

www.nasa.gov



International Earth Science Constellation Mission Operations Working Group

Jun 2-4, 2015

Aqua and Aura 2015 MLT Prediction Changes

Ryan J. Moore & David A. Tracewell

EOS FDS, esmo-eos-fds@lists.nasa.gov, +1.301.416.5050

- Introduction
- Background
- Aqua Long Term MLT Predictions
 - Original IAM Series dates
 - Updated IAM Series dates
- 2015 MLT Predictions
 - Original IAM trending method
 - New IAM trending method
- Predicted 2015 Aqua IAM Series Results Comparison
- Aqua and Aura MLT Separation
 - Updated Aqua plan vs. Original Aura plan
 - Updated Aqua plan vs. Updated Aura plan

- Change in Aqua MLT prediction was caused by three factors
 - The Aqua IAM dates were changed causing a minor excursion of the operational MLT requirement
 - Starting tank pressure, which could have been mitigated with DMUs at the descending node
 - TSF/Duty Cycle trending changes

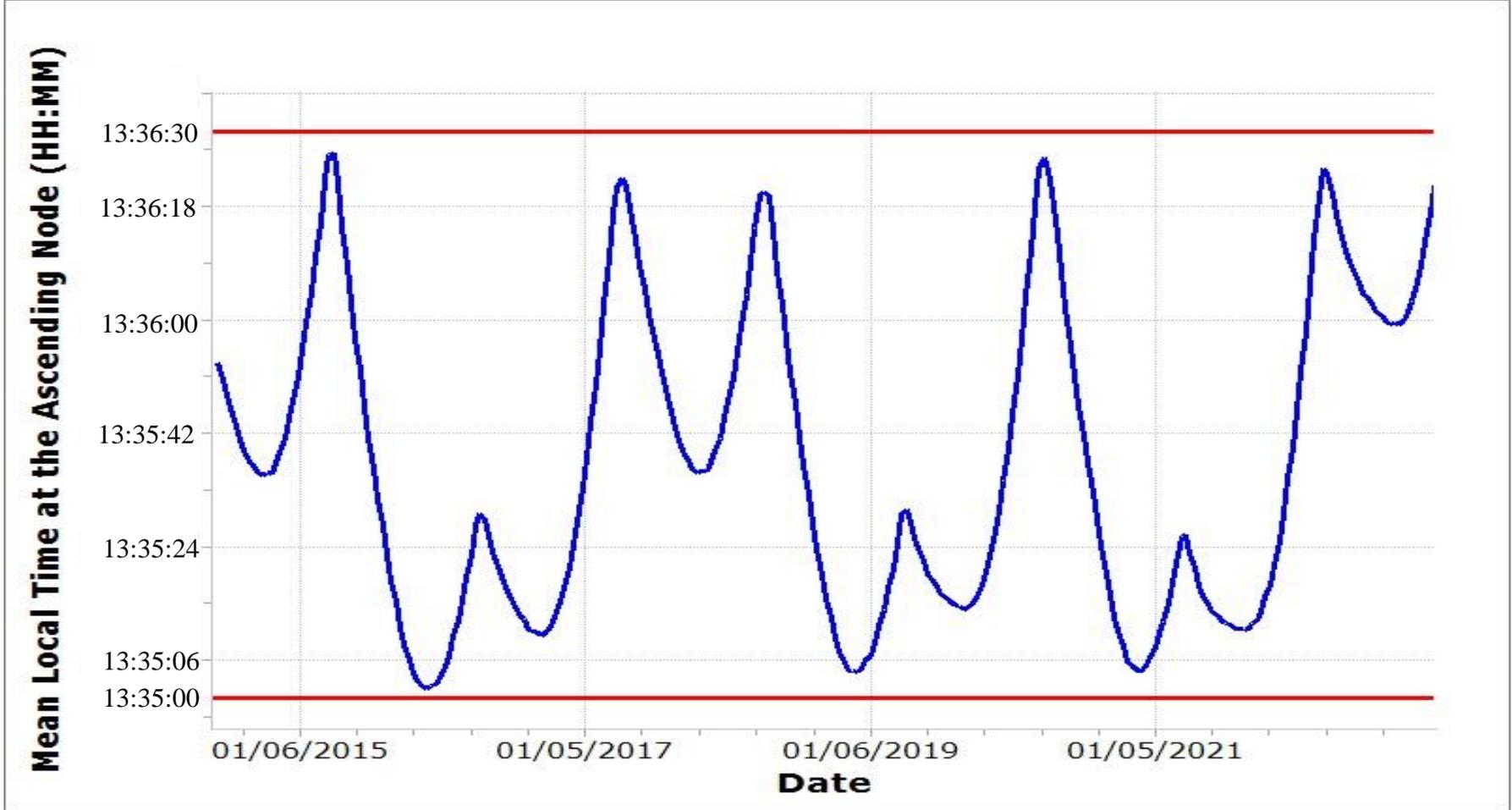
- Planned start date of the 2015 Aqua and Aura IAM series moved 1 week back
 - Changed to accommodate a Constellation Science Meeting
 - Allow other missions to perform inclination burns prior to 2015 Spring MOWG.
- Re-planning caused the small excursion outside of the desired operational MLT limits for Aqua and Aura (slide 5/slide 11).
 - Re-planning occurred before the 2014 Fall MOWG
 - Excursion was approved by the Aqua/Aura mission director during re-planning

- Reconstruction of the 2015 Aqua IAM series, derived from the 2014 Aqua lifetime analysis, revealed a discrepancy in the achieved delta-INC. Further investigation revealed:
 - Lifetime planning used pre-2014 IAM tank pressures. This resulted in a total delta-INC Aqua was not capable of achieving due to a 550 second burn limitation
 - New duty cycle and thrust scale factor trending introduced midway through the 2014 Aqua IAM series were not considered.
- The predicted MLT difference grew from 5 sec with the pressure discrepancy to 13 sec with the new tank pressure value and updated trending method.

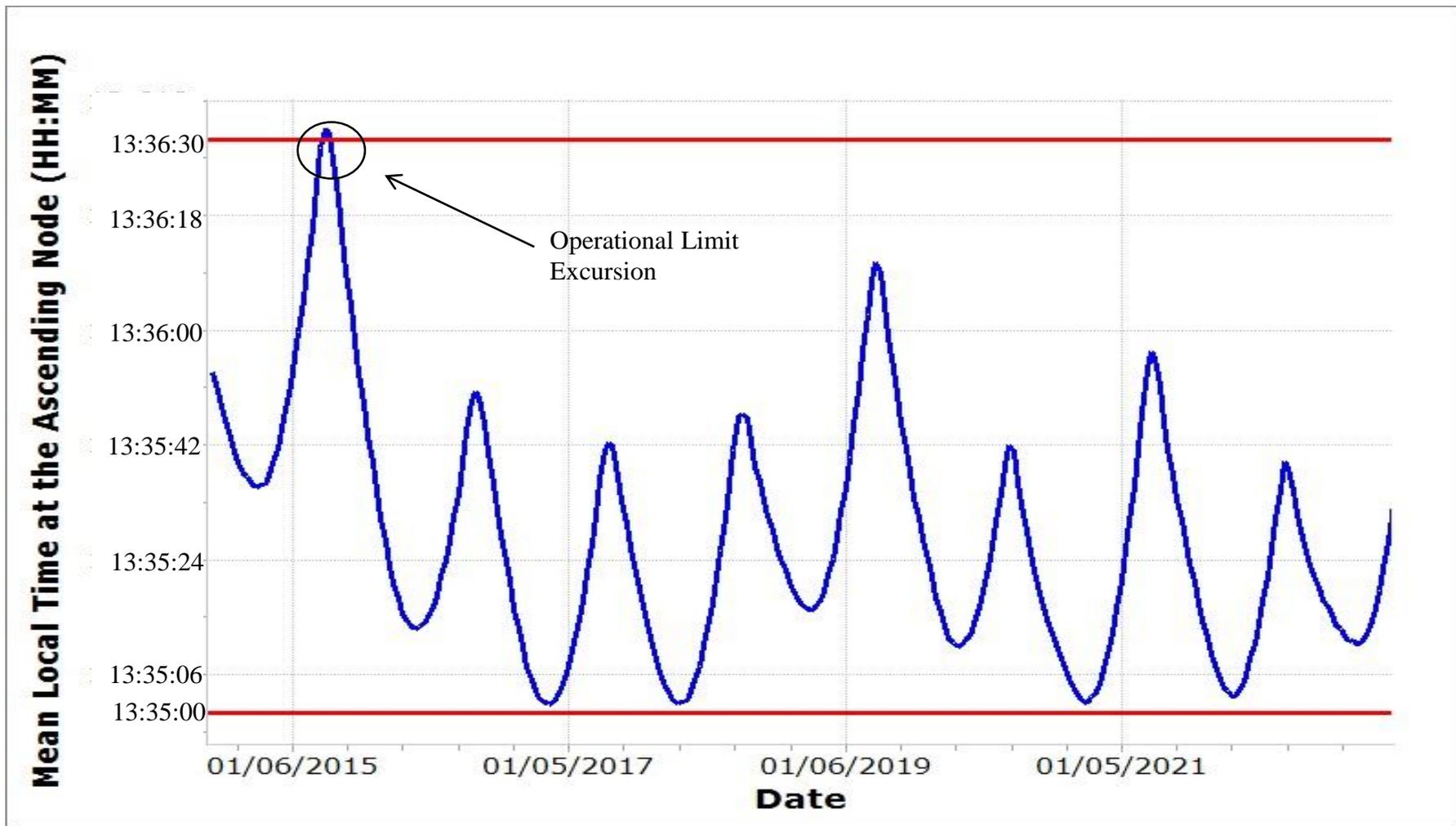
- To account for the differences, Aqua has:
 - Introduced additional inclination change by changing the target yaw angle to -82.1° , which has been a yaw angle range used historically, to achieve a closer predicted delta-INC value presented at the 2014 Fall MOWG (slide 9).
 - Performing no-slew maneuvers at the descending node to correct for MLT difference was originally considered but would be insufficient to adjust the 13 second difference

As a result, Aqua and Aura were able to maintain their mission requirements with the above changes to the 2015 Spring IAM series.

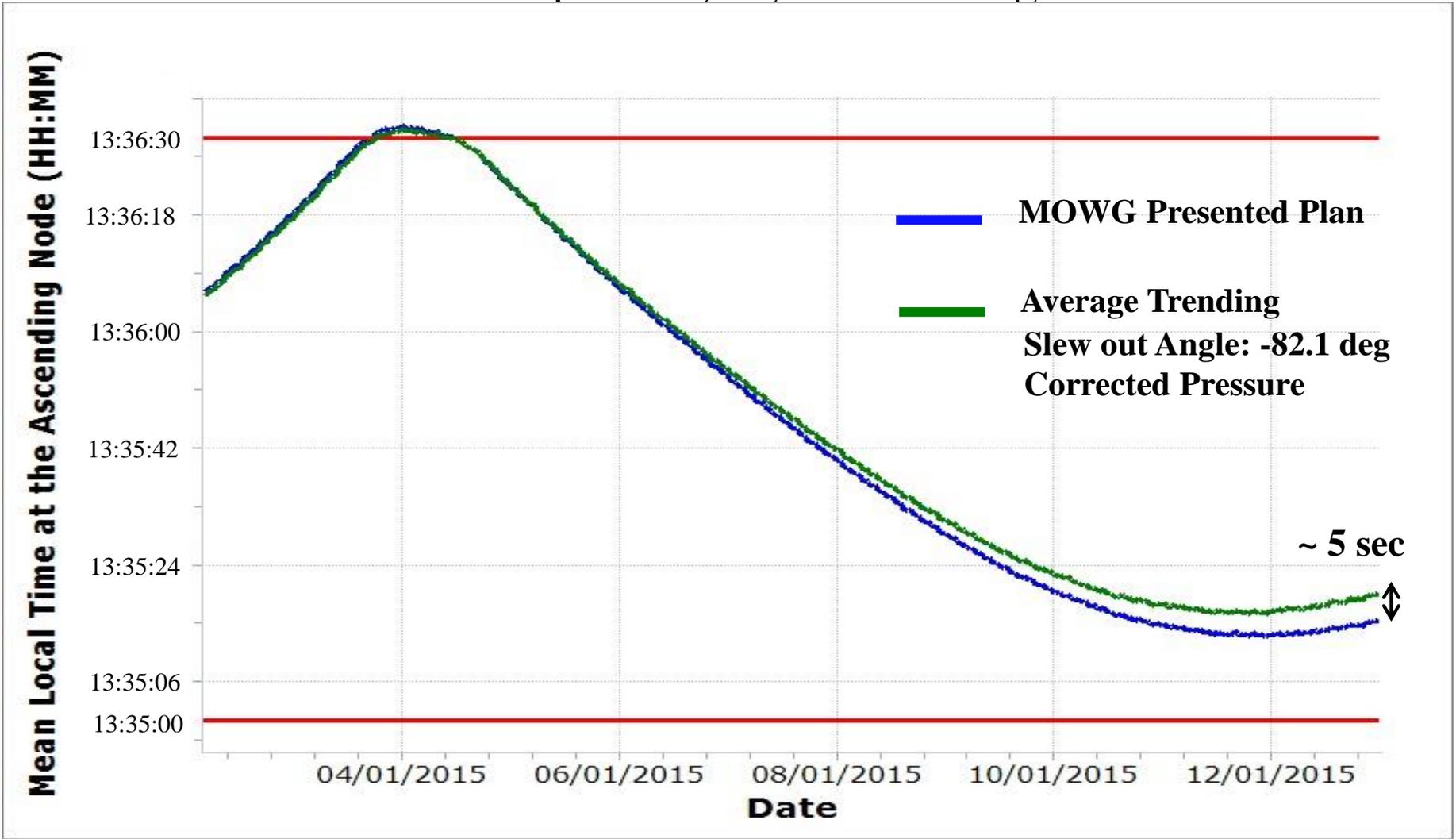
Mission Operations Working Group Aqua Long-Term MLT Predictions with 2014 Spring MOWG IAM Dates



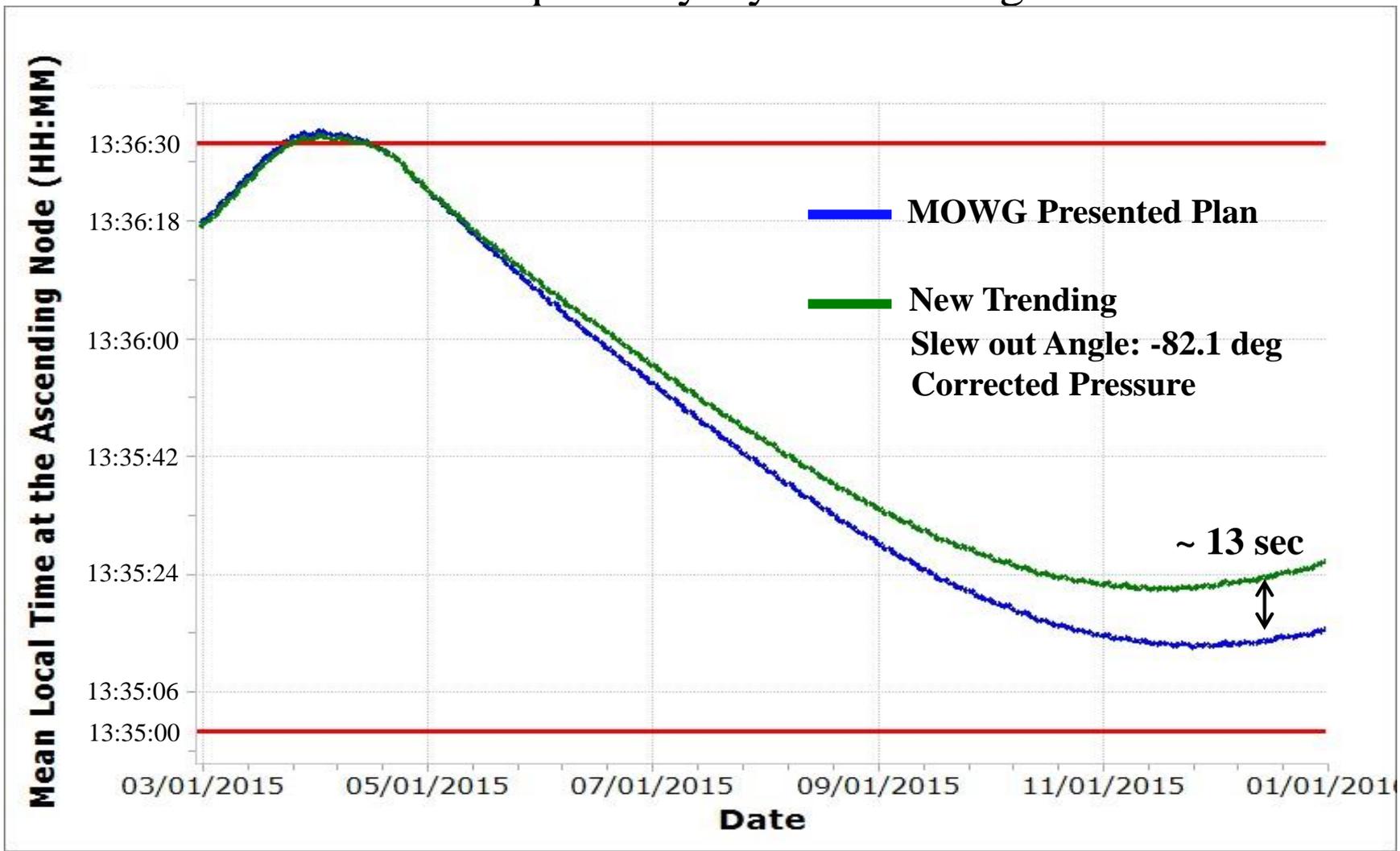
Aqua's MLT requirement is 13:30 ± 15 minutes. The mission has agreed to fly within tighter bounds for improved science data collection, as well as, more repeatability of delta-INC maneuvers from year to year.



Moving the original start date of 2015 IAM Series introduced a small excursion of the desired MLT limits (approved by mission director before Fall 2014 MOWG)



Aqua will have a maximum MLT difference of 5 seconds after utilizing the correct tank pressure.
4/8/2015



The maximum MLT difference is predicted to be 13 seconds after utilizing the new trending method.

4/8/2015

Predicted Results Comparison

2014 Fall MOWG Presented Predictions

| Inc # | Day of Week | Date | Burn Duration (sec) | Delta - Inc (deg) | Delta - V (m/s) | Delta - RAAN (deg) | Final Fuel Mass (kg) | PreMan Pressure (psi) |
|-------|-------------|-----------|---------------------|-------------------|-----------------|--------------------|----------------------|-----------------------|
| 43 | Wed | 18-Mar-15 | 550 | -0.0092 | 1.214 | 0.00103 | 90.946 | 205.4753 |
| 44 | Wed | 25-Mar-15 | 550 | -0.0092 | 1.210 | 0.00053 | 88.851 | 204.3107 |
| 45 | Wed | 1-Apr-15 | 550 | -0.0091 | 1.205 | 0.00005 | 86.775 | 203.1645 |
| 46 | Wed | 15-Apr-15 | 550 | -0.0091 | 1.200 | -0.00087 | 84.707 | 202.0408 |
| 47 | Wed | 22-Apr-15 | 550 | -0.0089 | 1.195 | -0.00125 | 82.666 | 200.9344 |
| | | | Totals: | -0.0454 | 6.025 | -0.00051 | -10.384 | -5.7376 |

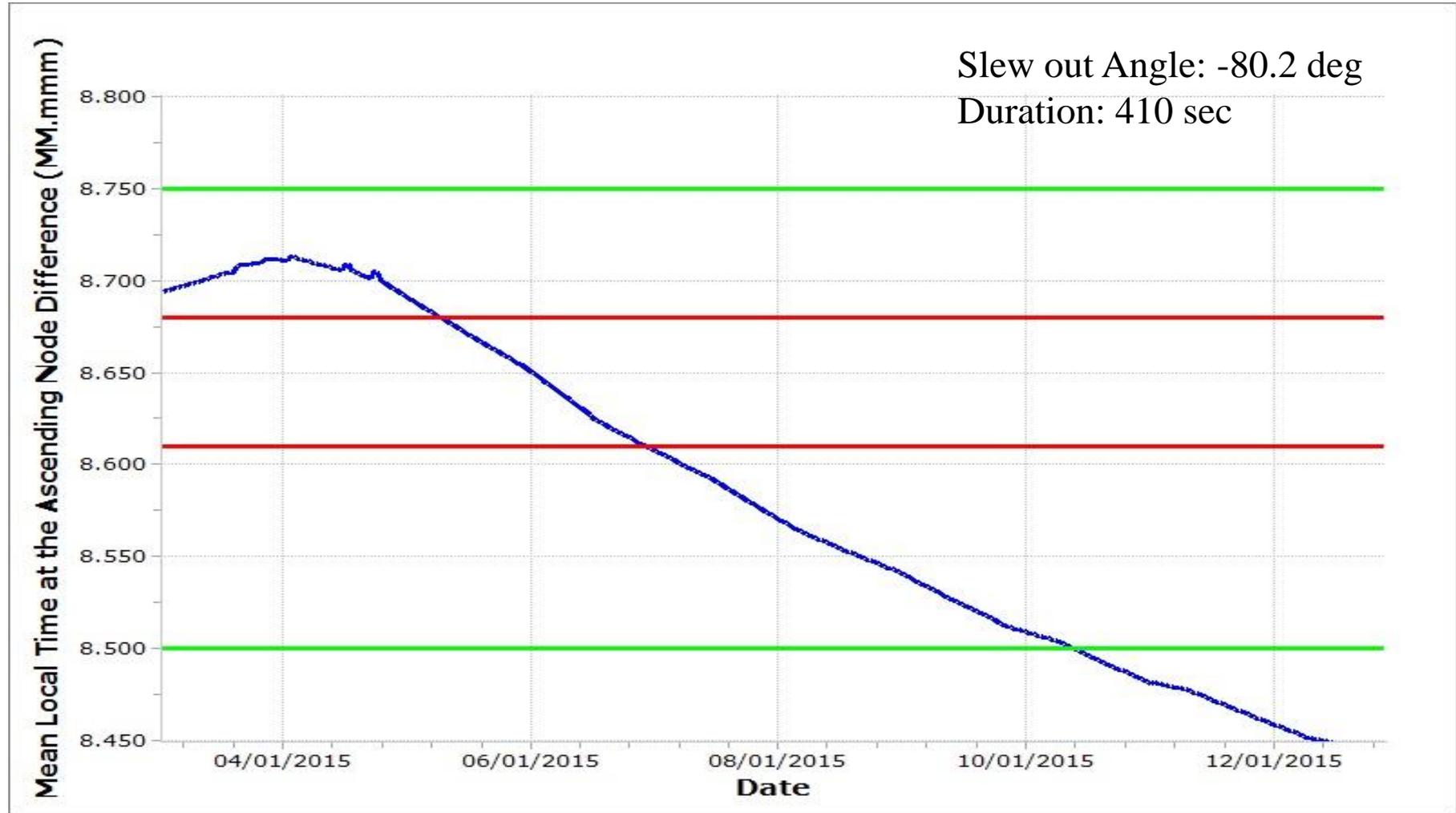
Final Updated Predictions with Adjusted Angles (provided to MOWG members in Feb 2015)

| Inc # | Day of Week | Date | Burn Duration (sec) | Delta - Inc (deg) | Delta - V (m/s) | Delta - RAAN (deg) | Final Fuel Mass (kg) | PreMan Pressure (psi) |
|-------|-------------|-----------|---------------------|-------------------|-----------------|--------------------|----------------------|-----------------------|
| 43 | Wed | 18-Mar-15 | 550 | -0.0088 | 1.167 | 0.00099 | 90.768 | 199.4869 |
| 44 | Wed | 25-Mar-15 | 550 | -0.0088 | 1.162 | 0.00051 | 88.652 | 198.3602 |
| 45 | Wed | 1-Apr-15 | 550 | -0.0088 | 1.158 | 0.00005 | 86.546 | 197.2512 |
| 46 | Wed | 15-Apr-15 | 550 | -0.0087 | 1.152 | -0.00084 | 84.449 | 196.1595 |
| 47 | Wed | 22-Apr-15 | 550 | -0.0086 | 1.147 | -0.00123 | 82.362 | 195.0414 |
| | | | Totals: | -0.0437 | 5.787 | -0.00052 | -10.531 | -5.5904 |

| | | | | | |
|--------------------|---------|--------|----------|--------|---------|
| Differences | -0.0017 | 0.2380 | 0.000009 | 0.1471 | -0.1472 |
|--------------------|---------|--------|----------|--------|---------|

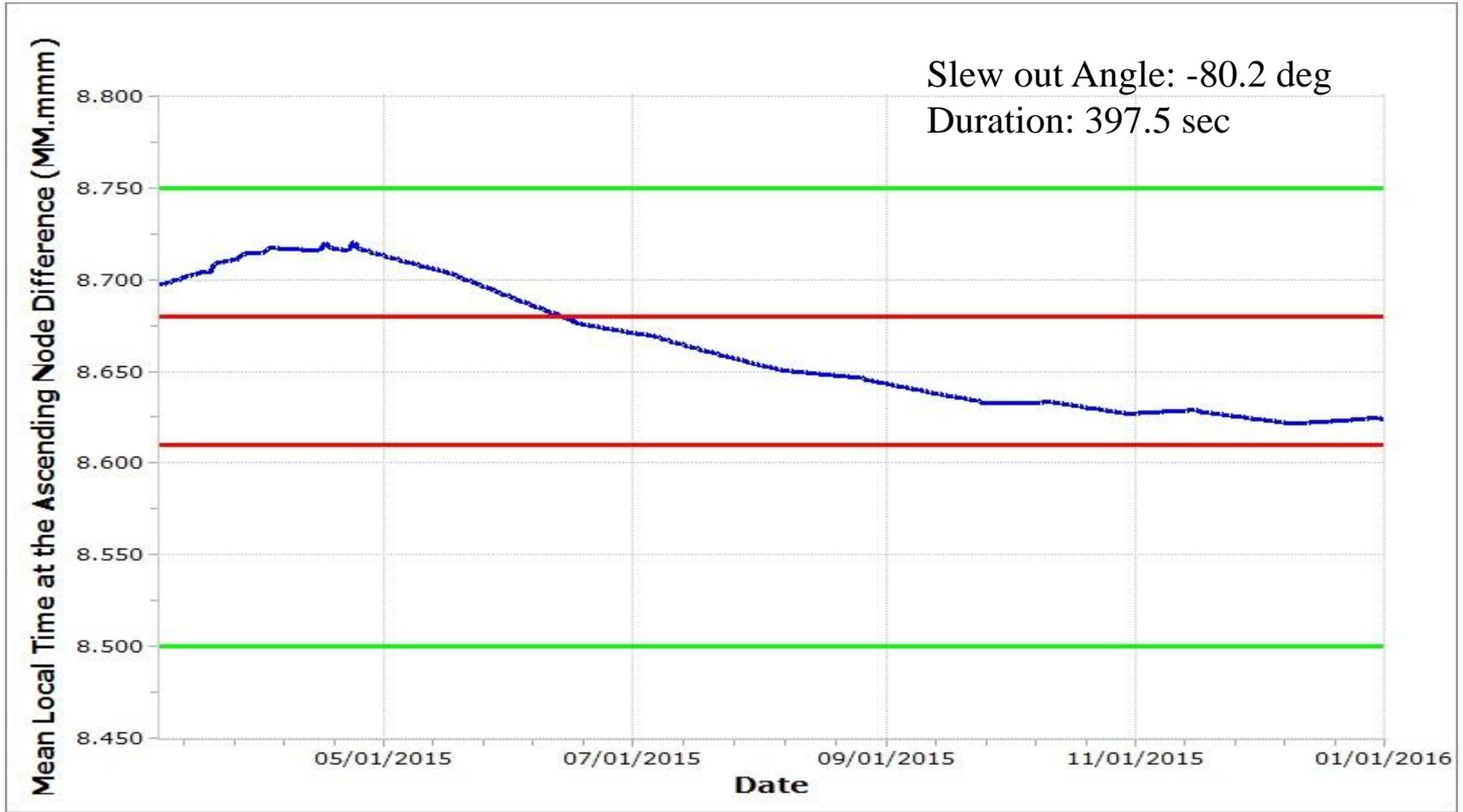
Aura vs. Aqua MLT Requirements

Aqua New Trending with Corrective Node DMUs



Aura IAM planned off the original CCS Aqua predictive ephemeris delivered to A-Train

4/8/2015



New Aura IAM planned off the updated CCS Aqua predictive ephemeris delivered to A-Train

4/8/2015

Summary

- Changing the original 2015 IAM Series dates caused a small excursion of the desired Aqua MLT limits.
- The pressure error, coupled with the decrease in predicted efficiency due to the updated duty cycle and TSF trending, Aqua was not able to fully correct the MLT difference using descending node DMUs.
- Aura will be able to maintain its required MLT separation from Aqua with minor changes to the burn duration of each Aura IAM.

Even with the issues involved in planning the 2015 IAM Series, Aqua and Aura will both maintain its orbit requirements.



Mission Operations Working Group



Questions?