

## Response to Reviewers

We are very grateful to the Editor and Reviewers for their most recent feedback. Below we outline how we have responded to their comments. Comments by the Editor and Reviewers are shown in *blue*, and our responses in black. Line numbers refer to the revised version of the manuscript with tracked changes.

## Response to Editor's Summary of Comments

### General Comments

The authors address most of my concerns and those of the second reviewer. They alter the tone to be more realistic about future trajectories of the technology, acknowledge complementary technology appropriately, discuss more the gaps in current understanding (e.g., the DAS transfer function), brought in DSS, long-range DAS, more on ANI, possible relationship to fitting into GOOS and TRLs. They added some development history that I was not aware of – good.

We are very pleased that the reviewer finds our revisions to be generally satisfactory, and thank them again for their efforts in improving our paper.

They still use ocean current/strum (distributed – per the article title - from between repeater segments to full cross basin) for the example associated with optical forward propagation sensing, rather than the sensitivity to commensurate large(r) scale ocean features for which the averaging is beneficial – averaging out smaller features thus increasing SNR for larger features. I continue to disagree with the authors – use of strum to infer 1-d current speed will be at best a curiosity (useful for cable protection/maintenance), but not useful for reliable, deterministic large scale ocean observing, whether research or operational.

We agree with the reviewer in that strumming and VIV interpretation of those signals is only applicable in regions with a significant amount of suspended cable. However, the approach could apply equally in some regions where the seabed is especially rough and cables are thus likely to have more spanning sections. We choose to keep the main section on measurements of near-bottom flow the same as it is currently, as it is consistent with other published work applying this technique. In the section on long-range measurements, we have adjusted the text to highlight that this is only one potential interpretation of the signal, and that there are limits to the applicability of the method to areas with a smoother seabed (lines 752-756).

The authors have now inserted an Appendix: A Novel frameworks for DOFS data analysis. The only reference to this in the main body is in the final paragraph of the conclusions, after a statement about new approaches to handle large data volumes. It does not directly address large data volumes. It reads as a very nascent idea. While discussing ocean temporal and spatial coherence scales, it does not include a discussion of the conventional means to accommodate current and future data types – namely objective mapping, ocean modeling and data assimilation (including scaled down versions, e.g., objective mapping). Models of the equations of motion which incorporates our best understanding of physics, and data assimilation, including our knowledge of temporal and spatial coherence scales, is the glue that can rigorously combine data of different types together with the dynamic represented by the physics, which includes coherence and account for “fundamental multiscalarly of the

observations.”

I recommend the Appendix be removed, and the topic addressed in subsequent publications.

We have followed the reviewer’s suggestions and removed the Appendix.

Details

Line 49, capitalize A in And for SMART – very important to emphasize the connection between sensing and telecom

Science Monitoring and Reliable Telecommunications

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Thank you – done.

193 spatial resolution. When people start making path integral measurements, often the first thought is, oh, that is not enough, we want to resolve sub-segment wavenumbers. But the segment average is extremely powerful as a (box car) low pass filter, removing high wavenumber “noise”. It is not which is better or not, but the application. In the seismic world, if the interest is in low wave number features in the earth, having a method that inherently averages out the high wavenumbers is advantageous (as Zhan in one of his papers illustrated). The same should apply to ocean features – if one is interested in low wavenumber (e.g. mesoscale and larger), having segments (100km) and larger are actually advantageous. In Marra’s 2018 paper, dealing with full cable length measurements, an obvious (perhaps conceptual) application would be to take all the cross-basin optical path integral measurements from many cables crossing at many different angles and do the tomographic inversion for global earth surface strain (ignoring things like variable transfer functions!).

We thank the reviewer for their suggestion. We have added further details to the text to highlight this potential (lines 203-205).

224 dBm, the signal generated by the source becomes unstable and unusable for distributed sensing

Should say by the “laser source”.

Or is it simply that at high laser input power, optical propagation becomes non-linear?

The reviewer is correct – it is optical nonlinearities that cause the signal to be unusable. This is now noted explicitly (line 226).

227 - or using higher-energy (longer) signals through linear frequency modulation This is what GPS does (pseudo-random codes) – and a very large number of other applications. DAS should take learn from these (and I imagine radar).

The reviewer is also correct on this point. The optical signal processing routines have made use of this knowledge for DOFS.

232 following pulse signal is fired,

“fired” is not right – use transmitted or similar.

Thank you – we have amended the wording.

276 For seismic and acoustic sensing, uncertainty in cable geometry primarily influences absolute localisation and angular interpretation, rather than detection capability itself. To use DAS as receivers of active low frequency acoustic signals for the purpose of ocean acoustic tomography typically means 1m/1ms positioning and timing accuracy. For any ocean observing application, all effort to achieve these accuracies should be made.

We agree with the Reviewer. We have not amended the text further, as we believe the current version captures the key point that the Reviewer highlights.

313 - units of degree Kelvin

Correct usage is K or Kelvin – NOT with degree

Thank you – corrected.

337 With these characteristics, the DTS systems became capable of quantifying temperature in the wavenumber-frequency space that is dominated by internal waves and stratified turbulence.

Could add a sentence – not applicable for use far from shore on the deep ocean seafloor where mK is required.

We have added this clarification (lines 337-338).

361 such core temperature was too rapid  
core temperature change/increase was ...

Thank you – amended.

430 °C are empirically

Do you want to unify temperature unit to K?

Done.

499 slower than seismic ( $c > 200 \text{ m s}^{-1}$ ) or acoustic ( $c > 1500 \text{ m s}^{-1}$ ) waves. Aren't seismic typically 3000 m/s for shear and 6000 m/s for p waves. Maybe less in mud where cable is? Tsunami is  $< 200 \text{ m/s}$ ....

The cited speeds are correct in a typical seafloor with unconsolidated sediments. We now include two references to back up the numbers cited (line 501).

779 - with a spatial resolution of 100 m or less.

What is the sampling frequency?

Thank you for spotting this oversight. We have added to the text that sampling of up to 1kHz has been reported (line 768).

785 - The second technique (Ronnekleivet et al., 2025)

Does this method require changes to the standard telecom repeater? Will it work in existing

systems, or only in future ones with suitable modification?

This method is indeed applicable with a standard repeater.

790 – what is the space/time sampling done by Mazur? Frequency, gauge length?

The characteristic space/time sampling of the Mazur technique is approx. 100 m / 100 Hz. This is now noted (lines 772-773).

1050 unmatched by other approaches. It is also a technology for which extensive, global-scale infrastructure is already in place (Fig.11). A

Should be Fig 12

Thank you – corrected.

1072 seismicity (via a three-axis accelerometer) (

Via three-axis accelerometers and seismometers, reference Howe et al 2022  
Perhaps note somewhere that the SMART seismic sensors can be regarded also as low frequency hydrophones.

Thank you – done.