Formats of apriori files for VTD.

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Abstract:

This document provides description of formats for a priori data used for computing VLBI time delay and Doppler frequency shift for observations of objects in the Solar system.

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2.22 HYDROSTATIC_MAPPING_FUNCTION/WET_MAPPING_FUNCTION: (MMF)

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1 Preliminaries remarks

1.1 Date format:

Internally dates are kept in VTD in a pair of variables:
MJD of INTEGER*4 type and TAI of REAL*8 type. TAI keeps
time elapsed from the midnight. External dates can be
presented in two formats: Solve format compatible with
ISO 8601 and VEX format.

1.2 Solve date format

YYYY.MM.DDThh:mm:ss.sssssssss
where YYYY stands for year
MM stands for the month number
DD stands for the day of month
hh stands for the hour
mm stands for the minute
ss stands for the second. Decimal point
and the fractional part are optional

Example: 2010.06.20T10:45:51.120391
This format is compatible with ISO 8601.

VTD also accepts date with character "_" instead of "T"
in the 11-th position for better readability.
Example: 2010.06.20_10:46:36
This format is incompatible with ISO 8601.

1.3 VEX date format

YYYYyDDDdHHhNNmSS.SSSSSSs

where YYYY stands for year
DDD stands for the day of year
HH stands for the hour
NN stands for the minute
SS stands for the second. Decimal point
and the fractional part are optional

Examples:

2010y171d10h49m19.129803s
2010y171d10h50m49s

1.4 Angle formats

Angles are presented in the form
DDD_MM_SS.SSSSS or HH_MM_SS.SSSSS
where DDD is degree
MM is arc-minute
SS is arcsecond. Decimal point
and the fractional part are optional

or HH is hour
MM is minute
SS is second of time. Decimal point
and the fractional part are optional

Delimiters "_" or ":" are acceptable

Examples:

-64_21_58.19083
+64:21:58
10:52:02.282921
10_54_57

2 Data formats

2.1 LEAP_SECOND

Label: # LEAP_SECOND file Version of 2004.01.29
Purpose: Data file in LEAP_SECOND format contains the dates of
of the difference TAI-UTC as a function of UTC time tag.
TAI stands for international atomic time
(Temps Atomique International), and UTC is a non-differential
step-wise function of time.
Type: Ascii
Example: $(VTD_ROOT)/share/leapsec.dat

Comment character: #
Data record format:

Field 1:6 A6 Delimiter: Date:
Field 7:27 A21 Date as UTC time tag in Solve format.
Field 28:38 A11 Delimiter: TAI-UTC:
Field 39:43 F5.1 The difference TAI minus UTC

2.2 DE_EPHEMERIDES

Label: ?
Purpose: Table of Chebyshev coefficients for expansion of positions

of the Sun, Moon and 9 major planets.
Type: Ascii
Example: $(VTD_ROOT)/share/DE403_JPL.dat

Comment character: n/a
Data record format: I completely forgot, sorry. It is rather complicated

2.3 STATION_DESCRIPTION

Label: # STATION DESCRIPTION Format version of 2004.01.26
Purpose: Defines name of the tectonic plate, type of the
mounting, and the value of axis offset for stations.
Type: Ascii
Example: $(VTD_ROOT)/share/station.desc

Comment character: #
Data record format:

Field 1:8 A8 IVS Site name
Field 12:15 A4 Antenna mounting code: AZEL, EQUA, X-YN, X-YE, RICH
Field 18:25 F8.5 Antenna offset (m)
Field 28:31 A4 Tectonic plate according to NUVEL
Field 35:80 A46 Comments

2.4 SOURCE_COORDINATES

Three formats are supported

2.5 SOURCE_COORDINATES: SOU-MODFILES

Label: $$ SOU-MODFILE Format pre-2000
Purpose: Defines IVS source name, source right ascension,
source declination, and the semi-major axis of the
error ellipse.
Type: Ascii
Example: $(VTD_ROOT)/share/glo.src

Comment character: $
Data record format:

2357-326 00 00 20.399945 -32 21 01.23327 0.60 ! J0000-3221

Field 1:4 A4 Delimiter. Must be blank
Field 5:12 A8 IVS name of the source. For 98% sources IVS name
coincides with B1950 name. For remaining sources
a common name is used.

Field 15:16 I2 Hours of right ascension
Field 18:19 I2 Minutes of right ascension
Field 21:28 F9.6 Seconds of right ascension
Field 35:37 I3 Degrees of declination

Field 39:40 I3 Minutes of declination
Field 42:49 F8.5 Arcseconds of declination
Field 53:58 F6.2 Semi-major axis of the error ellipse.
Units: milli-arcseconds.
Value 999.99 indicates that no estimate of the error
ellipse is available. NB: in that case there may be no
compact source at that position.
Field 61:128 A58 Comments

2.6 SOURCE_COORDINATES: CAT-FORMAT

Label: $$ SOU-MODFILE Format pre-2000
Purpose: Defines IVS source name, IAU J2000 name, source right ascension,
source declination, information about errors, and correlated
flux densities.
Type: Ascii
Example: http://astrogeo.org/rfc

Comment character: #
Data record format:

Field 1:1 A1 Category: C (calibrator), N (non-calibrator), U (unreliable coordinates)
Field 4:11 A8 IVS name (B1950)
Field 13:22 A10 IAU name (J2000.0)
Field 25:26 I2 Right ascension: hours
Field 28:29 I2 Right ascension: minutes
Field 31:39 F9.6 Right ascension: seconds
Field 41:43 I3 Declination: degrees
Field 45:46 I3 Declination: minutes
Field 48:57 F8.5 Declination: seconds
Field 58:63 F6.2 Inflated error in right ascension in mas
Field 65:70 F6.2 Inflated error in declination in mas
Field 73:78 F6.3 Correlation between right ascension and declination
Field 80:85 I6 Number of observations used
Field 88:88 A1 Blank or < or - for X-band total flux density integrated over entire map
Field 89:92 F4.2 X-band total flux density integrated over entire map, Jy
Field 94:94 A1 Blank or < or - for X-band unresolved flux density at VLBA baselines, Jy
Field 95:98 F4.2 X-band unresolved flux density at long VLBA baselines, Jy
Field 101:101 A1 Blank or < or - for S-band total flux density integrated over entire map
Field 102:105 F4.2 S-band total flux density integrated over entire map, Jy
Field 107:107 A1 Blank or < or - for S-band unresolved flux density at VLBA baselines
Field 108:111 F4.2 S-band unresolved flux density at long VLBA baselines, Jy
Field 114:116 A3 Used Band: X, S or X/S
Field 119:130 A12 Catalogue name

Missing value: -1.0
minus in columns 88, 94, 101 or 107 means that no data in the following column present
< in columns 88, 94, 101 or 107 means that the upper limit of the flux density is presented in the following c

2.7 SOURCE_COORDINATES: GETPAR SOU-FORMAT

Label: # GETPAR_SOU format version 1.0 of 2001.05.25
Purpose: Contains estimates of right ascension and declination of
sources, as well as their formal uncertainties and

correlations between right ascension and declination
of the same source.
Type: Ascii
Example: http://astrogeo.org/rfc

Comment character: #
Data record format:

	Field	Format	Units	Meaning
Field	1:8	A8	--	record type identifier: SOU_GCO:
Field	11:18	A8	--	IVS source name.
Field	25:26	I2	hours	right ascension. hours part
Field	27:27	A1	--	separator "_"
Field	28:29	I2	min.	right ascension. minutes part
Field	30:30	A1	--	separator "_"
Field	31:41	F11.8	sec.	right ascension. seconds part
Field	46:55	F10.4	mas	formal error of right ascension
Field	62:64	I3	deg.	declination. degrees part.
Field	65:65	A1	--	separator "_"
Field	66:67	I2	arcmin	declination. arcminutes part.
Field	68:68	A1	--	separator "_"
Field	69:78	F10.7	arcsec	declination. arcseconds part.
Field	83:92	F10.4	mas	formal uncertainty of declination
Field	99:104	F6.4	d/l	correlation between the estimates of right ascension and declination.
Field	116:122	I7	--	the number of observations of this source used in solution.
Field	133:139	I7	--	total number of observations of this source.
Field	151:155	I5	--	the number of sessions of this source used in solution.
Field	166:170	I5	--	total number of sessions with this source.
Field	182:191	A10	--	the date of the first session with this source used in solution. format: yyyy.mm.dd (as integer numbers).
Field	203:212	A10	--	the date of the last session with this source used in solution. format: yyyy.mm.dd (as integer numbers).

2.8 STATION_COORDINATES

Label: $$ SIT-MODFILE Format 2001.09.26
Purpose: Defines position of stations at the specified epoch.
Type: Ascii
Example: $(VTD_ROOT)/share/glo.sit

Comment character: #
Epoch of the station catalogue in date Solve formats defined
in the 3rd row at fields 11:21.

Data record format:

Field	1:4	A4	Delimiter. Must be blank
Field	5:12	A8	IVS station name
Field	13:15	A3	Delimiter. Must be blank
Field	16:27	F12.3	Station X-coordinate in meters
Field	28:31	A4	Delimiter. Must be blank
Field	32:43	F12.3	Station Y-coordinate in meters

Field 45:47 A4 Delimiter. Must be blank
Field 48:59 F12.3 Station Z-coordinate in meters
Field 60:128 A49 Comments

2.9 STATION_VELOCITIES

Label: $$ VEL-MODFILE Format 2001.09.26
Purpose: Defines secular velocities of stations
Type: Ascii
Example: $(VTD_ROOT)/share/glo.vel

Comment character: #
Data record format:

Field 1:4 A4 Delimiter. Must be blank
Field 5:12 A8 IVS station name
Field 13:20 A8 Delimiter. Must be blank
Field 21:28 F8.2 Station velocity along X-axis in mm/year
Field 29:36 A8 Delimiter. Must be blank
Field 37:44 F8.2 Station velocity along Y-axis in mm/year
Field 45:52 A8 Delimiter. Must be blank
Field 53:60 F8.2 Station velocity along Z-axis in mm/year
Field 62:128 A47 Comments

2.10 STATION_ECCENTRICITIES

Label: # ECC-FORMAT V 1.0 ECCENTRICITY FILE
Purpose: Defines a monument number for each VLBI station and an
eccentricity vector from the monument to the antenna's
reference point (axis intersection)
Type: Ascii
Example: $(VTD_ROOT)/share/ECCDAT.ecc

Comment character: #
Data record format:

Field 3:10 IVS station name
Field 12:15 Monument number
Field 18:33 Starting date of validity of the eccentricity vector
Field 18:21 Year of starting date of validity
Field 23:24 Month of starting date of validity
Field 26:27 Day of month of starting date of validity
Field 29:30 Hour (UTC) of starting date of validity
Field 32:33 Minute (UTC) of starting date of validity
Field 36:51 Ending date of validity of validity of the eccentricity vector
Field 36:39 Year of ending date of validity
Field 41:42 Month of ending date of validity
Field 44:45 Day of month of ending date of validity
Field 47:48 Hour (UTC) of ending date of validity
Field 50:51 Minute (UTC) of ending date of validity
Field 54:63 First coordinate of eccentricity (in meters)
Field 65:74 Second coordinate of eccentricity (in meters)

Field 76:85 Third coordinate of eccentricity (in meters)
Field 88:90 Type of eccentricity data. Set meaning of eccentricity coordinates.
Two types are supported:
NEU -- 1-st coordinate is a north projection;
2-nd coordinate is an east projection;
3-rd coordinate is a vertical projection directed up
(more precisely speaking it is directed along
a normal to the ellipsoid)
XYZ -- 1-st coordinate is a X-coordinate in crust
fixed system;
2-nd coordinate is a Y-coordinate in crust
fixed system;
3-rd coordinate is a Z-coordinate in crust
fixed system.

2.11 AEM_FILE

TBD

2.12 ERM_FILE

TBD

2.13 HARMONIC_EOP_FILE:

Label: HEO Format version of 2007.08.23
Purpose: Describes small harmonic variations in the Earth orientation. "Small" means that the squares of the rotation angles can be neglected.
Type: Ascii
Example: $(VTD_ROOT)/share/heo_20091201.heo

A file in HEO format consists of records of variable length in ASCII coding. The records are separated by a character with decimal code 13. The records of the following types are supported:

1) Header record;
2) N-record: Model name record;
3) E-record: Time epoch record;
4) H-record: Harmonic definition records;
5) A-record: Amplitude definition records;
6) V-record: Velocities definition records;
7) S-record: Amplitude errors definition records;
8) R-record: Velocities errors definition records;
9) Trailer record.

Records which start from # character are considered as comments.

The first record of a valid file in HEO format is the header record. It is followed by the model name record, time epoch record and then by one

or more harmonic definition records and one or more harmonic definition records. The last record is a trailer record. All harmonic definition records should precede amplitude and velocity definition records. Names of a harmonic in the amplitude or velocity records should be defined in the harmonic definition record. The number of velocity records can be less than the number of amplitude records, and the number of amplitude records can be less than the number of harmonic records. If a harmonic is not defined in an amplitude records, its amplitude is considered to be zero. If a harmonic is not defined in a velocity records, the rate of change of the amplitude of that harmonic is considered to be zero.

Records format:

1) A header record contains the string
"HEO Format version of 2007.08.23 "

The header record allows to distinguish the valid file in the HEO format from files in other formats and tells to a parsing software that is the version of the format.

2) A name record defines the name of the model of the harmonic Earth orientation variations.

Format of an N-record:

Field 1:1 A1 -- Records ID: letter N (decimal code 78).
field 2:3 a2 -- delimiters: blanks.
Field 4:80 A77 -- 77-letter long model name. May contain any characters in the decimal range [32, 255].

3) An epoch record defines the epoch of the expansion.
An expansion may have mixed terms (t-t0)*sin(at+p), (t-t0)*cos(at+p), where t is time. The E-record defines the epoch t0 in mixed terms. If an expansion does not have mixed terms, then the epoch defined in this record is not used. Time scale TDT is used for defining the reference epoch.

Format of a E-record:

Field 1:1 A1 -- Records ID: letter E (decimal code 69).
field 2:2 a2 -- delimiters: blanks.
Field 4:7 I4 -- Year
field 8:8 a1 -- delimiter: letter . (decimal code 46).
Field 9:10 I2 -- The index of the month in the year in the range [1,12]
field 11:11 a1 -- delimiter: letter . (decimal code 46).
Field 12:13 I2 -- The index of the day in the month in the range [1,31]
field 14:14 a1 -- delimiter: letter - (decimal code 45).
Field 15:16 I2 -- Hour in the range [0,23]
field 17:17 a1 -- delimiter: letter : (decimal code 58).
Field 18:19 I2 -- Minute in the range [0,23]
field 20:20 a1 -- delimiter: letter : (decimal code 58).
Field 21:24 F4.1 -- Seconds in the range [0.0, 59.9]

4) A harmonic definition record defines the argument of the harmonic in the form {phase + freq*(t-tr) + 1/2*accel*(t-tr)**2} where t is time in TDT time scale and tr is the reference epoch J2000.0,

01 January 2000, 12 hours TDT. The file cannot contain more than one definition of the same harmonic.

Format of an H-record:

Field 1:1 A1 -- Records ID: letter H (decimal code 72).
field 2:3 a2 -- delimiters: blanks.
Field 4:11 A8 -- 8-letter long harmonic name. May contain any characters with decimal codes 32-255, but blanks are allowed only at the end of the harmonic name. This field should not necessarily have a special meaning. Parsing software should not try to interpret this name.
field 12:13 a2 -- delimiters: blanks.
Field 14:25 F11.9 -- Phase of the harmonic in float format. Units: rad.
field 26:27 a2 -- delimiters: blanks.
Field 28:46 D19.12 -- Frequency of the harmonic in float format. Units: rad/sec.
field 47:48 a2 -- delimiters: blanks.
Field 49:59 D11.4 -- Acceleration of the harmonic in float format. Units: rad/sec**2.
field 60:60 a1 -- delimiters: blanks.
field 61:80 A20 -- Comment. Parser ignores contents of this field.

5) An amplitude record specifies the harmonic and 4 amplitudes of the variation of the Earth orientation: the in_phase polar motion (PM_amp_cos), the out_of_phase polar motion (PM_amp_sin), the in_phase rotation around E3 axis (E3_amp_cos), and the out_of_phase rotation around E3 axis (E3_amp_sin). A file cannot contain more than one amplitude record for the same harmonic. The harmonic referred in an amplitude record must be defined in the preceding harmonic definition record.

These amplitudes allows to define instantaneous small Euler angles of the perturbations in the Earth rotation with respect to an apriori model in this way:

E1 = [PM_amp_cos + PM_vel_cos*(t-t0)] *
cos { (ut1-tdt)*2*pi/86400 + phase + freq*(t-tr) + 1/2*accel*(t-tr)**2 }
+ [PM_amp_sin + PM_vel_sin*(t-t0)] *
sin { (ut1-tdt)*2*pi/86400 + phase + freq*(t-tr) + 1/2*accel*(t-tr)**2 }

E2 = [PM_amp_cos + PM_vel_cos*(t-t0)] *
sin { (ut1-tdt)*2*pi/86400 + phase + freq*(t-tr) + 1/2*accel*(t-tr)**2 }
- [PM_amp_sin + PM_vel_sin*(t-t0)] *
cos { (ut1-tdt)*2*pi/86400 + phase + freq*(t-tr) + 1/2*accel*(t-tr)**2 }

E3 = [E3_amp_cos + E3_vel_cos*(t-t0)] *
cos { (ut1-tdt)*2*pi/86400 + phase + freq*(t-tr) + 1/2*accel*(t-tr)**2 }
+ [E3_amp_sin + E3_vel_sin*(t-t0)] *
sin { (ut1-tdt)*2*pi/86400 + phase + freq*(t-tr) + 1/2*accel*(t-tr)**2 }

Where

E1 -- rotation around axis 1 (+Y angle of the polar motion)
E2 -- rotation around axis 2 (+X angle of the polar motion)

E3 -- rotation around axis 3 (-1.0027*Ut1 angle of the Earth's rotation)

t-tr -- The interval of time in scale TAU elapsed since
01 January 2000, 12 hours TAI, in seconds
t-t0 -- The interval of time in scale TAI elapsed since the reference
epoch for the expansion defined in the E-record, in seconds.

Format of a A-record

Field 1:1 A1 -- Record ID: letter A (decimal code 65).
field 2:3 a2 -- Delimiters: blanks.
Field 4:11 A8 -- 8-letter long harmonic name. The harmonic name
must be defined in a preceding H-record.
field 12:13 a2 -- Delimiters: blanks.
Field 14:25 F12.0 -- PM_amp_cos -- cosine amplitude of the small angle
of polar motion. Units: prad.
field 26:26 a1 -- delimiter: blank.
Field 27:38 F12.0 -- PM_amp_sin -- sine amplitude of the small angle
of polar motion. Units: prad.
field 39:39 a2 -- Delimiters: blanks.
Field 41:52 F12.0 -- E3_amp_cos -- cosine amplitude of the small angle
of the Earth rotation around axis 3. Units: prad.
field 53:53 a1 -- Delimiter: blank.
Field 54:65 F12.0 -- E3_amp_sin -- sine amplitude of the small angle
of the Earth rotation around axis 3. Units: prad.

6) A velocity record specifies rates of changes of the amplitudes of
the harmonic of the variation of the Earth orientation: in phase polar
motion (PM_vel_cos), out_of_phase polar motion (PM_vel_sin), in_phase
rotation around E3 axis (E3_vel_cos), out_of_phase rotation around
E3 axis (E3_vel_sin). A file cannot contain more than one velocity
record for the same harmonic. The harmonic referred in an velocity record
must be defined in the preceding harmonic definition record.

Format of a V-record

Field 1:1 A1 -- Record ID: letter A (decimal code 65).
field 2:3 a2 -- Delimiters: blanks.
Field 4:11 A8 -- 8-letter long harmonic name. The harmonic name
must be defined in a preceding H-record.
field 12:13 a2 -- Delimiters: blanks.
Field 14:25 F12.0 -- PM_vel_cos -- rate of change of the cosine amplitude
of the small angle of polar motion.
Units: 10^{-21} rad/sec.
field 26:26 a1 -- delimiter: blank.
Field 27:38 F12.0 -- PM_amp_sin -- rate of change of the sine amplitude
of the small angle of polar motion.
Units: 10^{-21} rad/sec.
field 39:40 a2 -- Delimiters: blanks.
Field 41:52 F12.0 -- E3_amp_cos -- rate of change of the cosine amplitude
of the small angle of the Earth rotation around axis 3.
Units: 10^{-21} rad/sec.
field 53:53 a1 -- Delimiter: blank.
Field 54:65 F12.0 -- E3_amp_sin -- rate of change of the sine amplitude
of the small angle of the Earth rotation around

axis 3. Units: 10^{-21} rad/sec.

7) An amplitude error record specifies the harmonic and 4 formal uncertainties of amplitudes of the variation of the Earth orientation: the error of the in_phase polar motion (PM_amp_cos_err), the error of the out_of_phase polar motion (PM_amp_sin_err), the error of the in_phase rotation around E3 axis (E3_amp_cos_err), and the error of the out_of_phase rotation around E3 axis (E3_amp_sin). A file cannot contain more than one amplitude error record for the same harmonic. If information about errors of the amplitude of the harmonic is unavailable, the record can be omitted. The harmonic referred in an amplitude error record must be defined in the preceding harmonic definition record.

Format of a S-record

Field 1:1 A1 -- Record ID: letter A (decimal code 83).
field 2:3 a2 -- Delimiters: blanks.
Field 4:11 A8 -- 8-letter long harmonic name. The harmonic name must be defined in a preceding H-record.
field 12:13 a2 -- Delimiters: blanks.
Field 15:26 F12.1 -- PM_amp_cos_err -- cosine amplitude of the small angle of polar motion. Units: prad.
field 27:27 a1 -- delimiter: blank.
Field 28:39 F12.1 -- PM_amp_sin_err -- sine amplitude of the small polar motion. Units: prad.
field 40:41 a2 -- Delimiters: blanks.
Field 42:53 F12.1 -- E3_amp_cos_err -- cosine amplitude of the small angle of the Earth rotation around axis 3. Units: prad.
field 54:54 a1 -- Delimiter: blank.
Field 55:66 F12.1 -- E3_amp_sin_err -- sine amplitude of the small angle of the Earth rotation around axis 3. Units: prad.

8) A velocity error record specifies errors of rates of changes of the amplitudes of the harmonic of the variation of the Earth orientation: the in_phase polar motion (PM_vel_cos_err), the out_of_phase polar motion (PM_vel_sin_err), the in_phase rotation around E3 axis (E3_vel_cos_err), and the out_of_phase rotation around E3 axis (E3_vel_sin_err). A file cannot contain more than one velocity record for the same harmonic. If information about errors of the rate of change of amplitude of the harmonic is unavailable, the record can be omitted. The harmonic referred in an velocity record must be defined in the preceding harmonic definition record.

Format of a R-record

Field 1:1 A1 -- Record ID: letter R (decimal code 82).
field 2:3 a2 -- Delimiters: blanks.
Field 4:11 A8 -- 8-letter long harmonic name. The harmonic name must be defined in a preceding H-record.
field 12:13 a2 -- Delimiters: blanks.
Field 14:25 F12.0 -- PM_vel_cos_err -- error of the rate of change of the cosine amplitude of the small angle of polar motion. Units: 10^{-21} rad/sec.
field 26:26 a1 -- delimiter: blank.

Field 27:38 F12.0 -- PM_amp_sin_err -- error of the rate of change of
                the sine amplitude of the small angle of polar motion.
                Units: 10^{-21} rad/sec.
field 39:40 a2   -- Delimiters: blanks.
Field 41:52 F12.0 -- E3_amp_cos_err -- error of rate of change of
                the cosine amplitude of the small angle of the Earth
                rotation around axis 3.
                Units: 10^{-21} rad/sec.
field 53:53 a1   -- Delimiter: blank.
Field 54:65 F12.0 -- E3_amp_sin_err -- error of rate of change of the sine
                amplitude of the small angle of the Earth rotation
                around axis 3. Units: 10^{-21} rad/sec.

9) Trailer record is the same as the header record.

2.14 EOP_SERIES

Label: EOP-MOD Ver 2.0
Purpose: Define the time series of the Earth orientation parameters,
        such as pole coordinates and UT1-TAI angle.
Type: Ascii, records of fixed length
Example: $(VTD_ROOT)/share/vlbi_apr.erp
NB: 1) All records of this file must have length 76 bytes
        2) non-standard units are used

Comment character: #
Header record format:

Filed 1:15   Label: EOP-MOD Ver 2.0
Field 18:26 F9.1 Julian date (TAI) of the first data record
Field 28:33 F6.2 Time step in days
Field 34:39 I6   The number of records
Field 42:48 A7   Meaning of the 4th column
Field 52:56 A5   Meaning is lost
Field 57:76 A18 Delimiter: blank

Data record format:

Filed 1:9 F9.1 Julian date (TAI)
Filed 11:17 F7.4 X pole coordinate. Units: 0.1 arcsec
Filed 19:25 F7.4 Y pole coordinate. Units: 0.1 arcsec
Filed 27:35 I9   UT1-TAI. Units: microsecond of time
Filed 36:76 A41 some information not used by VTD.
                Its meaning is forgotten

2.15 POSVAR_MOD: (HARMONIC_MODEL)

Label: HARPOS Format version of 2002.12.12
Purpose: Describes site displacements which can
        be represented by a finite set of harmonic components.
Type: Ascii
Example: $(VTD_ROOT)/share/2007b_oclo.hps

A file in HARPOS format consists of records of variable length in ASCII coding. The records are separated by a character with decimal code 13. The records of the following types are supported:

1) Header record;
2) Harmonic definition records;
3) Site definition records;
4) Displacement definition records;
5) Trailer record.

Records which start from # character are considered as comments.

Each valid file in HARPOS format has the first header record, one or more harmonic definition records, one or more site definition records and one or more displacement definition records. The last record is a trailer record. All harmonic definition records should precede site definition records. All site definition records should precede displacement definition records.

Records format:

1) A header record contains the string
"HARPOS Format version of 2002.12.12"

The header record allows to distinguish the valid file in the HARPOS format from files in other formats.

2) A harmonic definition record defines the argument of the harmonic in the form {phase + freq*(t-t0) + 1/2*accel*(t-t0)**2} where t is time in TDT time scale and t0 is the reference epoch J2000.0, 01 January 2000, 12 hours TDT. The file cannot contain more than one definition of the same harmonic.

Format of an H-record:

Field 1:1 A1 -- Records ID: letter H (decimal code 72).
field 2:3 a2 -- delimiters: blanks.
Field 4:11 A8 -- 8-letter long harmonic name. May contain any characters with decimal codes 32-255, but blanks are allowed only at the end of the harmonic name. This field should not necessarily have a special meaning. Parsing software should not try to interpret this name.
field 12:13 a2 -- delimiters: blanks.
Field 14:26 D13.6 -- Phase of the harmonic in float format. Units: rad.
field 27:28 a2 -- delimiters: blanks.
Field 29:47 D19.12 -- Frequency of the harmonic in float format. Units: rad/sec.
field 48:49 a2 -- delimiters: blanks.
Field 50:59 D10.3 -- Acceleration of the harmonic in float format. Units: rad/sec**2.
field 60:80 a21 -- delimiters: blanks.

3) A site definition record defines the site identifier and site coordinates in a crust-fixed reference frame. The file cannot contain more than one definition of the same site.

Format of an S-record:

```
Field  1:1   A1     -- Record ID. Should be letter S (decimal code 83)
Field  2:3   A2     -- Delimiters: blanks.
Field  4:11  A8     -- 8-letter long site identifier. May contain
                       any characters with decimal codes 32-255, but
                       blanks are allowed only at the end of the site
                       identifier. This site identifier should be
                       unique among S-records. This field should not
                       necessarily have a special meaning. Parsing
                       software should not try to interpret it.
field 12:13  a2     -- delimiters: blanks.
Field 14:26  F13.4  -- Site X coordinate in a crust fixed reference
                       frame. Units: meters.
field 27:27  a1     -- delimiters: blanks.
Field 28:40  F13.4  -- Site Y coordinate in a crust fixed reference
                       frame. Units: meters.
field 41:41  a1     -- delimiters: blanks.
Field 42:54  F13.4  -- Site Z coordinate in a crust fixed reference
                       frame. Units: meters.
field 55:56  a2     -- delimiters: blanks.
Field 57:64  F8.4   -- Site geocentric latitude, positive to north,
                       in degrees. This field is for information only.
                       Parsing software MUST ignore it.
field 65:65  a1     -- delimiters: blanks.
Field 66:73  F8.4   -- Site longitude, positive towards east,
                       in degrees. This field is for information only.
                       Parsing software MUST ignore it.
field 74:74  a1     -- delimiters: blanks.
Field 75:80  F6.1   -- Site height above the reference ellipsoid
                       in meters. This field is for information only.
                       Parsing software MUST ignore it.
```

4) A data record specifies the site, the harmonic and 6 amplitudes of displacements: Up cosine, East cosine, North cosine, Up sine, East sine, North sine. A file cannot contain more than one data record for the same harmonic, the same site. The site and the harmonic referred in a data record must be defined in the preceding site and harmonic definition records.

Notation "Up cosine" and "Up sine" amplitudes of the displacement means that the radial component of the topocentric vector of the displacement, which is parallel to the vector from the geocenter to the site, depends on time in the following way:

```
D_up= Ampl_cos_up * cos {phase + freq*(t-t0) + 1/2*accel*(t-t0)**2} +
      Ampl_sin_up * sin {phase + freq*(t-t0) + 1/2*accel*(t-t0)**2}
```

Analogously, "East cosine", "East sine" amplitudes define time dependence of the east component of the displacement vector, and "North cosine", "North sine" define time dependence of the north component.

Format of a D-record:

```
Field  1:1   A1     -- Record ID: letter D (decimal code 68).
field  2:3   a2     -- delimiters: blanks.
Field  4:11  A8     -- 8-letter long harmonic name. The harmonic name
```

must be defined in a preceding H-record.
field 12:13 a2 -- delimiters: blanks.
Field 14:21 A8 -- 8-letter long site identifier. The site
identifier must be defined in a preceding
S-record.
field 22:24 a3 -- delimiters: blanks.
Field 25:32 F8.5 -- Cosine amplitude of the Up component of the
displacement vector. Up direction is along the
vector from the geocenter to the site.
Units: meters.
field 33:33 A1 -- delimiter: blank.
Field 34:41 F8.5 -- Cosine amplitude of the East component of the
displacement vector. Units: meters.
field 42:42 a1 -- delimiter: blank.
Field 43:50 F8.5 -- Cosine amplitude of the North component of the
displacement vector. Units: meters.
field 51:53 a3 -- delimiter: blanks.
Field 54:61 F8.5 -- Sine amplitude of the Up component of the
displacement vector. Up direction is along the
vector from the geocenter to the site.
Units: meters.
field 62:62 a1 -- delimiter: blank.
Field 63:70 F8.5 -- Sine amplitude of the East component of the
displacement vector. Units: meters.
field 71:71 a1 -- delimiter: blank.
Field 72:79 F8.5 -- Sine amplitude of the North component of the
displacement vector. Units: meters.
field 80:80 a1 -- delimiter: blank.

5) Trailer record is the same as the header record.

2.16 POSVAR_MOD: (TIME_SERIES)

Label: BINDISP
Purpose: describing time series of site position
variations. A file in this format contains three
components of the
displacement vector of a specific site equally sampled
within a certain time range.
Type: Binary, little endian

A file consists of records of fixed length. Record length is
8 bytes. A file has 44 header records and at least one data record
which follows header records.

Header record 1:

Field 1:8 A8 -- Unix magic record. Should be "BINDISP " for
a valid file.

Header record 2:

Field 1:4 I*4 -- Integer modified Julian of the format
revision date.
Field 5:5 A1 -- Identifier for used binary integer format.
Supported identifiers:
B -- big endian format
L -- little endian format
Field 6:6 A1 -- Identifier for used binary float format.
Supported identifiers:
I -- IEEE 754/854 format.
D -- Dec format.
Field 7:8 I*2 -- Reserved. filled with binary value 0.

Header record 3:

Field 1:8 A8 -- 8-letter long site identifier. May contain
any characters with decimal codes 32-255, but
blanks are allowed only at the end of the site
identifier. This field should not necessarily
have a special meaning. Parsing software should
not try to interpret it.

Header record 4:

Field 1:4 I*4 -- The total number of data records.
Field 5:8 R*4 -- Sampling interval in seconds: the interval
between two consecutive epochs.

Header record 5:

Field 1:8 R*8 -- X site coordinate in a crust fixed reference
frame. Units: meter.

Header record 6:

Field 1:8 R*8 -- Y site coordinate in a crust fixed reference
frame. Units: meter.

Header record 7:

Field 1:8 R*8 -- Z site coordinate in a crust fixed reference
frame. Units: meter.

Header record 8:

Field 1:4 I*4 -- Integer modified Julian data at the midnight
of the time epoch of the first data record.
Field 5:8 R*4 -- Time in TDT elapsed from the midnight of
the time epoch of the first data record,
in seconds.

Header record 9:

Field 1:8 C*8 -- Model type

Header record 10:

Field 1:8 C*8 -- Model name

Header record 10:

Field 1:8 C*8 -- Model version

Header records 11 to 44:

Field 1:8 C*8 -- Comment

Data record:
==========

Displacement is endcoded as a sum of the base displacement and
extension. Total extension is computed as
total = 1.0D-5 * base + 0.32D0 * sign(base)*extension
The total displacement can be in a range [-5.44, 5.44] meters.

Field 1:2 I*2 -- 1.0D-5 singed base X coordinate of site displacement
for a given epoch in a crust-fixed reference system.
Units: 1.D-5 meter.

Field 3:4 I*2 -- base Y coordinate of site displacement without extension
for a given epoch in a crust-fixed reference system.
Units: 1.D-5 meter.

Field 5:6 I*2 -- base Z coordinate of site displacement without extension
for a given epoch in a crust-fixed reference system.
Units: 1.D-5 meter.

Field 7:8 I*2 -- Bit fields of extension. The word is split into four
bit fields of 4 bits each.
bits 0:3 -- reserved
bits 4:7 -- unsigned extension for X coordinate
bits 8:11 -- unsigned extension for Y coordinate
bits 12:15 -- unsigned extension for Z coordinate

Comments:

1. Data records follow in chronological order. No records can be
missed. The epoch of the J+1 th record is the epoch of the
J -th record plus the sampling interval. The epoch of the K-th
physical record of the file is (MJD,TDT) + (K-9)*Sample_interval.
Physical records are counted from 1.

2. Maximal displacements in site positions which can be described
in this file cannot exceed by modulo 5.4 meters.

2.17 POSVAR_MOD: (B_SPLINE)

Label: BSPPOS Format version of 2007.10.30"
Purpose: To describe site displacements which can
be represented as the sum of the polynomial of the first
degree and an expansion with the B-spline basis. The expansion
is defined on a expanded non-descending sequence of knots.
The first and the last knot has multiplicity 1-degree, other
knots are represented as simple. The sequence may have several
consecutive knots with equal epochs, except the first and
the last. The number of knots with the same epochs should
not exceed the degree of the B-spline basis. The expanded
sequence of knots has indexes
1-degree, 1-degree+1, ... 0, 1, 2, ... N, N+1, N+2, ... N+degree,
i.e. in the expanded sequence the first and the last knot
are split into the set of knots with the number of elements
equal to the degree.

BSPPOS file provides the number of knots, the degree of
the B-spline basis, apriori site position, time epochs of
knots, estimates of B-spline coefficients, global site position,
and global site velocity.

A file in BSPPOS format consists of records of variable length in ASCII coding. The records are separated by a character with decimal code 13. The records of the following types are supported:

1) Header record
2) Solution identifier
3) Solution date
4) Record that specifies the total number of sites
5) Site definition record
6) Record that specifies the B-spline degree
7) Record that specifies the number of knots for spline for this site
8) Record that specifies the reference epoch for site positions
9) Record that specifies position at reference epoch
10) Record that specifies site velocity
11) Record that specifies epoch of the spline
12) Record that specifies B-spline coefficients
13) Record that specifies elements of the covariance matrix of B-spline coefficients (optional)
14) Trailer record

The records should be placed in this order. Records 5-10 are repeated for each site, records 11-12 are repeated for each spline knot and each site.

Records which start from # character are considered as comments.

1. Header record
A header record contains the string
"BSPPOS Format version of 2007.10.30"

The header record allows to distinguish the valid file in the BSPPOS format from files in other formats.

2. Solution identifier

Field 1:7 A7 Field ID: SOL_ID:
Field 8:10 a3 Delimiter (blank)
Field 11:43 A32 Text identifying the solution

3. Solution date

Field 1:9 A9 Field ID: SOL_DATE:
Field 10:10 a1 Delimiter (blank)
Field 11:29 A19 Date of the solution in ISO format

4. Record that specifies the total number of sites

Field 1:6 A6 Field ID: N_STA:
Field 7:7 a1 Delimiter (blank)
Field 8:11 I4 The total number of sites

5. Site definition record

Field 1:2 A2 Field ID: S:
Field 3:3 a3 Site ID: an arbitrary sequence of letters.
NB: parsing software SHOULD NOT ATTEMPT to interpret
Field 8:11 I4 The total number of sites
Field 12:13 a2 Delimiter (blanks)
Field 14:26 F13.5 X-coordinate of the site in the crust fixed coordinate system
Field 27:27 a1 Delimiter (blank)
Field 28:40 F13.5 Y-coordinate of the site in the crust fixed coordinate system
Field 41:41 a1 Delimiter (blank)
Field 42:54 F13.5 Z-coordinate of the site in the crust fixed coordinate system
Field 12:13 a2 Delimiter (blanks)
Field 57:64 F8.4 Site geocentric latitude.
Field 65:65 a1 Delimiter (blank)
Field 66:73 F8.4 Site geocentric longitude positive to East in [0,360]
Field 74:74 a1 Delimiter (blank)
Field 75:80 F5.1 Site height above the reference ellipsoid

6. Record that specifies the B-spline degree

Field 1:6 A6 Field ID: L_DEG:
Field 7:7 a1 Delimiter (blank)
Field 8:11 I4 Spline degree
Field 12:18 a7 Delimiter STA:
Field 19:22 I4 Site index. The index of the site definition
record for this site, counted from 1
Field 23:24 a2 Delimiter (blanks)
Field 25:32 A8 Site name specified in the preceding site definition
record

7. Record that specifies the number of knots for spline for this site

Field 1:6 A6 Field ID: N_NOD:
Field 7:7 a1 Delimiter (blank)
Field 8:11 I4 The number of knots for this site
Field 12:18 a7 Delimiter STA:
Field 19:22 I4 Site index. The index of the site definition
record for this site, counted from 1
Field 23:24 a2 Delimiter (blanks)

Field 25:32 A8 Site name specified in the preceding site definition record

8. Record that specifies the reference epoch for site positions

Field 1:6 A6 Field ID: R_EPC:
Field 7:18 a12 Delimiter STA:
Field 19:22 I4 Site index. The index of the site definition record for this site, counted from 1
Field 23:24 a2 Delimiter (blanks)
Field 25:32 A8 Site name specified in the preceding site definition record
Field 33:34 a2 Delimiter (blanks)
Field 35:57 A23 Reference epoch for site positions in TAI in ISO format.

9. Record that specifies position at reference epoch

Field 1:6 A6 Field ID: P_EST:
Field 7:18 a12 Delimiter STA:
Field 19:22 I4 Site index. The index of the site definition record for this site, counted from 1
Field 23:24 a2 Delimiter (blanks)
Field 25:32 A8 Site name specified in the preceding site definition record
Field 33:34 a2 Delimiter (blanks)
Field 35:48 F14.6 X component of site position at the reference epoch in meters
Field 49:49 a1 Delimiter (blanks)
Field 50:63 F14.6 Y component of site position at the reference epoch in meters
Field 64:64 a1 Delimiter (blanks)
Field 65:78 F14.6 Z component of site position at the reference epoch in meters

10. Record that specifies site velocity

Field 1:6 A6 Field ID: P_EST:
Field 7:18 a12 Delimiter STA:
Field 19:22 I4 Site index. The index of the site definition record for this site, counted from 1
Field 23:24 a2 Delimiter (blanks)
Field 25:32 A8 Site name specified in the preceding site definition record
Field 33:34 a2 Delimiter (blanks)
Field 35:48 F14.6 X component of site velocity in m/s
Field 49:49 a1 Delimiter (blanks)
Field 50:63 F14.6 Y component of site velocity in m/s
Field 64:64 a1 Delimiter (blanks)
Field 65:78 F14.6 Z component of site velocity in m/s

11. Record that specifies epoch of the spline

Field 1:6 A6 Field ID: EPOCH:
Field 7:7 a1 Delimiter (blank)
Field 8:11 I4 The knot index starting from 1-L_DEG
Field 12:18 a7 Delimiter STA:
Field 19:22 I4 Site index. The index of the site definition record for this site, counted from 1
Field 23:24 a2 Delimiter (blanks)
Field 25:32 A8 Site name specified in the preceding site definition record
Field 35:57 A23 Epoch of the knot in TAI in ISO fort mat.

12. Record that specifies B-spline coefficients

Field 1:6	A6	Field ID: EPOCH:
Field 7:7	a1	Delimiter (blank)
Field 8:11	I4	The knot index starting from 1-L_DEG
Field 12:18	a7	Delimiter STA:
Field 19:22	I4	Site index. The index of the site definition record for this site, counted from 1
Field 23:24	a2	Delimiter (blanks)
Field 25:32	A8	Site name specified in the preceding site definition record
Field 33:35	a3	Delimiter (blanks)
Field 36:48	F13.6	B-spline coefficient for X component of position of this site, this knot
Field 49:49	a1	Delimiter (blanks)
Field 50:62	F13.6	B-spline coefficient for Y component of position of this site, this knot
Field 63:63	a1	Delimiter (blanks)
Field 64:76	F13.6	B-spline coefficient for Z component of position of this site, this knot

13. Record that specifies elements of the covariance matrix of B-spline coefficients (optional). Covariance matrix is a 4-dimensional array in the crust-fixed terrestrial coordinate system. The first two dimensions run through the knot indexes + global position + global velocity. The second two dimensions, the 3rd and the 4th, run through components of the coordinate vectors: X, Y, Z.

Field 1:6	A6	Field ID: EPOCH:
Field 7:18	a12	Delimiter (blank)
Field 12:18	a7	Delimiter STA:
Field 19:22	I4	Site index. The index of the site definition record for this site, counted from 1
Field 23:24	a2	Delimiter (blanks)
Field 25:32	A8	Site name specified in the preceding site definition record
Field 33:41	a9	Delimiters
Field 43:43	I1	The first component of the displacement vector in the terrestrial coordinate system. Components runs as X, Y, and Z.
Field 49:49	a1	Delimiter (blanks)
Field 50:52	a3	Delimiters
Field 53:56	I4	The first covariance element index. Index starts from 1-L_DEG and runs through N_NOD+L_DEG-1. The element with index N_NOD+L_DEG+1 corresponds to the global position, the element with index N_NOD+L_DEG corresponds to the global velocity, other indexes correspond to knot index.
Field 57:65	a9	Delimiters
Field 66:66	I1	The second component of the displacement vector in the terrestrial coordinate system. Components runs as X, Y, and Z.
Field 67:75	a9	Delimiters
Field 76:79	I4	The second covariance element index. Index starts from 1-L_DEG and runs through N_NOD+L_DEG-1. The element with index N_NOD+L_DEG+1 corresponds to the global position, the element with index N_NOD+L_DEG corresponds to the global velocity, other indexes correspond to knot index.
Field 80:86	a7	Delimiters
Field 87:99	D13.6	The element of the covariance matrix

14. Trailer record

The same as the header record, string:
"BSPPOS Format version of 2007.10.30"

2.18 ANTENNA_DEFORMATIONS_FILE

Label: $ Antenna Gravity Deformation File Format Version of 2008.04.25
Purpose: Contains the table of the antenna focus line as a function
of elevation angle.
Type: ascii
Example: $(VTD_ROOT)/share/agd.dat

Comment character: #
Data record format:

1:5 A3 Delimiter: "AGD "
6:13 A8 IVS station name
14:15 A2 Delimiter: blank
16:22 A7 Focus type
23:24 A2 Delimiter: blank
25:28 F4.1 Elevation (in deg)
29:30 A2 Delimiter: blank
31:37 F7.3 Focus length change (in mm)

2.19 SLANTED_PATH_DELAY_BIAS_FILE

Label: SPD_3D_BIAS Format version of 2010.05.18
Purpose: Determine empirical bias and scale factor for the
slanted path delay model. The non-hydrostatic
component of the Slanted path delay is to
be multiplied by the scale and added the bias.
Example: n/a
Comment character: #
Data record format:

A file in the SPD_ASCII format consists of records of variable length in ASCII coding. The records are separated by a character with decimal code 13. The records are grouped into sections. Sections follow in this order:

1) N-record -- defines the number of records in further other sections.

2) S-record -- defines name and coordinates of stations for which path delay have been computed.

3) B-record -- defines bias and scaling factor

Format of an N-record:

Field 1:1   A1   -- Record ID: letter "N".
field 2:3   a2   delimiter: blank.
Field 4:7   I4   -- Number of M-records in the file. i.e. brief algorithm
                      description and options used during computations.
field 8:9   a2   delimiter: blank.
field 10:13 I4   -- Number of I-records in the file, i.e. the number of
                      lines with a brief description of the numeric
                      model of the atmosphere used during computation.
field 14:15 a2   delimiter: blank.
field 16:21 I6   -- Number of S-records in the file, i.e. the number
                      of stations.
field 22:23 a2   delimiter: blank.
field 24:27 I4   -- Number of E-records in the file, i.e. the number
                      elevations in the grid.
field 28:29 a2   delimiter: blank.
field 30:33 I4   -- Number of A-records in the file, i.e. the number
                      azimuths in the grid.

Format of an S-record:

Field 1:1   A1   -- Record ID: letter "S".
field 2:3   a2   delimiter: blanks.
field 4:9   I6   -- station index
field 10:11 a2   delimiter: blanks.
Field 12:19 A8   -- 8-letter long site identifier. May contain
                      any characters with decimal codes 32-255, but
                      blanks are allowed only at the end of the site
                      identifier. This site identifier should be unique
                      among S-records. This field should not
                      necessarily have a special meaning. Parsing
                      software SHOULD NOT TRY TO INTERPRET it.
field 20:21 a2   delimiter: blanks.
Field 22:33 F12.3 -- X site coordinate in a crust fixed reference
                      frame. Units: meters.
field 34:34 a1   delimiter: blank.
Field 35:46 F13.4 -- Y site coordinate in a crust fixed reference
                      frame. Units: meters.
field 47:47 a1   delimiter: blank.
Field 48:59 F13.4 -- Z site coordinate in a crust fixed reference
                      frame. Units: meters.
field 60:61 a2   delimiter: blanks.
Field 62:69 F8.4 -- Site geocentric latitude, positive to north,
                      in degrees. This field is for information only.
                      Parsing software MUST ignore it.
field 70:70 a1   delimiter: blank.
Field 71:78 F8.4 -- Site longitude, positive towards east,
                      in degrees. This field is for information only.
                      Parsing software MUST ignore it.
field 79:80 a2   delimiter: blank.
Field 81:86 F6.1 -- Site height above the reference ellipsoid in
                      meters. This field is for information only.
                      Parsing software MUST ignore it.
field 87:87 a1   delimiter: blank.
Field 88:93 F6.1 -- Site height above the geoid in meters. This field
                      is for information only.
                      Parsing software MUST ignore it.

Format of an B-record:

Field 1:1   A1   -- Record ID: letter "B".
field 2:11 a10   -- delimiter: blank
Field 12:19 A8   -- 8-letter long site identifier.
field 20:24 a5   -- delimiter: blank
Field 25:34 D10.3 -- Slanted path delay offset. Units: seconds
field 35:37 a3   -- delimiter: blank
Field 38:44 F7.4 -- Slanted path delay scale factor

2.20 EXTERNAL_DELAY_DIR

Label: spd_3d_bin 1.0 version of 2009.01.07 LE
Purpose: Contains results of computing slanted path delay of
        radio wave propagation through the 3D, continuous,
        heterogeneous atmosphere. The path delay is defined as
        a difference in the propagation time between the emitter
        and the receiver through the atmosphere and the propagation
        between these two points along the geodetic line in
        vacuum. The path delay is computed for a set of stations for
        a certain epoch at a regular grid of azimuths and elevations.
        The grid is equidistant at azimuths and non-equidistant at
        elevation angles. The values of path delays computed on
        a grid can be used for computing coefficients of the
        interpolating functions that enable us to compute
        the path delay in an arbitrary direction.
Example: http://astrogeo.org/spd_data/spd_6h_bin
Type: Binary, little endian.

File in spd_3d_bin format consists of records of 7 types.
The type of each record is determined by the first
8-characters long field prefix. The records follow in this order:

LAB_REC -- Defines offsets, sizes and the number of other records
TIM_REC -- Defines the start time, stop time of DEL records
          and the time step
STA_REC -- Defines station coordinates
MOD_REC -- Defines the slanted path model type and the model description
MET_REC -- Defines description of the numerical weather model used
          for computation
ELV_REC -- Defines the elevation axis for the 2D grid of
          path delays through the neutral atmosphere
AZM_REC -- Defines the azimuth axis for the 2D grid of
          path delays through the neutral atmosphere
DEL_REC -- Defines the surface pressure surface temperature
          and the 2D grid of path delay through the neutral atmosphere.

The file contains only one record of the first seven types and usually
more than one record of DEL_REC. Each DEL_REC corresponds to one time
epoch. The time epochs follow each other in chronological order with
the same time step, without gaps. The time epoch of a specific DEL_REC
is determined by its index in the file, time of the first epoch, and
the time step.

Description of individual records:

```
LAB__REC
     CHARACTER  PREF*8     ! prefix: LAB_REC
     INTEGER*8  LEN        ! length of the LAB_REC record
     CHARACTER  FMT_LAB*40 ! Format label
     INTEGER*8  OFF_TIM    ! Offset of the TIM record in bytes wrt the file beginning
     INTEGER*8  OFF_STA    ! Offset of the STA record in bytes wrt the file beginning
     INTEGER*8  OFF_MOD    ! Offset of the MOD record in bytes wrt the file beginning
     INTEGER*8  OFF_MET    ! Offset of the MET record in bytes wrt the file beginning
     INTEGER*8  OFF_ELV    ! Offset of the ELV record in bytes wrt the file beginning
     INTEGER*8  OFF_AZM    ! Offset of the AZM record in bytes wrt the file beginning
     INTEGER*8  OFF_DEL    ! Offset of the first TIM record in bytes wrt the file beginning
     INTEGER*8  LEN_TIM    ! Length of the TIM record in bytes
     INTEGER*8  LEN_STA    ! Length of the STA record in bytes
     INTEGER*8  LEN_MOD    ! Length of the MOD record in bytes
     INTEGER*8  LEN_MET    ! Length of the MET record in bytes
     INTEGER*8  LEN_ELV    ! Length of the ELV record in bytes
     INTEGER*8  LEN_AZM    ! Length of the AZM record in bytes
     INTEGER*8  LEN_DEL    ! Length of the DEL record in bytes
INTEGER*4  TOT_NUM_DEL ! The number of DEL records

TIM_REC
     CHARACTER  PREF*8     ! prefix: TIM_REC
     INTEGER*8  NREC       ! The number of time epochs the file contains
INTEGER*4  MJD_BEG    ! Modified Julian date at TAI     ! Modified Julian date at TAI for the first epoch for the first
INTEGER*4  MJD_END    ! Modified Julian date at TAI for the last epoch
REAL*8     TAI_BEG    ! TAI for the first epoch. Units: seconds
REAL*8     TAI_END    ! TAI for the last epoch. Units: seconds
REAL*8     TIM_STEP   ! Time step. Units: seconds

STA_REC
     CHARACTER  PREF*8     ! prefix: STA_REC
     CHARACTER  NAME*8     ! Station name. NB: the station name does NOT necessarily
                           ! conforms any convention. It may be an arbitrary combination
                           ! of characters. Parser software should NOT assign any meaning
                           ! to this field
REAL*8     COO_CFS(3) ! Station coordinates in the crust-fixed coordinate system.
                           ! Units: meters
REAL*8     PHI_GCN    ! Station geocentric latitude. Units: radians
REAL*8     PHI_GDT    ! Station geodetic latitude. Units: radians
REAL*8     HEI_ELL    ! Station height above the reference ellipsoid. Units: meters
REAL*8     HEI_GEOID  ! Station height above the geoid. Units: meters

MOD_REC
     CHARACTER  PREF*8     ! prefix: MOD_REC
INTEGER*4  N_RFR      ! Number of components of the model
CHARACTER  SPD_TYPE(3)*8 ! Array of names of the slanted path delay model components.
                           ! Supported values:
                           !   total    -- Total path delay through the neutral atmosphere
                           !   hydro    -- Path delay through the hydrostatic component of the atmosphere
                           !   non-hydr -- Path delay through the non-hydrostatic component of the atmosphere
                           !   undef    -- Undefined, not used
     INTEGER*8  N_LINES       ! Number of lines with model description
     INTEGER*8  LEN_TEXT      ! Length of the text with model description in bytes
     CHARACTER*1, POINTER :: TEXT(:) ! Text with the model description as a string that contains \n characters
                                ! of length LEN_TEXT + 1 (the last character is \0)
MET_REC
     CHARACTER  PREF*8     ! Prefix: STA_REC
     INTEGER*8  N_LINES    ! Number of lines with numerical weather model description
     INTEGER*8  LEN_TEXT   ! Length of the text with the numerical model description in bytes
```

```
     CHARACTER*1, POINTER :: TEXT(:) ! Text with the numerical weather model description as
                             ! a string that contains \n characters of length
                             ! LEN_TEXT + 1 (the last character is \0)
ELV_REC
     CHARACTER  PREF*8     ! Prefix: ELV_REC
INTEGER*8  N_EL  ! The number of elements along the elevation angle axis
REAL*4,    POINTER ::   ELEV(:) ! Array of elevation angles. Dimension: N_EL,
                             ! Units: radians. Array is sorted in decreasing order.
AZM_REC
     CHARACTER  PREF*8
INTEGER*8  N_AZ       ! The number of elements along the azimuth axis
REAL*4,    POINTER ::   AZIM(:) ! Array of azimuth angles. Dimension: N_AZ,
                             ! Units: radians. Array is sorted in increasing order.
DEL_REC
     CHARACTER  PREF*8
REAL*4     SURF_PRES  ! Surface pressure. Units: Pascal
REAL*4     SURF_TEMP  ! Surface air temperature. Units: Kelvin
REAL*4,    POINTER ::   DEL(:,:,:) ! 3D array of slanted path delay components.
                              ! The first  axis runs over elevation angles.
                              ! Dimension: N_EL defined in ELV_REC
                              ! The second axis runs over azimuth angles
                              ! Dimension: N_AZ defined in AZM_REC
                              ! The third  runs over components.
                              ! Dimension: N_RFR defined in MOD_REC
                              ! Units: seconds
```

2.21 IONOSPHERE_DATA_FILE

Label: VIONO Little-Endian Format of 2010.05.08
Purpose: Contains the total electron contents of the ionosphere
presented at the regular 3D grid with axes: longitude,
latitude, and time.

Type: Binary, little endian
Example: http://astrogeo.org/viono/codg_01.vio

Format description:

The file in VIONO format consists of the header record and one
or more data records.

HEADER:

```
      CHARACTER  LABEL*48   ! File label
      CHARACTER  MODEL*16   ! Model name
 CHARACTER  AUTHOR*16  ! Name of the model author
 INTEGER*4  NLON       ! The number of grid steps along longitude axis
 INTEGER*4  NLAT       ! The number of grid steps along latitude axis
 INTEGER*4  NEPC       ! The number of grid steps along time axis
 INTEGER*4  MJD_BEG    ! MJD at TAI of the first epoch
 INTEGER*2  MISSING    ! Missing value
 INTEGER*2  FILLER(3)  ! fillers
 REAL*8     UTC_BEG    ! UTC Time tag of the first epoch. Units: seconds
 REAL*8     TIM_STEP   ! Time step along the time axis. Units: seconds
 REAL*8     SCALE      ! The scaling factor which should be applied to raw TEC values. Units: TECU
 REAL*8     LON_MIN    ! Longitude at the beginning of the longitude axis. Units: radians
 REAL*8     LAT_MIN    ! Latitude  at the beginning of the latitude  axis. Units: radians
```

```
 REAL*8     LON_STEP   ! Longitude step along the longitude axis. Units: radians
 REAL*8     LAT_STEP   ! Latitude  step along the latitude  axis. Units: radians
 REAL*8     HEIGHT     ! Height of the ionosphere. Units: meters

DATA RECORD:
      INTEGER*2, POINTER :: TEC_VAL(:,:) ! TEC values on a 2D longitude/latitude grid.
                                         ! Dimensions: NLON,NLAT. Units: dimensionless
```

TEC_VAL array must by multiplied by SCALE. Units of the results: TECU.

2.22 HYDROSTATIC_MAPPING_FUNCTION/WET_MAPPING_FUNCTION: (MMF)

Label: # MMF_MOD Format of 2008.09.21
Purpose: contains coefficients of polynomials that expand the mean
mapping function in the neutral atmosphere for the set
observing stations.
Example: $(VTD_ROOT)/share/mmf.mod

A file in MMF_EPO format consists of records of variable length
in ASCII coding. The records are separated by a character with decimal
code 13. The records are grouped into sections. Sections follow
in this order:

1) Header record -- the first record should have a signature:
TROPO_PATH_DELAY Format version of 2007.10.04

The header record allows to distinguish a valid
file in the TROPO_PATH_DELAY format from files
in other formats.

2) M-record section
M-record has letter M in the first field. The M record keeps the
model identifier.

3) N-record section

4) S-record section

5) D-record section

6) Trailer record -- the last record is the same as the header record.

Format of an S-record:

Field 1:1 A1 -- Record ID. Should be letter S (decimal code 83).
field 2:2 a1 delimiter: blanks.
Field 4:11 A8 -- 8-letter long site identifier. May contain
any characters with decimal codes 32-255, but
blanks are allowed only at the end of the site
identifier. This site identifier should be unique
among S-records. This field should not
necessarily have a special meaning. Parsing
software should not try to interpret it.
field 12:13 a2 delimiter: blanks.

```
Field 14:26  F13.4 -- X site coordinate in a crust fixed reference
                frame. Units: meters.
field 27:27  a1       delimiter: blank.
Field 28:40  F13.4 -- Y site coordinate in a crust fixed reference
                frame. Units: meters.
field 27:27  a1       delimiter: blank.
Field 42:54  F13.4 -- Z site coordinate in a crust fixed reference
                frame. Units: meters.
field 55:56  a2       delimiter: blanks.
Field 57:64  F8.4  -- Site geocentric latitude, positive to north,
                in degrees. This field is for information only.
                Parsing software MUST ignore it.
field 65:65  a1       delimiter: blank.
Field 66:73  F8.4  -- Site longitude, positive towards east,
                in degrees. This field is for information only.
                Parsing software MUST ignore it.
field 74:74  a1       delimiter: blank.
Field 75:80  F6.1  -- Site height above the reference ellipsoid in
                meters. This field is for information only.
                Parsing software MUST ignore it.
```

Questions and comments about this guide should be directed to:

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Last update: 2020.03.08