

Global adjustment of VLBI sessions using VieVS

1 Description

This exercise gives an introduction to combination of normal equation systems (NEQ) in a global solution using VIE_GLOB module of the Vienna VLBI and Satellite Software (VieVS). In the following, selected sessions from the so-called CONT17 campaign (continuous VLBI observations organized by the International VLBI Service for Geodesy and Astrometry) will be analyzed.

2 Your task

Your task is to analyze the first five sessions of the CONT17 from the IVS network (i.e., Nov 28 - Dec 02, 2017).

In the global adjustment, estimate all five Earth orientation parameters with daily resolution, a TRF (station positions) and a CRF (radio source positions).

2.1 CONT17

To get a general idea about the CONT17 campaign you can go to the IVS homepage

<https://ivscc.gsfc.nasa.gov/program/cont17/> where all the information is stored.

Normally, the geodetic VLBI technique observes only two to four 24-hour experiments every week, and the participating stations change between the sessions. Occasionally, however, special efforts are made to have CONTinuous VLBI observations over two weeks using a constant station network; the so-called CONT campaigns. The most recent CONT campaign is the CONT17 campaign, which was observed from November 28 until December 12, 2017.

3 Before you start

- It is assumed that you have VieVS available on your computer. The most recent version of VieVS is available on GitHub. It can be cloned and pulled using Git or simply downloaded as ZIP:

<https://github.com/TUW-VieVS/VLBI> and <https://github.com/TUW-VieVS/COMMON>

The VLBI repository and(!) the COMMON repository have to be in the same directory. If your main directory is called 'VieVS' for example, your folder structure should look like this:

VieVS/COMMON/

VieVS/VLBI/

This repository contains more or less only the program code. The data files necessary for processing have to be downloaded from external sources.

- VieVS V4.0 offers the download, renaming and storing of EOP, VMF3 and NTAL/VIE automatically in the welcome panel. For this exercise you need to download the data for year 2017. Alternatively, you can download the data manually:

- Earth orientation parameters. You can download the EOP from:

<https://datacenter.iers.org/data/234/eopc04.20.1962-now.txt> and store it as C04_20_1962_now.txt in *VieVS/VLBI/EOP/*

- Troposphere delay models
Mapping functions VMF3 can be retrieved from
http://vmf.geo.tuwien.ac.at/trop_products/VLBI/VMF3/VMF3_OP/yearly/
Choose the yearly file 2017 and store it in *VieVS/VLBI/TRP/VMF3/*
Gradients are available from
http://vmf.geo.tuwien.ac.at/trop_products/VLBI/GRAD/GRAD_OP/yearly/
Choose the yearly file 2017 and store it in *VieVS/VLBI/TRP/GRAD/*
Atmosphere non-tidal loading: yearly files are available from
http://vmf.geo.tuwien.ac.at/APL_products/VLBI/yearly/
Store the y2017.apl.r in *VieVS/VLBI/NTSL/NTAL/VIE/* as *vie_y2017.ntal.r* !!!

- Download of the VLBI experiments (observation data)
The observation data (c1701-c1705), i.e. the group delays, can be downloaded in the form of vgosDB files session-wise from e.g. <https://cddis.nasa.gov> and have to be stored in *VieVS/VLBI/DATA/vgosDB/2017/*.

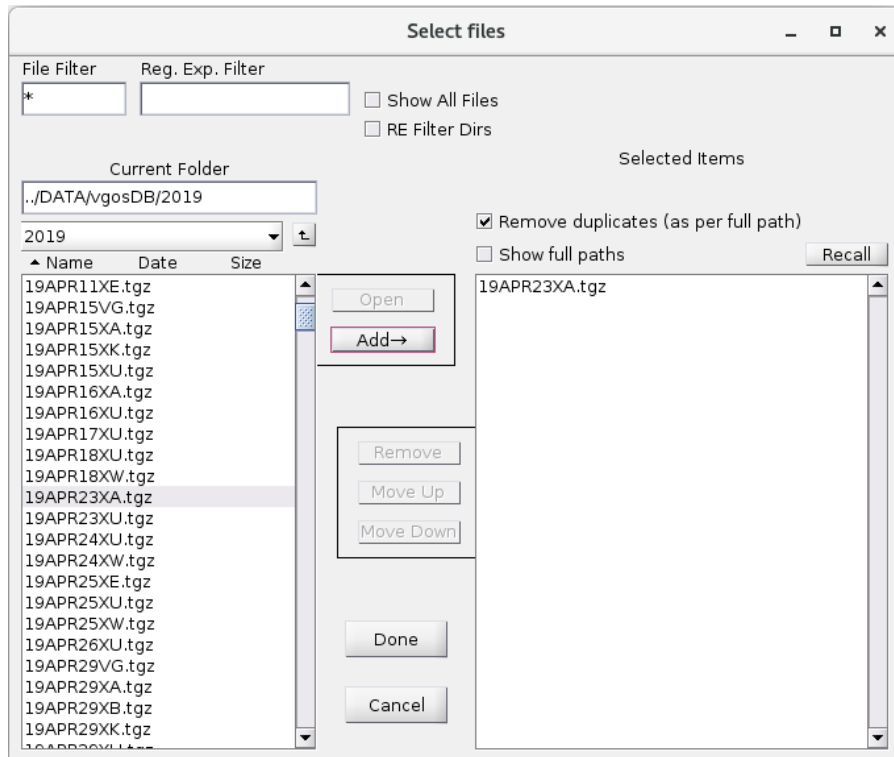
4 Starting VieVS

- start MATLAB
- browse to your VieVS working directory *VieVS/VLBI/WORK/*
- type “*views*” in the MATLAB command window

now VieVS should open.

5 Select input files

Select the input vgosDB file in “*File/Set input files/Browse for VGOS-DB*”. Add the five sessions c1701-c1705 from the **2017** folder. If it is listed under *Selected Items* click “*Done*”.



Now the databases should be listed in the “*Process list*”.

Check the “*Use OPT files*” checkbox and select a folder with your OPT files. An OPT file is a text file that lists some additional parametrization of the session like clock breaks or stations, sources, and baselines that you want to remove.

6 Look at Estimation settings

Select the menu “*Estimation/Least squares/**” and define parameters which should be estimated.

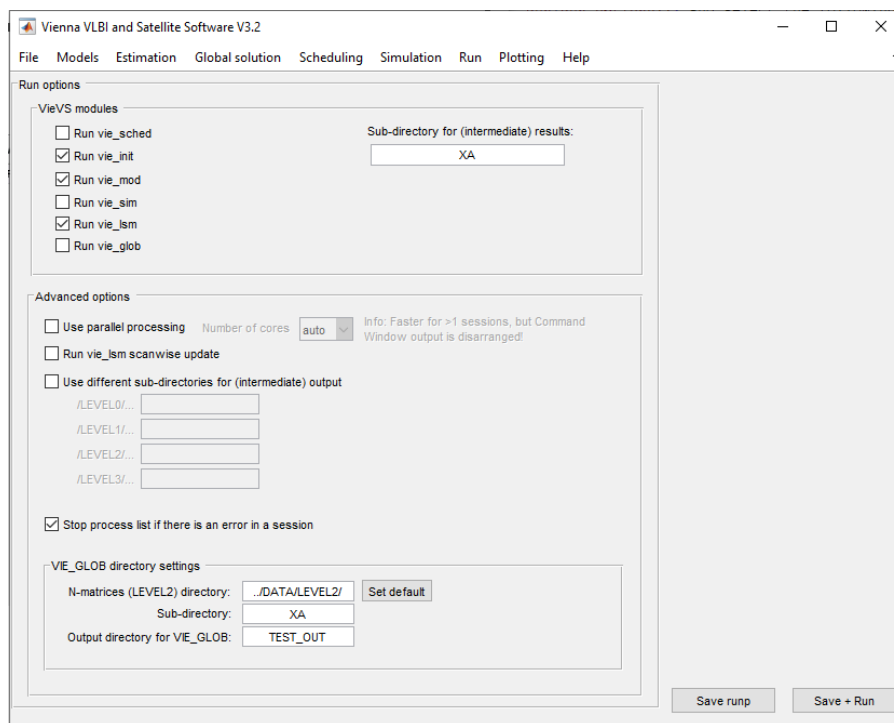
- What do we estimate?
- How often do we estimate parameters?
- How are they constrained?

7 Compute theoretical delay and estimate parameters from single-sessions

Click on the menu “*Run/Run options*” and select the following VieVS modules:

- VIE_INIT
- VIE_MOD
- VIE_LSM

Choose a new **sub-directory name** for (intermediate) results like *c17* and press “*Save + Run*”.



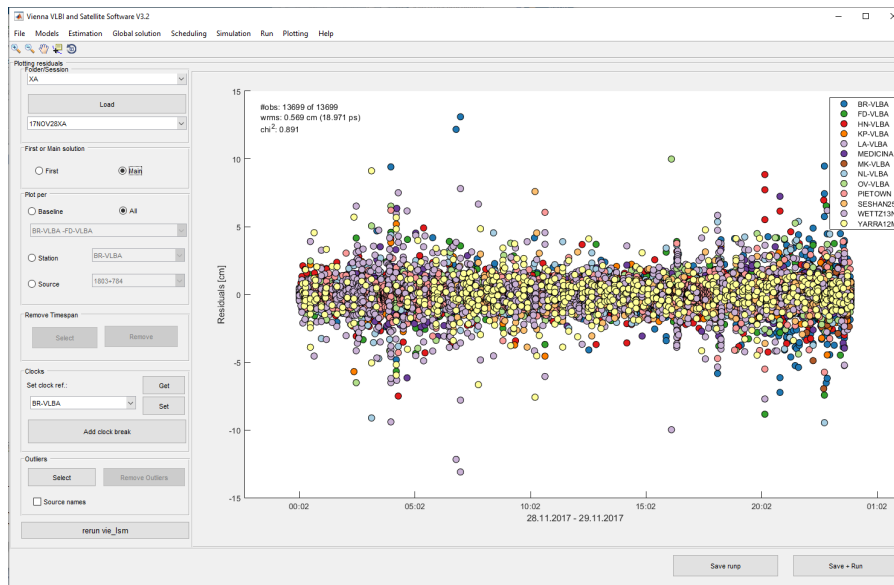
The theoretical delay and partial derivatives are saved during VIE_MOD, therefore you can **deselect** **vie_init** and **vie_mod** for improved performance during the upcoming runs.

8 Look for problems in the single session adjustment

Browse to “*Plotting/Residuals*” and select your previously defined directory name from the combo box at the top left and load your session.

Have a look at the residuals of your observations. You can switch between the first and the main solution and filter for stations, sources, and baselines. Ideally, the residuals should look normally distributed around 0 and the χ^2 should be close to 1. χ^2 indicates how well your model fits your

observations. The WRMS of your post-fit residuals should be around 30 ps for a typical S/X legacy 24-hour session.



Check the results from the individual single session adjustments to identify problems and try to fix them by putting the needed special parametrization in the OPT file of the particular session. You have to check each session and create an OPT file where the special needs will be defined.

9 Create and save datum-free NEQs for each session

In “*Estimation/Global parameters/**” click the “*Prepare N_global and b_global for global solution*” button. This means, that the datum-free normal equations will be saved in addition (*../DATA/LEVEL2/*), for further processing in VIE_GLOB. Run VIE_LSM again.

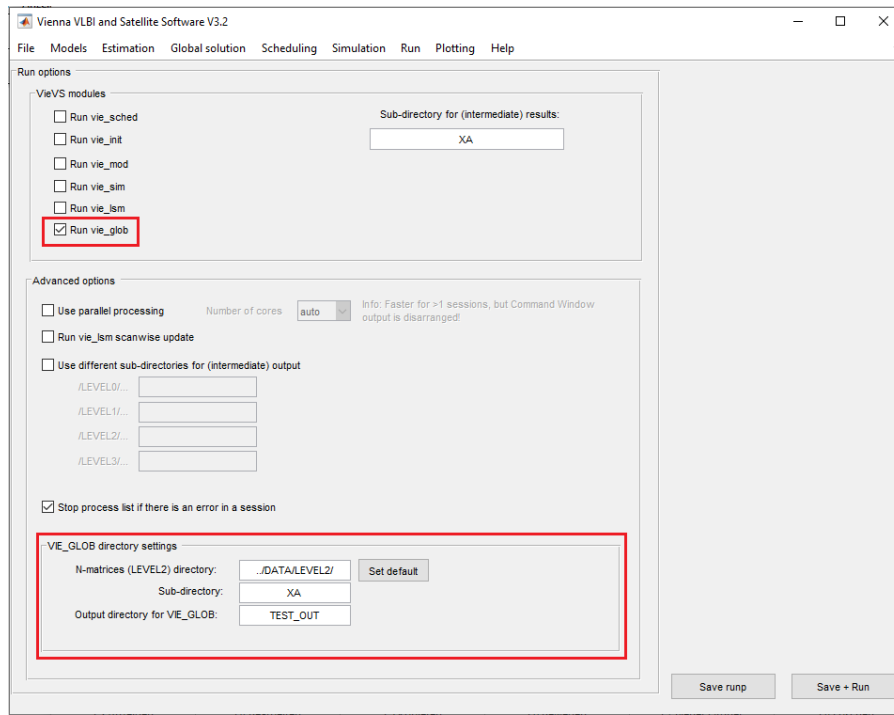
10 Global Solution

In a global solution, the datum-free normal equations from single sessions are added together and one common least square adjustment is carried out.

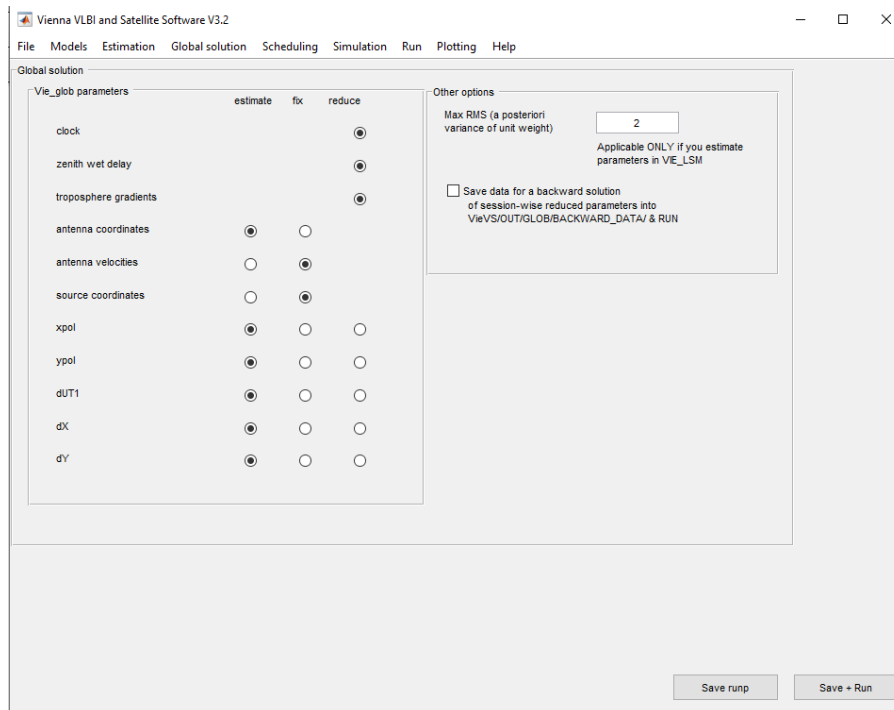
Click on the menu “*Run/Run options*” and select the following VieVS module:

■ VIE_GLOB

In the lower part of the window, there are settings for VIE_GLOB. Write the name of the sub-directory where you saved the (intermediate) results for the “c17” sessions.



In “*Global solution/Select parameters*” switch the button “*estimate*” for antenna coordinates, source coordinates and all five EOP. Antenna velocity has to be fixed to a priori values.



In “*Global solution/TRF/CRF parameterization*” you can define telescopes at which the NNT/NNR condition will be applied, and radio sources for the NNR condition. You have to prepare a text file with names of the stations (in one column), e.g., “*datum_c17.txt*” and store it in “*VieVS/VLBI/DATA/GLOB/TRF/DATUM/*”. Similarly, a text file with radio source IERS names have to be prepared and stored in “*VieVS/VLBI/DATA/GLOB/CRF/DATUM/*”. Press “*Save + Run*”. The results from the global solution are saved in “*VieVS/VLBI/OUT/GLOB/*”

- additions to a priori values in “*../OUT/GLOB/_ESTIMATES/*”
- absolute station positions in “*../OUT/GLOB/TRF/*”
- absolute radio source positions in “*../OUT/GLOB/CRF/*”