International Journal of Engineering Research and Advanced Technology (IJERAT)

E-ISSN : 2454-6135

DOI: http://doi.org/10.31695/IJERAT.2018.3332

Volume.4, Issue 10
October -2018

On the Determination of NTM and UTM Positions from Post Processing of Static DGPS Observations on the Nigeria Minna Datum

Eteje Sylvester O.[1], Oduyebo Olujimi F.[2] and Olulade Sunday A.[3]

Ph.D Candidate[1,2], Lecturer[3]
[1,2]Department of Surveying and Geoinformatics
Nnamdi Azikiwe University
Awka, Anambra State
Nigeria
[3]Department of Surveying and Geoinformatics
Federal School of Surveying
Oyo, Oyo State
Nigeria

ABSTRACT

The direct determination of NTM and UTM plane rectangular coordinates from post processing of static DGPS/GNSS observations on the Nigeria Minna datum using post processing software is feasible if the rectangular NTM or UTM coordinates of the control/base station are known, and the belt or zone in which the observations were acquired is accurately identified and the identified belt or zone parameters correctly applied during data processing. But most users of these post processing software process these observations in NTM rectangular coordinates and subsequently convert the NTM grid coordinates to UTM grid positions which are not always correct. Consequently, this paper presents detailed procedures and feasibility of obtaining directly NTM or UTM coordinates from post processing of DGPS observations on the Nigeria Minna datum using the appropriate belt or zone parameters and post processing software that accompanied the DGPS/GNSS receivers. The procedures and feasibility of obtaining these coordinates in the two systems from the processing of the observations have been demonstrated with Compass post processing software.

Keywords: *DGPS/GNSS Observations, Post Processing, NTM and UTM Coordinates, Minna Datum, Belt and Zone Parameters.*

1. INTRODUCTION

The Global Positioning System, GPS is one of the Global Navigation Satellite System for determination of precise position and time, using radio signals from the satellites, in real time or in post-processing mode.These satellites are equipped with four atomic clocks each to provide accurate timing. They transmit two radio frequencies on two separate L-bands (L1 = 1575.42 MHz and L2=1227.60 MHz). The L1 signal consists of a Coarse/Acquisition (C/A) and a Precision (P) code. The L2 signal contains only the P-code. Only the C/A code of the L1 signal, known as the Standard Positioning Service (SPS), is available for civilian use. The L1 and L2 signals are available for military and other authorized users and provide a Precise Positioning Service (PPS)**.** The GPS system consists of three basic elements: the space segment, control segment, and user segment. The space segment consists of the constellation of up to 24 active NAVSTAR satellites in six orbital tracks. The satellites are not in geo-synchronous orbit and are in constant motion relative to a ground user. The control segment consists of several ground stations that serve as uplinks to the satellites and that make adjustments to satellite orbits and clocks when necessary. The user segment consists of the GPS receiver which will typically consist of an antenna, multi-channel receiver, and processing unit [1].

The Nigeria Minna datum is a geodetic datum that is suitable for use in Nigeria - onshore and offshore. Minna datum references the Clarke 1880 (RGS) ellipsoid and the Greenwich prime meridian. The datum origin is fundamental point: Minna base station L40. Latitude: 9°38'08.87"N, longitude: 6°30'58.76"E (of Greenwich). It is a geodetic datum for topographic mapping. It was defined by information from NIMA. [2] gave the orthometric height, *H* of station L40 as: 281.13m.

In Nigeria, positions are determined in geographic coordinate system as well as rectangular coordinate system. The rectangular coordinates of points are computed in either the Nigerian (Modified) Transverse Mercator (NTM), Universal Traverse Mercator (UTM) or both with respect to the ellipsoid adopted for geodetic computation in Nigeria, Clarke 1880. Each of these grid systems has its own properties. These properties are used during position computation.

Static DGPS observations of points can be post processed in both NTM and UTM using the post processing software that accompanied the instrument (base and rover receivers). If both the NTM and UTM coordinates of observed DGPS points using the static mode are to be computed from the observations, users of these post processing software in most cases processed these observations in NTM and subsequently convert the computed NTM coordinates to UTM using another software. Thus, conversion software. The UTM coordinates obtained from the conversion of the NTM coordinates using a conversion software in most cases are not correct because the right properties/parameters are not applied during the conversion/computation. The post processing software has the capability of processing these positions in both NTM and UTM if both the NTM and UTM coordinates of the reference/control station are known and the NTM belt and UTM zone of the points are rightly identified and the parameters correctly applied. The known coordinates of the control station are used to constrain as well as adjust the observations during processing as it is assumed that both the base and rover receivers receive signal from the same set of satellites during observation. Constraining the observations also enables the new points to be fitted to the existing geodetic network. Since the GPS determines positions on the World Geodetic System 1984, WGS84 ellipsoid, there is also a need to supply the transformation parameters to enable positions of points on the WGS84 ellipsoid to be transformed to coordinates on the Clarke 1880 ellipsoid.

The processing of DGPS observations on the Minna datum involves the following:

1. Conversion of geodetic coordinates (latitude, φ, longitude, λ and ellipsoidal height, h) on the WGS84 datum/ellipsoid to Cartesian rectangular coordinates, X, Y and Z also on the WGS84 datum.
2. Conversion of the Cartesian rectangular coordinates on the WGS84 datum to Cartesian rectangular coordinates on the local datum, Minna datum.
3. Conversion of the Cartesian rectangular coordinates on the local datum to geodetic coordinates (φ, λ, h) on the local datum/ellipsoid.
4. Conversion of the geodetic coordinates (φ, λ, h) to plane rectangular systems, Nigeria Traverse Mercator (NTM) and Universal Traverse Mercator (UTM) coordinates.

This paper presents detailed procedures and feasibility of obtaining directly NTM or UTM coordinates from post processing of DGPS observations on the Nigeria Minna datum using the appropriate belt or zone parameters and post processing software (Compass) that accompanied the DGPS/GNSS receivers.

1.1 Conversion from Geodetic Coordinates to Cartesian Rectangular Coordinates

According to [3], on the ellipsoid, positions are either expressed in Cartesian coordinates (*X*, *Y*, *Z*) or in curvilinear coordinates (ϕ, λ, *h*), i.e. geodetic latitude, longitude and ellipsoidal height (see Figure 1).

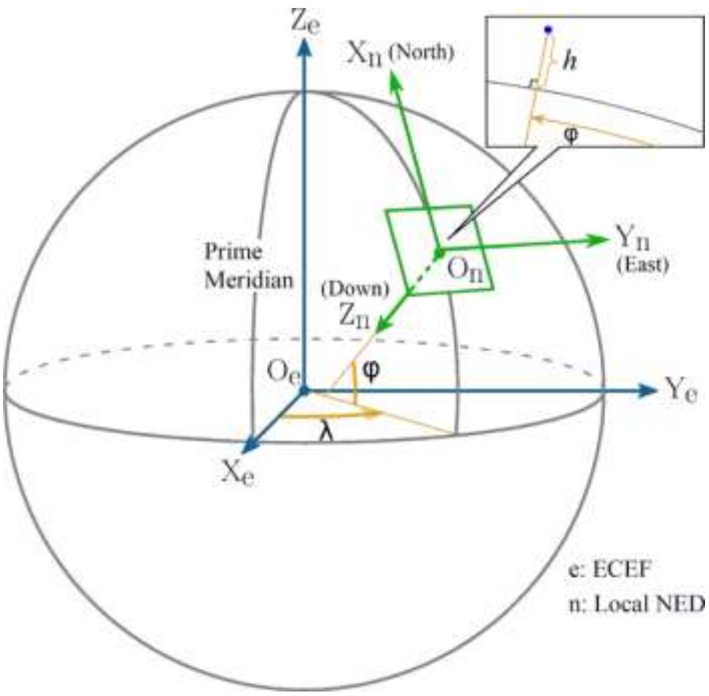

Fig. 1: Ellipsoidal Coordinate Systems
Source: [4]

DOI : 10.31695/IJERAT.2018.3332

In a geocentric, rectangular Cartesian coordinate system, the *Z*-axis coincides with the mean position of the earth's rotation axis. The *X*-axis passes through the intersection of the Greenwich meridian and the equator, and the *Y*-axis completes a right-handed coordinate system by passing through the intersection of the 90°E meridian and the equator [4].

In regards to curvilinear coordinates, geodetic latitude is defined as the angle in the meridian plane between the equatorial plane and the ellipsoid normal through a point P. Geodetic longitude is measured in the equatorial plane as the angle between the Greenwich meridian (*X*-axis) and the meridian through a point P, while the ellipsoidal height is measured from the ellipsoid surface along the ellipsoid normal. It is important to note that a single ground point can have different geodetic coordinates depending on which ellipsoid the coordinate system refers to [4]. Geodetic coordinates can be converted to rectangular Cartesian coordinates by [5] and [6]:

$$\begin{aligned} X &= (N+h)\cos\varphi\cos\lambda \\ Y &= (N+h)\cos\varphi\sin\lambda \\ Z &= \left[N(1-e^2)+h\right]\sin\varphi \end{aligned} \qquad (1)$$

Where, φ, λ and h are respectively the geodetic latitude, geodetic longitude and ellipsoidal height while X, Y, Z are the Cartesian coordinates to be estimated. *h* is ellipsoidal height (orthometric height, H + geoidal height, N). *N* in equation (1) is the radius of curvature in the prime vertical given by [7] as:

$$N = \frac{a}{(1-(2f-f^2)\sin^2\varphi)^{1/2}} \qquad (2)$$

Where, *a* is the semi-major axis while *f* is flattening given as [8]:

$$f = \frac{a-b}{a} \qquad (3)$$

b = semi-minor axis

It is to be noted here that the conversion of the geodetic coordinates on the global ellipsoid to Cartesian positions still on the global datum is necessary to enable the transformation of the coordinates to positions on a local datum/ellipsoid using the seven datum transformation parameters.

1.2 Transformation between WGS84 and Minna Datums

The processing of the DGPS observations which are always acquired on the WGS84 ellipsoid to obtain positions on the Minna datum/Clarke1880 ellipsoid requires datum transformation. This is because GPS/GNSS uses the WGS84 ellipsoid while the end datum is a local one with different ellipsoid which best fit the region of application, for instance, Minna datum. The accurate transformation of positions on the WGS84 ellipsoid to Minna Datum, Clarke 1880 ellipsoid requires the application of the seven datum transformation parameters. The application of the seven datum transformation parameters, requires their combination with the Cartesian coordinates, X, Y and Z. These parameters consist of an origin shift in three dimension, (T_X, T_Y, T_Z), a rotation about each coordinate axis (R_X, R_Y, R_Z) and a change in scale (ΔS) [7]. The model (Bursa-Wolf model) required for the transformation of positions from WGS84 ellipsoid to Minna datum is given as [9], [10], [11], [12] and [7]:

$$\begin{pmatrix} X \\ Y \\ Z \end{pmatrix}_{Minna} = \begin{pmatrix} T_X \\ T_Y \\ T_Z \end{pmatrix} + (1+\Delta S)\begin{pmatrix} 1 & R_Z & -R_Y \\ -R_Z & 1 & R_X \\ R_Y & -R_X & 1 \end{pmatrix}\begin{pmatrix} X \\ Y \\ Z \end{pmatrix}_{WGS84} \qquad (4)$$

The new set of transformation parameters that enables positions determined in Nigeria using DGPS receivers to be transformed between the WGS84 and Minna Datums are given by the Office of the Surveyor-General of the Federation, OSGOF, [13] and [14] as:

Transformation Parameters from WGS 84 to Minna Datum

T_x= 93.809786m ± 0.375857310m
T_y = 89.748672m ± 0.375857310m
T_z = -118.83766m ± 0.375857310m
R_x = 0.000010827829 ± 0.0000010311322
R_y = 0.0000018504213 ± 0.0000015709539
R_z =0.0000021194542 ± 0.0000013005997

DOI : 10.31695/IJERAT.2018.3332

S = 0.99999393 ± 0.0000010048219

Transformation Parameters from Minna Datum to WGS 84

T_x= -93.809786m ± 0.375857310m
T_y = -89.748672m ± 0.375857310m
T_z=118.83766m ± 0.375857310m
R_x = -0.000010827829 ± 0.0000010311322
R_y = -0.0000018504213 ± 0.0000015709539
R_z=-0.0000021194542 ± 0.0000013005997
S= 1.0000061 ± 0.0000010048219

It is also to be noted here that having applied the transformation parameters given above, the Cartesian coordinates are now on the Minna datum.

1.3 Conversion of the Cartesian Rectangular Coordinates on the Local Datum to Geodetic Coordinates (φ, λ, h) on the Local Datum/Ellipsoid

Having obtained the Cartesian coordinates on the Minna datum, they still need to be converted to curvilinear/geodetic positions on the Minna datum before they can be converted to plane rectangular coordinates such as NTM and UTM coordinates. The equations required to convert the local datum Cartesian coordinates to curvilinear coordinates are given as [3]:

$$\varphi_{Minna} = \tan^{-1}\left[\frac{Z}{\sqrt{X^2+Y^2}}\left(1-e^2\left(\frac{N}{N+h}\right)\right)^{-1}\right] \quad (5)$$

$$\lambda_{Minna} = \tan^{-1}\left[\frac{Y}{X}\right] \quad (6)$$

$$h_{Minna} = \sqrt{X^2+Y^2}.\sec\varphi - N \quad (7)$$

Where, e^2 = eccentricity squared = $2f - f^2$, N = radius of curvature as given in equation (2).

1.4 Conversion of the Geodetic Coordinates (φ, λ, h) to Plane Rectangular Systems, Nigeria Traverse Mercator (NTM) and Universal Traverse Mercator (UTM) Coordinates

To obtain the positions of points in local plane rectangular systems, the local ellipsoid curvilinear coordinates have to be converted to either NTM or UTM. The models and procedure for conversion of the local ellipsoid geodetic coordinates to either of the two local plane rectangular (NTM or UTM) coordinates are the same. The difference in the two plane systems are in the properties to be used in the conversion. Thus, the origin, and scale factor. To convert the geographic coordinates (latitude and longitude) on the local ellipsoid to either NTM or UTM northing and easting, equations (8) to (17) given by [15] are used.

$$E = k_o N\left[A + (1-T+C)A^3/6 + (5-18T+T^2+72C-58e'^2)A^5/120\right] \quad (8)$$

$$N = k_o\left[\begin{matrix} M - M_o + N\tan\varphi[A^2/2 + (5-T+9C+4C^2)A^4/24 + \\ (61-58T+T^2+600C-330e'^2)A^6/720] \end{matrix}\right] \quad (9)$$

$$k = k_o\left[\begin{matrix} 1+(1-C)A^2/2+(5-4T+42C+13C^2-28e'^2)A^4/24+ \\ (61-148T+16T^2)A^6/720 \end{matrix}\right] \quad (10)$$

Where,

$$k_o = 0.99975 \text{ for NTM and } 0.9996 \text{ for UTM} \quad (11)$$

$$e'^2 = e^2/(1-e^2) = \text{second eccentricity squared} \quad (12)$$

$$e^2 = 2f - f^2 \text{ eccentricity squared} \quad (13)$$

N = radius of curvature as given in equation (2)

$$T = \tan^2\varphi \quad (14)$$

$$C = e'^2\cos^2\varphi \quad (15)$$

$$A = (\lambda - \lambda_o)\cos\varphi \quad (16)$$

DOI : 10.31695/IJERAT.2018.3332

N = Northing of point.
E = Easting of point.
$\varphi =$ latitude of point
$\lambda =$ longitude of point
$\lambda_o =$ longitude of point of center meridian of belt or zone

$$M = a\begin{bmatrix} (1-e^2/4-3e^4/64-5e^6/256-\cdots)\varphi-(3e^2/8+3e^4/32+ \\ 45e^6/1024+\cdots)\sin^2\varphi+(15e^4/256+45e^6/1024+\cdots)\sin^4\varphi- \\ (35e^6/3072+\cdots)\sin^6\varphi+\cdots \end{bmatrix} \quad (17)$$

M = Distance on the meridian from parallel of false origin (4^{o}N for NTM and 0^o for UTM) to the parallel, φ_A of point.
φ_A = Latitude of the point.

According to [15], M_o is computed using Equation (17) for φ_o, which is the latitude crossing the central meridian at the origin of the (E, N) coordinates.

Equations (1) to (17) are used to develop programs which the DGPS/GNSS post processing software normally apply during post processing of static DGPS observations.

1.6 Properties/Characteristics of Nigeria (Modified) Transverse Mercator Projection (NTM)

The NTM is a modified version of TM adopted for Nigeria. The modifications take care of the large expanse of the country which covers about l0^0 (i.e. 4$^°$N - 14$^°$N) latitude and 12° (i.e. 2$^°$ 30$^'$ - 14$^°$ 30$^'$E) longitude. It is generally referred to as 3-belt system [16] and [17].

The characteristics of the Nigeria (modified) Transverse Mercator Projection (NTM) as given by [2] are:

1. NTM is a conformal projection
2. The country is divided into 3 belts each 4^o wide (Figure 2).
3. The 3 belts are bounded in the north by the 14^{o}N parallel and in the south by 4^{o}N .Hence the false origin of northing is at latitude 4^o N and False Northing, No = 0.000m (see Table 1and Figure 2).

Table 1: NTM Grid Parameters

Belt	Bounding Longitudes	Central Meridian (λ_o)	False Easting of Central Meridian
West	2^{o}30’ E – 6^{o}30’ E	4^o 30’ E	230738.266m E
Mid	6^o 30’ – 10^{o}30’ E	8^o 30’ E	670553.984m E
East	10^{o}30’ – 14^{o}30’ E	12^o 30’ E	1110369.702m E

Source: [2]

DOI : 10.31695/IJERAT.2018.3332

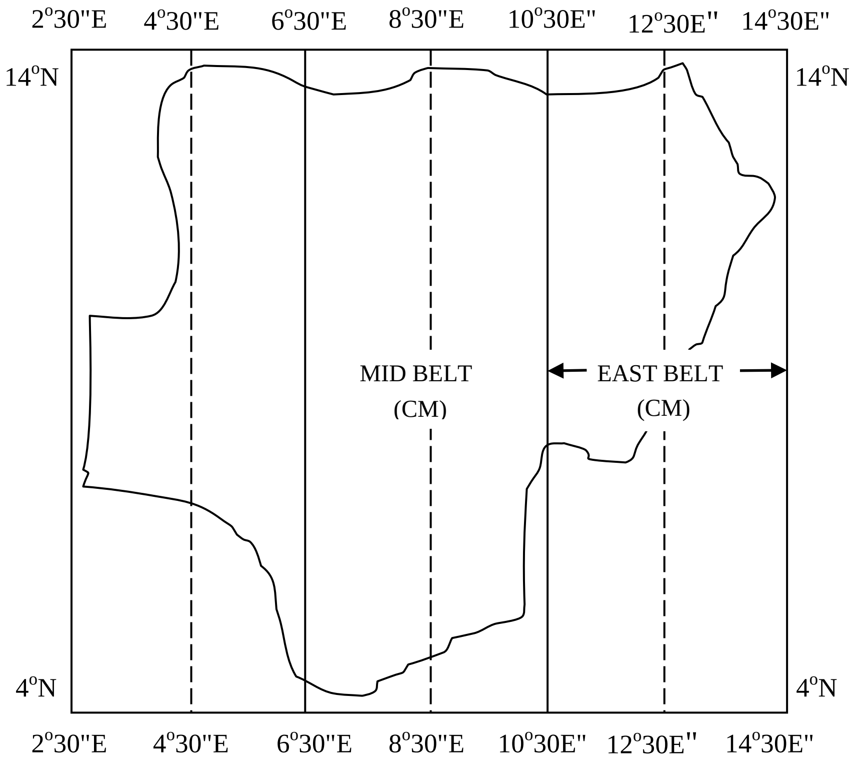

Fig. 2: Nigerian Transverse Mercator Belts
Source: [2]

4. The scale factor at each central meridian is 0.99975.
5. A rectangular metric grid is superimposed on the three belts such that they intersect along the 9°N parallel.

According to [18], the central meridians of the west and east belts are fixed respectively to be 439815.718 metres west and east of the central meridian of the mid belt along the 9°N parallel. The maximum angular distance of a point in a belt, from the central meridian of the belt is 2°. In other words, each belt is 4° wide.

1.7 Properties/Characteristics of Universal Traverse Mercator (UTM) as Applied in Nigeria

[2] also gave the properties/characteristics of the UTM as applied in Nigeria as follow:

1. Nigeria is covered by zones 31, 32 and 33 of the UTM.
2. Each zone has its own independent coordinate system with X-axis 500,000.0m west of the central meridian and Y-axis lying along the equator. The UTM grid parameters are shown in table 2 and figure 3 as given by [2].

Table 2: UTM Grid Parameters

Zone	Bounding Longitudes	Central Meridian(λ_o)	Grid Co-ord. ofCentral Meridian
31	0 -6 E	3 E	0.0m N, 500,000.0m E
32	6 – 12 E	9 E	0.0m N, 500,000.0m E
33	12 – 18 E	15 E	0.0m N, 500,000.0m E

Source: [2]

DOI : 10.31695/IJERAT.2018.3332

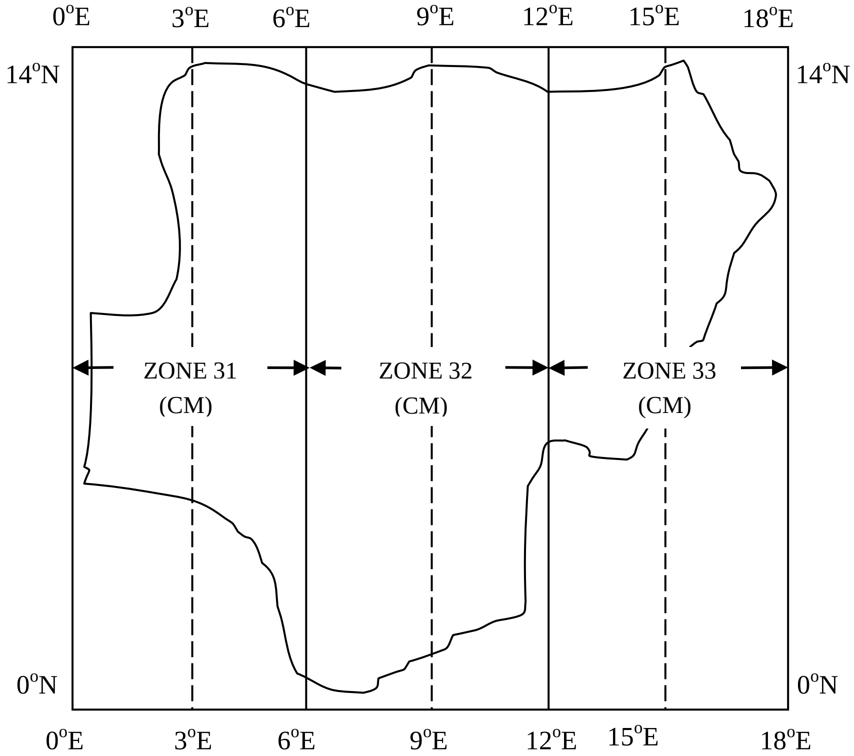

Fig. 3: UTM Zones in Nigeria
Source: [2]

3. UTM in Nigeria is computed on the Clarke 1880 reference ellipsoid.

In the UTM, the maximum angular distance of a point in a belt, from the central meridian of the belt is 3° [19]. Thus, each belt is 6° wide. Its application is limited to between latitudes 84°N and 80°S as stated by [20].

The properties/parameters of each of the plane rectangular systems, NTM and UTM are applied during DGPS observations post processing. The parameters to be applied in each plane rectangular system depend on either the belt or the zone in which the observations were carried out.

1.8 DGPS Post Processing Software

There are various types of post processing software that accompany different DGPS/GNSS receivers to enable static observations to be processed. These include: Compass, EZSurv, GrafNav GNSS, Topcon GNSS-Pro and SurveyGNSS post-processing software.

1.9 Compass Post-Processing Software

The compass post processing software is a post processing software that accompanies CHC900 dual frequency GNSS receivers. The software consists of nine menus that enable static observations to be post processed. The menus include: File, Edit, Baseline, Adjustment, Check, Result, Tools, View and Window menus.
File Menu: The menu enables new and existing works to be opened, save work, import and export data, print and set coordinate system in property submenu.
Edit Menu: This enables wrong entries to be undo and deleted.
Baseline Menu: This enables the setting and processing of the baseline data to be accomplished.
Adjustment Menu: This enables the adjustment of the observations with respect to the base station to be carried out.
Check Menu: This enables the observation files, closing errors, duplicating baselines, etc to be checked.
Result Menu: The result menu displays the output of the processing.
Tools Menu: This enables the transformation parameters to be entered and the coordinate system in which the positions to be determined to be set.
View Menu: The view menu enables the software environment to be viewed during processing.
Window Menu: This enables the processing windows and icons to be arranged.

DOI : 10.31695/IJERAT.2018.3332

2. POST PROCESSING OF DGPS OBSERVATIONS ON THE NIGERIA MINNA DATUM USING COMPASS SOFTWARE

2.1 For Nigeria Traverse Mercator (NTM)

Having downloaded the observations from the base and the rover receivers into a folder of a computer system, the processing of the observations involves the following steps:

1. Launch the Compass Post Processing software on the computer system.
2. Import the DGPS raw data into the compass environment by selecting import in the file menu.
3. Select station at the top left hand side of the software environment and right click on the base station to display station dialog box. In the dialog box, the following are set:
    i. Check xyH.
    ii. x(north): enter the NTM northing coordinate of the base station.
    iii. y(east): enter the NTM easting coordinate of the base station.
    iv. Check Constraint.
    v. Click ok.

The essence of these settings is to enable the NTM coordinates of the new points to be constraint with respect to the base station NTM coordinates (see Figure 4).

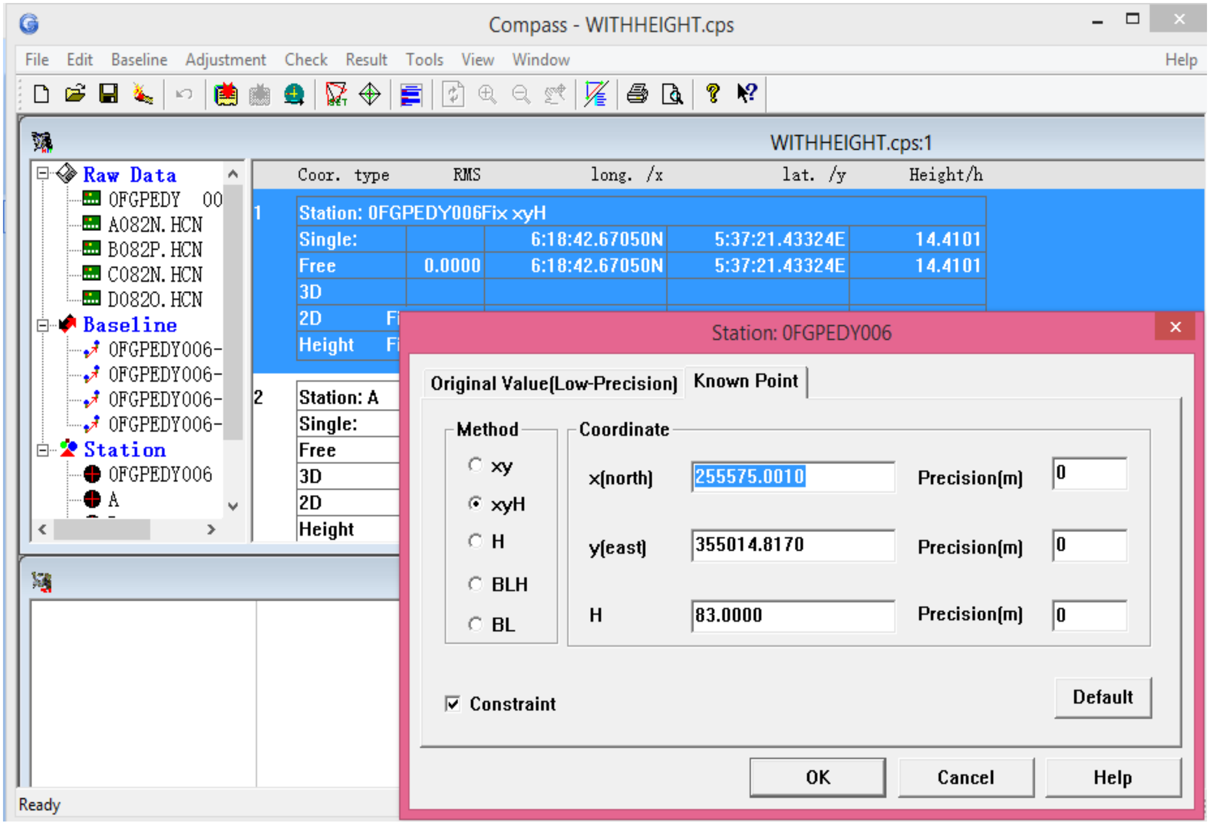

Fig. 4: Entering NTM Coordinates of Base Station

4. Select 'Setting' in Baseline menu to display 'Setup for Baseline Process' dialog box. In the dialog box, set the following (see Figure 5):
    i. Sample Interval = 5
    ii. Max Epoch = 9999
    iii. Elevation Mask (Degree) = 20 and
    iv. click ok.

DOI : 10.31695/IJERAT.2018.3332

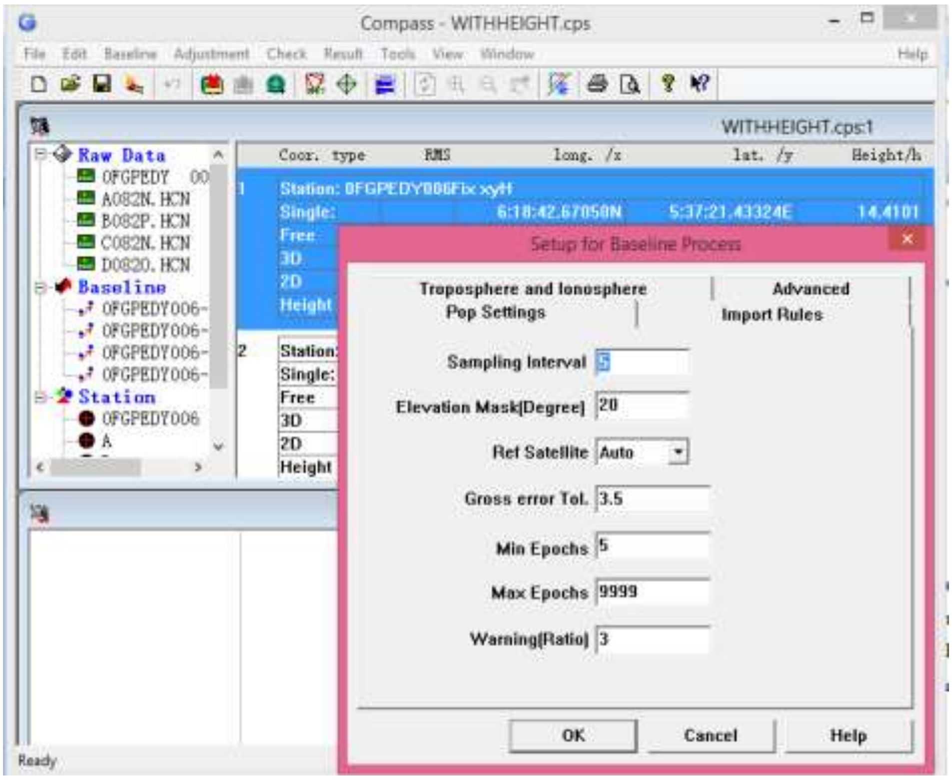

Fig. 5: Baseline Settings

5. Having accomplished step 4, select 'Process All' in Baseline menu to process the baselines data (see Figure 6).

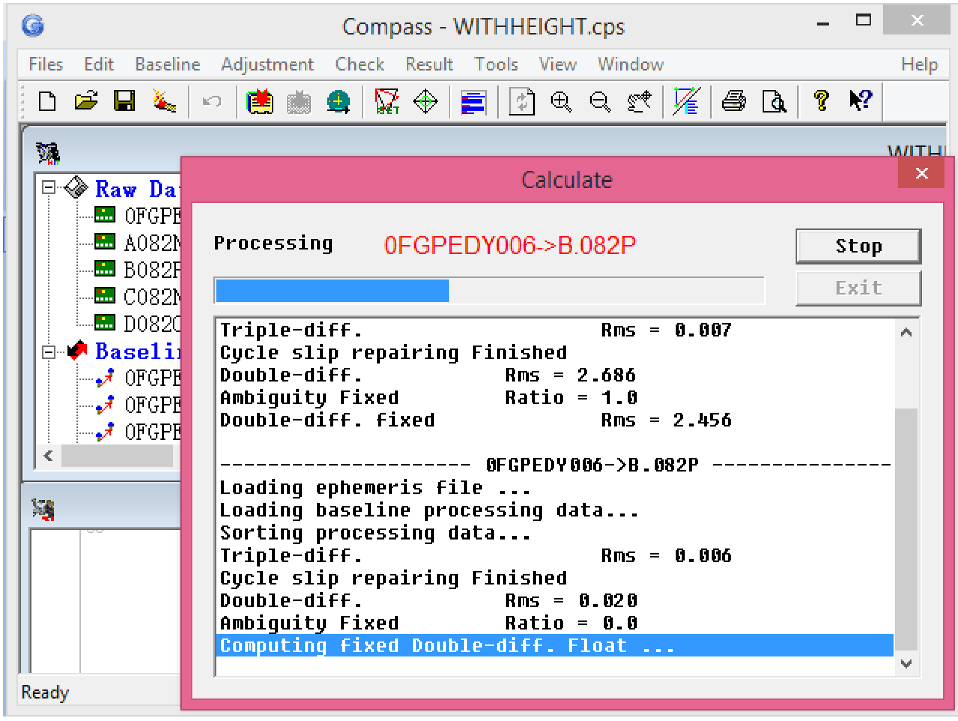

Fig. 6: Baselines Data Processing

6. Select 'Coordinate System Management(D)' in Tool menu to display Coordinate System Management dialog box. Click Add to display 'Modify Datum' dialog box. In the 'Modify Datum' dialog box, click 'Define Coordinates' tab and set the following:
   i. Coordinate System Name: Minna West Belt. If the observed points are within west belt.
   ii. Check use default ellipsoid to select Clarke 1880 in list (see Figure 7).

DOI : 10.31695/IJERAT.2018.3332

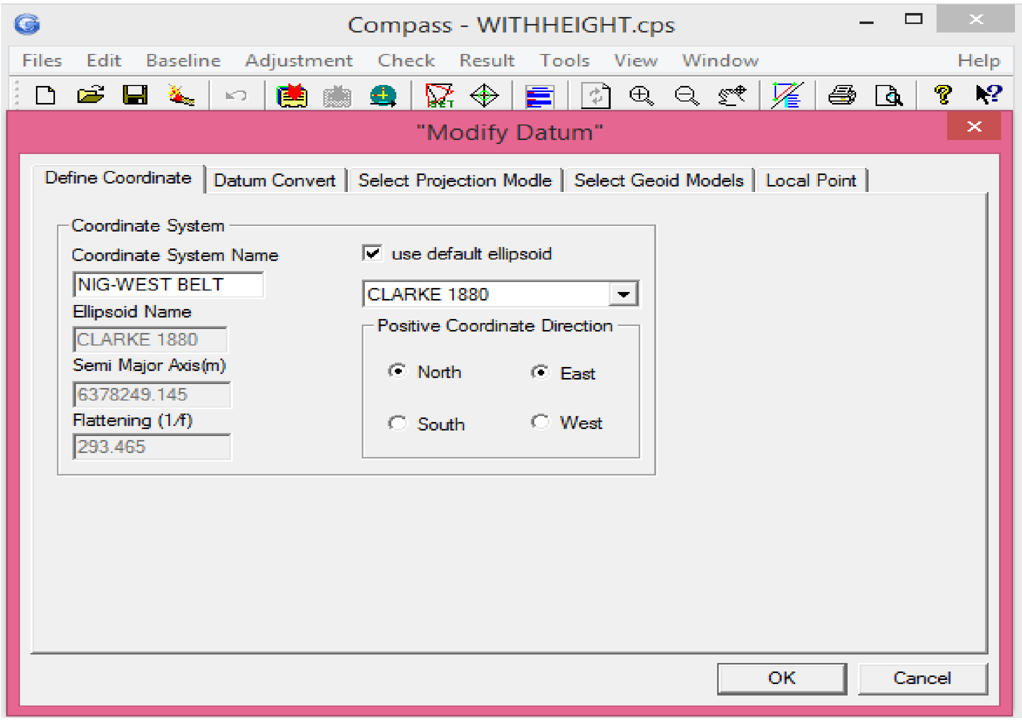

Fig. 7: Belt/Datum Selection/Entry

7. Also in the 'Modify Datum' dialog box, click 'Datum Convert' tab and set the following:
   i. Translation X: 93.809786
   ii. Translation Y: 89.748672
   iii. Translation Z: -118.83766
   iv. Rotation X: 0.000010827829
   v. Rotation Y: 0.0000018504213
   vi. Rotation Z: 0.0000021194542
   vii. Scale Factor: 0.99999393

Here, the transformation parameters from WGS 84 to Minna Datum given in section 1.2 are used (see Figure 8)

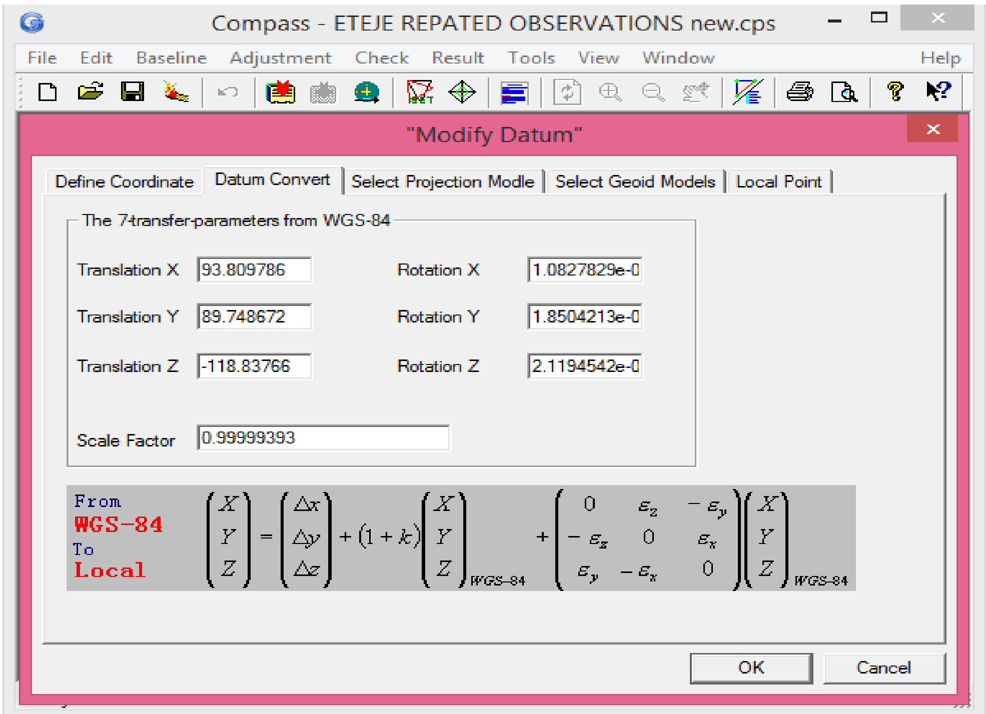

Fig. 8: Transformation Parameters Entry

8. Again, in the 'Modify Datum' dialog box, click 'Select Projection Modle' tab and select 'Traverse Mercator' in Projection 'Model'. In the selected Traverse Mercator, set the following for Nigeria West Belt:

DOI : 10.31695/IJERAT.2018.3332

i. Scale Factor = 0.99975
ii. Origin Latitude = 4° 00’ 00”
iii. Origin Longitude = 4° 30’ 00”
iv. False Northing = 0
v. False Easting = 230738.266
vi. Click ok to return to Coordinate System Management dialog box.
vii. In the Coordinate System Management dialog box, select the added datum (Nig-West Belt) and click ok (see Figures 9 and 10).

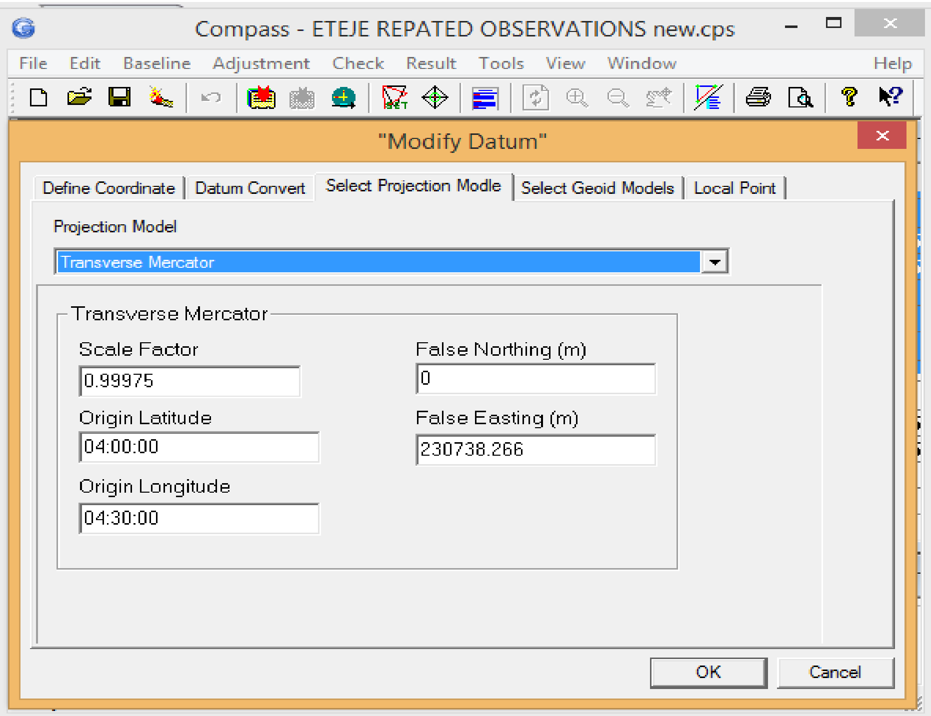

Fig. 9: Nigeria West Belt Parameters Entry

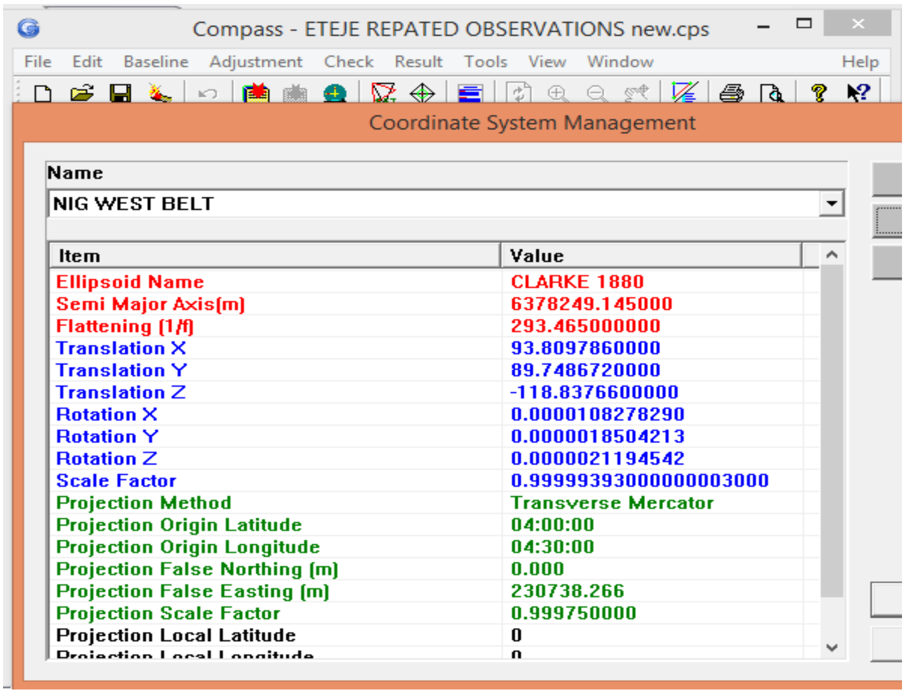

Fig. 10: Entered Datum, Transformation and West Belt Parameters

9. Select 'Setup' submenu in Adjustment menu to display the Setup dialog box. In the Setup dialog box, click Adjustment Setting tab and check 3D, 2D and Height Fighting boxes. Also, in the Setup dialog box, click Free Adjustment tab to fix the base station for network adjustment. Click ok (see Figure 11).

DOI : 10.31695/IJERAT.2018.3332

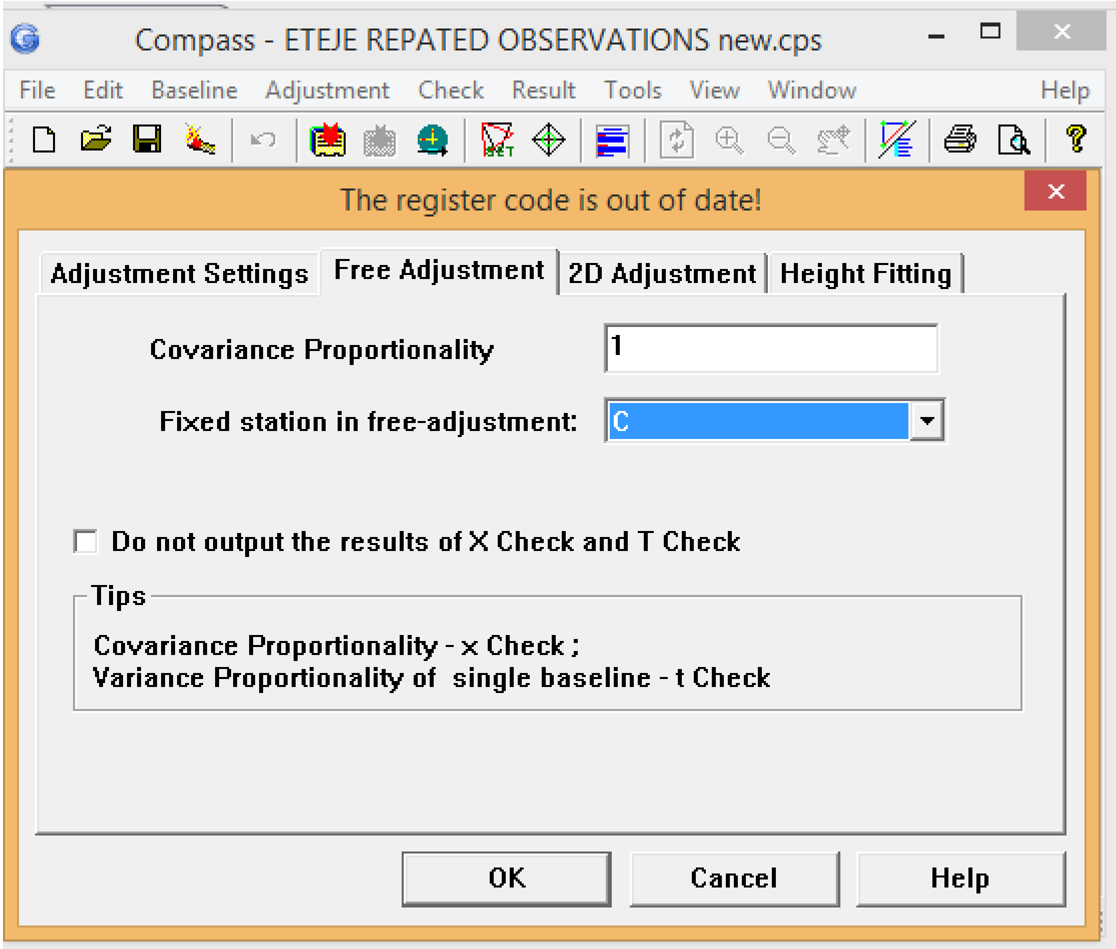

Fig. 11: Base Station Fixing for Network Adjustment

10. Having fixed the base station for network adjustment, select 'Run (W)' in adjustment menu to finally adjust the processed observations/positions (see Figure 12).

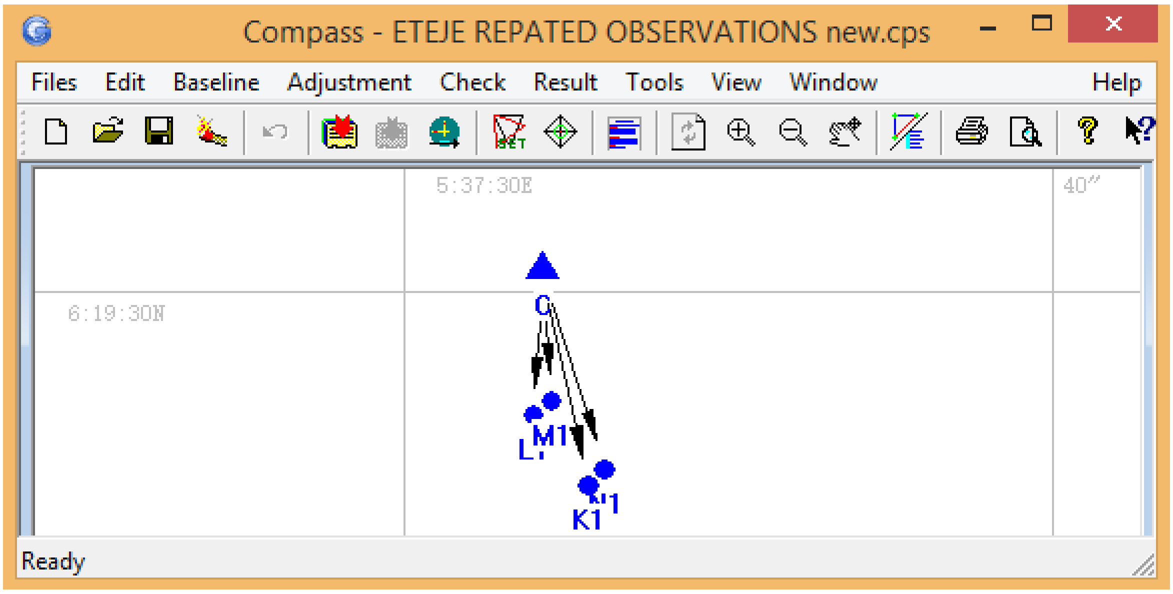

Fig. 12: Adjusted Network

11. Select 'Report' in Result menu to display the processing results (see Figure 13).

DOI : 10.31695/IJERAT.2018.3332

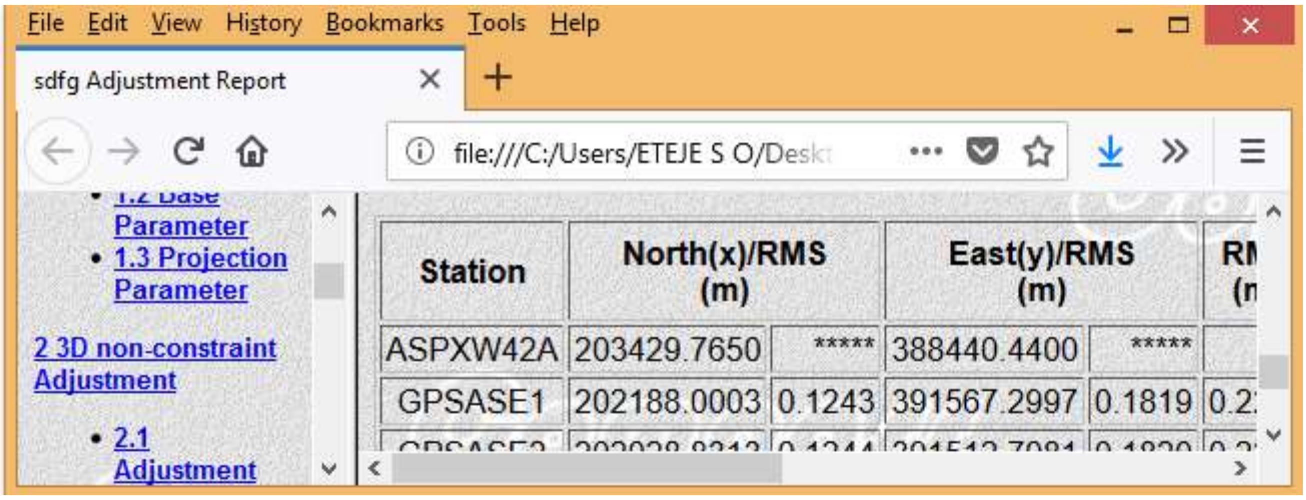

Fig. 13: Processed NTM Coordinates

2.1 For Universal Traverse Mercator (UTM)

The procedure for processing of DGPS observations in the UTM on Minna datum using the Compass post processing Software is the same as that of the NTM except for parameters input in steps 3, 6 and 8.

1. In step 3, enter the following parameters:
   i. Check xyH.
   ii. x(north): enter the UTM northing coordinate of the base station.
   iii. y(east): enter the UTM easting coordinate of the base station.
   iv. Check Constraint.

The essence of these settings is to enable the UTM coordinates of the new points to be constraint with respect to the base station UTM coordinates.

2 In step 6, click 'Define Coordinates' tab in the 'Modify Datum' dialog box, and set the following:
   i. Coordinate System Name: UTM Zone 31. If the observed points are within zone 31.
   ii. Check use default ellipsoid to select Clarke 1880 in list (see Figure 14).

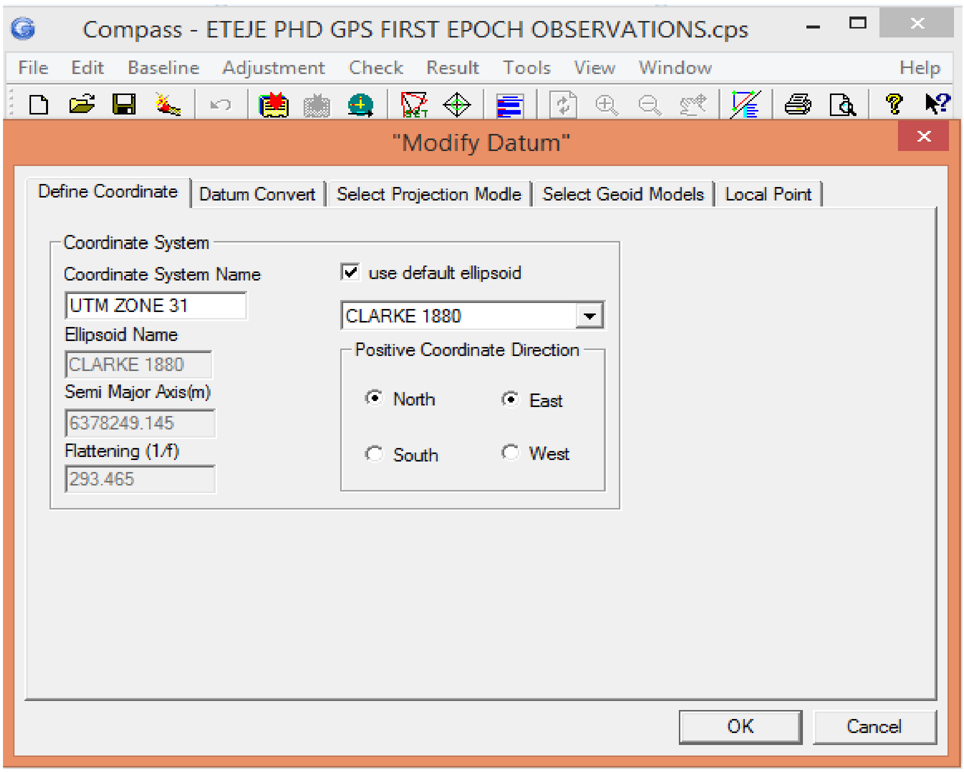

Fig. 14: Zone/Datum Selection/Entry

3. In step 8, select UTM in the 'Select Projection Modle' tab and set the following:

DOI : 10.31695/IJERAT.2018.3332

i. Hemisphere: North
ii. Zone: 31 and click ok.

Note that the selection of zone 31 automatically displays the zone parameters (see Figures 15 and 16).

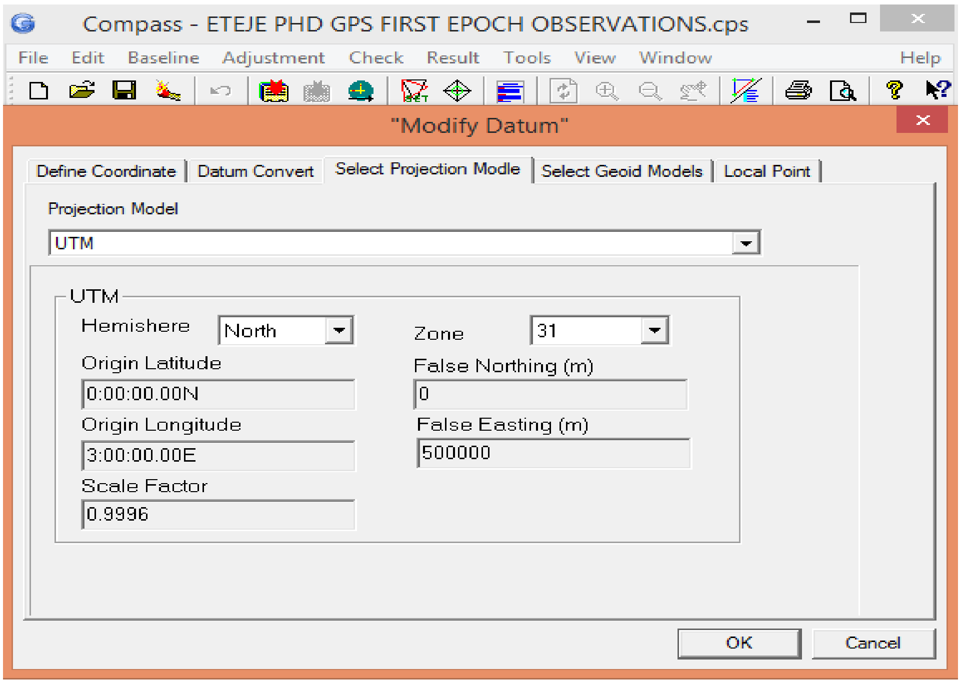

Fig. 15: UTM Zone 31 Parameters Entry

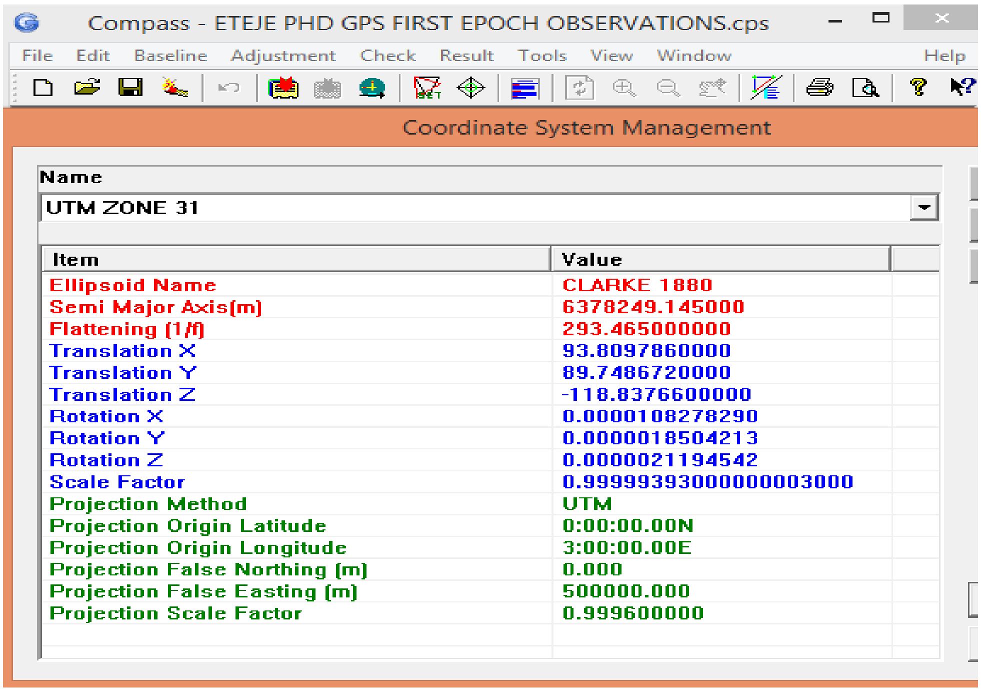

Fig. 16: Entered Datum, Transformation and UTM Zone 31 Parameters

3. CONCLUSION

The direct processing of DGPS observations in either NTM or UTM positions on the Nigeria Minna datum is achievable if the plane rectangular NTM or UTM coordinates (northing and easting) of the control/base station are known and the appropriate belt or zone parameters are applied. The NTM belt and UTM zone parameters to be applied for the processing of these observations depend on either the belt or the zone in which the observations were carried out. Since there is always inconsistency in the UTM coordinates obtained from the conversion of NTM rectangular coordinates using any other conversion software other than a post processing software that processes DGPS observations in either NTM or UTM positions, this paper has presented the step by step procedures and feasibility of obtaining directly NTM or UTM coordinates from post processing of DGPS observations on the Nigeria Minna datum using the appropriate belt or zone parameters and post processing software that accompanied the DGPS/GNSS receivers. The

DOI : 10.31695/IJERAT.2018.3332

procedures and feasibility of obtaining these coordinates in the two systems from the processing of the observations have been demonstrated with Compass post processing software.

REFERENCES

1. Vail, J., Parsons M., Striggow B. Deatrick J. and Johnson H. (2015): Global Positioning System. Region 4, U.S. Environmental Protection Agency, Science and Ecosystem Support Division, Athens, Georgia. https://www.epa.gov/sites/production/files/2015-10/documents/global_positioning_system110_af.r4.pdf. Accessed 28 August, 2018.
2. Uzodinma, V. N., Oguntuase, J. O., Alohan, and Dimgba, C. N. (2013):*Practical GNSS Surveying*. Professor's Press Ltd, Enugu.
3. Janssen, V. (2009): Understanding coordinate systems, datums and transformations in Australia. *International Journal of Geoinformatics*, Vol. 5, No. 4, pp. 41-53.
4. Gai, G., Chen, B. M. and Lee, T. H. (2011): *Unmanned Rotorcraft Systems*, Advances in Industrial Control, DOI 10.1007/978-0-85729-635-1_2, © Springer-Verlag London Limited.
5. Heiskanen, W. A., and Moritz, H. (1967): Physical Geodesy. *Bulletin Géodésique (1946-1975), Vol. 86* No. 1, 491–492. in Ziggah, Y. Y., Ayer, J., Laari, P. B. And Frimpong, E. (2017):Coordinate Transformation using Featherstone and Vaníček Proposed Approach - A Case Study Of Ghana Geodetic Reference Network. *Journal of Geomatics and Planning,* Vol. 4, No. 1, 19-26.
6. Ziggah, Y. Y., Ayer, J., Laari, P. B. And Frimpong, E. (2017):Coordinate Transformation using Featherstone and Vaníček Proposed Approach - A Case Study Of Ghana Geodetic Reference Network. *Journal of Geomatics and Planning,* Vol. 4, No. 1, 19-26.
7. Ono, M. N. (2009): On Problems of Coordinates, Coordinate Systems and Transformation Parameters in Local Map Production, Updates and Revisions in Nigeria. FIG Working Week, Eilat, Israel.
8. Eteje S. O., Oduyebo O. F. and Olulade S. A. (2018): Procedure for the Determination of Local Gravimetric-Geometric Geoid Model. *International Journal of Advances in Scientific Research and Engineering (IJASRE)*, Vol. 4, No. 8, pp 206-214. DOI: http://doi.org/10.31695/IJASRE.2018.32858.
9. Wolf, H. (1963): Geometric Connection and Re-Orientation of Three Dimensional Triangulation Nets. *Bulletin Geodesy*, Vol. 68, pp 165-169. In Hakan, S. K., Cetin, M. and Hakan, A. (2002): A Comparison of Two Well Known Models for 7-Parameter Transformation. *The Australian Surveyor* Vol. 47, No. 1, pp 24-30.
10. Bursa, M. (1966): Fundamentals of The Theory of Geometric Satellite Geodesy, Travaux De l'institut Geophsique De l'academie Tehecoslovaque Des Sciences. In Hakan, S. K., Cetin, M. and Hakan, A. (2002): A Comparison of Two Well Known Models for 7-Parameter Transformation. *The Australian Surveyor* Vol. 47, No. 1, pp 24-30.
11. Featherstone, W. and Vanicek, P. (1999): The Role of Coordinate Systems, Coordinates and Heights In Horizontal Datum Transformations. *The Australian Surveyor,* Vol. 44 No. 2. In Ono, M. N. (2009): On Problems of Coordinates, Coordinate Systems and Transformation Parameters in Local Map Production, Updates and Revisions in Nigeria. FIG Working Week, Eilat, Israel.
12. Hakan, S. K., Cetin, M. and Hakan, A. (2002): A Comparison of Two Well Known Models for 7-Parameter Transformation. *The Australian Surveyor* Vol. 47, No. 1, pp 24-30.
13. Okeke, F. I. (2014): Assessment of the Capabilities of the National Transformation Version 2 (Ntv2) Model for the Nigerian Datum Transformation. National Union of Planetry and Radio Sciences (NUPRS) Conference.
14. Okeke, F. I., Moka E. C., Uzodinma, V. N. and Ono, M. N. (2017): The Determination of Datum Transformation Parameters for Nigeria. *Nigerian Journal of Geodesy*, Vol. 1 No. 1 pp 49-64.
15. Manchuk, J. G. (2009): Conversion of Latitude and Longitude to UTM Coordinates. *Paper 410, CCG Annual Report 11.*
16. Omoigui, D. A. (1973): The Nigerian Triangulation and the Scale Check Programme. Proceedings of the International Seminar on EDM Measurement. University of Lagos - Nigeria. In Idowu, T. O. (2012):Comparison of Numerical Techniques for Coordinate Transformation: The Case Study of Nigeria Transverse Mercator and Universal Transverse Mercator. *International Journal of Applied Science and Technology*, Vol. 2 No. 4; April, 2012.
17. Idowu, T. O. (2012):Comparison of Numerical Techniques for Coordinate Transformation: The Case Study of Nigeria Transverse Mercator and Universal Transverse Mercator. *International Journal of Applied Science and Technology,* Vol. 2 No. 4; April, 2012.
18. Ufuah M. E. and Adesina J. G. (2005): Conformal Transformation of Co-Ordinates in Nigeria. https://icaci.org/files/documents/ICC_proceedings/ICC2005/htm/pdf/oral/TEMA2/Session%201/DR.%20M.E.%20UFUAH%202.pdf.
19. Mugnier, C. J., C. P. and C. M. S. (2009): Grids &Datums: Federal Republic of Nigeria. Photogrammetric Engineering and Remote Sensing.
20. Edan, J. D., Amadi, J. W., Bem, A. A. and Amadi, C. A. (2014):On the Conversion of Coordinates from Nigeria Transverse Mercator to Universal Transverse Mercator Using a Simple Mathematical Model. *International Journal of Applied Science and Technology,* Vol. 4, No. 4, pp292-299.

DOI : 10.31695/IJERAT.2018.3332