



GRACE Follow-On

Science Data System Newsletter

Period: Jul - Sep 2022 (No. 22)

Contact: gracefo@jpl.nasa.gov

Felix Landerer¹, Frank Flechtner², Himanshu Save³, Christoph Dahle²

¹ Jet propulsion Laboratory / California Institute of Technology, Pasadena, CA

² GFZ German Research Centre for Geosciences, Potsdam, Germany

³ Center for Space Research, University of Texas, Austin, TX

GRACE Follow-On Science Data System: Highlights & Updates

- In support of gap-less data continuity of gravity and mass change observations, on November 10, the German Bundestag funded the German mission elements for a GRACE-FO successor (e.g., Mass Change Mission). On November 23, the ESA Council at Ministerial level held in Paris formulated the goal to realize a Mass-change And Geoscience International Constellation (*MAGIC*). With those decisions, both data continuity as well as significantly higher temporal/spatial resolution can eventually be achieved.
- The 2022 GRACE-FO STM took place at GFZ in Potsdam (Oct 18-20) – thank you to all on-site attendees (see group picture below) and online participants (in total: 167) for making it a great success! The program included 85 oral presentations and 17 posters; proceedings and presentations are available [online](#).



- The following **Level 1, 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 **Oct 2022**.
 - ACX-L1B is available through Sep 2022.
- **Level-2 & 3** data products through **Sep 2022**.
 - **RL06**: we continue to update the RL06 stream (which is based on ACTv04)
 - **RL06.1**: is currently available through Sep-2022, in a delayed mode. We plan to provide the ACX-L1B data product operationally by early 2023.
- 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/
 - 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
- **Attention**: JPL/NASA PO.DAAC is migrating all data sets and data access to the new PO.DAAC AWS Cloud.
 - Please visit <https://podaac.jpl.nasa.gov/cloud-datasets/about> for instructions on how to update your data processing streams accordingly.
 - To access Technical Notes TN-13a/b/c and TN-14, please use the links provided below (p. 5).
- GRACE-FO science data collection and processing updates:
 - Continuous collection of science data in nominal fine-pointing mode, no major events.
 - Orbit raises:
 - The orbits of both satellites were raised by ca. 480m on Nov-22, 2022.
 - See L1 Releases Notes and Sequence of Events (SoE) for details.
- **Solar Cycle #25**: Increased solar activity is resulting in increased orbit altitude decay rates (see Fig.1 below), as well as increased non-gravitational acceleration on the two GRACE-FO satellites.
- 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 and 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 next **GRACE-FO Science Team Meeting 2023** will take place **Oct 18-20, 2023** in the US, with an exact location to be announced in early 2023.



- The **AGU Fall Meeting 2022** will take place from Dec 12-16, 2022, with many interesting Geodesy sessions featuring GRACE(-FO) and related data. Visit <https://www.agu.org/Fall-Meeting> for details and the program.
- The **2. Workshop of the Inter-Commission Committee on "Geodesy for Climate Research"** (ICCC) of the International Association of Geodesy (IAG) will take place March 28-30, 2023 as an online event (free of charge). Abstract submission and registration will open in January 2023. Visit <https://iccc.iag-aig.org/iccc-workshops/ws23> for details.
- **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).

Science Team Resources:

- Proceedings and presentations from the **2022 GRACE/GRACE-FO Science Team Meeting** are available [online](#).
- Proceedings and presentations from previous **GRACE/GRACE-FO Science Team Meetings** are also available [online](#).

GRACE Follow-On: Mission Status

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

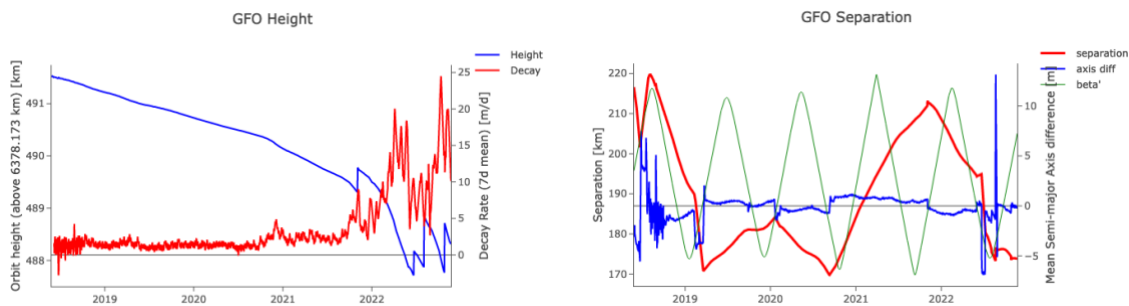


Figure 1: (left) Orbit altitude and daily decay rates [m/d] since launch. (right) Spacecraft separation distance and semi-major axis difference between GF1 and GF2, as well as beta-prime angle of the orbit plane.

The GRACE Follow-On orbital parameters on 2022-11-22 (day 326) were as follows:

Sun Beta (deg)	37
Absolute Distance (km)	173.7
Drift (km/d)	-0.04
Mean Altitude (>6378.1 km)	488.3



Decay Rate (GF1/GF2) (7d mean, m/d)	10.1 / 10.2
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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 ; ACX1B 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. 7) for GRACE-FO Level-1 data]
- [see Appendix 1B (p. 7) for de-aliasing AOD1B model data]

Level-1 Release Notes & Sequence of Events

- [see Appendix 1C (p. 7)]



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. 8) for overview tables on data availability].

Level-2 Ancillary Products, Technical Notes 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-14 Data Access:

- @PO.DAAC: via Data Collection Bundles for each SDS center (JPL, CSR, GFZ):
https://podaac.jpl.nasa.gov/dataset/GRACEFO_L2_JPL_MONTHLY_0061
 - @GFZ:
ftp://isdctftp.gfz-potsdam.de/grace-fo//DOCUMENTS/TECHNICAL_NOTES
- 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.

TN-13[a,b,c] Data Access:

- @PO.DAAC: via Data Collection Bundles for each SDS center (JPL, CSR, GFZ):
https://podaac.jpl.nasa.gov/dataset/GRACEFO_L2_JPL_MONTHLY_0061
- @GFZ:
ftp://isdctftp.gfz-potsdam.de/grace-fo//DOCUMENTS/TECHNICAL_NOTES

Level-3 Data Processing & Delivery & Availability

- The following SDS-generated **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/
 - 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



- 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>)

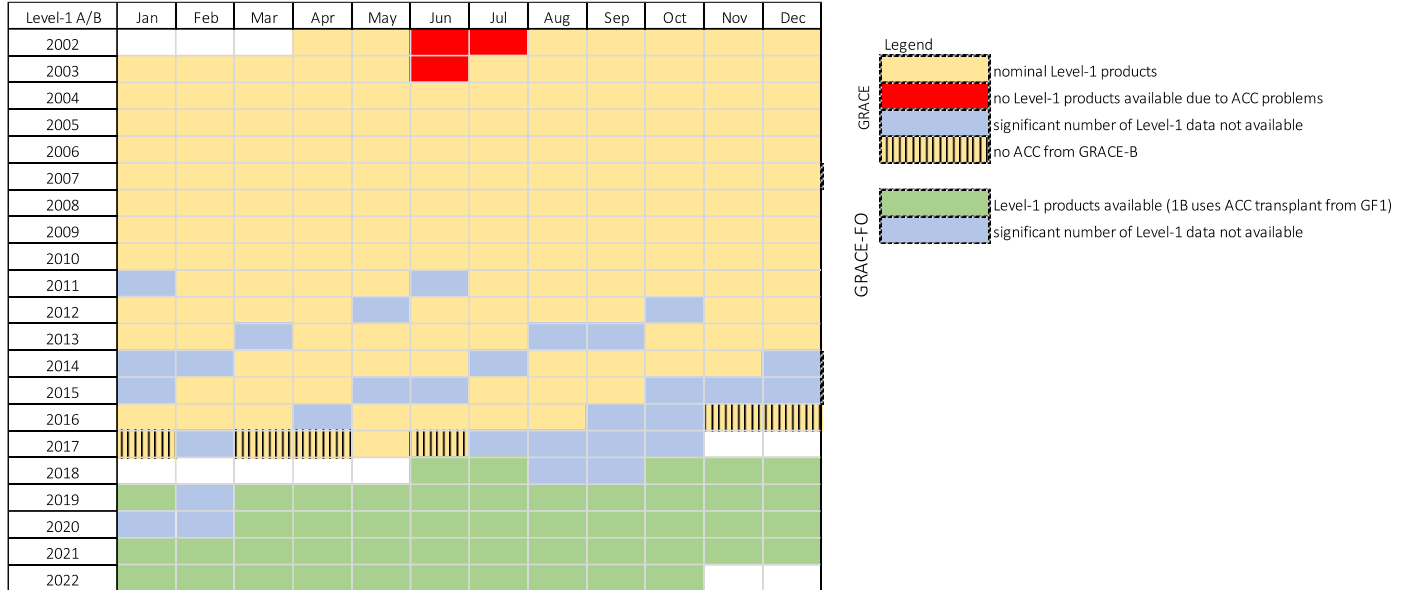
Miscellaneous Links:

- 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
 - <https://grace.jpl.nasa.gov/publications/>
 - For missing publications in the database, please contact Frank Flechtner (flechtne@gfz-potsdam.de) and the JPL team (grace_feedback@jpl.nasa.gov)

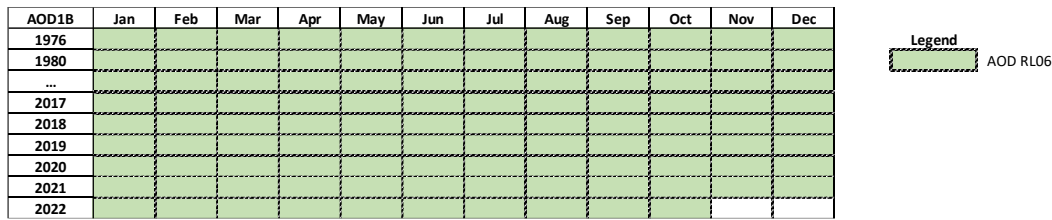


Appendix

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



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://isdftp.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*	48*	49*	50*			

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 3: 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+	48+	49+	50+			

GRACE
 Level-3 products
 no Level-3 products available

GRACE-FO
 Level-3 products available

Current Level-2 Release: RLO6

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

Table 4: GRACE and GRACE-FO Level-3 product availability