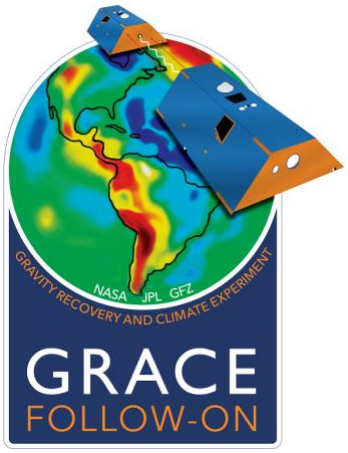

GRACE Follow-On

Science Data System Newsletter

Report: Jan 2020 (No. 11)

Contact: gracefo@jpl.nasa.gov

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GRACE Follow-On Science Data System: Highlights & Updates

- The on-board clocks on GF2 (Jan-2020) and GF1 (Feb-2020) were corrupted by single bit flips in the GPS integer seconds counter in the Instrument Processing Unit that tracks GPS time. Science mode was briefly interrupted following both events – see 'Science-relevant Mission Events & Plans' for more details.
- The following 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 & Level-2** SDS data products for **DEC-2019 & JAN-2020**
- The following SDS data products are available at NASA's Physical Oceanography Distributed Active Archive Center (PO.DAAC):
  - **Level-3** SDS data products for **JAN-2020** (Note: This monthly gravity and mass change field is derived from a reduced monthly data set, i.e., fewer days during the month due to outages).

Calendar & Upcoming Events:

- EGU General Assembly 2020:
  - Vienna | Austria | 3–8 May 2020
  - https://www.egu2020.eu/
- GGHS2020: Gravity Geoid and Height Systems 2020:
  - Center for Space Research, The University of Texas at Austin | 15-18 Sep 2020
  - https://www.csr.utexas.edu/gghs2020/
- **GRACE/GRACE-FO Science Team Meeting 2020:**
  - GFZ, Potsdam | Germany | 27-29 Oct 2020
  - Webpage coming soon!

GRACE Follow-On: Mission Status

GRACE Follow-On: Orbit

The GRACE Follow-On orbital parameters on 2020-01-21 (day 021) were as follows:

Sun Beta (deg)	-33
Absolute Distance (km)	184.0
Drift (km/d)	0.05
Mean Altitude (>6378.1 km)	490.7
Decay Rate (GF1/GF2) (7d mean, m/d)	0.8 / 1.1

Science-relevant Mission Events & Plans:

- **GF2:** On January 18, 2020, the GF2 satellite entered safe mode when the on-board clock was corrupted by a single bit flip in the GPS integer seconds counter in the Instrument Processing Unit that tracks GPS time. Science mode was reenabled on January 24 (see vent log below). The monthly gravity field and mass change field for Jan-2020 is computed from the reduced Jan-2020 data set, which causes slightly elevated error levels.
- **GF1:** On February 7, 2020, the GF1 satellite entered safe mode when the on-board clock was corrupted by a single bit flip in the GPS integer seconds counter in the Instrument Processing Unit that tracks GPS time, similar to the event on Jan-18, 2020 on GF1. Science mode was reenabled on February 13. The monthly gravity field and mass change field for Feb-2020 will be computed from the reduced Feb-2020 data set.
- Both accelerometers (ACCs) are operating and collecting observations. The GF1 ACC is operating in its nominal mode, Normal Range Mode (NRM), and the GF2 ACC is in Large-Range-Mode (LRM). 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 offset determinations are performed approx. every 6 months.
- Additional calibration periods, spacecraft activities and events are highlighted in the Level-1 v04 notes and event log below.

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

Level-1 Data Processing & Delivery

- Level-1 data products (current version: v04), which are available at NASA's Physical Oceanography Distributed Active Archive Center (PO.DAAC) and GFZ's Information System and Data Center (ISDC), have been continuously expanded approximately every 7 days since the first data release on May-24, 2019. 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, updates, and conventions (PO.DAAC / ISDC).

KBR Performance Statistics

- [see Appendix 1A (p. 5)]

Level-1 Data Product Availability

- [see Appendix 1B (p. 5) for GRACE-FO Level-1 data]
- [see Appendix 1C (p. 6) for de-aliasing AOD1B model data]

Level-1 Release Notes & Sequence of Events

- [see Appendix 1D (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-11 will no longer be updated; it is replaced by TN-14;
- 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

- SDS Level-3 monthly global grids of mass changes are generated by JPL and available at PO.DAAC.

Resources and Links:

Data Archives (Level 1-3):

- 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/.
- Searchable databases of **GRACE and GRACE-FO related publications** are available at
    - http://www-app2.gfz-potsdam.de/pb1/op/grace/references/sort_date.html
    - https://grace.jpl.nasa.gov/publications/
    - If you are missing a publication please send an e-mail to Frank Flechtner (flechtne@gfz-potsdam.de) and contact the JPL team via https://grace.jpl.nasa.gov/about/feedback/.

Appendix

1.A - KBR Performance Statistics

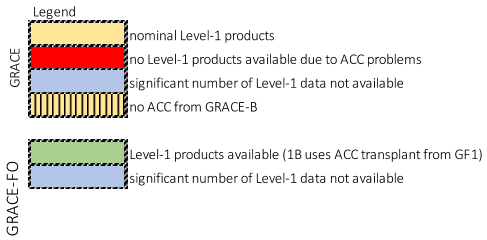
KBR QUALITY ASSESSMENT
Key to columns in the table below
1) KBR1B product name
2) Total arc length with data (hours)
3) Number of observations used in KBR-GPS range residual calculation
4) KBR-GPS range residual RMS (mm)
5) Minimum KBR-GPS range residual (mm)
6) Maximum KBR-GPS range residual (mm)
7) Number of continuous segments in the KBR product

KBR1B_2020-01-01_Y_04.dat	24.0	17280	1.82	-7.2	4.5	1
KBR1B_2020-01-02_Y_04.dat	24.0	17178	1.89	-5.5	6.6	2
KBR1B_2020-01-03_Y_04.dat	24.0	17280	1.43	-3.9	5.5	1
KBR1B_2020-01-04_Y_04.dat	24.0	17205	1.71	-6.3	6.4	2
KBR1B_2020-01-05_Y_04.dat	24.0	17280	1.11	-2.8	3.4	1
KBR1B_2020-01-06_Y_04.dat	24.0	17280	1.39	-4.1	4.0	1
KBR1B_2020-01-07_Y_04.dat	24.0	17280	1.53	-5.3	5.6	1
KBR1B_2020-01-08_Y_04.dat	24.0	16915	1.43	-3.5	5.7	4
KBR1B_2020-01-09_Y_04.dat	24.0	17075	1.50	-8.5	5.2	5
KBR1B_2020-01-10_Y_04.dat	24.0	17063	1.41	-4.5	5.1	4
KBR1B_2020-01-11_Y_04.dat	24.0	17280	1.34	-4.4	4.8	1
KBR1B_2020-01-12_Y_04.dat	24.0	17280	1.29	-5.1	4.6	1
KBR1B_2020-01-13_Y_04.dat	24.0	17280	1.44	-5.6	4.1	1
KBR1B_2020-01-14_Y_04.dat	22.8	16430	1.37	-4.2	5.0	1
KBR1B_2020-01-15_Y_04.dat	22.7	16196	1.40	-4.9	4.7	2
KBR1B_2020-01-16_Y_04.dat	24.0	17280	1.59	-5.0	7.1	1
KBR1B_2020-01-17_Y_04.dat	24.0	16987	1.27	-3.2	3.9	3
KBR1B_2020-01-18_Y_04.dat	5.1	3652	1.27	2.5	3.3	1
KBR1B_2020-01-24_Y_04.dat	13.8	9926	1.27	-3.8	2.4	1
KBR1B_2020-01-25_Y_04.dat	24.0	17280	1.40	-4.9	3.6	1
KBR1B_2020-01-26_Y_04.dat	24.0	17280	1.42	-5.0	4.5	1
KBR1B_2020-01-27_Y_04.dat	24.0	17280	1.34	-4.2	4.0	1
KBR1B_2020-01-28_Y_04.dat	24.0	17280	1.50	-7.6	4.2	1
KBR1B_2020-01-29_Y_04.dat	24.0	17280	1.23	-3.3	3.9	1
KBR1B_2020-01-30_Y_04.dat	24.0	17280	1.27	-3.5	4.8	1
KBR1B_2020-01-31_Y_04.dat	24.0	17280	1.55	-5.8	4.0	1

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

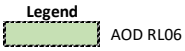
Table 1: Current version: Level-1 v04.

Level-1 A/B	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2002												
2003												
2004												
2005												
2006												
2007												
2008												
2009												
2010												
2011												
2012												
2013												
2014												
2015												
2016												
2017												
2018												
2019												
2020												



1.C – Level-1 De-aliasing Model AOD1B Data Availability

AOD1B	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976												
1980												
…												
2017												
2018												
2019												
2020												



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

1.D - Level-1 Release Notes & Sequence of Events

- See table below for current release period.

2020-01-02	D: IPU reboot at 17:29:40
2020-01-04	C: IPU reboot at 20:58:50
2020-01-08	C: two IPU reboots at 19:30:50 and at 21:46:10
2020-01-09	CD: GPS PRN #9 disabled in the IPUs (19:15 - 08:45 2020-01-10) due to an announced period of unavailability.
2020-01-08	CD: till 2020-01-10 KBR missed interrupt
2020-01-10	C: IPU reboot at 09:49:40; K/Ka-band trackers were restarted at 01:54 in order to cure an ongoing Missed Interrupt condition.
2020-01-10	C: IPU reboot at 09:50:00
2020-01-14	C: K-band SNR dropped significantly at 22:48. The SNR drop started over the Arctic Ocean and was likely caused by an SEU event in a DSP channel. This was cured by commanded IPU s/w restart on next day
2020-01-15	C: IPU reboot at 03:23:40; PRN #04 was re-enabled after it was announced usable again.
2020-01-10	CD: GPS PRN #9 was re-enabled in the IPUs (08:45) after its announced period of unavailability.
2020-01-17	C: GPS PRN #04 was re-enabled in the IPU yesterday at 18:14.
2020-01-18	C: IPU reboot at 17:30:40 and at 17:42:30; The IPU was restarted on 18-Jan-2020 at 17:30 with disabled K/Ka trackers and disabled radio occultation antenna. About 12 minutes later a spontaneous IPU reboot followed.
2020-01-19	C: IPU reboot at 03:45:26; In order to disable the K/Ka trackers again (required to avoid frequent reboots) another IPU restart was commanded. After being in Re-Acquisition Mode for 24 hours LRI switched to Diagnostic Mode.
2020-01-23	C: At 14:52 the pointing frame was switched from nadir to relative pointing.
2020-01-17	D: IPU reboot at 07:43:24
2020-01-18	D: At 05:05 the O/B Time changed to year 2037. It resulted in the cleaning of the MTL and drop to AOCS Safe Mode.
2020-01-19	D: At 1:50 the FDIR to ASM was re-enabled.
2020-01-20	D: At 12:30 the MMU pointer management of the HK (non-science) store was corrected - about 4 hours of HK data is lost.
2020-01-21	D: At 14:05 the MMU pointer management of the science data store was corrected - resulting in about 10 minutes of science data loss. The thermal loops of IPU-A, MWA-A, LRI and ACC were configured for instrument operations during the same contact.
2020-01-22	D: The satellite is in Nominal Mode (NOM). IPU-A was successfully switched on at 09:37. STRE-A was successfully switched on 12:00. Transition to NOM-AH mode was successfully executed at 12:05.
2020-01-23	D: At 10:03 the synchronization of the on-board time with GPS was activated. MWA-A was powered on at 14:42, but KBR tracking continues to be disabled. Shortly after the pointing frame was switched from nadir to relative point ing. Also, the MMU delete pointer movement via timetags in the MTL was re-activated at 10:03. The transition to NOM-FP mode was successfully executed at 13:20. MWA-A was powered on at 14:42, but KBR tracking continues to be disabled. IPU reboot at 17:15:33 and activated the K/Ka-band measurements; LRI was powered on at 14:25.
2020-01-17	CD: IPU reboot at 08:49:40; GPS PRN #28 was disabled in the IPU (16-Jan 18:15 - 17-Jan 18:15) due to an announced period of unavailability. In order to resume tracking to all available GPS satellites IPU restart was planned and executed on both satellites.
2020-01-18	CD: KBR and LRI link was lost after GF2 switched to AOCS Safe Mode at 05:05.
2020-01-24	C: At 10:19 the OCC antenna was switched on and the OCC measurements were re-activated in the IPU. LRI was commanded to Auto-Acquisition Mode at 14:01 in order to resume Science Mode after LRI switch-on on GF2.
2020-01-24	D: LRI was powered on at 14:25.
2020-01-24	CD: In order to resume the K/Ka-band tracking a restart of the IPUs was commanded at 10:00
2020-01-31	D: At 13:37 the ACC gold wire verification was performed for 1s.

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].

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

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+*											

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 cal-months

2.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.

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

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+*											

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