Upcoming features of Bernese GNSS Software, Version 5.4

The BSW-development team

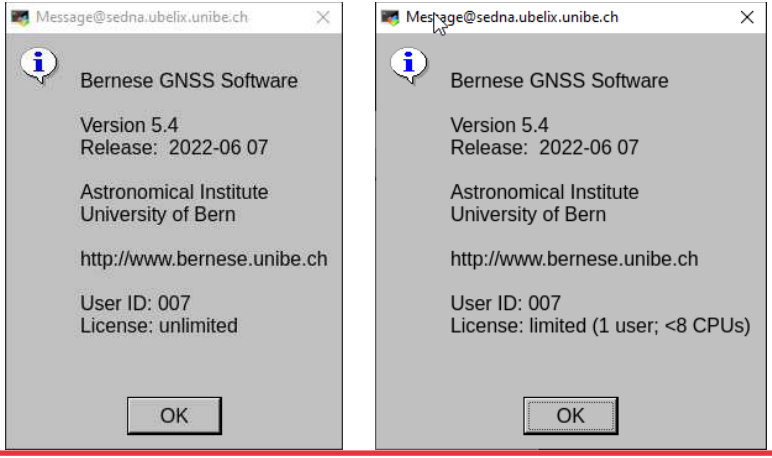
Astronomical Institute, University of Bern, Switzerland

EUREF 2022 Symposium
01.–03. June 2022, Zagreb, Croatia, held online

Installation

Installation procedure remains as it was in version 5.2.

New: the user ID file is required to extend the About box.



Directory structure

BERN	LOADGPS.setvar		
	GLOBAL	**MODEL**	Static models: IERS- and IGS-conventions (prev. in ${X}/GEN)
		CONFIG	Configurations, e.g., satellite information file (prev. in ${X}/GEN)
	SCRIPT	**BPE**	Former ${BPE}-area
		EXE	Former ${X}/EXE-area
	SUPGUI	**PAN**	Former ${X}/PAN-area
		HLP	Former ${X}/HLP-area
		DOC	Former ${X}/DOC-area
	USER	**SCRIPT**	Former ${X}/USERSCPT-area
		OPT	Former ${X}/OPT-area
		PCF	Former ${X}/PCF-area
	SOURCE	**MENU**	
		LIB	**FOR** Sum of former ${I}- and ${LG}-folders
			OBJ_xxx
		PGM	**FOR**
			EXE_xxx

Directory structure

CAMPAIGN

ATM
BPE
GEN

Campaign-specific files from former `${X}/GEN`-area:

- phase center corrections
- observation type selection
- SINEX-/IONEX-header skeletons
- session table

GRD
OBS
...

RINEX tools

- Bernese GNSS Software, version 5.2: based on RINEX 2 also accepting RINEX 3 .

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- Bernese GNSS Software, version 5.4: based on RINEX 3&4 also accepting RINEX 2.

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- All Bernese programs may directly read RINEX 2 or 3&4 file (no need for RNXSMT).
- Unified Bernese internal naming of RINEX files within the campaign area:

  `ZIM200CHE_R_20221300000_01D_30S_MO.rnx` $\Longrightarrow$ `ZIM200CHE_20221300.RXO`

  `ZIM21300.220` $\Longrightarrow$ `ZIM200XYZ_20221300.RXO`

Importing and checking the input orbit data

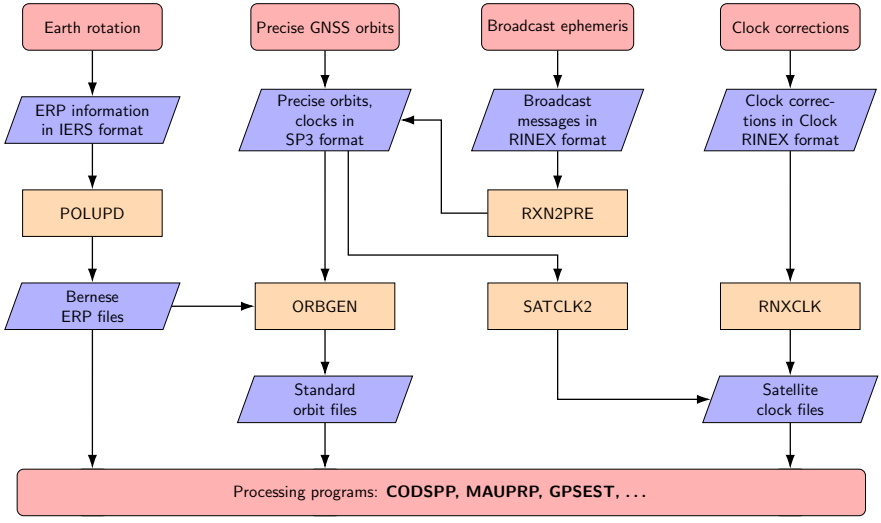
CCRNXN 4.3: Limits for the semi major axis

Semi major axis [m]
  Column 1: GNSS (1 character), empty means all GNSS
  Column 2: Block name for one GNSS (one of the names has to be empty)
  Column 3: Minimal semi major axis [m]
  Column 4: Maximal semi major axis [m]

GNSS	Block	from	to		
G		26d6	27d6	+	−
R		25d6	26d6	+	−
E		29.5d6	30.5d6	+	−
E	Ext	26d6	28d6	+	−
S		41d6	43.1d6	+	−
C		27.5d6	28.5d6	+	−
C	IGSO1	41.5d6	42.5d6	+	−
C	IGSO2	41.5d6	42.5d6	+	−
J		41.5d6	42.5d6	+	−

- Checking navigation messages are system-/satellite group-wise via user panels.

Simplified structure of the orbit programs



More orbit models are included

- ECOM: Beutler et al., 1994; Springer et al., 1999
  Standard model for a long time consisting of 5 empirical SRP parameters
- ECOM2: Arnold et al., 2015
  Current standard model for GNSS satellite orbit consisting of 7 empirical SRP parameters
- ECOM2-D1, ECOM2-YD1: Sidorov et al., 2020
  Extension of the ECOM2 to compensate for the additional radiators of Galileo satellites
- ECOM-TB, ECOM-TBM: Prange et al., 2020
  Empirical SRP-model of satellites in orbit normal mode

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In case of a multi-GNSS solution you may need several of these models since there are individual satellites that may switch from one to another when they are crossing specific beta-angle limits.

Advanced (but simple) orbit model handling

ORBGEN 4: Parameter Selection

DYNAMICAL ORBIT PARAMETERS
Apart from six osculating elements, estimate the following parameters:

Model-specific (default) setup of empirical parameters ☑

Manual selection of parameters and their scaling (for output only):

PAR1	☐	1.0E+7	PAR4	☐	1.0E+7	PAR7	☐	1.0E+7
PAR2	☐	1.0E+7	PAR5	☐	1.0E+7	PAR8	☐	1.0E+7
PAR3	☐	1.0E+7	PAR6	☐	1.0E+7	PAR9	☐	1.0E+7

ADDNEQ2 10.2: Options for Orbital Parameters

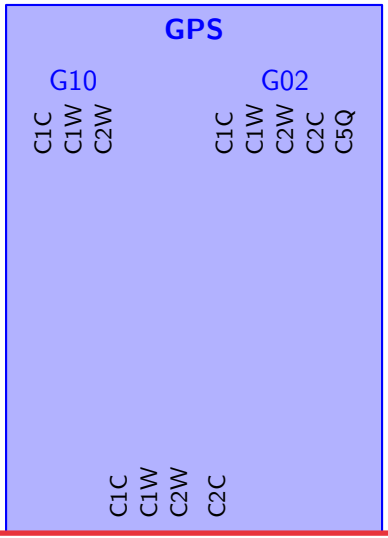
DEFAULT (MODEL-SPECIFIC) CONSTRAINING OF DYNAMICAL PARAMETERS ☑

A PRIORI SIGMAS FOR DYNAMICAL PARAMETERS (in meters/sec**2) Satellite list:

Parameter 1		valid for	ALL		to zero	☐
Parameter 2		valid for	ALL		to zero	☐
Parameter 3		valid for	ALL		to zero	☐

- With one checkbox the default orbit model setup can be established in ORBGEN and relevant processing programs.

Bias handling in a multi-GNSS environment: CLK



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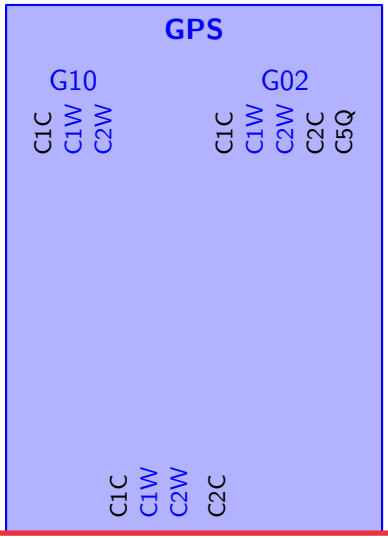

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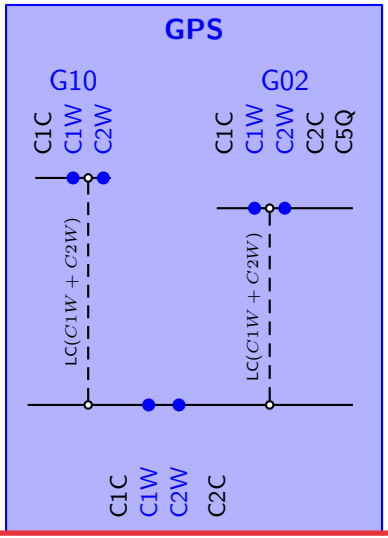

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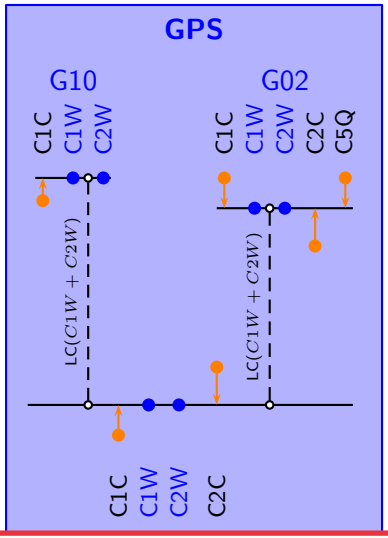

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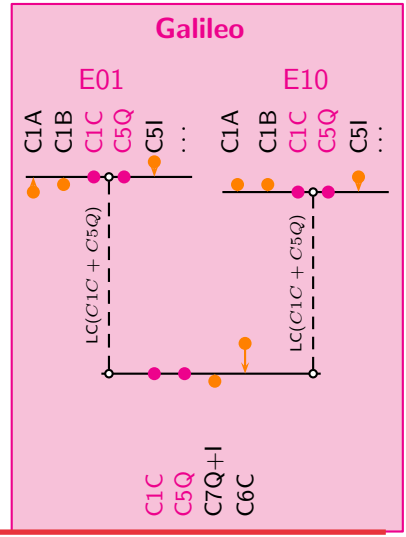

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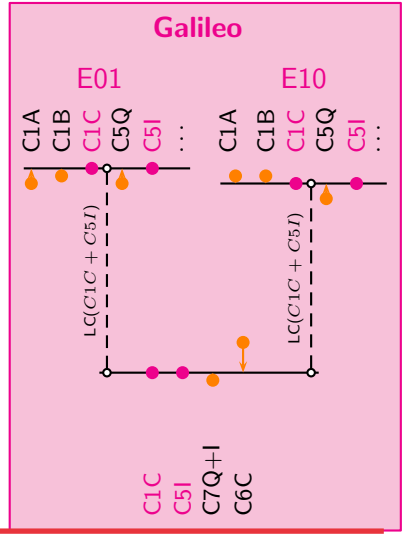

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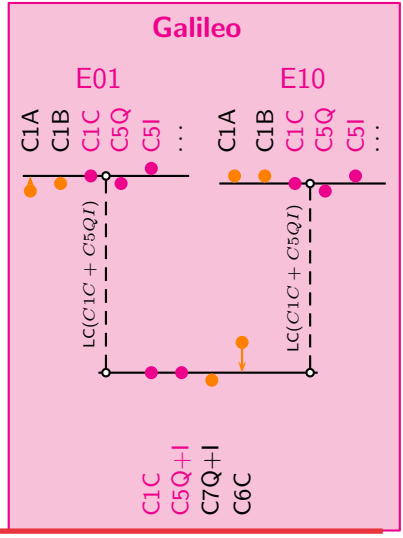
Satellite

Receiver



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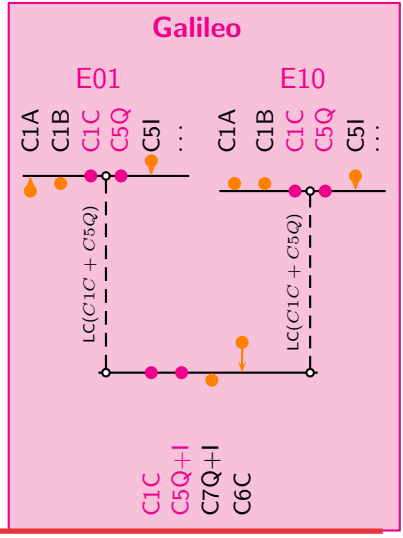

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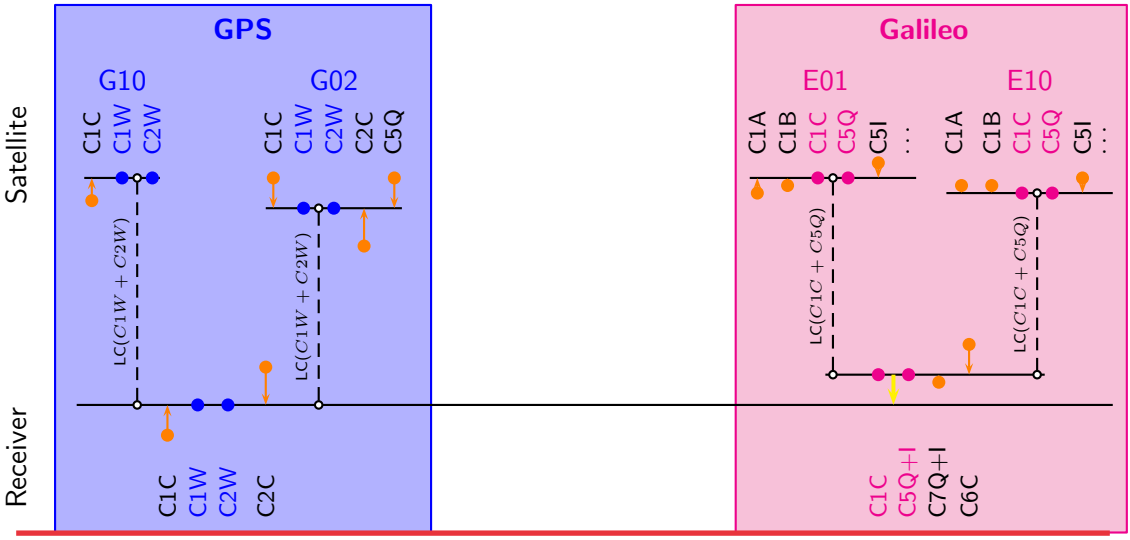

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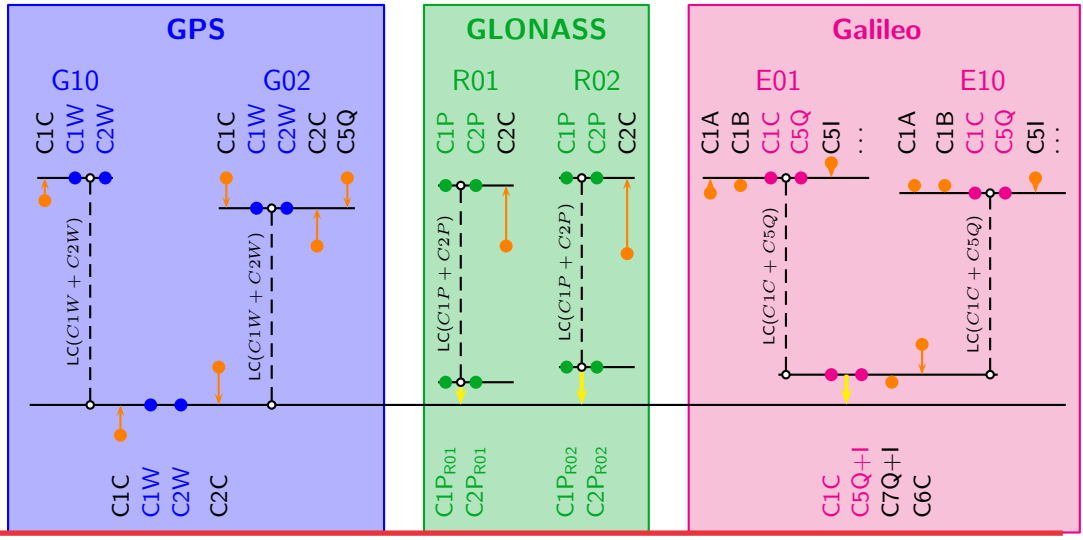

Bias handling in a multi-GNSS environment: code meas.

In the BSW, version 5.4, we have implemented the principle of "pseudo-absolute" Observation-specific signal biases (OSB):

- For each signal type a separate hardware delay (bias) is setup for the receiver and the satellite.
- When processing linear combinations of the original observations each observation contributes to four OSB parameters.
- Before the inversion the necessary constraints are applied according to the signals and linear combinations that have contributed to the biases.

Detailed description in Villiger et al. (2019)

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- When processing linear combinations of the original observations each observation contributes to four OSB parameters.
- Before the inversion the necessary constraints are applied according to the signals and linear combinations that have contributed to the biases.
- The users can directly correct for the biases needed for their observation scenario.

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Bias handling in a multi-GNSS environment: phase meas.

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- The same principle can also be applied to phase observations in the context of ambiguity resolution in a zero-difference network solution.

Detailed description in Schaer et al. (2021); see also
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- The same principle can also be applied to phase observations in the context of ambiguity resolution in a zero-difference network solution.
- The computation of the phase bias parameters together with the optimal ambiguity resolution is quite complex (regarding bookkeeping and consistency).
- The BSW, version 5.4 is capable to resolve ambiguities in a PPP-processing given consistent orbit, satellite clock corrections and phase bias products are provided.

Detailed description in Schaer et al. (2021); see also
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ITRF2020/IGS repro3-related changes

	Support in BSW version	5.2	5.4
Extended PSD model	ITRF 2020	✓[1]	✓
Seasonal station corrections	ITRF 2020	✗	✓

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New antenna corrections from `IGS20.ATX`	IGS 20	✓	✓
Azimuth for antenna not aligned towards north	repro3	✓[2]	✓
Apply antenna corrections for Melbourne/Wübbena-LC[3]	oper. IGS	✗	✓

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High-frequency pole model: Desai and Sibois, 2016	repro3	✓[4]	✓[4]
Mean/secular pole model: IERS convention 2010, v1.2.0	repro3	✗	✓

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[4] exchange `IERS2010XY.SUB` by `DESAI2016.SUB`

Many other model and format updates

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  - JPL-Ephemeris DE421, Ocean tidal loading FES2014b, ...
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Ready to use processing examples

- **PPP**: Standard PPP based on multi-GNSS data with phase ambiguity resolution to obtain coordinate, troposphere, and receiver clock determination. Pseudo-kinematic and high-rate troposphere estimation is prepared and can be enabled
- **RNX2SNX**: Standard double-difference network solution based only on GPS data or a multi-GNSS solution with an extended ambiguity resolution scheme
- **BASTST**: Baseline by baseline processing for trouble shooting
- **CLKDET**: Zero-difference network solution based only on GPS data or a multi-GNSS solution providing clock corrections
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Direct reporting of BPE server variables

```
# ================================================================================
# RNX2SNX.PCF
# ================================================================================

...
VARIABLE   DEFAULT        PARAMETERS
#
# General and model files:
# ------------------------
V_MEANPL = IERS2010;      DESCRIPTION=Mean pole model
V_SUBMOD = IERS2010XY;    DESCRIPTION=Subdaily pole model
V_NUTMOD = IAU2000R06;    DESCRIPTION=Nutation model
V_PCV    = I14;           DESCRIPTION=Absolute/relative PCV model
V_PCVINF = ANTENNA;       DESCRIPTION=PCV information file
V_SATINF = SATELLIT;      DESCRIPTION=Satellite information file
V_SATCRX = SAT_$Y+0;      DESCRIPTION=Satellite problem file
V_ORBDIR = ${D}/COD;      DESCRIPTION=Directory with orbit products
V_ORB    = COD;           DESCRIPTION=Orbit/ERP, CLK, bias information
#
# Reference frame and station related files:
# ------------------------------------------
V_REFDIR = ${D}/REF54;    DESCRIPTION=Directory with basic Bernese files
V_REFINF = IGB14;         DESCRIPTION=Master/reference CRD/VEL filename
V_REFPSD = IGB14;         DESCRIPTION=PSD corrections for ITRF2014
```

Direct reporting of BPE server variables

```
================================================================================
RNX2SNX BPE PROCESSING SUMMARY FOR YEAR-SESSION 2021-0950
================================================================================


Summary file generated at 28-Aug-2021 20:04:18 by R2S_SUM

General and model files:
------------------------
   Mean pole model:                          V_MEANPL = "IERS2010"
   Subdaily pole model:                      V_SUBMOD = "IERS2010XY"
   Nutation model:                           V_NUTMOD = "IAU2000R06"
   Absolute/relative PCV model:              V_PCV    = "I14"
   PCV information file:                     V_PCVINF = "ANTENNA"
   Satellite information file:               V_SATINF = "SATELLIT"
   Satellite problem file:                   V_SATCRX = "SAT_2021"
   Directory with orbit products:            V_ORBDIR = "/home/bern54/DATAPOOL/COD"
   Orbit/ERP, CLK, bias information:         V_ORB    = "COR"

Reference frame and station related files:
------------------------------------------
   Directory with basic Bernese files:       V_REFDIR = "/home/bern54/DATAPOOL/REF54"
   Master/reference CRD/VEL filename:        V_REFINF = "IGB14"
   PSD corrections for ITRF2014:             V_REFPSD = "IGB14"
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- **We hope you will have fun with the new version of the Bernese GNSS Software.**

THANK YOU
for your attention

Publications of the satellite geodesy research group:
`http://www.bernese.unibe.ch/publist`