Update Article

Updating datasets of ionospheric parameters provided by SCINDA GNSS receiver from Lisbon airport area with full data sets for 2014-2019 ☆

Anna Morozova [a,b,*], Tatiana Barlyaeva [a], Teresa Barata [a,c]

[a] *Instituto de Astrofísica e Ciências do Espaço, University of Coimbra, OGAUC, R. do Observatório S/N, 3040-004, Coimbra, Portugal*
[b] *Department of Physics, FCTUC, University of Coimbra, R. Larga, 3004-516, Coimbra, Portugal*
[c] *Department of Earth Sciences, FCTUC, University of Coimbra, R. Sílvio Lima, Pólo II, 3030-790, Coimbra, Portugal*

A R T I C L E   I N F O

A B S T R A C T

An updated dataset based on data from a GNSS receiver with the SCINDA software installed in Lisbon airport area are presented: the new dataset cover the entire time interval from December 2014 to February 2019, except for the original SCINDA data for 2015, which can be found in the original version of the paper. The dataset consists of 2 parts: (1) data produced by SCINDA; (2) processed data.

The types of the data produced by SCINDA are described in the original paper. The processed data are the TEC, S4, ROTI and position (latitude, longitude, altitude) extracted from the SCINDA data. Since the receiver was not calibrated when installed a provisionally calibrated TEC data is provided. The processing of the original SCINDA data was done using (1) a dedicated "SCINDA-Iono" toolbox for MATLAB; (2) scripts for R. Both the MATLAB toolbox and the R scripts allow to calculate 1-min and 1-hour means for ionospheric parameters both for each of available receiver-satellite pairs and averaged over all available satellites during the analysed hour, however the toolbox and the scripts are not interchangeable.

Specifications Table

Subject	Atmospheric Science
Specific subject area	The datasets provided by a GNSS receivers in particular, the total electron content (TEC), scintillation indices, position
Type of data	Table ASCII Tab-delimited data files Binary data files
How data were acquired	The data have been recorded by a GNSS receiver installed in Lisbon airport area. Instruments: the installed equipment is a NovAtel EURO4 with a JAVAD Choke-Ring antenna and a firmware (SCINDA) installed. SCINDA (Scintillation Network Decision Aid) is a system designed to specify ionospheric scintillation in real time and was developed by the US Air Forces. There are no differences in the data acquisition methods comparing to the original paper
Data format	Raw Processed
Description of data collection	Data presented here were collected from December 2014 to February 2019.The data were acquired continuously at 1 min cadence. The firmware SCINDA give a file as output with calculated receiver position along with time-tag and the number of satellites in view, including satellite identifier number (PRN) for the tracked ones. The total electron content (TEC) and scintillation indices S4 and ROTI were calculated by the SCINDA software for each of the satellites separately. The acquired TEC data are without correction for the reciever bias. The processed data of the updated version include not only TEC, S4 and ROTI values but also the positioning errors. Also, the series of TEC, S4 and ROTI are extended to the years 2014 and from 2016 to 2019.
Data source location	Institution: Lisbon airport area City/Town/Region: Lisbon Country: Portugal Latitude and longitude (and GPS coordinates) for collected samples/data: Latitude (degrees): 38.77932527 Longitude (degrees): -9.139699966 Altitude (ellipsoidal, m): 128.139
Data accessibility	Repository name: Mendeley Data Data identification number: 10.17632/3z6mjk39jv.2 Direct URL to data: https://data.mendeley.com/datasets/3z6mjk39jv/2
Related data article	Tatiana Barlyaeva, Teresa Barata, Anna Morozova, 2020, Datasets of ionospheric parameters provided by SCINDA GNSS receiver from Lisbon airport area, Data in Brief, 31, 105966, https://doi.org/10.1016/j.dib.2020.105966

Value of the Data

- Here a data set allowing to study ionospheric conditions and GNSS positioning quality for Lisbon area (Portugal) between December 2014 and February 2019 is provided: the total electron content (TEC), the scintillation indices S4 and ROTI and the position of the receiver in GPS coordinates (latitude, longitude, height).
- The data set contains both the raw and processed data. In general, the processing includes the removal of outliers and the data from non-GPS satellites, the replacement of missing data by "NA", and application of the elevation mask to the TEC data ($\geq 15°$). Since the receiver was not calibrated when installed a provisionally calibrated TEC data is also provided. The recommended tools to process the raw data are the "SCINDA-Iono" toolbox for the MATLAB [1,2] and a set of R scripts [3], which are publicly available.

- These data can be used for the analysis of atmospheric and space weather effects on the GNSS signal quality and estimations of corrections to be used in upcoming GNSS services/systems accounting for the space weather conditions.
- GNSS is widely used now in numerous applications for roads, railways, maritime, agriculture, air navigation and unmanned aerial vehicles (UAVs), so the improvements of (e.g.) position information provided by GNSS services can serve for the safety of life.
- At least three main communities can directly benefit from these data: the communities of ionosphere sciences, GNSS-based technologies and services and the scientific.

1. Objective

The GNSS receiver was installed in the frame of the SWAIR project (https://about.swair.ptech. io/#about) to monitor ionospheric conditions and the positioning errors at Lisbon airport. The goal was to understand severity and frequency of ionospheric disturbances at middle latitudes and to identify those that may be related to space weather (solar and geomagnetic activity variations). A receiver with the SCINDA equipment was provided by SEGAL (http://segal.ubi.pt/). This receiver has the SCINDA software that generate data automatically (TEC, S4, ROTI, position of the receiver) with 1 min cadence.

2. Data Description

The presented datasets cover the time interval from December 2014 to February 2019 (as was mentioned in [4], the receiver was installed in the Lisbon airport area between November 2014 and July 2019, but the data were collected for a shorter time interval due to technical and organizational problems), except for the SCINDA data for 2015, which can be found in the original dataset [4]. All the data are in an archived format and have 1 min cadence.

The dataset consists of the raw SCINDA data that can be found in the folder "\SCINDA data" and the processed data that are in the folder "\Processed data" (Fig. 1, top).

Fig. 1. The Root (top) and the "\SCINDA data" (bottom) folders.

2.1. SCINDA data

The data produced by SCINDA include the general messages on quality of records (∗.msg); random number generator files (∗.rng); raw observables as the signal-to-noise (S/N) ratios, pseudoranges and phases (∗.obs); receiver position information (∗.psn); ionosphere scintillations monitor (∗.ism); ionospheric parameters: total electron content (TEC), rate of change of TEC index (ROTI), and the scintillation index S4 (∗.scn). More details about the SCINDA software and its file formats and parameters can be found in [5,6].

The folder "\SCINDA data" contains five zip files (Fig. 1, bottom), one per a year (2014, 2016, 2017, 2018, 2019) and the SCINDA files can be downloaded for each year individually (data for 2015 can be downloaded from [4]). The structure of the files inside the each of a zip archive is the same as was described in [4,5]. To summarize:

All zip files in the "SCINDA data" folders contain archived folders for the specific year with the name in the format "YYYY\" (e.g., 2014), which, in turn, contain subfolders entitled "MM-Mon\" which, in turn, include sets of gz-archived files with the names in the format, e.g., "YYM-MDD_HH0000" (where '0000′ suffix corresponds to the hour '00:00′ etc.) and the extensions ".ism", ".msg", ".obs", ".psn" and ".scn".

Each data file covers 1-hour interval and consists of the data of 1-minute resolution for all visible satellites.

Format of ∗.scn files:

- Each epoch starts from the letter 'T' and contains
    - YY (year, in two digits),
    - MM (month, in two digits),
    - DD (day, in two digits),
    - UTSEC (seconds since midnight).
- The data of each epoch contains
    - AZ (azimuth of satellite, in degrees),
    - EL (elevation of satellite, in degrees),
    - L1S4 (Scintillation intensity index on L1),
    - L2S4 (Scintillation intensity index on L2),
    - %SAM (% samples taken compared to number expected, 0-100%),
    - TECP (differential pseudorange, in TECU),
    - TECF (differential carrier phase, in TECU),
    - TECR (relative (uncalibrated) TEC, in TECU),
    - ROTI (Std of rate of change of TEC over one minute),
    - N (time since last time slip, minutes),
    - PRN (pseudorandom noise satellite identifier).

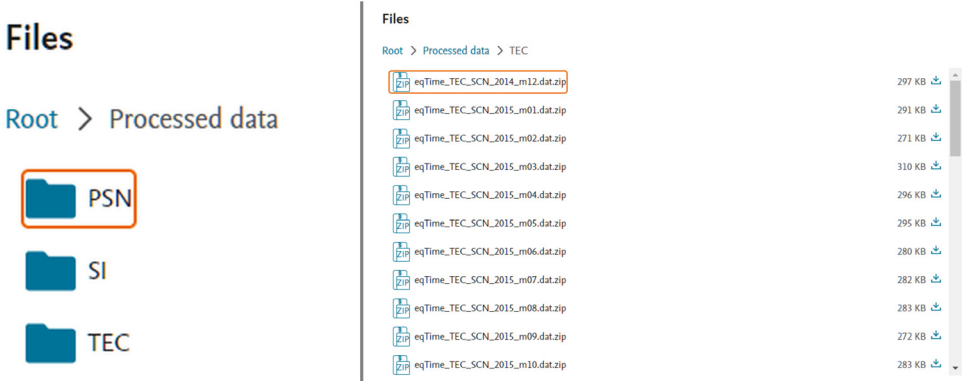Please note: the receiver was not calibrated on biases to calculate calibrated TEC in TECu.
Format of ∗.psn files:

- Each epoch starts from the letter 'T' and contains
    - YY (year, in two digits),
    - MM (month, in two digits),
    - DD (day, in two digits),
    - UTSEC (seconds since midnight).
- The data of each epoch contains
    - Latitude (°)
    - Longitude (°)
    - Height of the receiver antenna (cm)
    - Tracking information

Fig. 2. The "\Processed data" folder (left), and an example of the files in the "\Processed data\TEC" folder (right).

2.2. Processed data

The processed data are the TEC, S4, ROTI (rate of TEC index) and position (latitude, longitude, height) extracted from the SCINDA data and processed (see section Experimental Design, Materials and Methods). In general, the processing includes the removal of outliers and the data from non-GPS satellites, the replacement of missing data by "NA", application of the elevation mask to the TEC data ($\geq 15°$). Since the receiver was not calibrated when installed a provisionally calibrated TEC data is also provided.

The processing of the original SCINDA data was done using

(1) a dedicated "SCINDA-Iono" toolbox for MATLAB developed by T. Barlyaeva (2019, updated in 2022) and available online via MathWorks File Exchange system [1,2];

(2) scripts for R developed by A. Morozova (2022) and available online via GitHub [3].

Both the MATLAB toolbox and the R scripts allow to calculate 1-min and 1-hour means for ionospheric parameters both for each of available receiver-satellite pairs and averaged over all available satellites during the analysed hour, however the toolbox and the scripts are not interchangeable (please see section Experimental Design, Materials and Methods for more details).

The folder "\Processed data" contains 3 sub-folders: "\PSN" (contain data sets on the positioning errors), "\SI" (contains data sets on S4 and ROTI) and "\TEC" (contains data on TEC) – see Fig. 2 (left). Each of these sub-folders (Fig. 2, right) contains 51 zip files in the format "eqTime_***_SCN_data_YYYY_mMM.dat.zip", where *** is either "PSN", or "SI", or "TEC", YYY is a year and MM is a month's number. Each of the zip files contains a data file (Tab-delimited ASCII file) named "eqTime_***_SCN_data_YYYY_mMM.dat" for PSN and SI and "SCN_TEC_1min_YYYY_mMM.dat" for TEC.

Format of eqTime_PSN_data_YYYY_mMM.dat files (Fig. 3):

- time.stamp
- year
- month
- day
- sec.f.midnight (seconds from midnight)
- h (hour)
- m (minute)
- s (second)
- mean.x (mean latitude for the 1 min time interval, from all available measurements)
- mean.y (mean longitude for the 1 min time interval, from all available measurements)
- mean.z (mean height for the 1 min time interval, from all available measurements)

time.stamp	year	month	day	sec.f.midnight	h	m	s	mean.x	mean.y	mean.z	sigma.x	sigma.y	sigma.z
2017-09-01 00:00:00	2017	9	1	44	0	0	44	NA	NA	NA	NA	NA	NA
2017-09-01 00:01:00	2017	9	1	104	0	1	44	NA	NA	NA	NA	NA	NA
2017-09-01 00:02:00	2017	9	1	164	0	2	44	NA	NA	NA	NA	NA	NA
2017-09-01 00:03:00	2017	9	1	224	0	3	44	NA	NA	NA	NA	NA	NA
2017-09-01 00:04:00	2017	9	1	284	0	4	44	NA	NA	NA	NA	NA	NA
2017-09-01 00:05:00	2017	9	1	344	0	5	44	NA	NA	NA	NA	NA	NA
2017-09-01 00:06:00	2017	9	1	404	0	6	44	NA	NA	NA	NA	NA	NA
2017-09-01 00:07:00	2017	9	1	464	0	7	44	NA	NA	NA	NA	NA	NA
2017-09-01 00:08:00	2017	9	1	524	0	8	44	NA	NA	NA	NA	NA	NA
2017-09-01 00:09:00	2017	9	1	584	0	9	44	NA	NA	NA	NA	NA	NA
2017-09-01 00:10:00	2017	9	1	644	0	10	44	NA	NA	NA	NA	NA	NA
2017-09-01 00:11:00	2017	9	1	704	0	11	44	NA	NA	NA	NA	NA	NA
2017-09-01 00:12:00	2017	9	1	764	0	12	44	NA	NA	NA	NA	NA	NA
2017-09-01 00:13:00	2017	9	1	824	0	13	44	NA	NA	NA	NA	NA	NA
2017-09-01 00:14:00	2017	9	1	884	0	14	44	NA	NA	NA	NA	NA	NA
2017-09-01 00:15:00	2017	9	1	944	0	15	44	NA	NA	NA	NA	NA	NA
2017-09-01 00:16:00	2017	9	1	1004	0	16	44	NA	NA	NA	NA	NA	NA
2017-09-01 00:17:00	2017	9	1	1064	0	17	44	NA	NA	NA	NA	NA	NA
2017-09-01 00:18:00	2017	9	1	1124	0	18	44	NA	NA	NA	NA	NA	NA
2017-09-01 00:19:00	2017	9	1	1184	0	19	44	NA	NA	NA	NA	NA	NA
2017-09-01 00:20:00	2017	9	1	1244	0	20	44	NA	NA	NA	NA	NA	NA
2017-09-01 00:21:00	2017	9	1	1304	0	21	44	NA	NA	NA	NA	NA	NA

Fig. 3. Example of a eqTime_PSN_data_YYYY_mMM.dat file

time.stamp	az	el	L1S4	ROTI	PRN	
2019-02-01 00:00:00	236.5	10.4	0.36	23.5	1
2019-02-01 00:00:00	294.4	18.4	0.12	11.45	7
2019-02-01 00:00:00	311.1	50.3	0.05	8.02	8
2019-02-01 00:00:00	93.7	48.2	0.06	9.32	10
2019-02-01 00:00:00	261.3	18.8	0.15	NA	11
2019-02-01 00:00:00	159.8	60.9	0.04	7.76	16
2019-02-01 00:00:00	243.6	37.1	0.07	10.46	18
2019-02-01 00:00:00	59.6	34.9	0.11	11.39	20
2019-02-01 00:00:00	156.4	32.9	0.07	10.67	26
2019-02-01 00:00:00	12.4	69	0.03	6.41	27
2019-02-01 00:01:00	236.7	10.7	0.28	23.92	1
2019-02-01 00:01:00	294	18.4	0.09	11.76	7
2019-02-01 00:01:00	311.6	50.6	0.03	8.88	8
2019-02-01 00:01:00	92.9	48.3	0.07	8.31	10
2019-02-01 00:01:00	261.6	19.1	0.14	NA	11
2019-02-01 00:01:00	159.9	60.4	0.03	9.12	16
2019-02-01 00:01:00	244	37.5	0.06	9.22	18
2019-02-01 00:01:00	59.2	34.7	0.1	8.68	20
2019-02-01 00:01:00	156.5	32.5	0.1	9.25	26
2019-02-01 00:01:00	13.7	69	0.03	8.43	27
2019-02-01 00:02:00	237	11.1	0.25	17.21	1
2019-02-01 00:02:00	293.5	18.4	0.09	11.03	7
2019-02-01 00:02:00	312	51	0.03	8.58	8
2019-02-01 00:02:00	92.2	48.3	0.04	7.29	10
2019-02-01 00:02:00	261.8	19.4	0.16	NO	11

Fig. 4. Example of a eqTime_SI_data_YYYY_mMM.dat file

- sigma.x (standard deviation for latitude for the 1 min time interval, from all available measurements)
- sigma.y (standard deviation for longitude for the 1 min time interval, from all available measurements)
- sigma.z (standard deviation for height for the 1 min time interval, from all available measurements)

Please note that in case a "sigma.*" (where "*" is either x, y or z) value is equal to 0 or NA the corresponding "mean.*" values should be to considered as erroneous (a single position estimation was done by SCINDA software for this epoch).

Format of eqTime_SI_data_YYYY_mMM.dat files (Fig. 4):

Fig. 5. Example of a eqTime_TEC_data_YYYY_mMM.dat file

- time.stamp
- az (azimuth)
- el (elevation)
- L1S4 (S4 for the L1 band)
- ROTI
- PRN

Format of SCN_TEC_1min_YYYY_mMM.dat files (Fig. 5)*:*

- time.stamp
- TECR (relative (uncalibrated) TEC, in arb. u)
- TECR.calibrated (provisionally calibrated TEC, in TECu)

Please note that in all processed files the erroneous or absent observations are marked as "NA".

3. Experimental Design, Materials and Methods

The processing of the SCINDA files is recommend to be performed using either the "SCINDA-Iono" toolbox for the MATLAB specifically developed for this purpose [1,2] which also allows to simplify data analysis and visualization, or a set of scripts developed for R [3].

3.1. SCINDA-Iono toolbox for MATLAB

The "SCINDA-Iono" toolbox for the MATLAB [1,2] is described in detail in [5]. Here a short description of updates implemented in the most recent version [2] is given.
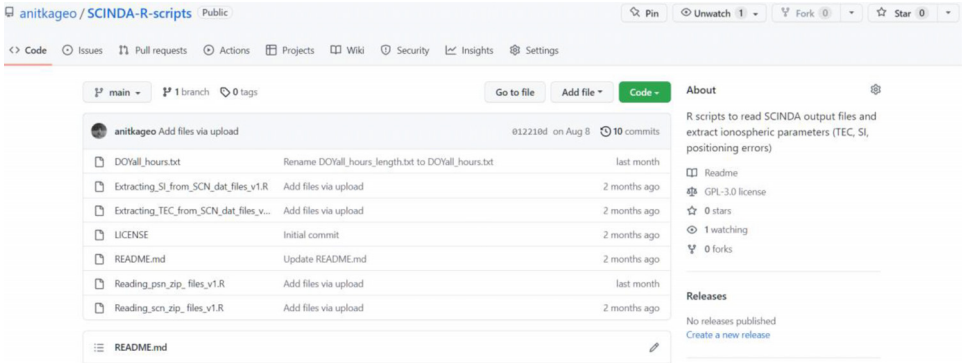
Fig. 6. Files in the SCINDA-R-scripts GitHub depository

The updated version of the "SCINDA-Iono" toolbox differs from the previous one mostly by a set of technical improvements that fix problems related to the slight changes in the receiver records' format appearing sometimes and found by the authors. Other modifications are related to the files' reading (i. e. missed values), and small improvements like spaces' appearance correction during the main script run in the MATLAB command window. The mostly important functional modification is related to the saving of additional output file that contain both the time stamps and the data in one file. The detailed "readme" file accompanies the new version of the toolbox.

3.2. SCINDA-R scripts

The set of "SCINDA-R-scripts" [3], Fig. 6, contains R scripts to read the SCINDA files *.scn and *.psn and extract ionospheric parameters (TEC, SI, positioning errors):

- Reading_scn_zip_files_v1.R
- Extracting_TEC_from_SCN_dat_files_v1.R
- Extracting_SI_from_SCN_dat_files_v1.R
- Reading_psn_zip_files_v1.R

Before using those scripts, it is fundamental to download and import to the R Environment the file "DOYall_hours_length.txt" available as well at [3]. This file contain formation on the names of the months and the length of the months for the leap and normal years, which is used by the SCINDA-R scripts.

*How to read *.scn files and extract TEC, S4 and ROTI values with 1 min time resolution:*

1. Use Reading_scn_zip_files_v1.R to read *.scn.zip files and save the content as "SCN_data_YYYY_mMM.dat" files (YYYY - year, MM - month's number)

- Input files: *.scn.zip files in a folder "D:/SCINDA/all data/…" or replace by correct address. Input folder may contain sub-folders
- Output files: "SCN_data_YYYY_mMM.dat", YYYY - year, MM - month's number Output files are saved in the current R working folder (can be checked by the getwd() command in R)

Output files header:

- year month day sec.f.midnight (seconds from midnight)
- h (hour)
- m (minute)
- s (second)

- time.stamp (format = "%Y-%m-%d %H:%M:%S)
- az (azimuth of satellite, in degrees)
- el (elevation of satellite, in degrees)
- L1S4 (Scintillation intensity index on L1)
- pc.samp.l1 (% samples taken compared to number expected, 0-100%)
- L2S4 (Scintillation intensity index on L2)
- pc.samp.l2 (% samples taken compared to number expected, 0-100%)
- TECP (differential pseudorange, in TECU)
- TECF (differential carrier phase, in TECU)
- ROTI (Std of rate of change of TEC over one minute)
- TECR (relative (uncalibrated) TEC, in TECU)
- t.since.last.cycle.slip (time since last time slip, minutes)
- PRN (pseudorandom noise satellite identifier)

2a. Use Extracting_TEC_from_SCN_dat_files_v1.R to read SCN_data_YYYY_mMM.dat files to extract TEC data with 1 min time resolution. This script reads and cleans SCINDA TEC data:

- only GPS satellites are used,
- only satellites with elevation ≥ 15° are used
- missing time epochs are identified, and missing data are set as NA

Afterward, the TEC means for 1 min time intervals (for all selected satellites) are calculated

- Input files: SCN_data_YYYY_mMM.dat files in a folder "D:/SCINDA/..." or replace by correct address. Input folder must not contain sub-folders
- Output files: "SCN_TEC_1min_YYYY_mMM.dat", YYYY - year, MM - month's number - TEC data from all available GPS satellites for 1 min time intervals

Output files are saved in the current R working folder.
Output files header:

- time.stamp
- TECR (relative/uncalibrated TEC, in arb. u)

2b. Use Extracting_SI_from_SCN_dat_files_v1.R to read SCN_data_YYYY_mMM.dat files to extract scintillation indices (SI) L1S4 and ROTI data with 1 min time resolution. This script also cleans SCINDA SI data:

- only GPS satellites,
- only satellites with elevation≥ 0° (el = 0 are missing/erroneous data),
- only satellites with ROTI > 0 (ROTI = 0 are missing/erroneous data),
- missing time epochs are identified and missing data are set as NA
    - Input files: SCN_data_YYYY_mMM.dat files in a folder "D:/SCINDA/..." or replace by correct address. Input folder must not contain sub-folders.
    - Output files: "eqTime_SI_SCN_data_YYYY_mMM.dat", YYYY - year, MM - month's number - all SI data from all available GPS satellites for 1 min time intervals

Output files are saved in the current R working folder.
Output files header:

- time.stamp
- az
- el
- L1S4
- ROTI
- PRN

How to read ∗*.psn files and extract positions and positioning errors with 1 min time resolution:*
1. Use Reading_psn_zip_files_v1.R to read ∗.psn.zip files and save the content as "PSN_data_YYYY_mMM.dat" files (where YYYY - year, MM - month's number)

- Input files: *.psn.zip fiules in a folder "D:/SCINDA/all data/..." or replace by correct address Input folder may contain sub-folders.
- Output files: "PSN_data_YYYY_mMM.dat", YYYY - year, MM - month's number - psn data as in the original SCINDA files
- Output files: "eqTime_PSN_data_YYYY_mMM.dat", YYYY - year, MM - month's number - psn data with 1 min time resolution (missing time epochs are identified and missing data are as NA)

Output files are saved in the current R working folder.
Output files header:

- time.stamp year month day
- sec.f.midnight (seconds from midnight)
- h (hour)
- m (minute)
- s (second)
- mean.x (mean latitude for the 1 min time interval, all available measurements)
- mean.y (mean longitude for the 1 min time interval, all available measurements)
- mean.z (mean height for the 1 min time interval, all available measurements)
- sigma.x (standard deviation for latitude for the 1 min time interval, all available measurements)
- sigma.y (standard deviation for longitude for the 1 min time interval, all available measurements)
- sigma.z (standard deviation for height for the 1 min time interval, all available measurements)

3.3. TEC calibration

As was mentioned above, the GNSS receiver was not calibrated during the installation, thus the generated by SCINDA TEC values are in arbitrary units. To convert these values to TEC units (1 TECu = 10^{16} electrons/m^2) one must calculate the satellite and, if possible, receiver bases [see, e.g., 6]. In the case of the uncalibrated receiver only satellite biases can be estimated using the data on the actual satellite (PRN) and its ephemerids and Differential Code Biases available, e.g., at https://igs.org/ or CDDIS GNSS Differential Code Bias Products (https://cddis.nasa.gov/Data_and_Derived_Products/GNSS/gnss_differential_code_bias_product.html).

A provisionally calibrated integrated TEC series in TECu (last column in the "SCN_TEC_1min_YYYY_mMM.dat" files) is made by calculating the means of all TEC values from different GPS satellites available for each time epoch (1 min time resolution). Then these integrated TEC values were averaged over 15 min time intervals and compared to the TEC values from the Royal Observatory of Belgium (ROB) TEC maps (http://www.gnss.be/Atmospheric_Maps/VTEC_Time_Series.php) using a grid point most close to the Lisbon airport location. The comparison was made for each day separately, and the linear regression coefficients were calculated. These linear regression coefficients were used to calibrate the 1 min integrated TEC data for that day. An example of the original integrated (in arb. u.) and provisionally calibrated integrated TEC (in TECu) series is shown in Fig. 7.

It must be noticed that for some time intervals the receiver was not working properly due to unknown (technical) reasons, so the calculated by the SCINDA software TEC value should be taken with care and verified using other data sets. There are plans to perform this analysis in future and prepare a cleaned and calibrated TEC dataset.
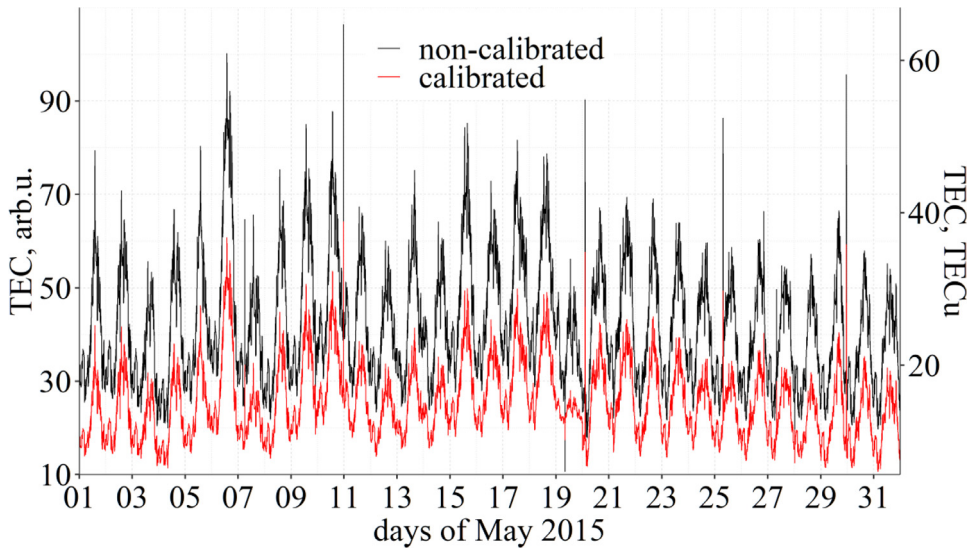
Fig. 7. Comparison of the integral non-calibrated (black) and provisionally calibrated (red) TEC series: May 2015

Ethics Statement

The authors have read and follow the ethical requirements for publication in Data in Brief. The work does not involve studies with animals and humans.

CRediT Author Statement

Anna Morozova: Conceptualization, Formal analysis, Methodology, Validation, Software, Visualization, Writing – original draft; **Tatiana Barlyaeva:** Software, Data processing, Visualization, Writing – review & editing; **Teresa Barata:** Data curation, Resources, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships which have or could be perceived to have influenced the work reported in this article.

Data Availability

Datasets of ionospheric parameters (TEC, SI, positioning errors) from Lisbon airport area for 2014-2019 (Original data) (Mendeley Data).

Acknowledgments

References

[1] Barlyaeva, T., 2019. SCINDA-Iono toolbox for MATLAB, MathWorks File Exchange system, https://www.mathworks.com/matlabcentral/fileexchange/71784-scinda-iono_toolbox.

[2] Barlyaeva, T., 2022. SCINDA-Iono_toolbox (version 1.0.4), File Exchange MATLAB Central (mathworks.com), https://fr.mathworks.com/matlabcentral/fileexchange/71784-scinda-iono_toolbox/.

[3] Morozova, A., 2022. "SCINDA-R-scripts", https://github.com/anitkageo/SCINDA-R-scripts.

[4] T. Barlyaeva, T. Barata, A. Morozova, Datasets of ionospheric parameters provided by SCINDA GNSS receiver from Lisbon airport area. https://data.mendeley.com/datasets/kkytn5d8yc/1.

[5] T. Barlyaeva, T. Barata, A. Morozova, Datasets of ionospheric parameters provided by SCINDA GNSS receiver from Lisbon airport area, Data in Brief 31 (2020) 105966, doi:10.1016/j.dib.2020.105966.

[6] Carrano, Ch. and K. Groves. Remote sensing the ionosphere using GPS-SCINDA. Presentation at IHY-AFRICA /SCINDA 2009 Workshop (2009)., available at https://slideplayer.com/slide/4903794/.