Formats of apriori files for VTD.

L. Petrov

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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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.ssssssss

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.SSSSSs

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:

Field1:6A6Delimiter: Date:Field7:27A21Date as UTC time tag in Solve format.Field28:38A11Delimiter: TAI-UTC:Field39:43F5.1The 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. Tvpe: Ascii Example: http://astrogeo.org/rfc Comment character: # Data record format: Category: C (calibrator), N (non-calibrator), U (unreliable coordinates) Field 1:1 A1 4:11 A8 Field 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 58:63 F6.2 Inflated error in right ascension in mas 65:70 F6.2 Inflated error in declination in mas Field Field 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, Jy Blank or < or - for X-band total flux density integrated over entire map 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 I	17	 total number of observations of this source.
Field	151:155 I	15	 the number of sessions of this source used in solution.
Field	166:170 I	15	 total number of sessions with this source.
Field	182:191 A	A10	 the date of the first session with this source used in solution. format: yyyy.mm.dd (as integer numbers).
Field	203:212 A	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;
- E-record: Time epoch record;
- 4) H-record: Harmonic definition records;
- 5) A-record: Amplitude definition records;
- V-record: Velocities definition records;
- 7) S-record: Amplitude errors definition records:
- 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 records, and 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 is not defined in 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:

 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.

 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	12	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	12	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	12	Hour in the range [0,23]
field	17:17	a1	delimiter: letter : (decimal code 58).
Field	18:19	12	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	+	<pre>[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 }</pre>	
E2	-	<pre>[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 }</pre>	
E3	= +	<pre>[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 }</pre>	

Where

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 mecord 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
			<pre>motion. Units: 10^{-21} rad/sec.</pre>
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:

Filed1:15Label: EOP-MOD Ver 2.0Field18:26 F9.1Julian date (TAI) of the first data recordField28:33 F6.2Time step in daysField34:39 I6The number of recordsField42:48 A7Meaning of the 4th columnField52:56 A5Meaning is lostField57:76 A18Delimiter: 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;

- Harmonic definition records;
- Site definition records;
- 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 coffware chould 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	reco	rd 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.		
Field 7:8	I*2		D Dec format. Reserved. filled with binary value 0.		
Header reco	rd 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 reco	rd 4:				
Field 1:4 Field 5:8	I*4 R*4		The total number of data records. Sampling interval in seconds: the interval between two consecutive epochs.		
Header reco	rd 5:				
Field 1:8	R*8		X site coordinate in a crust fixed reference frame. Units: meter.		
Header reco	rd 6:				
Field 1:8	R*8		Y site coordinate in a crust fixed reference frame. Units: meter.		
Header reco	rd 7:				
Field 1:8	R*8		Z site coordinate in a crust fixed reference frame. Units: meter.		
Header reco	rd 8:				
Field 1:4	I*4		Integer modified Julian data at the midnight		
Field 5:8	R*4		Time in TDT elapsed from the midnight of the time epoch of the first data record, in seconds.		
Header reco	rd 9:				
Field 1:8	C*8		Model type		
Header reco	rd 10:	-			
Field 1:8	C*8		Model name		
Header reco	rd 10:	-			
Field 1:8	C*8		Model version		
Header reco	rds 11	l to	o 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 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:

- 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
- 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
- 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.

 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

Field1:7A7Field ID: SOL_ID:Field8:10a3Delimiter (blank)Field11:43A32Text 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

1:6	A6	Field ID: L_DEG:
7:7	a1	Delimiter (blank)
8:11	I4	Spline degree
2:18	a7	Delimiter STA:
9:22	I4	Site index. The index of the site definition
		record for this site, counted from 1
3:24	a2	Delimiter (blanks)
5:32	A8	Site name specified in the preceding site definition
		record
	1:6 7:7 8:11 2:18 9:22 3:24 5:32	1:6 A6 7:7 a1 8:11 I4 2:18 a7 9:22 I4 3:24 a2 5:32 A8

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 Field 19:22 I4 Site index. The i STA: 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: Field 7:18 a12 Delimiter Field ID: P_EST: 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 Delimiter (blanks) a1 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 Field 19:22 I4 Site index. STA: Site index. The index of the site definition record for this site, counted from 1Field 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 al 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 Delimiter (blank) a1 Field 8:11 I4 The knot index starting from 1-L_DEG Field 12:18 a7 Delimiter STA: Site index. The index of the site definition Field 19:22 I4 record for this site, counted from 1Field 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:

A3 Delimiter: "AGD "
 A8 IVS station name
 A2 Delimiter: blank
 A7 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:

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

 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	16	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	16	 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 coffware SHOULD NOT TRY TO INTERDET it
fiold	20.21	_ 2	dolimitor: blocks
Fiold	20.21	az E12 3	 Y site coordinate in a crust fixed reference
11010	22.33	112.5	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
                     ! Length of the AZM record in bytes
INTEGER*8 LEN_AZM
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

TNTEGER*8 NREC ! The number of time epochs the file contains ! Modified Julian date at TAI ! Modified Julian date at TAI for the first epoch for the first epoc ! Modified Julian date at TAI for the last epoch INTEGER*4 MJD_BEG INTEGER*4 MJD END REAL*8 TAI BEG ! TAI for the first epoch. Units: seconds REAL*8 TAI_END ! TAI for the last epoch. Units: seconds TIM_STEP ! Time step. Units: seconds REAL*8 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 CO0_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 path delay through the neutral atmosphere total 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 ! Number of lines with model description INTEGER*8 N LINES ! Length of the text with model description in bytes INTEGER*8 LEN TEXT 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 TNTEGER*8 N A7 ! 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 SURF_PRES ! Surface pressure. Units: Pascal REAL *4 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,

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

latitude, and time.

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:

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:

Leonid Petrov (http://astrogeo.org/petrov)

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