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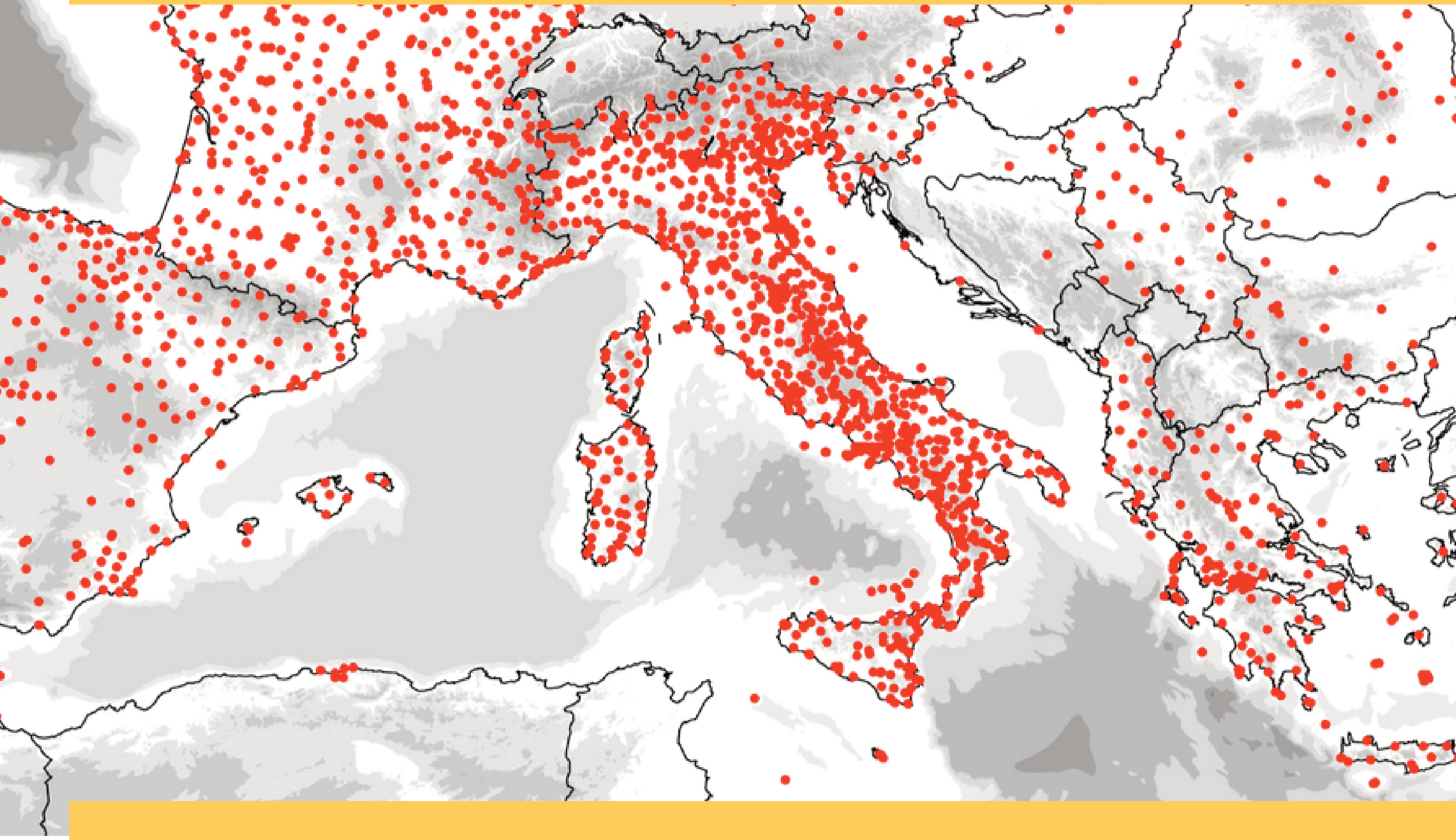

RAPPORTI TECNICI INGV

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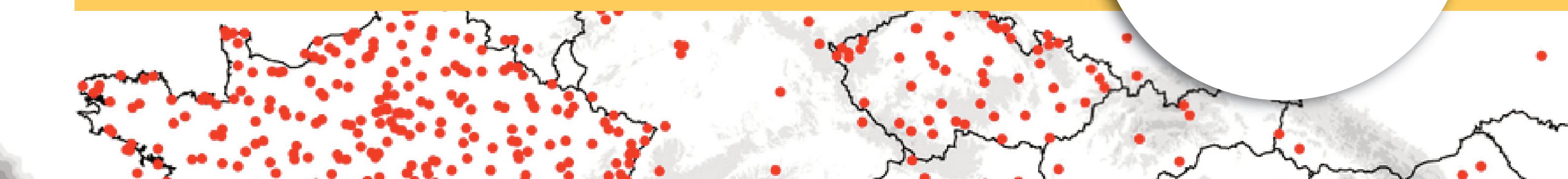

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PyGLogDB: software to generate STATION-INFO files for GNSS data analysis

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Cover Distribution of continuous GNSS stations for the Euro-Mediterranean area

446

INDEX

Abstract

Massive analysis of GNSS data (Global Navigation Satellite System) requires the development of specific tools to automate the different steps of processing: from data download to ground displacements estimates. In this technical report we describe the tools and algorithms we have developed to handle the metadata associated with GNSS observations from continuous networks operating in the Euro-Mediterranean and African area, which are routinely processed by the three main INGV data analysis centers. Obtaining accurate metadata, which records information on how a GNSS station is equipped (receiver, antenna, monument, etc..), is mandatory in order to obtain accurate GNSS stations daily position and their evolution through time. Here we will describe the processing chain, the software developed using open-source programming language, describing the major issues found in treating incomplete, inconsistent or wrong information, and the methods adopted to minimize or resolve these problems. The software developed is going to be implemented in the centralized GNSS data and metadata archive that we are realizing at INGV, and that will serve both institutional activities and research projects. The goal of this tool is to minimize errors and reduce/avoid the human intervention in handling a large set of information, facilitating the automatic analysis of data from thousands of GNSS stations on a daily basis. The software acronym is pyGLogDB, which stands for: "**py**thon **G**NSS **Log**file elaboration with the support of **D**ata**B**ase".

Keywords GNSS; Station-info (metadata from sitelog and rinex): Data processing

Introduction

The rapid increase of continuous GNSS stations availability worldwide in the last 10 years makes now possible to obtain detailed and precise maps of the Earth's surface three-dimensional displacements and velocities with unprecedented spatial details [e.g, Blewitt et al., 2018]. Applications go from solid-Earth geophysics (volcanology, seismology, tectonics and geodynamics) to climatology, hydrology and space weather. The necessity of massive processing of data from thousands of GNSS stations pushed forward the development of automatic processing procedures and the use of cluster computing. However, in order to achieve the highest accuracies and precisions, correctly accounting for instrumental changes at each station is still mandatory, as it is important to properly model displacement time-series, including jumps due to station equipment changes.

The IGS organization (https://www.igs.org/) is a federation of agencies which provides geodetic products for scientific purposes, among these the standard IGS log-files are still the most common format for which stations metadata are provided to data processing centers, these are in general available only for high-quality GNSS networks, such as those contributing to global or continental-scale geodetic networks for reference frame definition (e.g., IGS or EUREF - https://www.euref.org/), or those realized for geophysical purposes (e.g, EPOS GNSS federated network - http://gnssdata-epos.oca.eu/). However, a significant part of the global GNSS dataset, and in particular for the Italian and European regions, is now provided also by commercial networks or regional and national cadastral administrations, for which standard IGS log-files are not provided or not routinely updated. In many cases this information can be retrieved from the header included in RINEX files (the IGS Receiver INdependent Exchange format), but the presence of missing information, errors and inconsistencies require the development of specific

tools to mitigate these problems and obtain metadata information as much precise as possible. In this technical report we present the procedures and algorithms developed at INGV in order to provide reliable, accurate and updated (on a daily basis) metadata information to the GNSS data analysis centers [see Devoti et al, 2017] that routinely analyze GNSS data in the framework of both national and international research projects and for monitoring crustal deformation also in the framework of institutional activities (such as for the Italian Civil Protection Department). Figure 1 shows the distribution of the GNSS stations that are routinely archived and analyzed at INGV (at June, 2020), with a focus on the Euro-Mediterranean area, but that extends to the African continent. Currently, daily RINEX data from more than 4,000 GNSS stations are downloaded from remote data repositories and their metadata are archived into a specific database. Starting from the database developed, which is the objective of another specific technical report, here we describe the rationale behind the tools developed to manage GNSS stations information and deliver updated metadata for both geophysical and non-geophysical GNSS networks that freely provide data through the internet.
The software is developed in Python, which is an open source, interpreted, object-oriented, high-level programming language (https://www.python.org/) and leans on the open source object-relational database system PostgresQL (https://www.postgresql.org/), adopting and adapting tools developed also in the framework of EPOS GNSS TCS, to download, read and interpret metadata information from different sources. In particular, we consider two sources of information: 1) standard station log-files and 2) headers of RINEX files. In both cases, software tools have been developed in order to provide daily updates of metadata information for all sites analyzed in different file formats. In particular, the software provides stations metadata files in software-specific formats for BERNESE, GAMIT/GLOBK and GIPSY GNSS data processing tools which are scientific, high-precision, multi-GNSS data processing software developed by different institutions for geodetic analysis. It also provides output in the standard SINEX which is the Solution INdependent EXchange format. The tools help interpreting inconsistencies, correcting wrong information (for example translating receiver and antenna names to standard IGS naming conventions), merging information from both sources (1 and 2) in case log-files cover only a certain period with respect to the total data history, write and update metadata in different formats on a daily basis. The software is integrated with the one developed for handling RINEX data download and archiving.

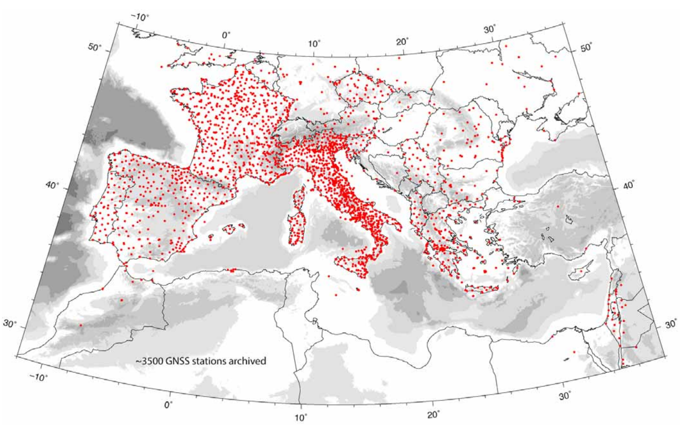


Figure 1 Distribution of continuous GNSS stations for the Euro-Mediterranean area for which we download and archive RINEX data at INGV. In total, considering the whole European and African region, we include data from ~4000 stations.

1. Software architecture

The proposed software handles geodetic metadata such as 1) the station log-files, hereinafter SITELOG, provided as ASCII text files by the GNSS network data providers and 2) the headers of daily RINEX files, which are retrieved from a specific DataBase, created from files on a daily basis from remote archives; the information after processing are saved again into the DataBase as shown in Figure 2.

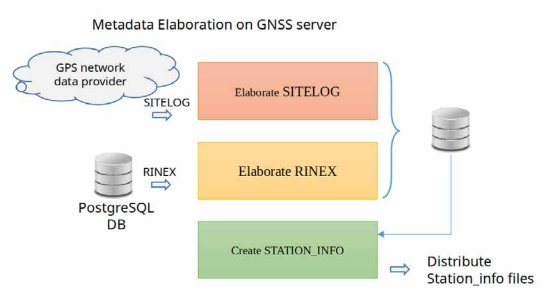


Figure 2 Flowchart of the software.

The metadata stored in the database are manipulated to generate the STATION-INFO files in the formats needed for the major GNSS processing software (GAMIT/GLOBK, BERNESE and GIPSY) and in the SINEX format. The sample below shows a STATION-INFO file in the format used for the GAMIT software, where for viewing convenience, the columns have been split into two groups:

COLUMNS GROUP 1

*SITE	Station Name	Session Start	Session Stop	Ant Ht	HtCod	Ant N	Ant E ...
ACOR	A Coruña, Spagna	1998 340 10 10 0	2001 353 0 0 0	3.0420	DHARP	0.0000	0.0000 ...
ACOR	A Coruña, Spagna	2001 353 0 0 0	2004 106 0 0 0	3.0420	DHARP	0.0000	0.0000 ...
ACOR	A Coruña, Spagna	2004 106 0 0 0	2007 77 0 0 0	3.0420	DHARP	0.0000	0.0000 ...
ACOR	A Coruña, Spagna	2007 77 0 0 0	2008 112 9 30 0	3.0460	DHARP	0.0000	0.0000 ...
ACOR	A Coruña, Spagna	2008 112 9 30 0	2008 340 12 30 0	3.0460	DHARP	0.0000	0.0000 ...
ACOR	A Coruña, Spagna	2008 340 12 30 0	2010 34 0 0 0	3.0460	DHARP	0.0000	0.0000 ...
ACOR	A Coruña, Spagna	2010 34 0 0 0	2010 43 0 0 0	3.0460	DHARP	0.0000	0.0000 ...
ACOR	A Coruña, Spagna	2010 43 0 0 0	2010 165 9 0 0	3.0460	DHARP	0.0000	0.0000 ...
ACOR	A Coruña, Spagna	2010 165 9 0 0	2010 180 0 0 0	3.0460	DHARP	0.0000	0.0000 ...
ACOR	A Coruña, Spagna	2010 180 0 0 0	2010 202 9 0 0	3.0460	DHARP	0.0000	0.0000 ...
ACOR	A Coruña, Spagna	2010 202 9 0 0	2011 140 10 20 0	3.0460	DHARP	0.0000	0.0000 ...
ACOR	A Coruña, Spagna	2011 140 10 20 0	2011 144 11 32 0	3.0460	DHARP	0.0000	0.0000 ...
ACOR	A Coruña, Spagna	2011 144 11 32 0	2011 298 8 0 0	3.0460	DHARP	0.0000	0.0000 ...
ACOR	A Coruña, Spagna	2011 298 8 0 0	2012 347 13 41 0	3.0460	DHARP	0.0000	0.0000 ...
ACOR	A Coruña, Spagna	2012 347 13 41 0	2019 35 12 0 0	3.0460	DHARP	0.0000	0.0000 ...
ACOR	A Coruña, Spagna	2019 35 12 0 0	2019 291 16 0 0	3.0460	DHARP	0.0000	0.0000 ...
ACOR	A Coruña, Spagna	2019 291 16 0 0	9999 365 23 59 59	3.0460	DHARP	0.0000	0.0000 ...

COLUMNS GROUP 2

Receiver Type	Vers	SwVer	Receiver SN	Antenna Type	Dome	AntSN
ASHTECH UZ-12	UE00-0A12	UE00-	00224	ASH700936D_M	SNOW	16122
ASHTECH UZ-12	ZC00	ZC00	12109	ASH700936D_M	SNOW	16122
ASHTECH UZ-12	ZC00	ZC00	12110	ASH700936D_M	SNOW	16122
LEICA GRX1200PRO	5.00	5.00	459187	LEIAT504	LEIS	103033

LEICA GRX1200PRO	5.62	5.62	459187	LEIAT504	LEIS	103033
LEICA GRX1200PRO	6.02	6.02	459187	LEIAT504	LEIS	103033
LEICA GRX1200PRO	7.53	7.53	459187	LEIAT504	LEIS	103033
LEICA GRX1200PRO	7.80	7.80	459187	LEIAT504	LEIS	103033
LEICA GRX1200PRO	7.80/2.125	7.80	459187	LEIAT504	LEIS	103033
LEICA GRX1200PRO	8.00/2.125	8.00	459187	LEIAT504	LEIS	103033
LEICA GRX1200PRO	8.00/2.125	8.00	459187	LEIAT504	LEIS	103033
LEICA GRX1200PRO	8.10/2.125	8.10	459187	LEIAT504	LEIS	103033
LEICA GRX1200PRO	8.20/2.125	8.20	459187	LEIAT504	LEIS	103033
LEICA GRX1200PRO	8.20/2.125	8.20	459187	LEIAT504	LEIS	103033
LEICA GRX1200PRO	8.20/2.127	8.20	459187	LEIAT504	LEIS	103033
LEICA GR10	4.31/6.525	4.31	1700065	LEIAT504	LEIS	103033
LEICA GR50	4.31/7.403	4.31	1833574	LEIAT504	LEIS	103033

1.1 Metadata from SITELOG

The SITELOG is a human readable ASCII text file, usually filled by a human operator, with the goal of summarize the history of a GNSS station in terms of instrumental equipment (e.g., receiver type, receiver firmware, antenna type, radome type) and geometrical characteristics (e.g., eccentricity, as the antenna height with respect to the geodetic marker); the Appendix reports a sample list of websites to freely download the SITELOG provided by the network data provider. In the SITELOG files the information is organized in paragraphs, but only a few of them are needed.

Portion of File extracted from SITELOG:

```
1.    Site Identification of the GNSS Monument
      Site Name                : (name)
      Four Character ID        : XXXX

2.    Site Location Information
        X coordinate (m)       : xxxxxxx.x
        Y coordinate (m)       : yyyyyyy.y
        Z coordinate (m)       : zzzzzzzz.z

3.    GNSS Receiver Information
3.x   Receiver Type            : (A20, from rcvr_ant.tab; see instructions)
      Serial Number            : (A20, but note the last A5 is used in SINEX)
      Firmware Version         : (A11)
      Date Installed           : (CCYY-MM-DDThh:mmZ)
      Date Removed             : (CCYY-MM-DDThh:mmZ)

4.    GNSS Antenna Information
4.x   Antenna Type             : (A20, from rcvr_ant.tab; see instructions)
      Serial Number            : (A*, but note the last A5 is used in SINEX)
      Marker->ARP Up Ecc. (m)  : (F8.4)
      Marker->ARP North Ecc(m) : (F8.4)
      Marker->ARP East Ecc(m)  : (F8.4)
      Date Installed           : (CCYY-MM-DDThh:mmZ)
      Date Removed             : (CCYY-MM-DDThh:mmZ)
```

The paragraph 3.x and 4.x are incrementally numbered according to any change in the equipment configuration starting from the installation of the station. The SITELOG are downloaded from remote archives, when available, and are parsed and interpreted by the software and stored into the database, as shown in the flowchart of Figure 3.
The "Translation Table" block is crucial in all our processing chain, since it helps to recognize the receivers and antenna codes, check for their consistencies with the standard IGS codes (link), and correct if not aligned with standard names, which would abruptly stop the processing of the geodetic software. The principle of this algorithm will be explained on Section 2.2. The metadata obtained from the processing of SITELOGs are stored into specific tables of the database, which group the changes by parameter (antenna, receiver and eccentricity) and are retrieved during the STATION-INFO file creations.

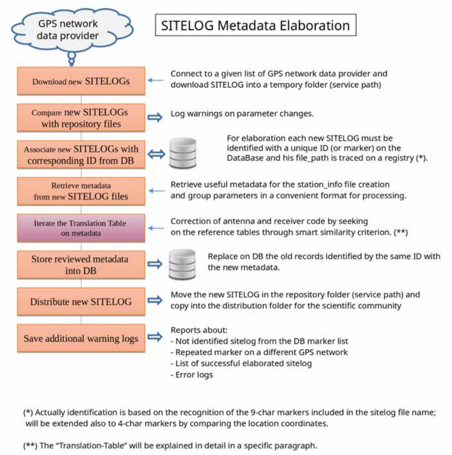


Figure 3 Flowchart of SITELOG elaboration.

1.2 Metadata from RINEX headers

The RINEX files of the GNSS networks taken into consideration in this report (see Table in Appendix) are daily stored and handled in a specifically designed DB. The GNSS station equipment information in the header is organized as a list of parameters, where the description is on the right side; only a few information are indeed required for the major processing software as shown below:

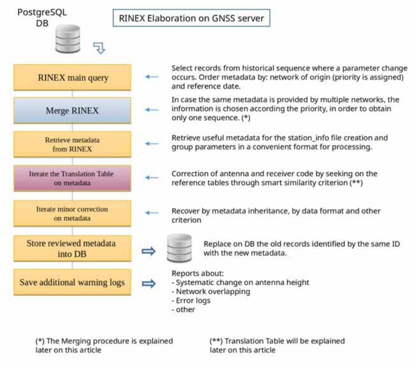
```
MMMM                                                                 MARKER NAME
#rrrr                 RRRRRRRRRRR       v.vv                  REC # / TYPE / VERS
#aaaa                 AAAAAAAAAAAAAAAAAAAA                    ANT # / TYPE
  xxxxxxx.xxxx   yyyyyy.yyyy  zzzzzzz.zzzz            APPROX POSITION XYZ
        h.hhhh         e.eeee         n.nnnn          ANTENNA: DELTA H/E/N
```

The RINEX file header of each GNSS station is retrieved by a different software which on a daily basis stores the metadata in the database; our software performs a main query to select for each station only those records where at least one parameter is changed, returning the parameters history. This procedure reduces the number of records to elaborate from more than 12 million records to thousands, then focuses on correcting antenna and receiver codes and other issues, as shown in Figure 4.
The "Translation Table" algorithm shown in this flowchart is the same as mentioned above and described in Section 2.2; here is introduced the "Merging" algorithm, described in Section 2.3, which allows to obtain a single historical sequence starting from two sequences with different priority. The metadata extracted from the RINEX files are stored into the same specific tables of the database as mentioned above, keeping trace of the respective origin (SITELOG or RINEX).

2. Creating the STATION_INFO files

This procedure combines the information obtained from the elaboration of the SITELOG and RINEX metadata, creating the STATION_INFO files for all the GNSS stations for each network.

Figure 4 Flowchart of RINEX elaboration.



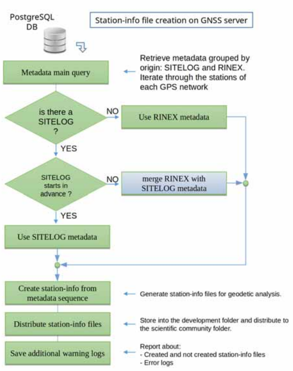
A combination of the two sources of information is required, for example, when a SITELOG doesn't cover the entire time-span of RINEX data available, for example when a few days or months, or even years, of RINEX data are available in the archive before the starting date present in the SITELOG.

It is worth providing some details on the reliability of the different metadata sources. Despite the algorithm being designed to correct the more common type of errors, the way RINEX files were generated makes this type of metadata sometimes difficult to manage. Station information available from network operators is often inaccurate, incomplete or completely absent, therefore the metadata sequence could show the alternation of periods with recognized and unrecognized parameters, making it necessary the user intervention to manage the correction of errors. On the other hand, the SITELOG of the station should be updated, and validated too, at each variation of the instrumental configuration (e.g. antenna change, firmware update, ...) by the station provider.

Since the SITELOG metadata should be verified from the data provider while the RINEX metadata is not, the former takes priority in creating the station information file. Nevertheless, the misalignment between different sources of metadata sometimes makes it necessary to combine the two sources in order to extend the coverage period of the metadata as described in the flowchart in Figure 5. In some cases, in fact, discrepancies were found between the installation date of the station provided by SITELOG and the actual availability of the RINEX files for the station itself, thus indicating that it could have been activated several days or months before.

Once the GNSS station metadata is retrieved as mentioned above, the raw data is processed by the fake code cleaning tools before creating the station information file.

Figure 5 Flowchart of STATION-INFO file creation.



Furthermore, the software provides error logfile and other metadata logs to help the user investigate discrepancies.

2.1 The inheritance algorithm

The algorithm will be described here without going into details. It is applied to metadata coming only from RINEX files. The RINEX metadata extracted from the database is first preprocessed by the TT algorithm then passed to the inheritance one, which rearranges the temporal sequence of the instrumental changes. The antenna and receiver metadata are the most important ones, so special attention was paid to them in the development of the algorithm.
The processing starts with a descriptive statistical analysis on the distribution of the time intervals of the instrument changes. This step is intended to filter out the not significant time intervals using the median of this distribution as the best estimator. In this case, intervals with a duration less than the median are rejected and their instrumental configuration is associated with the previous cluster if the same (inheritance), otherwise are discharged. The algorithm is iterative and based on the estimator threshold value beyond which processing is stopped.
Among others, a filter is applied to verify the correctness of the antenna offset on the three components (North, East, and Up). Also in this case, an upper threshold value is set, beyond which the offset is reset.
The output of the algorithm is a dictionary that contains a reduced number of records that are transferred to the suitably formatted final products, the so-called STATION_INFO files for the scientific GNSS software Gamit and Bernese (.stf and .sta extensions respectively).

2.2 The Translation Table algorithm (TT)

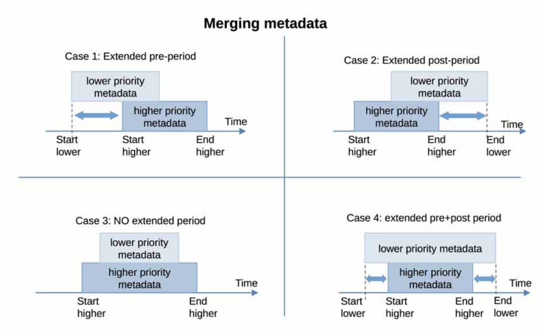
The "Translation Table" is one of the most important blocks on which the metadata processing relies. In order to optimize the code, the algorithm applies the same correction procedure to both the SITELOG and RINEX metadata, associating the corresponding antenna and receiver code as provided by the standard IGS file (available on the link ftp://igs.org/pub/station/general/rcvr_ant.tab). To use the same processing procedure for the two types of metadata, a standard format of the information had to be chosen, which simplifies maintenance and updating of the code.
The translation table uses two tables with reference codes of "GNSS receivers" and "antenna-dome" models, obtained from the official suppliers website, and three additional tables to create a mapping process between the "fake" codes received from the raw metadata and respective reference codes. Among these, the "New_Fake" table hosts all the antenna and receiver codes for which the algorithm does not find the corresponding reference code; it also contains supporting information to facilitate the operator in resolving the case, for example any correct and recognized codes from the sequence and any similar codes that could be associated are indicated; a dedicated column in this table indicates whether the code has already been "revised" and corrected, and another column indicates "notes" to specify how the case is resolved. The second and third tables instead are the mappings for the antenna and receiver codes respectively, where the reference code is associated with the fake code. All three tables have a column with the reference to the station's unique identifier and another with the origin "sitelog" or "rinex". Unlike the fake table which is automatically populated by the algorithm while scanning through the raw metadata sequence, the other two tables are populated thanks to the intervention of the operator through a specially written code, starting from the information contained in the "New_Fake" table.

For each code in the raw metadata sequence the Translation Table algorithm first compares with the reference codes, if there is no solution, an attempt is made to find a correspondence with the respective "mapping" tables and finally searches in the "New_Fake" table. In addition to the mapping which constrain the fake code correspondence, for the RINEX metadata there is the possibility that a metadata originated from the respective SITELOG for the same period provides the correct information, in this case the fake code is considered already revised and its correction is not required.
When the algorithm does not match the fake code, the processing is postponed and a list of possible codes is proposed on the basis of those recognized in the same metadata sequence and on the basis of similarity criteria starting from the fake code received; this list will be used to support the operator who will integrate the mapping tables using the aforementioned software tool.
The choice of the code to be associated is a responsibility on which the outcome of the geodetic processing depends, for this reason the choice cannot be left to the algorithm automatically.

2.3 Merging algorithm

An important feature of the software is the ability of merging metadata from different sources, in order to extend the period of availability of the GNSS station information. The metadata from the RINEX files can be provided by different GNSS networks and, for this reason, be considered with different priorities or can cover different periods. It may also happen that metadata is present from the SITELOGs, which are considered more reliable than the former. Merging consists in putting together the metadata and Figure 6 shows the operating scheme of the Merging algorithm: four cases may arise based on the "start" and the "end" date of the compared sequences.

Figure 6 Schema of Merging algorithm.



When the metadata is provided by multiple GNSS networks, the Merging algorithm is regulated by priority levels assigned to each network; in the case of merging between metadata from SITELOG and RINEX, the former is preferred.

3. Integration to the code

The software package includes tools such as terminal interfaces or python libraries that help the processing and its development. A brief outline is given below to introduce their use and the resulting advantages.

3.1 Software "updateTT", a terminal console to update the "Translation Table"

This code supports the operator in many utility functions, one of the most important is the correction of "fake" codes, which also requires the insertion of information and references related to the database itself. Starting from the information contained in the "New_Fake" table, the interface guides the operator leaving him only the choice of the reference code to associate. It is possible to correct the fake codes both for the single GNSS station or by grouping all the stations having the same fake type.
The interface also offers the possibility to save on a backup file the image of the corrections and therefore also the possibility of restoring them into the database.

3.2 Interfacing python to the database: Flask and SQLAlchemy

The functioning of this code is centered on the use of the database; there are several methods to manage this type of connection, our code uses one of the most popular and documented libraries to interface Python with a relational database: Flask with the SQLAlchemy extension[1]. Flask is a microframe that allows users to build web apps in Python, while SQLAlchemy is the SQL Python and ORM (Object Relational Mapper) toolkit, which facilitates interactions with the database. The following excerpt shows a simple code that initializes the connection and executes a SQL query:

```
#-----------
from flask import Flask
from flask_sqlalchemy import SQLAlchemy
from sqlalchemy import text

appDB = Flask(__name__)
appDB.config.from_object('config_file.config_class')

db = SQLAlchemy(appDB)
db.init_app(appDB)

query = db.engine.execute(text(sql))
#-----------
```

The database configuration is provided by the class "config_class" into an external file named "config_file.py", as shown below:

```
#-----------
class config_class
    HEADERS = {'content-type': 'application/json'}
    URL_BASE = '0.0.0.0:4300'

    SQLALCHEMY_TRACK_MODIFICATIONS = False
    TESTING = True
```

[1] https://flask.palletsprojects.com/en/1.1.x/, https://www.sqlalchemy.org/
https://stackoverflow.com/questions/17972020/how-to-execute-raw-sql-in-flask-sqlalchemy-app

```
    HOSTNAME = "gnssgiving.int.ingv.it"
    USERNAME = "nnnnnnn"
    PASSWORD = "*******"
    PORT = '5432'
    DB_NAME = 'gnss-ingv'

SQLALCHEMY_DATABASE_URI='postgresql:USERNAME:PASSWORD@HOSTNAME:PORT/DB_NAME'
#——————————
```

The database responds to the SQL query with a Python "dictionary" variable which is accessible through a for loop to retrieve the information.

3.3 Integration with GitLab

This code is already present on the GitLab platform and is part of a larger project where team members add their input. GitLab is a repository on the Web that provides functions for integrating, sharing and distributing code as well as reporting and tracing problems (https://gitlab.rm.ingv.it/daniele.randazzo/pygldb_stf), allowing to collaborate and work on different parts of the project.

Conclusions

After having instructed the Translation Tables to recognize the Antenna and Receiver codes, this software is able to process the RINEX and SITELOG metadata of about 4000 stations (stored in about 12 million database records) in about an hour and a half. The software also produces error log files that report useful information, such as changing parameters for existing stations and the presence of new stations. GNSS station metadata are also reported when "repetitive" variations occur on sensitive parameters such as the "deltaH" height of the antenna, or when the Translation Table does not find a solution, or when metadata is provided by more than one provider network. The station-info files created by the software have been tested on real data by processing the RINEX files with scientific software (GAMIT / GLOBK and BERNESE). Figure 7 shows an example of position time-series for a GNSS station where the offsets associated with changes in the station's configuration determined from the RINEX files are shown.

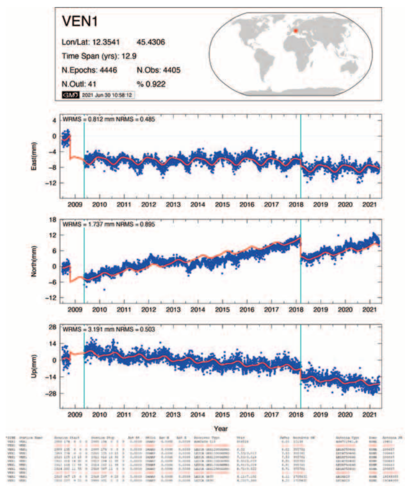


Figure 7 Position time-series, rotated in a Eurasia-fixed reference frame, of the station VEN1, as obtained from the GAMIT/GLOBK processing.

The vertical lines in the figure show the offsets due to changes in the station's equipment, as evidenced in red in the station.info below:

COLUMNS GROUP 1

*SITE	Station Name	Session Start	Session Stop	Ant Ht	HtCod	Ant N	Ant E
VEN1	VEN1	2008 174 0 0 0	2009 134 0 0 0	0.0000	DHARP	0.0000	0.0000
VEN1	**VEN1**	**2009 134 0 0 0**	**2009 135 0 0 0**	**0.0000**	**DHARP**	**0.0000**	**0.0000**
VEN1	VEN1	2009 135 0 0 0	2009 274 0 0 0	0.0000	DHARP	0.0000	0.0000
VEN1	VEN1	2009 274 0 0 0	2010 125 13 15 0	0.0000	DHARP	0.0000	0.0000
VEN1	VEN1	2010 125 13 15 0	2012 016 14 30 0	0.0000	DHARP	0.0000	0.0000
VEN1	VEN1	2012 016 14 30 0	2012 104 11 35 0	0.0000	DHARP	0.0000	0.0000
VEN1	VEN1	2012 104 11 35 0	2014 202 11 35 0	0.0000	DHARP	0.0000	0.0000
VEN1	VEN1	2014 202 11 35 0	2018 067 13 0 0	0.0000	DHARP	0.0000	0.0000
VEN1	VEN1	**2018 067 13 0 0**	**2018 067 15 0 0**	**0.0000**	**DHARP**	**0.0000**	**0.0000**
VEN1	VEN1	2018 067 15 0 0	2018 207 9 20 0	0.0000	DHARP	0.0000	0.0000
VEN1	VEN1	2018 207 9 20 0	9999 001 0 0 0	0.0000	DHARP	0.0000	0.0000

COLUMNS GROUP 2

Receiver Type	Vers	SwVer	Receiver SN	Antenna Type	Dome	AntSN
ASHTECH Z18	0065ZT16	0.00	12130	ASH701941.B	NONE	10402
LEICA GRX1200GGPRO		**0.00**	**355701**	**LEIAT504GG**	**NONE**	**200667**
LEICA GRX1200GGPRO	6.02	6.02	355701	LEIAT504GG	NONE	200667
LEICA GRX1200GGPRO	7.53/3.017	7.53	355701	LEIAT504GG	NONE	200667
LEICA GRX1200GGPRO	7.53/3.019	7.53	355701	LEIAT504GG	NONE	200667
LEICA GRX1200GGPRO	8.50/3.019	8.50	355701	LEIAT504GG	NONE	200667
LEICA GRX1200GGPRO	8.51/3.019	8.51	355701	LEIAT504GG	NONE	200667
LEICA GRX1200GGPRO	8.71/3.822	8.71	355701	LEIAT504GG	NONE	200667
LEICA GRX1200GGPRO	**8.71/3.822**	**8.71**	**355701**	**LEIAR20**	**NONE**	**19244003**
LEICA GR30	4.11/7.102	4.11	1705432	LEIAR20	NONE	19244003
LEICA GR30	4.20/7.300	4.20	1705432	LEIAR20	NONE	19244003

Consideration and future developments

The software is constantly developing in an attempt to optimize the quality of processed data. To obtain flexibility, the software is designed to recover SITELOGs from a list of sources, including file folders and also the possibility of decoding and processing files in the "station-info" format; this facilitates the RINEX metadata correction in the more complex periods, merging with higher priority level.
As this project is a part of a larger project, in the future the idea is to optimize the entire code in order to unify the common parts such as querying certain information to the database, which can be made available by accessing the same API services on a web server with a simple URL, avoiding query redundancy in the different parts of the project.
On the front-end side could be useful to create a web interface to manage all the station-info creation.

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Appendix

Table of the GNSS networks taken into consideration:

GNSS networks	Corresponding Network Website from which is possible to freely download metadata	Main source of metadata (RNX = rinex) (LOG = sitelog)
ABRUZZO	http://gnssnet.regione.abruzzo.it/	RNX
AGROS	http://agros.rgz.gov.rs/	RNX
ALBPOS	https://www.geo.edu.al/gnss/albpos/	RNX
ALGERIA	https://gpscope.dt.insu.cnrs.fr	RNX
ARAGEA	https://gnss.aragon.es	LOG
BASILICATA	http://geodaf.mt.asi.it/	RNX
CALABRIA	http://gpscalabria.protezionecivilecalabria.it	RNX
CAMPANIA	http://gps.sit.regione.campania.it	LOG
CANARY	ftp://www.canarygnsscenter.org (decommissioned)	LOG+RNX
CANTABRIA	https://www.territoriodecantabria.es/cartografia-sig/servicio-correcciones-gnss-precision	LOG
CARM	http://gps.medioambiente.carm.es/	LOG
CATNET	http://catnet-ip.icc.cat/spiderweb/frmIndex.aspx	LOG
CORINTH	https://nfo.crlab.eu/category/gnss	RNX
CZEPOS	http://czepos.cuzk.cz/	LOG
EMILIA	http://www.gpsemiliaromagna.it/	RNX
ERVA	http://icv.gva.es/es/web/icv-erva	LOG
EUREF	http://www.epncb.oma.be/	LOG
EUSKADI	http://www.gps2.euskadi.net/	LOG
FREDNET	http://frednet.crs.inogs.it/	LOG
FVG	http://gnss.regione.fvg.it/dati-GPS/default.jsp	LOG
GALNET	https://cartogalicia.com/galnet2/	RNX
GEODAF	http://geodaf.mt.asi.it	LOG
GEONAS	https://www.czechgeo.cz/en/sections-research-infrastructure-czechgeo/section-gnss-and-gravimetry/geodynamic-gnss-network	LOG
GIPUZKOA	https://b5m.gipuzkoa.eus/web5000/es/geodesia/red-gnss/	RNX
GREF	https://gref.bkg.bund.de/Subsites/GREF/DE/Home/home.html	LOG
HARTRAO	http://www.hartrao.ac.za/geodata.html	LOG+RNX
ICM	ftp://82.223.142.54	RNX
IGNE	http://www.ign.es/web/ign/portal/gds-gnss-estaciones-permanentes	LOG
IGS	https://www.igs.org	LOG
ITACYL	http://gnss.itacyl.es/	LOG
ITALPOS	https://hxgnsmartnet.com/	RNX
LARIOJA	https://www.iderioja.larioja.org/index.php?id=21&lang=es	LOG
LAZIO	http://gnss-regionelazio.no-ip.org/Spiderweb/frmIndex.aspx	RNX
LIGURIA	http://gnss.regione.liguria.it	RNX
METRICA	https://www.metrica.gr/	RNX
NEPAL	https://www.unavco.org/data/gps-gnss/gps-gnss.html	LOG
NETGEO	http://www.netgeo.it/	RNX
NIGNET	http://server.nignet.net (decommissioned)	RNX
NOA	http://geodesy.gein.noa.gr:8000/nginfo/	LOG+RNX
OLGGPS	https://www.oeaw.ac.at/ (decommissioned)	LOG+RNX
ORPHEON	https://reseau-orpheon.fr/	RNX
PIEMONTE	http://webgis.arpa.piemonte.it	LOG

PUGLIA	http://gps.sit.puglia.it/	RNX
RAP	https://www.juntadeandalucia.es/institutodeestadisticaycartografia/rap/	LOG
REGAM	https://sitmurcia.carm.es/estaciones	LOG+RNX
RENAG	http://webrenag.unice.fr/	LOG
RENEP	https://renep.dgterritorio.gov.pt/	LOG
REP	http://www.rep-gnss.es/	LOG
RGAN	http://www.navarra.es/appsext/rgan/default.aspx	LOG
RGAPA	http://rgapa.cartografia.asturias.es/	LOG
RGP	https://rgp.ign.fr/	LOG
RING	http://ring.gm.ingv.it/	LOG
ROGNSS	http://rognss.infp.ro/	LOG
SARNET	http://www.sarnet.it/applicazioni.html (decommissioned)	RNX
SEGAL	http://segal.ubi.pt (decommissioned)	LOG
SIGNAL	https://gu-signal.si/	LOG
SOI	ftp://garner.ucsd.edu	RNX
SONEL	https://www.sonel.org/-GPS-.html	LOG+RNX
SPINGNSS	http://www.spingnss.it	LOG
STPOS	http://www.stpos.it/	LOG
TPOS	http://www.catasto.provincia.tn.it/TPOS/	RNX
TRIGNET	http://www.trignet.co.za/	RNX
UMBRIA	http://labtopo.ing.unipg.it	RNX
UNAVCO	https://www.unavco.org/data/gps-gnss/gps-gnss.html	LOG
VENETO	http://retegnssveneto.cisas.unipd.it/	LOG
VESOG	https://www.czechgeo.cz/en/sections-research-infrastructure-czechgeo/section-gnss-and-gravimetry/network-permanent-gnss-vesog	LOG

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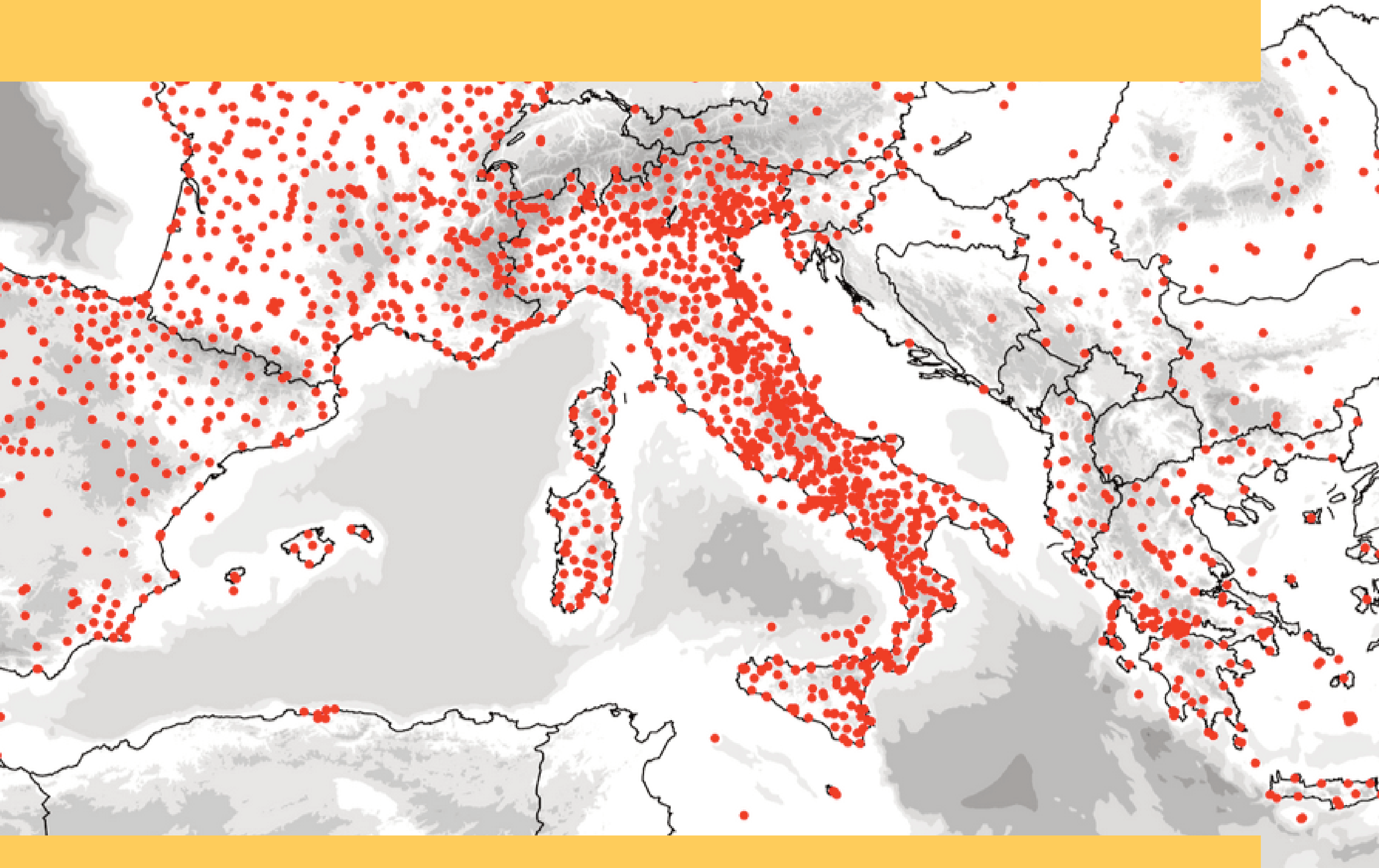

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