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# **Preparation, Analysis and Processing of RINEX v3.x files**

## **Analysis of RINEX observation file**

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## Contents

<b>1</b>	<b>Overview of rnxproc</b>	<b>3</b>
1.1	General directory structure for (semi-)permanent monitoring . . . . .	3
1.2	Purpose . . . . .	4
1.2.1	Converting (six-)hourly SBF files to (compressed) RINEX v3.x files . . . . .	4
1.2.2	Combining (15 minutes) P3RS2 RINEX files into daily RINEX v3.x files . . . . .	4
<b>2</b>	<b>Python scripts</b>	<b>5</b>
2.1	Converting (six-)hourly SBF files to (compressed) RINEX v3.x files . . . . .	5
2.1.1	<b>sbfdaily.py</b> . . . . .	5
2.1.2	<b>sbfrinex.py</b> . . . . .	5
2.1.3	<b>prepare_sbf2rnx.py</b> . . . . .	6
2.2	Combining (15 minutes) P3RS2 RINEX files into daily RINEX v3.x files . . . . .	9
2.2.1	<b>rnx15_combine.py</b> . . . . .	9
2.2.2	<b>prepare_rnx15.py</b> . . . . .	12

# 1 Overview of rnxproc

## 1.1 General directory structure for (semi-)permanent monitoring

The repository is based on the following directory structure<sup>1</sup> 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 `rinx` 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 use 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/amu_ls/RxTURP/BEGPIoS/P3RS2/rinx`. 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. As example:

<sup>1</sup>I never tested this repository using another directory structure.

```
[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

rxnproc 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
<b>sbf_daily.py</b>	Combine (six-)hourly SBF files to daily files
<b>sbf_rinex.py</b>	Convert SBF daily file to RINEX v3.X observation & navigation file
<b>prepare_sbf2rxn.py</b>	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
<b>rxn15_combine.py</b>	Combines 15 minutes RINEX files from P3RS2
<b>prepare_rxn15.py</b>	Usage above script and add possibility for compressed RINEX v3.x files

## 2 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

##### Usage

```
[amuls:~/amPython/rnxproc] [rnxproc]$ sbf_daily.py -h
usage: sbf_daily.py [-h] [-d DIR] [-o] [-l LOGGING LOGGING]
```

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

optional arguments:

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

##### Example run

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

```
[amuls:~/amPython/rnxproc] [rnxproc]$ sbf_daily.py -d ~/RxTURP/BEGPIOS/ASTX/19134/
INFO: sbf_daily.py - main: working directory is /home/amuls/RxTURP/BEGPIOS/ASTX/19134
INFO: sbf_daily.py - main: changed to directory /home/amuls/RxTURP/BEGPIOS/ASTX/19134
INFO: sbf_daily.py - main: combine SBF (six-)hourly files to daily SBF file
INFO: sbf_daily.py - main: reusing 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.

##### Usage

```
[amuls:~/amPython/rnxproc] [rnxproc]$ sbf_rinex.py -h
usage: sbf_rinex.py [-h] [-s SBFDIR] -f FILE [-r RNXDIR] [-l 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
-s SBFDIR, --sbfdir SBFDIR
                           SBF directory (default .)
-f FILE, --file FILE      Binary SBF file
-r RNXDIR, --rnxdir RNXDIR
                           Directory for RINEX output (default .)
-l LOGGING LOGGING, --logging LOGGING LOGGING
                           specify logging level console/file (default INFO DEBUG)

```

## Example run

```

[amuls:~/amPython/rnxproc] [rnxproc]$ sbf_rinex.py --sbfdir /home/amuls/RxTURP/BEGPIOS/ASTX/19134 \
--file SEPT1340.19_ --rnxdir /home/amuls/RxTURP/BEGPIOS/ASTX/rinex/19134
INFO: sbf_rinex.py - sbf2rnx3: arguments processed: dRnx = \
{'dirs': \
 {'sbf': '/home/amuls/RxTURP/BEGPIOS/ASTX/19134', \
  'rnx': '/home/amuls/RxTURP/BEGPIOS/ASTX/rinex/19134'}, \
 'sbff': 'SEPT1340.19_'}
INFO: sbf_rinex.py - checkValidityArgs: check existence of sbfDir /home/amuls/RxTURP/BEGPIOS/ASTX/19134
INFO: sbf_rinex.py - checkValidityArgs: check existence of binary file /home/amuls/RxTURP/BEGPIOS/ASTX/19134/SEPT1340.19_ \
to convert
INFO: sbf_rinex.py - checkValidityArgs: check existence of rnxdir /home/amuls/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 /home/amuls/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 /home/amuls/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": "/home/amuls/RxTURP/BEGPIOS/ASTX/19134",
    "rnx": "/home/amuls/RxTURP/BEGPIOS/ASTX/rinex/19134"
  },
  "sbff": "SEPT1340.19_",
  "bin": {
    "SBF2RIN": "/opt/Septentrio/RxTools/bin/sbf2rin"
  },
  "obs3f": "/home/amuls/RxTURP/BEGPIOS/ASTX/rinex/19134/SEPT00BEL_R_20191340000_01D_01S_MO.rnx",
  "nav3f": "/home/amuls/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/rnxproc] [rnxproc]$ prepare_sbf2rnx.py -h
usage: prepare_sbf2rnx.py [-h] [-r ROOT_DIR] -m MARKER -y YEAR -d DOY [-c] [-o] [-l LOGGING LOGGING]
```

prepare\_sbf2rnx.py Combining and conversion of SBF files to RINEX v3.x Obs/Nav files

optional arguments:

```
-h, --help                show this help message and exit
-r ROOT_DIR, --root_dir ROOT_DIR
                        Root directory of SBF data collection (default /home/amuls/RxTURP/BEGPIOS/)
-m MARKER, --marker MARKER
                        marker name (4 chars)
-y YEAR, --year YEAR     Year (4 digits)
-d DOY, --doy DOY       day-of-year [1..366]
-c, --compress           compress obtained RINEX files
-o, --overwrite         overwrite daily SBF file (default False)
-l LOGGING LOGGING, --logging LOGGING LOGGING
                        specify logging level console/file (default INFO DEBUG)
```

## Example run

```
[amuls:~/amPython/rnxproc] [rnxproc]$ prepare_sbf2rnx.py -m ASTX -y 2019 -d 134 -c
INFO: === prepare_sbf2rnx.py - combine_sbf: passing control to sbf_daily.py (options: --dir /home/amuls/RxTURP/BEGPIOS/ASTX/19134) ===
INFO: sbf_daily.py - combine_sbf: working directory is /home/amuls/RxTURP/BEGPIOS/ASTX/19134
INFO: sbf_daily.py - combine_sbf: changed to directory /home/amuls/RxTURP/BEGPIOS/ASTX/19134
INFO: sbf_daily.py - combine_sbf: combine SBF (six-)hourly files to daily SBF file
INFO: sbf_daily.py - combine_sbf: reusing daily SBF file SEPT1340.19_
INFO: >>>>> prepare_sbf2rnx.py - process_data: obtained daily SBF file = SEPT1340.19_
INFO: === prepare_sbf2rnx.py - sbf_rnx3: passing control to sbf_rinex.py (options: --sbfdir /home/amuls/RxTURP/BEGPIOS/ASTX/19134 --file SEPT1340.19_
INFO: sbf_rinex.py - sbf2rnx3: arguments processed: dRnx = {'dirs': {'sbf': '/home/amuls/RxTURP/BEGPIOS/ASTX/19134', 'rnx': '/home/amuls/RxTURP/BEGPIOS/ASTX/19134'}, 'sbf': '/home/amuls/RxTURP/BEGPIOS/ASTX/19134', 'rnx': '/home/amuls/RxTURP/BEGPIOS/ASTX/19134'}
INFO: sbf_rinex.py - checkValidityArgs: check existence of sbfDir /home/amuls/RxTURP/BEGPIOS/ASTX/19134
INFO: sbf_rinex.py - checkValidityArgs: check existence of binary file /home/amuls/RxTURP/BEGPIOS/ASTX/19134/SEPT1340.19_ to convert
INFO: sbf_rinex.py - checkValidityArgs: check existence of rnxdir /home/amuls/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 /home/amuls/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 /home/amuls/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": "/home/amuls/RxTURP/BEGPIOS/ASTX/19134",
    "rnx": "/home/amuls/RxTURP/BEGPIOS/ASTX/rinex/19134"
  },
  "sbf": "SEPT1340.19_",
  "bin": {
    "SBF2RIN": "/opt/Septentrio/RxTools/bin/sbf2rin"
  },
  "obs3f": "/home/amuls/RxTURP/BEGPIOS/ASTX/rinex/19134/SEPT00BEL_R_20191340000_01D_01S_MO.rnx",
  "nav3f": "/home/amuls/RxTURP/BEGPIOS/ASTX/rinex/19134/SEPT00BEL_R_20191340000_01D_MN.rnx"
}
INFO: >>>>> prepare_sbf2rnx.py - process_data: obtained RINEX observation file \
= /home/amuls/RxTURP/BEGPIOS/ASTX/rinex/19134/SEPT00BEL_R_20191340000_01D_01S_MO.rnx
INFO: >>>>> prepare_sbf2rnx.py - process_data: obtained RINEX navigation files \
= /home/amuls/RxTURP/BEGPIOS/ASTX/rinex/19134/SEPT00BEL_R_20191340000_01D_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 /home/amuls/RxTURP/BEGPIOS/ASTX/rinex/19134/SEPT00BEL_R_20191340000_01D_01S_MO.rnx
INFO: amutils.py - run_subprocess: running
/home/amuls/bin/rnx2crz -f -d /home/amuls/RxTURP/BEGPIOS/ASTX/rinex/19134/SEPT00BEL_R_20191340000_01D_01S_MO.rnx
INFO: >>>>> prepare_sbf2rnx.py - process_data: compressed RINEX observation file \
```

```

    = /home/amuls/RxTURP/BEGPIOS/ASTX/rinex/19134/SEPT00BEL_R_20191340000_01D_01S_MO.crx.Z
INFO: compress_utils.py - gzip_compress: Compressing RINEX navigation /home/amuls/RxTURP/BEGPIOS/ASTX/rinex/19134/SEPT00BEL_R_20191340000_01D_MN.rnx
INFO: amutils.py - run_subprocess: running
/usr/bin/gzip -f /home/amuls/RxTURP/BEGPIOS/ASTX/rinex/19134/SEPT00BEL_R_20191340000_01D_MN.rnx
INFO: >>>>> prepare_sbf2rnx.py - process_data: compressed RINEX navigation file \
    = /home/amuls/RxTURP/BEGPIOS/ASTX/rinex/19134/SEPT00BEL_R_20191340000_01D_MN.rnx.gz
INFO: prepare_sbf2rnx.py - process_data: SBF preparation information =
{
  "dirs": {
    "root": "/home/amuls/RxTURP/BEGPIOS/",
    "sbf": "/home/amuls/RxTURP/BEGPIOS/ASTX/19134",
    "rnx": "/home/amuls/RxTURP/BEGPIOS/ASTX/rinex/19134"
  },
  "cli": {
    "marker": "ASTX",
    "yyyy": 2019,
    "doy": 134,
    "compress": true,
    "overwrite": false
  },
  "rnx": {
    "obs3f": "/home/amuls/RxTURP/BEGPIOS/ASTX/rinex/19134/SEPT00BEL_R_20191340000_01D_01S_MO.rnx",
    "nav3f": "/home/amuls/RxTURP/BEGPIOS/ASTX/rinex/19134/SEPT00BEL_R_20191340000_01D_MN.rnx",
    "obs3fc": "/home/amuls/RxTURP/BEGPIOS/ASTX/rinex/19134/SEPT00BEL_R_20191340000_01D_01S_MO.crx.Z",
    "nav3fc": "/home/amuls/RxTURP/BEGPIOS/ASTX/rinex/19134/SEPT00BEL_R_20191340000_01D_MN.rnx.gz"
  },
  "sbffile": "SEPT1340.19_",
  "bin": {
    "rnx2crz": "/home/amuls/bin/rnx2crz",
    "gzip": "/usr/bin/gzip"
  }
}

```

## Resulting directory structure

```

[amuls:~/amPython/rnxproc] [rnxproc]$ 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_MO.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

```



## 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.

#### Usage

```
[amuls:~/amPython/rnxproc] [rnxproc]$ rnx15_combine.py -h
usage: rnx15_combine.py [-h] [-f FROM_DIR] [-r RNX_DIR] -m MARKER -y YEAR -d DOY \
                        [-c CRUX] [-l LOGGING LOGGING]
```

rnx15\_combine.py combines P3RS2 RINEX observation / navigation files

optional arguments:

```
-h, --help            show this help message and exit
-f FROM_DIR, --from_dir FROM_DIR
                        Directory of P3RS2 RINEX files (default .)
-r RNX_DIR, --rnx_dir RNX_DIR
                        Root directory of P3RS2 RINEX files \
                        (default /home/amuls/RxTURP/BEGPIOS/P3RS2/rinex/)
-m MARKER, --marker MARKER
                        marker name (4 chars)
-y YEAR, --year YEAR  Year (4 digits)
-d DOY, --doy DOY     day-of-year [1..366]
-c CRUX, --crux CRUX  CRUX template file for updating RINEX headers \
                        (default ~/amPython/rnxproc/p3rs2-obs.crux)
-l LOGGING LOGGING, --logging LOGGING LOGGING
                        specify logging level console/file (two of CRITICAL|ERROR|WARNING|INFO|DEBUG|NOTSET, \
                        default INFO DEBUG)
```

#### Example run

```
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 13 RINEX observation files
INFO: rnx15_combine.py - list_rinex_files: found 13 RINEX navigation files
INFO: rnx15_combine.py - create_crux_file: created crux file /tmp/tmpqe15s1w9
DEBUG: rnx15_combine.py - check_obstypes_order: P3RS-2_RX_R_20203110910_15M_00U_MO.rnx: \
    ['E  12 C1B L1B D1B S1B C1A L1A D1A S1A C6A L6A D6A S6A      SYS / # / OBS TYPES\n', \
    'G   4 C1C L1C D1C S1C      SYS / # / OBS TYPES\n']
DEBUG: rnx15_combine.py - check_obstypes_order: P3RS-2_RX_R_20203110925_15M_00U_MO.rnx: \
    ['E  12 C1B L1B D1B S1B C1A L1A D1A S1A C6A L6A D6A S6A      SYS / # / OBS TYPES\n', \
    'G   4 C1C L1C D1C S1C      SYS / # / OBS TYPES\n']
DEBUG: rnx15_combine.py - check_obstypes_order: P3RS-2_RX_R_20203111019_15M_00U_MO.rnx: \
    ['E  12 C1B L1B D1B S1B C1A L1A D1A S1A C6A L6A D6A S6A      SYS / # / OBS TYPES\n', \
    'G   4 C1C L1C D1C S1C      SYS / # / OBS TYPES\n']
DEBUG: rnx15_combine.py - check_obstypes_order: P3RS-2_RX_R_20203111034_15M_00U_MO.rnx: \
    ['E  12 C1B L1B D1B S1B C1A L1A D1A S1A C6A L6A D6A S6A      SYS / # / OBS TYPES\n', \
    'G   4 C1C L1C D1C S1C      SYS / # / OBS TYPES\n']
DEBUG: rnx15_combine.py - check_obstypes_order: P3RS-2_RX_R_20203111049_15M_00U_MO.rnx: \
    ['E  12 C1B L1B D1B S1B C1A L1A D1A S1A C6A L6A D6A S6A      SYS / # / OBS TYPES\n', \
    'G   4 C1C L1C D1C S1C      SYS / # / OBS TYPES\n']
DEBUG: rnx15_combine.py - check_obstypes_order: P3RS-2_RX_R_20203111104_15M_00U_MO.rnx: \
    ['E  12 C1B L1B D1B S1B C1A L1A D1A S1A C6A L6A D6A S6A      SYS / # / OBS TYPES\n', \
```

```

'G      4 C1C L1C D1C S1C                                SYS / # / OBS TYPES\n'
DEBUG: rxn15_combine.py - check_obstypes_order: P3RS-2_RX_R_20203111119_15M_00U_M0.rnx: \
['E      12 C1B L1B D1B S1B C1A L1A D1A S1A C6A L6A D6A S6A    SYS / # / OBS TYPES\n', \
'G      4 C1C L1C D1C S1C                                SYS / # / OBS TYPES\n'
DEBUG: rxn15_combine.py - check_obstypes_order: P3RS-2_RX_R_20203111134_15M_00U_M0.rnx: \
['E      12 C1B L1B D1B S1B C1A L1A D1A S1A C6A L6A D6A S6A    SYS / # / OBS TYPES\n', \
'G      4 C1C L1C D1C S1C                                SYS / # / OBS TYPES\n'
DEBUG: rxn15_combine.py - check_obstypes_order: P3RS-2_RX_R_20203111149_15M_00U_M0.rnx: \
['E      12 C1B L1B D1B S1B C1A L1A D1A S1A C6A L6A D6A S6A    SYS / # / OBS TYPES\n', \
'G      4 C1C L1C D1C S1C                                SYS / # / OBS TYPES\n'
DEBUG: rxn15_combine.py - check_obstypes_order: P3RS-2_RX_R_20203111207_15M_00U_M0.rnx: \
['E      12 C1B L1B D1B S1B C1A L1A D1A S1A C6A L6A D6A S6A    SYS / # / OBS TYPES\n', \
'G      4 C1C L1C D1C S1C                                SYS / # / OBS TYPES\n'
DEBUG: rxn15_combine.py - check_obstypes_order: P3RS-2_RX_R_20203111222_15M_00U_M0.rnx: \
['E      12 C1B L1B D1B S1B C1A L1A D1A S1A C6A L6A D6A S6A    SYS / # / OBS TYPES\n', \
'G      4 C1C L1C D1C S1C                                SYS / # / OBS TYPES\n'
DEBUG: rxn15_combine.py - check_obstypes_order: P3RS-2_RX_R_20203111309_15M_00U_M0.rnx: \
['E      12 C1B L1B D1B S1B C1A L1A D1A S1A C6A L6A D6A S6A    SYS / # / OBS TYPES\n', \
'G      4 C1C L1C D1C S1C                                SYS / # / OBS TYPES\n'
DEBUG: rxn15_combine.py - check_obstypes_order: P3RS-2_RX_R_20203111324_15M_00U_M0.rnx: \
['E      12 C1B L1B D1B S1B C1A L1A D1A S1A C6A L6A D6A S6A    SYS / # / OBS TYPES\n', \
'G      4 C1C L1C D1C S1C                                SYS / # / OBS TYPES\n'
DEBUG: rxn15_combine.py - check_obstypes_order: obs types found

```

DEBUG: rxn15_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	...
5	E	12	C1B	L1B	D1B	S1B	C1A	L1A	D1A	S1A	C6A	L6A...	G	4	C1C	L1C	D1C	S1C	...
6	E	12	C1B	L1B	D1B	S1B	C1A	L1A	D1A	S1A	C6A	L6A...	G	4	C1C	L1C	D1C	S1C	...
7	E	12	C1B	L1B	D1B	S1B	C1A	L1A	D1A	S1A	C6A	L6A...	G	4	C1C	L1C	D1C	S1C	...
8	E	12	C1B	L1B	D1B	S1B	C1A	L1A	D1A	S1A	C6A	L6A...	G	4	C1C	L1C	D1C	S1C	...
9	E	12	C1B	L1B	D1B	S1B	C1A	L1A	D1A	S1A	C6A	L6A...	G	4	C1C	L1C	D1C	S1C	...
10	E	12	C1B	L1B	D1B	S1B	C1A	L1A	D1A	S1A	C6A	L6A...	G	4	C1C	L1C	D1C	S1C	...
11	E	12	C1B	L1B	D1B	S1B	C1A	L1A	D1A	S1A	C6A	L6A...	G	4	C1C	L1C	D1C	S1C	...
12	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 13 RINEX files into /tmp/P3RS3110.200
```

```
INFO: amutils.py - run_subprocess_output: running
```

```
/home/amuls/bin/gfzrx -finp /tmp/P3RS3110.200 -nomren23 04,BEL
```

```
INFO: rnx15_combine.py - convert_obsrnx3: adjusting RINEX header for P3RS3110.200
```

```
INFO: amutils.py - run_subprocess_output: running
```

```
/home/amuls/bin/gfzrnz -finp /tmp/P3RS3110.200 -crux /tmp/tmpqei5s1w9 -f \
```

```
-fout /home/amuls/RxTURP/BEGPIOS/P3RS2/rinex/20311/P3RS04BEL_R_20203110000_01D_00U_MO.rnx
```

```
INFO: process output = DATE/TIME | C | EPOCH / FILE | SITE | T | MESSAGE
```

DATE	TIME	PROCESS	STATUS	DATA	FILE	TYPE	MESSAGE
2021-02-09	14:28:25	W	0000-00-00 00:00:00.000	P3RS	0	CRUX: (STRING) repair line >rnx_writer-1.0.0	P3RS-2 Receiver 20201106 091001
2021-02-09	14:28:25	W	0000-00-00 00:00:00.000	P3RS	0	no MARKER NAME in header / taken from file name	
2021-02-09	14:28:25	W	0000-00-00 00:00:00.000	P3RS	0	mismatch between header MARKER NAME () and file/station name (P3RS) / using >P3RS<	
2021-02-09	14:28:25	W	0000-00-00 00:00:00.000	P3RS	0	CRUX: skip >G	SYS / PHASE
2021-02-09	14:28:25	W	0000-00-00 00:00:00.000	P3RS	0	CRUX: skip > 0	GLONASS SLO
2021-02-09	14:28:25	N	0000-00-00 00:00:00.000	P3RS	0	update of head label >ANT # / TYPE< idx. 0 -> >BEANT<	
2021-02-09	14:28:25	N	0000-00-00 00:00:00.000	P3RS	0	update of head label >ANT # / TYPE< idx. 1 -> >NAVXPRIENCE<	
2021-02-09	14:28:25	N	0000-00-00 00:00:00.000	P3RS	0	update of head label >APPROX POSITION XYZ< idx. 0 -> >4023741.3045<	
2021-02-09	14:28:25	N	0000-00-00 00:00:00.000	P3RS	0	update of head label >APPROX POSITION XYZ< idx. 1 -> >309110.4584<	
2021-02-09	14:28:25	N	0000-00-00 00:00:00.000	P3RS	0	update of head label >APPROX POSITION XYZ< idx. 2 -> >4922723.1945<	
2021-02-09	14:28:25	N	0000-00-00 00:00:00.000	P3RS	0	update of head label >COMMENT< idx. 0 -> >HEADER CHANGED BY RMA-CISS<	
2021-02-09	14:28:25	N	0000-00-00 00:00:00.000	P3RS	0	update of head label >MARKER NAME< idx. 0 -> >P3RS04BEL<	
2021-02-09	14:28:25	N	0000-00-00 00:00:00.000	P3RS	0	update of head label >MARKER NUMBER< idx. 0 -> >0004<	
2021-02-09	14:28:25	N	0000-00-00 00:00:00.000	P3RS	0	update of head label >MARKER TYPE< idx. 0 -> >P3RS04BEL<	
2021-02-09	14:28:25	N	0000-00-00 00:00:00.000	P3RS	0	update of head label >OBSERVER / AGENCY< idx. 0 -> >CISS<	
2021-02-09	14:28:25	N	0000-00-00 00:00:00.000	P3RS	0	update of head label >OBSERVER / AGENCY< idx. 1 -> >RMA-BEL<	
2021-02-09	14:28:25	N	0000-00-00 00:00:00.000	P3RS	0	update of head label >REC # / TYPE / VERS< idx. 0 -> >BEP3RS2<	
2021-02-09	14:28:25	N	0000-00-00 00:00:00.000	P3RS	0	update of head label >REC # / TYPE / VERS< idx. 1 -> >P3RS2<	
2021-02-09	14:28:25	N	0000-00-00 00:00:00.000	P3RS	0	update of head label >REC # / TYPE / VERS< idx. 2 -> >001<	
2021-02-09	14:28:25	W	0000-00-00 00:00:00.000	P3RS	0	header SYS / PHASE SHIFT: missing	
2021-02-09	14:28:25	W	0000-00-00 00:00:00.000	P3RS	0	header SYS / PHASE SHIFT: E -> L1A not found	
2021-02-09	14:28:25	W	0000-00-00 00:00:00.000	P3RS	0	header SYS / PHASE SHIFT: E -> L1B not found	
2021-02-09	14:28:25	W	0000-00-00 00:00:00.000	P3RS	0	header SYS / PHASE SHIFT: E -> L6A not found	
2021-02-09	14:28:25	W	0000-00-00 00:00:00.000	P3RS	0	header SYS / PHASE SHIFT: G -> L1C not found	

```
INFO: rnx15_combine.py - combine_rnx_obs: combined 13 RINEX files into /tmp/P3RS3110.20M
```

```
INFO: rnx15_combine.py - combine_rnx_combine: combine_rnx_combine: adjusting RINEX files: files / tmp / P3RS3
INFO: rnx15_combine.py - convert_navrx3: adjusting RINEX header for P3RS3110.20M
```

```
INFO: amutils.py - run subprocess output: running
```

```
INFO:      process output = DATE/TIME          | C | EPOCH / FILE          | SITE | T | MESSAGE
```

2021-02-09 14:28:30	W	0000-00-00 00:00:00.000	P3RS	N	CRUX: (STRING) repair line >rxn_writer-1.0.0	P3RS-2 Receiver	20201106 091004
---------------------	---	-------------------------	------	---	--	-----------------	-----------------

2021-02-09 14:28:30	W	0000-00-00 00:00:00.000	P3RS	N	SKIP of EPOCH: not valid >2020 11 40 14 50 00.00000000<
---------------------	---	-------------------------	------	---	---

2021-02-09 14:28:30	W	2020-11-06 09:00:00.000	P3RS	N	wrong nav. value >4.756587184875e-234<
---------------------	---	-------------------------	------	---	--

```
2021-02-09 14:28:30 | W | 2020-11-06 09:00:00.000 | P3RS | N | SKIP of EPOCH: not valid >2020 11 60 80 50 00.00000000<
```

2021-02-09 14:28:30	W	2020-11-06 08:50:00.000	P3RS	N	wrong nav. value >1.375831935030e-233<
---------------------	---	-------------------------	------	---	--

```
2021-02-09 14:28:30 | W | 2020-11-06 09:00:00.000 | P3RS | N | wrong nav. value >1.375831935030e-233<
```

2021-02-09 14:28:30	W	2020-11-06 08:50:00.000	P3RS	N	wrong nav. value >1.375831935030e-233<
---------------------	---	-------------------------	------	---	--

```
2021-02-09 14:28:35 | W | 2020-11-06 11:30:00.000 | P3RS | N | wrong nav. value >8.176072524854e-233<
```

```
2021-02-09 14:28:35 | W | 2020-11-06 11:30:00.000 | P3RS | N | SKIP of 202 records via input (EPOCH CHECK)
```

```
INFO: rnx15_combine.py - combine_rnx15: Project information =
```

```
{
  "cli": {
    "from_dir": "/home/amuls/RxTURP/BEGPIOS/P3RS2/LOG/pvt_ls/",
    "rxn_dir": "/home/amuls/RxTURP/BEGPIOS/P3RS2/rinex/",
    "marker": "P3RS",
    "year": 2020,
    "doy": 311,
    "crux": "/home/amuls/amPython/rnxproc/p3rs2-obs.crux"
  }
}
```

```
},
"dirs": {
  "rinex": "/home/amuls/RxTURP/BEGPIOS/P3RS2/rinex/",
  "yydoy": "/home/amuls/RxTURP/BEGPIOS/P3RS2/rinex/20311"
```

```
},
"bin": {
  "gfzrnrx": "/home/amuls/bin/gfzrnrx",
  "rnrx2crz": "/home/amuls/bin/rnrx2crz",
  "gzip": "/usr/bin/gzip"
}
```

```
},
"rxn": {
  "date": "2020-11-07",
  "obs3f": "P3RS04BEL_R_20203110000_01D_00U_MO.rxn",
  "nav3f": "P3RS04BEL_R_20203110000_01D_MN.rxn"
}
```

```

    },
    "p3rs2": {
        "obs": [
            "P3RS-2_RX_R_20203110910_15M_00U_MO.rnx",
            "P3RS-2_RX_R_20203110925_15M_00U_MO.rnx",
            "P3RS-2_RX_R_20203111019_15M_00U_MO.rnx",
            "P3RS-2_RX_R_20203111034_15M_00U_MO.rnx",
            "P3RS-2_RX_R_20203111049_15M_00U_MO.rnx",
            "P3RS-2_RX_R_20203111104_15M_00U_MO.rnx",
            "P3RS-2_RX_R_20203111119_15M_00U_MO.rnx",
            "P3RS-2_RX_R_20203111134_15M_00U_MO.rnx",
            "P3RS-2_RX_R_20203111149_15M_00U_MO.rnx",
            "P3RS-2_RX_R_20203111207_15M_00U_MO.rnx",
            "P3RS-2_RX_R_20203111222_15M_00U_MO.rnx",
            "P3RS-2_RX_R_20203111309_15M_00U_MO.rnx",
            "P3RS-2_RX_R_20203111324_15M_00U_MO.rnx"
        ]
    }
}

```

```
],
"nav": [
    "P3RS-2_RX_R_20203110910_15M_MN.rnx",
    "P3RS-2_RX_R_20203110925_15M_MN.rnx",
    "P3RS-2_RX_R_20203111019_15M_MN.rnx",
    "P3RS-2_RX_R_20203111034_15M_MN.rnx",
    "P3RS-2_RX_R_20203111049_15M_MN.rnx",
    "P3RS-2_RX_R_20203111104_15M_MN.rnx",
    "P3RS-2_RX_R_20203111119_15M_MN.rnx",
    "P3RS-2_RX_R_20203111134_15M_MN.rnx",
    "P3RS-2_RX_R_20203111149_15M_MN.rnx",
    "P3RS-2_RX_R_20203111207_15M_MN.rnx",
    "P3RS-2_RX_R_20203111222_15M_MN.rnx",
    "P3RS-2_RX_R_20203111309_15M_MN.rnx",
    "P3RS-2_RX_R_20203111324_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/rnxproc] [rnxproc]$ prepare_rnx15.py -h
usage: prepare_rnx15.py [-h] [-f FROM_DIR] [-r RNX_DIR] -m MARKER -y YEAR -d DOY [-c] [-l LOGGING LOGGING]
```

prepare\_rnx15.py Combining partial (15 minutes) RINEX v3.x Obs/Nav files

optional arguments:

```
-h, --help            show this help message and exit
-f FROM_DIR, --from_dir FROM_DIR
                        Directory of 15 min P3RS2 data collection (default /home/amuls/RxTURP/BEGPIOS/P3RS2/LOG/pvt_ls/)
-r RNX_DIR, --rnx_dir RNX_DIR
                        Root directory of P3RS2 RINEX files (default /home/amuls/RxTURP/BEGPIOS/P3RS2/rinex/)
-m MARKER, --marker MARKER
                        marker name (4 chars)
-y YEAR, --year YEAR  Year (4 digits)
-d DOY, --doy DOY     day-of-year [1..366]
-c, --compress        compress obtained RINEX files
-l LOGGING LOGGING, --logging LOGGING LOGGING
                        specify logging level console/file (default INFO DEBUG)
```

### Example run

OUTPUT FROM RNX15\_COMBINE.PY COMES HERE

```
INFO: >>>>> prepare_rnx15.py - prepare_P3RS2_data: RINEX directory = /home/amuls/RxTURP/BEGPIOS/P3RS2/rinex/20311
INFO: >>>>> prepare_rnx15.py - prepare_P3RS2_data: obtained RINEX observation file = P3RS04BEL_R_20203110000_01D_00U_MO.rnx
INFO: >>>>> prepare_rnx15.py - prepare_P3RS2_data: obtained RINEX navigation files = P3RS04BEL_R_20203110000_01D_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 P3RS04BEL_R_20203110000_01D_00U_MO.rnx
INFO: amutils.py - run_subprocess: running
/home/amuls/bin/rnx2crz -f -d /home/amuls/RxTURP/BEGPIOS/P3RS2/rinex/20311/P3RS04BEL_R_20203110000_01D_00U_MO.rnx
INFO: >>>>> prepare_rnx15.py - prepare_P3RS2_data: compressed RINEX observation file = P3RS04BEL_R_20203110000_01D_00U_MO.crx.Z
INFO: compress_utils.py - gzip_compress: Compressing RINEX navigation P3RS04BEL_R_20203110000_01D_MN.rnx
INFO: amutils.py - run_subprocess: running
/usr/bin/gzip -f /home/amuls/RxTURP/BEGPIOS/P3RS2/rinex/20311/P3RS04BEL_R_20203110000_01D_MN.rnx
INFO: >>>>> prepare_rnx15.py - prepare_P3RS2_data: compressed RINEX navigation file = P3RS04BEL_R_20203110000_01D_MN.rnx.gz
INFO: prepare_rnx15.py - prepare_P3RS2_data: SBF preparation information =
{
  "dirs": {
    "pvt": "/home/amuls/RxTURP/BEGPIOS/P3RS2/LOG/pvt_ls/",
    "rnx_root": "/home/amuls/RxTURP/BEGPIOS/P3RS2/rinex/",
    "yydoy": "/home/amuls/RxTURP/BEGPIOS/P3RS2/rinex/20311"
  },
  "cli": {
    "marker": "P3RS",
    "yyyy": 2020,
    "doy": 311,
    "compress": true
  },
  "rnx": {
    "obs3f": "P3RS04BEL_R_20203110000_01D_00U_MO.rnx",
    "nav3f": "P3RS04BEL_R_20203110000_01D_MN.rnx",
    "obs3fc": "P3RS04BEL_R_20203110000_01D_00U_MO.crx.Z",
    "nav3fc": "P3RS04BEL_R_20203110000_01D_MN.rnx.gz"
  },
  "bin": {
    "rnx2crz": "/home/amuls/bin/rnx2crz",
    "gzip": "/usr/bin/gzip"
  }
}
```

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

```
[amu1s:~/amPython/rnxproc] [rnxproc]$ ls -l 20311/
total 1392
-rw-rw-r-- 1 amu1s amu1s 1218353 Feb  9 14:38 P3RS04BEL_R_20203110000_01D_00U_M0.crx.Z
-rw-rw-r-- 1 amu1s amu1s   20838 Feb  9 14:38 P3RS04BEL_R_20203110000_01D_MN.rnx.gz
-rw-rw-r-- 1 amu1s amu1s    2598 Feb  9 14:38 prepare_rnx15.log
-rw-rw-r-- 1 amu1s amu1s  173172 Feb  9 14:38 rnx15_combine.log
```