Time Series of GPS Stations in the Near East

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1. Abstract

For the detailed analyses of the GPS site variations in the east Mediterranean and Arabian area, weekly processed solutions from GPS week 1107 to 1315 (209 weeks) computed by the OLG (Observatorium Lustbühel Graz) are used. The variations of the site coordinates are processed and analysed to derive patterns about periodic or non-periodic effects of the time series due to environmental influences like varying weather conditions, seasonal changes, plate tectonics etc. First the coordinates of neighbouring stations are compared in order to investigate the influence of the above mentioned effects precisely and to separate them from equipment and adjustment effects. Time series analyses in the frequency domain and velocity estimations of the refined values will be carried out later to extend and confirm the first overview.

2. Motivation

This test area was chosen because only a few studies about geodynamics by GPS of the Eastern Mediterranean, the Arabian, and the Near East areas are existing. Therefore affiliations to different micro plates of GPS stations in the Eastern Mediterranean area are not known exactly. During investigations of the station coordinates similarities in the coordinate time series of nearby GPS stations were detected, which can provide information about common movements. So, analysis of those common movements are required. Furthermore if there are periodic effects it is necessary to research the reasons for and the consequences of those phenomenons, especially in the frequency domain.

3. Testing Area

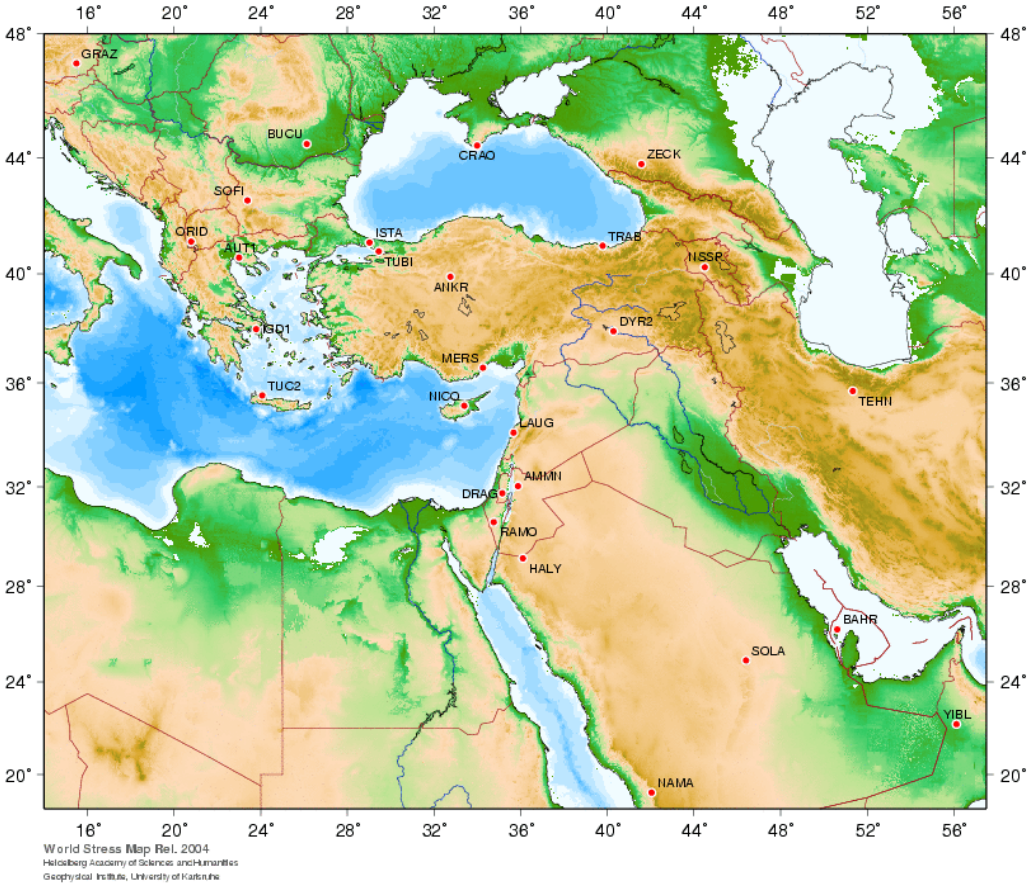

Figure 1: Map of the testing area

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The test area starts at the Balkan Peninsula. The focus lies at Anatolia and Arabia to investigate the corresponding tectonic units (plates). Most of the stations belong to the IGS (International GPS Service) network, a large part also to EPN (EUREF Permanent GPS Network), some are public stations established by MIT (Massachusetts Institute of Technology) at the end of the nineties.

4. GPS Stations

The GPS stations (Table 1) are distributed over 17 countries and were taken from the extended EUREF monitoring network processed by the OLG (Observatory Lustbühel Graz). The data are going from GPS week 1107 (2001-03-25) to GPS week 1315 (2005-03-26).

Table 1: GPS stations

COUNTRY	CODE
Austria	GRAZ
Bahrain	BAHR
Bulgaria	SOFI
Cyprus	NICO
Greece	AUT1
	IGD1
	TUC2
Iran	TEHN
Israel	DRAG
	RAMO
Jordan	AMMN
Lebanon	LAUG
Macedonia	ORID
Oman	YIBL

COUNTRY	CODE
Republic of Armenia	NSSP
Romania	BUCU
Russia	ZECK
Saudi Arabia	HALY
	NAMA
	SOLA
Turkey	ANKR
	DYR2
	ISTA
	MERS
	TRAB
	TUBI
Ukraine	CRAO

5. Data Preparation

The weekly solutions were processed with the Bernese GPS Software version 4.2 by the OLG, and the resulted normal equations were combined, while Bucuresti (BUCU) was held fixed. Subsequent to this it was necessary to split the data to be able to plot the coordinate differences in the North, the East, and the Up component station by station.

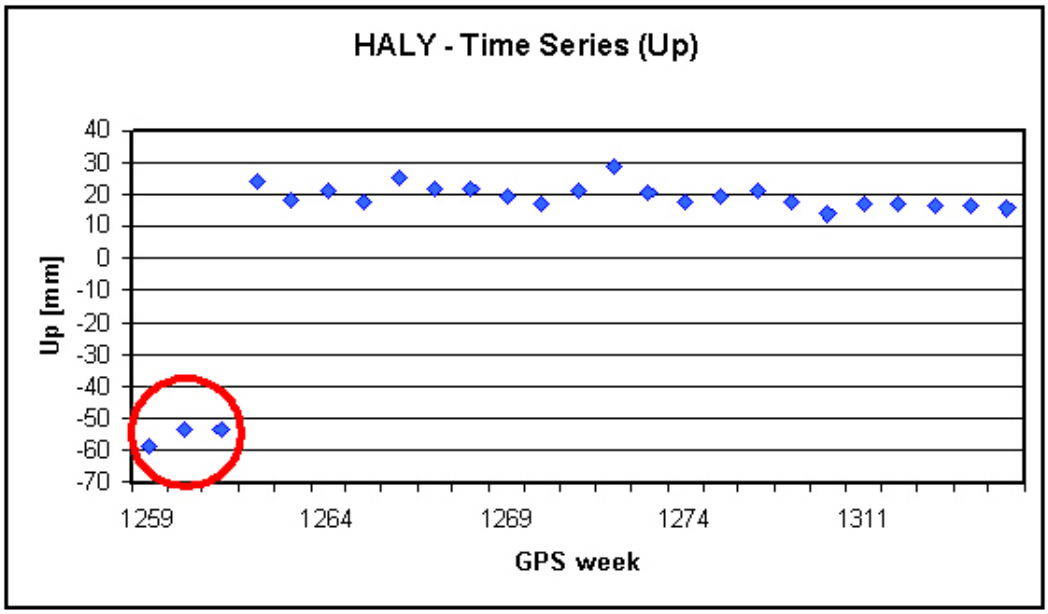

Figure 2: Data preparation – HALY (Up component)

As shown in Figure 2 coarse errors had to be detected, localised and eliminated. In this case the three dots marked with a red circle are deviating from the other solutions by about -80 mm because of a personal fault where a wrong antenna height was taken at the GPS station in Halat Ammar, Saudi Arabia. Afterwards combined pwlots of the coordinate differences (4 to 6 neighbouring stations together) were provided.

6. Time Series

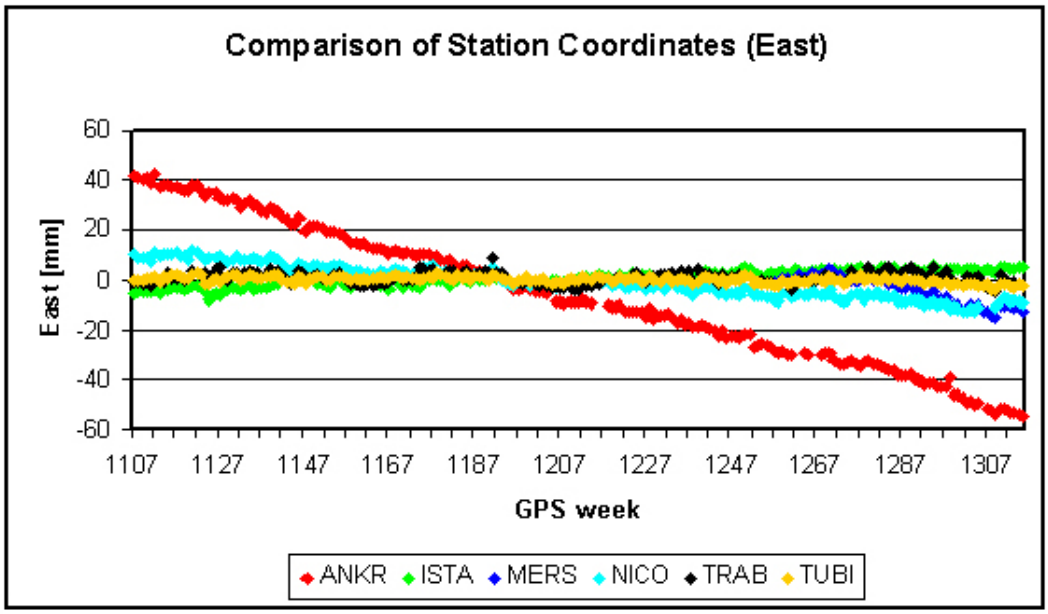

Figure 3: Time Series of ANKR, ISTA, MERS, NICO, TRAB and TUBI in the East Component

The first example of time series (Figure 3) shows the coordinate differences of Ankara (ANKR), Istanbul (ISTA), Mersin/Erdemli (MERS), Nicosia-Anthalassa (NICO), Trabzon (TRAB) and Gebze (TUBI) in the East component. The time series of ISTA, TRAB, TUBI are similar (in between ± 5 mm). MERS and NICO differ from the others, but they are also similar to each other. However the coordinates of Ankara drift (more or less linear) in a westward direction; they follow completely different characteristics than the stations in the surrounding area.

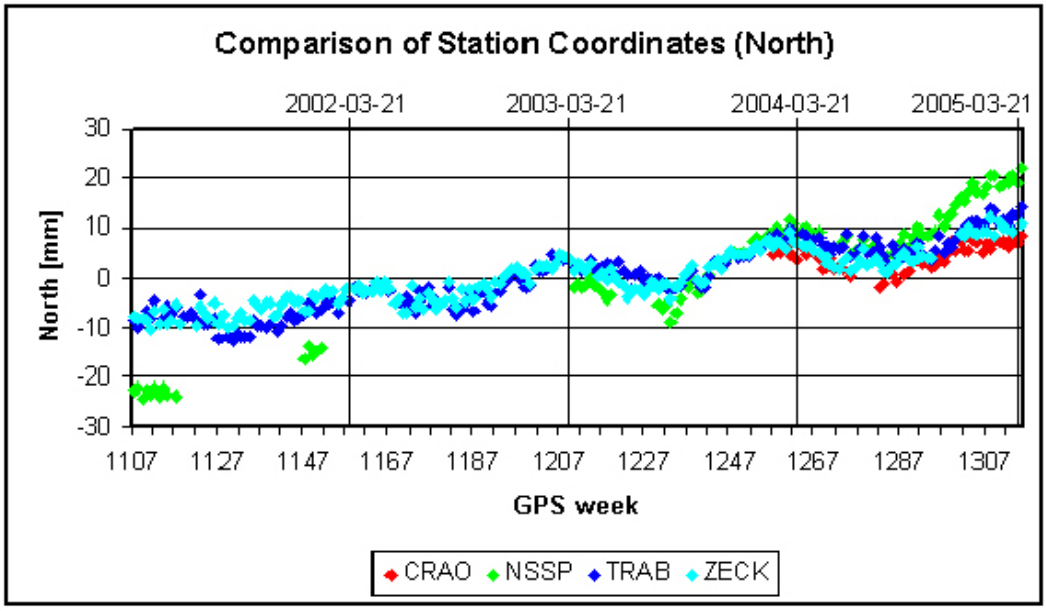

Figure 4: Time Series of CRAO, NSSP, TRAB and ZECK in the North component

Figure 4 represents the time series of Crimean Astrophysical Observatory (CRAO), Yerevan (NSSP), Trabzon (TRAB) and Zelenchukskaya (ZECK). A trend becomes appearent, especially at the time series of Yerevan. There is a periodic effect with the maxima in spring. The time series of these stations are very similar, they show the same movements and drifts except for Yerevan (trends in a northward direction).

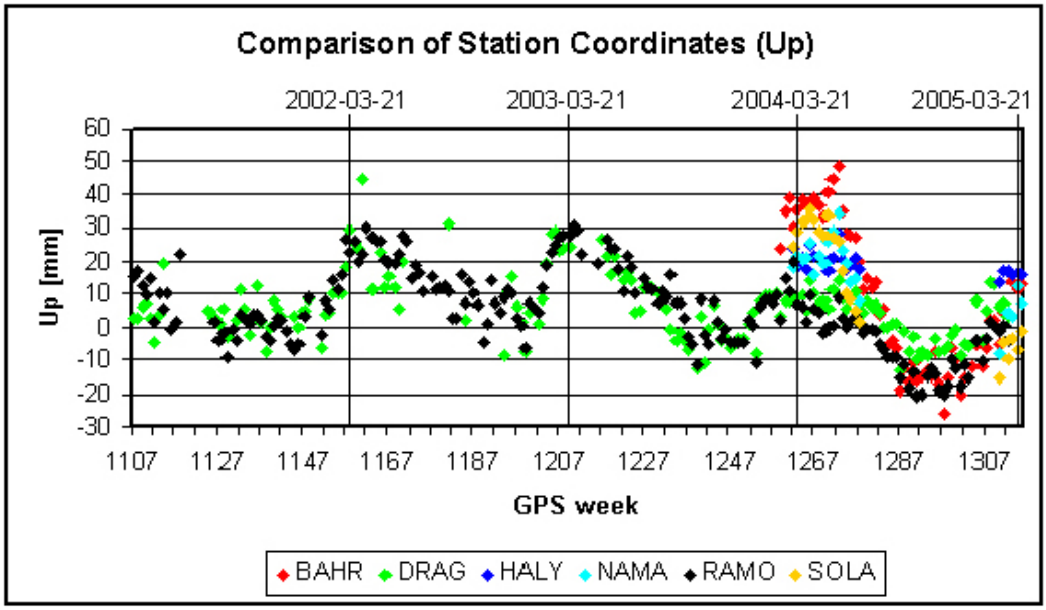

Figure 5: Time series of BAHR, DRAG, HALY, NAMA, RAMO and SOLA in the Up component

Time series of Bahrain (BAHR), Metzoki Dragot (DRAG), Halat Ammar (HALY), Namas (NAMA), Mitzpe Ramon (RAMO) and Solar Village (SOLA) in the North component are plotted in Figure 5. It seems that all stations follow the characteristics of a sawtooth with the maxima in spring. The Saudi Arabian stations have a larger amplitude than the Israeli ones, but all stations have the same characteristic of movements in the Up component. Unfortunately no data of the Saudi Arabian stations before GPS week 1259 have been included yet.

7. Conclusions

The time series of the analysed stations show that almost all of the stations have similar movements in the three test areas. It can be assumed that there are no blocks with very different movements. The transition zones should be investigated by a denser network.

Ankara seems to be isolated at the Anatolian plate, because the movements of the sourrounding stations all show other characteristics. This phenomenon has to be investigated carefully.

All stations follow periodic effects with the maxima in spring, especially in the North and Up component.

8. Planned Activities

More especially later data are required to compensate the late beginning of most of the GPS stations. Especially the data of Amman (AMMN), Tehran (TEHN) and Yibal (YIBL) are needed because they seem to be very interesting to analyse to get a better boundary information.

Periodic effects have to be analysed carefully, especially the impacts of air pressure, moisture, oceanic effects etc. Analysis in frequency domain will be done to be able to recognize periodic effects which are not visible in the time domain. It is planned to apply filters to eliminate high or low frequencies to be able to analyse the remaining ones carefully