The Cryosphere Discussions

The Cryosphere Discuss., referee comment RC2
https://doi.org/10.5194/tc-2021-340-RC2, 2022

Comment on tc-2021-340

Anonymous Referee #2

Referee comment on "Recovering and monitoring the thickness, density, and elastic properties of sea ice from seismic noise recorded in Svalbard" by Agathe Serripierri et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2021-340-RC2, 2022

The authors present an innovative passive seismic study that monitors the evolution of sea ice thickness and mechanical properties using passive seismic noise. The authors combine both array processing with ambient noise cross-correlation to produce dispersion curves for guided waves within sea ice. The results of these dispersion measurements are used to invert for ice thickness, Young's modulus, Poisson's ratio and ice density using a Bayesian framework.

The manuscript is interesting and merits publication in The Cryosphere. It is concise and well written but I think improvements could be made to the clarity of the paper. I have a number of minor comments and suggestions which are detailed below.

- Section 2.1: Seismic array would benefit from a paragraph describing the deployment of the seismic instruments, with details on how the geophones were installed i.e were they mounted prior to deployment, burial depth if at all and any challenges or difficulties encountered.

- Section 2.2.1 would benefit from a few sentences on the theoretical foundations on the retrieval of Green's functions from ambient noise. This section should also include a description of the processing steps, parameters used and the justification for their selection e.g., why and how was a 5 minute window selected for the noise correlation length. Also which stations were used and if correlations were made across stations components e.g., N with E.

- Section 2.2.2: In this section, it is unclear as to which of the seismic instruments (1C or 3C) is used in the beamforming and subsequent calculation of the noise correlation function. I assume that the authors beamform seismic noise using the 1C stations before using noise directed within 10 degrees of the 2 3C lines to compute the correction function

using the 3C stations.

- Section 2.2: A flow chart summarising the beamforming and noise correlation function workflow should be included to improve the clarity of this section.

- Section 2.3: The authors should expand upon the SVD methodology used to compute the dispersion curves.

- Section 2.4.2: In the inversion, why haven't the author's used uncertainties from their measurements for the estimate of sigma in equation 6? It is unclear from the text why this isn't possible. I'm also unsure as to why the Simulated Annealing method is used instead of the burn-in phase of the MCMC. Could this not affect the sampling of the posterior distribution?

- Results and Discussion: This section would benefit from comparisons between the retrieved parameters and previous estimates in past studies e.g., How does the Young's modulus compare with other estimates? Likewise, how does the estimated value of density compare with meteoric ice and sea ice? Additionally, the inversion appears to be insensitive to density. Why do you think this is the case? How could the inversion be improved to account for the insensitivity to density?

- Figure 1: A map of Svalbard and the location of Lake Vallunen highlighted should be included.

- Figure 6: The histograms should be normalised such that the area under each graph is 1 in order to show the PDF for each of the parameters. It is difficult to see the blue line indicating the maximum of each distribution and this should be changed to black or the shading of the histograms should be changed to grey or white.

- Lines 78 - 81: A schematic diagram illustrating the displacements of the different modes of the waveguides would be beneficial.

- Lines 280 - 281: Please include more detail on how the distribution is fitted to the posterior distribution.

- Lines 284 - 285: Since the distributions are not Gaussian, I'm unsure how relevant it is quoting uncertainties for the results using the standard deviation. The interquartile range would be a more relevant measure of uncertainty.