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VIE_MOD 3.1

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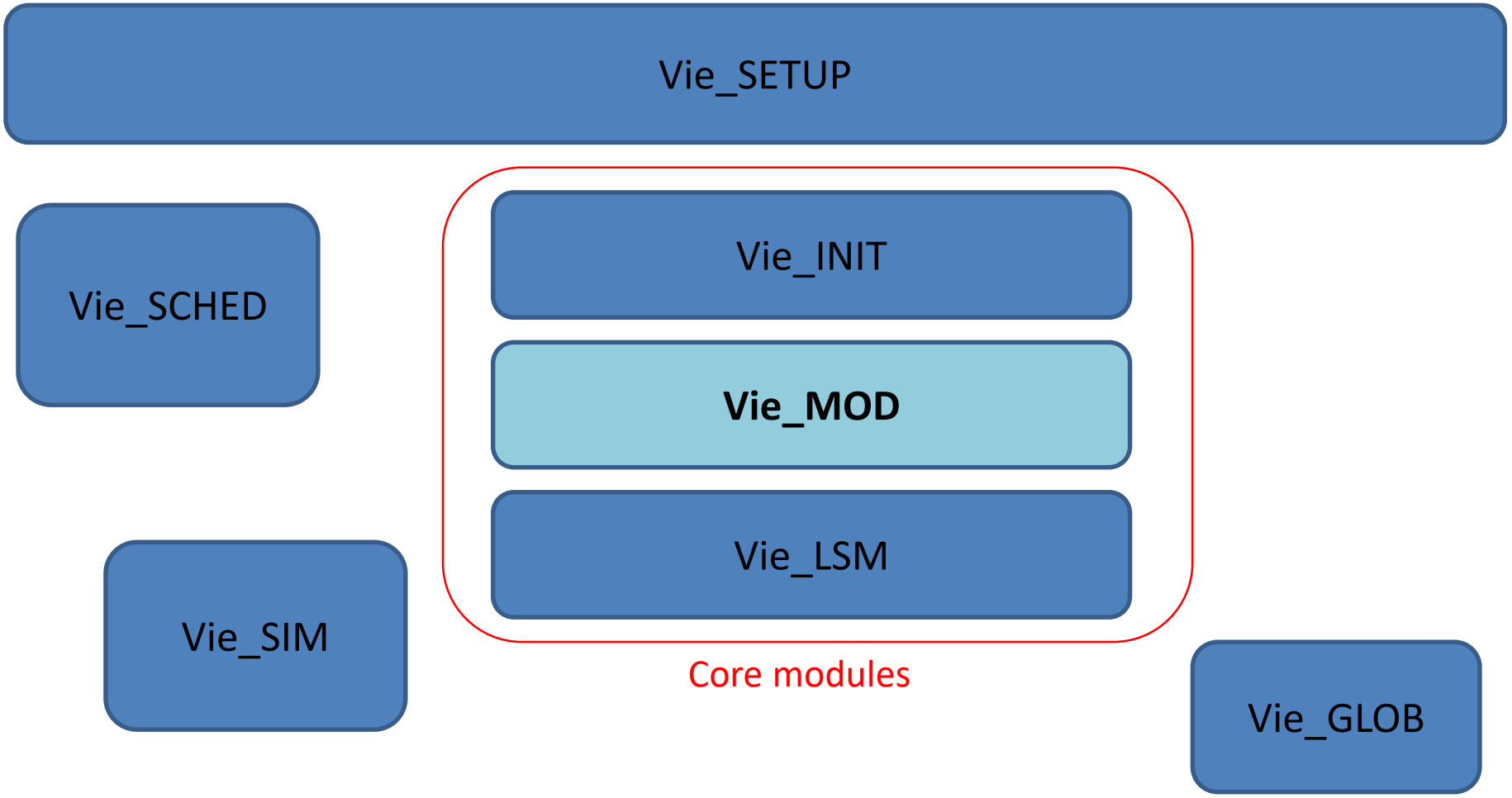
VIE_MOD

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

VieVS Modules

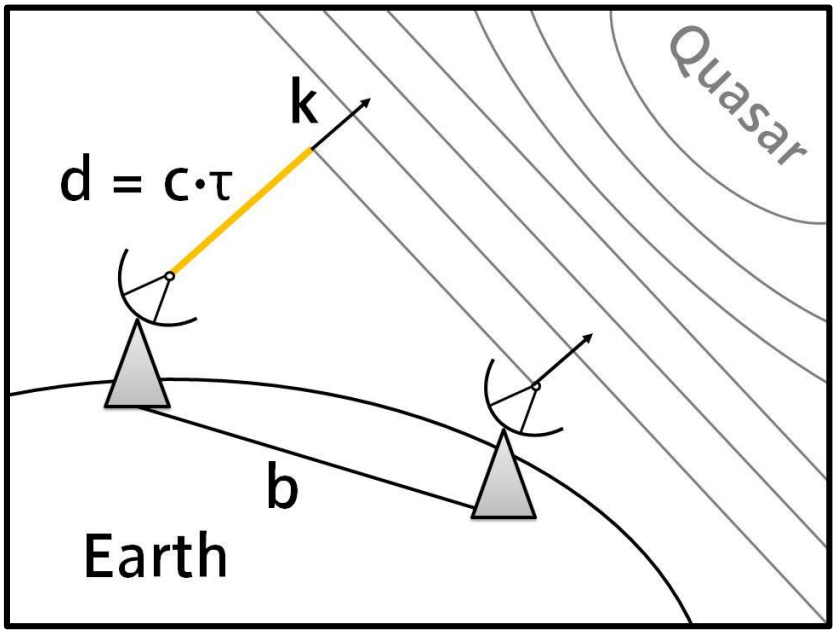


Vie_MOD….calculates the **theoretical time delay** and builds up the **partial derivatives**

Basics (1)

computed delay τ

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



computed delay τ_{comp}

- **Vie_MOD**

observed delay τ_{obs}

- From **observation file** (NGS, VSO, vgosDB), 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

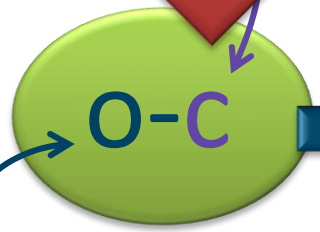
Partial derivatives $\frac{\partial \tau}{dVAR}$

computed delay τ_{comp}

- Vie_MOD

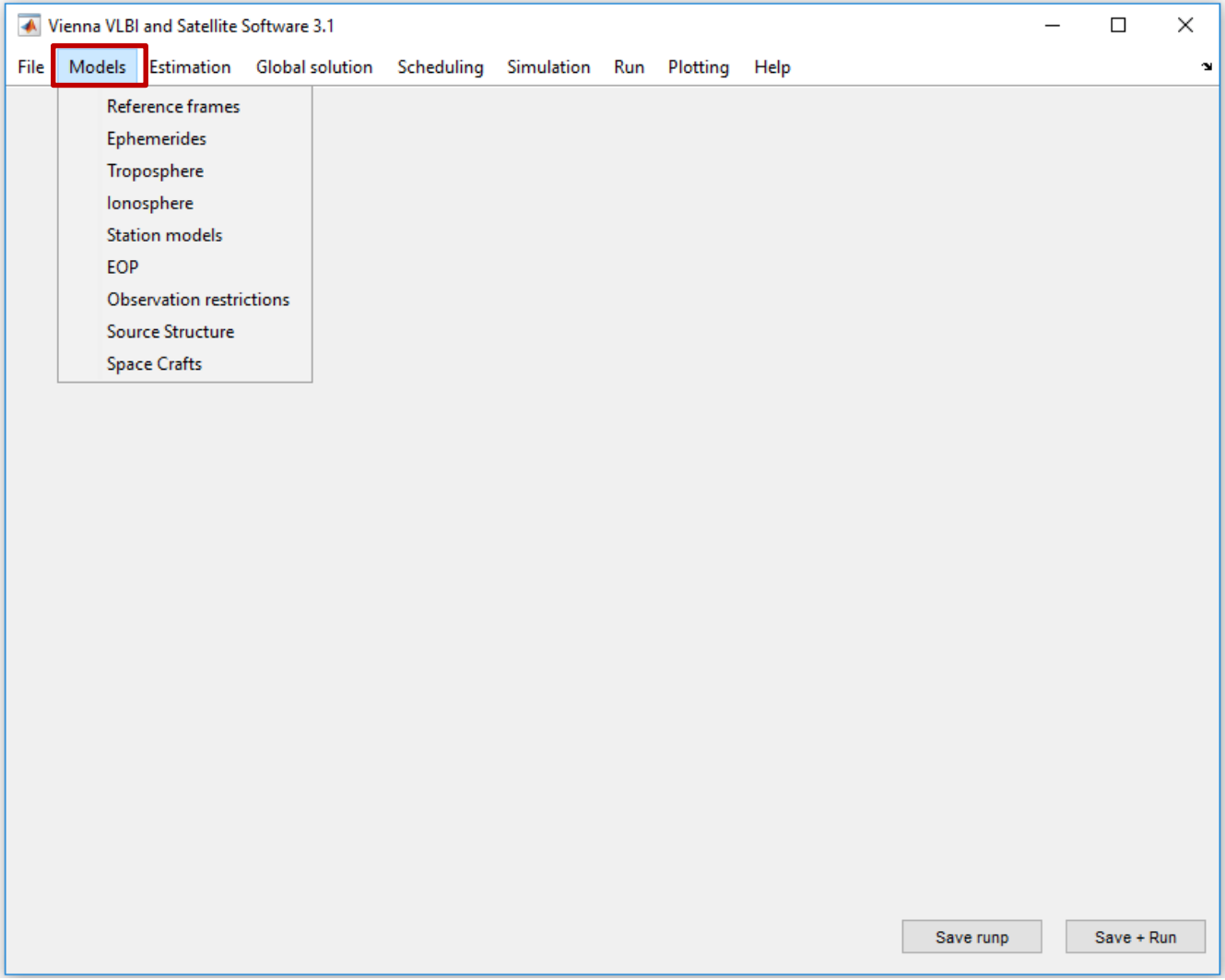
observed delay τ_{obs}

- From **observation file** (NGS, VSO, vgosDB), corrected for ionosphere

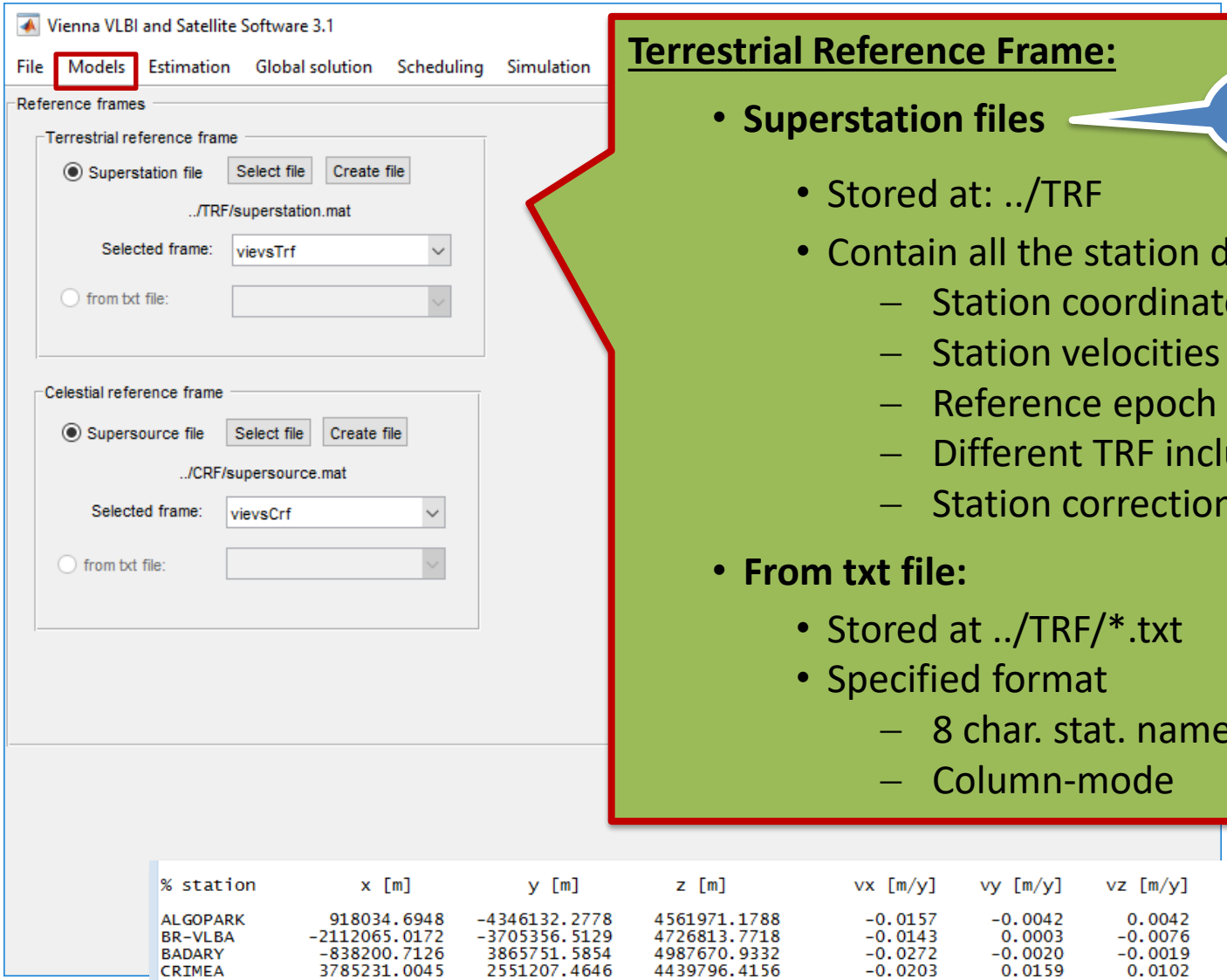


Adjustment (LSM)

Usage of VIE_MOD



Reference frames - TRF



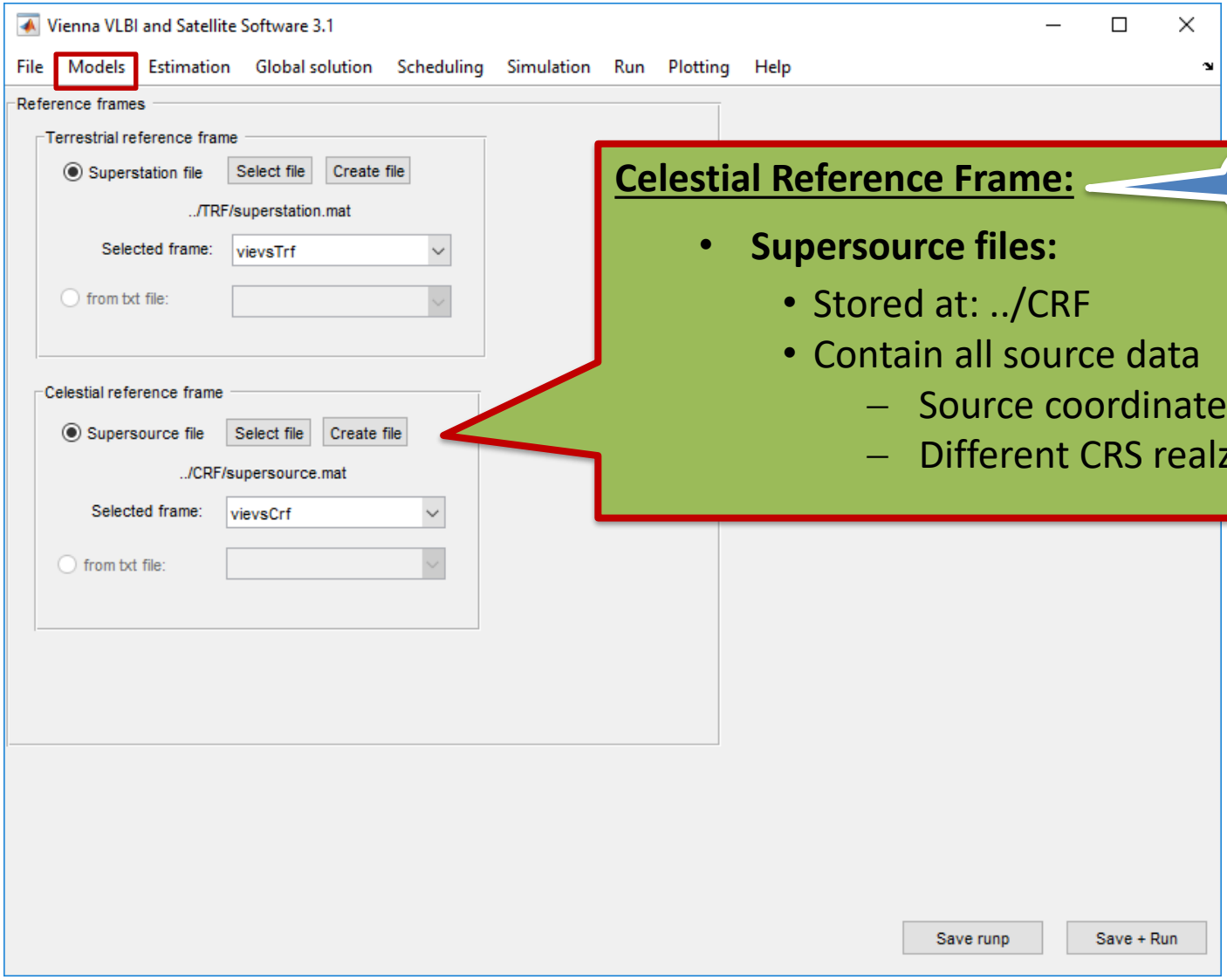
Terrestrial Reference Frame:

- **Superstation files**
  - Stored at: ../TRF
  - Contain all the station data
    - Station coordinates (TRS)
    - Station velocities
    - Reference epoch
    - Different TRF included
    - Station corrections
- **From txt file:**
  - Stored at ../TRF/*.txt
  - Specified format
    - 8 char. stat. name
    - Column-mode

Exercise!

% station	x [m]	y [m]	z [m]	vx [m/y]	vy [m/y]	vz [m/y]	epoch	start	end
ALGOPARK	918034.6948	-4346132.2778	4561971.1788	-0.0157	-0.0042	0.0042	51544	0	99999
BR-VLBA	-2112065.0172	-3705356.5129	4726813.7718	-0.0143	0.0003	-0.0076	51544	0	99999
BADARY	-838200.7126	3865751.5854	4987670.9332	-0.0272	-0.0020	-0.0019	51544	0	99999
CRIMEA	3785231.0045	2551207.4646	4439796.4156	-0.0203	0.0159	0.0102	51544	0	99999
CTVASTJ	2612545.6380	-3426878.7527	4686756.1070	-0.0162	-0.0042	0.0111	51544	0	99999
DSS45	-4460935.5060	2682765.7012	-3674381.0520	-0.0357	0.0010	0.0457	51544	0	99999
DSS65	4849336.6707	-360488.7368	4114748.8877	-0.0068	0.0189	0.0155	51544	0	50553
DSS65	4849336.6685	-360488.7334	4114748.8760	-0.0068	0.0189	0.0155	51544	50553	99999
DSS15	-2353538.8966	-4641649.4516	3676669.9816	-0.0183	0.0062	-0.0027	51544	0	48800
DSS15	-2353538.8964	-4641649.4590	3676669.9703	-0.0183	0.0062	-0.0027	51544	48800	99999

Reference frames - CRF

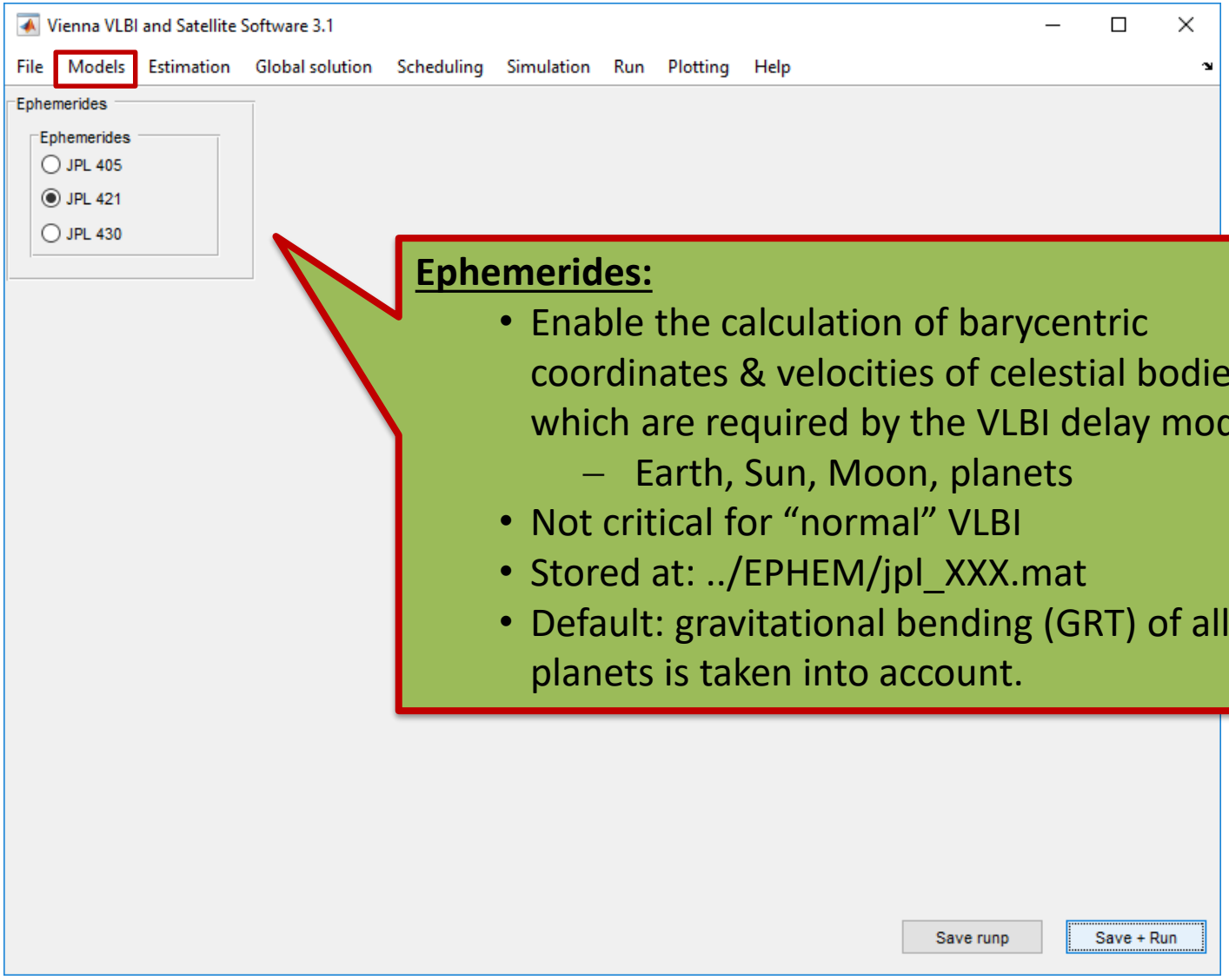


Celestial Reference Frame:

- **Supersource files:**
  - Stored at: ../CRF
  - Contain all source data
    - Source coordinates(Ra, Dec)
    - Different CRS realzations

Exercise!

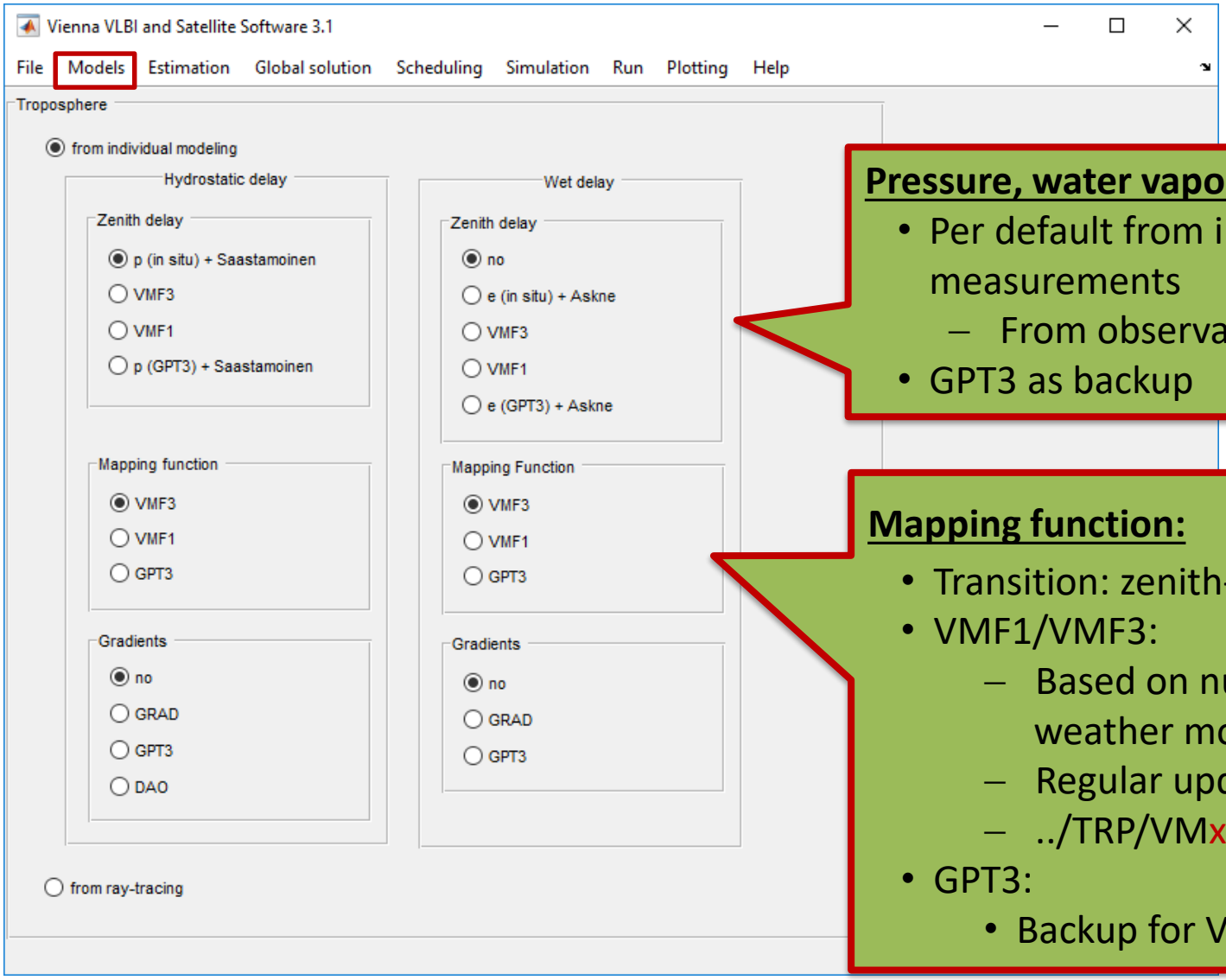
Ephemerides



Ephemerides:

- Enable the calculation of barycentric coordinates & velocities of celestial bodies, which are required by the VLBI delay model.
  - Earth, Sun, Moon, planets
- Not critical for “normal” VLBI
- Stored at: ../EPHEM/jpl_XXX.mat
- Default: gravitational bending (GRT) of all planets is taken into account.

Troposphere (1)



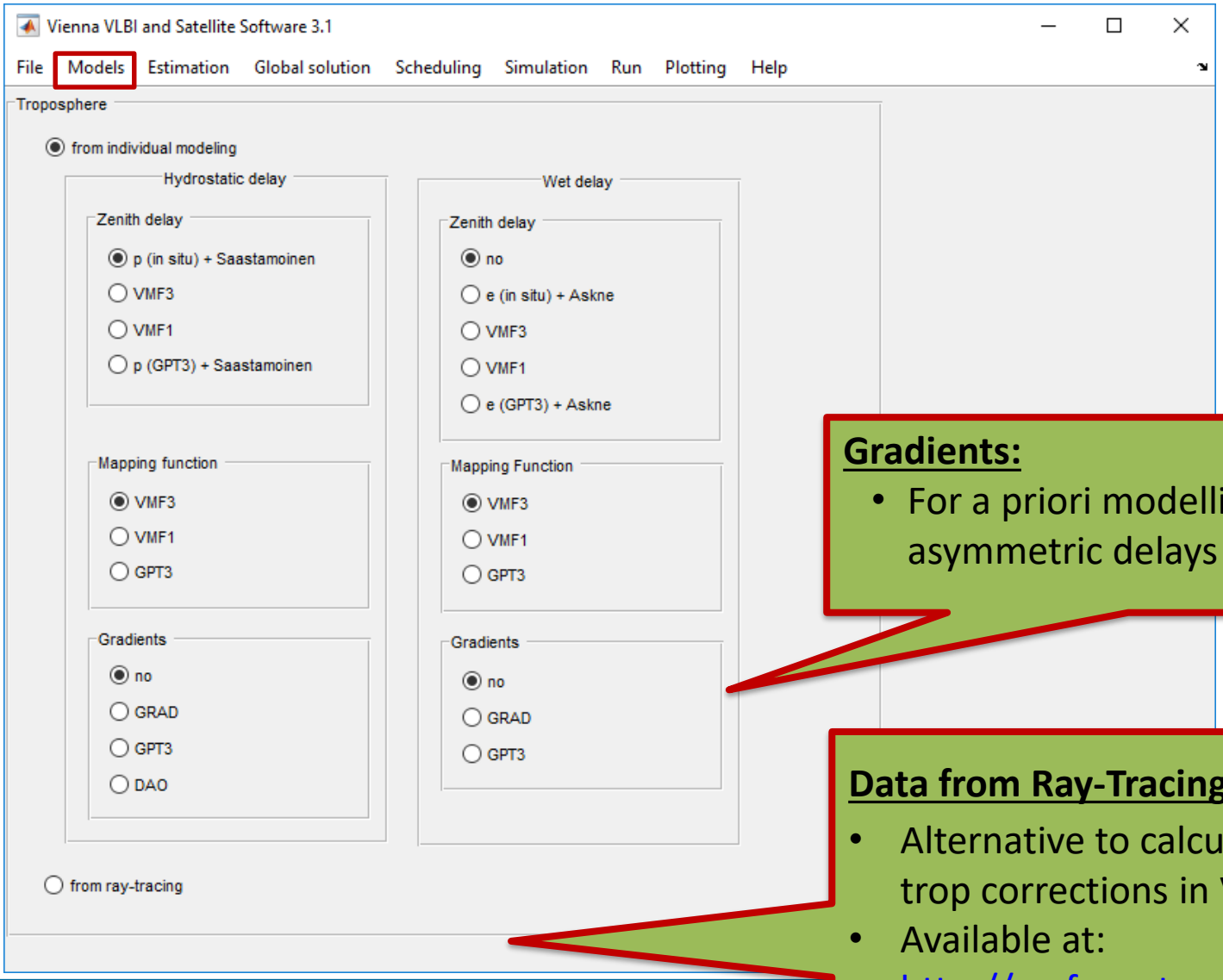
Pressure, water vapor pressure:

- Per default from in situ measurements
  - From observation files
- GPT3 as backup

Mapping function:

- Transition: zenith- to slant-delays
- VMF1/VMF3:
  - Based on nummerical weather models
  - Regular updates!
  - ../TRP/VMx/yyyyy.vmfx_r
- GPT3:
  - Backup for VMF1 and VMF3

Troposphere (2)



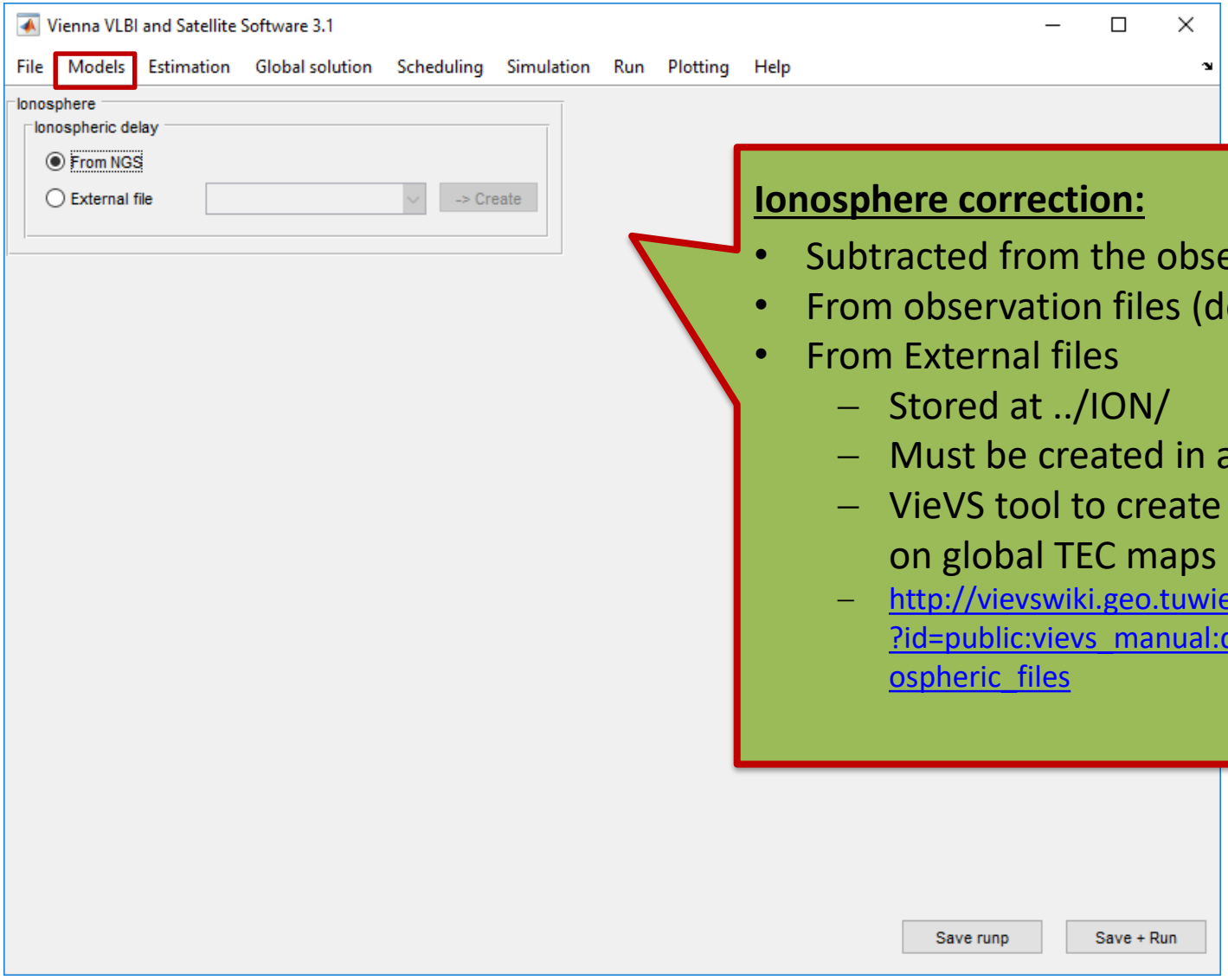
Gradients:

- For a priori modelling of azimuthally asymmetric delays

Data from Ray-Tracing

- Alternative to calculation of a priori trop corrections in VIE_MOD
- Available at: http://vmf.geo.tuwien.ac.at/

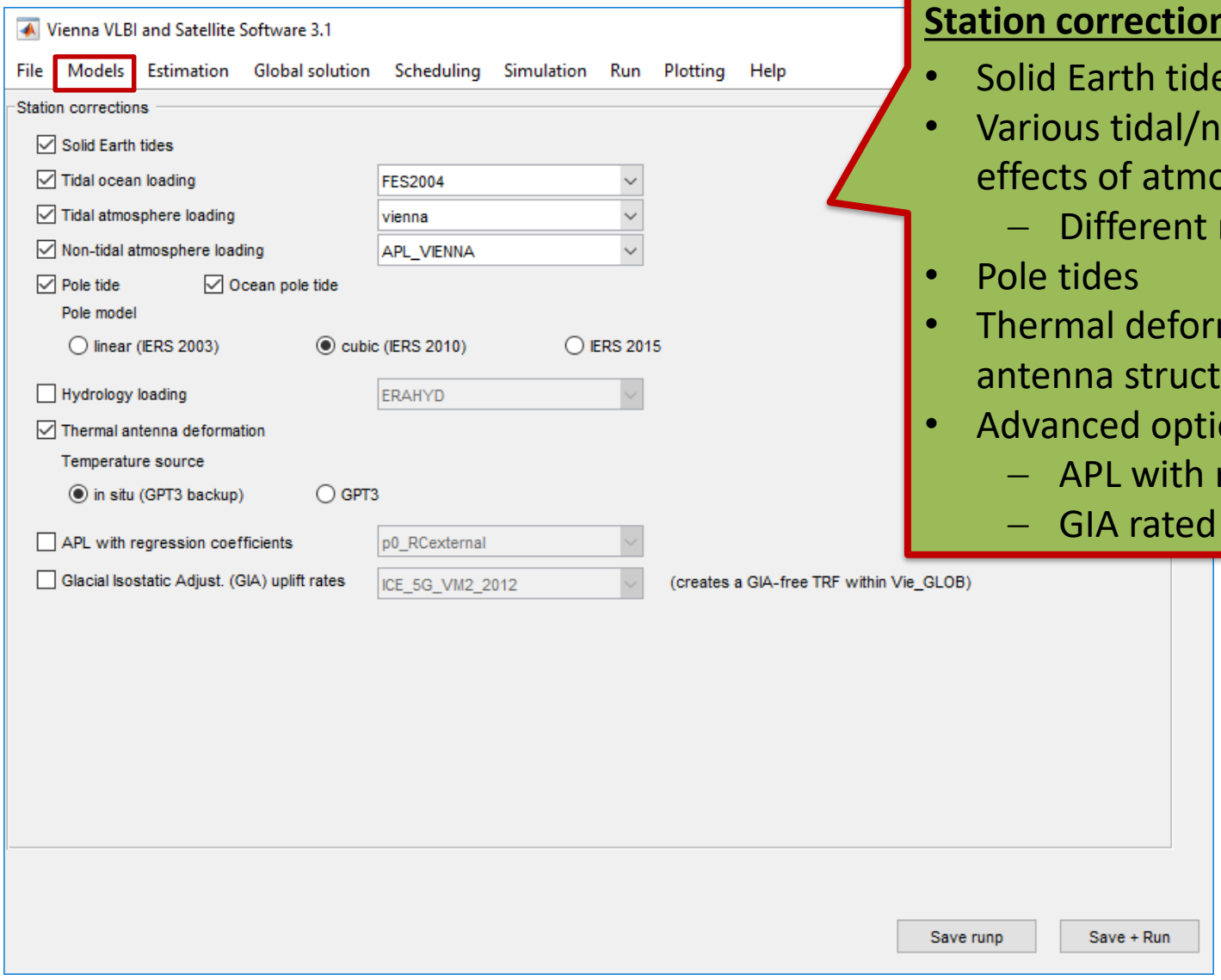
Ionosphere



Ionosphere correction:

- Subtracted from the observed delay
- From observation files (default)
- From External files
  - Stored at ../ION/
  - Must be created in advance
  - VieVS tool to create them based on global TEC maps
  - http://vievswiki.geo.tuwien.ac.at/doku.php?id=public:vievs_manual:data#external_ionospheric_files

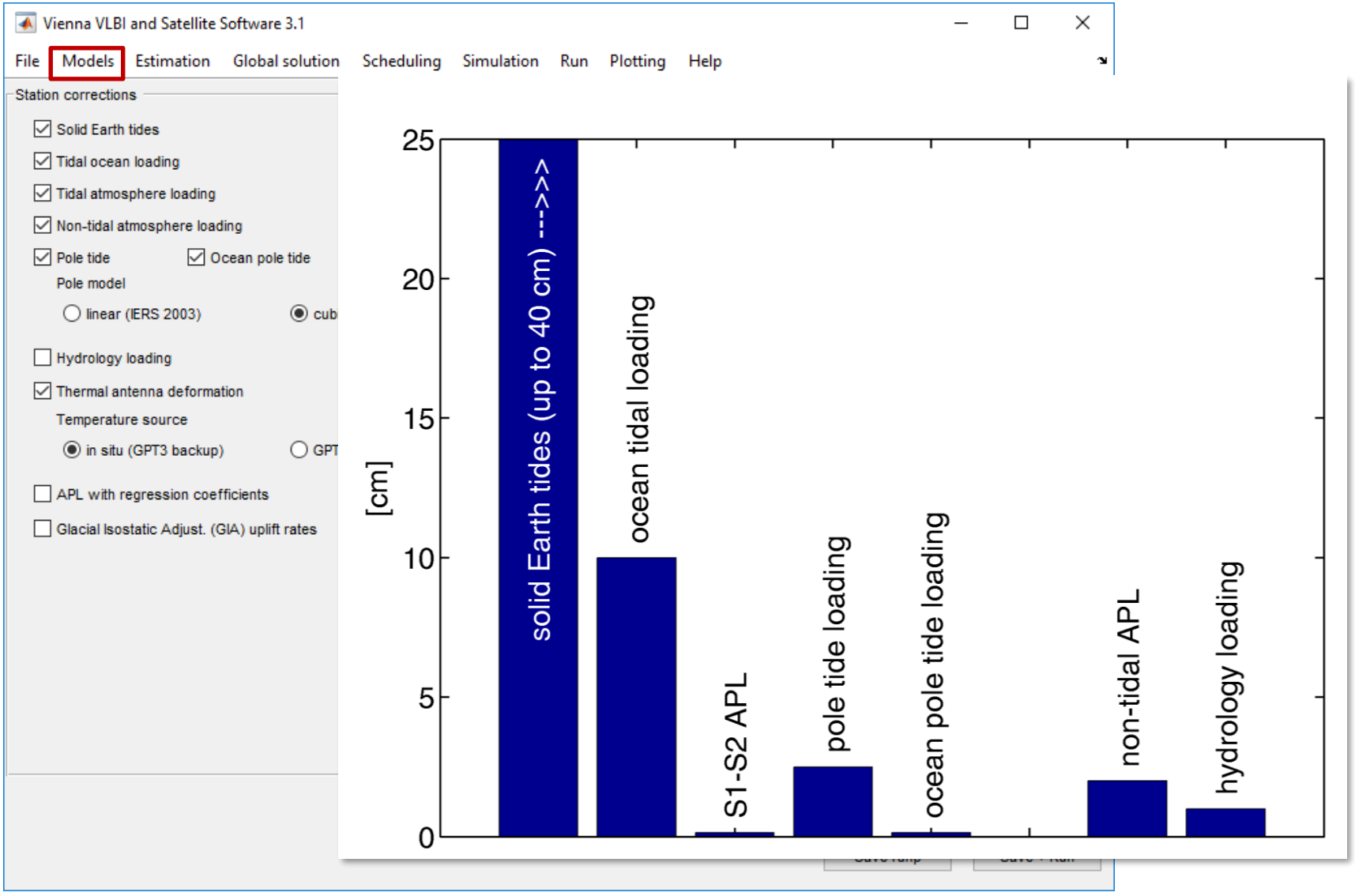
Station corrections (1)



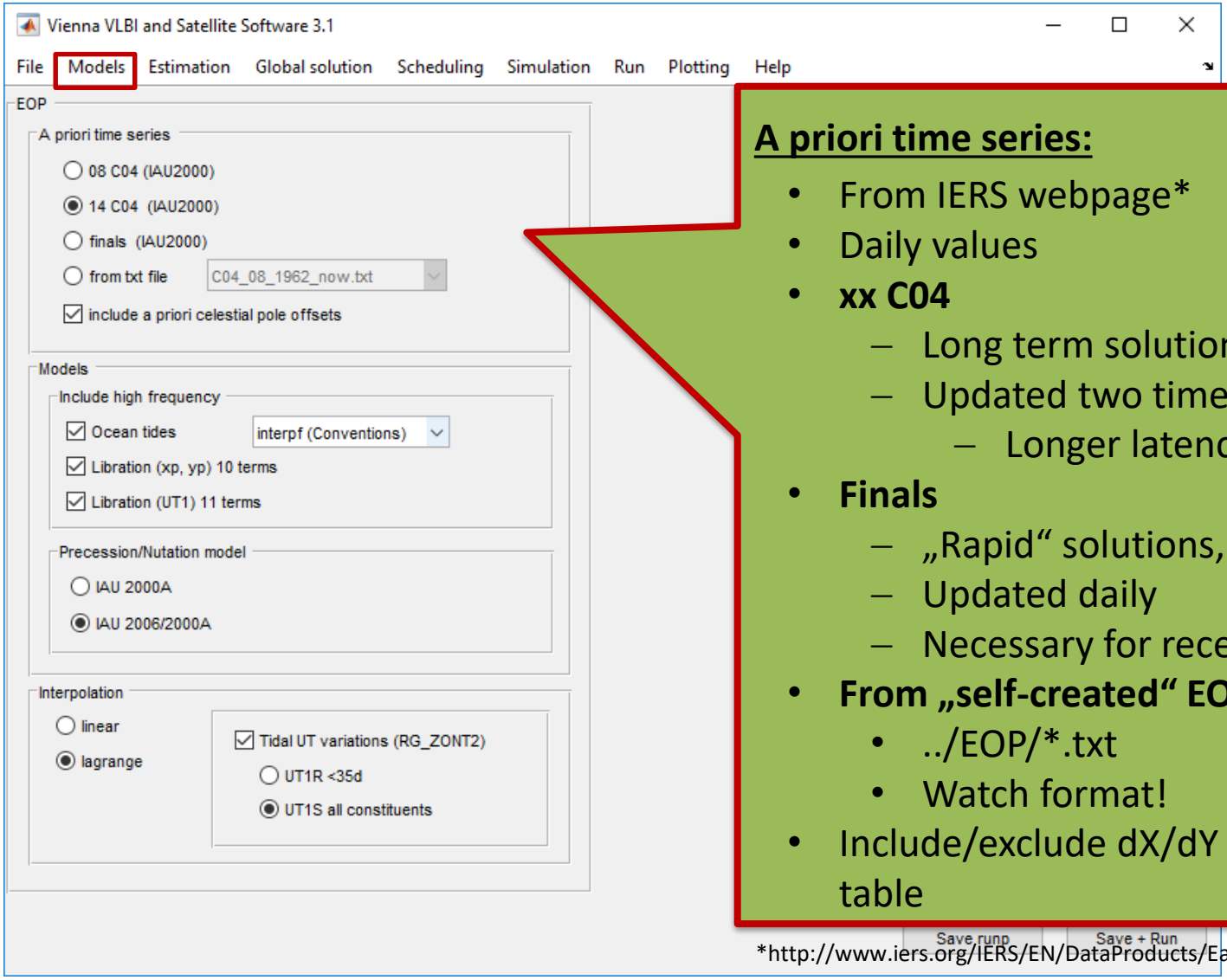
Station corrections:

- Solid Earth tides
- Various tidal/non-tidal loading effects of atmosphere and oceans
  - Different models
- Pole tides
- Thermal deformation of the antenna structure
- Advanced options
  - APL with regression coeff.
  - GIA rated

Station corrections (2)



EOP (1)

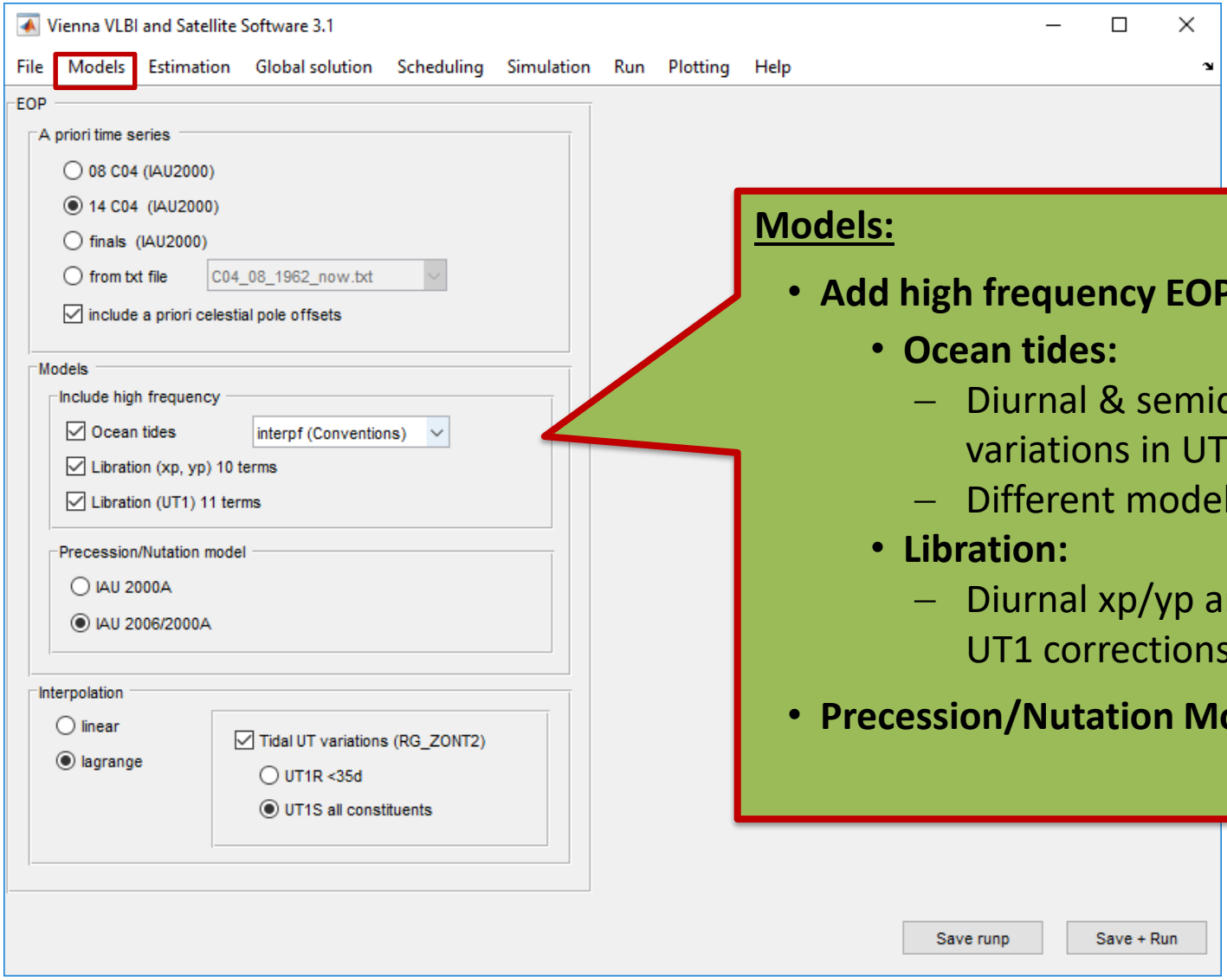


A priori time series:

- From IERS webpage*
- Daily values
- **xx C04**
  - Long term solution, high accuracy
  - Updated two times/week
    - Longer latency!
- **Finals**
  - „Rapid“ solutions, lower accuracy
  - Updated daily
  - Necessary for recent sessions, e.g. int
- **From „self-created“ EOP text file:**
  - ../EOP/*.txt
  - Watch format!
- Include/exclude dX/dY from EOP a priori table

*http://www.iers.org/IERS/EN/DataProducts/EarthOrientationData/eop.html

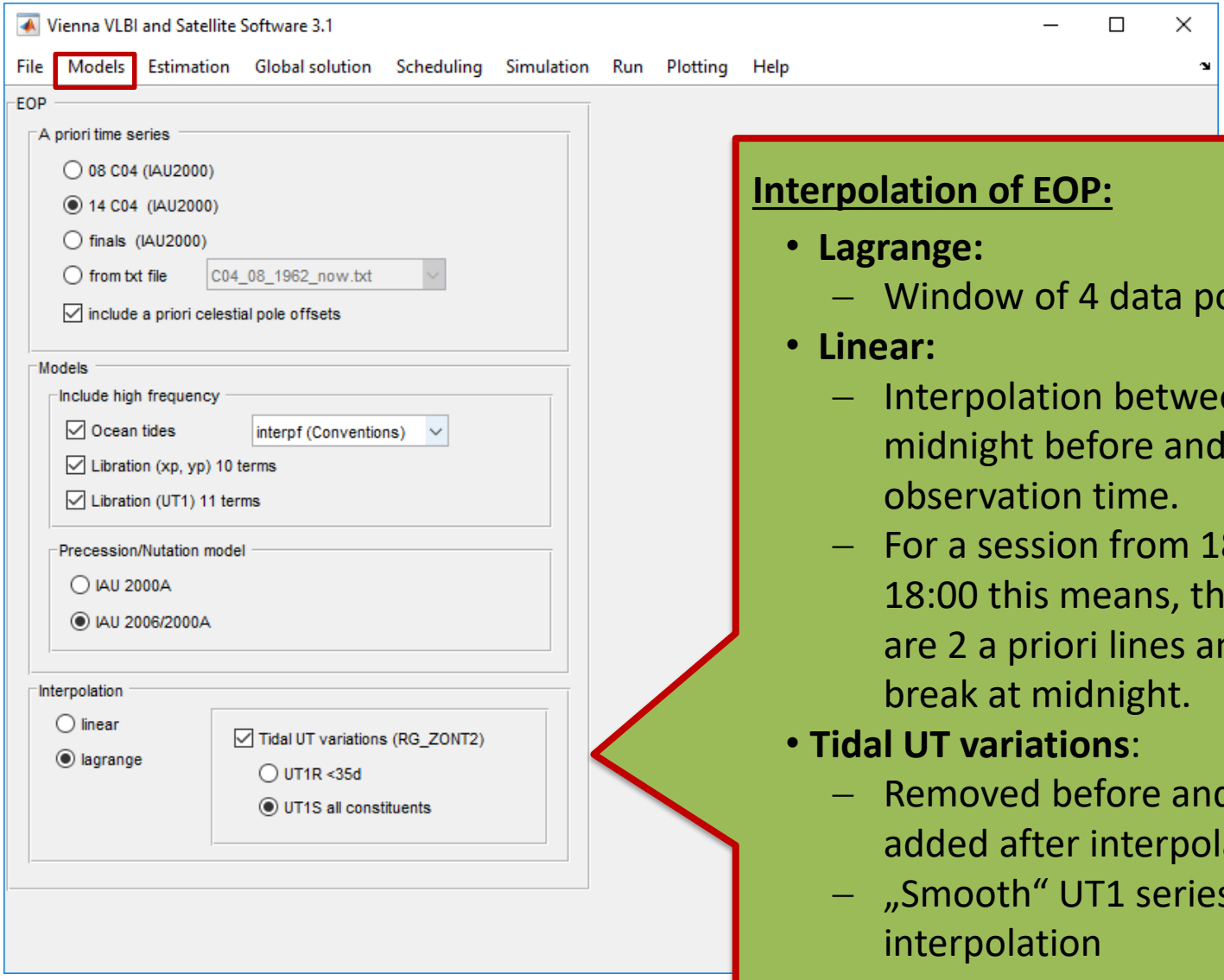
EOP (2)



Models:

- **Add high frequency EOP corrections**
  - **Ocean tides:**
    - Diurnal & semidiurnal variations in UT1 and xp/yp
    - Different models
  - **Libration:**
    - Diurnal xp/yp and semidurnal UT1 corrections
- **Precession/Nutation Model**

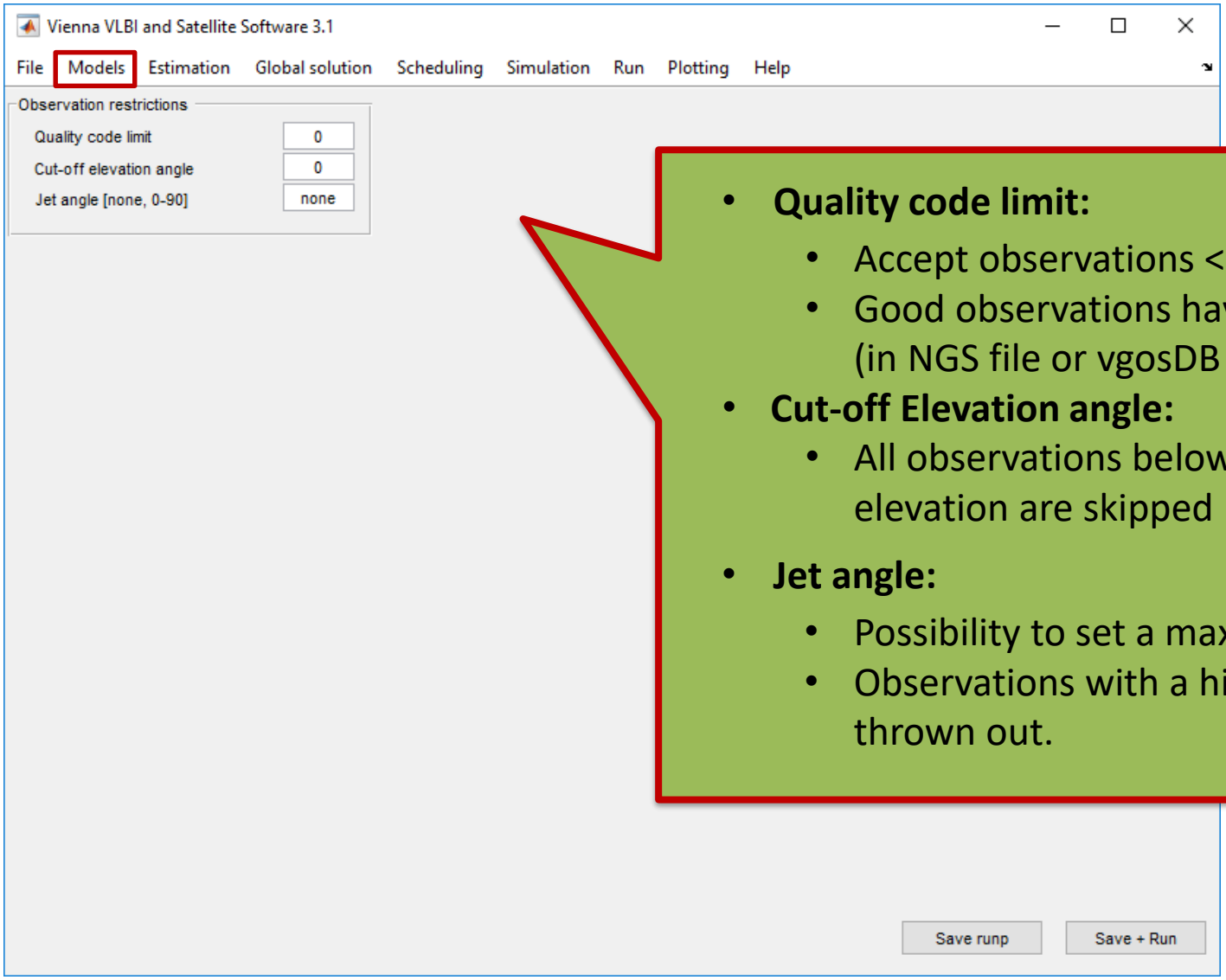
EOP (3)



Interpolation of EOP:

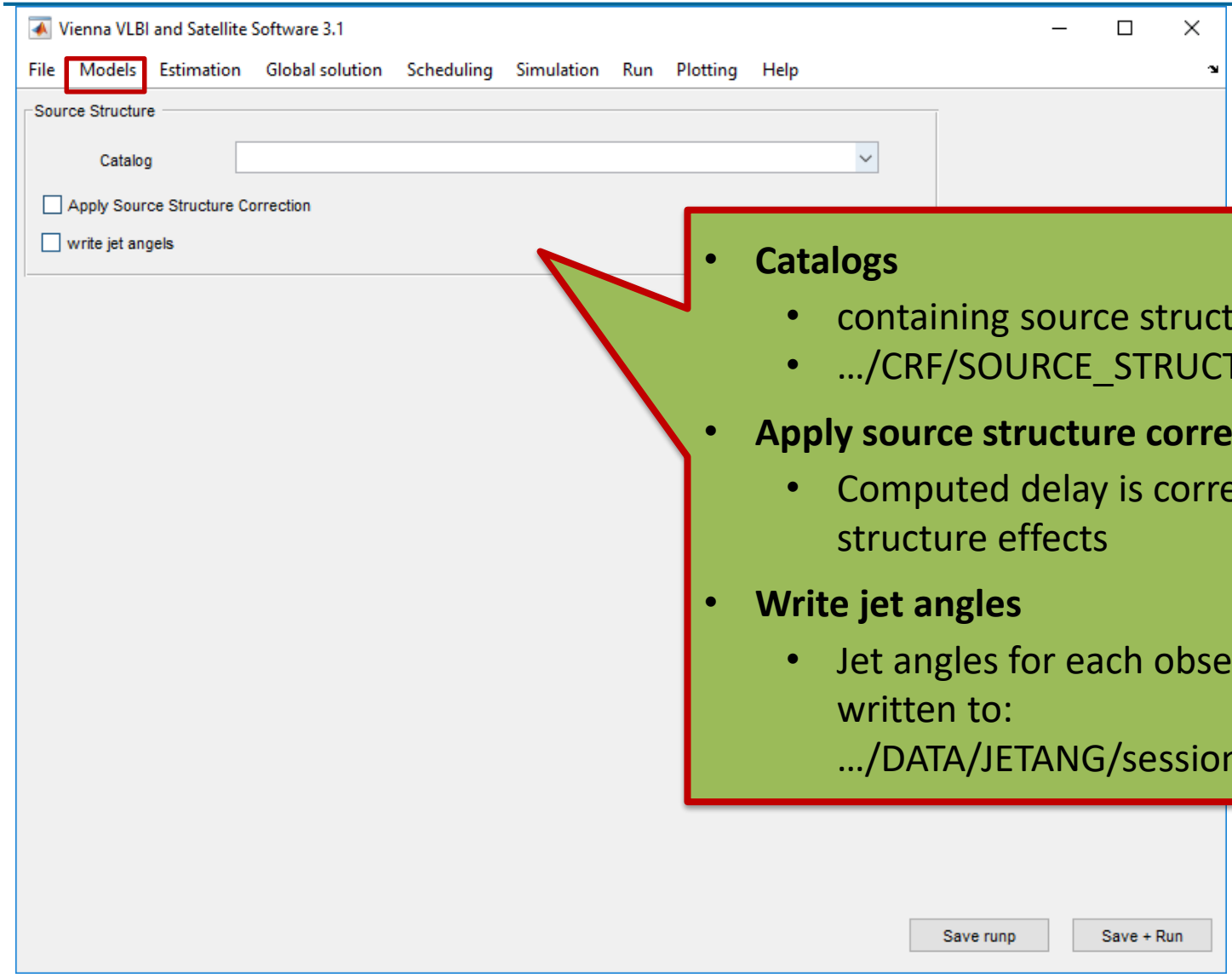
- **Lagrange:**
  - Window of 4 data points
- **Linear:**
  - Interpolation between the midnight before and after observation time.
  - For a session from 18:00 to 18:00 this means, that there are 2 a priori lines and a break at midnight.
- **Tidal UT variations**:
  - Removed before and re-added after interpolation
  - „Smooth“ UT1 series for interpolation

Observation restrictions



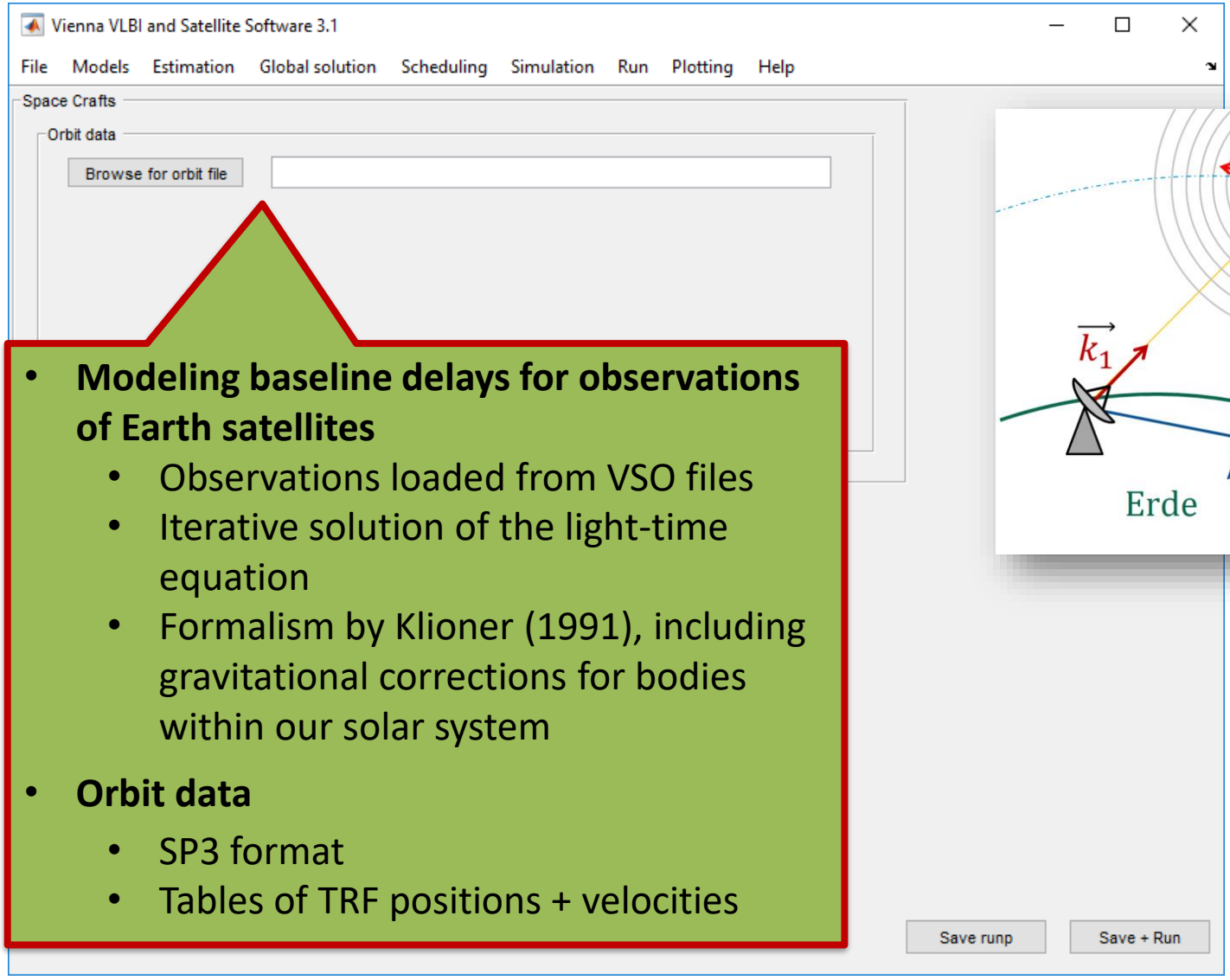
- **Quality code limit:**
  - Accept observations <= defined limit
  - Good observations have quality code 0 (in NGS file or vgosDB database)
- **Cut-off Elevation angle:**
  - All observations below this local elevation are skipped
- **Jet angle:**
  - Possibility to set a max. jet angle
  - Observations with a higher angle are thrown out.

Source structure

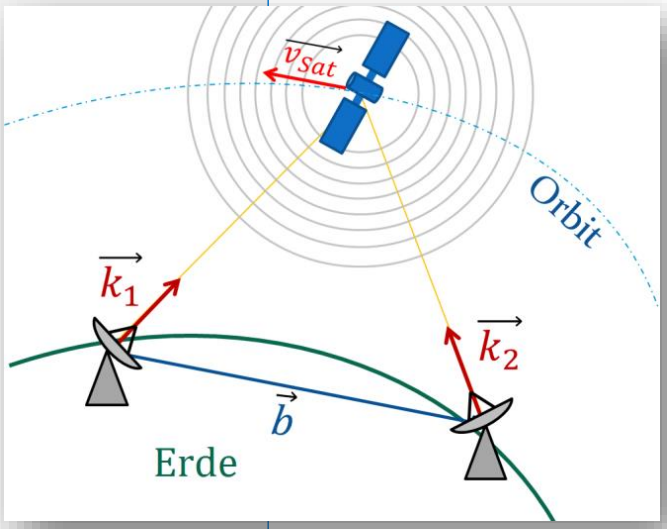


- **Catalogs**
  - containing source structure data
  - …/CRF/SOURCE_STRUCTURE_CAT/*.cat
- **Apply source structure correction**
  - Computed delay is corrected for source structure effects
- **Write jet angles**
  - Jet angles for each observation are written to: …/DATA/JETANG/session(1:9).JET

Space crafts



- **Modeling baseline delays for observations of Earth satellites**
  - Observations loaded from VSO files
  - Iterative solution of the light-time equation
  - Formalism by Klioner (1991), including gravitational corrections for bodies within our solar system
- **Orbit data**
  - SP3 format
  - Tables of TRF positions + velocities



Demonstration

- Run session in VieVS!
  - 18JUL23XA (vgosDB)

Results

- **Computed delay times τ_{comp}**
- **Partial derivatives $\frac{\partial \tau}{\partial VAR}$**
- **Results are stored in …/DATA/LEVEL1/<session name>_antenna**
  _parameter
  _scan
  _sources

(http://vievswiki.geo.tuwien.ac.at/doku.php?id=public:vievs_manual:important_files#vievs_data_structures)

➔ **Used as input for VIE_LSM**

Last slide

- **Vie_Mod models….**
  - Computed (theoretical) delay times τ_{comp}
  - Partial derivatives $\frac{\partial \tau}{\partial VAR}$
- **Modelling in agreement with IERS Conventions**
- **For more information…**
  - Check the code (main function: *vie_mod.m*)
  - Detailed documentation: …/DOC/vie_mod.pdf
  - VieVS-Wiki
    http://vievswiki.geo.tuwien.ac.at/doku.php?id=public:vievs_manual:input_parameters