First of all, we would like to thank Alex Brisbourne for his time and constructive, thorough and helpful suggestions, which are each addressed below. Our responses are organized in the following color code:

- the original text of the reviewer (black)
- response to the reviewer comments (blue)
- text removed from the main article (lila)
- text added to the main article (green)

Review of "A self-sufficient mobile broadband seismological recording system for year-round operation in Antarctica" by A. Eckstaller et al., 2022, Geoscientific Instrumentation

Alex Brisbourne, April 2022

Eckstaller et al. present an overview of their mobile seismic station system for use in the polar regions. The group have developed a relatively lightweight and mobile system for use in a modular manner with different seismic and recording systems. The manuscript covers concepts, requirements and solutions.

The paper is well written and easy to follow. It provides a lot of useful ideas and concepts which practitioners embarking on similar deployments will find useful to be highlighted prior to starting such projects and therefore forms a useful piece of work.

Major comments

The system has a lot of similarities with the IRIS Passcal system used for the Polenet Project which has become the standard for many deployments in Antarctica. However, it takes until the acknowledgements for this to be recognised. In addition, there is little mention in the introduction of Polenet or IRIS. For example, all the white circles on Fig. 1a are Polenet stations and the authors do a disservice to the work of these groups to have achieved the station coverage of West Antarctica that Figure 1 highlights. I would suggest a paragraph in the introduction covering: The IRIS Passcal system; the relationship between this system and the IRIS Passcal system and why the concept presented here I needed; the achievements of the Polenet project. Again, in section 4, I suspect that IRIS Passcal now have some impressive year-round data recovery rates. I would like to see these mentioned for comparison and perhaps some comments on how this work advances that of Passcal.

We gladly accept this suggestion and we agree with the reviewer's opinion that the developments of IRIS Passcal and the achievements of the POLENET project should be listed much earlier.

The achievements of the POLENET project and a statement why this and other systems are still needed were added the following paragraphs to the introduction:
"A major step in this direction was realized within a large international POLENET (Polar Earth Observing Network) within the activities of the International Polar Year (IPY) 2007-2009. In this project, a large number of seismic and GPS instruments were installed in remote sites in Antarctica over several years. The equipment required for POLENET was developed by IRIS (Incorporated Research Institutions for Seismology) PASSCAL (Portable Array Seismic Studies of the Continental Lithosphere) with a focus on a cold-resistant power and communication system that is easy to install and can withstand Antarctic weather conditions. In this project, large-scale temporary coverage of West Antarctica up to the Transantarctic Mountains, as well as central parts of East Antarctica, was

realized for the first time (Figure 1a).

To ensure the continuous extension of seismic coverage in the polar regions, it is essential to find new solutions to the same problems again and again. For polar seismology, it is therefore important to build on previous experience (e.g., from IRIS PASSCAL) in order to optimize the use of self-sufficient seismometer stations and to find flexible solutions for the different areas and deployment lengths. The specifications of the stations must also be realizable with the available resources and be based on long-term scientific goals.“

Furthermore, we have now added a statement at the end of Section 4.4 regarding the increasing data recovery rates from IRIS Passcal:
IRIS' successful continuous development strategies of the winter data collecting capability have increased the data recovery rate from < 50 % to more than 90 % within five years. The setup reported by Heeszel et al. (2013) enabled a total data recovery of 93 %.

I feel that there are details missing that would make this a much more useful paper. A number of the statements are subjective. I would like to see a table of specifications for components listing power draw and weight for example and a way of understanding the relative power-cost of individual components (sensor and data logger are reported), such as the XEOS or Solar controller. How about example overall station weight/volume etc.

We agree with the reviewer, that information on power draw and weight is missing and very useful for the reader. We have now integrated the power consumption of all electrical consumers (including iridium and solar charge controllers)l in Table 1. The power consumption is reported in ampere (A) with an input voltage of 12 V.

Furthermore, we have made the following estimates on the weight of our individual components:

Peli box: 10kg
AGM battery: 30kg
Seismometer: 5kg
Seismometer casing: 10kg
Data recorder: 5kg
Electronics: 5kg
Kabel + protection: 10 kg
Solar cell: 5kg
Solar cell rack: 15kg

For a single mobile station in the smallest possible configuration, we use two Peli boxes, two batteries, one seismometer (including casing), one data recorder, one solar cell rack and two solar cells. This equals 140 kg and comprises ~ 2-3 m^3 storage space.

We added the following sentence to the first paragraph of Section 3:
“The total weight of a single mobile station in its minimum configuration (one seismometer with casing, one seismic recorder, two AGM batteries, one solar charge and iridium controller, two solar panels mounted on one rack, one GPS, one iridium antenna and all cables; Figure 3a-e) is ~ 140 kg and comprises ~ 2 m3 storage space.”

The title including “year-round” may be a stretch as it seems that this concept has yet to be fully established for year-round recording. Maybe that’s why the word operation is used? Perhaps a little disingenuous.

Thank you very much for this remark, and we agree. We decided to change the title to “**Towards a** self-sufficient mobile broadband seismological recording system for year-round operation in Antarctica” to be in line with the comment from another reviewer and highlight that we are on the way but not there yet to record data year-round.

In many ways the manuscript leaves a lot of questions unanswered, mostly being why did the developers use this controller or that modem? Were other systems tested and ruled out? You could save future practitioners some effort by stating why these units were used over others (not necessarily having to publish manufacturer’s names).

This is a very good hint, which we gratefully accept. We have added some additional information comparing the instruments (seismometer, recorder, Iridium controller, etc.) and evaluating their advantages and disadvantages in Section 3.

Added text is marked green and existing text black:
“We can equip our stations with two data logger types: 3-channels Reftek RT-130 and 6-channels Quanterra Q330S+ (or Quanterra Q330 + baler) recorders (Table 1). Both logger types can be deployed at permanent or temporary mobile seismic stations. The power drain of the recorders is approximately 50 – 83 mA and depends on the number of active channels, sample rate and desired GPS-clock operation. The advantage of the Quanterras is the lower power consumption and the larger storage space. In addition, the Quanterra is easier and more versatile to configure (via a web page GUI from any computer) and has more modern interfaces. However, in contrast to the Reftek data loggers, they are also more expensive.

We commonly use (all three-component) Guralp CMG-3ESP, Kinemetrics Metrozet MBB2 broadband seismometers with a lower corner period of 120 sec and in some cases also Lennartz LE-3D/20s seismometers. The only exception represents UPST station, where we have deployed a Streckeisen STS-2 and a small short period tripartite array. A relevant disadvantage of the Guralp seismometer for the mobile stations is that during transport the mass must be locked to prevent damage. In addition, the instrument must be manually leveled during installation. The advantage of the Metrozet MBB-2 seismometers is the compact design, and the higher transport safety, as it is self-locking and can center the mass internally. In addition, the power consumption is very low for an active sensor (20 mA) in comparison to the Guralp seismometer or Lennartz (50 mA).

The solar-powered energy supply system consists of 100 W *Solara S405M36 Ultra* solar cells and a *Morning Star SunSaver SS-MPPT-15L* charge controller. Every seismic station is equipped with a state of health (SOH) transmitter that sends the station’s operation status in regular intervals via Iridium satellite radio to AWI. For the Quanterra Q330 recorders, we use XEOS XI-202 controllers, because they have an existing interface. However, this interface is not available for the newer Q330S+ recorders. For the RT-130 we use a custom-made iridium controller (SeiDL - Seismic Data Link) to have an influence on all parameters and configurations. For example, it gives us the possibility to transmit data from additional environmental sensors, such as wind, temperature, solar radiation, current and voltage (if available). This controller was developed by Arne Schwab (SchwaRTech, based near Bremen, Germany), and also uses the Iridium short burst data (SBD) transmission technique. For the wiring of all devices, we have moved away from PVC insulated cables, as they are too brittle at low temperatures. Now we use almost exclusively more flexible cables with PE or PU insulation with improved UV and cold resistance. A complete list of the specifications of the instruments is provided in Table 1 “

Minor comments

2 and elsewhere – 3k seismometer – do you mean 3-Component?

We agree with the reviewer that "3-component seismometer" is the correct term and believe the reviewer is referring to Figure 2. This has been changed throughout the document.

"3-k" to "3-component" (in Figure 2 and also in the text)

Table 1 – I am not sure I would call the table or column 2 "Instrument specifications", it is more the model numbers. I do however feel that at some stage (probably in the appendix) more detailed specifications would be welcome, such as temperature rating, power draw etc).

Changed "Instrument specification" to "Instrument model".

L108 – What is the power drain of the Morningstar 15L?

The power drain of the Morningstar solar controller is 35 mA per day. This has now been included in Table 1.

L110 – Likewise, what is the power requirement of the XEOS over a season?

The average power drain for the XEOS and SeiDL iridium controller is 0.17 mA, which corresponds to 4 mAh per day and 1.49 Ah per year. This is the sum of the power consumption in sleep mode and transmission mode for one (2 minutes) transmission per day.

L122 – can you quantify "high winds"?

We define "high winds" as wind speeds beyond the range where it is feasible to work outside (25-50 m/s). We added this number now in the text.

L159 – not sure what "into the drilling hole" means

We mean that the sensor is placed in a hole of an aluminium bar.

"The sensor is a PT-100 element that is placed in a hole of an aluminum bar that is attached to the aluminum plate."

L173 – good to quote power drain in Ah or Ah/day

We agree with the reviewer that quoting the power drain in Ah makes sense to provide an overview of the power consumption per day or year. However, at this particular place in the text, we believe that it doesn't make a lot of sense. The switching electronics mentioned in line 173 are operating very rarely and can therefore be neglected in our energy budget. Nonetheless, the reviewer makes a good point and we are referring to the power drain in Ah in another place in our responses to the reviewer's comments.

We also want to note that in that line we made a mistake in the original version, where 0.3 A is incorrect and should be 0.3 mA.

L174 – it would be good to know how the overall power budget is distributed amongst the components.

We agree and we have added an extra column in Table 1 with the power drain of all electrical consumers. These specifications refer throughout to operation with 12 V. The consumption in watts can therefore be calculated independently. For a power drain over an entire season we choose the following values:

Power drain (A)
Seismometer: 50 mA
Data logger: 80 mA
Iridium controller 0.17 mA (average value including a 2 minute transmission time per day at 50 mA)
Solar charge controller: 35 mA

Power drain over time (Ah)
The total power drain of all electric consumers is 165 mA, which would correspond to 4 Ah per day and 1447 Ah per year.

We added the following text at the end of section 3:
"The overall power consumption of a single mobile station is 4 Ah per day and 1447 Ah per year. The calculation is based on a station design which comprises a Guralp CMG-3ESP seismometer and a Reftek-130 data logger."

L194 – Again, IRIS Passcal have addressed and solved this issue in one way but it isn't mentioned.

We believe that by "this issue" the reviewer is referring to the gap in data logging in winter when operating with a few AGM batteries and solar cells. The reviewer is right and IRIS PASSCAL has already successfully bridged this gap with Li-based batteries. However, we would like to point out that we have already mentioned this in section 4.4 (L272-274 in the initial submission):

"The novel station design was developed by IRIS-PASSCAL for polar applications (Johns et al., 2006) and enabled the deployed stations to operate year-round with the usage of lithium backup batteries in the winter."

L227 – another issue that could be highlighted is that wind strengths are highly variable spatially and in my experience the manufacturing tolerance of wind generators tends to be poorly managed so two adjacent supposedly identical units can respond differently to wind strength. Do the authors have any experience of this that could be included?

We agree with the reviewer that this could be the reason why apparently identical wind generators behave differently under the same conditions. At VNA2, we actually use two identical wind generators, where we have had a couple of break downs of one of them, whereas the neighbouring wind generator worked fine. Unfortunately, we have not yet been able to determine a systematic pattern for this and must admit that this different behavior is still a mystery for us as well. For the selection of a wind generator type, we have been able to gather experience for different wind conditions. For example, very robust and slow models are not well suited in low wind regions. Wind sensitive models are often destroyed in stormy regions without appropriate modification (for example shortening of the wings, suitable brakes and switching behaviour).

L245 – do you mean discharging rather than charging?

Yes. Changed as suggested.