HTDP LOG

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Version 1.0 - June, 1992

Version 1.1 - March 23, 1993
The software was modified (a) to make it more user friendly, (b) to accept the 1989 blue-book formats as opposed to the 1982 blue-book formats, and (c) to accept GPS observations for updating their observed values to a user-specified date.

Version 1.2 - April 8, 1993
The software was modified to accept GPS observations for updating when these observations are entered as F records in the G-file. The new software still accepts C records as well.

Version 1.3 - May 11, 1993
The software was modified to use the Okada equations for dislocation theory as opposed to the Dunbar equations. The dislocation parameters in the file QUAKE were modified accordingly.
Dislocation parameters were added for the April 25, 1992 Petrolia earthquake as derived by Oppenheimer et al. (preprint submitted to Science).

Version 1.4 - July 15, 1993
Dislocation parameters were added for the June 28, 1992 Landers- Big Bear earthquakes as derived by Hudnut et al. (preprint submitted to Bulletin of the Seismological Society of America).

Version 1.5 - July 22, 1993
Corrected a logical error in the routine that updates GPS observations. Previous versions of the software would erroneously drop the negative sign when a component of a GPS vector is a negative number whose magnitude lies between 10 meters and 100 meters.

Version 1.6 - September 17, 1993
Dislocation parameters were added for the Nov. 24, 1987 Superstition Hill earthquake sequence as derived by S.

Larsen et al. (JGR, 1992, v97, pp4885-4902).

Dislocation parameters were added for the May 2, 1983 Coalinga earthquake as derived by R. Stein and G. Ekstrom (JGR, 1992, v97, pp4865-4883).

Dislocation parameters were added for the Aug. 4, 1985 Kettleman Hills earthquake as derived by G. Ekstrom et al. (JGR, 1992, v97, pp4843-4864).

Dislocation parameters were added for the Oct. 1, 1987 Whittier Narrows earthquake as derived by J. Lin and R. Stein (JGR, 1989, v94, pp9614-9632).

Changed format of QUAKE file to use month-day-year instead of julian day-year for earthquake date. The HTDP software was modified accordingly to read the new format.

Changed format of output file to be more compact. In particular, the name-of-site field was reduced from 30 characters to 24 characters.

Version 1.7 - December 16, 1993

Changed format of QUAKE file to contain centroid and radius for each earthquake. The software will now compute the dislacement at a given location if that location is within the specified radius of the centroid. Also changed the internal data structure for storing the earthquake parameters. In particular, the dislocation parameters are now stored on a direct access file.

Corrected a small error in the QUAKE file. A dislocation rectangle for the Landers earthquake had been unintentionally omitted.

Added capability to produce a file of point-velocity (PV) records when predicting velocities. These records are written in the required format for input into the DYNAPG software.

Dislocation parameters were added for the July 21, 1986 Chalfant Valley earthquake as derived by J. Savage and W.K. Gross (BSSA, 1995, v85, pp629-631).

New dislocation parameters for the 1934 and 1966 Parkfield earthquakes were introduced. The new model was derived by Paul Segall and Yijun Du (JGR, v98, pp4527-4538).

Dislocation parameters were added for the March 15, 1979 Homestead Valley earthquake as derived by R. Stein and M. Lisowski (JGR, 1983, v88, pp6477-6490).

Dislocation parameters were added for the July 8, 1986 North Palm Springs earthquake and the April 22, 1992 Joshua Tree earthquake as derived by J. Savage, M. Lisowski, and M. Murray (JGR, 1994, v98, pp19951-19958).

Dislocation parameters were added for the January 17, 1994 Northridge earthquake as derived by M. Murray (personal communication, January 25, 1994).

Version 1.8 - March 16, 1994

Dislocation parameters were added for the March 28, 1964 Prince William Sound, Alaska earthquake as derived by S. Holdahl and J. Sauber (*Pure and Applied Geophysics*,142:55-82).

Version 1.9

August 2, 1994

New dislocation parameters replaced the old parameters for the 1941 Red Mountain earthquake. The new parameters were derived by Snay (unpublished).

January 1, 1995

New dislocation parameters for the 1994 Northridge earthquake were introduced. The new model was derived by Ken Hudnut and 10 others (1995) BSSA, submitted.

January 1, 1995

New dislocation parameters for the 1992 Landers/Big Bear earthquake sequence were introduced. The new model was derived by K.W. Hudnut and 16 others (1994) BSSA 84:625-645.

Version 1.10

November 1, 1995

The capability was added to update geodetic positions and/or geodetic observations contained in a non-standard blue-book file featuring 5-digit station identifiers.

Version 2.0

January 1, 1996

Velocity information is now stored in grid format as opposed to storing coefficients of a piecewise linear function of latitude and longitude. The piecewise linear functions were used to predict the horizontal velocity for each node of a 15-minute-by-15-minute grid that spans California. These velocities are stored in the GRID2.0 file. The software uses bilinear interpolation to predict velocities at other locations.

January 1, 1996

The DYNAP-G software was used with a more extensive data set to obtain new estimates for horizontal velocities in the rectangular region bounded by latitudes 32.5N and 36.0N and longitudes 117.5W and 121.5W (Snay et al., JGR, 1996, v101, pp3173-3185).

January 1, 1996

HTDP now accepts positions in the ITRF93 reference frame as well as the NAD83 reference frame. Also HTDP will now predict velocities and/or displacements in either reference frame.

January 1, 1996
HTDP now accepts positions in cartesian coordinates (X,Y,Z) as well as in geodetic coordinates (latitude and longitude).

January 17, 1996
The dislocation model for the 1940 Red Mountain earthquake was deleted from the software as the values for its parameters were of questionable quality.

January 18, 1996
Changed the format of the earthquake input file so that latitudes and longitudes are given in decimal degrees as opposed to degrees-minutes-seconds.

January 19, 1996
New dislocation parameters for the 1992 Joshua Tree earthquake were introduced. The new model was derived by Bennett et al (1995) with a 1 km x 1 km grid defining the fault plane. The software uses a 5 km x 5 km grid where the slip on each grid element equals the average of the slip values for 25 1 km x 1 km elements.

Version 2.1

March 1, 1997
HTDP now accepts positions in all official realizations of ITRF (Boucher and Altamimi, 1996) as well as in NAD_83. Also HTDP now enables its users to transform positional coordinates among these reference frames in a manner that rigorously addresses differences among the definitions of their respective velocity fields.

Version 2.2

June 26, 1997
HTDP will now transform positional coordinates to a new reference frame and/or to a new epoch date when these coordinates are contained in the *80* records of a blue-book file. HTDP interprets the elevations in the *80* records as ellipsoid heights.

December 5, 1997
HTDP will now predict velocities in coastal Oregon and Washington by applying a model by Fluck et al. (1997).

December 24, 1997
HTDP will now predict velocities for points on selected tectonic plates (North American, Caribbean, Pacific, Juan de Fuca, and Cocos) using NNR-NUVEL-1A parameters adopted by the IERS (McCarthy, 1996).

August 18, 1998
HTDP will now perform transformations involving ITRF96. Also, the software now uses the new transformation from ITRF96 to NAD_83 that was recently adopted by NGS and the Geodetic Survey of Canada.

September 17, 1998
In updating GPS observations to a common date, HTDP now reads the reference frame identifier from the B-record of the GFILE (columns 52, 53), and uses this information to compute time-dependent changes to the corresponding observed vectors. Previous versions of HTDP erroneously used the reference frame that the user specified for the positions in the BFILE.

September 17, 1998
HTDP now enables users to transform all GPS vectors in a GFILE to a common, user-specified reference frame when these vectors are updated to a common date. Columns 52 and 53 of the B-records are modified accordingly. Alternatively, GPS vectors may be left in the reference frame noted in the corrsponding B-record upon input.

September 17, 1998
HTDP now puts a "warning" message at the top of the output BFILE and GFILE when their observations have been updated to a common date. Also, when the GPS vectors in a GFILE have been updated to a common date, HTDP enters the letters, ZT, in columns 79 and 80 of this file's A-record, and HTDP enters the new date for these vectors in the "start-of-project" and "end-of-project" fields of this A-record. Note that the dates appearing on the observational records are not modified; only the observed values are modified on the observational records.

December 1, 1998
The data that resides in the three ASCII files--GRIDx.y, BNDRYx.y, and QUAKEx.y--have now been transcribed into BLOCK DATA routines. Thus, the HTDP executable code does not need to read these three ASCII files.

Version 2.3

November 29, 1999
HTDP now performs transformations involving ITRF97. Because observing dates for classical observations in the standard blue-book BFILE (4-digit SSN) express years with only 2 digits, the source code was rewritten to identify the proper century from the information on the *12* record. See the routines called UPBB4 and TRFDAT.
To get observing dates for classical observations in a non-standard blue-book (5 digit SSN), the program now

reads the Year, Month, and Day from columns 101-108 of the observational records.

Version 2.4

April 28, 2000

HTDP was updated to incorporate a new transformation from ITRF96 (= ITRF94) to ITRF97. The previous version of HTDP assumed that ITRF97 = ITRF96, as declared by the IERS when ITRF97 was released on 1 AUG 1999. Several IGS researchers subsequently determined that the ITRF97 positions and velocities for about 50 GPS stations in their satellite tracking network differed systematically from their corresponding ITRF96 positions and velocities (positions at the 15 mm level and velocities at the 2 mm/yr level). Consequently, IGS adopted a 14-parameter Helmert transformation between ITRF96 and ITRF97 (IGS Electronic Mail: Message Number 2432, 20 AUG 1999). The IGS transformation parameters are expressed relative to an epoch date of 1 AUG 1999. HTDP incorporates this IGS transformation with parameters expressed relative to 1 JAN 1997.

HTDP now includes a term for the rate of change in scale in the array that specifies the parameters of a Helmert transformation. Also, the equations for converting positions and velocities between reference frames have been modified to consider a non-null rate of change in scale.

June 16, 2000

HTDP now enables users to specify values for site velocities (as opposed to using HTDP-predicted values) when predicting displacements or updating positions or transforming positions for individual sites entered interactively. Users can still opt to use HTDP-predicted velocities for any of these tasks.

HTDP now enable users to transform velocities between reference frames.

June 19, 2000

Encoded dislocation model for M7.1 Hector Mine, CA earthquake as derived by Jay.W.Parker@jpl.nasa.gov and as found at

http://milhouse.jpl.nasa.gov/hector/hectormine3.model .

This model will be published by Hurst et al. in Geophysical Research Letters.

Version 2.5

December 27, 2000

The velocity field model was completely revised using point velocities estimated from several sources:

* Version 2 of the SCEC velocity field for 363 sites in southern California,

* velocity field for 239 sites in the western U.S. derived by Matt van Domselaar of CSRC/SIO in November, 2000,
* velocity field for 86 CA HARN sites derived by Matt van Domselaar of CSRC/SIO in November, 2000,
* version 2 of the Western U.S. Cordillera velocity field for 373 sites,
* velocity field for 378 international sites derived by NGS as part of its ITRF97 solution for the CORS and its ITRF2000 solution for the IGS tracking network,
* velocity field for 73 sites in Oregon published by Robert McCaffrey et al. [2000],
* velocity field for 6 sites in Washington published by Khazaradze et al. [1999].

May 23, 2001
The new velocity field is defined by grids for 2 regions:
Region 1 = western U.S (31.75N-50N, 111W-125W)
Region 2 = Alaska (55N-56N, 131W-132W)
Elsewhere the velocity is defined by the NNR-NUVEL-1A model.
Added capability to convert positions and velocities to/from the IGS97 reference frame (= ITRF97).

Version 2.6
December 14, 2001
Added parameters to transfer to and/or from ITRF00.
Added code to input points in the southern hemisphere.
Added code to print the header "HTDP (version 2.6) OUTPUT" on the standard output file.

Version 2.7
February 28, 2002
Replaced dislocation model for 1999 Hector Mine earthquake with that published by Peltzer, Crampe, and Rosen (2001).

December 26, 2002
Included capability to convert positions and velocities to/from the Pacific-plate-fixed NAD 83 (PACP00) reference frame. Also, included capability to convert positions and velocities to/from the Mariana-plate-fixed NAD 83 (MARP00) reference frame. Also, included capability to convert positions and velocities to/from WGS 84 (G1150)reference frame.

December 27, 2002
When reading a blue book file, HTDP now uses the ellipsoid height given on the *86* record. If this record does not contain an ellipsoid height, then HTDP computes the ellipsoid height as the sum of the orthometric height and geoid height specified on this record. If the geoid height is not specified on the *86* record, then HTDP uses the orthometric height on this record as the ellipsoidal height. If the blue book file does not contain an *86* record for a particular station, then HTDP sets the ellipsoid height

equal to the value found in columns 70-75 of the *80* record, whereby a blank field is considered to represent an ellipsoid height of zero meters.

December 27, 2002
The numbers used to identify the different reference frames have been changed in subroutine MENU1.

December 30, 2002
The output file now displays the input velocities used when updating positions and/or transforming positions between reference frames.

November 26, 2004
HTDP now allows records in the GFILE to have a length of 120 characters (as opposed to 80) as requested by Dale Pursell for the adjustment of the National Spatial Reference System.

Version 2.8
August 19, 2005
HTDP now recognizes the IGb00 reference frame.

Version 2.9
July 3, 2006
Encoded dislocation model for the M6.0 Parkfield, CA earthquake of October 2004 as derived by Johanson et al. [2006].

November 21, 2006 - Corrected error involving the misuse of the radius of curvature in the parallel for the radius of curvature in the meridian (and vice versa) when converting angular units to linear units for earthquake displacements. This error occurred only when checking whether a point was within an “earthquakes radius of influence”. Hence, I doubt that it caused any substantial problem.

December 13, 2006 - Encoded dislocation model for M6.5 San Simeon earthquake of December 2003 as derived by Johanson in her Ph. D. dissertation at the University of California at Berkeley.

December 13, 2006 - Introduced two new reference frames, ITRF2005 and IGS05, and the transformations from these reference frames to other reference frames.

Version 3.0
February 8, 2008 - Incorporated a new model for horizontal crustal velocities within western CONUS. This model was developed by Dr. Robert McCaffrey and it spans the rectangle with latitudes between 31ºN and 49ºN and with longitudes between 100ºW and 125ºW. Dr. McCaffrey represents this region as being comprised of a collection of elastic, rotating blocks that are separated by geologic faults. He

used 4,890 GPS-derived horizontal velocities, 170 fault slip rates, and 258 fault slip vectors to estimate the model parameters.

February 8, 2008 - HTDP now computes all velocities relative to ITRF2005. These velocities are then transformed to NAD_83(CORS96) for performing all further computations in this latter reference frame. After the computations, the results are then transformed to the user-specified reference frame for output.

February 8, 2008 - HTDP now uses the ITRF2005 rotation pole for North America as published by Altamimi [2007] to predict ITRF2005 horizontal velocities for those points in North America that are located external to the region modeled by Dr. McCaffrey and external to the Alaska region that Snay had previously modeled. HTDP had previously been using the NNR-NUVEL1A rotation pole for North America to predict ITRF2005 velocities for these regions.

February 8, 2008 - HTDP now recognizes the new NAD_83 realization known as NAD_83(NSRS2007). HTDP equates this realization to NAD_83(CORS96).

April 22, 2008 - HTDP now contains a dislocation model for the magnitude 7.9 Denali earthquake that occurred on November 3, 2002. The model was developed by Elliott et al. [2007].