

**Mission Status for
Earth Science Constellation
MOWG Meeting
@ Sioux Falls, SD**

EOS Aura

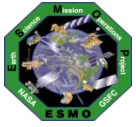
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June 12, 2018

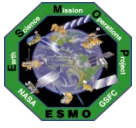


Topics



- **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**

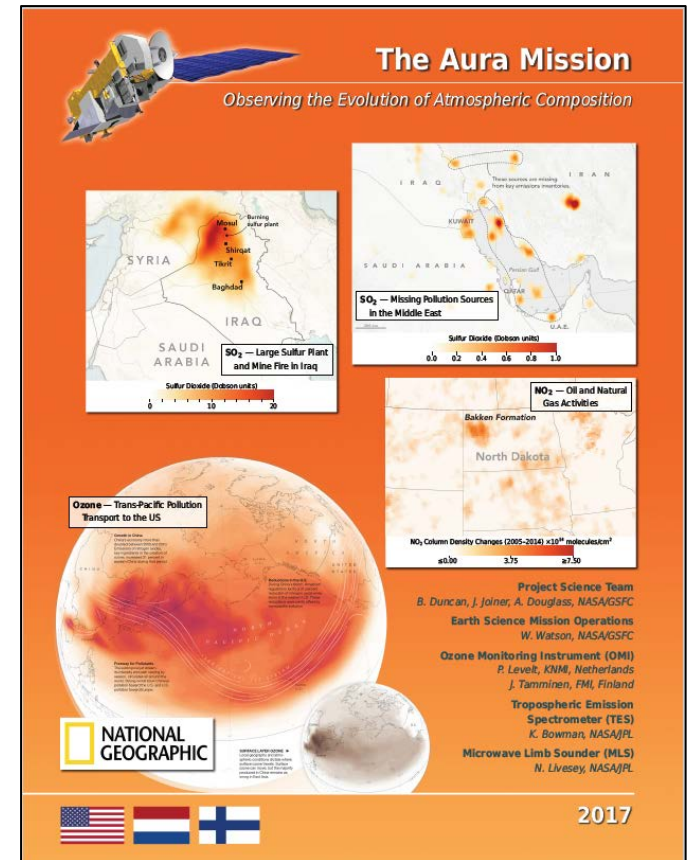


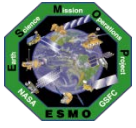
EOS Aura Mission Summary



(Updates since December 2017 MOWG @ KSC)

- **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
- **07/15/17: Aura 13-Year Anniversary**
- **01/24/18: ESMO Annual Review #11**
- **01/31/18: TES Decommissioning**





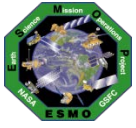
Aura Spacecraft Subsystems



(Updates since December 2017 MOWG @ KSC)

- **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 (2nd occurrence) – 01/05/18 – Yellow limits**
- **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-5C (9/27/12, 2/4/13), ARE-1A (3/12/10, 11/5/11), ARE-5A (4/25/13), ARE-6A (9/14/13), ARE-4A (12/8/14), ARE-1C (7/14/17, 12/22/17), ARE-2C (8/18/17)*
 - » *Estimated that Aura has lost 28 strings of solar cells out of a total of 132 strings (~78.8% remain)*
 - » *Aura continues to have significant power margin where the life limiting item is fuel*
- **Flight Software (FSW) – Nominal**
- **Guidance, Navigation & Control (GN&C) – Nominal**
- **Propulsion (PROP) – Nominal**
- **Thermal Control System (TCS) – Nominal**

All subsystems configured to primary hardware

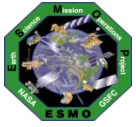


Recent Activities

(December 2017 – May 2018)



- **8 CARA High Interest Orbital Debris Events (Tiers 1-4) (As of 04/25/18)**
 - 6 required significant action (T3 / T4)
 - 03/01/18: Post-IAM conjunction of concern, TCA 22-hrs post burn, Pc rolled off (T3)
- **1 Spacecraft Bus Anomalies**
 - COMM: Transmitter-B Reflected Power Anomaly (01/05/18) – Not active
- **5 Instrument Anomalies**
 - TES: 3 ICS Stalls (#17 - 11/18/17, #18 - 12/22/17, #19 - 01/24/18)
 - MLS: 1 Mid-Band (01) Local Oscillator Out-of-Lock Anomaly (Recovered on 02/26/18)
 - OMI: 1 OMI-IAM Multi-bit Error Warm Restart (04/30/18, Recovered on 05/01/18)
- **7 Spacecraft Maneuvers**
 - **2 Drag Make-up Maneuvers (DMUMs # 109 – 110)**
 - » (2) Routine: 02/14/18, 05/03/18
 - **5 Inclination Adjust Maneuvers (IAMs # 53 – 57)**
 - » 02/28/18, 03/07/18, 03/14/18, 03/28/18, 04/18/17*
 - * Initially planned for 04/11/18, postponed due to Aqua post-maneuver concern
- **1 Instrument Maneuvers**
 - **1 MLS Moon Scan (#13) – Yaw Maneuver**
 - » 03/03/18

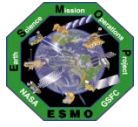


Recent Activities

(December 2017 – May 2018)



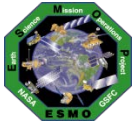
- **TES Decommissioning:**
 - FOT / IOT held regular bi-weekly meetings to define the final instrument, spacecraft, and ground system configurations
 - **TES Decommissioning Review @ JPL – 01/18/18**
 - **FOT / IOT executed instrument reconfiguration into decommissioned state – 01/31/18**
 - » Instrument transitioned to a modified safe state (IEM & Op Heaters ON)
 - » Disabled unnecessary spacecraft telemetry monitors (TMONs)
 - » Updated fault management to match the final instrument safe state
 - » Various Ground System proc and database updates
 - **TES Close-out Review & Science Highlights @ NASA HQ – 04/13/18**
 - **TES Laser End-of-Life Testing (Approved 05/14/18) – 6-weeks of tests in May/June**
- **Aqua/Aura Maneuver Working Group:**
 - **Aura Reaction Wheel Assembly (RWA) Slew Maneuver Test (#1a) – 12/12/17**
 - » Experienced unexpected delta-SMA due to incorrect wheel caging parameters
 - **Aura RWA Slew Maneuver Test (#1b) – 01/11/18**
 - » Corrected RWA maneuver planning tool and wheel caging parameters – nominal performance
 - **Simulations found issues during abort scenario contingency responses – mid-January**
 - » RWA Maneuver EPR, RWA Maneuver Test #2, & IAM #56 w/ RWA were subsequently postponed and efforts shifted to focus on 2018 IAM series execution



Planned Activities



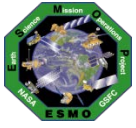
- **Aqua/Aura Maneuver Working Group:**
 - Finish remaining simulations for abort scenarios and contingency responses – Summer 2018
 - Update fault management thresholds – Summer 2018
 - Reschedule EPR, Aura RWA Slew Maneuver Tests (#2 & 3) – Fall 2018
- **Aura Alternate Decommissioning Plan Evaluation (Early A-Train Exit Scenario)**
 - OMI Science Team Meeting (September 2018), Aura Science Team Meeting (January 2019)
- **September 2018: Aura Decommissioning Review (*DRAFT*)**
 - Document Phase F spacecraft activities, any new products to be developed for spacecraft / instrument calibration, proposed Engineering Tests, and Passivation Sequence
- **Winter 2018: Earth Science Constellation (ESC) MOWG (Location TBD)**
 - Update propellant budget, decommissioning analysis, reliability predictions, etc.
- **January 2019: ESMO Annual Review #12**
 - ESMO has been reevaluating the purpose and content of the review moving forward
- **Spring 2019: Annual Inclination Adjust Maneuvers (*DRAFT*)**
 - 2/27/19 (#58), 3/6/19 (#59), 3/13/19 (#60), 3/20/19 (#61), 3/27/19 (#62), & 4/3/19 (#63)
- **Mid-to-Long-Term Plans:**
 - **EOS Automation (EA) – automation of routine operations**
 - » EA Phase III – ORR Summer 2018
 - **Continue to improve RMM / DAM execution**
 - » Support ESMO / CARA devolution initiative



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 6 (Δ ORR 01/18/18)**
- **Refine ESMO CA process in support of CARA Devolution initiative (Summer / Fall 2018)**



Spring 2019 Inclination Adjust Plan (*DRAFT*)



| Sunday | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday |
|--------|---------|---------|-----------------|-----------------|---------|----------|
| 24 Feb | 25 | 26 | 27 Aura IAM #58 | 28 Aqua IAM #61 | 1 March | 2 |
| 3 | 4 | 5 | 6 Aura IAM #59 | 7 Aqua IAM #62 | 8 | 9 |
| 10 | 11 | 12 | 13 Aura IAM #60 | 14 Aqua IAM #63 | 15 | 16 |
| 17 | 18 | 19 | 20 Aura IAM #61 | 21 Aqua IAM #64 | 22 | 23 |
| 24 | 25 | 26 | 27 Aura IAM #62 | 28 Aqua IAM #65 | 29 | 30 |
| 31 | 1 April | 2 | 3 Aura IAM #63 | 4 Aqua IAM #66 | 5 | 6 |
| 7 | 8 | 9 | 10 Aura Back-up | 11 Aqua Back-up | 12 | 13 |
| 14 | 15 | 16 | 17 | 18 | 19 | 20 |

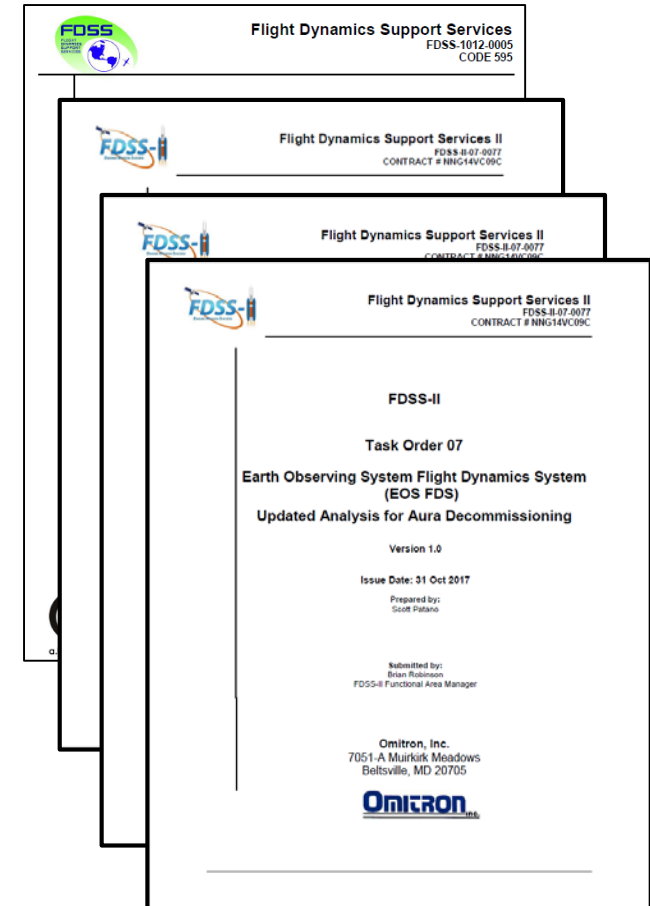


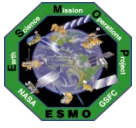
Aura Propellant Usage

(No Change - Analysis Updated October 2017)



- **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**
 - Updated Lifetime Estimates
- **2013 (August): Updated Decommissioning Plan**
 - Updated propellant trends for IAMs & DMUMs
 - Updated definitive fuel usage and predicted solar flux levels
 - Updated Constellation Exit Plan
- **2014 (September): Updated Decommissioning Plan**
 - Updated propellant trends for IAMs & DMUMs
 - Updated definitive fuel usage and predicted solar flux levels
- **2015 (September): Decommission Plan Update Postponed**
 - Postponed to evaluate long-term plan and decommissioning maneuvers
- **2016 (January): Updated Decommission Plan (v1.2)**
 - Updated definitive fuel usage & predicted solar flux levels
 - Updated propellant estimates for IAMs & DMUs
 - Included hypothetical MLT drift analysis with LS-8
- **2017 (October): Updated Decommission Plan (v1.0)**
 - Updated definitive fuel usage & predicted solar flux levels
 - Updated propellant estimates for IAMs & DMUs
- **2018 (Expected July): Updated Decommission Plan**
- **Annual updates will be provided each July (starting in 2017)**
 - Final will be produced 60 days before start of decommissioning





Remaining Fuel Estimate



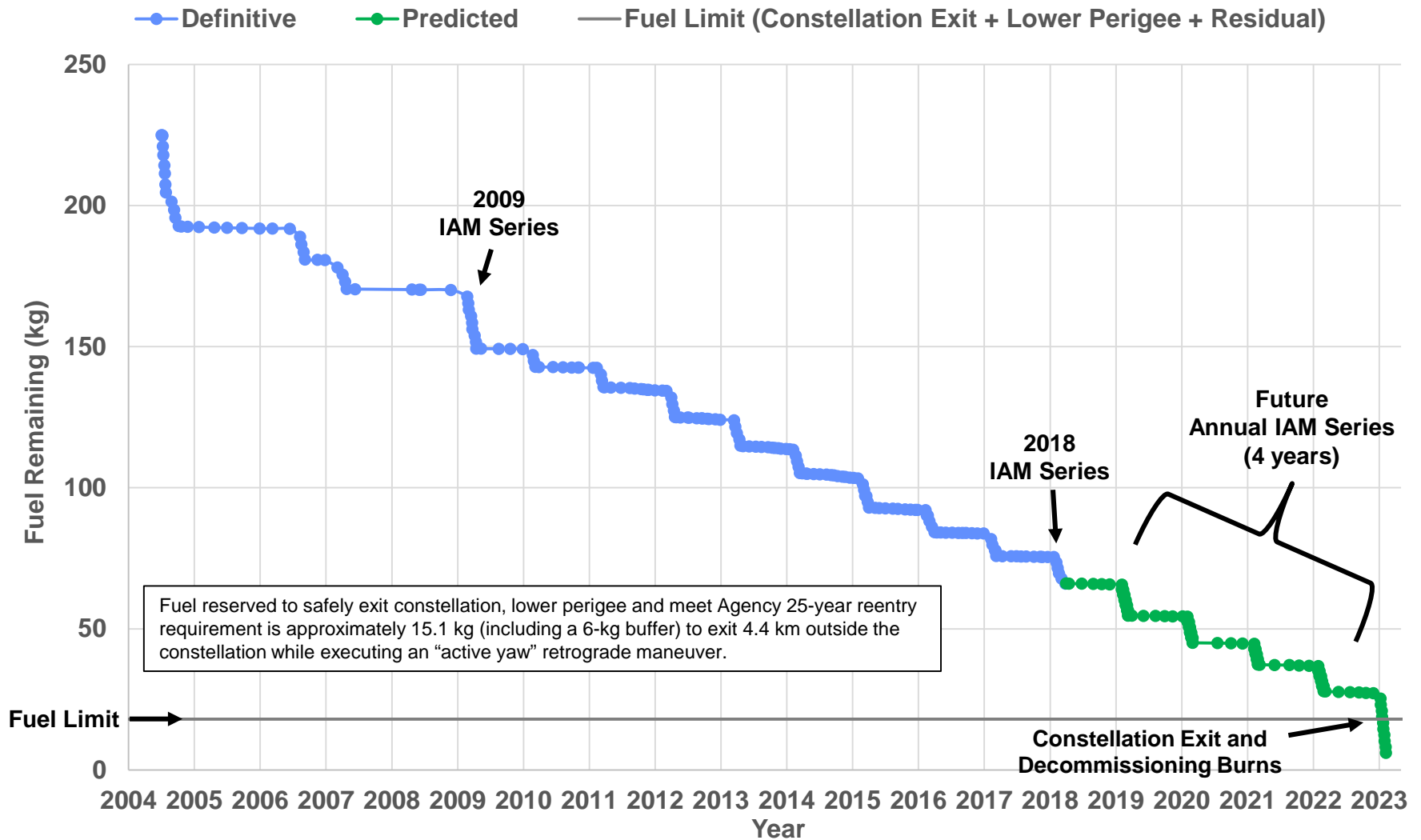
(No Change - Analysis Updated October 2017)

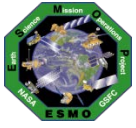
- **Long-term orbit simulations were run for Aura through Feb 2023**
 - Used mean nominal Schatten solar flux predictions (March 2017)
 - Estimated the frequency of drag make-up maneuvers to maintain Aura's WRS-2 ground track requirements
 - Estimated the required number of annual inclination maneuvers for Aura to maintain its mean local time (MLT) requirement (25 IAMs through 2023)
 - Did not include potential debris avoidance maneuvers
 - Utilized FreeFlyer 6.7.2 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 (before 2023 IAM series).**
- **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 and a more efficient inclination/mean local time option to extend the potential lifetime



Fuel Usage: Actual & Predicted

(Updated May 2018 – post-IAMs)





Debris Assessment Software

(No Change - Analysis Updated October 2017)



- **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)**
- **DAS requires several inputs describing the spacecraft's mission:**
 - Start apogee = Average Height = ~696 km (at constellation exit)
 - Spacecraft Dry Mass = 2791.746 kg (includes 1.2 kg of unusable fuel and 4.8 kg of uncertainty)
 - Tumbling Area = 46.1 m² (FDSS-II-07-0085_Aura Average Area _V1.0 (3/1/17))
 - Area-to-Mass Ratio = Tumbling Area / Dry mass = 0.016485 m²/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**

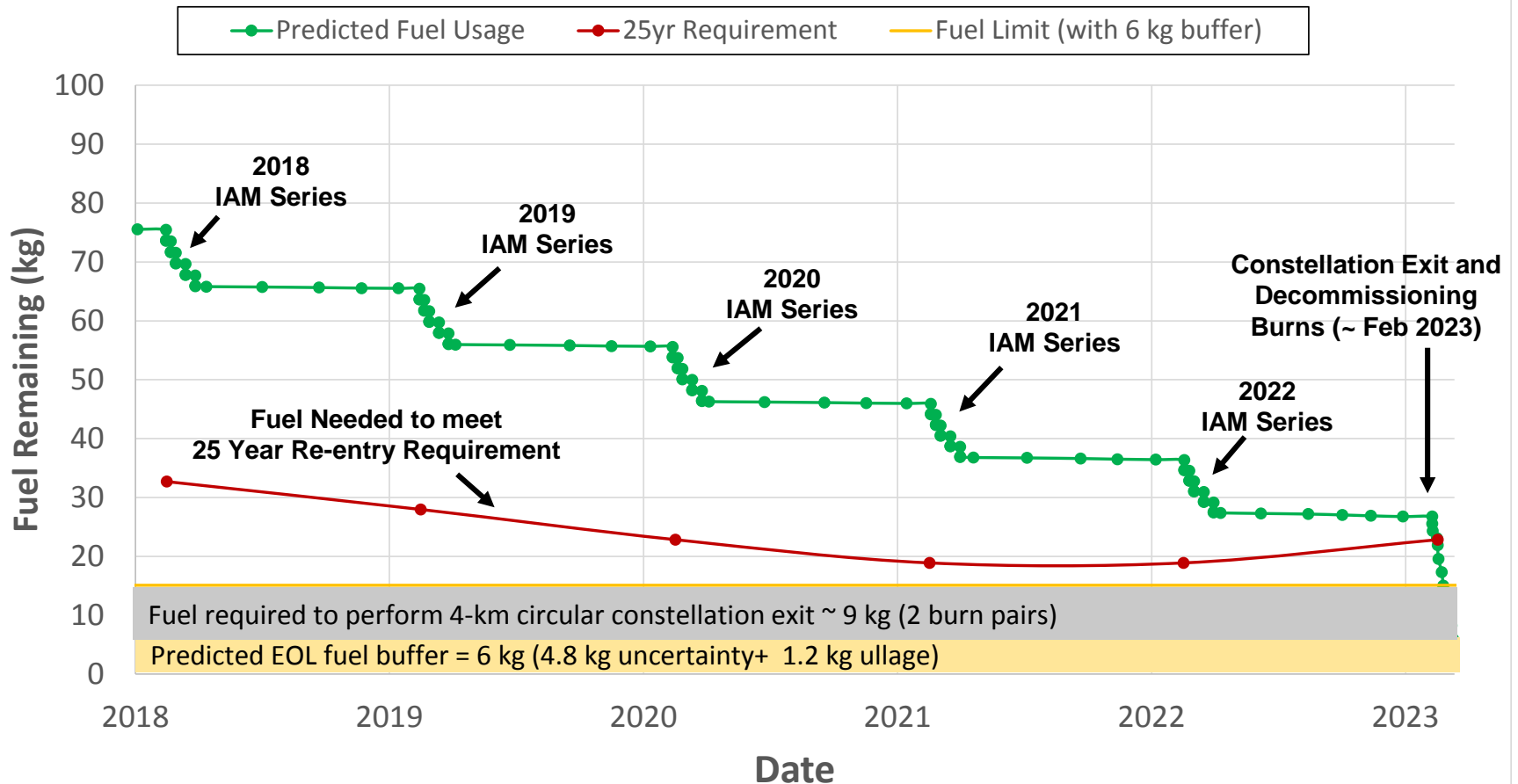


Aura DAS End of Life Predictions

(Same Baseline Plan – Analysis Updated October 2017)



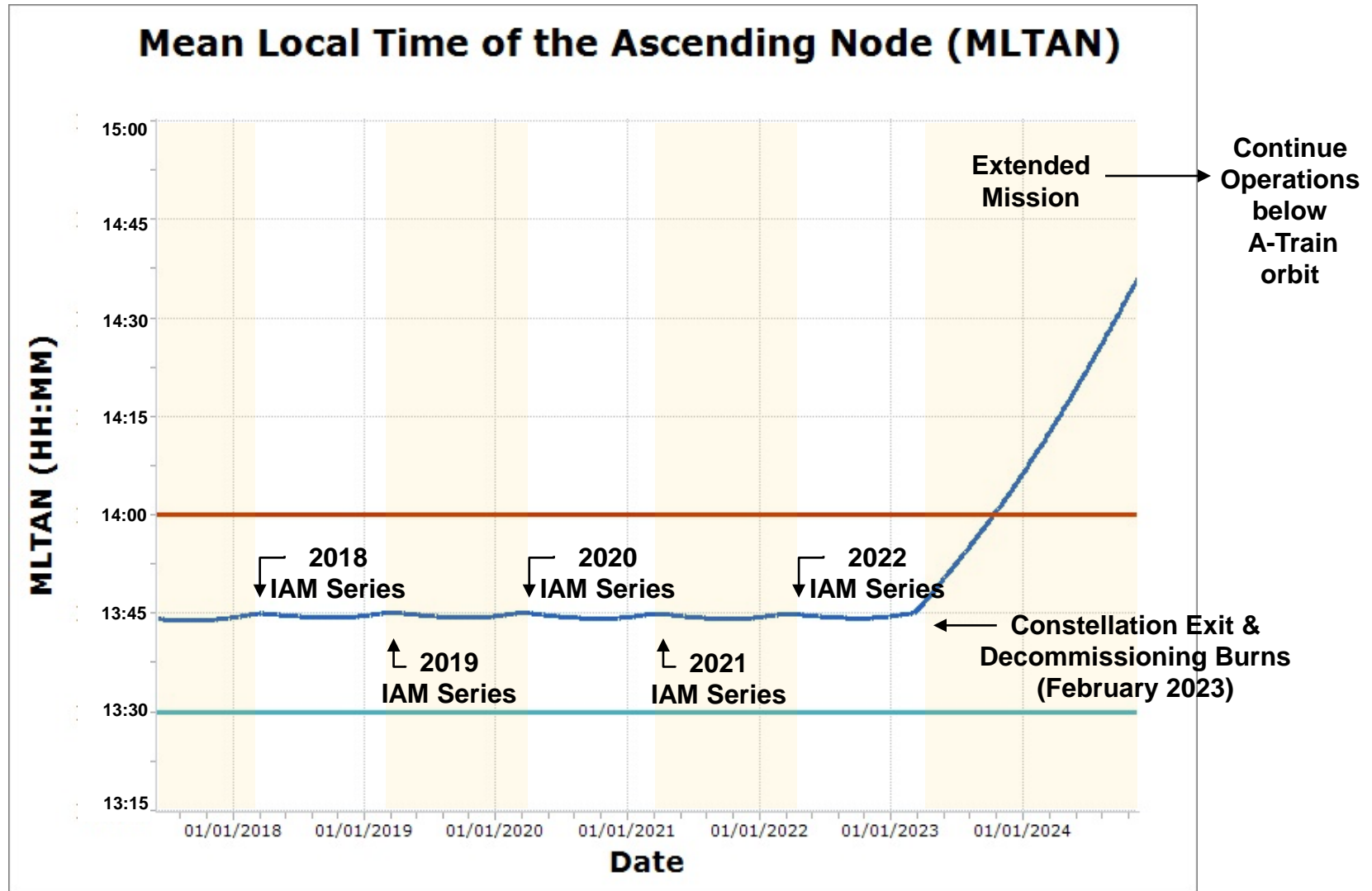
Aura Required Fuel Nominal Solar Flux Predictions and Tumbling Reentry Area 4.4 km Exit and Active Yaw Deorbit Maneuvers

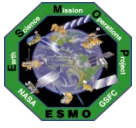




Aura Predicted Mean Local Time

(Same Baseline Plan – Analysis Updated October 2017)

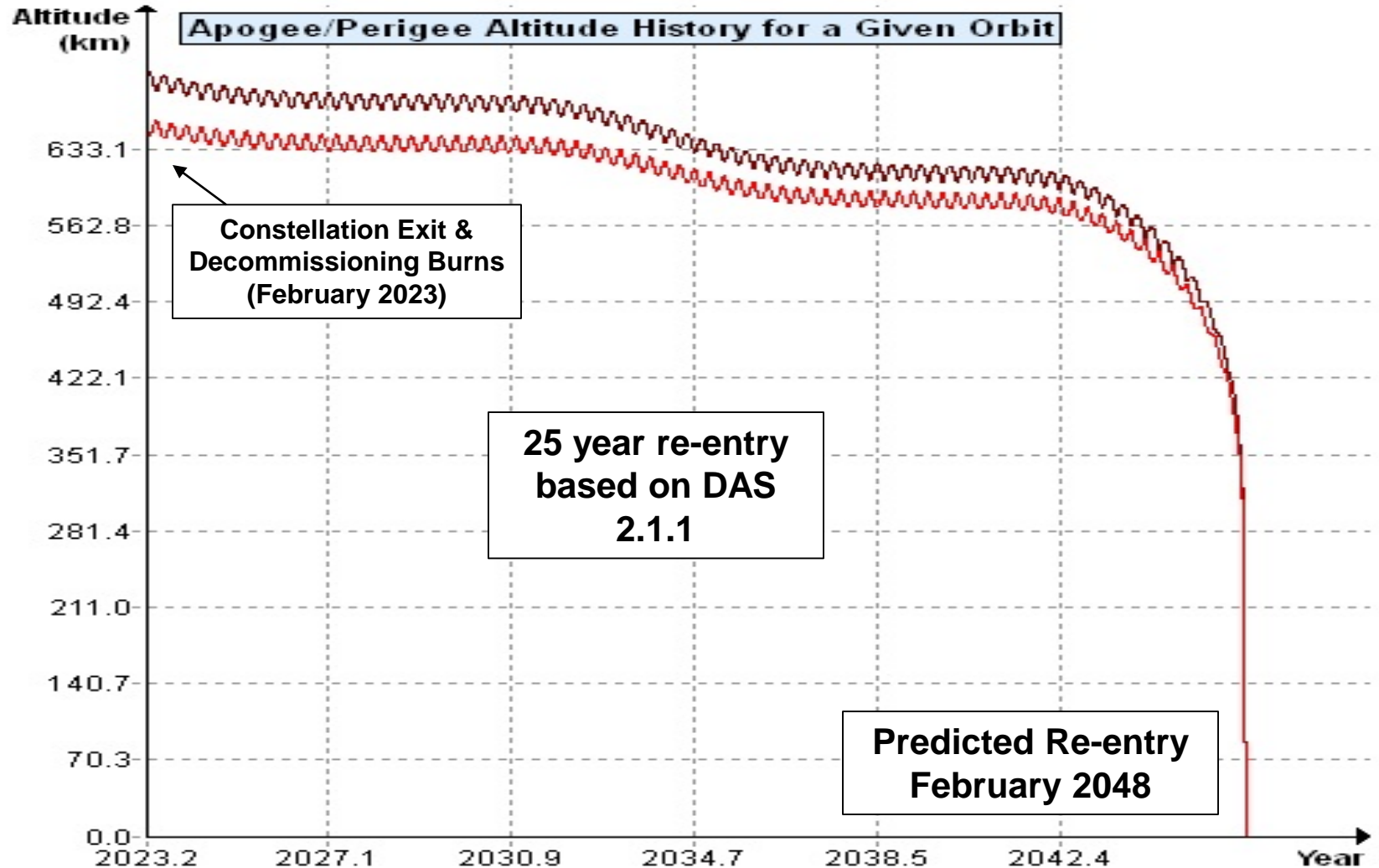


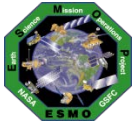


Aura Predicted Re-entry



(Same Baseline Plan – Analysis Updated October 2017)



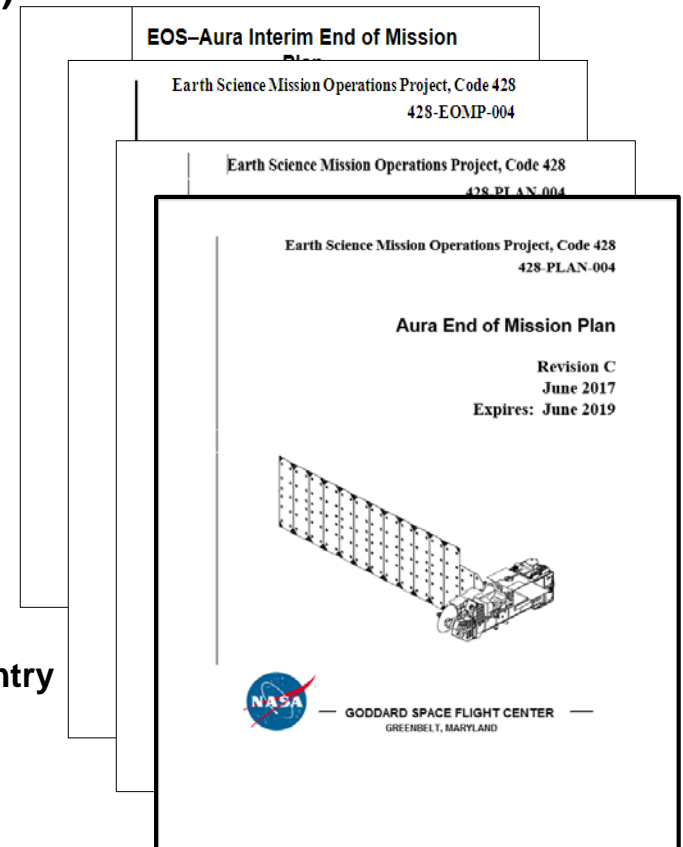


Aura End of Mission Plan (EOMP)

(No Change - Plan Updated Spring 2017)



- 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 (09/2012)
 - Added Small Object Collision Assessment
- Produced EoMP Rev B: February 2015
 - Updated Lifetime Estimate (09/2014)
- Produced EoMP Rev C: June 2017 (in Code 400 review)
 - Updated Lifetime (12/2016) & Reliability estimates
- Final will be produced 60 days before End of Mission
- 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)
 - » Re-entry Risk (Un-controlled)
 - Waivers were approved in May 2013





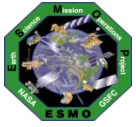
Summary



- **Spacecraft Status – GREEN**
 - **COMM: Transmitter-B Reflected Power Anomaly (01/05/18) – No active impact**
- **Instrument Status - GREEN**
 - **HIRDLS: Chopper Stalled 03/17/08 – Not collecting science data**
 - **MLS: Operating Normally – Only periodic Band 13 measurements**
 - » **08/06/13: Band 12 Shut down (reached end of useful life – 2-year design)**
 - » **THz module in Standby Mode – Potential for one final measurement – Date TBD**
 - » **02/23/2018: Mid-Band 1 Local Oscillator Out-of-Lock Anomaly (Recovered 02/26/18)**
 - **OMI: Operating Normally**
 - » **Field-of-View Anomaly started in September 2007 – currently stable**
 - » **03/12/17: OMI Survival Mode Transition (Recovered 03/16/17)**
 - » **04/30/2018: OMI IAM Warm Restart (Recovered 05/01/18)**
 - **TES: Instrument Decommissioned on 01/31/18**
- **Data Capture/L0 Processing Status – GREEN**
 - **SSR Data Capture to 04/30/18: 99.99582113%**
- **Ground Systems – GREEN**
 - **Responding to new security requirements and upgrades to obsolete hardware or COTS systems, as required**
 - **08/03/2017: EOS Automation (EA) Release 2.7 ORR (Phase II)**
 - **04/11/2017: MMS Build 24.2.0 (RHEL7) Transition for Aura**



Questions



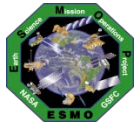
Additional Charts

**Maneuvers & Ground Track History
Orbital Trends**

**Aura Conjunction Assessment
High Interest Events (HIEs)**

Data Capture & Operations Errors

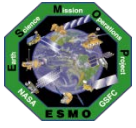
**Extended Mission Plans
(Analysis Updates)**



Orbit Maintenance



- **Mission Requirements:** Perform Drag Make-Up Maneuvers (DMUMs) to maintain Aura's 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
- **To date a total of 110 routine DMUMs have been performed**
 - 07/19/2012: DMUM # 43 No Yaw Slew Maneuver (NYS) #1 – NYS Maneuvers (37)
 - Last maneuver 05/03/2018 (#110) – Next planned maneuver 06/07/2018 (#111)
 - Variation in performance from -3.5% (cold) to +3.3% (hot)
- **Conducted 13 series of inclination adjustment maneuvers**
 - 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)
 - Variation in performance from -4.5% (cold) to +1.9% (hot)

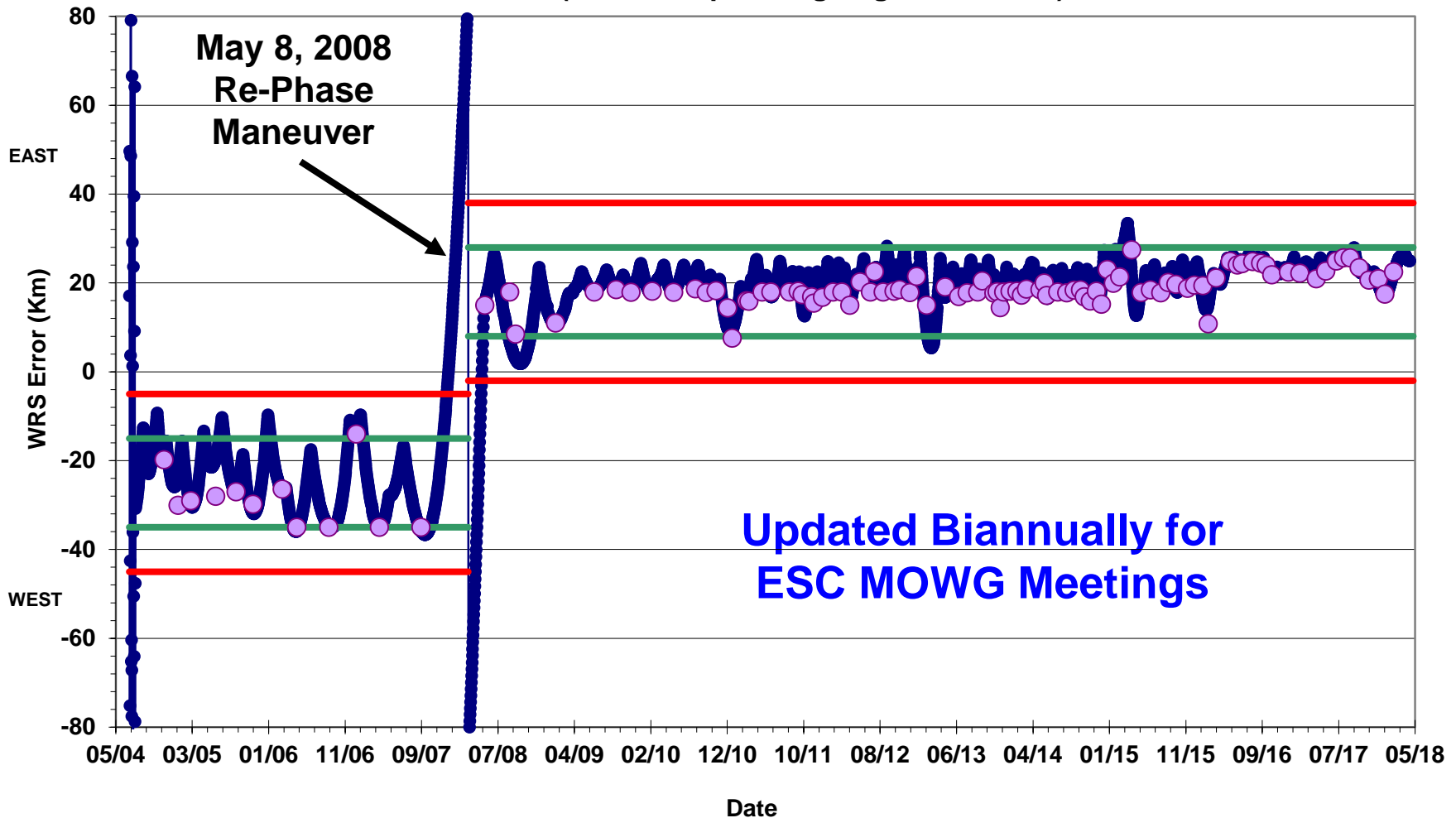


WRS Ground Track Error (GTE)

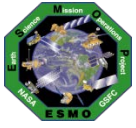
(As of April 23, 2018)



Aura WRS Groundtrack Error at the Descending Node
(Maneuver planning targets included)



Updated Biannually for
ESC MOWG Meetings

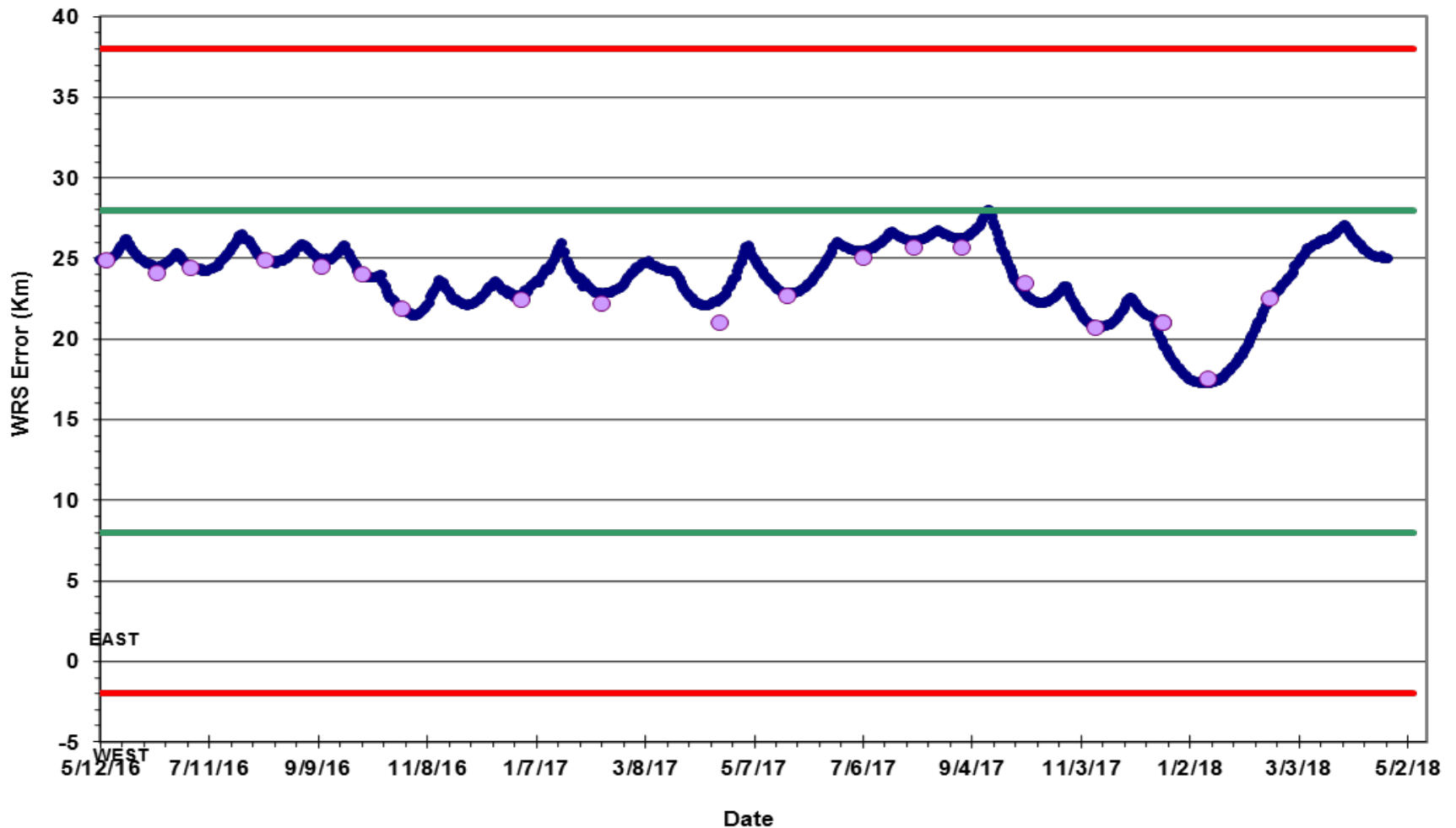


WRS Ground Track Error (GTE)

(As of April 23, 2018)



Aura WRS Groundtrack Error at the Descending Node
(Maneuver planning targets included)



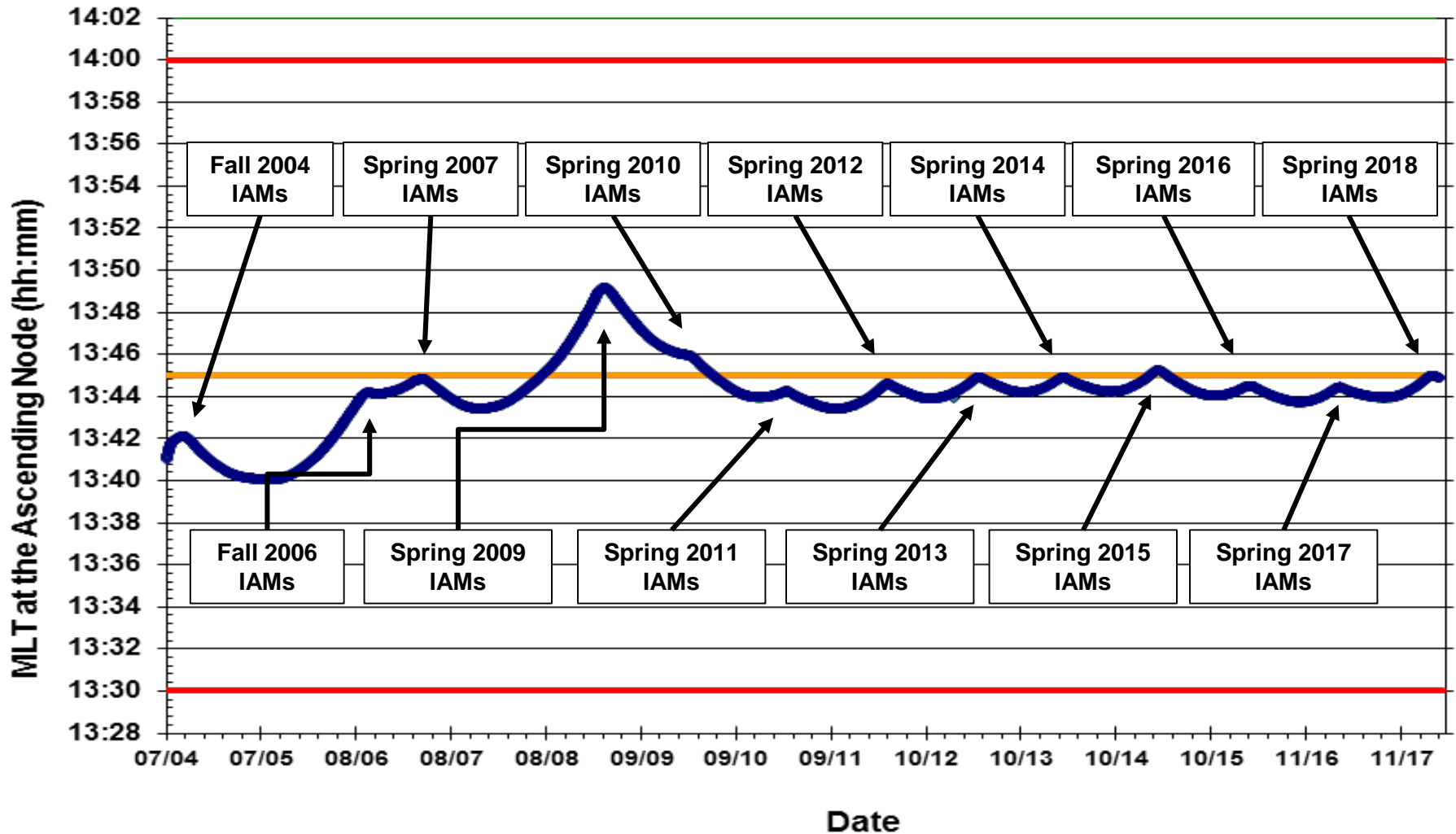


Aura Averaged MLT @ Ascending Node

(As of April 23, 2018)



Aura Averaged Mean Local Time at the Ascending Node



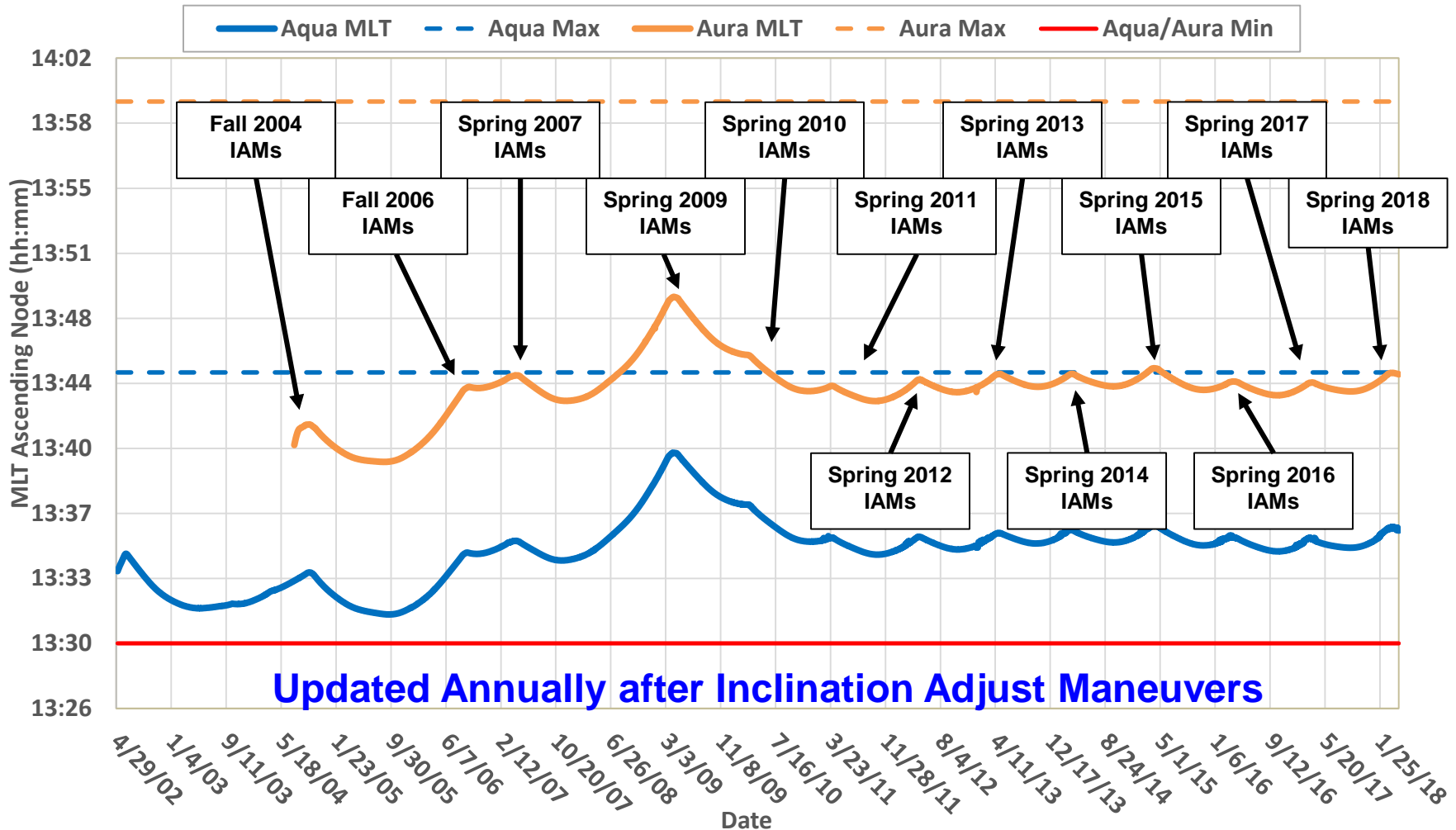


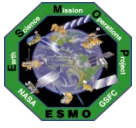
Aqua/Aura Mean Local Time (MLT)



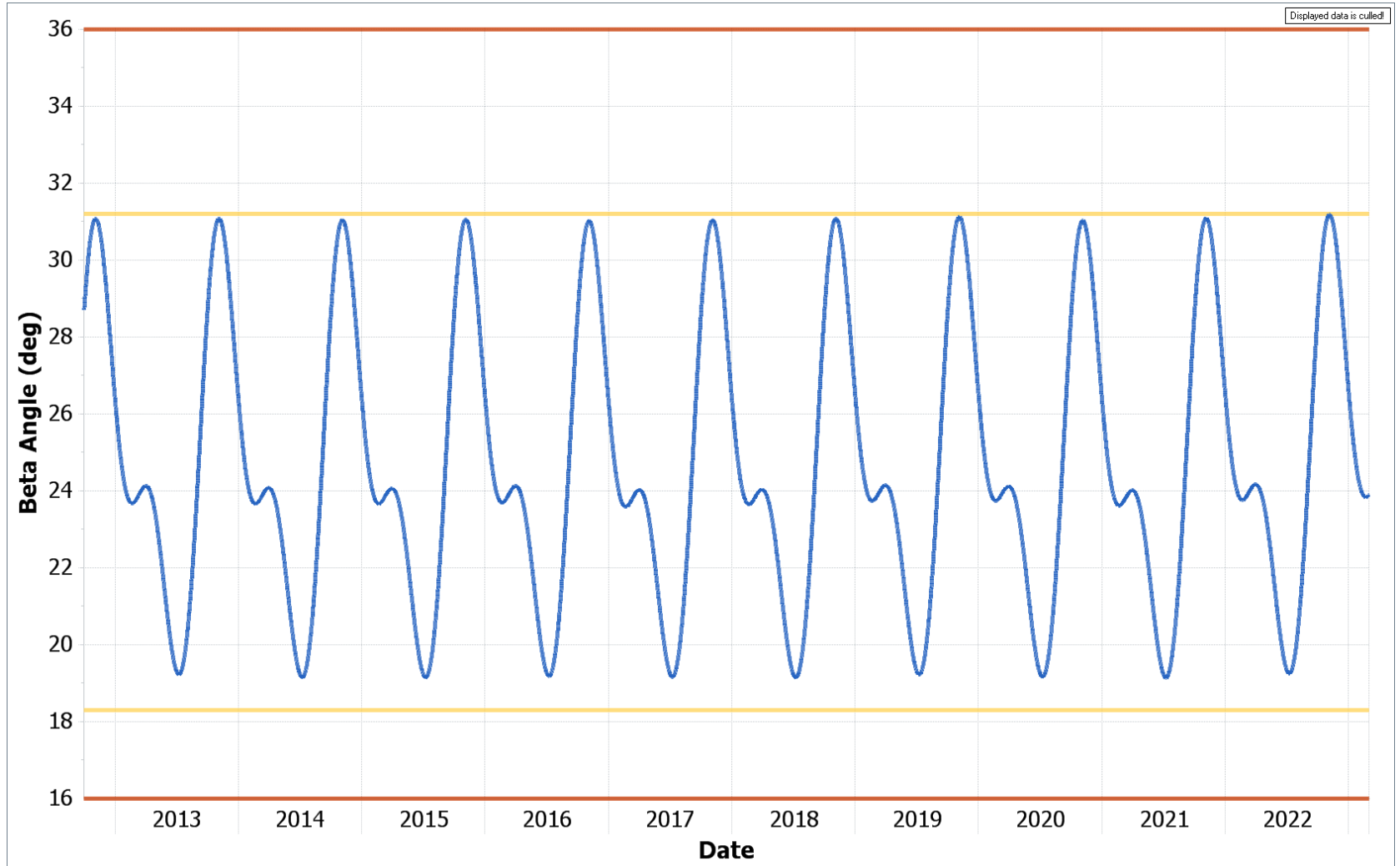
@ Ascending Node (As of April 23, 2018)

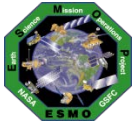
Aqua and Aura MLT Separation





Aura Predicted Beta Angle (With Yearly Inclination Maneuvers) (No Change)



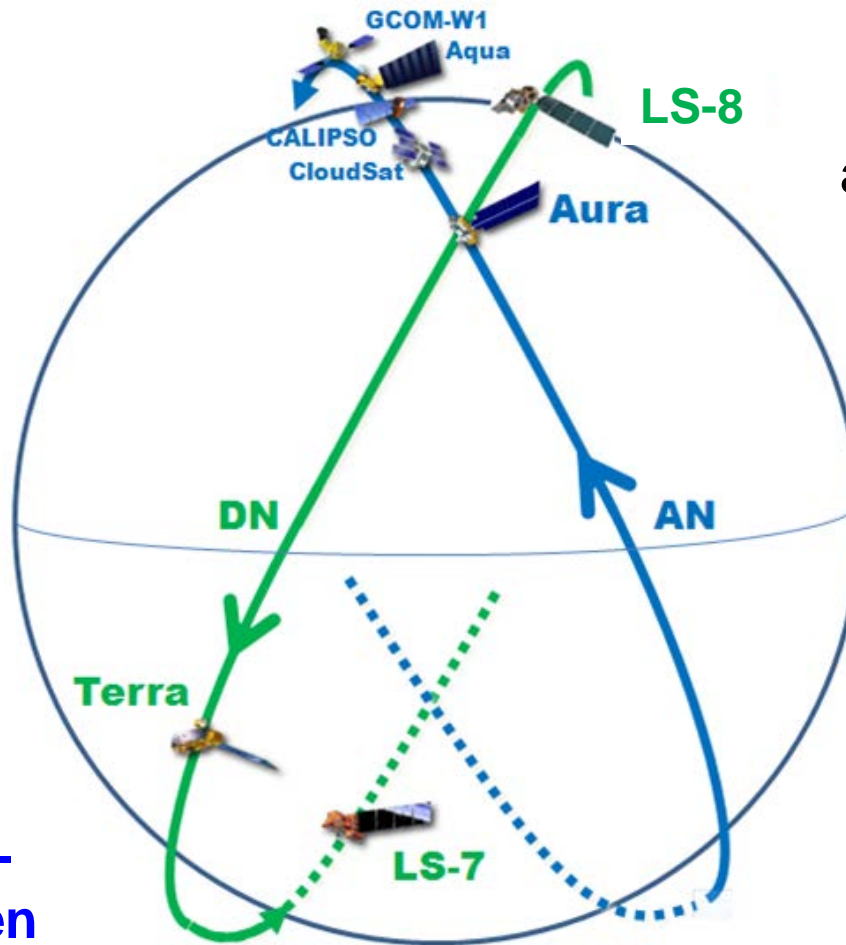


Aura and Landsat-8 (LS-8) Orbit Phasing



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 1/2 orbit apart



Over the past 12 months (May-Apr)
there has been 215-340 seconds between
Aura and LS-8

Terra ~ 30 min
behind LS-7

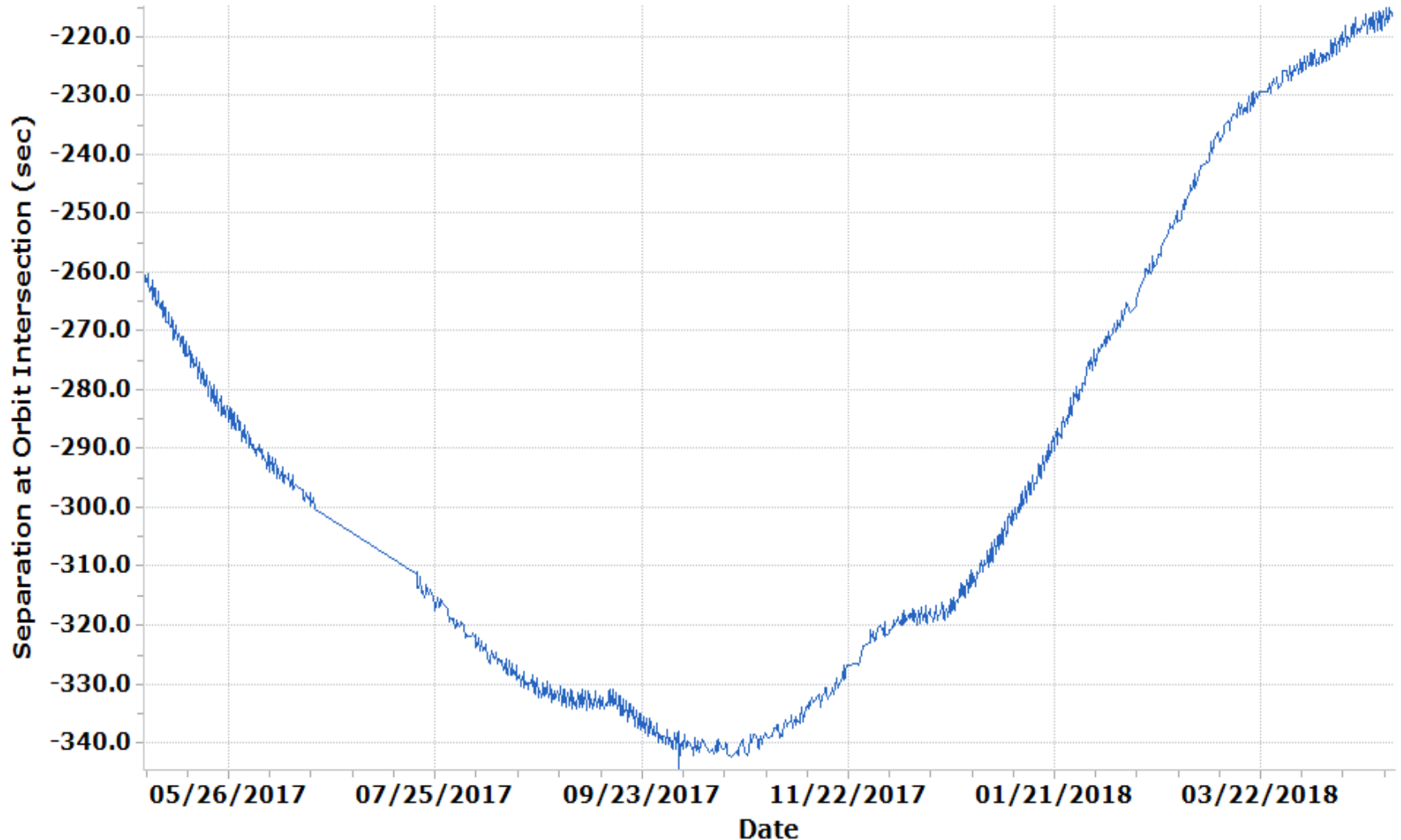
1 Orbit = ~ 100 minutes

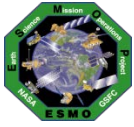


LS-8/Aura Phasing at Poles



@ Northern Intersection Point (as of April 30, 2018)





Aura Conjunction Assessment High Interest Events (HIEs)



| | Dec `17 | Jan `18 | Feb `18 | Mar `18 | Apr `18 | May `18 | Total |
|--------------|----------|----------|----------|----------|----------|---------|----------|
| Tier 1 | 0 | 0 | 0 | 0 | 0 | | 0 |
| Tier 2 | 1 | 0 | 0 | 0 | 1 | | 2 |
| Tier 3 | 1 | 1 | 2 | 1 | 1 | | 6 |
| Tier 4 | 0 | 0 | 0 | 0 | 0 | | 0 |
| Total | 2 | 1 | 2 | 1 | 2 | | 8 |

2014: 33 CARA HIEs – 18 required significant action (T2-T4)

2015: 32 CARA HIEs – 18 required significant action (T2-T4)

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

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

15. 12/09/2017: CA vs. 04638 on 12/11 at 01:53:54 GMT – Held briefing, screened maneuver options, but Pc dropped off (T3)

16. 12/28/2017: CA vs. 34319 on 12/31 at 07:39:43 GMT – Monitored but no action required (T2)

2018: 6 CARA HIEs (thru 04/25/2018) – 6 required significant monitoring and/or actions (T2-T4)

1. 01/16/2018: CA vs. 80720 at 08:46:49 GMT – DAM planned but conjunction Pc rolled off (T3)

2. 02/03/2018: CA vs. 89363 at 20:45:22 GMT – Automated options generated and screened but conjunction Pc rolled off (T3)

3. 02/13/2018: CA vs. 38243 at 06:29:36 GMT – DAM planned but conjunction Pc rolled off (T3)

4. 03/01/2018: CA vs. 30499 at 12:27:12 GMT – Post-IAM conjunction of concern, TCA was 22 hours post burn, Pc rolled off (T3)

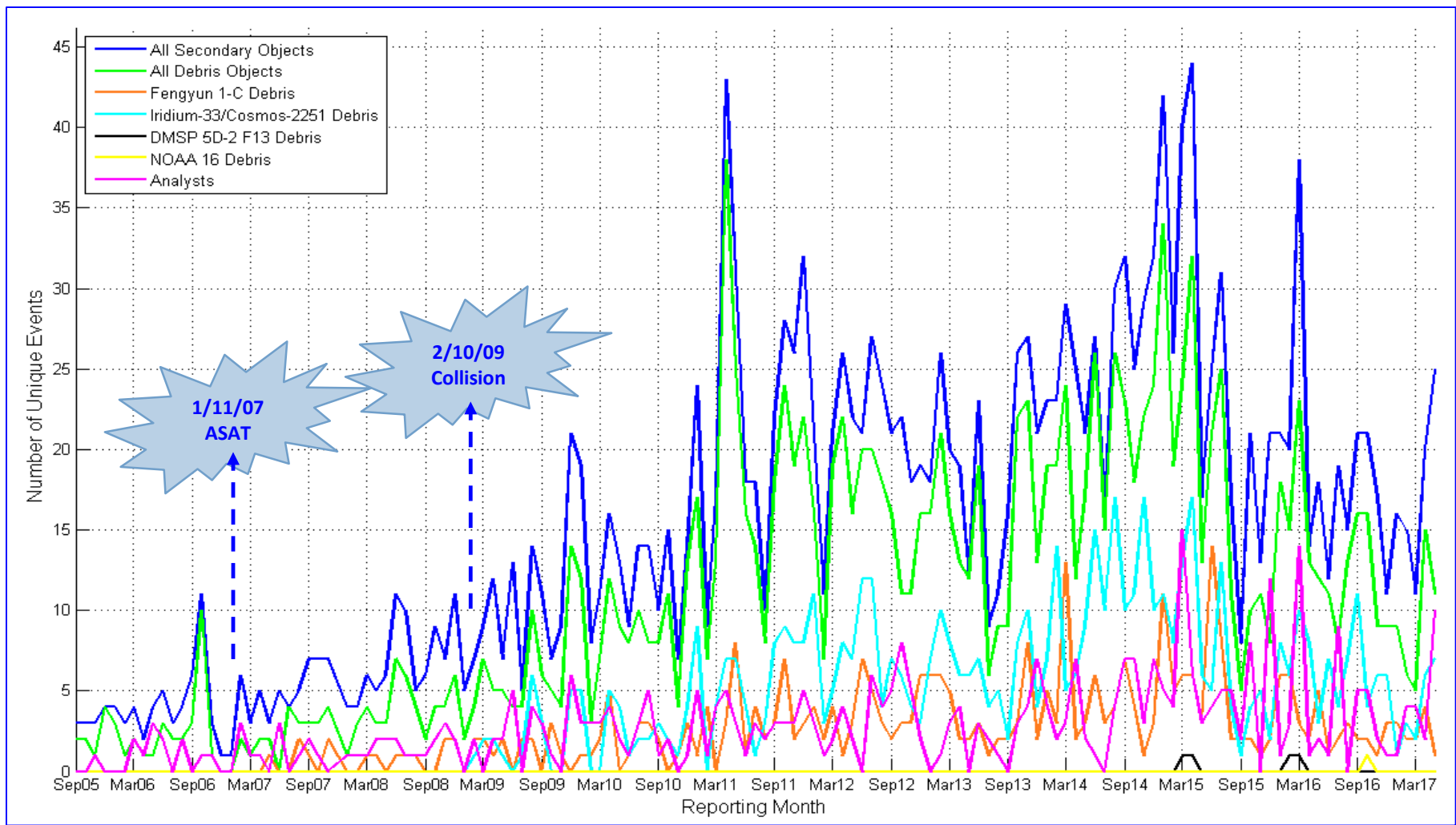
5. 04/09/2018: CA vs. 89188 at 12:30:36 GMT – Maneuver options generated and screened, Pc dropped w/ updated tracking (T3)

6. 04/15/2018: CA vs. 89301 at 19:15:35 GMT – Briefed for IAM CAM, after IAM postponement Pc rolled off (T2)

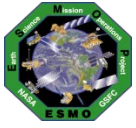
Tier 1 – Notify (email/phone), Tier 2 – Conduct Briefing,
Tier 3 – Plan Maneuver, Tier 4 – Execute Maneuver



Aura Conjunction Assessment (September 2005 thru June 2017)



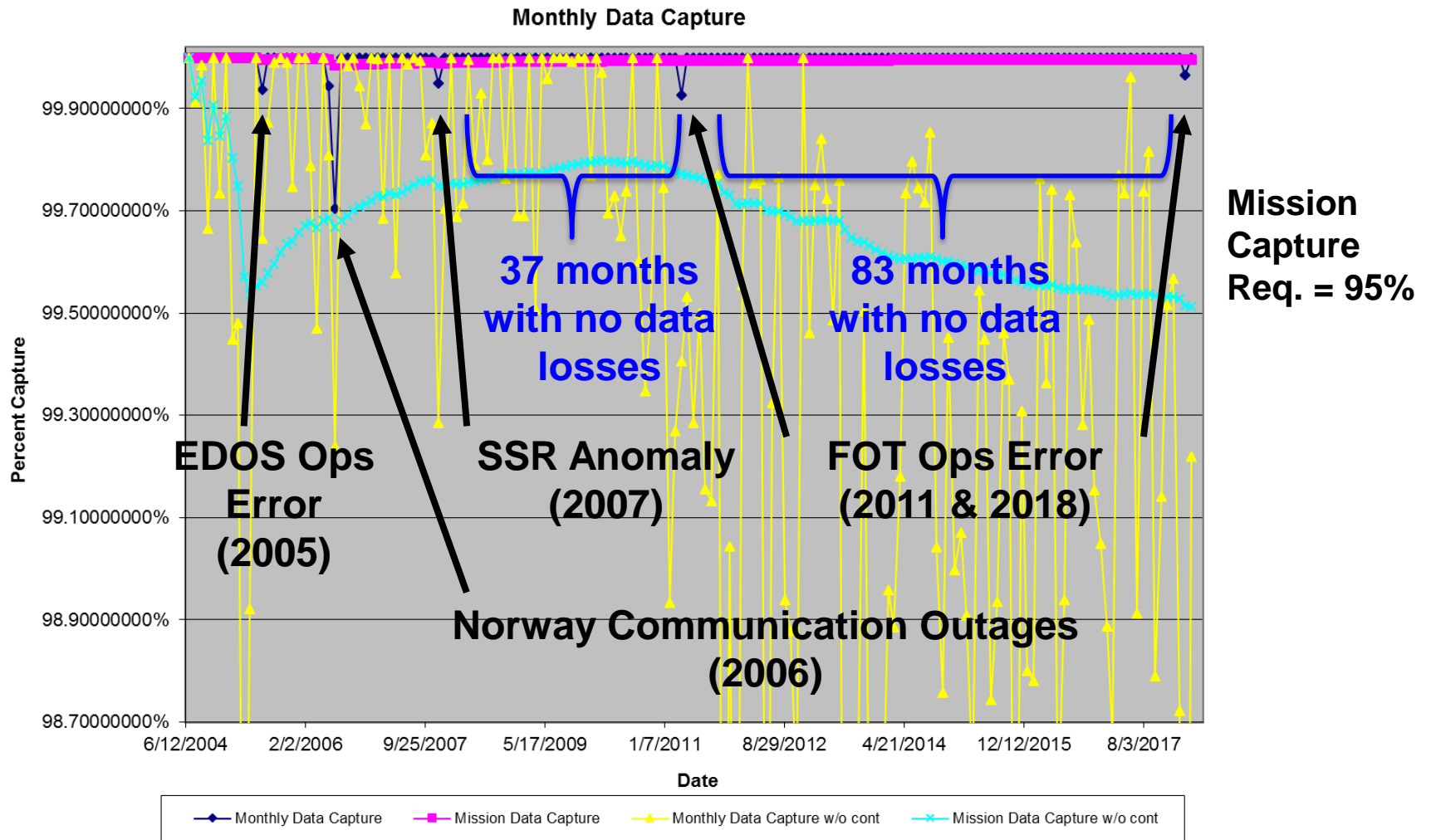
Credit: NASA CARA Team



Aura Monthly Data Capture



SSR Data Capture to 04/30/2018: 99.99582113%



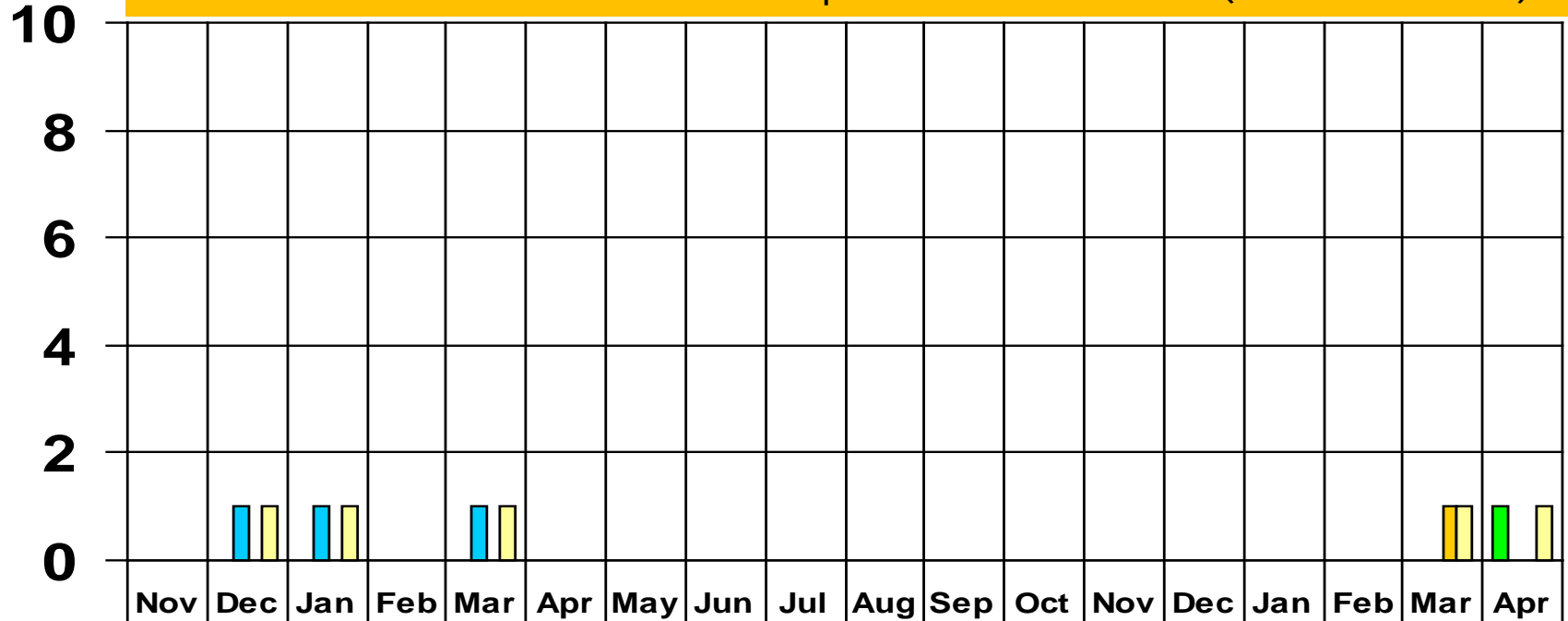


Operational Errors

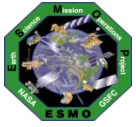
(18-Months: **November 2016 – April 2018**)



Aura: 1 Months since last operational error (March 2018)



| | | | | | | | | | | | | | | | | | | |
|---------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ■ Terra | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| ■ Aqua | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ■ Aura | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| ■ Total | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |



Aura Baseline Decommissioning Plan

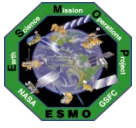
(Same Baseline Plan – No Change)



- **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 annual IAMs to maintain MLT
 - Perform periodic DMUs to maintain WRS-2 Ground Track Error

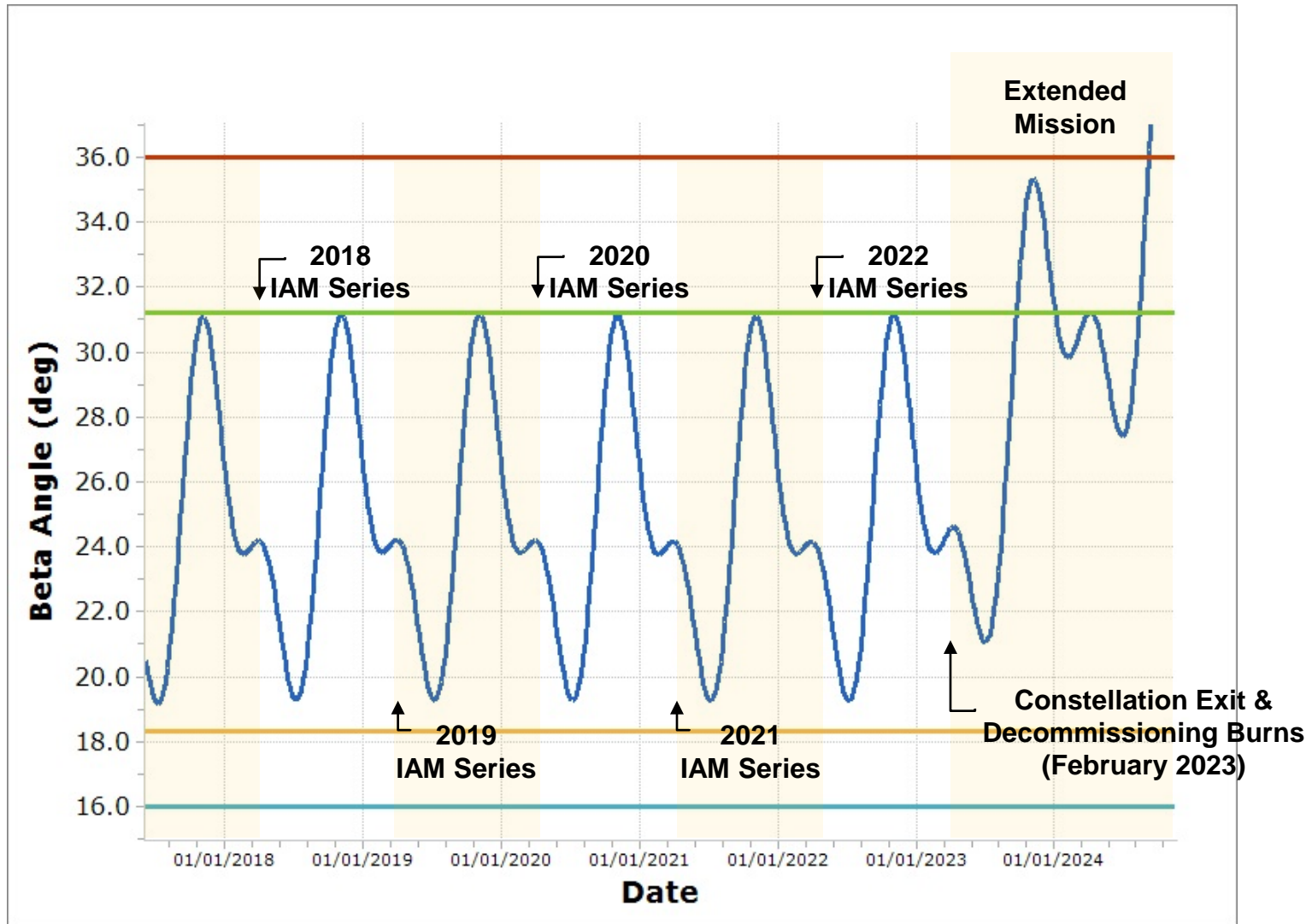
Documented in final 'EOS FDS Updated Analysis for Aura Decommissioning'
(v1.0, 10/31/17)

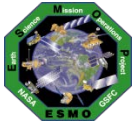


Aura Predicted Beta Angle



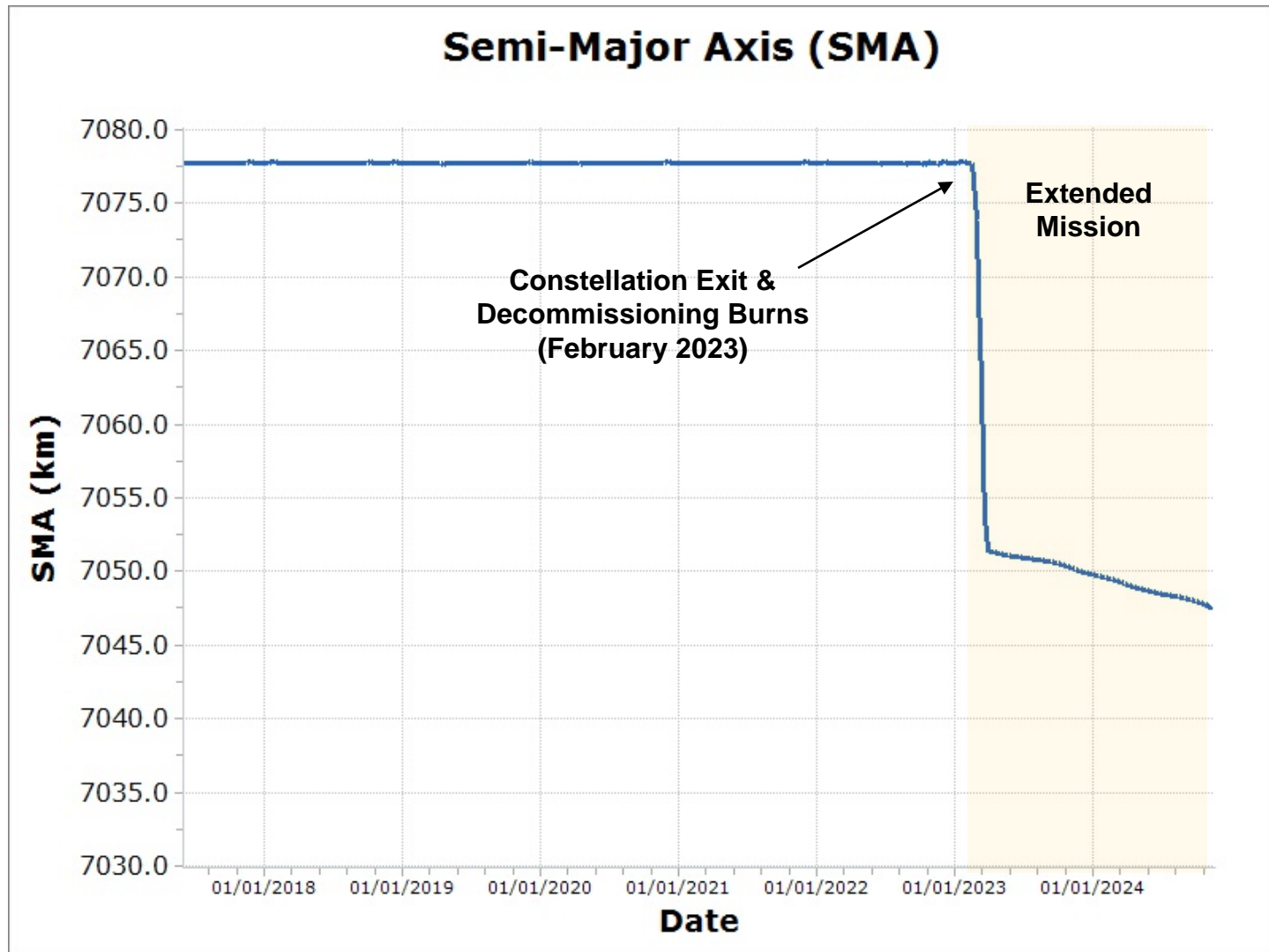
(Same Baseline Plan – Analysis Updated October 2017)

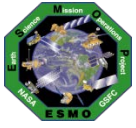




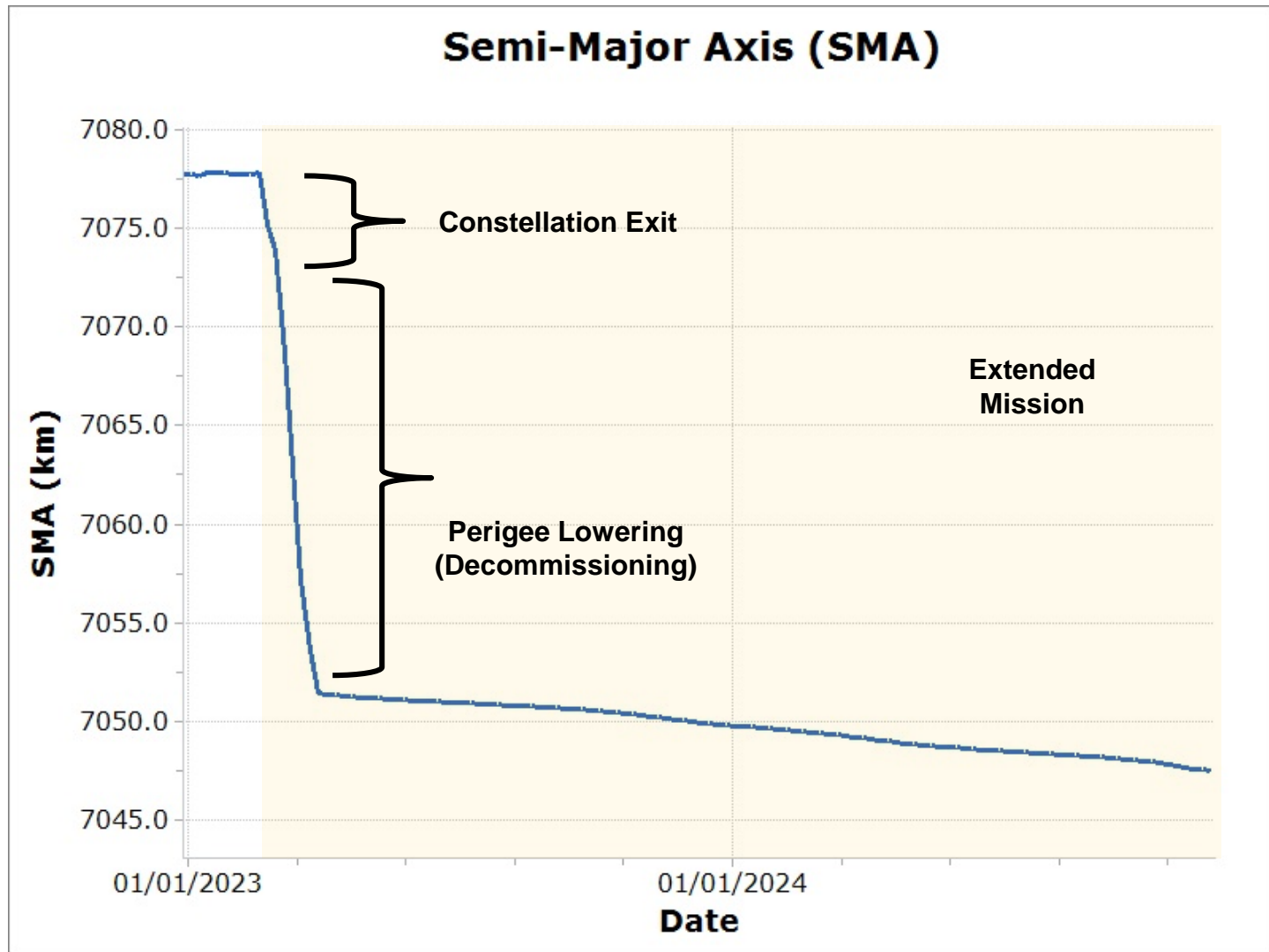
Aura Predicted Semi-Major Axis

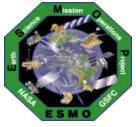
(Same Baseline Plan – Analysis Updated October 2017)





Aura Predicted Semi-Major Axis (Same Baseline Plan – Analysis Updated October 2017)





Aura Alternate Decommissioning Plan

(Same Alternate Plan – Analysis Updated October 2017)



- **Alternate Decommissioning Plan Rationale:**
 - After the OMI / TROPOMI 2-year overlap period ends, currently late 2019, fuel saving orbital maintenance schemes may be a consideration

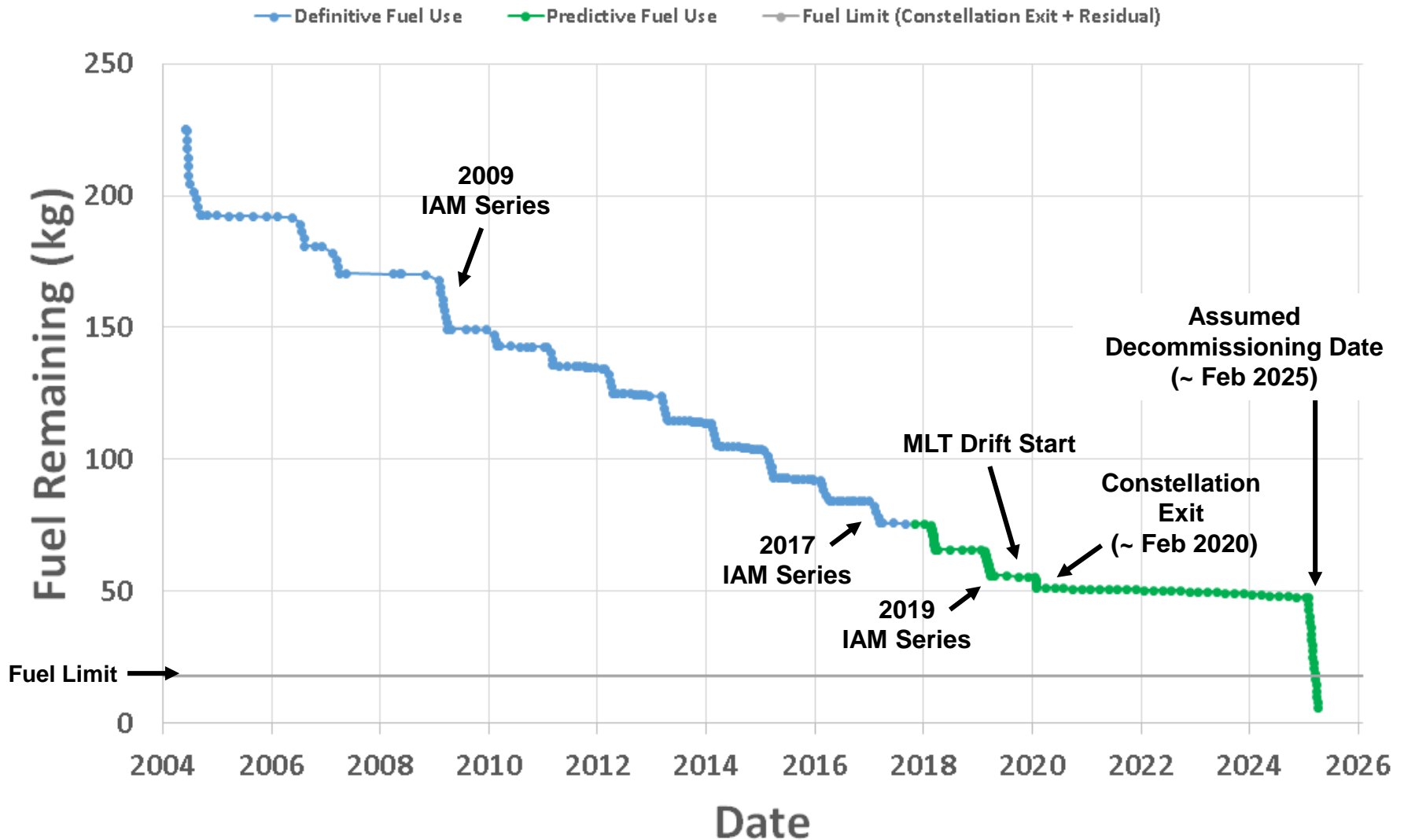
(Successful Sentinel-5P launch on 10/13/17, TROPOMI completed check out in April)
- **Alternate Decommissioning Plan Assumptions:**
 - Full IAM Series through 2019
 - Exit A-Train in February 2020 (4.4 km lower in SMA)
 - Stop performing annual IAMs after the 2019 series
 - Allow MLT and Solar Beta Angle to drift until 2025 (or beyond)
 - Perform periodic DMUs until 2025 (or beyond)
 - Maintain WRS-2 ground track and frozen orbit

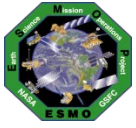
Documented in final 'EOS FDS Updated Analysis for Aura Decommissioning'
(v1.0, 10/31/17, Appendix B)



Aura Fuel Usage: Actual & Predicted

(Same Alternate Plan – Analysis Updated October 2017)

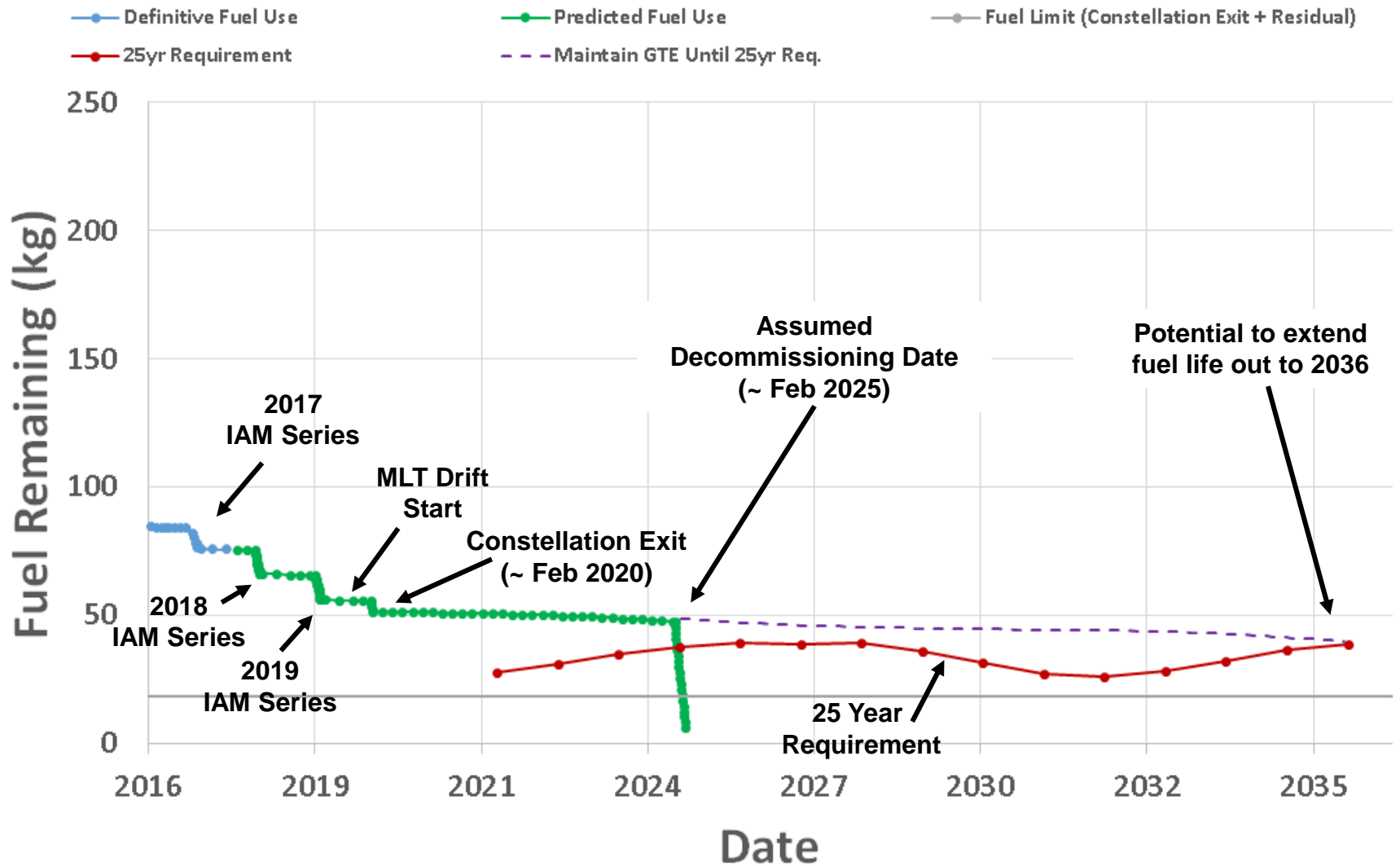




Aura Predicted Fuel Usage



(Same Alternate Plan – Analysis Updated October 2017)

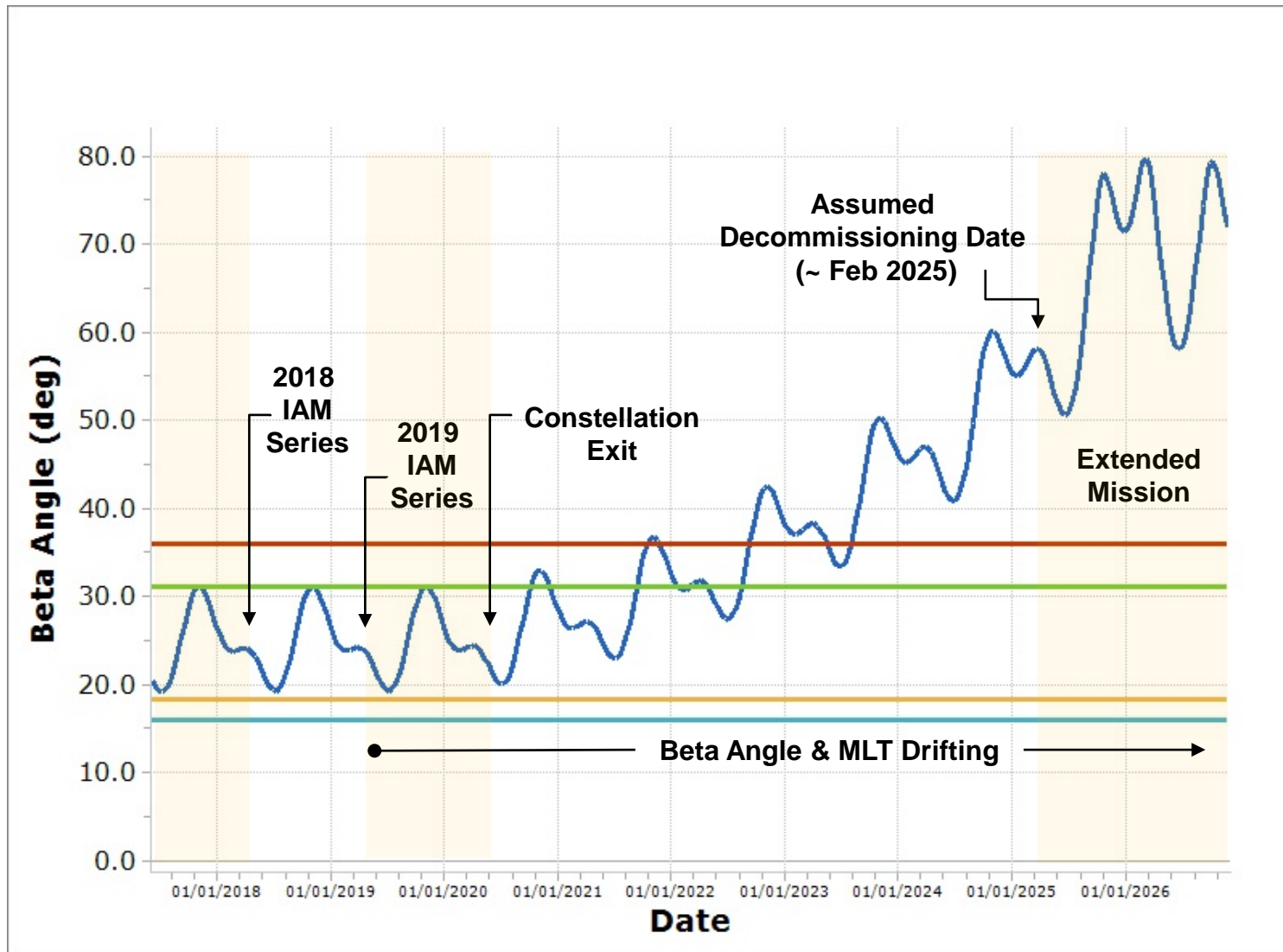




Aura Predicted Beta Angle

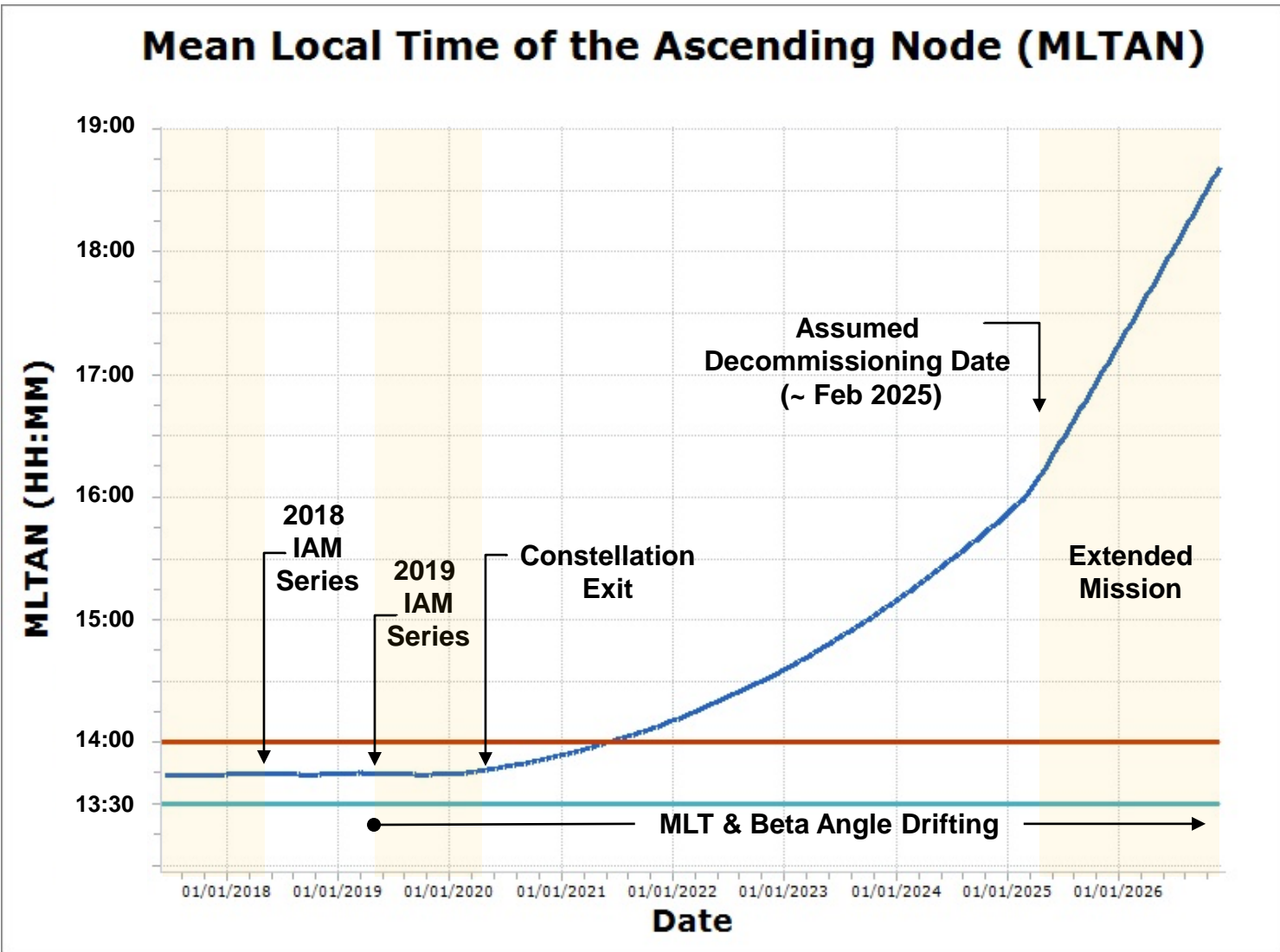


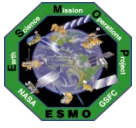
(Same Alternate Plan – Analysis Updated October 2017)





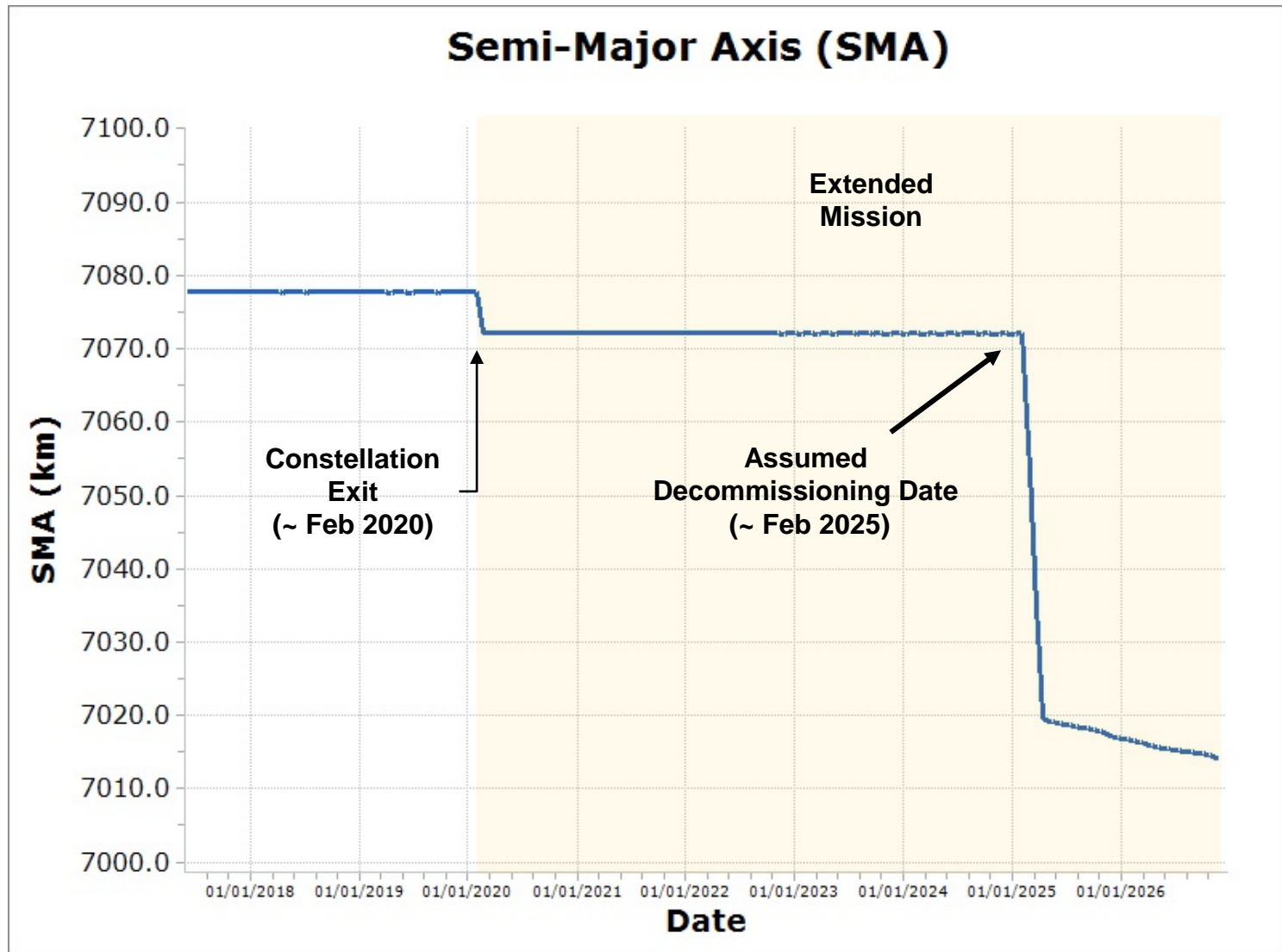
Aura Predicted Mean Local Time (Same Alternate Plan – Analysis Updated October 2017)

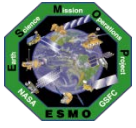




Aura Predicted Semi-Major Axis

(Same Alternate Plan – Analysis Updated October 2017)

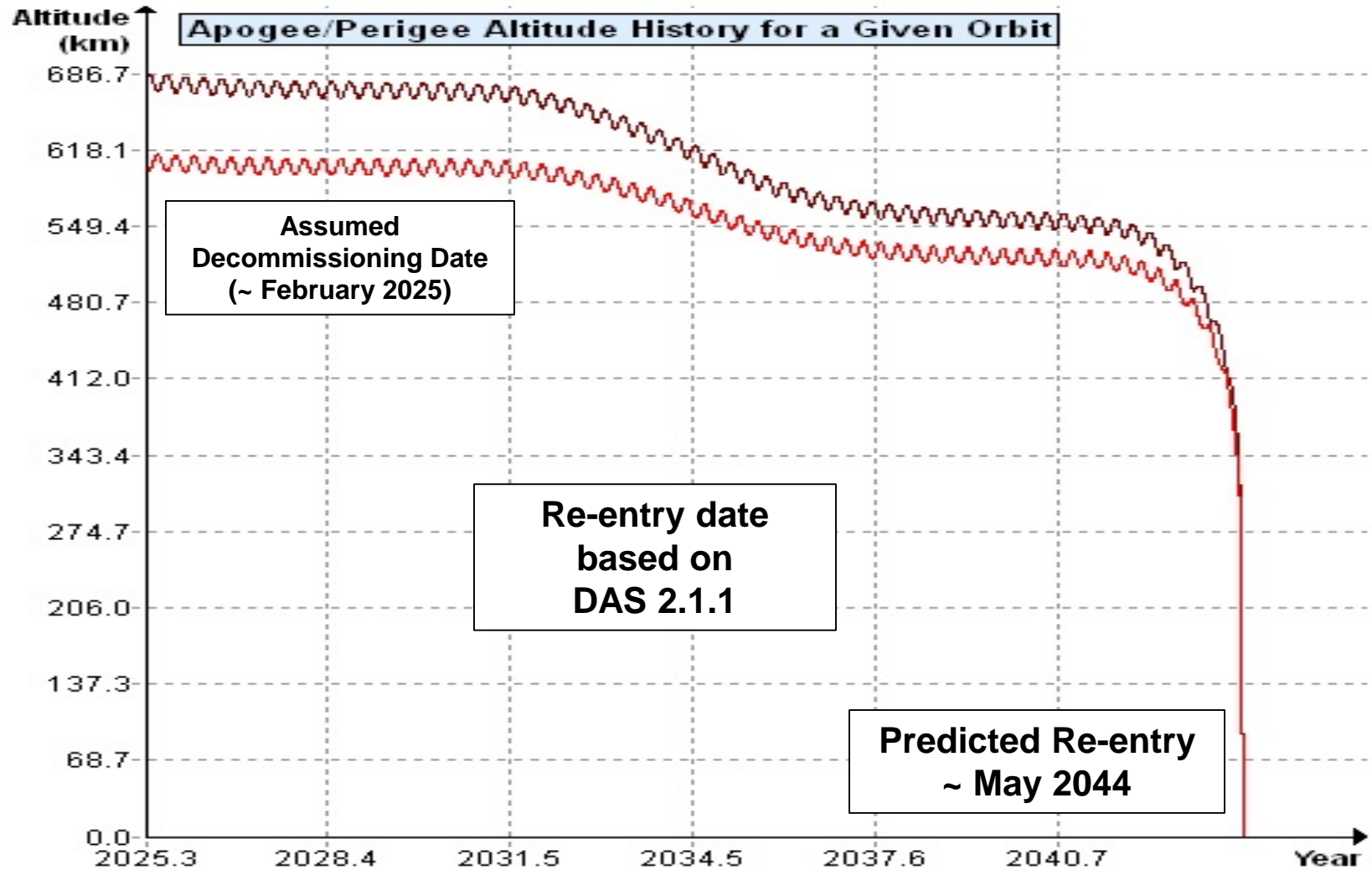




Aura Predicted Re-entry



(Same Alternate Plan – Analysis Updated October 2017)





Abbreviations / Acronyms List



| | | | | | |
|------------------|---|-----------------|---|------------------|--|
| AFM – | Aqua/Aura FSW Maintenance | FM – | Fault Management | NASA – | National Aeronautics & Space Administration |
| AN – | Ascending Node | FMU – | Formatter Multiplexer Unit | NOAA – | National Oceanic and Atmospheric Administration |
| ARE – | Array Regulator Electronics | FOT – | Flight Operations Team | NYS – | No Yaw Slew |
| ASAT – | Anti-satellite Weapon | FSW – | Flight Software | Ops – | Operations |
| CA – | Conjunction Assessment | GCOM-W – | Global Change Observation Mission- Water | OMI – | Ozone Monitoring Instrument |
| CALIPSO – | Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations | GMT – | Greenwich Mean Time | OMI-IAM – | OMI Interface Adapter Module |
| CARA – | Conjunction Assessment Risk Analysis | GNC – | Guidance Navigation & Control | ORR – | Operational Readiness Review |
| CDH – | Command & Data Handling | GS – | Global Survey | PROP – | Propulsion |
| CDR – | Critical Design Review | GSFC – | Goddard Space Flight Center | Pc – | Probability of Collision |
| CDM – | Conjunction Data Message | GTE – | Ground Track Error | R2 – | Receiver 2 |
| COMM – | Communications | HIE – | High Interest Event | RHEL – | Red Hat Enterprise Linux |
| COTS – | Commercial-Off-The-Shelf | HIRDLS – | High Resolution Dynamics Limb Sounder | RMM – | Risk Mitigation Maneuver |
| CRMS – | Collision Risk Management System | HK – | Housekeeping | RW – | Reaction Wheel |
| DAM – | Debris Avoidance Maneuver | HQ – | Headquarters | RWA – | Reaction Wheel Assembly |
| DAS – | Debris Assessment Software | IAM – | Inclination Adjustment Maneuver | SC – | Spacecraft |
| DMSP – | Defense Meteorological Satellite Program | ICS – | Interferometer Control System | SCS – | Stored Command Sequence |
| DN – | Descending Node | ID – | Ideal Date | SD – | South Dakota |
| DMUM – | Drag Make-up Maneuver | IEM – | Integrated Electronics Module | SMA – | Semi-Major Axis |
| EA – | EOS Automation | IOT – | Instrument Operations Team | SMD – | Science Mission Directorate |
| EDOS – | EOS Data Operations System | JPL – | Jet Propulsion Lab | SSR – | Solid State Recorder |
| EOC – | EOS Operations Center | JSpOC – | Joint Space Operations Center | TBD – | To Be Determined |
| EOL – | End of Life | kg – | kilogram | TCA – | Time of Closest Approach |
| EOMP – | End of Mission Plan | km – | kilometer | TCS – | Thermal Control System |
| EOS – | Earth Observing System | KSC – | Kennedy Space Center | TES – | Tropospheric Emissions Spectrometer |
| EOSSIM – | EOS Simulator | L0 – | Level-Zero | THz – | Terahertz |
| EPS – | Electrical Power System | LS – | Landsat | TMON – | Telemetry Monitor |
| EPR – | Engineering Peer Review | MLS – | Microwave Limb Sounder | TROPOMI – | Troposphere Measuring Instrument |
| ESC – | Earth Science Constellation | MLT – | Mean Local Time | WRS – | World Reference System |
| ESD – | Earth Science Division | MLTAN – | MLT of the Ascending Node | | |
| ESMO – | Earth Science Mission Operations | MMOD – | Micrometeorite Orbital Debris | | |
| ETSF – | EOC Training Simulator Facility | MMS – | Mission Management System | | |
| FDS – | Flight Dynamics System | MOWG – | Mission Operations Working Group | | |
| | | MTS – | Maneuver Trade Space | | |