

GRACE Science Data System Level-1 Processing Status

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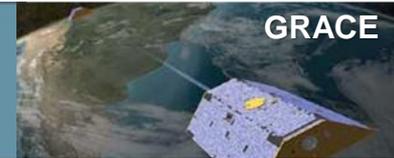
Austin, Texas

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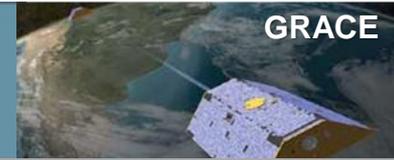
Overview



- V02 Level-0/Level-1 processing status
- V03 Level-1 (SCA1B, KBR1B) data reprocessing status
- Accelerometer data transplant
- V04 Level-1 data reprocessing
- Summary



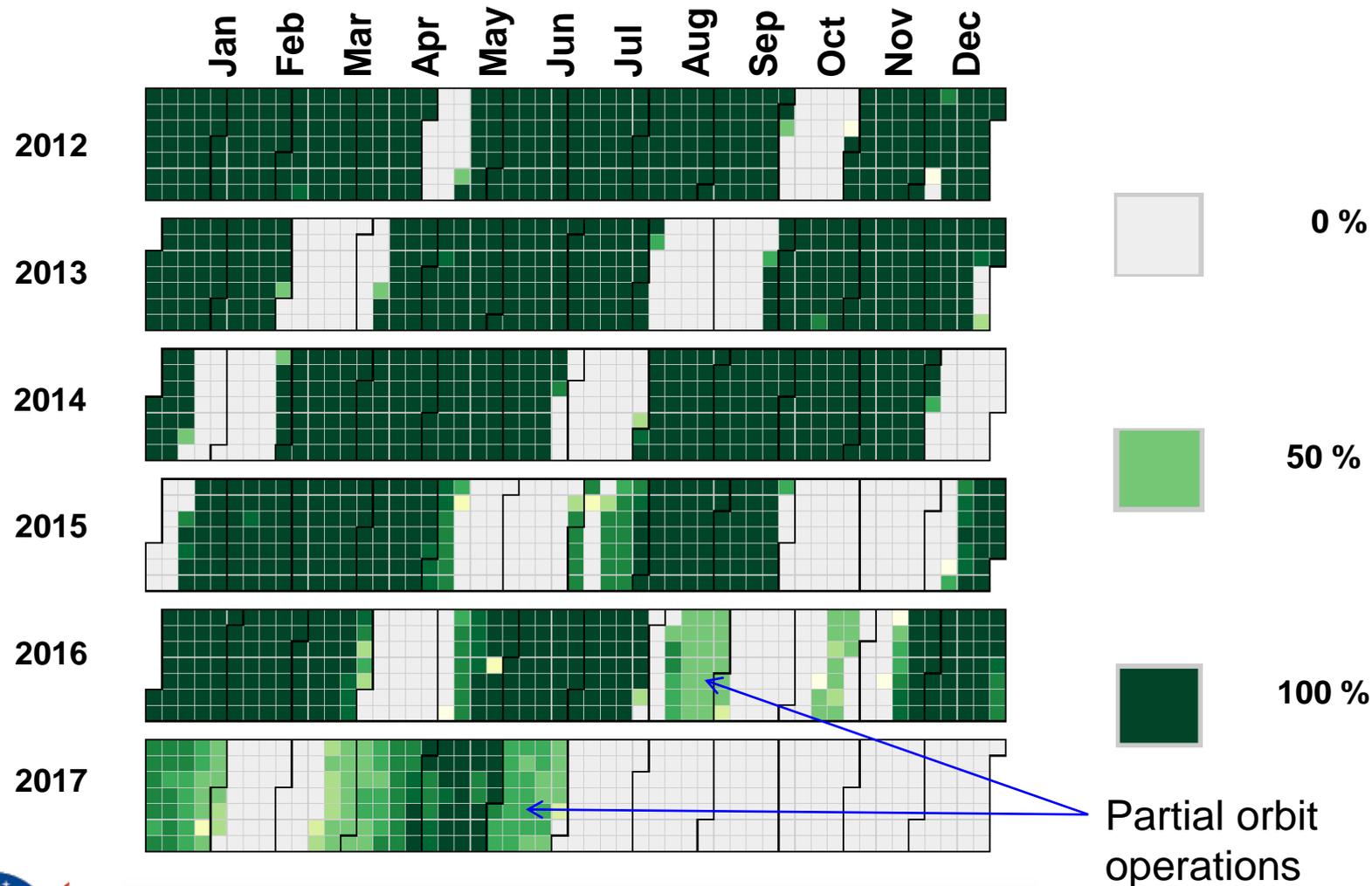
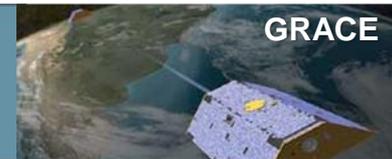
Level-0/Level-1 Processing Status



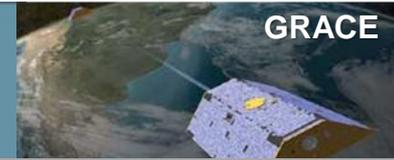
- Standard automatic Level-0/Level-1 processing is fully operational at PO.DAAC (JPL) since 2004-01-01. Only manual interventions during off-nominal operations of the GRACE spacecraft.
 - SDS is responsible for final L1B product quality.
 - Level-1 distribution by PO.DAAC to the level-2 centers. (latency ~12 days)
- Quick look Level-0/Level-1 processing is fully operational at JPL (section 335) since 2003-09-01 to monitor for non-nominal states of the science payload.
 - Quick look Level-1 data distributed to CSR for early gravity field analysis since 2008-02-06 (latency ~24 hours).
- Very limited telemetry (no science) available for GRACE-B starting from 3 September



GRACE Daily Nominal KBR Operations Percentage



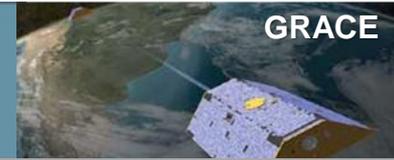
V03 SCA1B & KBR1B Reprocessing Status



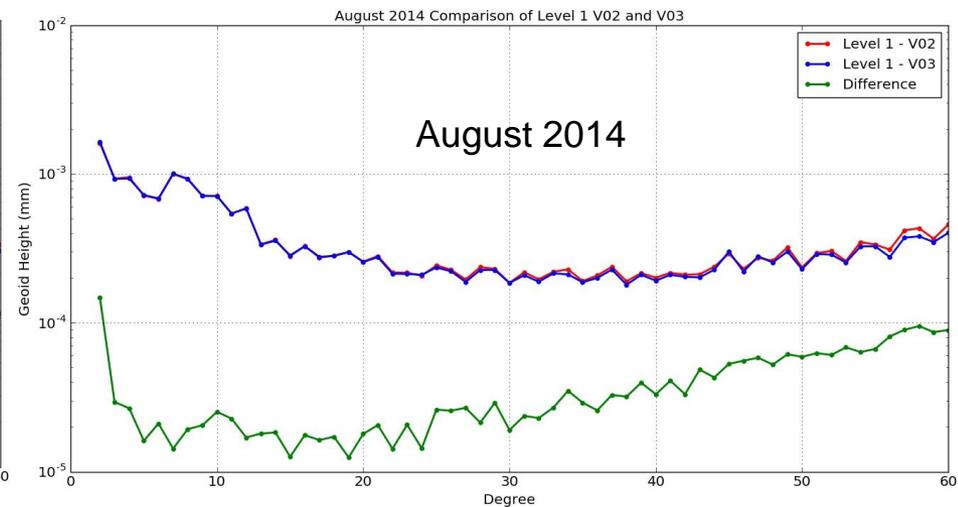
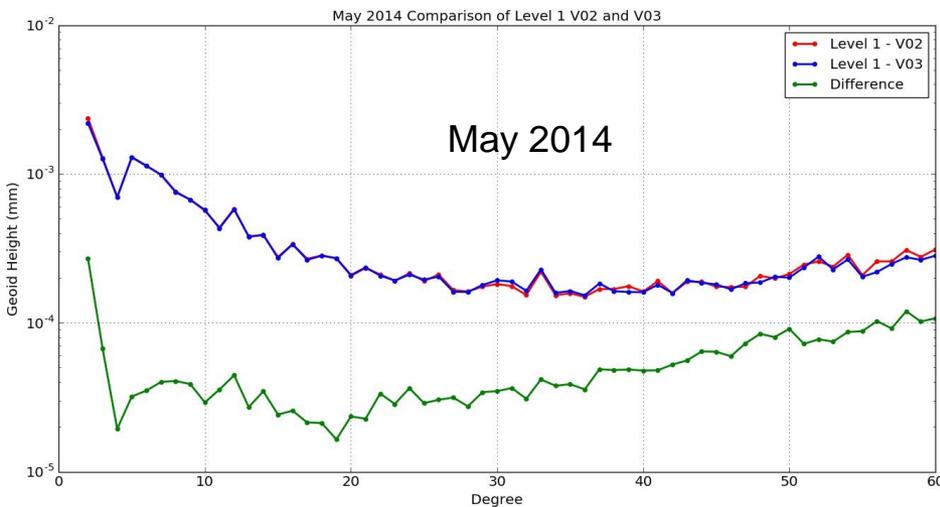
- At the 2015 GSTM in Austin it was decided not to wait until the end of GRACE mission to reprocess Level-1 data.
 - Decision driven by desire to use corrected SCA1B and KBR1B data in RL06 gravity products
 - Due to limited resources, it is was decided to only regenerate (using GRACE-FO software) the reconstructed attitude SCA1B and the derived KBR range corrections in KBR1B (V03).
 - V03 SCA1B and KBR1B will be distributed in ASCII format (compliant with GRACE-FO distribution plan) via JPL and GFZ archives at the time when the RL06 gravity products are released.
 - Years 2004 to 2008 and 2014 V03 data delivered to UTSR and GFZ. Years 2002, 2003, 2009 to 2013 and 2015 to 2017 will be delivered by the end of 2017



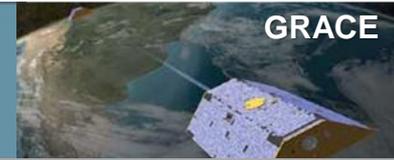
V03 SCA1B & KBR1B Gravity Recovery



- No significant change in the Level-2 gravity recovery was found when using the delivered V03 L1B data



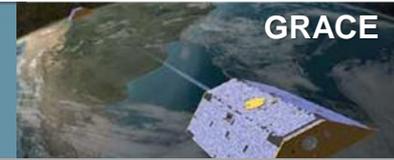
Accelerometer Data Transplant (1/2)



- Starting in September 2016 the GRACE-B ACC was powered off over extended periods of time due to the loss of power cells in the GRACE-B battery
- The following non-conservative forces that act on the GRACE spacecraft are measured by the ACC:
 - Atmospheric drag (very similar for both S/C. Differences due to different angle of attack with respect to the atmosphere)
 - Solar radiation pressure (very similar for both S/C. Difference due to slightly different S/C attitudes)
 - Attitude thruster pair imbalance (different on both S/C. Attitude control on-time commanding different)
- Objective of ACC data transplant is to use GRACE-A ACC data to synthesize GRACE-B data



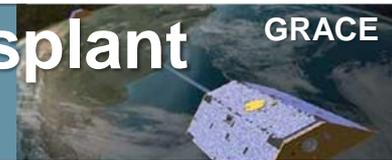
Accelerometer Data Transplant (2/2)



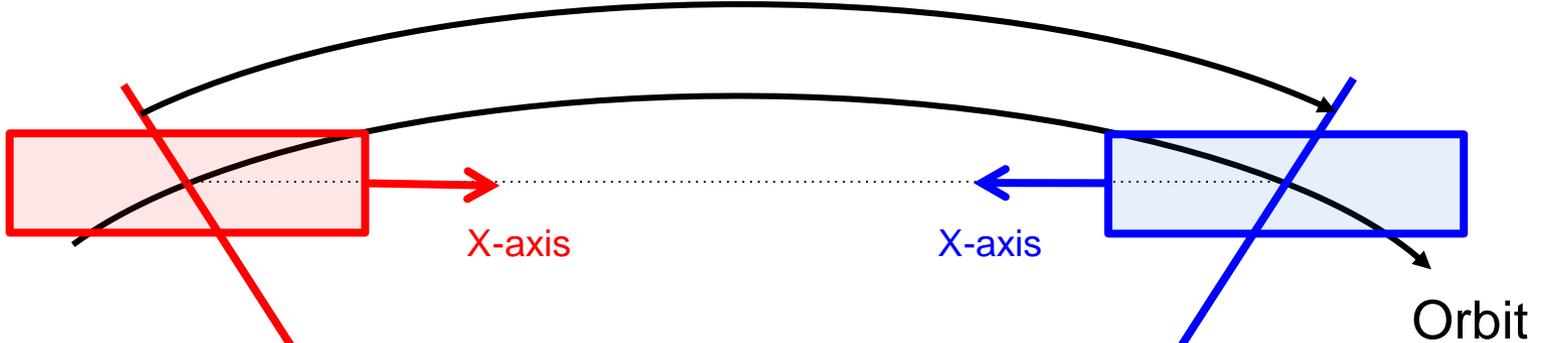
- Complete ACC data transplant procedure is described in Tamara Bandikova's Poster
- In April 2017 the angle of attack difference between the two spacecraft was removed to improve the ACC transplant
 - Prior to April 2017 an empirical derived 3.2 deg pitch rotation was used. This pitch rotation is larger than the attitude pitch difference between spacecraft.
 - Achieved minimization of difference in aerodynamic forces (largest force acting on the spacecraft). No need for empirical 3.2 degree pitch rotation.
 - Increased noise in geometric KBR range correction due to approximately 1 degree off pointing from line of sight after April 2017
 - Late braking: Analysis of estimated gravity fields suggest significant degradation of zonal coefficients, possibly due to single camera operations. Star tracker noise increases by factor 10 during single camera ops. This noise is amplified by 1 deg offset during sun-blinding (same latitude band every orbit, hence the degradation of the zonals).
- Removal and addition of thruster imbalance forces achieved by modeling and characterization of many years of ACC data (see Bandikova poster)



GRACE-A to GRACE-B Accelerometer Transplant Nominal Science Spacecraft Attitude



Spacecraft separation (~170 to ~270 km)



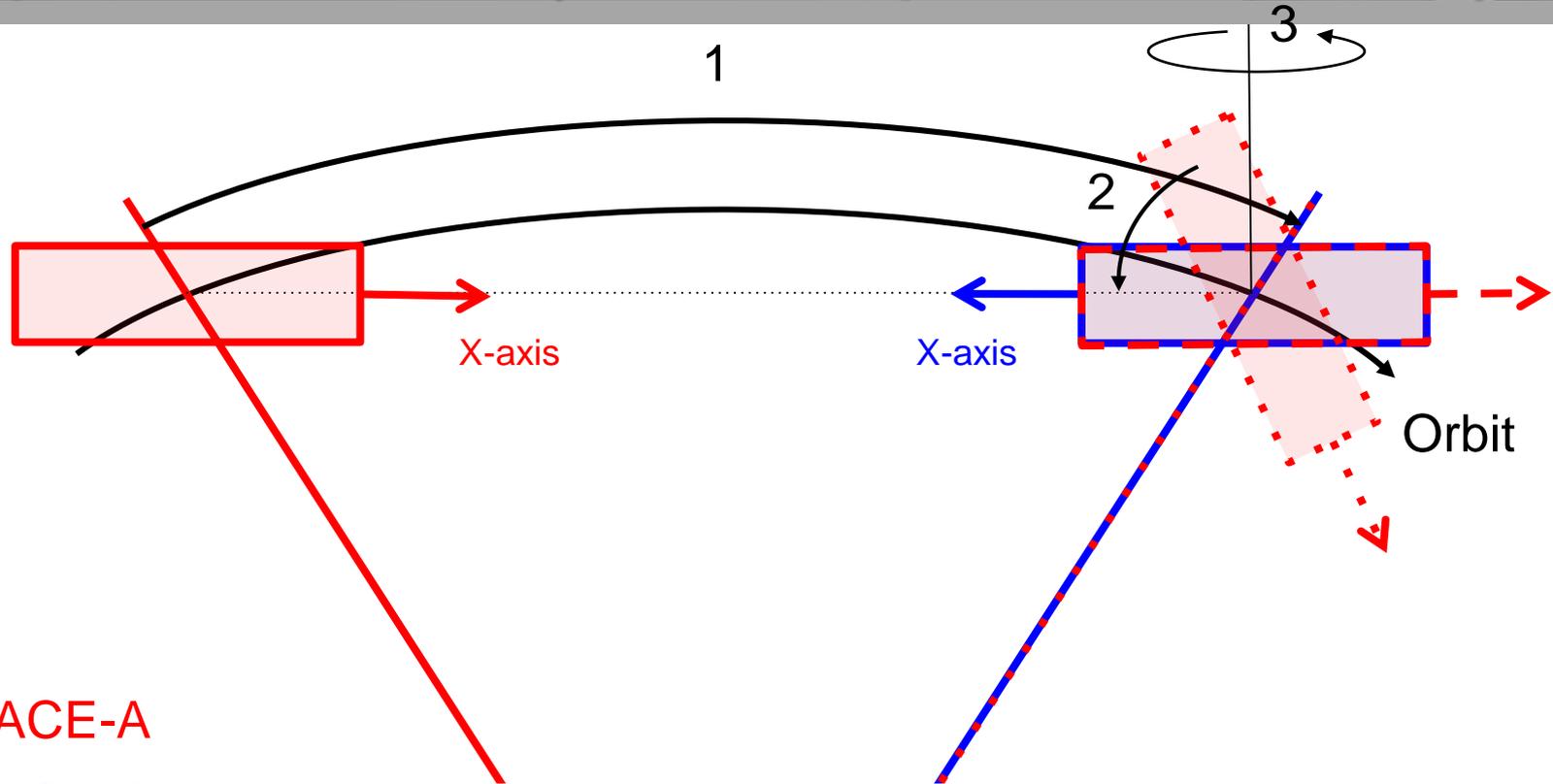
GRACE-A

GRACE-B



GRACE-A to GRACE-B Accelerometer Transplant Procedure (Nominal Spacecraft Attitude)

GRACE



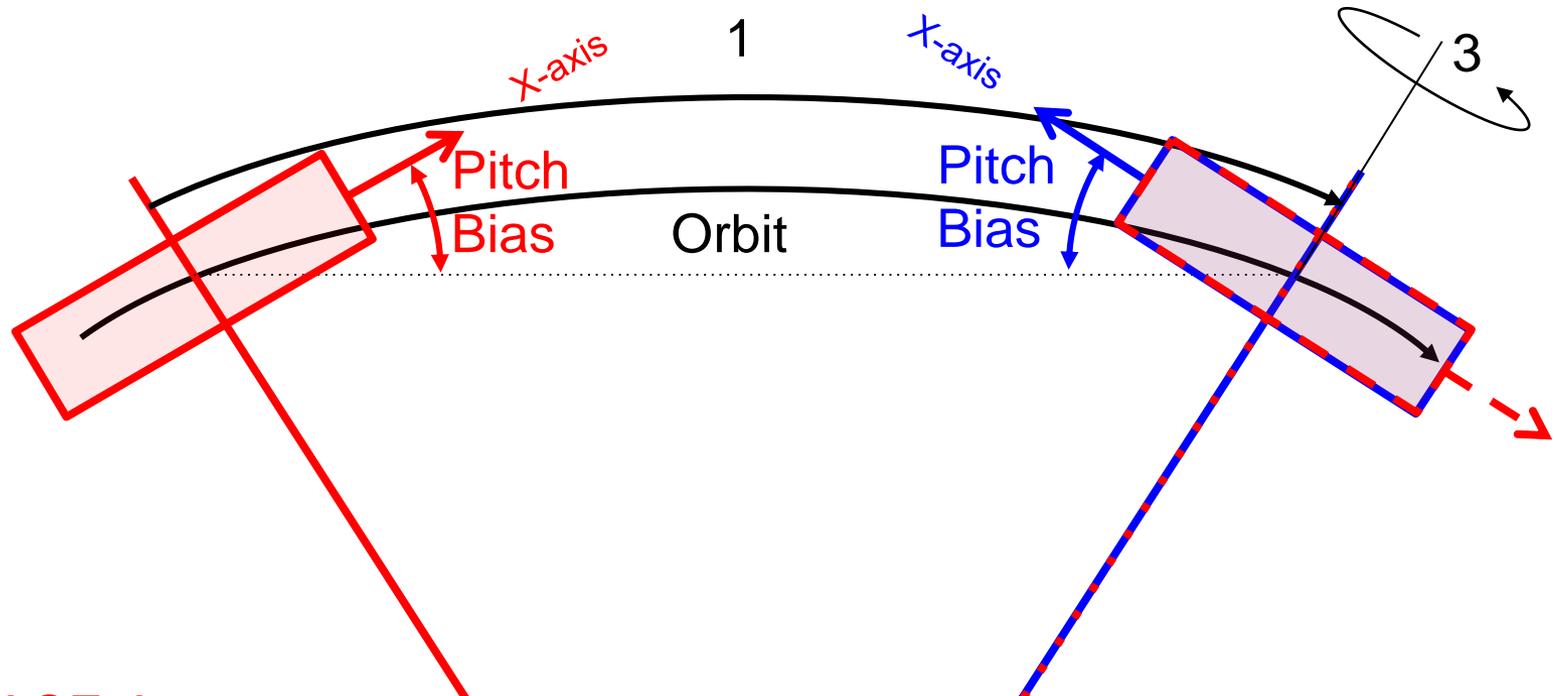
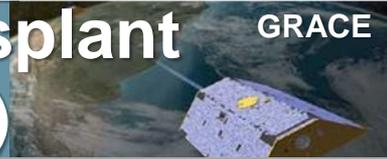
GRACE-A

GRACE-B

- 1) Time shift derived from spacecraft separation
- 2) Correct spacecraft orientation for pitch rate
- 3) Reverse spacecraft orientation
- 4) Remove GRACE-A ACC thrust response
- 5) Add GRACE-B ACC thrust response



GRACE-A to GRACE-B Accelerometer Transplant Transplant Procedure (With Pitch Bias)



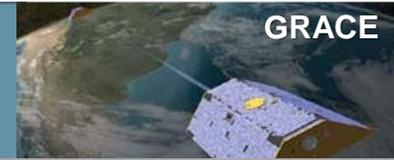
GRACE-A

GRACE-B

- 1) Time shift derived from spacecraft separation
- 2) No pitch rate attitude correction
- 3) Reverse spacecraft orientation
- 4) Remove GRACE-A ACC thrust response
- 5) Add GRACE-B ACC thrust response



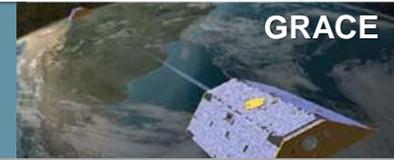
ACC Transplant Data Product



- The ACC transplant data is separately distributed from V02 by PO.DAAC and GFZ with filename:
 - ACC1B_YYYY-MM-DD_R3.dat
 - Transplant data only computed when GRACE-A ACC data available and KBR1B data available
- For V04 the ACC transplant data will become a separate product using the ACC1B format with filename
 - ACT1B_YYYY-MM-DD_04.dat
 - Transplant data only computed when GRACE-A ACC data available and KBR1B data available
 - ACT1B data will be distributed with the daily Level-1 data bundle



V04 Processing



- Final Level-1 Reprocessing (V04) is planned to start after the GRACE spacecraft are decommissioned
 - GRACE-FO Level-1 processing software will be used to generate GRACE Level-1 B data products
 - + Provide consistent processing between GRACE-FO and GRACE
 - + All Level-1B products are re-generated
 - Known problems in the level-1 V02/V03 data products will be fixed. For example:
 - + Star tracker data (L1 software bug, stellar aberration)
 - + ACC time tag error
 - Level-1 Reprocessing expected to be finalized about 1 year after decommissioning of the GRACE spacecraft
 - V04 Level-1 data will be distributed in ASCII

