Institute of Geodesy

Stefan Laller

Steyrergasse 30
A-8010 Graz

Office: ST02050

Office hours:
on appointment

s.laller@tugraz.at

# GNSS VU
# WS 2025/26

Graz, December 9th, 2025

**GNSS lab program 2**

## Analysis of different satellite constellations

Within this laboratory, analysis of different satellite constellations have to be conducted. As input data serve the files (`pos_ECSF.txt`) for earth-centered-space-fixed coordinates and (`pos_ECEF.txt`) for earth-centered-earth-fixed coordinates of GNSS satellites.

### Tasks:

- Visualize the given satellite coordinates within ECEF and ECSF systems.
- Generate groundplots of at least two arbitrary satellites. Discuss the results and evaluate them (e.g. ground track repeat, inclinations, ect.).
- Compute the DOP (Dilution of Precision) values, especially the PDOP, in between the epochs $t = 900$ until $t = 1200$ min. Use as user position your actual living place. Additionally, evaluate time series of VDOP and HDOP and compare the number of visible satellites within the time series. Thereby, vary the mask-angle, e.g. ($0°$, $5°$, $10°$, ...). Furthermore, exclude individual satellites and analyze the DOP time series.
- Choose as a second place a city in Norway and compare the DOP values with that from your living place.

### Minimal requirements for your technical report:

- Repetition of given tasks
- Execution of tasks
- Requested results and evaluation
  - visualizations and plots (time series number of satellites, skyplots, ...)
  - DOP values and time series
  - discussion of analysis

**Hand in:**
The implemented code and the technical report have to be uploaded to the TeachCenter by January 20th, 2026 at 12:00 p.m. The interview will take place on January 29th, 2026.

Philipp Berglez, Stefan Laller, Felix Salloker, December 9th, 2025

## References for execution

- You may use as parameters for coordinate transformation (cartesian $\longleftrightarrow$ geodetic), according to WGS84: $a = 6378137.0$ m, $f = 1/298.257223563$
- Rotation matrix for transformation between local $\longrightarrow$ global system:

$$R = \begin{pmatrix} -\sin\varphi\cos\lambda & -\sin\lambda & \cos\varphi\cos\lambda \\ -\sin\varphi\sin\lambda & \cos\lambda & \cos\varphi\sin\lambda \\ \cos\varphi & 0 & \sin\varphi \end{pmatrix}$$

- Transformation (cartesian $\longleftrightarrow$ geodetic) system

$$X = (N+h)\cos\varphi\cos\lambda \qquad \varphi = \tan^{-1}\left(\frac{Z + e'^2\, b\, sin^3\vartheta}{p - e^2\, a\, \cos^3\vartheta}\right)$$

$$Y = (N+h)\cos\varphi\sin\lambda \qquad \lambda = \tan^{-1}\left(\frac{Y}{X}\right)$$

$$Z = \left(\frac{b^2}{a^2}\,N + h\right)\sin\varphi \qquad h = \frac{p}{\cos\varphi} - N$$

with

$$N = \frac{a^2}{\sqrt{a^2\cos^2\varphi + b^2\sin^2\varphi}} \qquad p = \sqrt{X^2 + Y^2}$$

$$b = a\cdot(1-f) \qquad \vartheta = \tan^{-1}\left(\frac{Z\,a}{p\,b}\right)$$

$$e'^2 = \frac{a^2 - b^2}{b^2}$$

$$e^2 = \frac{a^2 - b^2}{a^2}$$