

Status of the Aqua Mission

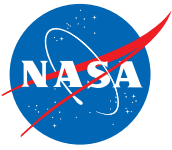
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Aqua Mission Director

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Presented at the NASA Sounder Science Team Meeting, Marriott Hotel & Conference Center, College Park, Maryland, September 26, 2019

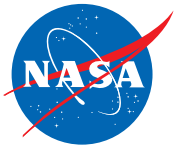


Aqua Overview

- Launched May 4, 2002.
- Altitude of 705 km; 1:36 a.m. and 1:36 p.m. equatorial crossing times, in the A-Train (Afternoon Constellation).
- Six Earth-observing instruments.
- Data used in thousands of scientific publications and wide-ranging practical applications.
- Six-year design life.
- Likely can continue operating in the A-Train until 2022.

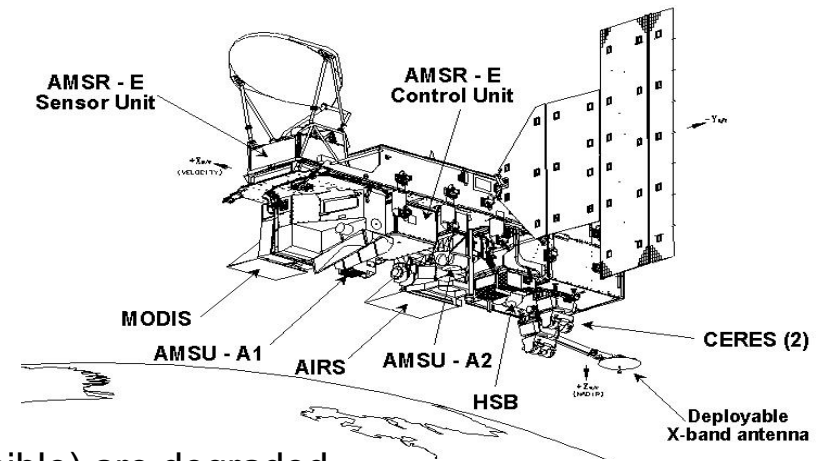


Aqua pre-launch (courtesy of Northrop Grumman)

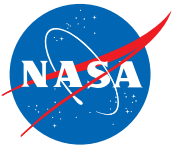


Aqua's Operating Earth-Observing Instruments*

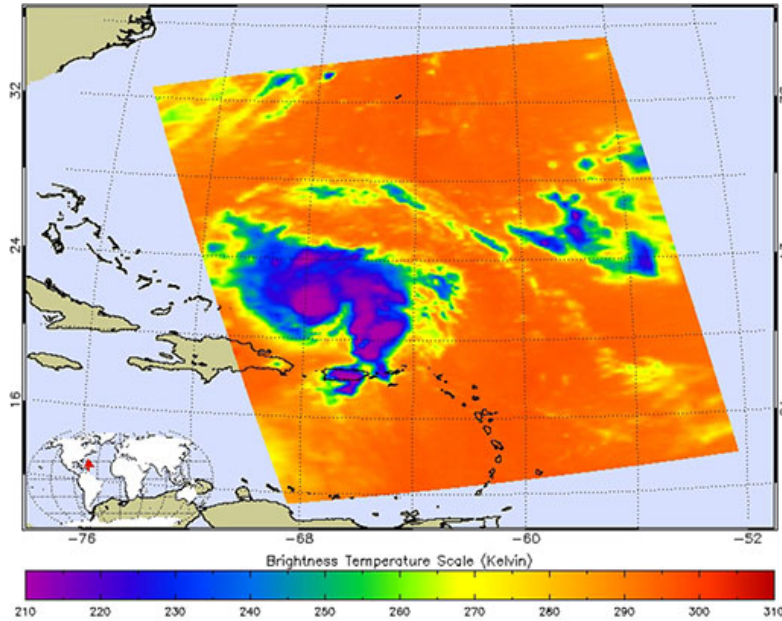
- **Atmospheric Infrared Sounder (AIRS)**
 - Excellent health.
 - Only ~ 200 of the 2382 channels (2378 infrared, 4 visible) are degraded.
- **Advanced Microwave Sounding Unit (AMSU).**
 - Fair health.
 - Nine of the 15 channels are performing well (including Channel 14, which had undergone an anomaly on 6/21/18 but recovered by 6/19/19) and another (Channel 6) is still providing useful data despite slowly degrading.
- **Clouds and the Earth's Radiant Energy System (CERES; 2 copies).**
 - Flight Model 3 (FM-3): Excellent health; all three channels are fully operational.
 - Flight Model 4 (FM-4): Good health; two of the three channels remain operational (the shortwave channel failed on 3/30/2005).
- **Moderate Resolution Imaging Spectroradiometer (MODIS).**
 - Excellent health.
 - Thirty-five of the 36 bands (visible to thermal infrared) operate well; the other, band 6, has been imperfect throughout the mission.
 - All components remain on primary hardware.
 - Three of the four 10 W lamps used for calibration have failed.



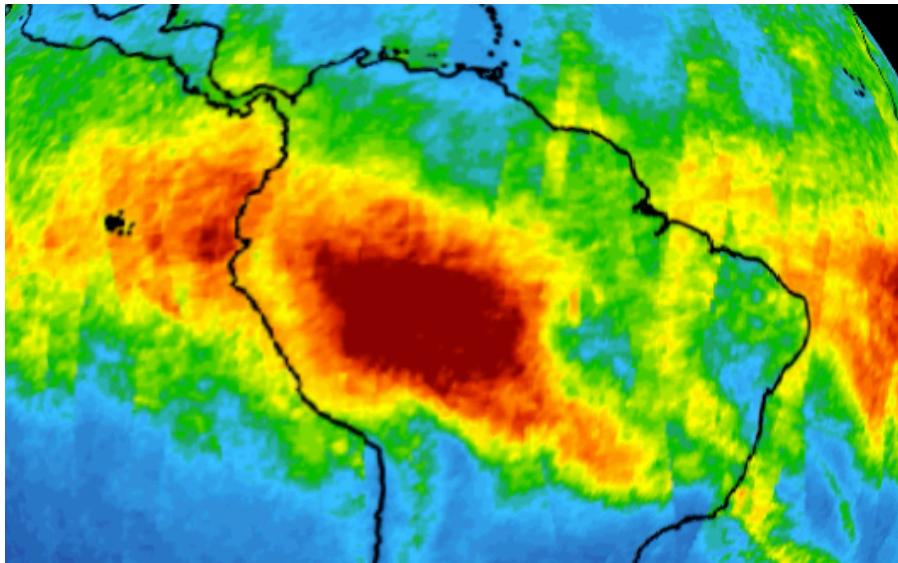
* Non-operating instruments: Advanced Microwave Scanning Radiometer for the Earth Observing System (AMSR-E) and Humidity Sounder for Brazil (HSB).



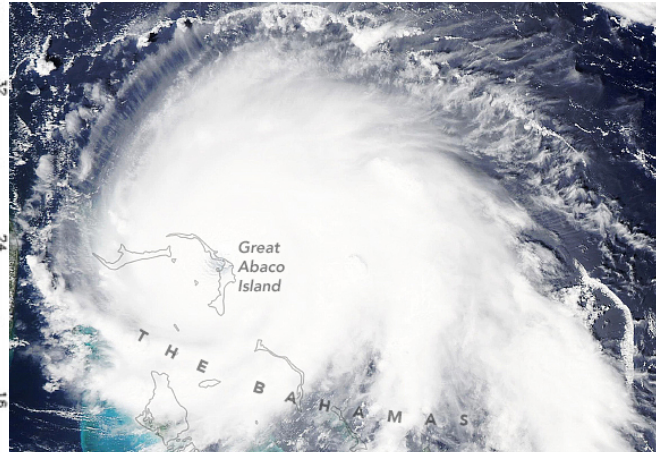
Recent Aqua Imagery



AIRS image of Hurricane Dorian, 8/29/19



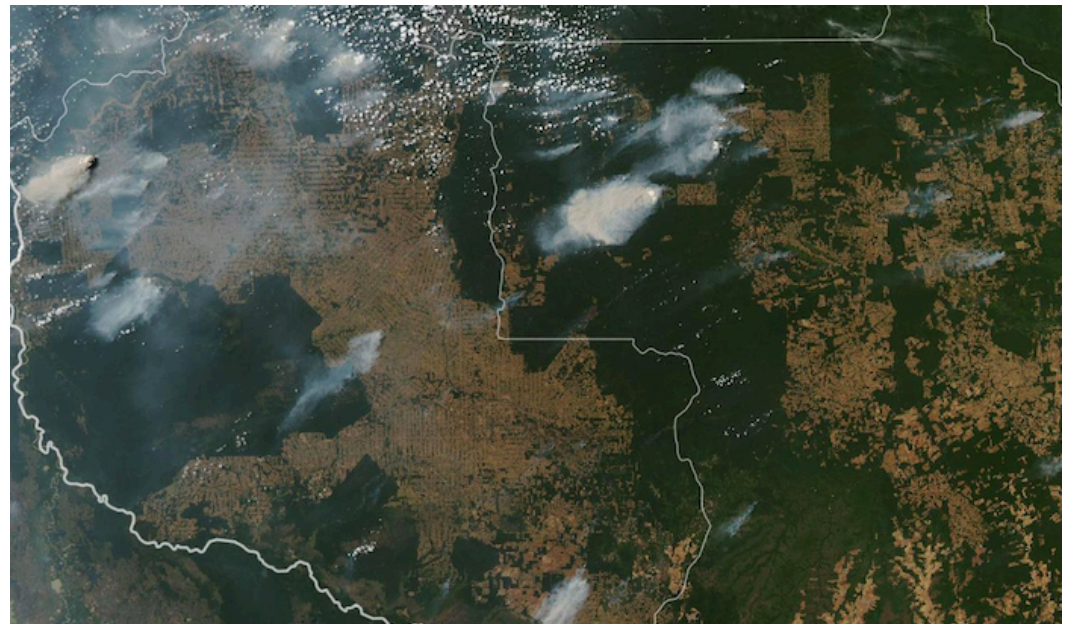
AIRS image of carbon monoxide at ~18,000 ft,
from Brazilian fires, 8/20-22/19



Aqua MODIS image of Hurricane
Dorian, 9/1/19

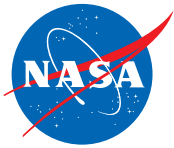


Aqua MODIS image of
Australian fires, 9/12/19



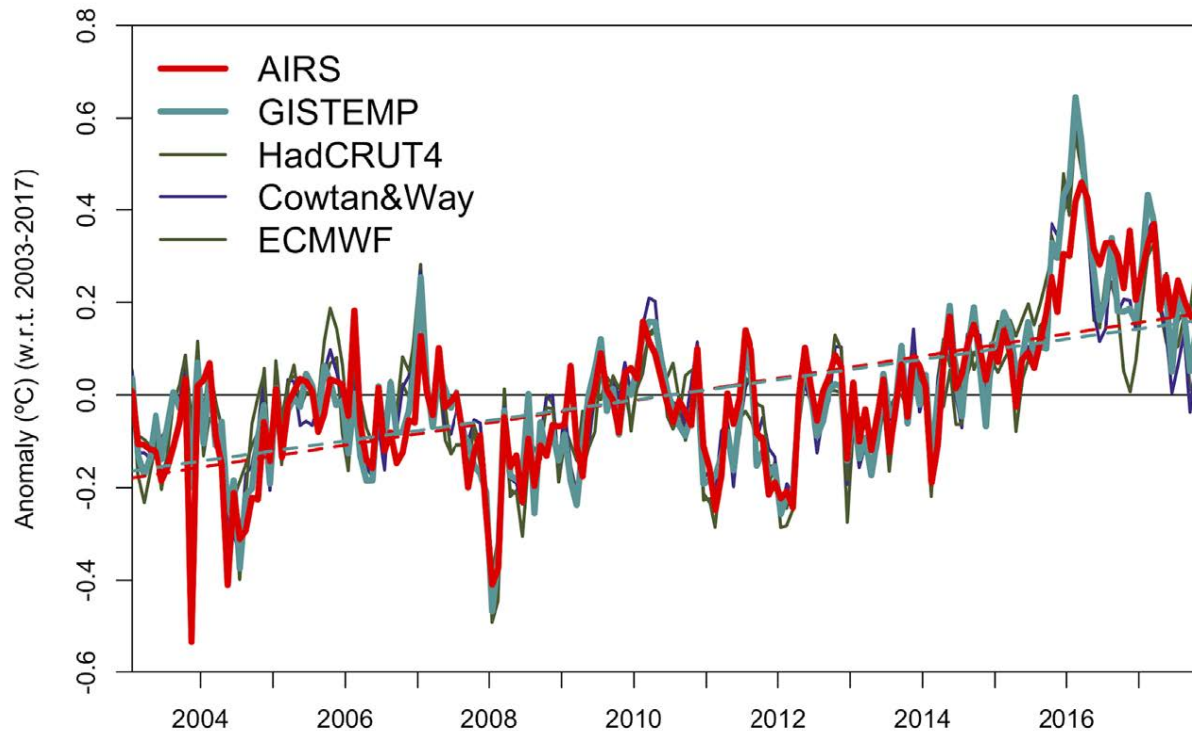
Aqua MODIS image of Brazilian fires, 8/11/19

(AIRS images from airs.jpl.nasa.gov; MODIS
images from earthobservatory.nasa.gov)



Sample Recent Aqua Science Result, from Susskind *et al.* 2019

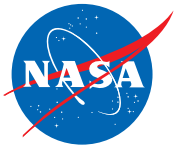
Global Monthly Mean Surface Temperature Anomalies
for AIRS data and four in situ data products



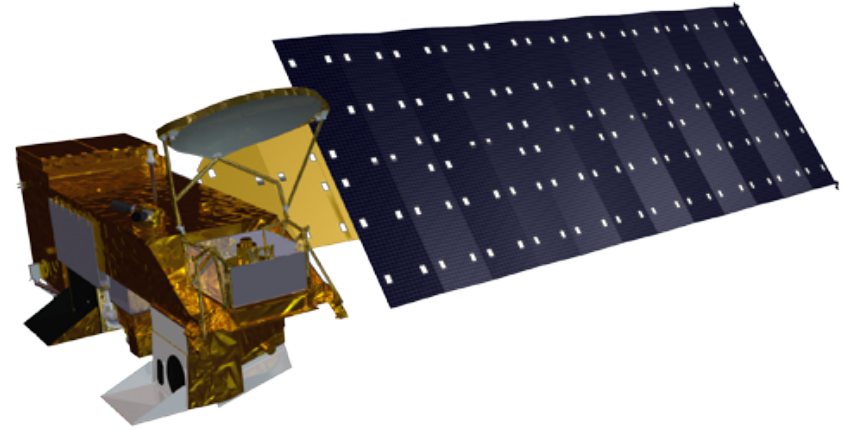
“We show in this paper that satellite-based surface temperatures can ... help to improve surface-based data sets in a way that can be extended back many decades ...”

(plot and quote from J. Susskind, G.A. Schmidt, J.N. Lee, and L. Iredell, 2019: Recent global warming as confirmed by AIRS, *Environmental Research Letters*, 14, 044030)

GISTEMP = Goddard Institute for Space Studies surface temperature analysis; HadCrut4 = Hadley Center & Climatic Research Unit temperatures; Cowtan&Way = Cowtan and Way 2014, *Q. J. R. Meteorological Society*; ECMWF = European Centre for Medium-Range Weather Forecasts.

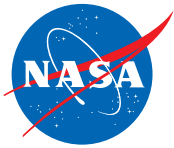


Status of the Spacecraft Bus, Solar Array, Battery, and Data Capture

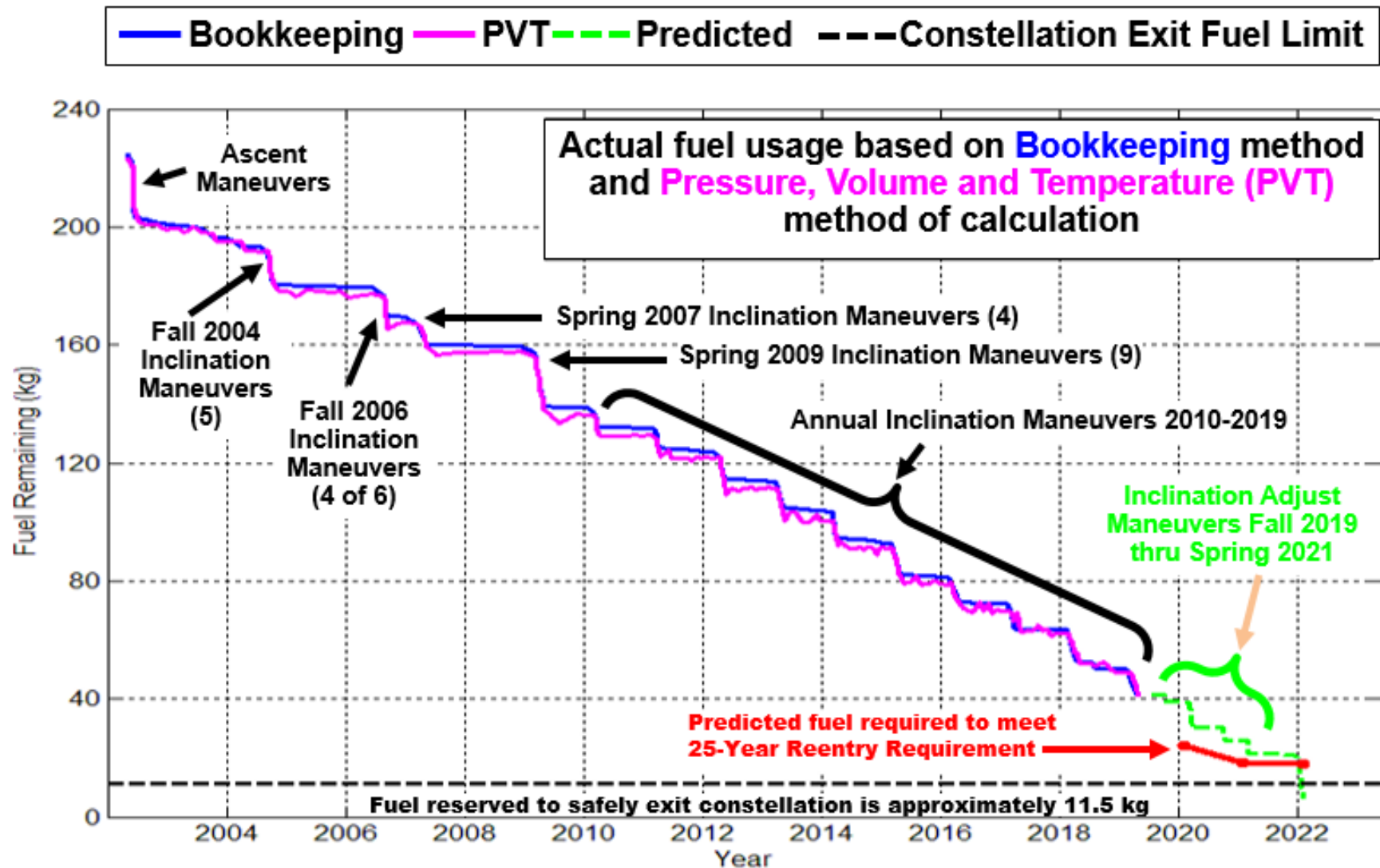


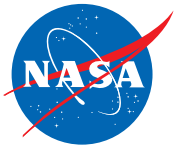
- **Overall status – Excellent**
- All components remain on primary hardware.
- The Solar Array could likely operate at least until early 2028 (114 of the 132 strings of solar cells continue to operate).
- The main Aqua battery is projected to be able to last 152,000 Earth orbits, until December 2030 (all 24 cells remain fully operational).
- So far in 2019 there have been two days with data losses.
 - 3/17/19 (about 6 seconds of missing data; recovered through direct broadcast).
 - 7/18/19 (about 42 seconds; not recovered).

(Aqua visualization by Marit Jentoft-Nilsen)



Timeline of Aqua Fuel Levels



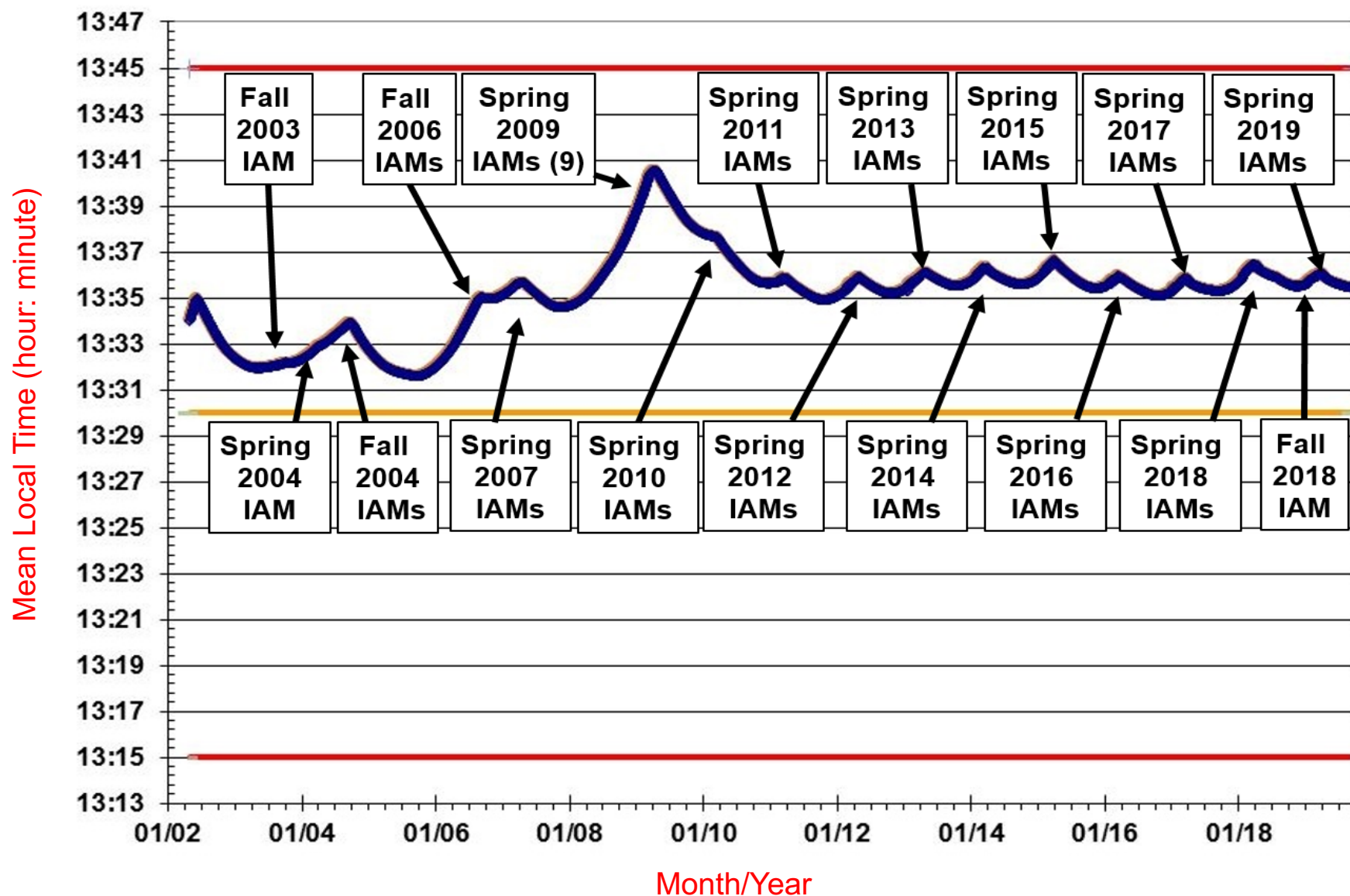


Fuel-Saving Plans

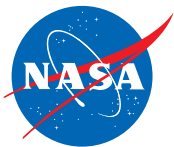
- Use reaction wheels during Inclination Adjust Maneuvers (IAMs).
 - Saves fuel
 - Takes longer
- Perform IAMs in both spring and fall.



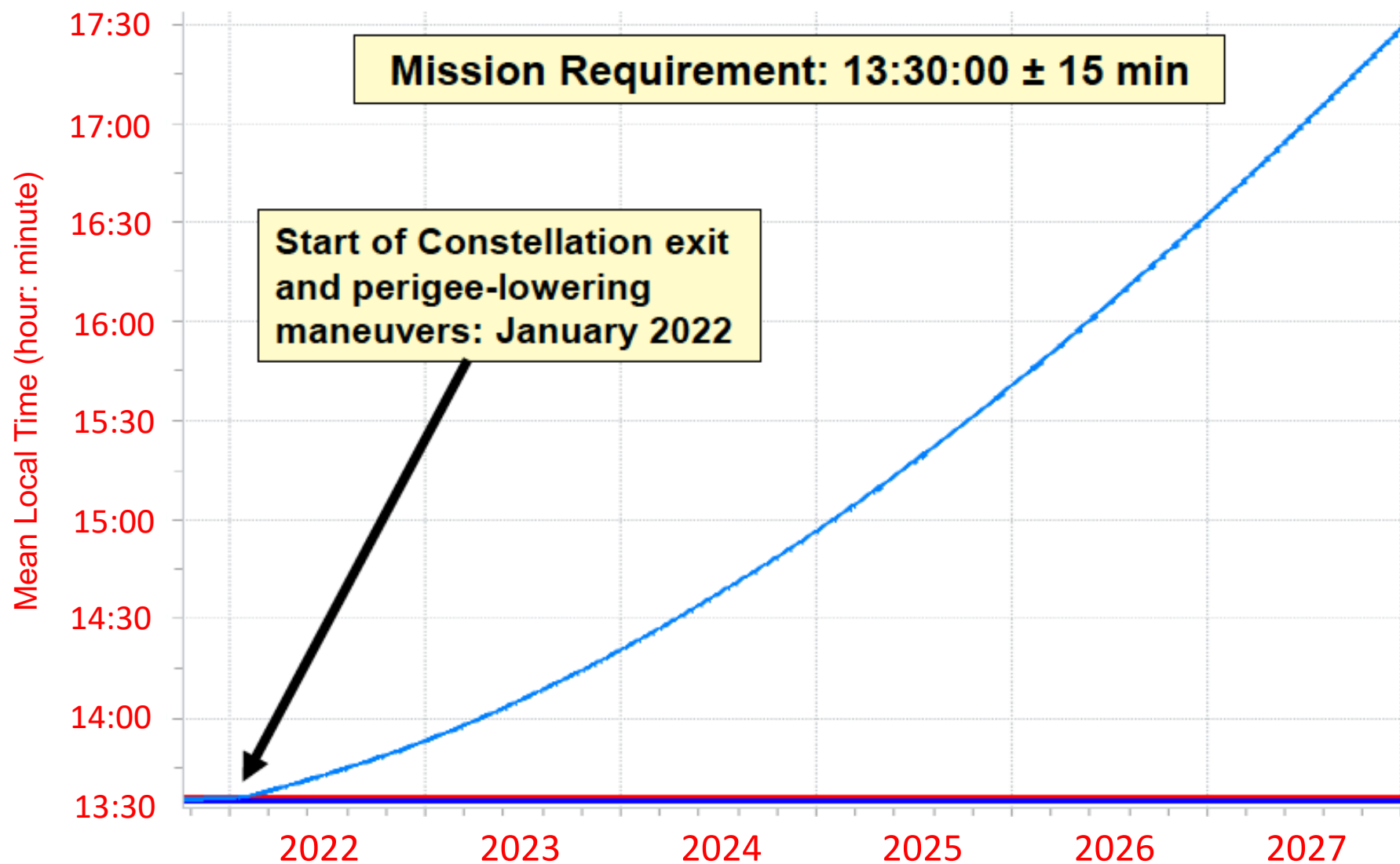
History of Aqua's Mean Local Time at the Northward Equatorial Crossing

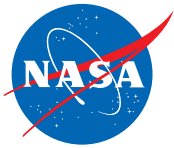


IAM = Inclination Adjust Maneuver



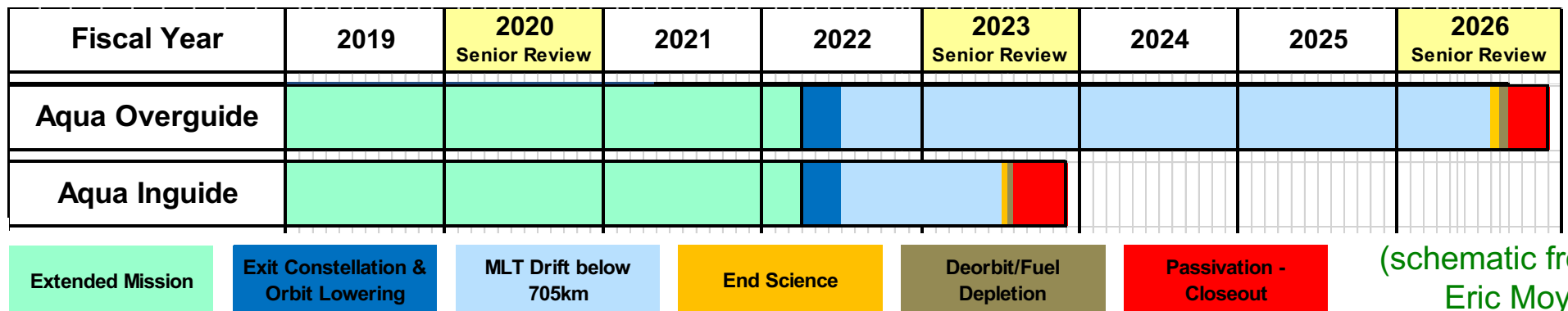
Predicted Mean Local Time Trajectory If Aqua Exits the A-Train in January 2022

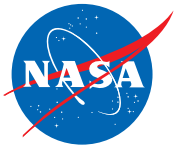




Budget Complications

- In-Guide budget provided by NASA HQ to the Aqua, Terra, and Aura Project Scientists, for the annual budget exercise, spring 2019
 - No cuts through FY22
 - Major cuts FY23 and beyond
- In-Guide decisions
 - Give the science teams the full amount they need for a complete Phase F
 - Exit the A-Train in 2022
 - End the mission (passivate the spacecraft) in 2023
- Over-Guide request
 - Maintain full budget as planned in 2018
 - Exit the A-Train in 2022
 - Continue to collect data until about 2026
- **Bottom line:** Make a case in the 2020 Senior Review for the value of the Aqua mission, including the value of the anticipated data after exiting the A-Train.





Concluding Summary

- The Aqua mission continues to collect valuable data from the AIRS, AMSU, MODIS, and CERES instruments.
- Fuel limitations will likely lead to Aqua's exiting the A-Train in early 2022, with a descent to approximately 4.4 km below the A-Train orbit.
- After exiting the A-Train, Aqua could continue to collect valuable science data, at a lower altitude, drifting with later equatorial crossing times, for several years.
- The spacecraft will be passivated when the data are no longer valuable, likely about 2026, unless budget or fuel considerations lead to earlier passivation.