Seventh VieVS User-Workshop

Discussions on optimized parameterization of VLBI auxiliary parameters in least-squares adjustment of VieVS software

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This work has been prepared with reference to work performed at Deutsche GeoForschungsZentrum (GFZ)-Potsdam during a research visit July-September 2013.


QUESTION? Presented optimization ideas for VieVS software should be inserted on official VieVS Software??

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WHAT WAS PERFORMED?

- The study investigated and presented three different approaches for achieving optimum parameterizations of the auxiliary parameters per station for each session.

- Optimization ideas presented in the work concentrated on:
  - determining the interval lengths and the optimal size of the constraints of the various auxiliary parameter groups to certain fixed number of observations at each estimation interval per station,
  - considering gaps and the time dependent variation of the parameters over certain interval(s).

- The impact of the different size of the constraints and the interval lengths for various auxiliary parameter on various VLBI solutions analyzed with the Vienna VLBI Software (VieVS) was assessed by descriptive statistics.
INTRODUCTION

VLBI solutions require

- a considerable number of auxiliary parameters (zenith wet delay (zwd), clock, and north (ngr) and east (egr) gradients) for optimally modeling the atmosphere and clock behavior.

Current version of VieVS uses

- a piece-wise linear representation of these parameters with a default temporal resolution of 60 minutes.
Approach 1

Using a solution interval w.r.t. time dependent behavior of parameters

- if the time dependent variation of a parameter over certain interval(s) is relatively small, then the estimation interval can be increased.
- if the variation is relatively large, the estimation interval can be decreased to better represent the behavior of this specific parameter.
Time dependent variations of clock estimation of station GILCREEK at Session 02NOV05
Time dependent variations of ngr estimation of station FORTLEZA at Session 00FEB03

Estimate more than 1 parameter!!
Time dependent variations of zwd estimation of station SVETLOE at Session 08AUG24 (CONT08)
Approach 2

Define no parameter inside a data gap.

- Such a parameter is only based on the constraint and is likely to degrade the solution (the non-singularity of the equation system is ensured by the constraint).
- In case of a data gap, the method considers the data in two subsets, one before and one after the gap.

Time difference of greater or equal 45 minutes between successive observations at a station as a data gap!!
Differences of sequential observation times at station OHIGGINS at Session 00FEB03
Differences of sequential observation times at station KOKEE at Session 02NOV05
Differences of sequential observation times at station WETTZELL at session 08AUG24 (CONT08)
Investigates flexible length of time intervals depending on a certain number of observations.

it is possible to obtain an equal partial redundancy for each auxiliary parameter, i.e. each parameter is determined by the same number of observations.
Number of observation used in estimation of zwd (60 min. intervals) and clock (60 min. intervals)
Number of observation used in estimation of gradients (360 min. intervals) at Session 02NOV05.
The total number of observations supporting an auxiliary parameter will vary if the auxiliary parameter time intervals are defined as equally spaced by the standard parameterization.

Because the parameterization is identical for ZWD and clk as well as for NGR and EGR, only the number of observations used to estimate clk and NGR parameters are displayed at a variety of VLBI stations during session 02NOV05.
Tanır Kayıkçı, et al 2015 shows that

- approach2 and approach3 provide results better than the standard approach (currently used parameterization in VieVS software) for VLBI single session analysis with the least squares solution of VieVS.
## Results of Approach3

<table>
<thead>
<tr>
<th>Parameterization</th>
<th>Number of obs. at each interval</th>
<th>Chi-square of overall solution</th>
<th>Used relative constraints (cm)</th>
</tr>
</thead>
</table>
| par.1            | 10-20 for ZWD and clock 40-50 for gradients | 2.0031                         | ZWD: 1.086  
                          |                                 | Clock: 0.942  
                          |                                 | Gradients: 0.030 |
| par.2            | 5-10 for ZWD and clock 40-50 for gradients | 0.5180                         | ZWD: 0.791  
                          |                                 | Clock: 0.686  
                          |                                 | Gradients: 0.030 |
| par.3            | 5-10 for ZWD and clock 50-60 for gradients | 0.5254                         | ZWD: 0.791  
                          |                                 | Clock: 0.686  
                          |                                 | Gradients: 0.033 |
| par.4            | 10-20 for ZWD and clock 60-70 for gradients | 2.1640                         | ZWD: 1.086  
                          |                                 | Clock: 0.942  
                          |                                 | Gradients: 0.037 |
| par.5            | 5-10 for ZWD and clock 20-30 for gradients | 0.5017                         | ZWD: 0.791  
                          |                                 | Clock: 0.686  
                          |                                 | Gradients: 0.021 |
| **current used option (default)** | changes in each interval | 4.0623                         | ZWD: 1.5  
                          |                                 | Clock: 1.3  
                          |                                 | Gradients: 0.05 |
Results of Approach3

- Table shows that using more parameters for ZWD/clock/gradients results in a smaller chi-square.

- In this session, one of the stations has a huge diurnal clock variation. The significant improvement of chi-square of the overall solution is likely due to better modeling of such a behavior with higher time resolution. For other sessions, the improvement may not be as large as for this session.