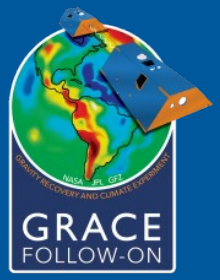
GRACE Follow-On Project

Mission Operations Status

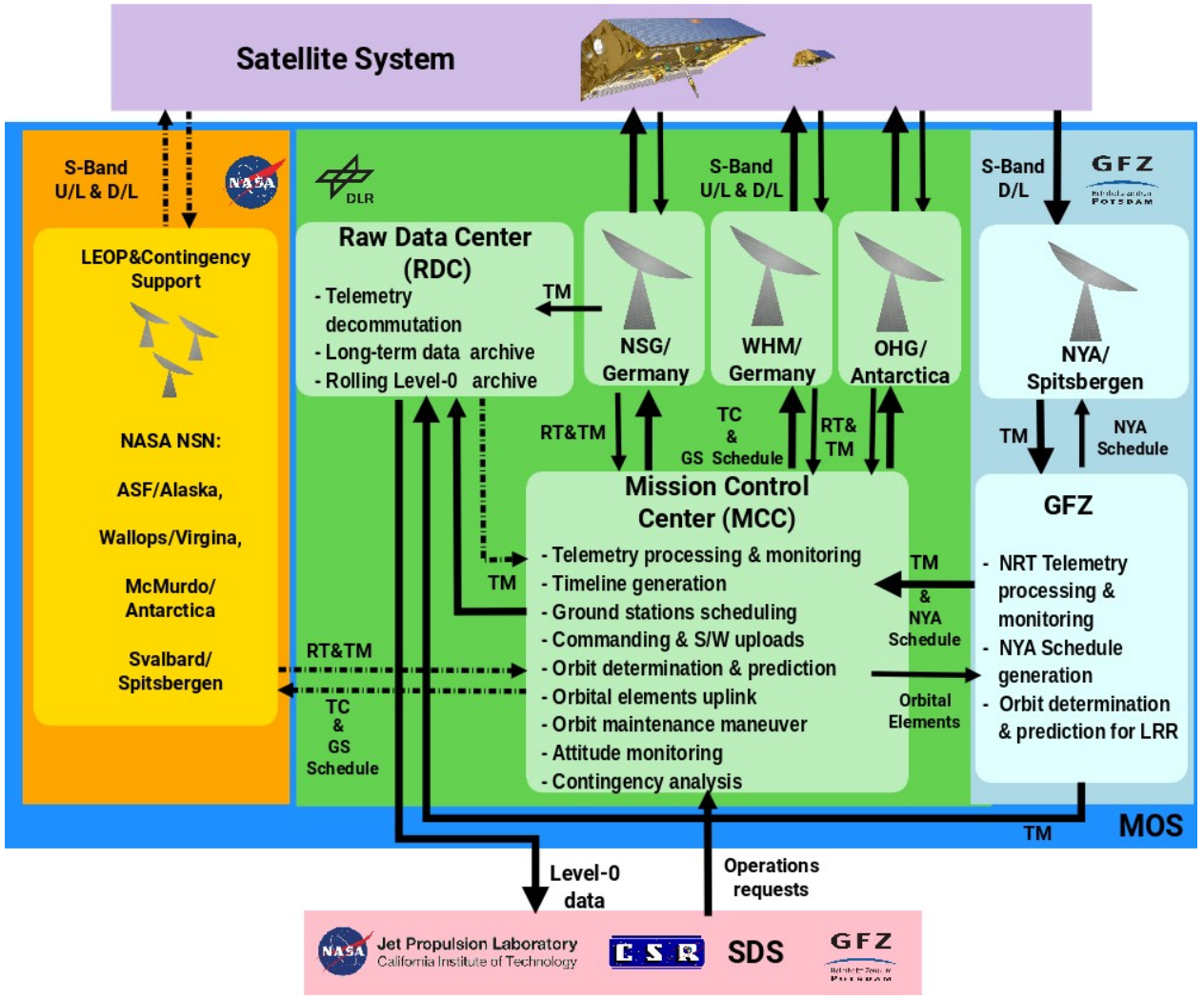


Krzysztof Snopek (GFZ), Mona Witkowski (JPL),

Sebastian Loew (DLR)

GRACE-FO Science Team Meeting, 8 October 2024

Ground Segment Status



Primary data downlink at Ny-Ålesund (NYA)

Uplink via Weilheim (WHM), Neustrelitz (NSG) and O'Higgins (OHG)

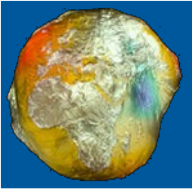
NSN stations for contingency support and software uploads.

Mission Control Centre (MCC) in Oberpfaffenhofen

Raw Data Centre (RDC) in Neustrelitz.

Ground segment performs nominally.

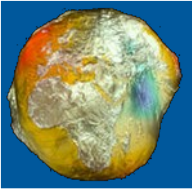
- Commanding problems with NSN stations: ASF, Wallops and McMurdo



Satellite Status

System	GF1	GF2
Bus		
- OBC	A - nominal	A – PM-A/1553 MilBus anomaly B – nominal
- PCDU	A - nominal	A – nominal
- SCA	STRE A,3 heads – nominal	STRE A,3 heads - nominal
- TX	A - nominal	A - nominal
- Battery	Nominal	Nominal
- CGPS	A & B – nominal	A & B - nominal
- IMU	3 units (IMU-4 Off)	3 units (IMU-4 Off)
AOCS	wide deadband mode, nadir pointing	wide deadband mode, nadir pointing
Payload		
- MWI	B – nominal (OCC On) IPU S/W v4.4	IPU-B failed A – nominal (OCC On), IPU S/W v4.4
- ACC	Normal Range Mode	Normal Range Mode - underperforming
- LRI	On (Diagnostic Mode, Master Role)	On (Diagnostic Mode, Master Role)

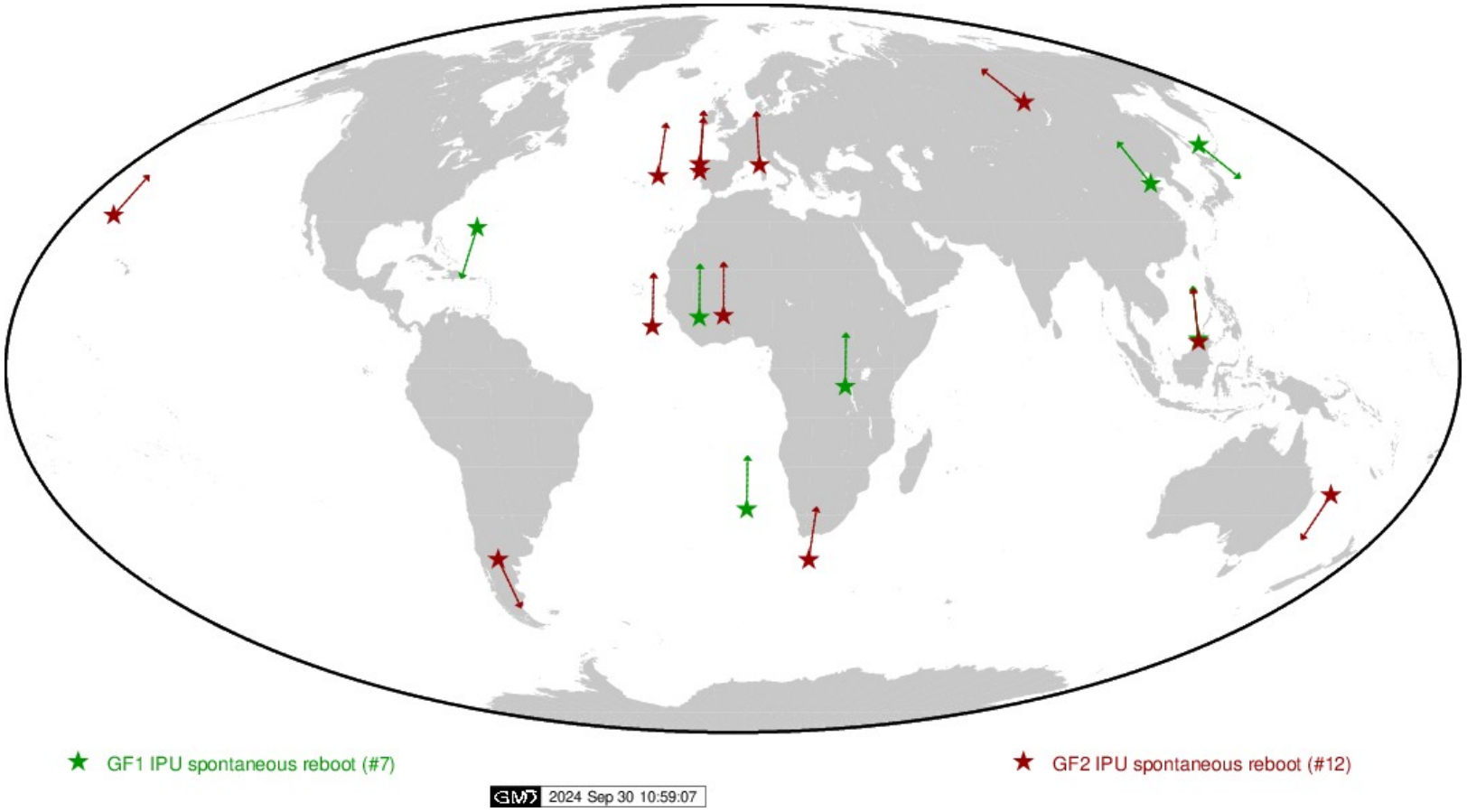
No changes last year. LRI in diagnostic mode due to the AOCS nadir pointing mode.



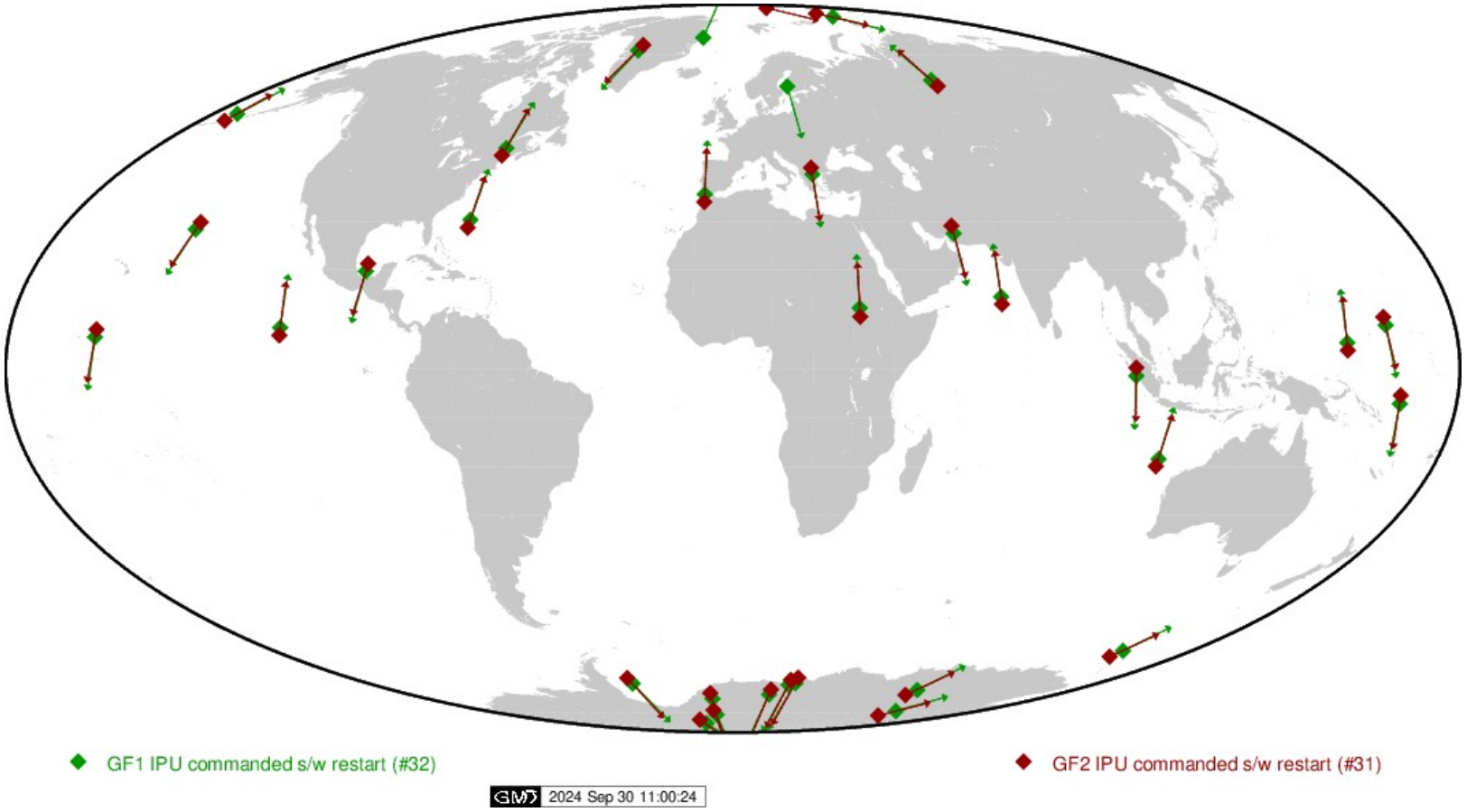
MOS Events Since Last GSTM

Date	Event
19-Oct-2023	GF2: drift correction maneuver
07-12-2023	GF2: drift and inclination correction maneuver
04-Jan-2024	GF2: collision avoidance maneuver (Astrocast nanosatellite)
06-Jan-2024	GF2: maneuver to restore formation and to minimize risk of another collision
15/18/22-Jan-2024	GF1: CMCal - Mass trim - CMCal
27-Feb-2024	GF2: drift correction maneuver
15-May-2024	GF2: drift correction maneuver
13-Jul-2024	GF1: collision avoidance maneuver (SAR-Lupe satellite)
16-Jul-2024	GF2: formation keeping maneuver
05/10-Sep-2024	Frequent IPU reboots on both satellites.
12-Sep-2024	GF2: drift correction maneuver

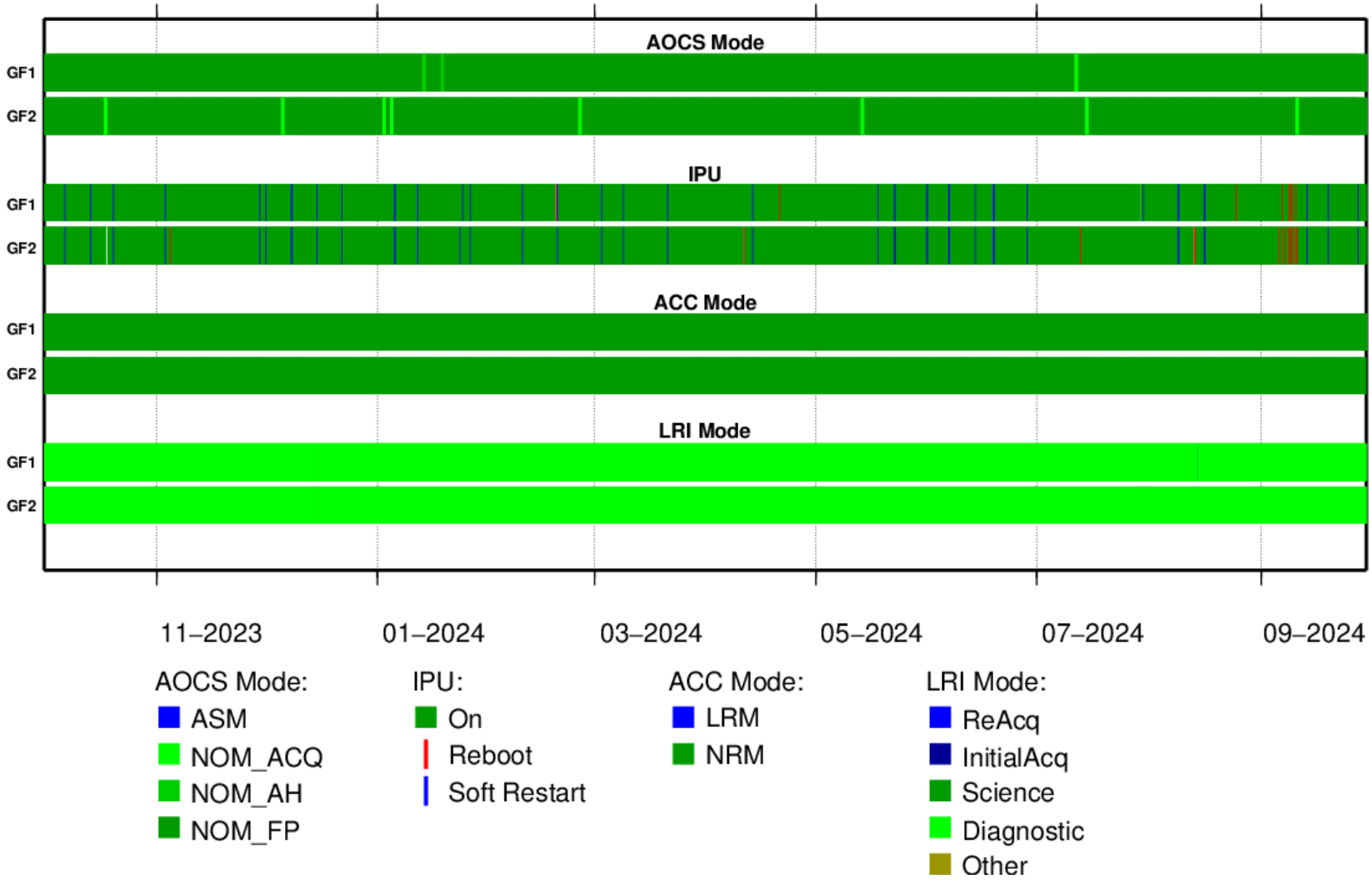
Last year IPU Reboots (spontaneous)



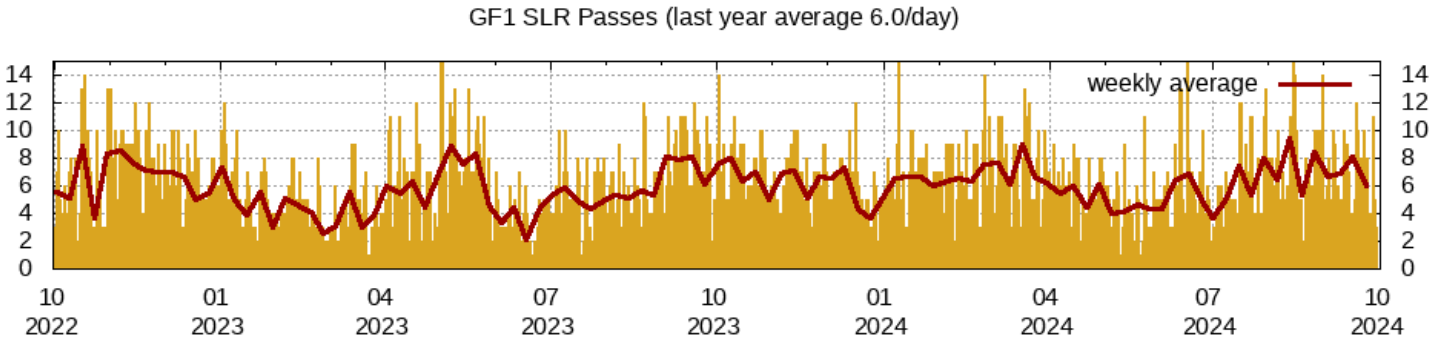
Last year IPU Reboots (commanded)

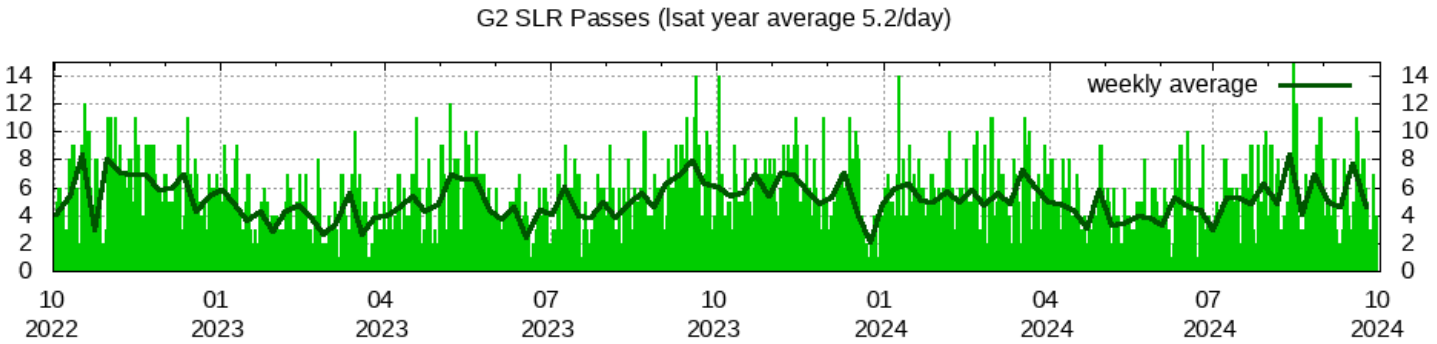


AOCS & Payload Status



SLR Observations





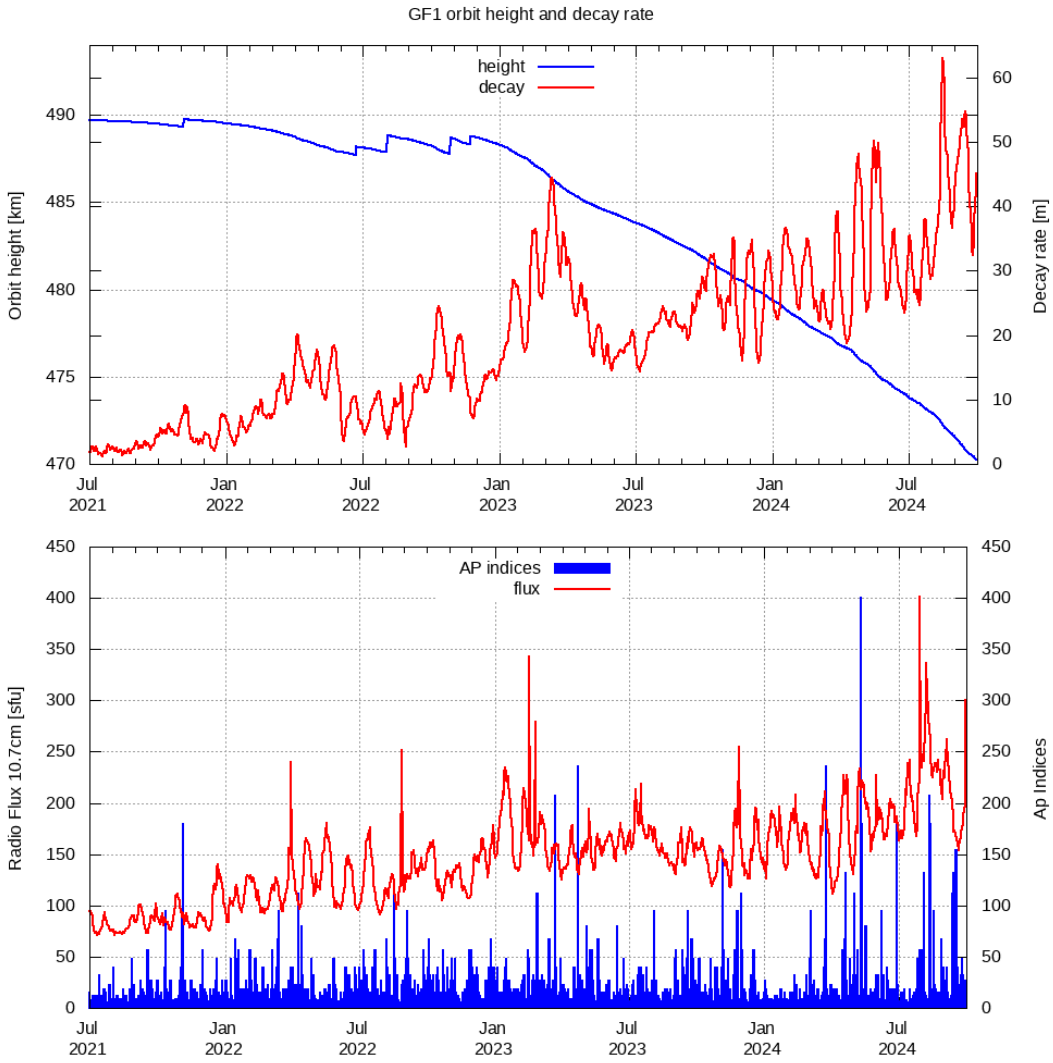
- Number of SLR observations stabilized on 5-6 passes per day.

Orbit Height and Decay Rate

- ~6.5 Years in Orbit
  - 2330 days in orbit
  - 35400 revolutions completed
  - GF1 Leading / GF2 Trailing

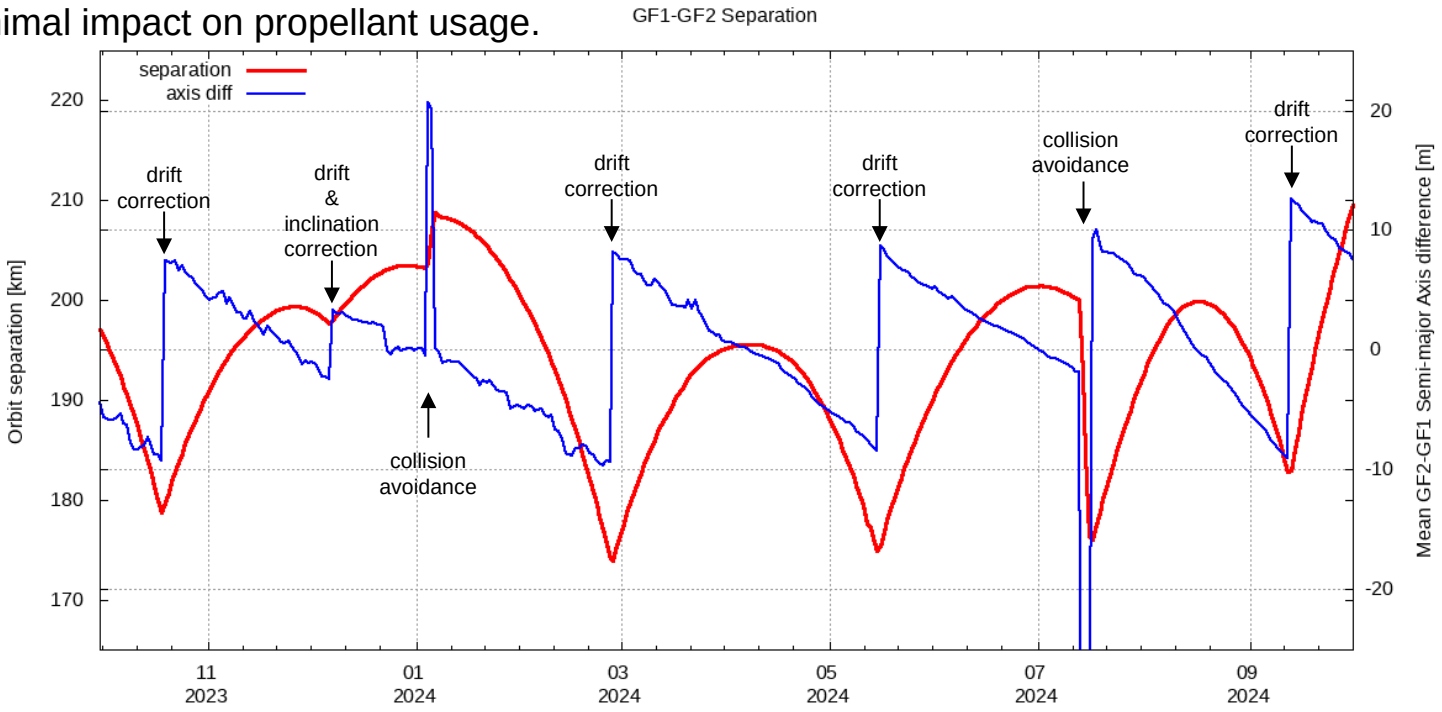
- Orbital Height
  - 470 km (491.5 after launch)
  - Decay rate:
    - Launch – Oct 2020: **1.3 m/d**
    - Oct 2020 – Oct 2021: **2.6 m/d**
    - Oct 2021 – Oct 2022: **9.1 m/d**
    - Oct 2022 – Oct 2023: **21.6 m/d**
    - Oct 2023 – Oct 2024: **31.8 m/d**
      (orbit decayed by **11 km**!)

- Decay prediction will be presented by Himanshu Save



Orbit Separation

- Inter-satellite distance between 170 and 210km
- When in the current wide deadband AOCS mode, GF1 and GF2 altitude decay rates differ slightly which affect relative altitude difference between satellites and drift rate:
  - Drift correction maneuvers performed about every two months on GF2.
  - Collision avoidance maneuvers and subsequent formation keeping maneuvers used to correct the drift.
  - Minimal impact on propellant usage.

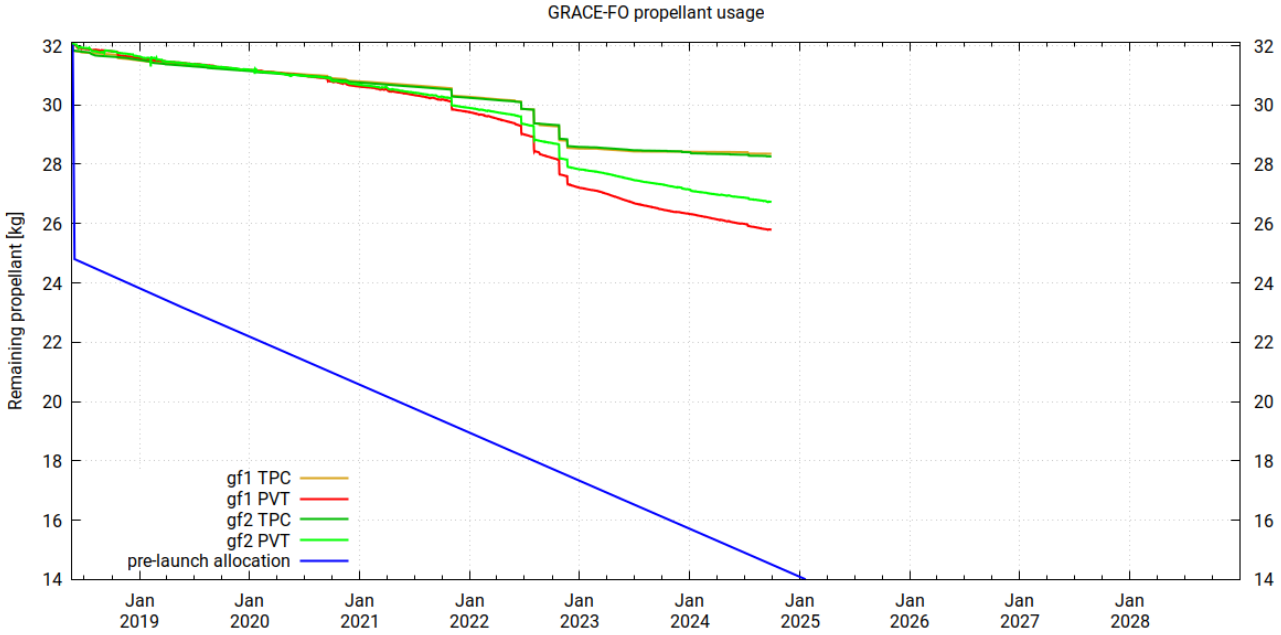


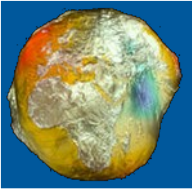
Lifetime Limiting Resources

- Propellant
  - Very low daily propellant consumption for AOCS (< 1g/d)
  - Launched with 32 kg
  - Used ~6 kg on GF1 and ~5 kg on GF2
    - CGPS leaks dominate fuel consumption (*details in H.Save talk)*
    - Current extended deadband AOCS mode minimalizes thruster usage and leak rate

- Battery
  - Nominal
  - End of Charge Voltage: 32.8V

Battery is healthy

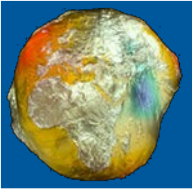


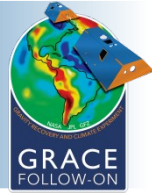


Summary and Outlook

- GFO mission operations proceeding nominally
- No significant satellite anomalies last year
- No life limiting resources prevent operations for the next year and beyond
- Plans for the next year:
  - Monitor and control orbit and propellant usage.
  - Continue routine operations in wide deadband mode.

- The Joint German/US Mission Operations Team continues to work well together
  - Annual Operations Status Meetings (the last one in June 2024)
  - Plans to extend the mission through 2029





Thank you !