

# THE INVESTIGATION OF DISPLACEMENT OF REFERENCE GNSS-STATIONS IN THE URALS DURING 2020-2023

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**Goal:** define the pattern and understand the reasons of coordinate variations of GNSS continuous operating reference stations

**Objectives:**

- 1) Obtain time series by processing RINEX-files
- 2) Make the periodogram of the time series: derive secular, periodic and noise components
- 3) Find and estimate magnitudes and directions of velocity vectors

**Outcomes:**

- 1) The horizontal displacements exhibit secular variation in the north-east direction moving with the velocities of from  $21.44 \pm 0.01$  mm/yr to  $27.0209 \pm 0.0023$  mm/yr. The azimuths of their vectors vary between  $74^\circ 32' 23.88'' \pm 00^\circ 00' 00.64''$  and  $81^\circ 49' 52.4'' \pm 00^\circ 00' 02.2''$ . The residual oscillations of coordinate variations in both north and east directions have amplitudes about 0.01 – 0.1 mas (see fig. 1 and fig. 2).

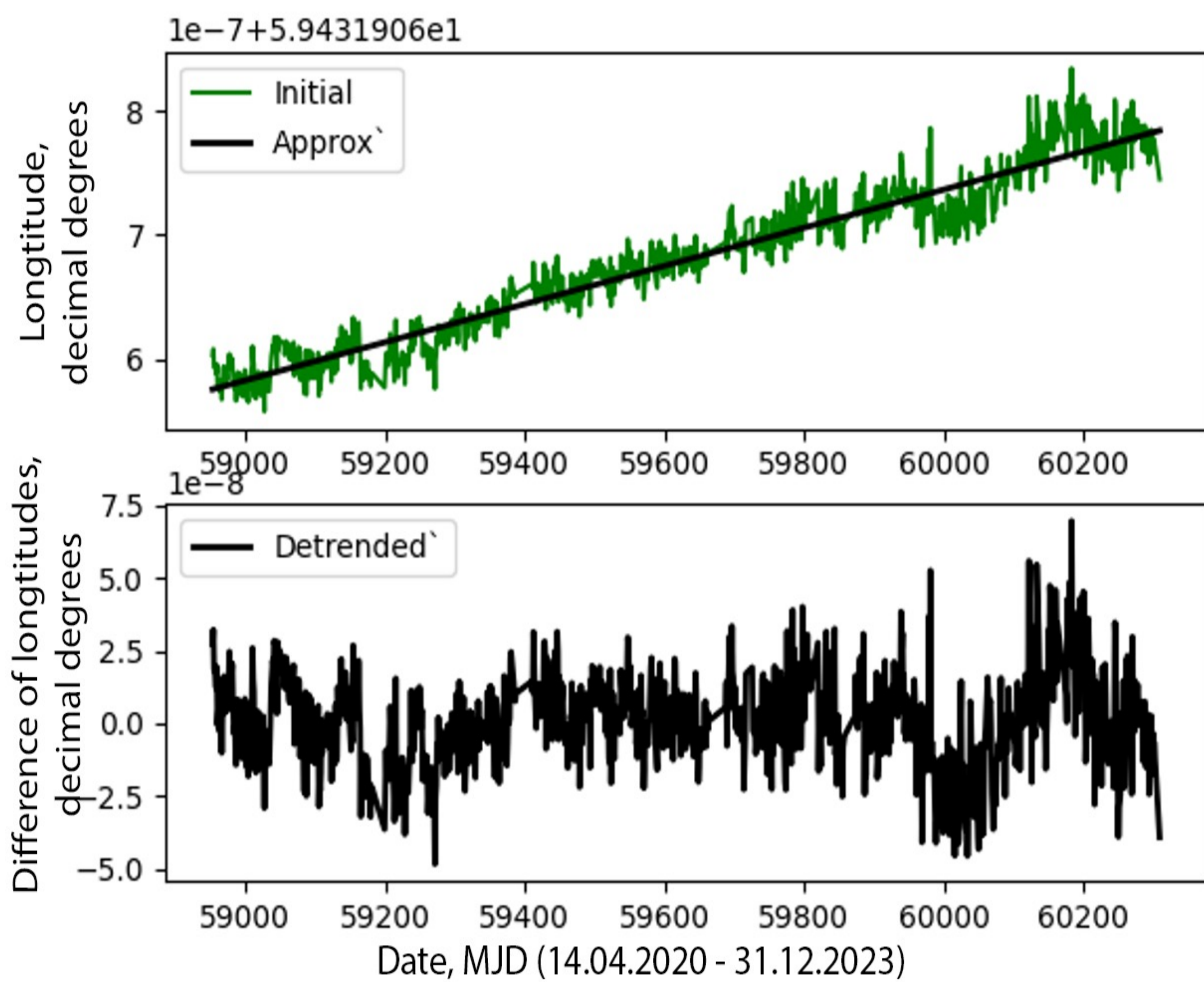


Figure 1 – Linear trend in coordinate changes in Alapaevsk town towards north (above), detrended plot (below)

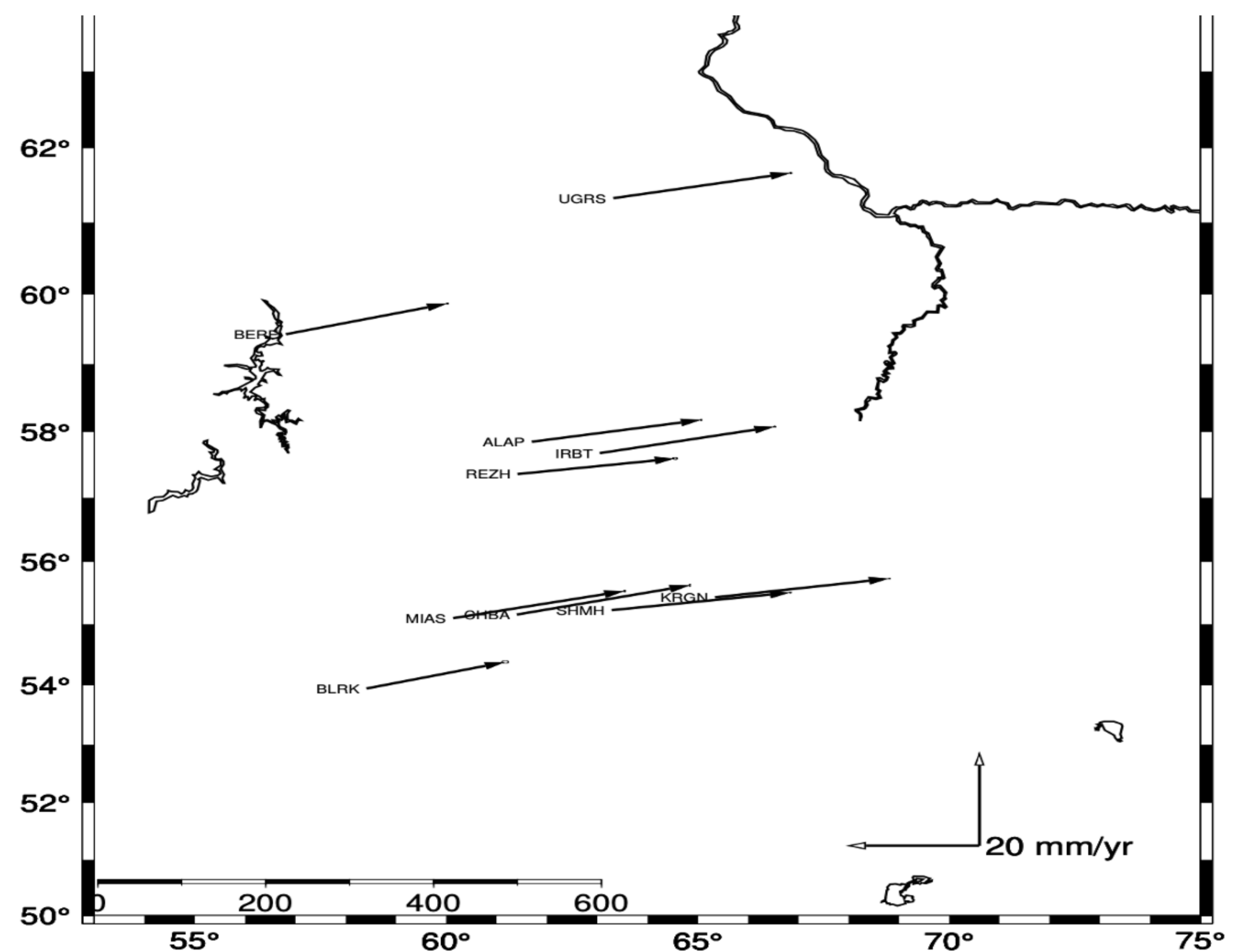


Figure 2 – Velocity vectors in 10 cities in the Urals (its magnitudes vary from  $21.44 \pm 0.01$  mm/yr to  $27.0209 \pm 0.0023$  mm/yr)

- 2) The vertical displacements of stations have white noise, with its amplitude being approximately 1 cm (see fig. 3). As for vertical oscillations on the top of the figure 3, their amplitudes are insignificant compared to the noise and constitute only between 1 and 3.5 mm. Thus, changes in the vertical coordinates of stations are not significant.

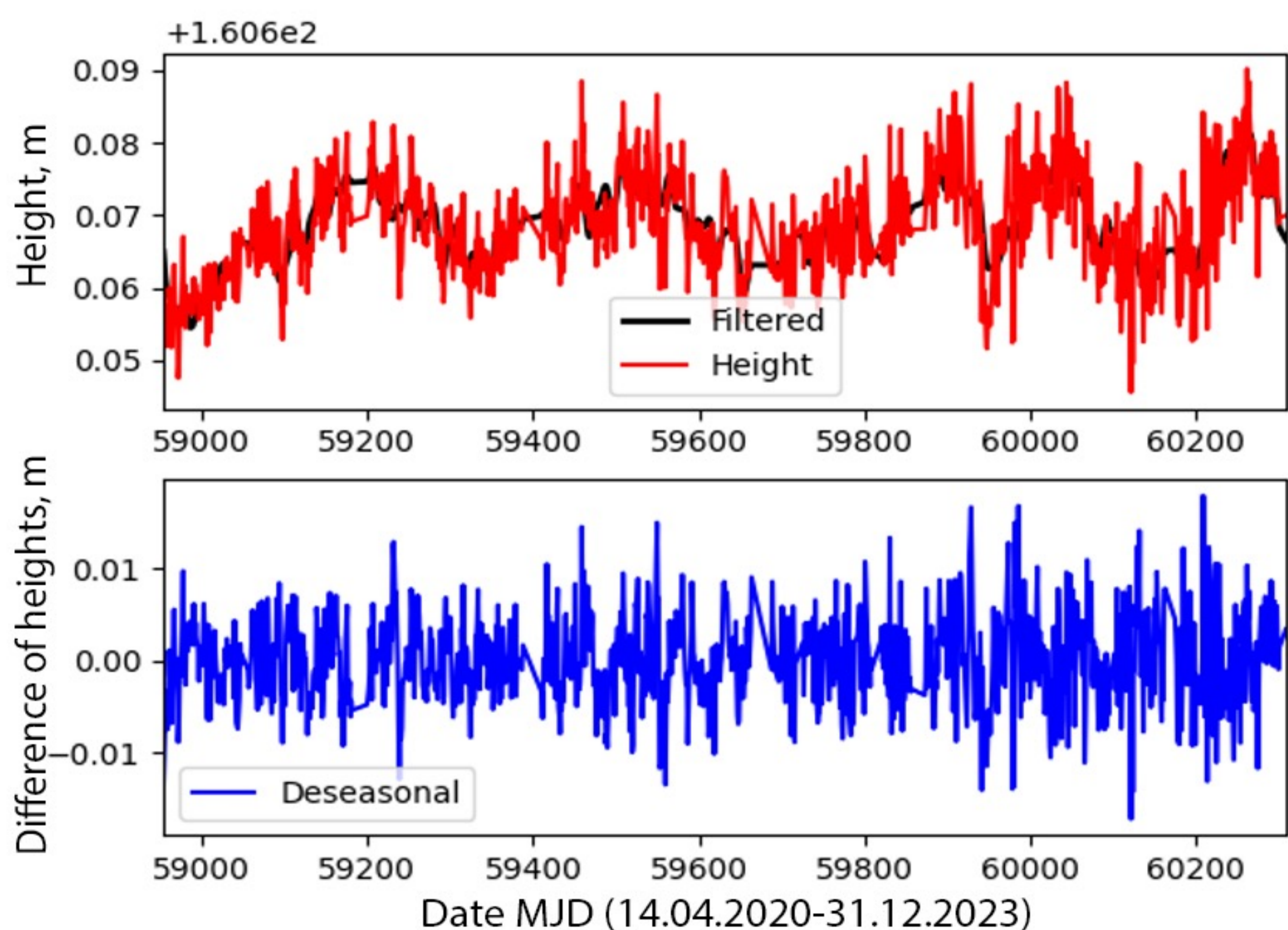


Figure 3 – Periodic oscillations in vertical coordinate changes in Berezniki (above), deseasoned plot (below)

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We used GAMIT/GLOBK software and NumPy library in Python.