## Simulation exercise

We will simulate one session (15FEB27) and calculate expected baseline length repeatabilities using different assumptions of measurement noise and tropospheric turbulence.

In a second exercise we will produce zero-input files for ten AUSTRAL sessions and investigate the effects of the solid Earth tides.

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## Example 1: Simulate the expected measurement precision

1. In the VieVS GUI, select the session you want to simulate (15FEB27XA)

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| File   | Models                       | Estimation             | Global solution | Scheduling                            | Simulation                         | Run | Plotting | Help |           |           |
|--------|------------------------------|------------------------|-----------------|---------------------------------------|------------------------------------|-----|----------|------|-----------|-----------|
| Set in | put files                    |                        |                 |                                       |                                    |     |          |      |           |           |
| P      | ocess list                   |                        |                 |                                       |                                    |     |          |      |           |           |
|        | 2015/15FEB<br>PT file        | 27XA_N004<br>Y DEFAULT |                 | Browse for<br>Browse for p<br>Add pro | sessions<br>rocess_lists<br>evious |     |          |      |           |           |
| 0      | utlier file<br>Dutlier direc | tory                   | ✓ □ EI          | iminate outliers                      |                                    |     |          |      |           |           |
|        |                              |                        |                 |                                       |                                    |     |          |      |           |           |
|        |                              |                        |                 |                                       |                                    |     |          |      |           |           |
|        |                              |                        |                 |                                       |                                    |     |          |      |           |           |
|        |                              |                        |                 |                                       |                                    |     |          |      |           |           |
|        |                              |                        |                 |                                       |                                    |     |          |      | Save runp | Save + Ru |

- 2. In the panel "Models Observation restrictions" set the quality code limit to 10. Select the start of the session in the "Session start" panel
- 3. Go to the panel "Simulation".
  - a. Run simulations using a predefined parameter file (austr\_turb50ps.DAT)
    - i. Simulate 10 days
    - ii. Remember the starting index you set (e.g. 50).
    - iii. Then go to step 4.

| in taka                  |   |  |
|--------------------------|---|--|
| mulation                 | Simulation parameters   |  |
| Slant wet delay          | From parameter file     austr. turb50ps.DAT   |  |
|                          | cont05_turb_04.dat  |  |
| White poise              | O Specify now:  |  |
| Source Structure         | <b>v</b>  |  |
|                          | Troposphere   |  |
|                          | Cn [1e-7 m <sup>6</sup> -1/3] 0.5 H [m] 2000 ve [m/s] 8 dh [m] 200  |  |
| to be simulated          | wzd0 [mm] 150 vn [m/s] 0 dhseg [h] 2  |  |
| starting index of 50     | Clock   |  |
| simulated NGS files      | ASD 1e-14 @ 50 min  |  |
| set reference clock to 0 |   |  |
| write ngs file           | White noise   |  |
|                          | wn [ps] 0.01  |  |
|                          |   |  |
|                          | Source Structure  |  |
|                          | Catalan Cat |  |
|                          | cataby  |  |
|                          |   |  |
|                          |   |  |
|                          | Save SIM parameters   |  |
|                          |   |  |
|                          |   |  |

- b. Run simulations using specified parameters
  - i. Choose low troposphere turbulence (e.g. 0.5)
  - ii. Choose lower noise (e.g. 30 ps)
  - iii. For all other values, use the default settings.
  - iv. Choose a different starting index (e.g. 30)

| nulation  |   |  |
|---|---|--|
| What to simulate Vhat to simulate Slant wet delay Clock White noise Source Structure unber of days tarting index of simulated NGS files set reference clock to 0 V write ngs file | Simulation parameters         Interference           From parameter file         Interference           © Specify now:         Interference           Troposphere         Interference           Cn [1e-7 m^-1/3]         0.5         H [m]         2000         ve [m/s]         8         dh [m]         200           wzd0 [mm]         150         vn [m/s]         0         dhseg [h]         2           Clock         ASD         te-14         50         min           White noise         wn [ps]         30 |  |
|   | Source Structure<br>Catalog<br>Save SM parameters   |  |

- 4. Go to the panel "Run"
  - a. Un-tick the box vie\_lsm
  - b. Tick the box vie\_sim
  - c. Choose a sub-folder (e.g. sim\_50, sim\_30 etc)
  - d. Run the simulation by clicking "Save+Run". Do this for both sets of simulations.
  - e. You now have simulated NGS files in /DATA/SIM/subfolder/year/session

|  | olution Schedulir                        | ng Simulation Run Plotting Help           |  |
|--|--|---|--|
| options  |  |   |  |
| VieVS modules  |  |   |  |
| Run vie_sched  |  | Sub-directory for (intermediate) results: |  |
| Run vie_init   |  | sim                                       |  |
| Run vie_mod  |  |   |  |
| 🗹 Run vie_sim  |  |   |  |
| Run vie_lsm  |  |   |  |
| Run vie_glob   |  |   |  |
| Advanted and set   |  |   |  |
|  |  | the construction of the construction      |  |
| Use parallel processing Number   | r of cores auto 🖂                        | Window output is disarranged              |  |
| Run vie_lsm scanwise update  |  |   |  |
| Use different sub-directories for (  | intermediate) output                     |   |  |
| /LEVEL0/   |  |   |  |
| /LEVEL1/   |  |   |  |
| /LEVELO/   |  |   |  |
| The bar When had a factor of the second seco |  |   |  |
| /LEVEL3/   |  |   |  |
| /LEVEL3/   |  |   |  |
| ✓ Stop process list if there is an error   | or in a session                          |   |  |
| ALEVELS/   | or in a session                          |   |  |
| ALEVELS //     Stop process list if there is an error     VE_GLOB directory settings   | or in a session                          |   |  |
| ALEVELS/      Stop process list if there is an error      VE_GLOB directory settings      N-matrices (LEVEL2) directory:   | or in a session                          | Set default                               |  |
| AEVEL3/<br>✓ Stop process list if there is an error<br>✓ VE_GLOB directory settings<br>N-matrices (LEVEL2) directory:<br>Sub-directory:  | ./DATA/LEVEL2/<br>TEST_LEVEL2            | Set default                               |  |
| AEVEL3/<br>AEVEL3/<br>✓ Stop process list if there is an error<br>VE_GLOB directory settings<br>N-matrices (LEVEL2) directory:<br>Sub-directory:<br>Output directory for VE_GLOB:  | JDATA/LEVEL2/<br>TEST_LEVEL2<br>TEST_OUT | Set default                               |  |
| AEVEL3/.<br>AEVEL3/<br>✓ Stop process list if there is an error<br>VE_GLOB directory settings<br>N-matrices (LEVEL2) directory:<br>Sub-directory:<br>Output directory for VE_GLOB:   | JDATA/LEVEL2/<br>TEST_LEVEL2<br>TEST_OUT | Set default                               |  |

- 5. Process the sessions
  - a. Go to the panel "File" and choose your simulated sessions. Since by default VieVS directs you to the DATA/NGS directory, you need to go one level up to the DATA/SIM directory. ATTENTION: run your two sets of sessions separately, using different subfolders.
  - b. In the panel "Run", tick the boxes vie\_init, vie\_mod, vie\_lsm. Choose different subdirectories for your two sets of simulations (e.g. simrun50, simrun30).
  - c. Run the simulated sessions. You can use parallel processing to speed things up a bit.

6. Results.

- a. For illustrating the results, we use the plotting tool in "Plotting Session analysis"
- b. Comparing the two simulations, we find the second option delivering a bit too optimistic results while the first one showing sensible values for baseline length repeatabilities, close to the results we get from real AUSTRAL data.



## Example 2: Zero-input files

- 1. In the VieVS GUI, select the sessions you want to simulate.
  - a. We want to simulate 10 AUSTRAL sessions of 2014. They can be loaded via the process list "sim\_zero\_austr".
- 2. In "Simulations" choose your parameters as follows:
  - a. Untick "Slant wet delay" and "Clock". "White noise" remains ticked.
  - b. Change the number of days to 1.
  - c. Choose a specific number for the NGS file counter (e.g. 77).
  - d. In order to avoid a program crash (e.g. by dividing with 0), it is advisable to simulate a tiny noise (e.g. 0.01 ps).

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|---|---|--|
| What to simulate  | Simulation parameters   |  |
| Slant wet delay   | From parameter file     auptin turb/50pg/DAT     cont05_turb_04.dat     cont011_turb_04.dat |  |
| White noise   | Specify now:  |  |
| Source Structure  | Troposphere   |  |
|   | Cn [1e-7 m^-1/3] 0.5 H [m] 2000 ve [m/s] 8 dh [m] 200                                       |  |
| o be simulated  | wzd0 [mm] 150 vn [m/s] 0 dhseg [h] 2  |  |
| starting index of 77 imulated NGS files 77 set reference clock to 0 | Clock<br>ASD 1e-14 @ 50 min   |  |
| 🗹 write ngs file  | White noise           wn [ps]         0.01  |  |
|   | Source Structure Catalog  |  |
|   | Save SIM parameters   |  |
|   |   |  |

- 3. You can then simulate the sessions.
  - a. Remember to set the right options in "Run".
  - b. Tick "vie\_init", "vie\_mod", "vie\_sim".
  - c. Also choose a subdirectory.
- 4. After simulation, you can analyse the sessions.
  - a. Select the simulated sessions in "File".
- 5. Run a test zero simulation.

- a. To test whether you use the identical settings run one session.
- b. The residuals should then be at the same level that you chose your noise in 2.d (e.g. 0.01 ps).
- 6. In a next step, you can change one of your modelling settings and investigate its effect on the results.
  - a. E.g. you can deselect the solid Earth tides in "Models Station models".
  - b. Then analyse the sessions. (in "Run" untick "vie\_sim" and tick "vie\_lsm").
  - c. You can then investigate the effects in
    - i. Plotting residuals
    - ii. Plotting parameters (coorx, coory, coorz)
    - iii. Plotting session analysis baseline repeatabilities.