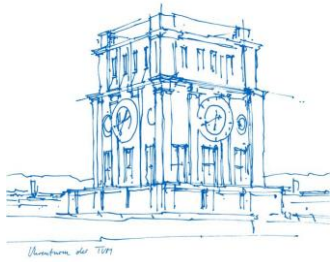
IAPG



Terrestrial strapdown inertial gravimetry in the Bavarian Alps

Peter Schack, Roland Pail, Thomas Gruber

Technical University of Munich
Institute of Astronomical and Physical Geodesy

Introduction

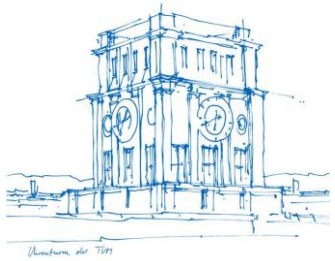
In Nov./Dec. 2019, a car-based 3D-gravimetry campaign was conducted in the Estergebirge. A navigation-grade IMU, GNSS equipment and a Scintrex CG-5 were deployed. The survey took place along a 25km north-south directed road in an area with precise reference data. This setup allows to determine the 3D-gravity disturbance and estimate the RMS-accuracy of the results to 1.1-1.7 mGal (vertical component) and 0.5-1.1 arcsec (horizontal components). This contribution provides a brief insight into the testing ground, the survey, the data processing and the results.

Content:

1. Survey area
2. Campaign setup and details
3. Gravity Disturbances
4. Discussion

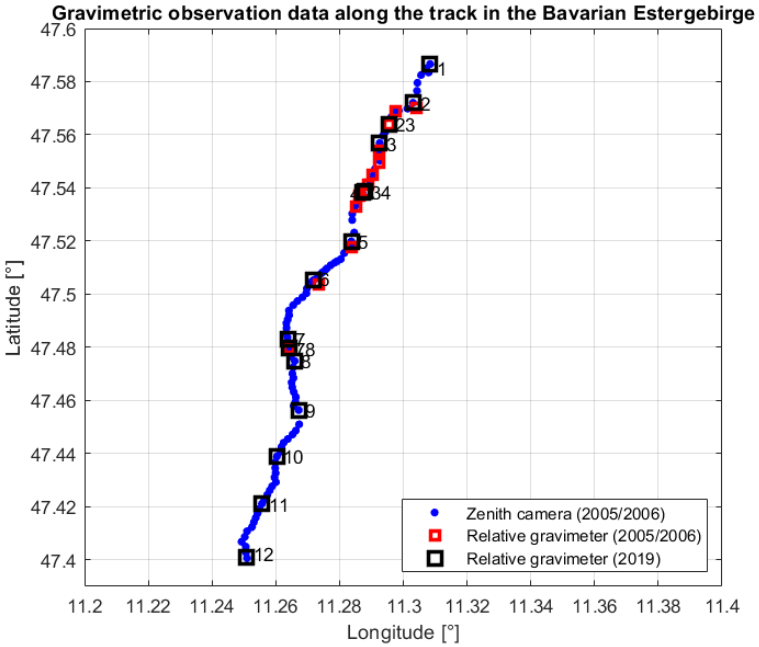
European Geosciences Union 2020

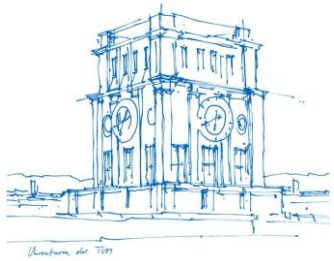
IAPG



1. Survey area

- 25 km track in the Estergebirge, 100km south of Munich in the northern Alps
- hundreds of geodetic observation points available in this area
  → >100 along the track (~200m spacing)
- Track: North-south direction, ~ 250m height variation, forest and tarred roads
  Partly strong GNSS shielding (forest, villages)



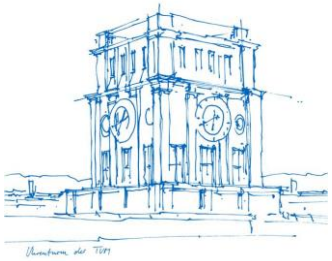


2. Campaign setup and details (1)

The idea behind this campaign is to combine IMU, GNSS, Scintrex and zenith camera observations to estimate the 3D-gravity disturbance along the track and to compare the results with the reference data. In this case, the available zenith camera reference data was used (no new measurements). The accuracy of these observations was set to the QDaedalus instrument's accuracy, which should normally be used for the determination of vertical deflections during such campaigns.

The track was measured twice. Each time starting in the middle going south, then driving to the northern end before returning to the starting point. IMU and GNSS data is recorded during movement, while Scintrex and zenith camera have to be collected during stops (possible for Scintrex only) or separately. Measurements were performed under normal traffic conditions (→ Speed variations between 10 and 70 km/h). During the second run stops for Scintrex measurements were integrated.

IAPG



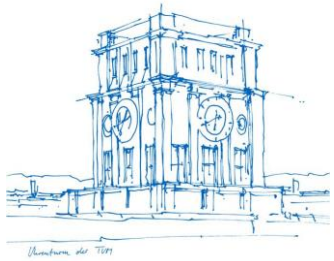
2. Campaign setup and details (2)

The processing is based on an extended Kalman Filter coupled with an RTS Smoother. Scintrex and zenith camera data are used for updates. The shown gravity disturbance is reduced by GGMplus inside the algorithm, only the residuals are estimated.

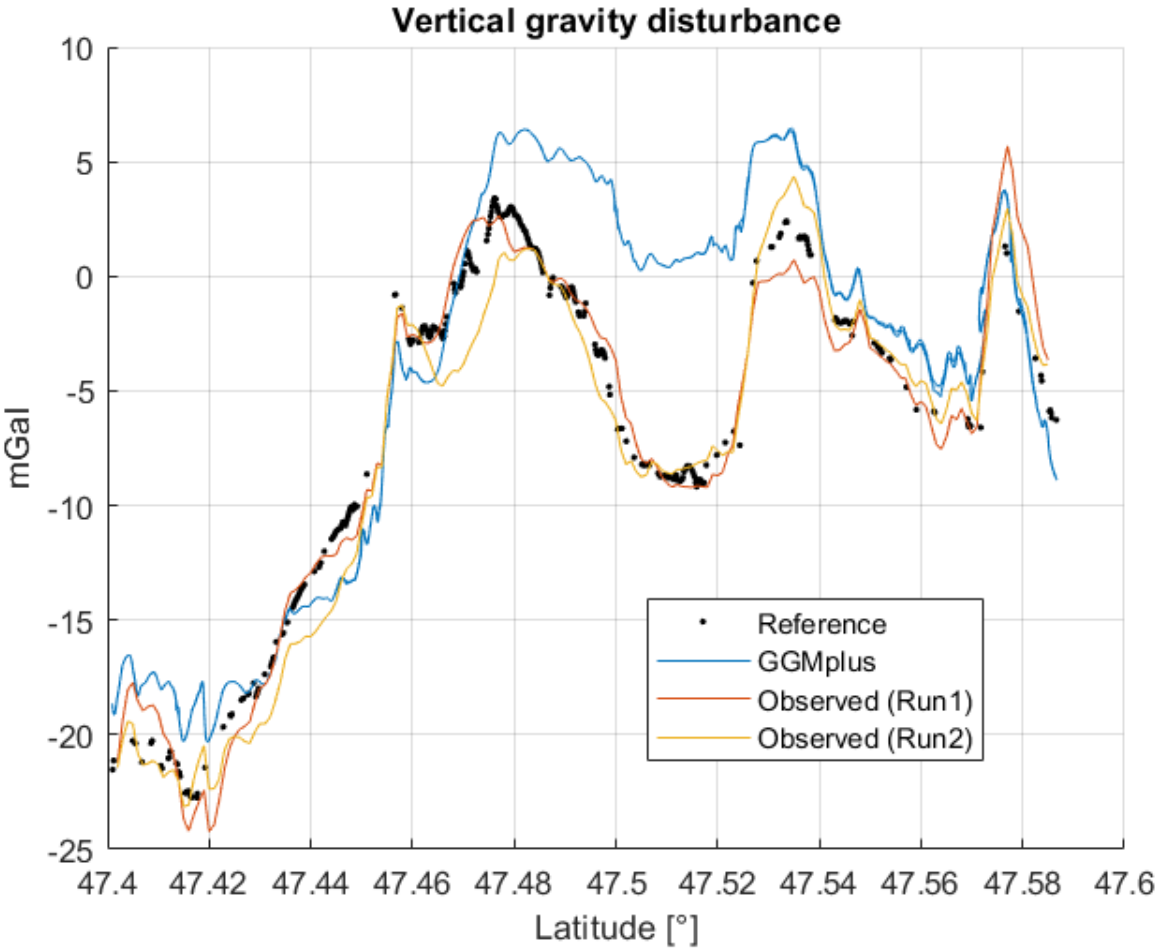
Best results were achieved with updates at the starting point, the southern and the northern end (every~ 10-15km). Furthermore, single/one-way tracks do not yield promising results, only the combination of the north-south and south-north run gives the shown accuracies.

Note: The reference data also includes interpolated values in between the observation points (see Hirt, C. and Flury J. (2008). Astronomical-topographic levelling using high-precision astrogeodetic vertical deflections and digital terrain model data. J Geod (2008) 82:231–248, Springer-Verlag. DOI 10.1007/s00190-007-0173-x).

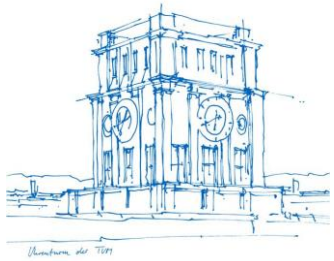
IAPG



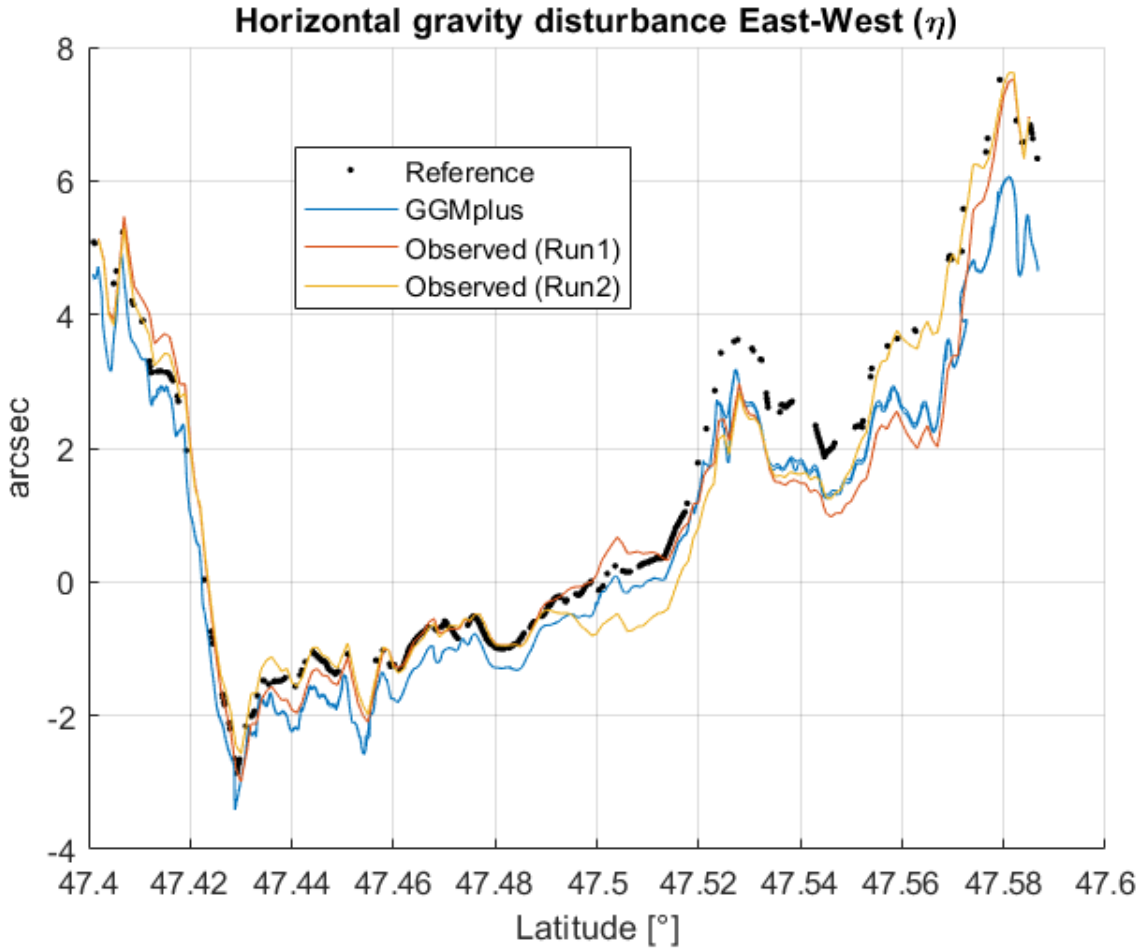
3. Gravity Disturbances (1)



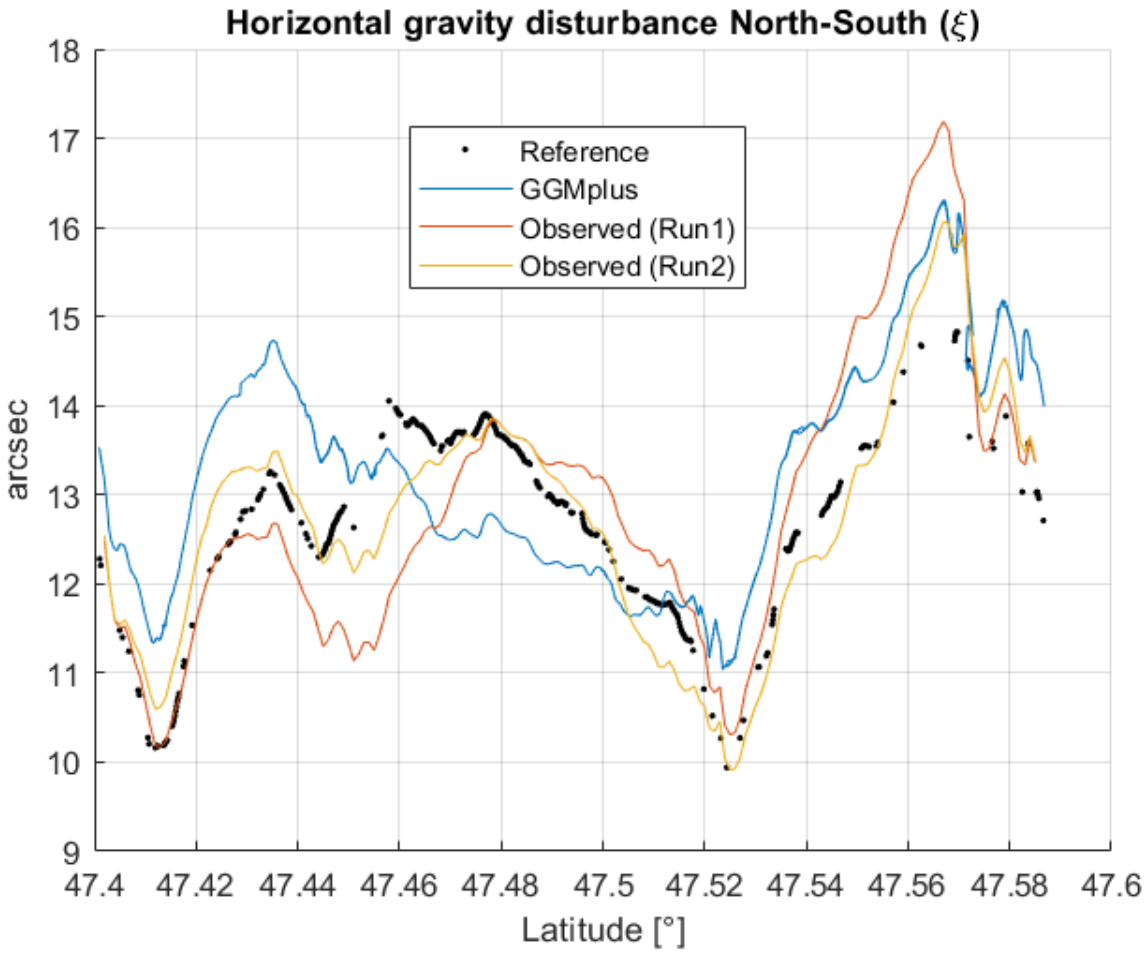
IAPG



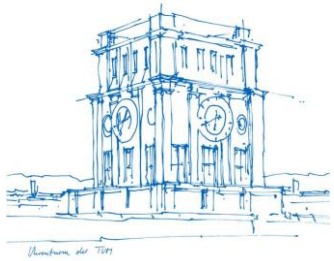
3. Gravity Disturbances (2)



3. Gravity Disturbances (3)



IAPG

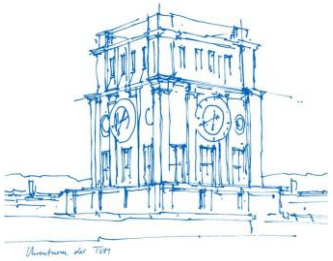


3. Gravity Disturbances (4)

RMS values are based on the difference between each reference value and its closest campaign/GGMplus value.

RMS Statistics			
	Vertical [mGal]	East-West [``]	North-South [``]
a) Run (1) with GGMplus	1.06	0.51	0.80
b) Run (2) with GGMplus	1.68	0.49	0.45
c) Combination of a and b	1.03	0.43	0.51
d) Run (1) w/o GGMplus	1.36	0.91	0.80
e) Run (2) w/o GGMplus	1.60	1.07	0.74
f) Combination of e and d	1.15	0.83	0.67
g) GGMplus alone	4.96	0.57	0.97

IAPG



4. Discussion

- Despite rather difficult measurement conditions (traffic, GNSS signal shielding, forest road, horizontal accelerations,…), the campaign showed that it is possible to determine the gravity disturbance vector with an accuracy of 1.1-1.7 mGal (vertical component) and 0.5-1.1 arcsec (horizontal components).

- The track has to be measured in both directions. Repeating the measurement leads to further improvement of the results.

- It is possible to validate and even improve the GGMplus values in mountainous regions.

- In the near future calibration values from a sophisticated IMU temperature calibration will be applied to the campaign data for further improvement of the results.

- If you want to know more details, if you have any questions or if anything is not clear, do not hesitate to write an email to **peter.schack@tum.de**.