TU WIEN VieVS

Vienna VLBI and Satellite Software

How to simulate VLBI observations with VieVS

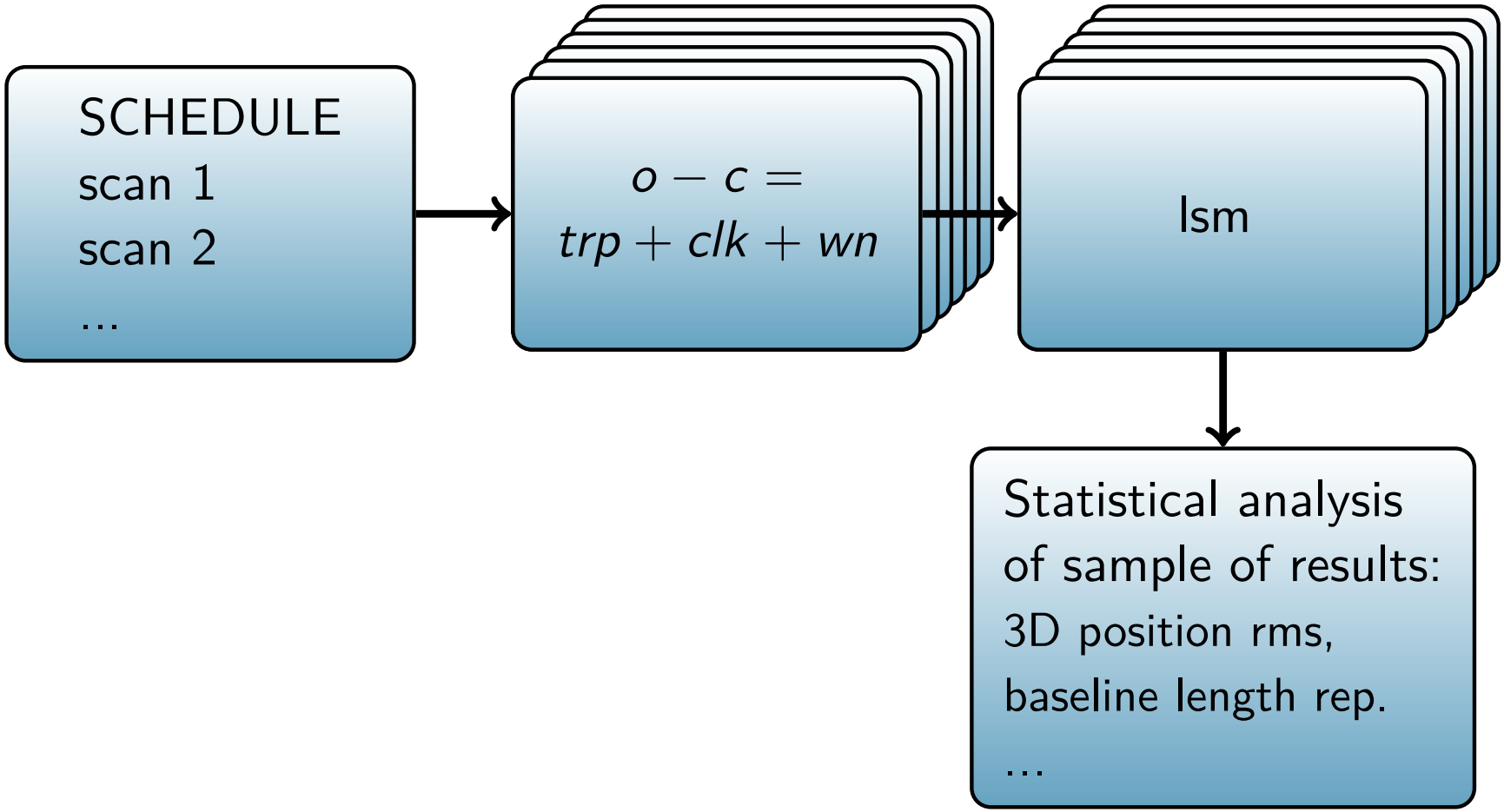
Matthias Schartner[a]

[a]TU Wien, Department of Geodesy and Geoinformation

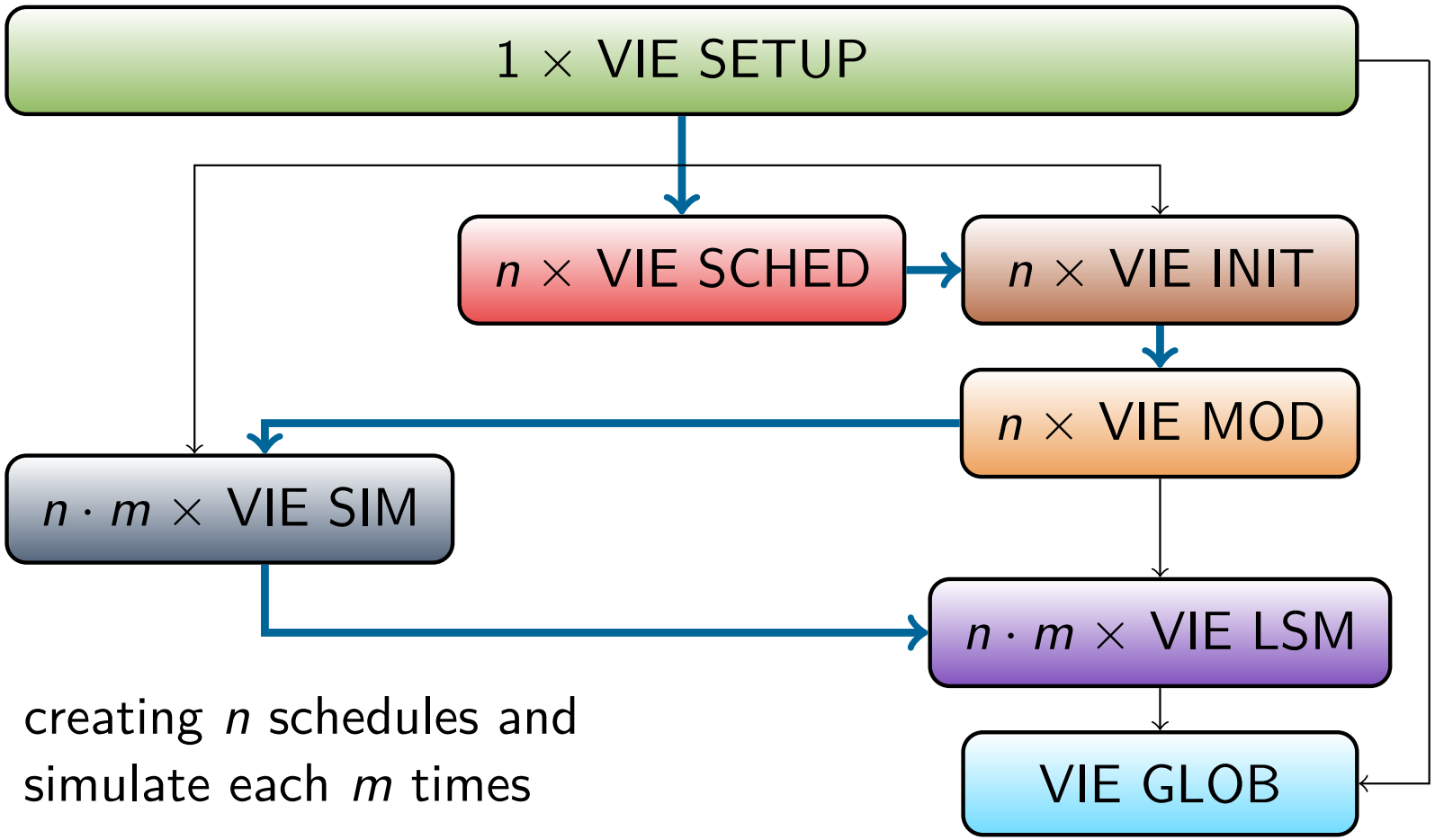
Why simulations?

- 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
- generate zero input NGS files - useful to test the impact of different models in the analysis

Simulation procedure



Implementation in VieVS



What is simulated?

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

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

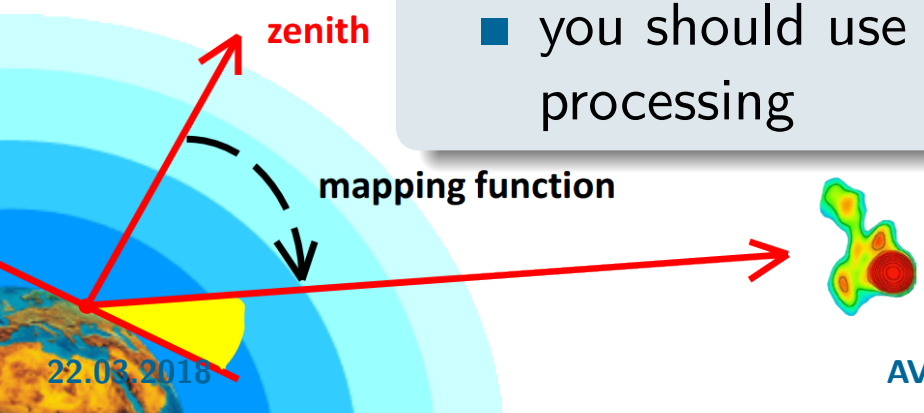
- provided by a turbulence simulator
- simulated per station
  - based on the approach by Nilsson et al. (2007)
  - accounts for spatial and temporal correlation

What is simulated? mapping function

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

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

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



What is simulated? station clock

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

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

Where is the output?

- simulated NGS files are stored to *VieVS/DATA/SIM/year*
- in *DATA/LEVEL4/your_dir* you find all simulated parameters
  - *yourSessionName_azel*: contains all azimuth, elevation and mjd information
  - *yourSessionName_mf*: contains all mapping function information
  - *yourSessionName_cov*: contains the simulated correlation matrices
  - *yourSessionName_sim*: contains the simulated values for *swd*, *clk* and *wn*

Parameters

- tropospheric parameters
  - ! *Cn* refractive index structure constant
  - *H* effective height of wet troposphere
  - *vn*, *ve* components of the wind vector
  - *wzd*0 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

Matthias Schartner[a], matthias.schartner@geo.tuwien.ac.at

[a]TU Wien, Department of Geodesy and Geoinformation