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Two years of permanent deployment of seismic station LIVV, Antarctica

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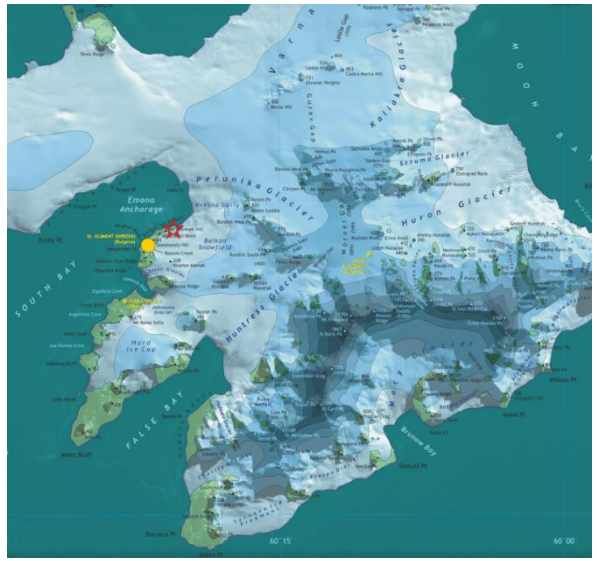
http://ultima0thule.blogspot.com/2015/03/livingston-island-south-shetlands-spain.html

Livingston Island is one of the eleven islands of the South Shetland Archipelago which is separated from the Antarctic Peninsula by Bransfield Strait and from South America by the Drake Passage.

https://bai-bg.weebly.com/10501072108810901080.html

In 1988 in the eastern part of the Island, the Bulgarian Antarctic Base “St. Kliment Ohridski” (BAB) was established. The Base works during the austral summers and accommodates scientists from different branches of the science.

http://ultima0thule.blogspot.com/2015/03/livingston-island-south-shetlands-spain.html



Inner sensor isolation

The first Bulgarian Polar Seismic Station LIVV was set in operation in 2014 as a seasonal station operating during the regular Antarctic expeditions.
The station is situated several hundred meters away from the Bulgarian beach of Emona Anchorage in the South bay of the Island and close to the calving zone of Perunika glacier . The site of the station is marked by red star on the map.
In 2019, the station LIVV (was rebuilt on a new site one kilometer far from Bulgarian Antarctic Base (the yellow circle on the map). The seismological equipment was installed on a bedrock outcrop at the base of a hill.

Seismological equipment

- ✓ Broad band (BB) seismometer Guralp CMG40T with 30 s to 50 Hz flat velocity response
- ✓ Short period 4.5 Hz Geophone
- ✓ Digital station RefTek DAS 130
- ✓ External GPS timing unit
- ✓ 16 GB Flash memory cards
- ✓ Battery and solar power supply

At the end of the XXVIII Bulgarian Antarctic expedition in March of 2020, the seismic station LIVV was set as permanent year-round operational Antarctic station.

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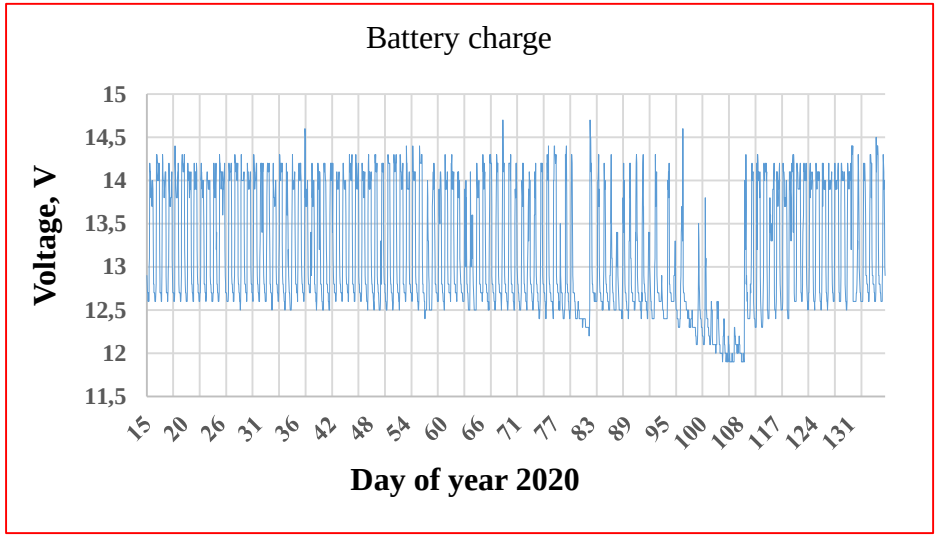
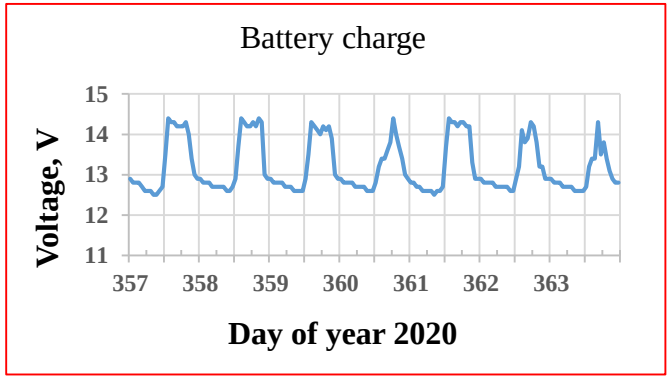
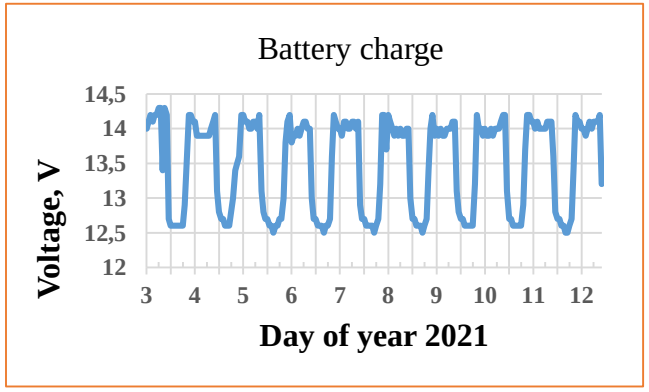
Performance of the station LIVV

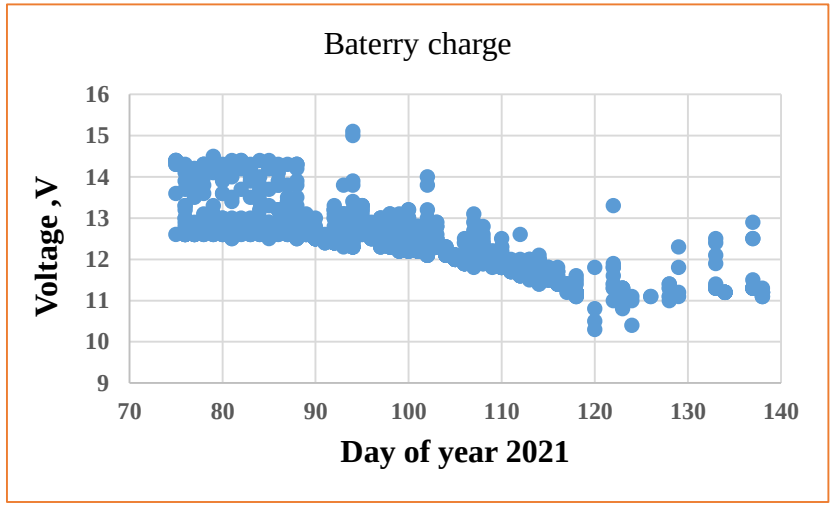


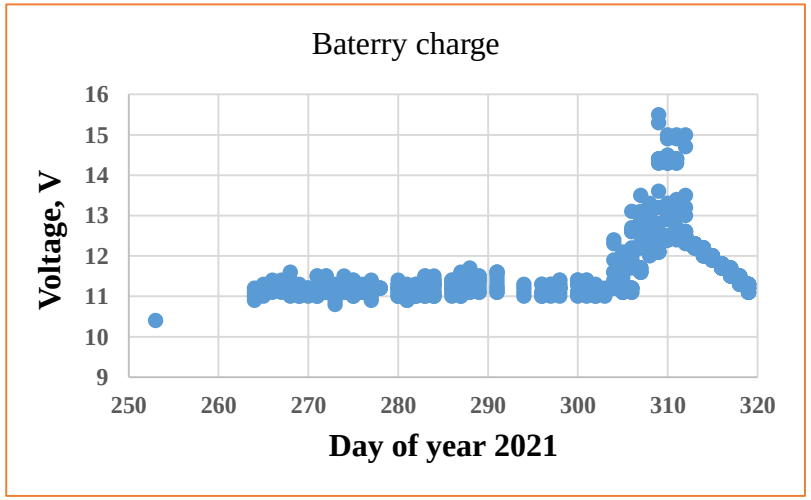


The battery has retained its working capacity despite low temperatures and high humidity.
There are interruptions in the recording

1. When the sunlight is not high enough to charge the battery above 12V – time periods :
- from 140 to 357 day of 2020;
- from 140 to 264 day of 2021.
2. Due to corrosion of the battery terminal
- From 364 day of 2020 to 003 day of 2021.
3. Solar panel controller failures – time periods
- From 013 day to 070 day of 2021
- From 320 day to the end of 2021







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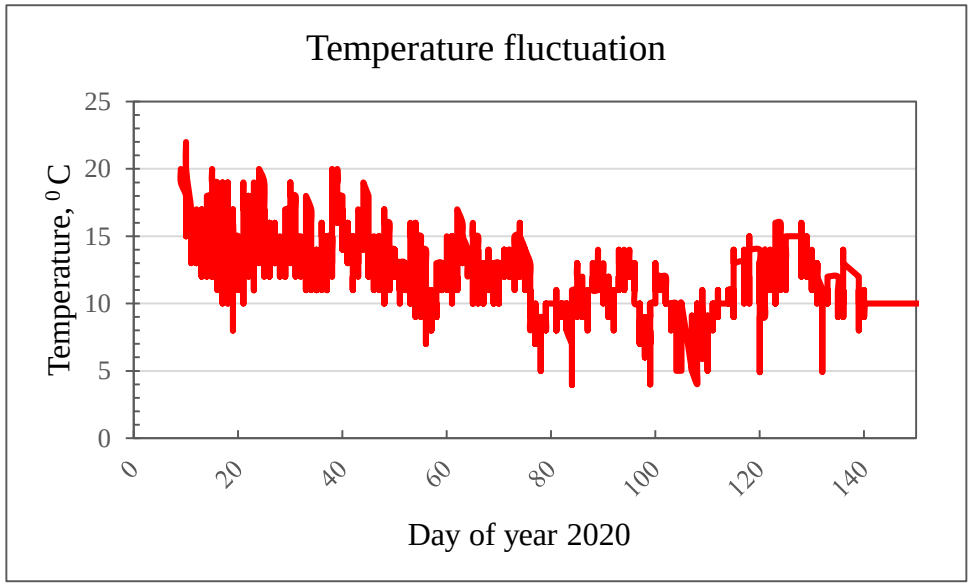
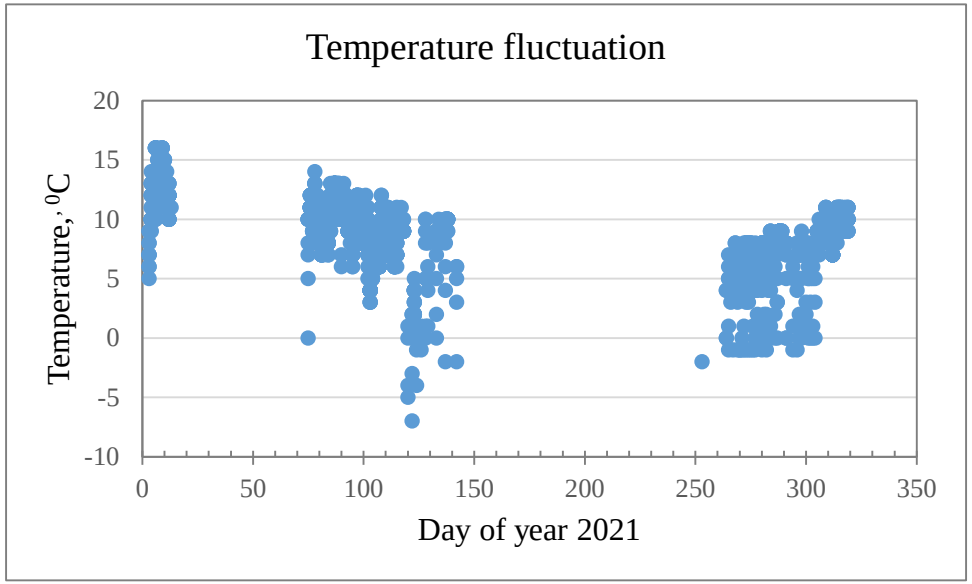
After restoring the power supply, the seismological equipment immediately is switched on in the normal registration mode.

Temperature fluctuation



The temperature inside of the thermal box of the electronic components hasn't dropped

- below 4 ⁰C during the period of stable uninterruptable power supply to the middle of May 2020 and 2021



- due to the unstable charging of the battery from the solar panel in the second half of May 2021, the electronic components periodically turn off and the temperature drops below 0 ⁰C.
- in the polar spring of 2021, the temperature does not fall below -2 ⁰C.

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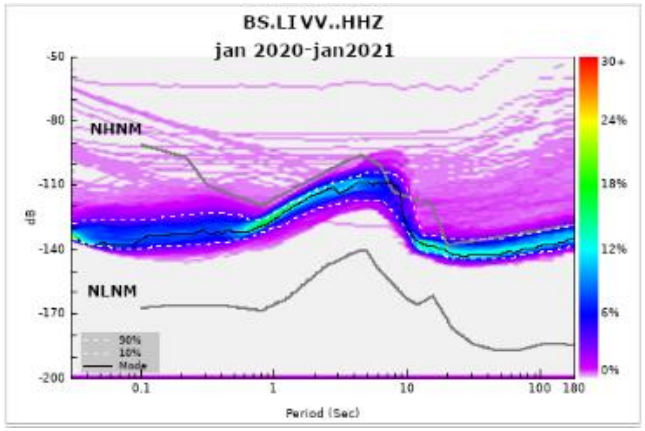
Seismic data

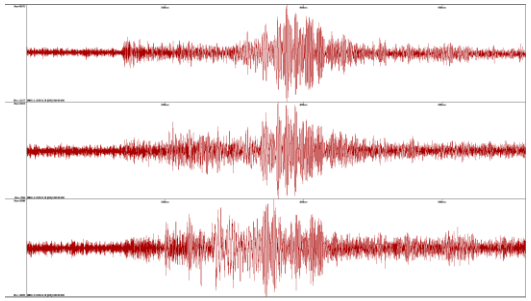


The analysis of the recorded seismic data shows that the mode value of the ambient seismic noise

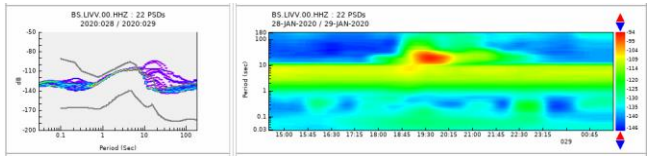
- for longer periods greater than 1s, it is 10-20dB below High Noise Model
- and for the shorter periods below 1 s, it falls to -140dB.

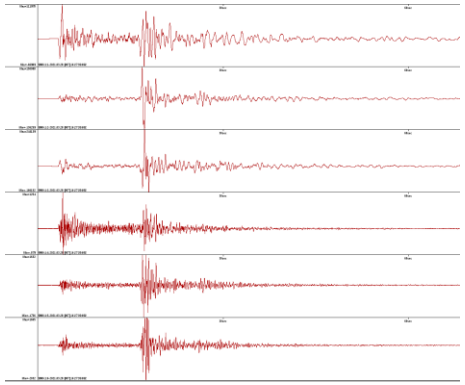
The noise level suggests good recording capabilities of the station especially in the short periods.

This is proven by the large number of recorded earthquakes and events in the ice cover of the Livingston Island during the two years exploitation period.

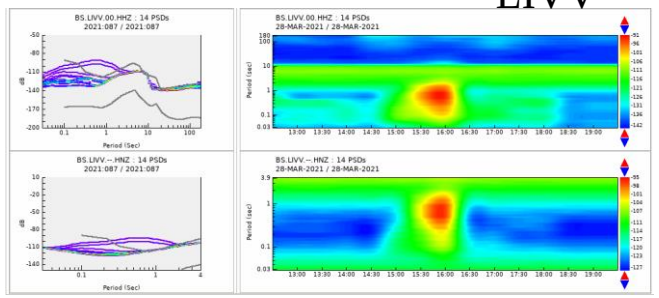


Waveforms, Power Spectral Density and the spectrum of the earthquake in Cuba region in 28.01.2020, T_0 = 19: 10: 25.1, coordinates 19.37N/ 78.85W, depth 10 km and magnitude Mw = 7.7





Waveforms of the regional earthquake with parameters: date 28.03.2021, T_0 = 16: 27: 26.6, coordinates of the epicenter 62.36S /58.36W, depth 10 km and magnitude mb = 5.0 (according to https://www.emsc-csem.org) in the South Shetland Islands region, recorded by the two seismometers at LIVV



Power spectral distribution and the spectrum and the same earthquake.

 (according to https://www.emsc-csem.org)

Conclusions

The analysis of the performance of the seismic station LIVV shows that:

1. The station LIVV (62^0 38.145'' S/ 60^0 20.754'' W) is built on a stable foundation (bedrock)
2. The provided thermal insulation creates an optimal mode of operation of the seismic equipment.
3. With an uninterruptible power supply, the seismic station will operate reliably and without interruption throughout the year, and the quality of the recorded data will be high enough to analyze the seismicity in the region and the behavior of the ice sheet of the Island.
4. We are planning to install a wind generator during the next Bulgarian Antarctic Expedition in the season 2022/2023.

The presented study is supported by the project 70-25-70/03.08.2021 "Complex geophysical study of glaciers in the South Bay area of Livingston Island" under the procedure "Competition for financing polar research-2021"

Publications related the presentation and our work

1. Dimitrova L., G. Georgieva, J. Afzali , D. Dimitrov. *Broad band seismic sensors and their application: case study – Livingston Island, Antarctica.* Proceedings of XXIX International Scientific Symposium “Metrology and Metrology Assurance “2019.IEEE Xplore. Section VI.2, p.140-144. DOI: 10.1109/MMA46899.2019

2. Dimitrova L. , G.Georgieva, R. Raykova, D. Dimitrov, V. Gurev, D. Solakov, I. Georgiev, P. Raykova, V. Protopopova, I. Aleksandrova, M. Popova. 2017. *Exploring seismicity of Livingston Island (Antarctica) and surroundings using records of Bulgarian Broadband Seismological Station LIVV during the astral summer 2015-2016*. Compres rendus de l’Acade'mie bulgare des Sciences, Vol 70, No12, 2017, pp.1709-1718. ISSN 1310-1331

3. Georgieva G., L. Dimitrova, V. Gourev. *Ice generated events in Perunika Glacier, recorded by LIVV station.* 10th Congres of Balkan Geophysical Society. 2019. BGS2019-ST1.1-N35O1.

4. Dimitrova L. *Seismic Noise At Bulgarian Antarctic Seismic Station And Influence From Site Selection.* Proc. 20th International Multidisciplinary Scientific GeoConferences SGEM 2020.V 20, N 1.2, p.623-630. DOI 10.5593/sgem2020/1.2/s05.079, ISSN: 1314-2704, ISBN: 1314-2704.

5. Dimitrova L. , G. Georgieva**,** P. Raykova, V. Protopopova, I. Aleksandrova, M. Popova, D. Dimitrov, V. Gourev,R. Raykova, D. Solakov. *Seismic activity of south shetland islands: results from expoatation of first bulgarian broad band seismic station in antarctica*. Annuaire de l’Université de Sofia “St. Kliment Ohridski”, Faculté de Physique, 2018

Thank you for your attention