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Combination of Long-term Time Series of Tropospheric Parameters Observed by VLBI

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Abstract

The long-term time series of wet zenith delays from five IVS Analysis Centers (AC) are combined on the level of results. Outliers are eliminated by robust outlier detection and weights are determined by variance component estimation. That is done for each AC series of each station. In this paper the method of combination is described briefly.

1. Combination Method

Within the IVS (International VLBI Service for Geodesy and Astrometry) five IVS Analysis Centers (AC) (see Table 1) send their long-term time series of tropospheric parameters including formal errors to the Institute of Geodesy and Geophysics (IGG), Vienna for comparison and combination. The requirements for the individual parameters are minimal: zenith delays and gradients have to be provided at integer hours and the time resolution of the zenith delays has to be one hour. For the combination the solutions are considered being independent, i.e. correlations between them are assumed to be zero. The long-term time series are combined by a three step procedure.

Table 1. ACs contributing to the IVS combined long-term time series of tropospheric parameters

BKG	Bundesamt fuer Kartographie und Geodaesie, Frankfurt a.M., Germany
GSF	Goddard Space Flight Center, Greenbelt, USA
IAA	Institute of Applied Astronomy, St. Petersburg, Russia
IGG	Institute of Geodesy and Geophysics, Vienna, Austria
MAO	Main Astronomical Observatory, National Academy of Sciences, Kiev, Ukraina

1.1. Data Editing

At first, basic checks are performed and outliers are eliminated. Then, each time series of zenith delays is modeled by a trend and seasonal components. The amplitudes and phases of the annual and semi-annual variations are determined by least-squares estimation. The outlier detection is achieved by the BIBER algorithm (Wicki, 1999, [5]). In each step of this iterative algorithm one observation, the observation with the biggest standardized residuum, is considered to be an outlier. If its standardized residuum exceeds an empirically determined treshold[1] the observation will be

[1] The treshold is set to 3.

downweighted in such a way that it just fulfills the criteria to be not an outlier any more. After this procedure the residuals fit the assumption of the normal distribution, a requirement for the variance component estimation.

1.2. Determination of Weights

A common observation vector is built up from the observations of the ACs with the mean values shifted to the common mean value. The formal errors reported by the ACs are considered, too, after their mean values were brought on a common level. They form a common diagonal covariance matrix. The variance components, additional unknowns in the linear Gauss-Markov model, are iteratively estimated with the method of Foerstner (1979, [1]) as described in Koch (1999, [3]).

1.3. Computation of the Combined Series

For each station the combined series is obtained by the sum of the weighted observations of the individual ACs. More details can be found on the web site of this IVS product [4].

2. Conclusions and Outlook

The combined tropospheric parameter series are more reliable than a single solution and can be used as a reference for any kind of comparisons, e.g. with other techniques, and for climate studies. There is a discrepancy between the formal errors of the combined solution and the deviations between contributing individual solutions, what shows that the formal errors of the combined series are too optimistic. Before a rigorous combination of the tropospheric parameters, i.e. on the level of normal equations, stricter requirements for the parameter model, the epochs, and the formal errors have to be followed. In addition, the various constraints on the tropospheric parameters should be avoided or reported together with the parameters in the SINEX file, to enable their removal before the combination process.

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