

GRACE Follow-On

Science Data System Newsletter Report: Nov & Dec 2019 (No. 9 & 10)

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GRACE Follow-On Science Data System: News, Highlights & Updates

- **Level-2** SDS data products for **October and November 2019** are available at NASA's Physical Oceanography Distributed Active Archive Center (PO.DAAC) and GFZ's Information System and Data Center (ISDC).
- **JPL Mascons** now available through Nov-2019
 - Reprocessed GRACE & GRACE-FO JPL Mascons ('RL06M.MSCNv02') can be downloaded at <https://doi.org/10.5067/TEMSC-3JC62>.
 - Please refer to the release notes for processing details and updates compared to JPL's RL06M.MSCNv01.
- **Updated Data Processing Recommendations:**
 - As announced at the 2019 Science Team Meeting and AGU Fall Meeting, we have updated our recommendations on the replacement of C20 and C30 coefficients as follows:
 - TN-11 will no longer be updated;
 - [TN-14](#) is now provided and contains both C20 and C30 SLR products for substitution in GRACE and GRACE-FO;
 - Please refer to section 'Level-2 Ancillary Products and Comments' below for further details;
 - [TN-13](#) geocenter estimates have been reprocessed for the entire GRACE and GRACE-FO time span to be consistent with TN-14; Note: user need to replace the entire TN-13 time series.

Calendar & Upcoming Events:

- EGU Annual Meeting 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/gggs2020/>
- **GRACE/GRACE-FO Science Team Meeting 2020:**
 - GFZ, Potsdam | Germany | 27-29 Oct 2020
 - Meeting web page will be available approximately in May 2020



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:

- 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. 6)]

Level-1 Data Product Availability

- [see Appendix 1B (p. 6) for GRACE-FO Level-1 data]
- [see Appendix 1C (p. 8) for de-aliasing AOD1B model data]



Level-1 Release Notes & Sequence of Events

- [see Appendix 1D (p. 8)]

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. 10) 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) as follows:
 - C20: replace all months (04/2002 – current)
 - C30: replace from 08/2016 onwards (08/2016 – current)
- [TN-13\[a,b,c\]](#) contains geocenter estimates using the methods of Swenson et al. (2008) 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_2019-11-01_Y_04.dat	24.0	17280	1.23	-3.4	6.4	1
KBR1B_2019-11-02_Y_04.dat	24.0	17280	1.71	-8.9	5.0	1
KBR1B_2019-11-03_Y_04.dat	24.0	17280	1.32	-4.8	3.9	1
KBR1B_2019-11-04_Y_04.dat	24.0	17280	1.31	-3.2	5.0	1
KBR1B_2019-11-05_Y_04.dat	24.0	17197	1.61	-5.2	5.0	2
KBR1B_2019-11-06_Y_04.dat	24.0	17075	1.72	-4.6	10.1	2
KBR1B_2019-11-07_Y_04.dat	24.0	17280	1.47	-4.8	5.2	1
KBR1B_2019-11-08_Y_00.dat	24.0	17280	1.36	-5.2	4.2	1
KBR1B_2019-11-09_Y_00.dat	24.0	17280	1.44	-4.8	5.9	1
KBR1B_2019-11-10_Y_00.dat	24.0	17280	1.31	-5.5	4.8	1
KBR1B_2019-11-11_Y_00.dat	24.0	17137	1.45	-5.8	6.0	2
KBR1B_2019-11-12_Y_00.dat	24.0	17280	1.23	-3.9	3.0	1
KBR1B_2019-11-13_Y_00.dat	24.0	17280	1.38	-5.4	3.6	1
KBR1B_2019-11-14_Y_00.dat	24.0	17280	1.76	-6.8	9.0	1
KBR1B_2019-11-15_Y_04.dat	24.0	17280	1.32	-4.4	4.4	1
KBR1B_2019-11-16_Y_04.dat	24.0	17280	1.36	-5.6	4.1	1
KBR1B_2019-11-17_Y_04.dat	24.0	17114	1.68	-8.4	7.1	2
KBR1B_2019-11-18_Y_04.dat	24.0	17280	1.68	-5.4	6.0	1
KBR1B_2019-11-19_Y_04.dat	24.0	17280	1.52	-7.2	5.7	1
KBR1B_2019-11-20_Y_04.dat	24.0	17188	1.56	-5.6	6.2	2
KBR1B_2019-11-21_Y_04.dat	24.0	17194	1.42	-4.7	3.9	2
KBR1B_2019-11-22_Y_00.dat	24.0	17280	1.46	-4.4	5	1
KBR1B_2019-11-23_Y_00.dat	24.0	17280	1.28	-4.3	4.7	1
KBR1B_2019-11-24_Y_00.dat	24.0	17280	1.40	-6.2	3.7	1
KBR1B_2019-11-25_Y_00.dat	24.0	17280	1.27	-4.0	4.2	1
KBR1B_2019-11-26_Y_00.dat	24.0	17280	1.32	-4.4	5.4	1
KBR1B_2019-11-27_Y_00.dat	24.0	17280	1.40	-4.9	3.9	1
KBR1B_2019-11-28_Y_00.dat	24.0	17280	1.46	-3.4	6.7	1
KBR1B_2019-11-29_Y_04.dat	24.0	17199	1.20	-3.0	4.9	2
KBR1B_2019-11-30_Y_04.dat	24.0	17280	1.23	-3.5	4.8	1
KBR1B_2019-12-01_Y_04.dat	24.0	17280	1.28	-3.7	4.1	1
KBR1B_2019-12-02_Y_04.dat	24.0	17280	1.34	-4.9	4.5	1

GRAVITY RECOVERY AND CLIMATE EXPERIMENT *Follow-On*

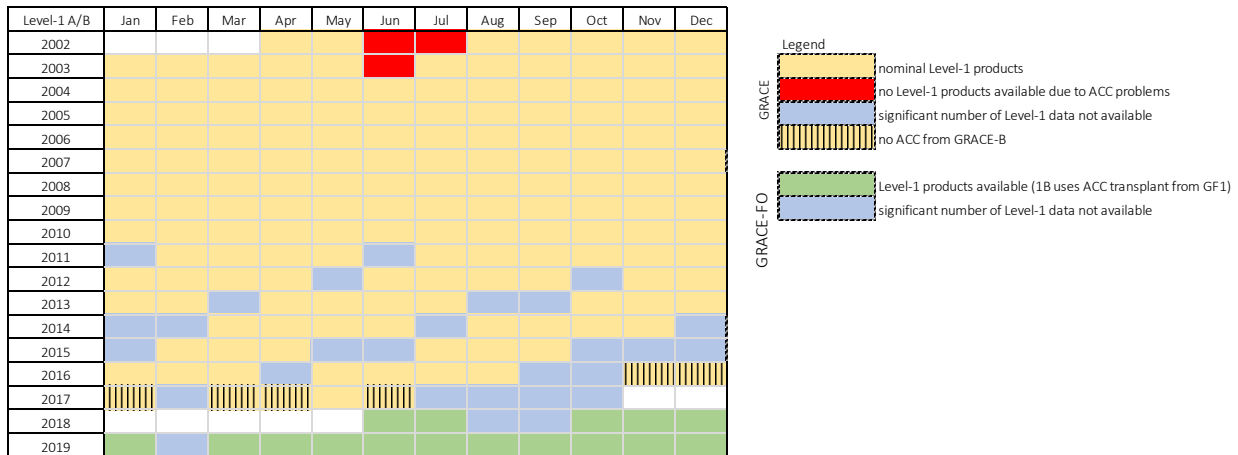


KBR1B_2019-12-03_Y_04.dat	24.0	17280	1.39	-4.0	4.3	1
KBR1B_2019-12-04_Y_04.dat	24.0	17280	1.40	-4.5	5.6	1
KBR1B_2019-12-05_Y_04.dat	24.0	17280	1.41	-4.9	4.5	1
KBR1B_2019-12-06_Y_04.dat	24.0	17280	1.24	-4.9	3.8	1
KBR1B_2019-12-07_Y_04.dat	24.0	17280	1.18	-3.9	2.9	1
KBR1B_2019-12-08_Y_04.dat	24.0	17280	1.33	-3.3	4.7	1
KBR1B_2019-12-09_Y_04.dat	24.0	17280	1.28	-4.4	4.0	1
KBR1B_2019-12-10_Y_04.dat	24.0	17184	1.40	-4.4	5.9	2
KBR1B_2019-12-11_Y_04.dat	24.0	17280	1.33	-3.8	4.3	1
KBR1B_2019-12-12_Y_04.dat	24.0	17280	1.30	-3.6	4.4	1
KBR1B_2019-12-13_Y_04.dat	24.0	17280	1.30	-4.3	3.7	1
KBR1B_2019-12-14_Y_04.dat	24.0	17280	1.27	-4.3	4.0	1
KBR1B_2019-12-15_Y_04.dat	24.0	17085	1.30	-4.1	3.8	2
KBR1B_2019-12-16_Y_04.dat	24.0	17280	1.38	-5.4	4.6	1
KBR1B_2019-12-17_Y_04.dat	24.0	17280	1.30	-5.3	3.4	1
KBR1B_2019-12-18_Y_04.dat	24.0	17280	1.33	-4.6	3.9	1
KBR1B_2019-12-19_Y_04.dat	24.0	17280	1.44	-4.1	5.1	1
KBR1B_2019-12-13_Y_04.dat	24.0	17280	1.30	-4.3	3.7	1
KBR1B_2019-12-14_Y_04.dat	24.0	17280	1.27	-4.3	4.0	1
KBR1B_2019-12-15_Y_04.dat	24.0	17085	1.30	-4.1	3.8	2
KBR1B_2019-12-16_Y_04.dat	24.0	17280	1.38	-5.4	4.6	1
KBR1B_2019-12-17_Y_04.dat	24.0	17280	1.30	-5.3	3.4	1
KBR1B_2019-12-18_Y_04.dat	24.0	17280	1.33	-4.6	3.9	1
KBR1B_2019-12-19_Y_04.dat	24.0	17280	1.44	-4.1	5.1	1
KBR1B_2019-12-20_Y_04.dat	24.0	17141	1.34	-4.0	5.4	3
KBR1B_2019-12-21_Y_04.dat	24.0	17280	1.79	-7.6	6.7	1
KBR1B_2019-12-22_Y_04.dat	24.0	17191	1.46	-6.1	9.8	2
KBR1B_2019-12-23_Y_04.dat	24.0	17280	1.43	-3.2	4.5	1
KBR1B_2019-12-24_Y_04.dat	24.0	17280	1.50	-4.4	3.7	1
KBR1B_2019-12-25_Y_04.dat	24.0	17280	1.74	-6.0	5.2	1
KBR1B_2019-12-26_Y_04.dat	24.0	17280	1.45	-3.9	5.2	1
KBR1B_2019-12-27_Y_04.dat	24.0	17280	1.65	-5.1	6.0	1
KBR1B_2019-12-28_Y_04.dat	24.0	17280	1.47	-4.3	5.2	1
KBR1B_2019-12-29_Y_04.dat	24.0	17280	1.55	-4.2	6.4	1
KBR1B_2019-12-30_Y_04.dat	24.0	17280	1.87	-7.7	6.6	1
KBR1B_2019-12-31_Y_04.dat	24.0	17280	1.60	-4.7	4.9	1

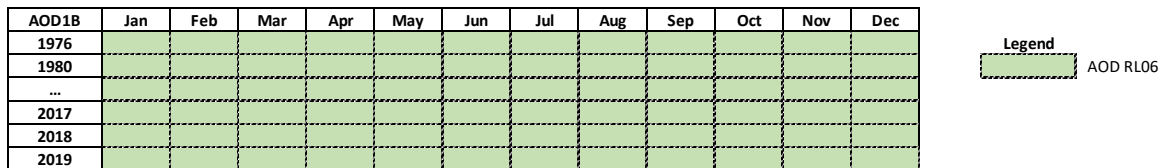


1.B – Level-1 GRACE-FO Data Availability

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

- [2019-08-10] Starting from the rl04 2019-08-10 LRI1B and LLK1B products, the Level-1 treatment of the LRI datation time offset has been updated. Previously, the jumps in datation bias that occurred at each IPU reset were not taken into account in the initial correction of LRI time-tags; this jump was left for the downstream time offset estimation to handle. The software has been updated so that these datation bias jumps – which can be determined from daily telemetry datation packets – are used in the initial time-tag correction. As a result, the estimated time offset is much smaller than before, and the LRI-KBR range differences are reduced for most days compared to the range differences from the previous method.

GRAVITY RECOVERY AND CLIMATE EXPERIMENT *Follow-On*



2019-11-06	GRACE-C: IPU reboot at 20:07:40
2019-11-05	GRACE-D: IPU reboot at 21:06:30
2019-11-06	GRACE-D: IPU reboot at 20:07:40 and again at 20:16:40
2019-11-05	C & D: PRN #29 disabled in the IPU at 19:45 (GF1) and 08:20 (GF2)
2019-11-06	C & D: PRN #29 enabled in the IPU at 17:47(GF1) and 19:23(GF2)
2019-11-08	D: GPS occultation antenna was unintentionally switched-on at 20:33, but it was switched off again at 22:03
2019-11-11	D: IPU reboot at 22:49:20
2019-11-20	C: IPU will be restarted at 18:07 over Antarctica in order to resume tracking to all available GPS satellites.
2019-11-17	D: The IPU rebooted yesterday at 09:22 :30 over Micronesia (6 days after the last restart).
2019-11-18	D: At 16:25 the ACC relay was opened for 3 minutes while the thrusters were disabled for 15 minutes (16:19-16:34). GF2 was commanded to NOM-AH (14:35-18:24) and event/action of OBCP14 (AOCS ASM Setup) was disabled. For comparison, before and after the relay test thrusters were disabled for 15 minutes while the relay remained closed (14:45-15:00, 17:54-18:09).
2019-11-19	D: The ACC relay test was continued - the thrusters were disabled for 15 minutes (12:41-12:56) interrupted by a single +roll/-roll thrust firing (12:48) during the 3 minutes with relay open (12:46-12:49). GF2 was in NOM-AH (12:31-13:11) and event/action of OBCP14 (AOCS ASM Setup) was disabled. Another ACC relay test was performed in the afternoon - the thrusters were disabled from 16:11 to 16:17 and the ACC relay opened from 16:13 to 16:16. During that time a single +yaw/-yaw thrust firings (16:15:00 and 16:15:15) were commanded. GF2 was in NOM-AH from 16:10 to 16:32. Event/action of OBCP14 (AOCS ASM Setup) was disabled at 16:10. LRI dropped to Re-Acquisition Mode at 12:52.
2019-11-20	D: Event/action of OBCP14 (AOCS ASM Setup) was enabled at 07:44. In the morning a 20min ACC relay test in NOM-FP was performed: the relay was opened from 06:08 to 06:28. Afterwards a 24h relay test in NOM-FP was started. The relay was opened at 07:48
2019-11-21	The ACC relay was closed at 05:47, 22h after it was opened, due to unexpected trends observed in the data. There are no further ACC tests planned for this week.
2019-11-15	GPS PRN#12 is disabled in the IPU's (3:00 - 16:30) due to an announced period of unavailability.
2019-11-19	LRI was in Re-Acquisition Mode from 12:52 to 13:12.
2019-11-21	GPS PRN#14 is disabled in the IPU's (8:10 - 21:40) due to an announced period of unavailability. Both IPU's were restarted at 21:45:26 over North Pole in order to resume tracking to all available GPS satellites.
2019-11-29	C: IPU reboot at 18:47
2019-12-04	STRE-A reboot at 20:41
2019-12-10	D: IPU reboot at 09:44:10
2019-12-10	AOCS parameters for STR mounting quaternions have been updated on GRACE-C at 16:35, on GRACE-D at 10:05.
2019-12-12	Four LRI reboots were commanded (05:37-05:46) in order to check whether all four flight software images are still booting correctly. The LRI was not able to lock into Science Mode after the commanded reboots. After 24h in Re-Acquisition Mode it switched autonomously into Diagnostic Mode at 05:47. It has been determined that reason for that was incompatibility between new STR quaternions uploaded earlier this week and LRI offsets parameters.(The STR quaternions were reset to their original values on the next day 2019-12-13)
2019-12-15	D: GRACE-D IPU reboot at 19:59:59. K-band SNR dropped before IPU reboot.
2019-12-13	STR quaternions were reset to their original values; LRI reboot commanded at 15:28 on GRACE-C and at 17:04 at GRACE-D. LRI reboot commanded at 15:28 on GRACE-C and at 17:04 at GRACE-D.
2019-12-15	GRACE-D IPU reboot at 19:59:59. K-band SNR dropped before IPU reboot.
2019-12-13	STR quaternions were reset to their original values
2019-12-20	C: IPU reboot at 04:52:40
2019-12-20	D: IPU reboot at 04:53:10
2019-12-22	C: IPU reboot at 00:49:00
2019-12-30	D: From 2019-12-30 01:29:20 until 2020-01-02 17:29:40, L2P tracking on channel 5 went bad. L2-Channel 5 data were deleted except for GPS1A.



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+	

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+	

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