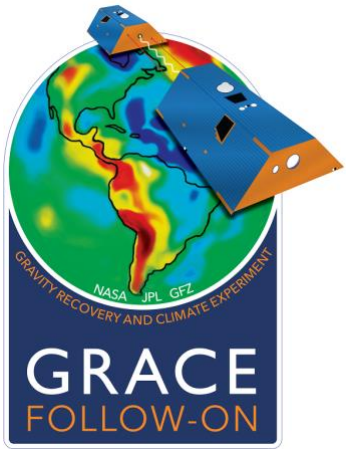


GRACE Follow-On

Science Data System Newsletter Report: June / July 2020 (No. 14)

Contact: gracefo@jpl.nasa.gov

Felix Landerer[1], Frank Flechtner[2], Himanshu Save[3], Christoph Dahle[2], Michael Watkins[1]

[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

- **GRACE/GRACE-FO Science Team Meeting 2020:** due to the ongoing COVID-19 crisis and associated disruptions, the GFO-STM will be an online-only meeting (Oct 26-30, 2020). **Important dates:**
  - **20 September 2020: Abstract submission deadline**
  - 28 September 2020: Notification of abstract acceptance and presentation format (live/offline display)
  - 2 October 2020: Final program publication

  For further GFO-STM information, please visit https://www.gstm-2020.eu/.
- The following **SDS data products** are now 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 **Aug 2020.**
  - **Level-2** data products through **July 2020.**
- The following **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
- 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 (please also consider a 1-slide highlight summary of the main findings).
  - 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.

Calendar & Upcoming Events:

- **GRACE/GRACE-FO Science Team Meeting (26-30 Oct 2020 – online event):**
  - Will be a virtual meeting; check https://www.gstm-2020.eu/ for information and important dates.
- **AGU Fall Meeting 2020 (1-17 Dec, 2020 – online event)**
  - See https://www.agu.org/Fall-Meeting for sessions and abstracts.

GRACE Follow-On: Mission Status

GRACE Follow-On: Orbit

The GRACE Follow-On orbital parameters on 20200914 (day 258) were as follows:

Sun Beta (deg)	-46
Absolute Distance (km)	170.1
Drift (km/d)	0.06
Mean Altitude (>6378.1 km)	490.4
Decay Rate (GF1/GF2) (7d mean, m/d)	1.2 / 0.9

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 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

- [2020-07-10]: JPL SDS Level-1 has updated the v04 LRI data processing to (1) improve the removal of LRI phase jumps, and to (2) reduce the noise of the time-of-flight (TOF) correction for range-acceleration to the level of 1 nm/s^2;
  Please see Level-1 Release Notes for details.

- 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. 7) for GRACE-FO Level-1 data]
- [see Appendix 1C (p. 7) 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. 10) 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):

- 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/.
- **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

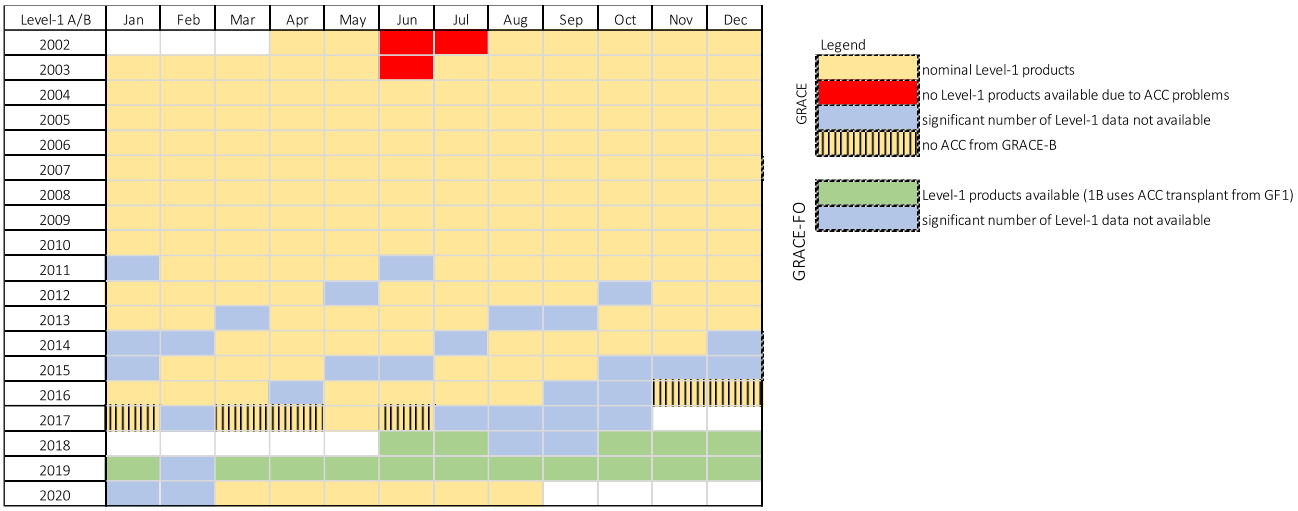
1.A - KBR Performance Statistics

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

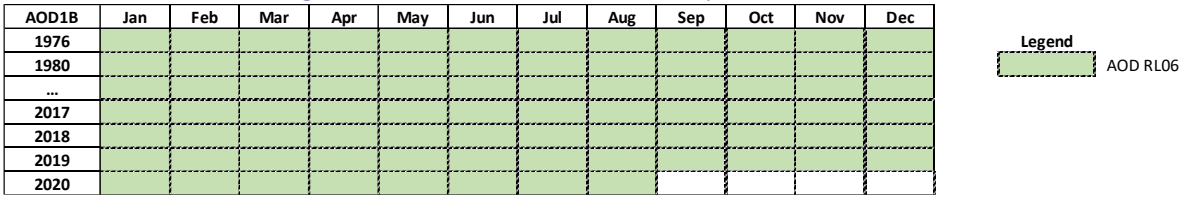
KBR1B_2020-07-01_Y_04.dat	24.0	17135	3.25	-12.2	16.8	2
KBR1B_2020-07-02_Y_04.dat	24.0	17280	2.87	-11.4	13.5	1
KBR1B_2020-07-03_Y_04.dat	24.0	17280	3.35	-11.7	18.4	1
KBR1B_2020-07-04_Y_04.dat	24.0	17280	2.44	-14.7	8.0	1
KBR1B_2020-07-05_Y_04.dat	24.0	17280	2.76	-12.8	9.4	1
KBR1B_2020-07-06_Y_04.dat	24.0	17280	2.57	-13.2	10.5	1
KBR1B_2020-07-07_Y_04.dat	24.0	17280	3.29	-16.8	17.2	1
KBR1B_2020-07-08_Y_04.dat	24.0	17280	3.14	-10.1	21.0	1
KBR1B_2020-07-09_Y_04.dat	24.0	17088	3.21	-13.1	11.8	2
KBR1B_2020-07-10_Y_04.dat	24.0	17280	2.35	-12.2	8.2	1
KBR1B_2020-07-11_Y_04.dat	24.0	17280	2.73	-10.8	9.0	1
KBR1B_2020-07-12_Y_04.dat	24.0	17280	2.53	-6.6	13.4	1
KBR1B_2020-07-13_Y_04.dat	24.0	17280	4.27	-29.3	14.8	1
KBR1B_2020-07-14_Y_04.dat	24.0	17165	3.29	-15.2	15.7	1
KBR1B_2020-07-15_Y_04.dat	24.0	17280	2.91	-16.2	7.6	1
KBR1B_2020-07-16_Y_04.dat	24.0	17099	3.27	-14.5	11.6	2
KBR1B_2020-07-17_Y_04.dat	24.0	17109	2.88	-14.7	8.2	2
KBR1B_2020-07-18_Y_04.dat	24.0	17280	2.05	-7.0	5.2	1
KBR1B_2020-07-19_Y_04.dat	24.0	17280	3.90	-10.5	25.3	1
KBR1B_2020-07-20_Y_04.dat	24.0	17113	3.24	-12.9	13.5	2
KBR1B_2020-07-21_Y_04.dat	24.0	17280	3.40	-17.4	11.5	1
KBR1B_2020-07-22_Y_04.dat	24.0	17280	4.08	-28.9	13.1	1
KBR1B_2020-07-23_Y_04.dat	24.0	17280	2.86	-9.1	15.6	1
KBR1B_2020-07-24_Y_04.dat	24.0	17175	3.08	-11.4	16.6	2
KBR1B_2020-07-25_Y_04.dat	24.0	17280	3.01	-10.6	12.7	1
KBR1B_2020-07-26_Y_04.dat	24.0	17280	3.66	-11.8	16.4	1
KBR1B_2020-07-27_Y_04.dat	24.0	17280	3.06	-12.5	12.4	1
KBR1B_2020-07-28_Y_04.dat	24.0	17280	4.31	-18.4	15.6	1
KBR1B_2020-07-29_Y_04.dat	24.0	17145	5.24	-34.8	17.2	2
KBR1B_2020-07-30_Y_04.dat	24.0	17280	3.02	-9.6	15.0	1
KBR1B_2020-07-31_Y_04.dat	24.0	17280	4.24	-30.0	13.1	1
KBR1B_2020-08-01_Y_04.dat	24.0	17280	3.16	-10.2	14.8	1
KBR1B_2020-08-02_Y_04.dat	24.0	17280	4.11	-10.7	28.3	1
KBR1B_2020-08-03_Y_04.dat	24.0	17280	2.31	-10.5	7.8	1
KBR1B_2020-08-04_Y_04.dat	24.0	17280	2.83	-9.2	11.4	1
KBR1B_2020-08-05_Y_04.dat	24.0	16977	3.00	-17.3	13.4	3
KBR1B_2020-08-06_Y_04.dat	24.0	16804	2.58	-12.7	9.1	16
KBR1B_2020-08-07_Y_04.dat	24.0	17054	2.46	-8.2	9.0	3
KBR1B_2020-08-08_Y_04.dat	24.0	17187	3.54	-15.7	15.0	2
KBR1B_2020-08-09_Y_04.dat	24.0	17183	3.37	-21.0	14.3	2
KBR1B_2020-08-10_Y_04.dat	24.0	17280	2.13	-5.3	7.3	1
KBR1B_2020-08-11_Y_04.dat	24.0	17163	2.56	-15.2	9.4	2
KBR1B_2020-08-12_Y_04.dat	24.0	17280	2.89	-11.6	15.1	1
KBR1B_2020-08-13_Y_04.dat	24.0	17280	2.26	-9.6	11.3	1
KBR1B_2020-08-14_Y_04.dat	24.0	17280	3.43	-14.6	10.7	1
KBR1B_2020-08-15_Y_04.dat	24.0	17280	3.50	-17.0	13.9	1
KBR1B_2020-08-16_Y_04.dat	24.0	17280	3.28	-7.0	17.9	1
KBR1B_2020-08-17_Y_04.dat	24.0	17280	2.26	-9.1	8.6	1
KBR1B_2020-08-18_Y_04.dat	24.0	17280	2.71	-14.5	10.1	1
KBR1B_2020-08-19_Y_04.dat	24.0	17280	3.79	-13.2	25.0	1
KBR1B_2020-08-20_Y_04.dat	24.0	17280	3.69	-14.1	19.8	1
KBR1B_2020-08-21_Y_04.dat	24.0	17070	3.56	-12.3	20.8	3
KBR1B_2020-08-22_Y_04.dat	24.0	17114	3.24	-15.6	11.3	2
KBR1B_2020-08-23_Y_04.dat	24.0	17280	2.67	-13.6	8.0	1
KBR1B_2020-08-24_Y_04.dat	24.0	17280	3.51	-14.9	15.5	1
KBR1B_2020-08-25_Y_04.dat	24.0	17212	2.57	-8.6	8.8	2
KBR1B_2020-08-26_Y_04.dat	24.0	17280	4.44	-33.6	14.5	1
KBR1B_2020-08-27_Y_04.dat	24.0	17280	3.84	-16.3	17.4	1
KBR1B_2020-08-28_Y_04.dat	24.0	17088	2.88	-11.7	11.4	2
KBR1B_2020-08-29_Y_04.dat	24.0	17280	2.98	-11.4	15.0	1
KBR1B_2020-08-30_Y_04.dat	24.0	17280	2.71	-5.8	13.7	1
KBR1B_2020-08-31_Y_04.dat	24.0	17280	3.09	-9.2	15.4	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:

2020-07-01	D: IPU reboot at 03:35:40
2020-07-09	C: PRN #14 disabled at 13:45
2020-07-09	C: IPU reboot (commanded) at 22:48:40
2020-07-09	D: PRN #14 disabled at 12:10
2020-07-09	D: IPU reboot (commanded) at 22:42:40

2020-07-09	CD: GPS PRN #14 was disabled in the IPUs after it was announced unusable until further notice. The IPUs on both satellites were restarted around 22:42 (see above) to resume tracking to all available GPS satellites (PRN #29 was disabled from 08:15 – 21:45 due to an announced period of unavailability – the restart was done to verify that it was reenabled).
2020-07-14	C: IPU reboot (commanded) at 23:56:40
2020-07-16	C: IPU reboot (spontaneous) at 13:51:10
2020-07-14	D: IPU reboot (commanded) at 23:51:40
2020-07-14	CD: GPS PRN#04 was disabled in the IPUs (09:30 - 23:00) due to an announced period of unavailability. The IPUs on both satellites were restarted at 23:51 (over Antarctica) in order to resume tracking to all available GPS satellites.
2020-07-24	C: IPU reboot (spontaneous) at 21:41:30
2020-07-17	D: IPU reboot (spontaneous) at 20:43:10
2020-07-20	D: IPU reboot (spontaneous) at 13:08:50
2020-07-24	C: IPU reboot (spontaneous) at 21:41:30
2020-07-29	D: IPU reboot (commanded) at 11:14:20
2020-08-05	C: IPU reboot (spontaneous) at 17:24:40; Shortly following the reboot (above), a Missed Interrupt (MI) occurred which continued to the next day
2020-08-06	D: A restart tracker command was sent at 09:51, which cured the MI temporarily; however, more MI events continued to occur. IPU reboot (commanded) at 22:56:20 to correct the MI
	GPS PRN #16 was temporarily disabled in the IPUs from 2020-08-05 19:30 to 2020-08-06 09:01 due to an announced period of unavailability.
2020-08-07	C: IPU reboot (commanded) at 09:34:40 and IPU reboot (spontaneous) at 18:07:50
2020-08-09	C: IPU reboot (spontaneous) at 20:36:30
2020-08-11	C: IPU reboot (spontaneous) at 16:42:00
2020-08-07	D: IPU reboot (commanded) at 09:30:40
2020-08-08	D: IPU reboot (spontaneous) at 04:38:00
2020-08-07	CD: The LRI Triple Mirror Assembly (TMA) co-alignment scans and Carrier to Noise Ratio (CNR) test was conducted on both satellites from 04:00-07:00. This test was conducted to identify the pointing angles where the LRI drops lock. Gaps are present in the LRI products corresponding to the scan times: For GF1 00:27:28 - 00:47:29, 01:20:30 - 01:37:36, 02:11:32 - 02:31:43, 03:00:34 - 03:16:35; For GF2 04:32:40 - 04:44:55, 05:21:43 - 05:33:00, 06:13:46 - 06:25:46, 07:00:48 - 07:13:49; We missed datation values resulting in jumps in LRI1B from 03:00 to 09:34.
2020-08-12	CD: A reacquisition of LRI was commanded at 20:37. This restored gain as well as in-phase and quadrature-phase amplitude values back to nominal resulting in ~110 second gaps in LRI products.
2020-08-18	C: OBCPs 12, 26, and 55 were uploaded and updated.
2020-08-19	D: OBCPs 12, 26, and 55 were uploaded and updated. Channels 31 and 32 went bad around 04:42:00 (an IPU reboot on 2020-08-21 at 10:45:40 was performed to fix this issue).
2020-08-21	C: IPU reboot (commanded) at 21:40:20
2020-08-22	C: IPU reboot (spontaneous) at 04:02:10
2020-08-21	D: IPU reboot (commanded) at 10:45:40 to resume nominal output of DSP channels 31 and 32; IPU reboot (commanded) at 21:35:40
2020-08-25	D: IPU reboot (spontaneous) at 02:11:30
2020-08-26	D: Test KBR calibration maneuver (wiggle test) was performed:At 10:00 the attitude pitch bias was set to -2 degrees; At 10:05 two cycles (250 sec length) of sinusoidal oscillation along the pitch axis were performed. Nominal AOCS settings restored at 10:38.

2020-08-21	CD: IPU reboots near 21:35 were commanded to resume nominal tracking to all available GPS satellites after GPS PRN #13 was disabled from 08:00 – 21:30 for an announced period of unavailability.
2020-08-28	C: IPU reboot (spontaneous) at 20:07:00

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+*	19+*	20+	21+	22+	23+	24+					

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			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+					

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