Dear Reviewers,

We would like to thank you for your insightful comments on the manuscript. Below is our response to the issues raised in the review by indicating the lines in the track-file revised manuscript:

Reviewer 1

Response: Analytical methods still play an important role in geophysics and are often used to assess the response to specific geological situations for a variety of geophysical methods. However, it has long been recognized that analytical methods cannot handle the complexity of many realistic geological situations. This is why numerical modeling methods including Finite-element (FE) have been developed and used widely for several decades. In our paper, we chose three-dimensional FE modeling as the primary method to model near-borehole effects on distributed acoustic sensing data acquired with helically-wound fiber-optic cable. The three-dimensional FE modeling approach used in our paper is state-of-the-art and provides all the accuracy required to model effects on such cable for complex and realistic geological situations. FE modeling has no geometry restrictions (i.e., planar or cylindrical) and further allows analyzing the strain around the cable, something not easy to achieve with analytical methods. As clearly stated in our paper, the analytical method introduced in Appendix is only used to validate the choice of boundary conditions of finite-element modeling and is by no means the primary method that we are advocating for in our work. The method is indeed not new and is a simple adaptation of Kennett's method. This is something that we clarified in the revised manuscript. Despite its inherent approximation, the comparison of results obtained with 3D FE modeling and the simple analytical method shown in the paper are quite acceptable and sufficient to confirm the choice of the boundary conditions. The analytical method in the appendix is simpler to implement than the approach of Kuvshinov (2016) especially when a larger number of layers are surrounding the fiber-optic cable. This is why we chose it over other methods. Again, we would like to re-emphasize that the main results of our paper are those obtained with 3D FE modeling and that the analytical was used to confirm the choice of boundary conditions for the FE modeling.

Point-by-Point relevant change in the revised manuscript: Lines 30, 79, 82, 86-90, 116-121, 125-132, 405-411

Reviewer 2

GC 1: The paper aims at presenting FE modeling results showing the effect of various geological scenarios on DAS data acquired with a helically wound cable. The various scenarios were chosen to help assess possible causes of weak-amplitude data acquired at the New Afton mine using a HWC cable. We clarified this in the revised manuscript (Lines 30, 79, 82, 86-90, 116-121, 125-132, 405-411).

In the revised version, the source code is provided, and the structure of appendix was modified according to the referee suggestion (Lines 630-670, 115-121)

GC 2:

a and b) The radial strain around the cable as a response of compressional wave propagation in 90° incident angle is shown (Lines 320-340). In this FE modelling, the HWC fiber strain is calculated based on radial and axial strain of cable by considering wrapping angle (α) equal to 30 degree, according to the following equation: (Lines 199-201, 249-252)

$$e_{HWC\ fiber} = e_{axial} * sin^2\alpha + e_{radial} * cos^2\alpha \quad (1)$$

c and d) Indeed, the cable is not exhibiting higher strain in these scenarios. As the number of domains is higher in other scenarios and smaller mesh are assigned to the thinner domains, COMSOL resolution is not able to show these strains and that is why cable domain is shown in white in other scenarios. (Lines 252-275).

e) In 3D simulation, the real dimension of geometries is taken into account, and the cable is completely bounded by surrounding material and its radial deformation is controlled by its characteristics and surrounding material. While in 2-D simulation, one dimension (y) is not considered into modelling (plain strain assumption) and whatever energy is applied by plane wave is used to make deformation in x and z direction (Lines 288-290).

GC3:

This is correct; the focus is on the HWC response only. The response of straight fibre-optic cable is well-documented in the literature (Mateeva *et al.* 2014, Kuvshinov 1996). Straight fibre-optic cable are sensitive to the axial strain. For plane P-waves, the sensitivity of a straight fibre-optic cable varies as a function of $\cos^2 \theta$, θ being the angle between the plane wave direction and the cable. A HWC is sensitive to both axial and radial strain, the latter being dependent on the material around the cable. The FE modeling conducted in the paper aims primarily at recovering the radial strain averaged over the circumference of the cable. The response of the HWC is then obtained using equation 1 above (see response to GC2)(Lines 354-359).

GC4:

The gauge length is the physical interval along the optical fiber over which the difference between the phases of backscattered signal is measured and used to compute strain rate (Hartog 2018). The gauge length is the main factor controlling the spatial resolution. A trace spacing less than the gauge length is generally used during acquisition as data for overlapping gauge lengths generally improve the clarity of events, especially those related to slower waves (Hartog, 2018). The same gauge length (10 m) was used for both straight and helically-wound DAS data (Lines 364-367).

Due to the wrapping, strain rate over the gauge length is measured over a shorter cable distance for a helically-wound fibre than for a straight optic-fibre. This resulted in more channels for the HWC data (925 for HWC vs 813 for straight fibre-optic) for cables with identical length (828.5 m). While this is an important difference between straight and helically-wound cables, it does not explain the difference between data (Lines 434-440).

GC 5:

Mentioned additional references are added in revised version (Lines 458-459, 468-473, 486-490)

GC 6:

(a), (b), (c), and (d), we considered those comments in the revised version. (Lines 95, 190, 212, 245)

(e) They are tightly overlapped; it is the reason that the slight difference is not nicely detectable, however, we decided to delete that figure to make the story smoother and more integrated.

f) More discussion is provided in the revised version 17 (Lines 249-275)

GC 7:

We introduced the field data issue earlier in the paper to improve rationale for the choice of simulated models (Lines 86-93).

GC 8:

We simulated incident P-waves because it is the primary body wave used for exploration purposes. S-waves are seldom used for exploration and are usually removed from the seismic data during data processing (at least direct and refracted S-waves). Rayleigh waves only propagate along a free surface and are not suitable source waves for the exploration of the subsurface. (Lines 125-132).

GC 9:

Since the maximum response of fiber optic as a function of incident angle was the main objective, simulation was conducted in the frequency domain. We do not expect significant variations over seismic frequencies (Lines 133-138).

Specific comments (mostly grammatical point):

(a)-(d): We considered those comments in the revised version. (Lines 14, 29, 31, 57),

(e): Boer is for 2017, not 2013 that reviewer 2 mentioned) (g): (Line 117)

(h): (Line 155-160)

(k) The quality of cement is defined by Young's modulus, density, and Poisson's ration. In this study, what distinguishes between different cements are Young's modulus and density, and different velocities. The soft and hard cement have the same Young's modulus and Poisson's ratio as the cements used in Kuvshinov (2016) (Lines 340-345).

(m) Interface between water domain and solid domain acts as a free surface. When a head wave hits this interface, some part of energy converts to surface waves (tube waves) and the other part as compressional wave. Fluid does not support shear waves (Lines 311, 420-422)

We were trying to cover all comments; we received from reviewers, however, in case of missing any point, I would appreciate if you would inform us about that.

If you have any additional questions/comments or further clarification, please do not hesitate to contact us.

Yours sincerely,

Mostafa

Mostafa Gorjian, BSc, MSc, PhD

Advanced Geological Engineering Lab.

Dept. of Earth, Ocean & Atmospheric Sciences | The University of British Columbia

2020-2207 Main Mall Vancouver, BC, Canada V6T 1Z4

Phone 604 827 1834, Cell 306 850 9349

mgorjian@eoas.ubc.ca

a place of mind

THE UNIVERSITY OF BRITISH COLUMBIA