Single Session Analysis using VieVS

1 Description

This exercise will give a short introduction to the possibilities to analyze VLBI observations using the Vienna VLBI and Satellite Software (VieVS). In the following the IVS session R1891 will be analyzed. To get a general idea about the session you can go to the IVS homepage "https://ivscc.gsfc.nasa.gov/sessions/" where all the information about sessions run by the IVS is stored.

2 Before you start

- download VieVS from https://github.com/TUW-VieVS

3 Starting VieVS

- start MATLAB
- browse to your VieVS working directory *VieVS/VLBI/VLBI/WORK/*
- type *"vievs"* in the MATLAB command window

now VieVS should open

4 Select input files

Select the input vgosDB file in *"File/Browse for VGOS-DB"*. Add the **19APR23XA** (IVS-R1891) vgosDB file from the **2019** folder. If it is listed under *Selected Items* click *"Done"*.
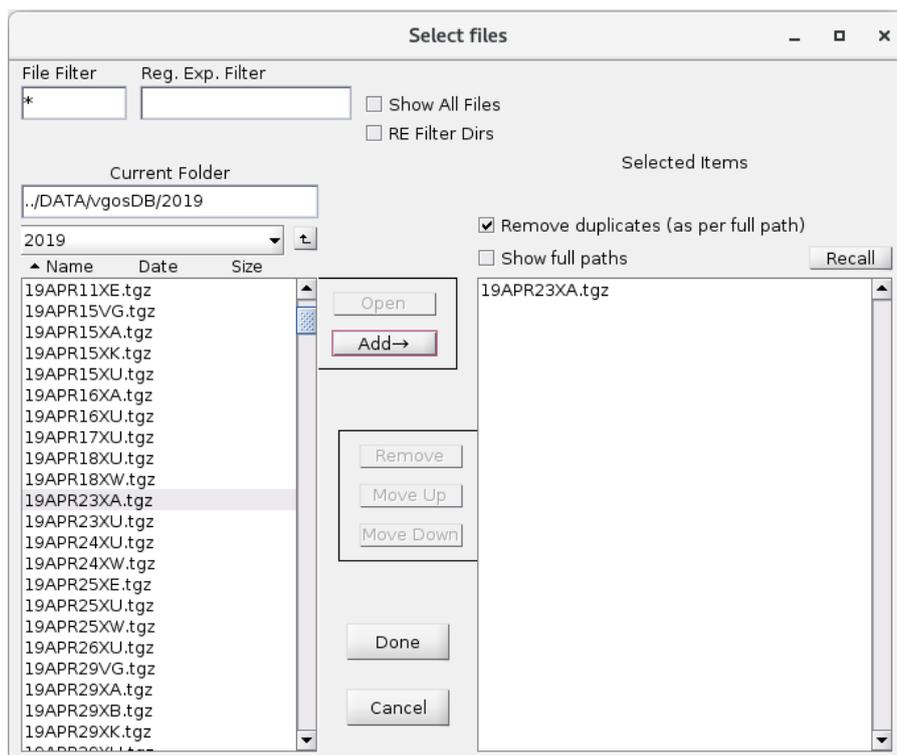
Now the file should be listed in the *"Process list"*.
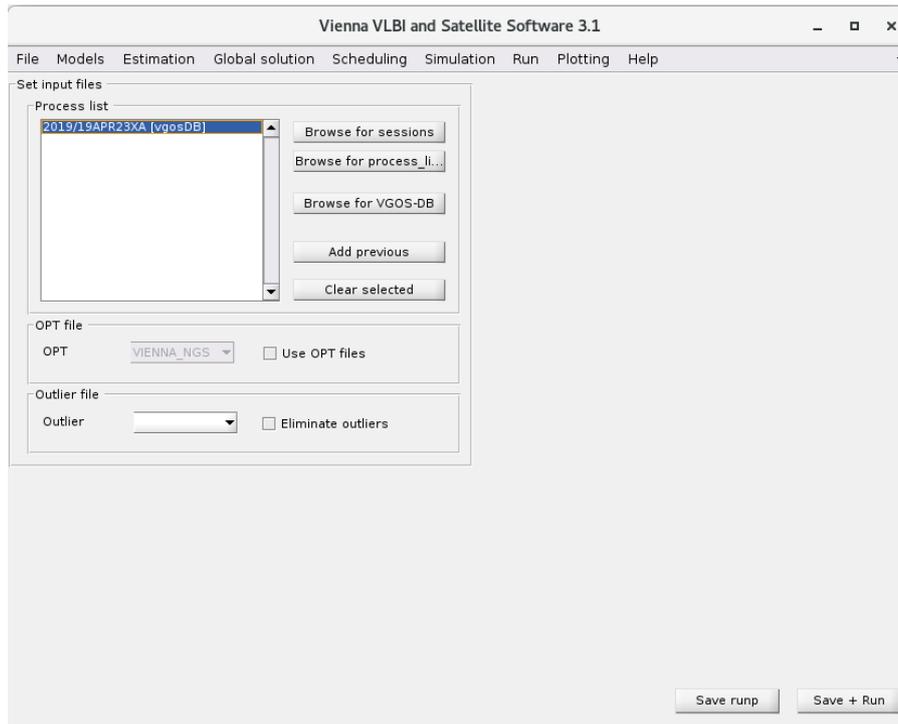
Check the *"Use OPT files"* checkbox and select the *"VIENNA_VGOSDB"* folder. Right-click the session name from the process list and select *"Open/Create OPT file"*. A OPT file is a text file which lists some additional information about the analysis of the session like clock breaks or stations, sources, and baselines which should be excluded.

It is likely that you need the OPT file later. You can close it for now.

5 Look at Estimation settings

Select the menu *"Estimation/Least squares/*"* and look at the parameters which should be estimated.

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

6 Compute theoretical delay and estimate parameters

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

- VIE_INIT
- VIE_MOD
- VIE_LMS

Choose a new **sub-directory name** for (intermediate) results like *R1891* and press *"Save + Run"*.
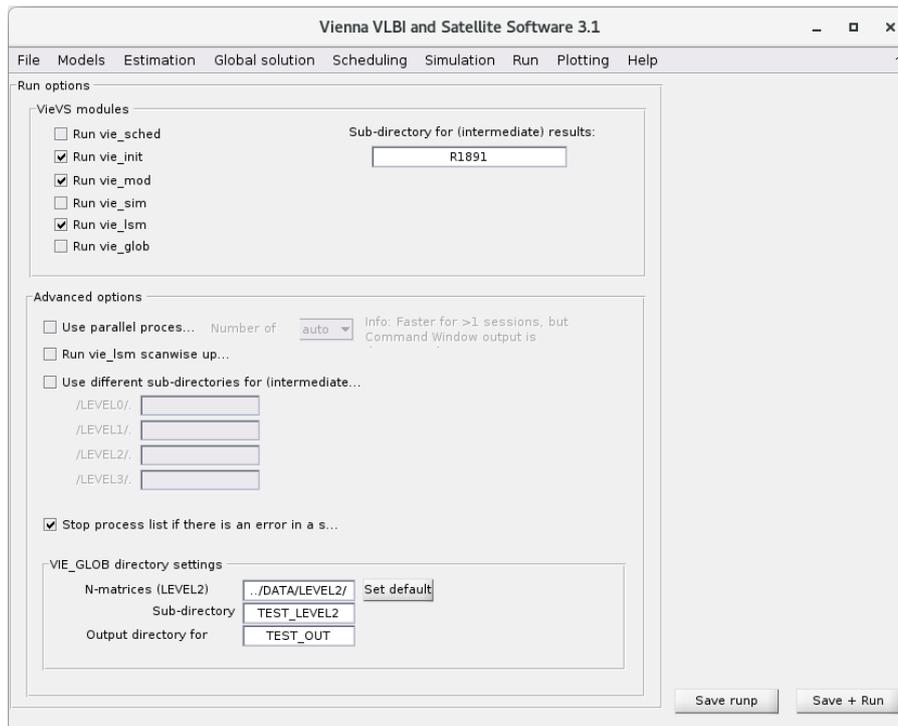
The theoretical delay is saved during VIE_MOD and you can **deselect vie_init and vie_mod** for improved performance during the upcoming runs.

7 Look for clock breaks and other issues

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 chi^2 should be close to 1. chi^2 indicates how well your model fits your observations. The WRMS of your post-fit residuals should be around 30 ps for a typical R1 or R4 session.

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- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
chi-squared of main solution vTPv/degOfFreedom: 1.347
WRMS of post-fit residuals sqrt(v_realTPv_real/sumOfWeights): 0.889 cm (29.641 ps)
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
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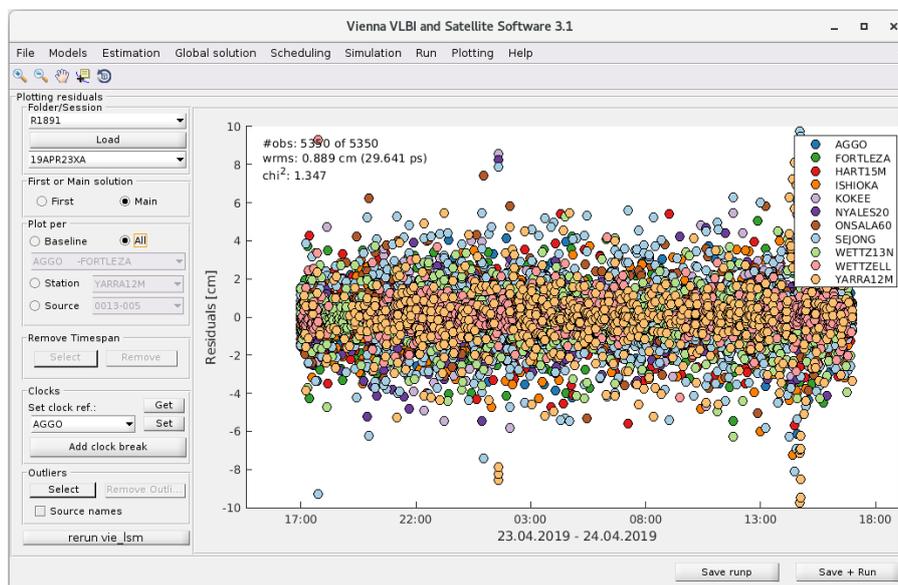
It is necessary to look for **clock breaks**. Clock breaks can be found easiest while filtering for station wise residuals and looking at the first solution. The first solution approximates the clock only as one offset, one rate and one quadratic term (no PWLO are calculated which would follow the clock break behaviour and would therefore mask it in the residuals). If you have a **jump in the residuals** like in the following image it is most likely due to a clock break.
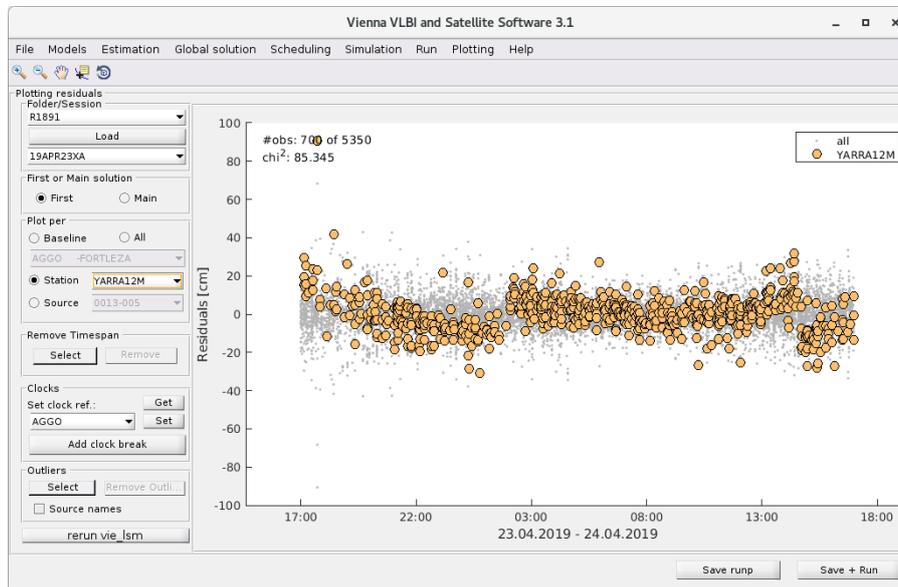
To remove a clock break change the **zoom in** in order to see the jump nicely. Click the *"Add clock break"* button. Your mouse pointer should now change to a crosshair. **Click between the residual jump** and confirm that you want to add a clock break there. It doesn't matter where exactly you click as long as it is in between the residual jump.

The clock break should now be listed in your OPT file. Make sure you selected *"use OPT files"* at *"File/Set input files"* and click *"Save + Run"* again to run another least squares adjustment with the additional clock break. After the process is finished you have to load the result in the *Plotting/Residuals* window again. Check if the clock break is now gone.

Repeat these steps as long as you do not see any clock breaks in your session. In this case are 2 clock breaks at the station Yarragadee. (**Hint:** It might be wise to double check again)

Hint:

If you messed your session up somehow you can always manually remove clock breaks again by looking at the OPT file and deleting the corresponding line. Do not forget to change the clock break counter from the header. If you messed up completely delete the whole OPT file. You can find the OPT file in the directory *VieVS/VLBI_OPT/*.

8 Remove outliers

Check the residuals again at *'Plotting/Residuals'"* and check if there are any obvious outliers. If you do not see any consider yourself lucky and relax. If there are outliers it is necessary to remove them. Removing outliers is a two-step process. Click on the menu *"Run/VieVS estimation settings"* and check *"simple outlier test c*m0"*.
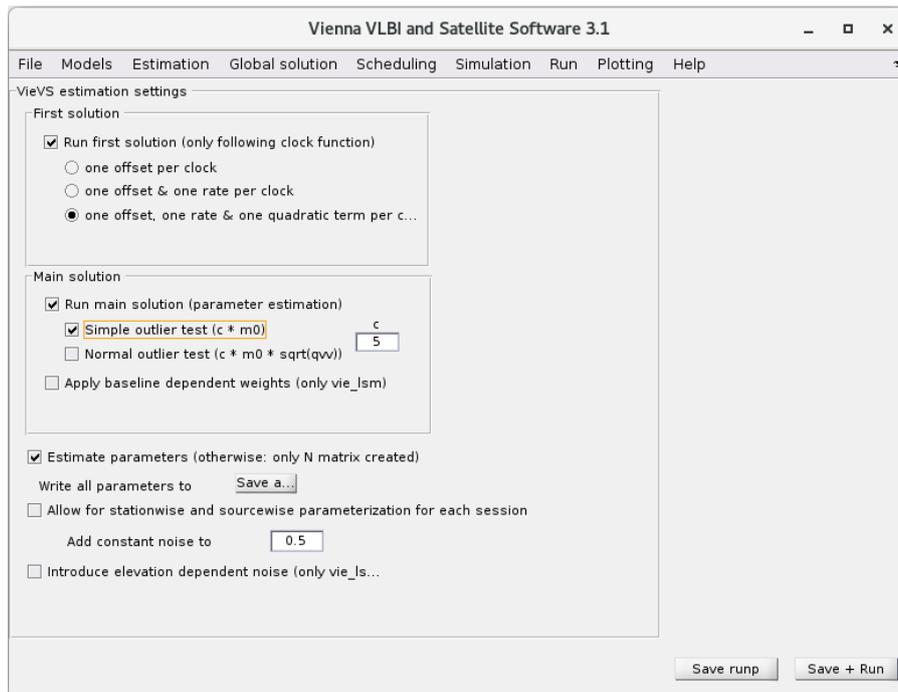
Press *"Save + Run"* to rerun the least squares adjustment. This time outliers are marked and an outlier list is saved. Have a look at the selected outliers through the *"Plotting/Residuals"* menu. You have to load the result again. Outliers are now marked with a black cross.

You need to rerun the least squares adjustment but this time eliminate the previously marked outliers. Therefore deselect the *"simple outlier test c*m0"* checkbox at *"Run/VieVS estimation settings"* again. At *"File/Set input files"* check the *"Eliminate outliers"* checkbox.
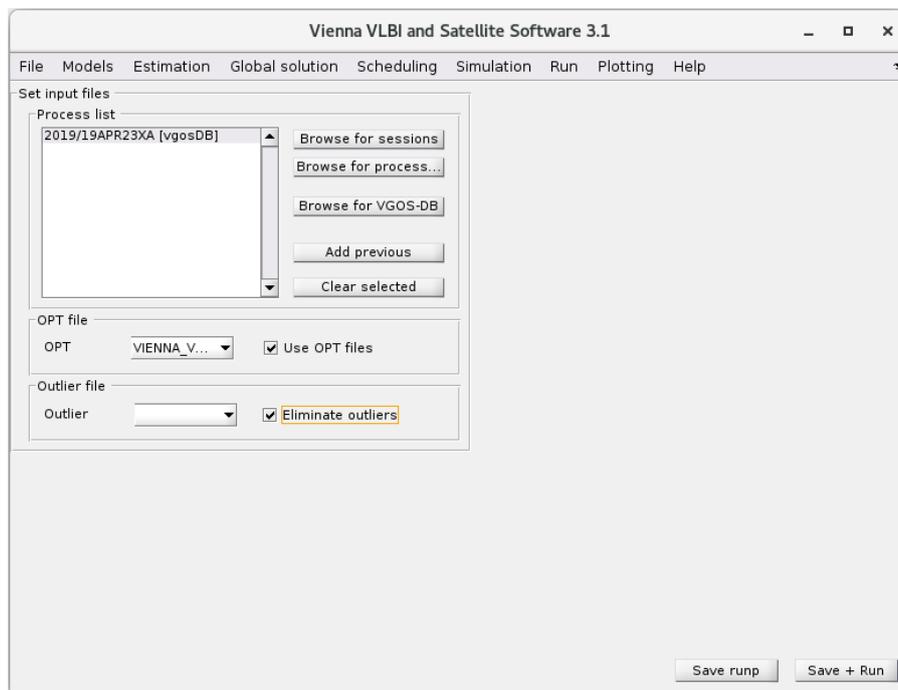
9 Output

9.1 estimated parameters

The estimated parameters can be viewed at *"Plotting/Parameters"*. Select your previously defined directory name from the combo box at the top left and load your session.
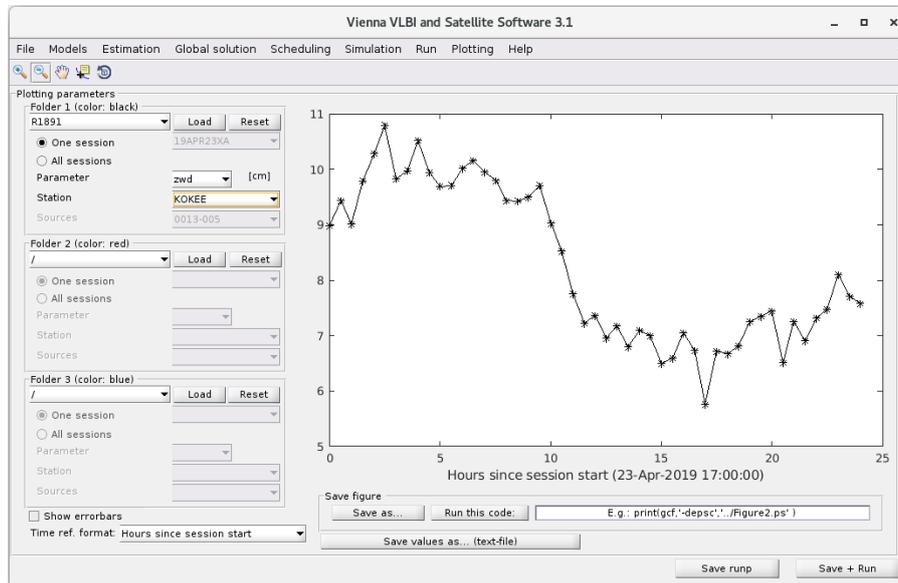
For some parameters we are more interested in the **accuracy** of the parameter instead of the **estimate**. You can add the errorbars by checking the *"Show errorbar"* checkbox at the bottom left. You can switch between different parameters. The values can be **saved in a text file** using the *"Save values as... (text file)"* button. Do not forget that this are just additions to a priori values! (Especially when looking at station coordinates.) The text file is saved in *"'VieVS/VLBI/VLBI/OUT/"*.

9.2 Data stored in MATLAB structure

For easier access to the estimated values and accuracies have a look at the *VieVS/VLBI/VLBI/DATA/LEVEL3/...* directory. There you should find the *"x_*"* MATLAB structure which contains all estimates. You can simply load it with MATLAB and do some further analysis.

9.3 SINEX file

SINEX is a standard output format for geodetic parameters. If you want to write these textfiles, go to *Run/Sinex output* and tick the checkbox *write SINEX file*. Here you can select the parameters to be included in the SINEX file by switching the radio buttons. Note, that the SINEX file could become very large when all parameters are written to the SINEX file. Now, you need to rerun the session to create the SINEX file. The file can be found in the directory *VieVS/VLBI/DATA/SNX*.