Review for "Monitoring surface gravity wave variability with State of Polarization sensing on a subsea telecommunication cable" by Quiñones et al.

Fiber-optic sensing technologies are rapidly emerging as promising tools to fill the longstanding subsea observational gap at the seafloor. State of polarization (SoP) sensing is particularly attractive because it requires minimal modification to existing light sources and cable infrastructure. This work by Quiñones et al. presents one of the first systematic comparison between SoP-derived wave measurements and in-situ observations, demonstrating that SoP can reliably capture variability of both wave height and frequency for most of the observational period.

Importantly, the reported mismatches also exposes limitations of SoP, notably the spatial averaging inherent to whole-cable measurements. However, In its current form, the manuscript risks leaving readers with a stronger impression of SoP's limitations than of its demonstrated potential. This is because the current presentation emphasizes mismatches of SoP with ground truths more than the substantial consistency. Moreover, the discussion on mismatch is scattered throughout the manuscript without a clear conclusion.

This paper would be more influential and accessible to ocean scientists with revisions in both text organization and analysis, especially to highlight the demonstrated consistency and provide a clearer conclusion regarding inconsistency.

Therefore, I recommend **major** revision focusing on restructuring and deeper analysis.

Main suggestions

Restructure texts and figures to foreground consistency. The most compelling result of this work is arguably Fig. 7e, yet it doesn't appear until near the end of the paper. Therefore, I strongly suggest restructuring the presentation to first establish the high level of consistency between SoP and in-situ observations, particularly by highlighting Fig. 7e early in the paper—at least before Fig. 5 which focuses on inconsistency. In addition:

- Adding a similar comparison for peak period, together with wave height, would further make the comparison even more convincing.
- The correlation in Fig. 7a is worse for small S_1' values, which is likely due to SoP noise levels. This is also evidenced in Fig. 7e that the value is almost never less than 0.1. Explicitly discussing and presenting the SNR limitation would clarify when SoP works or not.

A clear narrative arc–first establishing robustness, then examining limitations–would greatly improve readability and impact.

Separate observations from interpretation. The manuscript would benefit from a clear separation between observational results and interpretive discussion. Currently, these elements are interwoven in ways than obscure logical progression. Examples include:

- L218 says Fig. 5 will be explored in sec 4.3, which is not truly discussed until sec 5.2 L440.
- Fig. 6 is interpretation and is closely related to Fig. 8, but comes before Fig. 7 which is observation.
- The discussion on what SoP truly senses is embedded in describing observation (L235–250), which I elaborate more below.

I recommend reorganization such at observation are presented first, followed by a dedicated interpretive discussion about mechanisms.

Expand analysis of what SoP truly measures. A central unresolved question for fiber wave sensing is to understand whether waves induce strain via direct pressure loading or seafloor compliance, which remains controversial (e.g. Williams et al., 2022; Tonegawa & Araki, 2024; Liu et al., 2025). The authors' long-term SoP data, paired with in-situ observations, provides a unique opportunity to potentially resolve this issue. I therefore encourage a significant expansion of the discussion in L235–250 and L380–395, including:

- Examining the amplitude ratio between SoP and in-situ observations for the same wave frequency as a function of wave directions (Fig. 7b). Directional dependence would support the compliance mechanism.
- Interpret the scaling from S_1' to wave height of 0.017%/m. Does this scaling have any physical meaning, such as related to cable or seafloor mechanical properties?

This deeper analysis could potentially make a fundamental contribution to our understanding of how fiber senses waves in general with other technologies besides SoP, such as DAS.

Provide a clear conclusion for the reason of mismatch. In L440–450, the authors discuss four potential causes of mismatch, but the discussion remains speculative, lacking in-depth analysis and a clear conclusion. Some discussion can incorporate sections 5.3 and 5.4 to reduce repetition.

- For mechanism (1), why the authors use only S_1? The authors emphasize a few times (e.g. L97, L442, L545) that any single Stokes parameters can give unreliable result and all 3 parameters should give a more complete description, but they never explain why they chose to use only S_1.
- For (2), is there any evidence to support this, such as does the wave model show any large spatial variation for undetected wave events like Fig. 5?
- For (3), do the authors observe temporal variation in response? I think Fig. 7a answers this that the scaling of 0.017%/m appears stable over time except for weaker waves with lower SNR on SoP. This actually highlights the stability of SoP response. If the cable is buried ~1m deep (L130), how can current affect static tension? Furthermore, the authors do have current measurements to evaluate if change of current always correspond to response such as Fig. 5.
- For (4), S1' also measures large waves (Fig. 7b), which requires a blocker to appear and disappear in time. This seems rather ad hoc. As discussed in the previous point, the directional dependence needs further analysis to rule out.

Overall, the authors should provide at least a rank of likelihood on these four reasons, rather than leaving the discussion open-ended.

Secondary suggestions

Improve accessibility for ocean scientists. Sections 2, 3.1 and Fig. 1 appear rather technical for ocean scientists. On the other hand, how birefringence is quantitatively related to strain, which is how the waves are sensed ultimately, is never made clear. Moreover, how is birefringence variation related to refractive index change (L90–95)? Equations like those (16) and (19) in Mecozzi et al., 2021 would be very helpful. A clear physical chain from wave pressure => strain => birefringence => SoP variation would help broaden accessibility.

False positives vs. false negatives. The manuscript emphasizes false negatives of missed waves, but how should false positives be interpreted? For example, in Fig. 4b, the wave on SoP from Dec 16th to 18th is almost as strong as the 22nd and 25th.

Discuss more how to address limitations. L540–555 can have more discussion on how to address those key limitation of SoP, notably for distributed sensing (e.g. Costa et al., 2023).

Figure-specific comments.

- Fig. 3: Use identical vertical axis scale to avoid confusion that (c) is the same as (b). Does it make sense to plot $-V_1$ on top of V_2 to show they are almost identical?
- Fig. 4: Too many lines in (a). In particular, the top blue line does not seem to correlate to any observation. Consider picking at most two lines to show, such as the in-situ ones.
- Fig. 5: Should appear after Fig. 7e.
- Fig. 6: Better presented closer to Fig. 8.
- Fig.7:
    - (a) Explicitly discuss noise floor of SoP likely worsens correlation.
    - (d) The authors argue that swell correlation is worse than wind wave because swell affects both near-coast and offshore. Would correlation improve using model predictions with spatial weights of Fig. 6c (and formulations of e.g. Mecozzi et al. 2021)?
    - (e) This is the strongest validation figure and should be moved earlier in the manuscript.

References

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