Vienna VLBI Software

Current release and plans for the future

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Introduction

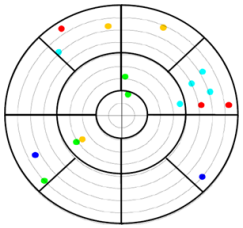
Vienna VLBI Software (VieVS)

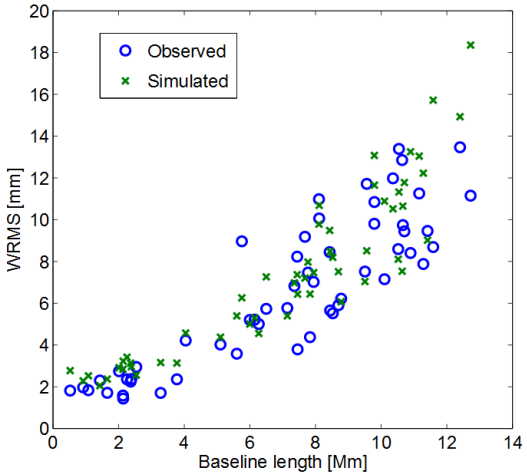
- VLBI data analysis software
- Developed since 2008
- Version 2.1 (release in March 2013)
- Written in Matlab
  - Easy to understand/use/modify
  - Many built-in functions
  - Slow
  - Expensive ($\rightarrow$ Octave)
- Graphical User Interface
- Freely available to registered users

Overview

- Single session analysis
  Analyze single VLBI session and estimate parameters
- Scheduling
  Create VLBI observation schedule
- Simulation
  Simulate VLBI observations
- Global solution
  Estimate global parameters

In one common Graphical User Interface

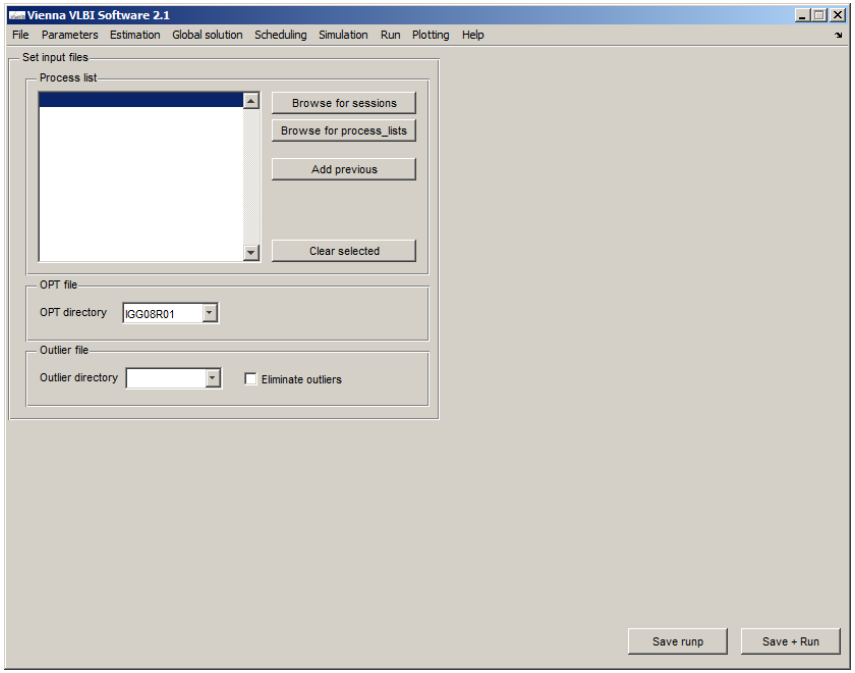




Graphical User Interface

Combines all modules in one graphical interface

- Matlab GUIDE
- Set input files
- Change processing settings
- Define output options

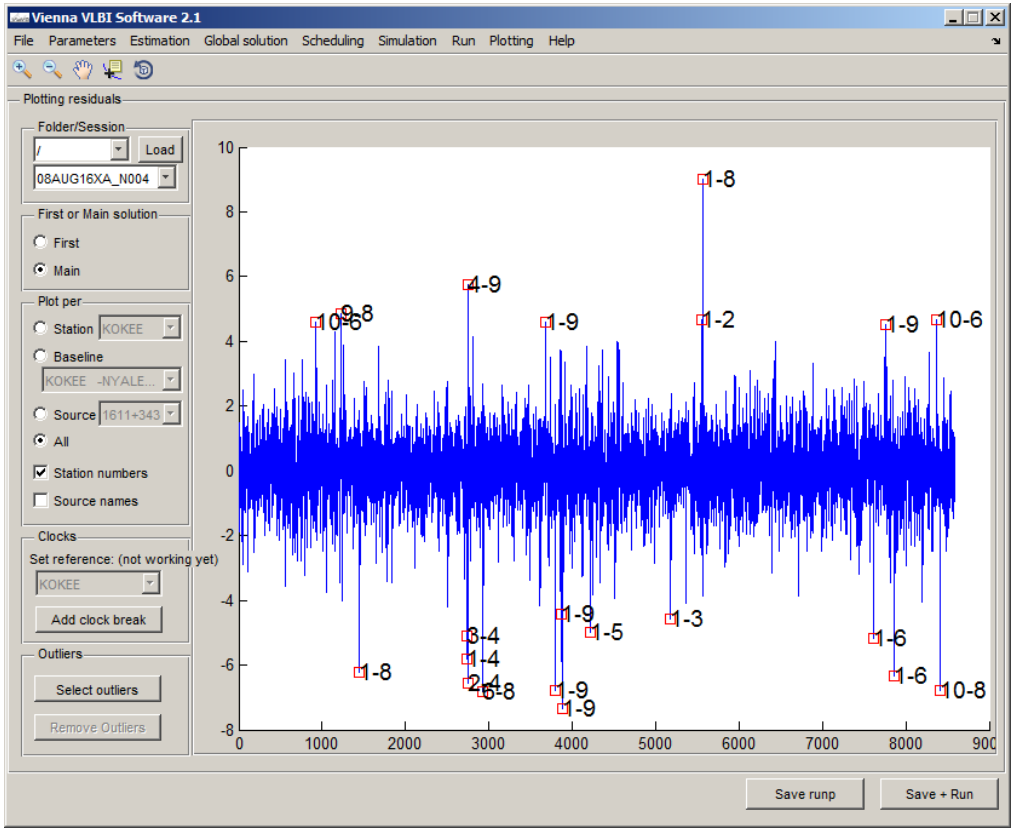


Plotting tool

Allows user to plot ...

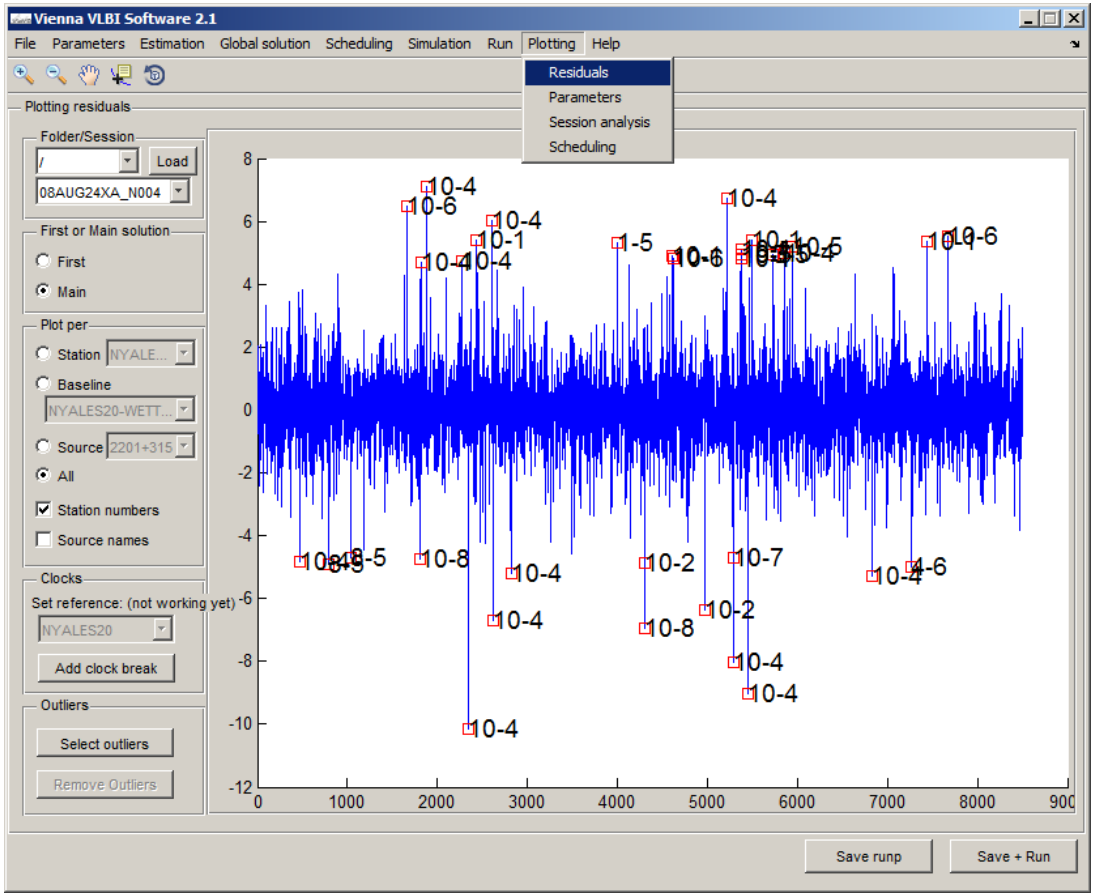
- Residuals
- Parameters
- Session overview

- Zoom
- Pan
- Get values



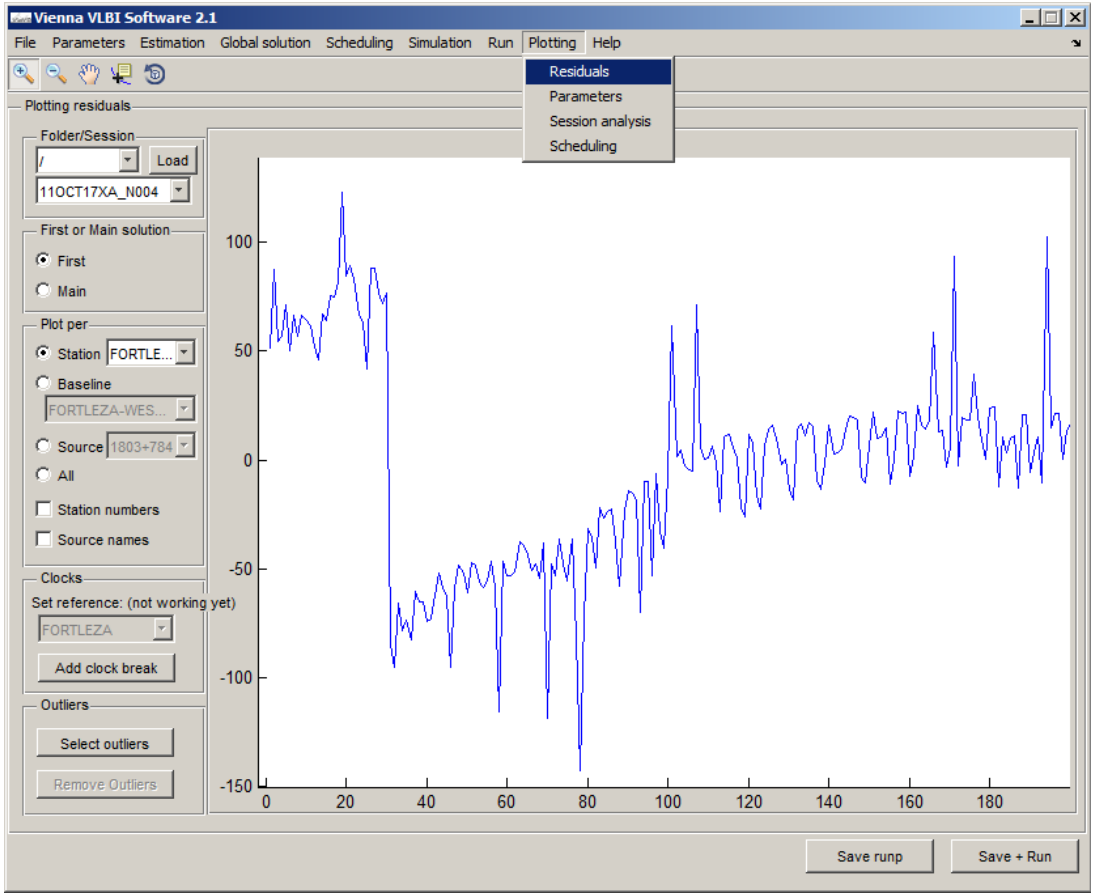
Plotting tool - Residuals

Detect bad stations, sources or baselines



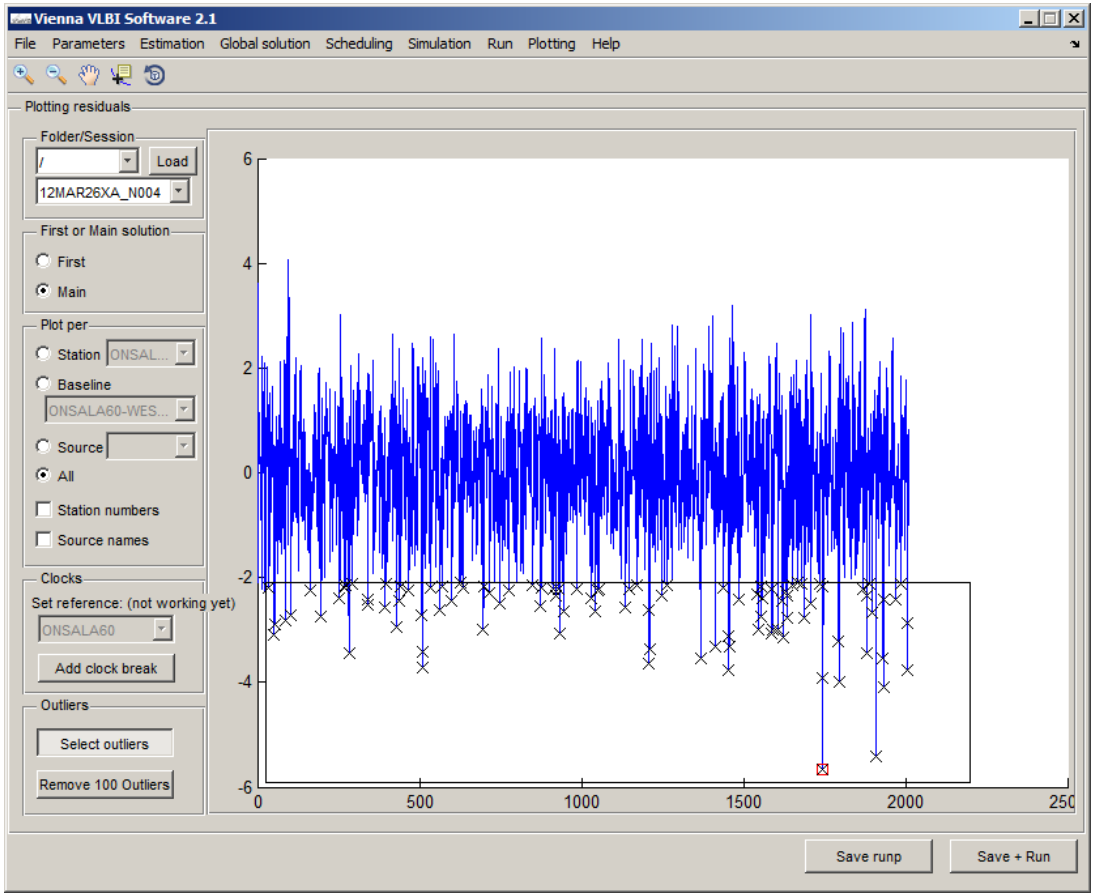
Plotting tool - Residuals

Find and remove clock breaks interactively



Plotting tool - Residuals

Select outliers interactively

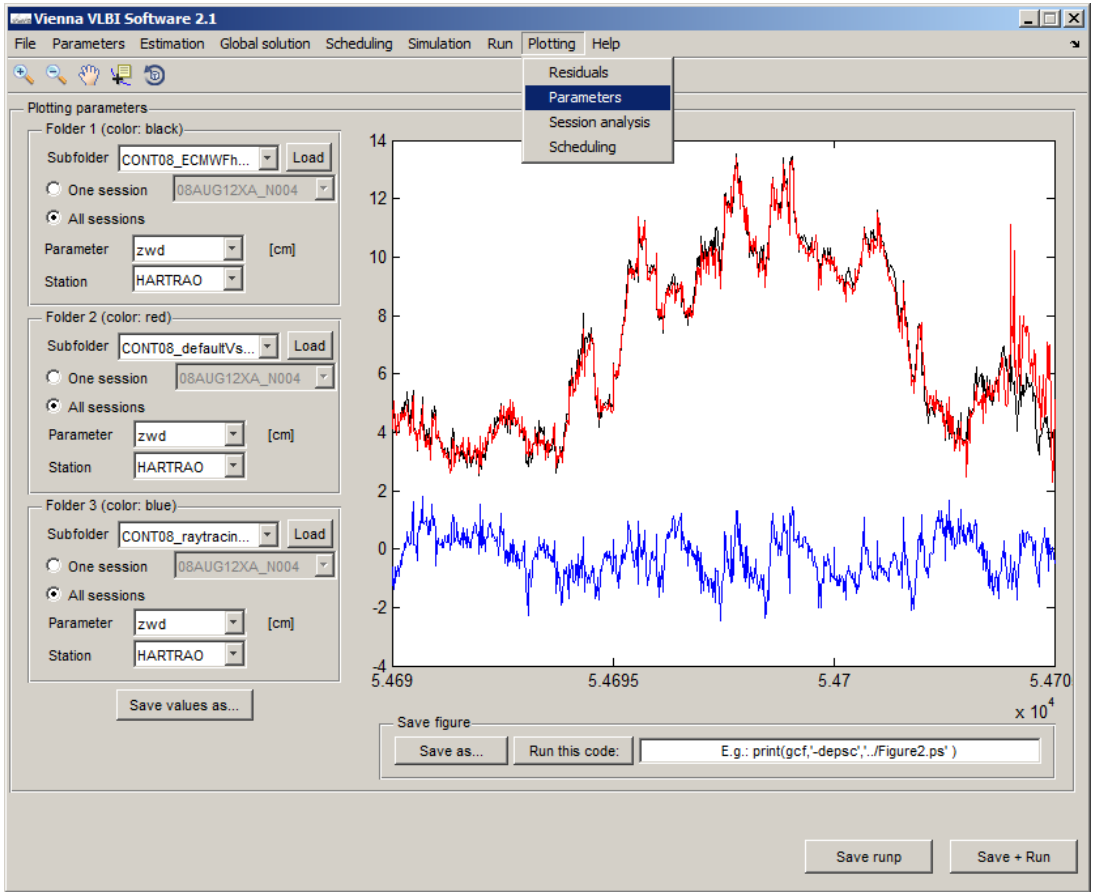


Plotting tool - Parameters

Visualize estimated parameters

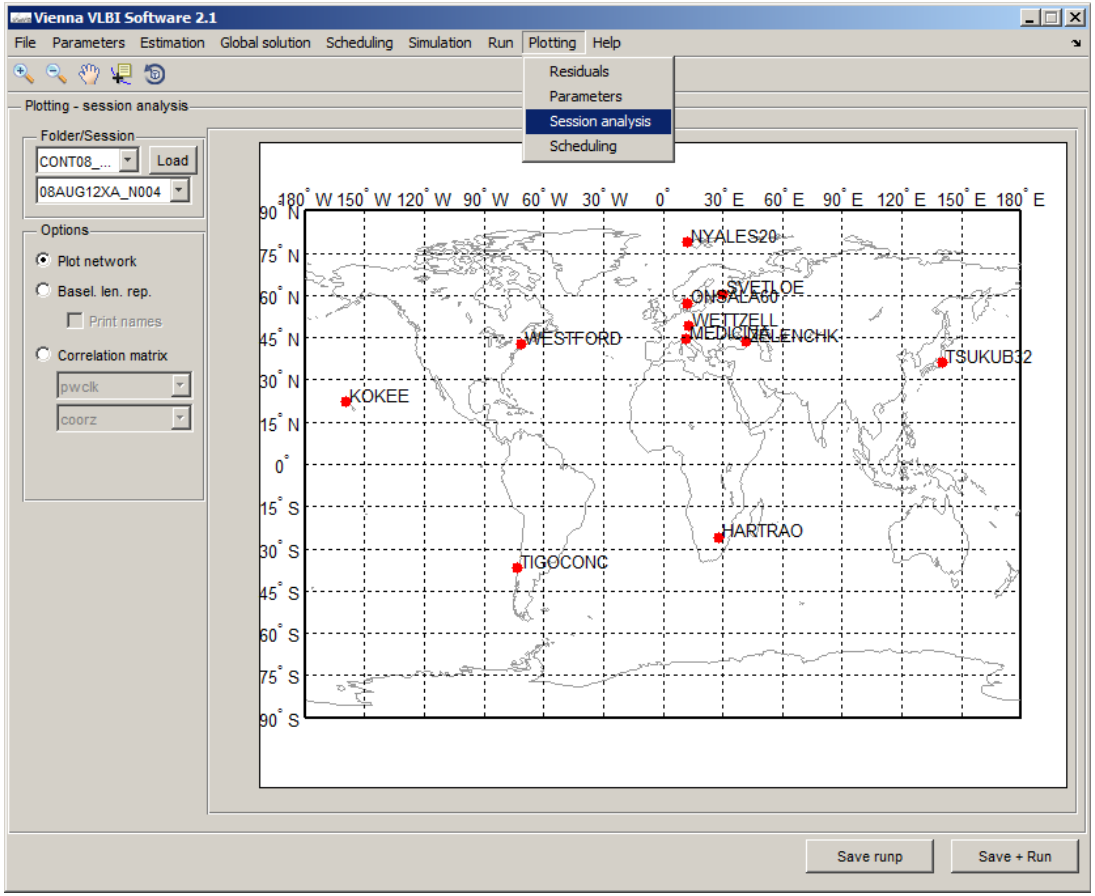
Check models

Output figure to any matlab supported filetype



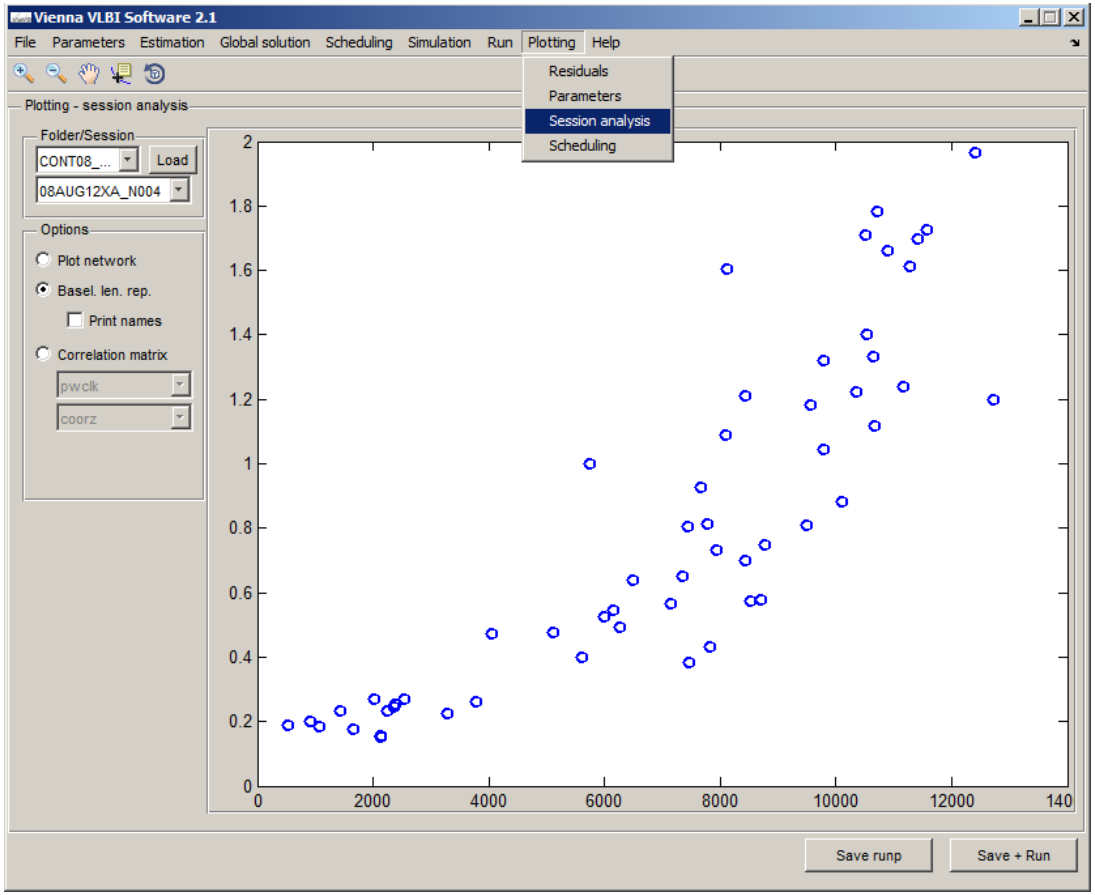
Plotting tool - Session analysis

Plot session network



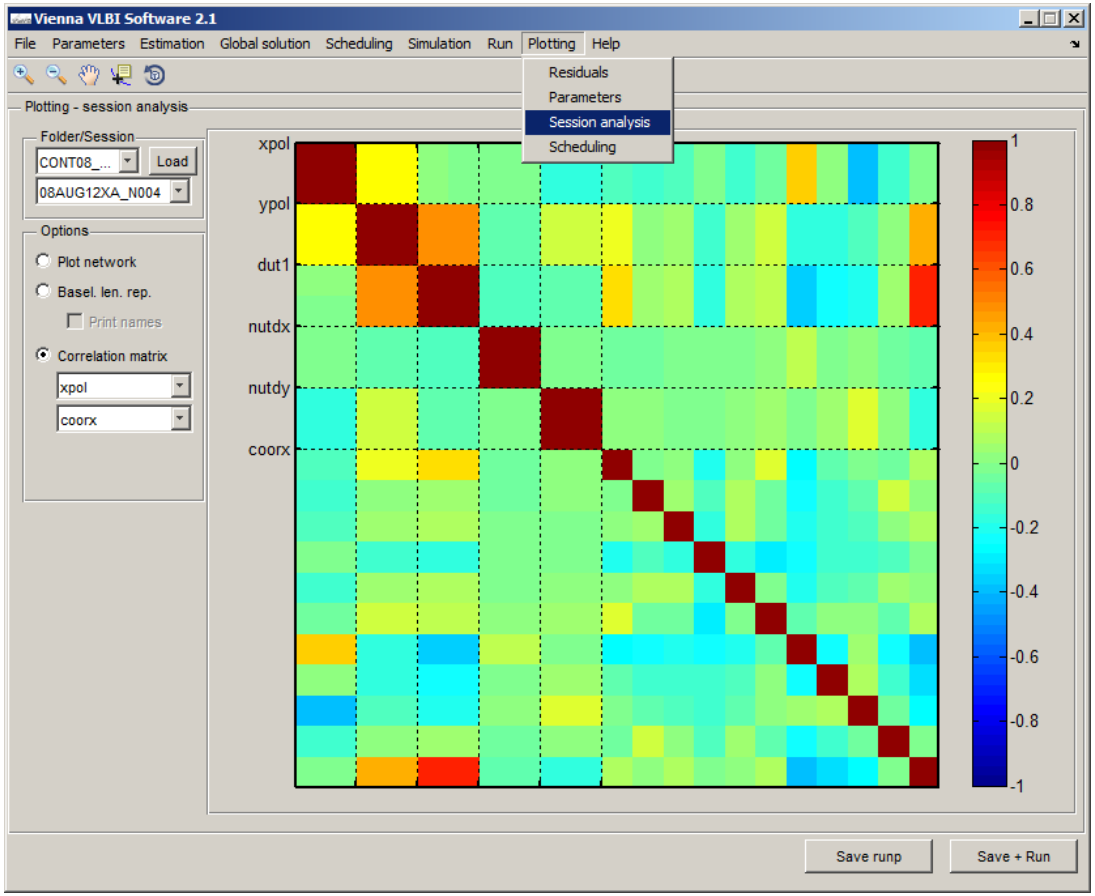
Plotting tool - Session analysis

Baseline length repeatability



Plotting tool - Session analysis

Correlation matrix



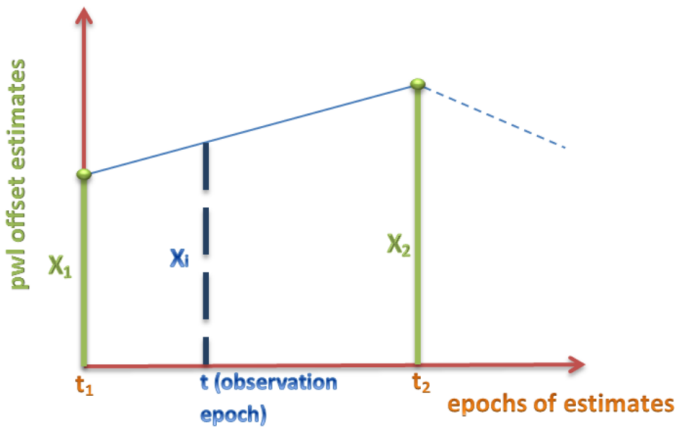
Single session analysis

Analyze one VLBI session and estimate parameters

- Read in data
  - NGS, netCDF
  - Removes outliers
  - Exclude stations, sources, baselines
- Calculate
  - Partial derivatives and theoretical delay
  - Most recent IERS conventions
- Estimation
  - Least squares
  - Clocks, zenith wet delays, gradients, Earth Orientation parameters, station coordinates, source coordinates
  - Piece-wise linear offsets

Piece-wise linear offsets

- At integer hours
- Estimation options
  - Intervals (5 minutes to 2 days)
  - Constraints

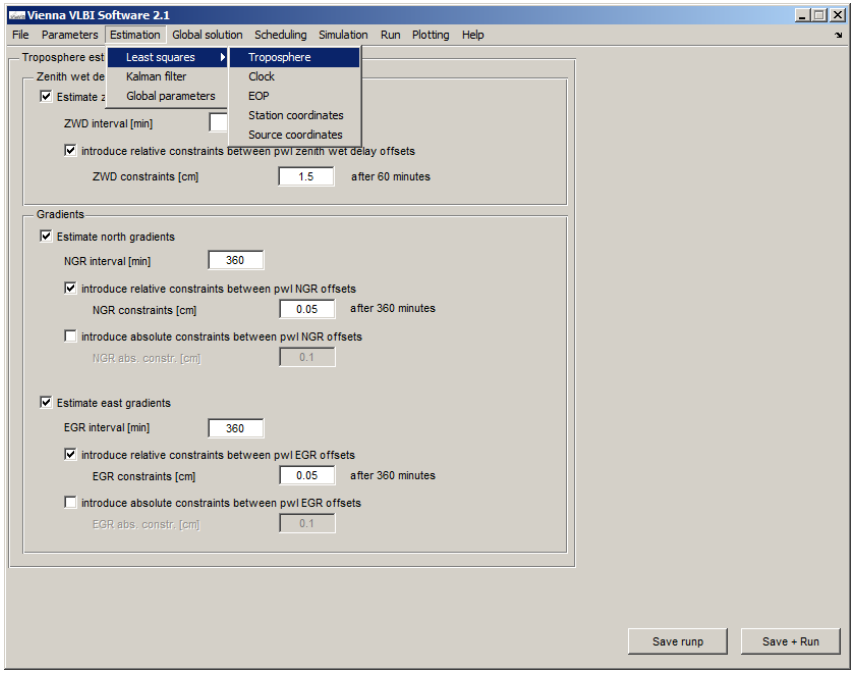


$$x_i = x_1 + \frac{t - t_1}{t_2 - t_1}(x_2 - x_1)$$

Least squares adjustment - GUI

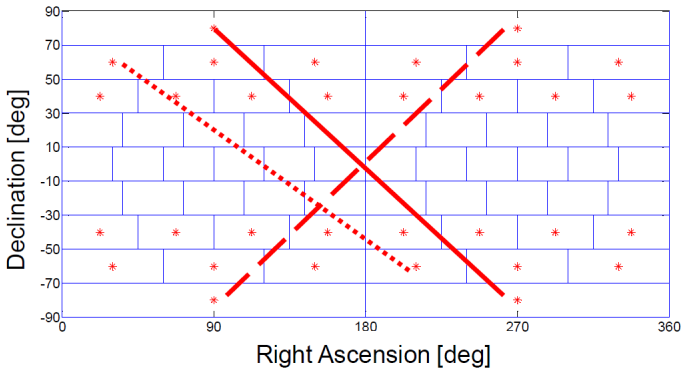
Estimation settings for tropospheric parameters

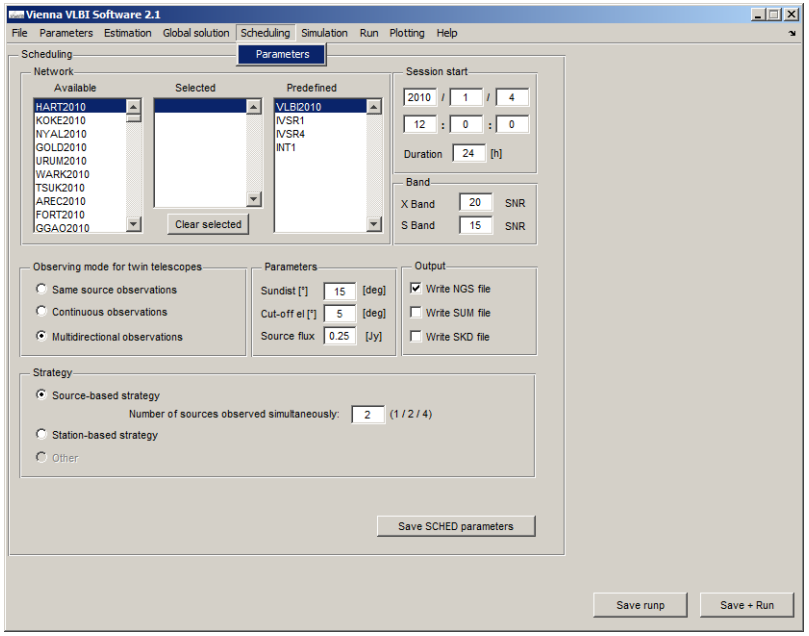
- Estimate (yes | no)
- Interval
- Constraints (absolute, relative)



Scheduling VLBI experiments

- Towards VLBI 2010
- Twins included
- 5 R&D sessions
- Source-based stretegy





2 sources simultaneously

Global geodetic parameters

Multi-session combination

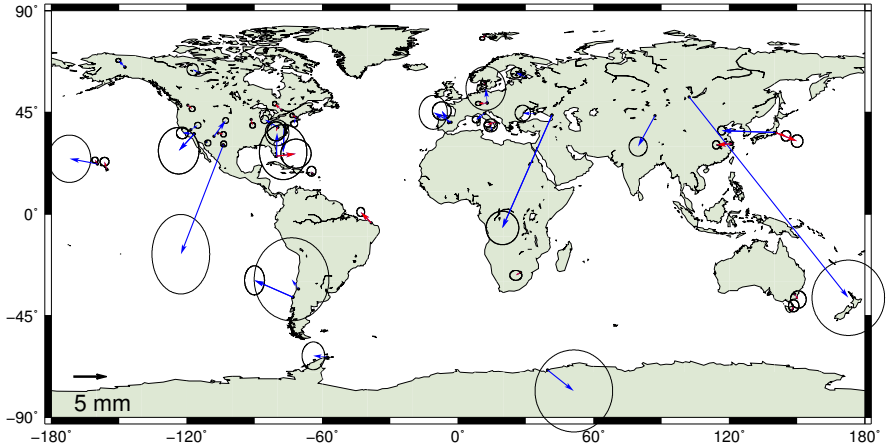
- TRF, CRF, EOP
- Stacking normal equations

Reduced parameters

- Wet zenith delays
- Gradients

Geodynamical parameters

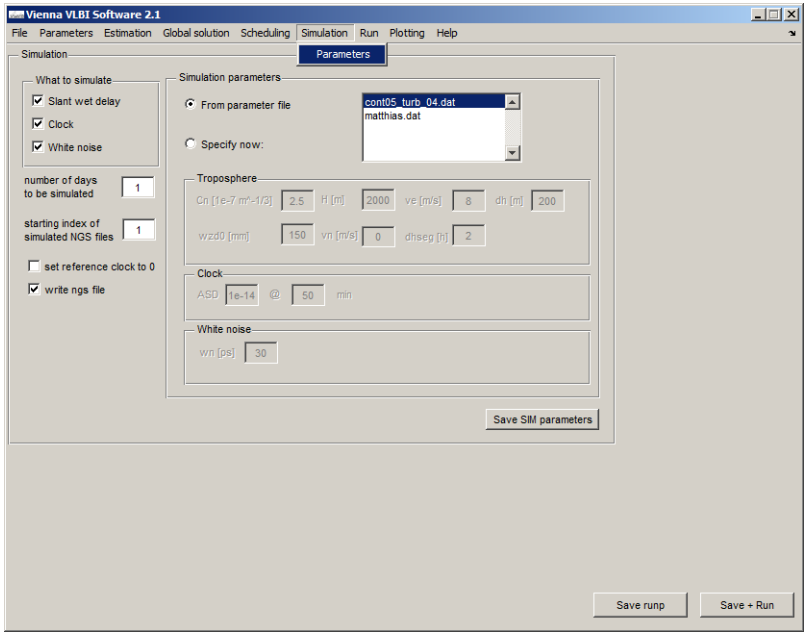
- FCN period
- Love, Shida numbers



Horizontal position differences (VieTRF10a, VTRF2008)

Simulation

- Create simulated observations
- Write NGS files
- Simulate
  - Tropospheric delays (*Nilsson and Haas, 2010*)
  - Clock errors
  - Measurement noise



Tropospheric and ionospheric delays

Textfiles containing delays of observations

- Own data possible
- Flexibility

Troposphere	Ionosphere
Delay models	From GNSS TEC maps
Mapping functions	Single frequency
Gradients	Ionospheric studies
Ray-tracing (some stations)	

Main station and source files

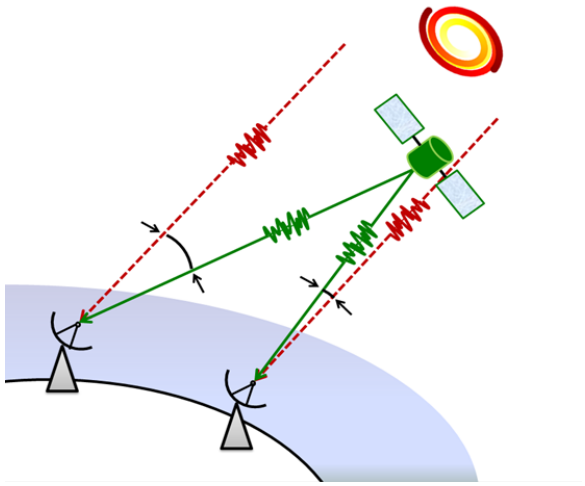
- Binary (.mat) files containing all static information
- All-purpose
- Station file
  - TRF
  - Loading data
  - Discontinuities
  - Eccentricities
  - Antenna information
  - ...
- Source file
  - CRF

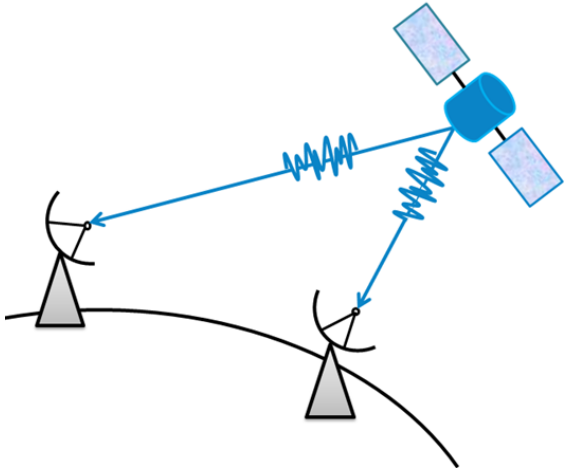
Command Window

```
K>> superstations(100)

ans =

                        code: ' Ma'
                        name: 'MATERA  '
                       domes: '12734S005'
                         CDP: '7243'
                    comments: [1x50 char]
                antenna_info: [1x1 struct]
                  antennadat: [1x1 struct]
                         ecc: [1x1 struct]
                       blokq: [1x1 struct]
               ocean_loading: [1x1 struct]
                       equip: [1x1 struct]
                 mask_vector: []
                    itrf2005: [1x1 struct]
                    itrf2008: [1x1 struct]
                    vtrf2008: [1x1 struct]
                   VieTRF10a: [1x1 struct]
    atmosphere_tidal_loading: [1x1 struct]
                 vlbiDiscont: [1x1 struct]
                    vievsTrf: [1x1 struct]
        oceanPoleTideLoading: [1x6 double]
```

Spacecraft tracking

- Processing of SELENE D-VLBI observations
  - Delay model of sources at finite distances
  - Moving target
- VLBI observations to satellites
  - Scheduling
  - Simulations
  - (Processing)
- Goals
  - Develop observing strategies
  - Frame ties





Future plans

- Parallel computing
- Kalman filter (Tobias Nilsson / GFZ)
- Scheduling (continue)
- Satellite observations (continue)
- Geopyhsical parameter estimation (e.g. galactic rotation)

Summary

- VieVS is VLBI data analysis software with several capabilities
- Written in Matlab
- Release of Version 2.1 in March 2013
- Free to registered users

User workshops

- Yearly held at TU Vienna (since 2010)
- Next: Probably autumn 2013
- Everybody welcome!

Participants of the VieVS User Workshop 2012