Height systems in Greece and its islands - some experimental results

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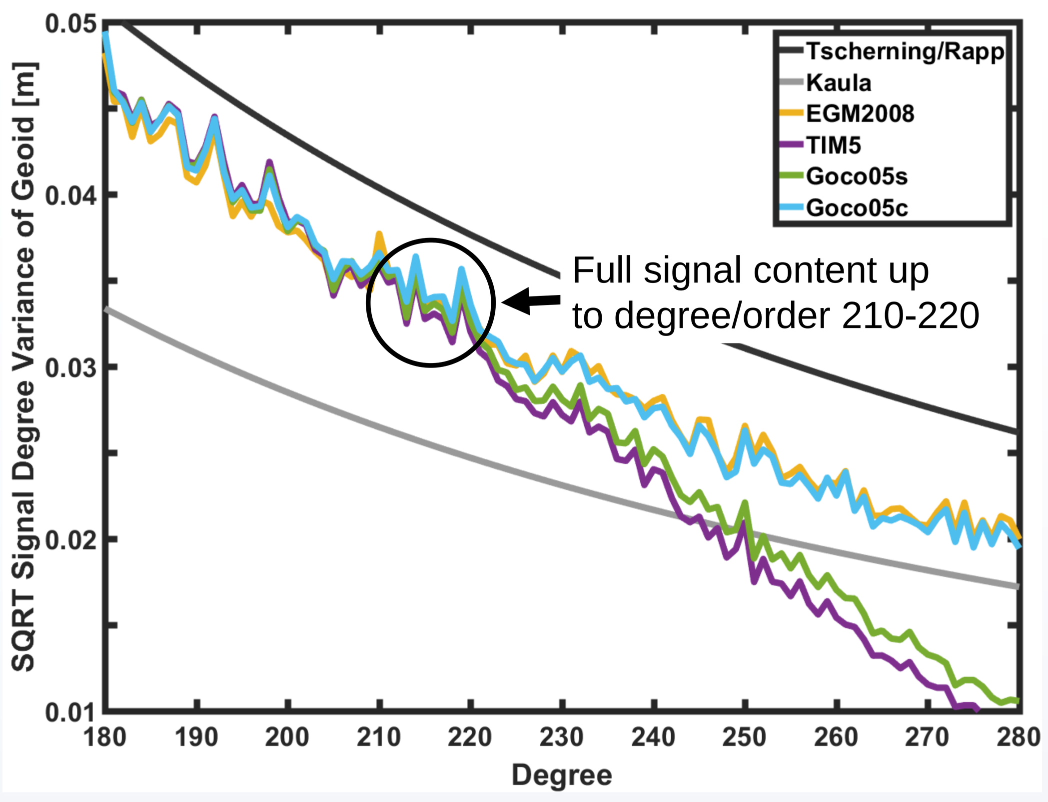
Introduction and Models Overview

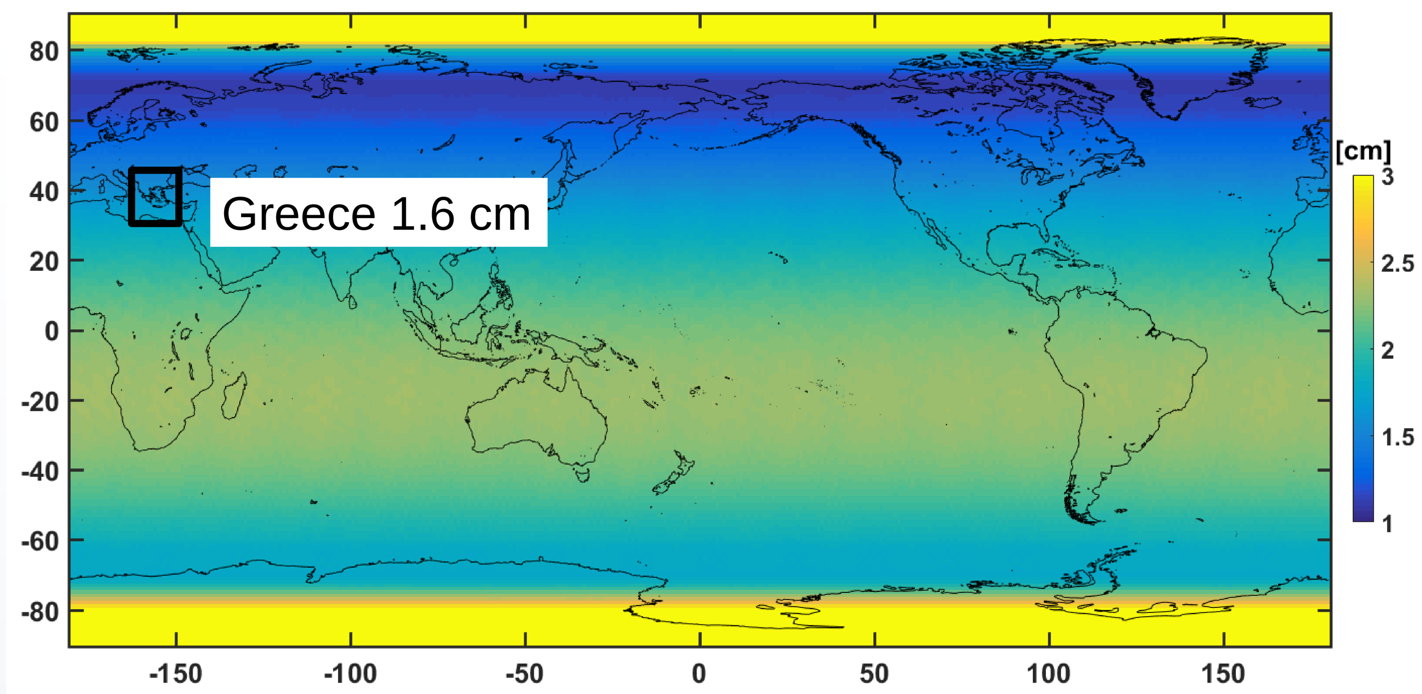
Abstract

Greek islands are not connected to the Hellenic vertical datum of the mainland. GNSS/levelling offers a tool to compare their equipotential reference surfaces on a global GOCE based geoid (here Goco05s). The offsets between these equipotential surfaces then can be used to connect the local vertical height systems to the mainland. Supposing that systematic effects like omission error and systematic distortions are treated correctly. The omission error is the difference between the spectrally limited geoid signal from GOCE models and the full spectral content of the Earth gravity field which is observed by GNSS/levelling. In case of systematic distortions in the GNSS/levelling observations they need to be identified and corrected.

Signal Content GOCE Models



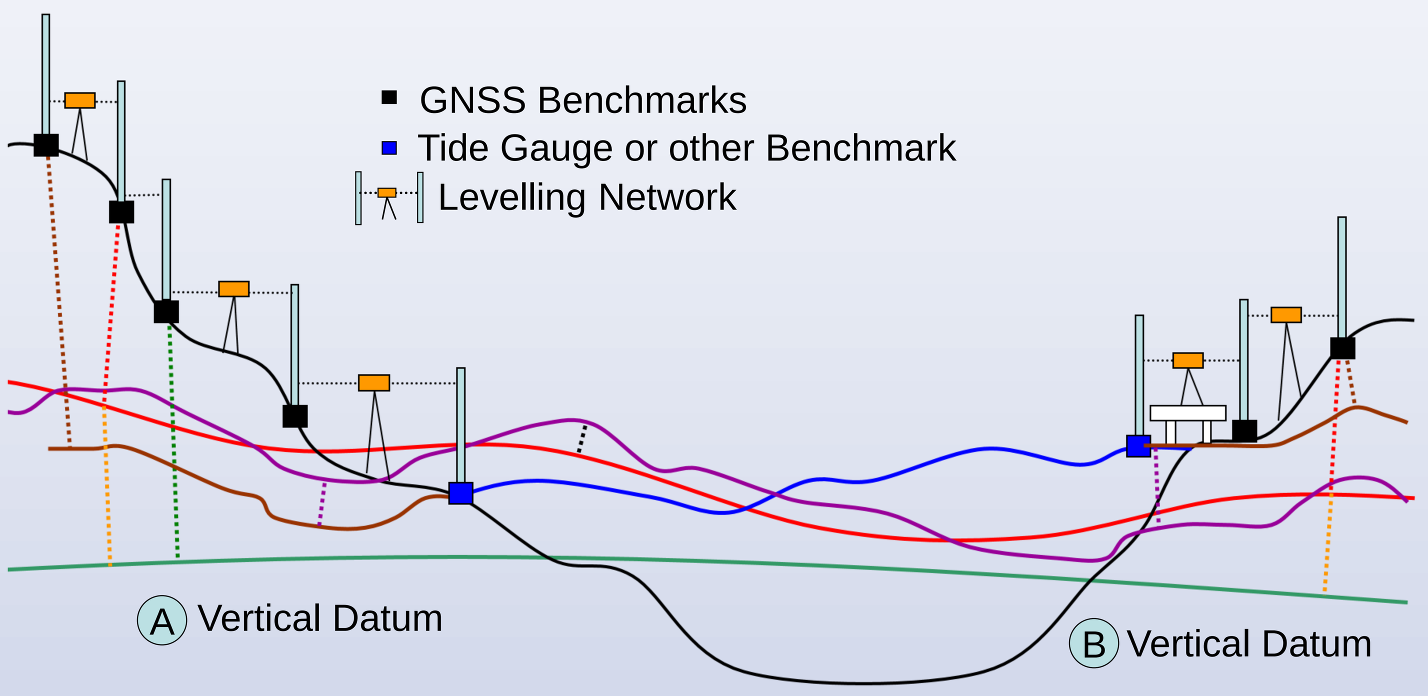
Map of Geoid Errors from Variance-Covariance Propagation (d/o 200)



Goco05s

Problem Definition and Procedure

Vertical Datum Connection



- Local vertical datum (equipotential surface)
- GOCE equipotential surface (long wavelengths)
- True equipotential surface (short wavelengths)
- GOCE orthometric/normal height
- h_i Ellipsoidal height determined by GNSS
- H_i Orthometric/normal height from spirit levelling
- N_i^{GOCE} Computed geoid height/height anomaly from GOCE model
- N_i^{om} Omission error (signal degree/order >200)
- $\overline{\Delta N_i}$ Mean offset of local vertical datum (to the true equipotential surface)
- n_{total} Number of GNSS/levelling points

Offset and RMS Calculation

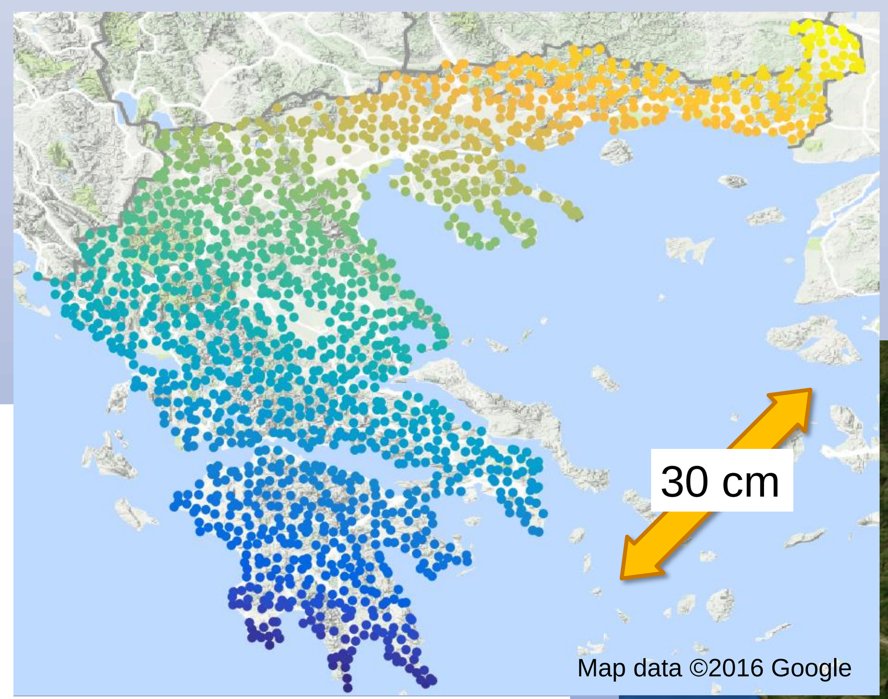
- Separately for each vertical datum (island):

$$\Delta N_i = h_i - H_i - (N_i^{GOCE} + N_i^{om})$$

$$\overline{\Delta N} = \frac{\sum \Delta N_i}{n_{total}}$$

- Goco05s model until d/o 200 is used for N_i^{GOCE}
- The omission error is computed from EGM2008 between spherical harmonic degree 201 and 2160/2190 and a Residual Terrain Model above (Hirt et al., 2010).
- Quasi-geoid/geoid separation is computed according to Rapp (1997).
- Presented are $\overline{\Delta N}$ for islands with n_{total} of 10 or more. One calculation is done with the omission error N_i^{om} like presented above and the other without.
- RMS after planar fit is visible through colored dots and shows the overall quality of the data.

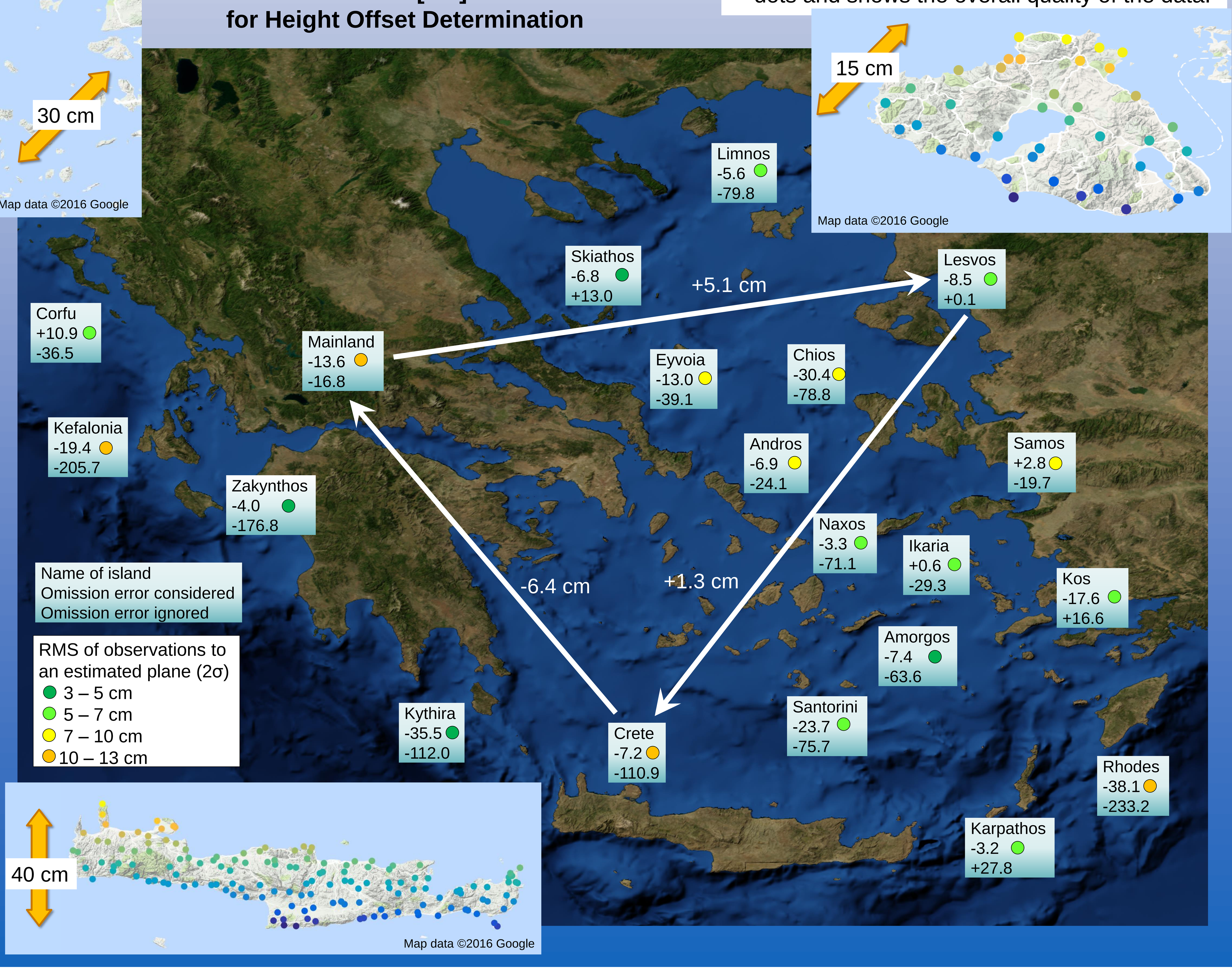
Summary & Conclusions



- GNSS/levelling enables height system unification through calculation of mean offsets.
- Distortions of vertical systems (see: mainland, Crete or Lesvos) need to be eliminated for comparison of heights.
- Distortions due to the local geoid (calculated from GNSS and spirit levelling) though levelling is considered to be the main reason.
- To improve this solution you have to enhance the local geoid and e.g. add gravimetric data.
- Omission error for islands far above world average (30 cm) due their size near GOCE resolution.
- Presented RMS has a high correlation to the number of measurements respectively size of the island.
- RMS values after planar fit between 3 – 13 cm

GNSS/levelling Observations

Mean Offset $\overline{\Delta N}$ [cm] and RMS for Height Offset Determination



References:

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