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Weekly TRF realization from non-singular input NEQ and related distorting effects in minimally constrained solutions

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The singularity of the input normal equations (NEQ) is a fundamental prerequisite of the minimal-constraint estimation framework in the context of geodetic network adjustment and terrestrial reference frame (TRF) realization. This operational framework is widely used for the primary realization of secular or epoch-based TRFs, as well as for the alignment of geodetic networks to existing global or continental reference frames, and it is known to impose important and desirable properties in the estimated solution. However, the minimal constraints are frequently applied in practice without verifying the true rank defect of the input NEQ at hand and, thus, their role should often be accepted rather loosely, that is without guaranteeing the distortion-free character of the corresponding solution.

Taking into account that the NEQ formed in practice either by single network analysis or by subnetwork combination through stacking procedures may often have full rank, the goal of this study is to investigate the distortion caused by additive datum constraints (which are supposedly “minimal”) in the absence of proper rank defect from the input NEQ. Note that the term distortion is employed here to identify the differences in the well-estimable characteristics between a free-net solution and a minimally constrained solution for the same network. Several examples are presented using weekly SINEX files from the EPN, SIRGAS and APREF networks, in which we compare the two aforementioned solutions on the basis of epoch-wise coordinate residuals after their fitting by weekly Helmert transformations over all network stations.