Baseline dependent weights in VieVS

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Abstract

It is well known that in processing VLBI data chi-squared is usually larger than 1, typically in the range of 4-8. This results from either too small measurement errors or of mismodeling the data. By re-weighting the data, by increasing the errors of the observation, we can make chi-squared~1 (Gipson et al. (2008)).

In Solve's (Ma et al. (1990)) operational solutions baseline dependent weights are always applied. VieVS (Böhm et al. 2009) uses a constant weight, i.e., global weighting. In order to use baseline dependent weights in VieVS we run the least-squares adjustment a second time after calculating the re-weights for each baseline in an observation. Baseline weighting reduces UT1 adjustment scatter significantly. Discrepancy between VieVS and Solve is also reduced.

1. Adding noise

1) Global re-weights, e.g., 33 ps for all observations, which is the VieVS default;
2) Station re-weights, which depend only on the stations in an observation;
3) Baseline re-weights, which only depend on the baselines in an observation.

$$\sigma^2_{t,ij,obs} = \sigma^2_{t,ij,meas} + \epsilon^2_{t,ij,w}$$

Eq. 1. Adding noise to VLBI measurements.

$$n_{mi\_observ} = \sqrt{(mi\_observ)^2 + \frac{\sum v_{bas}^2}{n} \cdot \left(\frac{0.01}{c}\right)^2}[seconds]$$

Eq. 2. Creation of baseline dependent P matrix in VieVS. n_{mi_observ} is replaced measured sigma for each observation in sec, mi_observ contains the sigmas, v_{bas} are the residuals to each observation in cm, n is the number of observations and c is the speed of light.

2. Results

We used VieVS version 2.2 and Solve release 2014.02.21 in our analysis. Baseline length repeatability was calculated from CONT08 data in three different cases: 1) VieVS using global weights (VieVS 33 ps); 2) VieVS using external weight files from Solve (GSFC); 3) VieVS deploying baseline dependent weights (VieVS bsl depend.)

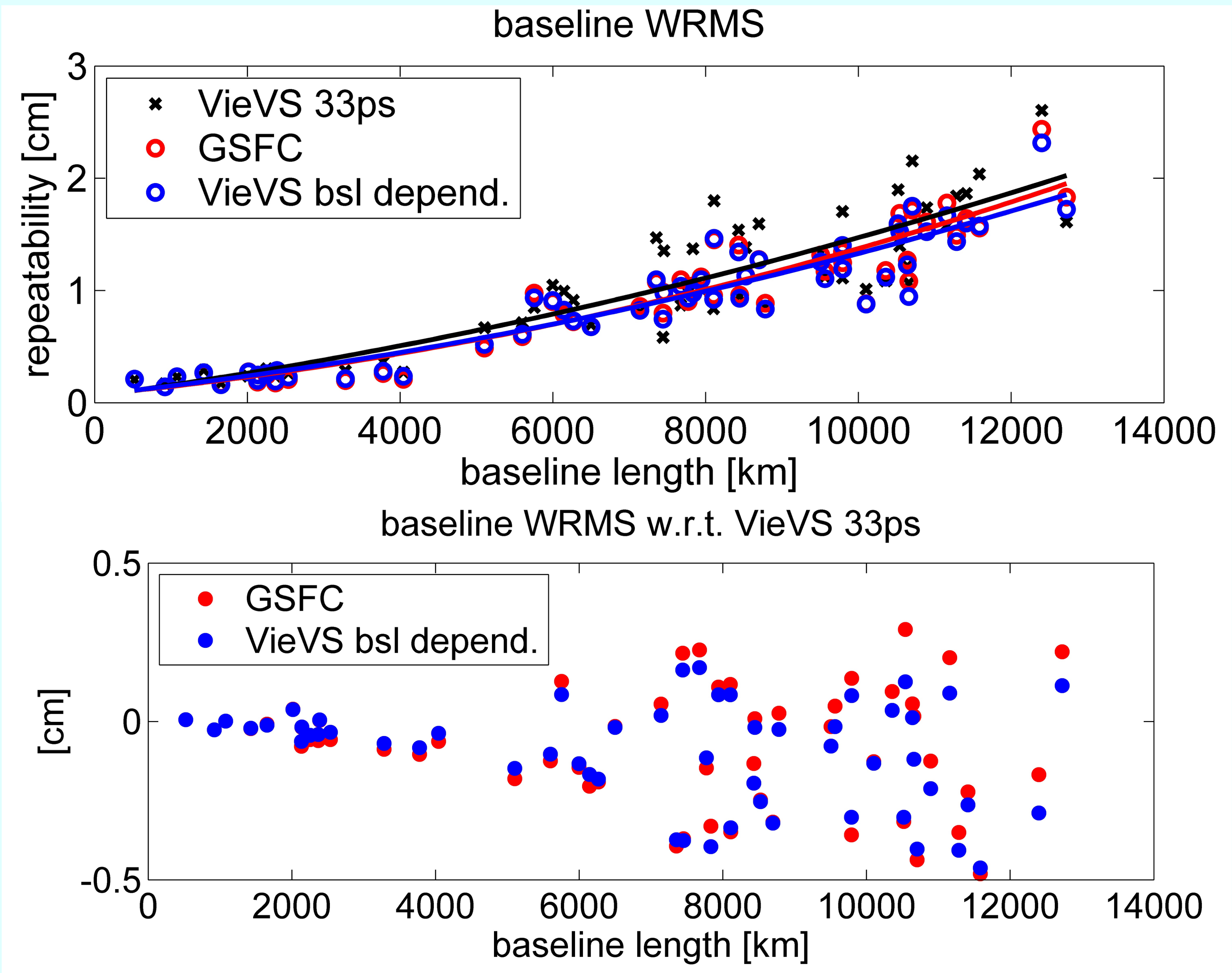

Figure 1. Baseline length repeatability and difference with respect to to VieVS using global weights.

The WRMS improved in 64% of the baselines when external weight files created by Solve were used, and in 71% of the baselines when VieVS used baseline dependent weights.

Table 1. Weighted Root Mean Square (WRMS) differences in microseconds between VieVS and Solve.

setup	WRMS: All INTs	WRMS: INT01s
default	8.84	7.38
baseline weights	7.14	5.18

One year (2012) of data from IVS intensive sessions was analyzed with VieVS and Solve (Uunila et al. 2015 (in preparation)). WRMS differences reduced from 8.84 to 7.14 microseconds in the case of Intensives solutions, and from 7.38 to 5.18 microseconds in the case of INT01 solutions (Kokee-Wettzell baseline), Table 1 and Figure 2.

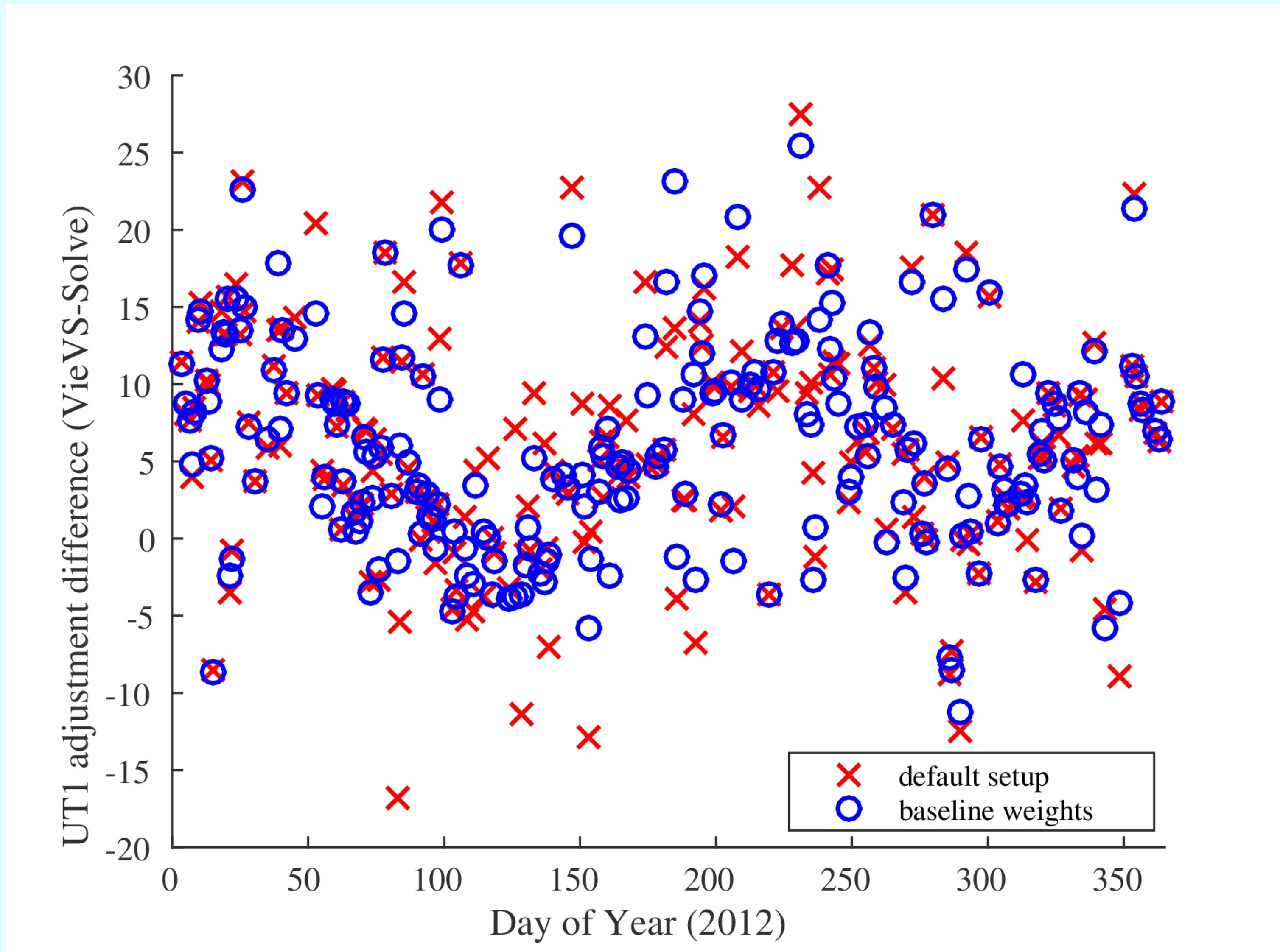

Figure 2. VieVS minus Solve UT1 adjustment in microseconds.

3. Conclusions

- The WRMS improved in 64% of the baselines, when we used weight files created with Solve. When we deployed baseline dependent weighting in VieVS, the WRMS reduced even more as 71% of the baselines showed improvement.
- UT1 WRMS difference between the two software packages reduced 19% for all Intensive sessions and 30% for INT01 sessions when baseline dependent weighting was deployed also in VieVS.
- In the future it would be worthwhile to add more iterations to the weighting process, and see its effect on the results.

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