



# GRACE Follow-On

## Science Data System Newsletter

Report: April - June 2022 (No. 21)

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## GRACE Follow-On Science Data System: Highlights & Updates

- The following **Level1, 2 & 3 SDS data products** are available at NASA's Physical Oceanography Distributed Active Archive Center ([PO.DAAC](#)) and GFZ's Information System and Data Center ([ISDC](#)):
  - **Level-1** SDS data products through **Jul 2022**.
  - **Level-2 & 3** data products through **Jun 2022**.
    - **RL06**: we continue to update the RL06 stream (which is based on [v04 ACT]) while we are working on catching up with the ACX-L1B data [v04.1].
    - **RL06.1**: is currently available through Jan-2022 in a delayed mode. We are working on updating the ACX-L1B data stream [v04.1] from Feb-2022 and will update RL06.1 L2/3 data streams accordingly.
- The following corresponding **Level-3 data** products (global, land, ocean, ice) are available:
  - JPL Tellus global mascon products:  
[https://grace.jpl.nasa.gov/data/get-data/jpl\\_global\\_mascons/](https://grace.jpl.nasa.gov/data/get-data/jpl_global_mascons/)
  - GFZ GravIS land, ocean and ice products:  
<http://gravis.gfz-potsdam.de/>
  - UT-CSR global mascon solutions:  
[http://www2.csr.utexas.edu/grace/RL06\\_mascons.html](http://www2.csr.utexas.edu/grace/RL06_mascons.html)
- **Attention**: JPL/NASA PO.DAAC is migrating all data sets and data access to the Cloud. Please visit <https://podaac.jpl.nasa.gov/cloud-datasets/about> for instructions on how to update your data processing streams accordingly.
- GRACE-FO science data collection and processing:
  - Continuous collection of science data.
  - In July and August 2022, both GF-1&2 satellites have been operated in a nadir-pointing configuration to assess the impact on the science data performance. In this configuration, the LRI link is temporarily disabled due to the relative off-pointing between the spacecraft.



- Orbit raises:
  - The orbits of both satellites were raised by ca. 460m on Jun-22, 2022, and by ca. 950m on Aug-03, 2022.
  - See L1 Releases Notes and Sequence of Events (SoE) for details.
- [Solar Cycle #25](#) continues to ramp up and is currently forecast to be above-average strength. Increased solar activity has resulted in increased orbit altitude decay rates (see Fig.1 below), as well as increased non-gravitational acceleration on the two GRACE-FO satellites. The SDS team continues to closely monitor the Level-1 data & measurement system performance.
- Do you have new GRACE-FO results, a conference presentation or paper publication you would like to share? Please send a copy of your GRACE and GRACE-FO related publications to [landerer@jpl.nasa.gov](mailto:landerer@jpl.nasa.gov) and [flechtne@gfz-potsdam.de](mailto:flechtne@gfz-potsdam.de) (please also consider a 1-slide highlight summary of the main findings).
- When using GRACE-FO data, please cite the **GRACE-FO Mission reference paper**:  
Landerer, F.W., Flechtner, F., et al., 2020, Extending the global mass change data record: GRACE Follow-On instrument and science data performance, *Geophys. Res. Lett.*,  
<https://doi.org/10.1029/2020GL088306>.

## Announcements & Upcoming Events:

- The **GRACE-FO Science Team Meeting 2022** will take place **Oct 18-20, 2022** at GFZ (Potsdam, Germany). We are planning for a hybrid meeting (in-person and remote participation options). Abstract submission will be possible from Aug 22, 2022 through Sep 11, 2022. Please visit the meeting website (<https://www.gstm-2022.eu>) for current information.
- **Call for papers:** A Special Issue on "Next-Generation Gravity Mission" in *Remote Sensing* (Guest Editors: Dr. T. Gruber & J.M. Lemoine) is inviting submissions (see [https://www.mdpi.com/journal/remotesensing/special\\_issues/gravity\\_mission](https://www.mdpi.com/journal/remotesensing/special_issues/gravity_mission)).

## Science Team Resources:

- Proceedings and presentations from the **2021 GRACE/GRACE-FO Science Team Meeting** are available [online](#).
- GGHS2022, the 3rd joint meeting of the International Gravity Field Service and Commission 2 of the International Association of Geodesy, will be held in Austin Texas from Sep 12-14, 2022 (<https://www.csr.utexas.edu/gghs2022>).



## GRACE Follow-On: Mission Status

GRACE Follow-On: Orbit (Data and plots provided by K. Snopek, GFZ)

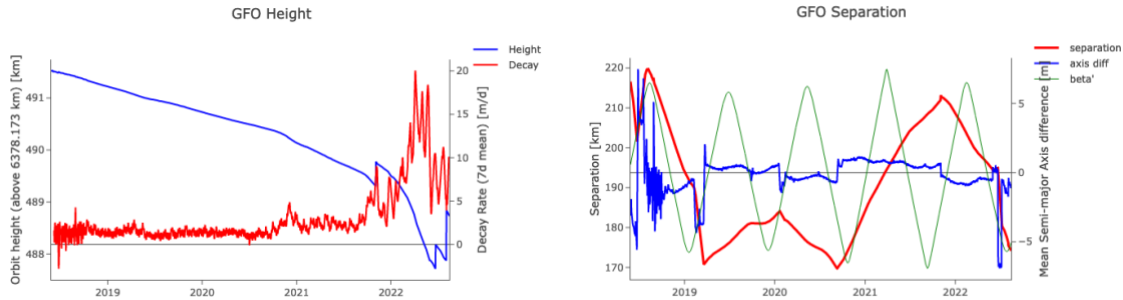


Figure 1: (left) Orbit altitude and daily decay rates [m/d] since launch. (right) Spacecraft separation distance and semi-major axis difference between GF1 and GF2, as well as beta-prime angle of the orbit plane.

The GRACE Follow-On orbital parameters on 2022-07-29 (day 210) were as follows:

Sun Beta (deg)	-69.5 (full-sun)
Absolute Distance (km)	177.4
Drift (km/d)	-0.20
Mean Altitude (>6378.1 km)	487.9
Decay Rate (GF1/GF2) (7d mean, m/d)	7.1 / 7.1

### Science-relevant Mission Events & Plans:

- Both accelerometers (ACCs) are operating and collecting observations in their nominal mode, Normal Range Mode (NRM). GF1 ACC data are used to generate an ACC transplant data product which is provided as the ACT1B product and should be used to substitute the GF2 ACC measurements (please check the ACT-Readme document for details at PO.DAAC).
- Center-of-Mass (CM) offset determinations are performed approx. every 6 months (See SOE/SCE files for details).
- Additional calibration periods, spacecraft activities and events are highlighted in the Level-1 release notes and event logs.



## Level-1, Level-2, Level-3 Data Products and Processing

### Level-1 Data Processing & Delivery

- Level-1 data products (current operational version: v04 ; v04.1 in 'delayed mode'), which are available at NASA's Physical Oceanography Distributed Active Archive Center (PO.DAAC) and GFZ's Information System and Data Center (ISDC), are continuously updated approximately every 7 days. The Level-1 data includes all data required for the generation of Level-2 gravity field products. Please refer to Level-1 release notes, documentation, as well as to the Sequence-of-Events (SOE) logfile for important updates, comments and detailed description of the data, file formats, and conventions ([PO.DAAC](#) / [ISDC](#)).

### KBR Performance Statistics

KBR-GPS performance statistics are available in file [TN-01b\_KBR\_GPS] at ([PO.DAAC](#) / [ISDC](#)).

### Level-1 Data Product Availability

- [see Appendix 1A (p. 6) for GRACE-FO Level-1 data]
- [see Appendix 1B (p. 6) for de-aliasing AOD1B model data]

### Level-1 Release Notes & Sequence of Events

- [see Appendix 1C (p. 6)]

## Level-2 Data Processing & Delivery

### Level-2 Data availability

- Level-2 Release 06 data have been processed at JPL, GFZ and CSR and are archived at JPL PO.DAAC and GFZ ISDC. The Level-2 products include the monthly gravity fields from the three mission Science Data System centers (JPL, GFZ, CSR), as well as the corresponding atmosphere and ocean dealiasing (AOD) background model data.
- Please refer to the Level-2 Release Notes and documentation description of the data for file formats, updates, conventions, as well as important processing recommendations ([PO.DAAC](#) / [ISDC](#)).
- [see Appendix 2A (p. 7) for overview tables on data availability].

### Level-2 Ancillary Products and Comments

- TN-14 contains C20 & C30 estimates derived from SLR and using Level-2 RL06 standards, updated in synch with Level-2 monthly releases. It is recommended to replace the native GRACE & GRACE-FO C20 & C30 coefficients with this product (Loomis et al., 2019).
- TN-13[a,b,c] contains geocenter estimates using the methods of Swenson et al. (2010) and Sun et al. (2016), and is updated in synch with Level-2 monthly releases. It is



recommended to augment the GRACE / GRACE-FO geocenter with this product for surface mass change estimation.

### Level-3 Data Processing & Delivery & Availability

- SDS Level-3 monthly global grids of mass changes are generated by JPL and available at PO.DAAC.
- The following corresponding **Level-3 data** products (global, land, ocean, ice) are available:
  - JPL Tellus global mascon & SDS harmonic products:  
[https://grace.jpl.nasa.gov/data/get-data/jpl\\_global\\_mascons/](https://grace.jpl.nasa.gov/data/get-data/jpl_global_mascons/)
  - GFZ Gravis land, ocean and ice products:  
<http://gravis.gfz-potsdam.de/>
  - UT-CSR global mascon solutions:  
[http://www2.csr.utexas.edu/grace/RL06\\_mascons.html](http://www2.csr.utexas.edu/grace/RL06_mascons.html)
  - GSFC global mascon products:  
<https://earth.gsfc.nasa.gov/geo/data/grace-mascons>
- Interactive GRACE & GRACE-FO data browsers (Level-3):
  - NASA/JPL: <https://grace.jpl.nasa.gov/data-analysis-tool>
  - GFZ: <http://gravis.gfz-potsdam.de/>

### Resources and Links:

#### SDS Data Archives (Level 1-3):

- JPL/NASA PO.DAAC (<http://podaac.jpl.nasa.gov>)
- GFZ ISDC (<https://isdc.gfz-potsdam.de/grace-fo-isdc>)

#### Miscellaneous Links:

- For GRACE Follow-On mission updates and news, please visit <https://gracefo.jpl.nasa.gov> and <http://gfz-potsdam.de/en/grace-fo>.
- The proceedings of previous GRACE / GRACE-FO Science Team Meetings are available at <https://www.gfz-potsdam.de/en/grace/> or at <https://grace.jpl.nasa.gov/events/>
- **GRACE and GRACE-FO related publications** are available via searchable databases:
  - [http://www-app2.gfz-potsdam.de/pb1/op/grace/references/sort\\_date.html](http://www-app2.gfz-potsdam.de/pb1/op/grace/references/sort_date.html)
  - <https://grace.jpl.nasa.gov/publications/>
  - For missing publications in the database, please contact Frank Flechtner ([flechtne@gfz-potsdam.de](mailto:flechtne@gfz-potsdam.de)) and the JPL team ([grace\\_feedback@jpl.nasa.gov](mailto:grace_feedback@jpl.nasa.gov))



## Appendix

### 1.A – Level-1 GRACE-FO Data Availability

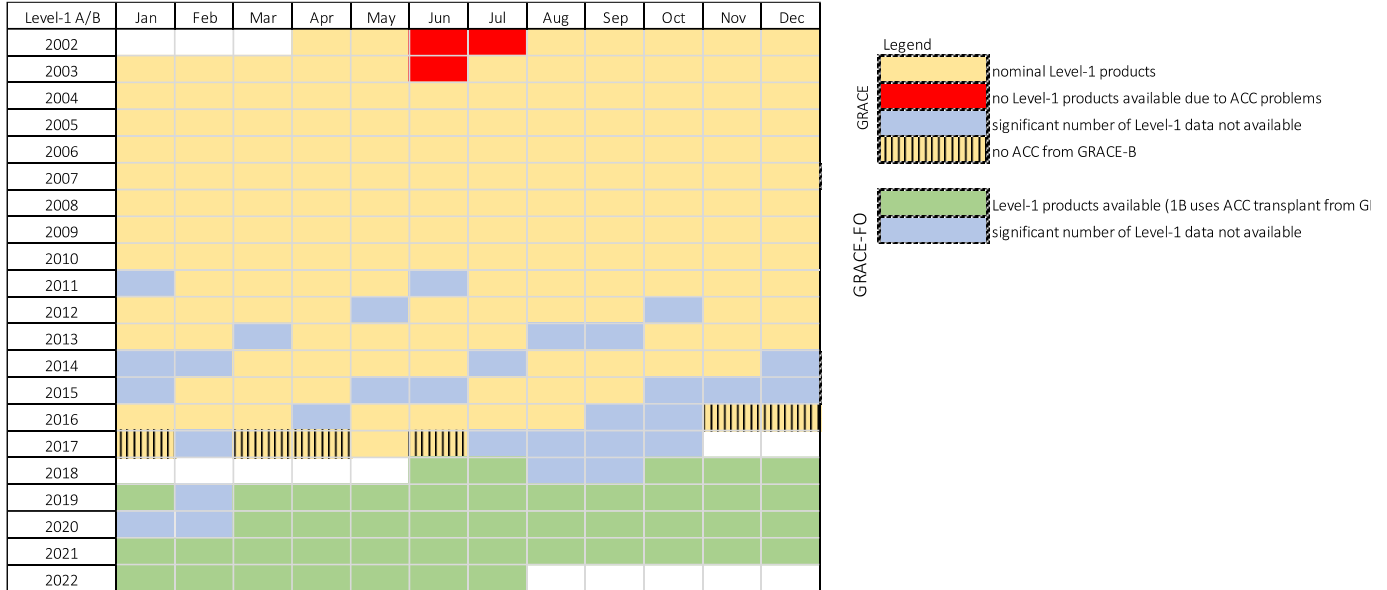
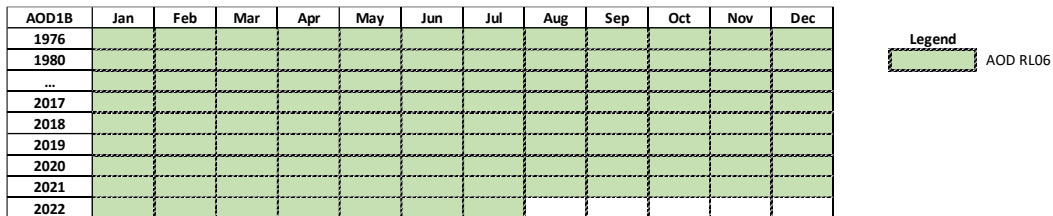


Table 1: Current version: Level-1 v04.

### 1.B – Level-1 De-aliasing Model AOD1B Data Availability



- For more information on the AOD de-aliasing AOD1B model please visit <https://www.gfz-potsdam.de/en/aod1b/>.

### 1.C - Level-1 Release Notes & Sequence of Events

A machine-readable Sequence-of-Events file is available: [TN-01\_SOE.txt]. An additional Spacecraft-Event log from JPL Level-1 operators is available as [TN-01a\_SCE.txt].

- <https://podaac-tools.jpl.nasa.gov/drive/files/allData/gracefo/docs/>
- <ftp://isdctf.gfz-potsdam.de/grace-fo/>



2.A – Level-2 Product and Data Availability

JPL, GFZ & CSR

- Current Level-2 version: RL06
- All centers provide GSM solutions
  - Please check the Level-2 Release Notes for further details
- JPL and GFZ provide corresponding monthly de-aliasing models [GAA, GAB, GAC, GAD]; CSR provides [GAC, GAD].

Level-2 (JPL)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2002				1	2			3	4	5	6	7
2003	8	9	10	11	12		13	14	15	16	17	18
2004	19	20	21	22	23	24	25	26	27	28	29	30
2005	31	32	33	34	35	36	37	38	39	40	41	42
2006	43	44	45	46	47	48	49	50	51	52	53	54
2007	55	56	57	58	59	60	61	62	63	64	65	66
2008	67	68	69	70	71	72	73	74	75	76	77	78
2009	79	80	81	82	83	84	85	86	87	88	89	90
2010	91	92	93	94	95	96	97	98	99	100	101	102
2011		103	104	105	106		107	108	109	110	111	112
2012	113	114	115	116		117	118	119	120		121	122
2013	123	124		125	126	127	128			129	130	131
2014	132		133	134	135	136		137	138	139	140	
2015	141	142	143	144	145		146	147	148			149
2016	150	151	152		153	154	155	156			157*+	158*+
2017	159*+		160*+	161*+	162*	163*+						
2018						1*+	2*+			3*+	4+	5+
2019	6+	7*+	8+	9+	10+	11+	12+	13+	14+	15+	16+	17+
2020	18*+	19*+	20+	21+	22+	23+	24+	25+	26+	27+	28+	29+
2021	30+	31+	32+	33+	34+	35+	36+	37+	38+	39+	40+	41+
2022	42+	43+	44+	45+	46+	47+						

**GRACE**  
 Level-2 products  
 no Level-2 products available

**GRACE-FO**  
 Level-2 products available

Current Level-2 Release: RL06

+ Level-2 products (with ACC transplant)  
 \* partial / overlapping calendar-months

Table 2: GRACE and GRACE-FO Level-2 product availability.



3.A – Level-3 Product and Data Availability

JPL, GFZ & CSR

- JPL provides Land (LND) and Ocean (OCN) global data grids for all three SDS centers (JPL, GFZ, CSR) via PO.DAAC.

Level-2 (JPL)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2002				1	2			3	4	5	6	7
2003	8	9	10	11	12		13	14	15	16	17	18
2004	19	20	21	22	23	24	25	26	27	28	29	30
2005	31	32	33	34	35	36	37	38	39	40	41	42
2006	43	44	45	46	47	48	49	50	51	52	53	54
2007	55	56	57	58	59	60	61	62	63	64	65	66
2008	67	68	69	70	71	72	73	74	75	76	77	78
2009	79	80	81	82	83	84	85	86	87	88	89	90
2010	91	92	93	94	95	96	97	98	99	100	101	102
2011		103	104	105	106		107	108	109	110	111	112
2012	113	114	115	116		117	118	119	120		121	122
2013	123	124		125	126	127	128		129	130	131	
2014	132		133	134	135	136		137	138	139	140	
2015	141	142	143	144	145		146	147	148			149
2016	150	151	152		153	154	155	156			157*+	158*+
2017	159*+		160*+	161*+	162*	163*+						
2018						1*+	2*+			3*+	4+	5+
2019	6+	7*+	8+	9+	10+	11+	12+	13+	14+	15+	16+	17+
2020	18*+	19*+	20+	21+	22+	23+	24+	25+	26+	27+	28+	29+
2021	30+	31+	32+	33+	34+	35+	36+	37+	38+	39+	40+	41+
2022	42+	43+	44+	45+	46+	47+						

GRACE  
 Level-3 products  
 no Level-3 products available

GRACE-FO  
 Level-3 products available

Current Level-2 Release: RL06

+ Level-3 products (with ACC transplant)  
 \* partial / overlapping cal-months

Table 3: GRACE and GRACE-FO Level-3 product availability