phase F
- **INST Off** – Power down instruments
- **DRR** – Disposal Readiness Review
- **Passivate** – Spacecraft passivation

Aura Spacecraft Subsystems

(Changes since June 2019 MOWG @ CNES)

- **Command & Data Handling (CDH) – Nominal**
  - **Formatter Multiplexer Unit (FMU) / Solid State Recorder (SSR) Anomaly**
    - » **Initial symptoms occurred December 4-18, 2007**
    - » **Newest symptoms started in January 2017 and remain active (impacting S-Band HK data capture)**
- **Communications (COMM) – Nominal**
  - **Transmitter-B Reflected Power Anomaly (10/17/17, 01/05/18)**
- **Electrical Power System (EPS) – Nominal**
  - ***Array Regulator Electronics (ARE) Anomalies:***
    - » ***Solar Panel Connector Anomaly – ARE-3C (01/12/05) – loss of 11 strings***
    - » ***MMOD Strike – ARE-5A (3/12/10) – loss of 6 strings***
  - ***ARE Degradation (due to aging):***
    - » ***ARE-1A (3/12/10, 11/5/11), ARE-1C (7/14/17, 12/22/17), ARE-2A (8/24/19), ARE-2C (8/18/17), ARE-4A (9/23/14, 12/8/14), ARE-4C (6/6/19), ARE-5A (4/25/13), ARE-5C (9/27/12, 2/4/13), and ARE-6A (9/14/13)***
  - ***Estimated that Aura has lost 33 strings of solar cells out of a total of 132 strings (~75.0% remain)***
- **Flight Software (FSW) – Nominal**
- **Guidance, Navigation & Control (GN&C) – Nominal**
- **Propulsion (PROP) – Nominal**
- **Thermal Control System (TCS) – Nominal**

All subsystems configured to primary hardware

Recent Activities

(June 2019 – November 2019)

- **0 Spacecraft Bus Anomalies**
- **1 Instrument Anomalies**
  - **1 MLS Anomaly**
    - » Receiver 2 Anomaly (07/18/19, recovered on 07/24/19)
      - 190 GHz R2 Receiver signal chain anomaly - identical to the occurrence in October 2012
  - **0 OMI Anomalies**
- **8 Spacecraft Maneuvers**
  - **7 Drag Make-up Maneuvers (DMUMs #124 – 130)**
    - » Routine: 06/26/19, 07/18/19, 08/15/19, 09/12/19, 10/09/19
    - » Debris Avoidance Maneuvers (DAMs): 10/23/19 & 10/28/19
  - **1 Inclination Adjust Maneuver (IAM #63)**
    - » Fall IAM completed successfully on 10/03/19
    - » Continue to observe degraded propulsion system performance
- **7 High Interest Events (HIEs) (Tiers 1-4) (As of 10/31/19 - See Slide #32)**
  - **5** required DAMs to be planned and screened (T3)
  - **2** required DAMs to be executed (T4)
    - » 10/24/2019: Aura vs. 34896 at 06:10:32 GMT
    - » 10/28/2019: Aura vs. 87408 at 12:44:28 GMT

Recent Activities

(June 2019 – November 2019)

- **Aura Science Team Meeting (STM) (Pasadena, CA)**
  - **08/27/2019: "Aura to Exit the A-Train? Aura Extended Mission Operations Concept" briefing**
  - **08/27/2019: Aura FOT / IOT Mission Operations Working Group (MOWG)**
  - **08/28/2019: Site visit to JPL (center tour and tag-up w/ MLS)**
  - **08/29/2019: Aura Mission Status briefing**
  - **Main take-aways:**
    - » No objections to keeping with the baseline fuel usage plan (i.e., A-Train exit in 2023)
    - » NASA HQ direction to proceed with handover of OMI instrument operations responsibilities from the KNMI IOT to the GSFC FOT
- **OMI IOT Transition Status**
  - **Kick-off meetings held with FOT (09/06/19), Science Team (09/09/19), and IOT (09/13/19)**
  - **Status meetings held with the FOT & IOT on 10/08/19 and 11/08/19**
  - **Identified general questions and defined roles / responsibilities**
  - **Currently in a period of parallel ops for instrument command load checks**
  - **Goal is to handover load approvals by the end of 2019, stop 24/7 support in January 2020, and then transfer activity scheduling in Spring 2020**

Recent Activities

(June 2019 – November 2019)

- **Aqua / Aura Maneuver Working Group (MWG)**
  - **Aqua / Aura IAM Planning**
    - » Investigated performing a Fall 2019 IAM (October) to better manage MLT drift and fuel usage (allowed for potentially 1 less IAM over the remaining mission life)
    - » After confirming with constellation members, planned Fall IAMs for Aqua & Aura (plan moving forward is to now have Spring and Fall IAMs)
  - **Aqua RWA IAM Development**
    - » Created Aqua Plan template, Aqua SCSs, and updated fault management thresholds
    - » Sent and reviewed timing for test maneuver to Aqua IOTs – no concerns
    - » Performed simulations including contingency responses with full team
    - » Test Maneuver successfully performed on 11/14/19

- **Fall 2019 Inclination Adjust Maneuver (IAM)**
  - **IAM #63 completed successfully on 10/03/19**
    - » Performance was 0.48% COLD but achieved ΔSMA of -67.38 m (vs. predicted of -9.03 m)
  - **Continue to observe degraded propulsion system performance**
    - » Thrust scale factor and duty cycles show a decrease in burn efficiency
    - » Working with FOT, FDS, and NGAS to assess the thruster issues

Recent Activities

(June 2019 – November 2019)

- **TES Laser End of Life (EOL) Testing [since Decommissioning on 01/31/18]**
  - **Phase 2 testing will alternate leaving Laser A or B ON for extended durations and characterize performance every 6 months**
  - **Round 1 Testing - 11/15/18 & 11/16/18 (Left Laser A ON afterwards)**
    - » Debrief of Round 1 testing on 03/28/19
  - **Round 2 Testing – 04/17/19 & 04/18/19 (Left Laser B ON afterwards)**
    - » Debrief of Round 2 testing on 08/27/19 (during Aura STM / FOT & IOT MOWG)
  - **Round 3 Testing – 10/22/19 & 10/24/19 (Left Laser A ON afterwards)**

- **TrollSat Ground Station certification**
  - **Mitigating potential scheduling conflicts with OCO-2 and Norway antennas**
    - » OCO-2 is in the process of starting their certification of Norway / TrollSat antennas
  - **Aqua / Aura will build off of successful testing that occurred in 2012 (X-Band downlink only)**
  - **EDOS has existing hardware to capture and deliver science data (SMAP)**
  - **FOT has completed the necessary ground system updates in the MOC to accommodate certification testing**

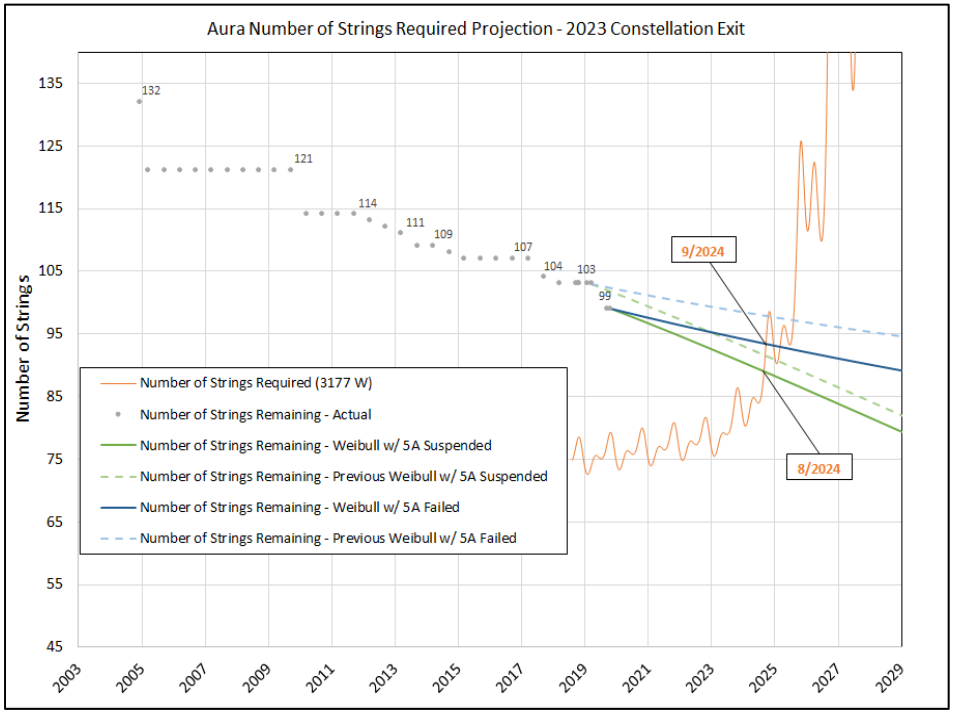
Recent Activities

(June 2019 – November 2019)

- **Aura Alternate Fuel Usage Evaluation**
  - Explored early A-Train exit scenario with the following assumptions:
    - » Full IAM Series through 2019 & 2020, then allow MLT & Beta angle to drift
    - » Constellation Exit Maneuver (CEM) in May 2021 (i.e., exit 2-years early)
  - While the scenario conserves significant amounts of fuel, the inability to maintain power generation as the Beta angle drifts made this scenario non-viable

Future Power Generation Analysis

- 99 out of 132 strings remaining
- Estimated to need 88 strings to produce current spacecraft power load (3177 W) after Aura exits the A-Train in 2023
- Latest projections put the Aura power generation limitation in late-2024 time frame



Planned Activities

- **Fall 2019: EOMP and FDS Lifetime Analysis Updates**
  - Updates will feed into 2020 Senior Review Proposal (SRP) cycle
- **December 2019: Earth Science Constellation (ESC) MOWG**
  - Update propellant budget, decommissioning analysis, reliability predictions, etc.
- **February 2020: ESMO Annual Review #13**
- **March 2020: Senior Review Proposal submission**
- **Spring 2020: Annual Inclination Adjust Maneuvers (4) (*FINAL Dates*)**
  - 3/4/20 (#64), 3/11/20 (#65), 3/18/20 (#66), 3/25/20 (#67), 4/1/20 (Backup)

- **Mid-to-Long-Term Plans:**
  - **EOS Automation (EA) – automation of routine operations**
    - » EA Phase 3.4 ORR – Early 2020
    - » Continue FOT automation procedure development into 2020
  - **Continue to improve RMM / DAM execution**
    - » CRMS Release 8.0 – Early 2020
    - » Support ESMO / CARA devolution initiative – Update processes as a result of Parallel Ops trial period

Spring 2020
Inclination Adjust Plan (*FINAL Dates*)

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1 **March**	2	3	4 Aura IAM #64	5 Aqua IAM #67	6	7
8	9	10	11 Aura IAM #65	12 Aqua IAM #68	13	14
15	16	17	18 Aura IAM #66	19 Aqua IAM #69	20 Equinox EPS SOH Test	21
22	23	24	25 Aura IAM #67	26 Aqua IAM #70	27	28
29	30	31	1 **April** Aura Backup	2 Aqua Backup	3	4
5	6	7	8	9	10	11

Collision Risk Management System (CRMS) Process Improvements

- **ESMO has developed ground system capabilities to autonomously identify and develop maneuver options to assist in Risk Mitigation Maneuver (RMM) / Debris Avoidance Maneuver (DAM) planning**

- **Developed in response to an increased number of predicted close approaches with orbital debris and operational satellites**
  - More High Interest Events (HIEs) had led to more effort to plan mitigation maneuvers
  - Concern is that updates to the US Air Force Space Fence will significantly increase the size of the Space Catalog

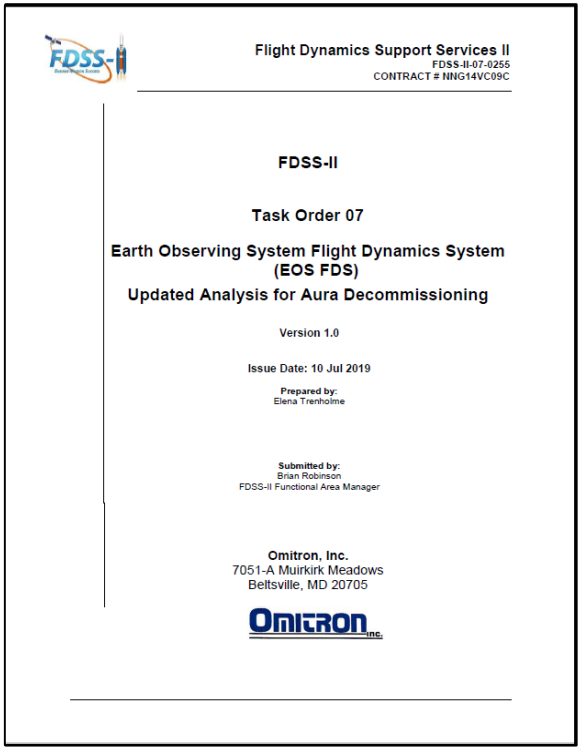
- **Key CRMS capabilities include:**
  - User defined collision risk thresholds
  - Maneuver optimization to address multiple conjunctions with secondary object conjunctions

- **EOC is currently operating with CRMS Release 7 (ORR 04/25/19)**

- **ESMO developed MOCA CONOPS in support of CARA Devolution initiative**
  - **Completed Parallel Ops test phase in Fall 2019 (10/02/19)**

Aura Propellant Usage
(Analysis Updated July 2019)

- **2006: Initial Aura lifetime fuel analysis**
- **2008: Detailed Aqua & Aura lifetime analysis**
  - Presented to MOWG and at Aura End of Prime Mission Review in September 2010
- **2012 (September): Initial Aura Decommissioning Plan**
  - Included updated Lifetime Estimates
- **2013 (August): Updated Decommissioning Plan**
  - Included updated Constellation Exit Plan
- **2014 (September): Updated Decommissioning Plan**
- **2015 (September): Decommission Plan Update Postponed**
  - Postponed to evaluate long-term plan and decommissioning maneuvers
- **2016 (January): Updated Decommission Plan (v1.2)**
  - Included hypothetical MLT drift analysis with LS-8
- **2017 (October): Updated Decommission Plan (v1.0)**
- **2018 (July): Updated Decommission Plan (v1.0)**
  - Summer IAM required update to document and IAM Plans
  - Included Appendix B with alternate plan to drift after 2019 IAMs
- **2018 (November): Updated Decommission Plan (v2.0)**
  - Updated definitive fuel usage & predicted solar flux levels
  - Updated propellant estimates for IAMs w/ RWAs & DMUs
- **2019 (July): Updated Decommission Plan (v1.0)**
  - Update definitive fuel usage & predicted solar flux levels



Flight Dynamics Support Services II
FDSS-II-07-0255
CONTRACT # NNG14VC09C

FDSS-II

Task Order 07

Earth Observing System Flight Dynamics System (EOS FDS)
Updated Analysis for Aura Decommissioning

Version 1.0

Issue Date: 10 Jul 2019

Prepared by:
Elena Trenholme

Submitted by:
Brian Robinson
FDSS-II Functional Area Manager

Omitron, Inc.
7051-A Muirkirk Meadows
Beltsville, MD 20705

- **Annual updates will be provided each July (starting in 2017)**
- **Final will be produced 60 days before start of decommissioning**

Remaining Fuel Estimate

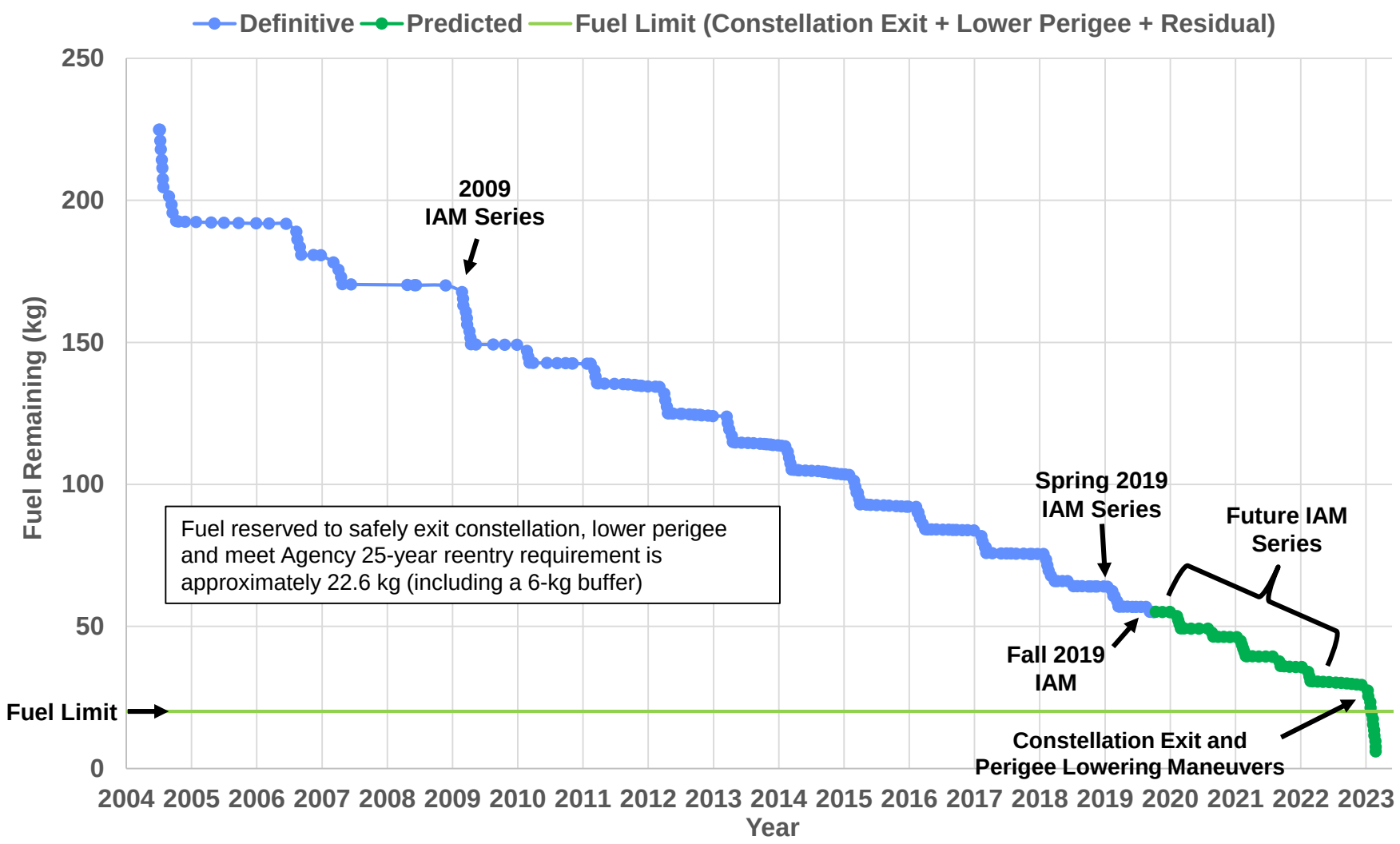
(Analysis Updated October 2019)

- **Long-term orbit simulations were run for Aura through Feb 2023**
  - **Used mean nominal Schatten solar flux predictions (May 2019)**
  - **Estimated the frequency of drag make-up maneuvers to maintain Aura's WRS-2 ground track requirements**
  - **Estimated the required number of annual inclination maneuvers for Aura to maintain it's mean local time (MLT) requirement (19 IAMs remaining)**
  - **Did not include potential debris avoidance maneuvers**
  - **Utilized FreeFlyer 6.10.0 which incorporated the solid earth tide model allowing greater accuracy for long term predictions of inclination, beta angle, and mean local time**
- **Lifetime predictions for Aura shows that the spacecraft will have sufficient fuel to maintain its current orbit within the Afternoon Constellation through 2022**
- **Aura will hold sufficient fuel in reserve after exiting the constellation to lower perigee such that reentry will meet the NASA 25-year reentry requirement.**
- **Analyses are updated annually by ESMO Flight Dynamics Team**
  - **Currently developing a retrograde maneuver capability**

Debris Assessment Software
(Analysis Updated October 2019)

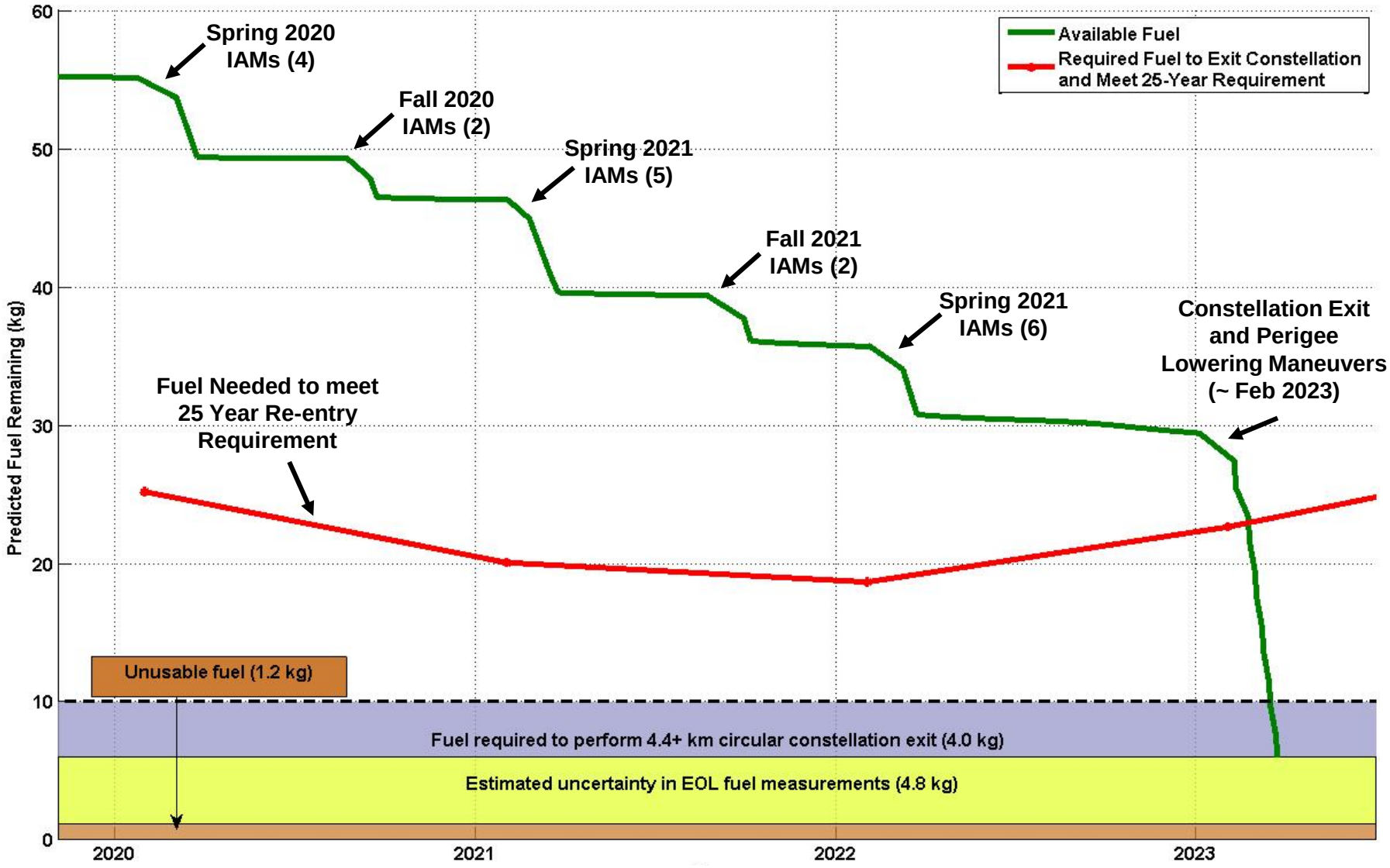
- **The Debris Assessment Software (DAS) was created by the Orbital Debris Office at Johnson Space Center and is the Agency standard for end of mission life analyses and lifetime estimations (Version 2.1.1)**
- **Solar Flux file from October 2019**
- **DAS requires several inputs describing the spacecraft's mission:**
  - Start apogee = ~695 km (varies slightly each year by constellation exit results)
  - Spacecraft Dry Mass = 2791.746 kg (includes 1.2 kg of unusable fuel and 4.8 kg of uncertainty)
  - Tumbling Area = 46.1 m^2 (FDSS-II-07-0085_Aura Average Area _V1.0 (3/1/17))
  - Area-to-Mass Ratio = Tumbling Area / Dry mass = 0.016485 m^2/kg
  - Start inclination = 98.2°
  - Launch date = 07/15/2004
- **In turn, DAS outputs:**
  - If the mission is compliant with NASA requirements for limiting orbital debris
  - A recommended apogee and perigee that will allow the spacecraft to reenter within a specific period and satisfy the NASA requirements
- **Aura has a waiver to the 30-years from launch requirement**
- **Aura will hold sufficient fuel in reserve to meet the 25-year requirement**

Fuel Usage: Actual & Predicted
(Analysis Updated October 2019)



Aura DAS End of Life Predictions

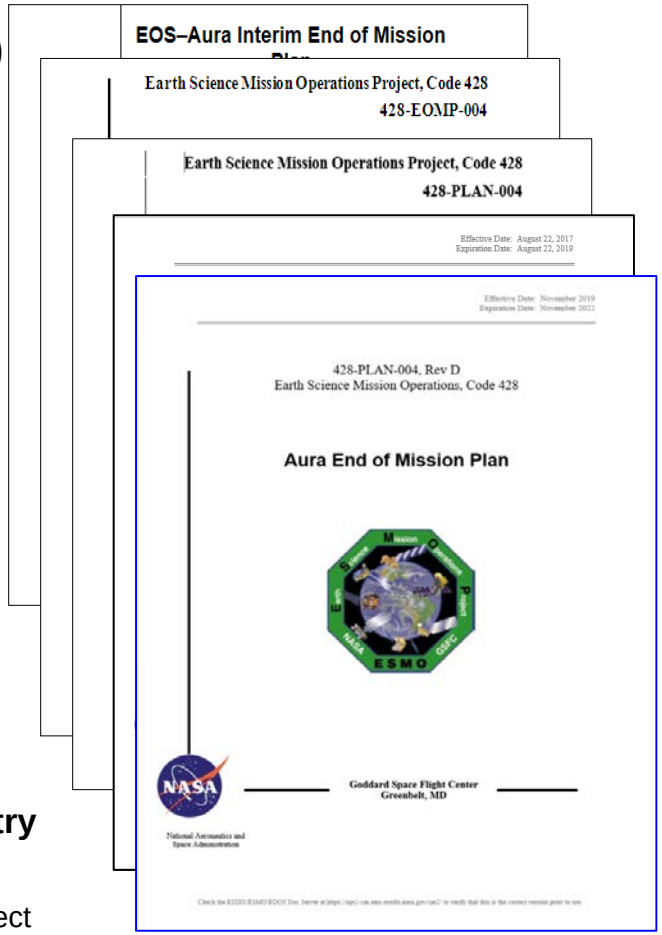
(Analysis Updated October 2019)



Aura End of Mission Plan (EOMP)

(Rev. D Updated Fall 2019)

- Initial draft February 2009
- Produced the first "Interim" End of Mission Plan (EOMP) in May 2011
  - Approved by NASA HQ July 2011
- Produced EOMP Rev A: February 2013
  - Updated Lifetime estimates, Small Object Collision Assessment
  - Waivers were approved in May 2013
- Produced EOMP Rev B: February 2015
  - Updated Lifetime Estimate
- Produced EOMP Rev C: August 2017
  - Lifetime estimates (as of 12/2016) & Reliability estimates
- **Produced EOMP Rev D: November 2019 (Under Review)**
  - **Lifetime and Reliability estimates as of October 2019**
- Content Synopsis:
  - Safely exit the A-Train Constellation
  - Passivate Aura to the extent possible for uncontrolled reentry
  - Aura has five (5) approved waivers for passivation
    - » Pressurant Passivation, Large Object Collision Probability, Small Object Collision Probability, Orbital Lifetime (30-Year), and Re-entry Risk (Un-controlled)
- Final will be produced 60 days before End of Mission



Summary

- Spacecraft Status – GREEN
- Instrument Status – GREEN
  - HIRDLS: Chopper Stalled 03/17/08 – Not collecting science data
  - MLS: Operating Normally –
    - 06/04/2018: 118 GHz Receiver-1A (R1A) Anomaly (Recovered 06/11/18)
    - 06/20/2018: GHz Mirror Electronics (GME-B) Anomaly (Recovered 06/26/18)
    - 07/10/2018: MLS Survival Mode Transition (Recovered 07/18/18)
    - 10/25/2018: GHz Mirror Electronics (GME-B) Anomaly (Recovered 10/25/18)
    - 01/27/2019: MLS Survival Mode Transition (Recovered 01/31/19)
    - 07/18/2019: 190 GHz Receiver-2 (R2) Anomaly (Recovered 07/24/19)
  - OMI: Operating Normally
    - 07/30/2018: OMI IAM Warm Restart (Recovered 07/31/18)
  - TES: Instrument Decommissioned on 01/31/18
- Data Capture/L0 Processing Status – GREEN
  - SSR Data Capture to 10/31/19: 99.99510658%
- Ground Systems – GREEN
  - Responding to new security requirements and upgrades to obsolete hardware or COTS systems, as required
  - 07/22/2019: Online (Eclipse) Build 21.02 ORR
  - 09/03/2019: EOS Automation (EA) Release 3.3 ORR

Questions

Additional Charts

Maneuvers & Ground Track History
Orbital Trends

Aura Conjunction Assessment
High Interest Events (HIEs)

Data Capture & Operations Errors

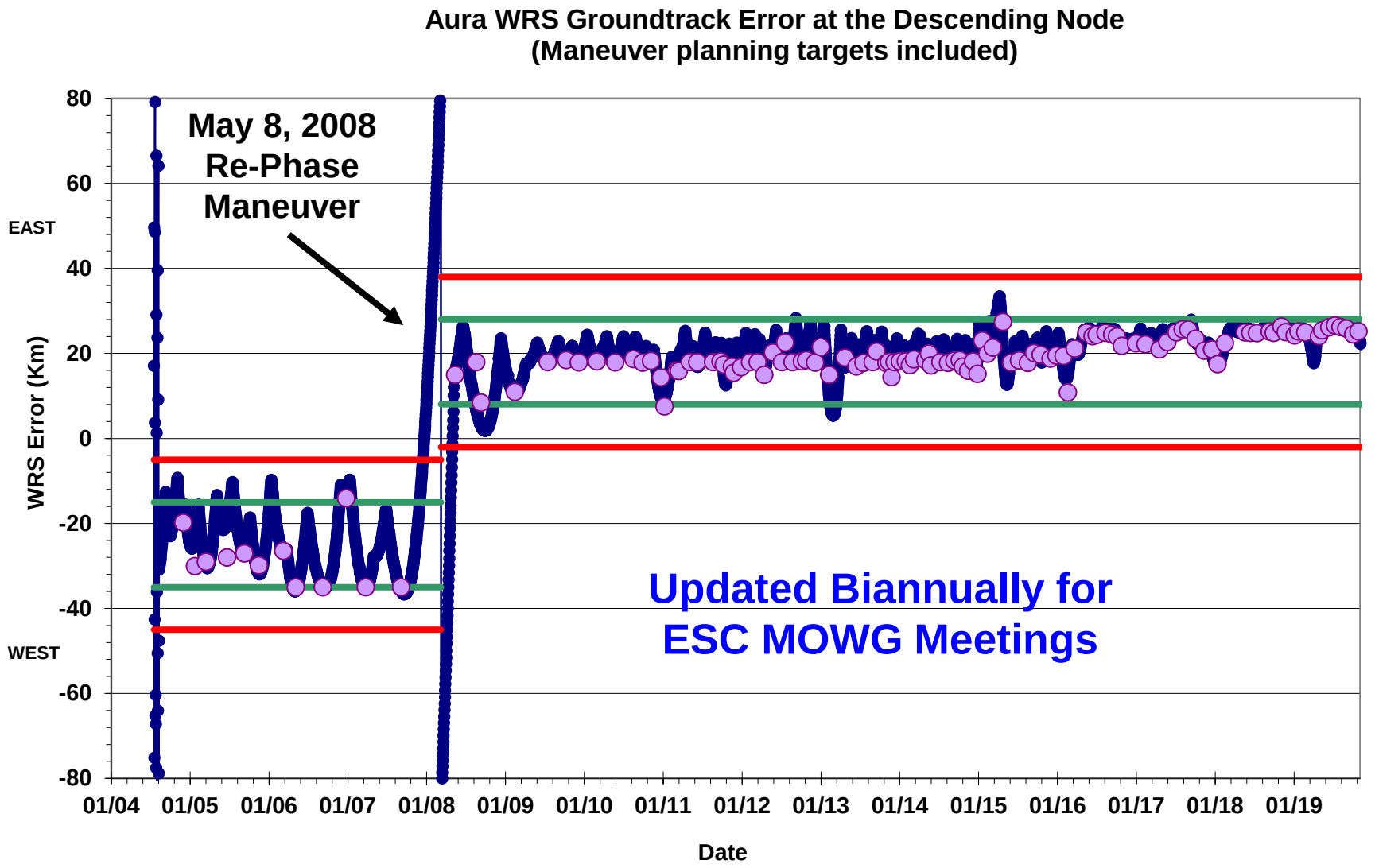
Extended Mission Plans
(Analysis Updates)

Orbit Maintenance

- **Mission Requirements: Perform Drag Make-Up Maneuvers (DMUMs) to maintain Ground Track Error (GTE) with respect to the World Reference System (WRS-2)**
  - **Requirement: +/-20 km as measured at the Descending Node**
- **To meet coincident viewing requirements, Aura's initial ground track was offset from Aqua's by one WRS path plus 25.4 km**
  - **Aura was maintained -5.4 to -45.4 km west of Aqua until late 2007**
  - **Since May 8, 2008, a new control box, +/- 10 km from a +18 km (east) offset of the Aqua WRS-2 path is used to maintain MLS-CALIPSO viewing request**
- **Control Box Excursions: To date there have been 3 Control box Excursions**
  - **2 on +10km front-side: 9/5/12 to 9/6/12, and 03/23/2015 to 04/17/2015 (increase in drag)**
  - **1 on -10km back-side: 2/12/13 to 3/13/13 (drop in drag after DMUM on 1/16/13)**
- **To date a total of 130 Drag Make-up (DMU) maneuvers have been performed:**
  - **07/19/2012: DMUM # 43 No Yaw Slew Maneuver (NYS) #1 – NYS Maneuvers (37)**
  - **Last maneuver 10/28/2019 (DMU #130 (RMM)) – Next maneuver will be early in 2020**
  - **Variation in performance from –6.7% (cold) to +5.3% (hot)**
- **To date a total of 63 Inclination Adjustment Maneuvers (IAMs) have been performed:**
  - **Fall '04 (4), Fall '06 (4 of 6), Spring '07 (4), Spring '09 (9), Spring '10 (3), Spring '11 (3), Spring '12 (4), Spring '13 (4), Spring '14 (4), Spring '15 (5), Spring '16 (4), Spring '17 (4), Spring '18 (5), Summer '18 (1), Spring '19 (4), and Fall '19 (1)**
  - **Variation in performance from -7.2% (cold) to +3.5% (hot)**

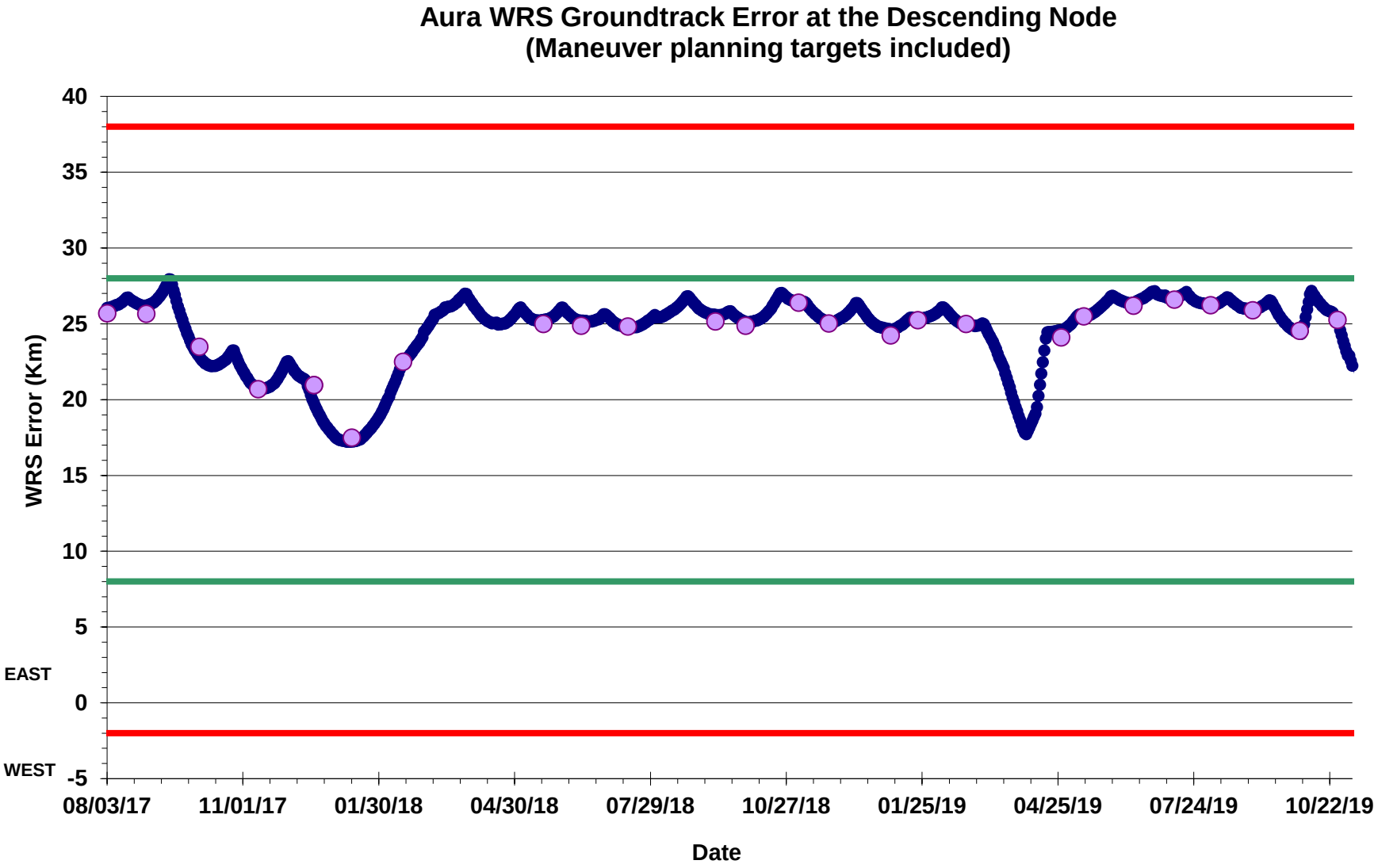
WRS Ground Track Error (GTE)

(As of November 10, 2019)



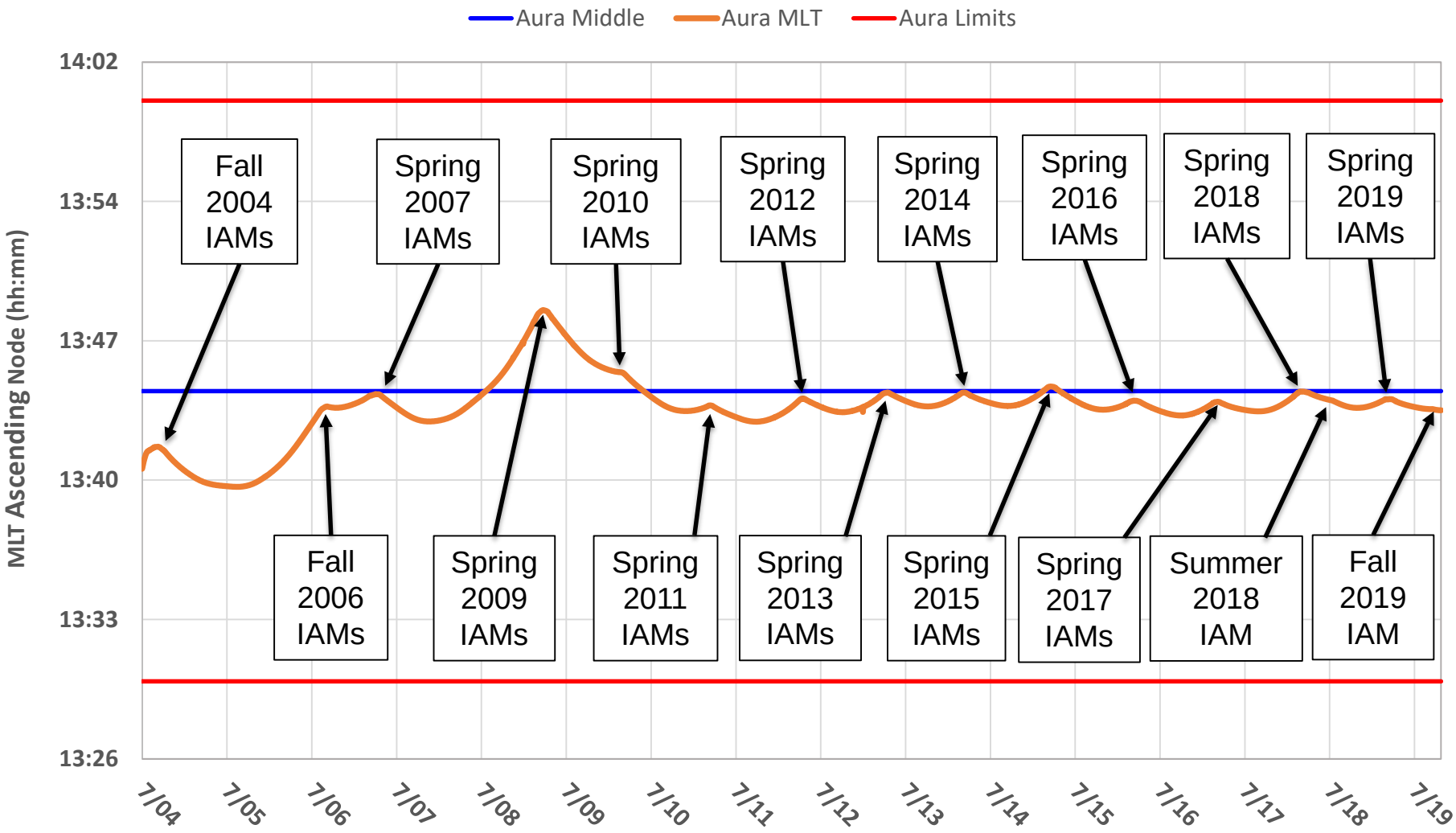
WRS Ground Track Error (GTE)

(As of November 10, 2019)



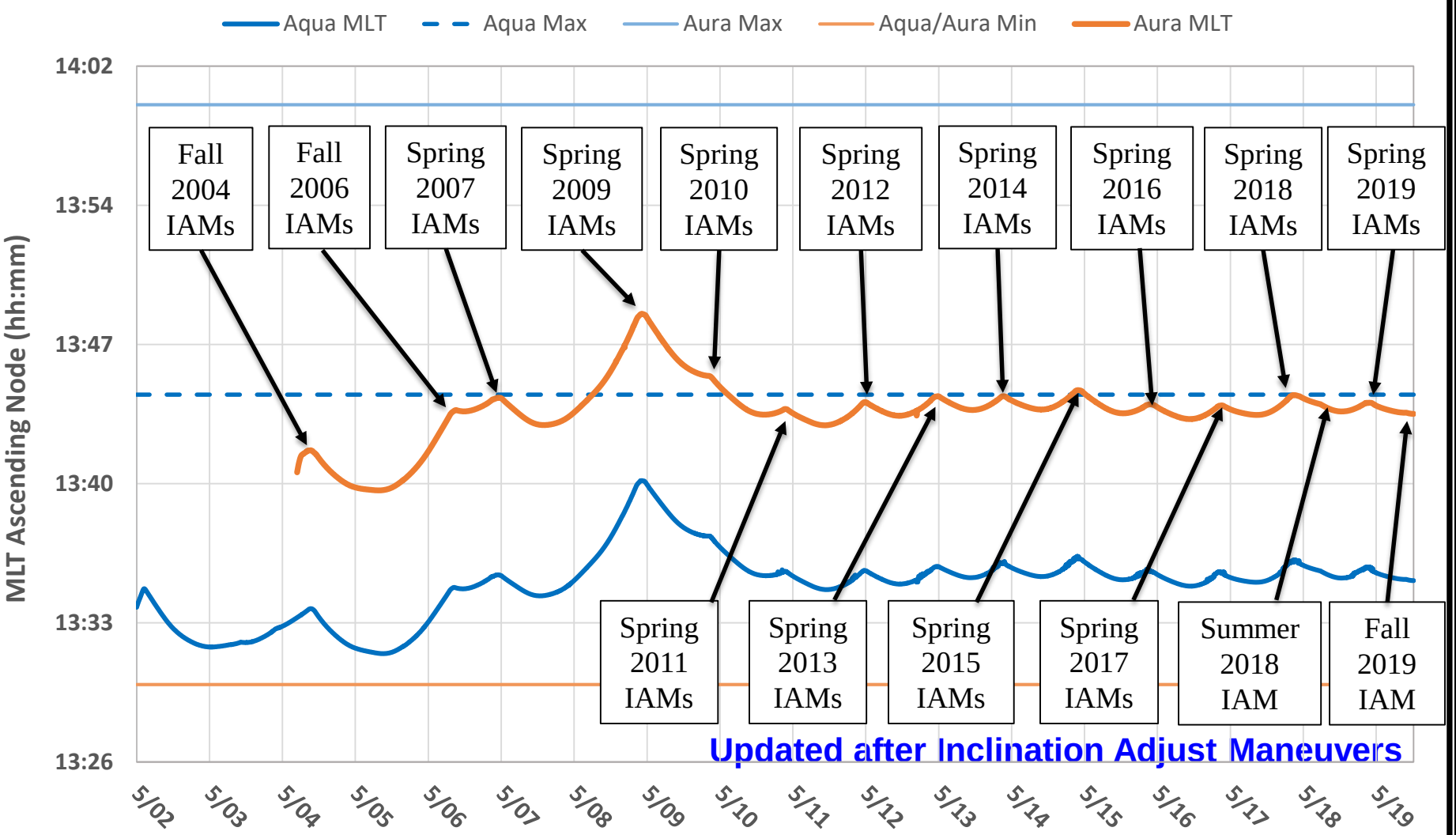
Aura Averaged MLT @ Ascending Node

(As of November 10, 2019)



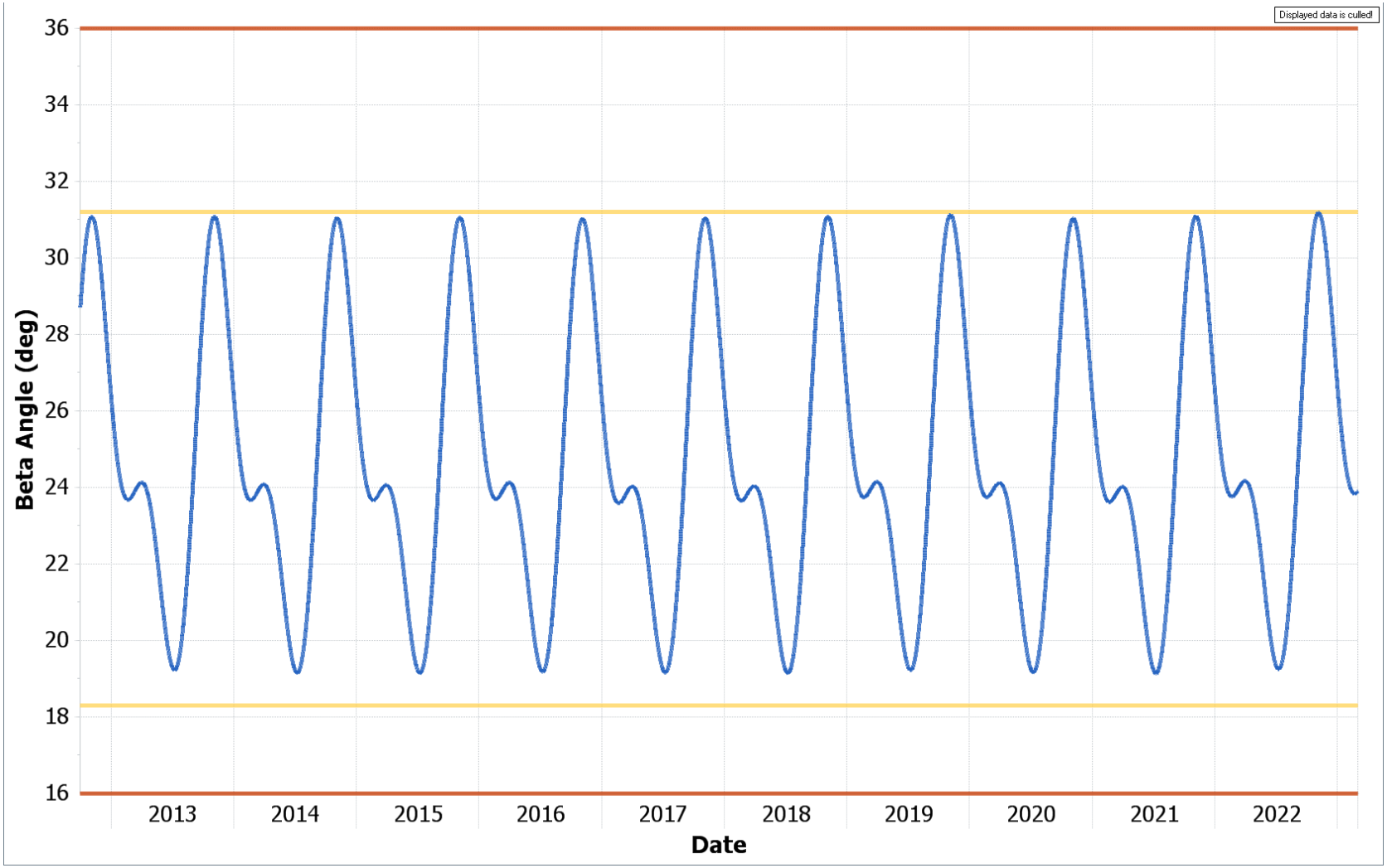
Aqua/Aura Mean Local Time (MLT)

@ Ascending Node (As of November 10, 2019)



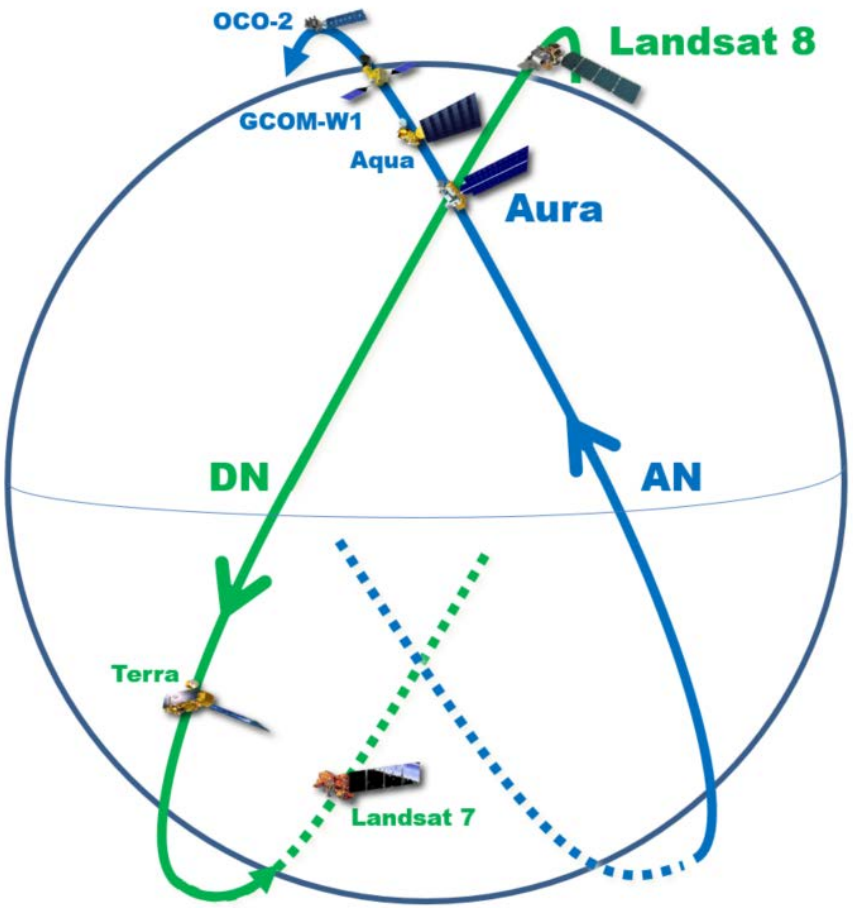
Aura Predicted Beta Angle

(With Yearly Inclination Maneuvers) (No Change)



Aura and Landsat-8 (LS-8)
Orbit Phasing

With Aura in the intersection point LS-8 will be ~ 77 seconds away from the intersection Point worse case



By Design – LS-8 and LS-7 are ½ orbit apart

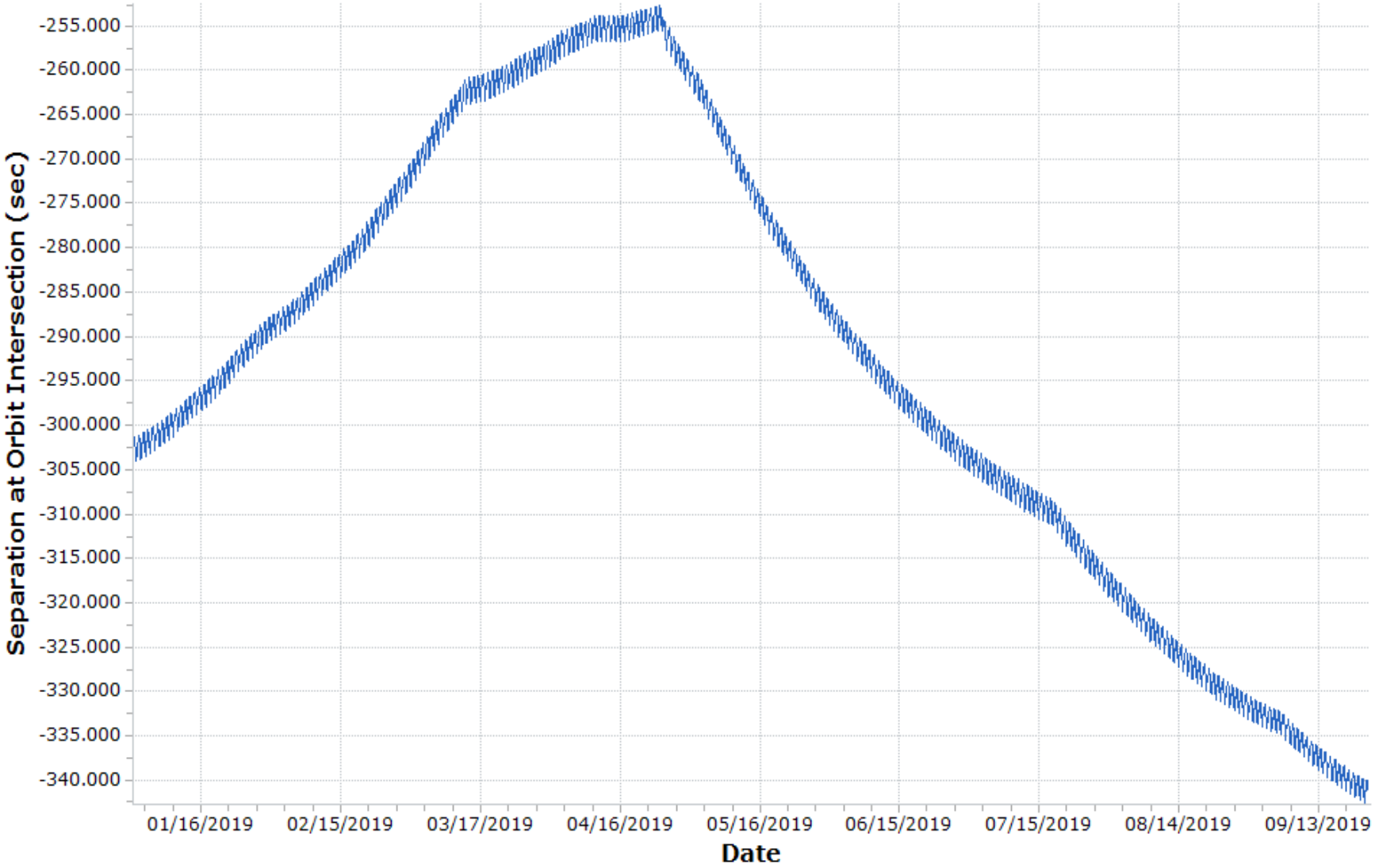
In 2019 there has been 254-342 seconds between Aura and LS-8

Terra ~ 30 min behind LS-7

1 Orbit = ~ 100 minutes

LS-8/Aura Phasing at Poles

@ Northern Intersection Point (as of Sept 24, 2019)



Aura Conjunction Assessment

High Interest Events (HIEs)

	Jun `19	Jul `19	Aug `19	Sep `19	Oct `19	Nov `19	Total
Tier 1	0	0	0	0	0		0
Tier 2	0	0	0	0	0		0
Tier 3	2	1	1	1	0		5
Tier 4	0	0	0	0	2		2
Total	2	1	1	1	2		7

2016: 24 CARA HIEs – 16 required significant action (T2-T4)

2017: 19 CARA HIEs – 16 required significant action (T2-T4)

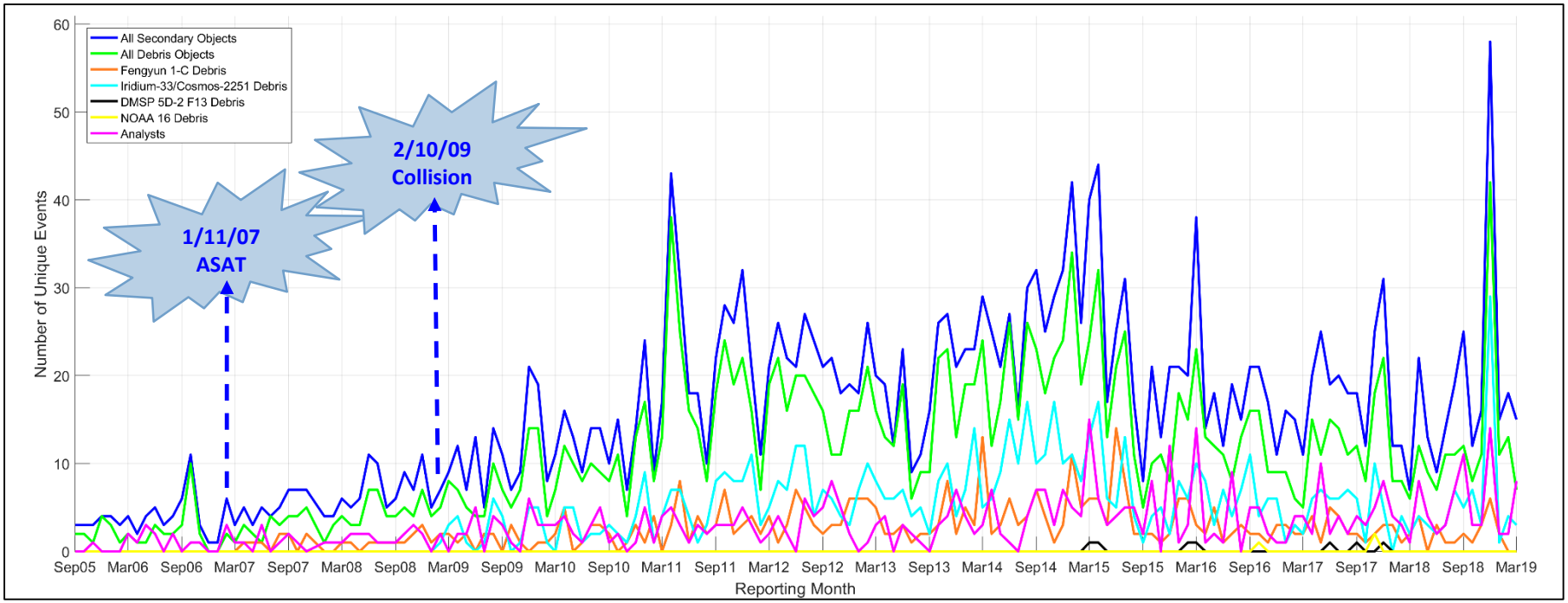
2018: 16 CARA HIEs – 16 required significant action (T2-T4)

Tier 1 – Notify (email/phone), Tier 2 – Conduct Briefing, Tier 3 – Plan Maneuver, Tier 4 – Execute Maneuver

2019: 13 CARA HIEs (thru 10/31/2019) – 13 required significant monitoring and/or actions (T2-T4)

1. 01/10/2019: CA vs. 43387 at 10:10:58 GMT – DAMs planned and screened, Self-mitigated (T3)
2. 02/05/2019: CA vs. 43387 at 05:50:18 GMT – DAMs planned and screened, Self-mitigated (T3)
3. 02/17/2019: CA vs. 81798 at 23:55:50 GMT – DAMs planned and screened, Self-mitigated (T3)
4. 03/20/2019: CA vs. 87932 at 03:17:19 GMT – DAMs planned, screened, and maneuver executed (T4)
5. 05/07/2019: CA vs. 81164 at 15:36:53 GMT – DAMs planned and screened, Self-mitigated (T3)
6. 05/23/2019: CA vs. 38062 at 05:53:17 GMT – DAMs planned and screened, Self-mitigated (T3)
7. 06/23/2019: CA vs. 82031 at 13:05:38 GMT – DAMs planned and screened, Self-mitigated (T3)
8. 06/24/2019: CA vs. 82868 at 11:46:53 GMT – DAMs planned and screened, updated tracking dropped Pc (T3)
9. 07/25/2019: CA vs. 42404 at 14:14:17 GMT – DAMs planned and screened, Self-mitigated (T3)
10. 08/04/2019: CA vs. 80566 at 23:53:13 GMT – DAMs planned and screened, Self-mitigated (T3)
11. 09/12/2019: CA vs. 89059 at 00:04:47 GMT – DAMs planned and screened, Self-mitigated (T3)
12. 10/24/2019: CA vs. 34896 at 06:10:32 GMT – DAMs planned, screened, and maneuver executed (T4)
13. 10/28/2019: CA vs. 87408 at 12:44:28 GMT – DAMs planned, screened, and maneuver executed (T4)

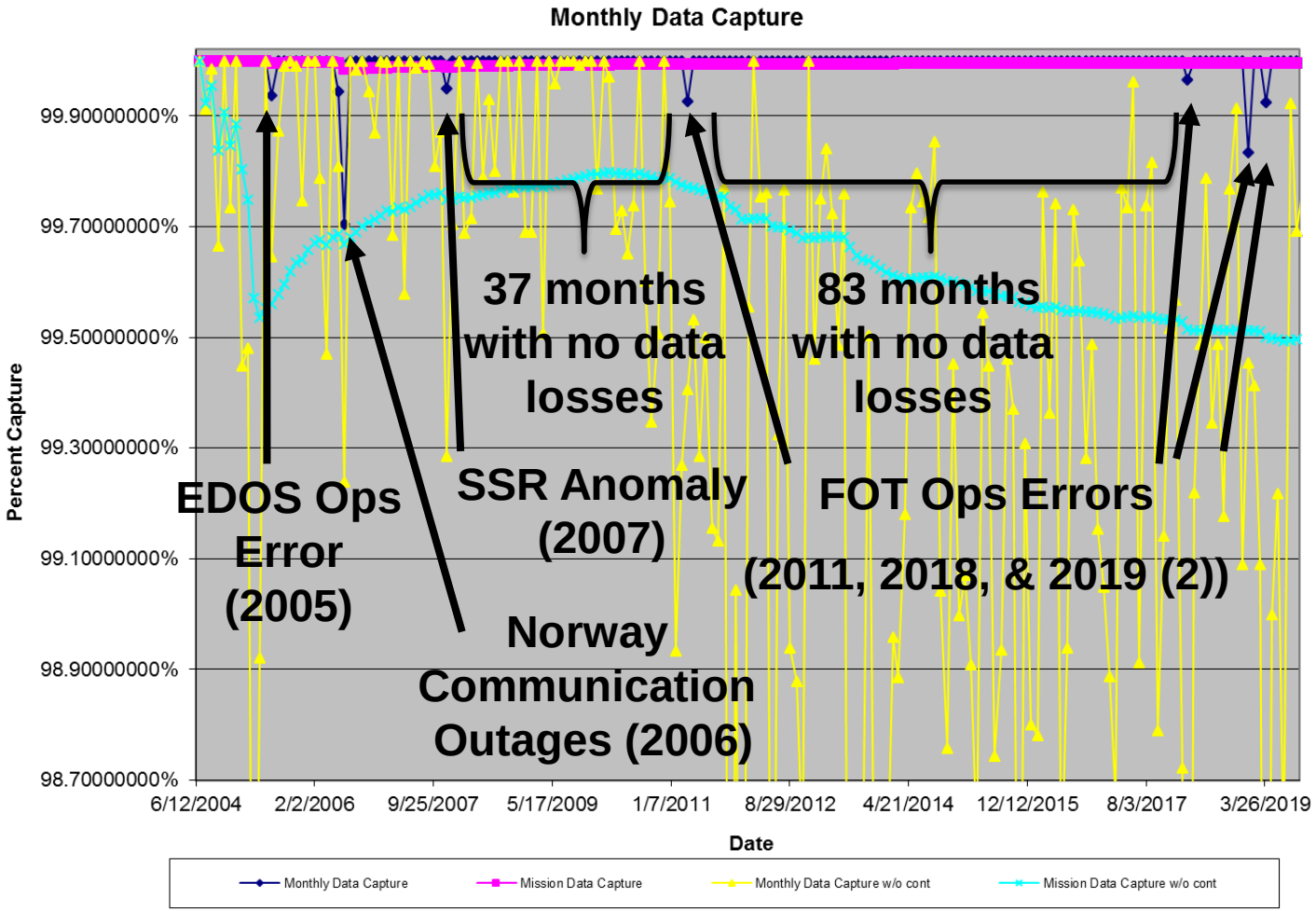
Aura Conjunction Assessment
(September 2005 thru March 2019)



Credit: NASA CARA Team

Aura Monthly Data Capture

SSR Data Capture to 10/31/2019: 99.99510658%



Mission Capture Req. = 95%

SSR Data Losses – 2019

Last Data Loss: April 2019 (FOT Ops Error)

January: Data Loss #1025 on DOY 030 (January 30, 2019)

February: None

March: None

April: Data Loss #1029 on DOY 094 (April 04, 2019)

- **Data gaps were observed in Low Rate Data from 14:11:54 - 14:46:02 and in OMI data from 14:12:26 - 15:10:47**

May: None

June: None

July: None

August: None

September: None

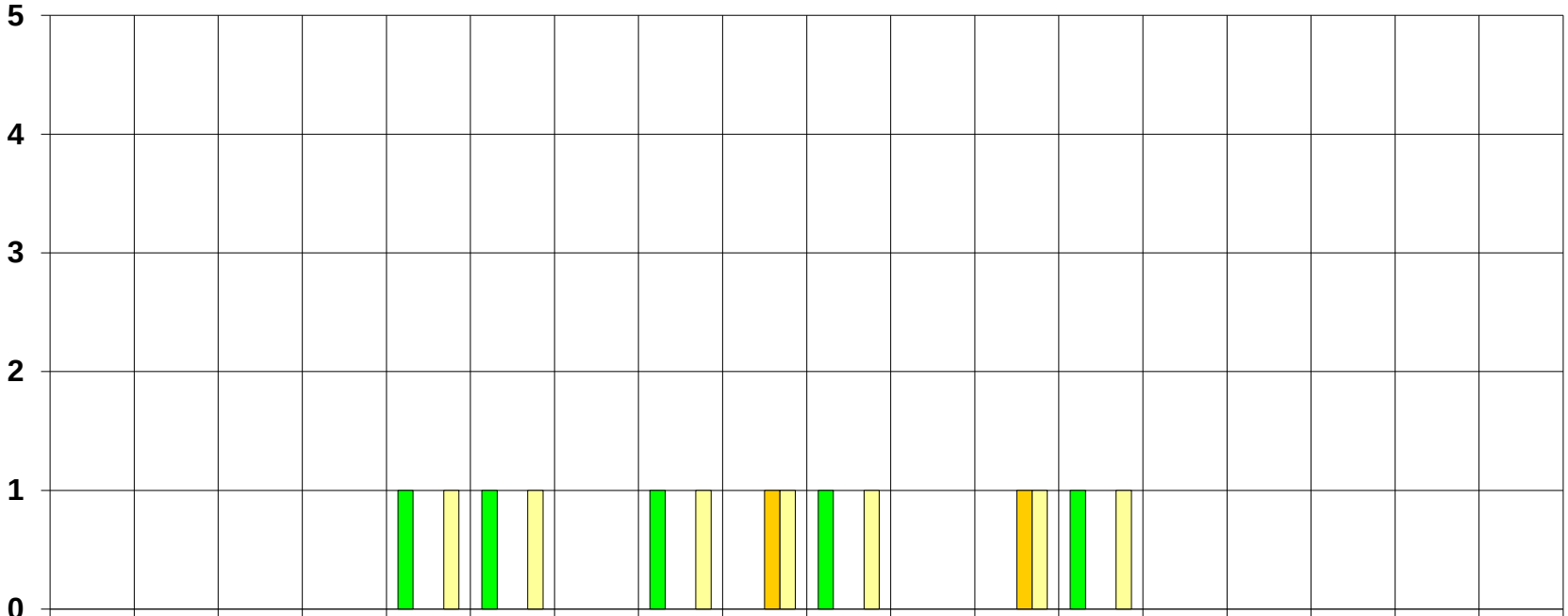
October: None

November: TBD

Operational Errors

(18-Months: May 2018 – October 2019)

Aura: 6 Months since last operational error (April 2019)



	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Terra	0	0	0	0	1	1	0	1	0	1	0	0	1	0	0	0	0	0
Aqua	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aura	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0
Total	0	0	0	0	1	1	0	1	1	1	0	1	1	0	0	0	0	0

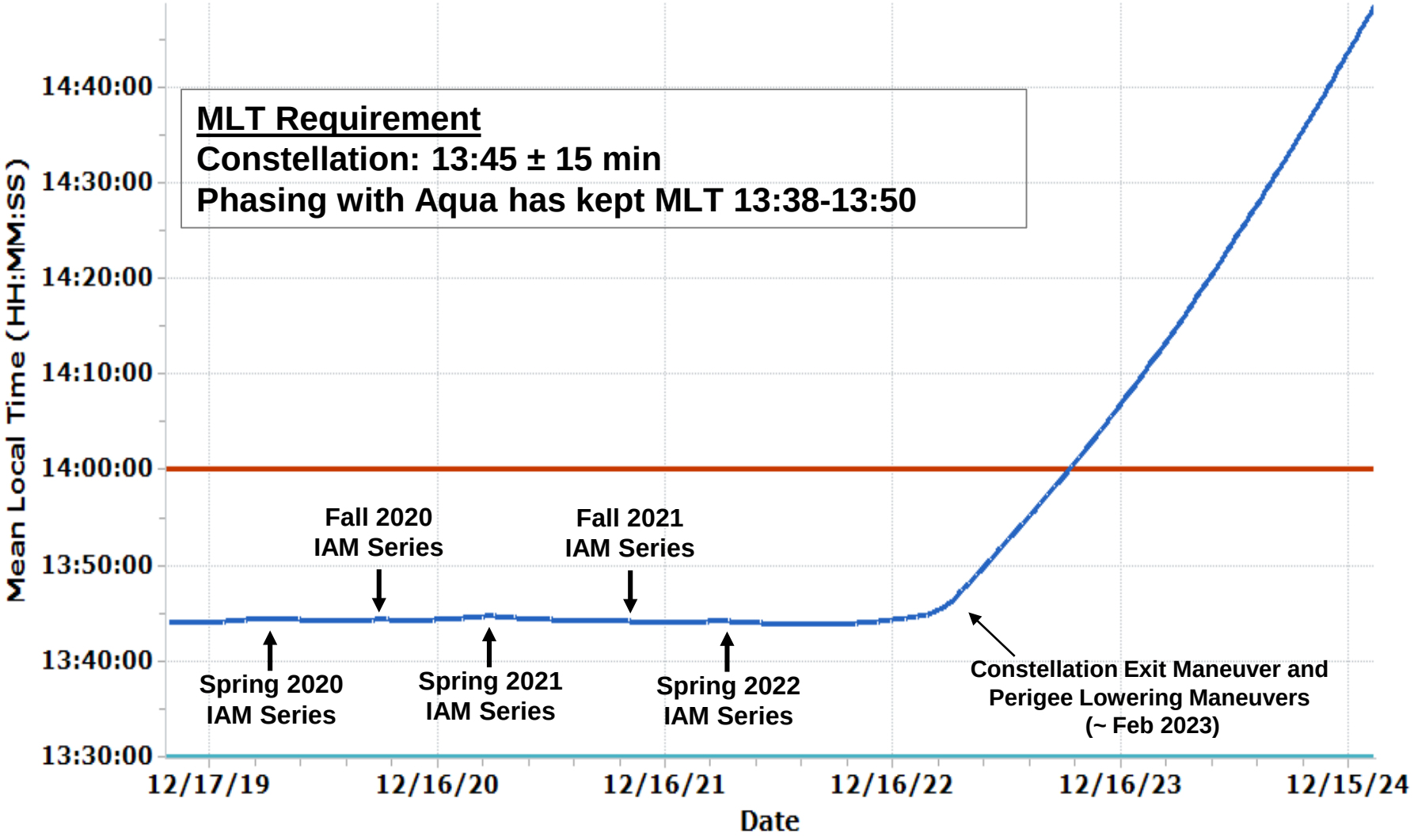
Aura Baseline Decommissioning Plan
(Current Baseline Plan – Analysis Updated October 2019)

- **Baseline Decommissioning Plan Assumptions:**
  - Maintain MLT and WRS-2 Ground Track requirements until the DAS 25-year re-entry fuel limit is reached (Spring 2023)
    - ➢ Perform nominal IAMs to maintain MLT
    - ➢ Perform periodic DMUs to maintain Ground Track Error

Documented in 'EOS FDS Updated Analysis for Aura Decommissioning' (v1.0, 07/10/19)

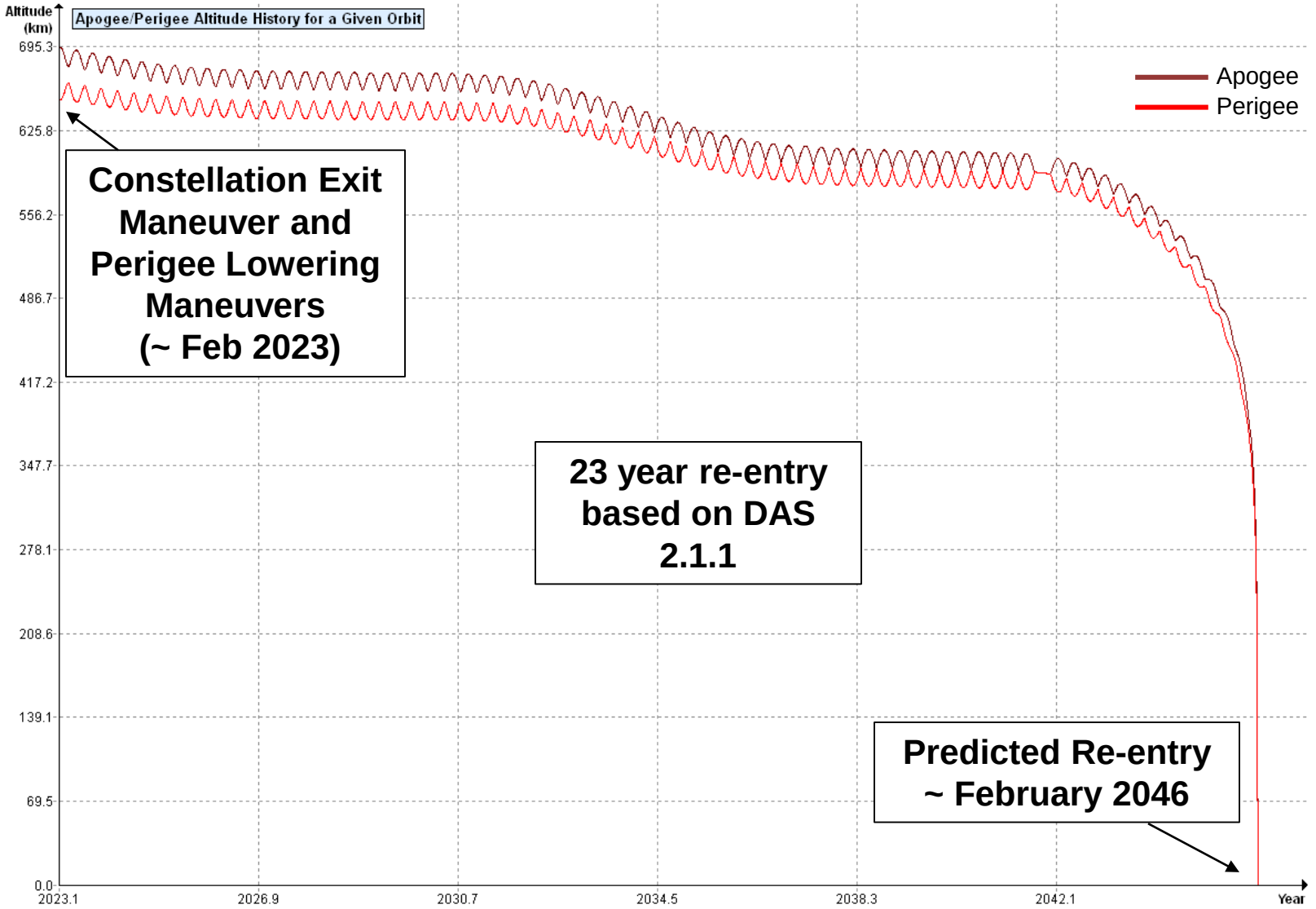
Aura Predicted Mean Local Time

(Current Baseline Plan – Analysis Updated October 2019)



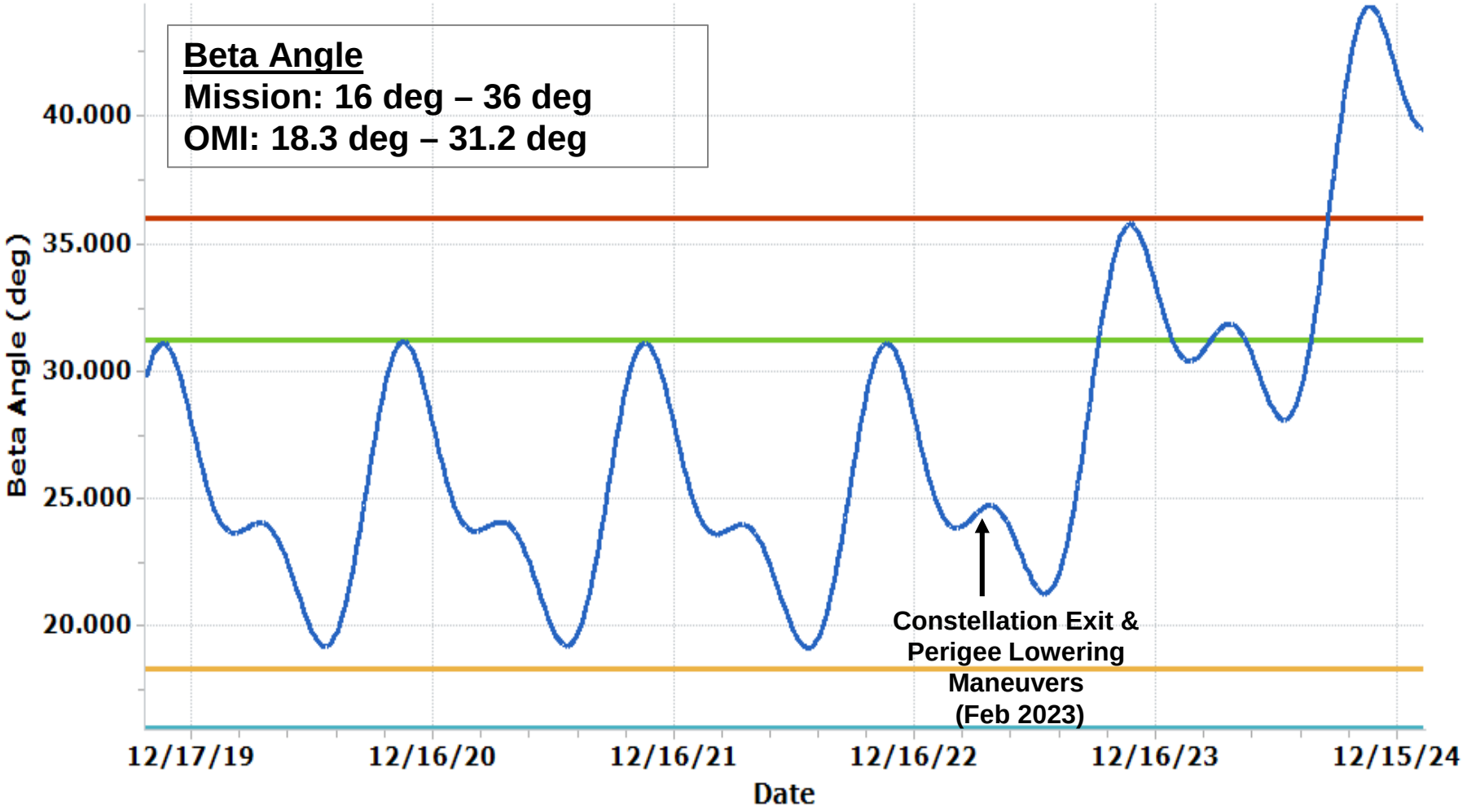
Aura Predicted Re-entry

(Current Baseline Plan – Analysis Updated October 2019)



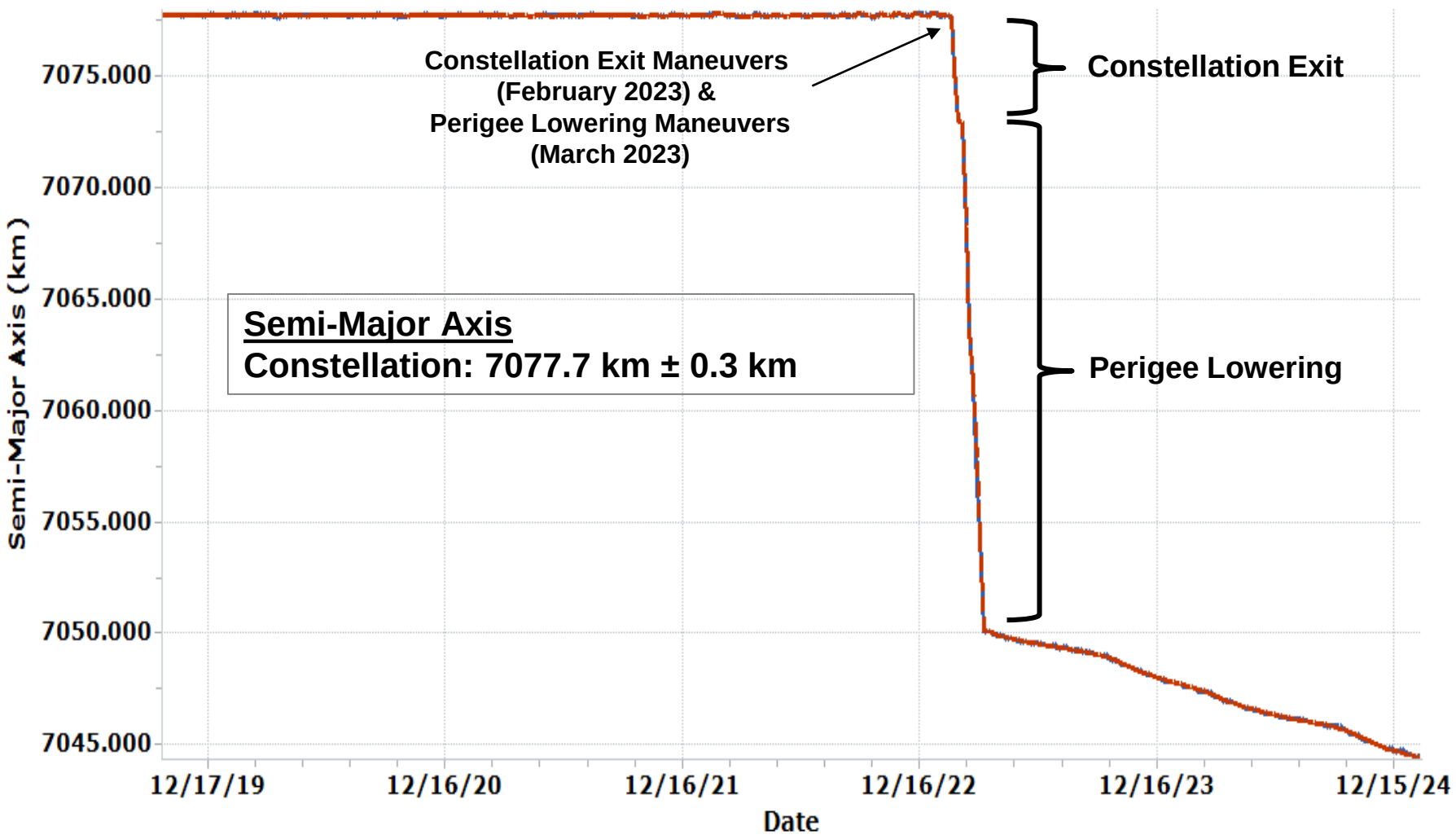
Aura Predicted Beta Angle

(Current Baseline Plan – Analysis Updated October 2019)



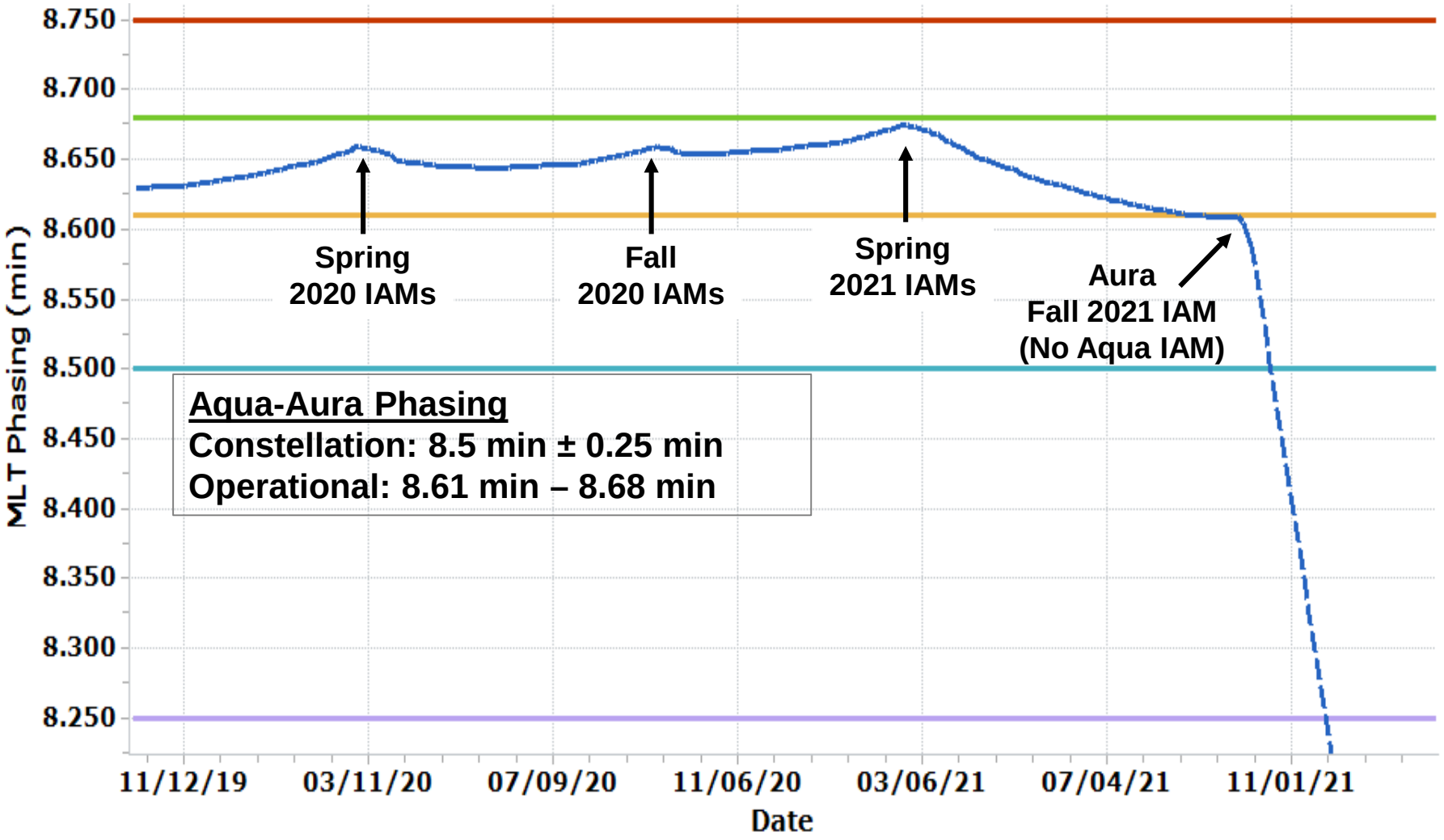
Aura Predicted Semi-Major Axis

(Current Baseline Plan – Analysis Updated October 2019)



Aura MLT Phasing with Aqua

(Current Baseline Plan – Analysis Updated October 2019)



Abbreviations / Acronyms List

ARE –	Array Regulator Electronics
ASAT –	Anti-satellite Weapon
CA –	Conjunction Assessment
CALIPSO –	Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations
CARA –	Conjunction Assessment Risk Analysis
CDH –	Command & Data Handling
CEM –	Constellation Exit Maneuver
CNES –	Centre National D'études Spatiales
COMM –	Communications
CONOPS –	Concept of Operations
COTS –	Commercial-Off-The-Shelf
CRMS –	Collision Risk Management System
DAM –	Debris Avoidance Maneuver
DAS –	Debris Assessment Software
DMUM –	Drag Make-up Maneuver
DR –	Decommissioning Review
DRR –	Disposal Readiness Review
EA –	EOS Automation
EDOS –	EOS Data Operations System
EOC –	EOS Operations Center
EOL –	End of Life
EOMP –	End of Mission Plan
EOS –	Earth Observing System
EPS –	Electrical Power System
ESC –	Earth Science Constellation
ESMO –	Earth Science Mission Operations
FDS –	Flight Dynamics System
FMU –	Formatter Multiplexer Unit
FOT –	Flight Operations Team
FSW –	Flight Software
FY –	Fiscal Year
GHz –	Gigahertz
GME –	Gigahertz Mirror Electronics
GMT –	Greenwich Mean Time
GNC –	Guidance Navigation & Control
GPM –	Global Precipitation Measurement
GSFC –	Goddard Space Flight Center
GTE –	Ground Track Error
HIE –	High Interest Event
HIRDLS –	High Resolution Dynamics Limb Sounder
HK –	Housekeeping
HQ –	Headquarters
IAM –	Interface Adapter Module
IAM –	Inclination Adjustment Maneuver
INST –	Instruments
IOT –	Instrument Operations Team
JPL –	Jet Propulsion Lab
KDP-F –	Key Decision Point to proceed with Phase F
kg –	kilogram
km –	kilometer
KNMI –	Royal Netherlands Meteorological Institute
L0 –	Level-Zero
LS –	Landsat
m –	meters
MLS –	Microwave Limb Sounder
MLT –	Mean Local Time
MMOD –	Micrometeorite Orbital Debris
MOC –	Mission Operations Center
MOCA –	Mission Operations Conjunction Assessment
MOWG –	Mission Operations Working Group
MWG –	Maneuver Working Group
NASA –	National Aeronautics & Space Administration
NG –	Northrop Grumman
NGIS –	Northrop Grumman Information Systems
NYS –	No Yaw Slew
OCO-2 –	Orbiting Carbon Observatory 2
Ops –	Operations
OMI –	Ozone Monitoring Instrument
ORR –	Operational Readiness Review
Pc –	Probability of Collision
PLM –	Perigee Lowering Maneuver
PROP –	Propulsion
R1A –	Receiver 1A
R2 –	Receiver 2
RMM –	Risk Mitigation Maneuver
RWA –	Reaction Wheel Assembly
SCS –	Stored Command Sequence
SMA –	Semi-Major Axis
SMAP –	Soil Moisture Active Passive
SOH –	State of Health
SR –	Senior Review
SRP –	Senior Review Proposal
SSR –	Solid State Recorder
STM –	Science Team Meeting
TBD –	To Be Determined
TCS –	Thermal Control System
TES –	Tropospheric Emissions Spectrometer
W –	watts
WRS –	World Reference System