

Reply to reviews on the manuscript
Modal sensitivity of rock glaciers to elastic changes from spectral seismic noise monitoring and modeling

By Antoine Guillemot, Laurent Baillet, Stéphane Garambois, Xavier Bodin, Agnès Helmstetter, Raphaël Mayoraz, Eric Larose

Contact :

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Dear reviewer,

We wish to thank you for the constructive review following the submission of our manuscript “***Modal sensitivity of rock glaciers to elastic changes from spectral seismic noise monitoring and modeling***” to *The Cryosphere*. We took into account all your comments, and wish that our manuscript is improved accordingly.

Since the editor decided that only minor revisions would be required before the manuscript can be accepted, we only changed the technical details that you raised. For example, we addressed the previous request to reduce the large number of figures in the main text by partly moving them in appendices. We also adapted the numbering notation of figures according to *TC* requests.

Please find below a point-by-point response to all your comments and those from the editor (our answers in red), in complement to the new manuscript with highlighted main changes (text in red as well).

Sincerely yours,

On behalf of the authors,

Antoine Guillemot

Report 1 (anonymous referee 2)

Suggestions for revision or reasons for rejection (will be published if the paper is accepted for final publication)

I appreciate the changes brought by the authors to the presented article. The authors brought sufficient argument to the two issues I pointed out: i.e. the noise source variability and the temporal evolution of the resonant frequency. They also point out the differences expected in ambient noise analysis from a glacier and a rock glacier, which was a bit confusing for me at the first reading of the paper. I think the discussion is well organized now and I am satisfied with the study.

The authors claim that a full modelling of the time evolution of the resonant frequency may be hard to address for the transition season, which I completely understand. This is a bit frustrating, but the authors argument in this way in the new version of the manuscript.

The naming of the figures were a bit confusing to me whether they are part of the main article or they are moved to the appendix or supplementary material. I would suggest to keep in the main article figures 1 to 4, 8 to 15; move to the appendix Figures 5, 16 to 19; move to the supplementary material Figures 6 to 7. Also for figure 5, it is unusual to split the figure labelling in Fig5:1(a-b) and Fig:2(a-b). Maybe use Fig 5a-d. It will be easier to reference the figure in the main text.

- The number of figures was actually confusing. We decided to move Figures 5, 6 and 7 to Appendix D (with new notation D1, D2, D3 respectively). We chose to keep Figures 6 to 7 to Appendix D because they show results from geophysical surveys in Laurichard rock glacier, and thus they are part of this appendix for us. But if the number of figures in appendices is also too high, we totally agree to move Figures 6 and 7 to Supplementary Materials in the final version.
- We also renamed Figures 16 to 19 to Figures A1, B1, B2, C1 respectively, according to the *TC* notation.
- Finally we modified the labelling of Figure 5 (a-d) accordingly.

Other comments (from the editor)

[Lines 16 - 17]

I suggest to re-write this phrase (by correcting punctuation and making it less wordy) as:

"Here, we analyse the spectral content of ambient noise to study the modal sensitivity of rock glaciers, which is directly linked to the system's elastic properties."

➤ Ok, we modified.

[Line 20]

hot periods -> "warm periods" seems to be more appropriate for the temperature range described.

➤ Ok

[Line 40]

high resolution observations

-> {add a hyphen}

high-resolution observations

➤ Ok

[Line 50]

here and elsewhere, please use

[e. g.] as [e.g.,] {with a comma}

➤ Ok

[Lines 54-56]

This phrase is difficult to follow due to its length, and I suggest to split it into two for clarity.

"Passive seismic monitoring systems have the potential to overcome these difficulties on debris slope (Samuel Weber et al., 2018; S. Weber et al., 2018), glaciated (Mordret et al., 2016; Preiswerk and Walter, 2018) and permafrost environments (James 55 et al., 2019; Köhler and Weidle, 2019; Kula et al., 2018), also recently illustrated on the Gugla rock glacier (Guillemot et al., 2020)."

➤ We agree. We split it : "Passive seismic monitoring systems have the potential to overcome these difficulties on debris slope (Samuel Weber et al., 2018; S. Weber et al., 2018), glaciated (Mordret et al., 2016; Preiswerk and Walter, 2018) and permafrost environments (James et al., 2019; Köhler and Weidle, 2019; Kula et al., 2018). The interest of such method has recently been illustrated also on the Gugla rock glacier (Guillemot et al., 2020)."

[Line 87]

Presentation of the sites

-> {I suggest more straightforward}

Study sites

➤ Ok

[Line 104]

The long term survey

->

The long-term survey

➤ Ok

[Line 105]

one meter, (Marsy et al., 2018)).

-> no need for the comma.

➤ Ok

[Line 107] here and elsewhere

at around 1m/yr

-> {around is colloquial}

at approximately 1_m/yr

➤ Ok

[Line 118]

ERT surveys

- ERT was defined so far.

➤ Ok, we precised : “Electrical Resistivity Tomography (ERT)”

[Line 134]

please, indicate the eigenfrequency of these sensors

➤ Ok, we precised : “Mark Products L4C, one vertical component, eigenfrequency 1 Hz”

[Lines 138-141]

usage of "although" in this phrase seems awkward. Please rephrase for your intended meaning. "...and despite our frequent site visits for sensor releveling"?

➤ Ok, we rephrased : “and despite our frequent site visits for sensors releveling”

[Line 139] if you stick to

in order to releveling sensors

->

... to relevel sensors

➤ Ok

[Line 162]

geophysical campaign from seismic refraction

->... {for} seismic refraction?

- Yes, “for”.

[Line 174]

variations (Snieder ... 2015, for a review).

->

... (for a review, see Snieder ... 2015).

- Ok

[Line 290]

the paragraph has an unnecessary indent.

- Ok, corrected.

[Line 306]

I do not understand what is meant by "(see 0)". Please check.

- Sorry for this bug. We removed this unnecessary mention.

(Figure 5(2))

As the referee also pointed, TC does not use such referencing to Figures, and it should be corrected here, in the caption, and the figure labels.

- Ok, corrected.

[Line 328]

The Vs profiles displayed in Figure 7b shows

-> show {plural}

- Ok.

best fitting models

-> best-fitting models

- Ok.

[Line 362]

bedrock, (Hausmann et al., 2012)),

-> no need for the comma.

- Ok.

[Line 368]

(see 0 for Laurichard and 0 for Gugla)

"see 0"? I do not follow this.

- Sorry for this bug, we modified : “see Figure 8(c) for Laurichard and Figure 9 for Gugla ”

[Line 375]

((CREALP, 2016)),

remove redundant parenthesis

➤ Ok.

[Line 440]

(i.e.

->

(i.e.,

➤ Ok.

[Line 493]

temperature reaches 0C and stay

- stays {plural}

Please, also recheck your intended meaning. I am not sure what do you mean by temperature stays during a zero-curtain period; something is missing.

➤ Yes, we precised : “when temperature reaches 0°C and stays constant during a zero-curtain period”

[Line 530]

a 2D mechanical modeling of rock glaciers, which fit

->

... which fits {plural}

➤ Ok.

[Line 535]

investigations, as

->

investigations, {such} as

➤ Ok.

Line 549

CREALP (see weblink in references)

-I failed to find such a link. Please check.

➤ Sorry the reference link was missing. We then added the link in the references : “www.vs.ch/programme-pilote-ofev-cryosphere”

[Line 606] and similar below

Fig5(1b)- see my earlier comment

➤ Yes, we adapted the labelling of the figure.

Line 885

(see 1b)

- I could not follow where and what this is.

- We removed this unnecessary mention.

Fig 12

label (c) drifted to the left subplot (b) and has to be placed appropriately.

- Yes, modified in the figure.