Comparative Study Between The Accuracy Of Dual And Single Frequency Precise Point Positioning

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Abstract —The most ideal GNSS exactness, a couple of centimeters or better, is gotten by utilizing transporter stage estimations from double recurrence collectors. Be that as it may, single-recurrence beneficiaries can give decimeter precision at a diminished cost for the recipient and for the most part achieve this level of exactness substantially quicker than a double recurrence beneficiary does. The most ideal GNSS accu-shocking, a couple of centimeters or better, is gotten by utilizing bearer stage estimations from double recurrence collectors. How-ever, single-recurrence beneficiaries can give decimeter accu-shocking at a decreased cost for the beneficiary and by and large achieve this level of exactness significantly speedier than a double recurrence re-ceiver does. An essential thought with PPP is the ne-cessity to amend for different impacts that would somehow or another counterbalance in relative situating methods utilizing at least one collectors.

Index Terms – PPP, Relative , Dual,Single ,GNSS

1 Introduction

The most ideal GNSS exactness, a couple of centimeters or better, is gotten by utilizing transporter stage estimations from double recurrence collectors. Be that as it may, single-recurrence beneficiaries can give decimeter precision at a diminished cost for the recipient and for the most part achieve this level of exactness substantially quicker than a double recurrence beneficiary does. The most ideal GNSS accu-shocking, a couple of centimeters or better, is gotten by utilizing bearer stage estimations from double recurrence collectors. How-ever, single-recurrence beneficiaries can give decimeter accu-shocking at a decreased cost for the beneficiary and by and large achieve this level of exactness significantly speedier than a double recurrence re-ceiver does. An essential thought with PPP is the ne-cessity to amend for different impacts that would somehow or another counterbalance in relative situating methods utilizing at least one collectors . PPP needs to manage numerous such impacts, including site-removals because of earth tides and sea stacking, stage twist up, reception apparatus stage focus varieties, et cetera (Hofmann-Wellenhof et al., 2008). The higher the required accuracy, the more complicated the models need to be.

2 Practical study

All the IGS stations GNSS RINEX data and products are free online through the following link ftp://cddis.gsfc.nasa.gov/. One-day observation (10/3/2015) taken as a sample day for analysis and all the IGS stations data were downloaded with their products like precise ephemeris. Also, the RINEX data had been divided into segments with the observation time (24) hrs to get the effect of observation time Precise Point Positioning (PPP) versus relative positioning with the base line length. The network shown in Figure (1)

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Figure (1): The selected IGS stations for analysis

2 IGS Stations Precise Coordinates in Study Area.

IGS exact satellite circle and clock rectifications contain the satellite equipment deferral of the sans ionosphere direct combi-country of GPS L1 and L2 signals (Kouba, 2009).

Table (1) shows the selected IGS stations precise coordinates and their standard deviations in ITRF solutions

Table (1): The selected IGS stations precise coordinates and their standard deviations in ITRF solutions

No	DATA SET EXPRESSED IN ITRF2008 FRAME				
	STATION POSITIONS AND VELOCITIES AT EPOCH 2015/01/01				
	DOMES NB	ID	X (meter)/ SIGMA x (mm)	Y(meter)/ SIGMA y (mm)	Z (meter)/ SIGMA z (mm)
1	12751M001	BZRG	4312657.332	864634.832	4603844.563
			0.005	0.002	0.005
2	12750S001	PADO	4388881.863	924567.647	4519588.855
			0.001	0.001	0.001
3	12711M003	MEDI	4461400.564	919593.773	4449504.884
			0.001	0.001	0.001
4	12712M002	GENO	4507892.176	707621.67	4441603.626
			0.001	0.001	0.001
5	14001M004	ZIMM	4331296.928	567556.058	4633134.056
			0.001	0.001	0.001
6	11001M002	GRAZ	4194423.652	1162702.875	4647245.524
			0.001	0.001	0.001
7	12724S001	IENG	4476537.277	600431.619	4488761.451
			0.001	0.001	0.001
8	11502M002	GOPE	3979315.966	1050312.641	4857067.201
			0.002	0.001	0.002
9	10077M005	AJAC	4696989.299	723994.667	4239678.663
			0.001	0.001	0.001
10	10073M008	MARS	4630532.637	433946.503	4350142.848
			0.002	0.001	0.001
11	11206M006	PENC	4052449.292	1417681.298	4701407.2
			0.001	0.001	0.002
10	12712M002	GENO	4507892.176	707621.67	4441603.626
			0.001	0.001	0.001
11	14001M004	ZIMM	4331296.928	567556.058	4633134.056
			0.001	0.001	0.001
12	14234M001	PTBB	3844059.803	709661.478	5023129.651

No	Precise Coordinates (from ITRF2008 Frame)				
	STATION POSITIONS AND VELOCITIES AT EPOCH 2015/01/01				
	DOMES NB	ID	X (meter)/ SIGMA x (mm)	Y(meter)/ SIGMA y (mm)	Z (meter)/ SIGMA z (mm)
13	12217M001	WROC	3835751.128	1177250.112	4941605.334
			0.001	0.001	0.001
14	14106M003	POTS	3800689.472	882077.545	5028791.409
			0.001	0.001	0.001
15	10001S006	OPMT	4202777.246	171368.178	4778660.311
			0.001	0.001	0.001
16	13212M010	HERT	4033460.794	23537.965	4924318.36
			0.001	0.001	0.001
17	15601M001	ORID	4498451.537	1708267.18	4173591.954
			0.001	0.001	0.001
18	10023M001	LROC	4424632.449	-94175.045	4577544.195
			0.001	0.001	0.001
19	11101M002	SOFI	4319371.918	1868687.97	4292064.026
			0.001	0.001	0.001
20	13410M001	EBRE	4833520.044	41537.303	4147461.673
			0.002	0.001	0.002
21	12717M004	NOT1	4934546.051	1321265.187	3806456.278
			0.001	0.001	0.001
22	10004M004	BRST	4231162.463	-332746.508	4745131.041
			0.001	0.001	0.002
23	10073M008	Yebes	4848725	4848724.614	-261632.012
			0.001	0.001	0.001
24	13407S012	MADR	4849202	-360329	4114913
			-0.0086	0.0194	0.013
25	20807M001	ISTA	4208830.129	2334850.487	4171267.339
			0.001	0.001	0.001

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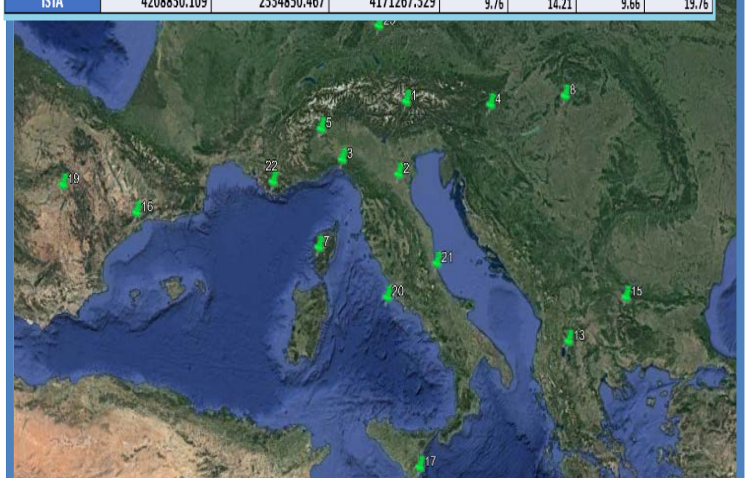
2.1 Relative Coordinates with Dual Frequency Receivers

Trimble Business Center software is used too obtaain the solution for post-processing satellite and terrestrial survey data. Table (2) gave the final results of the selected IGS stations relative coordinates of dueal frequance recivers.

Table (2) : Relative coordinates and its errors of dual frequency receivers for selected IGS stations

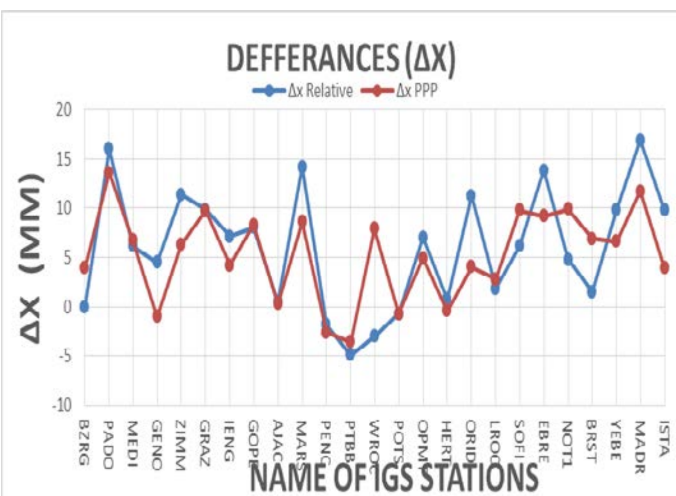
	Relative Coordinates (m)			Error= precise- relative (mm)			
Name	X	Y	Z	Δx	Δy	Δz	Δl
BZRG	4312657.332	864634.832	4603844.563	0	0	0	0
PADO	4388881.847	924567.632	4519588.843	16.01	15.05	2.2	22.08
MEDI	4461400.558	919593.7666	4449504.887	6.12	6.45	-2.94	9.365
GENO	4507892.171	707621.6644	4441603.629	4.51	5.61	-3.21	7.881
ZIMM	4331296.917	567556.0529	4633134.053	11.33	5.1	2.74	12.72
GRAZ	4194423.642	1162702.867	4647245.519	9.84	7.81	5.44	13.69
IENG	4476537.27	600431.619	4488761.45	7.16	-0.02	0.88	7.214
GOPE	3979315.958	1050312.635	4857067.199	8.01	6.17	2.16	10.34
AJAC	4696989.299	723994.6669	4239678.668	0.5	0.09	-4.92	4.946
MARS	4630532.623	433946.508	4350142.853	14.15	-5	-5.06	15.84
PENC	4052449.294	1417681.294	4701407.207	-1.81	4.09	-7.15	8.434
PTBB	3844059.808	709661.4754	5023129.655	-4.89	2.61	-4.12	6.906
WROC	3835751.131	1177250.114	4941605.344	-3	-1.62	-9.95	10.52
POTS	3800689.473	882077.5408	5028791.408	-0.74	4.23	1.33	4.495
OPMT	4202777.239	171368.1718	4778660.311	7.02	6.25	-0.08	9.399
HERT	4033460.793	23537.96556	4924318.368	0.72	-0.56	-7.63	7.684
ORID	4498451.526	1708267.178	4173591.938	11.23	2.09	5.86	12.84
LROC	4424632.447	-94175.04431	4577544.205	1.85	-0.69	-9.56	9.762
SOFI	4319371.912	1868687.956	4292064.029	6.12	14.21	-3.04	15.77
EBRE	4833520.02	41537.30048	4147461.662	13.79	2.52	11.27	17.99
NOT1	4934546.046	1321265.171	3806456.279	4.78	15.95	-1.45	16.71
BRST	4231162.462	-332746.4975	4745131.031	1.5	-5.55	-0.34	5.759
YEBE	4848724.604	-261632.017	4123094.283	9.84	4.96	0.43	11.03
MADR	4849202.265	-360328.773	4114913.328	16.89	1.97	3.34	17.33
ISTA	4208830.109	2334850.467	4171267.329	9.76	14.21	9.66	19.76



PPP Coordinates with Dual Frequency Receivers.

Name	PPP Coordinates (m)			Error =Precise- PPP (mm)			
	X	Y	Z	Δx	Δy	Δz	Δl
BZRG	4312657.33	864634.839	4603844.555	3.9	-7.4	7.7	11.369
PADO	4388881.85	924567.641	4519588.839	13.6	5.8	5.9	15.919
MEDI	4461400.56	919593.774	4449504.876	6.7	-0.9	7.8	10.322
GENO	4507892.18	707621.669	4441603.622	-1	1.3	4.3	4.6022
ZIMM	4331296.92	567556.057	4633134.045	6.3	0.7	11	12.696
GRAZ	4194423.64	1162702.87	4647245.516	9.7	0.5	8.2	12.711
IENG	4476537.27	600431.623	4488761.44	4.2	-3.5	10.6	11.927
GOPE	3979315.96	1050312.65	4857067.188	8.3	-4.6	13.5	16.502
AJAC	4696989.3	723994.668	4239678.651	0.3	-1.1	12.3	12.353
MARS	4630532.63	433946.504	4350142.845	8.6	-1	3.1	9.1962
PENC	4052449.29	1417681.3	4701407.194	-2.6	-6.8	6.1	9.4979
PTBB	3844059.81	709661.48	5023129.648	-3.6	-2.4	3.5	5.5651
WROC	3835751.12	1177250.12	4941605.323	7.9	-9.3	11.5	16.768
POTS	3800689.47	882077.549	5028791.402	-0.7	-4.4	6.9	8.2134
OPMT	4202777.24	171368.178	4778660.303	4.9	0.2	8	9.3835
HERT	4033460.79	23537.97	4924318.351	-0.4	-5	8.6	9.9559
ORID	4498451.53	1708267.19	4173591.933	4	-5.7	11.1	13.103
LROC	4424632.45	-94175.04	4577544.191	2.8	-4.7	3.8	6.6611
SOFI	4319371.91	1868687.96	4292064.011	9.8	5.3	15.2	18.846
EBRE	4833520.02	41537.3047	4147461.659	9.2	-1.7	14.3	17.089
NOT1	4934546.04	1321265.18	3806456.269	9.9	8.3	8.9	15.688
BRST	4231162.46	-332746.5	4745131.022	6.9	-8	9.1	13.943
YEBE	4848724.61	-261632.01	4123094.273	6.6	2.6	9.7	12.017
MADR	4849202.27	-360328.77	4114913.315	11.7	-0.9	15.6	19.521
ISTA	4208830.12	2334850.47	4171267.324	3.9	8.7	15.4	18.112

The Canadian Spatial Reference System (CSRS) Precise Point Positioning (PPP) is an online application for GNSS information present preparing permitting clients on figure higher exactness positions from their crude perception information. Table (3) illus-



trates the selected IGS stations PPP resulted coordinates and their standard errors for duel frequency receivers.

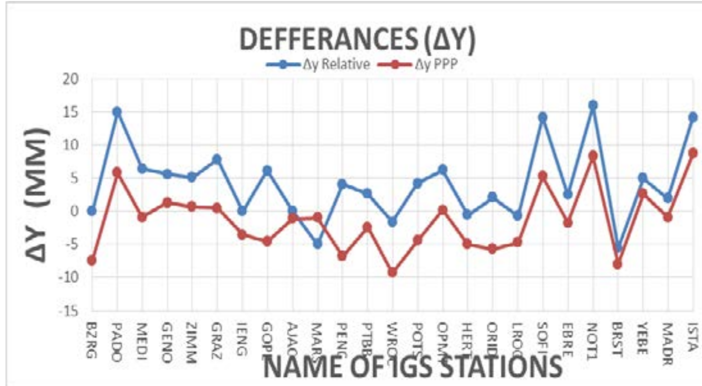
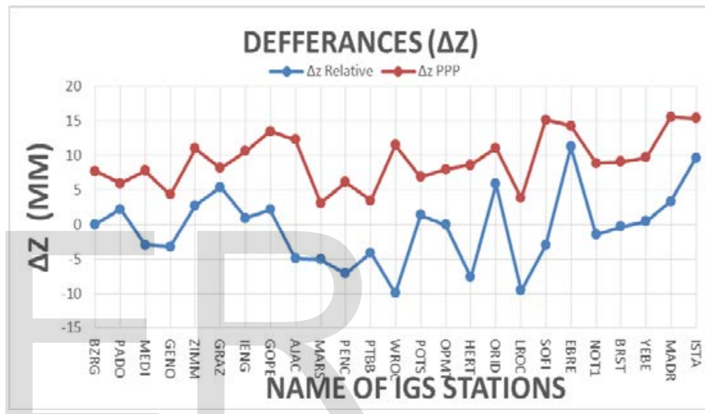


Table (3) : The selected IGS stations PPP coordinates of duel frequency receivers.



PPP and relative errors in IGS station coordinates at X -axis,Y-axis ,Z-axis shown from figure 2 to 4

Figure (2): PPP and relative errors in IGS station coordinates at X –axis (Dual).

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Figure (3): PPP and relative errors in IGS station coordinates at Y -axis (Dual).

Figure (4): PPP and relative errors in IGS station coordinates at Z -axis (Dual)

it is demonstrated in table 2 and figures the PPP solution gave an average errors with small variations about 5 to 10 mms in (X &Y) axis directions of IGS used stations coordinates better than the relative solution in case of duel frequency receivers. But the relative solution gave an average errors with small variations about 5 to 15 mms in (Z) axis directions of IGS used stations coordinates better than the PPP solution in case of duel frequency receivers.

It means that, the performance of dual PPP can furnish situating with a precision level of a couple of m-meters in static mode and there is typically next to no distinction between the exactness and preci-sion measurements in relative arrangements. Mistakes ascribed to receiv-er/recieving wire arrangement incorporate the beneficiary clock blunders, multipath mistake, collector clamor, recipient equipment delay, receiver beginning stage inclination, and collector reception apparatus stage focus varieties (ElRabbany, 2006).

		Relative Coordinates (m)			Error= precise- relative (mm)		
	Name	X	Y	Z	Δx	Δy	Δz
1	BZRG	4312657.206	864634.717	4603844.371	126	115	192
2	PADO	4388881.743	924567.533	4519588.617	120	114	228
3	MEDI	4461400.419	919593.664	4449505.034	145	109	-150
4	GENO	4507892.053	707621.533	4441603.799	123	137	-173
5	ZIMM	4331296.811	567555.961	4633133.801	117	97	255
6	GRAZ	4194423.543	1162702.766	4647245.302	109	109	222
7	IENG	4476537.166	600431.759	4488761.271	111	-140	180
8	GOPE	3979315.793	1050312.553	4857067.032	173	88	187
9	AJAC	4696989.113	723994.493	4239678.889	186	174	-226
10	MARS	4630532.463	433946.686	4350143.011	174	-183	-211
11	PENC	4052449.413	1417681.123	4701407.407	-121	175	-177
12	PTBB	3844059.982	709661.341	5023129.883	-179	137	-232
13	WROC	3835751.293	1177250.277	4941605.555	-165	-165	-221
14	POTS	3800689.654	882077.405	5028791.234	-182	140	193
15	OPMT	4202777.116	171368.028	4778660.491	184	150	-180
16	HERT	4033460.602	23538.153	4924318.533	192	-188	-173
17	ORID	4498451.371	1708267.018	4173591.974	193	162	222
18	LROC	4424632.267	-94175.241	4577544.365	182	-196	-229
19	SOFI	4319371.759	1868687.771	4292064.246	159	199	-220
20	EBRE	4833519.062	41537.151	4147461.453	177	152	219
21	NOT1	4934545.894	1321264.985	3806456.489	198	202	-231
22	BRST	4231162.266	-332746.721	4745131.054	197	-216	-218
23	YEBE	4848724.462	-261631.857	4123094.265	221	223	241
24	MADR	4849202.711	-360328.135	4114913.831	234	230	245
25	ISTA	4208830.109	2334850.277	4171267.329	248	204	262

Relative Coordinates with Single Frequency Receivers.

The arrangements in view of single recurrence PPP are inclined to beneficiary inclinations, and in addition the unfavorable ionospheric impacts. The ionospheric delay can't be totally expelled in transgression gle recurrence PPP even with the best accessible ionospheric blunder moderation item. Accordingly, the exactness of the po-sitioning arrangement diminishes, especially the stature compo-nent.

Trimble Business Center software is used too obtaain the solution for post-processing satellite and terrestrial survey data. Table (4) gave the final results of the selected IGS stations relative co-ordinates of dueal frequance recivers.

		PPP Coordinates (m)			Error= precise- PPP (mm)		
	Name	X	Y	Z	Δx	Δy	Δz
1	BZRG	4312657.22	864634.701	4603844.412	111	107	130
2	PADO	4388881.78	924567.555	4519588.729	80	92	116
3	MEDI	4461400.49	919593.693	4449504.969	73	80	-95
4	GENO	4507892.05	707621.552	4441603.645	124	118	-127
5	ZIMM	4331296.84	567555.978	4633134.085	93	80	111
6	GRAZ	4194423.57	1162702.79	4647245.543	87	90	107
7	IENG	4476537.19	600431.742	4488761.473	83	-123	125
8	GOPE	3979315.89	1050312.57	4857067.239	74	70	89
9	AJAC	4696989.16	723994.593	4239678.693	135	74	-157
10	MARS	4630532.76	433946.632	4350142.879	-122	-129	-146
11	PENC	4052449.37	1417681.16	4701407.232	-73	134	-100
12	PTBB	3844059.94	709661.398	5023129.631	-138	80	-144
13	WROC	3835751.25	1177250.24	4941605.368	-123	-131	-154
14	POTS	3800689.59	882077.475	5028791.435	-121	70	132
15	OPMT	4202777.18	171368.094	4778660.345	65	84	-99
16	HERT	4033460.66	23538.035	4924318.395	131	-70	-141
17	ORID	4498451.46	1708267.06	4173591.984	82	122	153
18	LROC	4424632.38	-94175.175	4577544.165	74	-130	-142
19	SOFI	4319371.82	1868687.89	4292064.065	95	78	-105
20	EBRE	4833519.98	41537.242	4147461.634	56	61	78
21	NOT1	4934545.92	1321265.05	3806456.243	136	133	-144
22	BRST	4231162.36	-332746.64	4745131.065	101	-132	-149
23	YEBE	4848724.53	-261632.04	4123094.345	85	131	137
24	MADR	4849202.29	-360328.67	4114913.656	115	99	125
25	ISTA	4208830.12	2334850.28	4171267.324	127	129	133

Table (4) : Relative coordinates and its errors of single frequance recivers for selected IGS stations.

PPP coordinates with single Frequency Receivers.

The Canadian Spatial Reference System (CSRS) Precise Point Positioning (PPP) is an online application for GNSS data post-processing allowing users to compute higher accuracy positions from their raw observation data. Table (4.2.d) illustrates the selected IGS stations PPP resulted coordinates and their standard errors for duel frequency receivers.

Table (5) : PPP coordinates and its errors of single frequency receivers for selected IGS stations

PPP and relative errors in IGS station coordinates at X -axis,Y-axis ,Z-axis shown from figure 5 to 7

FIGURE (5): PPP AND RELATIVE ERRORS IN IGS STATION COORDINATES AT X –AXIS (SINGLE).

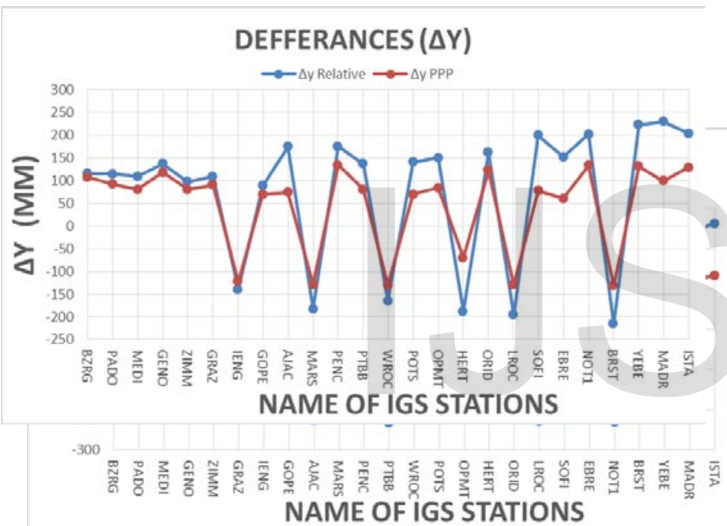


FIGURE (6): PPP AND RELATIVE ERRORS IN IGS STATION COORDINATES AT Y –AXIS (SINGLE).

FIGURE (7): PPP AND RELATIVE ERRORS IN IGS STATION COORDINATES AT Y –AXIS (SINGLE).

COMPARISON BETWEEN SINGLE AND DUAL

Comparison between single and dual shown in figure (8) , figure (9) and figure (10)

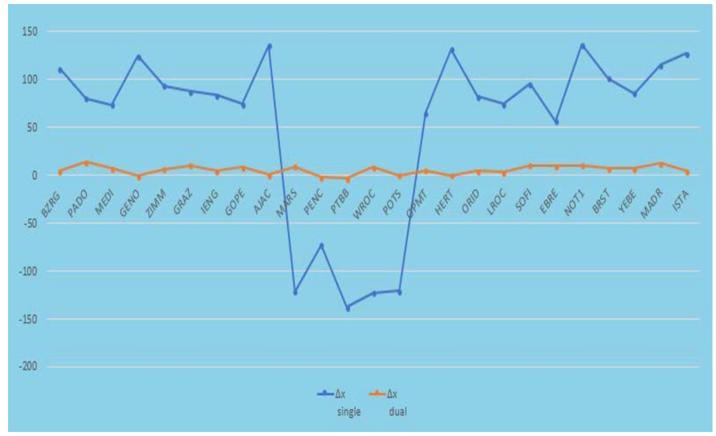
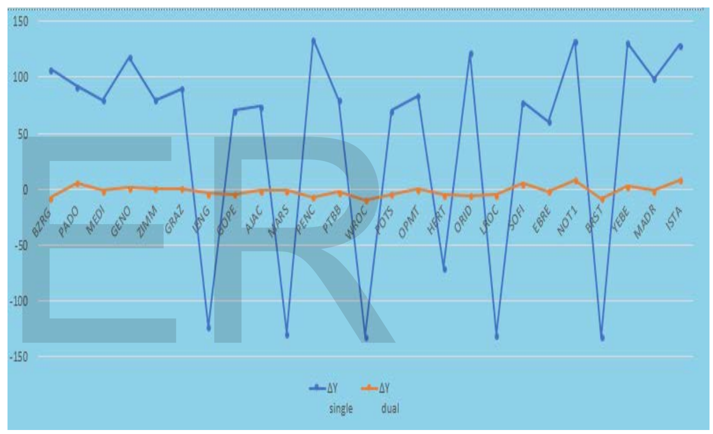


FIGURE (8): COMPARISON BETWEEN COMPONENT ERROR IN X COORDINATES SINGLE AND DUAL



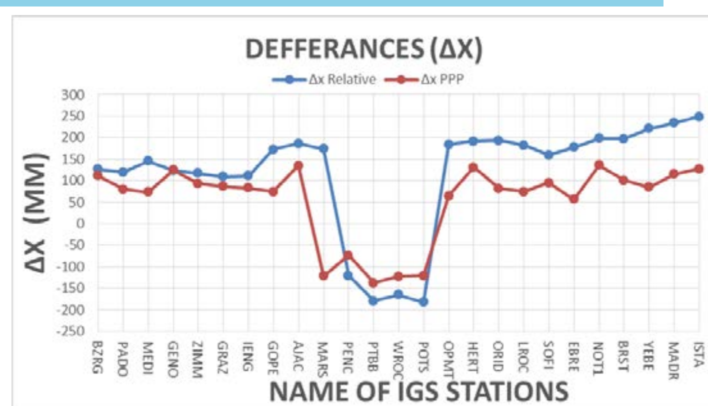


FIGURE (9): COMPARISON BETWEEN COMPONENT ERROR IN Y COORDINATES SINGLE AND DUAL

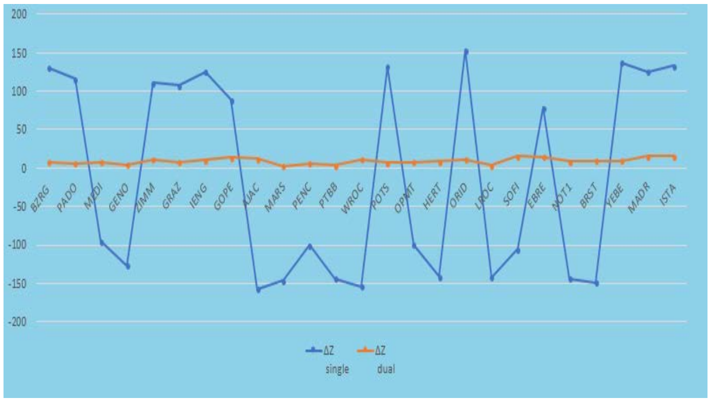


FIGURE (10): COMPARISON BETWEEN COMPONENT ERROR IN Z COORDINATES SINGLE AND DUAL

In PPP, a large portion of existing perception stochastic models are observational capacities, for example, sine, cosine, exponential and polynomial capacities. The majority of these stochastic models are elements of the satellite height points (Leandro and Santos 2007)

Conclusions

The exactness of the PPP arrangements is reliant on the quality of the GPS estimations and adjustments items utilized, and in addition the limit of the preparing motor.

` The single frequency receivers can be used for kinematic applications which require centimeter accuracy level for horizontal positioning and decimeter accuracy level for vertical position but, are not proper for kinematic applications which require high accuracy level like topographic survey works.

Dual frequency data achieve millimeter level accuracy for both horizontal and vertical position. So, dual frequency receivers can be used for kinematic applications which require high degree of accuracy level.

PPP solution gave an average errors with small variations about -9 to 15.6 mms in all axis directions of IGS used stations coordinates better than the relative solution in case of duel frequency receivers. On the other hand, the relative technique is mainly dependent on base line length

REFERENCES

El-Rabbany, A. (2006). Introduction to GPS: The global positioning system. Artech House Publishing.

Hofmann-Wellenhof, B., H. Lichtenegger, and E. Wasle (2008). "GNSS global navigation satellite systems; GPS, Glonass, Galileo & more". Springer Wien New York.

Kouba, J. (2009). A guide to using international GNSS service (IGS) products. Available at http://igscb.jpl.nasa.gov/igscb/resource/pubs/UsingIGSProductsVer21.pdf

Leandro, R. F. and M. C. Santos (2007). "Stochastic models for GPS positioning: An empirical approach." GPS World 18(2): 50-56.