



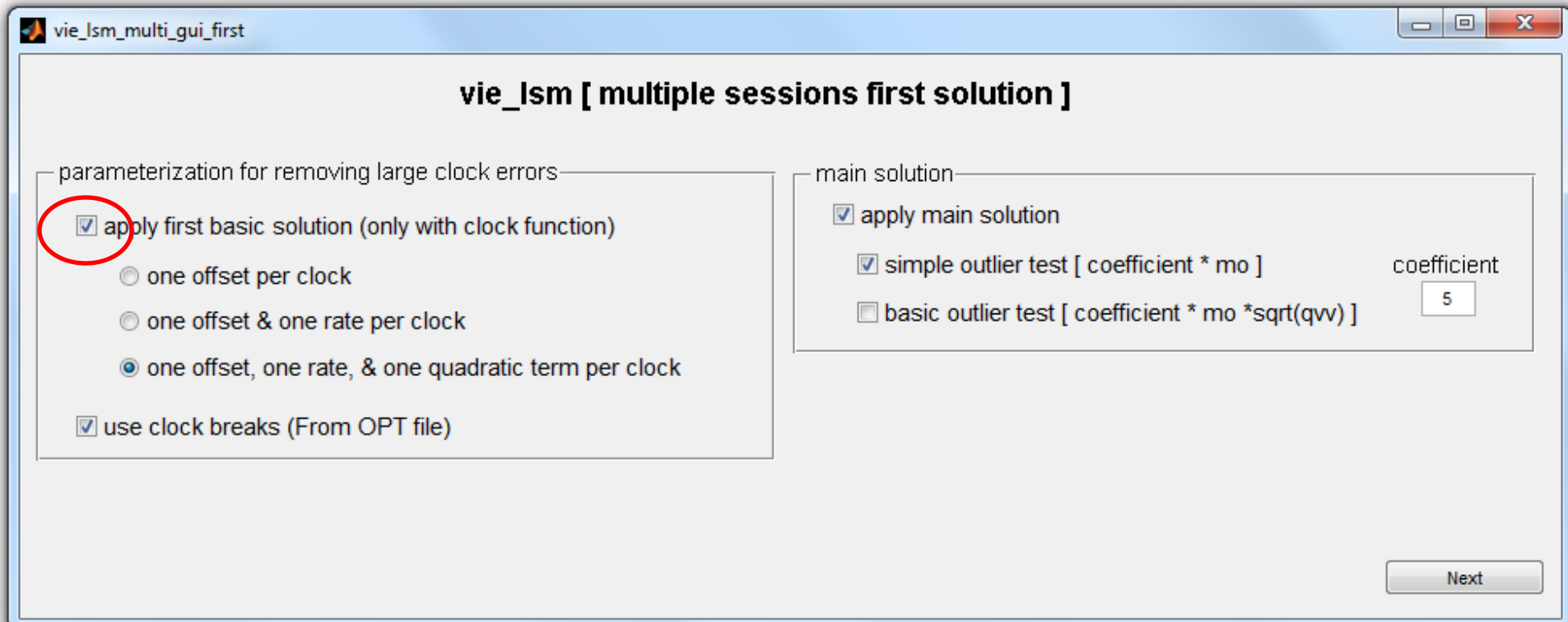
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Vie_LSM

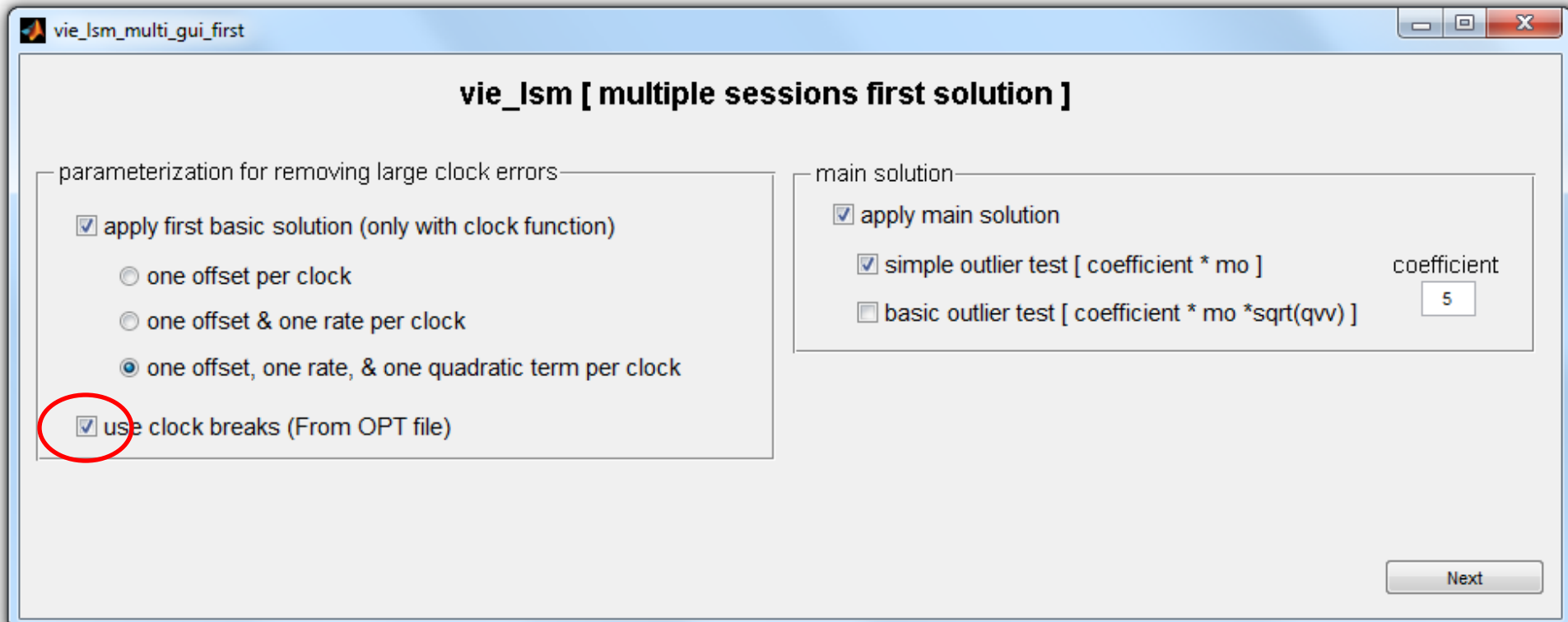
Kamil Teke and Johannes Böhm

VieVS User Workshop
7 - 9 September, 2010
Vienna



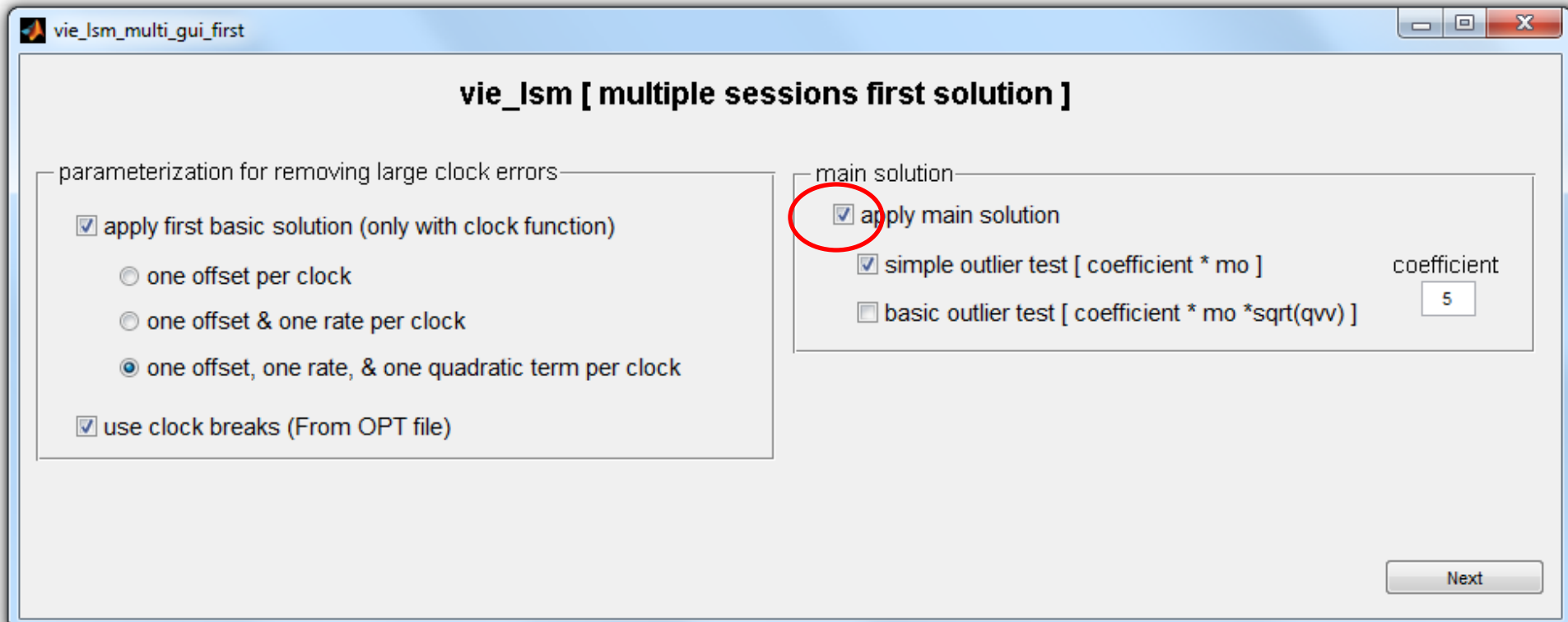


The first solution is meant to remove large clock offsets (and rates and quadratic terms) for numerical reasons. (Clock offsets can be several kilometers.) Together with the clocks, also constant zenith delays per station are estimated, but these tropospheric delays are not removed from the observations.



Information about clock breaks is read from the OPT files if available. At the epoch of a clock break, a new quadratic function is started. Clock breaks are only considered in the first solution.

If 'apply main solution' is not ticked, then the station-wise residuals from the first solution will be plotted. These plots are important to locate clock breaks.



If ticked, the main solution with piecewise linear clock offsets will be estimated.

If an outlier test is chosen, the outliers will be written into an ascii file in the DATA/OUTLIER directory. The outliers will not be removed during this VieVS solution but can be used for later use with vie_init!

vie_lsm [multiple sessions clocks]

parameterization for clocks

- estimate clocks
 - piecewise linear (pwl) offsets per clock
 - pwl offsets & one rate per clock
 - pwl offsets, one rate, & one quadratic term per clock
- introduce relative constraints between pwl clock offsets

clock constraints	clock interval
0.5000	60

- Reference clocks specified in OPT files.
- unit of clock estimation intervals is minute.
- unit of clock constraints is $\text{picosec}^2/\text{sec}$.
- 0.1 $\text{picosec}^2/\text{sec}$ is loose constraint for clock estimation.

Back

Next

In addition to the piecewise linear clocks, also a rate and a quadratic term can be estimated for the whole session. The reference epoch for the quadratic clock function is at the epoch of the first piecewise linear clock offset.

vie_lsm [multiple sessions clocks]

parameterization for clocks

- estimate clocks
- piecewise linear (pwl) offsets per clock
 - pwl offsets & one rate per clock
 - pwl offsets, one rate, & one quadratic term per clock
- introduce relative constraints between pwl clock offsets

clock constraints	clock interval
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- Reference clocks specified in OPT files.
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Back

Next

This combination adds relative constraints on the clock offsets. Actually, observation equations are added to the design matrix which tell that the difference between two adjacent piecewise linear clock offsets is zero \pm a certain standard deviation σ . (These constraints are mainly important to bridge gaps without observations to avoid singularity of the normal equation system.)

vie_lsm [multiple sessions clocks]

parameterization for clocks

- estimate clocks
- piecewise linear (pwl) offsets per clock
 - pwl offsets & one rate per clock
 - pwl offsets, one rate, & one quadratic term per clock
- introduce relative constraints between pwl clock offsets

clock constraints	clock interval
0.5000	60

- Reference clocks specified in OPT files.
- unit of clock estimation intervals is minute.
- unit of clock constraints is $\text{picosec}^2/\text{sec}$.
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Back

Next

How to interpret this constraint of $0.5 \text{ ps}^2/\text{s}$?

Our time interval between piecewise linear offsets is 60 minutes, i.e. we have a variance of 1800 ps^2 after one hour. This standard deviation of 42 ps is the standard deviation σ which is used for the observation equation.

vie_lsm_multi_gui_tropo

vie_lsm [multi sessions troposphere]

apply relative constraints between tropospheric offset estimates

- introduce REALTIVE CONSTRAINTS between pwl ZENITH WET DELAY offsets
- introduce RELATIVE CONSTRAINTS between pwl tropo. NORTH GRADIENT offsets
- introduce RELATIVE CONSTRAINTS between pwl tropo. EAST GRADIENT offsets
- introduce ABSOLUTE CONSTRAINTS between pwl tropo. NORTH GRADIENT offsets
- introduce ABSOLUTE CONSTRAINTS between pwl tropo. EAST GRADIENT offsets

- all units of estimation intervals are minutes
 - units of ZWD constraints are picosec^2/sec (0.7 is loose)
 - units of NGR & EGR relative constraints are millimeters/day e.g. 2 mm/day (relative) is loose
 - units of NGR & EGR absolute constraints are millimeters e.g. 1 mm (absolute) is loose

ZWD constr.	NGR rel. constr.	EGR rel. constr.	NGR abs. constr.	EGR abs. constr.	ZWD int.	NGR int.	EGR int.	est. ZWD	est. NGR	est. EGR
0.7000	2	2	1	1	30	360	360	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

These ticks define whether zenith wet delays, north gradients and east gradients are estimated.

vie_lsm_multi_gui_tropo

vie_lsm [multi sessions troposphere]

apply relative constraints between tropospheric offset estimates

- introduce REALTIVE CONSTRAINTS between pwl ZENITH WET DELAY offsets
- introduce RELATIVE CONSTRAINTS between pwl tropo. NORTH GRADIENT offsets
- introduce RELATIVE CONSTRAINTS between pwl tropo. EAST GRADIENT offsets
- introduce ABSOLUTE CONSTRAINTS between pwl tropo. NORTH GRADIENT offsets
- introduce ABSOLUTE CONSTRAINTS between pwl tropo. EAST GRADIENT offsets

- all units of estimation intervals are minutes
 - units of ZWD constraints are picosec^2/sec (0.7 is loose)
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ZWD constr.	NGR rel. constr.	EGR rel. constr.	NGR abs. constr.	EGR abs. constr.	ZWD int.	NGR int.	EGR int.	est. ZWD	est. NGR	est. EGR
0.7000	2	2	1	1	30	360	360	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

These are the corresponding time intervals in minutes.

vie_lsm_multi_gui_tropo

vie_lsm [multi sessions troposphere]

apply relative constraints between tropospheric offset estimates

- introduce REALTIVE CONSTRAINTS between pwl ZENITH WET DELAY offsets
- introduce RELATIVE CONSTRAINTS between pwl tropo. NORTH GRADIENT offsets
- introduce RELATIVE CONSTRAINTS between pwl tropo. EAST GRADIENT offsets
- introduce ABSOLUTE CONSTRAINTS between pwl tropo. NORTH GRADIENT offsets
- introduce ABSOLUTE CONSTRAINTS between pwl tropo. EAST GRADIENT offsets

- all units of estimation intervals are minutes
 - units of ZWD constraints are picosec^2/sec (0.7 is loose)
 - units of NGR & EGR relative constraints are millimeters/day e.g. 2 mm/day (relative) is loose
 - units of NGR & EGR absolute constraints are millimeters e.g. 1 mm (absolute) is loose

ZWD constr.	NGR rel. constr.	EGR rel. constr.	NGR abs. constr.	EGR abs. constr.	ZWD int.	NGR int.	EGR int.	est. ZWD	est. NGR	est. EGR
0.7000	2	2	1	1	30	360	360	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Back Next

How to interpret this constraint of $0.7 \text{ ps}^2/\text{s}$ for the zenith wet delays? (This is similar to the clocks.)

Our time interval between piecewise linear offsets is 30 minutes, i.e. we have a variance of 1260 ps^2 after one hour. This is a standard deviation of 35 ps. 35 ps is the standard deviation σ , which is used for the observation equation.

vie_lsm_multi_gui_tropo

vie_lsm [multi sessions troposphere]

apply relative constraints between tropospheric offset estimates

- introduce REALTIVE CONSTRAINTS between pwl ZENITH WET DELAY offsets
- introduce RELATIVE CONSTRAINTS between pwl tropo. NORTH GRADIENT offsets
- introduce RELATIVE CONSTRAINTS between pwl tropo. EAST GRADIENT offsets
- introduce ABSOLUTE CONSTRAINTS between pwl tropo. NORTH GRADIENT offsets
- introduce ABSOLUTE CONSTRAINTS between pwl tropo. EAST GRADIENT offsets

- all units of estimation intervals are minutes
 - units of ZWD constraints are picosec^2/sec (0.7 is loose)
 - units of NGR & EGR relative constraints are millimeters/day e.g. 2 mm/day (relative) is loose
 - units of NGR & EGR absolute constraints are millimeters e.g. 1 mm (absolute) is loose

ZWD constr.	NGR rel. constr.	EGR rel. constr.	NGR abs. constr.	EGR abs. constr.	ZWD int.	NGR int.	EGR int.	est. ZWD	est. NGR	est. EGR
0.7000	2	2	1	1	30	360	360	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

How to interpret these constraints of 2 mm/day for the gradients?

Caveat! Unlike clocks and zenith wet delays, these relative constraints scale linearly, i.e. 2 mm/day correspond to 0.5 mm after 6 hours (360 minutes). 0.5 mm is used as standard deviation.

(Please mind that 2 mm/day corresponds to 0.007 mm after 5 minutes. This constraint is too strong for VLBI2010 simulations with rapid gradients every 5 minutes.)

vie_lsm_multi_gui_tropo

vie_lsm [multi sessions troposphere]

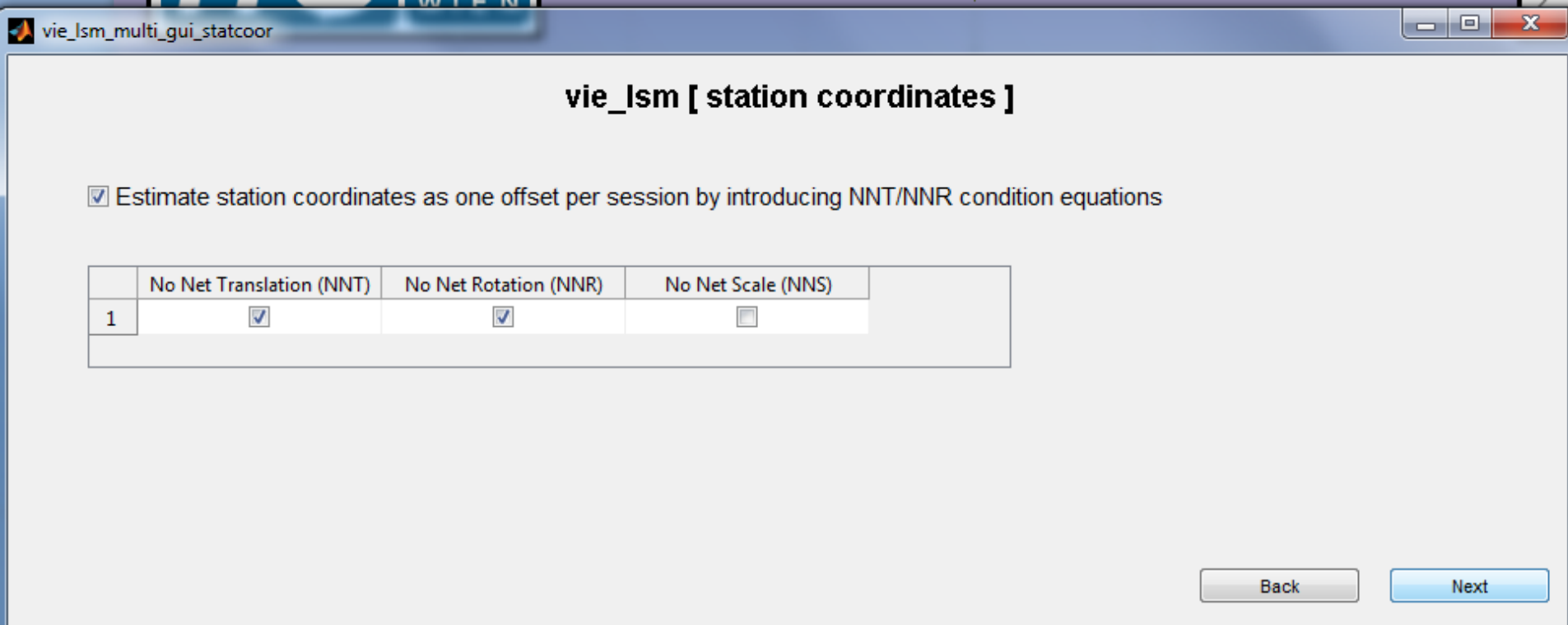
apply relative constraints between tropospheric offset estimates

- introduce REALTIVE CONSTRAINTS between pwl ZENITH WET DELAY offsets
- introduce RELATIVE CONSTRAINTS between pwl tropo. NORTH GRADIENT offsets
- introduce RELATIVE CONSTRAINTS between pwl tropo. EAST GRADIENT offsets
- introduce ABSOLUTE CONSTRAINTS between pwl tropo. NORTH GRADIENT offsets
- introduce ABSOLUTE CONSTRAINTS between pwl tropo. EAST GRADIENT offsets

- all units of estimation intervals are minutes
 - units of ZWD constraints are picosec^2/sec (0.7 is loose)
 - units of NGR & EGR relative constraints are millimeters/day e.g. 2 mm/day (relative) is loose
 - units of NGR & EGR absolute constraints are millimeters e.g. 1 mm (absolute) is loose

ZWD constr.	NGR rel. constr.	EGR rel. constr.	NGR abs. constr.	EGR abs. constr.	ZWD int.	NGR int.	EGR int.	est. ZWD	est. NGR	est. EGR
0.7000	2	2	1	1	30	360	360	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

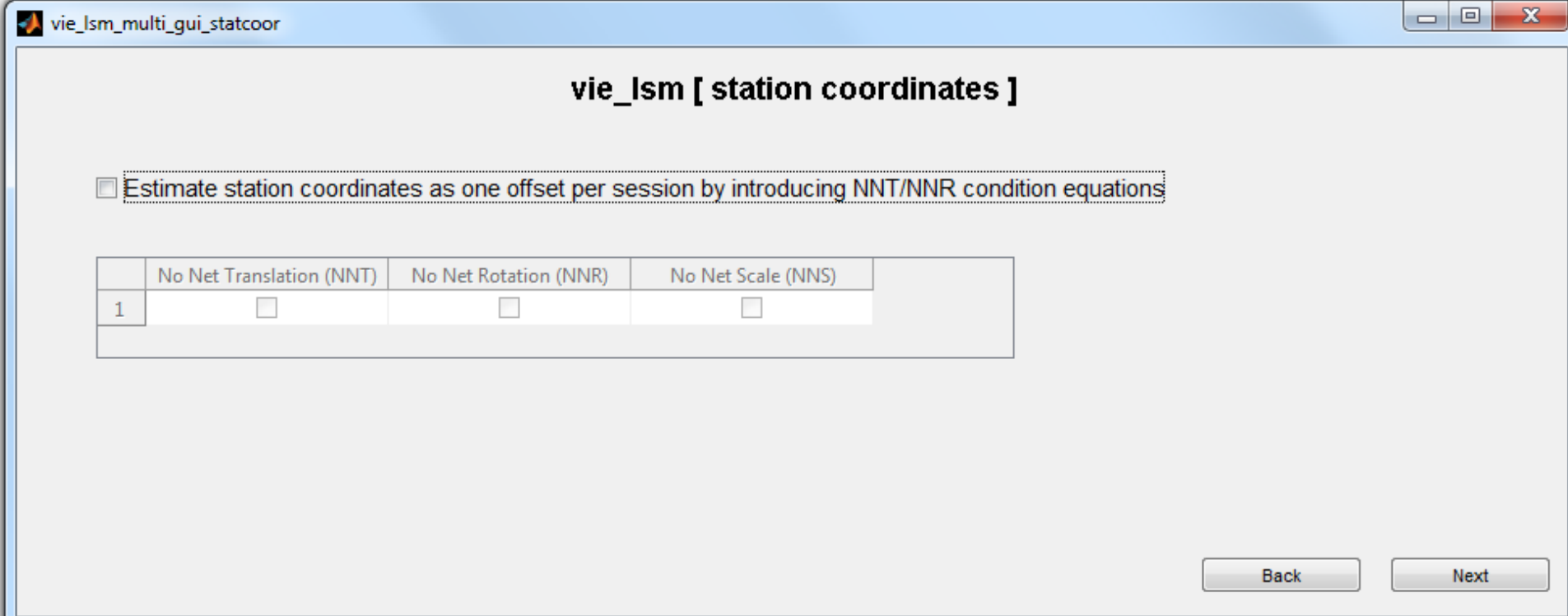
If ticked, absolute constraints of 1 mm are applied on the gradient offsets, i.e., additional observation equations are added which tell that the gradient offset is zero \pm 1 mm. (This feature might be necessary in early VLBI sessions.)



If like this, the NNR and NNT conditions are applied on all stations which are available in the selected TRF. (If e.g. the station is not in the TRF, the a priori coordinates are taken from the header of the NGS file and the station is not part of the datum.)

Typically, the scale is not ticked because the scale is taken from the VLBI observations.

(Please mind the possibility of station-wise parameterization to change the datum stations.)



If like this, all stations coordinates are fixed which are available in the selected TRF. (If e.g. the station is not in the TRF, the coordinates are taken from the header of the NGS file and the station is not fixed to those a priori values but the station coordinates are estimated.)

(Please mind the possibility of station-wise parameterization.)

vie_lsm [multiple sessions EOP]

Earth Orientation Parameter (EOP) pwl offsets estimation options

	include model	estimation interval	use constraints	constraints
Xpol (inter. pole coor. in TRF)	<input checked="" type="checkbox"/>	1440	<input checked="" type="checkbox"/>	1.0000e-04
Ypol (inter. pole coor. in TRF)	<input checked="" type="checkbox"/>	1440	<input checked="" type="checkbox"/>	1.0000e-04
dUT1 (rotation angle)	<input checked="" type="checkbox"/>	1440	<input checked="" type="checkbox"/>	1.0000e-04
nutdx (CIP coor. in celes. long.)	<input checked="" type="checkbox"/>	1440	<input checked="" type="checkbox"/>	1.0000e-04
nutdy (CIP coor. in obliquity)	<input checked="" type="checkbox"/>	1440	<input checked="" type="checkbox"/>	1.0000e-04

- unit of estimation intervals is minute.
- units of constraints are mas/day & ms/day for EOP
- 3 mas/day or 3 ms/day constraints are loose for all EOP
- 0.001 mas/day or 0.001 ms/day constraints are tight for all EOP

Back

Next

Tick here, if you want to estimate polar motion (x, y), UT1-UTC, and nutation (X, Y). Everything is carried out in the new system with the non-rotating origin.

vie_lsm [multiple sessions EOP]

Earth Orientation Parameter (EOP) pwl offsets estimation options

	include model	estimation interval	use constraints	constraints
Xpol (inter. pole coor. in TRF)	<input checked="" type="checkbox"/>	1440	<input checked="" type="checkbox"/>	1.0000e-04
Ypol (inter. pole coor. in TRF)	<input checked="" type="checkbox"/>	1440	<input checked="" type="checkbox"/>	1.0000e-04
dUT1 (rotation angle)	<input checked="" type="checkbox"/>	1440	<input checked="" type="checkbox"/>	1.0000e-04
nutdx (CIP coor. in celes. long.)	<input checked="" type="checkbox"/>	1440	<input checked="" type="checkbox"/>	1.0000e-04
nutdy (CIP coor. in obliquity)	<input checked="" type="checkbox"/>	1440	<input checked="" type="checkbox"/>	1.0000e-04

- unit of estimation intervals is minute.
- units of constraints are mas/day & ms/day for EOP
- 3 mas/day or 3 ms/day constraints are loose for all EOP
- 0.001 mas/day or 0.001 ms/day constraints are tight for all EOP

Back

Next

These are the time intervals in minutes.

vie_lsm [multiple sessions EOP]

Earth Orientation Parameter (EOP) pwl offsets estimation options

	include model	estimation interval	use constraints	constraints
Xpol (inter. pole coor. in TRF)	<input checked="" type="checkbox"/>	1440	<input checked="" type="checkbox"/>	1.0000e-04
Ypol (inter. pole coor. in TRF)	<input checked="" type="checkbox"/>	1440	<input checked="" type="checkbox"/>	1.0000e-04
dUT1 (rotation angle)	<input checked="" type="checkbox"/>	1440	<input checked="" type="checkbox"/>	1.0000e-04
nutdx (CIP coor. in celes. long.)	<input checked="" type="checkbox"/>	1440	<input checked="" type="checkbox"/>	1.0000e-04
nutdy (CIP coor. in obliquity)	<input checked="" type="checkbox"/>	1440	<input checked="" type="checkbox"/>	1.0000e-04

- unit of estimation intervals is minute.
- units of constraints are mas/day & ms/day for EOP
- 3 mas/day or 3 ms/day constraints are loose for all EOP
- 0.001 mas/day or 0.001 ms/day constraints are tight for all EOP

Back

Next

Tick here if you want to use relative constraints between the piecewise linear offsets for the respective Earth orientation parameter.

vie_lsm [multiple sessions EOP]

Earth Orientation Parameter (EOP) pwl offsets estimation options

	include model	estimation interval	use constraints	constraints
Xpol (inter. pole coor. in TRF)	<input checked="" type="checkbox"/>	1440	<input checked="" type="checkbox"/>	1.0000e-04
Ypol (inter. pole coor. in TRF)	<input checked="" type="checkbox"/>	1440	<input checked="" type="checkbox"/>	1.0000e-04
dUT1 (rotation angle)	<input checked="" type="checkbox"/>	1440	<input checked="" type="checkbox"/>	1.0000e-04
nutdx (CIP coor. in celes. long.)	<input checked="" type="checkbox"/>	1440	<input checked="" type="checkbox"/>	1.0000e-04
nutdy (CIP coor. in obliquity)	<input checked="" type="checkbox"/>	1440	<input checked="" type="checkbox"/>	1.0000e-04

- unit of estimation intervals is minute.
- units of constraints are mas/day & ms/day for EOP
- 3 mas/day or 3 ms/day constraints are loose for all EOP
- 0.001 mas/day or 0.001 ms/day constraints are tight for all EOP

Back

Next

Similar to the gradients, these constraints scale linearly. The units are mas/day for polar motion and nutation, and ms/day for UT1-UTC.

vie_ism_multi_gui_eop

vie_ism [multiple sessions EOP]

Earth Orientation Parameter (EOP) pwl offsets estimation options

	include model	estimation interval	use constraints	constraints
Xpol (inter. pole coor. in TRF)	<input checked="" type="checkbox"/>	1440	<input checked="" type="checkbox"/>	1.0000e-04
Ypol (inter. pole coor. in TRF)	<input checked="" type="checkbox"/>	1440	<input checked="" type="checkbox"/>	1.0000e-04
dUT1 (rotation angle)	<input checked="" type="checkbox"/>	1440	<input checked="" type="checkbox"/>	1.0000e-04
nutdx (CIP coor. in celes. long.)	<input checked="" type="checkbox"/>	1440	<input checked="" type="checkbox"/>	1.0000e-04
nutdy (CIP coor. in obliquity)	<input checked="" type="checkbox"/>	1440	<input checked="" type="checkbox"/>	1.0000e-04

- unit of estimation intervals is minute.
 - units of constraints are mas/day & ms/day for EOP
 - 3 mas/day or 3 ms/day constraints are loose for all EOP
 - 0.001 mas/day or 0.001 ms/day constraints are tight for all EOP

If you want to estimate one constant value per session, the recommendation is to set the parameterization as shown above. Very strong relative constraints of $1e-4$ m(a)s/day take care that the estimates are the same over the session.

Example: The session is from 18 UT to 18 UT. Then, three piecewise linear offsets are set up for each EOP. (They are set up a midnight before the session, at midnight during the session, and at midnight after the session.) The strong constraints take care that all three estimates per session are the same.

vie_lsm_multi_gui_eop

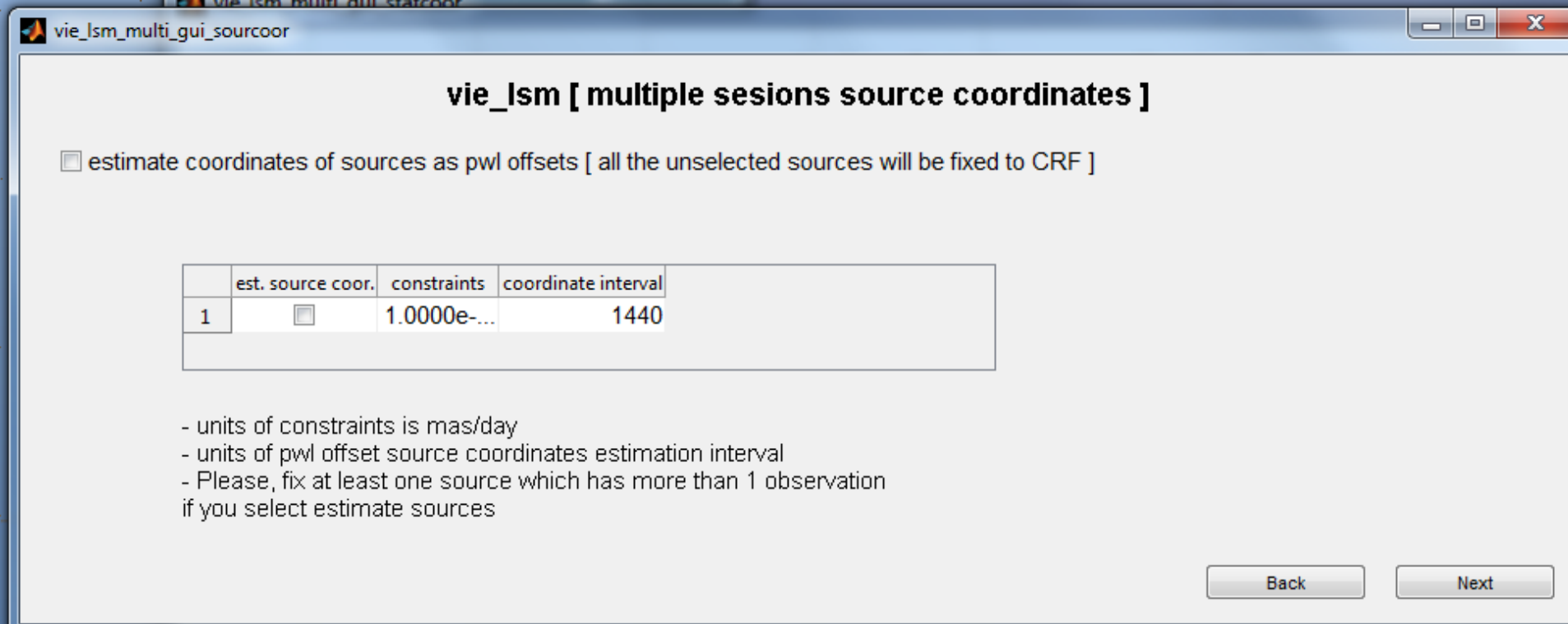
vie_lsm [multiple sessions EOP]

Earth Orientation Parameter (EOP) pwl offsets estimation options

	include model	estimation interval	use constraints	constraints
Xpol (inter. pole coor. in TRF)	<input checked="" type="checkbox"/>	60	<input checked="" type="checkbox"/>	30
Ypol (inter. pole coor. in TRF)	<input checked="" type="checkbox"/>	60	<input checked="" type="checkbox"/>	30
dUT1 (rotation angle)	<input checked="" type="checkbox"/>	60	<input checked="" type="checkbox"/>	30
nutdx (CIP coor. in celes. long.)	<input type="checkbox"/>	1440	<input type="checkbox"/>	1.0000e-04
nutdy (CIP coor. in obliquity)	<input type="checkbox"/>	1440	<input type="checkbox"/>	1.0000e-04

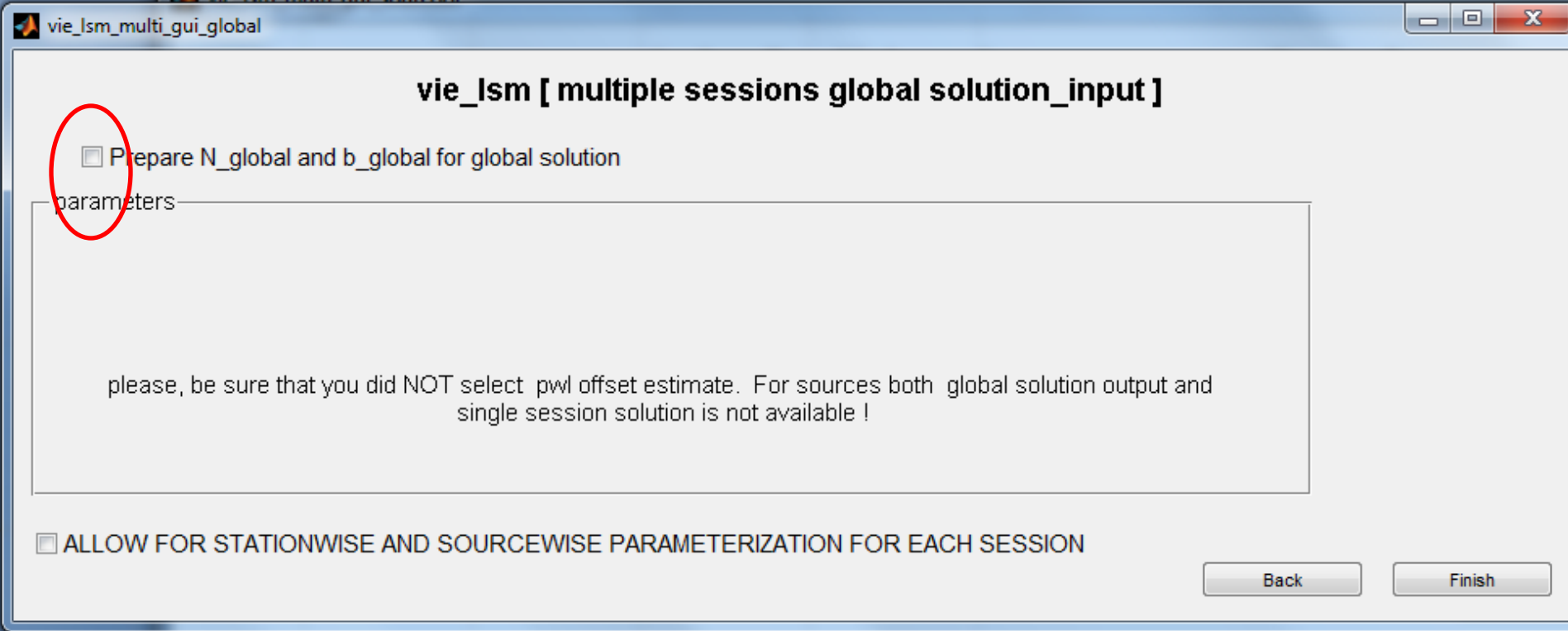
- unit of estimation intervals is minute.
 - units of constraints are mas/day & ms/day for EOP
 - 3 mas/day or 3 ms/day constraints are loose for all EOP
 - 0.001 mas/day or 0.001 ms/day constraints are tight for all EOP

If you want to estimate hourly Earth rotation parameters (polar motion and UT1-UTC), you should not estimate nutation, and you should use loose constraints like 30 m(a)s per day (1.25 m(a)s per hour).

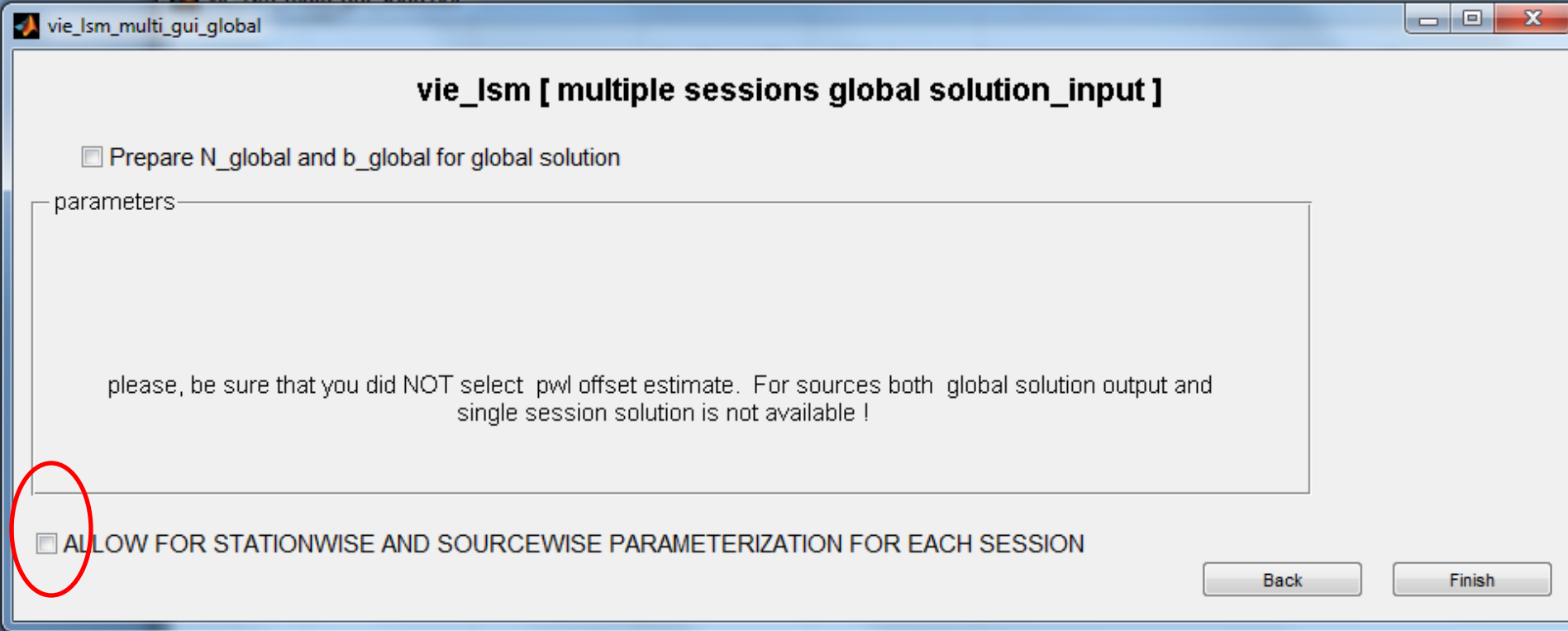


Typically, you do not want to estimate sources as piecewise linear offsets. You could do so by selecting certain sources via the source-wise parameterization.

The recommendation is to leave the settings like this.



Tick this, if you want to use the normal equations for later use in a global solution with vie_glob.



Tick this, if you want to make a station- or source-wise parameterization. E.g., if you want to set a certain datum for the stations.