Vienna VLBI and Satellite Software

How to simulate VLBI observations with VieVS

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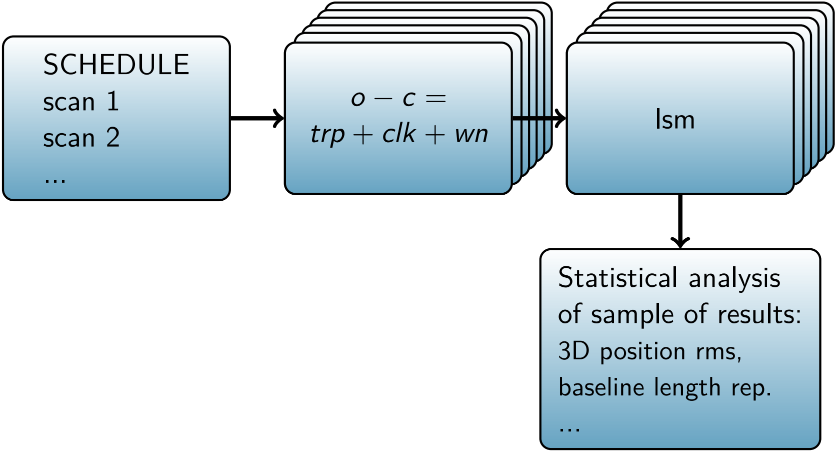
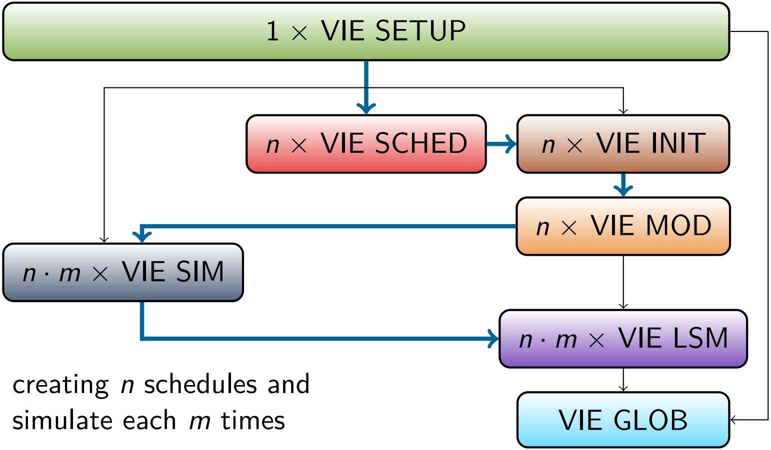
Why simulations?

- generate artificial delay observables - useful to test
    - new scheduling strategies
    - different station network geometries
    - antenna specifications
    - the influence of systematic effects, e.g. source structure
    - effect of different models

Simulation procedure



Implementation in VieVS



creating n schedules and simulate each m times

What is simulated?

$$o - c = \underbrace{\left(zwd_2 \cdot mf\left(el_2\right) + clk_2\right)}_{station2} - \underbrace{\left(zwd_1 \cdot mf\left(el_1\right) + clk_1\right)}_{station1} + wn_{bsl}$$

What is simulated? troposphere zenith wet delay

$$o-c = \underbrace{\left(zwd_2 \cdot mf(el_2) + clk_2 \right)}_{station2} - \underbrace{\left(zwd_1 \cdot mf(el_1) + clk_1 \right)}_{station1} + wn_{bsl}$$

zwd - troposphere zenith wet delay

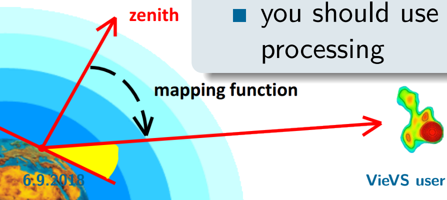
- provided by a turbulence simulator
- simulated per station
  - based on the approach by Nilsson et al. (2007)
  - accounts for spatial and temporal correlation

What is simulated? mapping function

$$o-c = \underbrace{\left(zwd_2 \cdot mf(el_2) + clk_2\right)}_{station2} - \underbrace{\left(zwd_1 \cdot mf(el_1) + clk_1\right)}_{station1} + wn_{bsl}$$

$mf(el)$ - mapping function (elevation)

- simulated per station
- you should use the same mf for creation and processing



What is simulated? station clock

$$o-c = \underbrace{\left(zwd_2 \cdot mf(el_2) + clk_2\right)}_{station2} - \underbrace{\left(zwd_1 \cdot mf(el_1) + clk_1\right)}_{station1} + wn_{bsl}$$

clk - station clock

- simulated as sum of a random walk and an integrated random walk process
- simulated per station
  - according to Herring et al. 1990

What is simulated? white noise

$$o-c = \underbrace{(zwd_2 \cdot mf(el_2) + clk_2)}_{station2} - \underbrace{(zwd_1 \cdot mf(el_1) + clk_1)}_{station1} + wn_{bsl}$$

wn - white noise

- simulated per baseline

Before running VIE_SIM

- Do not use any outlier files
- Make sure to set the quality code limit to >9 (it is important that all observations are used for the simulation)
- After the simulation you can process the simulated data with any options you like

Parameters

- tropospheric parameters
  - Cn refractive index structure constant
  - H effective height of wet troposphere
  - vn, ve components of the wind vector
  - $wzd0$ a priori zenith wet delay
  - $dhseg$ correlation interval
  - dh stepwidth for the numerical integration
- clock
  - ASD Allan Standard Devaiation
  - @ at this amount of minutes minutes
- white noise
  - wn white noise for quasars
  - wn_sat white noise for satellites

Turbulence file

- holds individual parameters for each station
- stored in *VieVS/DATA/TURB*

# station	Cn	H	vn	ve	wzd0	dhseg	dh	ASD	@	wn	wn_sat
BADARY	1.37	2000	0.0	8.0	250	2	200	1e-14	50	32	50
TSUKUB32	3.45	2000	0.0	8.0	250	2	200	1e-14	50	32	50
KOKEE	1.39	2000	0.0	8.0	250	2	200	1e-14	50	32	50
NYALES20	0.65	2000	0.0	8.0	250	2	200	1e-14	50	32	50
HOBART12	1.60	2000	0.0	8.0	250	2	200	1e-14	50	32	50
FORTLEZA	2.46	2000	0.0	8.0	250	2	200	1e-14	50	32	50
YEBES40M	1.48	2000	0.0	8.0	250	2	200	1e-14	50	32	50
HARTRAO	1.34	2000	0.0	8.0	250	2	200	1e-14	50	32	50
TIGOCONC	2.08	2000	0.0	8.0	250	2	200	1e-14	50	32	50
WETTZELL	1.50	2000	0.0	8.0	250	2	200	1e-14	50	32	50
ZELENCHK	1.86	2000	0.0	8.0	250	2	200	1e-14	50	32	50
ONSALA60	2.19	2000	0.0	8.0	250	2	200	1e-14	50	32	50

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Lecture VLBI Simulation

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