Dear Dr. Jens Turowski,

Thank you for your thoughtful review of our manuscript. We appreciate the valuable insights you have provided. We have carefully considered all of the comments you provided and have addressed them in this document in blue

Comment 1:

- I have the impression that some of the physics underlying the approach are a little unclear. Specifically, you state that you build your method on the assumption of additive PSDs (lines 88-89, eq. 7). Yet, displacements (amplitudes) are additive, energy is proportional to amplitude squared, and power is the derivative of energy wrt time. So, in general there should be a non-linear relationship. It may be that this accounted for implicitly in the equations; yet, it would be good to clarify the physical relations.
- L-88 two points: 1) amplitude is additive, not power (which scales with amplitude squared), 2) the additive effect of amplitude is true regardless of the distribution of noise.

Thank you for highlighting this point. First, we would like to acknowledge that both acoustic and seismic signals are forms of wave propagation in mediums (air or water for acoustics and the Earth for seismic), which can show several similarities however we can note also some differences to be considered. Unlike seismic waves, which involve particle motion in the Earth's crust, acoustic waves in water primarily involve variations in pressure. As a result, the concept of seismic moment, which is central to seismic source characterization, does not directly apply to underwater acoustics. Instead, we work with acoustic power, which is the rate of energy transfer through the water medium due to pressure variations (which is not a mechanical force).

Both acoustic and seismic follow the superposition and interference principles for waveform combination. The latest states that when waves from multiple sources pass through the same medium, their effects sum algebraically at each point.

In our method, 'additive' pertains to the accumulation of energy contributions across multiple bedload impacts in the frequency domain, which subsequently results in the total power of the measured signal. Regarding the assumption of additive PSDs (lines 88-89, eq. 7) in our method, we acknowledge that the non-linearity in the summation of acoustic powers may not be as strict as it is in the case of seismic waves. Allow us to clarify this aspect.

In the context of underwater acoustics and signal processing, the assumption of additive power spectral density (PSD) in our method aligns with well-established principles of coherent summation. While displacement amplitudes are additive in acoustic waves, it is important to note that the relationship between power and amplitude squared introduces some non-linearity. However, when dealing with random signals in time, such as ambient noise or acoustic emissions from various sources, the central limit theorem can be assumed. The central limit theorem states that the sum of a large number of independent and identically distributed random variables tends to follow a Gaussian distribution. In the case of acoustic powers, which are derived from the squared amplitudes of individual acoustic wave components, the summation often involves numerous contributing factors. The contributing factors in this context refer to individual sources, where each of these sources contributes its own amplitude and associated power to the overall acoustic field. As a result, the central limit theorem justifies the approximate linearity in adding acoustic powers, especially when the number of contributing factors is large (Papoulis, 1991) which is the case of bedload SGN sources (particles).

In underwater acoustics, the linear addition of acoustic powers is widely recognized as a common approach for coherent signal processing and source localization (Etter, 2018; Jensen et al., 2011). Therefore, despite the non-linearity introduced by the power-amplitude relationship, the assumption of adding acoustic powers remains a valuable and practically applicable concept in underwater acoustics and source localization (Vorländer, 2008).

Our method builds upon these established principles of underwater acoustics, coherent signal processing, and source localization.

Following your suggestion we modified (L103-L113) the text to support our assumption of linear relationship of acoustic power and energy.

Comment 2:

L-73 the method described in this chapter seems quite similar to methods for locating sources in seismology, especially amplitude source location (ASL). This is not surprising; after all, it is about wave propagation.

We appreciate your suggestion and will certainly incorporate in the introduction acknowledgment of prior work in the field signal inversion (seismic and acoustic). The revised text reads as follows:

- L60-L74: “The inversion method uses propagation laws to reconstruct the strengths and location of sources from the measured signal. It is extensively studied and used in acoustical engineering applications such as detecting noise sources for jet engines using a beamforming microphone array by manipulating the phase and the amplitude of the wave form (Presezniak & Guillaume, 2010), identify acoustic emissions in machinery using the spectral analysis coupled with the time-domain of acoustic signals (Arthur et al., 2017), and analyze vibrational patterns in automotive components using finite element models to reconstruct the source and propagation path (Madoliat et al., 2017). In seismology, inversion techniques have been instrumental in locating seismic sources using the amplitude source location (ASL) method (Battaglia & Aki, 2003; Walter et al., 2017), investigating microseismic events related to hydraulic fracturing using Stochastic inversion techniques (Maxwell, 2014), and understanding the structure of Earth's interior by determining the velocity distribution of the propagated waves (Rawlinson et al., 2010). Regardless of the specific field, inversion methods inherently involve modeling the propagation of signals in different environments. However, the inversed parameters and the used algorithm can widely vary depending the studied domain and the specificity of each application .In our work, the inversion is based on the spectral content of the measured bedload SGN signals propagated withing the river water column.”

We also add the reference to the mentioned papers (Battaglia & Aki, 2003; Walter et al., 2017), in the introduction to highlight the similarities and differences between our method and established techniques in seismology. This will provide readers with a better context and understanding of the inspiration and background for our approach.

Comment 3:

L-115 please specify units for the TL function here.

We apologize for the oversight. We precised that the TL function is dimensionless. We also provided an explanation of the TL1 function in equation 2 and 3 making it clear that the function's values are dimensionless. This will help ensure clarity and proper understanding of the equations.

Comment 4

L-120 This is equivalent to generic descriptions of wave attenuation, used, for example, widely in seismology. Maybe this should be acknowledged.

We support the editor suggestion that this point should be acknowledged. We modified the manuscript to acknowledge the similarities in propagation laws between acoustic and seismic waves. The revised text reads as follows:

- L171-L175: The accuracy of acoustic inversion is highly contingent on the precise description of the environment and its corresponding propagation model. In oceanic acoustics, these propagation models have been rigorously investigated and are well-understood (Roh et al., 2008), allowing for precise prediction and control of acoustic signals . Remarkably, the principles of these propagation models bear notable similarity to the seismic wave attenuation phenomena used in seismology (Müller et al., 2010; Soham & Abhishek, 2016), further demonstrating their validity and utility across different disciplines.

Comment 5

please give dimensions without referring to a particular unit system (i.e., speed as L/T).

Thank for you for this valuable suggestion to use dimensions without specific unit systems. While we can understand the value of such suggestion in a scientific article, we will kindly not accept this suggestion. After trying your suggestions in using dimensions in section 2 and section 3 (such as $p^2.F^{-1}.A^{-1}$ for PSD) we find that this can be confusing for the reader to follow up with different variables, equations and dismissions. Mainly that many symbols have been already used in this article. On the other hand by including specific unit systems(such as $\mu Pa^2.Hz^{-1}.m^{-2}$), it helps the readers to easily follow up and comprehend the various equations and symbols.

However, we highlighted and justified our choice to the pressure unit in this article:

- L86-L87: “In underwater acoustics, the pressure is typically measured in micro-pascals (μPa), which is the standard metric unit for this field, and will be the unit of choice used within this work.”

Comment 6

L154 unclear, what does ‘surfacic’ mean? Please define.

The use of the term "surfacic" is intended to emphasize sources that are distributed the surface the spatial distribution of such sources on a surface, in contrast to sources that might be located within the medium.

We added the following sentence in section 2.1 to clarify what surfacic source correspond to:

- L115-L119: “The riverbed then acts as a surfacic acoustic source which emphasizes the spatial distribution of bedload SGN noise at the surface of the riverbed. In this case, the source power spectral density (PSD, the variation of power with frequency) per unit area $\mathcal{S}$ (in $\mu\mathrm{Pa}^2 \cdot \mathrm{Hz}^{-1} \cdot \mathrm{m}^{-2}$) is computed using a linear system that weights…”

Other comments

- 68 work
- 86 noise
- 117 Based on experimental work, Geay et al. proposed…
- 134 where

Thank you for highlighting all of these points. We corrected the text.

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