GRACE Follow-On
Science Data System Newsletter
Report: Feb/Mar 2020 (No. 12)
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GRACE Follow-On Science Data System: Highlights & Updates

- A mission overview paper with contributions from JPL, GFZ, CSR and GSFC has been accepted for publication in *Geophys. Res. Lett.:*
    - 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.
- Science data collection and processing has been nominal
    - The SDS teams at JPL, GFZ and CSR, as well as the mission control team at GSOC, have been mostly working from home in response to the mandated COVID-19 responses;
    - No science data has been lost or delayed due to COVID-19 issues;
- 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 **Feb & Mar 2020** (Note: the Feb 2020 monthly gravity and mass change field is derived from a reduced monthly data set, i.e., fewer days during the month due to outages – see Mission Events in NL No.11).
- The following SDS data products are available at NASA's Physical Oceanography Distributed Active Archive Center (PO.DAAC):
    - **Level-3** SDS data products for **Feb & Mar 2020**
- Do you have exciting 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 (ideally also include a 1-slide highlight summary of the main findings).

Calendar & Upcoming Events:

- **GHS2020: Gravity Geoid and Height Systems 2020**
  - o Update: Postponed to a later date - TBD
- **GRACE/GRACE-FO Science Team Meeting 2020:**
  - o GFZ, Potsdam | Germany | 27-29 Oct 2020
  - O Note: A decision about how exactly this meeting will be made in the coming weeks.

GRACE Follow-On: Mission Status

GRACE Follow-On: Orbit

The GRACE Follow-On orbital parameters on 2020-05-11 (day 132) were as follows:

Sun Beta (deg)	72.5 (Full-Sun)
Absolute Distance (km)	176.5
Drift (km/d)	-0.04
Mean Altitude (>6378.1 km)	490.6
Decay Rate (GF1/GF2) (7d mean, m/d)	1.5 / 1.5

Science-relevant Mission Events & Plans:

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

Level-1 Data Product Availability
- [see Appendix 1B (p. 6) 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. 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 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
- 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/.
- **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/
    - 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

1	2	3	4	5	6	7
KBR1B_2020−02−01_Y_04.dat	24.0	17280	1.39	−4.6	4.8	1
KBR1B_2020−02−02_Y_04.dat	24.0	17280	1.35	−5.1	5.2	1
KBR1B_2020−02−03_Y_04.dat	24.0	17280	1.43	−5.4	4.0	1
KBR1B_2020−02−04_Y_04.dat	24.0	17280	1.22	−3.2	4.4	1
KBR1B_2020−02−05_Y_04.dat	24.0	17280	1.42	−4.3	3.7	1
KBR1B_2020−02−06_Y_04.dat	24.0	17280	1.77	−7.5	4.4	1
KBR1B_2020−02−07_Y_04.dat	10.6	7602	1.78	−5.6	5.2	1
KBR1B_2020−02−13_Y_04.dat	12.4	8904	1.22	−2.8	3.6	1
KBR1B_2020−02−14_Y_04.dat	24.0	17151	2.42	−9.9	8.6	2
KBR1B_2020−02−15_Y_04.dat	24.0	17280	2.43	−12	6.8	1
KBR1B_2020−02−16_Y_04.dat	24.0	17280	2.52	−9.0	8.3	1
KBR1B_2020−02−17_Y_04.dat	24.0	17177	2.04	−6.9	8.2	2
KBR1B_2020−02−18_Y_04.dat	24.0	17008	2.20	−8.7	8.7	2
KBR1B_2020−02−19_Y_04.dat	24.0	17280	2.95	−9.3	14.1	1
KBR1B_2020−02−20_Y_04.dat	24.0	17280	2.55	−8.7	11.4	1
KBR1B_2020−02−21_Y_04.dat	24.0	17179	2.30	−8.7	7.2	2
KBR1B_2020−02−22_Y_04.dat	24.0	17078	2.23	−11.0	5.1	2
KBR1B_2020−02−23_Y_04.dat	24.0	17280	2.35	−10.9	5.6	1
KBR1B_2020−02−24_Y_04.dat	24.0	17280	2.26	−11.6	8.1	1
KBR1B_2020−02−25_Y_04.dat	24.0	17280	2.21	−7.5	8.1	1
KBR1B_2020−02−26_Y_04.dat	24.0	17280	1.92	−6.2	5.6	1
KBR1B_2020−02−27_Y_04.dat	24.0	17280	2.66	−14.0	7.7	1
KBR1B_2020−02−28_Y_04.dat	24.0	17121	2.29	−12.2	10.1	2
KBR1B_2020−02−29_Y_04.dat	24.0	17280	2.56	−11.5	13.0	1
KBR1B_2020−03−01_Y_04.dat	24.0	17280	2.83	−16.1	6.0	1
KBR1B_2020−03−02_Y_04.dat	24.0	17213	2.14	−8.6	5.9	2
KBR1B_2020−03−03_Y_04.dat	22.9	16514	2.20	−7.8	10.3	1
KBR1B_2020−03−04_Y_04.dat	10.5	7564	2.49	−8.1	8.1	1
KBR1B_2020−03−05_Y_04.dat	24.0	17280	2.42	−9.1	10.6	1
KBR1B_2020−03−06_Y_04.dat	24.0	17280	2.43	−9.6	9.5	1
KBR1B_2020−03−07_Y_04.dat	24.0	17280	2.45	−10.5	9.7	1
KBR1B_2020−03−08_Y_04.dat	24.0	17280	2.25	−9.1	9.1	1
KBR1B_2020−03−09_Y_04.dat	24.0	17280	2.65	−9.9	7.7	1
KBR1B_2020−03−10_Y_04.dat	24.0	17197	2.65	−12.2	8.8	2
KBR1B_2020−03−11_Y_04.dat	24.0	17280	4.71	−35.6	8.3	1
KBR1B_2020−03−12_Y_04.dat	24.0	17280	3.07	−23.8	9.6	1
KBR1B_2020−03−13_Y_04.dat	24.0	17280	2.27	−12.8	9.2	1
KBR1B_2020−03−14_Y_04.dat	24.0	16902	3.82	−20.7	10.1	2

KBR1B_2020−03−15_Y_04.dat	24.0	17280	2.48	−8.8	7.9	1
KBR1B_2020−03−16_Y_04.dat	24.0	17280	2.43	−11.1	10.2	1
KBR1B_2020−03−17_Y_04.dat	24.0	17280	2.43	−10.4	10.0	1
KBR1B_2020−03−18_Y_04.dat	24.0	17015	2.58	−9.4	8.7	1
KBR1B_2020−03−19_Y_04.dat	24.0	16963	2.30	−10.0	6.5	1
KBR1B_2020−03−20_Y_04.dat	24.0	17280	2.28	−7.6	9.4	1
KBR1B_2020−03−21_Y_04.dat	24.0	17280	2.72	−11.2	13.5	1
KBR1B_2020−03−22_Y_04.dat	24.0	17280	2.02	−7.0	8.0	1
KBR1B_2020−03−23_Y_04.dat	24.0	17280	2.65	−7.2	12.6	1
KBR1B_2020−03−24_Y_04.dat	24.0	17280	2.46	−9.5	8.4	1
KBR1B_2020−03−25_Y_04.dat	24.0	17280	2.39	−8.8	9.8	1
KBR1B_2020−03−26_Y_04.dat	24.0	17142	2.75	−11.7	12.7	2
KBR1B_2020−03−27_Y_04.dat	24.0	17280	2.01	−6.2	7.0	1
KBR1B_2020−03−28_Y_04.dat	24.0	17280	2.68	−8.7	9.0	1
KBR1B_2020−03−29_Y_04.dat	24.0	17280	2.45	−8.5	7.3	1
KBR1B_2020−03−30_Y_04.dat	24.0	17280	2.64	−12.1	8.6	1
KBR1B_2020−03−31_Y_04.dat	24.0	17280	2.47	−8.3	9.8	1

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

Table 1: Current version: Level-1 v04.
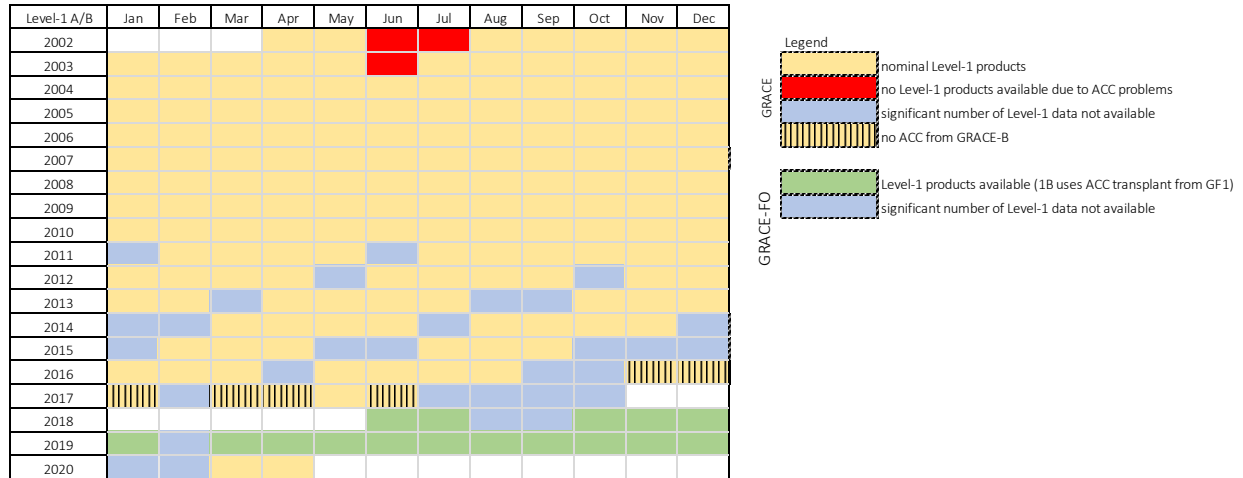
1.C – Level-1 De-aliasing Model AOD1B Data Availability
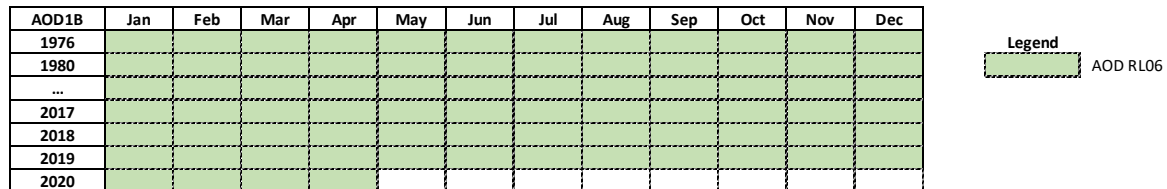
- For more information on the AOD de-aliasing AOD1B model please visit https://www.gfz-potsdam.de/en/aod1b/.

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

See table below for current release period. All times in UTC:

2020-02-01	C: Center-of-Mass Calibrations (CMCal) were performed as preparations for trim mass movement. Pitch at 04:49, 06:37, 08:12. Roll at 09:46, 11:21. Yaw at 17:25, 19:00
2020-02-06	C: CM trim. At 12:41 the Mass Trim Electronics (MTE-A) was switched on. At 12:45 the trim mass was moved in -x direction by 5453 steps (i.e. -13.633 mm) for a change in the center of mass of -113.0 μm. At 12:52 the MTE-A was switched off.
2020-02-02	D: At 14:06 the ACC gold wire verification was performed for 1s.
2020-02-04	D:At 12:08 the ACC gold wire verification was performed for 1s.
2020-02-05	D:At 13:24 the ACC gold wire verification was performed for 1s.
2020-02-06	D: At 11:25 the ACC gold wire verification was performed for 1s.
2020-02-06	CD: The LRI on both satellites collected diagnostic data during the mass trim on GF1. Both instruments were commanded to diagnostic mode at 12:40 and back to reacquisition mode at 13:30. LRI science mode resumed at 13:31
2020-02-07	C: IPU, MWA, LRI and STR are switched off starting from 10:35. The satellite is in Acquisition and Safe Mode (ASM). The On-Board Time suddenly changed to an epoch in the future (as on GF2 on day 18) - this time about 3 days ahead.
2020-02-08	C: IPU, MWA, LRI and STR are switched off
2020-02-09	C: IPU, MWA, LRI and STR are switched off
2020-02-10	C: IPU, MWA and LRI are switched off. STR switched on at 11:33. After that satellite switched to Nominal Attitude Hold Mode.
2020-02-11	C: MWA and LRI are switched off. IPU-B was successfully powered on at 12:38. The satellite is in Nominal Attitude Hold Mode.
2020-02-12	C: IPU restart at 12:26:41. At 13:56 MWA-B was successfully powered on. LRI switched off.
2020-02-13	C: IPU restart at 11:30:26. Transition to fine pointing mode at 11:15. LRI switched off. At 11:49 the OCC antenna was switched on and the OCC measurements were re-activated in the IPU.
2020-02-07	D: At 12:40 the ACC gold wire verification was performed for 1s; AOCS pointing was changed to nadir pointing at 12:30 to account for the missing inter-satellite measurements; The IPU was restarted at 13:20:26 with disabled K/Ka trackers (over Antarctica/Ross Ice Shelf).
2020-02-10	D: At 13:07 the ACC gold wire verification was performed for 1s.
2020-02-11	D: At 11:11 the ACC gold wire verification was performed for 1s.
2020-02-12	D: At 12:27 the ACC gold wire verification was performed for 1s.
2020-02-13	D: At 10:30 the ACC gold wire verification was performed for 1s. IPU restart at 11:30:26. Transition to fine pointing mode at ~11:00.
2020-02-13	CD: no LRI measurement; At 11:35 GPS PRN #26 was disabled in the IPUs due to announced period of unavailability (until 2020-02-14, 5:15); KBR tracking enabled at ~11:35.

2020-02-21	IPU reboot at 07:44:40
2020-02-21	D: IPU reboot at 07:44:40
2020-02-22	D: IPU reboot at 22:55:50; KBR SNR drop between 635683339 and 635684379
2020-02-22	CD GPS PRN #11 was re-enabled in the IPUs after its announced period of unavailability (7:15).
2020-02-28	C: IPU reboot at 16:56:50
2020-03-02	C: IPU reboot at 11:36:30
2020-03-03	C: At 22:57 a mode transition to ASM occurred. OBCP_14 was executed and all instruments (except USO and ACC) were switched-off. It was caused by accidentally uplinking a command which disabled the attitude control thrusters. Recovery actions were executed: At 23:48 yesterday the attitude control thrusters were re-enabled.
2020-03-04	C: At 07:51 the thermal loops of IPU-B, MWA-B, LRI and ACC were configured for instrument operations. At 09:16 STRE-A was switched on. At 09:20 the mode transition to NOM-FP was performed. IPU reboot at 10:16:40; At 11:08 the synchronization of the on-board time with GPS was activated. At 11:30 the pointing frame was switched from nadir to relative pointing. At 12:37 MWA-B was switched on. At 14:10 LRI was switched on. IPU S/W was successfully updated to version V4.3: At 11:51 FlashFileLib was uploaded and installed. IPU reboot at 13:28:10 and the new S/W was activated.
2020-03-05	C: At 08:54 radio occultation measurements were enabled in the IPU. At 09:30 GPS PRN#1 was disabled in the IPU for 12h (in order to test the new IPU S/W). At 12:15 OBCP_14 was enabled.
2020-03-04	CD: (through 2020-03-05) KBR1B may be degraded due to thermal effects by turning off the heaters/MWI about 13 hours.
2020-03-03	CD: At 22:57 the inter-satellite link (KBR, LRI) was lost after GF1 switched to AOCS Safe Mode.
2020-03-04	CD: At 13:29 the MWI link was resumed. At 14:14 the LRI link was resumed.
2020-03-08	C: LRI was short period in Reacquisition Mode due to LRI reboot on GF2
2020-03-10	C: At 10:05 the IPU was restarted on MWI request
2020-03-08	D: A spontaneous reboot of the LRI was experienced at 02:47
2020-03-09	CD: GPS PRN#23 was disabled in the IPUs at 14:00 after it was announced unusable until further notice.
2020-03-18	C: IPU reboot at 00:10:30
2020-03-14	D: IPU reboot at 13:25:20 and 13:48:50
2020-03-19	D: IPU reboot at 23:34:40
2020-03-13	LRI mega phase jumps on: Mar (13,14,16,17,18)
2020-03-26	D: IPU reboot at 01:01:07

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	(red)	(red)	3	4	5	6	7
2003	8	9	10	11	12	(red)	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	(red)	103	104	105	106	(red)	107	108	109	110	111	112
2012	113	114	115	116	(red)	117	118	119	120	(red)	121	122
2013	123	124	(red)	125	126	127	128	(red)	(red)	129	130	131
2014	132	(red)	133	134	135	136	(red)	137	138	139	140	(red)
2015	141	142	143	144	145	(red)	146	147	148	(red)	(red)	149
2016	150	151	152	(red)	153	154	155	156	(red)	(red)	157*+	158*+
2017	159*+	(red)	160*+	161*+	162*	163*+	(red)	(red)	(red)			
2018						1*+	2*+	(red)	(red)	3*+	4+	5+
2019	6+	7*+	8+	9+	10+	11+	12+	13+	14+	15+	16+	17+
2020	18+*	19+*	20+									

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

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.

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	(red)	(red)	3	4	5	6	7
2003	8	9	10	11	12	(red)	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	(red)	103	104	105	106	(red)	107	108	109	110	111	112
2012	113	114	115	116	(red)	117	118	119	120	(red)	121	122
2013	123	124	(red)	125	126	127	128	(red)	(red)	129	130	131
2014	132	(red)	133	134	135	136	(red)	137	138	139	140	(red)
2015	141	142	143	144	145	(red)	146	147	148	(red)	(red)	149
2016	150	151	152	(red)	153	154	155	156	(red)	(red)	157*+	158*+
2017	159*+	(red)	160*+	161*+	162*	163*+	(red)	(red)	(red)			
2018						1*+	2*+	(red)	(red)	3*+	4+	5+
2019	6+	7*+	8+	9+	10+	11+	12+	13+	14+	15+	16+	17+
2020	18+*	19+*	20+									

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