3. The Menu System

3.1 Introduction

3.1.1 Bernese GPS Processing Programs

The processing part of the *Bernese GPS Software* consists of more than 100 Fortran programs, designed for easy installation on a variety of computer platforms. Most of these programs run in a batch mode and they do not need any user interaction during execution time. All program options, lists of data (observation) files, and auxiliary files (e.g., the file containing Earth potential parameters) have to be prepared previously and made available to the program in special input files (the so-called `I-`, `F-`, or `N-`files). In the following sections we will always refer to these programs as *processing programs*.

One of the major design principles was to stick to standard Fortran 77 features and to omit any system- or installation-dependent language enhancements or to rely on given filenames or device and directory structures. This is one of the reasons why the processing programs do not need any user interaction, but fully rely on previously defined input option files, instead. These input files were initially meant to be prepared interactively, therefore they were designed to be rather verbose.

However, the growing number and complexity of the processing programs and the rapidly increasing volume of data to be processed required the development of tools helping the user to navigate through the various programs, to prepare the necessary input files, to handle the data and auxiliary files, and to keep track of the program output. Therefore, we decided to develop another series of programs, the so-called *menu system*.

3.1.2 The Bernese GPS Menu System for DOS, VMS, and UNIX

The menu system is an independent program system for the preparation of the input files and the management of all Bernese processing programs, data files, and of the program output.

It consists of

- a top-level program (MENU) allowing the user to select the specific task to be executed (e.g., to convert RINEX files to the Bernese binary observation files),
- a number of programs to allow the interactive preparation of the primary input files for the processing programs (principle: one preparatory program for each processing program),
- a number of programs for handling data files, program output, and menu system options,

- a number of command procedures to ensure the proper sequence of program calls and to prepare the necessary job environment.

Most of the user interaction (selection of programs, files, and options) is done through mask-type input panels. These panels are ASCII files.

In order to have the possibility to run a series of processing programs together with the preparation of the associated option input files fully automatically, we also provide a special non-interactive mode of operation that does not display the input panel files but takes the current content of the respective input fields in the panel files; we allow for special placeholders in the panel input fields that are automatically replaced by the actual values during execution of the preparatory programs.

Although we tried to follow the same design principles as for the processing programs, the menu system is slightly computer-dependent, because several tasks are

- outside of the capabilities of standard Fortran (e.g., the execution of system commands under the control of a Fortran program),
- dependent on the operating system (e.g., the creation of a list of existing files in a given directory),
- dependent on the terminal type (for non-standard output like, e.g., “clear screen”, “cursor position”, “attribute settings”).

Since version 3.2 of the *Bernese GPS Software* the menu system is available

- for the DEC VAX and Alpha Computers running under the OpenVMS operating system respectively,
- for Personal Computers under DOS (DOS-Box under MS-Windows) using a compiler (Lahey) that creates code to be run in protected mode in order to overcome the 640 kBytes limitation for the program size,
- for the UNIX operating system currently including various flavors and varieties on the Hewlett-Packard workstations, the SUN workstations under Sun-OS and Solaris, the IBM workstations under AIX, Linux on PC, and others (see Chapter 25.3 for a list of supported systems).

3.1.3 Structure of the Menu System

In order to gain a better overview of the various processing programs and their preparatory programs they have been grouped logically into a hierarchical structure. The top level is the major division into the first sub-levels (Figure 3.1). Each sub-level may again be divided into a number of lower-level branches until we arrive at the level of the actual preparatory programs.

```
0  DEFAULTS     : Defaults for Processing, Program and File Names
1  CAMPAIGNS    : Informations and Update of Campaigns
2  TRANSFER     : Data Transfer to Bernese Format; Simulation
3  ORBITS       : Orbit Computation, Check and Update
4  PROCESSING   : Preprocessing and Processing of Observations
5  SERVICES     : Service Programs
6  BPE          : Bernese Processing Engine
7  DOCU         : Documentation, Help Panels
9  USER         : Individual User Programs
```

Figure 3.1: Menu system top level.

Each branch is numbered from 0 to maximal 9. We access a specific branch by the series of the individual branch numbers, e.g.: `2.7.3` denotes the second branch on the top level, then the seventh branch on the first sublevel, and the third branch on the second sublevel.

```
top     first   second
         sub     sub

         1
 0       2
 1       3
 2 -->   4
 3       5
 4       6       1
 5       7 -->   2
                 3 -->  Program RNXMET_P
```

3.2 Starting the Menu System

3.2.1 Preparing the Environment (LOADGPS)

Before the MENU program can be run, the

- DOS batch file `X:\EXE\LOADGPS.BAT`, or
- VMS command file `X:[EXE]LOADGPS.COM`, or
- UNIX script file `$X/EXE/LOADGPS`

must be invoked to perform the following tasks:

- substitution of the general GPS-subdirectory by the drive name `X:` (and `$X` under UNIX),
- substitution of the user-dependent GPS-subdirectory by the logical `U:` (VMS), `$U` and `U:` (UNIX), `U:` (DOS),
- set system parameters that are used by the Lahey compiler (DOS only),

- define additional logicals and symbols (VMS),
- define additional variables (UNIX),
- define additional environment variables (DOS).

This command procedure could be called automatically by `AUTOEXEC.BAT` (DOS), the "Properties" settings of the DOS-window under Win9x, `LOGIN.COM` (VMS) or, e.g., `.profile` (UNIX) at system start-up time (see also Chapter 25).

```
@echo off
rem
rem  BATCH FILE TO PREPARE ENVIRONMENT FOR THE BERNESE GPS SOFTWARE
rem  -------------------------------------------------------------
rem
rem  Bernese GPS Software Version 4.2
rem  --------------------------------
     set VERSION=42
rem
rem  Operating System (W95 or WINNT)
rem  -------------------------------
REM     set OPSYS=W95
     set OPSYS=WINNT
rem
rem  Drive where Bernese is installed. Default is C:
rem  -----------------------------------------------
     set DRV=C:
rem
rem  Compiler command (lf90 or lf95). Default is lf90
rem  ------------------------------------------------
     set CMP_CMD=lf90
REM     set CMP_CMD=lf95
rem
rem ---- End of User Editable Part ----
rem
    ...
```

Figure 3.2: LOADGPS.BAT: Preparing the environment (DOS).

3.2.2 Calling the Menu System

The command procedure `G.BAT` (DOS) / `G.COM` (VMS), `G` (UNIX), executed by the symbol `G` on all platforms is used to start the *Bernese GPS Software*. It invokes the menu program MENU, the preparatory programs, and the processing programs. The following example (Figure 3.3) of the DOS command procedure contains comments to explain its operations.

```
@echo off
rem
rem                 Batch Program to Run the Menuprogram and to
rem          Invoke the Preparatory Program and the Mainframe Program
rem                           Selected by the User.
rem   --------------------------------------------------------------
rem                                Version 4.2
rem
rem  Parameter %1:  menu section to be executed first
rem  Write it to auxiliary file. It will be read back by MENU.
rem
     echo %1 >U:\WORK\MENU.AUX
rem
rem  copy options file into working directory
rem
     if not exist U:\WORK\MENU.OPT copy X:\SKL\MENU.OPT U:\WORK\*.* >nul:
rem
rem  Call menu program to display menu panels
rem
:menulabel
     %RUN% %C%\PGM\MENU%VERSION%\EXE\MENU
rem
rem  If the user selected preparatory program was to be executed,
rem  MENU would create a batch file MENUBAT1.BAT containing commands to
rem  execute the preparatory program.
rem
     if not exist U:\WORK\MENUBAT1.BAT goto end
rem
     call U:\WORK\MENUBAT1
rem
rem  If the user wanted the main program to be automatically
rem  executed (no abort of preparatory program, processing default to
rem  SUBMIT=YES), the preparatory program would create a batch file
rem  MENUBAT2.BAT containing commands to execute the main
rem  batch file.
rem
     if not exist U:\WORK\MENUBAT2.BAT goto menulabel
rem
     call U:\WORK\MENUBAT2
     goto menulabel
rem
:end
```

Figure 3.3: Menu system startup file for DOS.

`MENUBAT1.BAT` contains the command to execute the selected preparatory program *pgmnam*`_P`.

`MENUBAT2.BAT` contains the command to execute the selected processing program *pgmnam*.

Details on how the programs are called by the menu system can be found in Section 3.6.1.

UNIX version: because the scripts `MENUBAT1` and `MENUBAT2` have fixed names and are always saved in the `$U/WORK` directory it may be dangerous if *one* user runs the menu system *more than once* simultaneously on different terminals.

The *VMS version* shows one major difference w.r.t the other versions: The actually used filenames for the option and auxiliary files of the program MENU and the `MENUBAT1` and `MENUBAT2` procedures are process-specific: their original names are supplemented by the current process name as determined at startup by LOADGPS.COM. One and the same user can run the menu program simultaneously from different processes (e.g., if the user logs into the system several times under the same name). However, there may be conflicts between the different processes when accessing the same data files at the same time.

3.3 Panels

Three different panel types are used by the menu system:

(1) *Program panels* are used to navigate through the various levels of the menu system and to select the actual preparatory program (or other programs directly accessible through the menu system like, e.g., JOB — see Section 3.5).

(2) *Data panels* are displayed by the preparatory programs to select options, filenames, or other values and parameters that are used to prepare the basic input files for the processing programs.

(3) *Help Panels* contain information concerning the selected options and additional hints and tips for the programs.

All panels are simple ASCII files with the following naming conventions:

Program panels:	PAN_____.PAN: Top level panel
	PAN27___.PAN: Corresponds to selection 2.7
Data panels:	DAT273__.PAN: Primary panel of program 2.7.3
	DAT2731_.PAN: Subsequent data panel of 2.7.3 (i.e. 2.7.3-1)
Help panels:	DAT2731_.HLP: Help panel for data panel 2.7.3-1

The data panels for the preparatory programs again show a hierarchical order according to the logical structure of the programs, similar to the structure of the menu system. There is a maximum of 5 levels available in the panel naming (as the total of the program plus data panel levels). Unused levels are marked in the panel name with the "_" character.

The DOS version uses program, data, and help panels with graphic characters (ASCII values above 127) for the panel frames. For the VAX and UNIX version these characters have been replaced by standard characters like "−", "|", and "+".

3.3.1 Program Panels

The program panels are simplified panels that do not contain input fields. They are written to the screen by the MENU program using standard Fortran WRITE commands. The user input (usually the selected sublevel), entered after the prompt "Enter Selection :", is processed by MENU through the standard READ command.

```
     000000000111111
     123456789012345...
01  ======================================================================= = =
02  ||    4     |                      PROCESSING: OPTION MENU
03  ||----------+------------------------------------------------------------ - -
04  || S:Y C:1  |
05  ||----------+------------------------------------------------------------ - -
06  ||          |
07  ||    1     |   CODE CHECK      : Check Code Files for Outliers
08  ||    2     |   CODE PROCESSING : Single Point Positioning
09  ||    3     |   SINGLE DIFF.    : Form Single Difference Files
10  ||    4 ..  |   PHASE CHECK     : Check S.Diff. Files for Cycle Slips
11  ||    5     |   PAR. ESTIMATION : Estimation of Relevant Parameters
 .  ||    7     |   ION. ESTIMATION : Estimation of Ionosphere Models
 .  ||    8 ..  |   COMBINATION     : Combination of Solutions
    ||          |
    ======================================================================= = =
```

Figure 3.4: Left part of program panel `PAN4____.PAN`.

The second line of the program panel contains the level of the panel and a description. The fourth line also contains two fields: the first contains the current setting of the SUBMIT ("S") and JOBCLASS ("C") option (Menu 0.1 , see also Section 3.5, PRCDEF), the second is empty and may be used by the MENU program to display short messages.

The first six lines are part of the header of the panel.

The list of the branches (the panel body) starts at line 7. The branch numbers have to be in column 6. Two dots in the same field indicate that this branch will not yet call a preparatory program but will again split into various sub-branches.

```
                                                             11111
            66677777777777888888888899999                    22222
         ...789012345678901234567890123 4...              ...34567
01 = = =======================||===========||=====================================
02     MENU                   || Program   || Individual Paths                  ||
03 - - -----------------------||-----------||-----------------------------------||
04                            ||           ||                                   ||
05 - - -----------------------||-----------||-----------------------------------||
06                            ||           ||                                   ||
07     or Outliers            || CODCHK_P  ||                                   ||
08     ioning                 || CODSPP_P  ||                                   ||
09     ence Files             || SNGDIF_P  ||                                   ||
10     s for Cycle Slips      ||           ||                                   ||
11     vant Parameters        || GPSEST_P  ||                                   ||
12     sphere Models          || IONEST_P  ||                                   ||
 .     utions                 ||           ||                                   ||
 .                            ||           ||                                   ||
   = = =======================||===========||=====================================
```

Figure 3.5: Right part of program panel `PAN4____.PAN`.

A blank line concludes the body of the panel. Including the blank line the body may have a length of up to 11 lines.

10 additional lines may follow the body of the panel.

Columns 79 and following contain additional information never displayed by the MENU program (see Figure 3.5).

Entries in columns 81 to 88 determine whether a program is to be called, or the program panel of the next lower level is to be displayed. In the first case, columns 81 to 88 contain the name of the program to be called by the menu system (usually the preparatory program). The default path to the executable is defined in `X:\SKL\MENU.OPT`. Blanks in columns 81 to 88 will display the program panel of the next lower level.

More details to the program panel fields is available in Section 3.10.

3.3.2 Data Panels

Data panels are ASCII files containing in columns 81 ff. additional information used by the programs that read and interpret the panel files.

```
    000000000111111
    123456789012345...
01 ╔══════════════════════════════════════════════════════════════════ = =
02 ║2.5.1.1.2│          Trimble Rawdata Files to RINEX Files: Input 2
03 ║──────────────────────────────────────────────────────────────────  - -
04 ║
05 ║    Signal to Noise Ratio              Minimum    Threshold    Maximum
06 ║      Frequency L1                   >    3  <   >    8  <   >   42  <
07 ║      Frequency L2                   >   10  <   >   32  <   >  224  <
08 ║
09 ║    Tolerance for Jump Detection                 >  100  <   Microsecon
10 ║    Sampling Interval                            >    0  <   Seconds
11 ║    Offset to Full Minute                        >    0  <   Seconds
 .
 . ║
```

Figure 3.6: Left part of a data panel.

The data panel consists of a header of 3 lines and a body of an unlimited number of lines.

Each actual data input field is delimited by a right bracket (>) and a blank to the left end and a blank and a left bracket (<) to the right.

Obviously, such brackets may not be used anywhere in the panel text, as they would be interpreted as the start or the end of an input field.

At the right end of the data panel (see Figure 3.7) unique keywords for each input field have to be defined. There may be as many as 5 keywords (and corresponding input fields) on each line of the panel. The keywords start at cols. 82, 91, 100, 109, and 118, and may have a length of up to 8 characters.

The order of the keywords within the line has to correspond to the order of the respective input fields. Apart from this restriction the input fields may be positioned anywhere within the panel body. The access routines reading the panels read the input fields according to the corresponding keyword. A string of 8 double frame characters (PC) or 8 dashes (–) in one of the keyword fields (i.e., the bottom line of the frame around the panel) will indicate to the Fortran access routines (`GETPAN.FOR`, `PTKEYW.FOR`) the end of the panel.

It is also allowed to repeat the same keywords in different lines (see comments in the subroutine GTKEYW), as it is done, e.g., in the campaign definition panel `DAT11___.PAN`.

```
                                   7777777777888888888899999
                                ...1234567890123456789012345...
01 ══════════════════════════════════════════════╗╔══════════════════════════════╗
02   iles to RINEX Files: Input 2                ║║ KEYWORDS                     ║
03 ──────────────────────────────────────────────║║─┼─────────┼─────────┼────────║
04                                               ║║                              ║
05     Minimum     Threshold     Maximum         ║║                              ║
06    >    3  <   >    8  <   >   42  <          ║║ MIN1      THR1      MAX1     ║
07    >   10  <   >   32  <   >  224  <          ║║ MIN2      THR2      MAX2     ║
08                                               ║║                              ║
09                >  100  <   Microseconds       ║║ TOLER                        ║
10                >    0  <   Seconds            ║║ INTERV                       ║
11                >    0  <   Seconds            ║║ OFFSET                       ║
 .                                               .                                .
 .                                               .                                .
```

Figure 3.7: Right part of data panel.

Interaction with the User

The interaction with the user is done by means of a system-independent Fortran routine (DSPPAN) and some system-dependent routines for cursor positioning, character attribute setting, character display, and keyboard operation. The interfaces to the system-dependent Fortran routines have been defined in a system-independent way, therefore the main routine DSPPAN is identical under DOS, VAX, and UNIX.

The next lower level consists of the routines DSPFLD (to display a range of characters at a defined position on the screen), CLRSCR (to clear the screen), and RDKYBD (to wait for and accept a single keystroke). DSPFLD and CLRSCR use `ANSI.SYS` (DOS) or VT200 type escape sequences.

RDKYBD calls a Lahey routine (IXKEY for LF77, INKEYPAD, INKEYEVENT for LF90, a C-Routine for LF95) via routine INPCHR or, on the VAX system, routines using VMS-QIO system to determine what key has been entered and then defines a corresponding (system-independent) “action code”.

On UNIX systems we use the curses library which provides special C-routines for terminal handling.

The relation between the system-dependent key code or return code from the input routine and the corresponding “action code” is defined in a key code table file, the name of which is handed over to the program in the file `U:\WORK\KEYBOARD.TBL / U:[WORK]KEYBOARD.TBL / $U/WORK/KEYBOARD.TBL`. This file is prepared by the startup procedure `LOADGPS`, i.e., this is where the selection of the active key code table is actually performed.

The key code table on PCs is called `X:\SKL\PC_LAHEY.L92` for LF90, `X:\SKL\WIN_NT.KBD` for LF95 systems, on VT200 terminals on the VAX under VMS it is `X:[SKL]VMS_200.KBD`.

For UNIX the definition of the key codes depends on the use of the keypad() function in the `U_CUINIT.c` routine.

keypad active: You will get terminal-independent return codes for each key. (Refer to curses manual)

keypad inactive: The return codes are terminal-dependent. (Refer to your terminal manuals)

There are various key code tables available in the directory `$X/SKL` for different window environments and platforms (see command file `LOADGPS`).

The "action code" tells the calling program whether only a character key has been pressed or whether the user wants to execute some special action like moving the cursor to another input field, scrolling the screen up or down, delete characters or input fields, etc. The predefined action codes are linked to function keys or key combinations like Ctrl A or special keys like Enter or PgUp , etc. Pressing the help key (F1 on the PC, PF1 on the VT220) displays a help panel (see below) showing the available options and corresponding key strokes (If you got a help panel for the input fields "only", you have to press the F1 resp. PF1 once more.).

The most important key is the $<$ CONTINUE $>$ key to end the data entries and to continue with the program. We chose the left most key in the top row of the keyboard (ASCII value 96 decimal, key ') because it is comfortably placed and never used for anything else. On some keyboards, however this key might be found at a different place (!).

By pressing Esc twice (on DOS platforms only once!) you also invoke $<$ CONTINUE $>$.

You might of course easily re-program the key assignments according to your preferences by merely changing the key code tables. Please keep in mind that changes in this file affect other Bernese users, as well. Use the program KBTEST to determine the key codes of your keyboard. To run the program, enter

```
RMENU KBTEST.
```

Pressing any key will immediately show the respective key code (in decimal) or, for function or other non-standard keys, maybe a series of key codes. These codes then have to be written into the active key code table into the proper row.

The access to the data entered by the user into the data panel files is then performed by the routine GTKEYW with the data panel name and the keyword as input parameters and the string of the corresponding data field as output parameter.

3.3.3 Help Panels

Help panels are ASCII files, too. For nearly every data panel, there is a corresponding help panel with the same filename but the extension `.HLP`. It is stored in the directory `X:\HLP / X:[HLP] / $X/HLP`.

Help panels are displayed by pressing F1 or PF1. (A help panel also exists for the program panels. It may be displayed by entering "`=H`" in the MENU prompt).

Most of the help panels contain information and examples for all the input fields, sorted in the same order and flagged with the same short descriptive keywords (the uppercase description to the left of the input fields). When pressing the help key the corresponding section of the help panel should be displayed.

Help panels may contain links to other help or data panels or any other ASCII files. These links are embedded in brackets (e.g. `{DAT123__}` or `{U:[PAN]DAT123__.PAN}`). The default directory for the links is `X:\HLP` etc. and default extension is `.HLP`. The linked file is displayed by moving the cursor to the link field and pressing the help key again. If the link points to a help panel, F1 displays the help panel and F2 displays the corresponding data panel in `U:\PAN / U:[PAN] / $U/PAN`.

Pressing the help key when a help panel is displayed and the cursor is outside of a link field will display a general help panel showing all special key functions used for data entry in the respective data panels.

3.4 Selections

This section summarizes the use of the menu and data panels and describes the input options.

3.4.1 Menu Selections

After having started the menu system using the command "`G`" the top level (primary) program panel is displayed. Four types of input are possible:

(1) Selection of the menu item in the form "`i.j.k`":

The menu system will first go to selection i of the *current* level, then to selection j of the next sublevel and then to selection k of the third level. Each sub-selection is separated from the others through a period. You may enter in one command as many sub-selections as there are actually defined. The selection always starts at the *current* level!

Examples: `1, 4.2, 2.7.1`.

(2) Selection of the menu item in the form "`=i.j.k`":

The equal sign "=" tells the menu system to first go up to the top level and then down to selection i of the primary panel, etc. Such a selection might be called an *absolute* selection. It is independent of the current position within the menu system hierarchy.

(3) Special Selections `=H, =S, =P, =Q, =X`:

`=H` displays a help panel, either the program's help panel (if it exists) or a general help panel showing the basic commands for the menu selection.

`=S` allows to search for the menu system location of a specific program name. The menu system will ask you for the program name. Wildcards are allowed, e.g., entering `GPS*` will result in

```
PROGRAM GPSEST_P : NR 5 IN PANEL 4
PROGRAM GPSXTR_P : NR 5 IN PANEL 5.6
```

`=P` will bring you to the primary program panel.

`=Q` will bring you up one level.

`=X` will properly exit the menu system and go to the operating system prompt.

(4) Any other input:

Any other input will be passed to the operating system and immediately be executed. Some commands are filtered and *not* passed through, such as `LOGOFF` to avoid menu scratch files hanging around.

The menu system can also be started up by "`G i.j.k`" to immediately go to sublevel `i.j.k` .

3.4.2 Option Selections in Data Panels

Data panels contain input fields for all user entries. The display routine only allows you to move the cursor within these fields and from one field to another. The usual keys (cursor keys, PgUp, PgDn, etc.) may be used (press twice the help key to get the general help panel with the key descriptions).

Immediately to the right of the input fields you usually find a list of the allowed entries as uppercase KEYWORDS within parentheses. Instead of entering the desired keyword manually you may also scan through the keywords using the space key if the cursor is positioned at the start of the input field (toggling).

Some options only ask for YES, NO, and ASIS. YES will bring a follow-up subpanel with options to choose from, NO will of course not make use of these options, ASIS ("as is") acts as YES but will *not* display these options and take the values as they were stored in the respective panel at an earlier time.

The entry ''=Q'' brings you back to the previous data panel or to the first data panel of the preparatory program.

You may also enter ''=X'' into most of the input fields to immediately exit the current preparatory program and to go back to the menu system.

Enter ''=i.j.k'' to exit the preparatory program and go to sublevel i.j.k of the menu system.

We recommend to enter such exit commands into the campaign field of the first data panel (because this field will be filled in automatically with the currently selected campaign name the next time you enter the program).

The key combination ^D (Ctrl D) allows you to enter a command for immediate execution by the operating system.

3.4.3 File Selections

Many input fields concern names of files to be processed. Most of these fields only request the "stem" of the filenames, i.e. the filename extensions, the correct paths to the files being determined elsewhere (depending on the requested files, the menu system determines this additional information from the panels under Menu 0.3).

You may either directly insert the correct name of the file (when just one file has to be processed) or you may have the menu system display a selection list where you can mark all the files you want to process (usually the full names of the selected files will be passed to the processing program through the F-file).

To generate a file selection table you may either leave the input field blank (which will display all available files of the correct file type and current campaign) or you may limit the number of displayed filenames by using a wildcard notation:

Examples:

Phase files: `ABCD*` will display all available files from station ABCD

Single difference files: `????1234` will display all files from session 1234

A question mark or percent sign (VMS) is a place holder for exactly one character. An asterisk may be replaced by any number of characters. (DOS version: characters after an asterisk are allowed for zero-difference and single-difference files only!).

Files are selected by writing an "S" into the selection column of the selection table.

```
X:\TESTV42\RAW\                          RINEX FILE SELECTION

  ALBH2350.96O                     1787392  25-AUG-96  21:59:12
  ALGO2350.96O                     1731584  25-AUG-96  21:59:21
  AREQ2350.96O                     1858048  25-AUG-96  21:59:29
S ASC12350.96O                     1924608  25-AUG-96  21:59:39
  AUCK2350.96O                     1889280  25-AUG-96  21:59:49
S BAHR2350.96O                     2567680  25-AUG-96  22:00:00
  BOGT2350.96O                     1757184  25-AUG-96  22:00:20
S BOR12350.96O                     1318912  25-AUG-96  22:00:12
S BRDC2350.96N                      219648  25-AUG-96  22:12:55
  BRMU2350.96O                     1767936  25-AUG-96  22:00:29
  BRUS2350.96O                     1748480  25-AUG-96  22:00:38
```

Figure 3.8: Example: General file selection panel.

```
   File    Start Date   Frq    Stations           Receivers      Ant.heights

  ACAN2321 19-AUG-96 06:59 2 TIDB 50103M108B   ROGUE SNR-8        0.061
  ACAS2321 19-AUG-96 00:00 2 CAS1 66011M001    ROGUE SNR-8100     0.001
  ACHA2321 19-AUG-96 00:00 2 CHAT 50207M001    ROGUE SNR-8000     0.003
S ACOC2321 19-AUG-96 00:05 2 COCO              ROGUE SNR-8100     0.004
S ADAV2321 19-AUG-96 00:00 2 DAV1 66010M001    ROGUE SNR-8100     0.004
S AGUA2321 19-AUG-96 00:00 2 GUAM 50501M002    ROGUE SNR-8000     0.061
S AHO22321 19-AUG-96 00:00 2 HOB2 50116M004    ROGUE SNR-8100     0.000
S AKER2321 19-AUG-96 00:00 2 KERG 91201M002    ROGUE SNR-8C       0.420
  AMAC2321 19-AUG-96 00:00 2 MAC1 50135M001    ROGUE SNR-8100     0.036
  AMC42321 19-AUG-96 00:00 2 MCM4 66001M003    ROGUE SNR-8000     0.183
  APAM2321 19-AUG-96 00:00 2 PAMA 92201M003    ROGUE SNR-8100     7.790
  APER2321 19-AUG-96 00:00 2 PERT 50133M001    ROGUE SNR-8100     0.060
  AUCK2321 19-AUG-96 00:00 2 AUCK 50209M001    ROGUE SNR-8000     0.002
  AYAR2321 19-AUG-96 00:00 2 YAR1 50107M004    ROGUE SNR-8        0.073
  BHAR2321 19-AUG-96 00:00 2 HART 30302M002    ROGUE SNR-8000     9.754
  BMAL2321 19-AUG-96 00:00 2 MALI 33201M001    ROGUE SNR-8C       0.222
```

Figure 3.9: Example: Observation file selection panel.

The menu system maintains separate files containing the latest file selection for various file types (e.g. phase single diff. files, file `U:\WORK\PHSFILE.SEL`, `U:[WORK]PHSFILE.SEL`, `U:/WORK/PHSFILE.SEL`) and replaces the user input in the data panel by `SELECTED` whenever the user interaction results in more than one selected file. (Exception: file selections containing file-name parameters are *not* replaced!) Subsequent calls of the preparatory program will then access the previous file selections through the stored file selection list.

Special Selection Characters

If the selection table is containing the names of ASCII files you may look at the contents of the files by typing `B` (for "browse") into the selection column. The action is immediate, no continuation character has to be entered.

Typing `Q` brings you back to the previous panel, `X` leaves to the Menu System.

Entering `^D` allows you to enter a command that is immediately passed to the operating system.

Exception: `^D` and subsequently `S ALL` selects *all* files in the selection list. (In fact *c* `ALL` marks all files with the selection character *c*: some menu programs like OBS Menu 5.1 or JOB Menu 5.9 use other selection characters, as well).

The key `^D` followed by `RESET ALL` clears all current selections.

Filename Parameters

The Panel 1.5.1 allows you to define values for so-called filename parameters that can be used to facilitate routine or semi-automatic operation. More information is available in Section 3.8.

Example:

`????$SS1` will include into the selection list all available files of the session $SS1 only. The value of $SS1 has to be previously defined in Panel 1.5.1 .

3.5 Special Menu Commands

In order to simplify the use of some frequently used menu programs we defined some special commands, to be entered either at the operating system prompt or as input to the MENU program after the “`Enter selection: `” prompt. You find the corresponding command files in the directory `X:\EXE / $X/EXE / X:[EXE]`.

PRCDEF

`PRCDEF` (for *processing defaults*) calls the menu program DSPDPAN to display Panel 0.1 . In this panel you may set some processing default parameters, such as SUBMIT and JOBCLASS (see Section 3.6.1) .

SUBMIT defines whether (after the preparation of all processing program option input files) the processing program shall be called or whether the menu system should go back to the program panel level *without* executing the processing program.

On multitask systems JOBCLASS defines the processing mode *foreground* or *background*:

- JOBCLASS = 0 denotes foreground processing.
- JOBCLASSES 1 to 4 define different batch processing queues in VMS (logicals `BATCH1, ..., BATCH4`, their actual values have to be defined on the system level, e.g. `DEFINE BATCH1 SYS$BATCH`) or priorities in UNIX (an example for a command script is given in Section 3.11.2).
- Negative values -1, ..., -4 call the same batch queues 1 to 4, but with “timed” execution (you will get a panel displayed where you can enter the actual execution time).

The only meaningful value for JOBCLASS under DOS is 0!

PRCDEF is identical to ''G 0.1'' on the system level or ''=0.1'' on the menu level, with the exception that after having processed Panel 0.1, the former command brings you back to where you were, whereas the latter will bring you to the Menu 0.

JOB

JOB calls the menu program JOB. It corresponds to ''G 5.9'' or ''=5.9'' respectively, again with the difference of where you will go to after completion of the JOB command.

JOB allows you to handle the job outputs of the processing programs (browse, edit, print, copy to another file, delete) if you had them stored into a job output file (and not just displayed on the screen, see Panel 0.1). More information is available in Section 3.6.2.

OBS

OBS calls the menu program SERVOBS. It corresponds to ''G 5.1'' or ''=5.1'' respectively, again with the difference of where you will end up after command completion.

OBS allows you to browse, edit, display, or split the binary observation files or to mark/unmark observations in these files (see Chapter 21, "Services").

ERR, ERRDEL

Most processing programs may generate error messages that are stored into the SYSERR output file. SYSERR is the internal name, the actual name of the error message file is defined in Panel 0.3.1. Usually the file is named ERROR.MSG in the directory U:/WORK (UNIX), U:[WORK] (VMS), U:\WORK (DOS).

ERR is a symbol or command file that allows you to look at this error message file. ERRDEL browses *and deletes* the file.

The menu system displays a message in the message field of the program panels, whenever (and as long as) an error message file was created.

More details are available in Section 3.7.

SJ

SJ *pgmnam* (SJ for *Submit Job*) allows you to execute the processing program *pgmnam* using previously defined option files. This command has to be used whenever SUBMIT (see Panel 0.1) is set to NO in order to not execute the program. If you change some information directly in the primary option input files (N-, I-, or F-files), you may also reprocess *pgmnam* using SJ (see also Section 3.6.1).

3.6 Job Submission and Job Output Handling

3.6.1 Submit Jobs

The preparatory program *pgmnam*_P prepares the command file *pgmnam*.BAT (DOS) or *pgmnam*.COM (VMS and UNIX) containing the actual commands to properly call the processing program *pgmnam*. If SUBMIT (see Panel 0.1) is set to NO, the menu system does not immediately execute this command file.

If the program crashes you might want to see the error messages again; or you would like to execute the program again after having "manually" changed some input parameters directly in the `N-`, `I-`, or `F`-files (something an advanced user might want to do!). You may directly execute the program later by just typing `SJ` *pgmnam*.

The command file *pgmnam*`.COM` is always created by the preparatory program irrespective of the current setting of the SUBMIT and JOBCLASS processing defaults. It contains the actual call of the executable file *pgmnam*`.EXE` (VMS) or *pgmnam* (UNIX) and the command to create a copy of the `N`-file in the current directory under the name of *pgmnam*`N` (which is *hard-wired* into all the processing programs!).

In order to execute *pgmnam*`.COM` properly, i.e., according to the JOBCLASS parameter, the menu system prepares an additional command file *pgmnam*`.CTL` containing the proper commands. You call this file by typing:

`SJ` *pgmnam*

VMS: `SJ` is a symbol that points to a command file `X:[EXE]SUBJOB.COM`,
UNIX, DOS: `SJ` is an executable script file, see Section 3.11.3.

Whenever SUBMIT is set to NO, the menu system will remind you how to execute the processing program manually with a message in the message field of the menu panels.

3.6.2 Job Output

The primary job output may either be written to the standard output (the screen in the interactive processing mode (JOB CLASS = 0) or the LOG file in the VMS batch processing mode) or routed to a special job output file (which is the recommended practice). Values are defined in Panel 0.1 or by PRCDEF.

The name of the job output is *pgmnam*`.L`*nn*, e.g., `GPSEST.L15`. *pgmnam* is the name of the processing program (e.g. `GPSEST`), and *nn* is a number between 00 and 99. The menu system automatically increases the number within the valid range (it keeps track of the number to be used in the file *pgmnam*`.J` in the campaign's `OUT` subdirectory).

The job output of most of the programs are stored in the campaign's `OUT` subdirectory, i.e., they are campaign-dependent, and you may retain up to 100 job output files per program and campaign. Only very few programs store their output into a directory that may be selected in Menu 0.1).

If 100 different job output files are not enough you could ask the menu system to use three digits *nnn* in the job output filename extension. This is also set in Menu 0.1 . The filename will then look like *pgmnam.nnn*.

The Menu 5.9 or the command `JOB` allows you to handle the job output of the processing programs (browse, edit, print, copy to another file, delete). You may also reset the job output counter to any valid number by the same program.

3.7 Error Handling

3.7.1 Error Message File

Most processing programs may generate error messages and warnings that are stored in the SYSERR output file. SYSERR is the internal name *hardwired* in the processing programs. The actual (external) name of the error message file is defined in Panel 0.3.1, usually the name `$U/WORK/ERROR.MSG` is used. The same Panel 0.3.1 allows you to specify whether you really want to store the messages into a file or whether you prefer to have them included into the standard job output (background operation only, in foreground the messages are *always* written to the special file).

The menu system displays a message in the message field of the program panels, whenever (and as long as) this error message file exists.

You may look at and delete the error message file using the commands `ERR` and `ERRDEL` respectively (see Section 3.5).

3.7.2 Return Codes

Depending on the operating system, the Fortran subroutine EXITRC calls, if available, a routine EXIT with an exit status value that may signal an error condition to the operating system. More details may be found as comments in the source code of EXITRC and also in your Fortran users guide for the use of EXIT and its parameter.

These error conditions could be used and tested in command procedures for the semi-automated processing (see Section 3.8). They are extensively used by the Bernese Processing Engine (BPE) (see Chapter 22).

3.8 Semi-Automated Processing

Usually, the processing follows the same pattern. In the case of a single session we distinguish the following steps:

- Import of the data (RINEX → Bernese),
- Import of the orbits (precise → standard),
- Computation of receiver clocks,
- Network definition (→ single difference file creation),
- Check of phase data (cycle slip detection and repair),
- Double-difference processing,
- Interpretation of the results.

Each step usually consists of two parts: the preparation of the major input files through interactive option and file selection, and the execution of the corresponding processing programs.

The majority of the selected options in the data panels do not change from one session to the next. The session number *is* changing, however, implying that the names of the observation and orbit files change, as well.

Provided there are no major decisions to be taken between the steps, an automated sequencing through the steps of, e.g., one session is easily realized:

(1) We have to prepare the data panels beforehand.

(2) We have to provide the possibility to introduce certain parts of the data panel input fields as variable parameters, the values of which are determined at run time only (→ *filename parameters*, see below).

(3) We have to provide the possibility to run the preparatory programs without actual user interaction.

(4) We have to prepare special command files that contain the calls to both the preparatory programs and the processing programs in the proper order.

Ad (1):

The easiest way to prepare the panels properly is to actually run a sample session. In order to prevent overwriting the prepared panels it is recommended practice to save these panel files into a separate directory and to copy them into the user directory `$U/PAN` as part of the automated procedure.

Ad (2):

All those input fields that ask for file names (and some others as well, see help panel of Menu 1.5.1) accept the so-called filename parameters, i.e. a code starting with a dollar sign, e.g. `$CD1`. These codes are place holders, have the same length (number of characters) as the values they stand for, and they will be replaced by the actual values at run time.

The values are defined in Menu 1.5.1, either interactively or by means of an auxiliary program PUTKEYW, see below.

Example: `????$SS1`

The four question marks (VMS: percent signs) stand for any four characters, e.g. the code for the stations in observation files. The filename parameter `$SS1` will be replaced by the session number, previously defined in Menu 1.5.1. When calling the preparatory program interactively you would get a file selection table containing all existing observation files of the current campaign and the defined session, i.e. all the files you actually want to process.

Some of the parameters allow the assignment of up to three different values (e.g. $SS1 may have the values 4321 and 4323 and 4325, so that the files of these three sessions would be selected), some of the parameters allow for ranges ($4325 + 4 - 3$, i.e. all sessions between 4322 and 4329), details are found in the help panel of menu Menu 1.5.1.

Ad (3):

The subroutine DSPPAN displaying the data and file selection panels determines the current mode of operation by checking the existence of a "flag file" `U:/WORK/IAMODE.`*proc_id*. This file has to be created (*and deleted!)* by the general command file (see item (4)). *proc_id* is the current process identification under VMS (symbol defined by `LOADGPS`) to allow for more than one simultaneous automated processing (which has to be handled *very* carefully to prevent undesired interferences through panel or other files!). Under UNIX and DOS *proc_id* is set blank.

Whenever a file selection panel has to be prepared by the menu system in the non-interactive mode, it will automatically select all the files contained in the selection list. Therefore, you have to use a combination of wildcard characters (* and ?) and filename parameters to get the correct automatic file selection.

Ad (4):

The sample command file
`X:[EXE]AUTOSESS.COM / $X/EXE/AUTOSESS / X:\EXE\AUTOSESS.BAT`
shows the major steps to be performed for the automated processing of one session.

The program PUTKEYW, called by the command file `$X/EXE/PUTKEYW` etc, allows to directly write an option value into a specific input field. It reads from the standard input a first record containing the panel file name and in a second record the value and the keyword name of the input field (i.e., the name to be found in the panel file in columns 81ff.). All input consists of non-quoted ASCII strings, blanks act as delimiters.

The Bernese Processing Engine BPE (see Chapter 22) makes extensive use of these automation techniques.

3.9 Calling Programs Without the Menu System

There are few processing programs not included in the menu system, such as the simulation program GPSSIM. Of course you may still run these programs, but you have to prepare their primary options files (the `I-`, `N-`, and `F-`files) manually. There is a command procedure RUNGPS available (under VMS the symbol `RUNGPS` calls the command file `X:[EXE]RUNGPS.COM`), that displays the proper `I-`, `N-`, and `F-`file using the standard editor for modification, copies them to the working directory, and finally calls the processing program.

Example: `RUNGPS GPSSIM`

Sample `I-`, `N-`, and `F-`files for these programs are available in the directory `$X/INX`, etc, under the names *pgmnam*`N.INP`, *pgmnam*`I.INP`, and *pgmnam*`F.INP`, respectively. You have to copy them to `$U/INP`, etc.

In order to merely execute a preparatory program *pgmnam*`_P` or a processing program without any additional file copying, etc, you may use the command procedures (VMS: symbols) `RMENU` and `RMAIN`, respectively.

Examples: `RMENU GPSEST_P`, `RMAIN GPSEST`

The former command should be used on the *operating system prompt* if the preparatory program runs into a non-recoverable execution error to better see the system error messages.

The latter command might be used to run a processing program in the foreground to observe any runtime system error messages.

3.10 User-Specific Additions to the Menu System

With the exception of the primary program panel *selection 0* is never used by the menu system. Therefore, the user has the possibility to add his own sublevels to any one of the program panels. The escape to user program panels from the primary panel goes through selection 9 .

You have to follow these steps to add user-specific program panels and programs:

(1) Add the new selection (0) into the program panel of your choice to escape to a new sublevel.

(2) Prepare a new program panel, the name of which is `PAN`*ijk*`0_.PAN` in the directory `$U/PAN` etc, if you added the selection to panel `PAN`*ijk*`__.PAN`. Please keep in mind that there are five possible levels for both the program and the data panels. The easiest way to prepare a new panel is to copy an existing one to the new name and modify it according to your task.

(3) Include into the new panel any selections according to your needs. Make sure that the columns 81ff. are empty if the selection points to a new program panel or that they contain the name of and the path to the program to be called (see below for details).

(4) Put your program executables into the proper directories.

(5) After successful tests copy the new panels from `$U/PAN` to `$X/PAN` and, if appropriate, to other user panel directories. Use the panel update program(see Section 22.7.1) to distribute changes in the data panels to other users.

We recommend to escape to user program panels and programs through selection 9 of the primary program panel only, because user additions to existing panels will not be preserved after version updates. In any case you should carefully backup your own program panels before any version updates.

Let us give here some more rules and details to be observed (see also Section 3.3.1 and Figures 3.4 and 3.5):

Program Calls

Columns 81 to 88 contain the name of the program that is to be called by the menu system (usually the preparatory program). The default path to the executable is defined in `$X/SKL/MENU.OPT` .

Blanks in columns 81 to 88 indicate that there is no program to be called but a program panel of the next lower level is to be displayed.

Individual Paths

Columns 91 to 125 may contain an individual path to the executable, overriding the default in `MENU.OPT` . The current menu system version does not make use of these individual paths. So, most program panels do not contain information in columns 90 to 127.

Addition of Programs (DOS) or Calls with Symbols (VMS)

An exclamation character (!) in column 80 tells the program to send whatever text there is in cols. 81 to 88 to the operating system, preceded by any individual path found on the same line in cols. 91 to

125. Calls to programs or command files using predefined symbols (VMS) or execution of .COM or .EXE files in DOS may be included in this way into the menu system.

Calls to batch files (.BAT in DOS), command files (.COM in VMS) or script files (no extension in UNIX) are performed by putting an "at" sign (@) into col. 80. Either the individual path (if found) or the default path defined in `MENU.OPT` will be used to call the file defined in cols. 81 to 88 (preceded by the proper command CALL in DOS or "@" in VMS).

Display of Data Panels

A percent character (%) in col. 80 tells the MENU program to call a special program to display the data panel with the name stored in cols. 81 to 88. The name of the display program (DSPDPAN) is specified in `MENU.OPT`. This option is mainly used in Menu 0.

An "&" in col. 80 tells the MENU program to call a special program to display the data panel the name of which is stored in cols. 81 to 88. The name of the display program (UPDTPAN) is given in `MENU.OPT`.

3.11 Technical Details

3.11.1 Command Files *pgmnam*.BAT (DOS), *pgmnam*.COM (VMS and UNIX)

The command file *pgmnam*`.BAT` or *pgmnam*`.COM`, created by the preparatory program *pgmnam*_P irrespectively of the current setting of the SUBMIT and JOBCLASS processing defaults, contains the actual call to the executable file *pgmnam*`.EXE` / *pgmnam* and the command to create a copy of the `N`-file in the current directory under the name of *pgmnam*`N` (which is hardwired into all the processing programs!).

The command file also deletes the auxiliary file *pgmnam*`.SCR` if it already exists. At runtime Lahey would run into an error if a previously existing auxiliary file written with formatted records would now be opened for unformatted access (with `STATUS='UNKNOWN'`).

Examples for such a command file to call a processing program are given in Figures 3.10 (DOS), 3.11 (VMS), and 3.12 (UNIX).

```
@ECHO OFF
IF EXIST U:\WORK\ORBGEN.SCR DEL U:\WORK\ORBGEN.SCR >NUL:
COPY U:\INP\ORBGENN.INP ORBGENN >NUL:
%RUN% C:\PGM\MAIN42\EXE\ORBGEN.EXE
IF EXIST U:\WORK\ORBGEN.SCR DEL U:\WORK\ORBGEN.SCR >NUL:
DEL ORBGENN >NUL:
```

Figure 3.10: DOS example: `U:\WORK\ORBGEN.BAT`.

```
$ IEXIT == "1"
$ SET DEFAULT U:[WORK]
$ COPY U:[INP]ORBGENN.INP ORBGENN.DAT
$ ASSIGN/USER_MODE SYS$COMMAND SYS$INPUT
$ R XG:ORBGEN.EXE
$ IF $SEVERITY .NE. 1 THEN IEXIT == "3"
$ DELETE ORBGENN.DAT;
$ AUXFIL=F$SEARCH("U:[WORK]ORBGEN.SCR;*")
$ IF(AUXFIL .NES. "") THEN DELETE U:[WORK]ORBGEN.SCR;*
$ EXIT 'IEXIT'
```

Figure 3.11: VMS example: `U:[WORK]ORBGEN.COM`.

```
cd $2
cp U:/INP/ORBGENN.INP ORBGENN
echo "U:/WORK/ORBGEN.COM started at : `date`"
iex="0"
time XG:/ORBGEN
if [ $? != "0" ]
then
   iex="1"
fi
echo "U:/WORK/ORBGEN.COM   ended at : `date`
echo >$1
if test -f U:/WORK/ORBGEN.LOG
then
   tail -1 U:/WORK/ORBGEN.LOG >$1
fi
if test -f U:/WORK/ORBGEN.SCR
then
  rm U:/WORK/ORBGEN.SCR
fi
if [ $iex = ``1'' ]
then
  exit 1
fi
```

Figure 3.12: UNIX example: `$U/WORK/ORBGEN.COM`.

3.11.2 Command file *pgmnam*.CTL

In addition, the VMS and UNIX versions (see subroutine `VMS_CREBAT.FOR`, `U_CREBAT.f`) create a file *pgmnam*`.CTL` containing the commands to either call *pgmnam*`.COM` in the *foreground*:

VMS Example: `$ @U:[WORK]ORBGEN.COM`

UNIX Example:
```
cons=`tty`
sh U:/WORK/ORBGEN.COM ${cons} $U/WORK
```

or to submit the program to a batch queue into the *background*:

VMS Example:
```
$ SUBMIT/QUEUE='BATCH1'/NOPRINT/NOTIFY-
    /LOG=U:[WORK]ORBGEN.LOG U:[WORK]ORBGEN.COM
```

UNIX Example:
```
cons=`tty`
nohup nice -${PRIO1} sh U:/WORK/ORBGEN.COM ${cons} $U/WORK
                        >>U:/WORK:/ORBGEN.LOG &
```

according to the processing default defined in Menu 0.1 .

3.11.3 Command File SUBJOB.COM (VMS), SJ (UNIX)

The *pgmnam*.CTL file may be executed manually by means of a symbol SJ (standing for "@X:[EXE]SUBJOB") or a shell script SJ (for UNIX), e.g.: SJ ORBGEN.

VMS Example:
```
$ @U:[WORK]'P1'.CTL
```

UNIX Example:
```
cd $U/WORK
sh $1.CTL
```

3.11.4 Skeleton Files

The I- and F-files are pure ASCII files with a fairly complicated structure. The I-files in particular contain a lot of explanatory text. The properly formatted READ statements for these files are coded in the processing programs. In order *not* to depend too much on the actual format of these files in the coding of the preparatory programs we use so-called skeleton files (to be found in the directory $X/SKL, etc.) containing the proper structure with all the explanatory text. The fields where the actual data has to be written, are indicated with strings of percent characters. A subroutine (FILSKL) takes the proper skeleton panel, fills in the actual options values and creates the corresponding options file.

The directory $X/SKL, etc also contains similar skeleton files used for the run time creation of some data input panels. *The skeleton files must not be modified!*

```
RXOBV3: OPTION INPUT FILE                                   %%%%%%%%%%%%%%%
------------------------------------------------------------------------
(REMARK: YES=1,NO=0 ; 2 EMPTY LINES AFTER EVERY INPUT GROUP)

CAMPAIGN NAME:
-------------
      ****************

--> : %%%%%%%%%%%%%%%%


TITLE LINE:
----------
      *****************************************************

--> : %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%


RINEX FLAG INTERPRETATION:
--------------------------
                                 **

MINIMAL SIGNAL STRENGTH    --> : %%
ACCEPT CYCLE SLIP FLAGS    --> : %%

...
```

Figure 3.13: Sample skeleton file for `I`-file (extract).

```
RXOBV3: OPTION INPUT FILE                                   17-AUG-99 14:04
------------------------------------------------------------------------
(REMARK: YES=1,NO=0 ; 2 EMPTY LINES AFTER EVERY INPUT GROUP)

CAMPAIGN NAME:
-------------
      ****************

--> : ANT_TEST


TITLE LINE:
----------
      *****************************************************

--> : TEST OF VARIOUS ANTENNA TYPES


RINEX FLAG INTERPRETATION:
--------------------------
                                 **

MINIMAL SIGNAL STRENGTH    --> :  0
ACCEPT CYCLE SLIP FLAGS    --> :  0

...
```

Figure 3.14: Sample `I`-file (extract).

4. Processing Examples

The general overview of the processing procedure was given in Chapter 1 (see Figure 1.1). In this Chapter we present three examples for the usage of the *Bernese GPS Software* Version 4.2. The first example is a regional, the second a local campaign, and the third example illustrates rapid static positioning with the *Bernese GPS Software*. It should be said that only the basic functions of the software are shown in this chapter. We do not discuss, e.g., the usage of a global campaign for orbit determination purposes. Actually it is close to impossible to come up with better orbits than those produced by the IGS. Users interested in orbit determination find more information in Chapter 8 of this manual. Likewise, we cannot document many other options of the software in this Chapter. The examples illustrate the main steps to create very accurate station coordinates. These examples are also useful to test the installation, and the proper functioning of the software on your computer. Bear in mind, however, that the examples given here are not intended as "recipes" for your future work with *Bernese GPS Software*. In particular, the examples do **not** necessarily represent the "best" way to generate high-precision results. Actually, it is quite impossible to outline such a "best" procedure for your specific projects.

4.1 Example 1: Regional Campaign

Data from six European stations of the IGS Network are used, namely BRUS – Brussels, JOZE – Josefoslaw, KOSG – Kootwijk, ONSA – Onsala, WTZR – Wettzell, and ZIMM – Zimmerwald. The locations of these stations are given in Figure 4.1. Four stations were occupied by ROGUE receivers, two stations (Josefoslaw and Zimmerwald) by TRIMBLE 4000SSE receivers. The distances between neighboring stations are between 200 and 600 km. Let us call this example `DOCU42_1`. It may be a good idea for new users of the *Bernese GPS Software* to re-process these data according to the recommendations given in this Chapter. The data belonging to this campaign are included in the installation archives or are available through anonymous ftp at

Figure 4.1: Stations used in campaign `DOCU42_1`

`ftp://ftp.unibe.ch/aiub/BSWUSER/EXAMPLES/DOCU42_1/`

Campaign Setup

The first task is the campaign definition in Menu 1.1. Start the menu system (after the initial `LOADGPS`, see Chapter 25) using the `G 1.1` command (or `G` followed by the selection of option 1.1). You will then see a panel of the kind

```
 1-1  |                 CAMPAIGNS: DEFINITION OF NAMES

   Campaign       Start Date     End Date     Path         Comments

 > DOCU42_1 <   > 13-JUN-96 < > 14-JUN-96 < > P:/  < > BPE DEMO CAMPAIGN <
```

In order to create a completely new campaign, you can simply repeat the line describing the `DOCU42_1` campaign using the F3 key and overwrite it (press the F1 key to display the corresponding help panel) in the following way:

```
 1-1  |                 CAMPAIGNS: DEFINITION OF NAMES

   Campaign       Start Date     End Date     Path         Comments

 > DOCU42_1 <   > 13-JUN-96 < > 14-JUN-96 < > P:/  < > BPE DEMO CAMPAIGN <
 > TEST42_1 <   > 13-JUN-96 < > 14-JUN-96 < > P:/  < > EXAMPLE 1         <
```

Note, that the UNIX/Linux format was used above for the path specification (on VMS systems you would specify the path by `P:[` , on PC under DOS by `P:\`). Throughout this section, we will use the UNIX notation in the text. The meaning of the variable `$P` has to be defined in the `LOADGPS` script (it has been defined during the installation procedure as the first campaign directory). In the panel example above, a new campaign `TEST42_1` has been defined. In the following, we assume you are working in the `DOCU42_1` campaign. After having entered the campaign you leave the panel by pressing Esc twice (on DOS systems only once!) or the continuation key (see Chapter 3).

In the next step the subdirectories for the new campaign have to be created. Use Menu 1.2 to accomplish this task. If you have installed the example during the installation procedure of the software, this step was performed automatically. Otherwise, you have to leave the menu system now (`=X`) and copy the data into the directories manually. At the end you should have the following directories and data:

```
P:/DOCU42_1/ATM
P:/DOCU42_1/DATPAN
                      DAT132__.PAN
P:/DOCU42_1/OBS
P:/DOCU42_1/ORB
                      COD96165.PRE
                      COD96166.PRE
P:/DOCU42_1/ORX
P:/DOCU42_1/OUT       EXAMP_96.165   EXAMP_96.166
P:/DOCU42_1/RAW
                      BRUS1650.96O   KOSG1650.96O   WTZR1650.96O
                      BRUS1660.96O   KOSG1660.96O   WTZR1660.96O
                      JOZE1650.96O   ONSA1650.96O   ZIMM1650.96O
                      JOZE1660.96O   ONSA1660.96O   ZIMM1660.96O
P:/DOCU42_1/STA
                      ITRF0696.CRD   ITRFCODE.BLQ
                      ITRFCODE.HTR   EUROCLUS.FIX
                      ITRFCODE.STN
```

There are also some files contained in the example that have to be copied to the X:/GEN directory (C04_1996.ERP and COD9616*.ERP, SATELLIT.EX*, and SAT_1996.CRX). The file DAT132__.PAN contains the session table (see below). The precise orbits are in files *.PRE (no broadcast navigation messages are used in this example), the raw data (in RINEX format) in *.96O files. In the station directory STA there are five files:
ITRF0696.CRD contains the a priori coordinates of the stations in the reference frame ITRF93 for epoch June 15, 1996:

```
ITRF93 EPOCH 1993.0: ITRF93.SSC + TIDB CORR.                     23-DEC-94
--------------------------------------------------------------------------
LOCAL GEODETIC DATUM: ITRF93            EPOCH: 1996-06-15  0:00:00

NUM  STATION NAME           X (M)          Y (M)          Z (M)     FLAG

121  BRUS 13101M004     4027893.8308    307045.7093   4919475.0352    M
117  JOZE 12204M001     3664940.3155   1409153.7644   5009571.3334    G
153  KOSG 13504M003     3899225.2287    396731.8342   5015078.3421    G
159  ONSA 10402M004     3370658.6287    711877.0401   5349786.8604    G
161  WTZR 14201M010     4075580.6570    931853.6759   4801568.0465    G
158  ZIMM 14001M004     4331297.1682    567555.7538   4633133.8601    G
```

If no a priori coordinate file was available, it would be necessary to create it using Menu 1.4.1. It would be sufficient to just create the header of the coordinate file. A priori coordinates stemming from the RINEX headers might then be written into the a priori coordinate file using the program RXOBV3 (see Panel 2.7.1).

The file ITRFCODE.HTR contains the translation table between the antenna heights given in RINEX files and the antenna heights actually used in the *Bernese GPS Software*:

```
CODE: ANTENNA HEIGHT TRANSLATION TABLE                        02-APR-93  10:00
-------------------------------------------------------------------------------

STATION NAME          RINEX FILE     BERNESE    (99.9999: TAKE VALUE FROM FILE)
****************       **.****       **.****
BRUS 13101M004          3.9702        3.9702
JOZE 12204M001          0.1980        0.1980
KOSG 13504M003          0.1050        0.1050
ONSA 10402M004          0.9950        0.9950
WTZR 14201M010          0.0710        0.0710
ZIMM 14001M004          0.0000        0.0000
```

The reason to use this file has to be seen in the fact that some heights in the RINEX files may not be correct or may be measured to a different antenna reference point (this is not the case in our example). Similar problems may show up if the marker (station) names in the RINEX files differ from the names we want to use. The solution is the station name translation table file `ITRFCODE.STN`:

```
CODE: SITE NAME TRANSLATION TABLE                                 6-APR-93 12:12
--------------------------------------------------------------------------------

NUM  OLD STATION NAME  NEW STATION NAME

121  *BRU*             BRUS 13101M004
167  *JOZE*            JOZE 12204M001
153  *KOSG*            KOSG 13504M003
159  *ONSA*            ONSA 10402M004
161  *WETTZELL-1202*   WTZR 14201M010
158  *ZIMM*            ZIMM 14001M004
```

The wildcard (asterisk) may be used in the translation table to specify the old station name.

The fourth file `EUROCLUS.FIX` may specify the a priori constraints for the coordinates in the parameter estimation program GPSEST:

```
153 KOSG 13504M003   0.0001 0.0001 0.0001
154 MADR 13407S012   0.0001 0.0001 0.0001
156 TROM 10302M003   0.0001 0.0001 0.0001
157 WETT 14201M009   0.0001 0.0001 0.0001
157 WETT 14201S020   0.0001 0.0001 0.0001
```

For our example only the first line is interesting (the other stations are not in this campaign, they will not influence the solution). The a priori constraints for the station coordinates will be set to 0.1 mm for all coordinate components. This file will be necessary when you use the Bernese Processing Engine (BPE) for the data processing, but it can also be helpful for manual data processing.

The fifth file `ITRFCODE.BLQ` contains the ocean loading table. The explanation of the format may be found in Section 24.8.28 .

To process the GPS measurements using the *Bernese GPS Software* several more files containing general (e.g., not campaign-specific) data are necessary. These files are in the `X:/GEN` directory. The user may specify these general files in Panel 0.3.1 :

```
0.3-1                    DEFAULTS: GENERAL DATASET NAMES

General Datasets:
  GEODETIC DATUM     > DATUM.       <    CONSTANTS         > CONST.       <
  PHASE CENTER ECC.  > PHAS_IGS.01  <    RECEIVER INFO     > RECEIVER.    <
  EARTH POTENTIAL    > JGM3.        <    POLE INFORMATION  > C04_1996.ERP <
  POLE OFFSET COEF.  > POLOFF.      <    LEAP SECONDS      > GPSUTC.      <
  SAT. PARAMETERS    > SATELLIT.EX1 <    MANOEUVERS ETC.   > SAT_1996.CRX <
  SINEX GENERAL FILE > SINEX.       <    STATION PROBLEMS  > STACRUX.     <
  IONEX CONTROL FILE > IONEX.       <
Extensions:
  IERS BULLETINS     > IER <      RCVR/ANT.NAME TRANSLATION TABLES  > TRN <

Path to the Datasets:           > X:/GEN                 <
Input Files:                      Path                       Extension
  N-,I-,F-FILES                 > U:/INP                 <    > INP <
  SKELETON FILES                > X:/SKL                 <    > SKL <
  PANEL UPDATE DIRECTORY LISTS  > X:/SKL                 <    > UPD <

Auxiliary Files (Scratch Files) > U:/WORK                <    > SCR <
Error Message File (Full Name): > U:/WORK/ERROR.MSG               <
```

The files in `X:/GEN` directory are included in the distribution of the *Bernese GPS Software*. It is possible to use variables (so-called `$`-variables) in the panels. E.g., you might replace `SAT_1996.CRX` by `SAT_$JJ2.CRX`, if the corresponding value (1996) is specified for the variable `$JJ2` in the Panel 1.5.1 .

```
1.5.1        PROCESSING: FILENAME PARAMETERS FOR AUTOMATIC PROCESSING


  Station Parameters:
    $STATION1 >                  <      $STATION2 >                <
    ($i will be set to 2-char station abbrev, $STi to 4-char abbrev)

  4-character Parameters:
    $CD1      >                <        $CD2      >                <
    $CD3      >                <        $CD4      >                <

  ...

  4-character Year Parameters:
    $JJ1      >                <        $JJ2      > 1996           <
    $JJ3      >                <        $JJ4      >                <
    $J+1      >                <        $J-1      >                <
    $J+2      >                <        $J-2      >                <
```

In the interactive mode, all `$`-variables will be automatically substituted by the values specified. More details on panel variables may be found in Section 22.

Later on, when processing your own data, you will have to update the pole file (`BULLET_A.ERP`) or the `SATCRUX` file (`SAT_*.CRX`). You will find the latest versions of these files on our anonymous ftp directory `ftp://ftp.unibe.ch/aiub/BSWUSER/GEN/` (see Chapter 7). Note, that you should use the file `SATELLIT.TTT` if you use version 4.2. Even though we are using the `C04_*.ERP` file in this example, we recommend to use the `BULLET_A.ERP` file, or, for high precision work, the ERP files consistent with the precise orbits.

The file `PHAS_IGS.01` contains the positions (and variations) of the phase centers for various antenna types (see Chapter 17). It is important to use correct antenna and receiver names. If the information in RINEX files is not correct, it is necessary to use a translation table. You will find the file `DOCU42_1.TRN` on our anonymous ftp directory `ftp://ftp.unibe.ch/aiub/BSWUSER/EXAMPLES/DOCU42_1/` (the file has to be copied into your `X:/GEN` directory):

```
RECEIVER AND ANTENNA TYPE TRANS. TABLE                          21-SEP-99 16:29
-------------------------------------------------------------------------------

OLD RECEIV. TYPE  OLD ANTENNA TYPE  NEW RECEIV. TYPE  NEW ANTENNA TYPE

ROGUE SNR-8000    DORNE MARGOLIN T  ROGUE SNR-8000    DORNE MARGOLIN T
TRIMBLE 4000SSE   4000ST L1/L2 GEO  TRIMBLE 4000SSE   4000ST L1/L2 GEO
ROGUE SNR-12 RM   DORNE MARGOLIN B  ROGUE SNR-12 RM   DORNE MARGOLIN B
ROGUE SNR-8000    DORNE MARGOLIN    ROGUE SNR-8000    DORNE MARGOLIN B
TURBOROGUE SNR-8  DORNE MARGOLIN T  ROGUE SNR-8000    DORNE MARGOLIN T
```

When processing your own data it may be necessary to perform a station dependent renaming of the receiver and antenna types. This is possible when you add a fifth column to this file in the following way:

```
RECEIVER AND ANTENNA TYPE TRANS. TABLE                          21-SEP-99 16:29
-------------------------------------------------------------------------------

OLD RECEIV. TYPE  OLD ANTENNA TYPE  NEW RECEIV. TYPE  NEW ANTENNA TYPE  STATION NAME

ROGUE SNR-8000    DORNE MARGOLIN T  ROGUE SNR-8000    DORNE MARGOLIN T  BRUS 13101M004
TRIMBLE 4000SSE   4000ST L1/L2 GEO  TRIMBLE 4000SSE   4000ST L1/L2 GEO  JOZE 12204M001
ROGUE SNR-12 RM   DORNE MARGOLIN B  ROGUE SNR-12 RM   DORNE MARGOLIN B  KOSG 13504M003
ROGUE SNR-8000    DORNE MARGOLIN    ROGUE SNR-8000    DORNE MARGOLIN B  ONSA 10402M004
TURBOROGUE SNR-8  DORNE MARGOLIN T  ROGUE SNR-8000    DORNE MARGOLIN T  WTZR 14201M010
TRIMBLE 4000SSE   4000ST L1/L2 GEO  TRIMBLE 4000SSE   4000ST L1/L2 GEO  ZIMM 14001M004
```

Now, you should have all necessary files and may proceed with the actual processing. Start the menu system again, if necessary, (`G` command) and select Menu 1.3 to define the sessions. Please note that it is possible to use the wildcard string `???0` in Panel 1.3.2 . The panel shows the session definition for a typical permanent campaign with 24-hours sessions:

```
1.3-2                 CAMPAIGNS: SESSION DEFINITION

SESSION NUMBER          START DATE                  END DATE

    nnnn          yy mm dd     hh mm ss       yy mm dd     hh mm ss

  > ???0 <       >          < > 00 00 00 <   >          < > 23 59 59 <
```

In the next step the user usually prepares an a priori coordinate file in Menu 1.4.1 (or only the header of this file, and the coordinates are then extracted from RINEX files using the program RXOBV3 – see Panel 2.7.1) and the station name translation table (Menu 1.4.2). We may skip these two steps because both files (`ITRF0696.CRD` and `ITRFCODE.STN`) are already in the station directory. Optionally, in Menu 1.4.3 the station name abbreviations (necessary for automatic file name generation) may be defined. If you are not interested in special abbreviations, they will be generated automatically when you run the program RXOBV3.

```
1.4-3                      STATION ABBREVIATION TABLE

    Station Name              4-Char Abbreviation     2-Char Abbreviation

  > BRUS 13101M004   <            > BRUS <                > BR <
  > JOZE 12204M001   <            > JOZE <                > JO <
  > KOSG 13504M003   <            > KOSG <                > KO <
  > ONSA 10402M004   <            > ONSA <                > ON <
  > WTZR 14201M010   <            > WTZR <                > WT <
  > ZIMM 14001M004   <            > ZIMM <                > ZI <
```

If you use Menu 1.4.3 to define your own abbreviations, the menu system automatically offers abbreviations by simply taking the first four or two characters of the station name. You have to make sure that there are not two stations with the same abbreviation. The observation files might otherwise be overwritten! In Menu 1.4.5 the receiver and antenna name translation table may be prepared. In our case you may simply copy the file `DOCU42_1.TRN` into the directory `X:/GEN`.

Transfer Part

The campaign has now been set up and all necessary files are available. The first part of processing consists of the transfer from the RINEX into the Bernese (binary) format. In our example only the RINEX observation files have to be transferred (we do not use the broadcast orbits at all). This is the task of program RXOBV3 in Menu 2.7.1. When working through the examples, remember that the online help system describing all options can be invoked by pressing F1. If you note that some of the option settings used in this example deviate from the recommendations given in the online help system, don't let this confuse you. In your future work, it is a good idea to stick to the recommendations given in the help panels.

```
2.7.1           TRANSFER: RINEX OBS. to BERNESE  (Main Data Panel)

  CAMPAIGN         > DOCU42_1 <  (blank for selection list)

Input Files:
  RINEX            >          <  (blank for selection list)
  RINEX EXTENSION  > ??O <       (Wildcards allowed)
  COORDINATES      > NO       <  (NO, if no update; blank for sel.list)

Translation Tables:
  STATION NAMES    > ITRFCODE <  (NO, if not used; blank for sel.list)
  RCVR / ANTENNA   > DOCU42_1 <  (NO, if not used; blank for sel.list)
  ANTENNA HEIGHTS  > ITRFCODE <  (NO, if not used; blank for sel.list)
  STA.NAMES: STOP  > YES <       (NO or YES, yes=stop if station not found)
  ANT.HGT. : STOP  > YES <       (NO or YES, yes=stop if ant.hgt not found)

Output Files:
  CODE/PHASE/RANGE >          <  (blank: def.name; NO: do not create)
  RANGES (SLR)     > NO  <       (NO or YES)
```

If the user leaves the option `RINEX` blank, a selection list of all `P:/DOCU42_1/RAW/*.??O` files will appear. Type "`s`" in the first column to select individual files or "`Ctrl-D`" to enter the system command level followed by "`S ALL`" to select all files at the same time.

```
2.7.1-1                          RINEX OBS.: INPUT

 Title Line:
   TITLE          > PROCESSING EXAMPLE, TRANSFER PART    <

 Signal Strength Requirements:
   MINIMUM SIGNAL STRENGTH              > 1   <    (0-9)
   ACCEPT  SIGNAL STRENGTH = 0          > YES <    (YES or NO)
   ACCEPT  CYCLE SLIP FLAGS FROM RINEX  > NO  <    (YES or NO)

 Sampling:
   SAMPLING INTERVAL                    > 30  <    (sec; blank: take all obs)
   SAMPLING OFFSET TO FULL MINUTE       > 0   <    (sec)
   LIMIT DATA TO SESSION DEFINITION     > YES <    (YES or NO)

 Session Numbering:
   LENGTH OF SESSION NUMBERS             > 4 <     (3 or 4 characters)
```

In the two panels above all the options for RXOBV3 are specified. The program produces an output file `RXOBV3.L*` in the directory `P:/DOCU42_1/OUT`. This file may be browsed using the `JOB` command or Menu 5.9 . It should look like

```
******************************************************************************
TRANSFORMATION OF RINEX OBSERV. FILES INTO BERNESE OBSERV. FILES
******************************************************************************
...
...
...

  11  P:/DOCU42_1/RAW/ZIMM1650.96O      P:/DOCU42_1/OBS/ZIMM1650.CZH      2878
                                        P:/DOCU42_1/OBS/ZIMM1650.CZO
                                        P:/DOCU42_1/OBS/ZIMM1650.PZH      2878
                                        P:/DOCU42_1/OBS/ZIMM1650.PZO

  12  P:/DOCU42_1/RAW/ZIMM1660.96O      P:/DOCU42_1/OBS/ZIMM1660.CZH      2878
                                        P:/DOCU42_1/OBS/ZIMM1660.CZO
                                        P:/DOCU42_1/OBS/ZIMM1660.PZH      2878
                                        P:/DOCU42_1/OBS/ZIMM1660.PZO
```

After having run program RXOBV3 the menu system automatically creates the zero-difference observation lists `OBSLIST.CDZ` and `OBSLIST.PHZ` in `P:/DOCU42_1/DATPAN`. "Manually", these lists may be created in Menu 5.1 .

Orbit Part

In this processing example we use only two programs of the orbit part of the *Bernese GPS Software*. The first program is called PRETAB and may be accessed using Menu 3.2 . This menu handles two programs: PRETAB and BRDTAB. Which of the two is actually used depends on the type of orbits (precise or broadcast) available. We use precise orbits here. We recommend to use the consistent precise pole files (see Chapter 7) in your future high precision work. In this example, however, we are using the information from the `C04_1996.ERP` file, and we will see the effect of this inconsistency in the rms errors. The main task of PRETAB is to create tabular files for both days of the campaign (to transform the precise orbits from the terrestrial into the celestial reference frame). We run the program separately for each session (165 and 166), adapting the output file names accordingly. The program generates a satellite clock file, too. This file will be needed in program CODSPP (see below) if no broadcast orbits are used.

```
 3.2   |                  ORBITS: CREATE TAB.ORBITS
---------------------------------------------------------------------

  CAMPAIGN         > DOCU42_1 <     (blank for selection list)

Input File
  EPHEMERIS TYPE   > PRECISE   <    (BROADCAST or PRECISE orbits)
  BROAD./PRECISE   >          <     (blank for selection list)

Output Files
  TAB. ORBIT       > E1_96165 <     (blank for same names as input orbit
                                     files)
  SATELLITE CLOCKS > E1_96165 <     (NO for none, with precise orbits only)

Input Options
  REFERENCE SYSTEM  > J2000 <       (B1950 or J2000)
```

```
3.2-1  |              PRETAB: CREATE SATELLITE CLOCK FILE
---------------------------------------------------------------------

TITLE  >  SATELLITE CLOCKS FROM PREC. ORBIT                            <

                              hh mm ss
INTERVAL FOR POLYNOMIALS     > 12 00 00 <

POLYNOMIAL DEGREE              > 2  <
```

The second program of the orbit part used here is called ORBGEN, accessed in Menu 3.3. This program is described in detail in Chapter 8. It prepares the so-called standard orbits using the satellite positions in the tabular orbit files as pseudo-observations for a least-squares adjustment.

```
 3.3   |                ORBITS: GENERATE STD.ORBITS
---------------------------------------------------------------------

  CAMPAIGN            > DOCU42_1 <     (blank for selection list)

Input File
  TABULAR ORBITS      > E1_96165 <  (NO for orbit update, blank for sel.l.)
  IMPROVED ORBIT ELE. > NO       <  (NO for orbit fit, blank for sel. list)
  IMPROVED ORBIT ELE2 > NO       <  (NO for orbit fit, blank for sel. list)

Output File
  STANDARD ORBITS     > E1_96165 <     (NO, if not to be saved)
  RAD.PRESS. MODEL    > NO       <     (NO, if not to be saved)
  RESIDUALS           > NO       <     (NO, if not to be saved)
  SUMMARY FILE        > NO       <     (NO, if not to be saved)

Orbit Model:
  PLANETARY EPHEMERIS > DE200    <  (NO, DE200)
  OCEAN TIDES FILE    > OT_CSRC  <  (NO, OT_CSRC, OT_TOPEX, OT2TOPEX)
```

The planetary ephemeris file DE200 is located in the directory $X/GEN. It contains the JPL ephemerides for Moon, Sun, and Planets. It is not part of the *Bernese GPS Software*, therefore, it must be downloaded separately from JPL. For more details, you are referred to the installation guide for your operating system (see Chapter 25) for more information. If this file is not available to you at this moment, you may use the following work-around:
in Panel 3.2–1, set option PLANETARY EPHEMERIS to ‘‘NO’’, and set the orbit model flag in Panel 3.3–1 to ‘‘?’’. You will, of course, not be able to duplicate the results shown in this example by not using the JPL-ephemeris file.

We recommend to generate one standard orbit file for each session containing satellite orbit arcs of exactly one day, which means that the program ORBGEN has to be run twice (individually for days 165 and 166).

```
3.3-1                         GENERATE STD.ORBITS: INPUT

 General Options:
   # OF ARCS               > 1   <
   PRINT RESIDUALS         > NO  <     (NO, ALL Iterations, Iteration #)
   ORBIT PREDICTION        > NO  <     (NO, # Days)

 Numerical Integration:
   # OF ITERATIONS         > 2   <
   POLYNOMIAL DEGREE       > 10  <
   LENGTH OF INTERVAL      > 1.0 <     (hours)

 Representation of Variational Equations:
   POLYNOMIAL DEGREE       > 12  <
   LENGTH OF INTERVAL      > 6.0 <     (hours)

 Earth Potential and Time Frame:
   MAX.DEGREE OF EARTH POTENTIAL    > 8   <
   TIME FRAME OF TABULAR ORBITS     > GPS <     (GPS or UTC)
   APPLY ANTENNA OFFSET TO TAB POS  > NO  <     (YES or NO)
   ORBIT MODEL FLAG                 > B <       (0, A, B, C, or ?)
```

```
3.3-2                         GENERATE STD.ORBITS: INPUT

 Orbit Model Options:
   PARTIAL DERIV.          > ALLPAR <  (NONPER, DYNALL, ALLPAR)

 Parameter selection:
   D0 estimation (P0)      > YES <     (YES, NO)
   Y0 estimation (P2)      > YES <     (YES, NO)
   X0 estimation           > YES <     (YES, NO)

 Periodic Parameter selection:
   Periodic D terms        > YES <     (YES, NO)
   Periodic Y terms        > YES <     (YES, NO)
   Periodic X terms        > YES <     (YES, NO)
```

The program produces an output file `ORBGEN.L*` (for each run) which should look like

```
********************************************************************************
COMPUTATION OF BERNESE STANDARD ORBITS FROM TABULAR POSITIONS   19-JAN-01 14:09
********************************************************************************
--------------------------------------------------------------------------------
LIST OF INPUT AND OUTPUT FILENAMES
--------------------------------------------------------------------------------

GENERAL CONSTANTS           :  X:/GEN/CONST.
POLE INFORMATION            :  X:/GEN/C04_1996.ERP
SATELLITE INFO              :  X:/GEN/SATELLIT.EX1
COEFFIC. OF EARTH POTENT.   :  X:/GEN/JGM3.
SATELLITE PROBLEMS          :  X:/GEN/SAT_1996.CRX
PLANETARY EPHEMERIS FILE    :  X:/GEN/DE200.EPH
OCEAN TIDES INPUT FILE      :  X:/GEN/OT_CSRC.TID
ORBITAL ELEMENTS FILE       :   ---
ORBITAL ELEMENTS FILE 2     :   ---
STANDARD ORBITS             :  P:/DOCU42_1/ORB/E1_96165.STD
RADIATION PRESSURE COEFF.   :   ---
PLOT FILE                   :   ---
RESIDUAL FILE               :   ---
LIST FILE                   :   ---
MEAN ELEMENTS OUTPUT FILE   :  MEAELE.OUT
AUX. FILE FOR RESIDUALS     :  U:/WORK/ORBGEN.COP

--------------------------------------------------------------------------------
...
...
--------------------------------------------------------------------------------
RMS ERRORS AND MAX. RESIDUALS   ARC NUMBER:  1                   ITERATION:  2
--------------------------------------------------------------------------------

                          QUADRATIC MEAN OF O-C (M)         MAX. RESIDUALS (M)
SAT   #POS   RMS (M)     TOTAL   RADIAL  ALONG   OUT      RADIAL  ALONG   OUT
---   ----   -------     ----------------------------     --------------------

  1     96     0.09       0.09     0.04   0.02   0.15       0.07   0.07   0.18
  2     96     0.10       0.09     0.04   0.03   0.16       0.09   0.11   0.23
  3     96     0.06       0.05     0.06   0.04   0.07       0.10   0.08   0.23
  4     96     0.08       0.08     0.05   0.03   0.12       0.09   0.08   0.20

...
```

Maybe the most important information in the output file are the rms errors (see above) for each satellite. These should not be larger than about 10 cm if precise orbits were used (the actual rms errors depend on the quality of the precise orbits, on the pole file used for the transformation between ITRF and ICRF in PRETAB, and on the orbit model used in ORBGEN). Rms errors between 5 and 10 cm as they occur in our example are due to small inconsistencies between the precise orbits `COD96*.PRE` and the pole information in `C04_1996.ERP`. Without this inconsistency (using the `COD*.ERP` pole file, belonging to the precise orbit file – see Chapter 7) you would obtain something like

```
-------------------------------------------------------------------------------
RMS ERRORS AND MAX. RESIDUALS   ARC NUMBER:  1                    ITERATION:  2
-------------------------------------------------------------------------------

                          QUADRATIC MEAN OF O-C (M)        MAX. RESIDUALS (M)
SAT   #POS   RMS (M)     TOTAL   RADIAL  ALONG   OUT       RADIAL  ALONG   OUT
---   ----   -------     ----------------------------      --------------------

  1     96     0.01       0.01     0.01   0.01   0.00        0.01   0.02   0.00
  2     96     0.02       0.02     0.02   0.02   0.01        0.07   0.05   0.02
  3     96     0.01       0.01     0.01   0.01   0.01        0.02   0.04   0.02
  4     96     0.01       0.01     0.01   0.01   0.00        0.02   0.03   0.01
```

In your future high precision work, you should consequently pay attention to the consistent use of precise orbits and the corresponding precise pole information (specified in Panel 0.3.1). The files can be found in our anonymous ftp directory.

Processing Part

Now we are ready to invoke the processing part of the *Bernese GPS Software*. We have to run five programs for this example. The first program is called CODSPP, accessed by Menu 4.2. Its main task is to compute the receiver clock corrections (see Chapter 10). Because we have our orbit information in session-specific files (standard orbit files), we have to start CODSPP twice (to process both sessions, one at a time).

```
 4.2    |                     PROCESSING: CODE PROCESSING
-------------------------------------------------------------------------------

   CAMPAIGN         > DOCU42_1 <

 Job Identification:
   JOB CHARACTER        >   <       (blank or character from A - Z, 0 - 9)

 Input Files:
   CODE             > ????1650 <     COORDINATES      > ITRF0696 <
   BROADCAST        > NO       <     STANDARD ORBIT   > E1_96165 <
   ECCENTRICITIES   > NO       <     SATELLITE CLOCKS > E1_96165 <
   TROPO. ESTIMATES > NO       <

 Output Files:
   COORDINATES      > NO       <     RESIDUALS        > NO       <
   PHASE            >          <     RESULT SUMMARY   > NO       <
   SATELLITE CLOCKS > NO       <

                                                             See Help Panel
```

```
4.2-1                       CODE PROCESSING: INPUT 1

  TITLE    > DAY 165, L3 SOLUTION                                  <

  Parameters:
    FREQUENCY                > L3   <    (L1, L2 or L3)
    CLOCK POLY.DEGREE        > E    <    (max. 7, E for one offset per epoch)
    ESTIMATE COORDINATES     > YES  <    (YES or NO)

  Atmosphere Models:
    TROPOSPHERE              > SAAS <    (NO,SAAStamoinen, HOPField,
                                          MARIni-mur, or ESTImated)
    IONOSPHERE               > NO   <    (YES or NO)

  Observation Selection:
    MIN. ELEVATION           > 10   <    degrees
    SAMPLING RATE N          > 1    <    (only every n-th observation used)
    OBSERV. WINDOW           > NO   <    (YES.., NO or ASIS)
```

```
4.2-2                       CODE PROCESSING: INPUT 2

  Print Options:
    RESIDUALS                > NO   <     (YES or NO)
    ELEVATIONS               > NO   <     (YES or NO)

  Iterations:
    MAX. NUMBER OF ITERAT.   > 10 <       (greater than 0)

  Outlier Detection:
    OUTLIER DETECTION        > YES  <     (YES or NO)
    MAX. RESIDUAL ALLOWED    > 100.0   <  meters
    CONFIDENCE INTERVALL     > 5.0     <  (in units of one sigma)
```

If you do not have geocentric coordinates of good quality available for the sites you process you should specify a coordinate output file in Panel 4.2 to save the coordinates estimated by CODSPP. For more details on the best way to obtain good *geocentric* coordinates for your local/regional network see Chapter 10. CODSPP produces the following output:

```
*****************************************************************************
COMPUTATION OF SINGLE POINT POSITION          19-JAN-01 15:32
*****************************************************************************
...
...

STATION:  BRUS 13101M004   FILE:  P:/DOCU42_1/OBS/BRUS1650.CZO      RECEIVER UNIT:      321
-------------------------------------------------------------------------------------------
...
...

RESULTS:
--------

OBSERVATIONS IN FILE:     18706
BAD OBSERVATIONS    :         0.99 %
RMS OF UNIT WEIGHT  :        23.58 M
NUMBER OF ITERATIONS:         2


STATION COORDINATES:
--------------------

LOCAL GEODETIC DATUM:  ITRF93

                                  A PRIORI         NEW            NEW- A PRIORI   RMS ERROR
 BRUS 13101M004    X             4027893.83      4027890.86           -2.97         0.53
 (MARKER)          Y              307045.71       307043.23           -2.48         0.30
                   Z             4919475.04      4919472.93           -2.10         0.63

                   HEIGHT            149.66          146.04           -3.65         0.73
                   LATITUDE      50 47 52.141    50 47 52.177     0  0  0.036       0.0123
                   LONGITUDE      4 21 33.183     4 21 33.068  -  0  0  0.115       0.0153



CLOCK PARAMETERS:
-----------------

OFFSET FOR REFERENCE EPOCH:                0.000005541  SEC


CLOCK OFFSETS STORED IN PHASE OBSERVATION FILE
...
...

*****************************************************************************
SUMMARY OF BAD OBSERVATIONS
*****************************************************************************
...
...

NUMB FIL  STATION           TYP SAT       FROM               TO          #EP
-----------------------------------------------------------------------------

   1   2  JOZE 12204M001    OUT  21  96-06-13 11:50:00  96-06-13 11:50:00     1
   2   2  JOZE 12204M001    OUT  21  96-06-13 11:51:00  96-06-13 11:51:00     1
   3   2  JOZE 12204M001    OUT  21  96-06-13 11:52:00  96-06-13 11:52:00     2
...
...
```

The most important message in the output file is `CLOCK OFFSETS STORED IN PHASE OBSERVATION FILE`. If this message appears in the output you are sure that the receiver clock corrections δ_k (see Chapter 10) computed by CODSPP were actually stored not only in code observation files but also in the phase observation files. After this step we will no longer use the code observations. The a posteriori rms error (for each zero-difference file processed) should be checked in the output file from the program CODSPP. A value of about 20–30 m is normal if Selective Availability (SA – artificial degradation of the satellite clock accuracy) is on. Without SA a value of about 3 m could be expected if P-Code measurements are available. However, much worse code measurements would still be sufficiently accurate to compute the receiver clock corrections δ_k with the necessary (1 μs) accuracy (see Chapter 10).

The second processing program is called SNGDIF and may be activated in Menu 4.3 . SNGDIF creates the single differences and stores them in files (for details see Chapter 10). We use the strategy `OBS-MAX` and we have to run SNGDIF independently for each session:

```
 4.3                     PROCESSING: FORM SINGLE DIFF.

   CAMPAIGN               > DOCU42_1 <  (blank for selection list)

   STRATEGY               > OBS-MAX   < (MANUAL(M),DEFINED(D),SHORTEST(S),
                                         AUTO-STAR(A),OBS-MAX(O),PLUS(P))
 Input Files:
   MEASUREMENT TYPE       > PHASE    <  (Any  : CODE or PHASE)
   ZERO DIFF. FILE 1      > ????1650 <  (Any  : blank for selection list)
   ZERO DIFF. FILE 2      >          <  (M    : blank for selection list)
   COORDINATES            > ITRF0696 <  (S+A+P: blank for selection list)
   ECCENTRICITIES         > NO       <  (S+A+P: NO, blank for sel. list)
   PRE-DEFINED BASELINES  > NO       <  (S+O+P: NO, blank for sel. list)
   CLUSTER DEFINITION     > NO       <  (NO, blank for selection list)
 Output File:
   SINGLE DIFFERENCE      >          <  (Any: blank for default file name,
                                              HEADER: Header files only)
   BASELINE DEFINITIONS   > NO       <  (NO, if not to be saved)
   CLUSTER DEFINITION     >        <    (enter only if cluster input given)
```

```
 4.3-1                   FORM SINGLE DIFFERENCES: INPUT

 Simultaneous Observations:
   MAXIMUM TIME INTERVAL         > 1.50  <     SEC

 Set new Ambiguity:
   AFTER A BREAK OF              > 20    <     MIN
   WHEN CYCLE SLIP FLAG SET       > NO  <      (YES or NO)

 Optimize Baselines (Option O only):
   MAXIMUM BASELINE LENGTH       > 9000  <     KM  (Option O only)
   MINIMUM NUMBER OF OBSERVATIONS > 600   <     Scaled in 1 obs/min/freq
   MAX. DISTANCE OF FAST OBS. CNT.> 1000  <     KM

 Redundant Baseline Options (Option O only)
   REDUNDANT BASELINES            > NO  <      (YES or NO)
   MIN. REDUNDANT BASELINE LENGHT > 6000  <     KM
   MIN. IMPROVEM. IN SHORTEST WAY > 9000  <     KM

 Observation Filename Format
   LENGTH OF SESSION NUMBER       > 4 <        (4 or 3 characters)
```

The output of SNGDIF simply echoes the zero-difference files used and the single difference files created. If the strategy `OBS-MAX` is used the following lines are included:

```
  1 BRUS 13101M004   - JOZE 12204M001   CRIT.:    7969
  2 BRUS 13101M004   - KOSG 13504M003   CRIT.:    9804  OK
  3 BRUS 13101M004   - ONSA 10402M004   CRIT.:    8990
  4 BRUS 13101M004   - WTZR 14201M010   CRIT.:    9392
  5 BRUS 13101M004   - ZIMM 14001M004   CRIT.:    9786
  6 JOZE 12204M001   - KOSG 13504M003   CRIT.:    8538
  7 JOZE 12204M001   - ONSA 10402M004   CRIT.:    7914
  8 JOZE 12204M001   - WTZR 14201M010   CRIT.:    8553  OK
  9 JOZE 12204M001   - ZIMM 14001M004   CRIT.:    8409
 10 KOSG 13504M003   - ONSA 10402M004   CRIT.:    9783  OK
 11 KOSG 13504M003   - WTZR 14201M010   CRIT.:    9813  OK
 12 KOSG 13504M003   - ZIMM 14001M004   CRIT.:   10522  OK
 13 ONSA 10402M004   - WTZR 14201M010   CRIT.:    9297
 14 ONSA 10402M004   - ZIMM 14001M004   CRIT.:    9149
 15 WTZR 14201M010   - ZIMM 14001M004   CRIT.:    9759
```

All possible pairs of zero-difference files are listed with the corresponding criterion value. Baselines which were actually taken into the optimal set and created are labeled with "OK".

The main task of program MAUPRP, (Panel 4.4.2), is the cycle-slip screening (for details we refer to Chapter 10). We make separate program runs for each session using the following options:

```
4.4.2            PROCESSING: LATEST MANUAL/AUTOMATIC PREPROCESSING

  CAMPAIGN          > DOCU42_1 <    (blank for selection list)

 Input Files:
  SINGLE DIFF.      > ????165? <    (blank for selection list)
  COORDINATES       > ITRF0696 <    (blank for selection list)
  STANDARD ORBIT    > E1_96165 <    (blank for selection list)
  IONOSP. MODELS    > NO       <    (NO, if not used; blank for sel.list)
  ECCENTRICITIES    > NO       <    (NO, if not used; blank for sel.list)
  SATELL. CLOCKS    > NO       <    (NO, if not used; blank for sel.list)

 Output File:
  COORDINATES       > NO       <    (NO, if not to be saved)
  RESIDUALS         > NO       <    (NO, if not to be saved)
```

```
4.4.2-1                  NEW PREPROCESSING: INPUT 1

 General Parameters:
  PROCESSING MODE         > AUTOMATIC <     (MANUAL, AUTOMATIC)
  FREQUENCY TO CHECK      > COMBINED  <     (L1,L2,BOTH or COMBINED)
  SAVE SCREENED FILES        > YES <        (YES or NO)
  ADJUST FREQ./WLFAC.        > YES <        (YES or NO)

 Change Other Options:
  CHANGE OPTIONS             > YES <        (YES.. or NO)

 Saving Coordinates:
  FIXED STATION      >                  <  (AUTO for automatic selection)
```

```
4.4.2-2                    NEW PREPROCESSING: INPUT 2

 Marking of Observations:
   USE MARKING FLAGS IN OBS FILES       > NO   <    (YES or NO)
   MARK OBSERVATIONS BELOW              > 10   <    degrees elevation
   MARK UNPAIRED OBSERVATIONS           > YES  <    (YES or NO)
   MIN.TIME INT. FOR CONTINUOUS OBS     > 301  <    seconds
   OBS STILL CONT IF GAPS SMALLER THAN  > 61   <    seconds

 Non-Parametric Screening:
   PRINTING                             > SUMM <    (NO,SUMMary or ALL)
   SINGLE DIFF. SCREEN.                 > NO   <    (YES.. NO or ASIS
   DOUBLE DIFF. SCREEN.                 > YES  <    (YES.. NO or ASIS)
   MAX. INTERVAL OF FIT                 > 2    <    minutes

 Triple Diff. Solution:
   FREQUENCY                            > L3   <    (L1,L2,L3 or L5)
   APRIORI COORD.SIGMAS                 > NO   <    (YES.. NO or ASIS)
   MAXIMUM OBSERVED-COMPUTED VALUE     > 999.0    <   meters
```

```
4.4.2-2.2         AUTOMATIC PREPROCESSING: DOUBLE DIFF. SCREENING

      Double Diff. Screening:
        POLYNOMIAL DEGREE         > 1 <
        DISCONTINUITY LEVEL     > 0.01   <     meters
```

```
4.4.2-3                    NEW PREPROCESSING: INPUT 3

 Slip Detection:
   PRINTING                           > SUMMARY <   (NO,SUMMARY or ALL)
   ACCEPT SLIPS GREATER THAN          > 10      <   cycles (half)
   TEST OBS WITH CYCLE SLIP FLAG ONLY   > NO  <     (YES or NO)
   L5 IS CLEAN (EXCEPT FLAGGED EPOCHS)  > NO  <     (YES or NO)

 Sigmas:
   L1 OBSERVATIONS                    > 0.0020  <   meters
   L2 OBSERVATIONS                    > 0.0020  <   meters

 Cycles or Half:
   SEARCH L1 FOR                      > CYCLES  <   (CYCLES or HALF)
   SEARCH L2 FOR                      > CYCLES  <   (CYCLES or HALF)

 Search Widths:
   SEARCH WIDTH L1                      > 5   <     integers
   SEARCH WIDTH L5                      > 2   <     integers
```

```
4.4.2-4                    NEW PREPROCESSING: INPUT 4

 Outlier Rejection:
   OUTLIER REJECTION                    > YES <    (YES or NO)
   MAX. OBSERV.GAP                     > 181   <   seconds
   MAX. IONOS.DIFF                     > 400   <   percents of L1 cycles

 Setting of New Ambiguities:
   - IF CYCLE SLIP FLAG SET IN FILE     > NO  <    (YES or NO)
   - IF CYCLE SLIP DETECTION PROBLEM    > YES <    (YES or NO)
   - AFTER A GAP LARGER THAN           > 181   <   seconds
   USE AMBIGUITIES FROM FILE            > NO  <    (YES or NO)
   MINIMUM TIME INTERVAL PER AMBIGUITY > 301   <   seconds
```

The output of the program MAUPRP is discussed in detail in Chapter 10 (the example given there stems from the campaign `DOCU42_1`). It should be pointed out that it is not necessary to run program MAUPRP more than once on each baseline. However, it is mandatory to run MAUPRP again if you (for whatever reason) have to re-start the program SNGDIF and re-create the baseline(s). If you do not have any accurate geocentric coordinates for the sites you process you should specify a coordinate output file in Panel 4.4.2 to save the coordinates estimated by MAUPRP. In this case we recommend not to save the changes done by MAUPRP into the observation files (option `SAVE SCREENED FILES` in Panel 4.4.2–1) but to start the program MAUPRP for a second time using now the a priori coordinates stemming from the first run (now you save the observation files, of course).

The least-squares adjustment is the task of program GPSEST, accessed by Menu4.5. It is a good idea to start GPSEST first in the session mode and to produce an ambiguity-free L_3 solution. We do not expect any final results from this run but we want to check the quality of data and save the residuals after the least-squares adjustment. We use the following options:

```
 4.5                      PROCESSING: PARAMETER ESTIMATION

   CAMPAIGN          > DOCU42_1 <    (blank for selection list)

 Job Identification:
   JOB CHARACTER        >   <        (blank, or A..Z, 0..9)

 Input Files:
   PHASE Z.DIFF.     > NO       <    (NO, if not used; blank for sel.list)
   CODE  Z.DIFF.     > NO       <    (NO, if not used; blank for sel.list)
   PHASE S.DIFF.     > ????165? <    (NO, if not used; blank for sel.list)
   CODE  S.DIFF.     > NO       <    (NO, if not used; blank for sel.list)
   COORDINATES       > ITRF0696 <    (blank for selection list)
   STANDARD ORBIT    > E1_96165 <    (blank for selection list)
   RAD.PRESS.COE.    > NO       <    (NO, if not used; blank for sel.list)
   IONOSP. MODELS    > NO       <    (NO, if not used; blank for sel.list)
   TROPO. ESTIMATES  > NO       <    (NO, if not used; blank for sel.list)
   METEO DATA        > NO       <    (NO, if not used; blank for sel.list)
   ECCENTRICITIES    > NO       <    (NO, if not used; blank for sel.list)
   OCEAN LOADING     > ITRFCODE <    (NO, if not used; blank for sel.list)
   SATELL. CLOCKS    > NO       <    (NO, if not used; blank for sel.list)
   CODE BIASES       > NO       <    (NO, if not used; blank for sel.list)
   ANT. ORIENTATION  > NO       <    (NO, if not used; blank for sel.list)
```

```
 4.5-0                      PAR. ESTIMATION: OUTPUT FILES

   Output Files:
     COORDINATES          > NO       <    (NO, if not to be saved)
     ORBITAL ELEMENTS     > NO       <    (NO, if not to be saved)
     TROPOSPHERE PARAM.   > E1_96165 <    (NO, if not to be saved)
     TROPOSPHERE GRADI.   > NO       <    (NO, if not to be saved)
     TROPOSPHERE SINEX    > NO       <    (NO, if not to be saved)
     IONOSPHERE MODELS    > NO       <    (NO, if not to be saved)
     IONOSPHERE MAPS      > NO       <    (NO, if not to be saved)
     RESIDUALS            > E1_96165 <    (NO, if not to be saved)
     COVARIANCES (COORD)  > NO       <    (NO, if not to be saved)
     COVARIANCES (ALL)    > NO       <    (NO, if not to be saved)
     NORMAL EQUATIONS     > NO       <    (NO, if not to be saved)
     EARTH ROTATION PARA. > NO       <    (NO, if not to be saved)
     POLE IN IERS FORMAT  > NO       <    (NO, if not to be saved)
     SATELLITE CLOCK FILE > NO       <    (NO, if not to be saved)
     CODE BIASES          > NO       <    (NO, if not to be saved)
     ANTENNA PCV (GRID)   > NO       <    (NO, if not to be saved)
     ANTENNA PCV (HARM)   > NO       <    (NO, if not to be saved)
     GENERAL OUTPUT       > NO       <    (NO, if standard name to be used)
```

```
4.5-0.1        PARAMETER ESTIMATION: COMPUTATION OF RESIDUALS

 Computation of Residuals:
   TYPE OF RESIDUALS  > REAL       <   (REAL or NORMALIZED)
```

```
4.5-1                   PARAMETER ESTIMATION: INPUT 1

  TITLE    >  AMBIGUITY FREE SOLUTION, SESSION 165               <

  Frequency:
    FREQUENCY           > L3    <    (L1,L2,L3,L4,L5,L1&L2,L3&L4,MIXED,
                                      WUEBBena/Melbourne, or DTE)
  Fixed Station(s):
    STATION      > $FIRST            <    (blank for sel.list, ALL or NONE,
  Kin.  Station(s):                          SPECIAL_FILE.. $FIRST, $LAST)
    STATION      > NONE             <    (blank for sel.list, ALL or NONE,
                                             SPECIAL_FILE.. $FIRST, $LAST)
  Ambiguities:
    RESOL. STRATEGY     > NO     <   (ELIMIN..NO,ROUND,SEARCH..SIGMA..QIF)
    INTRODUCE WIDELANE  > NO  <      (YES or NO)
    INTRODUCE L1 AND L2 > NO  <      (YES or NO)
    SAVE AMBIGUITIES    > NO  <      (YES or NO)
  Observation selection:
    MIN. ELEVATION      > 10    <    degrees
    SAMPLING RATE       > 0     <    sec (0: all observations)
    OBSERV. WINDOW      > NO    <    (YES.. NO or ASIS)
```

Please note that we do not sample the observations in this run. This is important if we want to check *all* observations. Consequently the program run might be time consuming. The ambiguities may not be pre-eliminated if residuals should be written into the residual output file. In case you are not interested in residuals, the pre-elimination of the ambiguity parameters is recommended (option `ELIMIN` in Panel 4.5–1).

```
4.5-2                   PARAMETER ESTIMATION: INPUT 2


  Atmosphere Models:
    METEO DATA          > EXTRAPOLATED <  (EXTRAPOLATED, OBSERVED
                                           or ESTIMATED)
    TROPOSPH. MODEL     > NO           <  (SAASTAMOINEN,HOPFIELD,
                                           ESSEN-FROOME,MARINI-MUR,
                                           DRY_SAAST,DRY_HOPFIELD, or NO)
  Statistics:
    CORRELATIONS        > CORRECT      <  (CORRECT, FREQUENCY, or BASELINE)
    CORREL. INTERVAL       > 1      <     sec
    A PRIORI SIGMA         > 0.001  <     m
    ELEV.-DEP. WEIGHTING    > COSZ <      (NO, COSZ, or model number)

  Further Options:
    PRINTING                > NO   <      (YES.. NO or ASIS)
    HELMERT                 > NO   <      (YES.. NO or ASIS)
    ORBIT ADJUSTMENT        > NO   <      (YES.. NO or ASIS)
    SPECIAL REQUESTS        > YES  <      (YES.. or NO)
    ZERO DIFFERENCE EST.    > NO   <      (YES.. or NO)
```

```
4.5-2.4                 PARAMETER ESTIMATION: SPECIAL REQUESTS

 Special Requests:

   A PRIORI SIGMAS FOR SITE COORDINATES        > NO   <   (YES.. NO)

   SITE-SPECIFIC TROPOSPHERE PARAMETERS        > YES  <   (YES.. NO)
   STOCHASTIC IONOSPHERE PARAMETERS            > NO   <   (YES.. NO)
   GLOBAL IONOSPHERE MODEL PARAMETERS          > NO   <   (COE.. HGT.. NO)
   DIFFERENTIAL CODE BIASES                    > NO   <   (YES.. NO)
   EARTH ROTATION PARAMETERS                   > NO   <   (YES.. NO)
   COORDINATES OF CENTER OF MASS               > NO   <   (YES.. NO, ASIS)
   SATELLITE ANTENNA OFFSETS                   > NO   <   (YES.. NO)
   RECEIVER ANTENNA OFFSETS                    > NO   <   (YES.. NO)
   RECEIVER ANTENNA PATTERNS                   > NO   <   (YES.. NO)
   RECEIVER CLOCK ERRORS                       > NO   <   (YES.. NO)

   PARAMETER PRE-ELIMINATION                   > NO   <   (YES.. NO, ASIS)

   SATELLITE-SPECIFIC A PRIORI SIGMAS          > NO   <   (YES.. NO)
```

```
4.5-2.4.0      PARAMETER ESTIMATION: SITE-SPECIFIC TROPOSPHERE PARAMETERS

  General Zenith Apriori Sigmas:      General Gradient Apriori Sigmas:
    ABSOLUTE    > 5.0000 <  m           ABSOLUTE     > 5.0000 <  m
    RELATIVE    > 5.0000 <  m           RELATIVE     > 5.0000 <  m

  Special Zenith Apriori Sigmas:      Special Gradient Apriori Sigmas:
    ABSOLUTE    > 0.0000 <  m           ABSOLUTE     > 0.0000 <  m
    RELATIVE    > 0.0000 <  m           RELATIVE     > 0.0000 <  m

  Special Station Selection (no estimation if special sigmas set to 0.0):
    STATIONS    > NONE             < (blank for selection list, NONE,
                                     NO_TROPO, SPECIAL_FILE.. $FIRST, $LAST)
  Set-up of Parameters:
    MAPPING FUNCTION           > DRY_NIELL <  (COSZ, HOPFIELD, DRY_NIELL,
                                               or WET_NIELL)
    GRADIENT ESTIMATION MODEL  > NO        <  (NO, TILTING, or LINEAR)
    MODE OF PARAMETER SET-UP   > NUM <        (NUM: num/sess; MIN: minutes)
    # ZEN PAR/SESS OR INTERVAL > 12   <        (num/sess or minutes)
    # GRD PAR/SESS OR INTERVAL > 1   <        (num/sess or minutes)
```

An important information in the output file is the a posteriori rms error:

```
A POSTERIORI SIGMA OF UNIT WEIGHT (PART 1):
------------------------------------------

A POSTERIORI SIGMA OF UNIT WEIGHT  :    0.0011 M (SIGMA OF ONE-WAY L1 PHASE OBSERVABLE)
```

A posteriori rms error of about 1.0. . . 1.5 mm is expected. If the rms error is significantly higher this may mean that either your data stems from low-quality receivers or that the data was collected under extremely bad conditions or that the pre-processing step (MAUPRP, CODSPP) was not successfully performed. If the residuals have been stored in the files (Panel 4.5–0) it is possible to screen the residuals manually using the program REDISP in Menu 5.3.1 or automatically using the program RESRMS in Menu 5.3.2 . Program RESRMS produces an output file which may be used by the program SATMRK to mark outliers (see Chapter 10 for details).

We now process all baselines separately and we resolve the ambiguities using the QIF strategy (see Chapter 15). The following panels show the GPSEST options used for that purpose. Admittedly, it is cumbersome to process the baselines “manually” one after the other. This baseline processing mode is necessary because of the tremendous number of parameters. The attempt to resolve the ambiguities in a session solution might require too much CPU and memory to be feasible. Normally, we use the Bernese Processing Engine (see Chapter 22) to automate this processing step. The following options were used for this processing step:

```
 4.5          PROCESSING: PARAMETER ESTIMATION

  CAMPAIGN         > DOCU42_1 <    (blank for selection list)

 Job Identification:
  JOB CHARACTER       >   <        (blank, or A..Z, 0..9)

 Input Files:
  PHASE Z.DIFF.    > NO       <    (NO, if not used; blank for sel.list)
  CODE  Z.DIFF.    > NO       <    (NO, if not used; blank for sel.list)
  PHASE S.DIFF.    > KOWT1650 <    (NO, if not used; blank for sel.list)
  CODE  S.DIFF.    > NO       <    (NO, if not used; blank for sel.list)
  COORDINATES      > ITRF0696 <    (blank for selection list)
  STANDARD ORBIT   > E1_96165 <    (blank for selection list)
  RAD.PRESS.COE.   > NO       <    (NO, if not used; blank for sel.list)
  IONOSP. MODELS   > NO       <    (NO, if not used; blank for sel.list)
  TROPO. ESTIMATES > E1_96165 <    (NO, if not used; blank for sel.list)
  METEO DATA       > NO       <    (NO, if not used; blank for sel.list)
  ECCENTRICITIES   > NO       <    (NO, if not used; blank for sel.list)
  OCEAN LOADING    > ITRFCODE <    (NO, if not used; blank for sel.list)
  SATELL. CLOCKS   > NO       <    (NO, if not used; blank for sel.list)
  CODE BIASES      > NO       <    (NO, if not used; blank for sel.list)
  ANT. ORIENTATION > NO       <    (NO, if not used; blank for sel.list)
```

Note that we introduce the troposphere estimates from the previous network solution. Alternatively, if no tropospheric estimates are considered, the set up of tropospheric parameters for each QIF ambiguity resolution run is required.

```
 4.5-0          PAR. ESTIMATION: OUTPUT FILES

  Output Files:
    COORDINATES          > NO       <    (NO, if not to be saved)
    ORBITAL ELEMENTS     > NO       <    (NO, if not to be saved)
    TROPOSPHERE PARAM.   > NO       <    (NO, if not to be saved)
    TROPOSPHERE GRADI.   > NO       <    (NO, if not to be saved)
    TROPOSPHERE SINEX    > NO       <    (NO, if not to be saved)
    IONOSPHERE MODELS    > NO       <    (NO, if not to be saved)
    IONOSPHERE MAPS      > NO       <    (NO, if not to be saved)
    RESIDUALS            > NO       <    (NO, if not to be saved)
    COVARIANCES (COORD)  > NO       <    (NO, if not to be saved)
    COVARIANCES (ALL)    > NO       <    (NO, if not to be saved)
    NORMAL EQUATIONS     > NO       <    (NO, if not to be saved)
    EARTH ROTATION PARA. > NO       <    (NO, if not to be saved)
    POLE IN IERS FORMAT  > NO       <    (NO, if not to be saved)
    SATELLITE CLOCK FILE > NO       <    (NO, if not to be saved)
    CODE BIASES          > NO       <    (NO, if not to be saved)
    ANTENNA PCV (GRID)   > NO       <    (NO, if not to be saved)
    ANTENNA PCV (HARM)   > NO       <    (NO, if not to be saved)
    GENERAL OUTPUT       > NO       <    (NO, if standard name to be used)
```

```
4.5-1                 PARAMETER ESTIMATION: INPUT 1

  TITLE    >  QIF AMBIGUITY RESOLUTION                           <

  Frequency:
    FREQUENCY           > L1&L2 <    (L1,L2,L3,L4,L5,L1&L2,L3&L4,MIXED,
                                      WUEBBena/Melbourne, or DTE)
  Fixed Station(s):
    STATION      > $FIRST            <    (blank for sel.list, ALL or NONE,
  Kin.  Station(s):                         SPECIAL_FILE.. $FIRST, $LAST)
    STATION      > NONE             <    (blank for sel.list, ALL or NONE,
                                          SPECIAL_FILE.. $FIRST, $LAST)
  Ambiguities:
    RESOL. STRATEGY     > QIF    <    (ELIMIN..NO,ROUND,SEARCH..SIGMA..QIF)
    INTRODUCE WIDELANE  > NO  <       (YES or NO)
    INTRODUCE L1 AND L2 > NO  <       (YES or NO)
    SAVE AMBIGUITIES    > YES <       (YES or NO)
  Observation selection:
    MIN. ELEVATION      > 10   <    degrees
    SAMPLING RATE       > 0    <    sec (0: all observations)
    OBSERV. WINDOW      > NO   <    (YES.. NO or ASIS)
```

```
4.5-1.4     PARAMETER ESTIMATION: AMBIGUITY RESOLUTION (QIF)

 Quasi-Ionosphere-Free Ambiguity Resolution:
   MAX. NUMBER OF AMB. SOLVED IN ONE ITERATION STEP  > 10   <     (0:All)
   SEARCH WIDTH IN WIDE-LANE CYCLES                  > 0.50   <    cycles
   MAX. RMS OF RESOLVABLE NARROW-LANE AMBIGUITY      > 0.03   <    cycles
   MAX. FRACT. PART OF RESOLVABLE NL AMBIGUITY       > 0.10   <    cycles
```

```
4.5-2                 PARAMETER ESTIMATION: INPUT 2

  Atmosphere Models:
    METEO DATA          > ESTIMATED    <  (EXTRAPOLATED, OBSERVED
                                           or ESTIMATED)
    TROPOSPH. MODEL     > NO           <  (SAASTAMOINEN,HOPFIELD,
                                           ESSEN-FROOME,MARINI-MUR,
                                           DRY_SAAST,DRY_HOPFIELD, or NO)
  Statistics:
    CORRELATIONS        > CORRECT      <  (CORRECT, FREQUENCY, or BASELINE)
    CORREL. INTERVAL       > 1      <     sec
    A PRIORI SIGMA         > 0.001  <     m
    ELEV.-DEP. WEIGHTING    > COSZ <      (NO, COSZ, or model number)

  Further Options:
    PRINTING                > NO   <      (YES.. NO or ASIS)
    HELMERT                 > NO   <      (YES.. NO or ASIS)
    ORBIT ADJUSTMENT        > NO   <      (YES.. NO or ASIS)
    SPECIAL REQUESTS        > YES  <      (YES.. or NO)
    ZERO DIFFERENCE EST.    > NO   <      (YES.. or NO)
```

```
4.5-2.4                  PARAMETER ESTIMATION: SPECIAL REQUESTS

  Special Requests:

    A PRIORI SIGMAS FOR SITE COORDINATES        > NO   <   (YES.. NO)

    SITE-SPECIFIC TROPOSPHERE PARAMETERS        > NO   <   (YES.. NO)
    STOCHASTIC IONOSPHERE PARAMETERS            > YES  <   (YES.. NO)
    GLOBAL IONOSPHERE MODEL PARAMETERS          > NO   <   (COE.. HGT.. NO)
    DIFFERENTIAL CODE BIASES                    > NO   <   (YES.. NO)
    EARTH ROTATION PARAMETERS                   > NO   <   (YES.. NO)
    COORDINATES OF CENTER OF MASS               > NO   <   (YES.. NO, ASIS)
    SATELLITE ANTENNA OFFSETS                   > NO   <   (YES.. NO)
    RECEIVER ANTENNA OFFSETS                    > NO   <   (YES.. NO)
    RECEIVER ANTENNA PATTERNS                   > NO   <   (YES.. NO)
    RECEIVER CLOCK ERRORS                       > NO   <   (YES.. NO)

    PARAMETER PRE-ELIMINATION                   > YES  <   (YES.. NO, ASIS)

    SATELLITE-SPECIFIC A PRIORI SIGMAS          > NO   <   (YES.. NO)
```

```
4.5-2.4.7     PARAMETER ESTIMATION: STOCHASTIC IONOSPHERE PARAMETERS

  Stochastic Ionosphere Parameters:

   EPOCH-WISE PRE-ELIMINATION                            > YES <   (YES,NO)
   ELIMINATION OF REFERENCE IONOSPHERE PARAMETERS        > NO  <   (YES,NO)
   ELEVATION-DEPENDENT PARAMETER CONSTRAINING            > YES <   (YES,NO)

   ABSOLUTE A PRIORI SIGMA ON SINGLE DIFFERENCE LEVEL  > 0.25   < m
   RELATIVE A PRIORI SIGMA OF IONOSPHERIC RANDOM WALK  > 0.00   < m/min**1/2
```

```
4.5-2.4.8                     PARAMETER PRE-ELIMINATION

  Parameters to be Pre-Eliminated: NO= No Pre-Elimination
                                   BI= Before Inversion of Normal Eq. System
                                   AI= After  Inversion of Normal Eq. System
                                   EP= After Each Epoch

    STATION COORD.    > NO <     EARTH POTENTIAL   > NO <   (NO, BI, AI)
    RECEIVER CLOCKS   > NO <     HILL RESONANCES   > NO <   (NO, BI, AI)
    ORBIT ELEMENTS    > NO <     EARTH ALBEDO      > NO <   (NO, BI, AI)
    AMBIGUITIES       > NO <     CENTER OF MASS    > NO <   (NO, BI, AI)
    REC.HEIGHT.CALIB. > NO <     DIFF. IONOSPHERE  > EP <   (NO, BI, AI, EP)
    SITE TROPOSPHERE  > NO <     PHASE CENTER VAR. > NO <   (NO, BI, AI)
    LOCAL IONOSPHERE  > NO <     GLOBAL IONOSPHERE > NO <   (NO, BI, AI)
    DIFF. CODE BIASES > NO <     --                > NO <   (NO, BI, AI)
    LOCAL TROPOSPHERE > NO <     KIN. COORDINATES  > NO <   (NO, BI, AI, EP)
    EARTH ROTATION    > NO <
    STOCH. ORBIT      > NO <     STATION CLOCKS    > NO <   (NO, BI, AI, EP)
    SAT. ANT.OFF      > NO <     SATELLITE CLOCKS  > NO <   (NO, BI, AI, EP)
```

In the above Panel 4.5–2.4.8, the pre-elimination handling for each parameter type can be controlled individually. For ambiguities and differential ionosphere parameters, however, the pre-elimination can be enforced already in Panel 4.5.1, and Panel 4.5–2.4.7, respectively. So, for the current GPSEST run, the Panel 4.5–2.4.8 might be suppressed by setting "NO" for the corresponding option in Panel 4.5–2.4.

In the first part of the output generated by program GPSEST the selected options are echoed. Then the results of the initial least-squares adjustment (ambiguities estimated as real values) are given:

```
 NUMBER OF PARAMETERS (PART 1):
 -----------------------------

 PARAMETER TYPE                                       #PARAMETERS   #PRE-ELIMINATED
 ------------------------------------------------------------------------------------

 STATION COORDINATES                                            3           0
 AMBIGUITIES                                                  110           0
 STOCHASTIC IONOSPHERE PARAMETERS                           17395       17395  (EPOCH-WISE)

 ------------------------------------------------------------------------------------
 TOTAL NUMBER OF PARAMETERS                                 17508       17395
 ------------------------------------------------------------------------------------


 NUMBER OF OBSERVATIONS (PART 1):
 -------------------------------

 TYPE         FREQUENCY         FILE              #OBSERVATIONS
 ------------------------------------------------------------------------------------

 PHASE           L1              ALL                    14517
 PHASE           L2              ALL                    14517

 ------------------------------------------------------------------------------------
 TOTAL NUMBER OF OBSERVATIONS                               29034
 ------------------------------------------------------------------------------------


 A POSTERIORI SIGMA OF UNIT WEIGHT (PART 1):
 ------------------------------------------

 A POSTERIORI SIGMA OF UNIT WEIGHT  :    0.0011 M  (SIGMA OF ONE-WAY L1 PHASE OBSERVABLE)

 DEGREE OF FREEDOM (DOF)            :     14404
 CHI**2/DOF                         :      1.29


STATION COORDINATES:
-------------------

 NUM  STATION NAME     PARAMETER    A PRIORI VALUE       NEW VALUE     NEW- A PRIORI  RMS ERROR
 ----------------------------------------------------------------------------------------------

 161  WTZR 14201M010   X           4075580.6570      4075580.6708      0.0138      0.0003
                       Y            931853.6759       931853.6807      0.0048      0.0004
                       Z           4801568.0465      4801568.0415     -0.0050      0.0003

                       HEIGHT          666.0089          666.0147      0.0057      0.0004
                       LATITUDE    49  8 39.110745    49  8 39.110284   -0.0142      0.0002
                       LONGITUDE   12 52 44.068161    12 52 44.068240    0.0016      0.0004


                                                                             ...
```

```
...

AMBIGUITIES:
-----------
                                   REFERENCE
AMBI  FILE SAT. EPOCH FRQ WLF CLU  AMBI CLU    AMBIGUITY   RMS   TOTAL AMBIGU.
-------------------------------------------------------------------------------------

    1    1   19      1  1   1    1  111   57       -50.74   0.36    -1019143.74
    2    1   19   2452  1   1    2  111   57         2.35   0.26     4016148.35
    3    1   27      1  1   1    3  111   57       -50.83   0.31     -366146.83
    4    1   27   2565  1   1    4  111   57       -21.68   0.28     1079386.32

 ...

  111    1   28      1  1   1   57        -- REFERENCE --         1568791.
  112    1   28      1  2   1   57        -- REFERENCE --         1222452.
```

Next, the result of the QIF ambiguity resolution algorithm is given:

```
AMBIGUITY RESOLUTION:
--------------------

STRATEGY :  QUASI-IONOSPHERE-FREE AMBIGUITY RESOLUTION (QIF)

-------------------------------------------------------------------------------------
AMBIGUITY RESOLUTION ITERATION:     1
-------------------------------------------------------------------------------------

                                BEST INT.    CORRECTIONS IN CYCLES
FILE AM1 CL1 #AM1 AM2 CL2 #AM2   L1   L2    L1     L2     L5      L3    RMS(L3)
-------------------------------------------------------------------------------------

    1  49  53   1  111  57   1   -16   -3   0.09   0.10  -0.014   0.035   0.004
```

First, the individual iteration steps are described (we specified that up to ten ambiguities may be resolved within each iteration step – see Panel 4.5–1.4 and Chapter 15). The following information is listed for each resolved double-difference ambiguity:

- ... `FILE` file number (`1` in our case; we process one baseline only),
- ... `AM1` first ambiguity number (single-difference level),
- ... `CL1` corresponding ambiguity cluster,
- ... `#AM1` number of ambiguities belonging to the same cluster,
- ... `AM2, CL2, #AM2` similar information for the second ambiguity.
- ... `BEST INT. L1, L2` are the integer corrections to the a priori values (a priori values are computed using the a priori coordinates and may be rather inaccurate).
- ... `CORRECTIONS IN CYCLES` for carriers `L1` and `L2` give the information about the fractional parts of the L_1 and L_2 ambiguities. The `CORRECTIONS IN CYCLES L5` and `L3` are of greater interest, however. `L3` is given by Eqn. (15.23). The

value `L5` represents the ionosphere-induced bias expressed in L_5 cycles. These values may not be greater than the maximum value specified in Panel 4.5–1.4 (option `SEARCH WIDTH IN WIDE LANE CYCLES`). `RMS(L3)` is the criterion according to which the ambiguities are sorted. It is given by eqn. 15.26. Ambiguities with L_3 rms errors larger than the value specified in Panel 4.5–1.4 (in our example `0.03`) will not be resolved.

The results of the ambiguity resolution are summarized in the following table:

AMBI	FILE	SAT.	EPOCH	FRQ	WLF	CLU	REFERENCE AMBI	REFERENCE CLU	AMBIGUITY	RMS	TOTAL AMBIGU.
1	1	19	1	1	1	1	111	57	-48		-1019141.
2	1	19	2452	1	1	2	12	13	42		4016188.
3	1	27	1	1	1	3	5	5	-1		-366097.
4	1	27	2565	1	1	4	111	57	-24		1079384.
5	1	2	1	1	1	5	15	16	1		-2332154.
6	1	2	1795	1	1	6	111	57	-43.50	3.98	2469700.50
7	1	2	1890	1	1	7	111	57	-40.57	0.61	-5384997.57
8	1	2	2804	1	1	8	40	43	34		8291601.
9	1	26	1	1	1	9	111	57	-48.13	0.26	2851283.87
10	1	26	180	1	1	10	36	39	26		2851310.

The ambiguities for which an rms error is listed are not be resolved (these ambiguities will be treated as real values by all subsequent program runs). Ambiguity resolution has an influence on other parameters. The results of the ambiguity-fixed solution are given in part 2 of the output:

```
13. RESULTS (PART 2)
--------------------

NUMBER OF PARAMETERS (PART 2):
-----------------------------

PARAMETER TYPE                                    #PARAMETERS   #PRE-ELIMINATED
------------------------------------------------------------------------------------

STATION COORDINATES                                     3           0
AMBIGUITIES                                            32           0
STOCHASTIC IONOSPHERE PARAMETERS                    17395       17395  (EPOCH-WISE)

------------------------------------------------------------------------------------
TOTAL NUMBER OF PARAMETERS                          17430       17395
------------------------------------------------------------------------------------


NUMBER OF OBSERVATIONS (PART 2):
-------------------------------

TYPE         FREQUENCY         FILE              #OBSERVATIONS
------------------------------------------------------------------------------------

PHASE           L1              ALL                 14517
PHASE           L2              ALL                 14517

------------------------------------------------------------------------------------
TOTAL NUMBER OF OBSERVATIONS                        29034
------------------------------------------------------------------------------------


A POSTERIORI SIGMA OF UNIT WEIGHT (PART 2):
------------------------------------------

A POSTERIORI SIGMA OF UNIT WEIGHT  :    0.0012 M  (SIGMA OF ONE-WAY L1 PHASE OBSERVABLE)

DEGREE OF FREEDOM (DOF)            :     14482
CHI**2/DOF                         :      1.48


STATION COORDINATES:                       (NOT SAVED)
-------------------

NUM  STATION NAME     PARAMETER    A PRIORI VALUE       NEW VALUE     NEW- A PRIORI
------------------------------------------------------------------------------------

161  WTZR 14201M010   X            4075580.6570      4075580.6695      0.0125
                      Y             931853.6759       931853.6800      0.0041
                      Z            4801568.0465      4801568.0405     -0.0060

                      HEIGHT           666.0089          666.0130      0.0041
                      LATITUDE     49  8 39.110745    49  8 39.110297   -0.0138
                      LONGITUDE    12 52 44.068161    12 52 44.068218    0.0012
```

You may see from the output that from altogether 110 ambiguities 88 ambiguities could be resolved. This is not a bad result for the QIF strategy considering the fact that the baseline length Kootwijk–Wettzell is about 600 km and that no a priori ionosphere model was used. You find an example for such a model on our anonymous ftp in the directory
`ftp://ftp.unibe.ch/aiub/BSWUSER/EXAMPLES/DOCU42_1/ATM/`.
You may copy the `*.ION` files into your `ATM` directory, set the corresponding option in Panel 4.5

and re-process the baseline once more.

After the loop over all baselines is completed and the ambiguities are resolved you will use the program GPSEST in the session mode. In Panel 4.5, we do not include the troposphere file as in the baseline runs, but will estimate the troposphere parameters in Panel 4.5–2.4. In Panel 4.5 you may now select *all* the single difference files of the corresponding session. The next panel is

```
4.5-0                 PAR. ESTIMATION: OUTPUT FILES

  Output Files:
    COORDINATES          > E1_96165 <    (NO, if not to be saved)
    ORBITAL ELEMENTS     > NO       <    (NO, if not to be saved)
    TROPOSPHERE PARAM.   > NO       <    (NO, if not to be saved)
    TROPOSPHERE GRADI.   > NO       <    (NO, if not to be saved)
    TROPOSPHERE SINEX    > NO       <    (NO, if not to be saved)
    IONOSPHERE MODELS    > NO       <    (NO, if not to be saved)
    IONOSPHERE MAPS      > NO       <    (NO, if not to be saved)
    RESIDUALS            > NO       <    (NO, if not to be saved)
    COVARIANCES (COORD)  > NO       <    (NO, if not to be saved)
    COVARIANCES (ALL)    > NO       <    (NO, if not to be saved)
    NORMAL EQUATIONS     > E1_96165 <    (NO, if not to be saved)
    EARTH ROTATION PARA. > NO       <    (NO, if not to be saved)
    POLE IN IERS FORMAT  > NO       <    (NO, if not to be saved)
    SATELLITE CLOCK FILE > NO       <    (NO, if not to be saved)
    CODE BIASES          > NO       <    (NO, if not to be saved)
    ANTENNA PCV (GRID)   > NO       <    (NO, if not to be saved)
    ANTENNA PCV (HARM)   > NO       <    (NO, if not to be saved)
    GENERAL OUTPUT       > NO       <    (NO, if standard name to be used)
```

We decided to store site coordinates and normal equations in a file named `E1_96165.CRD` and `E1_96165.NEQ` respectively (the extensions are automatically added from the entries in Panel 0.3.4). Note that GPSEST automatically generates normal equation files with the extension `*.NQ0` to be used with the new ADDNEQ2 program as well.

Important changes have to be made in the following panels

```
4.5-1                 PARAMETER ESTIMATION: INPUT 1

 TITLE    >  SESSION PROCESSING                                   <

 Frequency:
   FREQUENCY           > L3    <    (L1,L2,L3,L4,L5,L1&L2,L3&L4,MIXED,
                                     WUEBBena/Melbourne, or DTE)
 Fixed Station(s):
   STATION      > NONE              <    (blank for sel.list, ALL or NONE,
 Kin.  Station(s):                        SPECIAL_FILE.. $FIRST, $LAST)
   STATION      > NONE             <    (blank for sel.list, ALL or NONE,
                                          SPECIAL_FILE.. $FIRST, $LAST)
 Ambiguities:
   RESOL. STRATEGY     > ELIMIN <   (ROUND,SIGMA..SEARCH..ELIMIN,QIF..NO)
   INTRODUCE WIDELANE  > NO  <      (YES or NO)
   INTRODUCE L1 AND L2 > YES <      (YES or NO)
   SAVE AMBIGUITIES    > NO  <      (YES or NO)
 Observation selection:
   MIN. ELEVATION      > 10    <    degrees
   SAMPLING RATE       > 240   <    sec (0: all observations)
   OBSERV. WINDOW      > NO    <    (YES.. NO or ASIS)
```

```
4.5-1.8 | PARAMETER ESTIMATION: AMBIGUITY PRE-ELIMINATION

 Ambiguity Pre-Elimination:
   EXECUTION  > SESSION <  (once per SESSION, every EPOCH, every n seconds)
```

```
4.5-2.4 |              PARAMETER ESTIMATION: SPECIAL REQUESTS

  Special Requests:

    A PRIORI SIGMAS FOR SITE COORDINATES        > YES  <   (YES.. NO)

    SITE-SPECIFIC TROPOSPHERE PARAMETERS        > YES  <   (YES.. NO)
    STOCHASTIC IONOSPHERE PARAMETERS            > NO   <   (YES.. NO)
    GLOBAL IONOSPHERE MODEL PARAMETERS          > NO   <   (COE.. HGT.. NO)
    DIFFERENTIAL CODE BIASES                    > NO   <   (YES.. NO)
    EARTH ROTATION PARAMETERS                   > NO   <   (YES.. NO)
    COORDINATES OF CENTER OF MASS               > NO   <   (YES.. NO, ASIS)
    SATELLITE ANTENNA OFFSETS                   > NO   <   (YES.. NO)
    RECEIVER ANTENNA OFFSETS                    > NO   <   (YES.. NO)
    RECEIVER ANTENNA PATTERNS                   > NO   <   (YES.. NO)
    RECEIVER CLOCK ERRORS                       > NO   <   (YES.. NO)

    PARAMETER PRE-ELIMINATION                   > NO   <   (YES.. NO, ASIS)

    SATELLITE-SPECIFIC A PRIORI SIGMAS          > NO   <   (YES.. NO)
```

We process the ionosphere-free (L_3) linear combination. No station is kept fixed. Ambiguities which have been resolved in the previous runs of program GPSEST using the QIF strategy are introduced as known. The unresolved ambiguities (estimated as real-valued parameters) are pre-eliminated. It is possible to use a higher sampling rate. We did not fix any station on its a priori position in Panel 4.5–1 , i.e., the coordinates of all stations will be treated as unknown parameters. This is very important to retain the flexibility for later changes of the reference frame (station constraints) using the program ADDNEQ. However, for numerical reasons it is necessary to constrain the coordinates of one station using the following options (the constraints may be removed in ADDNEQ again – see below):

```
4.5-2.4.B | PARAMETER ESTIMATION: A PRIORI SIGMAS: STATIONS AND DEFAULT SIGMA

   Station Selection:
      STATIONS    > $FIRST           <  (blank for selection list, SELECTED,
                                         SPECIAL_FILE.., $FIRST, $LAST)
   Default Sigma per Coordinate:
      SIGMA              > 0.0001  <    (meters)
```

For the final definition of the geodetic datum, we recommend to use ADDNEQ, also in the case of having one single normal equation file, only. The estimation of troposphere parameters is mandatory for a campaign of this type. You may try to increase the number of estimated parameters (e.g., 24 instead of 12 parameters per station and session). In order to keep the size of the resulting normal equation file within reasonable limits, it does make sense to pre-eliminate this parameter type “after inversion” (see Panel 4.5–2.4.8). If tropospheric delays are not your interest, you may even go for “before inversion”. The advanced user stores the full normal equation system and creates a second, reduced normal equation file using ADDNEQ (and pre-eliminate the tropospheric parameters there).

The large NEQs may be used to retrieve best possible tropospheric parameters by substituting, e.g., weekly coordinate results; the small, space-saving NEQs may be kept on-line and used for later long-term coordinate analysis. The output of a 1-session run of the program GPSEST should look like this:

```
12. RESULTS (PART 1)
--------------------

NUMBER OF PARAMETERS (PART 1):
-----------------------------

PARAMETER TYPE                                     #PARAMETERS   #PRE-ELIMINATED
------------------------------------------------------------------------------------

STATION COORDINATES                                     18           0
AMBIGUITIES                                             79          79  (BEFORE INV)
SITE-SPECIFIC TROPOSPHERE PARAMETERS                    72           0

------------------------------------------------------------------------------------
TOTAL NUMBER OF PARAMETERS                             169          79
------------------------------------------------------------------------------------


NUMBER OF OBSERVATIONS (PART 1):
-------------------------------

TYPE         FREQUENCY         FILE              #OBSERVATIONS
------------------------------------------------------------------------------------

PHASE           L3              ALL                   9033

------------------------------------------------------------------------------------
TOTAL NUMBER OF OBSERVATIONS                          9033
------------------------------------------------------------------------------------


A POSTERIORI SIGMA OF UNIT WEIGHT (PART 1):
------------------------------------------

A POSTERIORI SIGMA OF UNIT WEIGHT  :    0.0012 M  SIGMA OF 1-WAY L1 PHASE OBS. AT ZENITH

DEGREE OF FREEDOM (DOF)            :      8870
CHI**2/DOF                         :      1.48
```

After two runs of GPSEST in the session mode the following two normal equation files should be available in the directory `P:/DOCU42_1/OUT`

`E1_96165.NEQ` and `E1_96166.NEQ`

along with the corresponding `*.NQ0` files, and the two coordinate files

`E1_96165.CRD` and `E1_96166.CRD`

in the directory `P:/DOCU42_1/STA`. We may now try to compare the coordinates stemming from sessions 165 and 166 using a 6-parameter Helmert transformation (program computing the Helmert transformation is accessible through Menu 5.4.2). The result looks like this

```
LOCAL GEODETIC DATUM: WGS - 84
RESIDUALS IN LOCAL SYSTEM (NORTH, EAST, UP)


---------------------------------------------------------------------
| NUM |      NAME        | FLG |     RESIDUALS IN MILLIMETERS   |   |
---------------------------------------------------------------------
|     |                  |     |                                |   |
| 121 | BRUS 13101M004   | P P |      -2.8       0.0      -6.9 |   |
| 117 | JOZE 12204M001   | P P |      -0.6      -1.2      -1.2 |   |
| 153 | KOSG 13504M003   | P P |      -0.4      -0.4       0.7 |   |
| 159 | ONSA 10402M004   | P P |       1.6       1.3       3.6 |   |
| 161 | WTZR 14201M010   | P P |       0.4       0.6      -3.2 |   |
| 158 | ZIMM 14001M004   | P P |       1.8      -0.3       7.0 |   |
|     |                  |     |                                |   |
---------------------------------------------------------------------
|     | RMS / COMPONENT  |     |       1.7       0.9       4.9 |   |
---------------------------------------------------------------------


NUMBER OF PARAMETERS  :  6
NUMBER OF COORDINATES : 18
RMS OF TRANSFORMATION :  3.5 MM



PARAMETERS:

PARAMETERS:

TRANSLATION IN  X     :          2.1    +-  1.4    MM
TRANSLATION IN  Y     :         -0.0    +-  1.4    MM
TRANSLATION IN  Z     :          1.1    +-  1.4    MM
ROTATION AROUND X-AXIS:     0  0  0.0026 +-  0.0008 "
ROTATION AROUND Y-AXIS:  -  0  0  0.0007 +-  0.0008 "
ROTATION AROUND Z-AXIS:  -  0  0  0.0003 +-  0.0005 "
```

From the Helmert transformation we conclude that the results of the two sessions are consistent on the millimeter level.

The last program to be used is program ADDNEQ (see Chapter 18). This program produces the final solution by stacking the `*.NEQ` files. If there are two `*.NEQ` files (each file stemming from one session) and there are no correlations between the observations from different sessions, ADDNEQ gives exactly the same results as GPSEST when processing both sessions together. Processing each session separately with program GPSEST and combining the `*.NEQ` files with program ADDNEQ is much more efficient, however. To run program ADDNEQ use Menu 4.8.1 and select the following options:

```
4.8.1                    ADD NORMAL EQUATION SYSTEMS

   CAMPAIGN           > DOCU42_1 <    (blank for selection list)

  Job Identification:
   JOB CHARACTER         >   <        (blank, or characters A - Z, 0 - 9)

  Input Files:
   NORMAL EQUATIONS      > E1_9616* <    (blank:  sel.list)
   UPDATE CRD.           > NO       <    (NO: not used, blank: sel.list)
   FIX ON SPEC. COORD.   > NO       <    (NO: not used, blank: sel.list)
   A PRIORI VELOC.       > NO       <    (NO: not used, blank: sel.list)
   FIX ON SPEC. VELOC.   > NO       <    (NO: not used, blank: sel.list)
   PLATE TABLE NUVEL1    > NO       <    (NO: not used, blank: sel.list)
   COV. COMPONENT INTRO  > NO       <    (NO: not used, blank: sel.list)
   PRE-DEFINED BASELINES > NO       <    (NO: not used, blank: sel.list)
   SITES FOR REPEATABIL. > NO       <    (NO: not used, blank: sel.list)
```

```
4.8.1-0           ADD NORMAL EQUATION SYSTEMS: OUTPUT FILES

   Output Files:
     COORDINATES          > FINAL    <    (NO, if not to be saved)
     VELOCITIES           > NO       <    (NO, if not to be saved)
     SINEX (CRD+VEL+ERP)  > NO       <    (NO, if not to be saved)
     ORBITAL ELEMENTS     > NO       <    (NO, file name)
     TROPOSPHERE PARAM.   > NO       <    (NO, if not to be saved)
     TROPOSPHERE SINEX    > NO       <    (NO, if not to be saved)
     IONOSPHERE MODELS    > NO       <    (NO, if not to be saved)
     COVARIANCES (COORD)  > NO       <    (NO, if not to be saved)
     COVARIANCES (ALL)    > NO       <    (NO, if not to be saved)
     COVARIANCE COMPON.   > NO       <    (NO, if not to be saved)
     NORMAL EQUATIONS     > NO       <    (NO, if not to be saved)
     EARTH ROTATION PARA. > NO       <    (NO, if not to be saved)
     POLE IN IERS FORMAT  > NO       <    (NO, if not to be saved)
     PLOT FILE            > NO       <    (NO, if not to be saved)
     REPORT FILE (SUMMARY)> NO       <    (NO, if not to be saved)
     GENERAL OUTPUT       > NO       <    (NO, if standard name to be used)
```

```
4.8.1-1            ADD NORMAL EQUATION SYSTEMS: INPUT 1

    TITLE    > COMBINED SOLUTION FOR BOTH SESSIONS                   <

   Coordinates:
    FIXED STATIONS      > WTZR 14201M010   <   (blank: sel.list, ALL, NONE,
                                                SPECIAL_FILE, $FIRST, $LAST)
    A PRIORI SIGMAS     > NO   <               (YES, NO)
    FREE SOLUTION COND. > NO  <                (YES, NO)

   Velocities:
    FIXED STATIONS      > NONE             <   (blank: sel.list, ALL, NONE,
                                                SPECIAL_FILE, $FIRST, $LAST)
    A PRIORI SIGMAS     > NO   <               (YES, NO)
    FREE SOLUTION COND. > NO  <                (YES, NO)
    INTRODUCE VELOC.    > NO  <                (YES, NO)
```

```
4.8.1-2                ADD NORMAL EQUATION SYSTEMS: INPUT 2

    Statistics:
      A PRIORI SIGMA                      > 0.001  <     m

    Parameters:
      ORBIT ADJUSTMENT                     > NO   <   (YES, NO, ASIS)
      SITE-SPECIFIC TROPOSPHERE            > YES  <   (YES, NO, ASIS)
      EARTH ROTATION                       > NO   <   (YES, NO, ASIS)
      COORDINATES OF CENTER OF MASS        > NO   <   (YES, NO, ASIS)
      PARAMETER PRE-ELIMINATION            > NO   <   (YES, NO, ASIS)

    Special Options :
      INDIVIDUAL VAR-COVAR RMS ESTIMATION  > NO  <    (YES, NO)
      PROCESSING IN BASELINE MODE          > NO  <    (YES, NO)
```

```
4.8.1-2.2       ADD NORMAL EQUATION SYSTEMS: SITE-SPECIFIC TROPOSPHERE

    A priori Sigma:
       ABSOLUTE                          > 5.00  <    (meters)
       RELATIVE                          > 5.00  <    (meters)

    Modelling:
       CONTINUITY BETWEEN NEQS           > NO  <      (YES, NO)
       NUMBER OF PARAMETERS PER DAY      > 000 <      (0: AS IN NEQ)
```

The final results are contained in the file `FINAL.CRD`: like

```
                                                               23-JUL-96 16:15
--------------------------------------------------------------------------------
LOCAL GEODETIC DATUM: WGS - 84         EPOCH: 1996-06-13 23:59:45

NUM  STATION NAME           X (M)          Y (M)          Z (M)     FLAG

121  BRUS 13101M004     4027893.8219    307045.7090   4919475.0315    M
153  KOSG 13504M003     3899225.2208    396731.8309   5015078.3531    M
117  JOZE 12204M001     3664940.2840   1409153.7581   5009571.3006    M
161  WTZR 14201M010     4075580.6570    931853.6759   4801568.0465    F
159  ONSA 10402M004     3370658.6340    711877.0491   5349786.8706    M
158  ZIMM 14001M004     4331297.1587    567555.7433   4633133.8460    M
```

Note, that the coordinates of station Wettzell were kept fixed on their a priori values (flag "`F`"). More refined strategies for the geodetic datum definition are explained in Chapter 19.

The result obtained from the program ADDNEQ differs up to 4 mm from the arithmetic mean of the two coordinate sets `E1_96165.CRD` and `E1_96166.CRD`. This is simply due to the fact that ADDNEQ takes the full covariance information of the daily solutions into account.

4.2 Example 2: Local Campaign

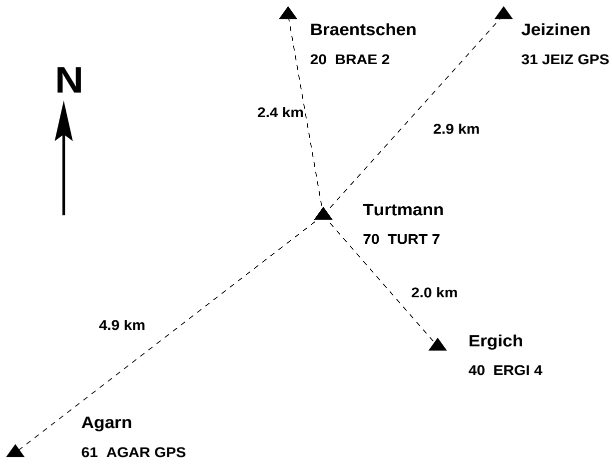

Figure 4.2: Stations used in campaign `DOCU42_2`.

The second example is taken from the Turtmann campaign 1993 [*Beutler et al.*, 1995]. The GPS data were made available through the Swiss Federal Office of Topography. For our example we selected five stations and two days of measurements (27. and 28. September 1993, day of year 270 and 271). A simple sketch of the survey is given in Figure 4.2. In this figure the station names, station numbers, and the distances between the stations are included. In this example we will proceed much faster than in the previous section. Actually, most of the processing is identical to the case of the regional network of Example 1. Therefore, we will focus on the main differences in processing strategy and program options when processing data from a local instead of a regional campaign.

If you are interested in re-processing this example you will find all necessary data in our anonymous ftp area (see previous section):

```
ftp://ftp.unibe.ch/aiub/BSWUSER/EXAMPLES/DOCU42_2
```

Campaign Setup

Use Menu 1.1 to define a new campaign `DOCU42_2` and copy the downloaded files into the corresponding directories. At the end you should have the following files:

```
P:/DOCU42_2/ATM
P:/DOCU42_2/DATPAN
                      DAT132__.PAN
P:/DOCU42_2/OBS
P:/DOCU42_2/ORB
P:/DOCU42_2/ORX
P:/DOCU42_2/OUT
P:/DOCU42_2/RAW
                      AGAR2700.93O  ERGI2700.93O  TURT2700.93N
                      AGAR2710.93O  ERGI2710.93O  TURT2700.93O
                      BRAE2700.93O  JEIZ2700.93O  TURT2710.93N
                      BRAE2710.93O  JEIZ2710.93O  TURT2710.93O
P:/DOCU42_2/STA
                      APRIORI.CRD
```

In addition, you will need to have the files `SATELLIT.EX2`, `C04_1993.ERP`, and `SAT_1993.CRX` in your `X:/GEN` directory, and you might have to update the file `DATUM.`, if you are working with a version of the software dated prior to June, 2000. These files are also available at the anonymous ftp location given above.

We use the broadcast instead of precise orbits in this example. The baselines are very short and therefore the accuracy of broadcast orbits is considered sufficient for this campaign. In "real life" we would recommend to use precise orbits, of course. We use broadcast orbits only to demonstrate the corresponding processing steps. The station names are given in Figure 4.2 and are the same as those in the RINEX files. Therefore, we do not need any station name translation table. The same is true for antenna heights and receiver/antenna names (you will use options "`NO`" in Panel 2.7.1 later). Before starting the actual processing you have to check the correct settings in Panel 0.3.1. We are using the Earth rotation parameter file `C04_1993.ERP`, the satellite problem file `SAT_1993.CRX`, and the satellite parameter file `SATELLIT.EX2`. In your future work, we recommend to use the `BULLET_A.ERP` pole file, except for high precision work using precise IGS orbits. In this case, you should use the consistent ERP files provided with the orbits (see Chapter 7). Looking at the file `SAT_1993.CRX`, we see that two problems (satellite numbers 5 and 24) are relevant for our example:

```
SATELLITE PROBLEMS: MANOEUVRES OR BAD OBSERVATION INTERVALS          12-JUN-92
--------------------------------------------------------------------------------

SATELLITE  PROBLEM    ACTION           FROM                   TO
   **         *         *       YYYY MM DD HH MM SS  YYYY MM DD HH MM SS

   23         0         0       1993 09 20 11 45 00
   24         0         0       1993 09 27 11 45 00
    1         3         1       1993 10 03 23 00 00  1993 10 06 12 00 00
    5         3         1       1993 09 27 00 00 00  1993 10 01 24 00 00
   24         3         1       1993 09 27 00 00 00  1993 10 01 24 00 00
   31         0         0       1993 11 01 00 00 00

PROBLEM:  MANOEUVRE=0, PHASE=1, CODE=2, CODE+PHASE=3
ACTION :  NEW ARC=0, MARK=1, REMOVE=2
```

Now you are ready to start the processing. First, it is necessary to define sessions in Menu 1.3. The sessions are 24 hours long and you can use exactly the same session definition as in Example 1. You do not need to prepare an a priori coordinate file in Menu 1.4.1 because such a file already exists in the directory `P:/DOCU42_2/STA` (file `APRIORI.CRD`).

Transfer Part

In Example 2 it is necessary to transfer not only the RINEX observation files into the Bernese format (Menu 2.7.1) but also the navigation messages (broadcast orbits). We do not use station name and receiver/antenna name translation tables, nor an antenna heights table (heights are taken from the `RINEX` files. Therefore, you can set the corresponding options in Menu 2.7.1 to `NO`. The navigation messsage files are transferred using Menu 2.7.2. This program has no options, only the input files have to be specified by the user. Several files may be processed in one program run.

Orbit Part

There are several small differences in the orbit processing if broadcast orbits instead of precise orbits are used. First of all it is necessary to check the broadcast orbits in Menu 3.1.2. The description of the program BRDTST is given in Chapter 8. Apart from the input (and output) file names the program has no options. Broadcast orbits from both sessions may be checked in one program run. The following message appears in the program output:

```
SHIFTS:
------
                LAST MESSAGE BEFORE SHIFT          FIRST MESSAGE AFTER SHIFT
NUM  SAT     DATUM      TIME     WEEK   TOE       DATUM      TIME     WEEK   TOE

  1   24    93-09-27 20:00:00    716  158400.   93-09-28  0:51:44    716  175904.
```

Do not panic, however. By using the correct satellite problem file `SAT_1993.CRX` (see above) the problem of satellite 24 is correctly handled (the observations of satellite 24 will not be used for day 270). In Menu 3.2 (creation of tabular orbits) there are two differences with respect to the first example: you have to specify that you are using `BROADCAST` ephemerides and you consequently cannot create a file containing satellite clocks.
When running program ORBGEN (Menu 3.3) only the model options should be set differently in Panel 3.3–2 :

```
3.3-2                      GENERATE STD.ORBITS: INPUT

  Orbit Model Options:
    PARTIAL DERIV.        > ALLPAR <  (NONPER, DYNALL, ALLPAR)

  Parameter selection:
    D0 estimation (P0)    > YES <     (YES, NO)
    Y0 estimation (P2)    > YES <     (YES, NO)
    X0 estimation         > NO  <     (YES, NO)

  Periodic Parameter selection:
    Periodic D terms      > NO  <     (YES, NO)
    Periodic Y terms      > NO  <     (YES, NO)
    Periodic X terms      > NO  <     (YES, NO)
```

It does not make sense to introduce the full orbit model (6+9 parameters) if broadcast orbits are used. The classical (6+2) model is sufficient – see Chapter 8 and Table 8.6. The rms values in the job output clearly show the modest quality of the broadcast ephemerides:

```
--------------------------------------------------------------------------------
RMS ERRORS AND MAX. RESIDUALS ARC NUMBER: 1 ITERATION: 2
--------------------------------------------------------------------------------

                           QUADRATIC MEAN OF O-C (M)        MAX. RESIDUALS (M)
SAT   #POS   RMS (M)     TOTAL   RADIAL  ALONG   OUT      RADIAL  ALONG   OUT
---   ----   -------     ----------------------------     --------------------

  1     20      0.98       0.91     0.78   0.89   1.04       1.27   1.52   1.62
  2     24      0.53       0.50     0.28   0.57   0.59       0.48   1.16   1.14
  3     24      0.32       0.30     0.30   0.41   0.11       0.56   0.88   0.21
  5     12      0.30       0.26     0.19   0.41   0.04       0.46   0.97   0.06
```

Processing Part

In program CODSPP the broadcast orbits are used instead of the standard orbits. Because broadcast orbits contain the information about the satellite clocks, no additional satellite clock file is required. Make sure to use the corresponding broadcast orbit file for each of the sessions.

```
 4.2                       PROCESSING: CODE PROCESSING

   CAMPAIGN         > DOCU42_2 <

 Job Identification:
   JOB CHARACTER        >   <       (blank or character from A - Z, 0 - 9)

 Input Files:
   CODE             > ????270? <     COORDINATES      > APRIORI  <
   BROADCAST        > TURT2700 <     STANDARD ORBIT   > NO       <
   ECCENTRICITIES   > NO       <     SATELLITE CLOCKS > NO       <
   TROPO. ESTIMATES > NO       <

 Output Files:
   COORDINATES      > NO       <     RESIDUALS        > NO       <
   PHASE            >          <     RESULT SUMMARY   > NO       <
   SATELLITE CLOCKS > NO       <
                                                         See Help Panel
```

The options for the subsequent panels for CODSPP can be taken over from the previous example. In program SNGDIF (Menu 4.3) the options are the same as in Example 1.

```
 4.3                       PROCESSING: FORM SINGLE DIFF.

   CAMPAIGN                > DOCU42_2 <  (blank for selection list)

   STRATEGY                > OBS-MAX   < (MANUAL(M),DEFINED(D),SHORTEST(S),
                                          AUTO-STAR(A),OBS-MAX(O),PLUS(P))
 Input Files:
   MEASUREMENT TYPE        > PHASE    <  (Any    : CODE or PHASE)
   ZERO DIFF. FILE 1       > ????270? <  (Any    : blank for sel. list)
   ZERO DIFF. FILE 2       >          <  (M      : blank for sel. list)
   COORDINATES             > APRIORI  <  (S+A+P  : blank for sel. list)
   ECCENTRICITIES          > NO       <  (S+A+P  : NO, blank for sel. list)
   PRE-DEFINED BASELINES   > NO       <  (S+O+P+D: NO, blank for sel. list)
   CLUSTER DEFINITION      > NO       <  (NO, blank for selection list)
 Output File:
   SINGLE DIFFERENCE       >          <  (Any: blank for default file name,
                                               HEADER: Header files only)
   BASELINE DEFINITIONS    > NO       <  (NO, if not to be saved)
   CLUSTER DEFINITION      >        <    (enter only if cluster input given)
```

You might also try to use the strategy `AUTO-STAR` instead of `OBS-MAX`. This strategy will create the baselines according to Figure 4.2 (forming a “star” with the shortest baseline lengths).

The options of program MAUPRP (Menu 4.4.2) are described in detail in Section 10.5 . The second example in that section stems from the Turtmann campaign discussed here. The only differences in the option settings with respect to Example 1 are :

- the coordinate file used in Panel 4.4.2 (set `COORDINATES` to `APRIORI`),
- select strategy `BOTH` instead of `COMBINED` in Panel 4.4.2–1 ,
- set `ACCEPT SLIPS LARGER THAN` to `0` in Panel 4.4.2–3 , and set the maximum ionosphere difference to 30% in Panel 4.4.2–4 .

```
4.4.2          PROCESSING: LATEST MANUAL/AUTOMATIC PREPROCESSING

   CAMPAIGN          > DOCU42_2 <    (blank for selection list)

  Input Files:
   SINGLE DIFF.      > ????270? <    (blank for selection list)
   COORDINATES       > APRIORI  <    (blank for selection list)
   STANDARD ORBIT    > E2_93270 <    (blank for selection list)
   IONOSP. MODELS    > NO       <    (NO, if not used; blank for sel.list)
   ECCENTRICITIES    > NO       <    (NO, if not used; blank for sel.list)
   SATELL. CLOCKS    > NO       <    (NO, if not used; blank for sel.list)

  Output File:
   COORDINATES       > NO       <    (NO, if not to be saved)
   RESIDUALS         > NO       <    (NO, if not to be saved)
```

```
4.4.2-1                    NEW PREPROCESSING: INPUT 1

  General Parameters:
   PROCESSING MODE         > AUTOMATIC <     (MANUAL, AUTOMATIC)
   FREQUENCY TO CHECK      > BOTH      <     (L1,L2,BOTH or COMBINED)
   SAVE SCREENED FILES        > YES <        (YES or NO)
   ADJUST FREQ./WLFAC.        > YES <        (YES or NO)

  Change Other Options:
   CHANGE OPTIONS             > YES <        (YES.. or NO)

  Saving Coordinates:
   FIXED STATION      >                  <  (AUTO for automatic selection)
```

```
4.4.2-3                    NEW PREPROCESSING: INPUT 3

 Slip Detection:
   PRINTING                             > SUMMARY <   (NO,SUMMARY or ALL)
   ACCEPT SLIPS GREATER THAN            > 0       <   cycles (half)
   TEST OBS WITH CYCLE SLIP FLAG ONLY     > NO  <     (YES or NO)
   L5 IS CLEAN (EXCEPT FLAGGED EPOCHS)    > NO  <     (YES or NO)

 Sigmas:
   L1 OBSERVATIONS                      > 0.0020  <   meters
   L2 OBSERVATIONS                      > 0.0020  <   meters

 Cycles or Half:
   SEARCH L1 FOR                        > CYCLES  <   (CYCLES or HALF)
   SEARCH L2 FOR                        > CYCLES  <   (CYCLES or HALF)

 Search Widths:
   SEARCH WIDTH L1                        > 5   <     integers
   SEARCH WIDTH L5                        > 2   <     integers
```

```
4.4.2-4                    NEW PREPROCESSING: INPUT 4

 Outlier Rejection:
   OUTLIER REJECTION                      > YES <    (YES or NO)
   MAX. OBSERV.GAP                       > 181   <   seconds
   MAX. IONOS.DIFF                       > 30    <   percents of L1 cycles

 Setting of New Ambiguities:
   - IF CYCLE SLIP FLAG SET IN FILE       > NO  <    (YES or NO)
   - IF CYCLE SLIP DETECTION PROBLEM      > YES <    (YES or NO)
   - AFTER A GAP LARGER THAN             > 181   <   seconds
   USE AMBIGUITIES FROM FILE              > NO  <    (YES or NO)
   MINIMUM TIME INTERVAL PER AMBIGUITY > 301   <   seconds
```

The most important part of the output of program MAUPRP is given in Section 10.5. Note the marked observations of satellite 24 due to the usage of the `SAT_1993.CRX` file.

Now you may run the program GPSEST a first time to save the residuals. Using the programs RESRMS and SATMRK, you can delete the outliers in the observation files (same procedure as in the regional network in the last example).

```
 4.5                        PROCESSING: PARAMETER ESTIMATION

   CAMPAIGN          > DOCU42_2 <    (blank for selection list)

  Job Identification:
   JOB CHARACTER        >   <        (blank, or A..Z, 0..9)

  Input Files:
   PHASE Z.DIFF.     > NO       <    (NO, if not used; blank for sel.list)
   CODE  Z.DIFF.     > NO       <    (NO, if not used; blank for sel.list)
   PHASE S.DIFF.     > ????270? <    (NO, if not used; blank for sel.list)
   CODE  S.DIFF.     > NO       <    (NO, if not used; blank for sel.list)
   COORDINATES       > APRIORI  <    (blank for selection list)
   STANDARD ORBIT    > E2_93270 <    (blank for selection list)
   RAD.PRESS.COE.    > NO       <    (NO, if not used; blank for sel.list)
   IONOSP. MODELS    > NO       <    (NO, if not used; blank for sel.list)
   TROPO. ESTIMATES  > NO       <    (NO, if not used; blank for sel.list)
   METEO DATA        > NO       <    (NO, if not used; blank for sel.list)
   ECCENTRICITIES    > NO       <    (NO, if not used; blank for sel.list)
   OCEAN LOADING     > NO       <    (NO, if not used; blank for sel.list)
   SATELL. CLOCKS    > NO       <    (NO, if not used; blank for sel.list)
   CODE BIASES       > NO       <    (NO, if not used; blank for sel.list)
   ANT. ORIENTATION  > NO       <    (NO, if not used; blank for sel.list)
```

```
 4.5-0                        PAR. ESTIMATION: OUTPUT FILES

   Output Files:
     COORDINATES           > NO       <    (NO, if not to be saved)
     ORBITAL ELEMENTS      > NO       <    (NO, if not to be saved)
     TROPOSPHERE PARAM.    > E2_93270 <    (NO, if not to be saved)
     TROPOSPHERE GRADI.    > NO       <    (NO, if not to be saved)
     TROPOSPHERE SINEX     > NO       <    (NO, if not to be saved)
     IONOSPHERE MODELS     > NO       <    (NO, if not to be saved)
     IONOSPHERE MAPS       > NO       <    (NO, if not to be saved)
     RESIDUALS             > E2_93270 <    (NO, if not to be saved)
     COVARIANCES (COORD)   > NO       <    (NO, if not to be saved)
     COVARIANCES (ALL)     > NO       <    (NO, if not to be saved)
     NORMAL EQUATIONS      > NO       <    (NO, if not to be saved)
     EARTH ROTATION PARA.  > NO       <    (NO, if not to be saved)
     POLE IN IERS FORMAT   > NO       <    (NO, if not to be saved)
     SATELLITE CLOCK FILE  > NO       <    (NO, if not to be saved)
     CODE BIASES           > NO       <    (NO, if not to be saved)
     ANTENNA PCV (GRID)    > NO       <    (NO, if not to be saved)
     ANTENNA PCV (HARM)    > NO       <    (NO, if not to be saved)
     GENERAL OUTPUT        > NO       <    (NO, if standard name to be used)
```

```
 4.5-0.1             PARAMETER ESTIMATION: COMPUTATION OF RESIDUALS

  Computation of Residuals:
    TYPE OF RESIDUALS  > REAL       <   (REAL or NORMALIZED)
```

```
4.5-1                    PARAMETER ESTIMATION: INPUT 1

  TITLE    >  AMBIGUITY FREE SOLUTION, SESSION 270                 <

  Frequency:
    FREQUENCY           > L3    <    (L1,L2,L3,L4,L5,L1&L2,L3&L4,MIXED,
                                      WUEBBena/Melbourne, or DTE)
  Fixed Station(s):
    STATION      > $FIRST            <    (blank for sel.list, ALL or NONE,
  Kin.  Station(s):                        SPECIAL_FILE.. $FIRST, $LAST)
    STATION      > NONE             <    (blank for sel.list, ALL or NONE,
                                           SPECIAL_FILE.. $FIRST, $LAST)
  Ambiguities:
    RESOL. STRATEGY     > NO     <   (ELIMIN..NO,ROUND,SEARCH..SIGMA..QIF)
    INTRODUCE WIDELANE  > NO  <      (YES or NO)
    INTRODUCE L1 AND L2 > NO  <      (YES or NO)
    SAVE AMBIGUITIES    > NO  <      (YES or NO)
  Observation selection:
    MIN. ELEVATION      > 10    <    degrees
    SAMPLING RATE       > 0     <    sec (0: all observations)
    OBSERV. WINDOW      > NO    <    (YES.. NO or ASIS)
```

```
4.5-2                    PARAMETER ESTIMATION: INPUT 2

  Atmosphere Models:
    METEO DATA          > EXTRAPOLATED <  (EXTRAPOLATED, OBSERVED
                                           or ESTIMATED)
    TROPOSPH. MODEL     > NO           <  (SAASTAMOINEN,HOPFIELD,
                                           ESSEN-FROOME,MARINI-MUR,
                                           DRY_SAAST,DRY_HOPFIELD, or NO)
  Statistics:
    CORRELATIONS        > CORRECT      <  (CORRECT, FREQUENCY, or BASELINE)
    CORREL. INTERVAL       > 1      <     sec
    A PRIORI SIGMA         > 0.001  <     m
    ELEV.-DEP. WEIGHTING    > COSZ <      (NO, COSZ, or model number)

  Further Options:
    PRINTING                > NO   <      (YES.. NO or ASIS)
    HELMERT                 > NO   <      (YES.. NO or ASIS)
    ORBIT ADJUSTMENT        > NO   <      (YES.. NO or ASIS)
    SPECIAL REQUESTS        > YES  <      (YES.. or NO)
    ZERO DIFFERENCE EST.    > NO   <      (YES.. or NO)
```

The last two programs (GPSEST and ADDNEQ) may be used in exactly the same way as in the previous example in Section 4.1. In principle, the ambiguity resolution strategy `QIF` may be used for short baselines as well (see Table 15.1). However, processing the L_1 and L_2 frequencies directly and using the `SIGMA` ambiguity resolution strategy works perfectly for baselines up to 10 km, as well (except for very short sessions). In this example you may proceed as follows:

(1) Use GPSEST in the *session* mode to resolve the ambiguities. If you do not have enough computer memory or if you exceed maximum dimensions, resolve ambiguities in the baseline mode.

(2) Use GPSEST in the *session* mode to create and store the normal equations.

(3) Use ADDNEQ to combine the single-session solutions exactly in the same way as in Section 4.1.

For the first step specify the following options:

```
 4.5               PROCESSING: PARAMETER ESTIMATION

  CAMPAIGN          > DOCU42_2 <    (blank for selection list)

 Job Identification:
  JOB CHARACTER        >   <        (blank, or A..Z, 0..9)

 Input Files:
  PHASE Z.DIFF.     > NO       <    (NO, if not used; blank for sel.list)
  CODE  Z.DIFF.     > NO       <    (NO, if not used; blank for sel.list)
  PHASE S.DIFF.     > ????270? <    (NO, if not used; blank for sel.list)
  CODE  S.DIFF.     > NO       <    (NO, if not used; blank for sel.list)
  COORDINATES       > APRIORI  <    (blank for selection list)
  STANDARD ORBIT    > E2_93270 <    (blank for selection list)
  RAD.PRESS.COE.    > NO       <    (NO, if not used; blank for sel.list)
  IONOSP. MODELS    > NO       <    (NO, if not used; blank for sel.list)
  TROPO. ESTIMATES  > E2_93270 <    (NO, if not used; blank for sel.list)
  METEO DATA        > NO       <    (NO, if not used; blank for sel.list)
  ECCENTRICITIES    > NO       <    (NO, if not used; blank for sel.list)
  OCEAN LOADING     > NO       <    (NO, if not used; blank for sel.list)
  SATELL. CLOCKS    > NO       <    (NO, if not used; blank for sel.list)
  CODE BIASES       > NO       <    (NO, if not used; blank for sel.list)
  ANT. ORIENTATION  > NO       <    (NO, if not used; blank for sel.list)
```

```
 4.5-0             PAR. ESTIMATION: OUTPUT FILES

  Output Files:
    COORDINATES          > NO       <    (NO, if not to be saved)
    ORBITAL ELEMENTS     > NO       <    (NO, if not to be saved)
    TROPOSPHERE PARAM.   > NO       <    (NO, if not to be saved)
    TROPOSPHERE GRADI.   > NO       <    (NO, if not to be saved)
    TROPOSPHERE SINEX    > NO       <    (NO, if not to be saved)
    IONOSPHERE MODELS    > NO       <    (NO, if not to be saved)
    IONOSPHERE MAPS      > NO       <    (NO, if not to be saved)
    RESIDUALS            > NO       <    (NO, if not to be saved)
    COVARIANCES (COORD)  > NO       <    (NO, if not to be saved)
    COVARIANCES (ALL)    > NO       <    (NO, if not to be saved)
    NORMAL EQUATIONS     > NO       <    (NO, if not to be saved)
    EARTH ROTATION PARA. > NO       <    (NO, if not to be saved)
    POLE IN IERS FORMAT  > NO       <    (NO, if not to be saved)
    SATELLITE CLOCK FILE > NO       <    (NO, if not to be saved)
    CODE BIASES          > NO       <    (NO, if not to be saved)
    ANTENNA PCV (GRID)   > NO       <    (NO, if not to be saved)
    ANTENNA PCV (HARM)   > NO       <    (NO, if not to be saved)
    GENERAL OUTPUT       > NO       <    (NO, if standard name to be used)
```

```
 4.5-1             PARAMETER ESTIMATION: INPUT 1
 TITLE    >  SIGMA AMBIGUITY RESOLUTION                           <

 Frequency:
   FREQUENCY           > L1&L2 <    (L1,L2,L3,L4,L5,L1&L2,L3&L4,MIXED,
                                     WUEBBena/Melbourne, or DTE)
 Fixed Station(s):
   STATION      > $FIRST            <    (blank for sel.list, ALL or NONE,
 Kin.  Station(s):                            SPECIAL_FILE.. $FIRST, $LAST)
   STATION      > NONE             <    (blank for sel.list, ALL or NONE,
                                          SPECIAL_FILE.. $FIRST, $LAST)
 Ambiguities:
   RESOL. STRATEGY     > SIGMA  <   (ELIMIN..NO,ROUND,SEARCH..SIGMA..QIF)
   INTRODUCE WIDELANE  > NO  <      (YES or NO)
   INTRODUCE L1 AND L2 > NO  <      (YES or NO)
   SAVE AMBIGUITIES    > YES <      (YES or NO)
 Observation selection:
   MIN. ELEVATION      > 10    <    degrees
   SAMPLING RATE       > 0     <    sec (0: all observations)
   OBSERV. WINDOW      > NO    <    (YES.. NO or ASIS)
```

```
4.5-1.1 |    PARAMETER ESTIMATION: AMBIGUITY RESOLUTION (SIGMA)

 Sigma-Dependent Ambiguity Resolution:
   MAX. NUMBER OF AMB. SOLVED IN ONE ITERATION STEP  > 10   <   (0:All)
   AMBIGUITY RESOLVABLE IF EXACTLY 1 INTEGER WITHIN  > 3    <    sigma
   MAXIMAL SIGMA OF A RESOLVABLE AMBIGUITY           > 0.07 <    cycles
   MINIMAL SIGMA OF AMBIGUITY USED FOR TESTS         > 0.05 <    cycles
```

```
4.5-2   |                 PARAMETER ESTIMATION: INPUT 2

   Atmosphere Models:
     METEO DATA          > ESTIMATED    <  (EXTRAPOLATED, OBSERVED,
                                            or ESTIMATED)
     TROPOSPH. MODEL     > NO           <  (SAASTAMOINEN,HOPFIELD,
                                            ESSEN-FROOME,MARINI-MUR,
                                            DRY_SAAST,DRY_HOPFIELD, or NO)
   Statistics:
     CORRELATIONS        > CORRECT      <  (CORRECT, FREQUENCY, or BASELINE)
     CORREL. INTERVAL       > 1      <     sec
     A PRIORI SIGMA         > 0.001  <     m
     ELEV.-DEP. WEIGHTING    > COSZ <      (NO, COSZ, or model number)

   Further Options:
     PRINTING                > NO   <      (YES.. NO or ASIS)
     HELMERT                 > NO   <      (YES.. NO or ASIS)
     ORBIT ADJUSTMENT        > NO   <      (YES.. NO or ASIS)
     SPECIAL REQUESTS        > YES  <      (YES.. or NO)
     ZERO DIFFERENCE EST.    > NO   <      (YES.. or NO)
```

The only special request to be selected in Panel 4.5–2.4 is the estimation of the site-specific troposphere parameters. Four tropospheric parameters per station are probably sufficient.

In the second step, the normal equations are saved. You may use exactly the same options as in Section 4.1. In Panel 4.5, we select again all phase single difference files of one session, the coordinates file and the corresponding standard orbit file. The troposphere estimates are **not** introduced.

In Panel 4.5–0, we ask for a coordinates output file and a normal equation output file.

In Panel 4.5–1, we set the L_3- frequency, do not fix a station, and use the `ELIMIN` ambiguity resolution strategy:

```
4.5-1   |                 PARAMETER ESTIMATION: INPUT 1
   TITLE    >  SESSION PROCESSING                                  <

   Frequency:
     FREQUENCY           > L3    <    (L1,L2,L3,L4,L5,L1&L2,L3&L4,MIXED,
                                       WUEBBena/Melbourne, or DTE)
   Fixed Station(s):
     STATION      > NONE              <    (blank for sel.list, ALL or NONE,
   Kin.  Station(s):                        SPECIAL_FILE.. $FIRST, $LAST)
     STATION      > NONE             <    (blank for sel.list, ALL or NONE,
                                            SPECIAL_FILE.. $FIRST, $LAST)
   Ambiguities:
     RESOL. STRATEGY     > ELIMIN <   (ROUND,SIGMA..SEARCH..ELIMIN,QIF..NO)
     INTRODUCE WIDELANE  > NO  <      (YES or NO)
     INTRODUCE L1 AND L2 > YES <      (YES or NO)
     SAVE AMBIGUITIES    > NO  <      (YES or NO)
   Observation selection:
     MIN. ELEVATION      > 10    <    degrees
     SAMPLING RATE       > 240   <    sec (0: all observations)
     OBSERV. WINDOW      > NO    <    (YES.. NO or ASIS)
```

Again, it is recommended not to fix any stations (Panel 4.5–1) but to constrain the coordinates of one station (e.g. the first). We will again process the ionosphere-free linear combination L_3. However, for very small networks with baselines up to about 10 km, better results may be achieved if the L_1 carrier is used. This is due to the higher noise on L_3. When using L_1 you should use a local ionosphere model (this may be generated in Menu 4.7) to correct for the scale factor caused by the ionospheric delays (see Chapter 13 for details concerning the modeling of the ionosphere). In the following Panel 4.5–1.8, we ask for session-wise execution. In the following Panel 4.5–2, we extrapolate meteo data, and do not use a model. We use `CORRECT` correlation handling, and use an a priori sigma of 0.001, and use the `COSZ` elevation dep. weighting scheme. We also want to specify special requests. In Panel 4.5–2.4, we request for a priori sigmas for site coordinates, and site-specific troposphere parameters (4 might suffice).

Afer this run, you may use Program 5.6.5, to generate an output summary of this GPSEST run. Specify the job number, and ask for an output file (option `AMB.RES SUMMARY`). You will find results like this:

```
File        Length   #Amb  RMS0   Max/RMS L1 Amb   #Amb  RMS0   #Amb Res
            (km)           (mm)   (L1 Cycles)            (mm)   (%)
-----------------------------------------------------------------------
GPSEST         0.0    158   2.0    0.095  0.018       0   2.2   100.0
GPSEST         0.0    218   1.7    0.081  0.020       0   2.0   100.0
-----------------------------------------------------------------------
Tot:   2       0.0    376   1.9    0.095  0.019       0   2.1   100.0
```

Note that since we processed in session mode, the baseline lenghts are not output. Otherwise, when processing baseline by baseline, you would also get the length of the baseline in km. We see, that all ambiguities could be resolved.

The third and last step consists of one ADDNEQ run. In this step the options are identical with those in Section 4.1: in Panel 4.8.1, we specify the two normal equation files as input, ask for a coordinate output file in Panel 4.8.1–0, and fix the coordinates of the `TURT` station in Panel 4.8.1–1.

The result of ADDNEQ is a “final” coordinate file which will look like this:

```
                                                                  28-JUL-96 17:30
--------------------------------------------------------------------------------
LOCAL GEODETIC DATUM: ITRF92            EPOCH: 1993-09-28  6:00:00

NUM  STATION NAME           X (M)          Y (M)          Z (M)     FLAG

 61  AGAR                4377340.6681    587795.3897   4588206.3477    M
 31  JEIZ                4373208.2382    593076.6579   4591518.4339    M
 20  BRAE                4373504.8778    590748.5230   4591508.3494    M
 40  ERGI                4375515.1963    593027.4703   4588794.8991    M
 70  TURT                4374374.5092    591480.7579   4589368.7025    F
```

4.3 Example 3: Rapid Static Positioning

In the third example, we want to demonstrate the power of the *general search ambiguity resolution algorithm*. For detailed information we refer to Chapter 15 of this documentation and to [*Frei and Beutler*, 1990]. The algorithm allows to resolve the initial phase ambiguities if one or both endpoints of a static baseline were visited only for a short time interval by a receiver (typically 1–5 minutes). The successful resolution of the ambiguities is crucial for the accuracy achieved by rapid static positioning.

Using the rapid static positioning method we have to distinguish between the single- and the dual-frequency case. If you have only one observation session and if only six or fewer satellites were observed you have *no chance* to resolve your ambiguities in the single-frequency case. *Do not trust any results* of this type. If you have two or more short sessions of, let us say, 5 minutes each separated by about one hour (re-occupation method), you have a good chance to resolve your ambiguities even if you only have single-frequency data, provided you process all sessions for the same baseline in the same program run.

If you are processing dual-band data you have a good chance to resolve the ambiguities using the "general search" algorithm, even if you could track only four satellites for 1 to 5 minutes. But you should be aware of the fact, that the statistical tests in the general search algorithm are only valid in the case where *no* systematic influences (e.g., ionosphere induced biases) are present. Therefore extreme care should be taken if baselines longer than 10 km are processed in the rapid static mode.

We give an example based on the same data as used in Example 2 in the previous section (Turtmann 1993 Campaign). It does not make sense to repeat all the steps explained there. Actually, the campaign setup, transfer part, orbit part, and pre-processing part would be exactly the same in the case of rapid static positioning. Make sure that you define sessions of at least one hour in length even if your observations merely cover a few minutes, because of the orbit integration in Menu 3.3). We start directly with processing one single difference file (baseline Turtmann-Agarn) with program GPSEST to demonstrate the usage of the general search ambiguity resolution algorithm. The single difference file contains the entire 24-hour session. It is not necessary (and even not recommended) to use the general search for such long sessions (static method). Here, we use only 1 minute (3 observation epochs) from the single difference file. This is done by setting an observation window in Panel 4.5–1.2 (be aware that this is only an example; in real life you will probably want to use all available data – but only 1 minute of data may be available):

```
4.5-1.2            PARAMETER ESTIMATION: OBSERVATION WINDOWS

                  START DATE                  END DATE

              yy mm dd     hh mm ss       yy mm dd     hh mm ss

            > 93 09 27 < > 12 00 00 <   > 93 09 27 < > 12 01 00 <
```

The important options are given in the following three panels:

```
4.5-1                    PARAMETER ESTIMATION: INPUT 1

  TITLE    >  GENERAL SEARCH AMBIGUITY RESOLUTION                  <

  Frequency:
    FREQUENCY           > L1&L2 <    (L1,L2,L3,L4,L5,L1&L2,L3&L4,MIXED,
                                      WUEBBena/Melbourne, or DTE)
  Fixed Station(s):
    STATION      > $FIRST           <    (blank for sel.list, ALL or NONE,
  Kin.  Station(s):                       SPECIAL_FILE.. $FIRST, $LAST)
    STATION      > NONE            <    (blank for sel.list, ALL or NONE,
                                          SPECIAL_FILE.. $FIRST, $LAST)
  Ambiguities:
    RESOL. STRATEGY     > SEARCH <   (ROUND,SIGMA..SEARCH..ELIMIN,QIF..NO)
    INTRODUCE WIDELANE  > NO  <      (YES or NO)
    INTRODUCE L1 AND L2 > NO  <      (YES or NO)
    SAVE AMBIGUITIES    > YES <      (YES or NO)
  Observation selection:
    MIN. ELEVATION      > 10    <    degrees
    SAMPLING RATE       > 0     <    sec (0: all observations)
    OBSERV. WINDOW      > YES   <    (YES.. NO or ASIS)
```

```
4.5-1.3      PARAMETER ESTIMATION: AMBIGUITY RESOLUTION (SEARCH)

 General Search Strategy:
   BASELINE-WISE AMBIGUITY RESOLUTION                    > YES <  (YES,NO)

   SEARCH WIDTH IN UNIT OF STD. DEV.                    >  5    <
   MAXIMUM ALLOWED RMS(FIXED)/RMS(FLOAT)                >  2    <
   MINIMUM ALLOWED RMS(2-ND AMB)/RMS(1-ST BEST AMB)     >  1.4  <
   SEARCH WIDTH FOR GEOMETRY-FREE LC (L1 CYCLES)        >  0.1  <
```

```
4.5-2                    PARAMETER ESTIMATION: INPUT 2

  Atmosphere Models:
    METEO DATA          > EXTRAPOLATED <  (EXTRAPOLATED, OBSERVED
                                           or ESTIMATED)
    TROPOSPH. MODEL     > SAASTAMOINEN <  (SAASTAMOINEN,HOPFIELD,
                                           ESSEN-FROOME,MARINI-MUR,
                                           DRY_SAAST,DRY_HOPFIELD, or NO)
  Statistics:
    CORRELATIONS        > BASELINE     <  (CORRECT, FREQUENCY, or BASELINE)
    CORREL. INTERVAL       > 1      <     sec
    A PRIORI SIGMA         > 0.002  <     m
    ELEV.-DEP. WEIGHTING    > NO   <      (NO, COSZ, or model number)

  Further Options:
    PRINTING                > NO   <      (YES.. NO or ASIS)
    HELMERT                 > NO   <      (YES.. NO or ASIS)
    ORBIT ADJUSTMENT        > NO   <      (YES.. NO or ASIS)
    SPECIAL REQUESTS        > NO   <      (YES.. or NO)
    ZERO DIFFERENCE EST.    > NO   <      (YES.. or NO)
```

For more information concerning the options in Panel 4.5–1.3 we refer to the corresponding help panel and to Chapter 15. In the first part of the output of program GPSEST (ambiguity-free solution) we may read

```
 12. RESULTS (PART 1)
 --------------------

 NUMBER OF PARAMETERS (PART 1):
 -----------------------------

 PARAMETER TYPE                                     #PARAMETERS   #PRE-ELIMINATED
 -------------------------------------------------------------------------------------

 STATION COORDINATES                                      3           0
 AMBIGUITIES                                              6           0

 -------------------------------------------------------------------------------------
 TOTAL NUMBER OF PARAMETERS                               9           0
 -------------------------------------------------------------------------------------

...
```

```
...

 NUMBER OF OBSERVATIONS (PART 1):
 -------------------------------

 TYPE         FREQUENCY         FILE              #OBSERVATIONS
 -------------------------------------------------------------------------------------

 PHASE           L1              ALL                        6
 PHASE           L2              ALL                        6

 -------------------------------------------------------------------------------------
 TOTAL NUMBER OF OBSERVATIONS                              12
 -------------------------------------------------------------------------------------



 A POSTERIORI SIGMA OF UNIT WEIGHT (PART 1):
 ------------------------------------------

 A POSTERIORI SIGMA OF UNIT WEIGHT  :    0.0004 M  (SIGMA OF ONE-WAY L1 PHASE OBSERVABLE)

 DEGREE OF FREEDOM (DOF)            :         3
 CHI**2/DOF                         :      0.05

 STATION COORDINATES:                       (NOT SAVED)
 -------------------

 NUM  STATION NAME     PARAMETER    A PRIORI VALUE       NEW VALUE     NEW- A PRIORI
 -------------------------------------------------------------------------------------

  61  AGAR             X             4377340.6652       4377340.2669     -0.3983
                       Y              587795.3917        587795.4879      0.0962
                       Z             4588206.3470       4588206.2934     -0.0536

                       HEIGHT           1525.6494          1525.3467     -0.3027
                       LATITUDE     46 17  1.634660    46 17  1.642398    0.2389
                       LONGITUDE     7 38 52.827326     7 38 52.834253    0.1478
```

Taking into account that the a priori coordinates are excellent it is obvious that with 1 minute data the ambiguity-free solution really does not give satisfactory results. This is also reflected by the formal rms errors of the coordinate estimates. The real-valued estimates of the ambiguities and their formal rms errors are given in the following table:

```
AMBIGUITIES:
-----------

                                                       REFERENCE
AMBI  FILE SAT. EPOCH FRQ WLF CLU  AMBI CLU    AMBIGUITY   RMS   TOTAL AMBIGU.
--------------------------------------------------------------------------------

   1    1   14      1  1   1   2    7    1         2.01   2.60      -23509.99
   2    1   15      1  1   1   3    7    1         1.42   1.68       -5258.58
   3    1   31      1  1   1   4    7    1         1.99   1.97      -10553.01
   4    1   14      1  2   1   2    8    1         1.57   2.02      -18318.43
   5    1   15      1  2   1   3    8    1         1.09   1.31       -4096.91
   6    1   31      1  2   1   4    8    1         1.54   1.54       -8222.46

   7    1    1      1  1   1   1       -- REFERENCE --           17232.
   8    1    1      1  2   1   1       -- REFERENCE --           13428.
```

The rms errors of the ambiguities are larger than one cycle. This is the reason for using the general search for a successful ambiguity resolution. The general search algorithm provides the following information:

```
AMBIGUITY RESOLUTION PROTOCOL FOR GENERAL SEARCH:

NUMBER OF NON-AMBIGUITY PARAMETERS:     3  (NOT PRE-ELIMINATED)
NUMBER OF AMBIGUITY PARAMETERS    :     6
NUMBER OF DD-OBSERVATIONS         :    12


SEARCH STATISTICS
-----------------
NUMBER OF AMBIGUITY SETS=                          324.
RMS ACTUALLY COMPUTED   =                           19.
DUMMY SETS              =                          305.


 #   RMS    RMS/RMS1     AMBIGUITIES
------------------------------------

 1 0.0006    1.000     0  0  0  0  0  0
 2 0.0018    3.007     9  9  9  7  7  7
 3 0.0051    8.733    -5 -5 -5 -4 -4 -4

SOLUTION NUMBER=  3
-------------------

PAR  TYPE  LOCQ(2)  SOLUTION      RMS

  1    1      2       1.3253     0.0101
  2    1      2      -0.2939     0.0051
  3    1      2       0.6747     0.0082

...
```

```
...

 SOLUTION NUMBER=  2
 -------------------

 PAR  TYPE  LOCQ(2)  SOLUTION      RMS

   1    1      2      -2.3238     0.0035
   2    1      2       0.5396     0.0018
   3    1      2      -1.1745     0.0028

 SOLUTION NUMBER=  1
 -------------------

 PAR  TYPE  LOCQ(2)  SOLUTION      RMS

   1    1      2       0.0106     0.0012
   2    1      2       0.0068     0.0006
   3    1      2       0.0081     0.0009


 AMBIGUITY RESOLUTION SUCCESSFUL
 RMS(FIXED)/RMS(FLOAT)              =     1.349
 RMS(2-ND AMB SET)/RMS(1-ST AMB SET) =     3.007


                                   REFERENCE
 AMBI  FILE SAT. EPOCH FRQ WLF CLU  AMBI CLU    AMBIGUITY   RMS   TOTAL AMBIGU.
 ---------------------------------------------------------------------------------

    1    1   14      1  1   1    2    7    1            0            -23512.
    2    1   15      1  1   1    3    7    1            0             -5260.
    3    1   31      1  1   1    4    7    1            0            -10555.
    4    1   14      1  2   1    2    8    1            0            -18320.
    5    1   15      1  2   1    3    8    1            0             -4098.
    6    1   31      1  2   1    4    8    1            0             -8224.

    7    1    1      1  1   1    1        -- REFERENCE --           17232.
    8    1    1      1  2   1    1        -- REFERENCE --           13428.
```

The ambiguity resolution was successful, indeed. The two criteria, `RMS(FIXED)/RMS(FLOAT)` and `RMS(2-ND AMB SET)/RMS(1-ST AMB SET)`, are described in Chapter 15. Please note, that only four satellites were tracked. This demonstrates the power of the general search algorithm. The ambiguities were resolved correctly which may be seen from the results of the ambiguity-fixed solution:

```
13. RESULTS (PART 2)
--------------------

NUMBER OF PARAMETERS (PART 2):
-----------------------------

PARAMETER TYPE                                     #PARAMETERS   #PRE-ELIMINATED
-------------------------------------------------------------------------------------

STATION COORDINATES                                      3            0
AMBIGUITIES                                              0            0

-------------------------------------------------------------------------------------
TOTAL NUMBER OF PARAMETERS                               3            0
-------------------------------------------------------------------------------------


NUMBER OF OBSERVATIONS (PART 2):
-------------------------------

TYPE         FREQUENCY         FILE              #OBSERVATIONS
-------------------------------------------------------------------------------------

PHASE           L1              ALL                      6
PHASE           L2              ALL                      6

-------------------------------------------------------------------------------------
TOTAL NUMBER OF OBSERVATIONS                            12
-------------------------------------------------------------------------------------


A POSTERIORI SIGMA OF UNIT WEIGHT (PART 2):
------------------------------------------

A POSTERIORI SIGMA OF UNIT WEIGHT  :    0.0006 M  (SIGMA OF ONE-WAY L1 PHASE OBSERVABLE)

DEGREE OF FREEDOM (DOF)           :         9
CHI**2/DOF                        :      0.09


STATION COORDINATES:                      (NOT SAVED)
-------------------

NUM  STATION NAME     PARAMETER    A PRIORI VALUE       NEW VALUE     NEW- A PRIORI
-------------------------------------------------------------------------------------

 61  AGAR             X            4377340.6652       4377340.6751      0.0099
                      Y             587795.3917        587795.3980      0.0063
                      Z            4588206.3470       4588206.3553      0.0083

                      HEIGHT          1525.6494          1525.6628      0.0134
                      LATITUDE     46 17  1.634660    46 17  1.634597   -0.0020
                      LONGITUDE     7 38 52.827326     7 38 52.827557    0.0049
```

The accuracy of the resulting coordinates (roughly 1 cm, assuming that the a priori coordinates are correct) is typical for rapid static positioning. Note the drastic change in the rms errors of the coordinate estimates with respect to the corresponding values of the ambiguity-free solution.

5. Processing and Naming Defaults

This chapter treat the default options of the *Bernese GPS Software*, which may be set in Menu 0. In the distributed version of the software, most of these options are already set correctly and you will have to change none or only a few of them. Is is important, however, that you are aware of the default options and names.

```
 0    |              DEFAULTS: OPTION MENU
------+--------------------------------------------------------------
      |
------+--------------------------------------------------------------
      |
 1    |  PROCESSING      : Default Options for Processing
 2 .. |  PROGRAM NAMES   : Default Names for Programs
 3 .. |  DATASET NAMES   : Default Names for Datasets
 4 .. |  SCRIPT NAMES    : Default Names for Scripts/Command Files
```

The default options for the processing are set in Panel 0.1. This panel is accessible through the "PRCDEF" command, too. The options are described in detail in Chapter 3 and in the corresponding help panel. On multitasking systems, you will probably want to set the option "JOB CLASS" according to your preferences. For special purposes, you may wish to set the option "SUBMIT JOBS" to "NO" (instead of the recommended "YES") to be able to edit the input I-, N- and F-files before starting the programs (see Chapter 3).

The names of all the programs accessible by the menu system are specified in Menu 0.2. The paths to the programs are specified there, too. There is little chance that you will ever need to change these program names.

> **Exception**: you would like, e.g., to test a version of the program GPSEST containing modifications of your own. Let us assume that this special program version has the name GPSES1. You would then have to change the program name in Panel 0.2.4 to GPSES1 and to generate a copy of all skeleton files for the program GPSEST (copy GPSESTI.SKL to GPSES1I.SKL etc. in the directory X/SKL, X:[SKL], X:\SKL, in UNIX, Vax, and DOS notation respectively).

Be aware, that if you destroy the settings in panels Menu 0.2, the menu system will not find the executable programs anymore, even if they are still at the correct place.

In Menu 0.3, the paths and extensions of all file types used by the *Bernese GPS Software* are set. The file paths and the file name extensions are used to distinguish among various kinds of information stored in files. Starting a program using the menu system, the user has to specify the names of the input and output files as 8-character strings. The extensions of the file names are appended automatically by the menu system. In the same way, the menu system automatically adds the full path to the files, using the path to the currently processed campaign and a subdirectory of the campaign (see Chapter 6). The *file name extensions* of the various file types and the *subdirectories* to which the files belong are specified in Panel 0.3.2 – Panel 0.3.5. You may look at these panels but we recommend not to change any settings. The only exception is the Panel 0.3.1. An example of this panel follows,

```
 0.3-1                      DEFAULTS: GENERAL DATASET NAMES

 General Datasets:
   GEODETIC DATUM     > DATUM.        <    CONSTANTS         > CONST.       <
   PHASE CENTER ECC.  > PHAS_IGS.01   <    RECEIVER INFO     > RECEIVER.    <
   EARTH POTENTIAL    > JGM3.         <    POLE INFORMATION  > BULLET_A.ERP <
   POLE OFFSET COEF.  > POLOFF.       <    LEAP SECONDS      > GPSUTC.      <
   SAT. PARAMETERS    > SATELLIT.TTT  <    MANOEUVERS ETC.   > SAT_$JJ2.CRX <
   SINEX GENERAL FILE > SINEX.        <    STATION PROBLEMS  > STACRUX.     <
   IONEX CONTROL FILE > IONEX.        <
 Extensions:
   IERS BULLETINS     > IER <      RCVR/ANT.NAME TRANSLATION TABLES  > TRN <

 Path to the Datasets:           > X:/GEN                   <
 Input Files:                      Path                         Extension
   N-,I-,F-FILES                 > U:/INP                   <    > INP <
   SKELETON FILES                > X:/SKL                   <    > SKL <
   PANEL UPDATE DIRECTORY LISTS  > X:/SKL                   <    > UPD <

 Auxiliary Files (Scratch Files) > U:/WORK                  <    > SCR <
 Error Message File (Full Name): > U:/WORK/ERROR.MSG                <
```

and you will probably have to update two options, namely:

`POLE INFORMATION:` the file containing the Earth orientation parameters for the time span of the currently processed campaign, and

`MANOEUVERS ETC. :` the file containing the information about satellite problems.

The newest versions of these files are available on our anonymous ftp account at `ftp://ftp.unibe.ch/aiub/BSWUSER/GEN/`. You may possibly want to change the file containing the information about receiver antenna phase centers and their variations (option "`PHASE CENTER ECC.`"). For details see Chapter 17. We do not recommend to change the other options in Panel 0.3.1. Be aware of the fact that these general files are used by many programs without the necessity to specify them explicitly when preparing a program run by the menu system. The files given in Panel 0.3.1 will be attached automatically to the `N`-files.

There are two important programs in the *Bernese GPS Software* which create output file names automatically: RXOBV3 and SNGDIF. The first program creates zero-difference observation files from RINEX files, the second program creates single-difference observation files using zero-difference files. The content of these files is described in Chapter 24. Let us present the naming convention for the observation files (the naming conventions used for RINEX files is given in Chapter 7).

There are four types of zero-difference files, distinguished by their extensions: `.PZH`, `.PZO`, `.CZH`, `.CZO` (the content of these files is explained in Chapter 24). For the 8-character names of these files we use the following convention:

`XXXXssss` or `XXXXsssn` ,

where

`XXXX`	is the 4-character abbreviation of the station name (see Panel 1.4.3 and an example in Chapter 4),
`ssss` or `sss`	is the session number (4-character session names or 3-character session names may be used – see the options of the program RXOBV3,
`n`	is the file order number within the session, if there are more files belonging to one session. It is 0 if there is one file only.

A similar naming convention is used for the single-difference observation files (extensions `.PSH`, `.PSO`, `.CSH`, `.CSO` – see Chapter 24)

`XXYYssss` or `XXYYsssn` ,

where `XX` and `YY` are the 2-character abbreviations of the name of the first and the second station in the single-difference file (also defined in Menu 1.4.3). When transferring the RINEX data to the Bernese observation file format using the program RXOBV3, the 4-character and 2-character station name abbreviations are automatically created.

6. Campaign Setup

Within the *Bernese GPS Software*, we use the term “campaign” for a set of data which should be processed together (there is still the possibility to combine the results of various campaigns using normal equations files or SINEX files — see Chapter 18 and Chapter 19, but even then all the normal equation files to be combined have to be copied into one campaign). An alternative term to “campaign” (also commonly used) might be “project”. Each campaign has its own directory and subdirectories where all the campaign-specific data are stored. While processing the campaign, the programs work on files in campaign-specific directories and (most of them) use the files from the directory `X:/GEN` (or `X:[GEN]`, `X:\GEN` in VAX and DOS notation respectively), too. The data files in `X:/GEN` are common to all campaigns (see Chapter 24).

Before data processing can be started, the campaign has to be defined, the campaign directories have to be created, the data have to be copied into these directories, and some basic information about the campaign has to be specified. This is called “campaign setup” and is the topic of this short chapter. The campaign setup should be performed using Menu 1.

First, the name of a new campaign and the path to the campaign directories have to be specified in Panel 1.1. Chapter 4 contains a detailed example for this step. We confine ourselves to two remarks, here: the path to the campaign is defined by a logical device or logical disk on VAX/VMS and DOS systems. Assuming that `P` is the logical device and `MYCAMP` is the campaign name, you have to specify the path by

`P:[` (on VAX/VMS) or `P:\` (on DOS)

which means, that the campaign root directory is

`P:[MYCAMP]` (on VAX/VMS) or `P:\MYCAMP` (on DOS).

The logical device `P` has to be defined (this is usually done in the `LOADGPS` script — see Chapter 25). On UNIX systems, there are no logical devices. In the `LOADGPS` script, the variable `$P` is defined and the symbolic link `P:` is set in the user working directory `$U/WORK`. Therefore, it is possible to specify the path as:

`P:/`

The second remark is relevant only for those users working on multiuser systems. In that case, all users have their own version of panels (usually in the `U:/PAN` directory). The only exception is Panel 1.1 which is in the directory `X:/PAN` (common to all users). Therefore, all users must have read *and* write privileges for this panel.

After defining the campaign, the campaign-specific directories have to be created. This is done in Menu 1.2. By default the following directories will be created (assuming P is the logical device and MYCAMP the campaign name):

```
P:/MYCAMP/ATM
P:/MYCAMP/DATPAN
P:/MYCAMP/OBS
P:/MYCAMP/ORB
P:/MYCAMP/ORX
P:/MYCAMP/OUT
P:/MYCAMP/RAW
P:/MYCAMP/STA
```

We refer to Chapter 24 for information on which data types belong into which directory. At the beginning, at least the observation files (in receiver binary format or in RINEX format) have to be copied into the RAW directory. If you are using precise (IGS) orbits, which we strongly recommend, the precise orbit files have to be copied into the ORB directory. Otherwise, if you decide not to use precise orbits, the broadcast orbits in RINEX format have to be made available to the software in the RAW directory.

If the RINEX files (or raw receiver files) of your campaign cannot easily be divided into sessions (e.g., if you have a mixture of 24-hours files from IGS sites and some data of your own covering different time intervals), you should put the raw data into the directory ORX. Using the programs CCRINEXO in Menu 2.5.6.1 and CCRINEXN in Menu 2.5.6.2, you may then concatenate/split your RINEX observation files into well-defined sessions (the sessions have to be defined already, see next paragraph). The concatenated (or split) files will be saved in the RAW directory, ready to be used.

The next step is the session definition in Panel 1.3.2. Some useful information about the session definition strategy may be found in the corresponding help panel. An example is given in Chapter 4. Please note that wildcard strings may be used.

Several files have to be prepared using Menu 1.4.1 – Menu 1.4.5. The meaning of the a priori coordinate file is straightforward. It is necessary to have a priori information about the station positions. However, this a priori information may be very inaccurate. You have the possibility to improve it using programs CODSPP and/or MAUPRP — see Chapter 10. If the a priori coordinates are available in the RINEX files, it is possible to prepare *only the header* of the coordinate file, and the coordinates are then extracted from the RINEX files using the program RXOBV3 — see Panel 2.7.1. If eccentric stations were used, it is necessary to create an eccentricity file (Menu 1.4.4) in addition to the coordinate file, too (see also Chapter 24).

If you are going to process your regional/local campaign and you do not have accurate (decimeter-level) coordinates of any of your stations in the ITRF, we recommend to include at least one IGS site (near to the area of your campaign) into the processing. Because the satellite positions are given in the IERS Reference System (ITRF/ICRF), the coordinates of the station(s) held fixed (for numerical reason it is necessary to fix — or heavily constrain — at least one station on the a priori coordinates) should be in the same reference frame. The coordinates of the IGS sites and corresponding translation tables are available from our anonymous ftp account in the directory ftp://ftp.unibe.ch/aiub/BSWUSER/STA/. The RINEX observation files have to be downloaded from the nearest IGS data center (see Chapter 7 and [*Gurtner and Liu*, 1995]).

In Menu 1.4.2, the translation table between the station names in the RINEX files and the station names actually used in the *Bernese GPS Software* may be created. Usually you do not need such a table if you process your own data. But the translation table is often important if the data was collected by a third party using different station naming conventions. An example is given in Chapter 4. There is even the possibility to translate not only the station names but also the station heights given in the RINEX files. In that case, a station height translation table has to be created, too. This cannot be done using the menu system, however. You have to edit a simple ASCII file manually. Examples are given in Chapters 4 and 24.

The station name abbreviations (Menu 1.4.3) are used by the programs RXOBV3 and SNGDIF to automatically create the observation file names (see Chapters 5 and 24). If you do not create the abbreviations in Menu 1.4.3, the program RXOBV3 will do so automatically.

In Menu 1.4.5, an antenna/receiver name translation table may be created or modified. This is important because several programs require information concerning receivers and antennas (e.g. phase center variations). Therefore, *unique* receiver and antenna names have to be present in the observation files. The translation table may be used by the program RXOBV3 (like the other two translation tables — see above). However, there is one difference concerning the antenna/receiver name table. Unlike the station name translation table and the station height translation table (which are in the campaign-specific `STA` directory), the antenna/receiver name translation table is in the directory `X:/GEN`. The reason is that usually the same antenna/receiver name translation table may be (or should be) used for all campaigns.

In Menu 1.9, you have the possibility to delete an old campaign. On multiuser systems you must have write (on UNIX) or delete (on VAX/VMS) privilege to be able to do that.

7. External Data Sources and Data Transfer

7.1 Transfer to RINEX

7.1.1 RINEX: The Receiver-Independent Exchange Format

All GPS data processing programs contain an explicit definition of the GPS observables that are to be used with that program. If these programs are to process data from different receivers, they must first convert the raw receiver information to these local definitions and formats. In order to facilitate this task, an exchange format has been designed that allows the conversion of any raw receiver data not only into this format, but also into an explicit definition of the observables.

The Astronomical Institute of the University of Berne developed a first version of such a format to be used for the data exchange and processing of the EUREF-89 GPS campaign, a campaign observed in May 1989 involving four different receiver types and nearly one hundred stations in most countries of Western Europe. The format started from a format developed and used by the US National Geodetic Survey for the exchange of GPS data collected in the CIGNET GPS network, the first global network of permanent GPS receivers used for civil geodetic purposes. The new format, named RINEX (Receiver-Independent Exchange Format), was presented to the geodetic community at the Fifth International Geodetic Symposium on Satellite Positioning in Las Cruces, New Mexico in March, 1989 where it was accepted as the format to be recommended for geodetic GPS data exchange. A second version (RINEX Version 2) was discussed and accepted at the Second International Symposium on Precise Positioning with the Global Positioning System in Ottawa, Canada in September,1990. In April 1997, the RINEX definitions were extended in order to allow the inclusion of GLONASS and mixed GPS/GLONASS data.

The format descriptions have been published in the *CSTG GPS Bulletins May/June 1989* and *September/October 1990*. The most recent description can be found on various web and ftp servers, e.g., at

`ftp://igscb.jpl.nasa.gov/igscb/data/format/rinex210.txt`

or on our anonymous ftp account at

`ftp://ftp.unibe.ch/aiub/rinex/rinex2.txt`.

The basic observables to be used in the RINEX format are:

- The epochs of observations defined as the time of the received signals expressed in the receiver time frame. The epochs are identical for all satellites (i.e., simultaneous observations with respect to receiver time).
- Carrier phase observations (integrated negative beat frequency between the received carrier of the satellite signal and the receiver-generated reference frequency). The sign is the same as for the pseudorange, i.e., decreasing phase if the satellite approaches the receiver.
- Pseudorange observations, i.e., the difference between the time of reception of a satellite code signal, expressed in receiver time, and the time of emission of the same signal, expressed in satellite time.

The three quantities are based on the same oscillator, such that any offsets and drifts of the oscillator directly show in the basic observables. Other observables have been defined for the direct Doppler frequency observations and for meteorological measurements.

Currently there are three different file types defined:

7.1.1.1 RINEX Observation Files

A RINEX observation file contains data collected by one receiver only. Usually, a file also contains data from one station and one session only, although possibilities exist to store, e.g., data collected by a roving receiver during kinematic or pseudokinematic surveys.

The file consists of a header section, containing all auxiliary information on the station and receiver necessary for post-processing of the data, and a data section containing the basic observables.

The recommended file naming is as follows:

```
ssssdddf.yyO
```

`ssss` is a four-character station code, `ddd` and `yy` are the day of the year and the two-digit year of the first observation epoch in the file, `f` is a file sequence number (to separate files collected during the same day), and `O` is the label for observation files.

```
     2              OBSERVATION DATA    G (GPS)             RINEX VERSION / TYPE
TRRINEXO V2.9.7 LH  IAP                 12-JAN-01 00:51     PGM / RUN BY / DATE
IAP Meteo Test                                              COMMENT
BIT 2 OF LLI (+4) FLAGS DATA COLLECTED UNDER "AS" CONDITION COMMENT
EXWI                                                        MARKER NAME
14001M009                                                   MARKER NUMBER
LOGST/COMPAQ        IAP                                     OBSERVER / AGENCY
2737                TRIMBLE 4000SSI     7.25                REC # / TYPE / VERS
00000               TRM29659.00                             ANT # / TYPE
  4325347.3993   564738.9952  4638540.7895                  APPROX POSITION XYZ
        0.0000        0.0000        0.0000                  ANTENNA: DELTA H/E/N
     1     1                                                WAVELENGTH FACT L1/2
     5    C1    L1    L2    P2    P1                        # / TYPES OF OBSERV
    30                                                      INTERVAL
  2001     1    11    14     5   30.000000                  TIME OF FIRST OBS
                                                            END OF HEADER
 01  1 11 14  5 30.0000000  0  7 17 29 24 05 06 25 30
  24825206.609    -1817087.892 3
  24731529.266    13741171.363 2
  23881970.477     5392326.669 5   6796525.27641  23881976.2424
  22894321.109    11795853.163 5   9773753.78742  22894327.1684
  20672967.836   -11718818.672 7  -8765873.91643  20672971.2234
  22021021.695    -9801614.452 6  -7059830.35642  22021025.2814
  20892974.820    -4560540.023 7  -3271703.53243  20892977.7734
 01  1 11 14  6  0.0000000  0  7 17 29 24 05 06 25 30
  24810818.961    -1892695.380 3
  24754905.320    13864016.796 2      9572.19251  24754911.4964
  23901004.906     5492349.431 5   6874465.01941  23901013.8054
  22916552.820    11912680.930 5   9864788.34942  22916557.7664
  20677509.250   -11694952.711 7  -8747277.04943  20677512.7664
  22018057.547    -9817190.424 6  -7071967.45842  22018061.2504
  20907766.563    -4482810.288 7  -3211134.92643  20907769.5394
                                          .
                                          .
                                          .
```

Figure 7.1: RINEX observation file (GPS).

7.1.1.2 RINEX Navigation Message Files

The RINEX navigation message files contain the broadcast messages for all satellites collected during the respective sessions.

The recommended file naming is as follows:

```
ssssdddf.yyN
ssssdddf.yyG
```

with `N` being the label for the GPS navigation message files and `G` being the label for the GLONASS navigation message files.

Usually,there is no need to exchange all the navigation messages collected at all the stations of a network in separate files. One comprehensive file containing non-redundantly every possible message might be preferable. In this case,`ssss` could be a code for the agency producing this file.

```
     2              NAVIGATION DATA                         RINEX VERSION / TYPE
TRRINEXN V2.10 LH   IAP                 12-JAN-01 00:51     PGM / RUN BY / DATE
EXWI Permanent GPS Station                                  COMMENT
    0.2142E-07  0.0000E+00 -0.1192E-06  0.1192E-06          ION ALPHA
    0.1434E+06 -0.1802E+06  0.0000E+00  0.6554E+05          ION BETA
    0.102445483208E-07 0.142108547152E-13   589824     1096 DELTA-UTC: A0,A1,T,W
    13                                                      LEAP SECONDS
                                                            END OF HEADER
22  1  1 11 16  0  0.0 0.502804294229E-03 0.137561073643E-10 0.000000000000E+00
    0.101000000000E+03 0.158750000000E+02 0.588095925127E-08 0.929884551938E+00
    0.122934579849E-05 0.139135728823E-01 0.484474003315E-05 0.515367374039E+04
    0.403200000000E+06-0.465661287308E-07 0.194678357364E+01 0.169500708580E-06
    0.932453874961E+00 0.271656250000E+03 0.644890201054E+00-0.886608359368E-08
   -0.145006040084E-09 0.100000000000E+01 0.109600000000E+04 0.000000000000E+00
    0.200000000000E+01 0.000000000000E+00-0.419095158577E-08 0.101000000000E+03
    0.396540000000E+06 0.000000000000E+00 0.000000000000E+00 0.000000000000E+00
10  1  1 11 16  0  0.0 0.625350512564E-04 0.568434188608E-12 0.000000000000E+00
    0.580000000000E+02 0.122187500000E+02 0.445697136503E-08 0.130323092151E+01
    0.638887286186E-06 0.429709546734E-02-0.333413481712E-06 0.515377133369E+04
    0.403200000000E+06-0.372529029846E-07-0.113465488624E+01 0.447034835815E-07
    0.976749941601E+00 0.393156250000E+03-0.535949576565E-01-0.851285459456E-08
    0.996470078407E-10 0.100000000000E+01 0.109600000000E+04 0.100000000000E+01
    0.300000000000E+01 0.000000000000E+00-0.232830643654E-08 0.314000000000E+03
    0.397170000000E+06 0.000000000000E+00 0.000000000000E+00 0.000000000000E+00
 1  1  1 11 16  0  0.0 0.160307157785E-03 0.170530256582E-11 0.000000000000E+00
    0.103000000000E+03-0.147843750000E+03 0.431160816722E-08-0.217049996981E+01
   -0.769086182117E-05 0.508953316603E-02 0.847131013870E-05 0.515363150024E+04
    0.403200000000E+06 0.391155481339E-07-0.663770814890E-01 0.894069671631E-07
    0.963391850829E+00 0.211500000000E+03-0.173367190134E+01-0.793675916931E-08
   -0.800033324599E-10 0.100000000000E+01 0.109600000000E+04 0.000000000000E+00
    0.300000000000E+01 0.000000000000E+00-0.325962901115E-08 0.103000000000E+03
    0.398730000000E+06 0.000000000000E+00 0.000000000000E+00 0.000000000000E+00
                                        .
                                        .
                                        .
```

Figure 7.2: RINEX navigation message file (GPS).

7.1.1.3 RINEX Meteorological Data Files

The RINEX meteorological data files are used to exchange weather data collected at different GPS stations.

The recommended file naming is as follows:

```
ssssdddf.yyM
```

with `M` being the label for the meteorological data files.

```
     2              METEOROLOGICAL DATA                     RINEX VERSION / TYPE
QLRINEXO V1.0.0 VM  AIUB                06-JUN-96 14:50     PGM / RUN BY / DATE
CDP SYSNUM:    34   CDP OCCNUM:    02   SYS CONFIG:     2   COMMENT
7839 GRAZ                                                   MARKER NAME
     3    PR    TD    HR                                    # / TYPES OF OBSERV
                                                            END OF HEADER
 96  5 31  8 34 28  964.7   20.1   54.0
 96  5 31  8 38 15  964.7   20.1   54.0
 96  5 31  8 42 34  964.7   20.1   54.0
 96  5 31  8 46 25  964.7   20.1   54.0
 96  5 31  9 18 49  964.7   20.1   54.0
 96  5 31  9 23  7  964.7   20.1   54.0
 96  5 31  9 49 21  964.7   20.1   54.0
 96  5 31  9 52 50  964.7   20.1   54.0
 96  5 31  9 57 48  964.7   20.1   54.0
 96  5 31 10  2 14  964.7   20.1   54.0
 96  5 31 10  7 42  964.7   20.1   54.0
 96  5 31 10 12 42  964.7   20.1   54.0
 96  5 31 10 17 33  964.7   20.1   54.0
 96  5 31 10 22 34  964.7   20.1   54.0
 96  5 31 10 27 41  964.7   20.1   54.0
 96  5 31 10 32 18  964.7   20.1   54.0
 96  5 31 10 35 50  964.7   20.1   54.0
 96  5 31 10 52 58  964.7   20.1   54.0
 96  5 31 10 57 54  964.7   20.1   54.0
 96  5 31 11  2 41  964.7   20.1   54.0
                                         .
                                         .
                                         .
```

Figure 7.3: RINEX meteorological data file.

7.1.2 Data Conversion to RINEX

As the manufacturer knows the properties and internals of the receiver and its data best, the data is ideally provided by the receiver in RINEX format directly, or, at least, software for the conversion from raw receiver data to the RINEX format is provided.

Ashtech, Leica, and Trimble all include programs into their own post-processing software to generate RINEX files from the raw data. We recommend to use this original conversion software if possible.

The *Bernese GPS Software* also contains conversion programs for various receiver types:

Table 7.1: Bernese RINEX converters.

Receiver Types	Converter Programs	RINEX Files
Ashtech L12/P12/Z12/Z18	ASRINEXO	Observation files
	ASRINEXN	GPS navigation files
	ASRINEXG	GLONASS navigation files
Rogue and Turborogue	RGRINEXO	Observation files
	RGRINEXN	GPS navigation files
Trimble 4000 SST/SSE/SSI	TRRINEXO	Observation files
	TRRINEXN	GPS navigation files

In addition to these programs a few auxiliary programs are made available for RINEX file manipulation and RINEX met file creation:

Table 7.2: Auxiliary programs.

Action	Auxiliary Programs	Comment
File concatenation	CCRINEXO	RINEX observation files
	CCRINEXN	GPS RINEX navigation files
	CCRINEXG	GLONASS RINEX navigation files
	CCRINEXM	Meteo RINEX files
Met file creation	RXMETEO	
File splitting	RNXSPLIT	RINEX observation files
Display file contents	RNXGRA	
Preprocessing	RNXSMT	See Section 10.2
	RNXCYC	See Section 10.2

All programs run on all computer systems supported by the *Bernese GPS Software*.

The conversion programs are accessed in the menu system in Panel 2.5. The help panels should give enough information about the options to be used. Additional information can also be found in the PCRINEX directory on our anonymous ftp account (see below) in the text file PCRINEX.TXT.

The program CCRINEXO may be used to concatenate several RINEX observation files of the same station into *one* file. This program may also be used to extract the observations of one or more files of a specified time interval, i.e., to cut the observation files for a particular session. **Hint:** if you are running CCRINEXO—or other converter programs— in background mode, you must select “ASIS” for “Automatic Filename Creation”. The program RNXSPLIT, on the other hand, is used to split rinex files containing more than one site into several RINEX files, resulting in one file for each site.

As there may be changes in the raw data format with the advent of new receivers, the distributed Bernese conversion programs might not be suitable at all times. As long as we support the creation of RINEX files for the above mentioned receiver types with our own converters, the latest versions (at least the executables for DOS) can always be downloaded from our anonymous ftp account:

```
ftp://ftp.unibe.ch/aiub/pcrinex/386rnx1.zip
ftp://ftp.unibe.ch/aiub/pcrinex/386rnx2.zip
```

Please contact AIUB for updated sources for UNIX and VMS systems.

7.2 Transfer RINEX ⟷ Bernese

The RINEX format is well suited for data transfer. RINEX is very flexible, and because it is an ASCII format, the transfer between different operating systems is simple. However, the processing software has to work extensively with observation files. The input/output operations are much faster if binary files are used. Therefore, the *Bernese GPS Software* transfers all the RINEX observation files and navigation messages into the Bernese binary format. If RINEX meteo files are to be used, they are translated, too. In this case, however, the Bernese file is an ASCII file as well.

We refer to Chapter 24 for the description of files used by the *Bernese GPS Software*. For each RINEX file containing both phase and code observations for a given station, the following four Bernese observation files are created:

`*.PZH` ... phase zero-difference header file (contains information about the station, receiver, antenna, ambiguities etc.),

`*.PZO` ... phase zero-difference observation file (contains phase observations),

`*.CZH` ... code zero-difference header file (contains similar information as the phase zero-difference file, but no ambiguities),

`*.CZO` ... code zero-difference observation file (contains code observations).

The navigation messages in RINEX files are transferred into Bernese broadcast orbit files (usually with the extension `.BRD`) or into orbit files in SP3 format (extension `.PRE`). The RINEX files containing meteorological data are translated into Bernese meteo files (extension `.MET`).

7.2.1 Transfer RINEX ⟶ Bernese

There are four programs in the transfer part of the *Bernese GPS Software* translating RINEX data into the Bernese format. All programs are accessible through Menu 2.7.

RXOBV3 (Menu 2.7.1) transforms RINEX observation data into Bernese code/phase header/observation files. The format of the Bernese files has not changed since Version 3.4. The program may process a list of RINEX observation files. The user may specify so-called translation tables to modify information coming from RINEX files. There are three translation tables which may be used. Examples for all three tables may be found in Chapter 4.

The station name translation table may be used to make sure that you end up with a unique set of station names in the Bernese observation files. It has the default extension `.STN` and is located in the campaign-specific station directory `STA`.

The receiver/antenna name translation table may be used to define a unique set of receiver and antenna names. The file containing this table is located in the `$X:/GEN` (`X:[GEN]` on VMS, `X:\GEN` on DOS) directory and has the default extension `.TRN`.

The antenna height translation table may be important if the antenna heights in the RINEX files are wrong or if they have been measured with respect to a non-standard reference point. The translation table has the default extension `.HTR` and it is located in the campaign-specific station directory `STA`.

For more details concerning the options of program RXOBV3 we refer to the corresponding help panels. RXOBV3 does not accept more than one station in each RINEX file. If data stemming from more stations are stored in one RINEX file, it is necessary to split up the RINEX file using program RNXSPLIT (see Section 7.1.2).

RXNBV3 (Menu 2.7.2) transforms the GPS RINEX navigation messages into Bernese broadcast files. The program has no options. It can process a list of RINEX navigation files.

RXNPRE (Menu 2.7.7) transforms the GPS and the GLONASS navigation messages into the SP3 format (see Chapter 8.3.3).

RXMBV3 (Menu 2.7.3) transforms the RINEX meteo files into Bernese meteo files. RINEX provides one meteo file per site and session, in the Bernese format one meteo file per site (in one run of the program GPSEST only one meteo file per site may be specified) is required. Therefore, the program RXMBV3 may concatenate RINEX meteo files from different sessions into one (site-specific) Bernese meteo file. Optionally, a station name translation table may be used.

There are three more programs accessible through Menu 2.7 . RNXGRA (Menu 2.7.4) creates a simple graphic of the observations available in the RINEX file(s) selected. RNXCYC (Menu 2.7.5) could be used for a pre-processing step on the RINEX level. This program is described in Chapter 10. Recommended for use as a preprocessing program on the RINEX level, however, is RNXSMT (Menu 2.7.6). A detailed description of this program is given in Chapter 16.

7.2.2 Transfer Bernese ⟶ Rinex

The program BV3RXO (Menu 2.6.1) transforms Bernese code/phase header/observation files into RINEX format observation files. More than one Bernese file may be written into one RINEX observation file. Be aware of the fact that only single-difference files are cleaned in the Bernese processing procedure and that RINEX files generated from Bernese *zero-difference* files are therefore not clean. Program BV3RXO makes use of a so-called receiver information file to supply additional information needed to create the RINEX headers (see Panel 0.3.1 and Chapter 24).

The program BV3RXN transforms one or more Bernese broadcast file(s) into RINEX navigation message file(s). Normally, for each Bernese broadcast input file one RINEX output file will be created, but it is also possible to specify the same output file for several Bernese input files. All messages will then be written into the same RINEX navigation message file. Because Bernese broadcast files do not exist for GLONASS, the program BV3RXN may only be used to generate GPS RINEX navigation message files.

7.3 The SINEX Format

7.3.1 Definition of the SINEX

At the 1994 IGS Workshop on the *Densification of the IERS Terrestrial Reference Frame through Regional GPS Networks* (JPL, Pasadena, December 1994), it was decided to start an IGS pilot project to prove the concept for a *distributed processing* of GPS data (see, e.g., Section 18.4). For that purpose, it was necessary to define a data (resp. solution) exchange format, the Software INdependent EXchange (SINEX) format [*Kouba et al.*, 1996]. This format should contain all important information necessary to combine coordinates, velocities, and Earth orientation parameter (EOP) estimates. In Section 24.8.13, we give more information concerning the contents of SINEX files.

7.3.2 Bernese NEQ File ⟶ SINEX

SINEX files contain a subset of the information available in the Bernese normal equation files (see Sections 24.8.8 and 24.8.9). The conversion Bernese NEQ ⟶ SINEX is generated by the combination programs ADDNEQ and ADDNEQ2, which allow to store normal equation files as well as SINEX files.

The SINEX files may contain additional information such as the 3-character identification of the agency, the identification of the data source, as well as information concerning the blocks “`FILE/REFERENCE`”, “`FILE/COMMENT`”, and “`INPUT/ACKNOWLEDGMENTS`”. A general file, described in detail in Section 24.4.9, makes it possible to include this information into the SINEX file automatically.

A piece of information which became important some time ago (July 1996), is the elevation-dependent antenna phase center model used for the processing (see Section 24.4.5). In the present Version 4.2, the characters “`-----`” denoting items that are not specified, are written into the SINEX file. If you use, e.g., the recommended model `IGS_01` [*Rothacher*, 1996], you have to “hard-wire” this name in the source code of the subroutine `SINSAV` or `SINSTORE`.

Writing Earth rotation parameters into the SINEX file is supported by the new program ADDNEQ2 only.

A remark also concerning the station names used in the SINEX file: let us assume that the station names used in the processing using Bernese consists of the 4-character codes of a site and the associated domes number (e.g., `WETT 14201M009`). In the SINEX format, a site is characterized by the 4-character code and a `PT` flag (A-Z), indicating the occupation. We interpret the station names in a way that all stations with the same first 4 characters belong to the same site. It may cause troubles, if you use a different naming convention.

7.3.3 SINEX ⟶ Bernese NEQ File

ADDNEQ needs normal equations in the Bernese normal equation (`.NEQ`) format (see Section 24.8.8) as input. We developed the program SNXNEQ to allow the conversion of SINEX files into Bernese NEQ files. Furthermore, SNXNEQ is able to generate Bernese coordinate (`.CRD`), velocity (`.VEL`), and variance-covariance (`.COV`) files. With these options you may “import” and process results obtained from other analysis centers using different processing tools.

The program may also be used to estimate approximate values of normal equation rescaling factors to ensure that in a combined solution all contributing solutions get a reasonable correct weight. The determination of proper rescaling values is essential, if you combine results obtained from different software packages. As reference (rescaling factor 1.0), we use the first SINEX file selected in the F-file (more details are given below). For common sites (specified in the N-file with the keyword `COVREF`), we derive rescaling factors from the main diagonals of the associated normal equations (computed from the given covariance information). These rescaling factors may be stored in a `.WGT` file (keyword COVCOMO in the N-file). This file may then be used together with the generated normal equation files as input for ADDNEQ. More information is given in Chapter 18 and Section 24.8.14.

The program SNXNEQ is not supported by the menu system. Please use the command RUNGPS SNXNEQ (see Section 3.8) to prepare and start the program. Below, we give some important information concerning the input files.

N-file

```
SNXNEQ: INTERNAL AND EXTERNAL FILE NAMES                  24-AUG-96 16:18
------------------------------------------------------------------------
INTERNAL  EXTERNAL NAME                      DESCRIPTION
*******   ********************************

CONST     X:/GEN/CONST.                      GENERAL CONSTANTS
INPUT     U:/INP/SNXNEQI.INP                 INPUT OPTIONS
AUXFIL    U:/WORK/SNXNEQ.SCR                 AUXILIARY FILE
DATUM     X:/GEN/DATUM.                      GEODETIC DATUM
SNXFIL    U:/INP/SNXNEQF.INP                 SINEX INPUT FILES AND OUTPUT FILES
SYSOUT    K:/IGSA/OUT/SNXNEQ.L00             JOB OUTPUT
SYSERR    U:/WORK/ERROR.MSG                  ERROR MESSAGES
COORD     K:/IGSA/STA/ITRF94.CRD             APRIORI COORDINATE FILE
VELAPR                                       APRIORI VELOCITY FILE
NUMCNV    K:/IGSA/STA/ITRF94.CRD             COORDINATE FILE FOR STATION NUMBER
COVREF    K:/IGSA/STA/COMMON.CRD             REFERENCE STATIONS FOR COVARIANCES
COVCOMO   K:/IGSA/OUT/TEST.WGT               COVARIANCE COMPONENTS OUTPUT
```

Figure 7.4: N-file of program SNXNEQ.

The input files CONST, INPUT, AUXFIL, DATUM, SNXFIL, SYSOUT, and SYSERR are general files and need no special explanations.

COORD — The specified coordinate file is used as master file to create coordinate files (specified in the F-file).

VELAPR — The specified velocity file is used as master file to create velocity files (specified in the F-file).

NUMCNV — SINEX files contain no station numbers. If station names given in the SINEX files are identical with the station names given in this coordinate file, the corresponding station number is written to the output coordinate files, velocity files, and normal equation files (specified in the F-file).

COVREF — Coordinate file defining the common sites which are to be used to derive approximate rescaling factors. If you do not specify a file, *all* sites of the SINEX files are used for the computation.

COVCOMO — A .WGT output file containing the computed rescaling factors.

F-file

You have to enter the name of one or more SINEX file(s) in the first column of the file. In the other columns you may specify the output files: .NEQ files, .COV files, .CRD files, and .VEL files.

I-file

Please do **not** change the default options (all settings to NO or 0).

We tested the conversion program SNXNEQ using the SINEX distributions of the global IGS Analysis Centers, the Global Network Associated Analysis Centers, and some Regional Network Associated Analysis Centers (SINEX files generated by at least 8-10 different SINEX "creators"). The Bernese SINEX reading routine reads both version 0.05 and 1.00 SINEX files. In case of problems, you can get assistance from AIUB.

7.3.4 Generating Bernese NQ0 Files from SINEX and NEQ Files

The new format of the Bernese normal equation files can be generated from the SINEX files, using the program SNX2NQ0, or from the old normal equation files (NEQ-files), using the program NEQ2NQ0 (see Chapter 19). The programs are not supported by the menu system and they use only one input file (N-file). The format of the N-file is identical for both programs:

```
INTERNAL AND EXTERNAL FILE NAMES                         02-OCT-98 08:49
------------------------------------
INTERNAL  EXTERNAL NAME                     DESCRIPTION
*******   ********************************

CONST     X:/GEN/CONST.                     GENERAL CONSTANTS
DATUM     X:/GEN/DATUM.                     LOCAL GEODETIC DATUM
POLE      X:/GEN/SCRATCH.ERP                SCRATCH POLE FILE
PHASECC   X:/GEN/PHAS_IGS.01                PHASE CENTER ECCENTRICITIES
SYSOUT                                      JOB OUTPUT
SYSERR    SYSOUT                            ERROR MESSAGES

INPUT_FILES   2
  "P:/DOCU42_1/OUT/H7_06917.SNX"   "P:/DOCU42_1/OUT/H7_06917.NQ0"
  "P:/DOCU42_1/OUT/H7_06927.SNX"   "P:/DOCU42_1/OUT/H7_06927.NQ0"
```

Figure 7.5: N-file of programs SNX2NQ0 and NEQ2NQ0.

7.4 External Data Sources

7.4.1 CODE Products

The Center for Orbit Determination in Europe (CODE) is one of at present eight IGS analysis centers. CODE is a joint venture of the Astronomical Institute of the University of Berne (AIUB) and the Swiss Federal Office of Topography (L+T), the German Federal Office of Cartography and Geodesy (BKG), and the French National Geographical Institute IGN). CODE is located at the AIUB in Berne. The CODE IGS products are made available on the AIUB anonymous ftp account. Apart from these IGS products, several other files that are specific to the *Bernese GPS Software* may be downloaded. This section describes how to use anonymous ftp to obtain the CODE and Bernese products.

In this section we use the following symbols:

Symbol:	Meaning:	Example:
`wwww`	GPS week	`1101`
`d`	day of week	`0`=Sunday, `1`=Monday, ... `6`=Saturday
`yyyy`	4-digit year	`2001`
`yy`	2-digit year	`01`
`ddd`	day of year	`046`
`mm`	month of year	`02`

To access AIUB's anonymous ftp server use

address:	`ftp.unibe.ch`
login:	`anonymous`
password:	*your full e-mail address*
products:	`cd aiub` (to get to top directory of AIUB's ftp area)

or direct your browser to

`ftp://ftp.unibe.ch/aiub/`

After entering our anonymous ftp area in this way, you will see several subdirectories. Our products are stored in two main directory trees according to the following structure:

```
BSWUSER --- ATM          CODE --- 1992
        |-- DATPAN            |-- 1993
        |-- EXAMPLES          |-- 1994
        |-- GEN               |-- 1995
        |-- ORB               |-- 1996
        |-- STA               |-- 1997
        |-- TXT               |-- 1998
                              |-- 1999
                              |-- 2000
                              |-- 2001
```

BSWUSER contains files specific to the *Bernese GPS Software*. These can either be general Bernese files or IGS products in a format specific to the Bernese software. Examples of general files, in the Bernese format, are the IERS pole files, the antenna phase center file, and the satellite information files. IGS products in the Bernese file format are, for instance, daily troposphere and orbit estimates or weekly coordinate and troposphere estimates. All files are in **uppercase** and **UNIX-compressed**. The notation for the filenames is

`SSSyyddd.ext.Z`	for daily files (e.g., troposphere, orbits),
`SSSwwww7.ext.Z`	for weekly files (e.g., poles, coordinates),

where the solution identifiers `SSS` are

`COD`	for CODE IGS final solutions,
`COR`	for CODE IGS rapid solutions,
`COE`	for CODE EUREF (European) solutions,
`BRD`	for broadcast clock corrections.

ATM contains tropospheric zenith path delay estimates for our global IGS and regional EUREF solutions, as well as for the rapid IGS solution where the final solution is not yet available. It contains the ionosphere information from the European solution in IONEX format (extension `INX`) and in Bernese format (extension `ION`). The files are arranged in yearly subdirectories.

GEN contains general Bernese software files. Here, the official IERS pole files (C04 and Bulletin A (rapid)) in the Bernese format, the `SATELLIT.TTT` and `SAT_yyyy.CRX` files and the antenna phase center file `PHAS_IGS.01` may be found. Yearly subdirectories contain weekly CODE final ERP files, which are consistent with the corresponding orbit solutions stored in the ftp directory `CODE`. Please note that the ERP files located in the `GEN` area are in the Bernese pole format and may, therefore, be directly used by the *Bernese GPS Software* Version 4.2. If you want to use ERP files produced by the IGS, which are in the IERS format, a conversion using the program POLUPD is required (see Section 14.3.2).

A file `SATELLIT.` may be downloaded from our anonymous ftp directory `ftp://ftp.unibe.ch/aiub/BSWUSER/GEN/` which contains entries for *all* ever active GPS satellites. Do **not** use this file with the *Bernese GPS Software* Version 4.2, otherwise you may get wrong satellite antenna offsets and radiation pressure a priori values for PRN numbers which were occupied by several satellites in the past. Always use the file `SATELLITE.TTT`, or in case of processing of “old” data, create another file, based on `SATELLIT.`, containing *one* entry per PRN number. The *Bernese GPS Software* Version 4.2 does not yet consider the time windows given in the `SATELLIT.` file.

ORB contains daily updated files with P1-P2 and P1-C1 differential code bias (DCB) information. Yearly subdirectories contain broadcast clock information, satellite clock corrections in Bernese format for every 5 minutes clocks from the CODE IGS final solution, and P1-P2 DCB estimates from the final and rapid solutions. The orbit information generated by CODE may be found in the ftp directory `CODE` (see below). The corresponding SP3 files (`*.EPH`) also contain precise clock corrections for the satellites (every 15 minutes).

Please note that the *Bernese GPS Software* Version 4.2 does **not** handle P1-C1 DCB corrections, consequently, **never** introduce this type of files in GPSEST Version 4.2.

STA contains CODE's antenna height and station name translation tables and ocean loading file, station coordinates and velocities in the ITRFyy, IGS_yy, and EURF97 realizations. Yearly subdirectories contain weekly coordinates from CODE IGS and EUREF solutions as well as monthly coordinate files in the ITRF (`ITRFmmyy.CRD`, until June 2000) and IGS realization (`IGS_mmyy.CRD`, since June 2000).

DATPAN contains the station name abbreviation table used by CODE.

TXT contains text files such as the read-me file describing the generation of the DE200 ephemeris binary file.

EXAMPLES contains processing examples.

CODE contains our official IGS products. The final products are arranged in yearly subdirectories, the rapid and predicted products are stored in the top directory until the final products for the corresponding day (or week) are available. A summary of the IGS products available on our anonymous ftp is provided in Table 7.3. The products include precise orbits, ERPs, satellite and receiver clock corrections, and global ionosphere maps.

Table 7.3: CODE products available through anonymous ftp.

CODE *rapid* and *predicted* products available at `ftp://ftp.unibe.ch/aiub/CODE/`:	
CODwwwwd.EPH_R	CODE rapid orbits
CODwwwwd.EPH_P	CODE 24-hour orbit predictions
CODwwwwd.EPH_P2	CODE 48-hour orbit predictions
CODwwwwd.EPH_5D	CODE 5-day orbit predictions
CODwwwwd.ERP_R	CODE rapid ERPs belonging to the rapid orbits
CODwwwwd.ERP_P	CODE predicted ERPs belonging to the predicted orbits
CODwwwwd.ERP_P2	CODE predicted ERPs belonging to the predicted orbits
CODwwwwd.ERP_5D	CODE predicted ERPs belonging to the predicted orbits
CODwwwwd.CLK_R	CODE rapid clock product, 5-minute values, clock-RINEX format
CODwwwwd.TRO_R	CODE rapid troposphere product, SINEX format
CORGddd0.yyI	CODE rapid ionosphere product, IONEX format
COPGddd0.yyI	CODE 1-day or 2-day ionosphere predictions, IONEX format
CODwwwwd.ION_R	CODE rapid ionosphere product, Bernese format
CODwwwwd.ION_P	CODE 1-day ionosphere predictions, Bernese format
CODwwwwd.ION_P2	CODE 2-day ionosphere predictions, Bernese format
GLOwwwwd.EPH_5D	CODE 5-day GLONASS orbit predictions (based on broadcast orbits)
P1C1.DCB	CODE moving 30-day P1-C1 DCB solution, Bernese format
P1P2.DCB	CODE moving 30-day P1-P2 DCB solution, Bernese format
CODE *final* products available at `ftp://ftp.unibe.ch/aiub/CODE/yyyy/`:	
CODwwwwd.EPH.Z	CODE final orbits, our *official* IGS orbit product
CODwwww7.ERP.Z	CODE final ERPs belonging to the final orbits, values for the full week
CODwwwwd.CLK.Z	CODE final clock product, 5-minute values, clock-RINEX format
CODwwwwd.TRO.Z	CODE final troposphere product, SINEX format
CODGddd0.yyI.Z	CODE final ionosphere product, IONEX format
CODwwwwd.ION.Z	CODE final ionosphere product, Bernese format
CODwwww7.SNX.Z	CODE weekly SINEX product
CODwwww7.SUM.Z	CODE weekly summary files
COXwwwwd.EPH.Z	CODE precise GLONASS orbits (for GPS week 0990–1066)
COXwwww7.SUM.Z	CODE weekly summary files of GLONASS analysis
P1C1yymm.DCB.Z	CODE monthly P1-C1 DCB solutions, Bernese format
P1P2yymm.DCB.Z	CODE monthly P1-P2 DCB solutions, Bernese format

Note that our precise orbit files should always be used together with the corresponding pole files!

7.4.2 IGS Products

The products of all IGS analysis centers are archived at three global data centers together with the observation data. The combined official IGS products may be found at the same locations. They consist of precise orbits, ERPs, coordinates and velocities of the ground stations, and tropospheric zenith delays. For more information please visit the web-site of the IGS Central Bureau `http://igscb.jpl.nasa.gov`.

Within the IGS we strive to keep the internet load at a minimum. Everyone is therefore advised to access the nearest global data center. The three data centers are located at IGN (France), CDDIS (USA east coast) and SIO (USA west coast). Below, we describe very briefly how to access these global data centers and where to find the IGS data and products.

To access IGN located in Paris, France, use the following commands:

Anonymous ftp:	address:	`igs.ensg.ign.fr`
	login:	`anonymous`
	password:	*your full e-mail address*
	data:	`cd igs/data`
	products:	`cd igs/products`
Internet browser:	`ftp://igs.ensg.ign.fr/pub/igs/`	

To access CDDIS located near Washington, USA, use the following commands:

Anonymous ftp:	address:	`cddisa.gsfc.nasa.gov`
	login:	`anonymous`
	password:	*your full e-mail address*
	data:	`cd pub/gps/gpsdata`
	products:	`cd pub/gps/products`
Internet browser:	`ftp://cddisa.gsfc.nasa.gov/pub/gps/`	

To access SIO located in California, USA, use the following commands:

Anonymous ftp:	address:	`lox.ucsd.edu`
	login:	`anonymous`
	password:	*your full e-mail address*
	data:	`cd pub/rinex/yyyy/ddd`
	products:	`cd /products/wwww`
Internet browser:	`ftp://lox.ucsd.edu/pub/`	

The IGS maintains the so-called *Central Bureau Information System* (CBIS). The primary functions of the CBIS are to facilitate communication, coordinate IGS activities, establish and promote compliance to IGS network standards, monitor network operations, and quality assurance of data and maintenance of documentation. The CBIS is accessible on the internet by anonymous ftp and the information is mostly available in easy-to-handle ASCII files. Alternative access methods are provided as well, such as third-party e-mail servers and a web site.

The CBIS can be accessed in the following ways:

web:	`http://igscb.jpl.nasa.gov`
ftp:	`ftp://igscb.jpl.nasa.gov`
e-mail:	`igscb@igscb.jpl.nasa.gov`

For more information about the CBIS please send an e-mail to `igscb@igscb.jpl.nasa.gov`.