Federal Agency for Cartography and Geodesy

IVS combination center at BKG

Combined solution vs. Individual solution

- An alternative Approach -

Introduction

The combination of solutions from different IVS analysis centers lead to a combined product which is assumed to be a best estimated solution of all input solutions. Within the combination process, each solution is introduced with a weighting factor representing the individual contribution to the combined solution.

The standard approach uses established variance component estimation (VCE) to calculate the weighting factors. Considering that the input data of all ACs are not independent (all ACs are using the same “raw data”), the mean error (RMS) and the weighted mean error (WRMS) of the estimated parameters of the individual solutions have a higher level than the combined solution. The level is currently adapted by applying an empirically determinated correction factor.

Actual Approach

The weighting factors are estimated in an iterative VCE. Figure 1 shows the weighting factors for different ACs. The accumulation of the normal equations (NEQ) is subsequently calculated using the individual weighting factor and an empirical multiplication factor (f_{emp}) is applied in a post process (Böckmann 2010): $\hat{x}_{addapted} = f_{emp} \cdot \hat{x}_{combi}$

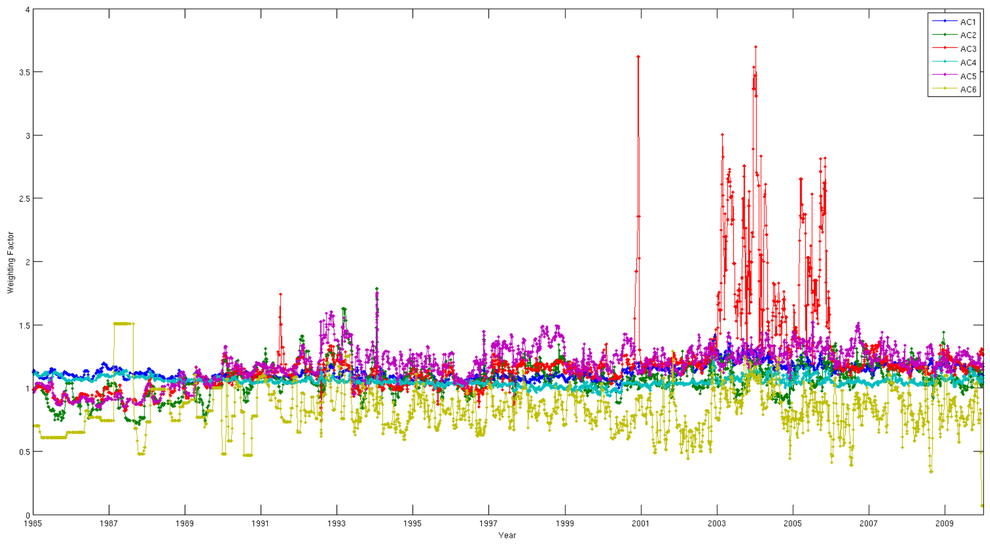

Figure 1: Weighting factors of different ACs calculated within the VCE.

Figure 2 shows the current combination process (black).

Alternative Approach

The idea is to extend the traditional VCE approach by an additional factor within the combination process. This factor takes into account the impact of the analysis software and the operator’s influence on the raw data during the analysis process (Operator Software Impact – OSI) as a random effect (white noise) (Figure 2, red box).

This approach introduces an additional weighting factor before the combination. Input values are estimated parameters from the individual solution (l_i with i=1 to number of ACs).

The residuals with respect to the (unweighted) mean value are used to calculate the covariances between the solutions and to derive a correction factor α: $\alpha_{(i)} = f(l_i)$

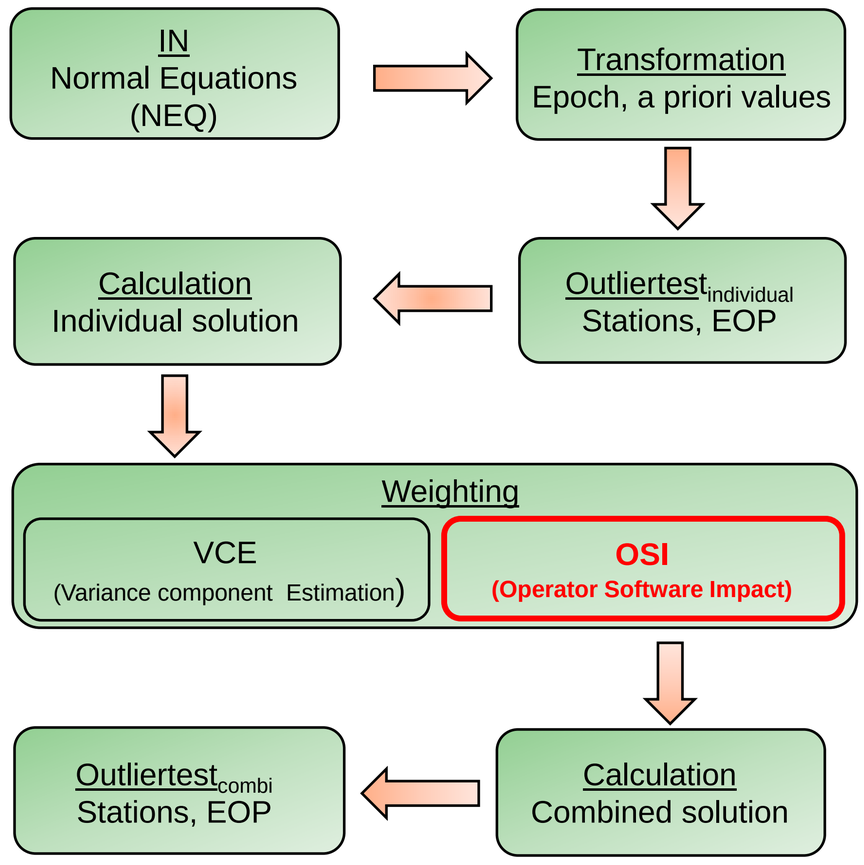

Figure 2: Current (black) and alternative combination Process with an additional correction factor (red).

Outlook

This approach has basically been introduced by (Kutterer 2009) and applied for tropospheric parameters in (Heinkelmann 2011). Both papers show the use of the OSI applied to estimated parameters showing improvements of the combined result compared to traditional approaches (e.g. VCE only). So far, this approach has not been applied to VLBI combination yet. The challenge is to determine reasonable correction factor(s) α reflecting the particularity of the VLBI analysis and combination. This alternative approach tends to better adjust the individual solutions and to spare a post-process correction factor.

Literature

Böckmann,S. et al.: International VLBI Service for Geodesy and Astrometry: Earth orientation parameter combination methodology and quality of the combined products. Journal of Geophysical Research, Vol.115, 2010.

Kutterer,H. et al.: Towards an Improved Assessment of the Quality of Terrestrial Reference Frames. H. Drewes (ed.), Geodetic Reference Frames, International Association of Geodesy Symposia 134, Springer-Verlag, 2009.

Heinkelmann,R. et al.: VLBI-derived tropospheric parameters during CONT08. Journal of Geodesy, 2011 (online first).

IVS combination web pages: http://ida.bkg.bund.de/IVS/

Additional Information

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