MONITORING THE DYNAMICS ON THE PECENEAGA–CAMENA FAULT: CHALLENGES OF 2024

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The Solid Earth Dynamics Department (SEDD) of the Romanian Academy's Institute of Geodynamics has been monitoring the Peceneaga–Camena Fault (PCF) slip rate for over a decade. The Bașpunar permanent geodynamic station has implemented a comprehensive monitoring system, including geodetic and meteorological measurements. The recent failure of the meteorological data acquisition system has significantly impacted the research since weather data is crucial for accurate correction applied to geodetic recordings. The absence of this data would have hindered the analysis of PCF dynamics, but our team has mitigated the effects of the hardware failure.

1. INTRODUCTION

Bașpunar Permanent Geodynamic Station, currently named Bașpunar Geodynamic Observatory (BGO), was meant to be a so-called "near-fault observatory". It was designed and built on the flanks of the deep-seated PCF, a major lithospheric contact between the Moesian Micro-Plate (MoP) and East European Plate (EEP). BGO location and equipment were set based on models previously proposed by Beșuţiu and Zugrăvescu (2004) and Beșuțiu (2009) to monitor changes in the tectonic stress within SE Carpathian foreland based on the observation of PCF slip rates. Detailed information regarding BGO infrastructure (Leica TPS 1200 and 1201 total stations and a semiprofessional weather station), operations, and results were presented in previous works (Beşutiu and Zlăgnean, 2009 a,b; Beșuțiu and Zlăgnean, 2010 a,b; Beşutiu *et al*., 2013, Zlăgnean *et al*., 2023; Pomeran and Zlăgnean, 2024; Zlăgnean and Beşutiu, 2024). Currently, a TPS 1201 total station and a weather station are in use.

2. RATIONALE BEHIND THE RESEARCH

As mentioned in previous works, the distance between the total station located on the Proterozoic Green Schist series of the MoP basement and the reflector installed on the other flank of PCF, on the North Dobrogea Triassic deposits (Beșuțiu *et al*. 2014) is measured, and stored every minute. Time series are corrected for changes in the atmospheric parameters as recorded by weather station (air pressure, temperature, and relative humidity) following the formulae provided by the manufacturer and geodetic literature:

$$S_Dcorr=(S_Dmeas \times n_o) / n_A$$

Where

S_Dcorr is the corrected distance,
S_Dmeas is the measured distance and
n_o and n_A have the following forms:

$$n_0 = 1 + \frac{n_g - 1}{1 + 0.003661 * 12} * \frac{760}{760} - \frac{5.5 * 10^{-8}}{1 - 0.003661 * 12} * 4.58 * 10^{\frac{12a}{b+12}} * \frac{60}{100}$$

$$n_A = 1 + \frac{n_g - 1}{1 + 0.003661 * t} * \frac{PmmHg}{760} - \frac{5.5 * 10^{-8}}{1 - 0.003661 * t} * 4.58 * 10^{\frac{at}{b+t}} * \frac{r}{100}$$

n_g is a constant of the instrument we use, in our case Leica TPS 1201, and is provided by the following formula:

$$n_g = 2876.04 + 3 * \frac{16.288}{\lambda^2} + 5 * \frac{0.136}{\lambda^4} 10^{-7} + 1$$

And
a=7.5, b= 237.3 and λ = 658 wavelength of the beam.

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To mitigate as much as possible the residual noise generated by the deformations produced by direct solar radiation on the support on which the station's reflector is installed, only the nocturnal recordings between sunset and sunrise are taken into account.

A system of scripts was developed, continuously improved, and maintained in operation for several years to apply the correction formulas. We use it daily to process data measured in the field. The original data post-processing scripts were largely described in Zlăgnean *et al*., 2023 and Pomeran and Zlăgnean, 2024.

During the past year, the necessity arose to develop a new method for acquiring primary data, as the previous weather station model had been discontinued, and existing stocks were depleted. This led to the use of a new weather station model. This new model has a different data storage format, necessitating a change in the data acquisition module. Since it was previously decided to develop auxiliary software to streamline the work of processing primary data collected automatically from the field, the change in acquisition equipment and the format in which it stores data necessitated integrating this equipment into the already functioning system.

The primary data collected from the field represent **the input data** for the script system. The text files received from the observatory contain a record of data on each line. The total stations record distances and angles, along with a time label.

No.	Date	Time	Slope distance	Horizontal distance	Horizontal angle	Vertical angle
14	24.10.2022	0.3755903	351.9198	351.7204	274.48519	102.14654
15	24.10.2022	0.3790741	351.9198	351.7204	274.48523	102.14646
16	24.10.2022	0.3825463	351.9199	351.7205	274.48529	102.14642
17	24.10.2022	0.3860185	351.9189	351.7195	274.48532	102.14635
18	24.10.2022	0.3895023	351.9199	351.7205	274.48539	102.14627
19	24.10.2022	0.3929745	351.9192	351.7198	274.4854	102.14623
20	24.10.2022	0.3964468	351.9191	351.7198	274.48547	102.14617
21	24.10.2022	0.3999306	351.9193	351.72	274.4855	102.14613
22	24.10.2022	0.4034028	351.9192	351.7199	274.48552	102.14611
23	24.10.2022	0.4068866	351.9191	351.7198	274.48563	102.14606
24	24.10.2022	0.4103588	351.9191	351.7198	274.4857	102.14604

Figure 1 Excerpt from the file acquired from total station.

In addition to the distances file, a separate file from a semi-professional weather station provides temperature, pressure, and air humidity information. Here is an excerpt from a data file obtained from the previously used weather station model:

Absolute Pressure [hPa]	Indoor Temperature [°C]	Indoor Humidity [%]	Outdoor Temperature [°C]	Outdoor Humidity [%]	Dewpoint [°C]	Windchill [°C]	Wind Speed [km/h]	Wind Direction	Rain Total [mm]	Time	Date
997,4	14,3	63	8,6	84	6,0	8,6	0,0	W	338,2	19:01	24.10.2022
997,4	14,2	63	8,6	84	6,0	8,6	0,0	W	338,2	19:06	24.10.2022
997,4	14,2	63	8,5	84	5,9	8,5	0,0	W	338,2	19:11	24.10.2022
997,5	14,1	63	8,5	85	6,1	8,5	0,0	W	338,2	19:16	24.10.2022
997,5	14,1	63	8,4	85	6,0	8,4	0,0	W	338,2	19:21	24.10.2022
997,5	14,0	63	8,4	85	6,0	8,4	0,0	WSW	338,2	19:26	24.10.2022
997,5	14,0	63	8,3	85	5,9	8,3	0,0	W	338,2	19:31	24.10.2022
997,5	13,9	63	8,3	85	5,9	8,3	0,0	WSW	338,2	19:36	24.10.2022
997,4	13,9	63	8,2	85	5,8	8,2	0,0	WSW	338,2	19:41	24.10.2022
997,4	13,8	63	8,1	85	5,7	8,1	0,0	WSW	338,2	19:46	24.10.2022
997,4	13,8	63	8,2	85	5,8	8,2	0,0	W	338,2	19:51	24.10.2022
997,3	13,8	63	8,2	85	5,8	8,2	0,0	WSW	338,2	19:56	24.10.2022
997,2	13,7	63	8,1	85	5,7	8,1	0,0	WNW	338,2	20:01	24.10.2022

Figure 2 Excerpt from the file acquired from the old weather station.

A snipped raw format of the data provided by the new weather station model, put into service last year, is presented in the following figure:

No.	Time	Interval	Indoor Temperature (°C)	Indoor Humidity (%)	Outdoor Temperature (°C)	Outdoor Humidity (%)	Relative Pressure (hpa)	Absolute Pressure (hpa)	Wind Speed (m/s)	Gust (m/s)	Wind Direction	DewPoint (°C)	WindChill (°C)	Hour Rainfall (mm)	24 Hour Rainfall (mm)	Week Rainfall (mm)	Month Rainfall (mm)	Total Rainfall (mm)
366	1/1/2024 0:02	5	21.9	32	-3.6	95	1008.6	995.4	0	0	WNW	-4.3	-3.6	0	0	0	0	0
367	1/1/2024 0:07	5	21.9	31	-3.7	95	1008.5	995.3	0	0	WNW	-4.4	-3.7	0	0	0	0	0
368	1/1/2024 0:12	5	21.8	31	-3.7	95	1008.3	995.1	0	0	WNW	-4.4	-3.7	0	0	0	0	0
369	1/1/2024 0:17	5	21.8	31	-3.7	94	1008.4	995.2	0	0	WNW	-4.5	-3.7	0	0	0	0	0
370	1/1/2024 0:22	5	21.7	31	-3.7	95	1008.3	995.1	0	0	WNW	-4.4	-3.7	0	0	0	0	0
371	1/1/2024 0:27	5	21.7	31	-3.4	95	1008.3	995.1	0	0	WNW	-4.1	-3.4	0	0	0	0	0
372	1/1/2024 0:32	5	21.6	31	-3.5	95	1008.1	994.9	0	0	WNW	-4.2	-3.5	0	0	0	0	0
373	1/1/2024 0:37	5	21.6	32	-3.5	95	1008.2	995	0	0	WNW	-4.2	-3.5	0	0	0	0	0
374	1/1/2024 0:42	5	21.7	32	-3.6	95	1008.2	995	0	0	WNW	-4.3	-3.6	0	0	0	0	0
375	1/1/2024 0:47	5	21.7	32	-3.6	95	1007.9	994.7	0	0	WNW	-4.3	-3.6	0	0	0	0	0
376	1/1/2024 0:52	5	21.8	32	-3.6	95	1008	994.8	0	0	WNW	-4.3	-3.6	0	0	0	0	0
377	1/1/2024 0:57	5	21.9	32	-3.2	96	1008.2	995	0	0	WNW	-3.8	-3.2	0	0	0	0	0
378	1/1/2024 1:02	5	22.1	32	-3.1	95	1008	994.8	0	0	WNW	-3.8	-3.1	0	0	0	0	0
379	1/1/2024 1:07	5	22.2	32	-3.3	95	1008	994.8	0	0	WNW	-4	-3.3	0	0	0	0	0
380	1/1/2024 1:12	5	22.2	31	-3.3	94	1008	994.8	0	0	WNW	-4.1	-3.3	0	0	0	0	0
381	1/1/2024 1:17	5	22.3	31	-3.4	94	1007.8	994.6	0	0	WNW	-4.2	-3.4	0	0	0	0	0
382	1/1/2024 1:22	5	22.3	31	-3.5	95	1007.9	994.7	0	0	WNW	-4.2	-3.5	0	0	0	0	0

Figure 3 Excerpt from the file acquired from the new weather station.

The above file would be the input data format for the software developed last year.

The proposed solution was chosen after careful consideration and was designed to minimize the impact on existing software components. Therefore, we rewrote the data recorded by the new weather station in the format used by the old weather station and the rest of the data processing software package.

3. METHODOLOGY

The Linux operating system was selected as the programming environment for applying the corrections on records in data files. This choice was mainly driven by the developer's preference for this platform and the significant advantage of cost-free access to Linux and its associated software ecosystem. This cost-effectiveness, combined with the rich suite of tools for text file processing and other tasks, makes Linux a highly practical choice.

Dr. Lucian Beșuțiu, head of SEDD, coordinated the development of the data processing software. Dr. Luminița Zlăgnean, Eng. Raluca Brezeanu, Eng. Mihai Pomeran and all members of the laboratory actively contributed to this work.

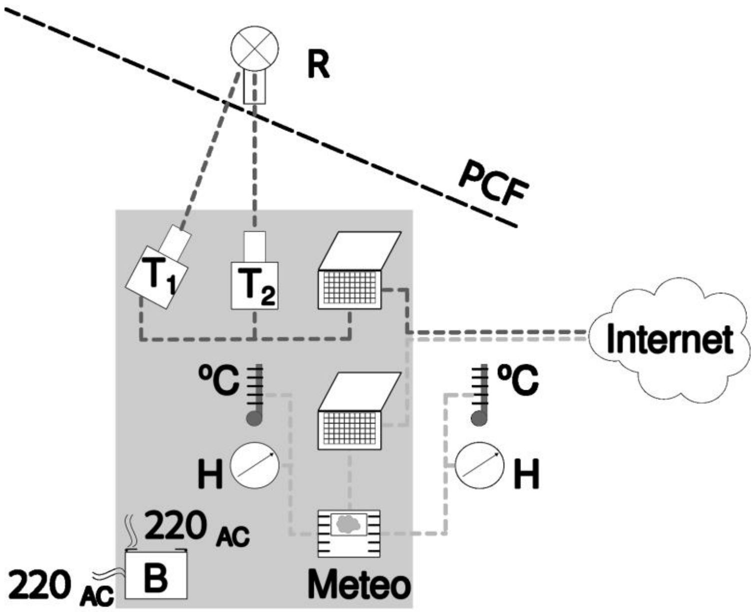

Figure 4 Data workflow at the BGO. The **T1** and **T2** Total stations measure distance; the **Meteo** weather station measures atmospheric conditions. The two kinds of information are transferred offsite via the WWW.

Figure 4 presents the overall workflow of the data at the BGO. The distance measured by the Total stations is stored on a computer that also controls the interval duration between records. Another computer controls the weather station, which stores the data on its hard drive. Once a day, the data is transferred to the center via the Internet.

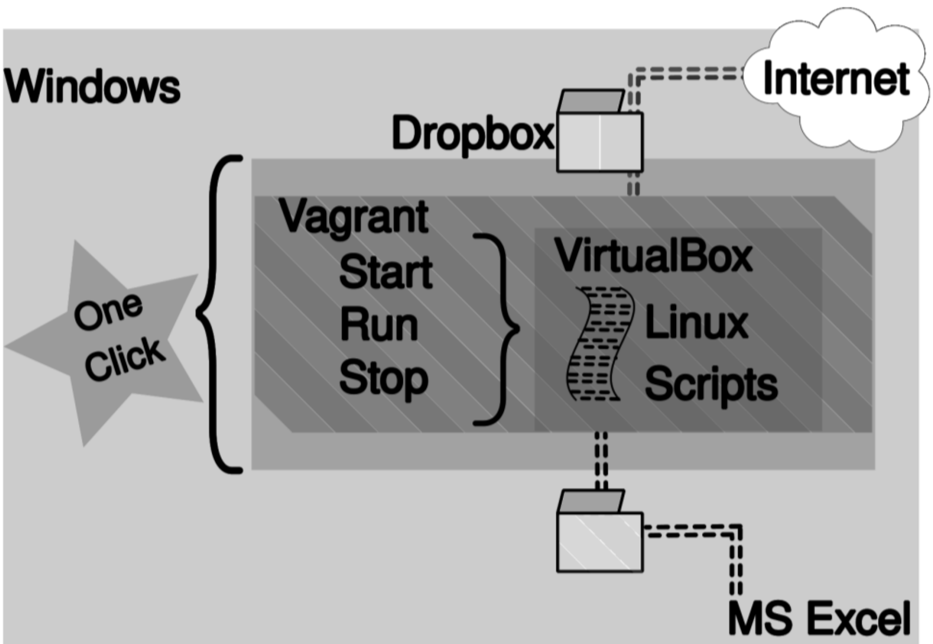

Figure 5 Schematic data workflow at the center. The integration of two types of information is achieved by running Linux scripts within a virtual machine (VM). The results are then processed and summarized in MS Excel, marking the final step of the workflow.

The data received from last weekday at the center, undergoes further processing. The formulae, as presented earlier, are applied to each record. Before this, various operations are performed, as the raw data often contains anomalies and the clocks of the different equipment drift apart. The overall workflow of this process is presented in Figure 5. The 'one-click ' launch (see Figure 5) is captured in a screenshot shown in Figure 6. The output messages of the VM are shown in Figure 7.

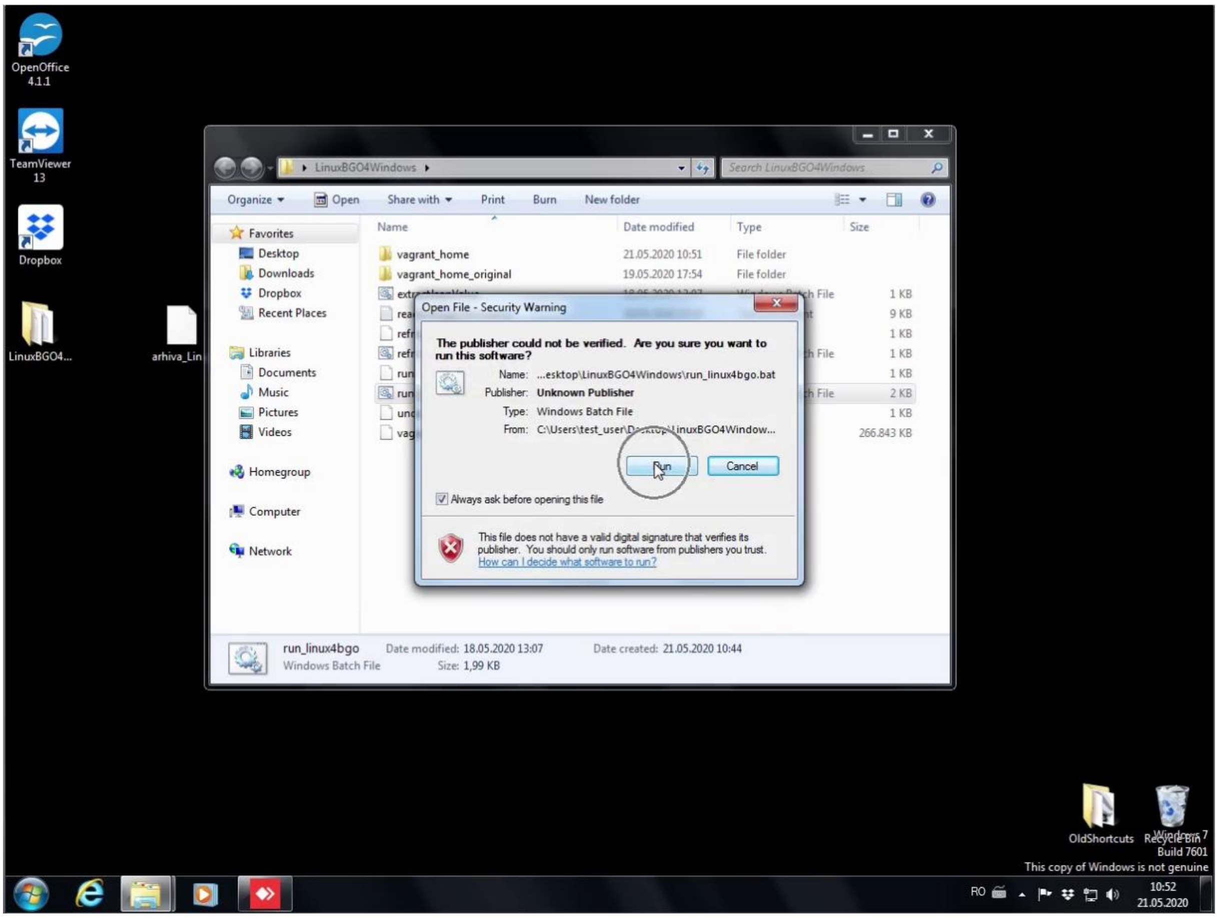

Figure 6 Screenshot at the launch of the Windows script
that runs the Linux VM and the scripts within.

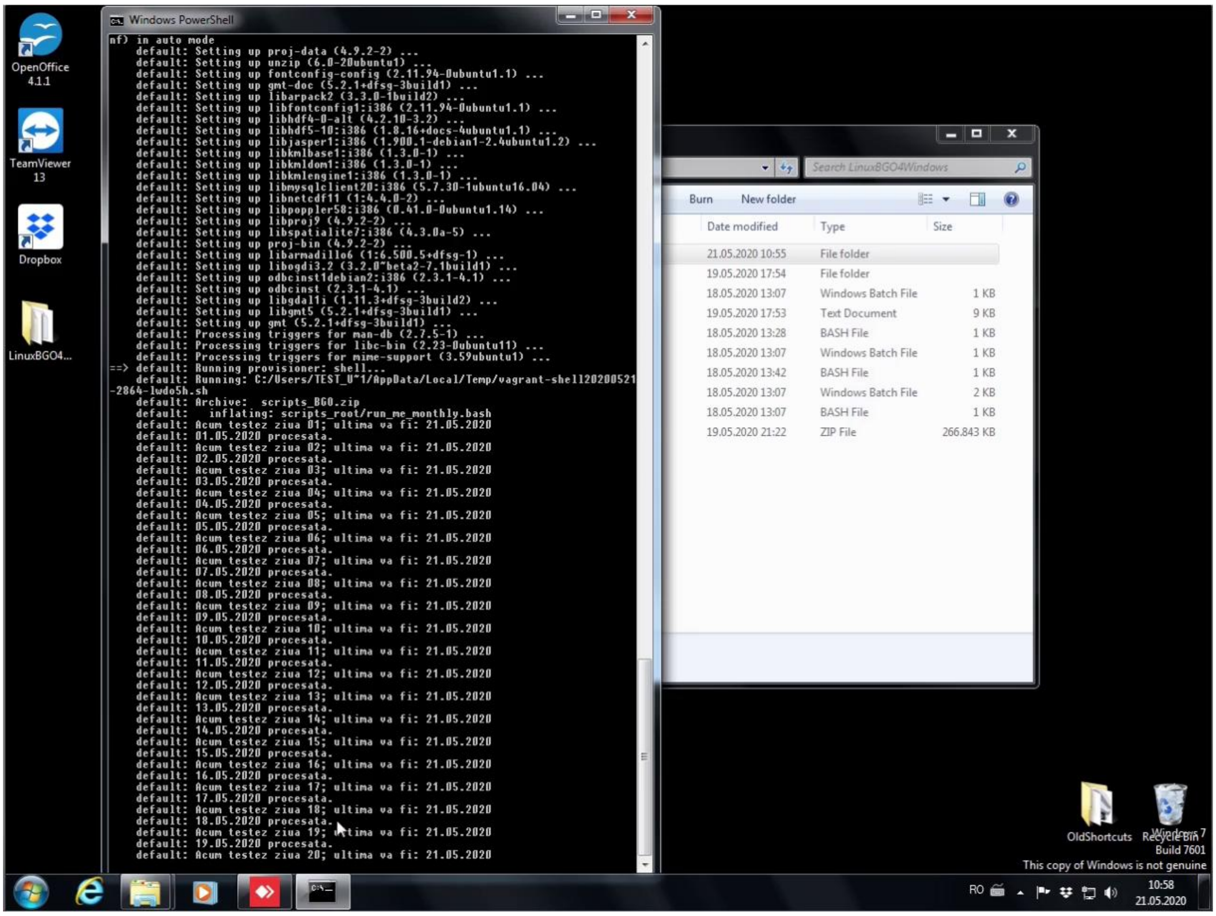

Figure 7 Screenshot of the running VM. The window on the left shows the "current day messages" that indicate the daily scripts are running without errors.

The new module was integrated into a script that performs the operations on the current month. The flowchart of that script is presented in Figures 8 and 9. The call to the new module is present within the "Test the existence of raw data" step at the bottom of Figure 8.

VM are shown in Figure 7.

The "Print the current day message" step in the loop at the bottom of Figure 9 is captured in the left window on the screenshot presented in Figure 7.

To make use of the new data acquisition module, we inserted it in the old program flow. Figure 10 illustrates the changes made to the old script. The call to the new module is made as part of the step that tests the existence of the input "meteo" files, which contain the weather data. If the files exist and a switch for using the new format is present in the *settings* portion of the script (top of Figure 10), then the files are translated from the new to the old format.

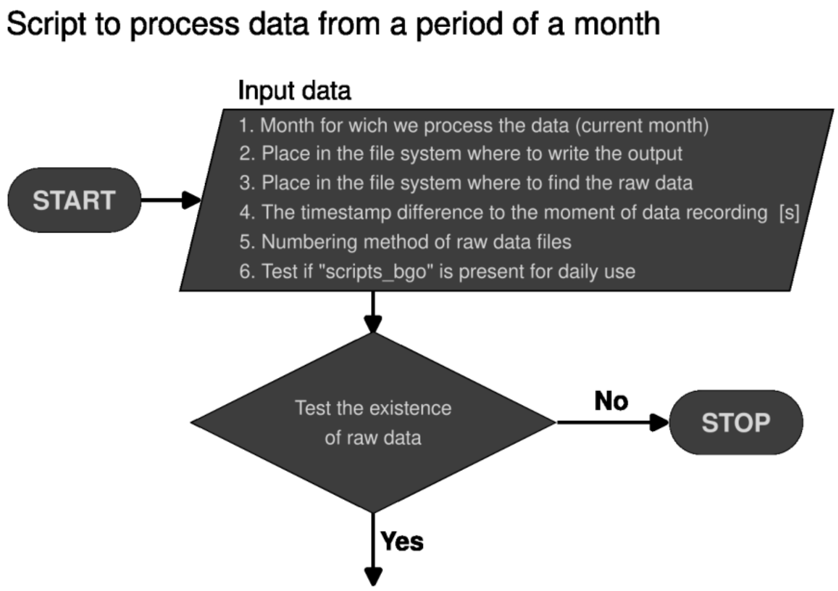

Figure 8 Flowchart of the main Linux script that launches in the loop the “daily” processing scripts – part 1 of 2.

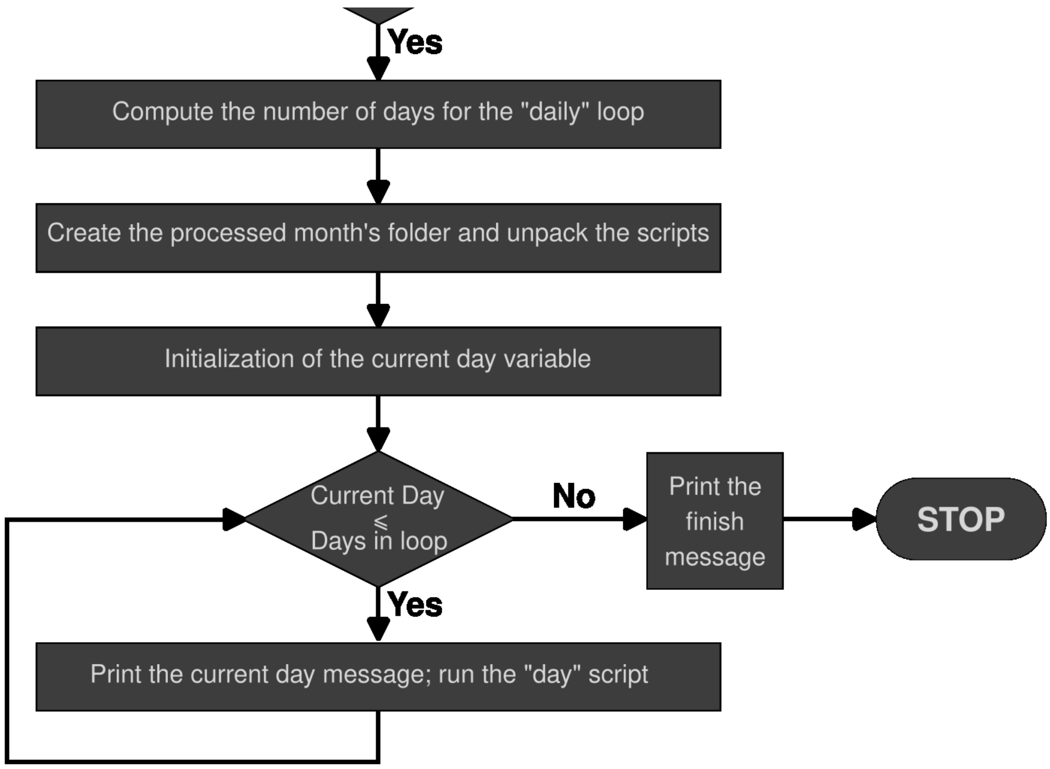

Figure 9 Flowchart of the main Linux script that loops the “daily” processing scripts – part 2 of 2.

```
...
source $whereSettings
...
if [[ $bUseNewFormat == "true" ]] ; then

      iUsefulNewMeteoFiles= $(ls -1d ${meteo_BGO_root}/ \
      meteo[${ISO_nextMonth}][${ISO_thisMonth}][[${ISO_lastMonth}]*.${newFormatSuff} \
                                                           2>/dev/null | wc -l )
      if [[ ! $iUsefulNewMeteoFiles > 0 ]] ; then
            echo "Nu exista fisiere de tip meteo*.${newFormatSuff} in" \
             $(realpath ${tc_BGO_root})
            exit 1
      else
        rm -fr \
${meteo_BGO_root}/meteo[${ISO_nextMonth}][${ISO_thisMonth}][[${ISO_lastMonth}]*.txt
        for fNewMETEOFileName in \
      $(ls -1d
${meteo_BGO_root}/meteo[${ISO_nextMonth}][${ISO_thisMonth}][[${ISO_lastMonth}]*.\
            ${newFormatSuff} 2>/dev/null)
        do
          echo Gasit $fNewMETEOFileName, aplic procesare ptr statie meteo noua.
          fNewMETEOTempFileName="/tmp/"$(basename $(echo $fNewMETEOFileName))
          iconv -f UTF-16LE -t UTF-8 $fNewMETEOFileName > $fNewMETEOTempFileName
          fProcessedMETEOFileName=\
                  $(echo $fNewMETEOFileName |sed -re 's|'${newFormatSuff}'|txt|')
          fProcessedMETEOTempFile=\
      "/tmp/"$(basename $(echo $fNewMETEOFileName |sed -re 's|'${newFormatSuff}'|txt|'))

          python easy2heavy_weather.py  -i $fNewMETEOTempFileName -o \
                               $fProcessedMETEOTempFile -c easy2heavy_weather.ini
          cp $fProcessedMETEOTempFile $fProcessedMETEOFileName

          echo Fisier procesat: $fProcessedMETEOFileName
        done
      fi
fi
...
```

Figure 10 Calling the new acquisition module: “easy2heavy_weather.py”; an excerpt from the BASH script that loops the “daily” processing scripts.

Prior to the implementation of the new data acquisition module, the following core software tools were required to execute data processing programs:

- *Linux operating system*
- *BASH shell*
- *GMT (Generic Mapping Tools)*
- *Gawk*

After the implementation of the new data acquisition module we added the *Python* programming language as a requirement

- *Python*

The Linux operating system underpins the functioning of all other components. This choice was made at the beginning of the software development process, specifically to encourage SEDD members to utilize this operating system, which is also used for operating the SEDD’s computer cluster (Manea *et al*. 2012).

The BASH shell is employed to execute scripts that perform various simple file operations, such as:

- changing date formats
- reordering columns
- filtering data to obtain records for a single calendar day
- other operations.

Variations in date and time formats exist between the Total and Weather stations. A standardized time stamp format for the final measurements was established to ensure consistency. Introducing new meteorological data acquisition equipment complicated these time stamp transformations due to the latest data storage format.

The GMT (Generic Mapping Tools) and gawk packages are utilized for approximations in cases where irregular time intervals appear in the record series and for other processing tasks that exceed the capabilities of the BASH scripting language.

The newly developed program can also be invoked to convert the data storage format from the new to the old version from a Linux command line as follows:

```
$python easy2heavy_weather.py -i NewMETEOFile.txt -o OldMETEOFile.txt \
        -c easy2heavy_weather.ini
```

Figure 11 Calling the new acquisition module: "easy2heavy_weather.py" from command line.

The *NewMETEOFile.txt* file contains data stored in the new weather station format, while *OldMETEOFile.txt* includes data stored in the old weather station format.

The configuration file *easy2heavy_weather.ini* encodes the desired data transformation. It is tailored to meet the SEDD management's requirements, but other input and output file configurations are also possible, thus enhancing the generality of the developed solution.

Configuration file

The data stored in the new format needs to undergo certain modifications: specific columns must be removed, and the order of the remaining columns must be rearranged.

The timestamp is a special case, with a single field in the new format compared to two in the old. Furthermore, both the date-part and time-part formats differ between the two formats.

Specifically, because a programming language is needed to handle this timestamp transformation, a module that could address this issue generally was decided to be developed.

An input (configuration) file is required to define the correspondences between columns (for removal and reordering), as well as the input data format (the format used by the newly acquired weather station) and the output data format (the format used by the old weather station).

Figure 12 illustrates some excerpts from the configuration file.

```
[input file]
delimiter = tab

[output file]
delimiter = tab


[output columns format]
Time = HH:MM
Date = DD.MM.YYYY

[input columns format]

Time = D/M/YYYY H:MM:SS AM/PM

[corresponding columns]
; corresponding columns:
; output = input
; a column will be skipped if present in the input file but not listed here

Absolute Pressure = Absolute Pressure(hpa)
Indoor Temperature = Indoor Temperature(C)
Indoor Humidity = Indoor Humidity(%%)
Outdoor Temperature = Outdoor Temperature(C)
Outdoor Humidity = Outdoor Humidity(%%)
Dewpoint = DewPoint(C)
Windchill = WindChill(C)
Wind Speed = Wind Speed(m/s)
Wind Direction = Wind Direction
Rain Total = Total Rainfall(mm)
Time = Time
Date = Time
```

Figure 12 Excerpts from the configuration file of the new acquisition module.

Algorithm

The algorithm processes data from the input file, transforming it according to the format specified in the configuration file.

Functionality:

Reading configuration:

- Initially, the algorithm reads the configuration file to determine how to interpret the data from the input file and how to format the output data.
- The configuration specifies, among other things, the correspondence between input and output fields.

Data processing:

For each line in the input file:

- The data is parsed according to the format specified in the configuration.
- The input field “Time” is interpreted in two different ways to populate the output fields “Time” and “Date”.
- The processed data is written to the output file, following the configured output format.

Input:

- Name of the input file (new format).
- Name of the output file (old format).
- Name of the configuration file.

Output:

- The output file, containing the transformed data.

Note: The algorithm assumes that the configuration file format defines in detail how the data should be interpreted and transformed. For example, the configuration file may specify whether to use a *tab* or *comma* as the field delimiter for the input and/or output files. Additionally, data types are specified for each field, including the format for the “Time” and “Date” fields.

Date and Time Processing

We place a special emphasis on the timestamp format. Given the need to split the timestamp field and modify its display format, we developed a module to interpret timestamps based on a predefined format. Thus, each of the six integers that could be present in a timestamp:

- Hour
- Minute
- Second
- Day
- Month
- Year

are identified and then reordered into a likewise predefined format.

This subprogram is defined as a Python module. The general format for representing data (both input and output) is:

YYYY:delim:MM:delim:DD[:whitesp:]HH:
delim:MM:delim:SS[:whitesp:]AM/PM

where :delim: represents a single-character delimiter, and [:whitesp:] represents whitespace obtained through ‘*white*’ or invisible characters: tabs or spaces. The character strings: YYYY, MM, DD, HH, MM, SS, and AM/PM represent the six units of time measurement used to construct timestamps in data received from the observatory. Respectively: year, month, day, hour, minute, second. The module, developed in-house by the author of this work, using the Python programming language and an in-house developed string transformation module, writes a file to disk in the format used by the old weather station. This requirement is fulfilled primarily through the rules stored in the configuration file described previously; by interpreting it, the program produces this format modification. There are also other possibilities for modifying the column order of text files, which gives the developed solution a general character.

4. CASE STUDY

Here we present the results of applying the new module on the data acquired with the new weather station. The algorithm processes data from the input file, transforming it according to the instructions specified in the configuration file.

```
NO.    Time   Interval      Indoor Temperature(°C)     Indoor Humidity(%)  Outdoor Temperature(°C)     Outdoor Humidity(%) Relative
Pressure(hpa)Absolute Pressure(hpa)      Wind Speed(m/s)      Gust(m/s)      Wind Direction       DewPoint(°C) WindChill(°C)Hour
Rainfall(mm) 24 Hour Rainfall(mm)        Week Rainfall(mm)    Month Rainfall(mm)  Total Rainfall(mm)
1      9/19/2024 10:42:51 5      22.4   57     17     78     1014.4 1000.8 0.3   1.7    NE    13.2  17    0     0     0     0     0
2      9/19/2024 10:46:30 5      22.4   57     17     78     1014.4 1000.8 0.3   1.7    NE    13.2  17    0     0     0     0     0
3      9/19/2024 10:47:51 5      22.4   57     16.7   78     1014.5 1000.9 1     2      NNE   12.9  16.7  0     0     0     0     0
4      9/19/2024 10:48:51 5      22.4   57     17     78     1014.4 1000.8 0.3   1.7    NE    13.2  17    0     0     0     0     0
5      9/19/2024 10:51:09 5      22.4   57     17     78     1014.4 1000.8 0.3   1.7    NE    13.2  17    0     0     0     0     0
6      9/19/2024 10:51:30 5      22.4   57     16.7   78     1014.5 1000.9 1     2      NNE   12.9  16.7  0     0     0     0     0
7      9/19/2024 10:52:51 5      22.3   56     16.7   79     1014.8 1001.2 0     0.7    NE    13.1  16.7  0     0     0     0     0
8      9/19/2024 10:53:51 5      22.4   57     16.7   78     1014.5 1000.9 1     2      NNE   12.9  16.7  0     0     0     0     0
9      9/19/2024 10:56:09 5      22.4   57     16.7   78     1014.5 1000.9 1     2      NNE   12.9  16.7  0     0     0     0     0
10     9/19/2024 10:56:30 5      22.3   56     16.7   79     1014.8 1001.2 0     0.7    NE    13.1  16.7  0     0     0     0     0
11     9/19/2024 10:57:51 5      22.4   58     17.6   76     1014.7 1001.1 0.3   1      NNE   13.3  17.6  0     0     0     0     0
12     9/19/2024 10:58:51 5      22.3   56     16.7   79     1014.8 1001.2 0     0.7    NE    13.1  16.7  0     0     0     0     0
13     9/19/2024 11:01:09 5      22.3   56     16.7   79     1014.8 1001.2 0     0.7    NE    13.1  16.7  0     0     0     0     0
14     9/19/2024 11:01:30 5      22.4   58     17.6   76     1014.7 1001.1 0.3   1      NNE   13.3  17.6  0     0     0     0     0
15     9/19/2024 11:02:51 5      22.6   58     17.6   77     1014.6 1001   0.3   1      NE    13.5  17.6  0     0     0     0     0
16     9/19/2024 11:03:51 5      22.4   58     17.6   76     1014.7 1001.1 0.3   1      NNE   13.3  17.6  0     0     0     0     0
17     9/19/2024 11:06:09 5      22.4   58     17.6   76     1014.7 1001.1 0.3   1      NNE   13.3  17.6  0     0     0     0     0
18     9/19/2024 11:06:30 5      22.6   58     17.6   77     1014.6 1001   0.3   1      NE    13.5  17.6  0     0     0     0     0
19     9/19/2024 11:07:51 5      22.5   57     17.4   78     1014.7 1001.1 0.3   1      NNE   13.5  17.4  0     0     0     0     0
20     9/19/2024 11:08:51 5      22.6   58     17.6   77     1014.6 1001   0.3   1      NE    13.5  17.6  0     0     0     0     0
21     9/19/2024 11:11:09 5      22.6   58     17.6   77     1014.6 1001   0.3   1      NE    13.5  17.6  0     0     0     0     0
22     9/19/2024 11:11:30 5      22.5   57     17.4   78     1014.7 1001.1 0.3   1      NNE   13.5  17.4  0     0     0     0     0
23     9/19/2024 11:12:51 5      22.4   57     17.5   77     1014.7 1001.1 0.3   1      ENE   13.4  17.5  0     0     0     0     0
24     9/19/2024 11:13:51 5      22.5   57     17.4   78     1014.7 1001.1 0.3   1      NNE   13.5  17.4  0     0     0     0     0
25     9/19/2024 11:16:09 5      22.5   57     17.4   78     1014.7 1001.1 0.3   1      NNE   13.5  17.4  0     0     0     0     0
26     9/19/2024 11:16:30 5      22.4   57     17.5   77     1014.7 1001.1 0.3   1      ENE   13.4  17.5  0     0     0     0     0
27     9/19/2024 11:17:51 5      22.4   57     17.8   76     1014.5 1000.9 1.4   2.7    NNE   13.5  17.8  0     0     0     0     0
28     9/19/2024 11:18:51 5      22.4   57     17.5   77     1014.7 1001.1 0.3   1      ENE   13.4  17.5  0     0     0     0     0
29     9/19/2024 11:21:09 5      22.4   57     17.5   77     1014.7 1001.1 0.3   1      ENE   13.4  17.5  0     0     0     0     0
```

Figure 13 Excerpt from a "meteo" data file acquired with the new weather station.

First we take a look at the acquired weather data file coming from BGO (see Figure 13). We note that the first three fields are "No.", "Time" and "Interval". From the *[corresponding columns]* section of the configuration file (seen in Figure 12) we take that only "Time" will be present in the output file. Also from the configuration file we can see that two output columns are "corresponding" with the "Time" input column: "Time" and "Date". To correctly split the data, the configuration file contains the info to interpret the input "Time" column in the *[input columns format]* section and info to correctly output the data read from the "Time" column in the *[output columns format]*.

The result of applying the new module on the excerpt presented in Figure 13 can be seen in figure 14.

```
1000.8      22.4   57    17.0   78    13.2   17.0   0.3   NE     0.00  10:42  19.09.2024
1000.8      22.4   57    17.0   78    13.2   17.0   0.3   NE     0.00  10:46  19.09.2024
1000.9      22.4   57    16.7   78    12.9   16.7   1.0   NNE    0.00  10:47  19.09.2024
1000.8      22.4   57    17.0   78    13.2   17.0   0.3   NE     0.00  10:48  19.09.2024
1000.8      22.4   57    17.0   78    13.2   17.0   0.3   NE     0.00  10:51  19.09.2024
1000.9      22.4   57    16.7   78    12.9   16.7   1.0   NNE    0.00  10:51  19.09.2024
1001.2      22.3   56    16.7   79    13.1   16.7   0.0   NE     0.00  10:52  19.09.2024
1000.9      22.4   57    16.7   78    12.9   16.7   1.0   NNE    0.00  10:53  19.09.2024
1000.9      22.4   57    16.7   78    12.9   16.7   1.0   NNE    0.00  10:56  19.09.2024
1001.2      22.3   56    16.7   79    13.1   16.7   0.0   NE     0.00  10:56  19.09.2024
1001.1      22.4   58    17.6   76    13.3   17.6   0.3   NNE    0.00  10:57  19.09.2024
1001.2      22.3   56    16.7   79    13.1   16.7   0.0   NE     0.00  10:58  19.09.2024
1001.2      22.3   56    16.7   79    13.1   16.7   0.0   NE     0.00  11:01  19.09.2024
1001.1      22.4   58    17.6   76    13.3   17.6   0.3   NNE    0.00  11:01  19.09.2024
1001.0      22.6   58    17.6   77    13.5   17.6   0.3   NE     0.00  11:02  19.09.2024
1001.1      22.4   58    17.6   76    13.3   17.6   0.3   NNE    0.00  11:03  19.09.2024
1001.1      22.4   58    17.6   76    13.3   17.6   0.3   NNE    0.00  11:06  19.09.2024
1001.0      22.6   58    17.6   77    13.5   17.6   0.3   NE     0.00  11:06  19.09.2024
1001.1      22.5   57    17.4   78    13.5   17.4   0.3   NNE    0.00  11:07  19.09.2024
1001.0      22.6   58    17.6   77    13.5   17.6   0.3   NE     0.00  11:08  19.09.2024
1001.0      22.6   58    17.6   77    13.5   17.6   0.3   NE     0.00  11:11  19.09.2024
1001.1      22.5   57    17.4   78    13.5   17.4   0.3   NNE    0.00  11:11  19.09.2024
1001.1      22.4   57    17.5   77    13.4   17.5   0.3   ENE    0.00  11:12  19.09.2024
1001.1      22.5   57    17.4   78    13.5   17.4   0.3   NNE    0.00  11:13  19.09.2024
1001.1      22.5   57    17.4   78    13.5   17.4   0.3   NNE    0.00  11:16  19.09.2024
1001.1      22.4   57    17.5   77    13.4   17.5   0.3   ENE    0.00  11:16  19.09.2024
1000.9      22.4   57    17.8   76    13.5   17.8   1.4   NNE    0.00  11:17  19.09.2024
1001.1      22.4   57    17.5   77    13.4   17.5   0.3   ENE    0.00  11:18  19.09.2024
1001.1      22.4   57    17.5   77    13.4   17.5   0.3   ENE    0.00  11:21  19.09.2024
```

Figure 14 Excerpt from a "meteo" data file after applying the translation to the old format with the new module.

We see in Figure 14 all the twelve columns specified in the *[corresponding columns]* section of the configuration file (Figure 12) starting with “Absolute pressure” and ending with “Date”. The “Time” input column is correctly split.

5. POTENTIAL FUTURE DEVELOPMENTS

Future developments at the BGO may include:

- Enhanced monitoring: upgrading the existing equipment (within the limits of available funds) for better data collection and analysis.

As for the data collected at BGO we may have in mind:

- Expanding the research (conducting more comprehensive studies on the geodynamic evolution of the PCF and its impact on seismic activity in the region)
- Collaborative Projects (partnering with other research institutions and organizations to share data and insights, and to develop new methodologies for studying tectonic stress).
- Public outreach: increasing public awareness and education about geodynamics with emphasis on the importance of studying the movement on faults. This could be achieved through workshops, seminars, and publications.

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