

A. Compare HTDP-transformed NGS IGS08 coordinates with CBS ITRF00 coordinates (N2) using NGS-provided velocities

Input and output locations should match

1. HTDP software

www.ngs.noaa.gov/TOOLS/Htdp/Htdp.shtml

HTDP - Horizontal Time-Dependent Positioning

HTDP is a utility that allows users to transform positional coordinates across time and between spatial reference frames.

Interactive Computations (using HTDP version 3.2.3):

- interactively estimate horizontal velocities.
- interactively estimate horizontal displacements between two dates.
- interactively update positions and/or observations for a specified date.
- interactively transform positions between reference frames and/or dates.
- interactively transform velocities between reference frames.

2. Enter parameters

| | |
|--|---|
| Specify the reference frame for the input values: | ITRF96 ITRF97 or IGS97 ITRF2000 or IGS00/IGb00 ITRF2005 or IGS05 ITRF2008 or IGS08 |
| Specify the reference frame for the output values: | ITRF96 ITRF97 or IGS97 ITRF2000 or IGS00/IGb00 ITRF2005 or IGS05 ITRF2008 or IGS08 |

month-day-year decimal year

Specify the reference date of the input position(s): 2005.0

Specify the reference date of the output position(s): 1997.0

IGS08 coordinates from NGS datasheet

```
IGS08 POSITION (EPOCH 2005.0)
Computed in Aug 2011 using data through gpswk 1631.
X = -2384509.112 m latitude = 40 24 59.49643 N
Y = -4239525.049 m longitude = 119 21 19.64385 W
Z = 4114370.733 m ellipsoid height = 1640.416 m
The IGS08 VELOCITY of the LI PC is the same as that for the ARP.
```

N3/C3

IGS08 velocities from NGS datasheet

```
IGS08 VELOCITY
Computed in Aug 2011 using data through gpswk 1631.
VX = -0.0178 m/yr northward = -0.0077 m/yr
VY = 0.0049 m/yr eastward = -0.0179 m/yr
VZ = -0.0063 m/yr upward = -0.0007 m/yr
```

Note, while velocities are expressed in m/yr on NGS datasheet, HTDP requests mm/yr

Select the type of coordinates to be entered:

- Latitude, Longitude, Height
- X, Y, Z

Latitude or X: 40 24 59.49643
Longitude or Y: 119 21 19.64385
Height or Z: 1640.416
Station Name (optional): GARL

Select how the required velocity (relative to the input frame):

- Use the velocity predicted by this program (ignore the input b
- Specify the velocity in terms of north-east-up components (us
- Specify the velocity in terms of global X-Y-Z components (use

North or X (mm/yr): -7.7
East or Y (mm/yr): -17.9
Up or Z (mm/yr): -0.7

3. Results

HTDP output does not match Trimble CBS ITRF00 location (N2/C2)

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HTDP Output
*****
HTDP (version 3.2.3) OUTPUT
TRANSFORMING POSITIONS FROM ITRF2008 or IGS08 (EPOCH = 01-01-2005 (2005.000))
TO ITRF2000 or IGS00/IGB00 (EPOCH = 01-01-1997 (1997.000))

INPUT COORDINATES OUTPUT COORDINATES INPUT VELOCITY
NGS IGS08
GARL
LATITUDE 40 24 59.49643 N 40 24 59.49796 N -6.43 mm/yr north
LONGITUDE 119 21 19.64385 W 119 21 19.63769 W -18.28 mm/yr east
ELLIP. HT. 1640.422 1640.422 m 0.00 mm/yr up
X -2384508.112 -2384508.972 m -18.04 mm/yr
Y -4239525.049 -4239525.097 m 5.21 mm/yr
Z 4114370.733 4114370.773 m -5.05 mm/yr
    
```

Other Information: **CBS ITRF00 N2/C2**

Reference Position (ITRF00 [Epoch 1997.0])

Latitude: 40°24'59.49643"N

Longitude: 119°21'19.63778"W

Altitude [m-NAE]: 1,640.422

B. Compare HTDP-transformed NGS IGS08 coordinates with CBS ITRF00 coordinates (N2) using HTDP-predicted velocities

Input and output locations should match

1. Enter parameters

Same as previous step but with HTDP-predicted velocities rather than NGS provided

values

Select how the required velocity (relative to the input frame)

- Use the velocity predicted by this program (ignore the input box)
- Specify the velocity in terms of north-east-up components (use North or X (mm/yr); East or Y (mm/yr); Up or Z (mm/yr);
- Specify the velocity in terms of global X-Y-Z components (use North or X (mm/yr); East or Y (mm/yr); Up or Z (mm/yr);

2. Results

HTDP output still does not match Trimble CBS ITRF00 location (N2/C2)

HTDP Output

```
*****
HTDP (version 3.2.3) OUTPUT
TRANSFORMING POSITIONS FROM ITRF2008 or IGS08 (EPOCH = 01-01-2008 (2008.000))
TO ITRF2000 or IGS00/IGB00 (EPOCH = 01-01-1997 (1997.000))
INPUT COORDINATES OUTPUT COORDINATES INPUT VELOCITY
NGS IGS08
GARL
LATITUDE 40 24 59.43643 N 40 24 59.49796 N -6.63 mm/yr north
LONGITUDE 119 21 19.64385 W 119 21 19.63769 W -18.28 mm/yr east
ELLIP. HT. 1640.422 1640.422 m 0.00 mm/yr up
X -2384508.112 -2384508.072 m -18.04 mm/yr
Y -4239525.049 -4239525.097 m 5.21 mm/yr
Z 4114370.733 4114370.773 m -5.05 mm/yr
```

Other Information: **CBS ITRF00 N2/C2**

| | |
|--|-------------------|
| Reference Position (ITRF00 Epoch 1997.0) | |
| Latitude | 40°24'59.43600"N |
| Longitude | 119°21'19.63778"W |
| Altitude (m MSL) | 1,640.422 |

C. Compare HTDP-transformed CBS ITRF00 coordinates with NGS IGS08 coordinates (N3) using HTDP-predicted velocities

Input and output locations should match

1. Enter parameters

☐☐ *Velocity data is not provided in PFO, therefore, as in the previous step,*

HTDP-predicted velocities were used

Select the type of coordinates to be entered:

* Latitude, Longitude, Height (N, E, Z)

Latitude of N

Longitude of W

Height of m

Station Name (optional):

entered from CBS list in Base Station tab (N2)

2. Results

HTDP output does not match NGS IGS08 location (N3/C3).

HTDP Output

HTDP (version 3.2.3) OUTPUT

TRANSFORMING POSITIONS FROM ITRF2000 or IGS05/IG05 (EPOCH = 01-01-1997 (1997.000)) TO ITRF2005 or IGS08 (EPOCH = 01-01-2005 (2005.000))

| | INPUT COORDINATES | OUTPUT COORDINATES | INPUT VELOCITY |
|------------|-------------------|--------------------|-------------------|
| GARL | | | |
| LATITUDE | 40 24 59.49800 N | 40 24 59.49647 N | -7.91 mm/yr north |
| LONGITUDE | 119 21 19.63778 W | 119 21 19.64394 W | -18.24 mm/yr east |
| ELLIP. HT. | 1640.422 m | 1640.416 m | -0.76 mm/yr up |
| X | -2384509.112 m | -2384509.114 m | -18.13 mm/yr |
| Y | -4239525.095 m | -4239525.047 m | 4.97 mm/yr |
| Z | 4114370.774 m | 4114370.734 m | -6.52 mm/yr |

Compare with NGS IGS08

IGS08 POSITION (EPOCH 2005.0)

Computed in Aug 2011 using data through gpswk 1631.

X = -2384509.112 m latitude = 40 24 59.49643 N

Y = -4239525.049 m longitude = 119 21 19.64385 W

Z = 4114370.733 m ellipsoid height = 1640.416 m

The IGS08 VELOCITY of the LI PC is the same as that for the ARP.

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D. Conclusions

Observations

Currently, base stations in the Trimble CBS list are listed such as (CORS, GARLIC (GARL), NEVADA (ITRF00 (1997)-Derived from IGS08 (NEW)). These are NGS IGS08 coordinates have been transformed to ITRF00 using HTDP. Entering the CBS ITRF00 coordinates into HTDP **should** return the IGS08 locations on the NGS datasheet. Yet, our demonstration **could not match**

CBS and NGS coordinates using HTDP to move from ITRF00-to-IGS08 or IGS08-to-ITRF00 using station specific or HTDP-predicted velocities.

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Explanation

This is because HTDP treats ITRF08 and IGS08 as equivalent; they are not. IGS08 has regional adjustments that ITRF08 lacks. These adjustments are not incorporated into Trimble's IGS08-to-ITRF00 transformations to populate the CBS list. Therefore, they are not truly ITRF00. Trimble notes the ITRF00 coordinates are "HTDP-derived from IGS08"; we refer to them as "HTDP-ITRF00."

Significance

Transforming IGS08 epoch 2005.0 coordinates ITRF00 epoch 1997.0 for use in PFO introduces an error due to the difference between IGS08 and ITRF08. This error is incorporated into any GPS data differentially corrected with these HTDP-transformed coordinates in the CBS. This is unacceptable.