
Preparation, Analysis and Processing of RINEX v3.x files

Analysis of RINEX observation file

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1 Overview of RX3proc

1.1 General directory structure for (semi-)permanent monitoring

The repository is based on the following directory structure¹ for the binary receiver data:

```

${HOME}/RxTURP
  BEGPiOS
    ASTX
      ...
      19133
      19134
      19135
      ...
    BEGP
      ...
      19133
      19134
      19135
      ...
    P3RS2
      LOG
      pvt_ls

```

where YYDDD represents 2 digits for the year and 3 digits for the day of year.

During processing, in each receiver type directory (ASTX, BEGP, ...) a `rinex` sub-directory is created with sub-directories with the same YYDDD as the original raw binary data sub-directories.

The P3RS2 outputs RINEX observation and navigation files each 15 minutes into a single directory `LOG/pvt_ls` and need to be treated differently. These files uses the following naming convention, loosely based on the official RINEX v3 naming convention:

- **P3RS-2_RX_R_YYYYDOYHHMM_15M_MN.rnx** for the RINEX navigation files,
- **P3RS-2_RX_R_YYYYDOYHHMM_15M_00U_MO.rnx** for the RINEX observation file

where:

- **YYYY** ... 4 digit year number
- **DOY** ... 3 digit day of year number
- **HHMM** ... hour and minutes of file creation

The resulting `::RX3::` formatted daily files are stored under directory `/home/amu1s/RxTURP/BEGPIOS/P3RS2/rinex`.

In this directory the (daily) created files are organised in sub-directories **YYDOY** similar to the structure followed for the other receivers. The `::RX3::` files are stored in Hatanaka compressed form for observation files, while **gzip** compresses the navigation files if compression is selected. As example:

¹This directory structure is suggested for daily continuous measurements, but another directory structure can be applied.

```
[amuls:~/RxTURP/BEGPIOS/P3RS2/rinex/20311] $ ls -l
total 1740
-rw-rw-r-- 1 amuls amuls 12534623 Jan 13 16:43 P3RS00BEL_R_202033000008_01D_01S_M0.crx.Z
-rw-rw-r-- 1 amuls amuls 165168 Jan 13 16:41 P3RS00BEL_R_202033000000_01D_MN.rnx.gz
```

1.2 Purpose

RX3proc provides several python scripts which can be run in stand alone mode or be called from other python scripts. The purpose is to create scripts performing a specific task. Some tasks will be grouped in a more general (super-)script to perform several elementary steps in a row.

1.2.1 Converting (six-)hourly SBF files to (compressed) RINEX v3.x files

Script	Task
sbf_daily.py	Combine (six-)hourly SBF files to daily files
sbf_rinex.py	Convert SBF daily file to RINEX v3.X observation & navigation file
prepare_sbf2rxn.py	Combines above scripts and offers to get compressed RINEX v3.x files

1.2.2 Combining (15 minutes) P3RS2 RINEX files into daily RINEX v3.x files

Script	Task
rxn15_combine.py	Combines 15 minutes RINEX files from P3RS2
prepare_rxn15.py	Uses above script and add possibility for compressed RINEX v3.x files

1.2.3 Converting and analysing RINEX files to observation tabular and statistics files

Script	Task
rxnobs_tabular.py	creates observation statistics/tabular file for selected GNSSs
obsstat_analyse.py	analyses observation statistics file for selected GNSSs
obstab_analyse.py	analyses observation tabular file for selected GNSSs

2 Description of python scripts

2.1 Converting (six-)hourly SBF files to (compressed) RINEX v3.x files

2.1.1 sbf_daily.py

`sbf_daily.py` creates a (daily) SBF file based on ((six) hourly) SBF files found in given directory. This script is oriented towards the continuous logging

Usage

```
[amuls:~/amPython/RX3proc] [RX3proc]$ sbf_daily.py --help
usage: sbf_daily.py [-h] [--dir DIR] [--overwrite] [--logging LOGGING LOGGING]
```

`sbf_daily.py` creates a daily SBF file based on (six) hourly SBF files found in given directory

optional arguments:

<code>-h, --help</code>	show this help message and exit
<code>--dir DIR</code>	Directory of SBF file (defaults to .)
<code>--overwrite</code>	overwrite daily SBF file (default False)
<code>--logging LOGGING LOGGING</code>	specify logging level console/file (default INFO DEBUG)

Example run

```
[amuls:~/amPython/RX3proc] [RX3proc]$ sbf_daily.py --dir ~/RxTURP/BEGPIOS/ASTX/19134/
INFO: sbf_daily.py - main_combine_sbf: working directory is /home/amuls/RxTURP/BEGPIOS/ASTX/19134
INFO: sbf_daily.py - main_combine_sbf: changed to directory /home/amuls/RxTURP/BEGPIOS/ASTX/19134
INFO: sbf_daily.py - main_combine_sbf: combine SBF (six-)hourly files to daily SBF file
INFO: sbf_daily.py - main_combine_sbf: reusing daily SBF file SEPT1340.19_
```

```
[amuls:~/amPython/RX3proc] [RX3proc]$ sbf_daily.py --dir ~/RxTURP/BEGPIOS/ASTX/19134/ --overwrite
INFO: sbf_daily.py - main_combine_sbf: working directory is /home/amuls/RxTURP/BEGPIOS/ASTX/19134
INFO: sbf_daily.py - main_combine_sbf: changed to directory /home/amuls/RxTURP/BEGPIOS/ASTX/19134
INFO: sbf_daily.py - main_combine_sbf: combine SBF (six-)hourly files to daily SBF file
INFO: sbf_daily.py - main_combine_sbf: creating daily SBF file SEPT1340.19_
```

2.1.2 sbf_rinex.py

`sbf_rinex.py` converts a SBF file into RINEX v3.x observation and navigation files. A time span can be specified.

Usage

```
[amuls:~/amPython/RX3proc] [RX3proc]$ sbf_rinex.py --help
usage: sbf_rinex.py [-h] --sbffile SBFFILE [--rxndir RNXDIR] [--startepoch STARTEPOCH] \
    [--endepoch ENDEPOCH] [--logging LOGGING LOGGING]
```

sbf_rinex.py convert binary raw data from SBF to RINEX Obs & Nav files

optional arguments:

```
-h, --help                show this help message and exit
--sbffile SBFFILE         Binary SBF file
--rnxdir RNXDIR           Directory for RINEX output (default .)
--startepoch STARTEPOCH   specify start epoch hh:mm:ss (default 00:00:00)
--endepoch ENDEPOCH       specify end epoch hh:mm:ss (default 23:59:59)
--logging LOGGING LOGGING specify logging level console/file (two of CRITICAL|ERROR|WARNING|INFO|DEBUG|NOTSET, c
```

Example run using all data in the SBF file

```
[amuls:~/amPython/RX3proc] [RX3proc]$ sbf_rinex.py --sbff /home/amuls/RxTURP/BEGPIOS/ASTX/19134/SEPT1340.19_ \
--rnxdir /home/amuls/RxTURP/BEGPIOS/ASTX/rinex/19134
INFO: sbf_rinex.py - sbf2rnx3: arguments processed: dRnx = {'dirs': {'sbf': '/media/amuls/porsche/RxTURP/BEGPIOS/ASTX/19134', 'rnx': PosixPath('/media/amuls/porsche/RxTURP/BEGPIOS/ASTX/rinex/19134')}, 'sbff': '/media/amuls/porsche/RxTURP/BEGPIOS/ASTX/19134/SEPT1340.19_', 'rnxdir': '/media/amuls/porsche/RxTURP/BEGPIOS/ASTX/rinex/19134'}
INFO: sbf_rinex.py - checkValidityArgs: check existence of sbfDir /media/amuls/porsche/RxTURP/BEGPIOS/ASTX/19134
INFO: sbf_rinex.py - checkValidityArgs: check existence of binary file /media/amuls/porsche/RxTURP/BEGPIOS/ASTX/19134/SEPT1340.19_ to convert
INFO: sbf_rinex.py - checkValidityArgs: check existence of rnxdir /media/amuls/porsche/RxTURP/BEGPIOS/ASTX/rinex/19134 and create if needed
INFO: location.py - locateProg: sbf2rin is /opt/Septentrio/RxTools/bin/sbf2rin
INFO: sbf_rinex.py - sbf2rnx3: convert binary file to rinex
INFO: sbf_rinex.py - sbf2rinex: RINEX conversion from SBF binary
INFO: sbf_rinex.py - sbf2rinex: creating RINEX observation file
INFO: amutils.py - run_subprocess_output: running
/opt/Septentrio/RxTools/bin/sbf2rin -f /media/amuls/porsche/RxTURP/BEGPIOS/ASTX/19134/SEPT1340.19_ -x RSCJI -s -D -v -R3 -l -O BEL
Creating RINEX file: done | 0%
INFO: sbf_rinex.py - sbf2rinex: creating RINEX navigation file
INFO: amutils.py - run_subprocess_output: running
/opt/Septentrio/RxTools/bin/sbf2rin -f /media/amuls/porsche/RxTURP/BEGPIOS/ASTX/19134/SEPT1340.19_ -x RSCJI -s -D -v -n P -R3 -l -O BEL
Creating RINEX file: done | 0%
INFO: sbf_rinex.py - sbf2rnx3: dRnx =
{
  "dirs": {
    "sbf": "/media/amuls/porsche/RxTURP/BEGPIOS/ASTX/19134",
    "rnx": "/media/amuls/porsche/RxTURP/BEGPIOS/ASTX/rinex/19134"
  },
  "sbff": "SEPT1340.19_",
  "bin": {
    "SBF2RIN": "/opt/Septentrio/RxTools/bin/sbf2rin"
  },
  "obs3f": "/media/amuls/porsche/RxTURP/BEGPIOS/ASTX/rinex/19134/SEPT00BEL_R_20191340000_01D_01S_M0.rnx",
  "nav3f": "/media/amuls/porsche/RxTURP/BEGPIOS/ASTX/rinex/19134/SEPT00BEL_R_20191340000_01D_MN.rnx"
}
```

Example run using selected data in the SBF file

```
[amuls:~/amPython/RX3proc] [RX3proc]$ sbf_rinex.py --sbff /home/amuls/RxTURP/BEGPIOS/ASTX/19134/SEPT1340.19_ \
--rnxdir /home/amuls/RxTURP/BEGPIOS/ASTX/rinex/19134 --startepoch="07:15:45" --endepoch="10:05:30"
INFO: sbf_rinex.py - main_sbf2rnx3: arguments processed: dRnx = {'dirs': {'sbf': '/media/amuls/porsche/RxTURP/BEGPIOS/ASTX/19134', 'rnx': PosixPath('/media/amuls/porsche/RxTURP/BEGPIOS/ASTX/rinex/19134')}, 'sbff': '/media/amuls/porsche/RxTURP/BEGPIOS/ASTX/19134/SEPT1340.19_', 'rnxdir': '/media/amuls/porsche/RxTURP/BEGPIOS/ASTX/rinex/19134'}
INFO: sbf_rinex.py - checkValidityArgs: check existence of sbfDir /media/amuls/porsche/RxTURP/BEGPIOS/ASTX/19134
INFO: sbf_rinex.py - checkValidityArgs: check existence of binary file /media/amuls/porsche/RxTURP/BEGPIOS/ASTX/19134/SEPT1340.19_ to convert
INFO: sbf_rinex.py - checkValidityArgs: check existence of rnxdir /media/amuls/porsche/RxTURP/BEGPIOS/ASTX/rinex/19134 and create if needed
INFO: location.py - locateProg: sbf2rin is /opt/Septentrio/RxTools/bin/sbf2rin
INFO: sbf_rinex.py - main_sbf2rnx3: convert binary file to rinex
INFO: sbf_rinex.py - sbf2rinex: RINEX conversion from SBF binary
INFO: sbf_rinex.py - sbf2rinex: creating RINEX observation file
INFO: amutils.py - run_subprocess_output: running
/opt/Septentrio/RxTools/bin/sbf2rin -f /media/amuls/porsche/RxTURP/BEGPIOS/ASTX/19134/SEPT1340.19_ -x RSCJI -s -D -v -R3 -l -O BEL -b 07:15:45 -e 10:05:30
Creating RINEX file: done | 0%
INFO: sbf_rinex.py - sbf2rinex: creating RINEX navigation file
INFO: amutils.py - run_subprocess_output: running
/opt/Septentrio/RxTools/bin/sbf2rin -f /media/amuls/porsche/RxTURP/BEGPIOS/ASTX/19134/SEPT1340.19_ -x RSCJI -s -D -v -n P -R3 -l -O BEL
Creating RINEX file: done | 0%
INFO: sbf_rinex.py - sbf2rinex: sorted list (by modification time) of rnx files:
```

```

/media/amuls/porsche/RxTURP/BEGPIOS/ASTX/rinex/19134/SEPT00BEL_R_20191340000_01D_01S_MO.rnx
/media/amuls/porsche/RxTURP/BEGPIOS/ASTX/rinex/19134/SEPT00BEL_R_20191340715_02H_01S_MO.rnx
/media/amuls/porsche/RxTURP/BEGPIOS/ASTX/rinex/19134/SEPT00BEL_R_20191340000_01D_MN.rnx
INFO: sbf_rinex.py - main_sbf2rnx3: dRnx =
{
  "dirs": {
    "sbf": "/media/amuls/porsche/RxTURP/BEGPIOS/ASTX/19134",
    "rnx": "/media/amuls/porsche/RxTURP/BEGPIOS/ASTX/rinex/19134"
  },
  "sbf": "SEPT1340.19_",
  "time": {
    "startepoch": "07:15:45",
    "endepoch": "10:05:30"
  },
  "bin": {
    "SBF2RIN": "/opt/Septentrio/RxTools/bin/sbf2rin"
  },
  "obs3f": "/media/amuls/porsche/RxTURP/BEGPIOS/ASTX/rinex/19134/SEPT00BEL_R_20191340715_02H_01S_MO.rnx",
  "nav3f": "/media/amuls/porsche/RxTURP/BEGPIOS/ASTX/rinex/19134/SEPT00BEL_R_20191340000_01D_MN.rnx"
}

```

2.1.3 prepare_sbf2rnx.py

This script combines the scripts `sbf_daily.py` and `sbf_rinex.py` and offers the possibility to perform compression of these files:

- RINEX observation file undergoes a Hatanaka compression using the program `rnx2crz`,
- RINEX navigation file is `gzip` compressed.

Usage

```

[amuls:~/amPython/RX3proc] [RX3proc]$ prepare_sbf2rnx.py --help
usage: prepare_sbf2rnx.py [-h] [--root_dir ROOT_DIR] --marker MARKER --year YEAR --doy DOY \
    [--startepoch STARTEPOCH] [--endepoch ENDEPOCH] [--rnxdir RNXDIR] [--compress] [--overwrite] \
    [--logging LOGGING LOGGING]

```

`prepare_sbf2rnx.py` Combining and conversion of SBF files to RINEX v3.x Obs/Nav files

optional arguments:

<code>-h, --help</code>	show this help message and exit
<code>--root_dir ROOT_DIR</code>	Root directory of SBF data collection (default /home/amuls/RxTURP/BEGPIOS/)
<code>--marker MARKER</code>	marker name(4 chars)
<code>--year YEAR</code>	Year (4 digits)
<code>--doy DOY</code>	day-of-year [1..366]
<code>--startepoch STARTEPOCH</code>	specify start epoch hh:mm:ss (default 00:00:00)
<code>--endepoch ENDEPOCH</code>	specify end epoch hh:mm:ss (default 23:59:59)
<code>--rnxdir RNXDIR</code>	Directory for RINEX output (default YYDOY subdir)
<code>--compress</code>	compress obtained RINEX files
<code>--overwrite</code>	overwrite daily SBF file (default False)
<code>--logging LOGGING LOGGING</code>	specify logging level console/file (default INFO DEBUG)

Example run

```
[amuls:~/amPython/RX3proc] [RX3proc]$ prepare_sbf2rnx.py --root_dir /media/amuls/porsche/RxTURP/CMT/ \
--marker TURP --year 2021 --doy 89 --compress --rnxdir /media/amuls/porsche/RxTURP/CMT/rnx/
INFO: === prepare_sbf2rnx.py - combine_sbf_files: passing control to sbf_daily.py (options: --dir /media/amuls/porsche/RxTURP/CMT/TURP/21089) ===
INFO: sbf_daily.py - main_combine_sbf: working directory is /media/amuls/porsche/RxTURP/CMT/TURP/21089
INFO: sbf_daily.py - main_combine_sbf: changed to directory /media/amuls/porsche/RxTURP/CMT/TURP/21089
INFO: sbf_daily.py - main_combine_sbf: combine SBF (six-)hourly files to daily SBF file
INFO: sbf_daily.py - main_combine_sbf: reusing daily SBF file TURX0890.21_
INFO: >>>>> prepare_sbf2rnx.py - main_prepare_rnx_data: obtained daily SBF file = TURX0890.21_
INFO: === prepare_sbf2rnx.py - sbf_rnx3: passing control to sbf_rinex.py (options: --sbff /media/amuls/porsche/RxTURP/CMT/TURP/21089/TURX0890.21_
INFO: sbf_rinex.py - main_sbf2rnx3: arguments processed: dRnx = {'dirs': {'sbf': '/media/amuls/porsche/RxTURP/CMT/TURP/21089', 'rnx': PosixPath('/media/amuls/porsche/RxTURP/CMT/TURP/21089')
INFO: sbf_rinex.py - checkValidityArgs: check existence of binary file /media/amuls/porsche/RxTURP/CMT/TURP/21089/TURX0890.21_ to convert
INFO: sbf_rinex.py - checkValidityArgs: check existence of rnxdir /media/amuls/porsche/RxTURP/CMT/rnx and create if needed
INFO: location.py - locateProg: sbf2rin is /opt/Septentrio/RxTools/bin/sbf2rin
INFO: sbf_rinex.py - main_sbf2rnx3: convert binary file to rinex
INFO: sbf_rinex.py - sbf2rinex: RINEX conversion from SBF binary
INFO: sbf_rinex.py - sbf2rinex: creating RINEX observation file
INFO: amutils.py - run_subprocess_output: running
/opt/Septentrio/RxTools/bin/sbf2rin -f /media/amuls/porsche/RxTURP/CMT/TURP/21089/TURX0890.21_ -x RSCJI -s -D -v -R3 -l -O BEL
Creating RINEX file: done
INFO: sbf_rinex.py - sbf2rinex: creating RINEX navigation file
INFO: amutils.py - run_subprocess_output: running
/opt/Septentrio/RxTools/bin/sbf2rin -f /media/amuls/porsche/RxTURP/CMT/TURP/21089/TURX0890.21_ -x RSCJI -s -D -v -n P -R3 -l -O BEL
Creating RINEX file: done
INFO: sbf_rinex.py - sbf2rinex: sorted list (by modification time) of rnx files:
/media/amuls/porsche/RxTURP/CMT/rnx/TURX00BEL_R_20210881014_13H_01S_MO.rnx
/media/amuls/porsche/RxTURP/CMT/rnx/TURX00BEL_R_20210881014_13H_MN.rnx
/media/amuls/porsche/RxTURP/CMT/rnx/TURX00BEL_R_20210890000_13H_01S_MO.rnx
/media/amuls/porsche/RxTURP/CMT/rnx/TURX00BEL_R_20210890000_13H_MN.rnx
INFO: sbf_rinex.py - main_sbf2rnx3: dRnx =
{
  "dirs": {
    "sbf": "/media/amuls/porsche/RxTURP/CMT/TURP/21089",
    "rnx": "/media/amuls/porsche/RxTURP/CMT/rnx"
  },
  "sbff": "TURX0890.21_",
  "time": {
    "startepoch": "00:00:00",
    "endepoch": "23:59:59"
  },
  "bin": {
    "SBF2RIN": "/opt/Septentrio/RxTools/bin/sbf2rin"
  },
  "obs3f": "/media/amuls/porsche/RxTURP/CMT/rnx/TURX00BEL_R_20210890000_13H_01S_MO.rnx",
  "nav3f": "/media/amuls/porsche/RxTURP/CMT/rnx/TURX00BEL_R_20210890000_13H_MN.rnx"
}
INFO: >>>>> prepare_sbf2rnx.py - main_prepare_rnx_data: obtained RINEX observation file = /media/amuls/porsche/RxTURP/CMT/rnx/TURX00BEL_R_20210890000_13H_01S_MO.rnx
INFO: >>>>> prepare_sbf2rnx.py - main_prepare_rnx_data: obtained RINEX navigation files = /media/amuls/porsche/RxTURP/CMT/rnx/TURX00BEL_R_20210890000_13H_MN.rnx
INFO: location.py - locateProg: rnx2crz is /home/amuls/bin/rnx2crz
INFO: location.py - locateProg: gzip is /usr/bin/gzip
INFO: compress_utils.py - compress_rnx_obs: Compressing RINEX observation /media/amuls/porsche/RxTURP/CMT/rnx/TURX00BEL_R_20210890000_13H_01S_MO.rnx
INFO: amutils.py - run_subprocess: running
/home/amuls/bin/rnx2crz -f -d /media/amuls/porsche/RxTURP/CMT/rnx/TURX00BEL_R_20210890000_13H_01S_MO.rnx
INFO: >>>>> prepare_sbf2rnx.py - main_prepare_rnx_data: compressed RINEX observation file = /media/amuls/porsche/RxTURP/CMT/rnx/ASTX02BEL_R_20210890000_13H_01S_MO.rnx
INFO: compress_utils.py - gzip_compress: Compressing RINEX navigation /media/amuls/porsche/RxTURP/CMT/rnx/TURX00BEL_R_20210890000_13H_MN.rnx
INFO: amutils.py - run_subprocess: running
/usr/bin/gzip -f /media/amuls/porsche/RxTURP/CMT/rnx/TURX00BEL_R_20210890000_13H_MN.rnx
INFO: >>>>> prepare_sbf2rnx.py - main_prepare_rnx_data: compressed RINEX navigation file = /media/amuls/porsche/RxTURP/CMT/rnx/ASTX02BEL_R_20210890000_13H_MN.rnx
INFO: prepare_sbf2rnx.py - main_prepare_rnx_data: SBF preparation information =
{
  "dirs": {
    "root": "/media/amuls/porsche/RxTURP/CMT/",
    "sbf": "/media/amuls/porsche/RxTURP/CMT/TURP/21089",
    "rnxdir": "/media/amuls/porsche/RxTURP/CMT/rnx/"
  },
  "cli": {
    "marker": "TURP",
    "yyyy": 2021,
    "doy": 89,
    "startepoch": "00:00:00",
    "endepoch": "23:59:59",
    "compress": true,
    "overwrite": false
  }
}
```



```

    },
    "rnx": {
        "obs3f": "/media/amuls/porsche/RxTURP/CMT/rnx/TURX00BEL_R_20210890000_13H_01S_M0.rnx",
        "nav3f": "/media/amuls/porsche/RxTURP/CMT/rnx/TURX00BEL_R_20210890000_13H_MN.rnx",
        "obs3fc": "/media/amuls/porsche/RxTURP/CMT/rnx/ASTX02BEL_R_20210890600_09H_01S_M0.crx.Z",
        "nav3fc": "/media/amuls/porsche/RxTURP/CMT/rnx/TURX00BEL_R_20210890000_13H_MN.rnx.gz"
    },
    "sbffile": "TURX0890.21_",
    "bin": {
        "rnx2crz": "/home/amuls/bin/rnx2crz",
        "gzip": "/usr/bin/gzip"
    }
}

```

Resulting directory structure

```

[amuls:~/amPython/RX3proc] [RX3proc]$ ls -lht ~/RxTURP/BEGPIOS/ASTX/rinex/19134
total 29M
-rw-rw-r-- 1 amuls amuls 3.1K Feb  4 15:16 prepare_sbf2rnx.log
-rw-rw-r-- 1 amuls amuls 28M Feb  4 15:16 SEPT00BEL_R_20191340000_01D_01S_M0.crx.Z
-rw-rw-r-- 1 amuls amuls 439 Feb  4 15:16 sbf_rinex.json
-rw-rw-r-- 1 amuls amuls 117K Feb  4 15:16 SEPT00BEL_R_20191340000_01D_MN.rnx.gz

[amuls:~/amPython/RX3proc] [RX3proc]$ ls -lht /media/amuls/porsche/RxTURP/CMT/rnx/
total 111M
-rw-rw-r-- 1 amuls amuls 3.2K Apr  2 16:11 prepare_sbf2rnx.log
-rw-rw-r-- 1 amuls amuls 4.1M Apr  2 16:11 TURX00BEL_R_20210890000_13H_01S_M0.crx.Z
-rw-rw-r-- 1 amuls amuls 506 Apr  2 16:11 sbf_rinex.json
-rw-rw-r-- 1 amuls amuls 2.5K Apr  2 16:11 sbf_rinex_py.log
-rw-rw-r-- 1 amuls amuls 79K Apr  2 16:11 TURX00BEL_R_20210890000_13H_MN.rnx.gz
-rw-rw-r-- 1 amuls amuls 355K Apr  2 11:46 TURX00BEL_R_20210881014_13H_MN.rnx
-rw-rw-r-- 1 amuls amuls 53M Apr  2 11:46 TURX00BEL_R_20210881014_13H_01S_M0.rnx
-rw-rw-r-- 1 amuls amuls 4.2M Mar 31 17:04 TURX00BEL_R_20210881014_13H_01S_M0.crx.Z
-rw-rw-r-- 1 amuls amuls 79K Mar 31 17:04 TURX00BEL_R_20210881014_13H_MN.rnx.gz
-rw-rw-r-- 1 amuls amuls 12M Mar 31 16:36 ASTX02BEL_R_20210890600_09H_01S_M0.crx.Z
-rw-rw-r-- 1 amuls amuls 21M Mar 31 16:36 ASTX02BEL_R_20210890000_14H_01S_M0.crx.Z
-rw-rw-r-- 1 amuls amuls 17M Mar 31 16:35 ASTX02BEL_R_20210881200_12H_01S_M0.crx.Z
-rw-rw-r-- 1 amuls amuls 103K Mar 31 16:33 ASTX02BEL_R_20210890000_15H_MP.rnx.gz
-rw-rw-r-- 1 amuls amuls 87K Mar 31 16:33 ASTX02BEL_R_20210881200_12H_MP.rnx.gz

```

2.2 Combining (15 minutes) P3RS2 RINEX files into daily RINEX v3.x files

2.2.1 rnx15_combine.py

`rnx15_combine.py` combines the 15 minutes RINEX files from P3RS2 Rx for a specific day to create observation and navigation files in correct RINEX v3.x format. The P3RS2 files contain errors for the open signals of Galileo and will report these errors and delete them from the obtained RINEX observation file.

Usage

```
[amuls:~/amPython/RX3proc] [RX3proc]$ rnx15_combine.py --help
usage: rnx15_combine.py [-h] [--from_dir FROM_DIR] [--rnx_dir RNX_DIR] --marker MARKER --year YEAR \
      --doy DOY [--startepoch STARTEPOCH] [--endepoch ENDEPOCH] [--crux CRUX] [--logging LOGGING LOGGING]
```

`rnx15_combine.py` combines P3RS2 RINEX observation / navigation files

optional arguments:

```
-h, --help                show this help message and exit
--from_dir FROM_DIR       Directory of P3RS2 RINEX files (default .)
--rnx_dir RNX_DIR         Root directory of P3RS2 RINEX files (default /home/amuls/RxTURP/BEGPIOS/P3RS2/rinex/)
--marker MARKER           marker name (4 chars)
--year YEAR               Year (4 digits)
--doy DOY                 day-of-year [1..366]
--startepoch STARTEPOCH  specify start epoch hh:mm:ss (default 00:00:00)
--endepoch ENDEPOCH       specify end epoch hh:mm:ss (default 23:59:59)
--crux CRUX               CRUX template file for updating RINEX headers (default /home/amuls/amPython/RX3proc/gfzrnx)
--logging LOGGING LOGGING specify logging level console/file (two of CRITICAL|ERROR|WARNING|INFO|DEBUG|NOTSET, c
```

Example run

```
[amuls:~/amPython/RX3proc] [RX3proc]$ rnx15_combine.py --from_dir ~/RxTURP/CHIRPSAWT00TH/P3RS2/ORIGS/ \
      --rnx_dir ~/RxTURP/CHIRPSAWT00TH/rnx/ --year 2020 --doy 349 --marker P3RS \
      --startepoch='14:06:45' --endepoch='14:55:30'
INFO: location.py - locateProg: gfzrnx is /home/amuls/bin/gfzrnx
INFO: location.py - locateProg: rnx2crz is /home/amuls/bin/rnx2crz
INFO: location.py - locateProg: gzip is /usr/bin/gzip
INFO: rnx15_combine.py - list_rinex_files: found 5 RINEX observation files
INFO: rnx15_combine.py - list_rinex_files: found 5 RINEX navigation files
INFO: rnx15_combine.py - create_crux_file: created crux file /tmp/tmpdxx548q3
DEBUG: rnx15_combine.py - check_obstypes_order: P3RS-2_RX_R_20203491354_15M_00U_MO.rnx: ['E 12 C1B L1B D1B S1B C1A L1A D1A S1A C6A L6A D6A S6A
DEBUG: rnx15_combine.py - check_obstypes_order: P3RS-2_RX_R_20203491409_15M_00U_MO.rnx: ['E 12 C1B L1B D1B S1B C1A L1A D1A S1A C6A L6A D6A S6A
DEBUG: rnx15_combine.py - check_obstypes_order: P3RS-2_RX_R_20203491424_15M_00U_MO.rnx: ['E 12 C1B L1B D1B S1B C1A L1A D1A S1A C6A L6A D6A S6A
DEBUG: rnx15_combine.py - check_obstypes_order: P3RS-2_RX_R_20203491439_15M_00U_MO.rnx: ['E 12 C1B L1B D1B S1B C1A L1A D1A S1A C6A L6A D6A S6A
DEBUG: rnx15_combine.py - check_obstypes_order: P3RS-2_RX_R_20203491454_15M_00U_MO.rnx: ['E 12 C1B L1B D1B S1B C1A L1A D1A S1A C6A L6A D6A S6A
DEBUG: rnx15_combine.py - check_obstypes_order: obs types found

      E
0  E  12 C1B L1B D1B S1B C1A L1A D1A S1A C6A L6A...  G  4 C1C L1C D1C S1C  ...
1  E  12 C1B L1B D1B S1B C1A L1A D1A S1A C6A L6A...  G  4 C1C L1C D1C S1C  ...
2  E  12 C1B L1B D1B S1B C1A L1A D1A S1A C6A L6A...  G  4 C1C L1C D1C S1C  ...
3  E  12 C1B L1B D1B S1B C1A L1A D1A S1A C6A L6A...  G  4 C1C L1C D1C S1C  ...
4  E  12 C1B L1B D1B S1B C1A L1A D1A S1A C6A L6A...  G  4 C1C L1C D1C S1C  ...
INFO: rnx15_combine.py - combine_rnx_obs: combined 5 RINEX files into /tmp/P3RS3490.200
INFO: amutils.py - run_subprocess_output: running
/home/amuls/bin/gfzrnx -finp /tmp/P3RS3490.200 -nomren23 04,BEL
```

```
/home/amuls/bin/gfzrn -finp /tmp/P3RS3490.200 -crux /tmp/tmpdpx548q3 -f -fout /home/amuls/RxTURP/CHIRPSAWT00TH/rnx/20349/P3RS04BEL_R_20203490000_
```

```
}  
    "c": {
```

”

```

    "rnx": {
        "date": "2020-12-15",
        "obs3f": "P3RS04BEL_R_20203490000_01D_00U_MO.rnx",
        "nav3f": "SEPT00BEL_R_20203491041_03H_MN.rnx"
    },
    "p3rs2": {
        "obs": [
            "P3RS-2_RX_R_20203491354_15M_00U_MO.rnx",
            "P3RS-2_RX_R_20203491409_15M_00U_MO.rnx",
            "P3RS-2_RX_R_20203491424_15M_00U_MO.rnx",
            "P3RS-2_RX_R_20203491439_15M_00U_MO.rnx",
            "P3RS-2_RX_R_20203491454_15M_00U_MO.rnx"
        ],
        "nav": [
            "P3RS-2_RX_R_20203491340_15M_MN.rnx",
            "P3RS-2_RX_R_20203491355_15M_MN.rnx",
            "P3RS-2_RX_R_20203491410_15M_MN.rnx",
            "P3RS-2_RX_R_20203491425_15M_MN.rnx",
            "P3RS-2_RX_R_20203491440_15M_MN.rnx"
        ]
    }
}

```

2.2.2 prepare_rnx15.py

prepare_rnx15.py calls script rnx15_combine.py and offers possibility to compress the obtained RINEX v3.x observation and navigation files.

Usage

```
[amuls:~/amPython/RX3proc] [RX3proc]$ prepare_rnx15.py --help
```

```
usage: prepare_rnx15.py [-h] [--root_dir ROOT_DIR] [--rnx_dir RNX_DIR] --marker MARKER --year YEAR --doy DOY [--startepoch STARTEPOCH] [--endepoch ENDEPOCH]
```

prepare_rnx15.py Combining partial (15 minutes) RINEX v3.x Obs/Nav files

optional arguments:

```

-h, --help            show this help message and exit
--root_dir ROOT_DIR  Directory of 15 min P3RS2 data collection (default /home/amuls/RxTURP/BEGPIOS/P3RS2/LOG/pvt_ls/)
--rnx_dir RNX_DIR    Root directory of P3RS2 RINEX files (default /home/amuls/RxTURP/BEGPIOS/P3RS2/rinex/)
--marker MARKER      marker name (4 chars)
--year YEAR          Year (4 digits)
--doy DOY            day-of-year [1..366]
--startepoch STARTEPOCH
                    specify start epoch hh:mm:ss (default 00:00:00)
--endepoch ENDEPOCH  specify end epoch hh:mm:ss (default 23:59:59)
--obs_crux OBS_CRUX  CRUX template file for updating RINEX headers (default /home/amuls/amPython/RX3proc/gfzrnx/P3RS2-obs.crux)
--compress           compress obtained RINEX files
--logging LOGGING LOGGING
                    specify logging level console/file (default INFO DEBUG)

```

Example run

```

prepare_sbf2rnx.py --root_dir /media/amuls/porsche/RxTURP/CMT/ --marker TURP --year 2021 --doy 89 --compress --rnx_dir /media/amuls/porsche/RxTURP/
INFO: === prepare_sbf2rnx.py - combine_sbf_files: passing control to sbf_daily.py (options: --dir /media/amuls/porsche/RxTURP/CMT/TURP/21089) ===
INFO: sbf_daily.py - main_combine_sbf: working directory is /media/amuls/porsche/RxTURP/CMT/TURP/21089
INFO: sbf_daily.py - main_combine_sbf: changed to directory /media/amuls/porsche/RxTURP/CMT/TURP/21089
INFO: sbf_daily.py - main_combine_sbf: combine SBF (six-)hourly files to daily SBF file
INFO: sbf_daily.py - main_combine_sbf: reusing daily SBF file TURX0890.21_
INFO: >>>>> prepare_sbf2rnx.py - main_prepare_rnx_data: obtained daily SBF file = TURX0890.21_
INFO: === prepare_sbf2rnx.py - sbf_rnx3: passing control to sbf_rinex.py (options: --sbf /media/amuls/porsche/RxTURP/CMT/TURP/21089/TURX0890.21_
INFO: sbf_rinex.py - main_sbf2rnx3: arguments processed: dRnx = {'dirs': {'sbf': '/media/amuls/porsche/RxTURP/CMT/TURP/21089', 'rnx': PosixPath('/
INFO: sbf_rinex.py - checkValidityArgs: check existence of sbfDir /media/amuls/porsche/RxTURP/CMT/TURP/21089
INFO: sbf_rinex.py - checkValidityArgs: check existence of binary file /media/amuls/porsche/RxTURP/CMT/TURP/21089/TURX0890.21_ to convert
INFO: sbf_rinex.py - checkValidityArgs: check existence of rnx_dir /media/amuls/porsche/RxTURP/CMT/rnx and create if needed

```

```
INFO: location.py - locateProg: sbf2rin is /opt/Septentrio/RxTools/bin/sbf2rin
INFO: sbf_rinex.py - main_sbf2rxn3: convert binary file to rinex
INFO: sbf_rinex.py - sbf2rinex: RINEX conversion from SBF binary
INFO: sbf_rinex.py - sbf2rinex: creating RINEX observation file
INFO: amutils.py - run_subprocess_output: running
/opt/Septentrio/RxTools/bin/sbf2rin -f /media/amuls/porsche/RxTURP/CMT/TURP/21089/TURX0890.21_ -x RSCJI -s -D -v -R3 -l -O BEL
Creating RINEX file: done | 0%
INFO: sbf_rinex.py - sbf2rinex: creating RINEX navigation file
INFO: amutils.py - run_subprocess_output: running
/opt/Septentrio/RxTools/bin/sbf2rin -f /media/amuls/porsche/RxTURP/CMT/TURP/21089/TURX0890.21_ -x RSCJI -s -D -v -n P -R3 -l -O BEL
Creating RINEX file: done | 0%
INFO: sbf_rinex.py - sbf2rinex: sorted list (by modification time) of rxn files:
/media/amuls/porsche/RxTURP/CMT/rnx/TURX00BEL_R_20210881014_13H_01S_MO.rnx
/media/amuls/porsche/RxTURP/CMT/rnx/TURX00BEL_R_20210881014_13H_MN.rnx
/media/amuls/porsche/RxTURP/CMT/rnx/TURX00BEL_R_20210890000_13H_01S_MO.rnx
/media/amuls/porsche/RxTURP/CMT/rnx/TURX00BEL_R_20210890000_13H_MN.rnx
INFO: sbf_rinex.py - main_sbf2rxn3: dRnx =
{
  "dirs": {
    "sbf": "/media/amuls/porsche/RxTURP/CMT/TURP/21089",
    "rxn": "/media/amuls/porsche/RxTURP/CMT/rnx"
  },
  "sbf": "TURX0890.21_",
  "time": {
    "startepoch": "00:00:00",
    "endepoch": "23:59:59"
  },
  "bin": {
    "Sbf2RIN": "/opt/Septentrio/RxTools/bin/sbf2rin"
  },
  "obs3f": "/media/amuls/porsche/RxTURP/CMT/rnx/TURX00BEL_R_20210890000_13H_01S_MO.rnx",
  "nav3f": "/media/amuls/porsche/RxTURP/CMT/rnx/TURX00BEL_R_20210890000_13H_MN.rnx"
}
INFO: >>>>> prepare_sbf2rxn.py - main_prepare_rnx_data: obtained RINEX observation file = /media/amuls/porsche/RxTURP/CMT/rnx/TURX00BEL_R_20210890000_13H_01S_MO.rnx
INFO: >>>>> prepare_sbf2rxn.py - main_prepare_rnx_data: obtained RINEX navigation files = /media/amuls/porsche/RxTURP/CMT/rnx/TURX00BEL_R_20210890000_13H_MN.rnx
INFO: location.py - locateProg: rxn2crz is /home/amuls/bin/rxn2crz
INFO: location.py - locateProg: gzip is /usr/bin/gzip
INFO: compress_utils.py - compress_rnx_obs: Compressing RINEX observation /media/amuls/porsche/RxTURP/CMT/rnx/TURX00BEL_R_20210890000_13H_01S_MO.rnx
INFO: amutils.py - run_subprocess: running
/home/amuls/bin/rxn2crz -f -d /media/amuls/porsche/RxTURP/CMT/rnx/TURX00BEL_R_20210890000_13H_01S_MO.rnx
INFO: >>>>> prepare_sbf2rxn.py - main_prepare_rnx_data: compressed RINEX observation file = /media/amuls/porsche/RxTURP/CMT/rnx/ASTX02BEL_R_20210890000_13H_01S_MO.crz.Z
INFO: compress_utils.py - gzip_compress: Compressing RINEX navigation /media/amuls/porsche/RxTURP/CMT/rnx/TURX00BEL_R_20210890000_13H_MN.rnx
INFO: amutils.py - run_subprocess: running
/usr/bin/gzip -f /media/amuls/porsche/RxTURP/CMT/rnx/TURX00BEL_R_20210890000_13H_MN.rnx
INFO: >>>>> prepare_sbf2rxn.py - main_prepare_rnx_data: compressed RINEX navigation file = /media/amuls/porsche/RxTURP/CMT/rnx/TURX00BEL_R_20210890000_13H_MN.rnx.gz
INFO: prepare_sbf2rxn.py - main_prepare_rnx_data: SBF preparation information =
{
  "dirs": {
    "root": "/media/amuls/porsche/RxTURP/CMT/",
    "sbf": "/media/amuls/porsche/RxTURP/CMT/TURP/21089",
    "rxn": "/media/amuls/porsche/RxTURP/CMT/rnx/"
  },
  "cli": {
    "marker": "TURP",
    "yyyy": 2021,
    "doy": 89,
    "startepoch": "00:00:00",
    "endepoch": "23:59:59",
    "compress": true,
    "overwrite": false
  },
  "rxn": {
    "obs3f": "/media/amuls/porsche/RxTURP/CMT/rnx/TURX00BEL_R_20210890000_13H_01S_MO.rnx",
    "nav3f": "/media/amuls/porsche/RxTURP/CMT/rnx/TURX00BEL_R_20210890000_13H_MN.rnx",
    "obs3fc": "/media/amuls/porsche/RxTURP/CMT/rnx/ASTX02BEL_R_20210890000_09H_01S_MO.crz.Z",
    "nav3fc": "/media/amuls/porsche/RxTURP/CMT/rnx/TURX00BEL_R_20210890000_13H_MN.rnx.gz"
  },
  "sbf": "TURX0890.21_",
  "bin": {
    "rxn2crz": "/home/amuls/bin/rxn2crz",
    "gzip": "/usr/bin/gzip"
  }
}
```

Resulting directory structure Output shown when compress option has been chosen.

```
[amuls:~/amPython/RX3proc] [RX3proc]$ ls -l 20311/
total 1392
-rw-rw-r-- 1 amuls amuls 1218353 Feb  9 14:38 P3RS04BEL_R_20203110000_01D_00U_M0.crx.Z
-rw-rw-r-- 1 amuls amuls   20838 Feb  9 14:38 P3RS04BEL_R_20203110000_01D_MN.rnx.gz
-rw-rw-r-- 1 amuls amuls    2598 Feb  9 14:38 prepare_rnx15.log
-rw-rw-r-- 1 amuls amuls  173172 Feb  9 14:38 rnx15_combine.log
```

2.3 Converting and analysing RINEX files to observation tabular and statistics files

The following scripts convert the RINEX obtained files to a tabular observation file (*.obstab) and an overview of general observation statistics file (obssstat). An analysis based on these files is performed and LaTeX sections are generated.

2.3.1 rnxobs_tabular.py

rnxobs_tabular.py converts the RINEX file to the **statistics** and **tabular** files and creates a summary LaTeX section used for reporting.

Usage

```
[amuls:~/amPython/RX3proc] [RX3proc]$ rnxobs_tabular.py --help
usage: rnxobs_tabular.py [-h] --obsfile OBSFILE [--gnss GNSSES [GNSSES ...]] [--logging LOGGING LOGGING]
```

rnxobs_tabular.py creates observation tabular/statistics file for selected GNSSES

optional arguments:

```
-h, --help            show this help message and exit
--obsfile OBSFILE     RINEX observation file
--gnss GNSSES [GNSSES ...]
                        select (1 or more) GNSS(s) to use (out of E|G, default E)
--logging LOGGING LOGGING
                        specify logging level console/file (two of CRITICAL|ERROR|WARNING|INFO|DEBUG|NOTSET, c
```

Example run

```
[amuls:~/amPython/RX3proc] [RX3proc]$ rnxobs_tabular.py \
--obsfile ~/RxTURP/CHIRPSAWT00TH/rnx/20349/TURX00BEL_R_20203491400_01H_01S_M0.rnx \
--gnss E
INFO: location.py - locateProg: gfzrnx is /home/amuls/bin/gfzrnx
INFO: rnxobs_analysis.py - RX3obs_header_info extracting observation header info \
from TURX00BEL_R_20203491400_01H_01S_M0.rnx
INFO: amutils.py - run_subprocess: running
/home/amuls/bin/gfzrnx -finp TURX00BEL_R_20203491400_01H_01S_M0.rnx \
-fout TURX00BEL_R_20203491400_01H_01S_M0-obs.json \
-meta basic:json -f
INFO: rnxobs_tabular.py - main_rnx_obstab: dGFZ[hdr] =
{
  "data": {
    "epoch": {
      "first": "2020 12 14 14 00 00.0000000",
      "last": "2020 12 14 14 59 59.0000000"
    }
  },
  "file": {
    "duration": "3600",
    "epo_first": "2020 12 14 14 00 00.0000000",
    "epo_first_name": "2020 12 14 14 00 00.0000000",
    "interval": "1.000",
    "md5": "031c398b308f4e4a15dff54ffa5ecbe1",
    "name": "TURX00BEL_R_20203491400_01H_01S_M0.rnx",
    "pgm": "sbf2rin-13.4.5",
    "pgm_date": "20210318 121941 UTC",
    "pgm_runby": "",
```

```

    "satsys": "E",
    "site": "TURX00BEL",
    "source": "R",
    "sysfrq": {
      "E": [
        "1",
        "6"
      ]
    },
    "sysobs": {
      "E": [
        "C1A",
        "C6A",
        "D1A",
        "D6A",
        "L1A",
        "L6A",
        "S1A",
        "S6A"
      ]
    },
    "sysobs_num": {
      "E": 8
    },
    "sysobs_sum": 8,
    "system": "E",
    "systyp": {
      "E": [
        "C",
        "D",
        "L",
        "S"
      ]
    },
    "type": "O",
    "version": "3.04"
  }
}
INFO: rxnobs_tabular.py - main_rnx_obstab: dGFZ =
{
  "info": {
    "obs_date": "14 December 2020",
    "marker": "TURX00BEL",
    "yyyy": 2020,
    "doy": 349
  },
  "cli": {
    "GNSSs": [
      "E"
    ],
    "obsf": "TURX00BEL_R_20203491400_01H_01S_MO.rnx",
    "path": "/home/amuls/RxTURP/CHIRPSAWT00TH/rnx/20349"
  },
  "bin": {
    "gfzrnx": "/home/amuls/bin/gfzrnx"
  },
  "hdr": {
    "data": {
      "epoch": {
        "first": "2020 12 14 14 00 00.0000000",
        "last": "2020 12 14 14 59 59.0000000"
      }
    },
    "file": {
      "duration": "3600",
      "epo_first": "2020 12 14 14 00 00.0000000",
      "epo_first_name": "2020 12 14 14 00 00.0000000",
      "interval": "1.000",
      "md5": "031c398b308f4e4a15dff54ffa5ecbe1",
      "name": "TURX00BEL_R_20203491400_01H_01S_MO.rnx",
      "pgm": "sbf2rin-13.4.5",
      "pgm_date": "20210318 121941 UTC",
      "pgm_runby": ""
    }
  }
}

```



```

"satsys": "E",
"site": "TURX00BEL",
"source": "R",
"sysfrq": {
  "E": [
    "1",
    "6"
  ]
},
"sysobs": {
  "E": [
    "C1A",
    "C6A",
    "D1A",
    "D6A",
    "L1A",
    "L6A",
    "S1A",
    "S6A"
  ]
},
"sysobs_num": {
  "E": 8
},
"sysobs_sum": 8,
"system": "E",
"systyp": {
  "E": [
    "C",
    "D",
    "L",
    "S"
  ]
},
"type": "O",
"version": "3.04"
}
},
"ltx": {
  "path": "/home/amuls/RxTURP/CHIRPSAWTOOTH/rnx/20349/ltx"
},
"obstab": {},
"obshdr": "TURX00BEL_R_20203491400_01H_01S_MO.obshdr"
}
INFO: rnxobs_tabular.py - create_tabular_observations \
      creating observation tabular file TURX00BEL_R_20203491400_01H_01S_MO_E.obstab
INFO: amutils.py - run_subprocess_output: running
/home/amuls/bin/gfzrnx -finp TURX00BEL_R_20203491400_01H_01S_MO.rnx \
      -tab_obs -fout TURX00BEL_R_20203491400_01H_01S_MO_E.obstab \
      -f -tab_sep , -satsys E

proc_out =
DATE/TIME      | C | EPOCH / FILE      | SITE | T | MESSAGE
-----+-----+-----+-----+-----+-----
2021-04-20 16:26:57 | W | 0000-00-00 00:00:00.000 | TURX | 0 | mismatch between header MARKER NAME (TURX) and file/station name (TURX00BEL) / using
INFO: rnxobs_tabular.py - create_tabular_observations creating observation statistics file TURX00BEL_R_20203491400_01H_01S_MO.obsstat
INFO: amutils.py - run_subprocess_output: running
/home/amuls/bin/gfzrnx -finp TURX00BEL_R_20203491400_01H_01S_MO.rnx -stk_obs -fout TURX00BEL_R_20203491400_01H_01S_MO_E.obsstat -f -satsys E
proc_out =
DATE/TIME      | C | EPOCH / FILE      | SITE | T | MESSAGE
-----+-----+-----+-----+-----+-----
2021-04-20 16:26:58 | W | 0000-00-00 00:00:00.000 | TURX | 0 | mismatch between header MARKER NAME (TURX) and file/station name (TURX00BEL) / using
INFO: rnxobs_tabular.py - main_rnx_obstab: Project information =
{
  "info": {
    "obs_date": "14 December 2020",
    "marker": "TURX00BEL",
    "yyyy": 2020,
    "doy": 349
  },
  "cli": {
    "GNSSs": [
      "E"
    ]
  },
}

```

```

    "obsf": "TURX00BEL_R_20203491400_01H_01S_MO.rnx",
    "path": "/home/amuls/RxTURP/CHIRPSAWT00TH/rnx/20349"
  },
  "bin": {
    "gfzrnx": "/home/amuls/bin/gfzrnx"
  },
  "hdr": {
    "data": {
      "epoch": {
        "first": "2020 12 14 14 00 00.0000000",
        "last": "2020 12 14 14 59 59.0000000"
      }
    },
    "file": {
      "duration": "3600",
      "epo_first": "2020 12 14 14 00 00.0000000",
      "epo_first_name": "2020 12 14 14 00 00.0000000",
      "interval": "1.000",
      "md5": "031c398b308f4e4a15dff54ffa5ecbe1",
      "name": "TURX00BEL_R_20203491400_01H_01S_MO.rnx",
      "pgm": "sbf2rin-13.4.5",
      "pgm_date": "20210318 121941 UTC",
      "pgm_runby": "",
      "satsys": "E",
      "site": "TURX00BEL",
      "source": "R",
      "sysfrq": {
        "E": [
          "1",
          "6"
        ]
      },
      "sysobs": {
        "E": [
          "C1A",
          "C6A",
          "D1A",
          "D6A",
          "L1A",
          "L6A",
          "S1A",
          "S6A"
        ]
      },
      "sysobs_num": {
        "E": 8
      },
      "sysobs_sum": 8,
      "system": "E",
      "systyp": {
        "E": [
          "C",
          "D",
          "L",
          "S"
        ]
      },
      "type": "O",
      "version": "3.04"
    }
  },
  "ltx": {
    "path": "/home/amuls/RxTURP/CHIRPSAWT00TH/rnx/20349/ltx",
    "script": "/home/amuls/RxTURP/CHIRPSAWT00TH/rnx/20349/ltx/TURX00BEL_01_E_script_info"
  },
  "obstab": {
    "E": {
      "obs_E_tabf": "TURX00BEL_R_20203491400_01H_01S_MO_E.obstab",
      "obs_E_statf": "TURX00BEL_R_20203491400_01H_01S_MO_E.obsstat"
    }
  },
  "obshdr": "TURX00BEL_R_20203491400_01H_01S_MO.obshdr"
}

```

```
dobstabs = {'E': {'obs_E_tabf': 'TURX00BEL_R_20203491400_01H_01S_MO_E.obstab', 'obs_E_statf': 'TURX00BEL_R_20203491400_01H_01S_MO_E.obsstat'}}
```

Resulting directory structure

```
[amuls:~/amPython/RX3proc] [RX3proc]$ ll -R
.:
total 569628
drwxrwxr-x 2 amuls amuls      4096 Mar  2 14:37 ltx
-rw-rw-r-- 1 amuls amuls      1631 Mar  2 14:10 prepare_sbf2rnx.log
-rw-rw-r-- 1 amuls amuls      9873 Mar  2 14:44 rnxobs_tabular_py.log
-rw-rw-r-- 1 amuls amuls       475 Mar  2 14:10 sbf_rinex.json
-rw-rw-r-- 1 amuls amuls      2075 Mar  2 14:10 sbf_rinex_py.log
-rw-rw-r-- 1 amuls amuls      1537 Mar  2 14:44 SEPT00BEL_R_20191340000_01D_01S_MO_E.obsstat
-rw-rw-r-- 1 amuls amuls 89775895 Mar  2 14:44 SEPT00BEL_R_20191340000_01D_01S_MO_E.obstab
-rw-rw-r-- 1 amuls amuls      3969 Mar  2 14:43 SEPT00BEL_R_20191340000_01D_01S_MO_G.obsstat
-rw-rw-r-- 1 amuls amuls 179788882 Mar  2 14:42 SEPT00BEL_R_20191340000_01D_01S_MO_G.obstab
-rw-rw-r-- 1 amuls amuls      1172 Mar  2 14:41 SEPT00BEL_R_20191340000_01D_01S_MO-obs.json
-rw-rw-r-- 1 amuls amuls 312972740 Mar  2 14:10 SEPT00BEL_R_20191340000_01D_01S_MO.rnx
-rw-rw-r-- 1 amuls amuls      711736 Mar  2 14:10 SEPT00BEL_R_20191340000_01D_MN.rnx
-rw-rw-r-- 1 amuls amuls      97118 Mar  2 16:57 obsstat_analyse_py.log
-rw-rw-r-- 1 amuls amuls       834 Mar  2 16:57 obsstat_analyse.json

./ltx:
total 4
-rw-rw-r-- 1 amuls amuls 1296 Apr 20 16:26 TURX00BEL_01_E_script_info.tex
```

The *.obstab and *.obsstat files are Comma Separated Values (CSV).

Latex section created TURX00BEL_01_E_script_info.tex

```
\subsection{Script details}%
\label{subsec:Scriptdetails}%
\subsubsection{Program information}%
\label{ssubsec:Programinformation}%
\setlength{\tabcolsep}{4pt}%
\begin{longtabu}[l]{rc}
Script&:rnxobs\_tabular.py\\
Run at&:20/04/2021 16:26\\
Run by&:A. Muls\\
&&Royal Military Academy\\
\end{longtabu}

%
\subsubsection{Parameters}%
\label{ssubsec:Parameters}%
\setlength{\tabcolsep}{4pt}%
\begin{longtabu}[l]{rc}
RINEX root directory&:/home/amuls/RxTURP/CHIRPSAWT00TH/rnx/20349\\
RINEX observation file&:TURX00BEL\_R\_20203491400\_01H\_01S\_MO.rnx\\
RINEX version&:3.04\\
Marker&:TURX00BEL\\
Year/day{-}of{-}year&:2020/349\\
```

```
&&\\%
\end{longtabu}

%
\subsubsection{Observation header information}%
\label{ssubsec:Observationheaderinformation}%
\setlength{\tabcolsep}{4pt}%
\begin{longtabu}[l]{rc l}%
First epoch&:2020/12/14 14:00:00\\%
Last epoch&:2020/12/14 14:59:59\\%
Interval&:1.0\\%
&&\\%
GNSS&:E (Galileo) \\%
Frequencies E&:1, 6\\%
&&\\%
Observable types&:S (Pseudorange) \\%
&:C (SNR) \\%
&:D (Doppler) \\%
&:L (Carrier) \\%
&&\\%
\end{longtabu}

%
\subsubsection{Logged observables}%
\label{ssubsec:Loggedobservables}%
\setlength{\tabcolsep}{4pt}%
\begin{longtabu}[l]{rc l}%
Observable types E&:C1A, C6A, D1A, D6A, L1A, L6A, S1A, S6A\\%
&&\\%
\end{longtabu}
```