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The Analysis of GPS Data in Different Observation Periods Using Online GNSS Process Services

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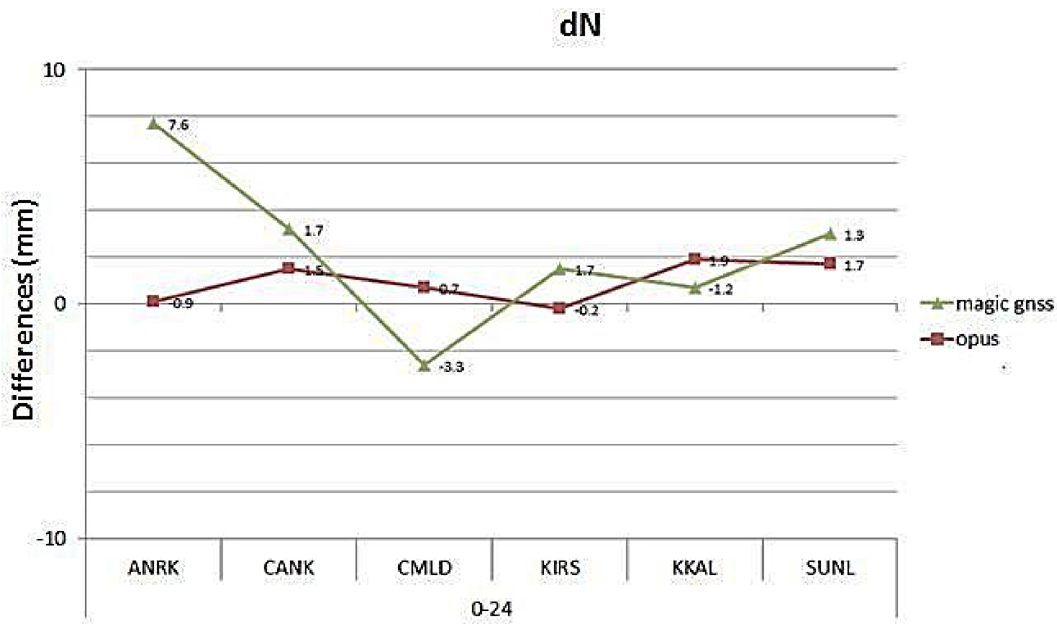
The Evaluation of 24-hour observation data in various systems

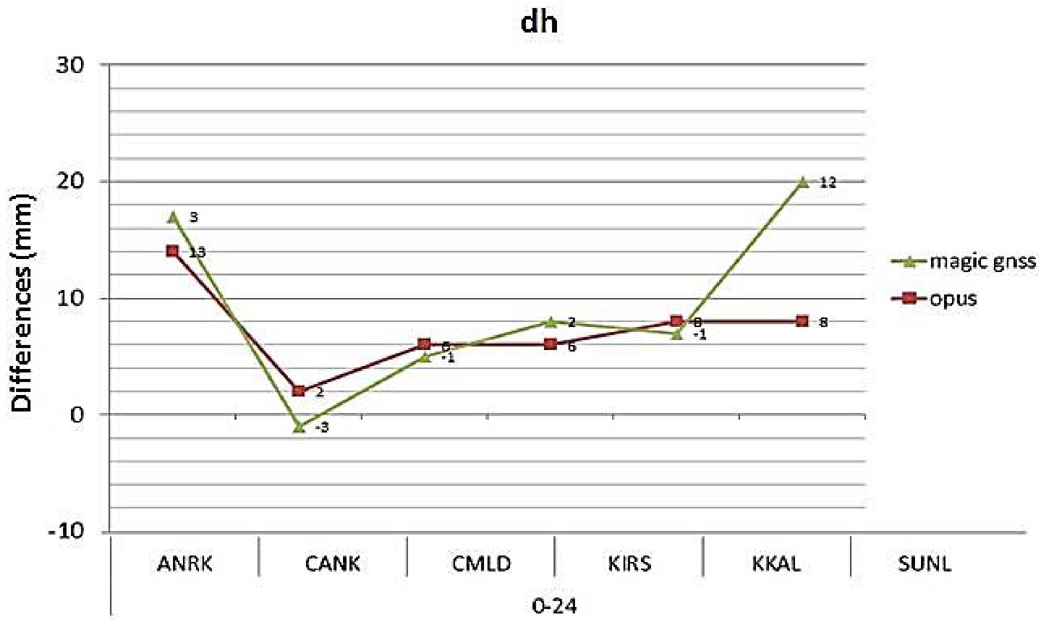
The results were obtained about 24 hour rinex observation files related to the points using three systems called Magic GNSS, AUSPOS and OPUS. The evaluations were carried out by means of static PPP method in all three systems. There are the values of latitude, longitude and ellipsoid heights about 6 stations in the final reports. These coordinates were turned into TM projection coordinates. In 3 degree-system, zone central meridian was taken as 33 degrees and its differences were calculated according to AUSPOS system. These differences are given at Table-1 by taking them in mm measure.

Table 1: The differences of 24 hour data with AUSPOS service

		dN (mm)	dE (mm)	dh (mm)
OPUS	**ANRK**	-0.9	-0.4	13.0
	CANK	1.5	-4.0	2.0
	CMLD	0.7	-1.8	6.0
	KIRS	-0.2	-1.5	6.0
	KKAL	1.9	-2.7	8.0
	SUNL	1.7	-1.5	8.0
MAGICGNSS	**ANRK**	7.6	-5.9	3.0
	CANK	1.7	-8.6	-3.0
	CMLD	-3.3	-3.3	-1.0
	KIRS	1.7	-4.6	2.0
	KKAL	-1.2	-3.7	-1.0
	SUNL	1.3	-7.4	12.0

As seen above, the results of 24-hour rinex data, which were evaluated in all three systems, are similar to each other. The difference of all coordinates value is below 1 cm. This shows that the results don't have a significant difference for the coordinates obtained from 24 –hour data no matter which internet based system is used.





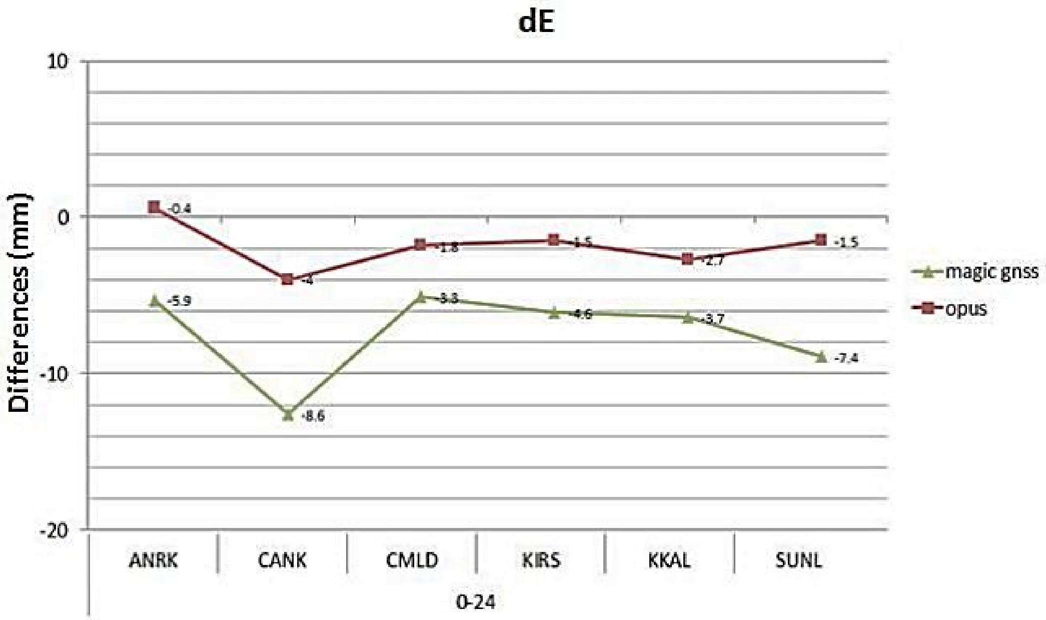


Figure 2. The differences between coordinates components for 24-hour data obtained by taking AUSPOS as a reference

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The evaluation of the data with different observation period

Rinex observation files were divided into time periods as 12, 6 and 2 at a time so as to see the effects in different systems in case the observation periods may change. In this way, rinex observation files were obtained as two 12

-hour sessions, four 6 -hour sessions and twelve 2 -hour sessions for each station. The time periods of observation files are seen at Table 2.

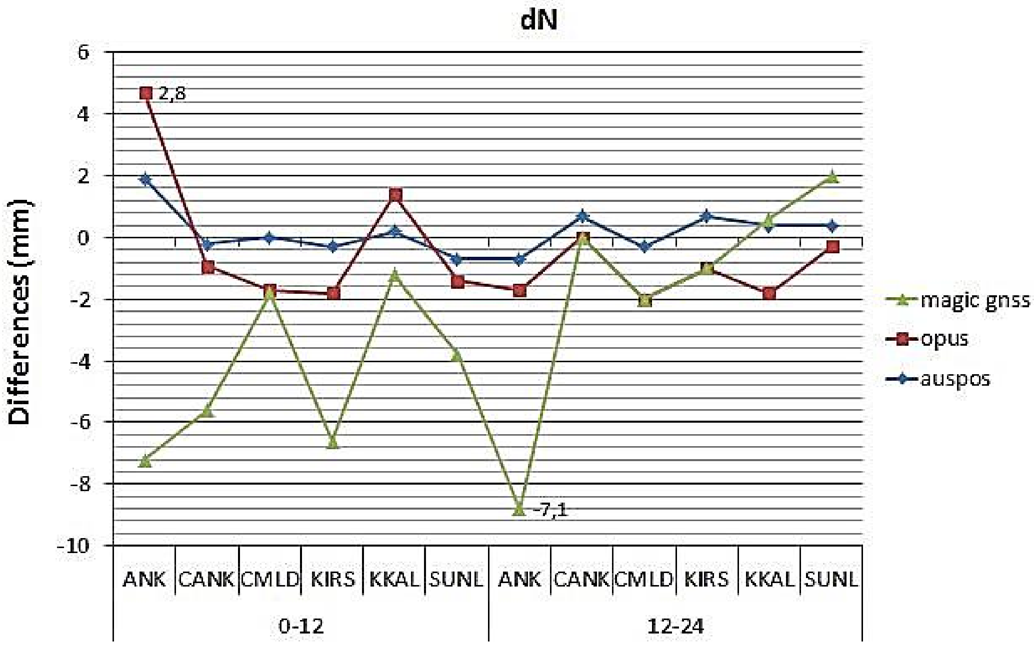
Table 2: Time periods of RINEX observation files

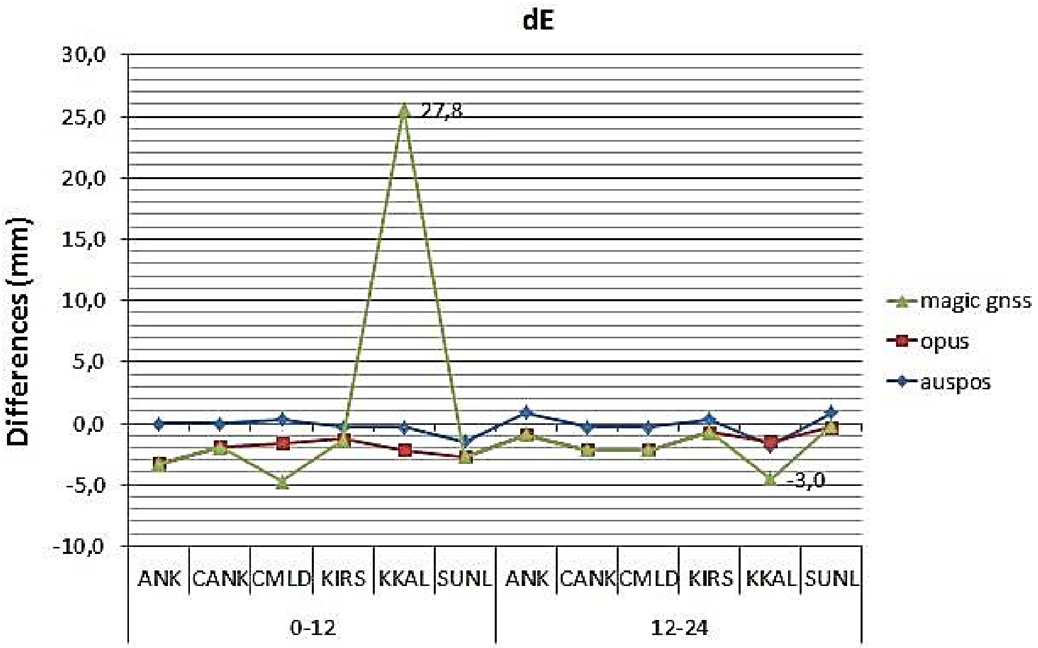
	Rinex File observation period											
24 hour	0-24											
12 hour	0-12						12-24					
6 hour	0-6			6-12			12-18			18-24		
2 hour	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24

The evaluation of 12 hour data

Observation data files were divided into 12 hour periods, and then 24 hour results in each system and the differences between them were taken.

In an evaluation performed in 12 hour observation periods, it is seen that one value of Magic-GNSS is bigger than 2 cm. This error is in the Y component of KKAL station between 0-12 hours. Besides, both values are bigger than 1 cm in the same system. Both of these errors are in ANK station. In AUSPOS and OPUS systems, difference values are below 1 cm and they generally give similar results. Some values are nearly the same with 24 hour observation values.





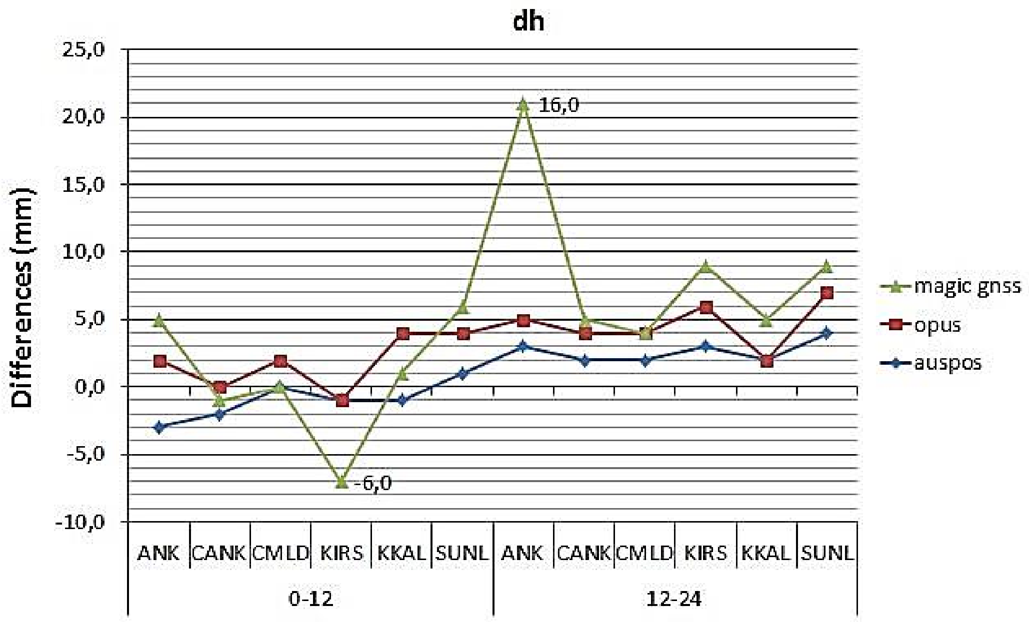
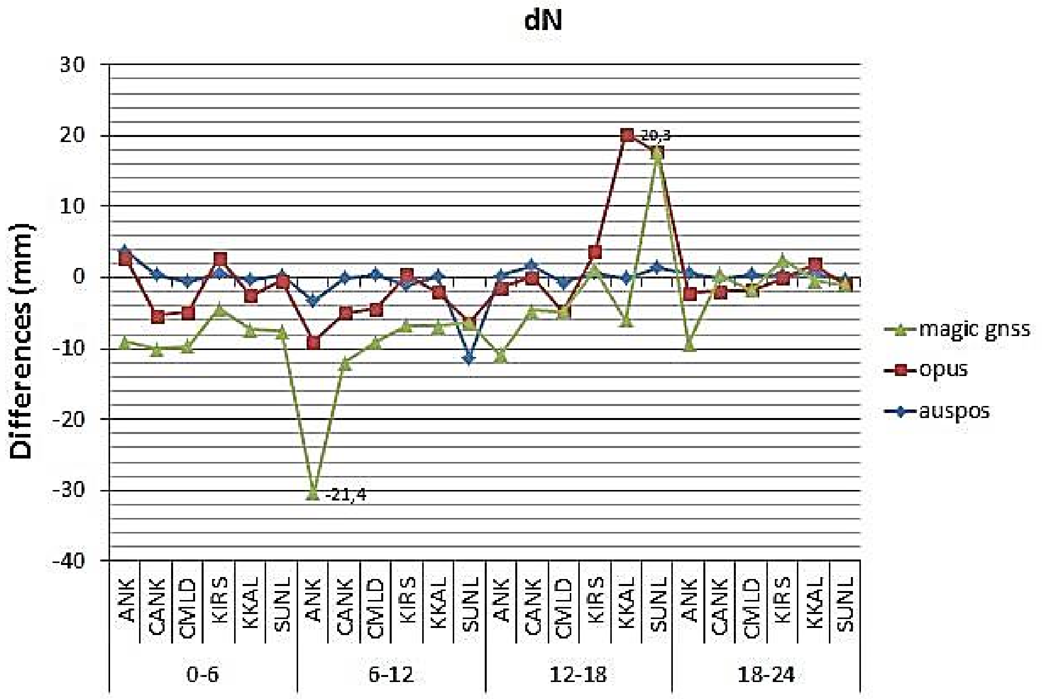


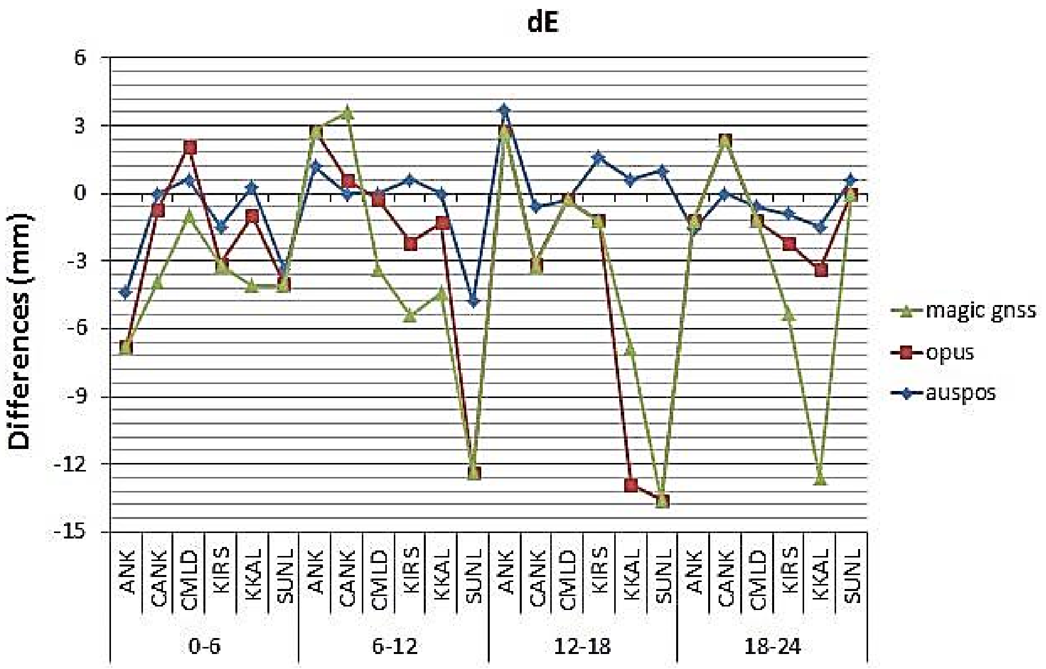
Figure 3: the differences of coordinates components for 12-hour data

The evaluation of 6- hour data

Observation data were evaluated by dividing into 6-hour periods. Besides, 24 hour results in each system and the differences between them were taken.

According to 6-hour evaluation results, it is seen that AUSPOS and OPUS services give similar results in dN and dE values. 7 values in total, which consist of one value in AUSPOS, two values in OPUS and four values in Magic-GNSS service, gave an error bigger than 2 cm. Considering the errors between 1-2 cm, it is seen that Magic-GNSS contains more errors. Besides, in all three systems the errors are generally in dh components.





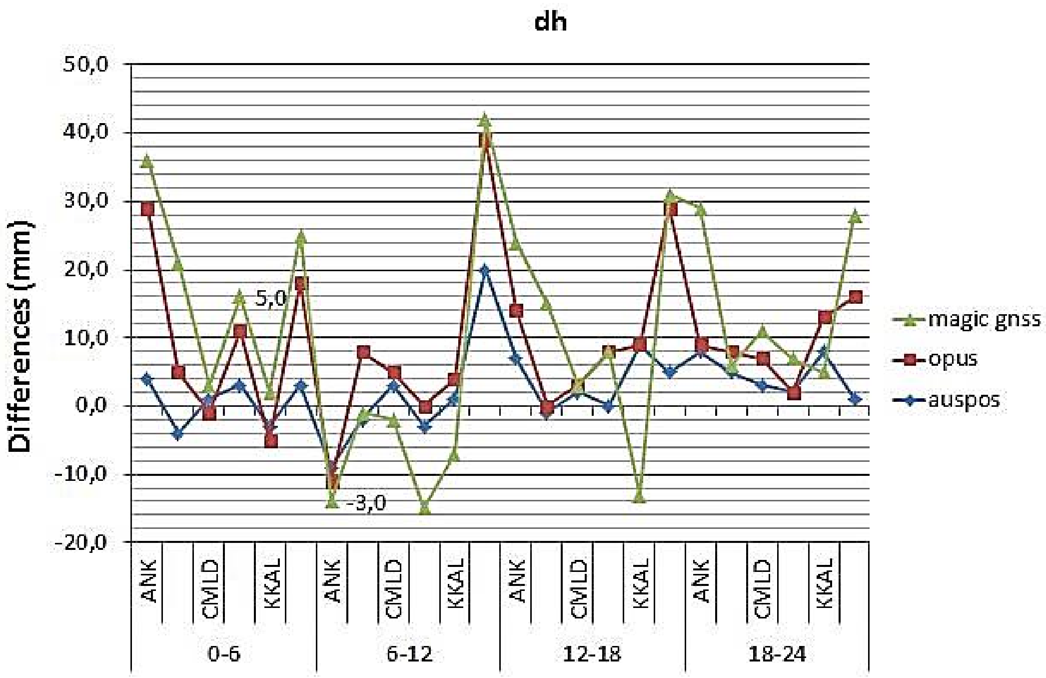


Figure 4: The differences of coordinates components for 6 hour data

The evaluation of 2-hour data

The processes performed for 12 and 6-hour data files were repeated for 2 -hour data as well. The highest, the lowest and the average values for dN, dE and dh components were given in a table to understand the results of the 2-hour data better.

Table 3: The minimum, maximum and average values for 2-hour data

		dN (mm)	dE (mm)	dh (mm)
The minimum difference	AUSPOS	0.00	0.00	0.00
The maximum difference		-23.80	-29.60	-38.00
The average		-11.90	-14.80	-19.00
The minimum difference	OPUS	0.00	0.00	0.00
The maximum difference		-35.20	-35.50	-37.00
The average		-17.60	-17.75	-18.50
The minimum difference	MAGIC-GNSS	0.00	0.00	0.00
The maximum difference		-38.10	-36.20	39.00
The average		-19.05	-18.10	19.50

In the evaluation of 2 hour observation files, there are points with more than 3 cm error in all three systems. The system that gives the fewest errors is AUSPOS. In all systems, there are more than 2 - cm error in two - hour results. The error rate is generally higher in dN, dE and dh coordinates at ANK points. There is a significant increase in error rate in comparison with 12 and 6 hour data. However, this increase in all three systems shows that it typically gives similar results.

Results and Discussion

Many studies were carried out for the accuracy research of the results of internet based evaluation services. 24-hour measurement files which were collected in NCTU and DONS IGS stations between 1st-31st March 2001 in Taiwan were evaluated in OPUS, AUSPOS, SCOUT, Auto-GIPSY and Auto-BERNESE services. Besides, comparisons were made separately by dividing 24 hour measures into 2,4 and 6-hour data. When calculating maximum and minimum errors by taking BERNESE software as a reference, the differences between horizontal coordinates in all services stayed in cm measure. However, there were 10-20 cm and 2-3 cm differences in the obtained values of height. (Liu and Shih, 2007). In an another study performed at Athens University, 24,6 and 1 hour measurements taken from 8 different IGS stations were used. When comparing current coordinates of IGS points with the results received from CSRS-PPP, Auto-GIPSY, SCOUT and AUSPOS online services, the accuracy is 1-2 cm level for 24-hour data in all services. Significant differences occur between the services as the observation period decreases (Tsakiri, 2008). In another study 24-hour measurement data, which was collected on 16th May 2009 and 6th November 2009 at 6 fixed stations belonging to ISKI-UKBS network founded by ISKI, were evaluated in OPUS, AUSPOS and SCOUT services. The differences from three services were found separately by basing the results calculated in BERNESE software. It was seen that it approached in 1-2 cm accuracy in the position components of online services and a few cm accuracy in the height components (Subaşı and Alkan, 2011).

In a study carried out in America, the measurement data belonging to a single day was evaluated in Auto-GISPY, OPUS and SCOUT services and compared to the coordinates calculated by Graf Net software (MacDonald, 2002). Likewise, the daily data collected at UNB1 IGS station in Canada were set as separate data sets of 24 hour and 10 hour and the results were calculated by AUSPOS, SCOUT, OPUS, Auto-GIPSY and CSRS-PPP services. The obtained coordinates were compared to the current coordinates of UNB1 station. Considering that the measurement time is also effective in these studies, it is seen that the accuracy rates a range between 0.1-20 cm in horizontal coordinates and 0.1-54 cm in height (Ghoddousi-Fard and Dare, 2006).

In this application, Auspos, Magic-GNSS and Opus systems were evaluated between each other and each system was evaluated in itself by different observation periods. It was seen that Opus and Auspos gave more similar results when the systems were searched between each other according to the same observation periods. However, the differences between three systems were below 1 cm according to 24hour observation results and there was not a significant difference. In the results which were obtained by changing the observation periods in the application, as the observation periods got shorter, error rate increased proportionally. Especially when the observation period reduced to 2 hours, nearly 3-4 cm differences occurred and the number of different values increased in dN, dE and dh values of the stations. Namely, it is more suitable for the users to choose the observation periods according to the intended accuracy rate.

Conclusions

As PPP methods gain importance today, internet based evaluation services have stated to be commonly used. The most important advantage of these systems is that the results can be obtained by one receiver. This makes it easy to calculate to a great extent. On the other hand, the fact that the services are free and easy to be used provide an advantage in terms of the cost and labour. In these systems, the errors that result from the users without sufficient knowledge are prevented because the other software require GNSS speciality and experience.

Internet based services choose the stations near the application area automatically in the application process. When the conditions are provided by a single GNSS receiver in terms of sufficient satellite number and observation period, the accuracy is obtained in cm measurement. This system can be used efficiently if there is a national network that consists of fixed GPS frequency stations. In this way, it can be said that internet based evaluation services sustain adequate accuracy and provide more advantage in terms of time and cost than the classical method for topographical engineering applications.

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