GRACE/GRACE-FO Level-2 Status from JPL

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GRACE/GRACE-FO Science Team Meeting
Virtual
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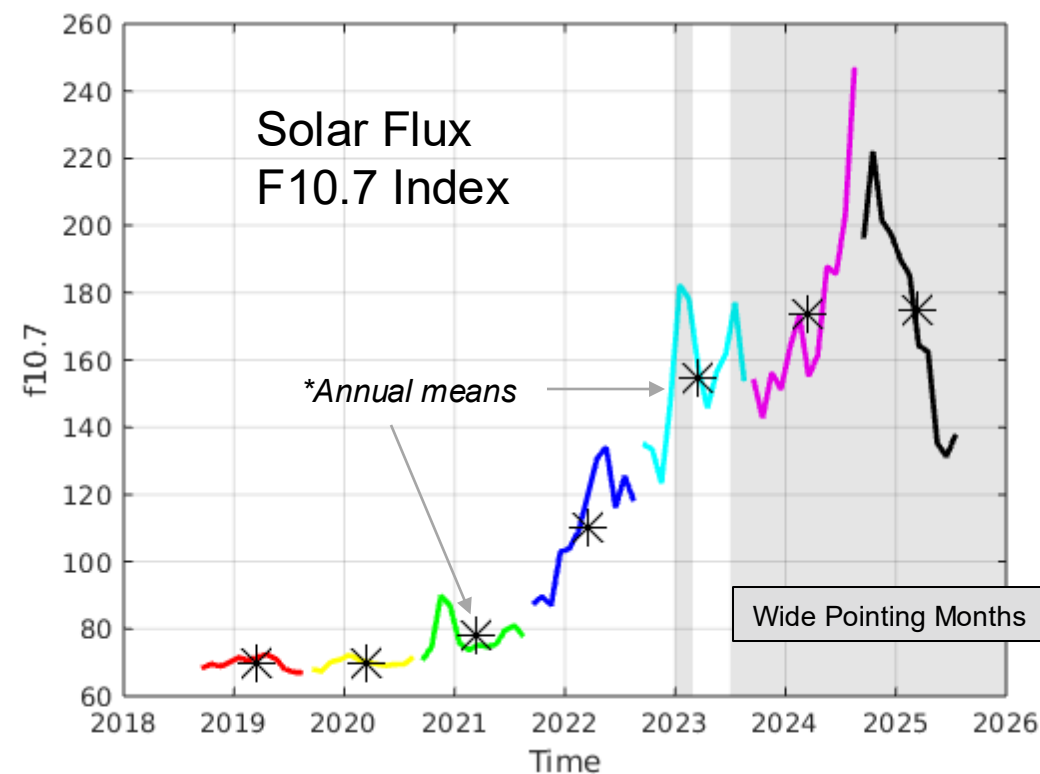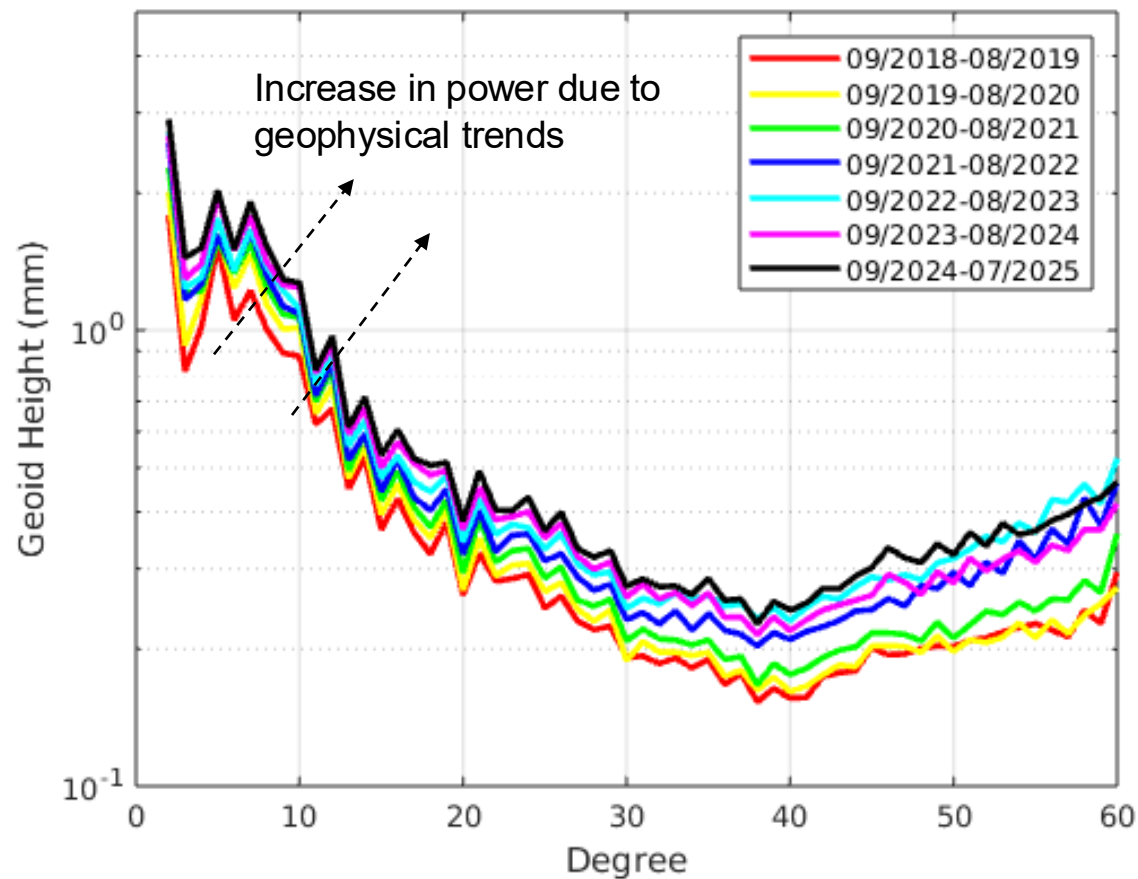## Jet Propulsion Laboratory
California Institute of Technology

RL06.3 quality by year

RL06.3 anomalies relative to static field

Increase in power due to geophysical trends

Legend:
- 09/2018-08/2019 (red)
- 09/2019-08/2020 (yellow)
- 09/2020-08/2021 (green)
- 09/2021-08/2022 (blue)
- 09/2022-08/2023 (cyan)
- 09/2023-08/2024 (magenta)
- 09/2024-07/2025 (black)
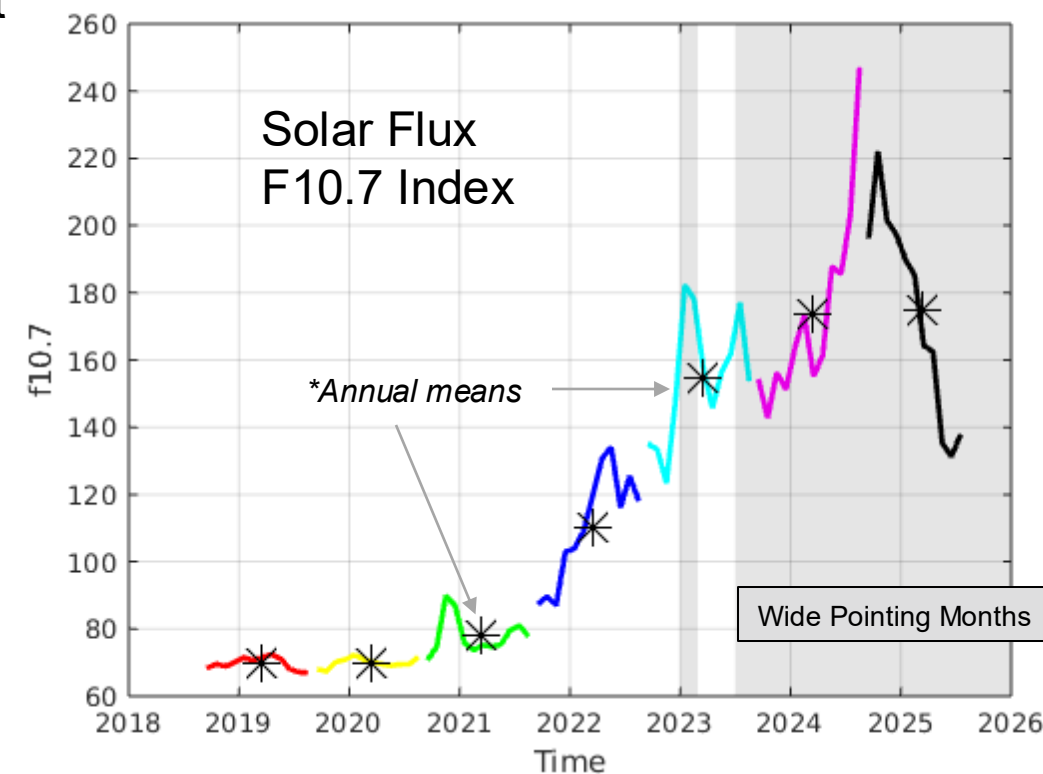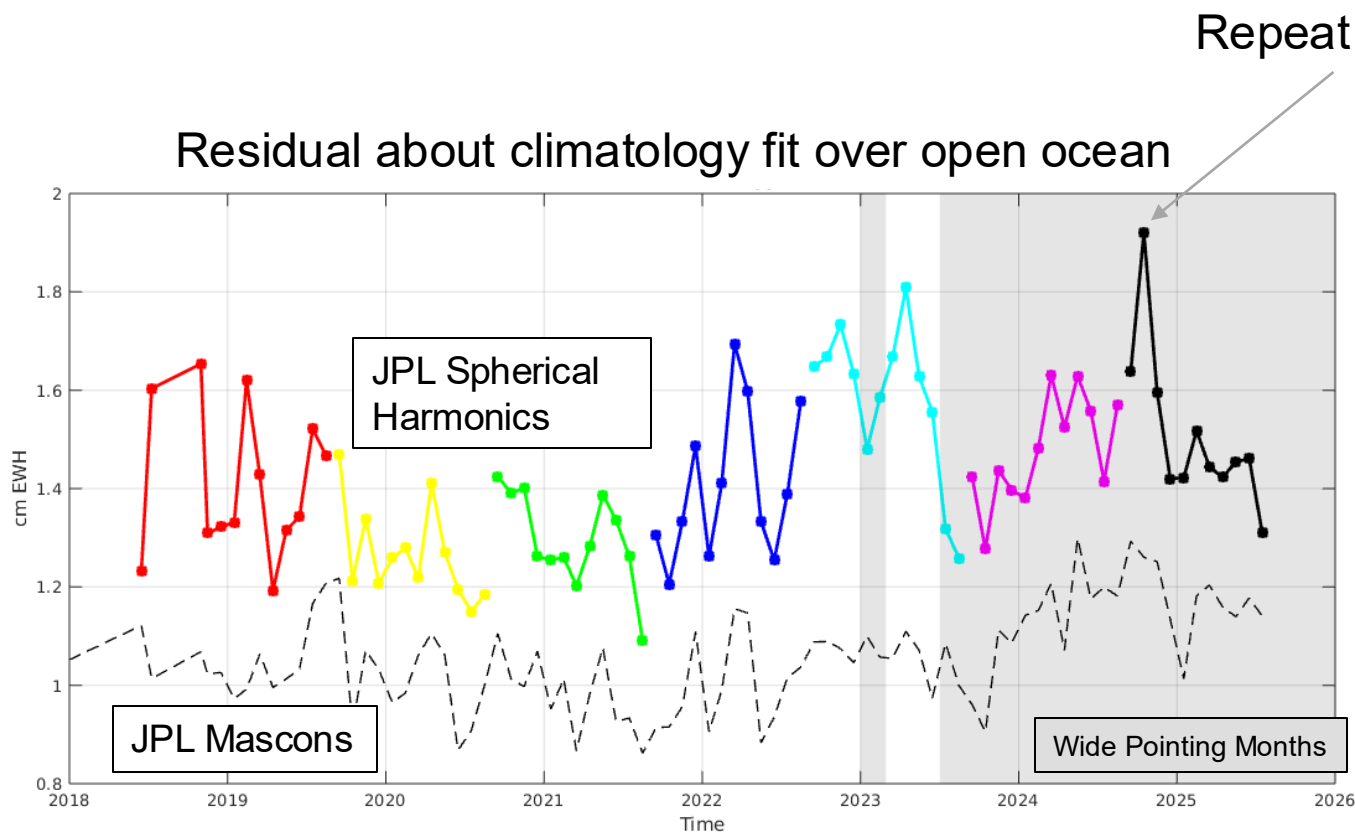
Solar Flux F10.7 Index

*Annual means

Wide Pointing Months

Stable solution quality over the last year, despite highest average solar activity in mission

Solution quality remains stable

Repeat orbit

Residual about climatology fit over open ocean

JPL Spherical Harmonics

JPL Mascons

Wide Pointing Months

Solar Flux F10.7 Index

*Annual means

Wide Pointing Months

Wide pointing mode continues to enable improved accelerometer transplant

Mascon Constraints Remain an effective mitigation tool against high solar activity

Changes from RL06 to RL07

|	GRACE/-FO RL06/RL06.3	GRACE/-FO RL07	
Static Field	GGM05C	GIF63	
AOD	AOD RL06	AOD RL07	
Ocean Tides	FES2014	GOT5.6 - Ellipsoidal Correction - Spatially Variable Sea Water Density Correction - 3rd degree tides (4 constituents)	Testing on GRACE-FO
Air Tides	S1, S2 from Ray, Ponte, 2003	TiME22* (10 constituents)	
Ocean Pole Tide	Coefficients (Desai et al., 2003)	Coefficients (Desai et al., 2015)	
Data Noise	Diagonal; White Noise	**Stochastic Models of KBRR, LRI, and GPS reduced observations[1,2]**	
Weighting	Optimal Weighting	**Variance Component Estimation[1,2]**	Testing on GRACE
Level-1 Data	V04	V05	

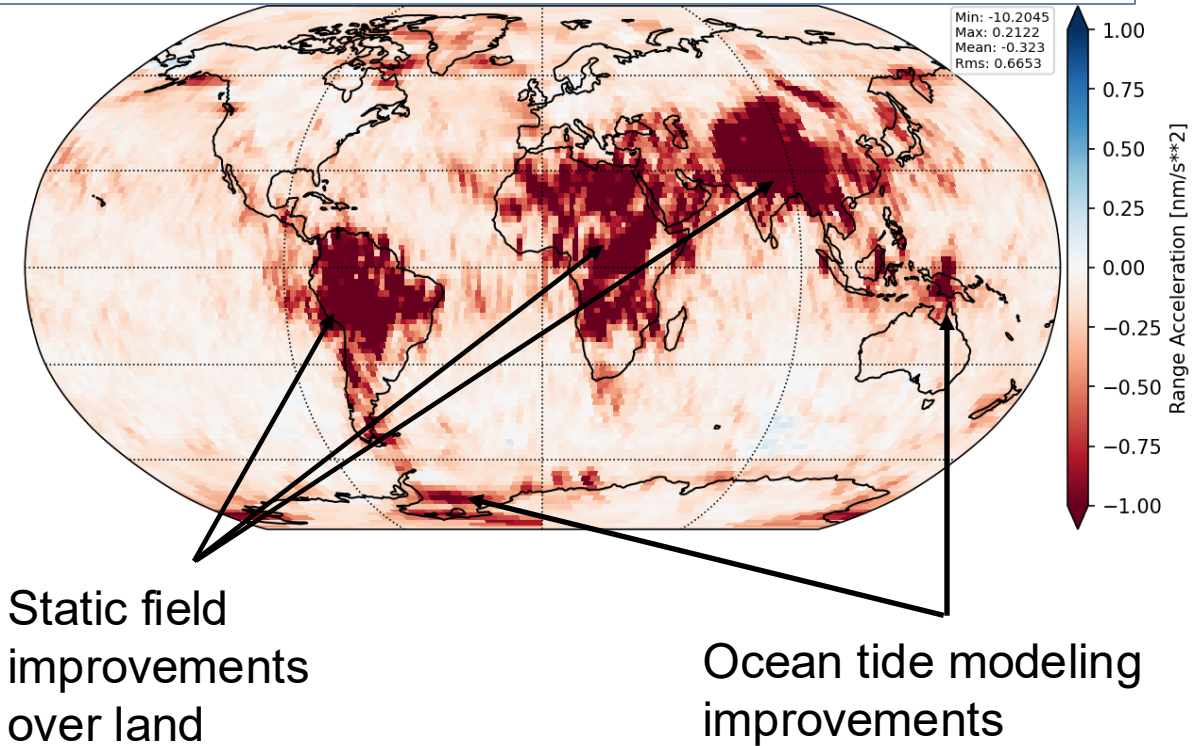[1] *Ellmer, 2018*
[2] *Kvas et al., 2019*

RL07 Force Models Improve Gravity Estimation

Average degree variance of 12 GRACE-FO months processed with LRI range-accelerations. RL07-prelim includes only improvements to background models
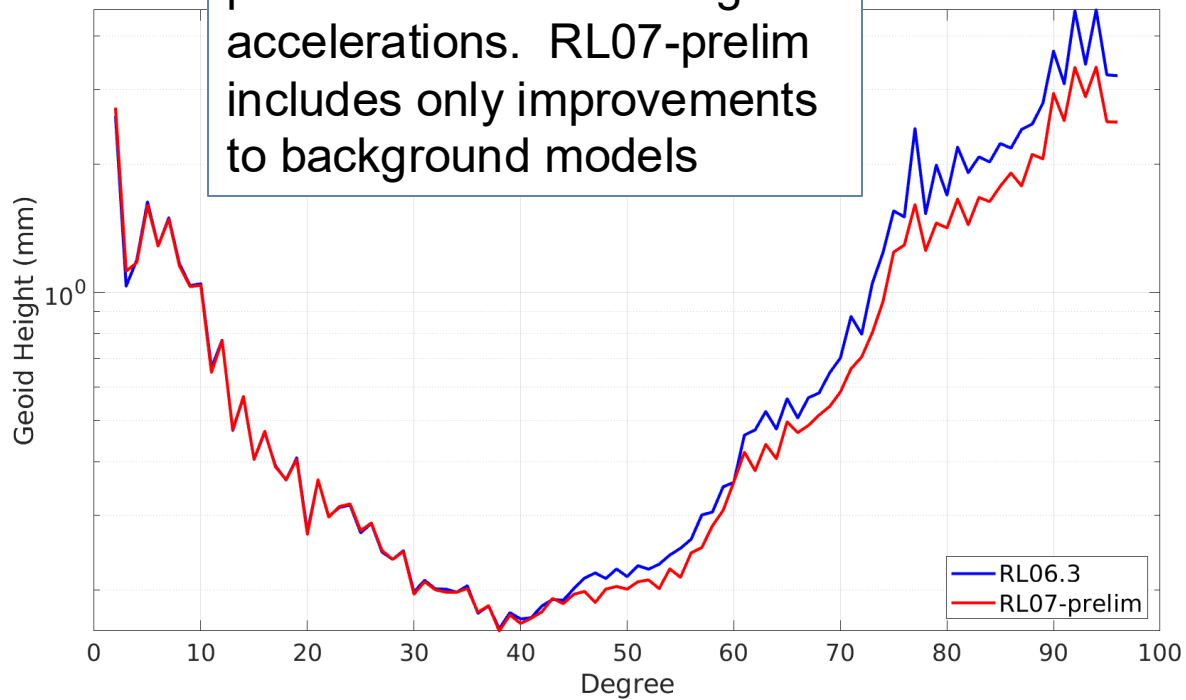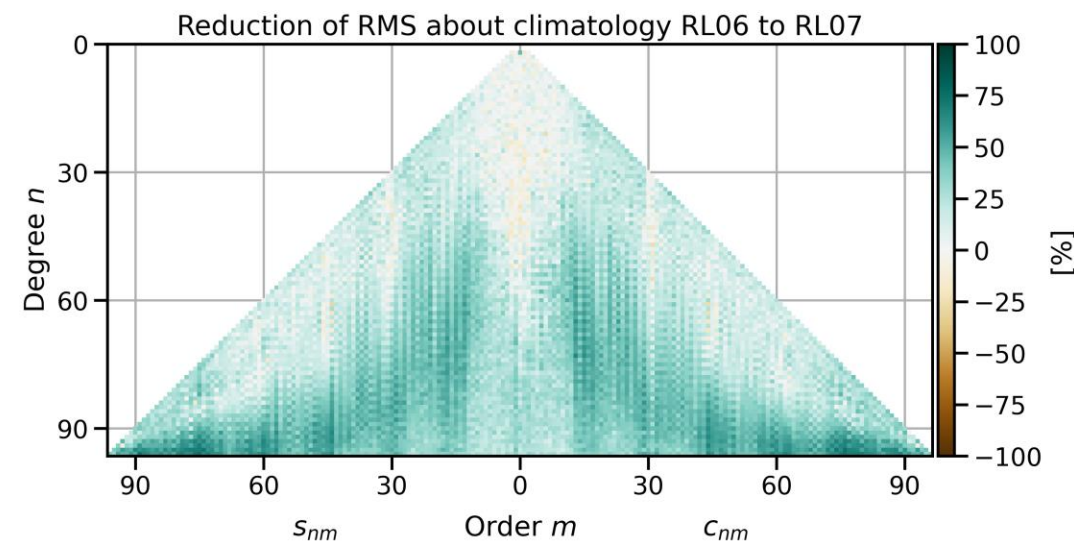
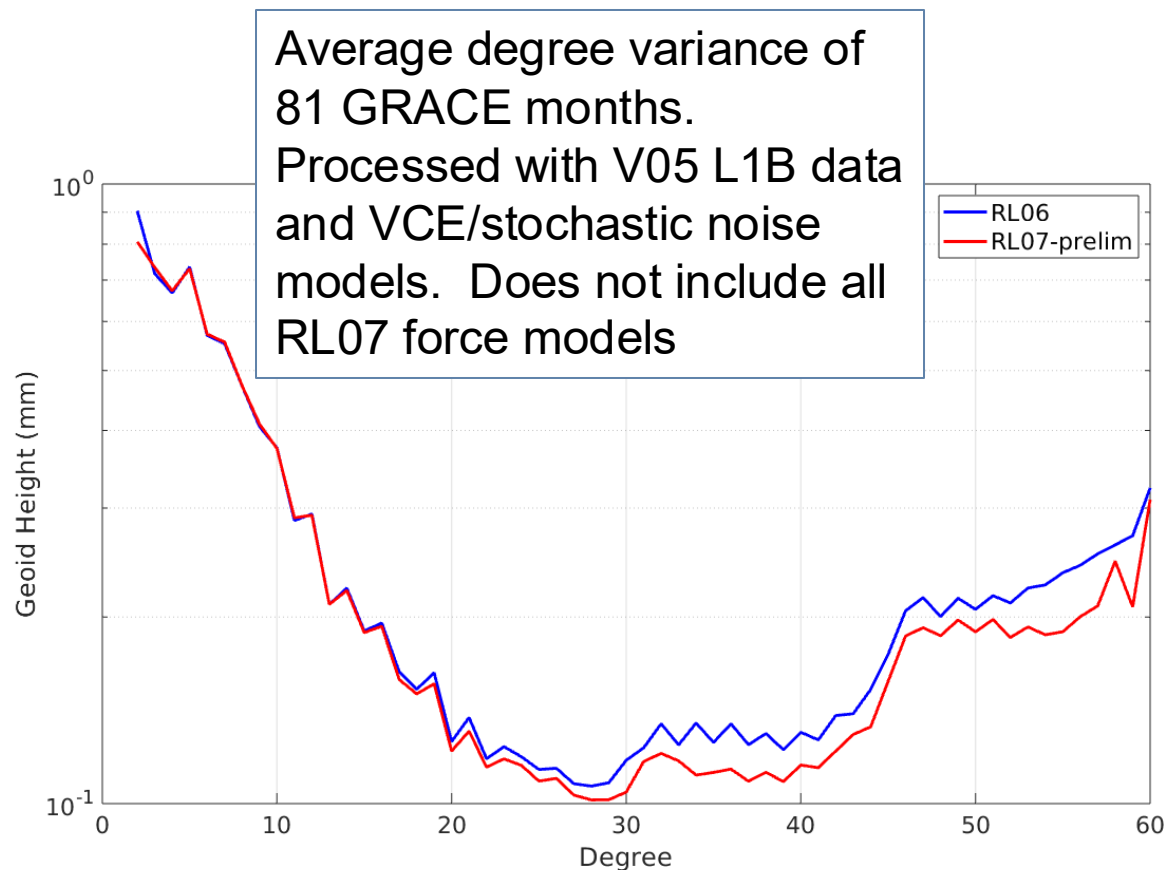Reduction in LRI Range-Acceleration residuals averaged over 12 months due to improved RL07 background models

Min: -10.2045
Max: 0.2122
Mean: -0.323
Rms: 0.6653

Static field improvements over land

Ocean tide modeling improvements

Red → Improvements

New Level-1B data and stochastic noise models in Level-2 gravity estimation gives improvements

Average degree variance of 81 GRACE months. Processed with V05 L1B data and VCE/stochastic noise models. Does not include all RL07 force models

Reduction of RMS about climatology RL06 to RL07

Blue colors indicate improvement in solution

Summary

- Data product release is stable with ~60-day latency:
    - RL06.3 fully unconstrained spherical harmonics
    - RL06.3Mv4 regularized mascons
- GRACE-FO gravity solutions have had stable quality over the last year, despite high solar activity
- RL07 will provide improved gravity solutions owed to:
    - Reprocessing of Level-1 data (V05)
    - Stochastic noise modeling of KBR and GPS observations at Level-2
    - Improved background force models
- Next steps:
    - Full RL07 reprocessing merging all improvements

- The following slides are Supplementary Info

RL06.3 Operational Processing is Stable

- RL06.3 is current data release
  - Uses ACX2 bundle for accelerometer data
  - Parameterization has been held constant for all wide pointing months
    - Less aggressive (no empirical accelerations estimated)
- Data Products
  - RL06.3 Fully Unconstrained Spherical Harmonics: 60x60 and 96x96
    - Derived gridded maps of surface mass change (Level-3)
  - RL06.3Mv04 Regularized 3° Mascons (Level-2/3)
  - Timeseries for Greenland, Antarctica, and Ocean Mass (Level-4)
    - Climate.nasa.gov
    - Sealevel.nasa.gov
  - Updated monthly with ~60-day latency
  - Current through July 2025

GOT5.6 slightly better than FES2022 in testing

Difference in Postfit LRI Range-Acceleration residuals from 12 months in GRACE-FO
(FES2022 – GOT5.6)
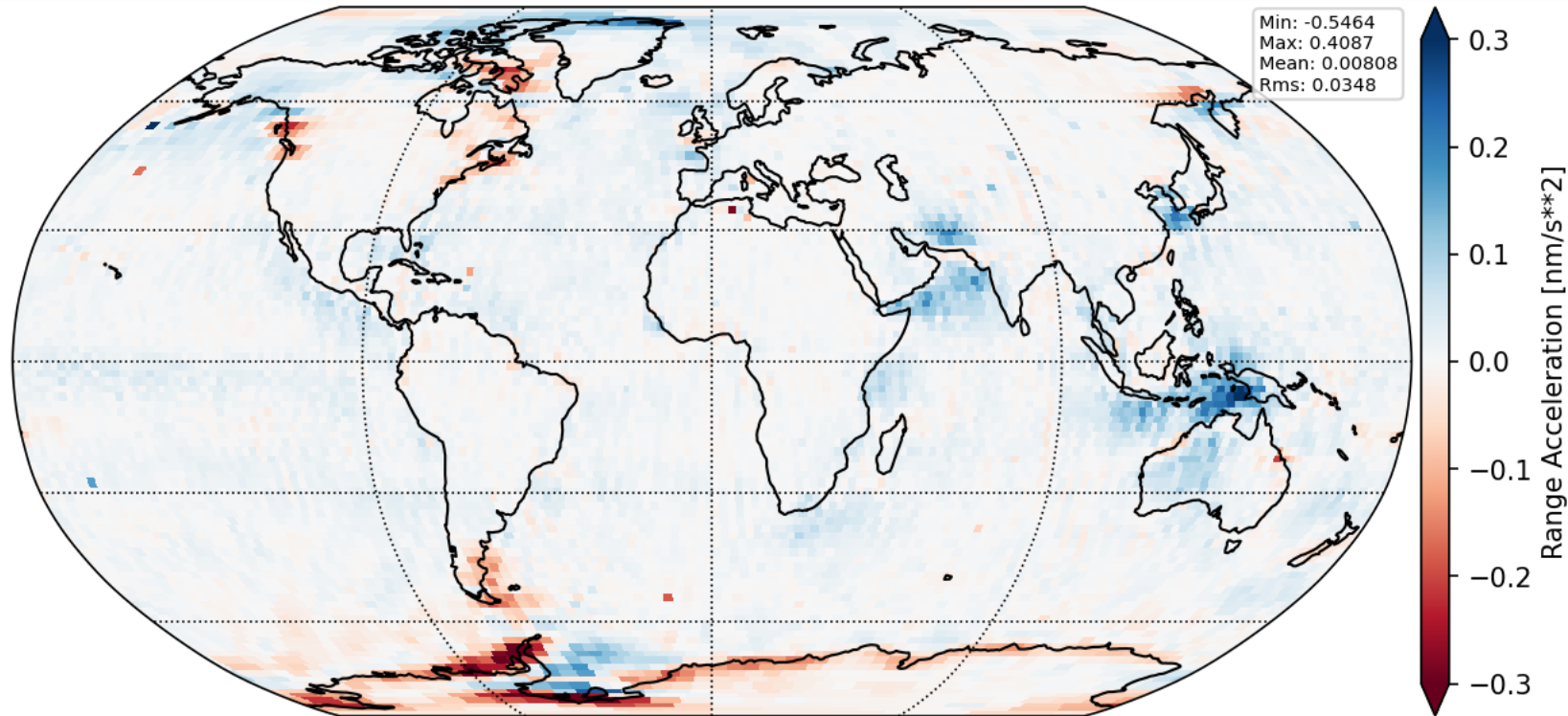
Blue → GOT5.6 better

Red → FES2022 better

GOT5.6 is better in the global mean. FES2022 is found to be better in certain areas, particularly Antarctica

RL07 Improves Formal Errors

RL07 formal errors are more realistic