New RINEX file monitoring at CODE

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Introduction

The availability of consistent tracking data is a prerequisite to process the signals of the Global Navigation Satellite Systems (GNSS) and to generate best possible analysis products. In this context, the Center for Orbit Determination in Europe (CODE) has developed an extensive monitoring of the RINEX observation files in order to improve the reliability of the derived products.

In the frame of the Multi-GNSS Experiment (MGEX) of the International GNSS Service (IGS), CODE has extended its file monitoring procedure to the new signals and GNSS defined in RINEX-3 to handle the increasing number of satellites, systems and observation types. This procedure has also been applied to the RINEX-3 files from the EUREF Permanent Network (EPN).

Daily updated GNSS specific summaries for all stations and satellites can be found at:
ftp://ftp.unibe.ch/aiub/mgex
There is a README.TXT explaining the content of these summaries.

New procedure

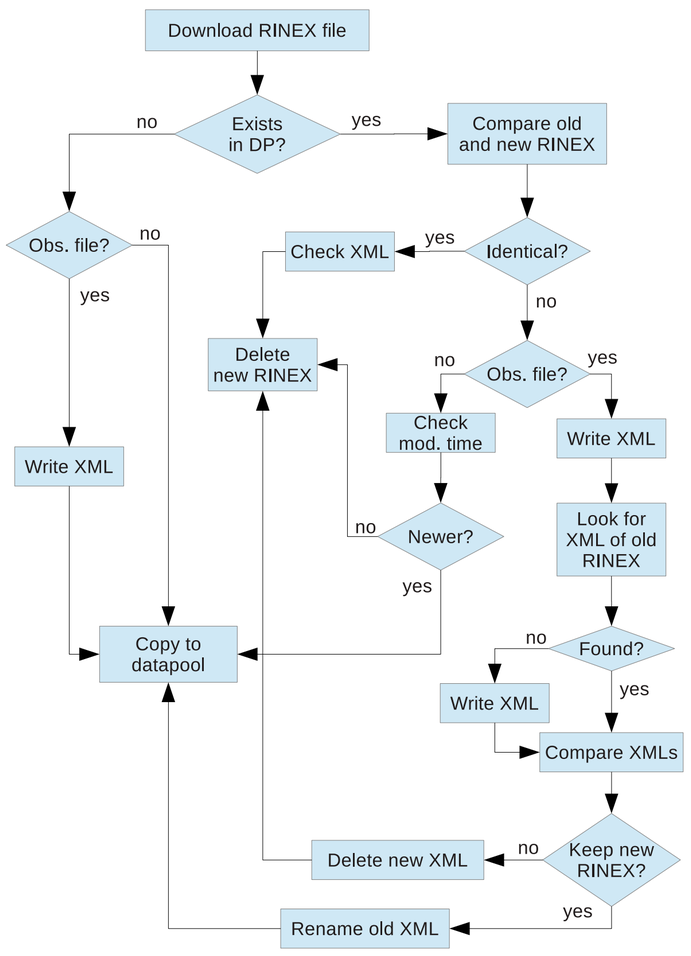
- Perl routines for reading the entire RINEX files and for writing extensive meta-data files in XML format (standard packages)
- Evaluation and comparison of the RINEX data
- Generation of daily and monthly summaries
- Possibility to filter stations according to given properties (equipment, satellite systems, observation types, ...)

Structure of XML file

- **FILE section**: Information on download (e.g., download time, availability at data centers) and RINEX file specifications
- **HEADER section**: All relevant parts from the RINEX file header with consistency tests, e.g., with respect to the RINEX format description or external files (rcvr_ant.tab of IGS for receiver and antenna types)
- **RDATA section**: Information on epochs (first, last, number, event flags, etc.), number of observation types and combinations for each satellite, loss of lock and S/N ratio summaries
- **XML section**: Information on the XML file itself

Update of datapool

Data download can be optimized using specific criteria stored in the XML files to compare with already existing RINEX files in the datapool.



Flow chart of RINEX file download with XML creation and comparison.

RINEX-3 data sources

For global multi-GNSS activities, RINEX-3 files are freely available from the stations of the IGS-MGEX network, other IGS stations, as well as from some EPN stations:
ftp://igs.bkg.bund.de/EUREF/obs_v3

EPN stations providing RINEX-3

At present, there are about 20 stations of the EUREF Permanent Network (EPN) not participating in MGEX but delivering GNSS observation data in RINEX-3 format.

The following statistics are based on daily RINEX-3 files of these EPN stations for day 141 of 2013 (21-May-2013).

Map of the EPN stations providing RINEX-3.

```
  5.0%  JAVAD TRE_G3TH DELTA  MAKERINEX 2.0.10850   3.02     E  G  R
 20.0%  LEICA GR10            GR10 V3.00            3.01     E  G  R
 10.0%  LEICA GR25            BNC 2.6               3.01     E  G  R
 20.0%  LEICA GR25            BNC 2.6               3.01     E  G  R  S
  5.0%  LEICA GR25            BNC 2.6               3.01        G  R
  5.0%  LEICA GR25            GR25 V2.62            3.01     E  G  R  S
 10.0%  LEICA GR25            GR25 V3.00            3.01     E  G  R
 10.0%  LEICA GRX1200GGPRO    BNC 2.4               3.00        G  R
 15.0%  TRIMBLE NETR9         NetR9 4.80            3.02  C  E  G  R  S
```

Variety of receiver types, programs creating the RINEX files, RINEX format versions and satellite systems given in the RINEX-3 files of the EPN stations. About half of the files are created using BKG Ntrip Client (BNC). Unfortunately, some stations do not provide any Galileo (E) tracking data.

```
C
100.0%  C2I C6I C7I                         L2I L6I L7I
E
 35.3%      C1X     C5X C7X C8Q                 L1X     L5X L7X L8Q
 35.3%  C1C     C5Q                          L1C     L5Q
 17.6%      C1X     C5X C7X     C8X             L1X     L5X L7X     L8X
 11.8%      C1X     C5X                         L1X     L5X
G
 50.0%  C1C             C2W     C2X C5X      L1C         L2W     L2X     L5X
 30.0%  C1C         C2S C2W C5Q              L1C     L2S L2W         L5Q
 10.0%  C1C     C2P                          L1C             L2P
  5.0%  C1C             C2W         C5X      L1C         L2W             L5X
  5.0%  C1C C1W         C2W     C2X C5X      L1C L1W     L2W     L2X     L5X
R
 45.0%  C1C         C2P                      L1C         L2P
 35.0%  C1C     C2C C2P                      L1C     L2C L2P
 20.0%  C1C C1P C2C C2P                      L1C L1P L2C L2P
S
100.0%  C1C                                  L1C
```

In RINEX-2:

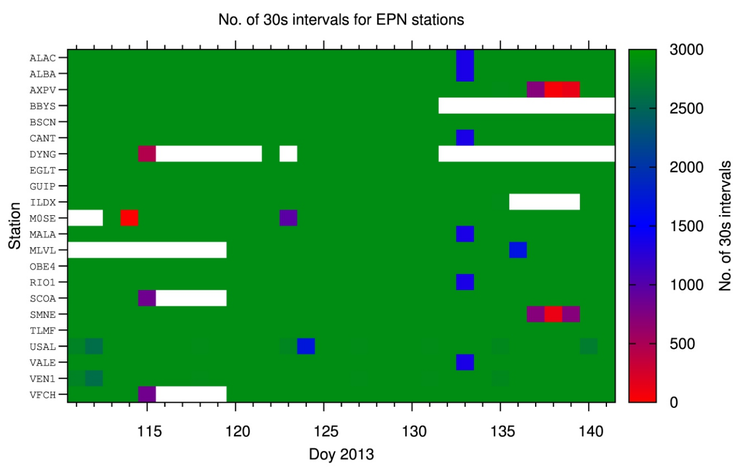
```
C1 C2    C5 L1 L2 L5
C1 C2    C5 L1 L2 L5
C1    P2    L1 L2
C1 C2    C5 L1 L2 L5
C1 C2    C5 L1 L2 L5
```

Multitude of code and phase observation types for the different satellite systems stored in the RINEX-3 files. Together with new signals emitted by the GNSS satellites, the stations' tracking capabilities have been extended. The ambiguousness of the reported types in RINEX-2 is minimized in RINEX-3 but the selection of the optimal set of observables for the processing has become a challenging task.

Completeness of daily observation files

One indicator for the qualitiy of an observation file is the number of available epochs with tracking data within the nominal time span. Missing epochs cannot be compensated later on. In addition to the number of epochs at 30 seconds intervals, the number of epochs with event flags etc. can be extracted from the XML files for evaluation purposes. Furthermore, observations with loss of lock indicators are summarized over all epochs.

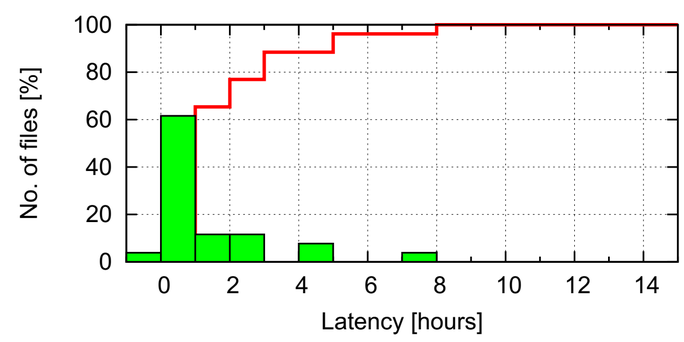
Most of the EPN stations have uninterrupted time series of daily RINEX-3 observation files. Incomplete or missing files can be identified.



Number of epochs at 30 seconds intervals in the RINEX-3 files over the last 30 days.

Latency of daily observation files

For scheduling the processing of a daily session, e.g., for the past day in a rapid-like analysis, the timely availability of the observation files is a crucial factor. Both the performance of the computer for the analysis and the deadline for submission of the results have to be taken into account.



About 90% of all daily observation files are available at 5 o'clock UT of the following day.

Summary

- We are confronted with an increasing number of signals, frequencies and satellite systems. This implies new challenges for receiver manufacturers, station operators, data centers and specifically for the analysis centers and the user community.
- The new RINEX file monitoring allows for an analysis of the raw RINEX data prior to any pre-processing step. Incomplete tracking and other irregularities or inconsistencies in the input files might be detected at an early stage and files with predefined characteristics can be selected for the processing.
- A web-based access to the XML files for individual requests is in preparation.

AIUB
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