VGOS Session Analysis

Overview

We will analyze the VGOS session VGOS-T9035 (vgosDB: 19FEB04VG) and solve the datum defect in two different ways and then compare the results.
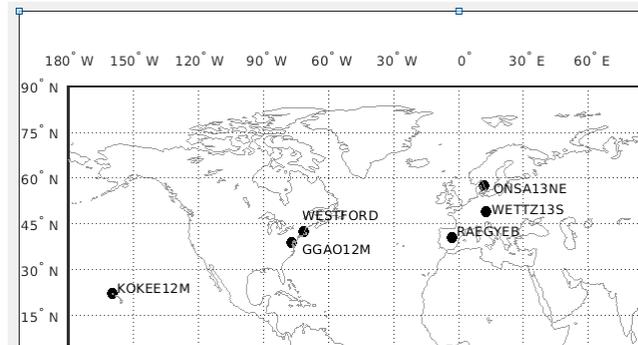
Session

VGOS-T9035
vgosDB: 19FEB04VG
6 Stations: K2, Wf, Gs, Oe, Ws, Yj
24h VGOS session

First analysis

Process the session as a single session solution. For this go to "File → Set input files" and there click on "Browse for vgosDB" in order to add the corresponding file. Although not necessary in this case, you can use OPT-files with VGOS sessions just as with regular sessions.

For this first run the default parametrization can be used. However, make sure to go to "Run → Run options" and choose a name for the sub-directory. You can also deactivate the outlier test. After these changes you can start the processing with "Save and Run".

Pay attention to the command window output. Matlab warns us, that the normal-equation matrix is singular. That means that the LSM can't be executed properly and we get NaN (not a number) values for the Chi² and the WRMS of the postfit residuals.

```
Warning: Matrix is singular to working precision.
> In vie lsm (line 1086)
  In vie batch (line 452)
  In vie setup>pushbutton run Callback (line 4175)
  In gui mainfcn (line 95)
  In vie setup (line 146)
  In matlab.graphics.internal.figfile.FigFile/read>@(hObject,eventdata)vie setup('pushbuttor
```

The problem

Why does this happen? The problem is that our geodetic datum isn't defined. VieVs uses so called No-Net-Rotation (NNR) and No-Net-Translation (NNT) conditions on the datum defining stations in order to define the TRF. This allows for all station coordinates to be estimated while still defining the datum. The NNT says that the sum of all corrections of the station positions in each direction has to be zero. NNR does the same for rotation. Since VLBI measurements define the scale of our datum, six DOF remain which are accounted for with the NNT and NNR. In order for this to work at least three stations need to be in the datum. However, only Westford (Wf) has coordinates in the ITRF2014 reference frame, which is selected in VieVs by default.

Solution 1

An easy fix is to tell VieVs to use all stations in the NNT and NNR conditions regardless if they have coordinates in the selected reference frame. If a station has no coordinates in the specific frame the vievsTRF coordinates are used. These coordinates serve as a backup when no others exist, because even when a station can't help define the datum, its position is needed in order to calculate the

theoretical delays for the LSM. However, the quality of these coordinates varies quite a bit and is generally worse than for example the ones in the ITRF2014.

Go to "Estimation → Least squares → Station coordinates" and select "All stations".
Since we only changed something concerning the LSM (we changed something in the "Estimation" tab) it is enough to just rerun vie_lsm. To do this go to "Run → Run options", deselect all modules except vie_lsm and start VieVs by pressing "Save + Run".

Solution 2

The other possibility is to select the vievsTRF directly as the reference frame. In order to do this go to "Models → Reference frame" and select the vievsTRF in the dropdown menu. Also go to "Estimate → Least squares → Station coordinates" again and select "TRF stations". Since we want to be able to compare the results of the two solutions afterwards change the subdirectory in "Run → Run options". Since we changed something about the models for the theoretical delays as well as the subdirectory we have to rerun vie_init and vie_mod. Simply press "Save and Run" in order to do this.

You will notice that the N matrix is singular again. This is because there is a flag in the vievsTRF that tells VieVs whether to include a station in the NNR and NNT conditions. In the current standard Superstation file only Westford (Wf) has this flag set to true.

In order to overcome this issue please change the Superstation file to the provided one. For this go to "Models → Reference frames", click "Select file" in the TRF section and browse for the provided file. This altered Superstation file has improved coordinates for Ws from local surveying and for Gs, K2 and Yj from a global solution of 5 VGOS Sessions from CONT17.

Don't forget to change the TRS to vievsTRF after loading the file since the selection gets reset upon loading the file. With these settings you can rerun VieVs (we changed the models again so we need to rerun everything again) by clicking "Save + Run".

Solution 3 (not shown)

It would be also possible to load a custom TRF as a .txt file in "Models → Reference frames" "from txt file". Such a file could for example be the result of a global solution or contain coordinates from different sources such as local surveying.

Comparison

The two solutions have the same Chi² so does the datum definition matter after all? In order to compare the results go to "Plotting → Parameters" and load the different subfolders you chose for the two different solutions. Go ahead and compare the parameters of the different results.

You will find that the estimates for the clocks are offset from one another while the estimates for the troposphere as well as the gradients are the same. More importantly the corrections for the station coordinates are estimated differently. The corrections for all stations are smaller in the second solution. The only exception to this is Oe which is the only station not participating in the NNR/NNT conditions in the second solution. This station has quite bad coordinates in the vievsTRF and skews the TRF in the first solution. Wf is especially interesting. It has good coordinates but the correction in the y-direction for example is -14cm in the first solution while it is almost zero for the second one.

The EOP are the link between the TRF and CRF. Since the TRF gets defined differently depending on the datum definition the EOP "compensate" for change and are estimated differently as well. Therefore the datum definition has a big impact on the estimated parameters and better station coordinates for VGOS-stations are needed.