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The Effects of Seasonal Variation on GPS Height Component

Nihal Tekin Ünlütürk[1], Uğur Doğan[2]

[1]Erciyes University, Department of Geomatic Eng., Kayseri, Turkey
[2]Yıldız Technical University, Department of Geomatic Eng., Istanbul, Turkey

Contact: nihaltekin@erciyes.edu.tr

The Effects of Seasonal Variation on GPS Height Component

Motivation:

1. By time series analysis of continuous GPS stations calculated velocities.
2. Continuous GPS stations for seasonal changes on vertical position accuracy.
3. The stations: according to the ellipsoid heights.

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Data:

Location of GPS stations:

1. Study area: 4 continuous GPS stations located in East of Turkey (topographic features and seasonal changes are more effective than the rest of the country).
2. Vertical position time series.
3. Time series analysis by GAMIT/GLOBK daily solutions.

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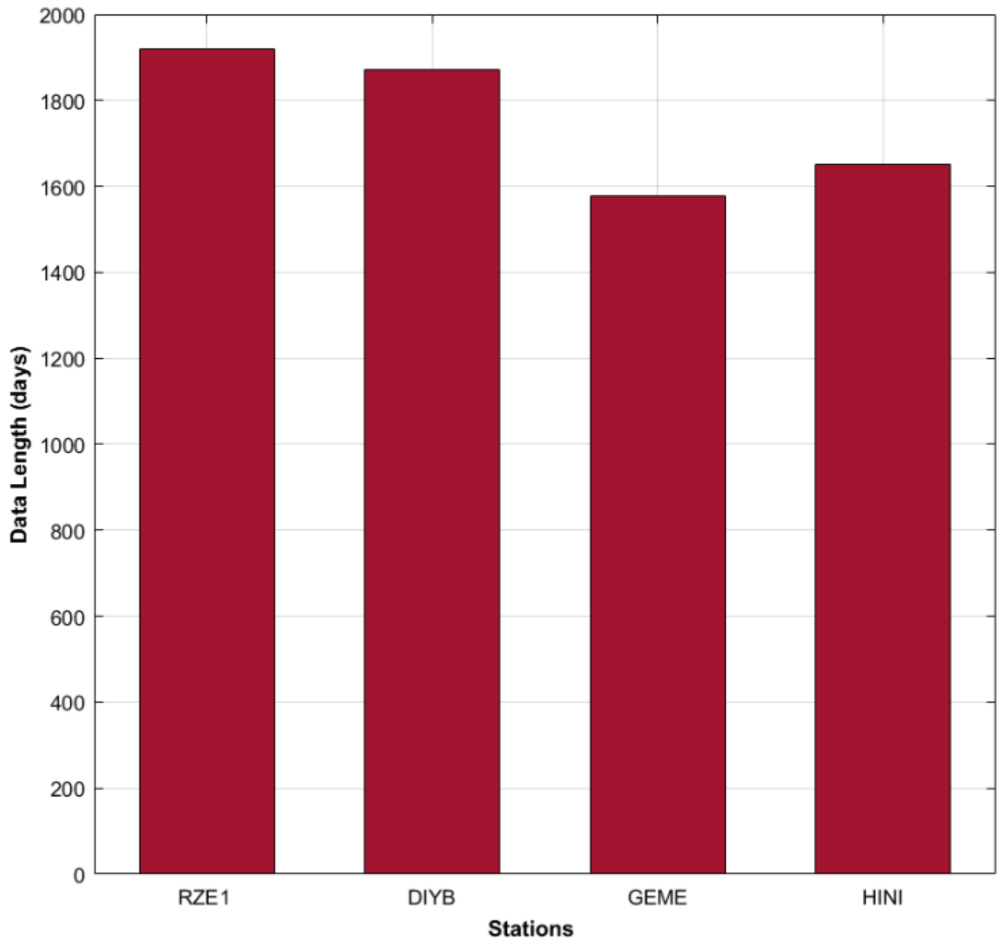
Data:

GPS stations:

Data span: 2014-2019.

Station Name	Total Number of Measures (Days)	Number of Measures (Days)	Missing Data (%)
DIYB	2118	1871	**11,66**
GEME	2118	1578	**25,50**
HINI	2118	1652	**22,00**
RZE1	2118	1920	**9,35**



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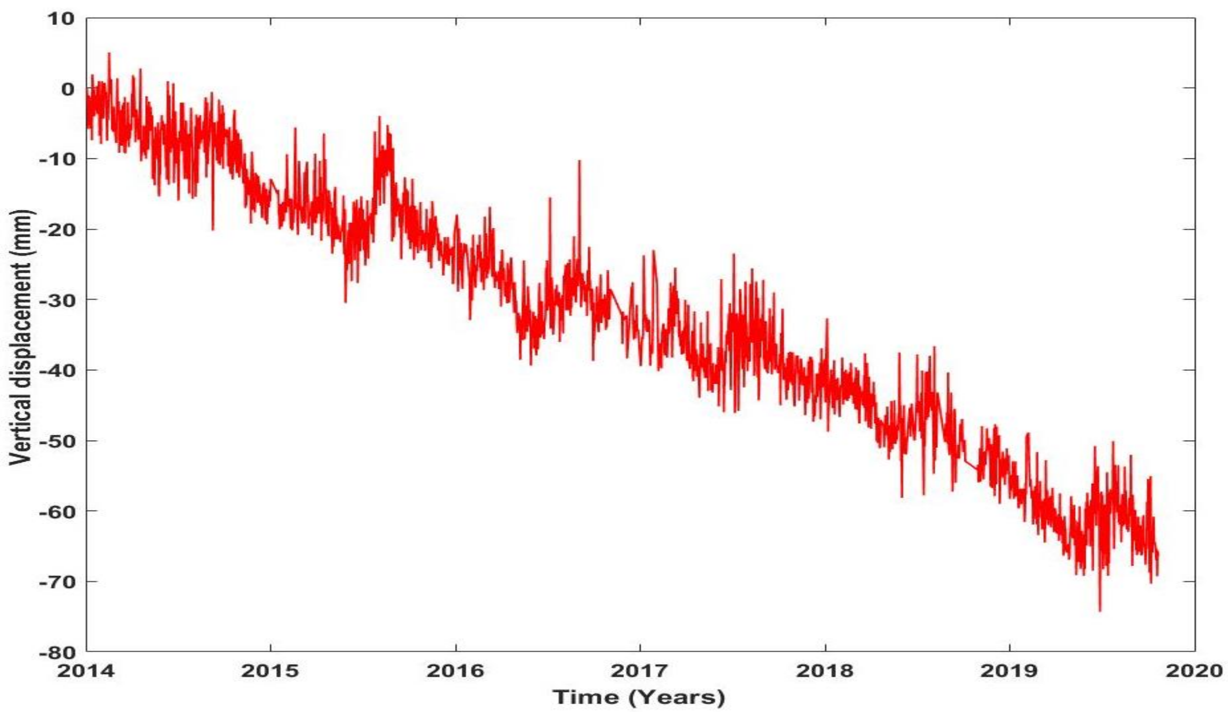

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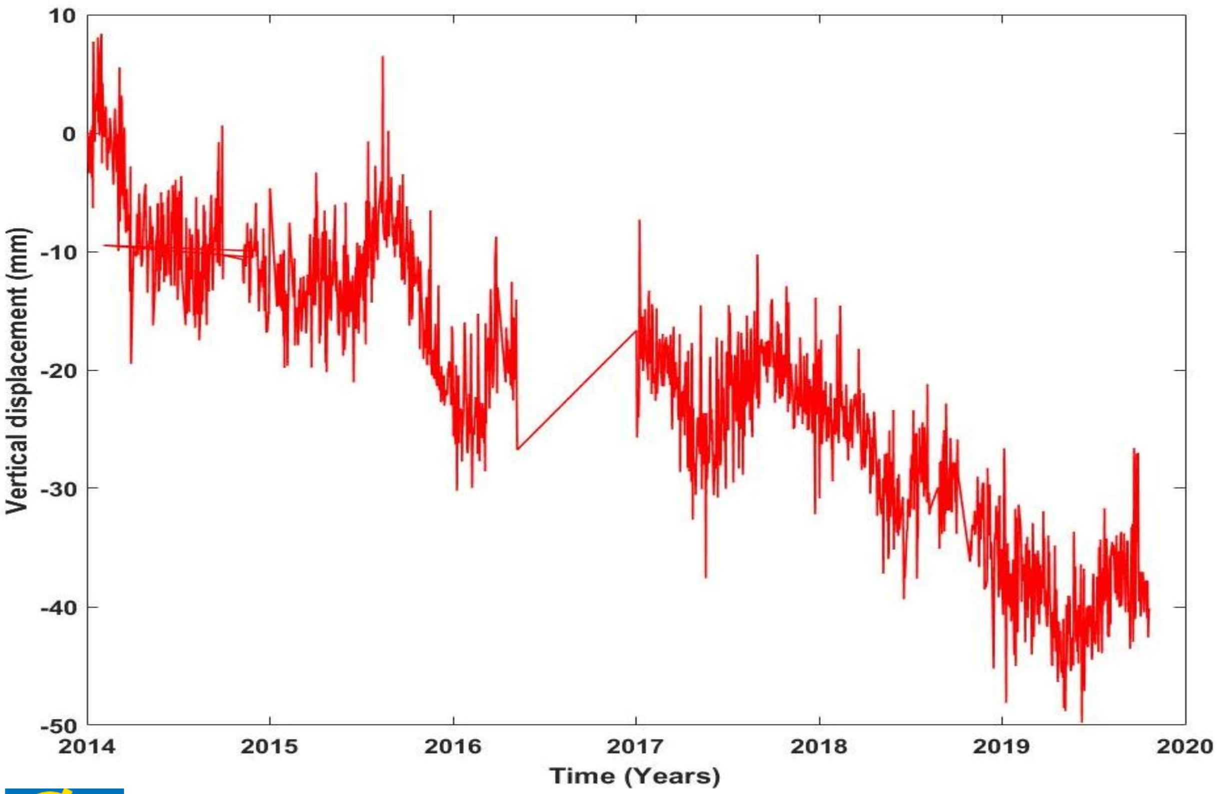

Time Series Analysis:

1. By applying time series analysis, the trend, periodic and stochastic components of the stations are determined.
2. A model of annual, semi-annual and seasonal components is formed for the stations.

$$X(t_i) = \underbrace{\sum_{k=1}^{m} a_k t_i^{k-1}}_{Trend\ Component} + \underbrace{\sum_{s=1}^{q} \left[b_s \cos(2\pi f_s t_i) + c_s \sin(2\pi f_s t_i) \right]}_{Periodical\ Component} + \underbrace{\sum_{j=1}^{p} \alpha_j X(t_{i-j})}_{Stochastic\ Component} + \underbrace{v(t_i)}_{Error}$$

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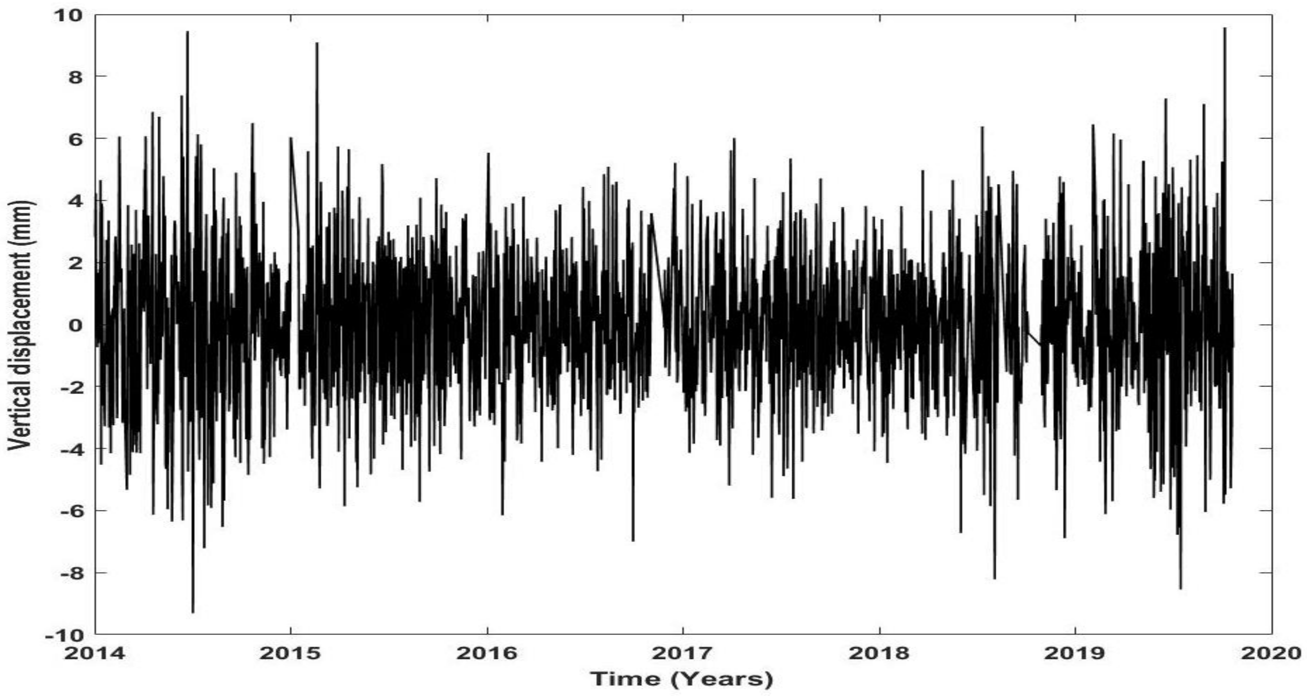
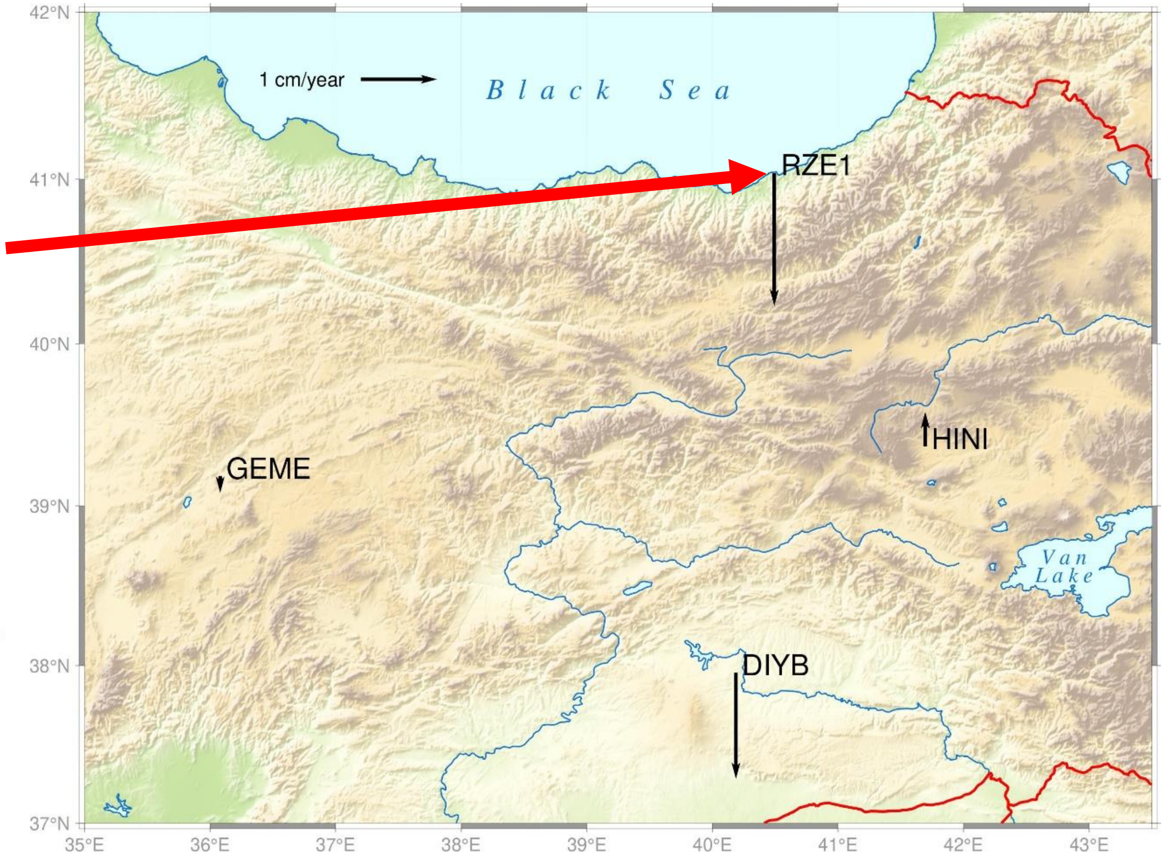


Station Name	Velocity (mm/year)	Standard deviation (mm)
DIYB	-1.39	0.07
GEME	-0.22	0.06
HINI	0.45	0.07
RZE1	-1.74	0.08



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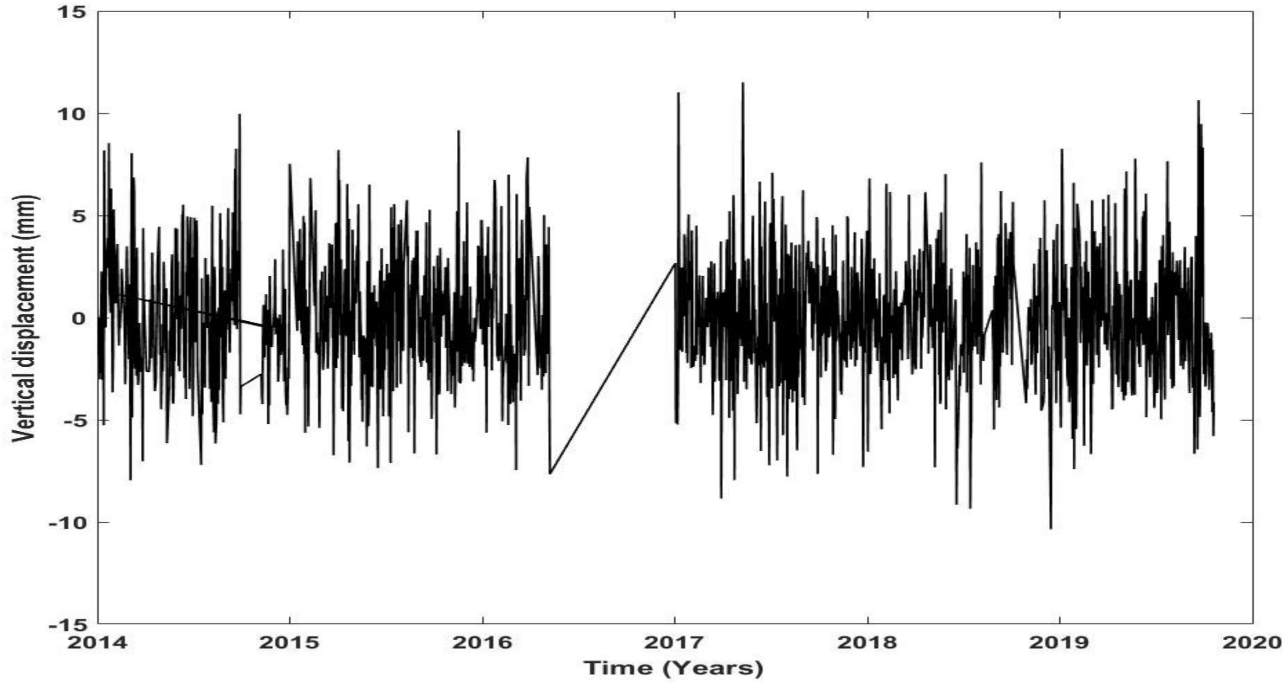

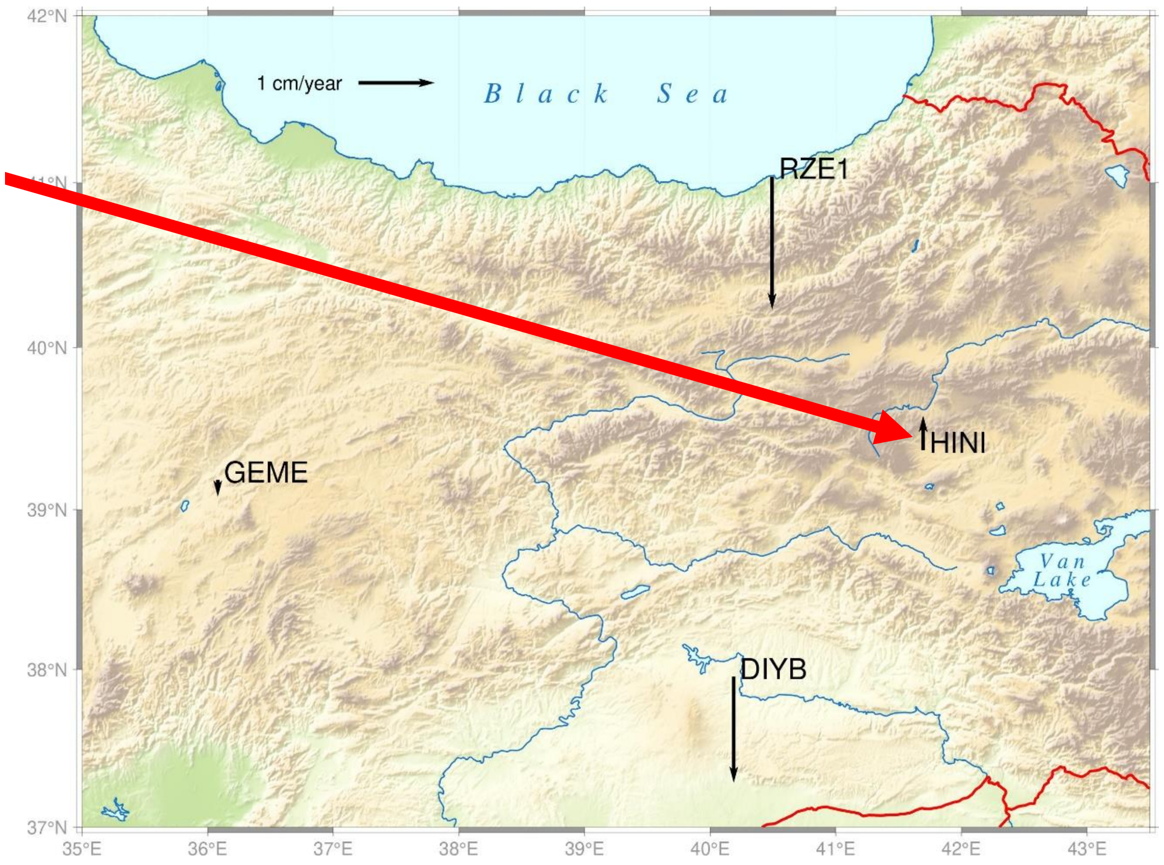

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Results:

1. Velocity and standard deviation values of the height component are calculated for each month, season and year.
2. As the ellipsoid height increases, the velocity and its standard deviation values decrease.

Station Name	Latitude	Longitude	Height (m)
RZE1	41.03690	40.49309	70.6990
DIYB	37.95442	40.18749	773.6755
GEME	39.18513	36.08085	1214.7947
HINI	39.36879	41.69579	1742.6226

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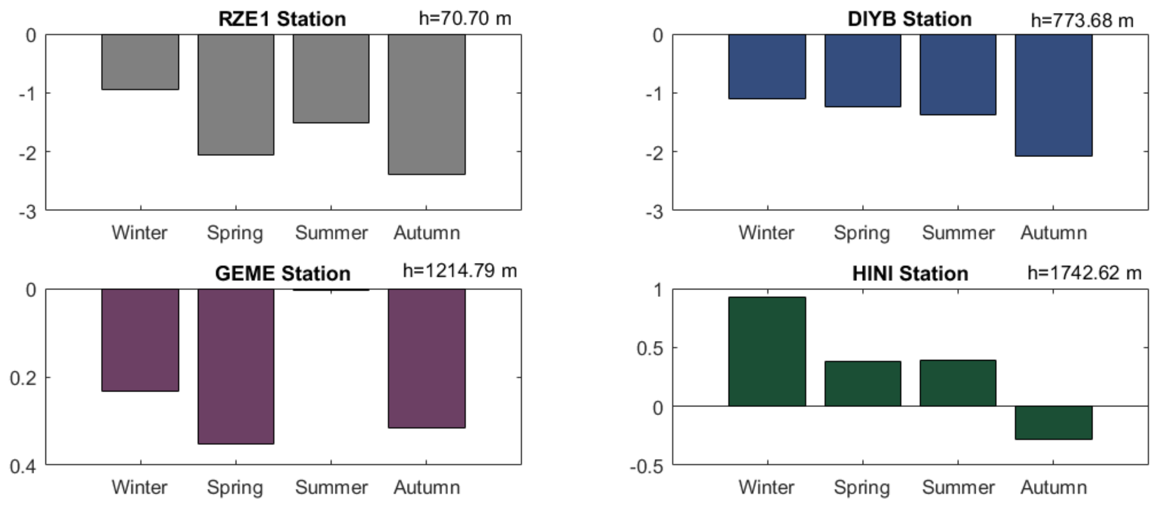
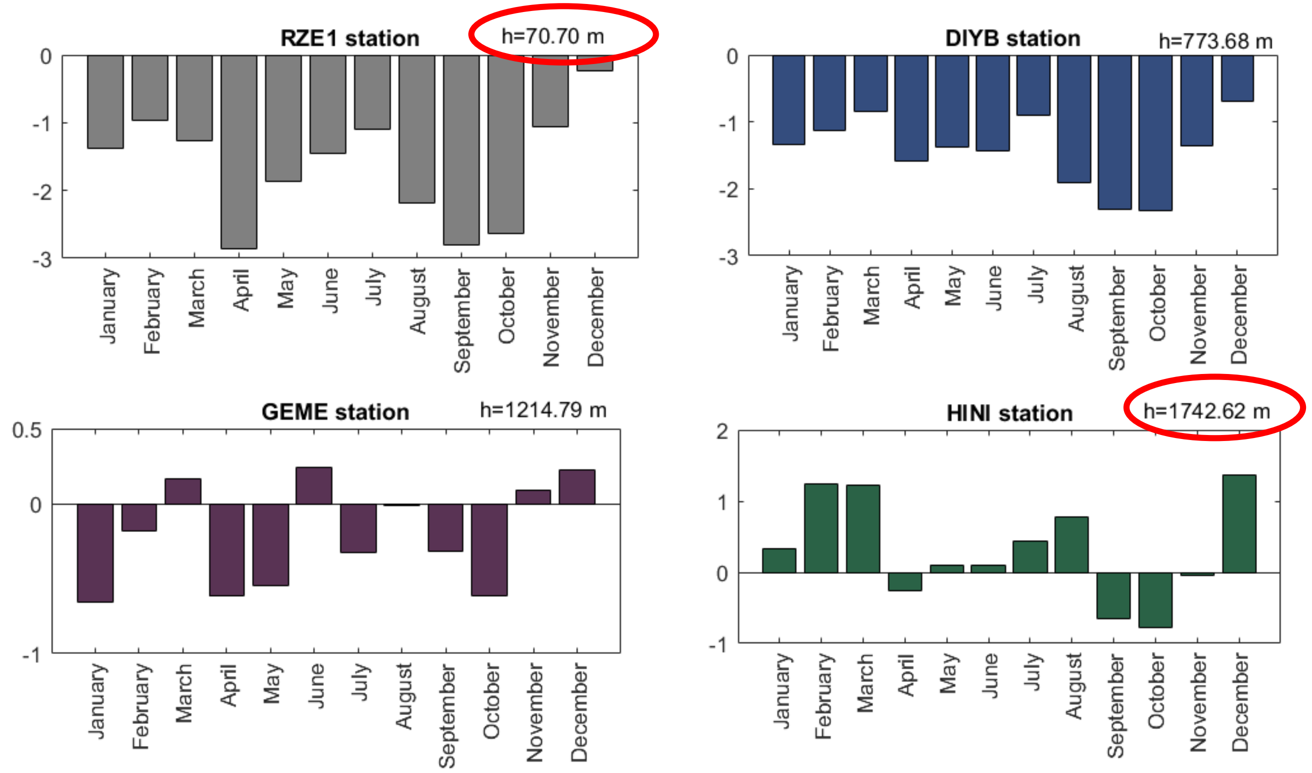
1. The minimum velocity for RZE1 station in winter (December), for HINI station in autumn (November).
2. The maximum velocity for RZE1 station in autumn (September), for HINI station in winter (December).





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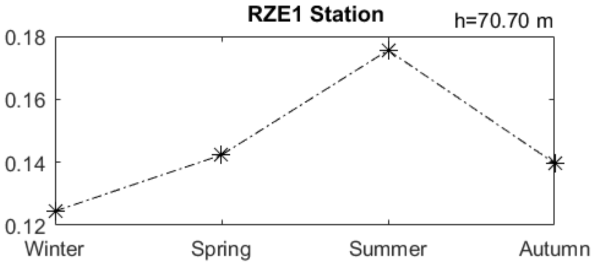
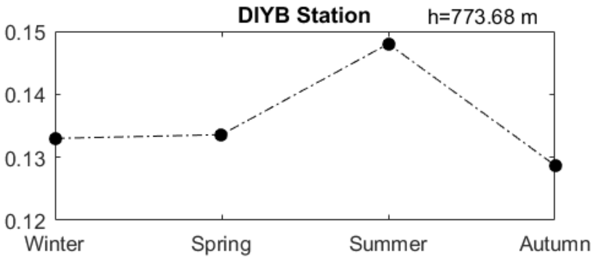
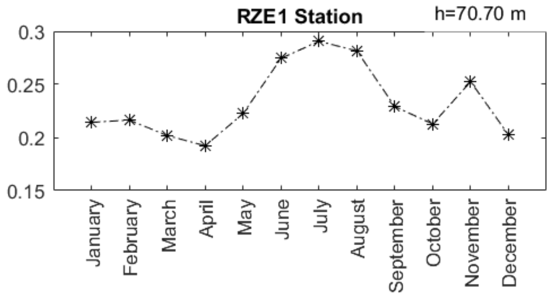
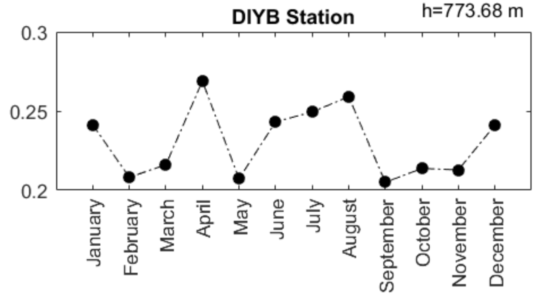
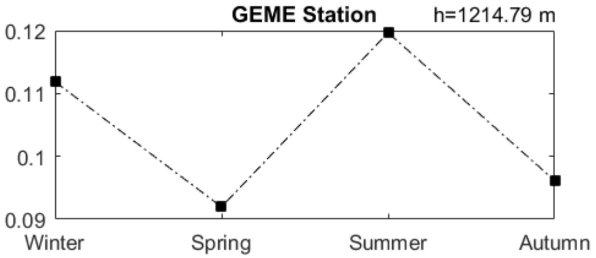
1. The minimum standard deviation for RZE1 station in winter (December), for HINI station in summer (June).
2. The maximum standard deviation for RZE1 station in summer (July), for HINI station in autumn (October).

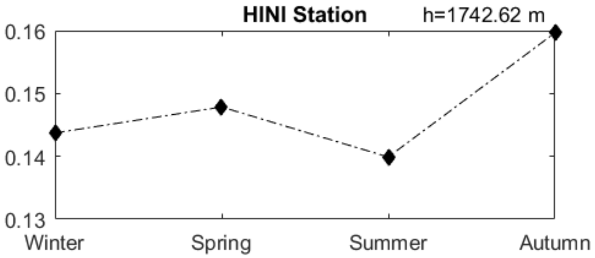


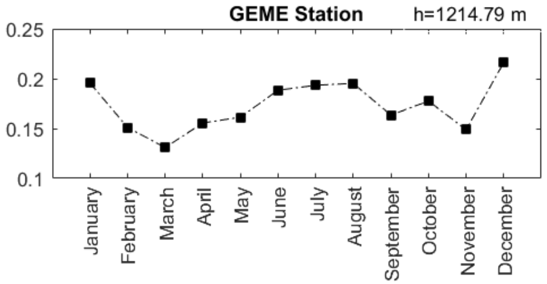


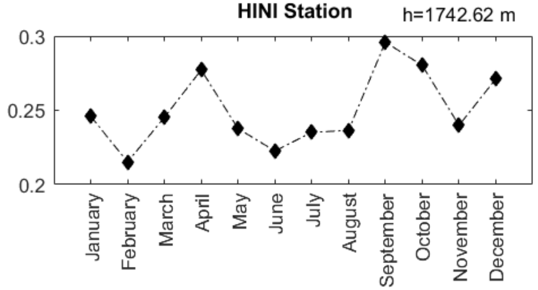












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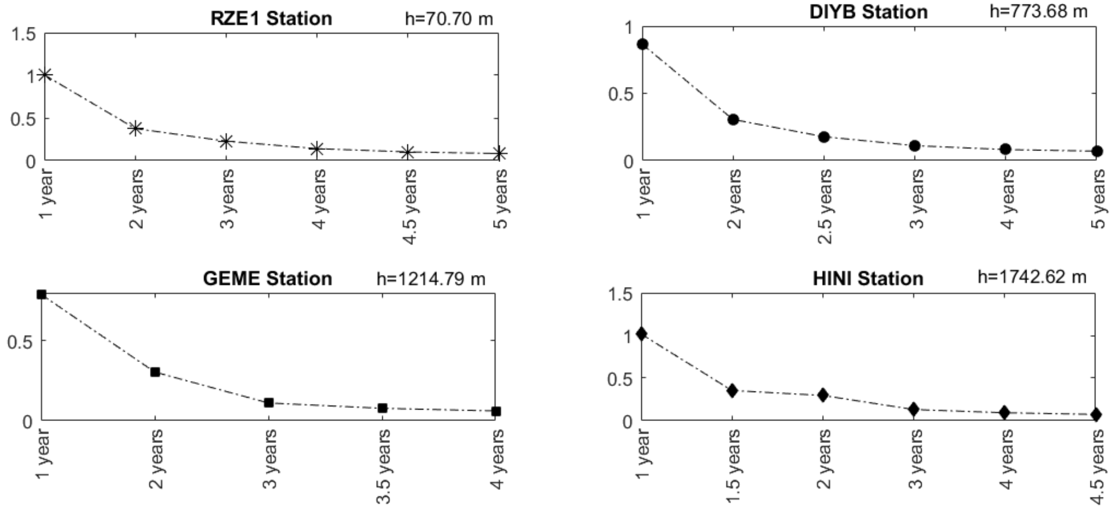
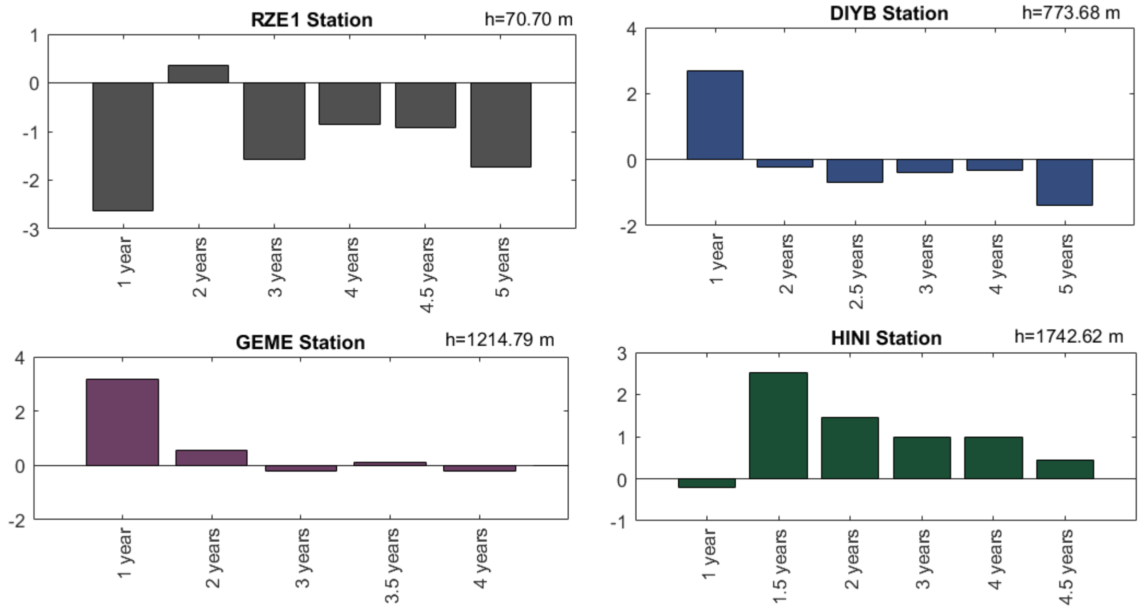
1. The velocity and standard deviation values decrease depending on the observation time.





Conclusions:

1. The less changing velocity values in GPS height occur in December (winter). This indicates the impact of atmospheric water vapor on the GPS positioning accuracy. It is also found that the GPS height is sensitive to temperature.
2. Weather changes, water vapor in the atmosphere impact the position accuracy of GPS and cause fluctuations in GPS height values.
3. According to the results, the coordinate displacements caused by seasonal variation may be notable and their effects should be considered especially in high precision geodetic surveys.
4. To avoid velocity estimation error completely, the data length should be more than 4.5 years.

Future Work:

1. To correlate the vertical component position accuracy of GPS with meteorological data (pressure, humidity, temperature, etc.).

Thank You for Your Attention!