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Geoscientific Instrumentation Methods and Data Systems
Discussions



# *Interactive comment on* "Autonomous distributed temperature sensing for long-term heated applications in remote areas" *by* A.-M. Kurth et al.

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Dear Reviewer

Thank you for taking the time to review our manuscript; your comments were very constructive and will help us to further improve our manuscript. In the following, we will address all your remarks. Please note, as it is impossible to change the font of the writing, our comments are marked with a hyphen. For ease of use, the paragraphs in the first part of your remarks were numbered; the numbering in the "specific comments" section was kept unchanged.

1). This manuscript describes the components required for the setup and deployment of an autonomous DTS system for long-term heated applications in remote areas. As

such, the manuscript is very topical for GI-MDS. The availability of such a system entails several advantages: (a) potential for research in interesting but rather inaccessible areas and environments, (b) time efficiency for operators and scientists, (c) real-time data access and possibility for remote data quality and system control. In this sense the paper constitutes a very useful contribution and gives guidance on how to compose and implement such a system. On the other hand, the paper is (maybe intentionally) somewhat limited to the technical description of the system components, similar to a technical report or manual (c.f. summary sentence of the introduction (860, 01-03.) which underpins this impression.

- Indeed, the manuscript is intended to be a technical report serving as manual when constructing an autonomous DTS system.

2). Additionally, I feel the level of technical (and particularly scientific) innovation is rather low.

- Sometimes something seemingly small can make a huge difference – an autonomous DTS system will enable research in far-off regions that were inaccessible for such systems before. As the manuscript provides guidance on how to construct this system, this "low-level" innovation might make quite a difference for some researchers.

3). While the proposed system opens the window for addressing interesting scientific questions, the paper does not present a practical application, which would help gauging the performance and practicability of the autonomous system.

- This is true. We'll include the paragraph: "One application of the autonomous DTS system will be to investigate the effect of river restoration on hyporheic exchange in Swiss rivers and streams."

4). Well aware that the scope of the journal is geophysical instrumentation, I still deplore that the manuscript does not present an experimental example as a proof-of-concept of the proposed instrument set-up including a small scientific finding.



GID

2, C345–C355, 2013

Interactive Comment



- The reason for not presenting any data is that it is intended as a purely technical report to be used as a manual when constructing the autonomous DTS system. Additionally, the system has only been lab tested so far, as the authors‘ field site is in a remote valley that is closed off during winter due to high frequency of avalanches, in which the autonomous DTS system could not yet be installed. As the data by the autonomous DTS system is exactly the same as data from a non-autonomous DTS system, it was not considered to be of importance to the manuscript.

5). The authors apparently conducted such an experiment (Thur River?) but information on this is very sparse or inexistent although such data would be very helpful to demonstrate the functionality of the proposed autonomous DTS system for heated applications. The authors often refer to an experiment or experiences of the authors (e.g. 863, 09; 866, 01, 26; 867, 05, 11) while the actual experiment is not at all described or presented. I think that the inclusion and discussion of an application would nicely illustrate the potential and applicability of the proposed system. This should not require a full data analysis of the experiment (which would be beyond the scope of the paper and journal) and still be acceptable given the present length of the manuscript.

- The experiments at the River Thur focussed on refining the heated DTS application in stream beds and were not conducted with an autonomous DTS system (hence, the description of this experiment was not included in the manuscript). Incidentally, this experiment gave us the idea to develop such an autonomous DTS system. However, it is a good point to include at least one application – therefore, our application of the autonomous DTS system will be included as mentioned in paragraph 3).

6). Overall, the paper is very well written and easy to read. Technical explanations are very detailed, clear and easy to understand. However, Section 2 needs some reorganization or changes in structure as indicated in the specific comments below.

Specific comments (according to occurrence in manuscript, not relative importance)

1. 857, 20: The value of 0.01°C is misleading as it indicates the potentially best case



GID

2, C345–C355, 2013



under ideal, stable conditions. In reality, i.e. environmental applications, it is larger, depending on the chosen sampling and spatial resolution, type of DTS instrument, etc.

- Of course. We'll change "with an excellent temperature resolution of 0.01°C" to "with a temperature resolution of 0.01°C under ideal conditions" to avoid misunderstandings.

2. 857, 07 – 859, 02: This part of the introduction is a nice description of relevant facts but elaborates on rather trivial points. The content is largely known and sufficiently discussed in the references cited in this section. This section should be more targeted to innovation.

- As a technical report the manuscript might be read by someone who is unfamiliar with the cited references and therefore provides a short summary on the "DTS background" to enable full understanding.

3. 858, 25: Here it should be mentioned if heat is injected into the cable or the surrounding media.

- In line 25f. it is quite clearly stated that in an active mode the metal armour surrounding the fibre-optic cable is heated by electrical resistance heating. In publications, the "active DTS mode" seems to describe the heating of fibre-optic cable components, while "heated applications of DTS" seem to be used when the surrounding media of the fibre-optic cable is heated. Please provide us with a feedback if you think this should be stated more clearly.

4. 859, 02: It would still be of interest for the community to know who did this study and where this data may be available.

- The "unpublished data" refers to experiments performed by the authors and several other groups, but with publications pending. So far, there are no publications about hyporheic exchange processes, but several papers are being reviewed at the present time and might be published soon. With a bit of luck, some of these papers will be published before the reviewing process of our manuscript is closed, in which case a



GID

2, C345–C355, 2013

reference will be included. Otherwise “unpublished data” will be changed to “articles in preparation”.

5. 859, 12-16: It should be mentioned whether this system works for any commercial DTS unit.

- The autonomous DTS system should work with any DTS instrument that is connected to a computer. However, this cannot be guaranteed, as we would have had to build an autonomous DTS system with all DTS instruments available worldwide prior to making such a statement. This is quite impossible, and hence there is no mentioning of which DTS instruments will work in an autonomous DTS system, as we simply don‘t know.

6. 860, 06-10: The computer is sometimes an integrated part of the DTS system, depending of the unit.

- Yes. However, all computers that can be connected to the internet via modem are suitable to upgrade a non-autonomous DTS system to an autonomous DTS system.

860, 14: For point (iv) I would be more general and say, for instance, “temperature controlled enclosures for reference temperature measurement” instead of “water baths”.

- This is a valuable remark, thank you. Accordingly, it will be changed in the manuscript.

7. 860, 16 – 861, 20: The whole section is useful for new DTS users but environmental DTS literature now covers almost 10 years and a lot of information could be referenced. These paragraphs read like a field handbook and could possibly be condensed.

- The manuscript is intended as technical report and manual; hence, this “field handbook” provides information, rather than referencing it (cf. comment 2. in this section).

8. 861, 25 – 863, 24: I don’t understand why this section is part of Section 2.1.1 “passive DTS components”. It describes the whole background of active DTS measurements and therefore does not fit here.

- Thank you, this is very true! We‘ll change the position of this section in the manuscript.



GID

2, C345–C355, 2013

Also the next part (863, 25 – 864, 18) on cable calibration is somehow out of context here; I suggest making it an independent section and place it accordingly.

- This is true as well. We will make this into a separate section and label it “Cable Considerations”.

9. 862, 13-18: The electrical resistivity is a function of temperature, which is not mentioned here. How does this affect the presented relations?

- The general formula is rho = rho(0) [1+alpha(T-T0)], with rho being the resistivity in [Ohm] of the metal after/during heating, rho(0) is the initial resistivity in [Ohm], alpha is the temperature coefficient [Ohm/(Ohm °C)], T is the temperature after/during heating in [°C] and T0 is the initial temperature in [°C]. As, however, it is impossible to determine the temperature of the metal components of the fibre-optic cable (without damaging the whole system), the resistivity function is not stated (although it would, undoubtedly, be very interesting to know the resistivity of the metal components during heating!).

10. 862, 26: Cross sectional area; not diameter.

- Thank you! We missed that error!

11. 863, 11-14: a) It would be interesting to also have the actual stream temperature reported.

- True. The actual stream temperature will be included in the manuscript.

b) Not clear: “if flowing water was present”; On line 11 it is said that flowing water was present. ?

- Yes, during the experiment flowing water was present – hence, it did not heat up as much as in stagnant water and therefore it is mentioned in the next sentence that the heating behaviour of the cable will change “if flowing water is present”.

12. 863, 28: Why is it necessary to have more than one water bath?



GID

2, C345–C355, 2013

Interactive Comment

- Calibration with two water baths is more accurate than with one water bath – hence, two water baths are employed.

13. 864, 28 – 865, 18: This part is a bit lengthy, describing minor technical details while it is not really clear what is the technical innovation beyond a few standard features.

- Unfortunately, the “minor technical details” are crucial for system functioning and necessary to know if such an autonomous DTS system is being rebuilt by another researcher.

14. 866, 11-15: a) 200-800m is not very long w.r.t. the potential range of many current DTS instruments. b) What would be typical applications for this short range of cable length in remote, inaccessible locations?

- a) No, compared to the 30km of cable 200 m – 800 m really is very short. However, if the DTS instrument is placed strategically, then at least two of these 200 m – 800 m long cables might be employed – leaving a range of 400m to 1600 m to investigate “m for m” (a range which would be impossible to monitor with temperature probes!).

- b) A typical application might be, as in our case, the investigation of hyporheic processes or, e.g. investigation of soil moisture, air temperature distribution, etc.

15. 866, 24 – 867, 01: a) It is not clear which data you are referring to; no experiment is described or mentioned. b) The mentioned data platforms where data are published are specific. I suggest generally mentioning the advantage of feeding measurements directly in a publicly accessible system, and then present your specific solution (GSN/OSPER) for your own data, which actually should be presented in this manuscript as an example and proof-of-concept. c) Btw, what is OSPER? No reference provided.

- a) The “data” in this section refers to the DTS data the autonomous DTS system will inevitably collect.

- b) Yes, SwissEx is a specific platform but was developed by ETH/WSL etc. specifically



GID

2, C345–C355, 2013



as “the” platform for Swiss researchers – hence it was mentioned. Of course, you are right about mentioning a general way of data handling first and then presenting our specific solution. We‘ll change this accordingly in the manuscript.

- c) OSPER, the “Open Support Platform for Environmental Research”, is, as the name mentions, a platform where everyone can provide, exchange and share data with other environmental scientists.

16. 868, 04: At the end of section 2.1.2 (866, 14) it is stated that the practical range is around 200m. The phrase used here “over long distances” may thus be misleading for many readers being familiar with the potential range of several km for many DTS systems. Simply say “...over distances of a few hundred meters...” or similar.

- Compared to employment of temperature probes a range of measurements over 200 m with a 1 m-resolution is “long distance”. However, as the term seems to be misleading, we‘ll change “over long distances” to “over a distance of a few hundred meters”.

17. 868, 16-19: What is a typical overall consumption with all components (power converters, etc) included? Has such a set-up been tested and run for a sufficiently long time to evaluate its performance?

- As mentioned above, we could not yet test the autonomous DTS system in the field. In the lab, the power consumption was around 250 W without heating and between 600 W and 900 W with heating (depending on the current).

I am somehow concerned if the system in grid-independent configuration would get the required power continuously from power supplies such as solar panels or wind turbines.

- This is indeed the crucial and most difficult point in the development of the autonomous DTS system – as the cable will not sufficiently heat if a low voltage is applied, but it will still drain the batteries. This issue may be overcome by not enabling heating if a specific voltage cannot be provided by the batteries (of the solar panels or the wind



GID

2, C345–C355, 2013





turbine) or not using solar panels in winter.

Minor comments:

1. 857, 01: Replace “sciences” by “conditions and processes”.

2. 857, 18: Remove the word “or” and put DTS in parentheses.

3. 857, 19: ...collection of distributed temperature data...

4. 857, 27: ...and for electrical insulation.

5. 858, 06: ...the injected light wavelength...

6. 858, 17: ...commercial Raman DTS systems... (Brillouin based systems can do <5cm!)

7. 859, 05: In remote and inaccessible regions without power supply...

8. 859, 09: ...particularly in environmental science and engineering.

9. 859, 10: ...independent of the physical presence of an operator,... enable research in scientifically interesting remote areas.

10. 859, 12: The autonomous DTS system proposed here consists of...

- All proposed changes are approved and will be changed accordingly.

11. 859, 16: I would rather say “necessary” instead of “optional”.

- Indeed, it is optional, as the “autonomous” in autonomous DTS system refers to the data collection and transfer, rather than the power supply.

12. 859, 18: Better say “constraints” instead of “issues”.

- Approved.

13. 859, 24: Give a (typical) value or range for “high voltage”.



GID

2, C345–C355, 2013

- “High voltage” generally refers to any voltage that might harm humans or animals. In this context it refers to any voltage above 10 V.

14. 859, 25: Very interesting!!! Humans as animals similar to rodents? :-)

- Actually, it states “animals,..., and humans”, but to avoid misunderstandings we‘ll change the position to “humans and animals” – although humans are animals as well, biologically speaking.

15. 860, 22: Remove the words “extremely” and “very”.

- Ok.

16. 862, 10: What exactly is meant with “length” here?

- The length of the metal armour – if this is a simple tube, the length of the armour equals the length of the cable; quite often, however, copper or steel wires are wound around the glass fibre-optic cable (or rather its loose tube) and therefore the length of the metal armour will exceed the length of the cable.

17. 863, 08: ...require high voltage. Tests at the River Thur... 18. 864, 04: typo: unfeasible

- No, it actually says “infeasible”, not “unfeasible” – no typo there.

19. 864, 09: ...is known precisely and can be used...

- We would prefer “actual water temperature is known”, rather than “is known precisely”.

20. 865, 16: Note that the system...

- This might be a valuable change, as the abbreviation “Nb.” does not seem to be widely known.

21. 867, 02: ...an area with network coverage...

- Yes, very good.



GID

2, C345–C355, 2013

Interactive Comment

22. 868, 05: ...which will enable measurements in...

- Good comment as well!

Dear Reviewer, we would like to thank you again for taking the time to review our manuscript in such detail and for providing such constructive comments! We are sure our manuscript will be greatly improved by them and hope you will thus recommend our manuscript for publication.

Kind regards

Anne-Marie Kurth

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Interactive comment on Geosci. Instrum. Method. Data Syst. Discuss., 2, 855, 2012.