GRACE Simulation Study

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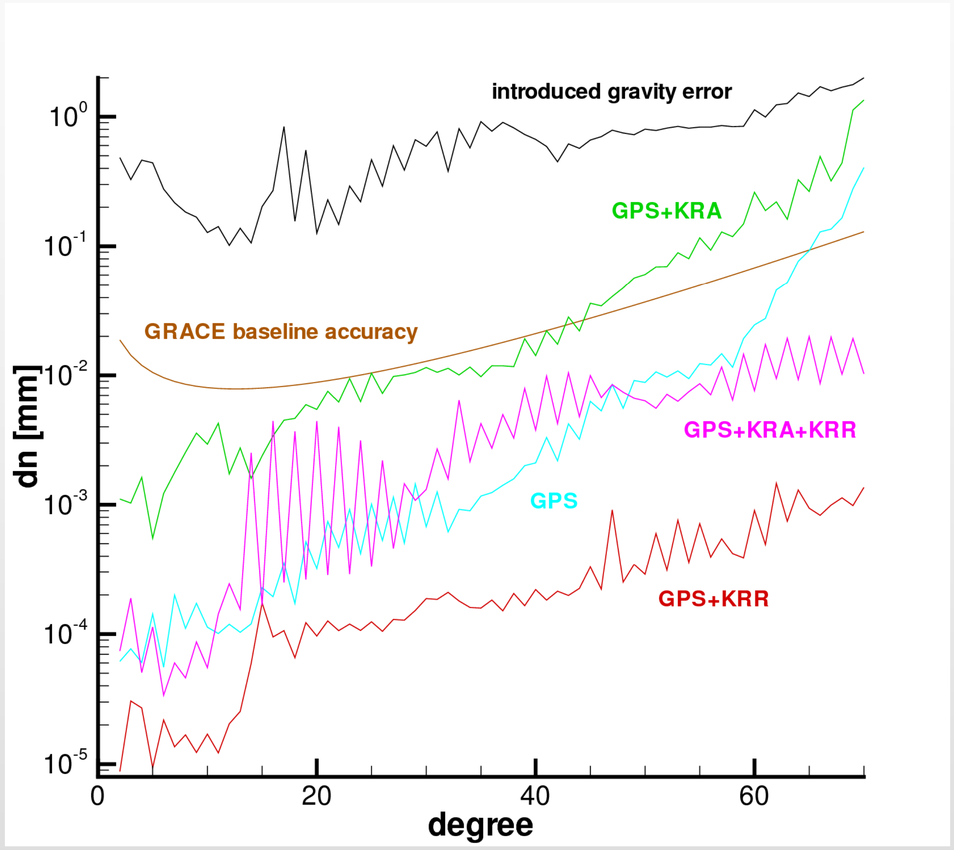
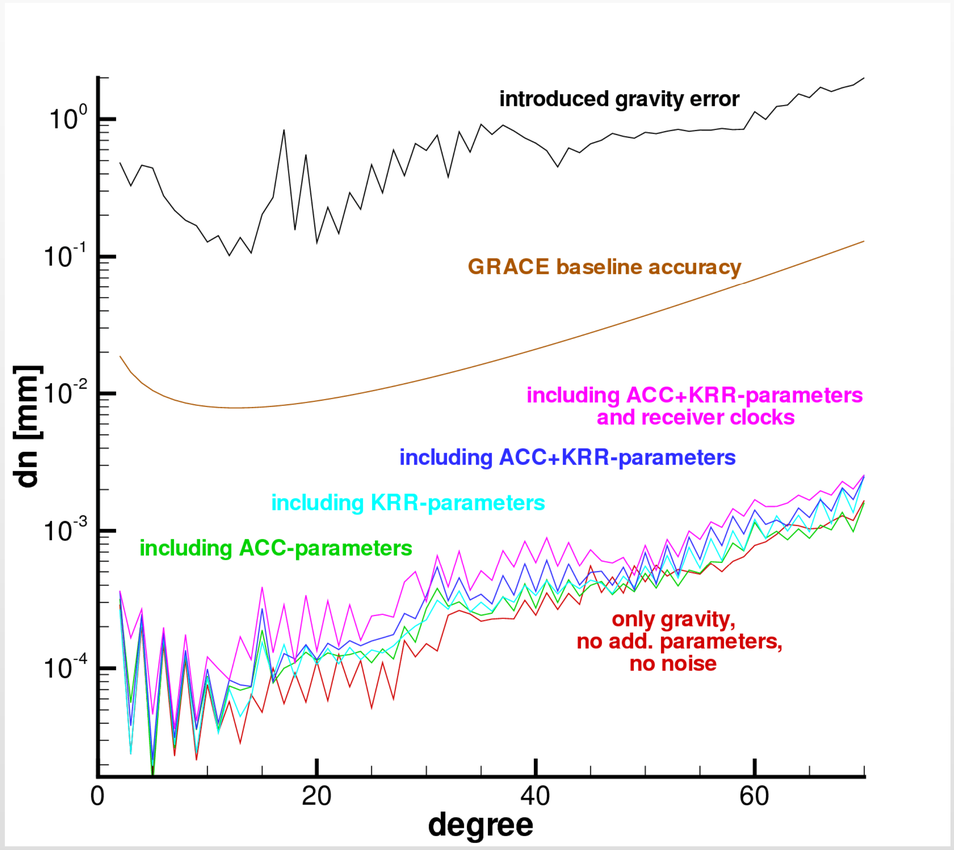
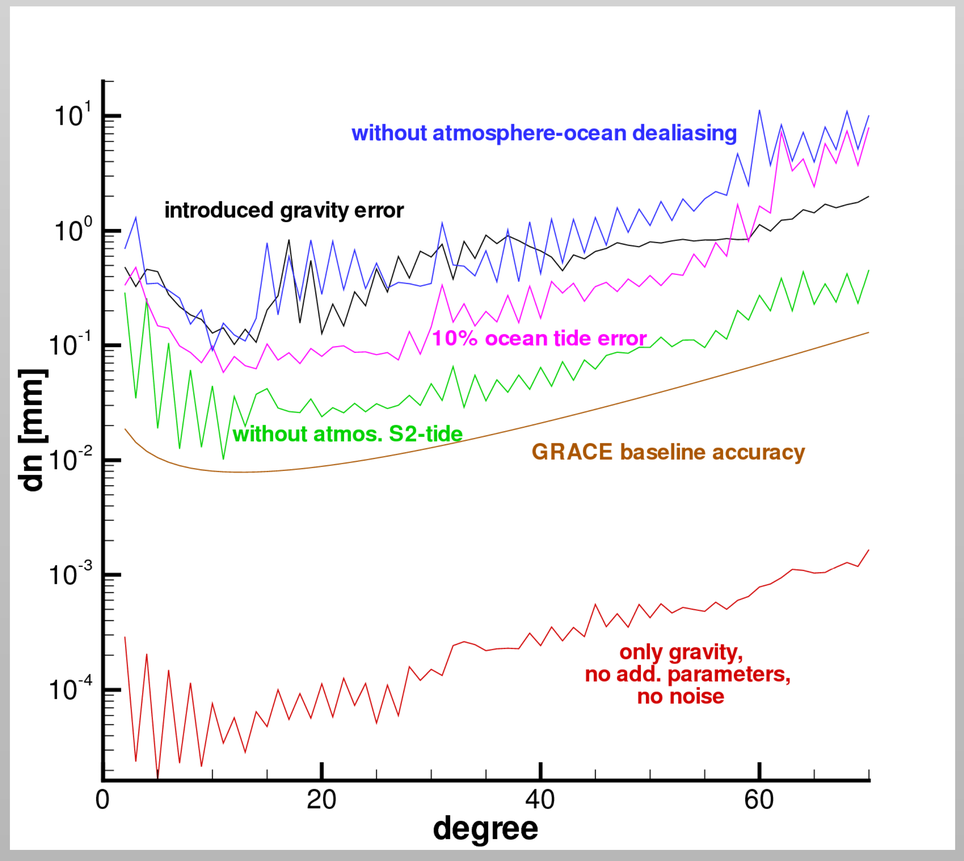
Simulation of GRACE-Observations: To study the effect of observation noise, model errors and instrument parameterization on the accuracy of the estimated gravity field, a closed loop simulation is performed. In a first step noise free K-band, GPS, star camera and accelerometer observations are simulated by the Earth Parameter and Orbit System (EPOS) software, that is used for the standard GRACE processing at GFZ. In a second step these observations are transformed into GRACE-L1B format and given to TUM, where noise is simulated by the measurement system simulator and added to the observations. In a third step a gravity field is estimated from the observations and compared to the input gravity field. The degree variances of the resulting differences are taken as a measure for the success of the gravity field recovery and compared to the pre-launch baseline accuracy. Different model errors are introduced and their effect on the gravity recovery is shown. Moreover experiments on the influence of the instrument parameterization are performed.



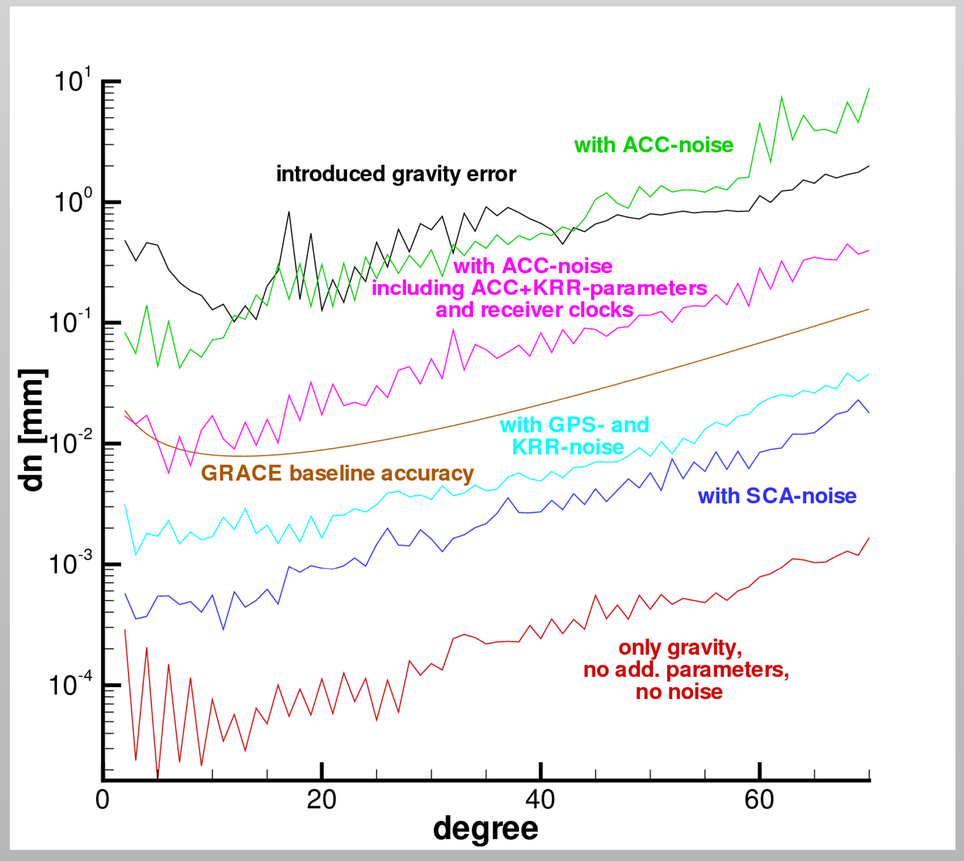
Closed Loop Simulation: A gravity field is estimated from noise free observations. As model error the difference between EIGEN-CG03C and GGM02C is introduced. Using GPS and K-band range rate (KRR) observations this error is recovered two orders of magnitude better than the foreseen baseline accuracy. When including K-band range (KRA) observations the accuracy decreases. A possible reason may be the numerical accuracy of the orbit integrator. All in all EPOS is considered fit for the job.



Instrument Parameterization: In standard processing daily biases and scale factors are estimated for the accelerometers. K-band observations are parameterized by range, range-rate and range-acceleration biases every 90 minutes as well as once per revolution oscillations. Receiver clocks are estimated every 30 seconds. The influence of all these parameters is studied in a closed loop gravity field recovery using noise free GPS and K-band range rate (KRR) observations. No significant impair on gravity estimation is observable.



Model Errors: To determine the static gravity field of the earth, time variable gravity signal like atmosphere and ocean tides as well as short time mass variations have to be corrected for. If for example the S2-atmospheric tide is omitted during the gravity estimation, it will result in an error well above baseline, but not visible at the accuracy level of current GRACE gravity fields. A 10% error in the ocean tide model in contrast is clearly visible, as is the effect of the atmosphere-ocean dealiasing (AOD1B).



Observation Noise: The main error source in gravity field estimation is the noise of the observations. Non gravitational accelerations, attitude angles and K-band observations are degraded by coloured noise following the instrument specifications. White noise is added to GPS-code (35cm) and phase (0.85cm). Estimating the gravity field from noisy observations, the accelerometer noise turns out to be most significant. The results highly depend on the instrument parameterization, but even including all accelerometer, K-band and receiver clock parameters the baseline accuracy can not be reached.