Description of the keywords of BATCH control language.

L. Petrov
K. D. Baver

Abstract:

This document provides detailed description of syntax of the language used for specification of control files for batch subsystem of pSolve, the VLBI Analysis System for astronomy and geodesy.

Table of contents:

---

1 $SETUP

The $SETUP section determines the solution's general characteristics.

1.1 SETUP.DEFAULTS

{DEFAULTS [YES or NO]}

Specifies how strictly syntax of the control file should be checked.

YES - defaults will be permitted. If some fields are omitted Solve will

try to guess what it should do. This feature is provided for backward compatibility only.

NO - defaults are not permitted. All keywords should be specified, otherwise BATCH would detect an error condition and terminate. It is recommended to use this option!!

NB: 1) if the keyword DEFAULTS is omitted then DEFAULTS YES is assumed.
2) Currently (2000.05.10) DEFAULTS keyword is deactivated and makes no effect.

1.2 SETUP.SOLUTION

SOLUTION [COMPLETE or FORWARD or BACK or GLOBAL_ONLY or INDEPENDENT or SUPPRESS{ION} or *SUBTRACT]

The SOLUTION keyword specifies the solution's type.

COMPLETE - performs complete combined global solution. At least one parameter is treated as global parameter and estimated over all observations and at least one parameter is treated as a local parameter and estimated for each session independently.

FORWARD - Performs only the first step of the global solution. CGM is created but not inverted at the end of this run.

GLOBAL_ONLY - Performs the first step of global solution, creates CGM, inverts it, obtains global parameters adjustment, computes some statistics and quits without computing adjustment to local parameters.

BACK - Performs only the second step of the global solution. Required the input CGM which hold intermediary results of the forward step of the global solution. Solve first inverts CGM, finds estimates of the global parameters and their formal uncertainties, then consecutively finds the estimates of the local parameters and their formal uncertainties. Finally, statistics of the solution are computed.

INDEPENDENT - Solve analyzes each session in the arc-list specified in the section $ARCS independently. It means that all parameters are estimated using the observations of one session only.

SUPPRESSION - removes suppressed global parameters from a CGM so that two programs not related to BATCH can use it. Rarely used mode.

*SUBTRACT: - modifies CGM for taking out contributions of some sessions from an existing CGM.

1.3 SETUP.CGM

CGM [NONE or input_name] {output_name}

This keyword identifies the solution's input and output CGMs (if any).

Field 1 - identifies the input CGM.

NONE - no CGM used.

input_name - full path to the input CGM.

Field 2 - names the output CGM, if the solution produces one: COMPLETE or FORWARD or SUPPRESSION solution type. The output CGM is ignored if the solution is not producing the CGM. If the solution produces a CGM, but the name of the output CGM is not specified, then BATCH will name the CGM according to rules given below.

output_name omitted - names the output CGM C#####.#####, where each pair of numbers represents the year, month, day, hour, minute and second of the solution, in that order in UTC timescale.

output_name specified - names the output CGM output_name. output_name should not include a path, because BATCH automatically decides where to place the CGM, as described below. The user should make sure that output_name does not duplicate an existing name. If it does, BATCH will stop before processing the first superfile.

If the output CGM is specified without path name then BATCH puts output CGM in the following directories and catalogs:

Test solution:	catalog:	TSTCAT on SCRATCH_DIR
	directory:	$SCRATCH_DIR/
Regular solution:	catalog:	CGMCAT on CGM_CAT_DIR
	directory:	$CGM_DIR/

(The ID keyword determines whether or not the solution is a test solution.)

If the first symbol of the filename is / then the filename is interpreted as an absolute name.

1.4 SETUP.MERGE_CGM

{MERGE_CGM [NONE or (input_file)...]
.
.
. }

Combines several CGMs to a new one.

Field 1 -
NONE - not to do merging

(input_file) - specifies the merged CGM files. Path should be supplied. Solve doesn't make any guesses where to find the CGM(s).

1.5 SETUP.ARC_FILES

ARC_FILES {SAVE} [NONE or 0 or [dir_1 [0 or dir_2 [0 or dir_3]]]

Determines whether the run produces/uses arc_files, and, if so, where to store/search for them. Arc_file is a file with intermediary results produced by Solve in the forward step and used in the backward step.

Field 1 - Ordinarily back steps purge arc files as soon as they've used them. This field saves the files for future solutions.

Field 2 - Determines whether BATCH produces/uses arc files, and, if so, where to store/search for them.

0 - Prevents forward steps from producing arc_files. Tells back steps to create arc_file information. In this case back will repeat the work which forward step has done but did not store.

Up to three paths can be specified. BATCH creates (forward step) or looks for (back step) arc files on these directories. BATCH creates/looks for session n in the $ARCS section as [####XX, where #### is n specified as four digits and XX is the run's initials. Leading zero(es) will be added if necessary in order to fit 4 digit format.

NB: "n" (the number of the session in the arc-list) is computed according to the line number in the control file. If any line is removed or added then SOLVE cannot restore run correctly.

In the forward step, BATCH starts with the first path and works its way through the list as each path fills. Once BATCH goes to a new path, it does not go back to see if space has been restored to previous paths, unless the user restarts BATCH. Before creation of an arc_file BATCH checks disk space. It considers the disk as full if it has less than 64 Mb free space. Once it runs

through the list, BATCH stops silently making arc files.

Arc files take up a lot of space, so the users at an installation should agree on the directories where the files should be created. Disk for arc_files should be a fast disk. DON'T ASSIGN A REMOTE DISK as an arc-dir disk!

If a back step cannot find an arc file, there is usually no problem, since back steps can make the information on the fly, however, it would take additional CPU time.

1.6 SETUP.ID

ID [60 characters]

60 characters - a comment describing the solution. Setting the first four characters to TEST turns the solution into a test solution.

BATCH places the comment in the solution's progress file and CGM catalog entry (if any). Some recommended pieces of information are the name of the solution's control file, the purpose of the solution and the data being used.

Setting ID to "TEST ...." redirects the output CGM to the test CGM directory and catalog. The CGM keyword gives more details.

1.7 SETUP.TRAIN

{TRAIN [YES or NO GLO_PARLIM <number> INC_PARLIM <number>]}

The keyword TRAIN specifies the mode in which Solve should run.

TRAIN YES - forces Solve to call a chain (train) of executables for processing the job. It is not recommended to use this since Solve runs much slower than in NO TRAIN mode.

TRAIN NO - means that only one executable: BATCH will do entire work. It calls other modules as subroutines.

NO TRAIN mode can be used for COMPLETE, FORWARD, BACK and INDEPENDENT types of solutions.

Qualifier GLO_PARLIM specifies an expected number of global parameters. It should not exceed the maximal number of parameters specified by solve_reset and should not be less than parameter GLO_PARLIM__LIM specified in ../include/glbc4.i (current value: 256). BATCH grabs dynamic memory from the very beginning and it should know the maximal size of CGM. What will occur if the actual number of global parameters turns out greater than

GLO_PARLIM? In the case BATCH will save CGM, free dynamic memory, increase the limit of expected parameters by INC_PARLIM (but not more than the maximal number of parameters for the set of scratch files, specified by solve_reset!), grab dynamic memory once more, restore CGM and continue computation. INC_PARLIM specifies the increment of the parameters limit.

Example:

If a user makes a global solution and expects the number of global parameters will be about 1280 then a good choice is

```
TRAIN NO GLO_PARAM 1280 INC_PARLIM 128
```

NB: If the actual number of parameters turns out exceeding the limit specified by solve_reset in making scratch files then Solve will treat this situation as a fatal error.

1.8 SETUP.SORT

{SORT {NO or {YES} STATIONS [NO or ALPHABET or LONGITUDE]
SOURCES [NO or ALPHABET or RIGHT_ASCENSION] } }

BATCH in "NO TRAIN" mode is able to sort (or not to sort) global parameters. Parameters follow in this order: a) stations: position, velocity, axis offset; b) sources: right ascension, declination; c) other global parameters; d) user global parameters. They are kept in memory and put in the listing in that order.

Field 1 -

NO - not to sort sources, stations

Filed 2 -

STATIONS - how to sort stations

NO - not to sort at all. Stations are kept in order of their appearance during the run.

ALPHABET - to sort the names in the alphabet order.

LONGITUDE - to sort them in increasing their longitudes.

Filed 3 -

SOURCES - how to sort stations. Sources are kept in order of their appearance during the run.

NO - not to sort at all. Sources are kept in order of their appearance during the run.

ALPHABET - to sort the names in the alphabet order.

RIGHT_ASCENSION - to sort them in increasing their right ascensions.

Stations and sources follow in the order of their appearance in processing the database list if they are not sorted. Stations can be sorted in alphabetic order of their names, in increasing longitudes or not sorted at all. Sources can be sorted in alphabetic order of their names, in increasing their right ascensions or not sorted at all. It is more convenient to read listing with sorted stations and sources.

Recommended sorting:

SORT SOURCES ALPHABET STATIONS ALPHABET

NB: SORT is ignored in TRAIN mode or in INDEPENDENT solution.

1.9 SETUP.USER_PROGRAM

{USER_PROGRAM [NONE or NAME {USER_BUFFER $STRING$}] }

Each time BATCH processes an session, it reads it into the run's obsfil and other work files, then executes the programs that perform least squares analysis on the arc. USER_PROGRAM specifies the name of the program which runs after reading obsfil but before processing the first observation. USER_PROGRAM is used for adding user calibration to obsfil. User program can also write down a file with user constraints to be imposed on local parameters. File with constraints should has a name $WORK_DIR/ULC{solve_initials} .

Field 1 - the program.

NONE - disables the USER_PROGRAM feature.

NAME - the name of the program. May be up to 128 characters long and should not be enclosed in delimiters. If the first symbol of the name is "/" then it is interpreted as an absolute path. If not, then it is assumed that the executable with this name as in the $SOLVE_DIR directory. Specification of the full path name is recommended.

Field 2 - a string passed to the user program

STRING - specifies a string up to 80 characters long. The string be enclosed by a delimiter (e.g., ") which is not blank and not backslash character \ . This string is passed to the user program without delimiters as argument of CHARACTER*80 type. If the actual length of the STRING is less than 80 than trailing blanks will added.

User program should read this string using pipe.

Comments:

1) If the field 2 is supplied, then the user program **MUST ALWAYS** read 80 bytes from the pipe. For example it should have a statment like

```
CALL USE_BUFFER ( %REF(STRING), INT2(40), 'ORC' )
```

   Failure to execute this statment in user program will result in overflowing the pipe. When the pipe is overflown, Solve "hangs": it waits indefinitely for reducing the size of message in the pipe.

2) If the field 2 is not supplied then user program SHOULD NOT attempt to read from the pipe.

3) Character "\" cannot be used as a delimeter in USER_BUFFER.

1.10 SETUP.USER_PARTIALS

{USER_PARTIALS [NONE or PROGRAM_NAME] }

USER_PARTIALS allows user to add a list of his/her own parameters. BATCH reads a superfile, writes it in obsfil and then call a program specified as a value of the keyword USER_PARTIALS. That program has access to obsfil and writes a list of user parameters and partial derivatives which correspond to these parameters. User parameters are estimated in addition to the SOLVE pre-defined parameters.

Field 1 - user program name, which generates user partials. If the first symbol of the name is "/" then it is interpreted as absolute path. If not then it is assumed that the executable with this name is in the $SOLVE_DIR directory. Specification of the full path name is recommended.

1.11 SETUP.USER_CONSTRAINTS

{USER_CONSTRAINTS [NONE or PROGRAM_NAME] }

USER_CONSTRAINTS allows user to apply his/her constraints imposed on global parameters. The program specified as a value of the keyword USER_CONSTRAINTS reads a superfile, writes it in obsfil and then call a program specified as a value of the keyword USER_PARTILAS. That program has access to obsfil and writes a list of equations of constraints and right parts in the file with

name CNSF{solve_initials}.

NB: USER_CONSTRAINTS imposes constraints ONLY on global parameters. If the user need to impose constrains on local parameters he/she should force USER_PROGRAM to write down the file with name ULC{solve_initials} .

Field 1 - user program name, which generates user partials. If the first symbol of the name is "/" then it is interpreted as absolute path. If not then it is assumed that the executable with this name is in the $SOLVE_DIR directory. Specification of the full path name is recommended.

1.12 SETUP.WEIGHTS

{WEIGHTS [NO or IN or ([USE or REQUIRE or MAKE or APPEND]
[weight_file or (#NUM weight_file ...)]
{ [BY_SITE or BY_BASELINE or BY_ARC or DEFAULT] }
{ ALGORITHM [MYWAY or UPWEI or UPWEI_OPT or
(ELIM paru_file)] })] }

This keyword determines whether BATCH
a) should use corrections to weights from the external file, and if yes which type corrections: by baseline, by site, by session;
b) should generate the external files of corrections to weights.

weighs of observable are computed as

weight = 1/dsqrt (sig_snr**2 + corr**2)

here sig_snr -- formal uncertainty computed on the basis of SNR,
corr -- correction to weights. It may be baseline-dependent, site-dependent or session-dependent.

If a keyword WEIGHTS is not specified then weights saved in superfile will be in use.

NO - means no corrections to weights will applied, and the corrections to the weights kept in the superfiles will be discarded.

IN - means that corrections to weights kept in the superfiles should be applied.

MAKE and APPEND - generate corrections to weights for every session in the solution and place them in output weight_file. (MAKE creates the new file, and APPEND appends to an existing file.)

USE and REQUIRE - attempt to use weight_file for every session in the solution. If weight_file does not contain a session, USE uses the weighting scheme recorded in the session's superfile, and

REQUIRE aborts.

#NUM -- the number of weight files in the range 1 to 4. If only one weight file is used, this parameter can be omitted.

weight_file -- a full path to the file with additive re-weighting parameters.

BY_BASELINE together with MAKE and REQUIRE means that baseline-dependent correction to weights should be generated. Ignored if USE of REQUIRE qualifiers were specified, since the type of corrections to the weights is determined by file file format.

BY_SITE together with MAKE and REQUIRE means that station-dependent correction to weights should be generated. Ignored if USE of REQUIRE qualifiers were specified.

BY_ARC together with MAKE and REQUIRE means that session-dependent correction to weights should be generated. Ignored if USE of REQUIRE qualifiers were specified.

DEFAULT (or keyword omitted) - weights by baseline. It is strongly recommended not to use this qualifier!

ALGORITHM - specifies the algorithm to be used for making corrections to weights. Ignored if USE of REQUIRE qualifiers were specified.

MYWAY - John Gipson's algorithm for computing corrections to weights for delays and delay rates will be used. NB: MYWAY algorithm is not compatible with NO TRAIN mode!

UPWEI - Leonid Petrov's algorithm for computing corrections to weights for delays will be used.

UPWEI_OPT - optimized version of Leonid Petrov's algorithm for computing corrections to weights for delays will be used.

ELIM - weights, outliers elimiation and resurrection of previously suppressed observations is computed by the ELIM algorithym developed by Leonid Petrov. The name of the PARU control file should be specified after the qualifier ELIM. Refer to ELIM documenatation for syntax of the PARU control file.

BATCH produces corrections to weights which match the data type selected for the session through the $SESSIONS section or the $DATA sections TYPE keyword. BATCH writes each session's weights to a separate line, along with the session's key name and version. Weight files are in ASCII format. Weights file has different formats for baseline-dependent corrections, site-dependent corrections, session-dependent corrections.

Only independent solutions can create or update weight files.

1.13 SETUP.SOURCE_WEIGHTS

{SOURCE_WEIGHTS [NO or ([USE or REQUIRE] source_weight_file]) }

This keyword determines how to use source-dependent correction to weights.

Field 1 -

NO - not to use source-dependent correction to weights.

USE - if there is a source_weight_file and the source is found in the file, use its value from this file, otherwise, use from superfile.

REQUIRE - all sources must be in source_weight_file, otherwise, there will be an error.

Field 2 - specifies the source weight file.

1.14 SETUP.ELEVATION_DEPENDENT_NOISE

{ELEVATION_DEPENDENT_NOISE [NO or [YES el_dep_noise_file] or
([GLOBAL global_sigma]
{[STATION_FILE file_name]}) or
[MULTI_GLOB value]]}

The keyword ELEVATION_DEPENDENT_NOISE allows user to make correction to weights according to their elevation angles. The new weight ata baseline {ij} is expressed throuth the old weight signa_in as

sigma_out_ij = sqrt (sigma_in_ij**2 + (R_i*M(e_i))**2 + (R_j*M(e_i))**2)

where R_k is the parameter from the table below for the k-th station, e_k is the elevation at the k-th station, and M(e) is the mapping function. Two formats are supported: pre-JAN2000 and POST-DEC2007. The pre-JAN2000 format uses these qualifiers:

Field 1 -

YES - weights data.

Field 2 -

specifies the elevation dependent noise file in the pre-JAN2000 format.

Documentation in the format of the elevation dependent noise in the pre-JAN2000 format is lost. This format is not recommended for use.

The post-JAN2000 format uses these qualifiers:

Field 1 -

GLOBAL

Field 2 -

global_sigma -- reciprocal weight for the zenith direction in seconds that is applied to all stations.

Field 3

STATION_FILE

Field 4

file_name -- the file name in eldep format that specifies reciprocal weights for the zenith direction in seconds for each listed station individually. That reciprocal weight overrides global_sigma. For those stations, not listed in the this file, reciprocal weight global_sigma is to be applied.

Format specifications of the ELDEP format of 2007.12.03

The file in ELDEP format specifies reweighting parameters that are elevation-dependent and station dependent

The used reciprocal weights at the baseline ij is computed as

sigma_out_ij = sqrt (sigma_in**2 + (R_i*M(e_i))**2 + (R_j*M(e_i))**2)

where R_k is the additive parameter from the table below for the k-th station, e_k is the elevation at the k-th station, and M(e) is the mapping function of elevation that is the ration of the slanted path delay at elevation e to the path delay in the zenith direction.

Format:

The file in ELDEP format consists of records in ASCII coding.
The first records identifies the format revision date
Records that starts from character # are considered as comments
Date records have the following format:

Field 1:8 A8
Field 11:24 D14.8 Additive reweighting parameter to delay in seconds

```
Field  27:40  D14.8  Additive reweighting parameter to delay rate in s/s

  An alternative way to specity the elevation dependent noise variance is
to use MULTI_GLOB keyword

  Keyword:

  MULTI_GLOB  {value}  -- sets the variance of the elevation depended
                          noise proportional to the slanted
                          un-hydrostactic path delay. The value specifies
                          the coefficent of this proportionality.
```

1.15 SETUP.GPS_TEC_NOISE

{GPS_TEC_NOISE [NO or [YES gps_tec_noise_file] [NO_IONO_CONTRIB]}

```
   The keyword GPS_TEC_NOISE allows a user to make correction to weights
by incorporating an empirical model of residual errors of propgation
through the ionosphere after applying the GPS TEC model.

      Field 1 -

            NO  -- do not apply the empirical GPS TEC model
            YES -- apply an empirical GPS TEC model

      Field 2 -

            gps_tec_noise_file --  name of the file in gps_tec_noise
                                   format that describes the error
                                   model.

      Field 3 - NO_IONO_CONTRIB -- if present, then the ionosphere
                                   contribution specified in VTD
                                   will be used onbly for computation
                                   of additional noise and will not
                                   be applied to delay and rate


  The format of gps_tec_noise file:

The file in gps_tec_noise format consists of records in ASCII coding.
The first records identifies the format revision date
Records that starts from character # are considered as comments
Date records have the following format:

Field   1:8    A8    Mode. Mode RMS_REGR is currently supported.
Field   11:18  A8    First station name of a baseline. Wilrdcard characters
                     ? and * are supported
Field   22:29  A8    Second station name of a baseline. Wilrdcard characters
                     ? and * are supported
```

```
Field   31:38  D8.2  Floor of the regression model in sec.
Field   41:46  F6.4  Slope of the regression model.
```

1.16 SETUP.USER_TAG

{USER_TAG [user_inits] SOL_TAG [solution_tag]}

By specifying these two options, users' solution will be recorded into solution archive catalog system. User_inits, two letters user initials, case insensitive, must be registered in solution catalog, or, solution stops with error. solution_tag must consist of a number from 1 to 9999, optionally followed by up to 4 characters. USER_TAG and SOL_TAG must be taken as a pair to present or be omitted.

This option is only available on the 700 series HP computers. 4 files, gl, ar, sp, pr, will be registered in solution catalog. gl: control file; ar: session list; sp: spool file; pr: outline data. name expression:

```
aavvuunnnncccc
++--**////////
| | |    |__ solution tag.
| | |__ user tag
| |__ version
|__ gl/ar/sp/pr
```

1.17 SETUP.SNR_MIN

{SNR_MIN [NO or [SNR_MIN_X SNR_MIN_S]]}

The keyword SNR_MIN allows a user to set the minimum SNR at two bands: upper and lower. Observations with SNR less than these limits, will be suppreessed. NB: this feature works only if the database is in the GVF format and suppression type is META.

Field 1 -

NO -- do not suppress observations with low SNR.

Field 2 -

SNR_MIN_X -- Minumim SNR for the upper (X) band.

Field 3 -

SNR_MIN_X -- Minumim SNR for the lower (X) band.

1.18 SETUP.FAST_MODE

{FAST_MODE [NONE or B3D or B1B3D]}

BATCH Solve supports several algorithms of solving LSQ problem. The keyword FAST_MODE sets the algorithm.

NONE - in INDEPENDENT mode means to use strait-forward algorithm; in COMPLETE, FORWARD, BACK solution types means to use B1D algorithm (arc parameters elimination).

B3D - in INDEPENDENT solution type means to use B3D algorithm (recommended way). B3D mode is not supported in COMPLETE, FORWARD and BACK solution types.

B1B3D - in in COMPLETE, FORWARD, BACK solution types means to use B1B3D algorithm (recommended way). B1B3D is not supported in INDEPENDENT solution types.

B3D and B1B3D algorithms are mathematically equivalent to the direct strait-forward methods of solving LSQ problems but they are much faster. In practice they give slightly different results since rounding errors are accumulated by the different way. However, the difference in the estimates usually are very small: less than 0.0001 sigma and does not exceed 0.1 sigma even for the worst case of unstable parameterization.

B3D and B1B3D together are called "fast mode" while NONE is called slow mode. Solve runs faster by the factor 1.5-20 in fast mode.

1.19 SETUP.FAST_DBG

{FAST_DBG [NONE or APPEARANCE or PRINTOUT or TIMER or MONITOR]}

Keyword FAST_DBG specifies debugging mode. Additional information is printed on the screen and in temporary files if debugging mode is applied.

NONE - no debugging information will be printed (normal way).

APPEARANCE - messages about starting and finishing computations from sole modules will appear on the screen.

PRINTOUT - verbose information about parameterization will be printed on the screen. Additional information including the list of parameter names will be printed in the file /tmp/param.fil

TIMER - information about elapsed and CPU time taken by different subroutines during processing each session is printed on the screen and in parallel is written in the file $WORK_DIR/TIMR{solve_initials} .

MONITOR - The line with current status of SOLVE is printed and it is updated every second. The format of the status line is the same as the format of the SMON status line.

1.20 SETUP.FAST_COV

{FAST_COV [GLOBAL or LOCAL or SEGMENTED or FULL]}

It is possible to restrict computation of covariance matrix when Solve runs in fast mode. Solve runs faster when computation of covariance matrix is restricted. Keyword FAST_COV doesn't make any effect in slow mode.

GLOBAL - only covariance of global parameters are computed. chi/ndg statistics is not available in this mode.

LOCAL - Covariance of global and local parameters (but not segmented) is computed. chi/ndg statistics is not available in this mode.

SEGMENTED - Covariance of global, local and segmented parameters is computed, while only blocks of covariance matrices between parameters of the same and adjacent blocks are computed. chi/ndg statistics is available in this mode.

FULL - all elements of covariance matrix are computed. This mode is slow and is not recommended.

1.21 SETUP.SAVING_RATE

{SAVING_RATE <rate>}

Keyword SAVING_RATE specifies how frequently intermediary CGM should be written in disk in forward step of global solution. BATCH writes intermediary CGM after processing each <rate> sessions where <rate> is an integer value. SAVING_RATE affects only forward step of global solution. Recovery of the interrupted BATCH solution is possible only after saving the intermediary CGM. For example if saving rate is 100 and solution was interrupted during processing the 188-th session, a Solve run in recovery mode would start from the 101-th session. Thus, the larger value <rate>, the more unnecessary work will be done in recovery of the solution. The smaller value <rate>, the slower Solve is running since writing intermediary CGM takes considerable time.

Recommended value is 128 for normal runs.

1.22 SETUP.EMULATION

{EMULATION [0 or 9612]}

Solve internal logic of handling segmented parameters was slightly changed since December 1996 what resulted in small differences between solutions (which, however, don't exceed 1.0 sigma in the worst case). Solve is able to emulate pre DEC-1996 logic.

0 - normal way of computation (recommended)
9612 - emulation of compatibility with old, pre-DEC96 logic. This mode is incompatible with fast modes. Do not use it unless you really understand what you are doing.

1.23 SETUP.SUPMET

{SUPMET [UND or PRE98 or PRE91 or COMB1 or SNGBA or META]}

Keyword SUPMET specifies the suppression method used for determination suppression status of each observation.

UND - undefined method. The suppression method saved in the database will be used.

PRE98 - pre-1998 method

PRE91 - pre-1991 method (not recommended). Supported for compatibility only.

COMB1 - combination method

SNGBA - single baseline method.

META - meta method.

Refer to manual to ELIM for details.

1.24 SETUP.QUALCODE_LIMIT

{QUALCODE_LIMIT [1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9]}

Keyword QUALCODE_LIMIT sets the maximum quality code of the observation which is still considered as potentially recoverable. Value 5 is recommended.

1.25 SETUP.SINGULARITY_CHECK

SINGULARITY_CHECK [NONE or ACTION [NONE or WARINING or REPARAMETERIZE or SKIP or STOP]
SOUMIN [NO or <non-negative_integer>]
STAMIN [NO or <non-negative_integer>]
BASMIN [NO or <non-negative_integer>]]

Keyword SINGULARITY_CHECK specifies whether to enable or disable singularity check. If singularity check is enabled then criteria of singularity and the action what to do in the case when singularity is detected are to be specified. Singularity check is performed after building a normal matrix but before its inversion.

NONE -- singularity check is disabled.

ACTION -- determines which action is to be done if the normal matrix will be pronounced singular:

NONE -- nothing

WARNING -- a warning message will be printed in the screen. Then Solve will stoop in attempt to invert a singular matrix, but a user will know the reason why the normal matrix turned out singular.

REPARAMETERIZE -- Solve will try to correct parameterization. Then it starts to build the normal matrix anew. The type of correction depends on the reason of singularity:

a) too few observations of the source which coordinates are to be estimated -- all observations of this source are deselected, and coordinates of this sources are not estimated.

b) too few observations at the station -- all observations at this station are deselected, and all parameters related to this station, position, clock function, atmosphere path delay etc are not estimated. The list of baseline-dependent clock parameters is re-computed.

```
                        c) too few observations at the baseline -- all
                           observations at this baseline are deselected,
                           the list of baseline-dependent clock parameters
                           is re-computed.

                        If the session was considered as singular on the
                        basis of more than one criteria then more than
                        one action is performed.

       SKIP -- session is skipped if a singularity is detected.

       STOP -- Solve will stopped it a singularity is detected.

SOU_MIN <value> - specifies criterion for singularity detection on the
                  basis of the number of observation of each source.

                  NO - means not to apply this criterion.
                  <integer_value> - means that if at least one source
                                    a) had less than the <integer_value> of
                                    good observations and b) coordinates of
                                    this source were estimated, then the
                                    normal matrix is considered singular.

STA_MIN <value> - specifies criterion for singularity detection on the
                  basis of the number of observation at each station.

                  NO - means not to apply this criterion.
                  <integer_value> - means that if at least one stations
                                    had less than the <integer_value> of
                                    good observations then the normal matrix
                                    is considered singular.

BAS_MIN <value> - specifies criterion for singularity detection on the
                  basis of the number of observation at each baseline.

                  NO - means not to apply this criterion.
                  <integer_value> - means that if at least one baseline
                                    had less than the <integer_value> of
                                    good observations then the normal matrix
                                    is considered singular.

Matrix is considered singular on the basis of at least one criterion.
```

1.26 SETUP.DECIMATION

```
{DECIMATION [NO or
                  [CREATE  directory [ASCII or BINARY]] or
                  [REQUIRE directory param] or
                  [USE     directory param]
```

]

Keyword DECIMATION specifies one of the actions

CREATE -- create a set of decimation files in the directory specified in the second value of the keyword. The file has name {exp}.edb or {exp}.eda where {exp} is the database name with leading $-character removed. The ascii decimation file has five header lines and NOBS observations record, where NOBS is the number of observations. An observation record has fields observation index, scan index, station names, source name, suppression status and decimation status. Solve writes in the observation the suppression status of each observation and an initial decimation status 0 for suppressed observations and 1 for used observations.

The third value, ASCII or BINARY, specifies in which format the decimation file is to be created. Files in ascii format have extension .eda, files in binary format have extension .edb .

REQUIRE -- requires to use decimation status recorded in decimation files. Solve searches for a file with name in the directory specified in the second value of the keyword with name {exp}.edc if does not exist, with name {exp}.eda, where {exp} is the database name with leading $-character removed. If it does not find decimation file, Solve writes the error message and stops. Solve examines the header of the file. If the header has different number of stations, sources, scans etc than the database, Solve writes the error message and stops. Solve examines each observation record. If the field decimation status is the same as the third argument param, Solve uses this observation, otherwise the observations is discarded. If param is zero or positive and the observations is suppressed, Solve does not use this observation. If param is negative, and decimation status is the same as param, Solve uses the observation regardless, whether it was previously suppressed or not.

USE -- the same as require, but if the decimation file does not exist or has wrong format, or wrong header, Solve prints a warning and ignores decimation.

Solve supports two formats for external decimation files: binary and ascii. An external decimation file in binary format has extension .edb, and an external decimation file in binary format has extension .eda. Solve first searches for a binary file with extension .edb . It if does not find, it searchs for an ascii file with extension .eda . If there exist two files,with estension .edb and with extension .eda , the file with extension .eda is ignored.

Binary files should be used. Usage of ascii files involves siginificant overheads and desigined primarily for testing.

1.27 SETUP.THEORETICAL_DELAY_FILE

```
{THEORETICAL_DELAY_FILE [NO or
                         [DATEBASE database_name] or
                         [IGNORE] or
                         [UPDATE  DIRECTORY directory_name] or
                         [USE     DIRECTORY directory_name] or
                    ]
```

Keyword THEORETICAL_DELAY_FILE specifies whether to use theoretical path delay files in order to speed-up batch solution.

IGNORE -- ignore theoretical path delay files

DATABASE -- ??

USE -- to use path delay files. If path delay files exist for a database with a given name, than the path delay and its partial derivatives will not be re-computed, but be read from these files.

UPDATE -- to update path delay file. Teh path delay will be computed for the forward run of batch solution and will be used for the back run of a global solution or cres path of an indepedent solution.

1.28 SETUP.EXTERNAL_IONO_PATH_DELAY

```
EXTERNAL_IONO_PATH_DELAY {NONE or ([GEN or LOAD or USE] ionov_directory]
```

Keyword EXTERNAL_IONO_PATH_DELAY specifies usage of external ionosphere path delay.

GEN -- generate transport files for external ionosphere path delay

LOAD -- load external ionosphere path delay into database

USE -- take external ionosphere path delay from the database and use it

ionov_directory -- directory where files with external ionosphere path delay are located.

1.29 SETUP.WARNING

{WARNING [NO or ON or OFF]}

Keyword WARNING specifies whether or not to print warnings on the screen.

NO - not to print.
OFF - not to print.
ON - print all warnings on stdout.

1.30 SETUP.DTEC_USE

{APPLY [IMPORT NO]}

Keyword DTEC_USE specifies the use of external files that have dTEC and delay bias between upper and lower band.

APPLY -- then FUSED data are created on the fly, DTEC, DTEC_ERR, DTEC_FLG, and DEL_BIAS_UL variables are iserted in oborg. If DTEC_FLG was zero, it is initialized. If DTEC_FLG was not zero, it is not changed. If data type FUSED is specified, this data type is used for data analysis.

IMPORT -- the same as APPLY, but the database is updated and variables DTEC, DTEC_ERR, DTEC_FLG, and DEL_BIAS_UL are written. The database version counter is not updated.

1.31 SETUP.DEFINE

{name values}

Keyword DEFINE defines envirnoment variable. Its definition will be used inside Solve.

name   -- name of the envirnoment variable in upper case

values -- value of the envirotment variable. The value may have more than one word.

Solve prints a message when it processes DEFINE keyword.

1.32 SETUP.UNDEFINE

{name}

Keyword UNDEFINE removes a definition of the envirnoment variable specified as the keyword qualifier. If the envirnoment was not defined, Solve does not consider that as an error and proceeds. The removal of the definition is valid only within the Solve run and is discarded upon Solve termination.

2 $FLAGS

This section specifies parameters to be estimated (adjusted). It must precede the $CARRY and $SUPPRESSION sections. Rules specified in this section are applied to all sessions from arc-list, unless special flags are specified in the arc-list for special session which overrides rules in the $FLAGS section.

2.1 FLAGS.SOURCES

SOURCES [NO or YES or IN] {REF_EPOCH epoch} {src_comp}
[ref_source or PICK or
EXCEPT ([src_comp] source ...\) }

The SOURCES keyword determines whether BATCH estimates source coordinates. Fields 1-3 sets estimation flags globally, i.e. for all sources. Field 4 adjusts the estimation flags which have been already set for the specific sources. This includes either lifting the flag to estimate right ascension for the reference source or specifying exception list. The estimation flag is reversed for the specified components of the objects in the exception list.

Field 1 -

YES - to estimates coordinates of all source.

NO - does not estimate any source's coordinates.

IN - keep estimation flags set in the database in interactive solution and saved in the superfile.

Field 2 - Epoch too which the estimates are to be referred. In the case if no proper motion is estimated this qualifier is ignored. If proper motion is estimated, then source coordinates are modeled as "prop_motopm*(t - t0) + coord". So, the field 2 specified this epoch t0 in TDB scale. The value of the qualifier is in the format YYYY.DD.MM-hh:mm:ss . Only YYYY

potion is mandatory. Other fields of the epoch, if omitted, are filled by xxxx.01.01-00:00:00 . Example of valid epochs: 2000, 1997.01.01, 2002.12.27_08:40:49 . If the qualifier REF_EPOCH and its value are omitted then Solve sets default date 2000.01.01_12:00:00 . This default is for compatibility with early version of Solve only. It is recommended that the qualifier REF_EPOCH should **always** be specified in global solutions when source coordinates and proper motions are estimated.

Field 3 - a global source component. Field 1 is applied only for the component specified in field 2. If omitted then RD (right ascension and declination) is assumed.

Field 4 - defines the rules which overrides global definitions specified in the fields 1-2. If field 3 is omitted then the previous qualifiers are applied to "All sources".

ref_source -- selects the reference source, the source whose right ascension is not estimated. This flag for estimation of source's declination is not changed. If an session does not contain ref_source, BATCH aborts.

PICK - uses the first source in every session as the reference source.

EXCEPT -- exception list. Each element if this list is the source name which can be preceded by the sub-field source components. If the sub-field source component is omitted than "RD" is assumed. Estimation flag for the specified coordinate component of the specified source is toggled: if global definition defined YES (to estimate this component for this source), then this flag is reversed (NOT to estimate) and vice versus.

src_comp -- one of "RD", "R-", "-D", "--" where
R -- stands for right ascension,
D -- stands for declination,
- -- stands for an unwanted component.

How does it work.

a) Initialization.

If field 1 is IN then source estimation status saved in the database/superfile is kept. Otherwise estimation flag is set to the status "not to estimate any source coordinate".

b) Global setting.

If Field 1 is YES, then estimation flag is set for the specified components. If source component is omitted, estimation flag is set for both right

ascension and declination. If Field 1 is NO, then this step is skipped.

c) Adjustment.

If the reference source was specified explicitly or implicitly (PICK) then the right ascension estimation flag of this source is lifted.

For each source found in exception list, for each specified component of such a source the estimation flag is toggled: if it was "YES", it is set to "NO", if it was before "NO" it is set to "YES".

Comment: if not all two components of source coordinates were estimated, the NO-NET rotation constraints cannot be applied to such a source.

Example:

1) SOURCES YES REF_EPOCH 1997.01.01 EXCEPT 3C345

Estimate right ascensions and declination for all sources, except 3C345.

1) SOURCES YES REF_EPOCH 1996.01.01 -D

Estimate right declination for all sources.

3) SOURCES NO EXCEPT 3C345

Estimate right ascensions and declination of 3C345 only.

4) SOURCES NO R- EXCEPT 3C345

Estimate right ascensions and declination of 3C345 only.

5) SOURCE NO REF_EPOCH 1994.07.01 RD EXCEPT R- NGC5141 2134+00 -D 3C345

Estimation right ascension of NGC5141, right ascension and declination of 2134+00, declination of 3C345

6) SOURCE YES REF_EPOCH 2000.01.01_12:00:00

Estimate coordinates of all sources.

2.2 FLAGS.PROPER_MOTIONS

{PROPER_MOTIONS [NO or YES] {src_comp} {EXCEPT ([src_comp] source ...\) }

The PROPER_MOTIONS keyword determines whether BATCH estimates sources proper motions. Fields 1-2 sets estimation flags globally, i.e. for all

sources. Field 3 adjusts the estimation flags which have been already set for the specific sources. It defines exception list which consists of source name and optionally source components. Estimation flag is reversed for the specified components of the objects in the exception list.

Field 1 -

YES - to estimates all proper motions

NO - does not estimate any source's proper motions.

Field 2 - a global source component. Field 1 is applied only for the component specified in field 2. If omitted then RD (right ascension and declination) is assumed.

Field 3 - defines the rules which overrides global definitions specified in the fields 1-2. If field 3 is omitted then the previous qualifiers are applied to "All sources".

EXCEPT -- exception list. Each element if this list is the source name which can be preceded by the sub-field source components. If the sub-field source component is omitted than "RD" is assumed. Estimation flag for the specified coordinate component of the specified source is toggled: if global definition defined YES (to estimate this component for this source), then this flag is reversed (NOT to estimate) and vice versus.

src_comp -- one of "RD", "R-", "-D", "--" where
R -- stands for right ascension,
D -- stands for declination,
- -- stands for an unwanted component.

How does it work.

a) Initialization.

Estimation flag is set to the status "not to estimate proper motion for any source".

b) Global setting.

If Field 1 is YES, then estimation flag is set for the specified components. If source component is omitted, estimation flag is set for both right ascension and declination. If Field 1 is NO, then this step is skipped.

c) Adjustment.

For each source found in exception list, for each specified component of such a source the estimation flag is toggled: if it was "YES", it is set to "NO", if it was before "NO" it is set to "YES".

2.3 FLAGS.STATIONS

STATIONS [NO or YES] {REF_EPOCH epoch} {sta_comp} {D}
[ref_station or PICK or
{EXCEPT ([sta_comp] station) ...\) ...}]

The STATIONS keyword determines whether BATCH estimates station positions. Fields 1-2 sets estimation flags globally, i.e. for all stations. Field 4 adjusts the estimation flags which have been already set for the specific stations. This includes either lifting the flag to estimate station position for the reference station or specifying exception list. The estimation flag is reversed for the specified components of the objects in the exception list.

Field 1 -

YES - to estimates station positions.

NO - does not estimate any station positions.

Field 2 - Epoch too which the estimates are to be referred. In the case if no velocity is estimated this qualifier is ignored. If velocity is estimated, then position is modeled as "vel*(t - t0) + pos". So, the field 2 specified this epoch t0 in TDB scale. The value of the qualifier is in the format YYYY.DD.MM-hh:mm:ss . Only YYYY potion is mandatory. Other fields of the epoch, if omitted, are filled by xxxx.01.01-00:00:00 . Example of valid epochs: 2000, 1997.01.01, 2002.12.27_08:40:49 . If the qualifier REF_EPOCH and its value are omitted then Solve sets default date 1980.10.17_00:00:00 (This is the date of the best experiment of Merit program). This default is for compatibility with early version of Solve only. It is recommended that the qualifier REF_EPOCH should **always** be specified in global solutions when station positions and velocities are estimated.

Field 3 - a global station component. Field 1 is applied only for the component specified in field 2. If omitted then XYZ (three Cartesian components in the crust-fixed reference system) is assumed.

Field 4 (D) - (rarely used -- most users omit this field)

field omitted - the components described below are not estimated.

D - estimates the diurnal radial station component by session at every station. This field was implemented because nutation mimics

diurnal station motion, and this field can show how much the station vertical affects nutation. BATCH performs this estimate by fitting a sine to the station vertical.

Field 5 - defines the rules which overrides global definitions specified in the fields 1-2. If field 3 is omitted then the previous qualifiers are applied to "All stations".

PICK - BATCH chooses the reference station for each session. BATCH refers to a list of reference stations, using the first station that is in the session. If none are, BATCH uses the first station it finds in the session. The list is located in the file $SAVE_DIR/STATION_PICK
Estimation flag for all components of the reference station is set to "NO".

ref_station - BATCH tries to use this station for every session. If any session does not have the station, BATCH aborts at the end of that session. Estimation flag for all components of the reference station is set to "NO".

EXCEPT -- exception list. Each element if this list is the station name which can be preceded by the sub-field station components. If the sub-field station component is omitted than "XYZ" is assumed. Estimation flag for the specified coordinate component of the specified station is toggled: if global definition defined YES (to estimate this component for this station),then this flag is reversed (NOT to estimate) and vice versus.

sta_comp -- one of
"XYZ", "XY-", "X-Z", "-YZ", "--Z", "-Y-", "X--", "---"
"UEN", "UE-", "U-N", "-EN", "--N", "-E-", "U--", "---"

X -- stands for X component in CFS system;
Y -- stands for X component in CFS system;
Z -- stands for X component in CFS system;
U -- stands for Up component in local UEN system;
E -- stands for East component in local UEN system;
N -- stands for North component in local UEN system;
- -- stands for an unwanted component.

How does it work.

a) Initialization.

Estimation flag is set to the status "not to estimate any station position".

b) Global setting.

If Field 1 is YES, then estimation flag is set for the specified components.

If the station component is omitted, estimation flag is set for all three components in XYZ system. If Field 1 is NO, then this step is skipped.

c) Adjustment.

If the reference station was specified explicitly or implicitly (PICK) then the estimation flag for the reference station is lifted.

For each station found in the exception list, for each specified component of such a station the estimation flag is toggled: if it was "YES", it is set to "NO", if it was before "NO" it is set to "YES".

Restriction: XYZ and UEN components should not be mixed. You cannot estimate XYZ components for one station and UEN component for another station.

Example:

1) STATIONS YES REF_EPOCH 1997.01.01

Estimate XYZ coordinates of all stations

2) STATIONS YES REF_EPOCH 1996.07.01 UEN EXCEPT U-- GIFU3 U-- CRIMEA

Estimate Up, East North components for all stations, but to estimate only horizontal coordinates for stations GIFU3 and CRIMEA

Comment: if not all three components of station position were estimated, the NO-NET trasnaltion and rotation constraints cannot be applied to such a station.

NB: The STATIONS keyword must always precede the VELOCITIES keyword.

2.4 FLAGS.VELOCITIES

VELOCITIES [YES or NO] {sta_comp}
{EXCEPT ([sta_comp] station) ...\) }

The VELOCITIES keyword determines whether BATCH estimates station velocities. Fields 1-2 sets estimation flags globally, i.e. for all stations. Field 3 adjusts the estimation flags which have been already set for the specific stations. It defines exception list which consists of station name and optionally station components. Estimation flag is reversed for the specified components of the objects in the exception list.

Field 1 -

YES - to estimates station positions.

NO - does not estimate any station positions.

Field 2 - a global station component. Field 1 is applied only for the component specified in field 2. If omitted then XYZ (three Cartesian components in the crust-fixed reference system) is assumed.

Field 3 - defines the rules which overrides global definitions specified in the fields 1-2. If field 3 is omitted then the previous qualifiers are applied to "All stations".

EXCEPT -- exception list. Each element if this list is the station name which can be preceded by the sub-field stations components. If the sub-field station component is omitted than "XYZ" is assumed. Estimation flag for the specified coordinate component of the specified station is toggled: if global definition defined YES (to estimate this component for this station),then this flag is reversed (NOT to estimate) and vice versus.

sta_comp -- one of
"XYZ", "XY-", "X-Z", "-YZ", "--Z", "-Y-", "X--", "---"
"UEN", "UE-", "U-N", "-EN", "--N", "-E-", "U--", "---"

X -- stands for X component in CFS system;
Y -- stands for X component in CFS system;
Z -- stands for X component in CFS system;
U -- stands for Up component in local UEN system;
E -- stands for East component in local UEN system;
N -- stands for North component in local UEN system;
- -- stands for an unwanted component.

How does it work.

a) Initialization.

Estimation flag is set to the status "not to estimate any station velocity".

b) Global setting.

If Field 1 is YES, then estimation flag is set for the specified components. If the station component is omitted, estimation flag is set for all three components in XYZ system. If Field 1 is NO, then this step is skipped.

c) Adjustment.

For each station found in the exception list, for each specified component of such a station the velocity estimation flag is toggled: if it was "YES", it is set to "NO", if it was before "NO" it is set to "YES".

Examples:

1) VELOCITIES YES EXCEPT XY- GILCREEK HRAS_085

BATCH estimates X, Y and Z velocities at all stations except GILCREEK and HRAS 085, where only X and Y are estimated.

2) VELOCITIES NO UEN EXCEPT -EN GILCREEK

Only the East and North velocities at GILCREEK are estimated.

3) VELOCITIES YES X-- EXCEPT -YZ WESTFORD HRAS_085 XYZ GILCREEK

At GILCREEK and HRAS 085, estimates Y and Z. No velocity component is estimated at Westfor. Everywhere else, estimates X component

2.5 FLAGS.HARMONIC_POS

```
{HARMONIC_POS
 [NONE  or
  @file_name or
            (NAME (name_of_harmonic)
             STATION   [@file_name  or (station ...)]
             PHASE     (value_in_rad)
             FREQUENCY (value_in_rad/s)
             NNT_CNS_SIGMA  (sigma_of_constraint) \
             NNR_CNS_SIGMA  (sigma_of_constraint)  \
            ) ...
           )

 ] ...
}
```

The HARMONIC_POS keywords specifies the harmonics (name, phase, frequency), the list of station(s) for which harmonic variations of coordinates are adjusted and the reciprocal weights of no-net-rotation and no-net-translation constraints. More than one harmonic can be specified. Each harmonic may have its own station list. Contents of this keyword or any part of it may be specified in the external file. Solve will read the file name specified with the prefix @ and add its content to the batch control file for parsing. Six parameters are adjusted for each harmonic and for each station from the station list: the amplitude of sin (phase + freq*t) for X, Y, and Z components, and the amplitude of cos (phase + freq*t) for X, Y, and Z components.

In general, if harmonic variations were estimated for all sites, the LSQ problem has rank deficiency 6*N_HAR, where N_HAR is the number of harmonics. In order to overcome the rank deficiency, no-net-translation

and no-net-rotation constraints are to be imposed.

Care should be taken in designing the list of stations for harmonic site position variations estimation. A station with poor observation history may not have enough observations for reliable estimation of harmonic site position amplitudes and for its separation from global site position, global velocity, and possibly coefficients of B-spline estimates. For example, if a station observed only during several occupations it is unlikely that its harmonic position variations at annual frequency can be adjusted. A poor history of observations of even one site may cause a failure of the global matrix inversion.

NAME -- Unique name of the harmonic with 1-8 characters.

STATION -- List of stations which participated in estimation of position variations for this harmonic. Blanks insides station names blank should be replaced with the underscore. Alternatively, the list of stations or its portion can be specified in a file. Character @ should precede the station name file.

PHASE -- Phase of the harmonic with respect to J2000.0 epoch. Units: radians.

FREQUENCY -- Angular frequency of the harmonic. Units: rad/sec

NNT_CNS_SIGMA -- Reciprocal weight of no-net-translation constraint. Units: meters. Recommended value: 1.D-4. Value 0.0 means net-translation constaints will not be applied.

NNR_CNS_SIGMA -- Reciprocal weight of no-net-rotation constraint. Units: meters. Recommended value: 1.D-4 Value 0.0 means net-translation constaints will not be applied.

2.6 FLAGS.SPLINE_POS

```
{SPLINE_POS
  [ NONE or
    @file_name or
    STATION (station_name)
    DEGREE  (degree_value)
    [ NODE    (epoch)  MULT (multiplicity) ]...
    CNS_STA_SIGMA                (sigma_of_constraint)
    CNS_VEL_SIGMA                (sigma_of_constraint)
    CNS_DER_SIGMA    (derivative) (sigma_of_constraint)
  ] ...
}
```

Keyword SPLINE_POS determines the parameterization for estimation of coefficients of expansion with the B-spline basis of positions displacements of one or more sites. For each station the degree of the basis, the time epoch of modes, the multiplicity of each nodes and the reciprocal weights of constraints are specified. Either entire specification of the keyword or any portion of specifications can be put in an external file and the name of this file can be used as an option with preceding @ character. Solve will read this @-file, and puts its contents to the batch file (without modifying original batch file) and parse its contents.

NB: The multiplicity of the first and node should be equal to spline degree. The multiplicity of the last node should be zero.

If global site position is estimated, the global normal matrix has rank deficiency 3. In order to reduce rank deficiency, de-mean constraint can be imposed which requires the integral of the B-spline over the interval from the first to the last node be equal to zero.

If global site velocity is estimated, the global normal matrix has rank deficiency 3. In order to reduce rank deficiency, de-trend constraint can be imposed which requires the first moment of the B-spline over the interval from the first to the last node be equal to zero.

Care should be taken in designing the list of stations for non-linear site position variations estimation. A station with poor observation history may not have enough observation for reliable estimation of harmonic site positions and for its separation from global site position, global velocity and coefficients of B-spline estimates. A poor history of observations of even one site may cause a failure of the global matrix inversion.

This keywords is incpomatible with EPISODIC_MODION and PIECE_WISE_STA keywords.

STATION -- Name of the stations which participates in estimation of spline coefficients. Blanks insides station names blank should be replaced with the underscore.

DEGREE -- degree of B-spline in the range [0, M__SPD] (M__SPD is defined in $MK5/include/solve.i

NODE -- specifies node of the spline
value: epoch in format YYYY.MM.DD_hh:mm:ss.sss
were YYYY -- year
MM -- decimal month number
DD -- day of month
hh -- hour
mm -- minute
sssss.sss -- seconds
time scale: TAI.

```
   MULT    -- node multiplicity in the range [0, degree]

   CNS_STA_SIGMA -- reciprocal weight of de-mean constraint.
                    This constraint requires that integral of the
                    B-spline over the interval from the first to
                    the last node be equal to zero.

   CNS_VEL_SIGMA -- reciprocal weight of de-trend constraint.
                    This constraint requires that first moment of the
                    B-spline over the interval from the first to
                    the last node be equal to zero.

   CNS_DER_SIGMA -- this keyword specifies the reciprocal weight of
                    constraints imposed on a derivative of the
                    specified order which can be zero at each node.
                    value -- derivative in the range (0,degree)
                    sigma_of_constraint -- reciprocal weight of
                    constraint. Units: m/s^(derivative)
```

2.7 FLAGS.ATMOSPHERES

```
   ATMOSPHERES [NO or IN or FORCE or
                [(MOST interval_in_minutes) or
                 (AUTO interval_in_minutes {EXCEPT NO {station} ...\})] ]
```

The ATMOSPHERES keyword determines how the atmosphere path delay in zenith direction parameters are estimated.

```
   Field 1

     NO    -- no parameters are estimated.

     IN    -- for each session, uses the parameterization recorded in
              that session's superfile.

     FORCE -- forces estimation of an offset which is constant over the
              experiment at each station in the session.

     MOST  -- for each session performs a linear spline ( linear
              piecewise-continuous ) parameterization with the given interval
              at each station, unless the session's superfile contains a linear
              spline parameterization with a shorter interval.
              In that case, uses the parameterization saved in superfile.

     AUTO  -- for each session performs a linear spline (piecewise-continuous)
              parameterization with the given interval at each station,
```

regardless of what's in the session's superfile.
EXCEPT NO lists exceptions, stations for which BATCH estimates no atmosphere parameters.

NB: For MOST and AUTO, the interval must be in minutes and only integer. Decimal point is not allowed.

2.8 FLAGS.CLOCKS

CLOCKS {MAX_DEGREE [IN or ([AUTO or MOST] [1 or 2])]}
INTERVALS [IN or or NO or
([FORCE or AUTO or MOST] interval_in_minutes)]

***CLOCKS [DEFAULT or**
([FORCE or AUTO or PICK or MOST] interval_in_minutes)]

The CLOCKS keyword determines how the clock parameters are estimated. Two formats are supported: the current and the obsolete marked by *. The obsolete format is maintained only for providing backward compatibility and it is not recommended to use it.

Clocks in general are modeled by a sum of a local polynomial of the 1-st or 2-nd degree plus linear spline with intervals of equal spans (linear spline can be omitted). The local polynomial is estimated using all observations at this station in the session. If the session has N clock breaks then N local polynomials are estimated. Clock polynomials has discontinuities at the epochs of clock breaks.

Current format:

MAX_DEGREE - specifies the order of the local polynomial of clock function.

IN - take the same order as it saved in the database.
AUTO - set order of the polynomial regardless the value saved in the superfile.
MOST - set order of the polynomial which is maximal between the specified one conserved in the database.
1 -- polynomial of the first order will be used.
2 -- polynomial of the second order will be used.

INTERVALS - specifies length of span of linear spline.

IN - the length of linear spline is taken from superfile.

NO - no linear spline is estimated

FORCE - uses a linear spline parameterization for every station in every session, with the requested interval in minutes. Totally

overrides the parameterization in the sessions' superfiles, INCLUDING CLOCK BREAKS. Provided for backward compatibility only. Not recommended to use.

AUTO - uses a linear spline parameterization for every station in every session, with the requested interval in minutes. Ignores the parameterization in the superfiles, except for preserving all clock breaks.

MOST - for each session, performs a linear spline parameterization with the given interval at each station, unless the session's superfile contains a linear piecewise-continuous parameterization with a shorter interval. Then BATCH uses that interval. Preserves clock breaks. The interval must be in minutes.

Obsolete format: (provided for backward compatibility only)

DEFAULT - for each session, uses the parameterization recorded in that session's superfile.

FORCE - uses a linear piecewise-continuous parameterization for every station in every session, with the requested interval in minutes. Totally overrides the parameterization in the sessions' superfiles, including clock breaks.

PICK - uses a linear piecewise-continuous parameterization for every station in every session, with the requested interval in minutes. Ignores the parameterization in the superfiles, except for preserving clock breaks inserted with Solve's interactive automatic constraint feature.

MOST - for each session, performs a linear piecewise-continuous parameterization with the given interval at each station, unless the session's superfile contains a linear piecewise-continuous parameterization with a shorter interval. Then BATCH uses that interval. Preserves clock breaks inserted with Solve's automatic constraint feature. The interval must be in minutes.

2.9 FLAGS.UT1/PM

```
UT1/PM      NO or
        [(POLYNOMIAL {OFFSET xyu_comp} {RATE xyu_comp} {2ND_ORDER xyu_comp}
                     {START or END or MIDNIGHT or NOON or MIDDLE or
                      DAYOFTIME_EPOCH time or EPOCH date }) or
         (SEGMENTS_G.RATE {INTERVAL int_in_min
           PM_RATE_CONSTRAINT constraint_pm
           UT_RATE_CONSTRAINT constraint_ut} }  ) or
         (SEGMENTS_ONLY {INTERVAL wob_comp
```

```
                PM_RATE_CONSTRAINT constraint_pm
                UT_RATE_CONSTRAINT constraint_ut
                {EOP_FILE NONE or RESET or APPEND} } ) or
             (SINE_STYLE  PM_RATE_CONSTRAINT constraint_pm
                UT_RATE_CONSTRAINT constraint_ut) ]

   *UT1/PM      [YES or NO or
                    (WOBBLE [({OFFSET wob_comp {RATE wob_comp}}) or (eop_type
                {int_in_hrs constraint})] UT1 [({OFFSET ut1_comp
                    {RATE ut1_comp}}) or (eop_type {int_in_hrs constraint})]
                {OFF or APPEND or RESET})] {MIDDLE}
```

The UT1/PM keyword determines how BATCH estimates UT1 and polar motion (X- and Y-wobble). UT1 and polar motion are collectively called earth orientation. UT1/PM has two syntax format: the current ad the obsolete. The obsolete format is provided only or backward compatibility and it is not recommended to use. Long lines can be divided on shorter pieces. Symbol \ at the end of the line is used as a continuation sign.

Current format:

Field 1 - determines how BATCH estimates UT1 and polar motion.

NO - does not estimate UT1 or polar motion.

POLYNOMIAL - estimate parameter of polynomial coefficient of earth orientation. Coefficients are estimated over all observations of the session.

OFFSET - determines whether to estimate coefficients of the zeroth order polynomial.

xyu_comp - is a three-letter line. It is XYU or "-" for either component (X -- means to estimate parameter for X pole coordinate, Y -- to estimate parameter for Y pole, U -- to estimate for UT1, "-" means don't estimate the component.

RATE - determines whether to estimate coefficients of the first order polynomial.

xyu_comp - has the same meaning as above.

2ND_ORDER - determines whether to estimate coefficients of the second degree polynomial.

xyu_comp - has the same meaning as above.

START - time epoch of earth orientation offset is the nominal start of the session as recorded in the

```
                superfile.

            END   - time epoch of earth orientation offset is the
                    nominal end of the session as recorded in the
                    superfile.

            MIDNIGHT - time epoch of earth orientation offset is 0 hours
                       of TDB at the midnight following nominal start of
                       the session.

            NOON - time epoch of earth orientation offset is 12 hours
                   of TDB at the midnight following nominal start of
                   the session.

            END   - time epoch of earth orientation offset is the
                    the middle epoch of the session between the nominal
                    start and the nominal end of the session as recorded
                    in the superfile.

            DAYOFTIME_EPOCH time - time epoch of earth orientation
                                  offset in TAI specified in
                                  the following qualifier. Format:
                                  hh:mm:ss.sss . EOP epoch be this
                                  time on the moment which follows
                                  nominal start time. If,
                                  for instance, the experiment started
                                  on 08-DEC-2006 16:37:49 and the
                                  time is specified as 16:00:00, then
                                  the EOP epoch will be on
                                  09-DEC-2006 16:00:00. If time
                                  specified as 17:00:00, then the EOP
                                  epoch is 08-DEC-2006 17:00:00.

            EPOCH date - The absolute date of the EOP estimation in
                         format yyyy.mm.dd_hh:mm:ss.sss in TAI.
                         This EOP epoch will be used for EOP estimation
                         of ALL experiments of this run.

SEGMENTS_G.RATE - earth orientation is modeled as a sum of global rate
                  computed over all observations of the session and
                  linear spline with constraints imposed on the rate of
                  change between nodes.

       INTERVAL - specifies length of the interval in minutes

                  int_in_min - duration of the interval.
                               Format: an integer number.

       PM_RATE_CONSTRAINT - specifies sigma of constrains to be imposed
                            on polar motion.

            constraint_pm - sigma of constraint. Units are mas/day.
                            Format: a real number.
```

UT_RATE_CONSTRAINT - specifies sigma of constrains to be imposed on UT1.

constraint_ut - sigma of constraint. Units are msec/day. Format: a real number.

SEGMENTS_ONLY - earth orientation is modeled by a linear spline with constraints imposed on the rate of change between nodes.

INTERVAL - see above

PM_RATE_CONSTRAINT - see above

UT_RATE_CONSTRAINT - see above

EOP_FILE - set flags whether the series of high frequency EOP are to be written in $WORK_DIR/EOPLxx file and if yes, how. Each line of the file contains a five field time tag, then an estimate and sigma for X-wobble, then the Y-wobble values, then the UT1 values.

NONE - no file is produced.

RESET - writes the values to $WORK_DIR/EOPLxx where xx are the solve user initials. Overwrites the previous contents of this file.

APPEND - appends the values to $WORK_DIR/EOPLxx.

SINE_STYLE - ?? Probably nobody except Jim Ryan knows...

PM_RATE_CONSTRAINT - ??

UT_RATE_CONSTRAINT - ??

Examples:

1) UT1/PM POLYNOMIAL OFFSET XYU RATE XYU 2ND_ORDER --U MIDNIGHT
means to estimate offset and rate for polar motion and offset, acceleration rate for UT1. Offsets are referred to 0 TDB of the midnight following the nominal start of the session.

2) UT1/PM SEGMENTS_G.RATE INTERVAL 90 PM_RATE_CONSTRAINT 5.0 \
UT1_RATE_CONSTRAINT 0.33
means to estimate polar motion and UT1 as a sum of linear spline with segment length 5400 seconds and the rate of change which is estimated over all observations of the session. Constraints on the rate of change between adjacent nodes 5.0 mas and 0.33 msec/day are imposed.

3) UT1/PM NO means not to estimate UT1 at all.

Obsolete format:

Field 1 (the first five lines) - determines how BATCH estimates UT1 and polar motion.

NO - does not estimate UT1 or polar motion.

YES - estimates one offset apiece for X-wobble, Y-wobble and UT1. BATCH estimates each offset at the first 0000 UTC epoch in the session.

Other parameterizations - must be set as follows:

The user must specify separate choices for polar motion (WOBBLE) and UT1. There are three categories of choices:

1. No parameterization:

Specified by OFFSET ---. (Both WOBBLE and UT1 use this syntax.)

2. Parameterization style "0" (the traditional style, which estimates 0000 UTC offsets and rates):

Offsets - specified by OFFSET XY- (for WOBBLE) or OFFSET --U (for UT1). The user can turn off X- or Y-wobble by substituting a dash for that parameter.

Rates - specified by RATE XY- or RATE --U. (Again, the user can turn off X- or Y-wobble.) Rates cannot be estimated unless offsets are estimated.

3. Parameterization style "1" (the new style, which estimates linear-piecewise continuous rates, etc.):

This style always automatically estimates an offset and an unconstrained global rate at the beginning of the experiment. The user may select up to three additional parameterizations, using eop_type. eop_type must be DSR, where each letter turns on one of the following choices and a dash in its place turns it off:

D - estimates a diurnal sine.

S - estimates a semi-diurnal sine.

R - estimates constrained linear piecewise-continuous rates. The user must also specify two real numbers, the

interval of the parameterization and the constraint upon the rates, in that order. These values have no default. The interval must be specified in hours, but BATCH converts it to days. The constraint must be specified in mas/day for WOBBLE and ms/day for UT1. Readers should note the difference between these constraints and the ones for earth orientation in the $CONSTRAINTS section. The constraints in the $CONSTRAINTS section apply to earth orientation offsets, while the constraints in this section apply to a specific type of earth orientation rate.

The syntax for style "1" applies to both WOBBLE and UT1. This style parameterizes X- and Y-wobble the same way.

Field 2 - produces a file containing hourly UT1 and polar motion estimates and sigmas.

OFF (or field omitted) - no file is produced.

RESET - writes the values to WORK_DIR/EOPLxx, where xx are the Solve user initials. Overwrites the previous contents of EOPLxx.

APPEND - appends the values to EOPLxx.

Each line of the file contains a five field time tag, then an estimate and sigma for X-wobble, then the Y-wobble values, then the UT1 values.

Field 3 - calculates UT1/PM at the middle of experiment time.

2.10 FLAGS.NUTATION

NUTATION [NO or OFFSET or XY_OFFSET]

The NUTATION keyword determines how BATCH estimates the nutation parameters.

NO - does not estimate nutation offsets.

OFFSET -- estimate daily offsets of nutation in longitude and nutation in obliquity using formalism of Newcomb-Andoyer. This forces Solve to put in listing in Sinex format estimates of nutation angles in longitude and in obliquity.

XY_OFFSET -- estimate daily offsets of nutation in X and nutation in Y using formalism of Ginot-Capitaine.

This forces Solve to put in listing in Sinex format
estimates of nutation angles in X and Y.

NB: Solve puts estimates of nutation angles both for nutation in longitude, nutation in obliquity, and nutation in X, nutation in Y direction in listing in Spool format. Therefore, this keyword does not change listing in Spool format, but changes listing in Sinex format.

2.11 FLAGS.PRECESSION

PRECESSION [NO or YES]

This keyword determines whether to estimate the precession constant.

NO - does not estimate the precession constant

YES - estimate the precession constant

2.12 FLAGS.ERM

```
{ERM
  [ NONE or
    DEGREE    E1  degree
    DEGREE    E2  degree
    DEGREE    E3  degree
    SPAN_DAYS E1  time_interval
    SPAN_DAYS E2  time_interval
    SPAN_DAYS E3  time_interval
    DATE_BEG  start_date
    DATE_END  end_date
    CNS_DER_SIGMA  E1  order  sigma
    CNS_DER_SIGMA  E2  order  sigma
    CNS_DER_SIGMA  E3  order  sigma
  ]
}
```

Keyword ERM determines the parameterization for estimation of coefficients of expansion over the B-spline basis of perturbations of Euler angles describing the Earth's rotation. These parameters describe the Earth's rotation at the specified period of time and are treated as global parameters. This keyword is incompatible with

```
UT1/PM keyword

      DEGREE    E1  degree -- degree of B-spline for representing
                            Euler angle around axis 1;
      DEGREE    E2  degree -- degree of B-spline for representing
                            Euler angle around axis 2;
      DEGREE    E3  degree -- degree of B-spline for representing
                            Euler angle around axis 3;
                          Degree should be in the range [0, 3].

      SPAN_DAYS E1  time_interval  --  time interval between knots
                                       of B-spline for representing
                                       Euler angle around axis 1;
      SPAN_DAYS E2  time_interval  --  time interval between knots
                                       of B-spline for representing
                                       Euler angle around axis 2;
      SPAN_DAYS E3  time_interval  --  time interval between knots
                                       of B-spline for representing
                                       Euler angle around axis 3;
                                    Units: days.

      DATE_BEG  start_date  -- Start date of B-spline in TAI.
                               Format: YYYY.MM.DD_hh:mm:ss.sss

      DATE_END  end_date    -- End date of B-spline in TAI.
                               Format: YYYY.MM.DD_hh:mm:ss.sss

      CNS_DER_SIGMA  E1  order sigma  -- resporical weight on
                                         derivative of the specified
                                         order at each knot of B-spline
                                         representing Euler angle
                                         around axis 1;

      CNS_DER_SIGMA  E2  order sigma  -- resporical weight on
                                         derivative of the specified
                                         order at each knot of B-spline
                                         representing Euler angle
                                         around axis 2;

      CNS_DER_SIGMA  E3  order sigma  -- resporical weight on
                                         derivative of the specified
                                         order at each knot of B-spline
                                         representing Euler angle
                                         around axis 3;
                          Order should be in range 0, DEGREE-1.
                          Reciprocal weights for several orders may be
                          specified.
```

2.13 FLAGS.HEO

```
{HEO
```

```
  [ NONE or
    ( YES REF_EPOCH reference_epoch \
      (
        W name phase frequency  acceleration
               e12_est_flag     e3_est_flag
               e12_cns_flag     e3_cns_flag
               e12_vel_est_flag e3_vel_est_flag
               e12_vel_cns_flag e3_vel_cns_flag \ ...
      )
      (
        C name_1 real_ampl_1 image_ampl_1  name_2 real_ampl_2 image_ampl_2
      )
      (
        CNS constraint_name SIGMA sigma_value )
      )
    )
  ]
}
```

Keyword HEO determines the parameterization for estimation of harmonic variations in Earth orientation. The instantaneous small Euler angles of the perturbations in the Earth rotation with respect to an apriori model are modeled as a sum of constituents of this form:

```
E1 = [ E12_amp_cos + E12_vel_cos*(t-t0) ] *
     cos { (ut1-tdt)*2*pi/86400 + phase + freq*(t-tr) + 1/2*accel*(t-tr)**2 }
   + [ E12_amp_sin + E12_vel_sin*(t-t0) ] *
     sin { (ut1-tdt)*2*pi/86400 + phase + freq*(t-tr) + 1/2*accel*(t-tr)**2 }

E2 = [ E12_amp_cos + E12_vel_cos*(t-t0) ] *
     sin { (ut1-tdt)*2*pi/86400 + phase + freq*(t-tr) + 1/2*accel*(t-tr)**2 }
   - [ E12_amp_sin + E12_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 1 axis (+Y angle of the polar motion)
E2 -- rotation around 2 axis (+X angle of the polar motion)
E3 -- rotation around 3 axis (-Ut1 angle of the Earth's rotation)
t-tr  -- The interval of time in scale TDT elapsed since
         01 January 2000, 12 hours TDT, in seconds
t-t0  -- The interval of time in scale TDT elapsed since the reference
         epoch for the expansion defined in the E-record, in seconds.

The qualifier W of the HEO keyword defines the following constituent:
```

```
name             -- unique name of the constituent, limited by 10 characters.
phase            -- phase of the constituent in rad.
frequency        -- frequency of the constituent in rad/sec
acceleration     -- acceleration of the constituent in rad/sec**2
e12_est_flag     -- Flag: T or F. If T then parameters E12_amp_cos
                          and E12_amp_sin are to be estimated for
                          this constituent.
e3_est_flag      -- Flag: T or F. If T then parameters E3_amp_cos
                          and E3_amp_sin are to be estimated for
                          this constituent.
e12_cns_flag     -- Flag: T or F. If T then decorrelation constraint
                          on the coefficients of B-spline of the
                          estimates of the E1 and E2 components of the
                          empirical model of the Earth rotation and
                          E12_amp_cos and E12_amp_sin amplitudes
                          are imposed.
e3_cns_flag      -- Flag: T or F. If T then decorrelation constraint
                          on coefficients of B-spline of the estimates
                          of the E3 component of the empirical model
                          of the Earth rotation and E12_amp_cos and
                          E12_amp_sin amplitudes are imposed.
e12_vel_est_flag -- Flag: T or F. If T then parameters E12_vel_cos
                          and E12_vel_sin are to be estimated for
                          this constituent.
e3_vel_est_flag  -- Flag: T or F. If T then parameters E3_vel_cos
                          and E3_vel_sin are to be estimated for
                          this constituent.
e12_vel_cns_flag -- Flag: T or F. If T then decorrelation constraint
                          on the coefficients of B-spline of the
                          estimates of the E1 and E2 components of the
                          empirical model of the Earth rotation and
                          E12_vel_cos and E12_vel_sin amplitudes are
                          imposed.
                          NB: Not implemented on 2006.06.16
e3_vel_cns_flag  -- Flag: T or F. If T then decorrelation constraint
                          on the coefficients of B-spline of the
                          E3 components of the estimates of the empirical
                          model of the Earth rotation and E3_vel_cos and
                          E3_vel_sin amplitudes are imposed.
                          NB: Not implemented on 2006.06.16

The value reference_epoch defines the reference epoch for amplitudes.
It has an effect if rate of change of amplitudes is estimated.
Format: YYYY_MM_DD_HH:MM:SS.S

NB: \ may should be put only after the value of the reference epoch and
only after e3_vel_cns_flag, except the last one.

Qulifier C defines the constraints imposed on the ratio of complex
amplitudes of two consitituents of the harmonic Earth orienation
parameters in the form
  (E1_r + i*E1_i)/(E2_r + i*E2_r) = (A1_r + i*A1_i)/(A2_r + i*A2_r)
where E1, E2 are adjustments to the complex amplitudes, and
A1, A2 are complex a priori amplitudes. The complex apriori amplitudes
```

```
for the first and the second constients of the constrataint are
defined as qualifiers of the C keyword:

  C name_1 real_ampl_1 image_ampl_1  name_2 real_ampl_2 image_ampl_2

  name_1       -- name of the first constituent;
  real_ampl_1  -- real part of the a priori amplitude of the first
                  constituent of the constraint;
  image_ampl_1 -- image part of the a priori amplitude of the first
                  constituent of the constraint;
  name_2       -- name of the second constituent;
  real_ampl_2  -- real part of the a priori amplitude of the second
                  constituent of the constraint;
  image_ampl_2 -- image part of the a priori amplitude of the second
                  constituent of the constraint;

Qualifier CNS defines the constraints imposed on HEO or ERM parameters.
The following constraitns names are supported:

   HEO_VAL_E1E2_HAR
   HEO_VAL_E1E2_CROSS
   HEO_VAL_E1E2_SHIFT
   HEO_VAL_E1E2_DRIFT
   HEO_VAL_E3_HAR
   HEO_VAL_E3_CROSS
   HEO_VAL_E3_SHIFT
   HEO_VAL_E3_DRIFT
   HEO_ERM_E1E2_HAR
   HEO_ERM_E1E2_CROSS
   HEO_ERM_E1E2_SHIFT
   HEO_ERM_E1E2_DRIFT
   HEO_ERM_E3_HAR
   HEO_ERM_E3_CROSS
   HEO_ERM_E3_SHIFT
   HEO_ERM_E3_DRIFT
```

2.14 FLAGS.GRADIENTS

```
{GRADIENTS      [(YES <interval_in_hours> {EXCEPT NO station ...\}) or
                 (NO {EXCEPT YES <interval_in_hours> station ...\})]}

This keyword determines whether to estimate atmosphere gradients

YES - to estimate as a linear spline for all stations unless EXCEPT NO
      clause is specified.

      <interval_in_hours> - time span between nodes of linear spline. Units
                            are hours. If the interval is longer than
                            duration of the session then the interval is
```

set to the actual duration of the session.

EXCEPT NO - clause specifies the list of the stations those atmosphere gradient will not be estimated.

NO - not to estimate atmosphere gradient for any station unless EXCEPT YES clause is specified.

EXCEPT YES - clause specifies the list of the stations those atmosphere gradient will be estimated.

station ... - list of stations.

2.15 FLAGS.HI_FREQ_EOP

{HI_FREQ_EOP [NO or (YES file_name)]}

Determines if to estimate tidal high frequency eop parameters.

NO - Does not estimate.

YES - set flags to estimate high frequency eop parameters.

file_name - determines which components are estimated.

2.16 FLAGS.RELATIVITY

RELATIVITY [NO or YES]

This keyword estimates the gamma of PPN (generalized formalism of Post-Newtonian theory of gravitation).

NO - does not estimate the gamma.

YES - estimate the gamma parameter

2.17 FLAGS.AXIS

{AXIS [NO or YES] {EXCEPT (station ...\)}}

The AXIS keyword determines which stations' antenna axis offsets BATCH

estimates.

Field 1 -

NO - does not estimate any offsets.

YES - estimates every station's offset once for the entire solution.

Field 2 -

The EXCEPT clause lists stations whose offsets should be estimated (when used with the NO option) or excluded from estimation (when used with the YES option).

2.18 FLAGS.BASELINE_CLOCKS

BASELINE_CLOCKS [NO or YES or IN]

the keyword BASELINE_CLOCKS determines whether to estimate baseline dependent clocks.

NO - not to estimate

YES - estimate. The list of baseline-dependent clock is built by such a manner in order to estimate the maximal number of parameters which still guarantee the lack of singularity of the normal matrix.

IN - estimate baselines dependent-clocks for those baselines which were selected in superfile. Exceptions: a) if at least one baseline was deselected on the fly and the number of used baseline in the solution will be less than the number of baselines saved in the superfile; b) if the number of baselines were changed as a result of reparameterization when the session failed singularity test. In these cases the list of baseline-dependent clock parameters is computed anew in order to estimate the maximal number of parameters which still guarantees the lack of singularity of the normal matrix.

2.19 FLAGS.IONOSPHERE_SCALE

IONOSPHERE_SCALE [NO or SES or STA or BAS]

the keyword IONOSPHERE_SCALE determines whether to estimate ionosphere path delay scale adjustment. Ionosphere scale is a factor of the difference between of group delays at upper and lower bands for dual-band observations.

IONOSPHERE_SCALE is always local parameter. It is ignored for single-band data types.

NO - not to estimate

SES - estimate for each session.

STA - estimate for each session and each station.

BAS - estimate for each session and each baseline

2.20 FLAGS.STRUCTURE_ADMITTANCE

```
STRUCTURE_ADMITTANCE [NO or
                          ([GLOBL or LOCAL]
                           [YES or ALL or NO]
                           {EXCEPT source1 source2 ...})
                     ]
```

the keyword STRUCTURE_ADMITTANCE determines whether to estimate admittance of source structure to group delay.

NO - not to estimate

GLOBL - to estimate the admittance as global parameter.

LOCAL - to estimate the admittance as local parameter.

YES - to estimate admittance for each selected source separately

ALL - to estimate admittance for all sources combined

EXCEPT - exception list.
Construction "NO EXCEPT list" means that the source structure admittance should be estimated for each selected source from this list separately.
Construction "YES EXCEPT list" means that the source structure admittance should be estimated for each selected source, which does not belong to this list, separately.

3 $OUTPUT

This section determines what output BATCH produces.

3.1 OUTPUT.RESET

RESET **[YES or NO]**

This keyword determines whether the new output should be appended to the old spool file or the spool file would be overwritten.

YES - overwrites the spool file.

NO - appends the new output to the spool file.

3.2 OUTPUT.FORWARD

FORWARD **[YES or NO or LAST or number_of_sessions]**

This keyword determines the points in a forward step of global solution at which BATCH makes estimates of global and local parameters, based on the sessions processed so far. This option is designated for the special purposes and it not recommended for usual runs.

NO - no estimation. (recommended)

YES - does the estimation after every session. This is not recommended, because it will take a LONG time.

number_of_sessions - does the estimation whenever BATCH has finished the number of sessions specified. (For example, FORWARD 5 does the estimation every fifth session.)

LAST - does the estimation after the last session. This option is useful in a forward solution, but pointless in a complete solution, since the solution's back step does the estimation itself.

3.3 OUTPUT.BASELINES

BASELINES **[YES or NO]**

YES - adds up to three types of output to the run's spool file, as described below, depending on how the station positions and velocities are estimated.

NO - suppresses all three types of output described below.

For a given session, BATCH produces baseline components for any baselines with a station whose position components are session parameters. Specifically, BATCH produces the baseline's length, transverse and vertical components, the magnitude of the baseline vector, and these values' sigmas. BATCH produces this output as part of the session's session parameter output.

Assuming BATCH estimates at least one station's position components as global parameters, BATCH produces the above information for every pair of stations in the solution, even if some of the resulting baselines have no observations. BATCH produces this output as part of the global parameter output.

Assuming BATCH estimates velocities in addition to global position components at one or more stations, BATCH also produces rate of change information for every pair of stations in the solution. Specifically BATCH produces the rate of change of each baseline's length, transverse and vertical components, the rate of change of each vector's magnitude, and these values' sigmas. BATCH produces this output as part of the global parameter output.

3.4 OUTPUT.MINIMUM

MINIMUM [YES or NO]

The MINIMUM keyword suppresses part of the spool file output, to save space.

YES - suppresses the following output.

NO - produces the following output.

- the correlations that BATCH produces between a station's X, Y and Z position and velocity components, when the position components are global parameters. The correlations are part of the global output.
- part of the station table output that BATCH produces as part of the spool file's global output, if the user has set the STATION_TABLE keyword. The discussion for this keyword describes this output in more detail.
- the following parts of BATCH's session parameter output:
  - the list of the calibrations added to an session's theoreticals.
  - the baseline and source statistics from an session's solution.
  - the correlations between an session's UT1/PM and nutation parameters that BATCH produces for certain UT1/PM parameterization styles.

3.5 OUTPUT.SCREEN

***SCREEN [YES or NO]**

The SCREEN keyword determines whether the information sent to this run's spool file is also sent to the run's terminal (screen). Since the size of spool file may be as large as one million lines it is not recommended to use this option.

YES - to send this information

NO - not to send this information (recommended).

3.6 OUTPUT.COVARIANCES

***COVARIANCES [NO or**
(YES [ALL or BY_SESSION or CGM or (dbname ver)]
[STA or NUT or EOP or ALL or SOU])]

The COVARIANCES keyword determines what covariance output BATCH produces. This option is obsolete and provided only for backward compatibility. There is a restriction on the number of sessions and number of parameters which can be supported by this option. These restrictions are installation specific. It is recommended to use a keyword CORRELATIONS instead of.

NO - no covariance output.

YES - produces output as follows:

Field 1 - determines the extent to which BATCH produces the type of covariance selected in field 2. For example, if field 2 selects an session parameter, field 1 determines whether BATCH produces the parameter's covariances for a single session or for every session in the solution. Fields 1 and 2 must make sense when combined. For example, if the user chooses CGM for field 1, to produce global covariances, then he/she must choose global parameters in field 2. The $CARRY section identifies session and global parameters.

ALL - produces the covariance matrix for the entire solution. Depending on field 2, this potentially includes covariances between global parameters, covariances between session parameters in a given session, and covariances between pairs of session and global parameters. ALL potentially generates a large amount of output, so users should select it carefully.

CGM - produces a matrix for the covariances between the global parameters.

BY_SESSION - produces the covariances between the session parameters in a given session for every session in the solution. Produces each session's covariances in a separate matrix.

dbname ver - produces a matrix for the covariances between the session parameters in the given session.

Field 2 - the type(s) of covariances BATCH produces.

STA - produces station position covariances.

SOU - produces source coordinate covariances.

EOP - produces covariances for the earth orientation parameters selected in the $FLAGS section's UT1/PM keyword.

NUT - produces covariances for the nutation parameters selected in the $FLAGS NUTATION keyword.

ALL - produces all of the above types.

If the user selects ALL ALL, which generates covariances between different sessions' parameters, he/she must make sure that the solution has an session file for every session.

BATCH writes the covariance output to the covariance file, $WORK_DIR/CVRFxx file where xx are the solve user initials.

3.7 OUTPUT.CORRELATIONS

```
{CORRELATIONS [NO or YES FORMAT [ASCII or BINARI]
                [{ GLO_GLO   PARAM_INCLUDE <par_filename>
                            {PARAM_EXCLUDE <par_filename>} }
                 { GLO_LOC   PARAM_INCLUDE <par_filename>
                            {PARAM_EXCLUDE <par_filename>}}
                 { LOC_LOC   PARAM_INCLUDE <par_filename>
                            {PARAM_EXCLUDE <par_filename>}}
                 { CROSS_LOC PARAM_INCLUDE <par_filename>
                            {PARAM_EXCLUDE <par_filename>}}
                             SES_INCLUDE   <ses_filename>
                            {SES_EXCLUDE   <ses_filename>}}
                ]
              ]
```

The CORRELATIONS keyword determines what correlations output BATCH produces.

NO - no correlation output will be produced.

YES - correlation output will be produced and written in the file $WORK_DIR/CORLxx where xx are solve users initials.

FORMAT - determines the output format. See documentation about correlations for specifications of the output format.

ASCII

BINARY - (not implemented on 05-MAY-2000)

The next fields determines what kind of correlations are to be computed.

GLO_GLO - correlations between global parameters should be computed.

PARAM_INCLUDE - specifies the file name of the correlations definition file. Correlations between the parameters listed in PARAM_INCLUDE definition files are computed except the parameters listed in PARAM_EXCLUDE files. See documentation about correlations for specifications of the format of this file.

<par_filename> - file name of the correlations definition file. If the path is omitted then this file is sought in $SAVE_DIR .

PARAM_EXCLUDE - specifies the file name of the correlations definition file. Correlations between any parameter and the parameters listed in the PARAM_EXCLUDE are not computed.

<par_filename> - see above

GLO_LOC - correlations between global and local parameters should be computed. Local parameters are parameters which are estimated for each session independently and which are not segmented parameters. Example: nutation angle Delta Psi.

The meaning of PARAM_INCLUDE, PARAM_EXCLUDE, <par_filename> is the same as for GLO_GLO qualifier.

LOC_LOC - correlations between local parameters within the same session are to be computed.

The meaning of PARAM_INCLUDE, PARAM_EXCLUDE, <par_filename> is the same as for GLO_GLO qualifier.

CROSS_LOC - correlations between local parameters of different sessions are to be computed.

The meaning of PARAM_INCLUDE, PARAM_EXCLUDE, <par_filename> is the same as for GLO_GLO qualifier.

SES_INCLUDE - specifies the filename with the list of the sessions. Correlations between local parameters between these sessions are computed except the sessions in the SES_EXCLUDE list.

<ses_filename> - File name with the session list. If the path is omitted the file is sought in $SAVE_DIR/

SES_EXCLUDE - specifies the filename with the list of the sessions. Correlations between local parameters for the sessions from this list will not be computed.

NB: CROSS_LOC option is not implemented by 05-MAY-2000

3.8 OUTPUT.STATION_TABLE

{STATION_TABLE [NO or YES]}

The STATION_TABLE keyword produces a table of projected X, Y and Z position components, at noon on January 1, for 1979 through 1992, for each globally estimated station.

NO - not to produce the station table output (recommended).

YES - produce the station table output. The form of the tables depends on the MINIMUM keyword:

If MINIMUM = YES - each station's table has one line per year containing the projected X, Y and Z position totals and unscaled sigmas.

If MINIMUM = NO - each station's table has four lines per year. Line 1 contains the projected correlations between the station's position components and between each component's position and velocity. Lines 2-4 contain the components' projected position totals, estimates and unscaled and scaled sigmas.

BATCH uses velocities and a reference date to project the positions. BATCH projects positions for 1979 through 1992, regardless of the solution's data span.

BATCH only produces tables for the XYZ coordinate system.

3.9 OUTPUT.POS_ELLIPSES

{POS_ELLIPSES [NO or YES]}

This keyword specifies whether or not to compute error ellipses of horizontal components of station positions.

NO - used to disable writing error ellipses of station position adjustments.

YES - used to enable writing error ellipses of station position adjustments.

3.10 OUTPUT.MOD_FLAGS

{MOD_FILES [YES or NO]}

This keywords specifies whether or not to attach MOD_FILES to the end of spool files.

YES -- to attach copies all a priori mod files to the end of spool file.

NO - not to attach these copies.

3.11 OUTPUT.RESIDUALS

{RESIDUALS [NONE or file_name]}

This keyword specifies whether to write residuals.

NONE -- not to write residuals (recommended).

SPOOL -- to write residuals in ascii format into the spool file.

FULL -- the same as SPOOL: to write residuals in ascii format into the spool file.

file_name -- the name of the output residual file ina a binary format. The file will be put in the directory where BATCH started, unless the full path name has been specified.

3.12 OUTPUT.MINIMIZE_SIGMAS

{MINIMIZE_SIGMAS [YES or NO]}

When station positions and velocities are estimated then adjustments of positions and the estimates of their uncertainties are referred to the specified epoch. However, some stations participated only in a subset of sessions. If the mean weighted epoch of the station observations substantially differs from the reference epoch then the uncertainties of the station positions increases. There exists an epoch such as the formal uncertainty of the station position referred to that epoch is minimal. BATCH is able to compute such an epoch for each station and compute the formal uncertainty for the station positions referred to this epoch called "minimal sigmas".

NO - not to compute minimal sigmas.

YES - compute minimal sigmas for each station whose positions and velocity are estimated as global parameters.

3.13 OUTPUT.SINEX

```
{SINEX                [ NO or
                        [ YES
                          FORMAT_VERSION                value
                          ALLOW_OVERWRITE               [YES or NO]
                          GLOBAL                        [YES or NO]
                    LOCAL                         [YES or NO]
                          SEGMENTED                     [YES or NO]
                          ESTIMATES                     [YES or NO]
                          COVARIANCES                   [YES or NO]
                          CONSTRAINTS                   [YES or NO]
                          DECOMPOSED_NORMAL_EQUATIONS   [YES or NO]
                          ACKNOWLEDGMENTS_FILE          <input_file_name>
                          COMMENTS_FILE                 <input_file_name>
                          INCLUDE_PARAM                 <input_file_name>
                          EXCLUDE_PARAM                 <input_file_name>
                          OUTPUT_FILE                   value
                         ]
                       ]
```

Determines to generate a listing in SINEX format with results of the parameters estimation related to the session. Currently, (2002.05.23) this keyword is supported only for INDEPENDENT solution types and will be ignored in global modes.

NO -- no output file of results in SINEX format is produced.

```
YES    -- the output listing in SINEX format will be generated.

FORMAT_VERSION  -- the string with format identification. Currenly,
                   only the format 2.10 and 2.20 are supported.
                   The format 2.10 is an extension of the format 2.00
                   The format 2.20 differs from format 2.10 that it uses
                   alternative parameter names suggested by Markus
                   Rotather in 2008. As of July 2008, no exsiting Sinex
                   parser will accept Sinex files in 2.20 format.


ALLOW_OVERWRITE -- the flag which indicates an action in the sitation
                   if the output file with the listing already exists.
                   If ALLOW_OVERWRITE YES, then Solve proceeds.
                   If ALLOW_OVERWRITE NO,  then Solve issues an error
                   message and stops.

GLOBAL -- whether global parameters should be put in the listing
          (not supported yet).

LOCAL  -- whether the local, session dependent, parameters should be put
          in the listing.

SEGMENTED -- whether segmented parameters should be put in the listing
             (not supported yet).


ESTIMATES -- whether the block of the estimates and their standard
             deviations is to be out in the listing.

COVARIANCES -- whether covariance matrix of the parameter estimates
               is to be put in the listing.

CONSTRAINTS -- whether the blocks with constraints info, matrix of
               constraints, right hand side of constraint equations,
               weight matrix of constraints are to be put in the listing

DECOMPOSED_NORMAL_EQUATIONS -- whether the block with decomposed normal
                               matrix and normal vector is to be put in
                               the listing.

ACKNOWLEDGMENTS_FILE -- name of the file which contains contents of the
                        "acknowledgments" section of the listing file.


COMMENTS_FILE        -- name of the file which contains contents of the
                        "comments" section of the listing file.

INCLUDE_PARAM -- specifies the file name of the parameters definition file.
                 Parameters listed in the INCLUDE_PARAM are included in
                 the listing, except the parameters defined in the
                 EXCLUDE_PARAM list. See document "sinex_implementation"
                 http://gemini.gsfc.nasa.gov/solve_root/help/sinex.html
```

```
                  for specifications of the format of this file.

 EXCLUDE_PARAM -- specifies the file name of the parameters definition file.
                  Parameters listed in the EXCLUDE_PARAM are not included in
                  the listing. See document "sinex_implementation"
                  http://gemini.gsfc.nasa.gov/solve_root/help/sinex.html
                  for specifications of the format of this file.

 OUTPUT_FILE   -- output filename. If the directory name is omitted, output
                  file(s) will be put in the current directory, from which
                  Solve started. The value of this keyword can have one
                  or more meta-definitions which will be expanded. The
                  following meta-definitions are supported:
               <YY> -- year of the session in YY-format
               <YYYY> -- year of the session in YYYY-format
               <DATABASE>  -- database name in format YYMMMDDCC
                              (if the category CC has only one character
                               then the trailing character "_" will be
                               added)
               <VERS>      -- database version in xxx format. Leading zeroes
                              are added if the version number is less than
                              100
               <SESSION>   -- session name in characters of lower register
               <ID>        -- The first word of solution ID defined in batch
                              control file.
               <WORK_DIR>  -- Name of the solve working directory where
                              user scratch files are located. NB: system
                              wide default may be overrode by the
                              environment variable.
               <SAVE_DIR>  -- Solve save directory. NB: system-wide default
                              may be overrode by the environment variable.
               <SPOOL_DIR> -- Solve spool directory. NB: system-wide default
                              may be overrode by the environment variable.
               <MK5_ROOT>  -- Root directory of Mark-5 VLBI analysis
                              software system. NB: environment variable
                              MK5_ROOT overrides system-wide default.

Example:
  Let's database name is $02MAY23XE.
  Then
    /tmp/<SESSION>.snx               is expanded in  /tmp/r4021.snx

    <SPOOL_DIR><DATABASE>_<VERS>.snx  is expanded in
               /box1/solve/spool_files/02MAY23XE_004.snx

    /data10/sessions/<YYYY>/<SESSION>/<SESSION>.snx is expanded in
                /data10/sessions/2002/r4021/r4021.snx
```

3.14 OUTPUT.NORMAL_MATRIX

***{NORMAL_MATRIX [NO or YES or ZERO]}**

Meaning is unclear. NO is recommended.

NO -- no special manipulation with normal matrix.

YES -- meaning is unclear.

ZERO -- besides covariances of both parameters and their constraints
(they are mixed together), writes the covariance of constraints
by zeroing the elements in normal matrix.

3.15 OUTPUT.SEG_OUTPUT

{SEG_OUTPUT [YES or NO]}

Determines whether the adjustments and the estimates of formal uncertainties of all segmented parameters (coefficients of linear spline) are to be included in the spool file. Solve considered coefficients of linear spline of clock function, atmosphere and earth orientation parameters as segmented parameters.

NO - estimates of segmented parameters are not to be put in the spool file.

YES - estimates of segmented parameters and their formal uncertainties
are to be put in the spool file.

3.16 OUTPUT.MAPPED_EOP_OUTPUT

***{MAPPED_EOP_OUTPUT [YES <time_epoch> or NO]}**

This keywords specifies whether to compute the estimates of EOP and their formal uncertainties at additional time epoch.

NO - not to compute EOP at the specific time epoch.

YES - compute EOP at the specific time epoch for three dates:
1) a day before nominal start of the session;
2) a day when the session started;
3) a day after the nominal start of the session.

<time_epoch> - time epoch in TDB to which additional EOP output will be
referred. Two formats area allowed:
a) hh_mm_ss.ssss -- hours, minutes, seconds
b) hh.hhhhh -- hours and its pats.

For example,

1) MAPPED_EOP_OUTPUT YES 18_30_00.0

2) MAPPED_EOP_OUTPUT YES 18.5

3) MAPPED_EOP_OUTPUT NO

3.17 OUTPUT.APRIORI_ZENDEL

***{APRIORI_ZENDEL [NO or YES]}**

This keywords allows to print in the spool file a priori atmosphere zenith path delay for each epoch of linear spline. This kind of the output is used for the specific purposes and is not recommended for usual runs.

NO - not to add a priori zenith path delay in spool file (recommended).

YES - to print in the spool file a priori zenith path delay for each epoch of linear spline. If SEG_OUTPUT is YES then a priori zenith path is printed just before each line with adjustments of segmented parameters.

3.18 OUTPUT.CRES_EMULATION

{CRES_EMULATION [199804 or 200308 or NO]}

The format of listing was slightly changed in April 1998 and in August 2003. Keyword CRES_EMULATION allows us to get the listing in the old format. You should understand that using option makes your lising incompatible with software developed or modified after April 1998. For example, program getpar will not be able to parse such a listing.

Field 1 -

```
        NO   - the current format of the listing will be generated
               (recommended)
    199804 - old pre-APR98 format of the listing will be generated
               (NOT recommended)
    200308 - old pre-AUG03 format of the listing will be generated
               (NOT recommended)
```

3.19 OUTPUT.LISTING_OPTIONS

```
{LISTING_OPTIONS
     SRC_STAT  [PRE2004 or SHORT or LONG or POST2021]
     SEG_STYLE [PRE2005 or POST2005 ]
}
```

This keywords controls the format of listing statistics section.

SRC_STAT -- controls the format of source statistics for each experiment

```
            PRE2004  -- old, pre 2004 format for source statistics
            SHORT    -- concise format;
            LONG     -- verbose format: source name, number of used,
                        recoverable and total observations, delay postfit
                        residuals, experiment name, nominal session start
                        time.
            POST2021 -- verbose format: source B-name, source J-name,
                        number of used and recoverable observations, delay
                        postfit residuals, experiment name, nominal session
                        start time.
```

If ommited, PRE2004 format will be used.

SEG_STYLE -- controls the format of date tag in spool-file for the atmospheric zenith path delay, atmospheric gradients and clocks.

```
            PRE2005  -- old, pre 2004 format for time tag.
            POST2005 -- modern format. Time tag in in ISO-compatible format
                        with truncation at 1 millisecond level.
```

If ommited, PRE2005 format will be used.

3.20 OUTPUT.IONOSPHERIC_MODEL

```
{OUTPUT.IONOSPHERIC_MODEL [NO or ]
                    COLLECT          [YES or NO]
                    BIAS_COMPUTE     [YES or NO]
                    REGR_COMPUTE     [YES or NO]
                    DB_UPDATE        [YES or NO]
                    IONO_INFO_DIR    <ionosphere_info_dir_name>
                    IONO_DTEC_DIR    <dtec_dir_name>
                    IONO_ADDW_DIR    <aditive_weight_dir_name>
                    IONO_DEL_DIR     <delay_dir_name>
                    IONO_NOI_DIR     <noise_dir_name>
                    BCL_FIL          <baseline_depenedent_clock_file>
```

```
 BRK_FIL         <clock_break_file>
 GIM_MODE        <value>
 GIM_DEG         <value>
 GIM_TIM_STEP    <value>
 GIM_SCALE       <value>
 GIM_SEED        <value>
 GIM_VERB        <value>
}
```

This keyword puts pSolve in a special mode for computation of the parameters of the ionospheric model used for processing single band observations. No least square solution is made. This computation is done in three steps: 1) extract information about VLBI ionospheric path delay and GNSS TEC model; 2) adjust dTEC bias (for dual-band observations only); and 3) compute uncertainty of the ionospheric path delay from the GNSS TEC maps using a regression model.

```
COLLECT      YES  -- extract VLBI ionospheric path delay, path
                    delay from GNSS TEC model, suppression flags
                    and write down collected information into
                    an ascii file in directory IONO_INFO_DIR.

BIAS_COMPUTE YES  -- adjust delta TEC bias for each station in
                    a form of an expansion into B-spline basis for
                    a dual-band experiment. This function cannot
                    run for single-band experiments.

REGR_COMPUTE YES  -- compute uncertainty of the ionospheric path
                    delay from the GNSS TEC maps using
                    a regression model.

DB_UPDATE    YES  -- writes down dTEC and its adjustment into the
                    database.

IONO_INFO_DIR     -- directory where files with information about
                    ionospheric path delay from both VLBI and GNSS
                    TEC maps, as well as station names, source
                    name, effective ionospheric frequencies,
                    suppression status, elevations, azimuths, and
                    used ionospheric mapping functions are written.

IONO_DTEC_DIR     -- directory where files with information of
                    results of dTEC bias adjustments is written.
                    It includes dTEC from GNSS maps, dTEC bias
                    adjustment, error of the dTEC bias adjustment,
                    delay bias adjustment, a priori and a posteriori
                    difference in dTEC from VLBI and GNSS TEC maps,
                    and the errors of the ionospheric path delay
                    from GNSS TEC maps with dTEC bias adjusted in
                    TECU units.

IONO_ADDW_DIR     -- directory where output files with additive
```

weights that account for error in GNSS TEC maps without dTEC bias adjustments are written.

IONO_DEL_DIR -- directory where output files with ionospheric path delay from GNSS TEC maps are written.

IONO_NOI_DIR -- directory where output files with additive weights that account for error in GNSS TEC maps without dTEC bias adjustments are written.

BCL_FIL -- input file with information about statistically significant baseline dependent clocks.

BRK_FIL -- input file with information about experiments with clock breaks.

GIM_MODE -- Mode for computation of the ionospheric bias adjustment. Supported modes:

1 -- dTEC bias adjustment computed for every station is considered not changing with time within an experiment.

2 -- time dependence of dTEC bias adjustment computed for every station is modeled with B-spline (Recommended mode).

3 -- time dependence of dTEC bias adjustment computed for every station is modeled with B-spline. The bias adjustment accounts for spacial variability: the bias adjustments are computed for five areas: an inner circle for observations with elevations above 27deg, and four sectors for observations below 27 deg: north-east, south-est, south-west, and north-west.

GIM_DEG -- Degree of the B-spline that accounts for time variability of the ionospheric bias adjustment.

GIM_TIM_STEP -- Time step of the B-spline that accounts for time variability of the ionospheric bias adjustment. Unit: seconds

GIM_SCALE -- Scaling factor of a priori GNSS TEC maps used for computation of the ionospheric bias adjustment. Range: [0.001, 2.000]. (Recommended scale: 1.0)

GIM_SEED -- Seed of the random number generator used for computation of the uncertainty in the ionospheric path delay for a case when no ionospheric bias adjustment can be computed, for instance, for single-band observations. An integer number is

accepted. If GIM_SEED is zero or below zero, then
the seed is computed from time of the run.

GIM_VERB -- Verbosity level.

0 -- no information messages are printed.

1 -- Summary of statistics of the ionospheric
bias adjustment is printed in stdout.

>1 -- debugging information is printed.

3.21 OUTPUT.NRD_TABLE

{NRD_TABLE [YES or NO]}

Not support yet.

3.22 OUTPUT.CHI_SQUARE_TABLE

{CHI_SQUARE_TABLE [YES or NO]}

Not support yet.

4 $CARRY

Some parameters can be treated either as global or as session parameters. This section tells to BATCH how to treat these parameters. The user must specify a choice for these parameters. The $CARRY section must be preceded by the $FLAGS section.

The following table lists the current parameters and how BATCH treats them:

Type	Parameters
global or local	station positions, source coordinates
always local	atmospheres, clocks, UT1/PM, parameters, nutation offset
always global	station velocities, source proper motions, precession

and relativity parameters, antenna axis offsets.

* Although the AXIS keywords appear to let the user make the axis offset session parameters, this keywords was created for a different purpose.

4.1 CARRY.STATIONS

STATIONS [YES or NO] {sta_comp} {EXCEPT (station ...\)}

The STATIONS keyword in the CARRY section determines how BATCH treats the station positions selected in the $FLAGS section.

Fields 1 and 3 - used together to make a basic choice. Field 2 can then be used, as described below, to partially override this choice.

Field 1 -

YES - treats every station position as a global parameter.

NO - treats every station position as a local parameter.

Field 3 (the EXCEPT phrase) - treats the listed stations' positions as local parameters, if field 1 is YES, and as global parameters, if field 1 is NO.

Field 2 (sta_comp) -

sta_comp omitted - BATCH treats the station positions as described above.

sta_comp - partially overrides the basic choices made in fields 1 and 3. sta_comp must be XYZ or UEN, with '-'s (dashes) indicating components to be treated as session parameters at every station, including stations listed in the EXCEPT clause. BATCH ignores components not replaced by dashes, except to make sure that they match the coordinate system specified in the STATIONS keyword in the $FLAGS section. So components not replaced by dashes will be treated as specified in fields 1 and 3.

Examples:

1) STATIONS YES EXCEPT PT_REYES

BATCH treats PT REYES' station position components as local parameters and all other station positions as global parameters.

2) STATIONS NO EXCEPT PT_REYES

BATCH treats PT REYES' station position components as global parameters

and all other station positions as session parameters.

3) STATIONS YES X-Z EXCEPT PT_REYES

BATCH treats the station position components as follows:

Stations other than PT REYES		PT REYES
X components	Global	Local
Y components	Local	Local
Z components	Global	Local

4) STATIONS NO -EN EXCEPT PT_REYES

BATCH treats the station position components as follows:

	Stations other than PT REYES	PT REYES
U components	Local	Local
E components	Local	Global
N components	Local	Global

4.2 CARRY.SOURCES

SOURCES [YES or NO] {EXCEPT (source ...\)}

The SOURCES keyword determines how BATCH treats the source coordinates selected in the $FLAGS section.

Field 1 -

YES - treats every coordinate as a global parameter.

NO - treats every coordinate as an session parameter.

Field 2 -

If field 1 is YES/NO, BATCH treats the listed sources' coordinates as session/global parameters. The sources must be upper case.

4.3 CARRY.AXIS

{AXIS [YES or NO]}

The AXIS keyword determines how BATCH treats the axis offset parameter selected in the $FLAGS section.

YES - treats axis offsets for the stations specified in the $FLAGS AXIS section as global parameters. NB: even if position of a station are modeled by a linear spline or had a break caused by episodic motion, only one antenna axis offset for that station will be estimated.

NO - treats axis offsets for every station specified in the $FLAGS AXIS section as session parameters.

If the keyword is omitted, Solve assumes YES, i.e. treats axis offsets for the stations specified in the $FLAGS AXIS section as global parameters. NB: it is a good practice to specify all keywords and do not rely on defaults.

5 $DATA

This section determines which data is included in the solution. To be included, an observation must pass all of the criteria in this section.

5.1 DATA.SOURCES

SOURCES [YES or NO] {EXCEPT (source ...\)}

This keyword specifies which sources may be included in the solution, however, actually it is used for excluding some sources from appearance in the solution. NB: these criteria are applied to all sessions.

YES - includes all sources except any listed in the EXCEPT clause.

NO - excludes all sources except any listed in the EXCEPT clause.

5.2 DATA.STATIONS

STATIONS [YES or NO] {EXCEPT (station ...\)}

This keyword specifies which stations may be included in the solution, however, actually it is used for deselecting some stations in the solution. NB: these criteria are applied to all sessions. If you need to exclude some stations in the specific session refer to ARCS.ARCFILE .

YES - includes all stations except any listed in the EXCEPT clause.

NO - excludes all stations except any listed in the EXCEPT clause.

Stations to be excluded take precedence over stations to be included, if both types occur in an observation.

5.3 DATA.BASELINES

***{BASELINES [YES or NO] {EXCEPT (<station-station> ... \)}}**

Uses to exclude or to include just only one or a set of baselines in this solution.

YES EXCEPT or EXCEPT - does not include baselines preceded by keyword EXCEPT in solution.

NO EXCEPT - just only include baselines preceded by keyword EXCEPT in solution.

NO - (without any other qualifiers) means to take all baselines

YES - (without any other qualifiers) means to take all baselines

NB: if you need to exclude some baselines in the specific experiment see syntax of ARCS.ARCFILE

5.4 DATA.TYPE

TYPE [GROUP_DELAYS_AND_RATES or GROUP_DELAYS_ONLY or PHASE_DELAYS_AND_RATES or PHASE_DELAYS_ONLY or GRPRAT or PHSRAT or SNBRAT or GRPONL or PHSONL or SNBONL or RATONL or G_GXS or PX_GXS or PS_GXS or PX_GX or PX_GS or PS_GX or PS_GS or P_PXS or GX or GS or PX or PS]

The TYPE keyword determines which type of data will be used. Solve supports 19 data types. The following values are the same and provided for compatibility:

GROUP_DELAYS_AND_RATES	and	GRPRAT,
GROUP_DELAYS_ONLY	and	GRPONL,
PHASE_DELAYS_AND_RATES	and	PHSRAT,
PHASE_DELAYS_ONLY	and	PHSONL

Data type is applied to all sessions, but arc-list may override data type for the specific session(s) for arc-list.

5.5 DATA.ELEVATION

{ELEVATION cutoff {EXCEPT cutoff (station ...\) {cutoff (station...\) ...}}}

The ELEVATION keyword excludes observations in which one or both stations observed the source at a lower elevation than is acceptable at the station.

Field 1 (cutoff) -

Uses this cutoff at every station not listed in the EXCEPT clause.

Field 2 (EXCEPT clause) -

The EXCEPT clause lists alternate cutoffs for specific stations.

The cutoffs must contain decimal points (e.g., 5.0) and be specified in degrees.

Example

1) ELEVATION 8.0 EXCEPT 9.0 WESTFORD HATCREEK 0.0 KAUAI___ 7.5 PRESIDIO

BATCH uses the following elevation cutoffs:

KAUAI	None
PRESIDIO	7.5 degrees
WESTFORD, HATCREEK	9 degrees
Other stations	8 degrees

2) ELEVATION 0.0

BATCH uses all observations.

5.6 DATA.WVR_MASK

{WVR_MASK [NO or mask {EXCEPT mask (station ...\) {mask (station...\) ...}}]}

This keyword was created for special applications. Most users will want to use WVR_MASK NO .

DBCAL, the program which adds weather data to an session, tries to add WVR corrections to each observation in the session. However, the corrections may have been obtained by methods of varying quality. For example, one observation's corrections may have been actually taken during the observation,

while another observation's corrections may have been interpolated from surrounding observations. The WVR_MASK keyword rejects observations in which one or both stations' corrections were obtained by specified methods.

If the qualifier mask is omitted - BATCH does not reject any observation based on its WVR corrections.

If the qualifier mask is included - BATCH uses one or more bit masks to determine which methods to reject at which stations. Without an EXCEPT phrase, the same mask is used for every station. Station(s) in the EXCEPT phrase use the mask preceding them.

Bit WVR masks of zero - BATCH does not reject any observation based on the existence or quality of its WVR corrections.

Non-zero WVR bit masks - each method is assigned a bit position within all the masks. Within a specific station mask, the user sets the bit to zero to reject or to one to accept observations corrected by that method. The following table tells which bit controls which method. In addition, all non-zero masks reject observations without WVR corrections. The bit masks must be specified as octal numbers.

Bit number	Method
1	The WVR correction was measured during the observation within 2 degrees of the source.
2	The correction was mapped from zenith measurements made during the observation.
3	The correction was measured during the observation, but more than 2 degrees from the source.
4	The correction was interpolated from the two closest available observations. These observations are within 30 minutes of the desired observation's mid-epoch.
5	Same as bit 4, except that the observations used for interpolation are more than 30 minutes from the desired observation's mid-epoch.
6	The correction was extrapolated from other WVR data. The correction could not be interpolated because WVR data only existed on one side of the desired observation.
7	The method cannot be determined.

Example

```
WVR_MASK 0 EXCEPT 32 WESTFORD 45 KAUAI___ MOJAVE12
                              177 GILCREEK
```

An octal 32 has bits 2, 4 and 5 set to one, so BATCH only accepts observations at WESTFORD if their WVR corrections were mapped from zenith measurements made during the observation, or interpolated. (The data used for the interpolation can be less than or greater than 30 minutes from each observation's mid-epoch). An octal 45 has bits 1, 3 and 6 set to one, so BATCH only accepts observations at KAUAI and MOJAVE12 if their WVR corrections were measured during the observation (either greater than or less than 2 degrees from the source), or extrapolated from other observations. BATCH throws out observations at all three stations if they have no WVR correction for the station. Bits 1 through 7 are all set to one in 177, so observations at GILCREEK are acceptable, as long as they have some WVR correction at GILCREEK. No criteria are applied for any other station.

5.7 DATA.EVERY

***{EVERY [NO or (<N> START <M>)]}**

This keyword allows to reduce a data set by applying decimation: rejection some portion of observations.

NO -- means not to apply decimation

Integer value - means that you wish to include only every Nth data point in the solution, starting with the M-th point (where M <= N) For example, EVERY 3 START 2 causes only data points 2, 5, 8, 3Xi-1, ... are taken into account in solution.

5.8 DATA.NORATE_FLAG

NORATE_FLAG [NO or YES]

Solve may compute statistics for delay rate even if delay rate observables were not used in the solution. Computation of delay rate statistics takes additional time. If we don't need this kind of statistics we can bypass this step.

YES - Solve will not compute delay rate statistics.

NO - Solve will compute delay rate statistics.

NB: 1) NORATE_FLAG YES is not compatible with data types which require delay rate: GRPRAT or PHSRAT or SNBRAT or RATONL
2) NORATE_FLAG YES cannot be used when a correction to weights is computed by using MYWAY algorithm.

6 $CALIBRATIONS

This section specifies which station-dependent calibrations (e.g., cable, Chao) and zenith path delay calibrations (e.g. NMFDRFLY, CFAKBDRY) BATCH applies. It also determines whether BATCH applies the ionosphere calibration and rejects observations with bad or missing S-band ionospheric values. The main purpose of CALIBRATIONS keyword is to set uniform calibration setup for all sessions. Each superfile keeps its own calibration setup, but it may not be consistent with calibration setup of other superfiles. Keywords of the section $CALIBRATIONS may force to set the same setup for all or some calibrations.

$CALIBRATIONS supports two syntax formats: the old (pre-MAY2000) and the modern syntax (post-MAY2000). It is not recommended to use the old syntax.

6.1 CALIBRATIONS.ION

{ION [ON or OFF or IN]}

Determines the sessions to which BATCH applies the ionosphere calibration. This phrase also determines the sessions for which BATCH rejects observations with bad or missing S-band ionospheric values, subject to restrictions stated below. The keyword ION is ignored when the data type is an ionosphere free linear combination of several observables.

ON - applies the calibration to every session. Rejects every observation with bad or missing S-band values, except those flagged in the session's superfile as manually reweighted. (This flag indicates that the analyst who made the superfile solution wanted the observation included despite its bad values, for other reasons.) Users are strongly advised to select this option unless you are analyzing very short baselines (say, shorter than 5 km) when we can totally neglect ionosphere contribution. The other options create the risk of letting observations with bad residuals into the solution.

OFF - does not apply the calibration to any session. Accepts every observation with bad or missing S-band values, except those that have bad quality codes or were manually rejected in the superfile solution for other reasons.

IN - consults each session's superfile to decide whether to apply the calibration and reject or accept observations with bad values.

6.2 CALIBRATIONS.RESET

```
*(
   RESET [NO or YES]
*)
```

   This keyword determines whether station and zenith calibration should reset. Resetting calibrations changes the meaning the following keywords: KEEP, ENABLE, DISABLE. If the calibrations were not reset then KEEP, ENABLE and DISABLE modifies calibration setup which was saved in the superfile. However, if calibrations were reset then status of all calibrations is set to "not available", "not applied" and the keywords KEEP, ENABLE, DISABLE change the status of calibrations with respect "not available, not applied" status.

   NO - not to reset calibrations

   YES - reset calibrations: to set status for all calibrations "not available", "not applied"

6.3 CALIBRATIONS.KEEP

(KEEP   [NO or <calibration_name>]) ...

   Keyword KEEP forces BATCH to keep the status of the <calibration_name> (station-dependent calibration or zenith calibration) the same as it is kept in the superfile: "applied" or "not applied". If the <calibration_name> was not found in the superfile, no actions is done and BATCH proceed silently.

   NO -- makes no effect.

   <calibration_name> - name of the calibrations. Supported calibrations are listed
   1) in the section 20 of CORFIL file (refer to your $WORK_DIR/CORFxx file of $SAVE_DIR/CORFIL.template)
   2) in the file $SAVE_DIR/flyby_calibrations

NB: More than one keyword KEEP is allowed but not more than MAX_CAL (constant defined in ../include/gsfcb.i, currently (2000.05.12) 15)

6.4 CALIBRATIONS.ENABLE

(ENABLE [NO or <calibration_name>]) ...

   Keyword ENABLE forces BATCH to set the status of the <calibration_name> (station-dependent calibration or zenith calibration) "applied". If the <calibration_name> was not found in the superfile, then BATCH issue a warning, unless "WARNING NO" was specified in the $SETUP section and then proceed.

```
   NO -- makes no effect.

   <calibration_name> - name of the calibrations. Supported calibrations are
                        listed
                        1) in the section 20 of CORFIL file (refer to
                           your $WORK_DIR/CORFxx file of
                           $SAVE_DIR/CORFIL.template)
                        2) in the file $SAVE_DIR/flyby_calibrations

 NB: More than one keyword ENABLE is allowed but not more than MAX_CAL
     (constant defined in ../include/gsfcb.i, currently (2000.05.12) 15 )
```

6.5 CALIBRATIONS.DISABLE

(DISABLE [NO or <calibration_name>]) ...

Keyword DISABLE forces BATCH to set the status of the <calibration_name> (station-dependent calibration or zenith calibration) "Not applied". If the <calibration_name> was not found in the superfile, then no action is made.

```
   NO -- makes no effect.

   <calibration_name> - name of the calibrations. Supported calibrations are
                        listed in
                        1) the section 20 of CORFIL file (refer to
                           your $WORK_DIR/CORFxx file of
                           $SAVE_DIR/CORFIL.template)
                        2) the file $SAVE_DIR/flyby_calibrations

 NB: More than one keyword DISABLE is allowed but not more than MAX_CAL
     (constant defined in ../include/gsfcb.i, currently (2000.05.12) 15 )
```

6.6 CALIBRATIONS.DEFAULT

***DEFAULT**

DEFAULT tells to BATCH to handle the station-dependent calibrations and the ionosphere calibration and editing in the ways recorded in each session's superfile. Users who want to handle either issue differently must specify a combination of the above phrases, as described below. Different keywords are allowed in $CALIBRATIONS section. Usually ION and ALL corfile_display_name keywords are specified.

The remaining four phrases in this section (AVAILABLE, USE ..., corfile_display_name ..., GROUP...) determine which calibrations BATCH applies.

In all four phrases, corfile_display_name should be one of the names entered in the first field in sections 10 and 20 of the LIPTN corfil ($WORK_DIR/CORFLP). Only the first eight characters are significant. For example, to specify Marini dry, the user should specify dry_Mari or dry_Marini, not MARI.DRY or MARISTAT. Users should replace any blanks with '_'s (underscores). The suggested forms of some commonly used calibrations are Chao, cable, dry_Marini, wet_Marini, WVR, CFAKBDRY, CFAKBWET, CFA22DRY, and CFAJJDRY.

When BATCH processes an session, it initially sets up the calibrations the way they are set up in the session's superfile. BATCH then modifies that set up according to the last three phrases in this section. First it turns the specified calibrations in the corfile_display_name and GROUP phrases on and off. Then it processes any USE phrases, substituting certain calibrations for others if the latter are turned on after the other modifications.

BATCH only performs whatever instructions it is given in this section. It does not turn off one calibration when told to turn on a conflicting one. For example, if an session's superfile has Marini dry turned on, and the user wants to turn on CFAKBDRY instead, he/she must explicitly turn off Marini dry or else use CFAKBDRY for Marini dry. If the user just turns on CFAKBDRY, BATCH leaves marini dry on as well. So users should be careful to give BATCH a full set of instructions covering every calibration which may be in their solutions' superfiles. Specifying corfile_display_name ON or corfile_display_name OFF for every calibration accomplishes this and is strongly recommended.

6.7 CALIBRATIONS.AVAILABLE

***{[AVAILABLE or (AVAILABLE corfile_display_name ...\)]}**

Keyword AVAILABLE determines which flyby calibrations are currently available.

The available flyby calibrations are now listed in flycal_avail on $SAVE_DIR. AVAILABLE tells to BATCH to read this file. For backwards compatibility, AVAILABLE can still be followed by a list of flyby calibrations. However, BATCH now ignores the list.

Whenever a standard flyby calibration is missing from flycal_avail, users should consult a SOLVE programmer or check the socal subroutine before entering the calibration again. The calibration may be temporarily disabled due to problems.

Users should always specify this phrase. BATCH cannot use flyby calibrations without it, and it has no harmful effects in solutions which do not use flyby calibrations.

6.8 CALIBRATIONS.CORFILE_DISPLAY_NAME

```
*{(corfile_display_name [ON or OFF or IN]
                        {[ALL or NONE] {EXCEPT station ...\}}) ...}
```

This phrase turns or leaves individual calibrations on or off.

Field 1 - the calibration.

Field 2 - the instructions.

ON - turns the calibration on in every session. If the calibration is not available to an session, BATCH aborts.

OFF - turns the calibration off in every session.

DEFAULT - leaves the calibration the way it is set in each session's superfile.

Field 3 - the stations affected. The default is all stations.

ALL - affects every station except those listed in the optional EXCEPT clause.

NONE - only affects stations listed in the (optional) EXCEPT clause.

Users are strongly advised to use this phrase to explicitly turn EVERY calibration on or off at every station. Otherwise users may make incorrect assumptions about which calibrations BATCH is using, and they may experience cases in which an session has no calibration or too many calibrations turned on.

6.9 CALIBRATIONS.GROUP

```
*{(GROUP corfile_display_name ...
         [(PICK DEFAULT) or
         ((PICK corfile_display_name ...)
           {{ELSE corfile_display_name ...} ...}
             {ELSE DEFAULT} )]
             {STATIONS {[ALL or NONE] {EXCEPT station ...\}}} \) ...}
```

This phrase tells to BATCH how to set up a group of calibrations. (BATCH may turn some on and the rest off or leave them all the way each session's superfile set them up.)

Field 1 (GROUP corfile_display_name ...) - the calibrations in the group.

Field 2 (PICK DEFAULT ... ELSE DEFAULT) - the instructions.

PICK/ELSE DEFAULT - leaves each calibration the way it is set in each session's superfile.

PICK/ELSE corfile_display_name(s) - must be a subset of the list in field 1. BATCH turns on this subset and turns off the remaining calibrations in the group.

If BATCH cannot turn on every calibration in a given subset, it will try the series of alternate subsets specified in ELSE phrases, until it finds one that works or finds an ELSE DEFAULT. If BATCH runs out of ELSE phrases without finding a usable subset or DEFAULT, it aborts.

Field 3 - the stations affected. The default is all stations.

ALL - affects every station except those listed in the optional EXCEPT clause.

NONE - only affects stations listed in the (optional) EXCEPT clause.

6.10 CALIBRATIONS.USE

***{(USE corfile_display_name FOR corfile_display_name) ...}**

After BATCH uses the other phrases to set up an session's calibrations, if the second calibration in this phrase is turned on, BATCH turns on the first one instead. If the substitute is not available or is already turned on, BATCH aborts.

If the second calibration is not turned on, this phrase has no effect.

Examples

GROUP dry_Mari wet_Mari WVR PICK dry_Mari wet_Mari ELSE dry_Mari

BATCH first tries to turn on dry and wet Marini and turn off the WVR calibration. If one or both of the Marini calibrations are unavailable in an session, BATCH tries to turn on dry Marini alone. If this is unavailable, BATCH aborts.

ELSE DEFAULT

Appending ELSE DEFAULT to the previous example makes sure that BATCH does not abort, if the PICK and ELSE selections fail. However, this is a mixed blessing. What BATCH turns on in this case depends on what was turned on in the session's superfile solution. Dry (and probably therefore wet) Marini are out of the picture, leaving the WVR calibration. If this was on in the solution, BATCH leaves it on, replacing the desired Marini calibrations with one the user didn't request and may not notice being used for the session. If WVR was off, BATCH leaves it off, probably leaving the session without any calibrations, since the user presumably did not choose any other calibrations

if he/she was hoping to get the Marini calibrations.

7 $PARTIALS

This section specifies which partials with respect to atmosphere wet path delay BATCH should use.

7.1 PARTIALS.SET

{SET} <partial_name> {ON}

Set the model according to which partial derivatives wrt atmosphere path delay should be computed. The name of the model should be one of the names listed in the file $SAVE_DIR/partial_calibrations.

NB: Two syntax format allowed:
1) the obsolete: partial_name ON
2) the modern: SET <partial_name>

NB: partial names are case sensitive!

8 $CONTRIBUTIONS

This section determines which contributions BATCH applies to an session. Contribution are corrections to delay and delay rate which were computed, stored in the superfile but not yet added to the theoretical delay and/or delay rate.

8.1 CONTRIBUTIONS.SET

({SET} [NO or NONE or IN or <contribution_name> ...])

The keyword SET specifies what contributions should be applied.

NO - means that no contribution should be applied. Only one keyword with

qualifier NO is allowed in the section $CONTRIBUTIONS.

NONE - the same as NO

IN - applies whatever contributions are stored in each session's superfile. Only one keyword with qualifier NO is allowed in the section $CALIBRATIONS.

SET - applies the listed contributions to every session and doesn't apply any other calibration not listed in the section $CONTRIBUTIONS. More than one SET keywords are allowed. Thus, if you are going apply several contributions, it is better to puit several SET-statments, one statement for each contribution.

<contribution_name> - is the name of the calibration. The list of supported names can be in section 40 of the corfil used for making superfiles (f.e. $WORK_DIR/CORFLP). BATCH applies only the contributions specified by keywords SET and doesn't apply contribution not listed there. If at least one contribution is specified in the control file but not found in the superfile, BATCH will issues an error message and terminate.

NB: '_' (Underscore character) should be used instead of blank if the contribution contains a blank. For example, to specify pole tide, the user should specify Pol_Tide, not PTD CONT.

NB: contribution names are case sensitive!

9 $MODE_CALIBRATIONS

This section determines which mode calibration should be applied to each session. Mode calibrations are the calibrations which are depends on a) band; b) observable type. 6 quantities are computed for each mode calibrations: Mode calibration for

1) Group delay observable at X-band;
2) Phase delay observable at X-band;
3) Delay rate observable at X-band;
4) Group delay observable at S-band;
5) Phase delay observable at S-band;
6) Delay rate observable at S-band.

9.1 MODE_CALIBRATIONS.SET

({SET} [NO or NONE or IN or <mode_calibration_name> ...] ...)

The keyword SET specifies what mode calibrations should be applied.

NO - BATCH does not apply any contribution to any session. Only one keyword with qualifier NO is allowed in the section $MODE_CALIBRATIONS.

NONE - the same as NO

IN - applies whatever mode calibration are applied in each session's superfile. Only one keyword with qualifier IN is allowed in the section $MODE_CALIBRATIONS.

SET - apply the mode_calibration specified and don't apply any mode calibration not listed. More than one keyword SET is allowed in the section $MODE_CALIBRATIONS.

<mode_calibration_name> - is the name of the mode calibration. The list of supported names can be in section 50 of the corfil used for making superfiles (f.e. $WORK_DIR/CORFLP).

NB: mode calibrations names are case sensitive!

10 $MAPPING

This section replaces a priori calculated from a standard theoretical model and read from the sessions' superfiles with alternate a priori. This process is called mapping. All keywords from the section contains a value file_descriptor. If the first character of the <file_descriptor> is "/" then the name is interpreted as a name with absolute path. Otherwise the prefix $SAVE_DIR/ is prepended before the name. By the another words BATCH seeks the files in $SAVE_DIR directory unless full file name including path is specified. Restriction: the full file name after expansion should have no more than 128 symbols. It is strongly recommended ALWAYS to use mapping files for ALL stations, ALL sources for all kind of solutions. Superfiles may contain different a priori for the same stations, sources in different sessions. If Solve detects such a situation it terminates the run.

10.1 MAPPING.STATIONS

STATIONS [NONE or file_name]

Determines a priori file of station positions used in BATCH solution.

Field 1 -
NONE - BATCH uses the superfiles' positions for every station.
file_name - file, a priori positions BATCH are read from.

Each line of file_name must give a station followed by X, Y and Z components, in meters. If file_name does not list a station, BATCH uses its superfile position. Comments may be placed anywhere in the file preceded by $$.

10.2 MAPPING.PLATE_MODEL

PLATE_MODEL [NONE or ([AM0-2 or NUVEL]
{REF_DATE <date>}
***{SCALE scaling_factor} *{FIX plate_name})]**

Determines plate model used in solution. Field 1 and field 2 have similar meaning as STATIONS' in this section.

Field 1 - the model.

AM0-2 - the AM0-2 model.

NUVEL - the NUVEL model.

Field 2 - reference epoch.

date specified - uses the given date, which must be in the yymmdd format.

date omitted - uses October 17, 1980.

SCALE - scales the magnitude of baseline length by scaling_factor.

FIX - requested plate has zero velocity.

10.3 MAPPING.VELOCITIES

VELOCITIES [NONE or file_name] {REF_DATE <date>}

Determines a priori file of station velocities used in BATCH solution.

Field 1 -
NONE - does not use a priori values,

file_name - file, a priori values are read from.

Field 2 -
REF_DATE - reference epoch of the

date specified - uses that date, which must be in the
yymmdd format.

date omitted - the date from the velocity file will be used
as a reference date.

Each line in the VELOCITIES file except the fist line should give a station and X, Y and Z velocities (in mm/year) formatted as (4X, 4A2, 1X, D15.11, 1X, D15.11, 1X, D15.11). BATCH assigns unlisted stations a velocity of zero, although it is a bad practice. If Solve doesn't find the station in the velocity substitution file it issues a warning (unless a keyword WARNING was set to NO in the $SETUP section). Comments may be placed anywhere within the file, preceded by $$. The first line of a valid velocity substitution file contains a reference epoch data in the format YYYY.MM.DD (f.e. 2000.05.08) or yymmmdd (f.e. 970101)

In both methods(PLATE_MODEL and VELOCITIES, BATCH assumes that every station started at a specific position at the reference epoch. If this sections STATIONS keyword specifies a file, BATCH uses its positions for the reference positions of the stations in that file. BATCH uses the superfile positions for the remaining stations or if STATIONS is NONE.

NB: VELOCITY and PLATE_MODEL cannot be used both.

10.4 MAPPING.SOURCES

SOURCES [NONE or file_name]

The SOURCES keyword replaces the superfile source coordinates with coordinates from a file. Field 1 and field 2 have similar meaning as in STATIONS in this section.

Each line of file_name should give a source name, right ascension (in hours, minutes and seconds) and declination (in degrees, minutes and seconds). To specify a southern (negative declination) source, the user should start the degree field of the declination with a negative sign. Comments may be placed anywhere in the file, preceded by $$.

The following is a partial example of a source mapping file:

```
$$ SOURCE POSITIONS FROM 1989 IERS SUBMISSION GLB482
    0048-097   0 50 41.3173455     -9 29  5.21116
    4C39.25    9 27  3.0138348     39  2 20.85500
    NRAO190    4 42 38.6607392     -0 17 43.42023
    1130+009  11 33 20.0557999      0 40 52.83728
```

10.5 MAPPING.EARTH_ORIENTATION

EARTH_ORIENTATION [NONE or file_name] {[LIN or CUB or SPL]}
{[UT1R or UT1S or NO_ZONAL]}

The EARTH_ORIENTATION keyword replaces the a priori earth orientation parameters: pole coordinates and UT1 with parameters interpolated from the external time series.

NONE - uses the EOP saved in the superfile.

file_name - BATCH interpolates the X- and Y-wobble and UT1-TAI time series contained in file_name.

Field 2 - interpolation algorithm.

LIN - linear

CUB - cubic polynomial

SPL - cubic interpolating spline with free ends

Field 3 - how to treat variations of UT1 induced by zonal tides for interpolating external file.

UT1R - the difference UT1R-UT1 in accordance with the table of Yoder, Williams, and Parke, 1981, "Tidal Variations of Earth Rotation", J. Geophys. Res., Vol. 86, p. 881-891 are subtracted from the external file before interpolating and then added after interpolating.

UT1R - the difference UT1S-UT1 in accordance with the table of Dickman (1991) are subtracted from the external file before interpolating and then added after interpolating.

NO_ZONAL - direct interpolation without subtracting contribution due to zonal tide.

BATCH expects the three series to contain the same dates. The first line of an external EOP file should give the dates the series cover, specified as the series' starting (Julian) date, the interval between dates (in days) and the number of dates. Each remaining line should give a successive date, followed by its X-wobble, Y-wobble and UT1 offsets, X-wobble, Y-wobble and UT1 sigmas and X- Y, X-U and Y-U correlations. X-wobble and Y-wobble should be given in deci-arcseconds. UT1 should be in microseconds of time. A comment may be appended to the first line, starting in column 18.

The following is an example of an earth orientation mapping file:

```
2447804.5.0   7   -testing adjst rate totals
2447804.5 .700000 .99000 -24000000. .0028 .0029 15. .136 -.623 .155
2447809.5 .732598 .90192 -24357049. .0028 .0029 15. .136 -.623 .155
```

```
2447814.5 .767656 .88290 -24364199. .0026 .0027 13. .143 -.630 .100
2447819.5 .839824 .84651 -24371450. .0028 .0025 13. .158 -.650 .037
2447824.5 .963750 .78631 -24378806. .0037 .0034 17. .091 -.669 .246
2447829.5 1.15408 .69588 -24386268. .0035 .0031 16. .152 -.705 .195
2447834.5 1.42547 .56878 -24393838. .0032 .0029 15. .109 -.681 .176
```

10.6 MAPPING.NUTATION_SERIES

NUTATION_SERIES [NONE or file_name]

This keyword substitutes corrections the a priori values of nutation in longitude and nutation in obliquity angles by interpolated from a time series supplied by external file. Linear interpolation between adjacent nodes is used. NB: external file should contain corrections with respect to the nutation angles used as a priori. Different versions of CALC used different a priori nutation models. BE CAUTIOUS!

NONE - uses the superfile a prioris.

file_name - BATCH linearly interpolates the nutation in longitude and nutation in obliquity time series contained in file_name.

The first line of the external file should give the first Julian date in the time series, the interval between the series' dates (in days) and the number of dates in the series. The remaining lines should give successive dates in the series, followed by the longitude offset and sigma, obliquity offset and sigma and the correlation between the longitude and obliquity offsets, at that date. The offsets and sigmas must be given in .0001 arcseconds. A comment may be appended to the first line, starting in column 22.

The following is an example of a nutation series mapping file:

```
2448619.5 .0      4 Nutation series file example for doc
2448619.5     1.205      .135    -5.008      .054      .074
2448624.5     1.619      .145    -4.962      .055      .063
2448629.5     1.881      .138    -4.713      .057      .061
2448634.5     2.102      .131    -4.311      .056      .070
```

10.7 MAPPING.SPLINE_DISPLACEMENTS

SPLINE_DISPLACEMENTS
[NONE or
(BSP (file_name))...
]

Keyword SPLINE_DISPLACEMENT specifies the files(s) with the models for displacement for one or more sites models with expansion with the B-spline basis. The model contains the station name, station apriroi coordinates, degree of the B-spline basis, the epoch of each node and coefficients of expansion on the B-spline basis over these nodes for X, Y and Z components of site coordinates.

BSP -- qualifiers indicating that its value specifies the model of displacement for a specific site in BSP format. One BSP file contains set of coefficients for one site. Refer to specifications of BSP format in $MK5_ROOT/help/bsppos_format.txt

(file_name) -- Name of the file in BSP format with the model of displacement for a specific site.

10.8 MAPPING.EPISODIC_MOTION

***{EPISODIC_MOTION [NONE or file_name]}**

This is obsolecent keyword. Use SPLINE_POS instead of it.

The EPISODIC_MOTION keyword tells to Solve to estimate a break in station positions of global station at the specified epochs. It is assumed that the station position has a discontinuity(ies) at the epoch of break(s) for some reasons, e.g., due to earthquake or rails repairing or whatever other reasons. If one break epoch is specified then two estimates of station positions are adjusted: the first estimates is obtained over all observations before the break epoch and the second station positions are estimated over all observations after the clock break. But the estimates of velocity doesn't have breaks, so if station velocity is adjusted then it is adjusted over all observations both before the break and after the break. Unlimited number of breaks can be specified but at least one sessions with good observations at the station under consideration should take place between the epochs of clock breaks.

Keyword EPISODIC_MOTION is ignored for INDEPENDENT solution types or for the stations those positions are considered as local parameters. This keyword is incompatible with PIECE_WISE_STA and SPLINE_POS keywords.

NONE - estimates every station's position components as specified in the $FLAGS and $CARRY STATIONS keywords (as local parameters or as one set of global components based on every session in the solution).

file_name - BATCH estimates each listed station's components at the listed epochs, as well as at the start of the experiment. BATCH estimates the position at each epoch based on the data in the interval between it and the next epoch.

The user must treat each listed station's position components as global parameters. BATCH estimates the components in whatever coordinate system is given in the $FLAGS section's STATIONS keyword.

Each line in file_name must list a station (columns 1 - 8) and an epoch (columns 10 - 15). Comments may occur anywhere in the file, preceded by an asterisk.

This keyword does not affect the way BATCH estimates velocities.

Although this keyword is in the $MAPPING section, it does not affect which a prioris BATCH uses.

The following is an example of an episodic motion mapping file:

```
* This is a file containing information about episodic site motion
* Each line contains a station name in columns 1-8, and a date on
* which episodic motion occurred at that station in columns 10-15
*
* L. Petrov 07-NOV-99 13:13:45
*
YAKATAGA 871201                          * Earthquake
SOURDOGH 871201                          * Earthquake
WHTHORSE 871201                          * Earthquake
FORTORDS 891001                          * Seismic event
PRESIDIO 891001                          * Seismic event
NRAO85 3 901201                          *   Change in phase cal mode
MOJAVE12 920627                          * Earthquake
DSS15    920627                          * Earthquake
MEDICINA 960701                          *   rail repairing
EFLSBERG 961001                          *   rail repairing
DSS65    970415                          *   rail repairing
TSUKUB32 990401                          *   rail repairing
```

10.9 MAPPING.ECCENTRICITY

{ECCENTRICITY [NONE or file_name]}

This keyword allows user to apply an eccentricity substitution file. The eccentricity file defines a vector from the dome reference points to the antenna reference point for each station for the specified interval of time. Solve supports eccentricity file format ECC v. 1.0 . The purpose of the eccentricity file is to model slow local motion of the antenna with respect to the local marks. Originally this file was designed for specifying eccentricity vector for mobile stations for each campaign. However, each station should have at least one record (eccentricity is usually set to zero for fixed antennas) and each antenna, including large fixed antennas, may have proper local motion, e.g. due to antenna rail repairing, post-seismic notion or whatever reason an analyst finds appropriate.

The values of eccentricity vectors from the external eccentricity file supersedes eccentricity values saved in the superfile.

Each valid eccentricity file of ECC-format v 1.0 has the first line

```
# ECC-FORMAT V 1.0   ECCENTRICITY FILE
```

and the last line

```
# ECC-FORMAT V 1.0   ECCENTRICITY FILE (trailing line)
```

Lines with the first symbol $ are considered as comments and ignored. Other lines should contain definitions of eccentricity vector for each epoch:

```
$  ( 3:10)  IVS station name
$  (12:15)  Monument number
$  (18:33)  Starting date of validity of the eccentricity vector
$           (18:21)  Year  of starting date of validity
$           (23:24)  Month of starting date of validity
$           (26:27)  Day of month of starting date of validity
$           (29:30)  Hour (UTC) of starting date of validity
$           (32:33)  Minute (UTC) of starting date of validity
$  (36:51)  Ending date of validity of validity of the eccentricity vector
$           (36:39)  Year  of ending date of validity
$           (41:42)  Month of ending date of validity
$           (44:45)  Day of month of ending date of validity
$           (47:48)  Hour (UTC) of ending date of validity
$           (50:51)  Minute (UTC) of ending date of validity
$  (54:63)  First coordinate of eccentricity (in meters)
$  (65:74)  Second coordinate of eccentricity (in meters)
$  (76:85)  Third coordinate of eccentricity (in meters)
$  (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.
```

NB: Solve before 1999.10.15 kept eccentricity vector only up to 1mm. Discrepancies in the estimates of positions of some stations when an eccentricity file in the ECC v 1.0 format is used may reach 0.7mm due to rounding errors.

10.10 MAPPING.HI_FREQ_EOP

{HI_FREQ_EOP [NONE or file_name]}

Determines high frequency eop a priori substitution file. Contributions of tidally high frequency EOP to delay and delay rate are applied to the data.

NONE - no contributions due to high frequency EOP are applied.

file_name - the name of external file with coefficients of the
high-frequency EOP model

Comment: this keyword is incompatible with HARMONIC_EOP

10.11 MAPPING.HARMONIC_EOP

{HARMONIC_EOP [NONE or file_name]}

Determines harmonic varitaions in the Earth orientation a priori substitution file. Contributions of tidally induced high frequency EOP and/or nutation and/or non-tidal variation in the Earth orientation to delay and delay rate are applied to the data.

NONE - no contributions due to high frequency EOP are applied.

file_name - the file in HEO format which defines a set of
phases, frequencies, accelations, cosine and since
components of a 3D small rotation. This file can
contain constituents of tidally induces high frequency
EOP variations, nutation and ad hoc non-tidal harmonic
varitaions in EOP. Format description is in file
$MK5_ROOT/help/heo_format.txt

Comment: this keyword is incompatible with HI_FREQ_EOP

NB: when HARMONIC_EOP is in use, then the line in the listing
"EOP corrected for hi-freq variations (a-sigmas) VLBI solution"
may be wrong, since Solve does not distingish between prograde
in retrograde (nutation) variations in EOP.

10.12 MAPPING.PRESSURE_LOADING

{PRESSURE_LOADING [NONE or file_name]}

Determines a priori file atmospheric pressure loading which defines apriori regression model of atmosphere pressure loading. According to that model pressure loading is considered to be proportional local atmosphere pressure. The coefficients of this model are determined by fitting to either VLBI data or to the pressure loading series computed on the basis of a meteorological model. Contributions of the modeled atmosphere pressure loading to delay and delay rate are applied to the data.

NONE - no contributions due to atmospheric pressure loading are applied.

file_name - the name of external file with coefficients of the high-frequency EOP model

NB: This feature is obsolete, and will be removed in the future.

10.13 MAPPING.PIECE_WISE_STA

{PIECE_WISE_STA [NONE or file_name]}

Determines the list stations whose positions are modeled by linear spline (continuous piece-wise function) and the time span. Positions of some station can be estimated each nnn days. The keyword PIECE_WISE_STA specifies the list of such stations. This keyword is incompatible with EPISODIC_MOTION and SPLINE_POS keywords.

NONE - no station positions will be estimated as piece-wise function.

file_name - the requested file name.

Format of the piece-wise station control file:

```
yymmdd <interval> <number_of_epochs>
<station_1>
<station_2>
...
<station_n>
```

```
  where  yymmdd            -- data of the first epoch at 00 hours in scale TDB.
        <interval>         -- interval between the nodes in calendar months.
        <number_of_epochs> -- number of nodes of linear spline
```

Example:

```
800901 1 65
HRAS 085
```

It means that position of the station "HRAS 085" will be models by linear spline with nodes 01-SEP-80, 01-OCT-80, 01-NOV-80, 01-DEC-80 etc., in total 65 nodes.

10.14 MAPPING.AXIS_OFFSET

{AXIS_OFFSET [NONE or file_name]}

Determines axis offset external substitution a priori file. Values of antenna axis offset and antenna mounting type form the substitution file supersedes values used by CALC for computing a prioris.

NONE - no substitution should be done.

file_name - the requested file name.

10.15 MAPPING.SITPL

{SITPL [file_name]}

Determines site plate information file.
file_name - this file tells which plate each site locates.

10.16 MAPPING.METRIC_TENSOR

{METRIC_TENSOR [NONE or IERS92 or GRS or TOPOCNTR]}

This keyword enables to apply correction to theoretical time delay due to changes in metric tensor for geocentric reference frame. NB: Calc 9.12 and earlier (and, probably, released after 2001.01.16) uses INCORRECT formula for geometric time delay, namely, the formula presented in the IERS Conventions, 1992. This formula is not consistent with any known metric of geocentric reference frame and with formulas used for analysis of GPS, SLR and other geodetic techniques. Using this erroneous formula leads to systematic changes in scale.

NONE -- no correction is done. Theoretical time delay and delay rate are used as taken from Calc.

IERS92 -- peculiar metric IERS92-VLBI is used.

GRS -- GRS metric as defined in the IERS Conventions 2000 or as in the recommendation B.1 in the resolution adopted at the 24-th General Assembly of IAU in 2000, adopted at the 180-th IAU Symposium.
NB: This metric consistent with formulas for pseudo-range used for processing SLR, GPS and other observations.

TOPOCNTR -- Topocentric metric for the first station is used. This metric is consistent with the expression for VLBI delay published

in IERS Conventions 1996.

10.17 MAPPING.POSITION_VARIATIONS

{POSITION_VARIATIONS [NONE or
(external_file [HARMONIC_MODEL or TIME_SERIES]
[LINEAR or SPLINE] [REQUIRED or IF_AVAILABLE] ...)]

This keyword enables to apply external models of site position variations. The model can be presented either in the form of the set of coefficients for sine and cosine amplitudes for Up, East and North components of the displacement vector for each site for a finite set of harmonics or in the form of time series of X, Y and Z component of the displacement vector for each site. If more than one model is specified, then the contribution of the sum of the displacements is applied to the delay and delay rates. Up to 8 models can be specified. More details about this option can be found in $MK5_ROOT/help/posvar.txt

NONE -- no site position variations model is defined

Field 1 -- external file -- specifies either the file name with harmonic site position variations model in HARPOS format, or the name of the directory with the set of files with time series of site position variations with each site in BINDISP binary format. That directory should also have the summary file of the time series position variation model. If the path to the file is omitted, then the directory name from $SAVE_DIR is prepended before the external file name.

Filed 2 -- one of HARMONIC_MODEL (short form HMD is also accepted) or TIME_SERIES (short form TSR is also accepted). This qualifier specifies the type of the model: harmonic site position variations model or time series. In the case of HARMONIC_MODEL it is assumed that the external_file field specifies the name of the file in HARPOS format. In the case of TIME_SERIES it is assumed that the external_file field specifies the directory where files in BINDISP format for all sites are located as well as the file in BINDISP_SUMMARY format which keeps the summary of the contents of that directory.

Filed 3 -- one of LINEAR (short form LIN is also accepted) or SPLINE (short form SPL is also accepted). This field specifies the type of interpolation used for computing site displacement at the epoch of the observation. Site displacement first are computed at the sequence of nodes around the time range of the session. In the case of harmonic model, displacements are computed directly at the epochs of the nodes, in the case of time series, an interpolation scheme defined in the field

3 is used. Then the displacements computed for that sequence of nodes are interpolated again to the time epoch of each individual observation.

Filed 4 -- one of REQUIRED (short form REQ is also accepted) or IF_AVAILABLE (short form AVL is also accepted). This field defines the action in the case if harmonic site position variations turned out to be not defined for one or several stations. It can occur for two reasons: 1) no sites closed enough to the VLBI station participated in the particular experiment is found in the external file(s); 2) time series of site position variations are defined for the time range which does not include the time range of the particular experiment. If the action REQUIRED is specified, Solve issues the error message and terminates abnormally. If the action IF_AVAILABLE is specified, then in the case if for some sessions site position displacements for one ore more stations are not defined, Solve sets apriori displacement for these sites and these sessions to zero and proceeds. If the option WARNING in the $SETUP section was specified ON, then Solve prints a warning message in the screen and in the spool file.

Restriction: POSITION_VARIATIONS keyword is incompatible with TRAIN mode.

10.18 MAPPING.ERM

ERM [NONE or erm_file]

The keyword ERM specified the file with the B-spline coefficients which represents the perturbation to the Euler angles which describes the Earth rotation. The perturbatiosn are presented in the form of expansion with the B-spline basis.

10.19 MAPPING.VTD_CONF

VTD_CONF [NONE or vtd_file]

The keyword VTD_CONF specified the control file for VTD. Value of the control file, others than NONE, will force BATCH Solve to re-calculate theoretical time delay, delay rate and partial derivatives on the fly completely ignoring Calc.

10.20 MAPPING.EXTERNAL_TRP_DELAY

EXTERNAL_TRP_DELAY [NONE or {[REQUIRE OR USE] DIRECTORY {directory_name}]}]

The keyword EXTERNAL_TRP_DELAY specifies the directory name where external files with the path delay in the neutral atmosphere and its partial derivative with respect to the atmosphere path delay in zenith direction, as well as parital derivatives with respect to the tilts of the atmosphere axis of symmetry are located. At present, fioles in TROPO_PATH_DELAY format are supported.

Filed 1

NONE -- not to use this feature

USE -- use this feature. Issue a warming if no external atmosphere path delay for a specific experiment is found

REQUIRE -- use this feature. To stop Solve if if no external atmosphere path delay for a specific experiment is found

Field 3

{directory_name} -- name of the directory where files with the path delay in the neutral atmosphere and its partial derivative with respect to the atmosphere path delay in zenith direction, as well as parital derivatives with respect to the tilts of the atmosphere axis of symmetry are located. NB: only files with extension .trp or .spm are considered.

10.21 MAPPING.ANTENNA_THERMAL

ANTENNA_THERMAL [NONE or (MODEL model_use model_file_name INSITU [NONE or insitu_file_name)]

The keyword ANTENNA_THERMAL forces Solve to compute the contribution to delay caused by thermal expansion of the antenna structure.

Field 1

NONE -- not to use this feature;

MODEL -- tells to BATCH that the model of the antenna thermal expansion will be used;

Field 2

model_use:

INSTANT -- to use instant air temperature as a measure of

effective temperature of antenna construction.

AVERAGED -- to use the air temperature averaged over the observing session as a measure of effective temperature of antenna construction.
(not implemented as of 2008.05.02)

LAGGED -- to use the air temperature smoothed and 2 hour lagged behind the instant air temperature as a measure of effective temperature of antenna construction.
(not implemented as of 2008.05.02)

Field 3

model_file_name -- name of the file with antenna information. These file contains dimensions and coefficients of thernal expansion for antennas used in VLBI experiments. The contribution to delay caused by thermal expansion will not be computed for those antennas that are missing from this file.

Field 4

INSITU -- this is a mandatory qualifier

Field 5

insitu_file_name -- name of the file with names of antennas for which in-situ variations of height caused by thermal expansion are available. Contribution to delay caused by thermal expansion in accordance to the model will NOT be computed for these stations. It is assumed that thermal expansion for these antennas will be treated as site position variations. The purporse of this file is to avoid accounting for thermal expansion more than once.

11 $CONSTRAINTS

The $CONSTRAINTS section constrains specific parameter estimates.

The keyword NONE means to estimates every parameter without constraints. To constrain parameters, the user must select one or more keywords.

NB: Special care should be taken when using options in $CONSTRAINTS A user should understand clearly what he/she is going. BATCH checks only syntax. It is very easy to get completely wrong results when suppression is

used incorrectly!

NB: constrains on user parameters are imposed by the different way.

11.1 CONSTRAINTS.EARTH_ORIENTATION

```
{EARTH_ORIENTATION [ IN or NO or
                     ( YES {SIGMA x_s_mas y_s_mas u_s_ms} *{FACTOR sigfact}
                       *{RATES
                         [NO or { SIGMA x_s_mas/day y_s_mas/day u_s_ms/day}]}
                     ) ]
```

The keyword EARTH_ORIENTATION constrains the earth orientation parameters: pole coordinates and UT1.

Field 1 -

IN - constrains are imposed on UT1 and pole coordinates. Sigmas of constraints and correlations between EOP are taken from the apriori EOP file.

NO - does not constrain any of the offsets.

YES - constrains all three offsets. No correlation between EOP will be used.

Field 2 (after YES) - determines the sigmas of constraints and the correlations BATCH uses to constrain the EOP.

Field 2 (after YES) omitted - uses the sigmas and correlations from the earth orientation mapping file.

Field 2 after YES specified - If the user selected a mapping file, uses the file's correlations and the root sum squares of the listed sigmas and the mapping file's sigmas. Otherwise, BATCH uses the listed sigmas and sets the correlations to zero. x_s_mas and y_s_mas must be in milliarcseconds, and u_s_ms must be in milliseconds of time.

Field 3 after YES - to scale the formal errors in file $MAPPING.EARTH_ORIENTATION

Field 4 after YES - determines the constraints imposed on rate of change of EOP.

NO - no constraints

Field 5 after YES - determines the sigmas (constraints) and the correlations

BATCH uses to constrain the rate of change of EOP.

If the user does not select a mapping file, he/she must specify the first field YES and list values in field 2. Otherwise, BATCH produces unpredictable results.

The NO_EOP_CONSTRAINT field in the $ARCS section disables these constraints for individual sessions.

These constraints should not be confused with the constraints in the $FLAGS section's UT1/PM keyword. Those constraints apply to earth orientation rates under a specific parameterization scheme, linear spline, while constrains in $CONSTRAINS section apply the estimates of EOP (and rate of change) adjusted over all observations of the session.

11.2 CONSTRAINTS.NUTATION

***{NUTATION [YES or NO] {SIGMA} {psi_mas eps_mas}}**

Constraints on the estimates of daily offsets of nutation angles: nutation in longitude and nutation in obliquity.

Field 1 -
YES - applies constraints to nutation

NO - does not apply constraints to nutation

Field 2 - determines the sigmas of the constraints imposed on the estimates of daily nutation offset in longitude and in obliquity. Units are milliarcseconds.

11.3 CONSTRAINTS.ATMOSPHERES

{ATMOSPHERES [IN or NO or
(WEAKEST constraint_in_ps/hour) or
***(MOST constraint_in_ps/hour) or**
(YES constraint_in_ps/hour
{EXCEPT constraint_in_ps/hour station})]}

The ATMOSPHERES keyword imposes constraints on the coefficients of linear spline modeling atmosphere zenith path delay for each station by such a manner that the rate of change of linear spline between each adjacent segments is constrained to zero.

NO - does not constrain any rate at any station for any session.

IN - uses the constraints sigmas kept in the session's superfile. If an session does not have constraints for a station, that station's atmosphere rates are unconstrained for that session.

WEAKEST - uses the constraint sigma which is the maximum between the specified constraint and the constraint for that station saved in the superfile. By another words, the requested constraint sigma will be used unless a weaker (larger sigma) constraint sigma was saved in the superfile. The requested constraint must be given in picoseconds/hour.

MOST - uses the constraint sigma which is the maximum between the

YES - uses the requested constraint for all stations for all sessions regardless of any constraints in the sessions' superfiles.

EXCEPT - specifies a different constraint for a single station. Both of the requested constraints must be given in picoseconds/hour.

station - station name.

11.4 CONSTRAINTS.CLOCKS

```
{CLOCKS      [IN or NO or
              (WEAKESTconstraint_in_parts_in_1.d-14)
             *(MOST constraint_in_parts_in_1.d-14)
                 or
                   (YES constraint_in_parts_in_1.d-14
                   {EXCEPT constraint_in_parts_in_1.d-14 station})]}
```

The CLOCKS keyword imposes constraints on coefficients of linear spline modeling clock function for each station except the reference one by such a manner that the rate of change of linear spline between each adjacent segments is constrained to zero.

NO - does not constrain any clock rate at any station for any session.

IN - uses the constraint sigmas kept in the session's superfile. If an session does not have constraints for a station, then Solve will terminated abnormally since normal matrix will be singular.

WEAKEST - uses the constraint sigma which is the maximum between the specified constraint and the constraint for that station saved in the superfile. By another words, the requested constraint sigma will be used unless a weaker (larger sigma) constraint was sigma saved in the superfile. The requested constraint must be given in 10**-14

MOST - the same as WEAKEST

YES - uses the requested constraint for all stations for all sessions regardless of any constraints in the sessions' superfiles.

EXCEPT - specifies a different constraint for a single station. Both of the requested constraints must be given in 10**-14

11.5 CONSTRAINTS.GRADIENTS

***{GRADIENTS [NO or (YES <offset_const_mm> <rate_const_mm/day>)]}**

This keyword imposes constraints on the estimates of atmosphere path delay gradients. Constraints are imposed on both gradient offset and gradient rate.

NO - no gradients constraints.

YES - to impose atmospheric gradients constraints.

SIGMA - specifies sigma of constraint for each component. Value 0.0 means that no constraint for this component is imposed.

<offset_const_mm> - specifies sigma of constraints imposed on gradient offset.
<rate_const_mm/day> - specifies sigma of constraints imposed on gradient rate.

11.6 CONSTRAINTS.IONOSPHERE_SCALE

IONOSPHERE_SCALE [NO or (YES SIGMA value)]

This keyword imposes constraints on the estimates of the ionosphere scale.

NO - no ionosphere scale constraint (default).

YES - to impose constraint on inosphere scale.

SIGMA - specifies sigma of constraint for ionospere scale. The scale is dimensionless.

valie - the value of the reciprocal weigtht (or sigma) for ionospere scale estimates.

11.7 CONSTRAINTS.STATIONS

```
{STATIONS   [NO
               or
                  (XYZ [NO
                           or
                              (NO  SIGMA <x_meter> <y_meters> <z_meter>
                                         {EXCEPT (station ...\)} )
                           or
                              (YES SIGMA <x_meter> <y_meters> <z_meter>
                                         {EXCEPT (station ...\)} )
                       ] )
                  (UEN [NO
                           or
                              (NO  SIGMA <u_meter> <e_meters> <n_meter>
                                         {EXCEPT (station ...\)} )
                           or
                              (YES SIGMA <u_meter> <e_meters> <n_meter>
                                         {EXCEPT (station ...\)} )
                       ] )
           ] }
```

Determines whether to impose constraints on station positions. This keyword allows to impose either no constraints (STATIONS NO) or constraints only on XYZ (X-coordinate, Y-coordinate and Z-coordinate) components of station positions or constraints only on UEN (Up East North) components of station positions or on both. By another words constraints may be set up twice: first on XYZ component and in addition on UEN components. The optional EXCEPT list for XYZ constraints and for UEN constraints may be different. NB: both UEN and XYZ qualifiers must present unless "VELOCITIES NO" form is used.

NO - no constraints on station positions are imposed.

XYZ NO - no constraints are imposed on XYZ components of station positions.

UEN NO - no constraints are imposed on UEN components of station positions.

XYZ YES - constraints are imposed on XYZ components of station positions.

UEN YES - constraints are imposed on UEN components of station positions.

SIGMA - specifies sigma of constraint for each component. Value 0.0 means that no constraint for this component is imposed.

<x_meter> <y_meter> <z_meter> <u_meter> <e_meter> <n_meter> -- value of constraint in meter in real number format.

EXCEPT (station) ... - stations listed behind this keyword are exempts from

NO or YES. Constriction NO SIGMA ... EXCEPT station_list means that constraints are imposed ONLY for the stations in that list. Construction YES SIGMA ... EXCEPT station_list means that constraints are not imposed for the stations from the list, but are imposed for all other stations.

Examples:

```
1) STATIONS XYZ NO \
           UEN SIGMA 3.0 1.0 1.0
```

constraints are imposed on Up-projection of station coordinates with sigma 3 meters, on East-projection of station coordinates and on North-projection of coordinates.

```
2) STATIONS XYZ YES SIGMA 10.0 10.0 10.0 EXCEPT HRAS_085 \
           UEN NO  SIGMA  0.0  3.0  3.0 EXCEPT HRAS_085
```

constraints are imposed on X-component of station coordinates with sigma 10 meters, on Y-component of station coordinates and on z-component of coordinates for all stations except HRAS_085. In addition constrains on East-projection of station coordinates and on North-projection of coordinates of HRAS 085 only are imposed. Since the name of the station HRAS 085 contained the blank, it MUST be replaced with underscore character.

11.8 CONSTRAINTS.VELOCITIES

```
{VELOCITIES [NO or
                    (XYZ [NO
                             or
                                (NO SIGMA  <x_mm/year> <y_mm/year> <z_mm/year>
                                           {EXCEPT (station ...\)} )
                             or
                                (YES SIGMA <x_mm/year> <y_mm/year> <z_mm/year>
                                           {EXCEPT (station ...\)} )
                         ] )
                    (UEN [NO
                             or
                                (NO SIGMA  <u_mm/year> <e_mm/year> <n_mm/year>
                                           {EXCEPT (station ...\)} )
                             or
                                (YES SIGMA <u_mm/year> <e_mm/year> <n_mm/year>
                                           {EXCEPT (station ...\)} )
                         ] )
               ] }
```

Determines whether to impose constraints on station velocities. This keyword allows to impose either no constraints (VELOCITIES NO) or constraints only on XYZ (X-component, Y-component and Z-component) components of station velocity or constraints only on UEN (Up East North) components of station velocity or on both. By another words constraints may be set up twice: first on XYZ component and in addition on UEN components. The optional EXCEPT list for XYZ constraints and for UEN constraints may be different. NB: both UEN and XYZ qualifiers must present unless "VELOCITIES NO" form is used.

NO - no constraints on station positions are imposed.

XYZ NO - no constraints are imposed on XYZ components of station velocities.

UEN NO - no constraints are imposed on UEN components of station velocities.

XYZ YES - constraints are imposed on XYZ components of station velocities.

UEN YES - constraints are imposed on UEN components of station velocities.

SIGMA - specifies sigma of constraint for each component. Value 0.0 means that no constraint for this component is imposed.

<x_mm/year> <y_mm/year> <z_mm/year> <u_mm/yr> <e_mm/yr> <n_mm/yr> -- value of constraint in mm/year in real number format.

EXCEPT (station) ... - stations listed behind this keyword are exempts from NO or YES. Constriction NO SIGMA ... EXCEPT station_list means that constraints are imposed ONLY for the stations in that list. Construction YES SIGMA ... EXCEPT station_list means that constraints are not imposed for the stations from the list, but are imposed for all other stations.

Examples:

1) VELOCITIES NO

No constraints are imposed. It is, probably, the best way of using this keyword. Great care should be taken in imposing constraints, since any constraint biases your solution.

```
2) VELOCITIES XYZ YES SIGMA 10.0 10.0 10.0         \
              UEN NO  SIGMA  0.0  3.0  3.0  EXCEPT \
                        AIRA      AUSTINTX  AZORES    BERMUDA   BLOOMIND  \
                        BREST     CARNUSTY  CARROLGA  CHLBOLTN  DAITO     \
                        GRASSE    HOFN      HOHENFRG  HOHNBERG  KARLBURG  \
                        KIRSBERG  KOGANEI   LEONRDOK  METSHOVI  MILESMON  \
                        MIURA     MIYAZAKI  OCOTILLO  SAGARA    SEST      \
                        SUWON     SYOWA     TATEYAMA  TIDBIN64  TOULOUSE  \
                        USSURISK  USUDA64   VICTORIA  VLA
```

weak constraints are imposed on X-, Y- and z- components of the adjustments of the velocity vector of all stations with sigmas 10 mm/year. In addition

constrains on East-projection of station coordinates and on North-projection of 34 weak stations with short history of observations are imposed with sigma 3.0 mm/year

```
3) VELOCITIES XYZ YES SIGMA  3.0  3.0  3.0 \
              UEN NO
```

weak constraints are imposed on X-, Y- and z- components of the adjustments. NB: "UEN NO" clause was used.

11.9 CONSTRAINTS.PIECE_WISE_STA

***{PIECE_WISE_STA [NO or (YES <mm/yr>)]}**

This keyword allows to impose constraints on rate of change of station position modeled by linear spline (piece-wise function).

NO - no constraints for piece wise stations.

YES <mm/yr> - applies constraints on the rate of change of positions the stations whose position is modeled by linear spline.

11.10 CONSTRAINTS.NUVEL_COVAR

***{NUVEL_COVAR [YES or NO] fixed_plate {weight} {EXCEPT (station ...\)}}**

??? The meaning is unclear.

NO - doesn't bring any harm.

11.11 CONSTRAINTS.SOURCES

{SOURCES [NO or (YES {SIGMA <value_in_rad>})] }

Determines whether to impose constraints on source positions. This trick allows Solve to invert normal matrix even if less than two good observations of the source has been done (although the estimates themselves are senseless). It is potentially dangerous options. Constraints should be loose enough, otherwise they may bias the solution.

NO - no constraints on source positions are imposed.

YES - constraints are imposed on both right ascension and declination

SIGMA - specifies sigma of constraint

value_in_rad - sigma of constraint. It is the same for declination and right ascension. Units: rad. It is not recommended to use constraints larger less than 1.D-5 rad (2 arcsec),

11.12 CONSTRAINTS.PROPER_MOSIONS

{SOURCES [NO or (YES {SIGMA <value_in_rad/sec>})] }

Determines whether to impose constraints on source proper motions. This allows Solve to invert normal matrix even if less than two good observations of the source has been done (although the estimates themselves are senseless). It is potentially dangerous options. Constraints should be loose enough, otherwise they may bias the solution. NB: 1 mas/year = 1.5363D-16 rad/s. Constraint sigma 2.0D-15 is recommended.

NO - no constraints on source positions are imposed.

YES - constraints are imposed on both right ascension and declination

SIGMA - specifies sigma of constraint

value_in_rad - sigma of constraint. It is the same for declination and right ascension. Units: rad. It is not recommended to use constraints larger less than 1.D-5 rad (2 arcsec),

11.13 CONSTRAINTS.NO_NET_TRANSLATION

***{NO_NET_TRANSLATION [NO or (YES {station_weight_file})]}**

Comment: this is an obsolete keyword. it is recommended to use NO_NET_TRANSLATION_POSITION instead of NO_NET_TRASNLATION.

This keyword allows user to impose weighted no-net-translation constraints at station positions considered as LOCAL parameters constraints for each session. (You should use NO_NET_TRANSLATION_POSITION if you are going to apply constraints on station positions considered as GLOBAL parameters).

NO - not use

YES - applies this constraints with station_weight_file.
station_weight_file - file which contains relative weights of constraints.
If the qualifier is omitted then the file defined
in $MK5_ROOT/progs/solve/include/gsfcb.i in variable
STATION_WEIGHT_FILE

Three equations of constraints are built: for X, Y, and Z coordinates of station positions. Equations of constraints are the weighted sum of station coordinates. These sums are constrained to zero. Sigma of the constraint is defined in the constant LIN_STA__SIG__DEF .

NB: if the file station_weight_file does not contain some stations, solution may appear singular. As a rule of thumb station_weight_file should contain ALL statations, although Solve doesn't have a mechanism to check it and to warn a user.

11.14 CONSTRAINTS.NO_NET_TRANSLATION_POSITION

{NO_NET_TRANSLATION_POSITION [NO or
({GLOBAL} {LOCAL} {SIGMA <value_in_meters>}
[ALL or HORIZ]
{UNIFORM or WEIGHTED}
{RIGHT_PART value_1 value_2 value3}
{[YES or NO] {EXCEPT (station {station}...\) } })

This keyword allows to impose net translation constraints applied to station position parameters.

Field 1 (what to do)

NO - not to apply constraints.

Field 2

GLOBAL - in global mode, means to apply constraints on stations estimated as global parameters. In independent mode this parameter means nothing.

LOCAL - in global mode, means to apply constraints on stations estimated as local parameters. In independent mode this parameter means nothing.

If both GLOBAL and LOCAL are omitted, then GLOBAL is used as default. It is recommended that at least one of the qualifiers should be used.

Field 3

SIGMA - specifies sigma of constraint

```
      value_in_meter - sigma of constraint in meters

   Field 4 (type of equations)

      ALL - total form of the constraint is chosen. Three equations
            of constraints are built: for X, Y, and Z coordinates of station
            positions. Equations of constraints are the sum of station
            coordinates. These sums are constrained to zero.

      HORIZ - horizontal form of constraint is chosen. Three equations
              of horizontal projections of station positions vectors are
              formed: for X, Y, and Z coordinates of the vectors of
              horizontal projections. Equations of constraints are the sum
              these projections over all stations. These sums are
              constrained to zero.

   Field 5 (type of weights)

      UNIFORM - equal weights for all stations used in constraints.

      WEIGHTED - unequal weights for each station will be applied.
                 Weights were used are the diagonal values from this CGM

   Field 6 (right hand stide of constaint equation)

      RIGHT_PART value_1 value_2 value_3 -- right hand side of
                 net-translation constraint. Units: meters. value_1
                 corresponds to the net-translation for x coordinate,
                 value_2 -- for y, and value_3 for z coordinate.
                 If this keywords is omitted, then the values of zero of
                 the right hand side of constraint equations are assumed.

   Field 7 (include/exclude clause)

   YES EXCLUDE - determines that stations except the ones listed in the clause
                 are participating in the equations of constraints.

   NO EXCLUDE  - determines that only the stations listed in the clause
                 are participating in the equations of constraints.

   (station {station}...\) - stations list.
```

In global mode constraints may be imposed on positions of stations estimated as local parameters and/or positions of stations estimated as global parameters. The same exclude list is applied to the stations whose position are estimated as local and global parameters.

11.15 CONSTRAINTS.NO_NET_TRANSLATION_VELOCITY

```
{NO_NET_TRANSLATION_VELOCITY [NO or
                    ( {GLOBAL} {SIGMA <value_in_meters/year>}
                      [ALL or HORIZ ]
                      {UNIFORM or WEIGHTED}
                      {RIGHT_PART value_1 value_2 value3}
                     {[YES or NO] {EXCEPT (station {station}...\) } } )
```

This keyword allows user to impose net translation constraints applied to global station velocities parameters.

Field 1 (what to do)

NO - not to apply constraints.

GLOBAL - means nothing. It emphases that velocities are global parameters.

SIGMA - specifies sigma of constraint

Field 2

value_in_meter/sec - sigma of constraint in meters

Field 3 (type of equations)

ALL - total form of the constraint is chosen. Sum of adjustments of adjustments to station velocities for X-, Y- ad Z- components is constrained to zero.

HORIZ - horizontal form of constraint is chosen. Three equations of horizontal projections of station velocities vectors are formed: for X, Y, and Z coordinates of the vectors of horizontal projections. Equations of constraints are the sum these projections over all stations. These sums are constrained to zero.

Field 4 (type of weights)

UNIFORM - equal weights for all stations used in constraints.

WEIGHTED - unequal weights for each station will be applied. Weights were used are the diagonal values from this CGM

Field 5 (right hand stide of constaint equation)

RIGHT_PART value_1 value_2 value_3 -- right hand side of net-translation constraint. Units: meters/year. value_1 corresponds to the net-translation for x component, value_2 -- for y, and value_3 for z velocity component. If this keywords is omitted, then the values of zero of the right hand side of constraint equations are assumed.

Field 6 (include/exclude clause)

YES EXCLUDE - determines that stations except the ones listed in the clause
are participating in the equations of constraints.

NO EXCLUDE - determines that only the stations listed in the clause
are participating in the equations of constraints.

(station {station}...\) - stations list.

11.16 CONSTRAINTS.NO_NET_ROTATION_POSITION

{NO_NET_ROTATION_POSITION [NO or
({GLOBAL} {LOCAL} {SIGMA <value_in_meters>}
{UNIFORM or WEIGHTED}
{RIGHT_PART value_1 value_2 value3}
{[YES or NO] {EXCEPT (station {station}...\) } })

This keyword imposes no net rotation constraints applied to station position parameters. Horizontal projection of the vector of adjustment can be represented as a small rotation. The sum of all these rotations is constrained.

Field 1 (what to do)

NO - not to apply constraints.

Field 2

GLOBAL - in global mode, means to apply constraints on stations
estimated as global parameters. In independent mode this
parameter means nothing.

LOCAL - in global mode, means to apply constraints on stations
estimated as local parameters. In independent mode this
parameter means nothing.

If both GLOBAL and LOCAL are omitted, then GLOBAL is used as default.
It is recommended that at least one of the qualifiers should be used.

Field 3

SIGMA - specifies sigma of constraint
value_in_meter - sigma of constraint in meters

Field 4 (type of weights)

UNIFORM - equal weights for all stations used in constraints.

WEIGHTED - unequal weights for each station will be applied.
Weights were used are the diagonal values from this CGM

Field 5 (right hand stide of constaint equation)

RIGHT_PART - value_1 value_2 value_3 -- right hand side of net-rotation constraint. Units: meters. value_1 corresponds to the net-translation for x component of of net rotation, value_2 -- for y, and value_3 for the z component of the vector of net rotation. If this keywords is omitted, then the values of zero of the right hand side of constraint equations are assumed.

Field 6 (include/exclude clause)

YES EXCLUDE - determines that stations except the ones listed in the clause are participating in the equations of constraints.

NO EXCLUDE - determines that only the stations listed in the clause are participating in the equations of constraints.

(station {station}...\) - stations list.

In global mode constraints may be imposed on positions of stations estimated as local parameters and/or positions of stations estimated as global parameters. The same exclude lists is applied to stations estimated as local and global parameters.

11.17 CONSTRAINTS.NO_NET_ROTATION_VELOCITY

{NO_NET_ROTATION_VELOCITY [NO or
({GLOBA} {SIGMA <value_in_meters/year>}
{UNIFORM or WEIGHTED}
{RIGHT_PART value_1 value_2 value3}
{[YES or NO] {EXCEPT (station {station}...\) } })

This keyword allows to impose no net rotation constraints applied to global station velocity parameters. Horizontal projection of the vector of adjustment of station velocity can be represented as a small rotation. The sum of all these rotations is constrained to zero.

Field 1 (what to do)

NO - not to apply constraints.

GLOBAL - means nothing. It emphases that velocities are global

parameters.

SIGMA - specifies sigma of constraint

Field 2

value_in_meter/year - sigma of constraint in meters/year

Field 3 (type of weights)

UNIFORM - equal weights for all stations used in constraints.

WEIGHTED - unequal weights for each station will be applied.
Weights were used are the diagonal values from this CGM

Field 4 (right hand stide of constaint equation)

RIGHT_PART - value_1 value_2 value_3 -- right hand side of net-rotation constraint. Units: meters/year. value_1 corresponds to the net-translation for x component of of net rotation, value_2 -- for y, and value_3 for the z component of the vector of net rotation. If this keywords is omitted, then the values of zero of the right hand side of constraint equations are assumed.

Field 5 (include/exclude clause)

YES EXCLUDE - determines that stations except the ones listed in the clause are participating in the equations of constraints.

NO EXCLUDE - determines that only the stations listed in the clause are participating in the equations of constraints.

(station {station}...\) - stations list.

11.18 CONSTRAINTS.NO_NET_ROTATION_SOURCE

{NO_NET_ROTATION_SOURCE [NO or
({GLOBAL} {LOCAL} {SIGMA <value_in_rad>}
{UNIFORM or WEIGHTED}
{[YES or NO] EXCEPT (source {source} ...\) ...}) }

This keyword allows to impose no net rotation constraints applied to global source position coordinates. A vector of adjustment of source coordinates can be represented as a small rotation. The sum of all these rotations is constrained to zero.

Field 1 (what to do)

NO - not to apply constraints.

GLOBAL - in global mode, means to apply constraints on the sources estimated as global parameters. In independent mode this parameter means nothing.

LOCAL - in global mode, means to apply constraints on the sources estimated as local parameters. In independent mode this parameter means nothing.

If both GLOBAL and LOCAL are omitted, then GLOBAL is used as default. It is recommended that at least one of the qualifiers should be used.

Field 2

SIGMA - specifies sigma of constraint
value_in_rad - sigma of constraint in radians

Field 3 (type of weights)

UNIFORM - equal weights for all sources used in constraints.

WEIGHTED - unequal weights for each sources will be applied. Weights were used are the diagonal values from this CGM

Field 4 (include/exclude clause)

YES EXCLUDE - determines that sources except the ones listed in the clause are participating in the equations of constraints.

NO EXCLUDE - determines that only the sources listed in the clause are participating in the equations of constraints.

(source {source}...\) - source list.

In global mode constraints may be imposed on positions of the sources estimated as local parameters and/or positions of the sources estimated as global parameters. The same exclude lists is applied to the sources estimated as local and global parameters.

11.19 CONSTRAINTS.NO_NET_ROTATION_PROPER_MOTION

{NO_NET_ROTATION_PROPER_MOTION [NO or
({SIGMA <value_in_rad/sec>}
{UNIFORM or WEIGHTED}
{[YES or NO] EXCEPT (source {source} ...\) ...}) }

This keyword allows to impose no net rotation constraints applied to

source proper motions. A vector of adjustment of source proper motions can be represented as a small rotation. The sum of all these rotations is constrained to zero.

Field 1 (what to do)

NO - not to apply constraints.

Field 2

SIGMA - specifies sigma of constraint
value_in_rad/sec - sigma of constraint in radians/sec

Field 3 (type of weights)

UNIFORM - equal weights for all sources used in constraints.

WEIGHTED - unequal weights for each sources will be applied. Weights were used are the diagonal values from this CGM

Field 4 (include/exclude clause)

YES EXCLUDE - determines that sources except the ones listed in the clause are participating in the equations of constraints.

NO EXCLUDE - determines that only the sources listed in the clause are participating in the equations of constraints.

(source {source}...\) - source list.

11.20 CONSTRAINTS.STRUCTURE_ADMITTANCE

```
STRUCTURE_ADMITTANCE [NO or
                          ([YES SIGMA value])
                     ]
```

the keyword STRUCTURE_ADMITTANCE determines the reciprocal weight of constraints imposed on parameres for admittance of source structure delay.

NO - no constraints to impose

YES SIGMA value - specifies the reciproical weight of the constraint imposed on parameres for admittance of source structure delay. The reciprocal weight is dimensionless.

12 $SUPPRESSION

This section has two purposes. It suppresses specific global parameters. It also imposes certain restrictions on the estimates BATCH produces. For example, BATCH can produce identical velocity estimates for a group of (closely located) stations.

NB: Special care should be taken when using options in $SUPPRESSION. A user should understand very clear what he/she is going. BATCH checks only syntax. It is very easy to get completely wrong results when suppression is used incorrectly.

The $FLAGS section must precede this section.

NONE turns off both functions of this section. To suppress global parameters or restrict parameter estimation, the user must specify one or more of the following options in any combination. The VELOCITIES, STATIONS, SOURCES, PROPER_MOTIONS, PRECESSION, RELATIVITY, and TIDES options suppress parameters. The DIRECTION, RIGHT_ASCENSION, STATION_ORIGIN, VELOCITY_ORIGIN and VELOCITY_TIE options restrict parameter estimation.

Readers should keep in mind that in the $SUPPRESSION keywords that suppress parameters, the syntax is the reverse of the syntax in the other control file sections. That is, in the rest of the control file, specifying things or choosing YES turns things on, and not specifying them or choosing NO turns things off. In this section, the opposite is true: YES means to suppress parameter, NO -- not to suppress.

Example:

```
RELATIVITY YES
RELATIVITY NO
```

RELATIVITY NO in the $FLAGS section and RELATIVITY YES in the $SUPPRESSION section keep BATCH from estimating the parameter gamma Post-Newtonian theories of gravitation. RELATIVITY YES in the $FLAGS section and RELATIVITY NO in the $SUPPRESSION section estimate it.

12.1 SUPPRESSION.VELOCITIES

{VELOCITIES [YES or NO or sta_uen]
{EXCEPT (sta_uen {station} ...\) ...}}

The VELOCITIES keyword suppresses station velocities. BATCH only suppresses UEN velocities.

Field 1 -

YES - suppresses every component at every station.

NO - does not suppress any component at any station.

sta_uen - suppresses specific components (at every station).
Its format is UEN, where '-'s (dashes) replace components
that should not be suppressed.

Field 2 - suppresses alternate sets of velocity components at the listed stations. The specific components are determined by the sta_uen preceding each station. sta_uen must be specified as above.

BATCH suppresses the velocities whether BATCH estimates them directly or calculates them from an estimation of XYZ velocities.

12.2 SUPPRESSION.STATIONS

{STATIONS [YES or NO or sta_xyz]
{EXCEPT (sta_xyz {station} ...\) ...}}

The STATIONS keyword suppresses station positions. BATCH allows user to suppress only XYZ positions.

Field 1 -

YES - suppresses every component at every station.

NO - does not suppress any component at any station.

sta_xyz - suppresses specific components (at every station).
Its format is XYZ, where '-'s (dashes) replace components
that should not be suppressed.

Field 2 -

Suppresses alternate sets of components at the listed stations. The specific components are determined by the sta_xyz preceding each station. sta_xyz must be specified as above.

12.3 SUPPRESSION.RIGHT_ASCENSION

{RIGHT_ASCENSION [YES or NO] {EXCEPT {source ...\}}}

Keyword RIGHT_ASCENSION forces to estimate the selected sources' right ascensions so that if each source's estimate is weighted by the cosine of its declination, the weighted estimates average to zero. This option eliminates some degrees of freedom, preventing degenerate solutions.

YES - imposes this restriction on all sources except those in the EXCEPT clause.

NO - imposes this restriction on the sources in the EXCEPT clause.

YES EXCLUDE - determines that sources except the ones listed in the clause are participating in the equations of constraints.

NO EXCLUDE - determines that only the sources listed in the clause are participating in the equations of constraints.

(source {source}...\) - source list.

12.4 SUPPRESSION.DECLINATION

{DECLINATION [YES or NO] {EXCEPT {source ...\}}}

Keyword DECLINATION forces to estimate the selected sources' declination so that the average of the estimates is zero. This option eliminates some degrees of freedom preventing degenerate solutions.

YES - imposes this restriction on all sources except those in the EXCEPT clause.

NO - imposes this restriction on the sources in the EXCEPT clause.

YES EXCLUDE - determines that sources except the ones listed in the clause are participating in the equations of constraints.

NO EXCLUDE - determines that only the sources listed in the clause are participating in the equations of constraints.

(source {source}...\) - source list.

12.5 SUPPRESSION.STATION_ORIGIN

{STATION_ORIGIN [YES or NO] {EXCEPT {station ...\}} }

Keyword STATION_ORIGIN forces to estimates the selected stations' positions so that their X (and Y and Z) component estimates average to zero. This eliminates three degrees of freedom (the true averages), preventing degenerate solutions.

YES - imposes the restriction on all stations except those in the EXCEPT

clause.

NO - doesn't imposes any restriction (unless EXCEPT clause. is specified)

YES EXCEPT - imposes the restriction on all stations except those in the EXCEPT list

NO EXCEPT - imposes the restriction on the stations in the EXCEPT list.

station ...\ - station list

12.6 SUPPRESSION.SOURCES

{SOURCES [YES or NO or src_comp]
{EXCEPT (src_comp {source} ...\) ...}}

The SOURCES keyword suppresses source coordinates.

Field 1 -

YES - suppresses every source's coordinates.

NO - does not suppress any source's coordinates.

src_comp - suppresses specific coordinates (for every source). Its format is RD, where '-'s (dashes) replace coordinates that should not be suppressed.
RD means to suppress both right ascension and declination;
R- means to suppress right ascension only;
-D means to suppress declination only;
-- means to suppress nothing;

Field 2 -

Suppresses alternate sets of coordinates for the listed sources. The specific coordinates are determined by the src_comp preceding each source. Src_comp must be specified as in field 1.

Examples

1) SOURCES YES EXCEPT -- 2345-167

BATCH suppresses every right ascension and declination for every source except 2345-167. In other words, BATCH only estimates 2345-167's right ascension and declination.

2) SOURCES NO EXCEPT R- 0048-097 -D 0106+013 2345-167

BATCH suppresses three coordinates, 0048-097's right ascension and 0106+013 and 2345-167's declinations. That is, BATCH

estimates the right ascension and declination of every source, except 0048-097 (declination ascension only), 0106+013 (right ascension only) and 2345-167(right ascension only).

SOURCES R- EXCEPT RD 2134+00 0048-097

BATCH suppresses every source's right ascension and also suppresses 2134+00 and 0048-097's both right ascension and declinations. That is, BATCH estimates every declination except those of 2134+00 and 0048-097.

12.7 SUPPRESSION.PROPER_MOTIONS

{PROPER_MOTIONS [YES or NO or src_comp]
{EXCEPT (src_comp {source} ...\) ...}}

The PROPER_MOTIONS keyword suppresses source proper motions.

Field 1 -

YES - suppresses every source's proper motions.

NO - does not suppress any source's proper motions.

src_comp - suppresses specific proper motions (for every source). Its format is RD, where '-'s (dashes) replace proper motions that should not be suppressed.

RD means to suppress both right ascension and declination;
R- means to suppress right ascension only;
-D means to suppress declination only;
-- means to suppress nothing;

Field 2 -

Suppresses alternate sets of proper motions for the listed sources. The specific proper motions are determined by the src_comp preceding each source. stc_comp must be specified as in field 1.

The PROPER MOTIONS keyword is analogous to the SOURCES keyword, and users should refer to that keyword's examples.

12.8 SUPPRESSION.PRECESSION

{PRECESSION [YES or NO]}

YES - BATCH suppresses the estimate of the precession constant.

NO - BATCH does not suppress the estimate of the precession constant.

12.9 SUPPRESSION.RELATIVITY

{RELATIVITY [YES or NO]}

YES - BATCH suppresses the estimate of the Post-Newtonian parameter gamma.

NO - BATCH does not suppress the estimate of the Post-Newtonian parameter gamma.

12.10 SUPPRESSION.DIRECTION

{DIRECTION [NO or (YES station_1 TO station_2)]}

Keyword DIRECTION forces to estimate station 1's velocity in such a way that the total azimuth vector from station_1 to station_2 keeps the same orientation as the a priori vector. (BATCH permits the vectors' magnitudes to differ.) In essence, this option constrains station 1 to move away from or towards station 2, along the cord connecting them along the Earth's surface. This eliminates degrees of freedom, producing a minimum constraint solution.

Field 1 - specifies whether constraint on direction should be applied

YES - to suppress

NO - not to suppress

Field 2 - station_1

Field 3 - TO

Field 4 - station_2

12.11 SUPPRESSION.VELOCITY_ORIGIN

{VELOCITY_ORIGIN [YES or NO] {[HORIZ_ONLY or VERT_ONLY or BOTH or XYZ]}
{EXCEPT {station ...\}} }

The keyword VELOCITY_ORIGIN impose constraints on velocity adjustments.

Field 1 -

NO - not to impose additional constraints

YES - impose constraints.

Field 2 -

HORIZ_ONLY - Sum of horizontal components of all stations except the stations listed in EXCEPT list is constrained to zero.

VERT_ONLY - Sum of vertical components of all stations except the stations listed in EXCEPT list is constrained to zero.

BOTH - Sum of both horizontal and vertical components of all stations except the stations listed in EXCEPT list is constrained to zero.

XYZ - Sums of X-, Y- and Z- components of velocities of all stations except the stations listed in EXCEPT list are constrained to zero.

Field 3 -

EXCEPT - specifies the list of stations which will not be participating in suppression

station ...\ - station list

12.12 SUPPRESSION.VELOCITY_TIE

{VELOCITY_TIE [NO or (YES (station_list ...\))
({AND (station_list ...\)} ...) }

The keyword VELOCITY_TIE imposes strong constraints on the difference between velocities of stations. As a result each group of stations listed in VELOCITY_TIE will effectively have the same velocity.

Field 1 -

NO - not to impose velocity ties.

YES - impose velocity tie on some stations

Field 2 -

```
            station_list - list of station. The difference in velocities
                           of the the stations in this list is strongly
                           constrained to zero.
```

The keyword VELOCITY_TIE allows to specify more than one list of tied stations. The qualifier AND should be used as a delimiter of lists. If two or more station lists are specified then velocities are tied within each list, but the velocities of the stations from the different lists are not tied.

Examples:

```
1)  VELOCITY_TIE YES      DSS65    ROBLED32 MADRID64  \
                      AND SESHAN25 SHANGHAI           \
                      AND DSS15    GOLDMARS
    It means that a) three stations, DSS65 ROBLED32 MADTRID64, will
                     be analyzed in such a manner that the adjustments
                     of their velocity will be the same and
                  b) two stations: SESHAN25 and SHANGHAI will have
                     the same velocities and
                  c) two stations: DSS15 GOLDMARS will have the same
                     velocities
```

NB: the same station cannot specified more than once! If you would like to tie velicities of three stations: A, B and C, then construction

```
          A B \
       AND A C
```

will be illegal. Correct constuction is

```
       A B C
```

```
2)  VELOCITY_TIE NO
```

It means that no constraints on difference in velocities will be imposed.

12.13 SUPPRESSION.STATION_TIE

```
{STATION_TIE     [NO  or (YES  (station_list ...\})
                         ({AND (station_list ...\}) ... }
```

The keyword STATION_TIE imposes strong constraints on the difference between positions of stations. As a result each group of stations listed in STATION_TIE will effectively have the same vector of coordinates.

```
Field 1 -
        NO - not to impose station ties.
```

```
        YES - impose station tie on some stations

   Field 2 -

        station_list - list of station. The difference in position
                       of the the stations in this list is strongly
                       constrained to zero.
```

The keyword STATION_TIE allows to specify more than one list of tied stations. The qualifier AND should be used as a delimiter of lists. If two or more station lists are specified then their positions are tied within each list, but the coordinates of the stations from the different lists are not tied.

NB: the same station cannot specified more than once! If you would like to tie velicities of three stations: A, B and C, then construction

```
        A B \
    AND A C
```

will be illegal. Correct constuction is

```
    A B C
```

13 $ARCS

The $ARCS section lists the session names which are to participate in the solution. Suppression solutions do not process sessions, but must specify a session in this section in order to activate the proper BATCH paths.

The arc section may contain either the session list itself or the filename which actually contains the list. The format of the station list in both cases is the same.

The arc-list consists of lines of variable length. Each line contains the name of the session and, perhaps, some options or contains and * symbol in he first field what is an indication that this line is a comment and therefore is ignored by BATCH.

NB: An empty line means the end of the arc-list. Batch doesn't look at the contents of the arc-list which follow the empty line

13.1 SUPPRESSION.SUPRESS_FILE

{SUPPRESS_FILE [NONE or file_name]

The SUPPRESS_FILE specifies the name of the so-called suppression file or NONE if this function is not needed. SUPPRESS_FILE specifies the list of parameters or their index which are to be suppressed. Lines which starts from # are considered as comments and ignored. One record specifies one suppressed parameter. It can be either in the form of a 20 characters long internal SOLVE parameter name or in the form of a parameter index. Solve first tries to interpret the record as a parameter index. If the record is an integer in the range [1, n_par], where the n_par is the total number of parameters in the solution, then the record is considered as a parameter index. If Solve fails to interpret this number as a parameter index, it tires to interpret it as as a parameter name. If it cannot find parameter with such a name, it generates the error message and stops.

If a solution runs in global mode, only global parameters can be suppressed. If a solution runs in the independent mode, any parameter can be suppressed.

It should be noted the SUPPRESS_FILE option should be used only as a last resort for correcting errors in parameterization.

13.2 ARCS.ARCFILE

ARCFILE [NONE or file_name]

The keyword ARCFILE in the $ARCS section specifies filename of the arc-list. (Please, don't be confused with the keyword ARC_FILES in the $SETUP section!)

Field 1

NONE - no arc-list is supplied the list of session follows the keyword at the next line.

file_name - file name of the arc-list. If the filename is specified then this line should be the last line of the control file.

13.3 ARCS.DBNAME

```
{( repo_name dbname ver
  {@<include_file>}
        {ADDW <file_name>}
        {ADDW_SCLE value}
        {AOC  <file_name>}
        {ATMOSPHERE_CONSTRAINTS [(AUTO constraint_in_ps/hour) or
                                 (MOST constraint_in_ps/hour) or
```

```
                                (YES  constraint_in_ps/hour) or
                                 IN or
                                 NO]}
        {ATMOSPHERE_FLAGS       [(AUTO INTERVAL interval_in_minutes) or
                                 (MOST INTERVAL interval_in_minutes) or
                                 (YES  INTERVAL interval_in_minutes) or
                                 IN or
                                 NO]}
        {ATMOSPHERE_OFF    [nsites (site1 sites ...)] or [site] or ALL}
        {ATMOSPHERE_OFFSET [nsites (site1 sites ...)] or [site] or ALL}
       @{ATMOSPHERE_EXCLUDE
        {BASDEP_CLO [YES or NO or IN]}
        {CLOCK_CONSTRAINTS      [(AUTO constraint_in_parts_in_1.d-14) or
                                 (MOST constraint_in_parts_in_1.d-14) or
                                 (YES  constraint_in_parts_in_1.d-14) or
                                 IN or
                                 NO]}
        {CLOCK_FLAGS MAX_DEGREE [(IN   [1 or 2]) or
                                 (AUTO [1 or 2]) or
                                 (MOST [1 or 2])   ]
                                [(AUTO   INTERVAL interval_in_minuts) or
                                 (MOST   INTERVAL interval_in_minutes) or
                                 (FORCE  INTERVAL interval_in_minutes) or
                                 IN or
                                 NO]}
        {CLOCK_REF_SITES [nsites (site1 sites ...)] or [site]}
        {CONTROL_ONLY}
        {DTEC <file_name>}
       @{DTEC_SBA_USED
       @{DTEC_ERR_SCL
        {ELEVATION cutoff [ALL or {NUM_STA} (station ...)}
        {EDIT <file_name>}
        {EOP_CONSTRAINT   SIGMA  xp_sigma yp_sigma ut1_sigma}
{EOP_DAYOFTIME_EPOCH time}
{EOP_EPOCH time}
        {EOPR_CONSTRAINT  SIGMA  xp_rate_sigma yp_rate_sigma ut1_rate_sigma}
{EQUAL_EFF_FREQ}
        {EXT_ERR <file_name>}
        {GRADIENTS_OFF [nsites (site1 sites)] or [site] or ALL}
        {GRAD_OFF      [nsites (site1 sites)] or [site] or ALL}
        [GRADIENT_CONSTRAINTS   [(AUTO constraint_mm constraint_mm/d ) or
                                 (MOST constraint_mm constraint_mm/d ) or
                                 (YES  constraint_mm constraint_mm/d ) or
                                 NO]}
        [GRADIENT_FLAGS         [(AUTO INTERVAL interval_in_hours) or
                                 (YES  INTERVAL interval_in_hours) or
                                 NO]}
```

```
            {IN_EOP_CONSTRAINT}
            {IONO_ERR <file_name>}
            {[MOD_ONLY or CONTROL_ONLY]}
            {[NO_EOP_CONSTRAINT or IN_EOP_CONSTRAINT or
              EOP_CONSTRAINTS  {SIGMA xp_mas    yp_mas    ut1_ms}
              EOPR_CONSTRAINTS {SIGMA xpr_mas/d ypr_mas/d utr_ms/d} ]}
            {NO_EOP_MOD}
            {NOCAL}
            {NOCONTR}
            {NOMAP}
            {PARU_FILE <file_name>}
            {REWEI SCALE value ADD_QUADR value }
            {SNR_MIN value}
            {SOU_EXCLUDE [nsources (source1 sources ...)] or [source]}
            {SOU_OFF     [nsources (source1 sources ...)] or [source]}
            {SOU_USE_DB_IGNORE}
            {STA_INCLUDE [nsites (site1 sites ...)] or [site]}
            {STA_EXCLUDE [nsites (site1 sites ...)] or [site]}
            {STA_OFF     [nsites (site1 sites ...)] or [site]}
            {STA_ON      [nsites (site1 sites ...)] or [site]}
            {STA_POS_ON  [nsites (site1 sites ...)] or [site]}
            {STA_POS_OFF [nsites (site1 sites ...)] or [site]}
            {(SUPPRESS_XYULPE <ext_eop_comp_flag>)]}
            {TEC_BIAS value}
            {TEC_SCAL value}
            {TYPE [GDR    or     GD or    PDR or     PD or
                       GRPRAT or PHSRAT or SNBRAT or GRPONL or PHSONL or
                       SNBONL or RATONL or  G_GXS or PX_GXS or PS_GXS or
                        PX_GX or  PX_GS or  PS_GX or  PS_GS or  P_PXS or
                           GX or     GS or     PX or     PS           or
                        FUSED                                        ]}
            {VTD_CONF control_file}
   }
```

The control file must list one line with the above format for each session in the solution. Mandatory fields are the fields 1 and 2. Other fields are optional. They changes settings of BATCH Solve for this session only. NB: arc-line cannot exceed 256 characters and cannot be broken. If you need to put a lot of options you may consider putting all or part of the options in @include files. The total length of all include files should not exceed 8192 characters.

Fields 1, 2 and 3 (repository dbname and ver) -- session identifier. These are mandatory fields

repo -- three charater long repository name. Repositories should be defined in the VLBI Catatalogue (VCAT) configuration file.

Usually, vlbi catalogue repository name resides in $PSOLVE_SAVE_DIR/vcxat.conf directory. Usually OBS name is reserved for observed database and SIM for simulated datasets.

dbname -- the name of the session, as recorded in the superfile catalog. Although may take any ascii characters, usually names abide YYYYMMDD_S or YYYYMMDD-S notation, where YYYY is year, MM -- integer month number, DD -- integer day number, S -- low case letter suffix. Underscore in 9th position is used for observations, hyphen is for simulations.

ver -- the session's version number. Ver must be the exact version number. The user cannot specify zero for the last superfile version, as he/she can for database versions in various programs.

ADDW -- specifies the name of the file with additive weight corrections. These weight correctison are added in quadrature to observable uncertainties. The file has a header and data records, one record per observation. A line that starts with # beyond first three lines of the header is considered as a comment is bypassed by the parser. Format of the data record:

field	fmt	
1-9	--	Delimeter
10-15	-- I6	Observation index
16-26	--	Delimeter
27-32	-- D12.6	Additive reciprocal weight in sec

file_name -- full path to the additive weight file.

ADDW_SCL -- not used

AOC -- specifies the name of the file with additive corrections to o-c (obsevatum minus caluculatum). The file has a header and data records, one record per observation. A line that starts with # beyond first three lines of the header is considered as a comment is bypassed by the parser. Format of the data record:

field	fmt	
1-9	--	Delimeter
10-15	-- I6	Observation index
16-26	--	Delimeter
26-32	-- D13.6	Correction to o-c in sec

file_name -- full path to the additive weight file.

```
ATMOSPHERE_CONSTRAINTS -- sets flags which controls imposing
                          constraints on rates of changes in
                          the estimates of the atmosphere path
                          delay for all stations of this session.

   AUTO -- uses the requested constraint for all stations of this
           session regardless of any constraints in the sessions'
           superfiles. The requested constraint must follow the
           qualifier AUTO and be given in picoseconds/hour.

   IN   -- uses the constraints sigmas kept in the session's superfile.
           If an session does not have constraints for a station, that
           station's atmosphere rates are unconstrained for that session.

   MOST -- uses the constraint sigma which is the maximum between the
           specified constraint and the constraint for that station
           saved in the superfile. By another words, the requested
           constraint sigma will be used unless a weaker (larger sigma)
           constraint sigma was saved in the superfile. The requested
           constraint must follow the qualifier MOST and be given
           in picoseconds/hour.

    NO  -- does not constrain any rate at any station for any session.

    YES -- the same as AUTO.

    constraint_in_ps/hour -- sigma of the constraint in psec/hr.


ATMOSPHERE_FLAGS -- sets flags which controls parameterization of
                    the troposphere path delay in zenith direction
                    for this session.

    AUTO -- performs a linear spline (piecewise-continuous)
            parameterization with the given interval at each station,
            regardless of what's in the session's superfile.
            The length of interval of spline in minutes should be
            specified after the qualifier INTERVAL.

    IN   -- for each session, uses the parameterization recorded in
            that session's superfile.

    MOST -- for each session performs a linear spline ( linear
            piecewise-continuous ) parameterization with the given
            interval at each station, unless the session's superfile
            contains a linear spline parameterization with a shorter
            interval. In that case, uses the parameterization saved
            in superfile. The length of interval of spline in minutes
            should be specified after the qualifier INTERVAL.

    NO   -- not to estimate atmosphere path delay in zenith direction.

    YES  -- the same as AUTO.
```

INTERVAL -- the second qualifier. Indicates that the interval of the spline should follow.

interval_in_minutes -- specifies time span of the spline in minutes.

ATMOSPHERE_OFFSET -- sets the flags indicating that only time independent atmosphere zenith path delay for the sites from the list should be estimated.

nsites -- the number of sites. If the number of sites is 1, then and only then this counter can be omitted. If the parser detects that the first parameter after the keyword ATMOSPHERE_OFF, it considers nsites=1 and treats the first parameter as the name of the site.

site1 sites ... -- list of sites. If a site has a blank inside the name, that blank should be replace with the underscore.

ATM_OFF -- synonum of ATMOSPHERE_OFFSET

ATMOSPHERE_EXCLUDE -- sets the flags indicating that atmospheric path delay in zenith direction and atmosphere gradients of the of the specified station(s) should not be estimated. The list of stations is preceded with the number of stations in the list.

nsites -- the number of sites. If the number of sites is 1, then and only then this counter can be omitted. If the parser detects that the first parameter after the keyword ATMOSPHERE_OFF, it considers nsites=1 and treats the first parameter as the name of the site.

site1 sites ... -- list of sites. If a site has a blank inside the name, that blank should be replace with the underscore.

BASDEP_CLO -- sets estimation of the baseline-dependent clocks for this session only. It totally overrides the keyword BASELINE_CLOCKS in the $FLAGS section.

NO -- not to estimate

YES -- estimate. The list of baseline-dependent clocks is built by such a manner in order to estimate the maximal number of parameters which still guarantee the lack of singularity of the normal matrix.

```
    IN  -- estimate baselines dependent-clocks for those baselines
           which were selected in superfile.


CLOCK_CONSTRAINTS -- sets flags which controls imposing
                     constraints on rates of changes in
                     the estimates of the clock function
                     for all stations of this session.

   AUTO -- uses the requested constraint for all stations of this
           session regardless of any constraints in the sessions'
           superfiles. The requested constraint must follow the
           qualifier AUTO and be given in picoseconds/hour.

   IN   -- uses the constraints sigmas kept in the session's superfile.
           If an session does not have constraints for a station, that
           station's atmosphere rates are unconstrained for that session.

   MOST -- uses the constraint sigma which is the maximum between the
           specified constraint and the constraint for that station
           saved in the superfile. By another words, the requested
           constraint sigma will be used unless a weaker (larger sigma)
           constraint sigma was saved in the superfile. The requested
           constraint must follow the qualifier MOST and be given
           in picoseconds/hour.

    NO  -- does not constrain any rate at any station for any session.
           NB: normal matrix maybe singular in this case.

    YES -- the same as AUTO.

    constraint_in_parts_in_1.d-14 -- sigma of the constraint
                                     in 1.D-14 sec/sec.


CLOCK_FLAGS -- sets flags which controls parameterization of
               clock function for this session for all stations,
               except the stations used as reference.

    1st qualifier:
        MAX_DEGREE -- specifies the order of the low polynomial
                      of clock function.

    2nd qualifier: type of parameterization of the low polynomial
                   of clock function.

        IN   -- take the same order as it saved in the database.

        AUTO -- set the order of the polynomial regardless the value
                saved in the superfile.

        MOST -- set order of the polynomial which is maximal between the
                specified one conserved in the database.
```

```
    3rd qualifier: -- the order of the polynomial:

        1 -- polynomial of the first order will be used.
        2 -- polynomial of the second order will be used.

    4th qualifier: --

        INTERVALS  -- indicates that the length of the spline time
                      span will follow

    5th qualifier: --

        IN    -- the length of linear spline is taken from superfile.

        NO    -- no linear spline is estimated

        FORCE -- uses a linear spline parameterization for every
                 station in every session, with the requested interval
                 in minutes. Completely overrides the parameterization
                 in the sessions' superfiles, INCLUDING CLOCK BREAKS.
                 Provided for backward compatibility only.
                 Not recommended to use.

         AUTO -- uses a linear spline parameterization for every station
                 in every session, with the requested interval in
                 minutes. Ignores the parameterization in the
                 superfiles, except for preserving all clock breaks.

         MOST -- for each session, performs a linear spline
                 parameterization with the given interval at each
                 station, unless the session's superfile contains
                 a linear piecewise-continuous parameterization with
                 a shorter interval. Then BATCH uses that interval.
                 Preserves clock breaks. The interval must be in minutes.

    6th qualifier: --
        interval_in_minutes -- specifies time span of the spline
                               in minutes.


CLOCK_REF_SITES -- specifies clock reference station(s) for this
                   session.

    nsites  -- the number of sites. If the number of sites is 1,
               then and only then this counter can be omitted.
               If the parser detects that the first parameter
               after the keyword  CLOCK_REF_SITES, it considers
               nsites=1 and treats the first parameter as the
               name of the site.

    site1 sites ... -- list of sites. If a site has a blank
                       inside the name, that blank should be
                       replaced with the underscore.
```

```
CONTROL_ONLY -- eop sigmas and covariances only from
                $CONSTRAINTS.EARTH_ORIENTATION.

DTEC   -- specifies the name of the external file with differential
          total electron contents (dTEC) in the ionosphere and results
          of its adjustments oto VLBI data. The results of adjusments
          are in a form of time-variable dTEC adjustement, errors of
          this adjustment, and a delay bias between upper and lower
          band that is a  sum of a constant and a finite number of
          jumps for a small fraction of experiments. The file has
          a header and data records, one record per observation.
          A line that starts with # beyond first three lines of the
          header is considered as a comment is bypassed by the
          parser.

          Format of the data record:

          field     fmt

           1-9    --        Delimeter
          10-15   -- I6      Observation index
          16-27   --        Delimeter
          28-37   -- F10.2   dTEC from GPS TEC maps in TECU.
          38-49   --        Delimeter
          50-59   -- F10.2   adjustment to GPS TEC from analysis of VLBI
                             observations in TECU.
          60-71   --        Delimeter
          72-81   -- F10.2   Error in VLBI TEC adjustment in TECU.
          82-93   --        Delimeter
          94-106  -- F10.2   Delay bias of S band with respect to X band
                             in seconds
         106-118  --        Delimeter
         119-119  -- L1      Flag of availability of group delays to
                             compute adjustments. If flag is F, no
                             adjustment for this observation is
                             avialble.

    file_name -- full path to the dTEC file

DTEC_SBA_USE  -- set the flag of using dTEC adjustment for single band
                 data types, provided dTEC was loaded. Without that
                 flag dTEC adjustment will be used only for fused data
                 type.

DTEC_ERR_SCL value -- scale dTEC adjustment errors for single band
                      data types when DTEC_SBA_USE is applyed. Default
                      scaling factor is 1.

EDIT  -- specifies the name of the edit file. File consisets of
         a header and data record. A line that starts with #
         beyond first three lines of the header is considered as
         a comment is bypassed. Format is simple: observation
```

```
          index, one integer number per line.

     file_name -- full path to the editing file.

ELEVATION cutoff [ALL or {NUM_STA} (station ...)  -- set elevation
       cutoff for all or some stations of this experiment only.

     cutoff  -- elevation in degrees. Observations lower than this
                elevation are not used on solution

     ALL     -- means that the elevation cutoff will be applied to
                all stations.

     NUM_STA -- the number of station in the following list

    (station ...)  -- list of NUM_STA stations for which elevetion
                      cutoff will be applied. For other stations the
                      global elevation cutoff specified in the $DATA
                      section will be applied.

EOP_EPOCH           time -- time epoch for Earth orientation
                            estimation in TAI specified in
                            the following qualifier.
                            Format: yyyy.dd.mm:hh:mm:ss.sss

EOP_DAYOFTIME_EPOCH time -- time epoch for Earth orientation
                            estimation in TAI specified in
                            the following qualifier without date.
                            Format: hh:mm:ss.sss . EOP epoch be this
                            time on the moment which follows
                            nominal start time. If, for instance,
                            the experiment started on
                            08-DEC-2006 16:37:49 and the
                            time is specified as 16:00:00, then
                            the EOP epoch will be on
                            09-DEC-2006 16:00:00. If time specified
                            as 17:00:00, then the EOP epoch is
                            08-DEC-2006 17:00:00.

EOP_CONSTRAINT -- sets reciprocal weights to EOP estimate for this
                  experiment only.

    SIGMA -- specifies reciprocal weights

          xp_mas -- reciprocal weight for constraint on X pole coordinate.
                    Units: mas.

          yp_mas -- reciprocal weight for constraint on Y pole coordinate.
                    Units: mas.

          ut1_ms -- reciprocal weight for constraint on UT1 angle
                    Units: mas.

EOPR_CONSTRAINT -- sets reciprocal weights to EOP rate estimate for this
```

experiment only.

SIGMA -- specifies reciprocal weights

xpr_mas/d -- reciprocal weight for constraint on X pole rate.
Units: mas/day

ypr_mas/d -- reciprocal weight for constraint on Y pole rate.
Units: mas/day.

utr_ms/d -- reciprocal weight for constraint on UT1 rate.
Units: ms/day.

EQUAL_EFF_FREQ -- flag that requires the effective ionospheric frequency should be the same. If set, the mean effective ionospheric frequency is computed for all observations of the experiment, and that frequency is used for computation of ionospheric contribution for the single band observation or the ionospheric-free linear combination of dual-band observables.

The effective ionospheric frequency depends on IF weights, and in general, differs from an observation to observation within several pro cents. Therefore, Solve supports observation-dependent effective ionospheric frequencies, and the use of observation-dependent effective ionospheric frequencies in most cases residual residuals.

However, there are two cases when observation-dependent effective ionospheric frequency can degrade, sometimes significantly, the fit.

1) ionospheric frequencies can be wrong for some observations due to bugs in visibility analysis.

2) group delays between low and high bands may have a significant constant offset. This offset can be due to different path delay in the signal chain or due to ambiguity in phase calibration. When the ionosphere-free path delay is computed, the difference in group delays is multiplied by the expression that depends on effective ionospheric frequencies. If the effective ionospheric frequency has a jitter due to differences in IF weights, the constant difference is group delay will by multiplied by this jitter which will be added to o-c and will cause and additional noise.

In cases 1-2, setting EQUAL_EFF_FREQ improves results.

NB: Solve honors environment variable EQUAL_EFF_FREQ. If it value is YES, then EQUAL_EFF_FREQ is applied to all observing sessions.

```
EXT_ERR -- specifies the name of the file with reciprocal weights
           This weight file supersedes all other parameters and variables
           that control reciprocal weights. The file has a header and data
           records, one record per observation. A line that starts
           with # beyond first three lines of the header is considered
           as a comment is bypassed by the parser. Format of the data
           record:

           field     fmt

            1-9   --        Delimeter
           10-15  -- I6      Observation index
           16-26  --         Delimeter
           26-38  -- D13.6   Reciprocal weight in sec

     file_name -- full path to the additive weight file.

GRADIENT_CONSTRAINTS  -- sets flags which controls imposing
                         constraints on value of atmosphere gradient
                         and the rate of its change for all stations

    AUTO -- uses the requested constraint for all stations of this
            session regardless of any constraints in the sessions'
            superfiles. The requested constraint must follow the
            qualifier AUTO and be given in mm and mm/d

    MOST -- uses the constraint sigma which is the maximum between the
            specified constraint and the constraint for that station
            saved in the superfile. By another words, the requested
            constraint sigma will be used unless a weaker (larger sigma)
            constraint sigma was saved in the superfile. The requested
            constraint must follow the qualifier MOST and be given
            in mm and mm/d

     NO  -- does not constrain any rate at any station for any session.

     YES -- the same as AUTO.

     constraint_mm   -- sigma of the constraint imposed on the value of
                        the atmosphere gradients. Units: mm.

     constraint_mm/d -- sigma of the constraint imposed on the rate of
                        change of the the atmosphere gradients.
                        Units: mm/d.


GRADIENT_FLAGS  -- sets flags which controls parameterization of
                   the troposphere gradients for this session.

     AUTO -- performs a linear spline (piecewise-continuous)
             parameterization with the given interval at each station,
             regardless of what's in the session's superfile.
             The length of interval of spline in hours should be
```

```
            specified after the qualifier INTERVAL.

    NO   -- do not estimate atmosphere gradients

    YES  -- the same as AUTO.


    INTERVAL -- the second qualifier. Indicates that the interval of
                the spline should follow.

    interval_in_hours -- specifies time span of the spline in hours.


GRADIENTS_OFF -- sets the flag indicating that atmosphere gradients
                 at the of the specified station(s) should not be
                 estimated. The list of stations is preceded with
                 the number of stations in the list.

   nsites  -- the number of sites. If the number of sites is 1,
              then and only then this counter can be omitted.
              If the parser detects that the first parameter
              after the keyword  GRADIENTS_OFF, it considers
              nsites=1 and treats the first parameter as the
              name of the site.

   site1 sites ... -- list of sites. If a site has a blank inside the
                      name, that blank should be replace with the
                      underscore.
GRAD_OFF  -- synonym of GRADIENTS_OFF

IN_EOP_CONSTRAINT -- overrides the earth orientation offset
                     constraints given in the $CONSTRAINTS
                     section. Sigmas of constraints and
                     correlations between EOP are taken from
                     the apriori EOP file. (NB: this field does
                     not affect the constraint of the Earth
                     orientation RATES through the $FLAGS
                     section's UT1/PM keyword.)

           option specified -- BATCH does constrain this session's
                               earth orientation offsets with
                               the covariance matrix of constraints
                               taken from the EOP mode file.

           option left out  -- BATCH applies the constraint in the
                               $CONSTRAINTS section (if any) to this
                               session's offsets.

IONO_ERR -- not used any more

MOD_ONLY     -- sets the flag indicating that the eop sigmas and
                covariances are only taken from the file specified
                in $MAPPING.EARTH_ORIENTATION
```

```
NO_EOP_CONSTRAINT -- overrides the earth orientation offset
                     constraints given in the $CONSTRAINTS
                     section. (This field does not affect the
                     constraint of the earth orientation RATES
                     through the $FLAGS section's UT1/PM keyword.)

           option specified  - BATCH does not constrain this session's
                               earth orientation offsets.

           option left out   -  BATCH applies the constraint in the
                               $CONSTRAINTS section (if any) to this
                               session's offsets.


NOCAL      -- prevents BATCH Solve from applying any calibrations, even
              if they specified in the $CALIBRATIONS section.


NOCONTR    -- prevents BATCH Solve from applying any contributions, even
              if they specified in the $CONTRIBUTIONS section.


NO_EOP_MOD -- prevents BATCH from using the earth orientation
              mapping file for this session.

           option included - uses the earth orientation offset a priori
                             from this session's superfile. BATCH does not
                             use the earth orientation mapping file to
                             determine this session's offset constraints,
                             even if directed to do so in the $CONSTRAINTS
                             section.

           option left out - if the $MAPPING section specified a file,
                             BATCH uses it to generate earth orientation
                             a priori.  BATCH also uses the file to
                             determine this session's offset constraints,
                             as directed in the $CONSTRAINTS section.

NOMAP      -- prevents BATCH Solve from applying any corrections of
              apriori parameters even if they are specified in
              the $MAPPING section.

PARU_FILE  -- overrides the name of the control file used in keyword ELIM
              of GSETUP section. That control file us used for this session
              only.

      name -- Name of control file for program for automated outlier
              elimination and weight update.

REWEI      -- modifies formal uncertainties of group delay that are used
              for weight computation. This modification happanes after
              applying additibve reweithing defined in the reweight file.
```

```
    SCALE     value -- a scaled factor applied to formal uncertainties
                       of group delay.

    ADD_QUADR value -- an additive parameter in seconds that is added
                       in quadrature to the formal uncertainy  after
                       multiplying group delay formal uncertainty by
                       SCALE parameter.

SNR_MIN -- keywords sets the minimum SNR at two bands: upper and lower
           for this experiment only. Observations with SNR less than
           these limits, will be suppressed. Keyword SNR_MIN is followed
           up with two values. NB: this feature works only if the database
           is in the GVF format and suppression type is META.

  Field 1 -

        SNR_MIN_X -- Minumim SNR for the upper (X) band.

  Field 2 -

        SNR_MIN_X -- Minumim SNR for the lower (X) band.

SOU_EXCLUDE -- specifies which sources should be excluded
               from the solutions when this session is analyzed.
               All observations of these sources will be marked as
               unrecoverable and excluded from the solution.

    nsources  -- the number of sources. If the number of sources
                 is 1, then and only then this counter can be
                 omitted. If the parser detects that the first
                 parameter after the keyword SOU_EXCLUDE,
                 it considers nsources=1 and treats the first
                 parameter as the name of the source.

    source1 sourcess ... -- list of sources.


SOU_OFF -- clears the flags of estimation of position and proper
           motion for the sources in the list which follows this
           keyword. Coordinates and proper motion of these sources
           will not be estimated.

    nsources  -- the number of sources. If the number of sources
                 is 1, then and only then this counter can be
                 omitted. If the parser detects that the first
                 parameter after the keyword SOU_OFF,
                 it considers nsources=1 and treats the first
                 parameter as the name of the source.

    source1 sources ... -- list of sources.


SOU_USE_DB_IGNORE -- if set, then the source usage flag stored in the
                     database or superfile will be ignored, and all
```

```
                    sources will be processed, unless specified in
                    the keyword SOU_EXCLUDE.

STA_INCLUDE   -- specifies which stations should be included
                 from the solutions when this session is analyzed.
                 All observations at the baselines that do not have
                 both stations in the list are be marked as
                 unrecoverable and excluded from the solutions.

     nsites  -- the number of sites. If the number of sites is 1,
                then and only then this counter can be omitted.
                If the parser detects that the first parameter
                after the keyword  STA_INCLUDE, it considers
                nsites=1 and treats the first parameter as the
                name of the site.

    site1 sites ... -- list of sites. If a site has a blank
                       inside the name, that blank should be
                       replaced with the underscore.

STA_EXCLUDE   -- specifies which stations should be excluded
                 from the solutions when this session is analyzed.
                 All observations at the baselines with at least
                 one station in the list will be marked as
                 unrecoverable and excluded from the solutions.
                 If both STA_INCLUDE and STA_EXCLUDE keywords are
                 use, STA_EXLUDE excludes the stations that were
                 includede with STA_INCLUDE

     nsites  -- the number of sites. If the number of sites is 1,
                then and only then this counter can be omitted.
                If the parser detects that the first parameter
                after the keyword  STA_EXCLUDE, it considers
                nsites=1 and treats the first parameter as the
                name of the site.

    site1 sites ... -- list of sites. If a site has a blank
                       inside the name, that blank should be
                       replaced with the underscore.


STA_OFF  -- sets the flag indicating that position and velocity of
            the stations from the list, which follow this keyword,
            should not be estimated.


    nsites  -- the number of sites. If the number of sites is 1,
               then and only then this counter can be omitted.
               If the parser detects that the first parameter
               after the keyword  STA_OFF, it considers
               nsites=1 and treats the first parameter as the
               name of the site.

    site1 sites ... -- list of sites. If a site has a blank
```

inside the name, that blank should be
replaced with the underscore.

SUPMET -- specifies the suppression method used for determination
suppression status of each observation. This option
overrides suppression method which has been specified
in the $SETUP section of the control file with the
value which will be used for processing this experiment
only.

<value> -- one [UND or PRE98 or PRE91 or COMB1 or SNGBA]}

PRE98 - pre-1998 method

PRE91 - pre-1991 method (not recommended). Supported
for compatibility only.

COMB1 - combination method

SNGBA - single baseline method.

Refer to manual to ELIM for details.

SUPPRESS_XYULPE -- specifies which components of EOP and nutation
should not be estimated for this session
regardless contents of the $FLAGS section.

<ext_eop_comp_flag> - is a six-characters string. Each
character of the string specifies
suppress or not suppress the i-th
EOP parameter:

Y -- suppress (not to estimate)
N -- not to suppress (estimate if

it was specified in UT1/PM).
EOP are numbered as

1) X pole coordinate and its rate
2) Y pole coordinate and its rate
3) UT1
4) UT1 rate and 2-nd order of UT1
5) nutation in longitude
6) nutation in obliquity.

TEC_BIAS value -- specifies the bias in total electron contents (TEC)
in TEC units that will be added to the a priori
TEC for all the stations. TEC_BIAS has effect only
for processing single-band data type.

```
TEC_SCAL value -- specifies the scale for total electron contents (TEC)
                  that will be multiplied by the a priori TEC for all the
                  stations. TEC_SCA: has effect only for processing
                  single-band data type.


TYPE  -- keyword determines which type of data will be used.

       GDR, GD, PDR, PD - (obsolete format) uses the specified data type.
                          G and
                          P indicate group versus phase data.
                          D indicates delay data only, and
                          DR indicates delay and rate data.

      GRPRAT, PHSRAT, SNBRAT, GRPONL, PHSONL, SNBONL, RATONL, G_GXS,
      PX_GXS, PS_GXS, PX_GX, PX_GS, PS_GX, PS_GS, P_PXS, GX, GS, PX, PS

      specifies the flag of the data type for processing this session.
      It is a linear combination of phase delay, group delay, single
      band delay, delay rate at different bands

VTD_CONF control_file -- this keyword specifies the name of the control
                         file for VTD. This option will force BATCH
                         Solve to re-calculate theoretical time delay,
                         delay rate and partial derivatives on the fly
                         completely ignoring Calc.
```

Questions and comments about this guide should be directed to:

Leonid Petrov (Leonid.Petrov at nasa.gov)

Last update: