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Interactive comment on "Random Noise Attenuation of Sparker Seismic Oceanography Data with Machine Learning" *by* Hyunggu Jun et al.

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The paper describes a signal processing algorithm that can be used to suppress noise in images and how it can be applied to seismic oceanography data, in particular sparker data which inherently has a higher frequency content than air-gun data but has a lower signal-to-noise ratio. The algorithm uses a Neural Network to identify and suppress the noise. The authors present a fair and balanced assessment of the method, highlighting the issues with training the Neural Network to discriminate what is wanted from what is not wanted. In this case the training is to extract the noise which is then subtracted from the original data to reveal the underlying reflectivity.

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Discussion paper

As it is written I think the detailed description of the methodology will be of low interest to the majority of readers of this Journal. However, the paper does show how SO may be used to successfully investigate the turbulent sub-range and fine-scale mixing. So I am recommending the authors revise the paper: the detailed methodology and training should be moved to supplementary material; then the paper should focus and expand on the East Sea data and its analysis of the implications for understanding ocean processes.

Richard Hobbs

The English is generally poor as is sentence structure, however despite this the meaning is generally unambiguous. Recommend careful editing to improve readability.

For example I suggest the authors consider the revised Abstract below:

Abstract. Seismic oceanography (SO) acquires water column reflections using controlled source seismology and provides high lateral resolution that enables the tracking of the thermohaline structure of the oceans. Most SO studies obtain data using air guns, which can produce acoustic energy 0ver the 5-150 Hz bandwidth. For higher-frequencies other seismic systems may be used, such as a sparker source with central frequencies of 250 Hz. However, the sparker source has relatively lower energy compared to air-guns and consequently produces data with a lower signal-to-noise (S/N) ratio. To address this problem we apply machine learning to attenuate the random noise without distorting the true shape and amplitude of water column reflections. Specifically we use a denoising convolutional neural network (DnCNN) that successfully suppresses random noise in a natural image. One of the most important factors of machine learning is the generation of an appropriate training dataset. We generate two different training datasets using synthetic and field data then the trained filters are applied to test data, and the denoised results are quantitatively compared. To demonstrate the technique, the trained filters are applied to an SO sparker seismic dataset acquired in the East Sea and the denoised seismic sections are evaluated and show

..... The results demonstrate that machine learning can successfully attenuate the random noise in sparker water column seismic reflection data.

Please use the above as an example of how to clarify your English but also how better to engage with your intended audience who are oceanographers. I do not intend to rewrite the rest of the paper for you! Further, this paper requires a significant revision so detailed correction at this stage serves no purpose.

line 34 - delete "relatively low" as you do not state relative to what. Please edit paper to remove, as much as is possible, unqualified comparative statements.

line 46 - This problem is more accentuated in SO because the impedance contrasts between the layers are small.

line 65 - this reference list ignores the long history of the use of Neural Networks see McCormack's paper in Leading Edge 1991 which shows an early attempt to use these NN to identify noisy traces in seismic data, since then NN have been evaluated for many tasks in the processing of seismic reflection data. Suggest authors change sense to recognise the history but equally highlight the recent advances in AI. I now note that this history is partly addressed in the following paragraph.

line 153 - scaling by the sq-rt of time is not "spherical divergence" correction but a "geometric correction" as for true spherical divergence loss the amplitude scales by a 1/z which for a constant sound-speed medium is proportional to 1/t.

line 158 - an SVD filter can be effective in removing direct wave and maybe worth trying, though extreme care is needed to get offsets correct and correctly estimate of surface mixed layer sound-speed.

Fig 3 - plot sections in the same orientation and spatially lined up so it is possible to appreciate the similarity/differences in the two images but note in caption or by arrow on section the acquisition direction.

line 183 - the subsurface will contain a range of reflection coefficients some will be tens to hundreds times larger but others will be of the order of magnitude as SO.

lines 220-224 - definition of epochs and iterations is not clear.

General question about noise - it is not clear, or I have overlooked the statement in the paper, but was the noise section extracted from data before or after divergence correction? If so, have you not imposed a time scaling on the noise as environmental noise levels would be expected to remain constant with time? So should this denoising be applied to non-divergence corrected data?

line 290 - what is the "Static 94 synthetic seismic section?

Figs 16 & 17 see request for Fig 3.

A useful analysis would be to generate a synthetic with the expected spectral slopes then add noise at different levels and try to recover the input, the question I would like to know is is the shift after filtering (shown in Fig 19) removing weak signal too. Also discussion on the expected horizontal resolution. You state the peak frequency is 250 Hz which, after migration, should give a maximum horizontal resolution of ∼1.5 m. However, it will be less as this is a 2D profile over a 3D structure so there will be out-of-plane contamination.

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