Data analysis with VieVS

(exercise)

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AVN Training School, 22 February – 08 March 2016,
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Definition of the task

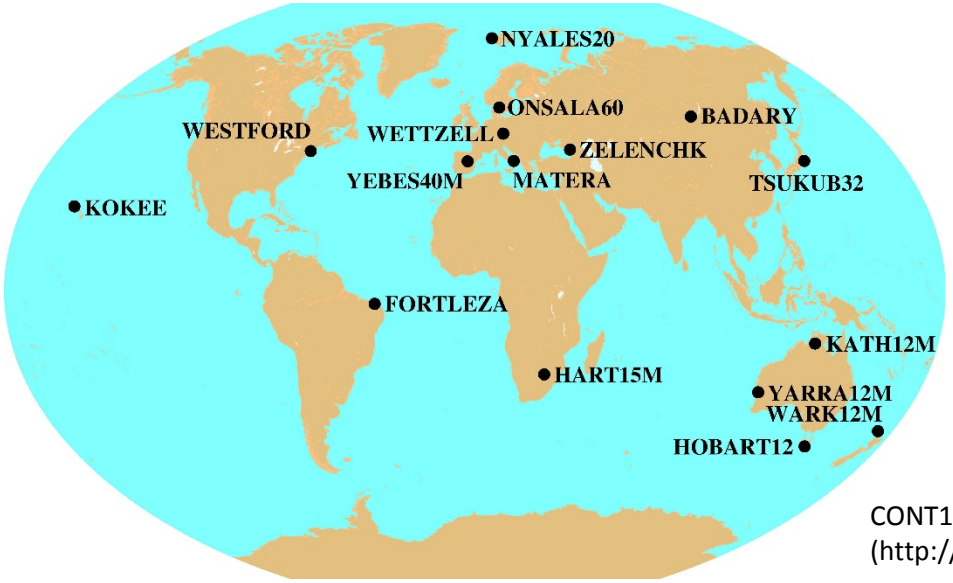
- **Analyze the data acquired during the first 4 days of the CONT14 campaign with VieVS**
- Target parameters:
  - Station coordinates
  - EOPs: Polar motion (Xp, Yp), Nutation parameter (dX, dY), dUT1

- **Processing steps:**

1. Load data (➔ Vie_INIT)
2. Calculate theoretical delays + partial derivatives (➔ Vie_MOD)
3. Estimate Parameters in a least squares adjustment (➔ Vie_LSM)
4. Check data residuals and investigate results

Data - CONT14

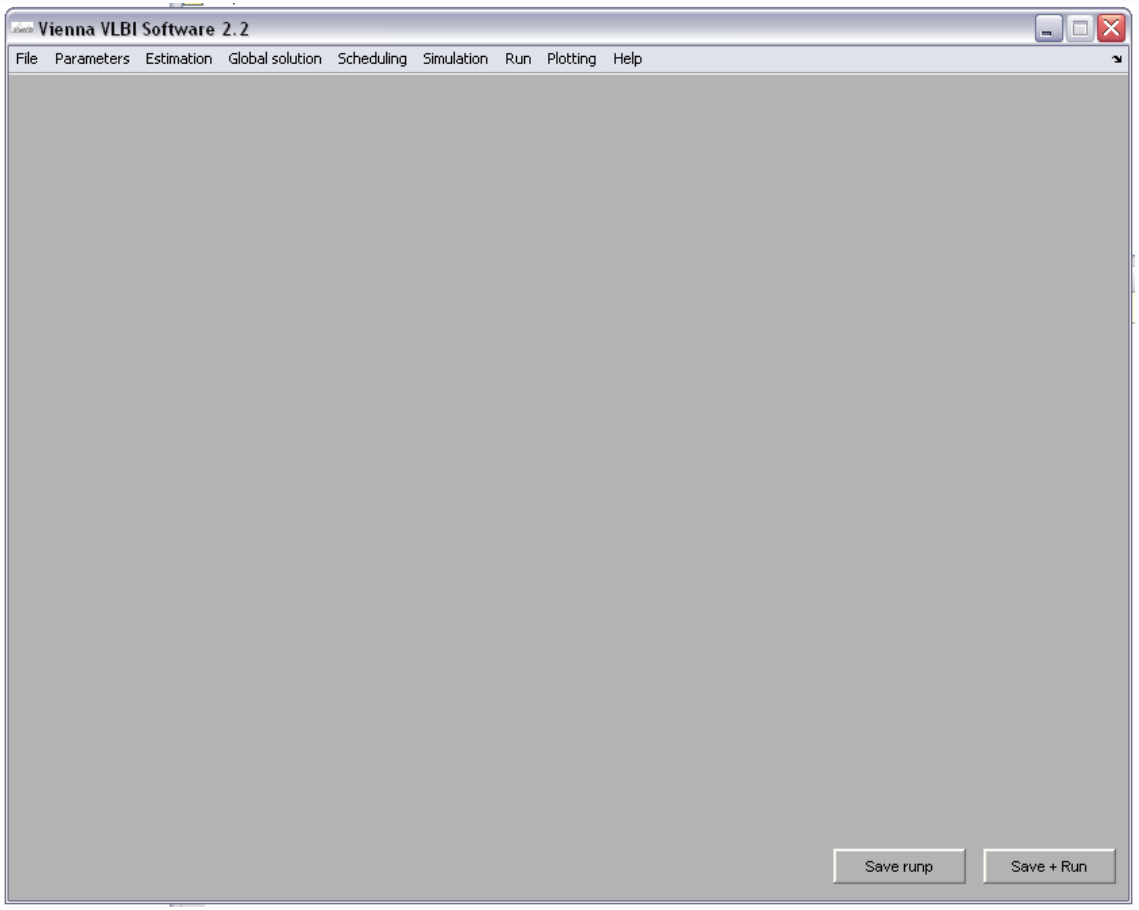
- Continuous VLBI Campaign 2014 (CONT14)
- 2 weeks of continuous VLBI observation with a global 17 station network
- 6-MAY-2014 00:00 UT to 20-MAY-2014 24:00 UT ➔ 15 * 24 hour sessions
- **Goal**: *"… is to acquire state-of-the-art VLBI data over a time period of about two weeks to demonstrate the highest accuracy of which the current VLBI system is capable"*



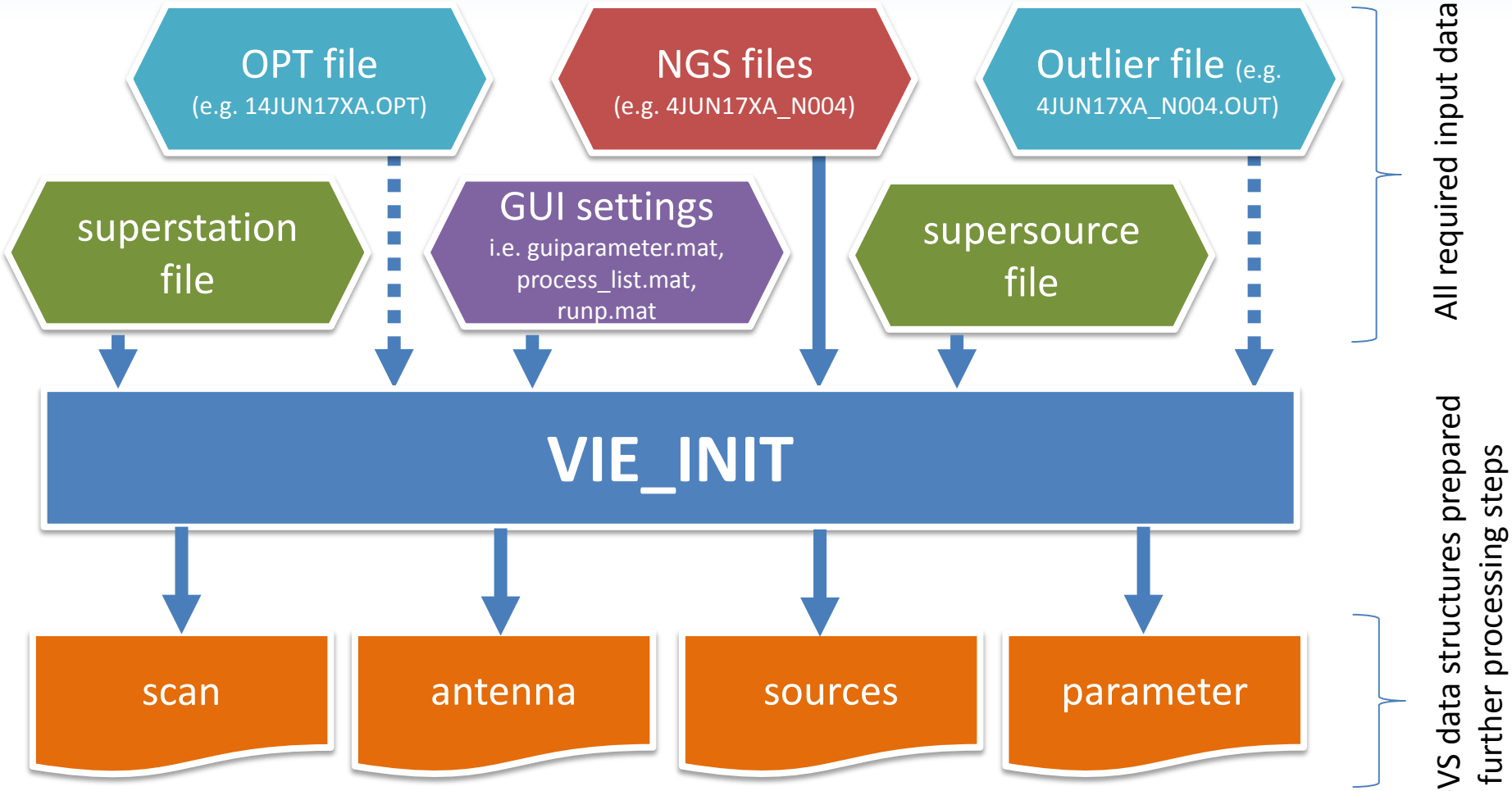
CONT14 station network
(http://ivs.nict.go.jp/mirror/program/cont14/)

How to start VieVS

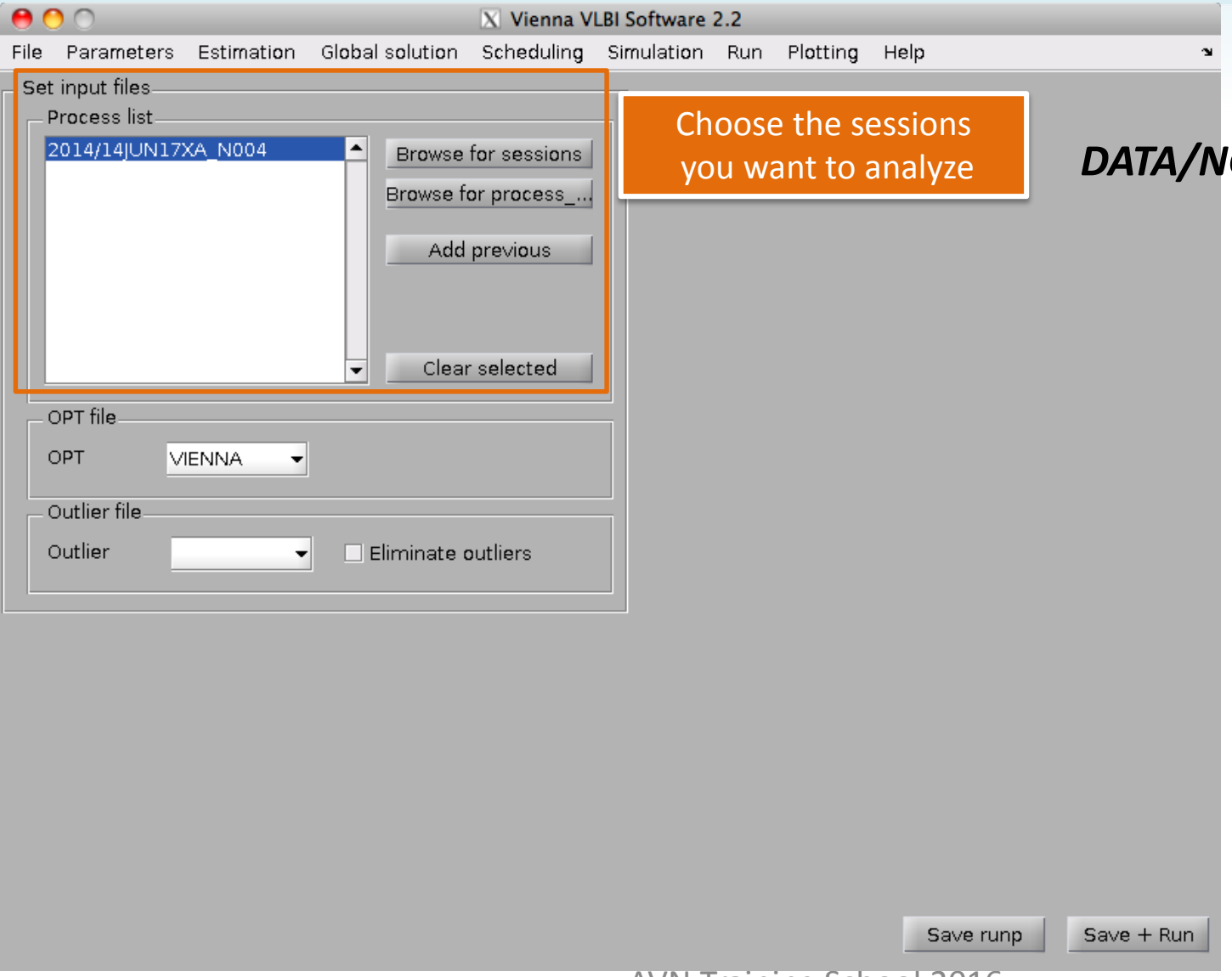
- Start MATLAB
- Change directory to **VieVS/WORK/**
- Start VieVS with the command: *vievs*
- The VieVS GUI will now appear



1) Loading data (Vie_INIT)



VIE_INIT Options



Choose the sessions you want to analyze

File > Set input files

DATA/NGS/

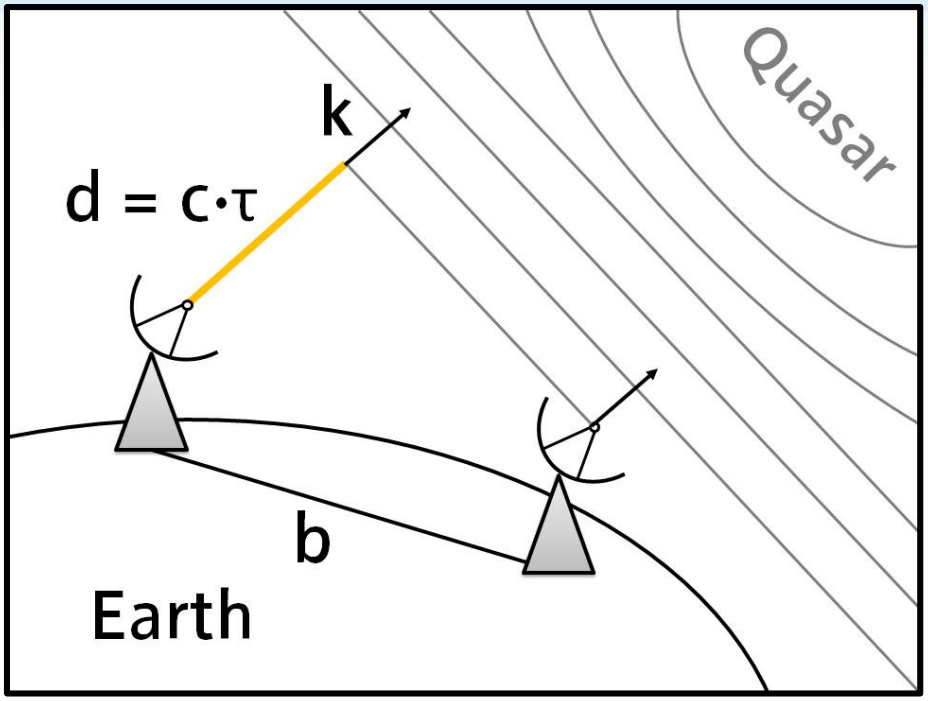
2.) Delay modelling (Vie_MOD)

- Vie_**MOD**elling of….
  - Computed delay times τ_{comp}
  - Partial derivatives $\frac{\partial \tau}{\partial VAR}$

Basics (1)

computed delay τ

$$\tau = -\frac{\vec{b} \cdot \vec{k}}{c}$$



computed delay τ_{comp}
- **Vie_MOD**

observed delay τ_{obs}
- from **NGS-card file**, corrected for ionosphere

O-C

Adjustment (LSM)

Basics (2)

Models in Vie_MOD

+ Tropospheric delay
+ Solid Earth tides
+ Ocean loading
+ Atmospheric loading
+ Hydrologic loading
+ Thermal antenna deformation
+ EOP

partial derivatives $\frac{\partial \tau}{dVAR}$

computed delay τ_{comp}

- Vie_MOD

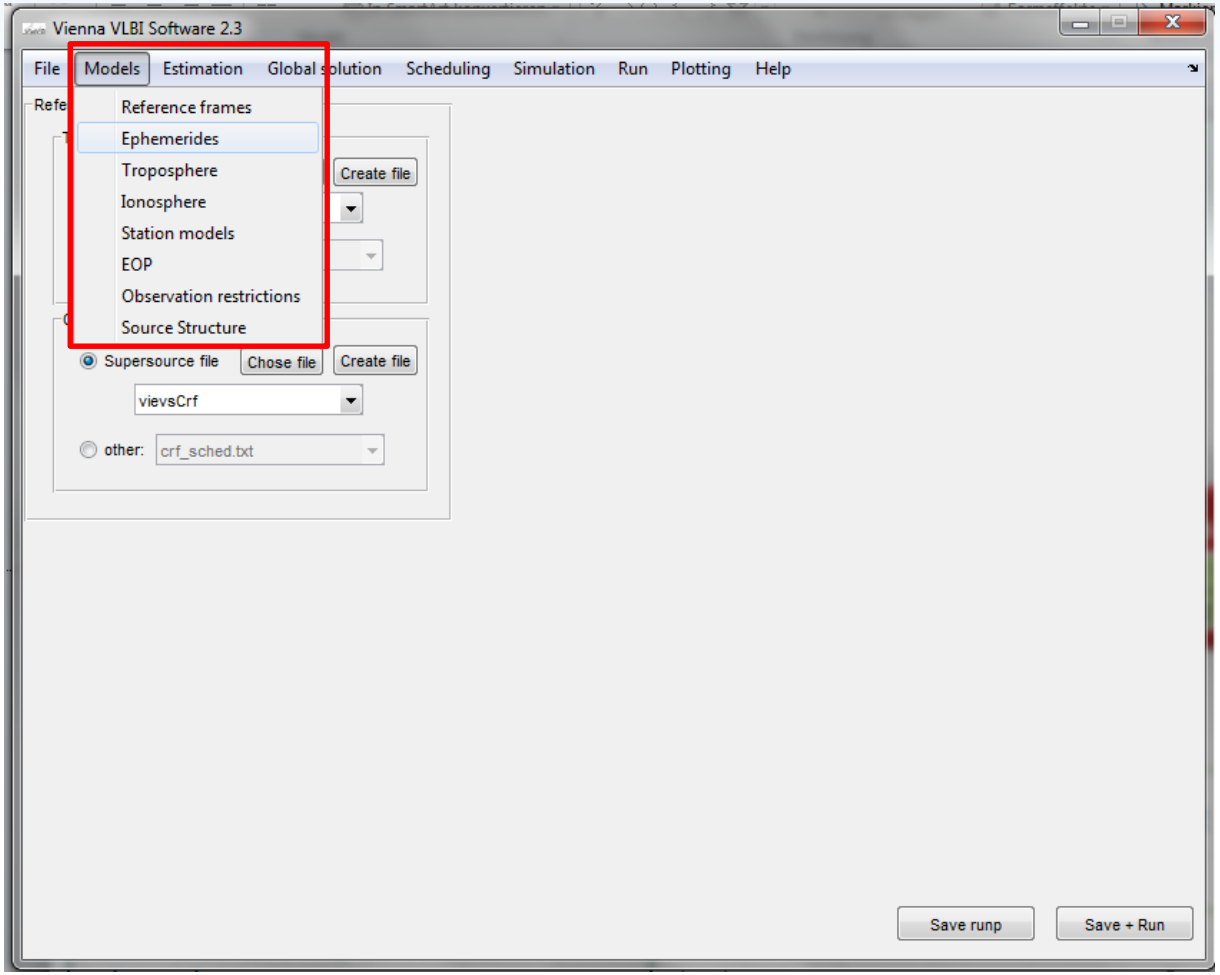
observed delay τ_{obs}

- from **NGS-card file,** corrected for ionosphere

O-C

Adjustment (LSM)

Vie_MOD


Vienna VLBI Software 2.3
File
Models
Estimation
Global solution
Scheduling
Simulation
Run
Plotting
Help
Reference frames
Ephemerides
Troposphere
Ionosphere
Station models
EOP
Observation restrictions
Source Structure
Create file
Supersource file
Chose file
Create file
vievsCrf
other:
crf_sched.txt
Save runp
Save + Run

Results of Vie_MOD

- Computed delay times τ_{comp}
- Partial derivatives $\frac{\partial \tau}{\partial VAR}$
- Results are stored in:

…/DATA/LEVEL1/<sub_dir>/<sess_name>**_antenna.mat**

_parameter.mat

_scan.mat

_sources.mat

➔ Used as input for VIE_LSM

3.) Parameter estimation

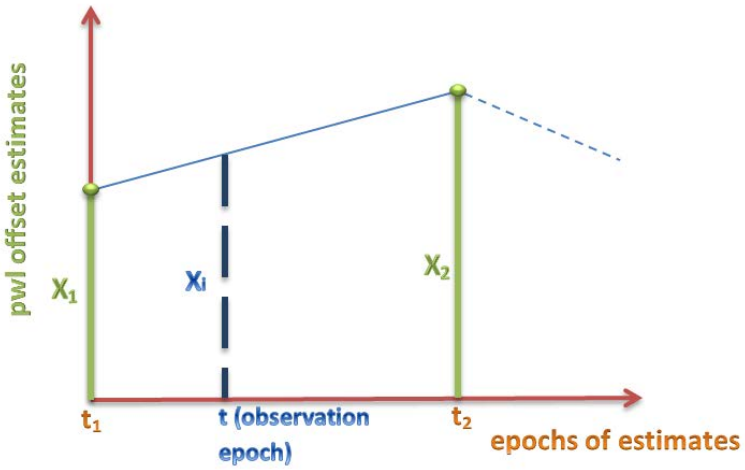
- **Vie_LSM module**: estimation of geodetic parameters with least squares adjustment from VLBI observations

- **Target parameters**
  - Station coordinates (one estimate per session)
  - EOPs (daily estimates)

- **Auxiliary parameters** (have to be estimates along the other parameters)
  - Troposphere
    - Zenith Wet Delay (hourly)
    - Gradients (every 6 hours)
  - Clock
    - PWLO (hourly) + one rate + one quadratic term per clock

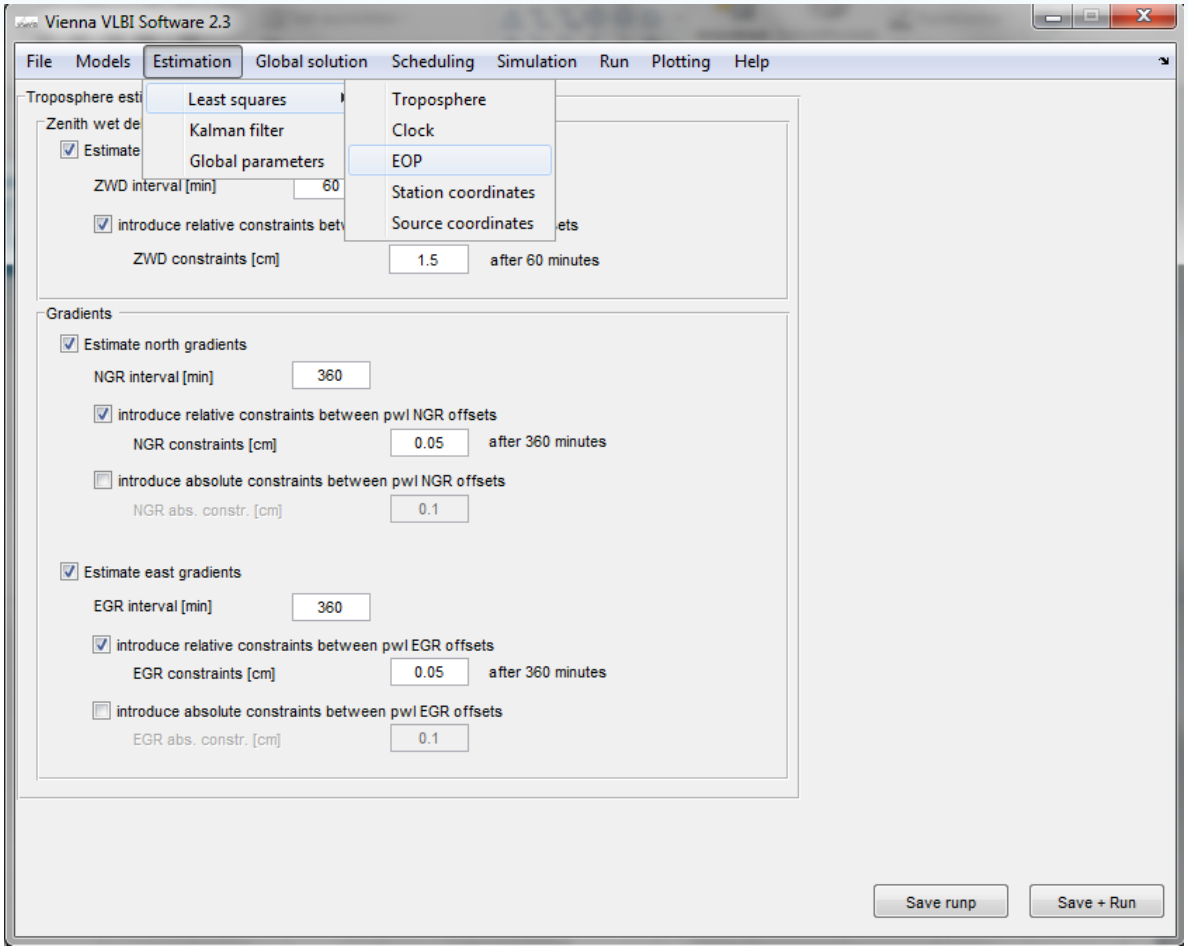
Estimates

- In VieVS all parameters are estimated as **P**iece-**w**ise **l**inear **O**ffsets (**PWLO**)
- Total values = estimates (PWLO) + a priori values (modelled)



$$x_i = x_1 + \frac{t - t_1}{t_2 - t_1}(x_2 - x_1)$$

Vie_LSM


Vienna VLBI Software 2.3
File
Models
Estimation
Global solution
Scheduling
Simulation
Run
Plotting
Help
Least squares
Kalman filter
Global parameters
Troposphere
Clock
EOP
Station coordinates
Source coordinates
Troposphere esti
Zenith wet de
Estimate
ZWD interval [min]
60
introduce relative constraints bet
ets
ZWD constraints [cm]
1.5
after 60 minutes
Gradients
Estimate north gradients
NGR interval [min]
360
introduce relative constraints between pwl NGR offsets
NGR constraints [cm]
0.05
after 360 minutes
introduce absolute constraints between pwl NGR offsets
NGR abs. constr. [cm]
0.1
Estimate east gradients
EGR interval [min]
360
introduce relative constraints between pwl EGR offsets
EGR constraints [cm]
0.05
after 360 minutes
introduce absolute constraints between pwl EGR offsets
EGR abs. constr. [cm]
0.1
Save runp
Save + Run

Results of Vie_LSM

- The result of Vie_LSM are estimates and formal errors of the target and auxiliary parameters
- They are stored in:

…/DATA/LEVEL3/<sub-dir>/**atpa**_<session_name>.mat

x_<session_name>.mat

res_<session_name>.mat

4.) Check the results

- Check the **estimation quality** and detect problems:
  - Characteristic values for one session: Chi2, WRMS
  - Post-fit residuals of the Least squares adjustment

- In case of **problems with a session**, e.g.:
  - lots of noise or flawed data due to problems at the observatory
  - Unstable clocks, clock jumps,...
  - etc.

➢ Detect and **eliminate Outliers** in the observations

➢ Apply certain rules defined in **OPT files**, e.g.
  - do not use observations of a specific baseline/station/source
  - Add “clock breaks” to account for jumps in the time stamps (clock jumps)
  - Downweight specific observations in the LSM parameter estimation

Investigate the estimates

- Tools in VieVS to inspect the results:
  - Parameter plotting tool
  - Session analysis tool

- Write output:
  - EOP/BAS out functions
    - EOP values
    - Baseline repeatabilities (measure for quality of estimated station coordinates)

Thank you for your attention!

Visit our webpage for more information on VieVS:
http://vievs.geo.tuwien.ac.at

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