On the Estimability and Reliability of correction models from CORS Networks

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Motivation

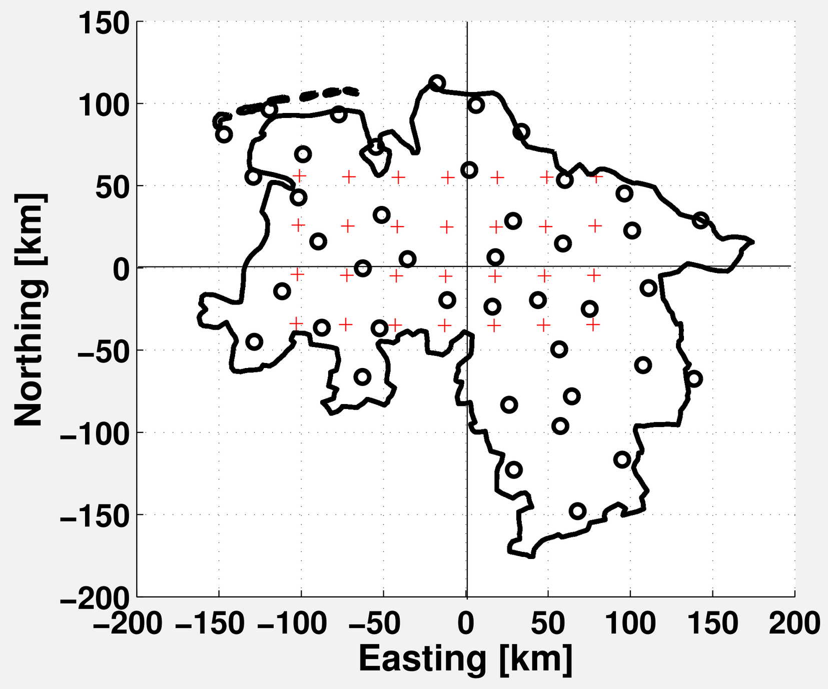
Continuously operating reference stations (CORS) are collecting observation data of different GNSS and are realizing global and regional GNSS networks. Besides the establishment and maintenance of reference frames, like e.g., the IGS frame, CORS are the basis for network real time kinematic (NRTK) applications and services, like e.g., the German Satellite Positioning System (SAPOS). The basic principle of NRTK is to derive appropriate correction models for the covered area. This enables users interpolating their individual distance dependent error corrections, like e.g., tropospheric corrections to achieve positioning accuracy of a few centimeters. According to the dimension of the reference stations network different parameterizations for the correction models are desired. From a user's point of view it is very important that the derived correction parameters by the provider are reliable and of high quality. To derive appropriate quality indicators for the correction parameters we started investigating the estimability and reliability of correction model parameters with a given scenario.

Scenario

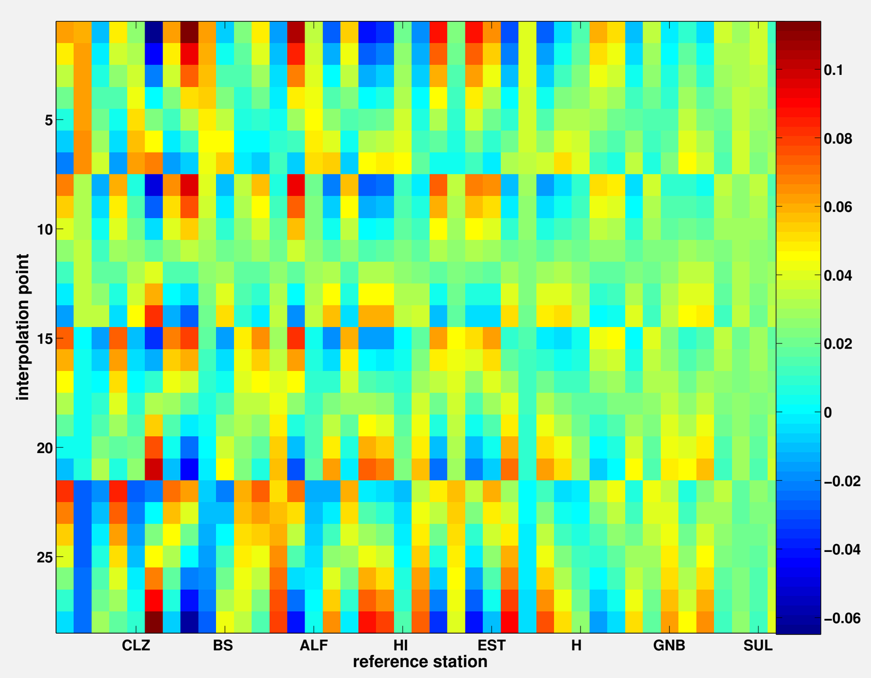
In our investigations we use the station geometry of the SAPOS network in Lower Saxony consisting of 41 reference stations cf. fig. (a). In the GNSS reference station networks several distance dependent errors are modeled using surfaces. Considering the atmosphere there are several modeling options possible. One way is to set up a global model which covers the whole network of involved reference stations and additionally estimating individual station parameters in a second step. In the following our investigations are based on a simple global correction model which is implemented in a Kalman filter. The focus here is analyzing the effects which arise due to the parameters set up in the state vector and satellite-station geometry only.

Method

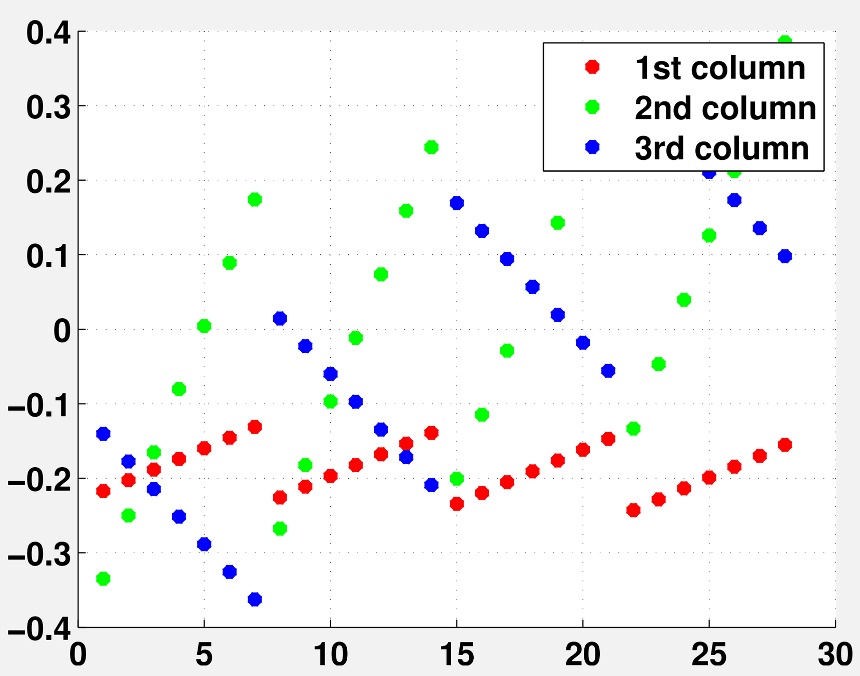
In a first investigation we started analyzing every stations influence to an arbitary chosen interpolation point. As a result a color coded plot is shown in which the contribution of every reference station to an interpolation point is reflected. Moreover a singular value decomposition (SVD) was performed. The corresponding vectors the the significant singular values are shown in figures (c) and (d). Moreover analyzing the estimatability of state space parameter dependent on a given geometry of a reference station network can be done by regarding the transfer matrix $K = Q_x A' P$ cf. figure (e). The impact of each observation to the estimated parameters is shown in figure (f) for one epoch.



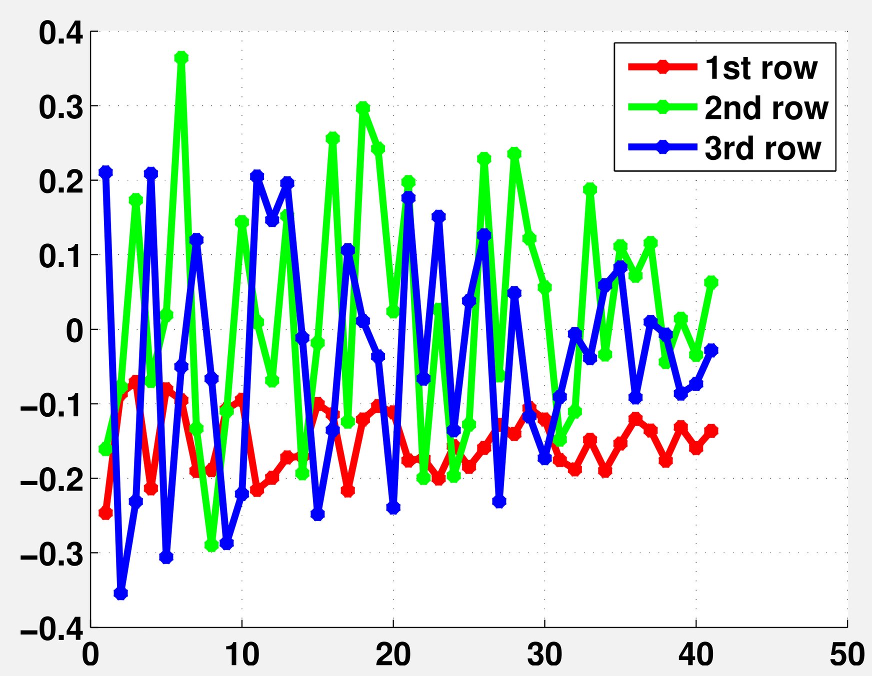
(a) network



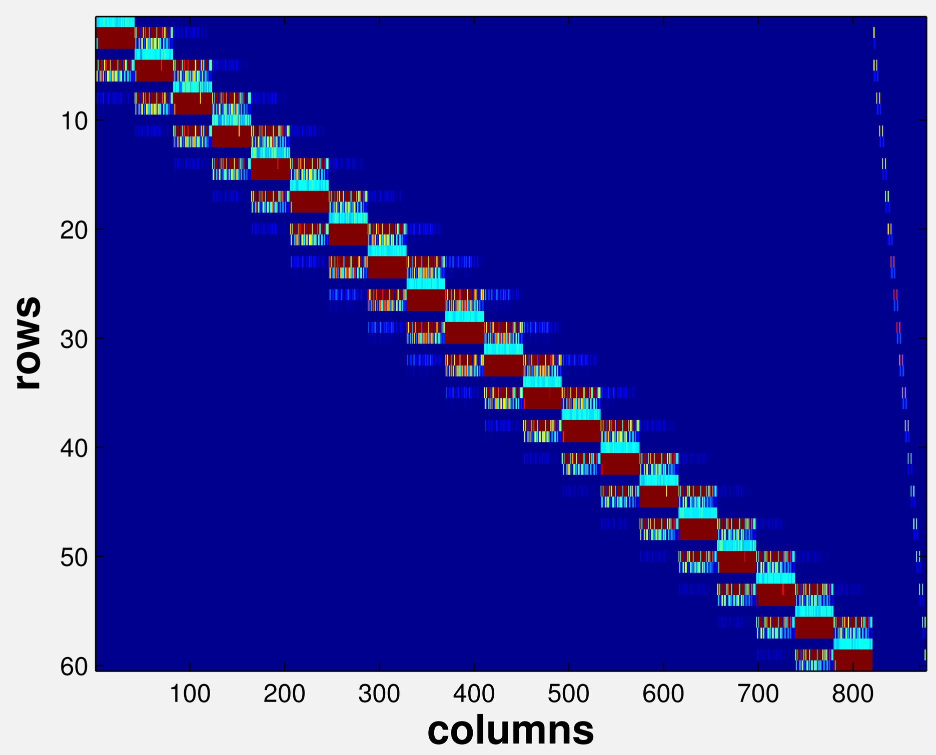
(b) interpolation matrix



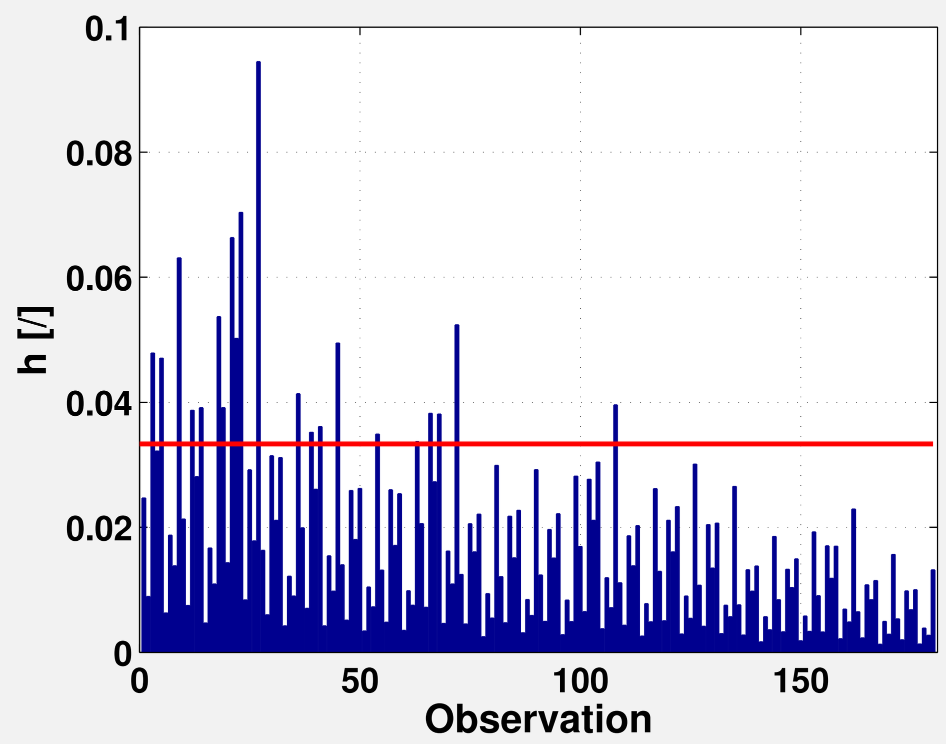
(c) Matrix U



(d) Matrix V



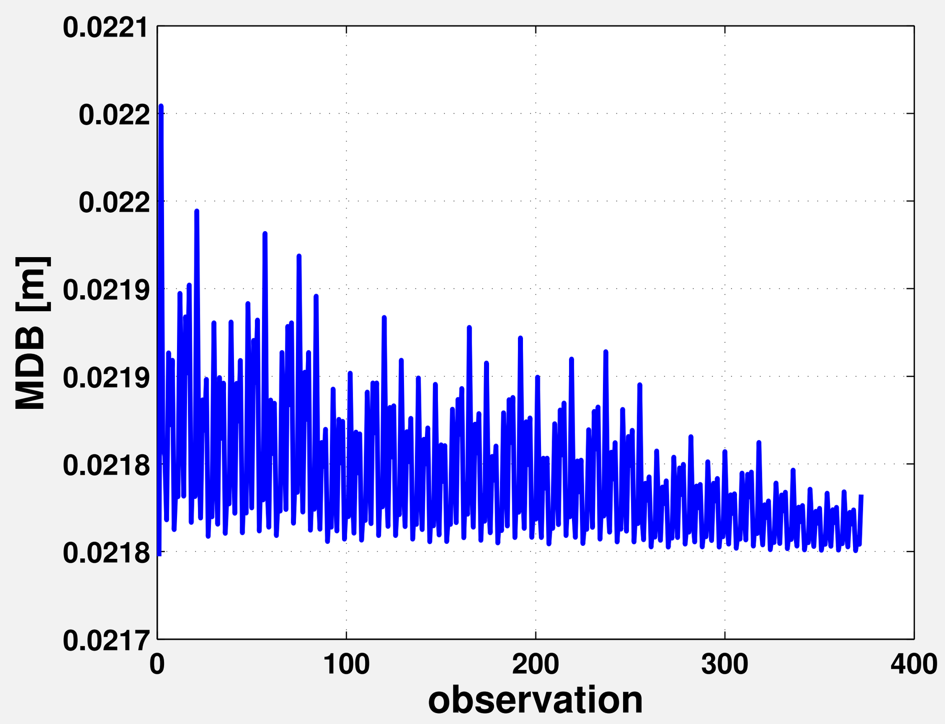
(e) Transfer matrix



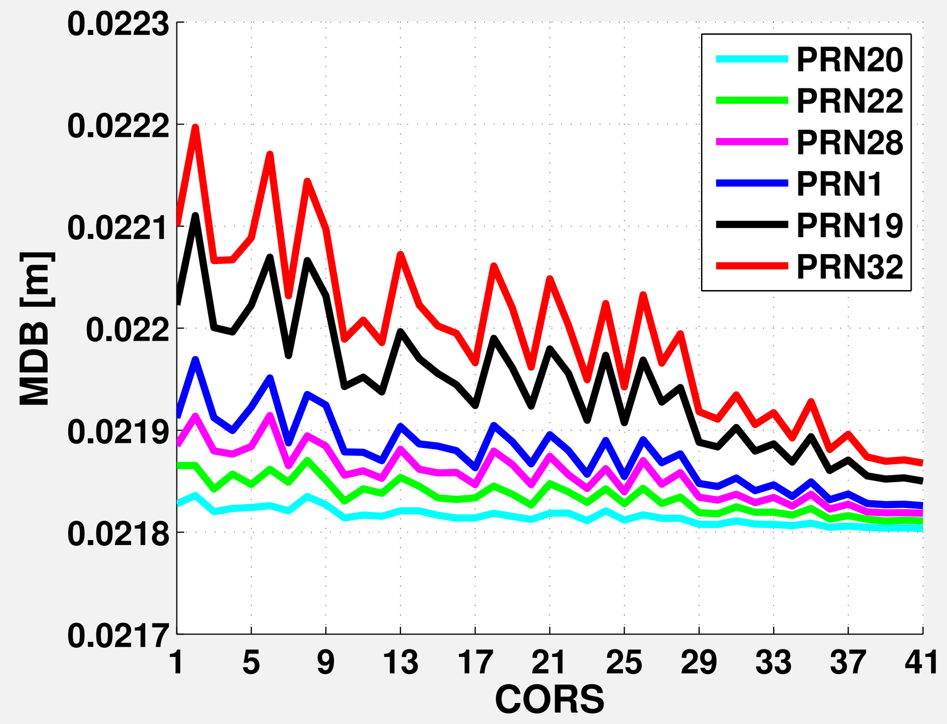
(f) Impact factors

- rows in figure (b) are showing the influence of every CORS to an interpolation point (cf. fig. (a))
- colums in figure (b) are showing the influence of one CORS to any interpolation point
- dependence of longitude
- station near to the centre have small contribution
- Matrices U and V reflect the geometry of the network (cf. figure (d)) and the interpolation points (cf. figure (c))

An important diagnostic tool are minimal detectable biases for analyzing the given mathematical model, cf. Teunissen (1997). MDB are statistical parameters and are used to represent and quantify the internal reliabily. They give an information about the size of detectable errors in the model, which can be identified with a given probability. In the following figures we show the MDB for our scenario described above. In figure (g) the MDB for two epochs are shown and in figure (h) the MDB are satellite-wise plottet for one epoch on each station of the network.



(g) MDB for two epochs



(h) MDB satellite-wise

- magnitude is near to 2.2 cm
- become smaller on stations to the network centre
- become bigger for satellites in higher elevations
- are small for satellites in low elevations

References

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