VLBI Baseline Length Repeatability Tests of IVS-R1 and -R4 Session Types

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Abstract

Very Long Baseline Interferometry (VLBI) has reached centimeter precision for baseline lengths and station coordinates determined in a global terrestrial reference frame. However, future expectations are to improve the precision of these parameters to millimeter level. The baseline length and station coordinate repeatabilities are dependent on the precision of coordinate determination of earth-based stations, the amount of observables, and the lengths of the baselines, but also on the accuracy of models, e.g. the tropospheric delay model. There is a trade-off between smaller correlations of zenith delays, clocks and station heights when using low elevation observations on the one hand and mapping function errors, which become larger at low elevations on the other hand. In this study, the effects of baseline lengths and cut off elevation angles on the baseline length repeatabilities are investigated with the troposphere mapping functions NMF, GMF and VMF1. We also investigate different cut off elevation angles (between 3° and 30°) for low elevation observations of IVS-R1 and IVS-R4 sessions.

Results

To find out the baseline length repeatabilities of IVS-R1 and -R4 Sessions from 01/04/2002 (52278) to 06/29/2007 (54280) a linear function was fitted in a least-squares adjustment for each baseline. The RMS value of the residuals is considered as the baseline length repeatability. Because of the Denali Earthquake (03/11/2002), two regression functions were formed (before and after the Earthquake) for the baselines with station Gilcreek. Figures 1 and 2 show time series of two baselines included in R1- and R4-Sessions.

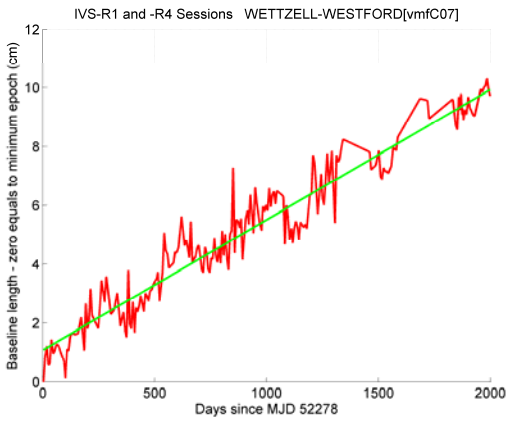

Figure 1. Time series of Wettzell – Westford baseline with VMF1 for cut off angle 7°

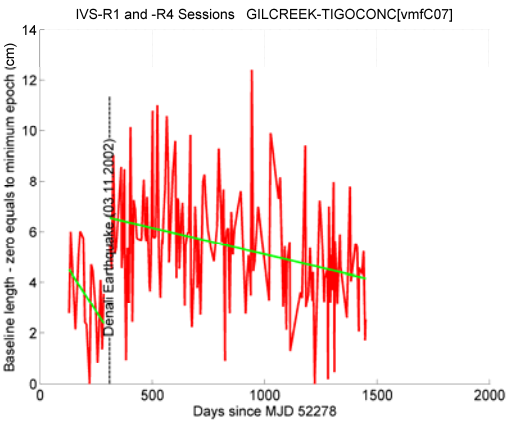

Figure 2. Time series of Gilcreek – Tigoconc baseline with VMF1 and cut off angle 7°

Results

Figures 3 and 4 show baseline length repeatabilities for baselines that are included in R1- and R4-Sessions. A quadratic polynomial was fitted to the repeatabilities (without linear term) [Niell 2006].

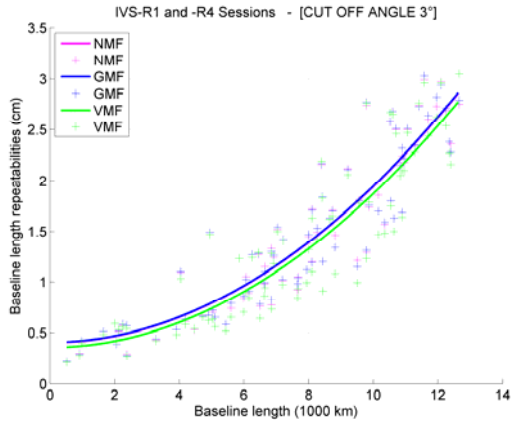

Figure 3. Baseline length repeatabilities with VMF1, GMF and NMF for the cut off angle 3°

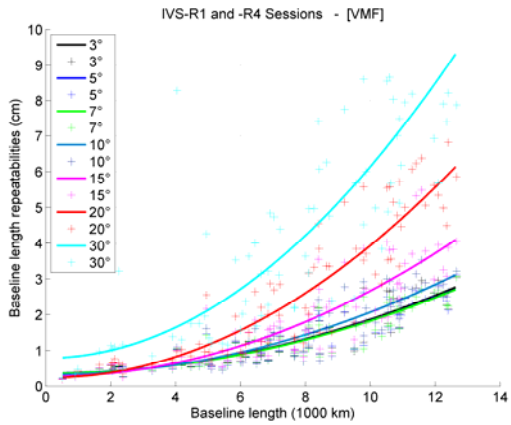

Figure 4. Baseline length repeatabilities with VMF1 for the cut off angles 3°, 5°, 7°,10°, 15°, 20°, and 30°

The mapping functions yielded similar baseline repeatabilities for cut off angles 3°, 5°, 7° and 10°, whereas from 15° onwards, the repeatabilities grew significantly. VMF1 gives the best repeatabilities in the interval [3° to 10°] with the lowest value at 7°. Above 10° all three mapping functions more or less yield the same repeatabilities.

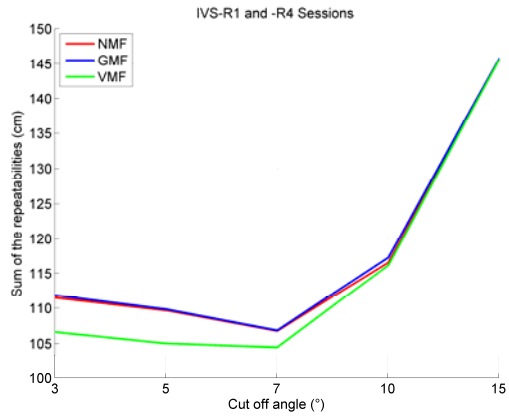

Figure 5. Sum of the baseline length repeatabilities provided by VMF1, GMF, and NMF for the cut off angle 3°, 5°, 7°,10°, 15°, 20°, and 30°

Figures 6 and 7 show the mean and median differences of baseline length repeatabilities between VMF1, GMF, and NMF. There is a clear improvement with VMF1 at low elevation angles.

Results

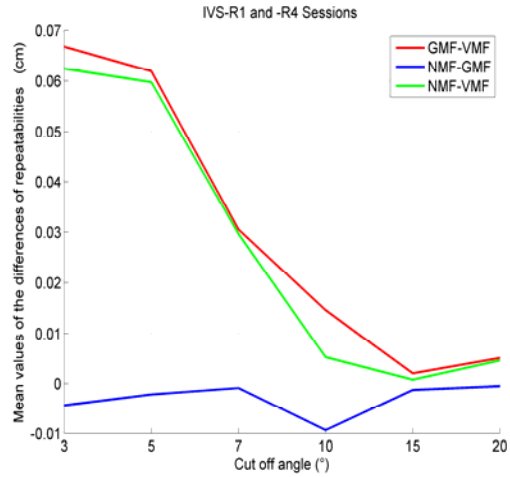

Figure 6. Mean differences of repeatabilities between VMF1, GMF and NMF for the cut off angles 3°, 5°, 7°,10°, 15°, 20°, and 30°

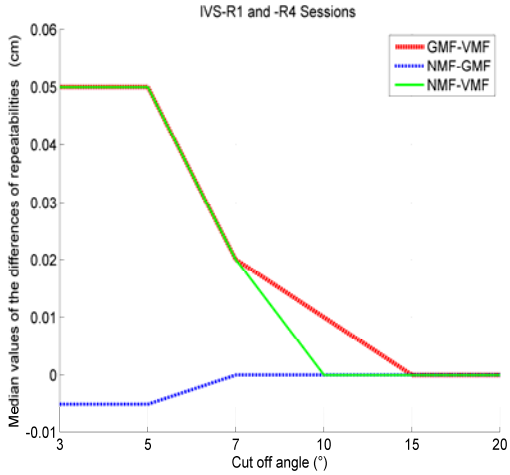

Figure 7. Median differences of repeatabilities between VMF1, GMF and NMF for the cut off angles 3°, 5°, 7°,10°, 15°, 20°, and 30°

Conclusions

From the investigations of R1- and R4-Sessions baseline repeatabilities for the mapping functions VMF1, GMF, and NMF and the cut off angles 3°, 5°, 7°, 10°, 15°, 20°, and 30° the following conclusions can be drawn:

•VMF1 gives the best repeatabilities for low cutoff elevation angles [3° to 10°].

•The repeatabilities are lowest with a cutoff elevation angle of 7°.

There is no significant difference in repeatabilities between NMF and GMF.

•For cutoff elevation angles larger than 10°, VMF1, NMF, and GMF yield the same baseline length repeatabilities.

Outlook and Future Work

- Elevation dependent downweighting
- Atmosphere loading
- Investigation of bias and annual signals

References

Niell, A:, 2006, Baseline Length Repeatability, Report, MIT Haystack Observatory.

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