Precise Orbit Determination and accelerometry calibration modelling of the GRACE Follow-On mission

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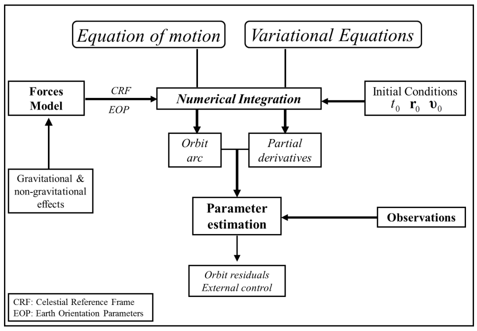
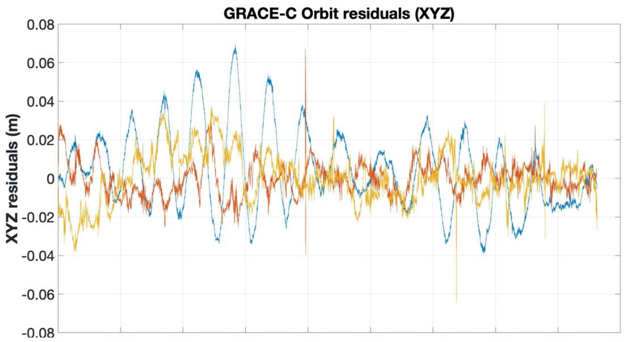
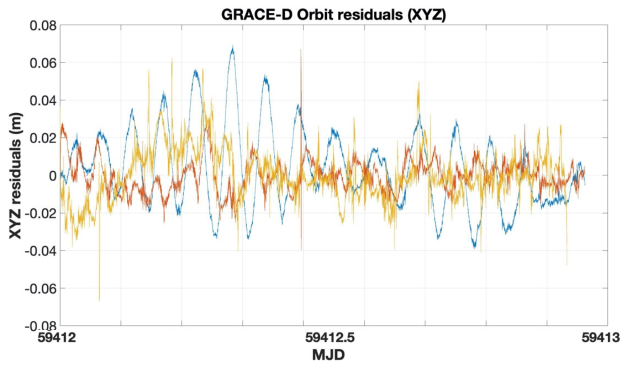
Abstract

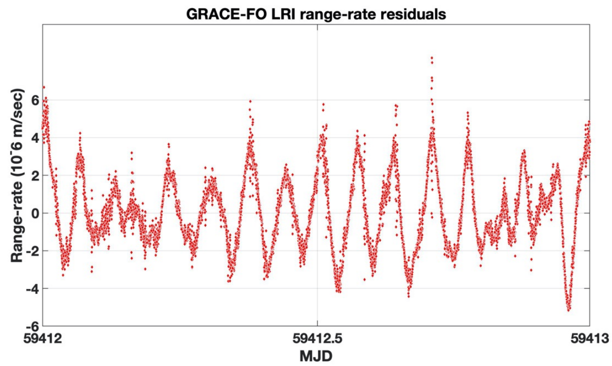
Precise orbit determination is a major objective in satellite geodesy and data analysis of several satellite missions observing Earth or another planet. Satellite gravity missions such as the Gravity Recovery And Climate Experiment (GRACE) and GRACE Follow-On missions, require high level of orbit precision (cm level) in order to capture the gravity field modelling of static and time-variable components. GRACE satellites are equipped with on-board accelerometers as being a key observation instrument for the direct measurement of non-gravitational perturbations at orbital altitude. The accelerometers calibration modelling within an orbit determination scheme is essential for precise orbits and the gravity field mapping. Furthermore, the accelerometry data processing may become crucial for accelerometers with reduced performance following the launch into space. That is the case of one of the GRACE-FO satellites. The current study's focus is on the GRACE-FO precise orbit determination along with the accelerometry calibration modelling. In particular, the non-gravitational forces modelling is based on the estimation of accelerometer calibration parameters such as bias, drift and scale factors in combination with empirical forces of cycle-per-revolution terms. The consideration of such empirical perturbations aims at capturing periodic mismodelling effects. The applied approach leads to orbital residuals varying within a few cm while the inter-satellite LRI and KBR range-rate data residuals vary within a few μm/sec.

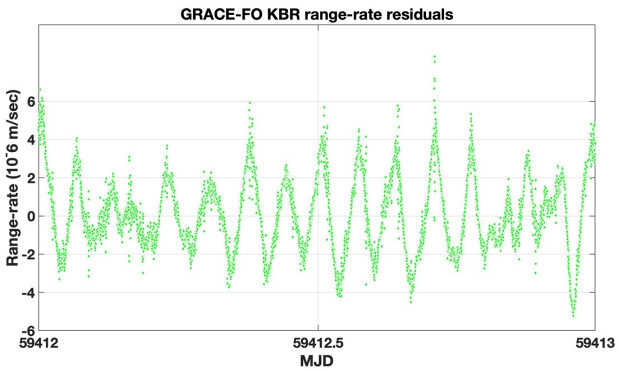


Dynamic Orbit Determination scheme (Papanikolaou 2012)









GRACE-FO Orbit Determination and Accelerometer calibration modelling

Orbit arc length / Date	Daily orbit arcs / 18/7/2021
Earth Orientation	IERS Conventions 2010
EOP	IERS 08 C04; IAU2006/200A
Numerical Integrator	Gauss-Jackson 12th order; RKN7(6)-8 start integrator
Integration step	10 sec
Pseudo-Observations	Kinematic Orbit XYZ (Suesser-Rechberger et al. 2020)
Gravity Model (d/o)	GOCO06s (Kvas et al. 2019)
Planetary Ephemeris	DE423
Solid Earth Tides	IERS Conventions 2010
Ocean Tides	FES2014b
Relativistic effects	IERS Conventions 2010
Accelerometers	ACC1B data, Estimated parameters: Full Scale matrix (9 parameters), Bias (XYZ), Bias drift (XYZ)
Empirical Forces	One-Cycle per revolution (1-CPR) in along & cross-track
Stochastic Parameters	Piecewise Accelerations per 6 hours in along & cross-track)
Intersatellite range-rate data	K-band ranging KBR1B & Laser Ranging Interferometry LRI1B
External Orbit Comparison	GNV1B orbit data

GEORB

Open Source Software for

GEodetic ORBit analysis and Precise Orbit Determination

References

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