

Satellite Scheduling with VieSched++: current status and future plans

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Introduction

- scheduling observations to quasars is an integral part of VLBI but also satellite scheduling is an important topic
 - observations to satellites enable interesting scientific applications
 - variety of new possibilities
 - improvement of geodetic products, in terms of ITRF
 - provide geodetic space ties for connecting reference frames
 - tracking of satellite and space probes
 - so far, the scheduling module of the Vienna VLBI and Satellite Scheduling Software (**VieVS**) was used to generate schedules
 - supports observations to quasars and satellites
 - but this software has also some downsides
 - a new scheduling software **VieSched++** was developed
 - both software packages are freely available at <https://github.com/TUW-VieVS>
- open task: satellite scheduling in **VieSched++**

VieSched++

- developer: *Matthias Schartner*
- new, modern scheduling software written in C++
- new features
 - recursive scan selection
 - station-, source- and baseline dependent parameters
 - automated iterative source selection
 - multi-scheduling approach
 - automatic scheduling of intensive sessions
 - simulations and parameter estimation

Schedules created with VieSched++

- AUA (035, 037, 040, 041, 044, 047, 048, 049, ...)
- INT3 (021, 028, 035, 042, 049, 056, 063, 077, ...)
- T2 (130 - 138)
- OHG (117 - 124)
- EURR&D (09 - 12)
- AUM (001 - 010)
- EUR (149, 150)
- EINT (01 - 13)

Current status of Satellite Scheduling

- developer: *Helene Wolf*
- still in development
- implemented features
 - integration in GUI
 - checking visibility from all stations
 - calculation of possible observation periods for each satellite
 - adjust scans manually
 - add satellite scan to schedule
 - graphic visualisation
- missing features and future plans
 - semi-automatic mode
 - consideration of antenna slew limits
 - station based VEX-file generation
 - satellite based parameters
 - minimum number of stations per scan
 - minimum scan length
 - minimum elevation

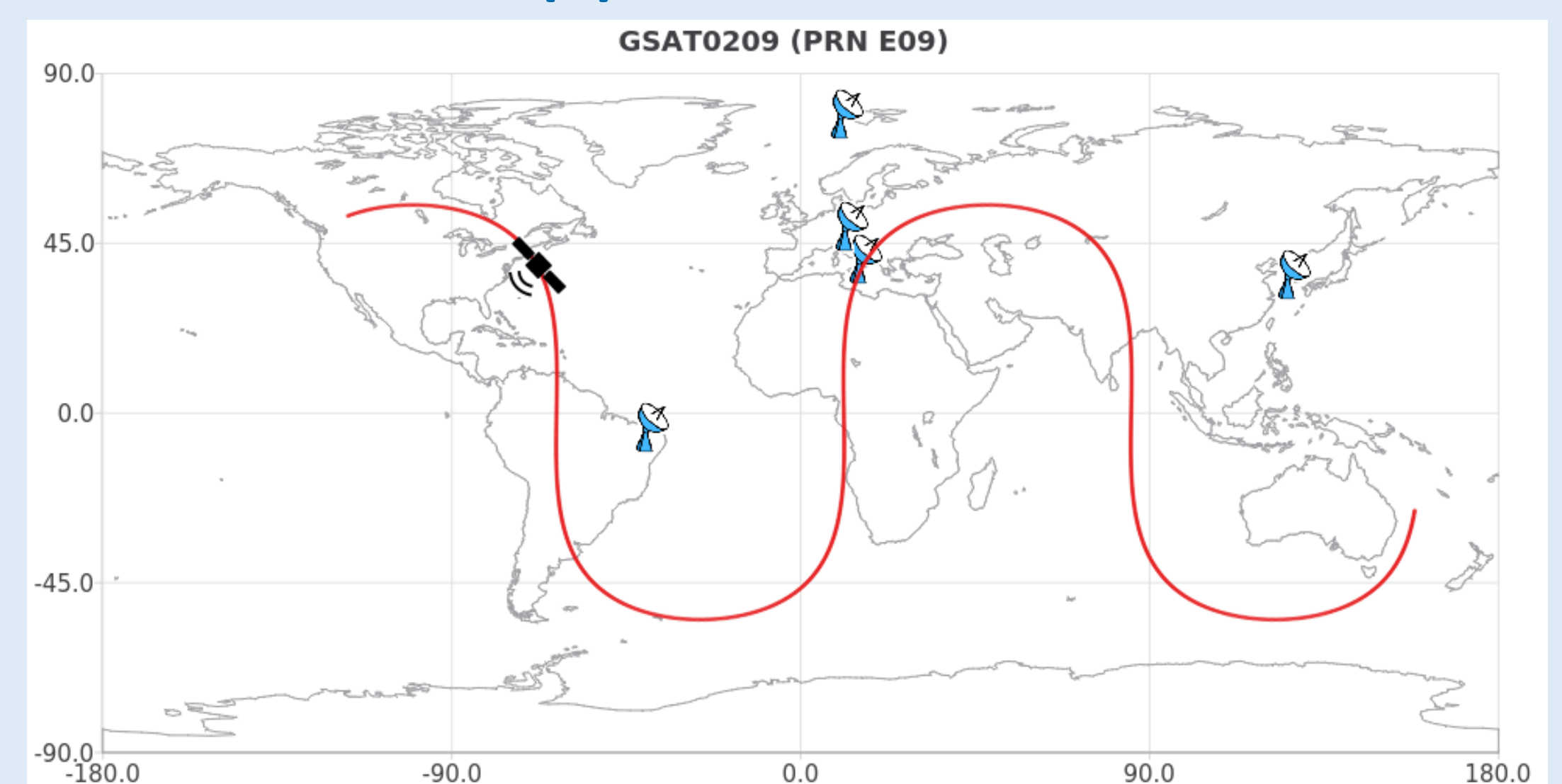
Satellite Scheduling module in VieSched++

- user loads Two-Line-Element (TLE) data of satellites
- possibility of investigating different satellites based on graphical visualisation of
 - ground track of the satellite (Figure a)
 - elevation angles over time (Figure c)
 - percentages of visibility (Figure b and e)
- implementation as semi-automatic mode
 - interactive mode
 - selection of satellites which should be observed
 - calculation of available observation periods for selected satellites
 - C++ SGP4 Satellite Library – available at <https://github.com/dnwrnr/sgp4>
 - based on station network and satellite parameters (TLE data)
 - user can select and manually adjust these scans
 - removing station from scan
 - adjust the start/ end time and duration of satellite observation
 - these scans are added as fixed scans to the schedule
 - scan specific visualisation
 - automatic mode
 - around satellite observations schedule is filled with observations to quasars

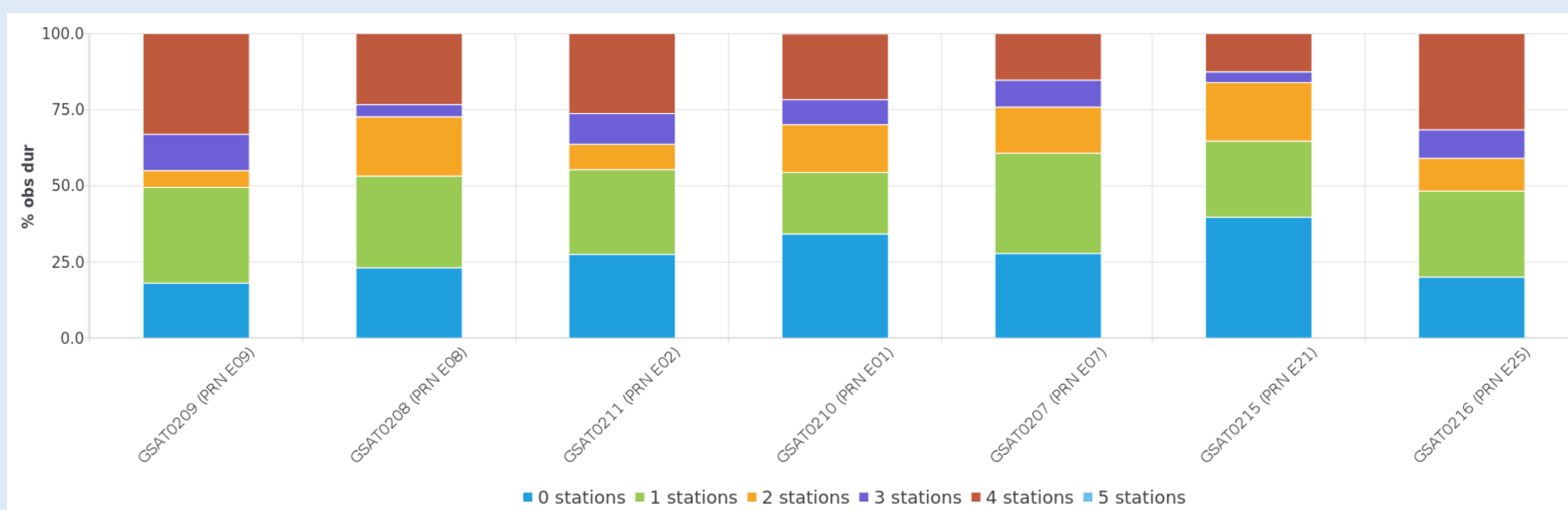
Graphic Visualisation

The satellite scheduling module allows the user to investigate and compare different satellites being potentially observed based on the graphical visualisation of their ground track (a) , elevation angles over time (c) and the percentages of their visibility (b and e). The following figures show this information for the satellite GSAT0209 for the 24 hour session R1926. The session start time was on December 23, 2019, 17 UT and the station network consists of 5 telescopes.

(a) Ground track

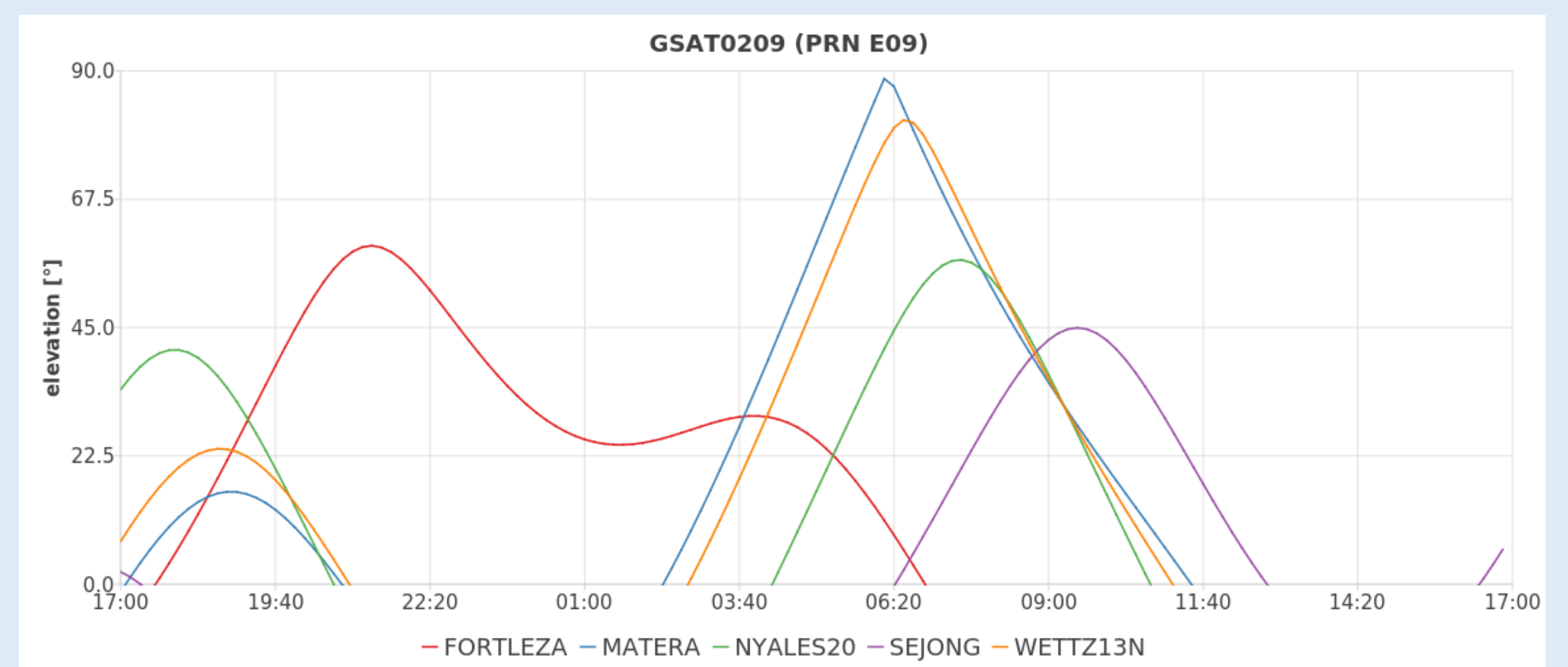


(b) Comparison of visibility percentages

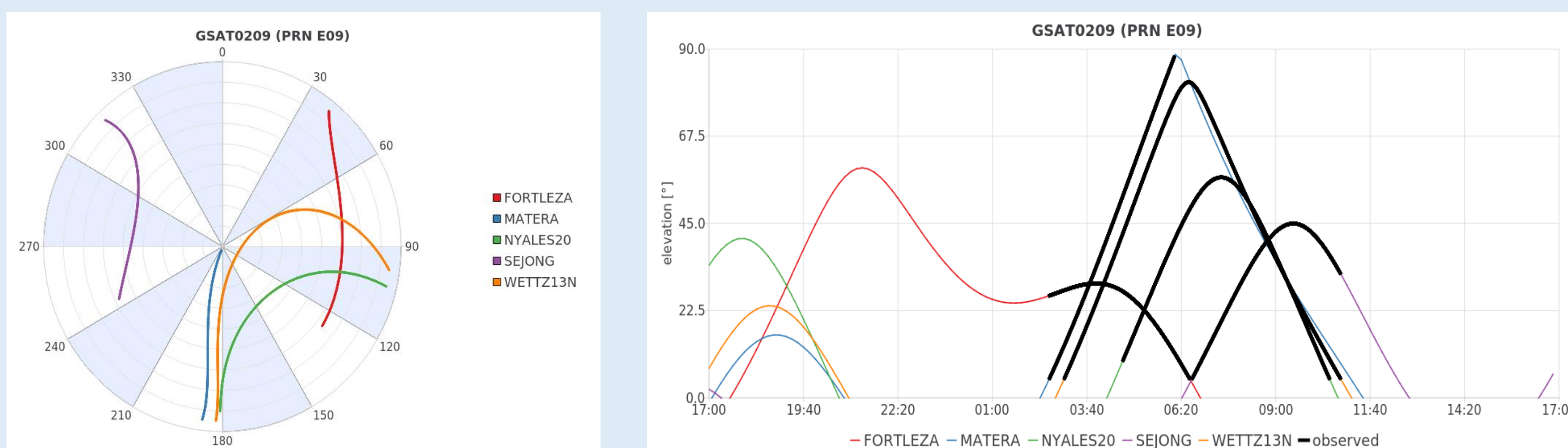


visibility percentages for seven different satellites for the session R1926

(c) Elevation angles over time



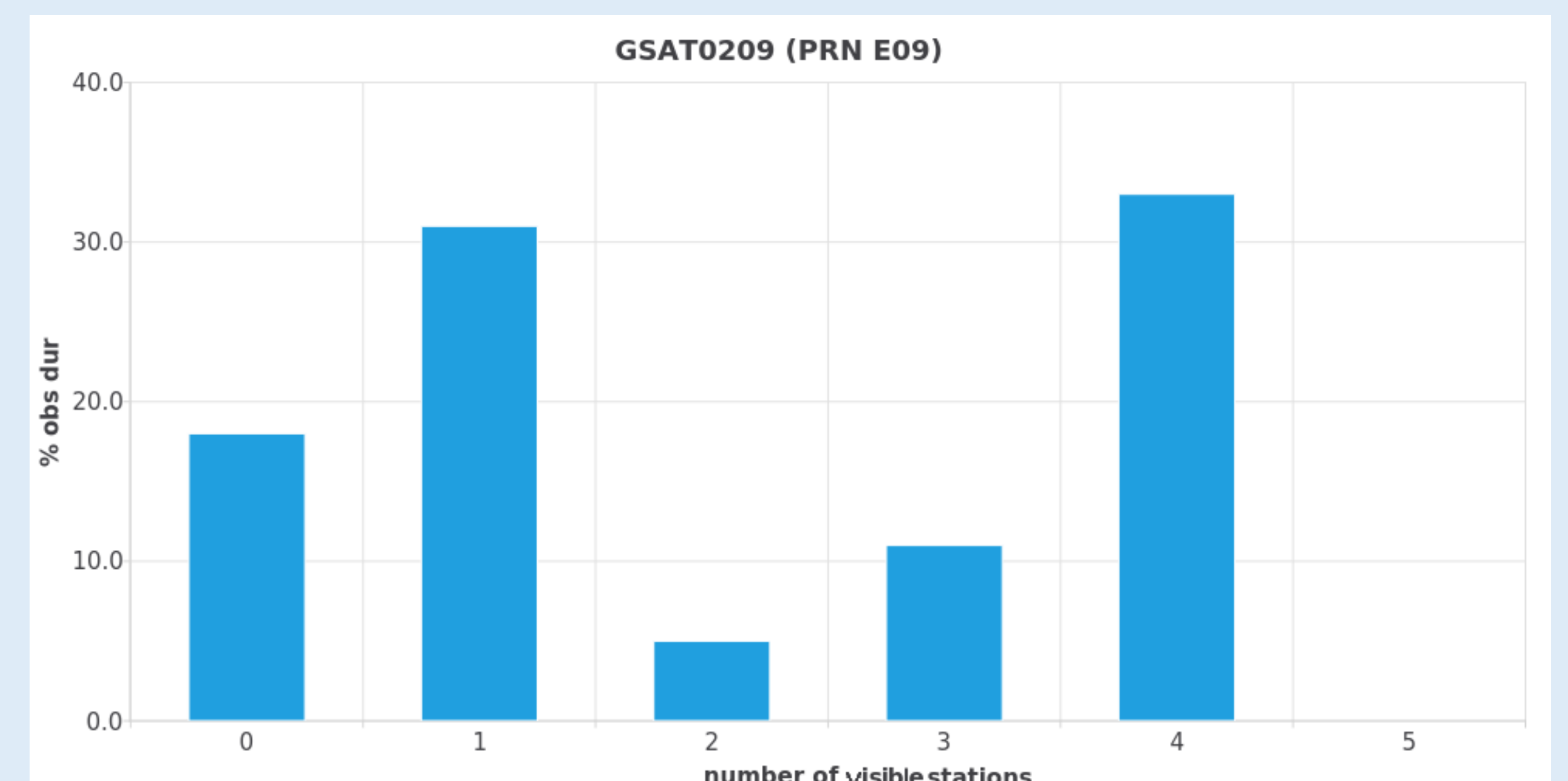
(d) Visualisation of potential satellite observations



skyplot with azimuth and elevation angles of all stations

elevation angles over time, potential satellite observation times are highlighted with black lines

(e) Percentage of visibility



References

VieVS : <https://iopscience.iop.org/article/10.1088/1538-3873/aaa22b> , **VieSched++** : <https://iopscience.iop.org/article/10.1088/1538-3873/ab1820>