Introduction:
In the era of modern technologies and GNSS developments the precise quasi-geoid (QGeoid) model is necessary as geodetic infrastructure for GNSS services in different engineering needs, as it allows the determination of normal height much faster in comparison to levelling and directly from GNSS. This poster represents the software for QGeoid determination based on parametric modelling, as well as further version based on Adjusted Spherical Cap Harmonics (ASCH) modelling. The example of the QGeoid model for Ulaanbaatar region and computation results are introduced. The theory of deflections of vertical measurements by digital zenith camera is also included.

Computations of Ulaanbaatar qgeoid:
In order to compute the DFHRS_DB for Ulaanbaatar 94 identical points (ellipsoidal h and normal heights H in Baltic Height system) together with the EGM2008 geopotential model data were used. EGM2008 is a spherical harmonic model of the earth’s external gravitational potential in degree and order of 2160, with additional spherical harmonic coefficients extending up to degree of 2190 and order of 2160 that offers a spatial resolution of 9 km [1]. For meshing, the area, mesh size of 5x5 km was chosen. Total amount of meshes ~ 1536. The total number of patches is 5. One patch must contain at least 4 fitting points.

Zenith camera and determination of DoV:
With the star coordinates at the observation time t_UTC have: \[ R_{SV}^{QG} = R_{SV}^{QG}(B, L, \eta, \xi) = \]
\[
\begin{pmatrix}
\sin B \sin \Phi \cos (A - L) + \cos B \cos \Phi \\
\sin B \sin (A - L) - \cos B \sin \Phi \\
\sin (A - L)
\end{pmatrix}
\]
\[
\begin{pmatrix}
\cos B \cos \Phi \\
\cos B \sin \Phi \\
\cos (A - L) + \sin B \Phi
\end{pmatrix}
\]
To compute the vertical surface deflections determination the equation reads:
\[ R_{SV}^{QG}(1) - R_{SV}^{QG}(2a, b) = 0 \]
\[ R_{SV}^{QG} = R_{SV}^{QG}(B, L, \eta, \xi) \cdot r \cdot \epsilon^2(\lambda) \]
Further development of the DFHRS software:
The extension of DFHRS concept and software to physical observation types – such as terrestrial, air- /space-borne gravimetric measurements or physical observation types taken from geopotential models, e.g. EGM 2008 – is based on a regional adjusted spherical cap harmonic parameterization (ASCH) of the Earth’s gravitational potential (V) [4,5]:

By introducing the disturbance potential applied to the Bruns theorem and Molodensky’s theorem, we obtain the observation equation for fitting-points converted to quasi-geoid heights NQG and vertical deflections (h, n) at measured at the earth surface by zenith camera at a point P reading [3, 5, 6]:

\[ V(r, \lambda, \theta) = \frac{GM \sum_{k=0}^{K_{max}} \left\{ \left( \frac{n}{k} \right) \sum_{m=0}^{K} \left( \frac{Y_{m}^{n}}{\sin m\theta} \right) + S_{m}^{n} \sin m\theta \right\} P_{k}(\cos \theta) }{\sum_{k=0}^{K_{max}} \left\{ \left( \frac{n}{k} \right) \sum_{m=0}^{K} \left( \frac{Y_{m}^{n}}{\sin m\theta} \right) + S_{m}^{n} \sin m\theta \right\} P_{k}(\cos \theta) } \]

References: