Bernese GPS Software: Recent Developments and Plans

R. Dach,
H. Bock, A. Jäggi, S. Lutz, M. Meindl, L. Ostini, L. Prange,
S. Schaer[a], A. Steinbach, D. Thaller, P. Walser, G. Beutler

rolf.dach@aiub.unibe.ch

bernese@aiub.unibe.ch

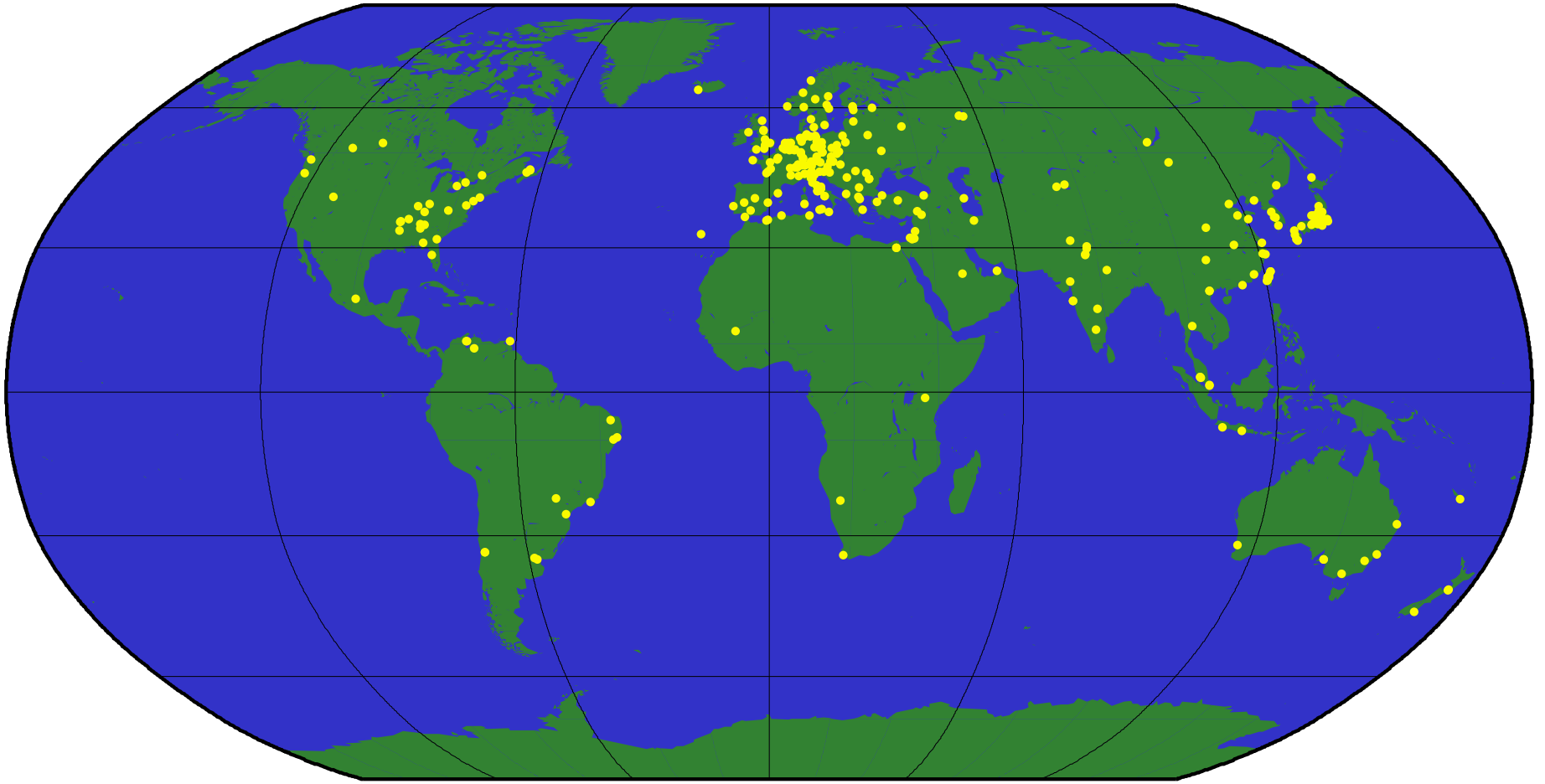
Astronomisches Institut, Universität Bern, Sidlerstrasse 5, CH-3012 Bern

[a] Bundesamt für Landestopographie swisstopo, Seftigenstrasse 264, CH-3084 Wabern

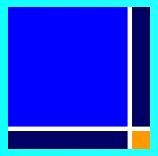
EUREF–LAC–Workshop; Frankfurt; 22/23. October 2008

Bernese GPS Software

The Bernese GPS Software is used all over the world.



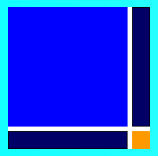
GMT 2008 Aug 18 16:34:57 **Geographical Distribution of Institutions using the Bernese GPS Software**



Introduction

Bernese GPS Software:
recent developments and plans

- Bernese GPS Software, Version 5.0 is distributed since May 2004.
- User manual was completed in January 2007.



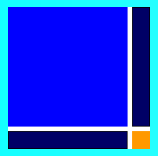
Introduction

Bernese GPS Software:
recent developments and plans

- Bernese GPS Software, Version 5.0 is distributed since May 2004.
- User manual was completed in January 2007.

Current developments:

- New GNSS are expected in the near future.
  There are plans to modernize the existing GNSS.
- Reprocessing efforts are ongoing at many places.
- Many model developments have been carried out in the last years.



Introduction

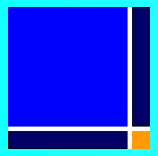
Bernese GPS Software:
recent developments and plans

- Bernese GPS Software, Version 5.0 is distributed since May 2004.
- User manual was completed in January 2007.

Current developments:

- New GNSS are expected in the near future.
  There are plans to modernize the existing GNSS.
- Reprocessing efforts are ongoing at many places.
- Many model developments have been carried out in the last years.

What does this mean for the Bernese GPS Software?



A Multi–GNSS Analysis Software

Bernese GPS Software:

A multi–GNSS analysis software

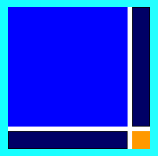
- The software has been started as a GPS analysis tool.
- It is capable to process GLONASS data already for a long time.
- The measurements from both systems can be processed together on the observation level.

A Multi–GNSS Analysis Software

Bernese GNSS Software:

A multi–GNSS analysis software

- The software has been started as a GPS analysis tool.
- It is capable to process GLONASS data already for a long time.
- The measurements from both systems can be processed together on the observation level.



A Multi–GNSS Analysis Software

Bernese GNSS Software:
A multi–GNSS analysis software

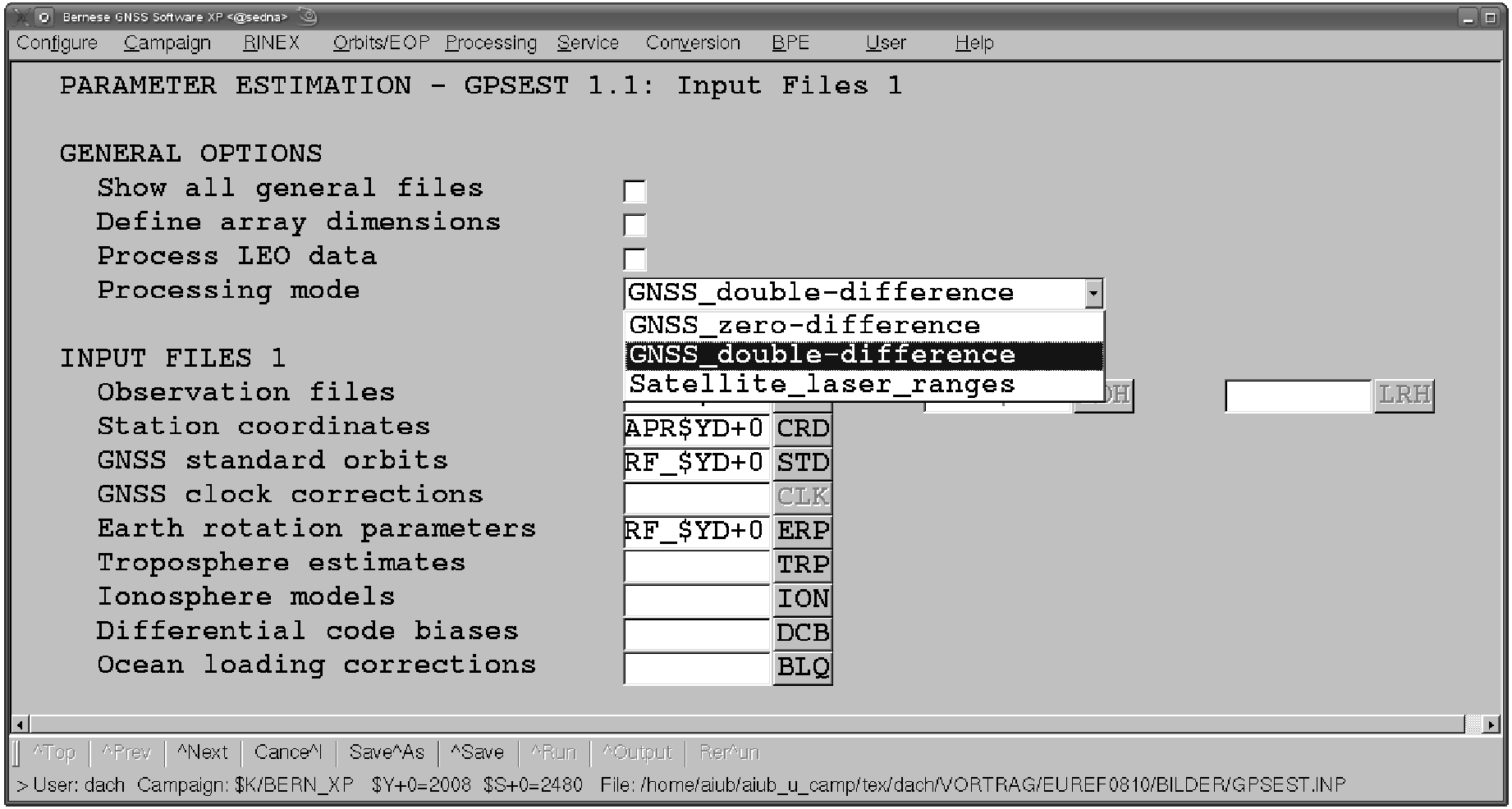
- The software has been started as a GPS analysis tool.
- It is capable to process GLONASS data already for a long time.
- The measurements from both systems can be processed together on the observation level.

Extensions to the announced new/modernized GNSS:

- extension from two to n frequencies for each GNSS
- each GNSS may have different set of observation types

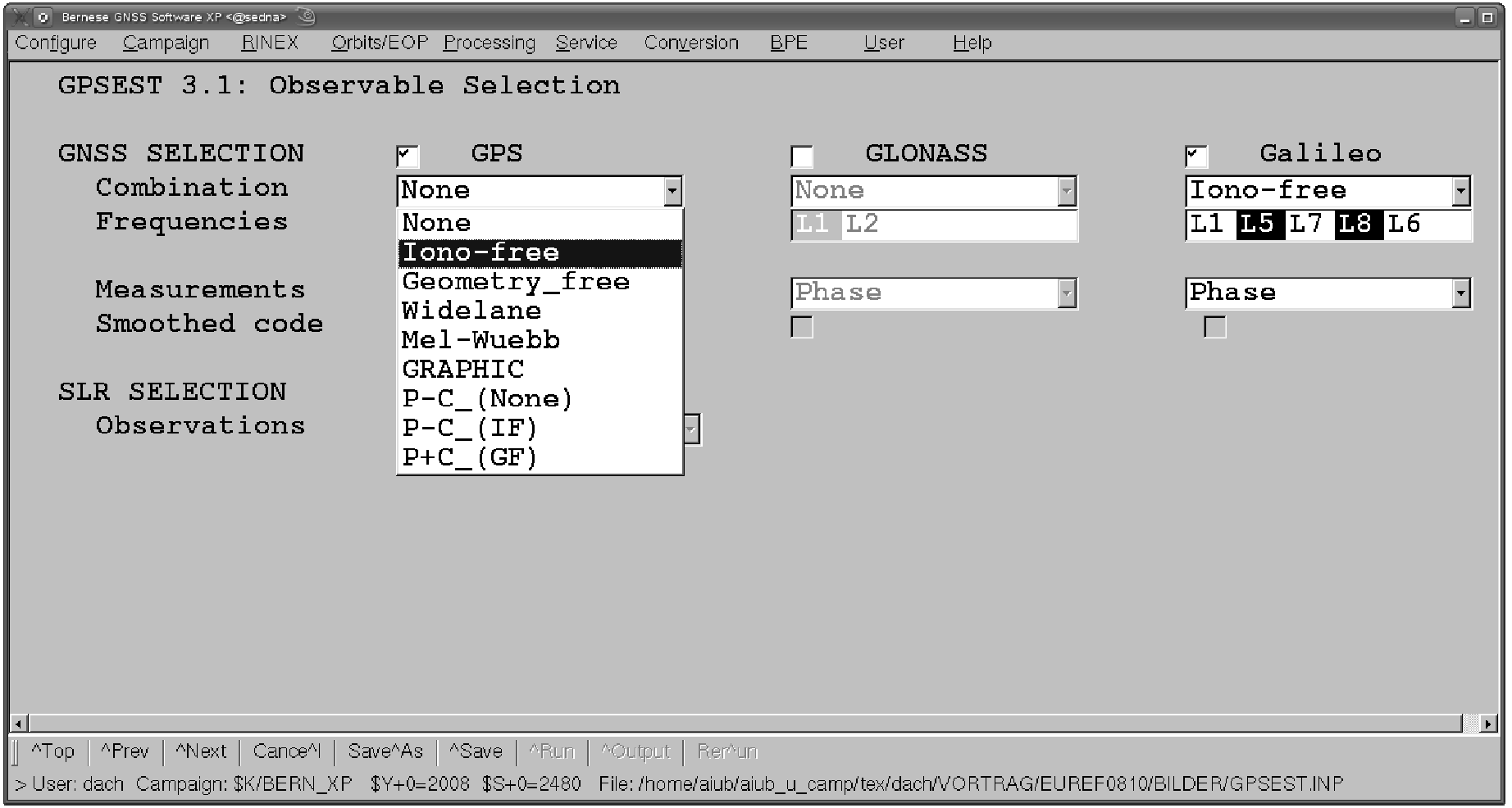
Bernese GNSS Software

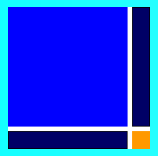
Flexible handling of observation types is necessary:



Bernese GNSS Software

Flexible handling of observation types is necessary:





Bernese GNSS Software

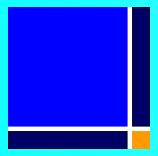
Flexible handling of observation types is necessary:

- All observations types from RINEX3 are kept together in one Bernese observation file per station and session.
- A complex set of modern F90 modules guarantees a flexible access to the measurements with individual linear combinations for each GNSS.
- The use of these modules simplifies the observation handling within the processing programs.
- New linear combinations may be easily implemented at one place for the entire software package.

$\Rightarrow$ M. Meindl et al., Developing a Generic Multi–GNSS Software Package, IGS Workshop, Miami, June 2008.

New file formats are necessary:

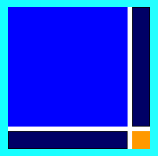
- Bernese observations files
  (may contain all types of observations in one (common) file)



Bernese GNSS Software

New file formats are necessary:

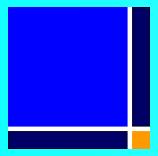
- Bernese observations files
  (may contain all types of observations in one (common) file)
- Bernese residual files
  (considering the new linear combinations)
- Differential code biases
  (many new DCBs have to be expected with the new signal types)
- Receiver information file
  (which receiver type is capable to receive which signal and priority lists for the observation selection)
- Antenna phase center corrections
  (GNSS-dependent receiver antenna PCV information)



Bernese GNSS Software

Other necessary developments to get a multi–GNSS software:

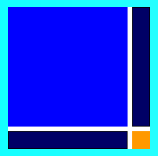
- increase the number of satellites that can be processed together
  (32 GPS + 24 GLONASS + 36 Galileo = 92 satellites)



Bernese GNSS Software

Other necessary developments to get a multi–GNSS software:

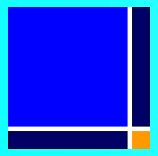
- increase the number of satellites that can be processed together
  (32 GPS + 30 GLONASS + 36 Galileo = 98 satellites)



Bernese GNSS Software

Other necessary developments to get a multi–GNSS software:

- increase the number of satellites that can be processed together
  (32 GPS + 30 GLONASS + 36 Galileo ≈ 100 satellites)



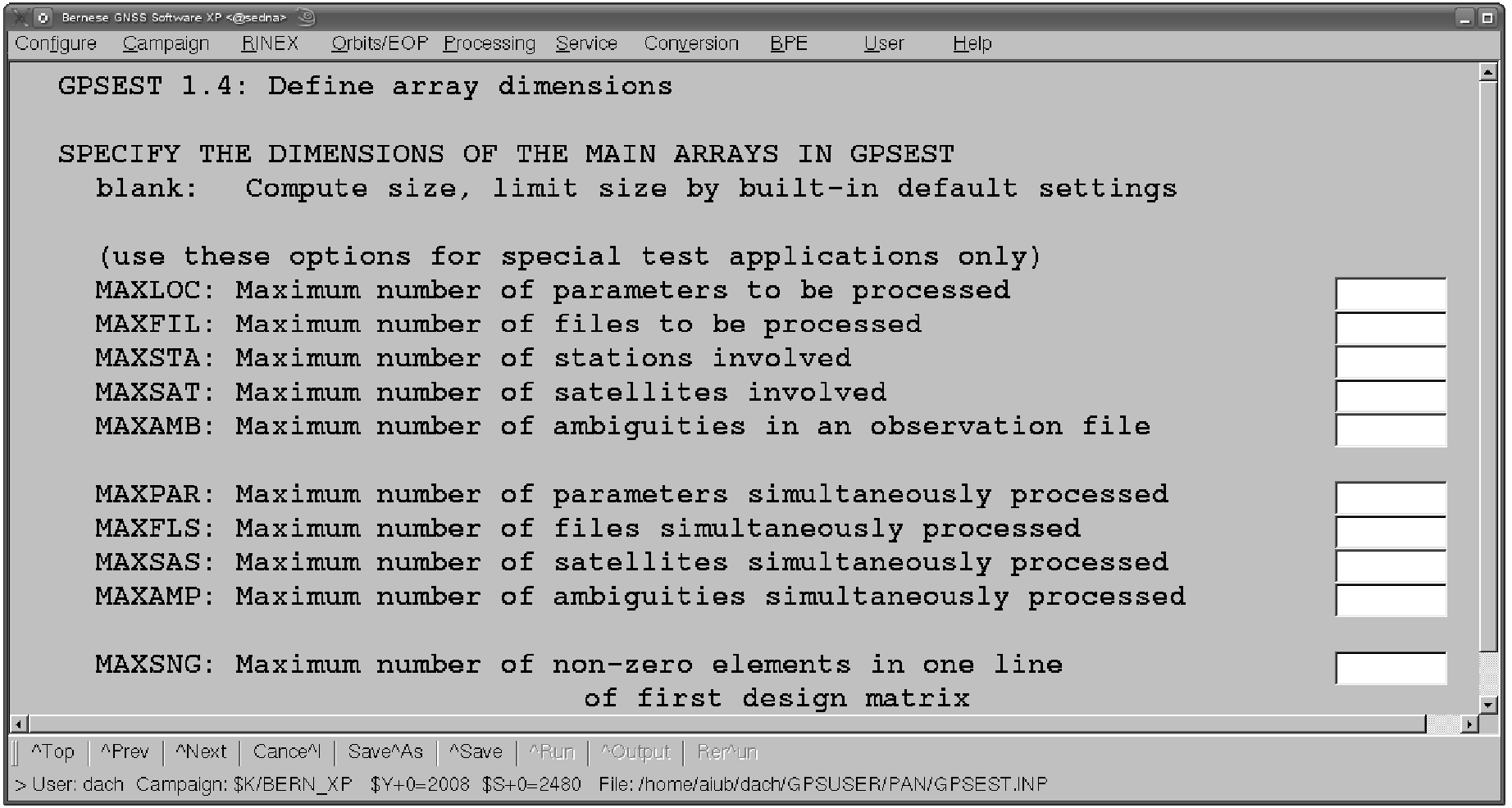
Bernese GNSS Software

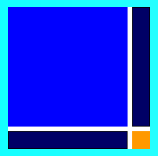
Other necessary developments to get a multi–GNSS software:

- increase the number of satellites that can be processed together
  (32 GPS + 30 GLONASS + 36 Galileo ≈ 100 satellites)
- correct input and output codes for each GNSS for all external files
  (e.g., precise orbit file, clock RINEX file, . . .)
- GNSS dependent parameter setup
  (e.g., receiver antenna phase center offsets/variations, Earth rotation parameters, . . .)
- requires the dynamic allocation of several arrays in many of the processing programs

Bernese GNSS Software

Other necessary developments to get a multi–GNSS software:





Bernese GNSS Software

Other necessary developments to get a multi–GNSS software:

- increase the number of satellites that can be processed together
  (32 GPS + 30 GLONASS + 36 Galileo $\approx$ 100 satellites)
- correct input and output codes for each GNSS for all external files
  (e.g., precise orbit file, clock RINEX file, . . .)
- GNSS dependent parameter setup
  (e.g., receiver antenna phase center offsets/variations, Earth rotation parameters, . . .)
- requires the dynamic allocation of several arrays in many of the processing programs

$\Rightarrow$ Version 5.1 will be declared as “Galileo–ready”.

To improve the reprocessing capability

1. a new coordinate/velocity file containing time intervals

```
IGS05 COORDINATES EXTRACTED FROM IGS05.SNX                          09-MAY-2008
--------------------------------------------------------------------------------
FORMAT:  1
DATUM : IGS05

TYPE 001: STATION COORDINATES
-----------------------------
STATION NAME              X (M)          Y (M)          Z (M)      FLG         EPOCH              VALIDITY INTERVAL (FROM -> TO).
****************     *********.***** *********.***** *********.*****  *****  YYYY MM DD HH MM SS  YYYY MM DD HH MM SS  YYYY MM DD ...
ABPO 33302M001         4097216.75080   4429118.87830  -2065771.49240  PPP    2000 01 01 00 00 00                              ...
ADE1 50109S001        -3939181.98450   3467075.28480  -3613220.74210  PPP    2000 01 01 00 00 00                    2004 12 23 ...
ADE1 50109S001        -3939181.98450   3467075.28480  -3613220.74210  PPP    2000 01 01 00 00 00  2004 12 24 00 00 00            ...
ADIS 31502M001         4913652.94450   3945922.49800    995383.14420  PPP    2000 01 01 00 00 00                              ...
AJAC 10077M005         4696989.50620    723994.38050   4239678.47430  IGS05  2000 01 01 00 00 00                              ...
...

TYPE 002: STATION VELOCITIES
----------------------------
STATION NAME              VX (M/Y)       VY (M/Y)       VZ (M/Y)     FLG       VALIDITY INTERVAL (FROM -> TO)         RMS VX     ...
****************     *********.***** *********.***** *********.*****  *****  YYYY MM DD HH MM SS  YYYY MM DD HH MM SS  *****.*****...
ABPO 33302M001             -0.01100        0.01790        0.01660  NUVEL                                                        ...
ADE1 50109S001             -0.04600        0.00570        0.04170  NUVEL                                                        ...
ADIS 31502M001             -0.01850        0.01840        0.01870  NUVEL                                                        ...
AJAC 10077M005             -0.01460        0.00370       -0.00530  IGS05                                                        ...
...
```

To improve the reprocessing capability

1. a new coordinate/velocity file containing time intervals

2. a section on local ties is added to the station information file

```
TYPE 001: RENAMING OF STATIONS
------------------------------

TYPE 002: STATION INFORMATION
-----------------------------

TYPE 003: HANDLING OF STATION PROBLEMS
--------------------------------------

TYPE 004: STATION EVENTS AND ECCENTRICITIES (INCLUDING TROPOSPHERE)
-------------------------------------------------------------------          LOCAL TIE (2 MINUS 1) (M)         CONSTRAINTS (M)  ...
        CORRELATIONS
STATION NAME 1       STATION NAME 2       FLG         EPOCH         SYS    DN/DX      DE/DY      DU/DZ     DN/DX     DE/DY     D...
***************      ***************      ***  YYYY MM DD HH MM SS  ***  ****.****  ****.****  ****.****  **.*****  **.*****  **...
AIS1 49998S001                            001  1996 04 17 00 00 00
ALBH 40129M003                            001  1994 04 14 00 00 00
ALBH 40129M003                            001  2003 09 08 00 00 00
...
ZIMJ 14001M006       ZIMM 14001S007       001  1998 07 06 00 00 00  XYZ     3.1340    13.750     -1.785
...

TYPE 005: HANDLING STATION TYPES
--------------------------------
```

To improve the reprocessing capability

1. a new coordinate/velocity file containing time intervals
   (“station ABC” no longer necessary)

2. a section on local ties is added to the station information file
   (discontinuities and local ties may be specified considering an uncertainty)

3. FODITS: Find Outliers and Discontinuties in Time Series
   (presented by L. Ostini et al. at the EUREF Symposium in Brussels, June 2008)

4. improved SINEX support
   (e.g., several equipment setup per coordinate interval,
   GNSS–dependent antenna corrections directly from the NEQ)

5. derive periodic functions for parameters in ADDNEQ2
   (under development, not sure whether this feature will be a part of version 5.1)

Other Highlights from our Development

Other new features/models of a version 5.1*:

Other Highlights from our Development

Other new features/models of a version 5.1*:

* The final list of features and models provided with the delivery of version 5.1 to the user community will be defined later.

Other Highlights from our Development

Other new features/models of a version 5.1*:

selection with a potential relevance for EPN–processing

- GLONASS ambiguity resolution (not for all strategies)
- ADDNEQ2 supports SINEX containing NEQ (instead of COV).
- support of individually calibrated antennas in ANTEX in an automated processing scheme
  (Keywords: RINEX, SINEX)
- troposphere modelling: GMF/GPT, VMF1
- ionosphere modelling: higher order ionosphere correction
- ADDNEQ2: refinemened support for regional networks
  (e.g., repeatability computation with Transformation parameters)
- ORBGEN: Stochastic pulses for orbit fitting
- introducing corrections for atmospheric pressure loading

Time Line to Deliver Version 5.1

- The main developments shall be finished in 2009.
- Define a list of further implementations to finalize a deliverable version.
- Review of the on–line help.
- Update the processing examples.
- Develop and test the installation procedure.
- Update the initial “README”–files.
- Update and complete the user manual.

THANK YOU!