Review of

# Internal solitary waves refraction and diffraction from interaction with eddies off the Amazon Shelf from SWOT

October 8, 2025

The authors explore internal solitary waves (ISWs) off the Amazon Shelf as measured by the recently launched SWOT satellite altimetry mission, complemented by sunglint images. The novelty of this study lies in the observational evidence of ISW refraction/diffraction due to interactions with mesoscale eddies of different polarity. To do so, the authors first extract ISWs from SWOT swaths through spatial bandpass-filtering technique knowing the typical length-scale of ISWs in the region from previous studies. The extracted ISWs are then quantified including a characterization of their geometry (propagation axis, concave/plane/convex wavecrest, curvature intensity, azimuth). These characteristics are classified by investigating three different case studies with each case study corresponding to a different background mesoscale eddy field: No Eddy (NE), Cyclonic Eddy (CE), Anticyclonic Eddy (AE).

The presented work is a valuable addition to the assessment of SWOT and the understanding of ISW and their interaction with eddies. Overall, the manuscript is well written and easy to read. I recommend its publication in Ocean Science. I do have some comments, which I consider mostly minor, listed below.

**Comment #1** One concern that I have had is how the background conditions are interpreted. The NE and CE case appear to represent the same mesoscale background field (NE: 18 Sep 2023; CE: 29 Sep 2023). In other words, the cyclone and anticyclone detected in the CE case are also evident in the NE case. Just because the eddy tracking does not identify those as eddies, the ADT and associated currents highly in Figure 5a and 5b suggest eddy or mesoscale activity, don't they? Are the associated currents in the NE case significantly weaker than in the CE case? I guess that for the given day (18 Sep 2023) there are no enclosed ADT contours for the anticyclone and cyclone in ISW propagation direction? The eddy detection considers only local extrema of ADT? Is it possible to add the velocity field (local normalized angular momentum) as it is done in the AMEDA algorithm (Le Vu et al., 2018). I assume that the authors have not found a better example for NE with corresponding SWOT passes. The authors may stick with the given example but change the definition of NE, which for now is defined as "absence of mesoscale eddies" to something like "absence of interaction...".

**Comment #2** Following up the above a comment, there is a lot of speculation on the ISW propagation direction after encountering seamounts and eddies, though this is well discussed and limitations of the presented manuscript are clearly listed (see Discussion). A ray tracing experiment that models the horizontal propagation of tidal rays (separated by vertical modes) through a mesoscale eddy field (see Rainville and Pinkel, 2006; Vic et al., 2023; Bendinger et al., 2024 or a more dedicated approach by Duda et al., 2018, Guo et al., 2023) would certainly remove any doubt on the ISW propagation direction proofing whether the observed mesoscale eddies (CE and AE) explain indeed the observed ISW refraction in propagation direction and whether NE causes no refraction in propagation direction. Such ray tracing could be applied to the three surface geostrophic velocity fields in Figure 7D to 7F (or Figure 12) to see whether it matches the changing propagation of ISWs observed in SWOT and sunglint images. However, I understand that this involves further work, which is why I leave it to the authors whether they want to quantify their findings with theory.

**Comment #3** Before focusing on how eddies impact ISW characteristics, I would start with a small paragraph describing their mean characteristics (based on Table 1). How many ISW were detected, etc.? I think it is also worth to quantify their SSH signature (>10 cm)?

## Comments by line

**lines 24-26:** Personally, I think that the characterization of ISWs using SWOT deserves a bit more attention in the abstract (and in the conclusion also), stating at least how many ISW you detected and what their SSH amplitude is.

**line 41:** in a stratified ocean

**line 62 and throughout the manuscript:** To be double checked with the Copernicus editorial service whether work not submitted/published should be mentioned as reference. If so, it would be great to show associated results of those studies in preparation wherever they are relevant in the given manuscript. This could be in form of appendix, etc.

**line 77 and 81:** The authors introduce the terms coherent and incoherent. Briefly define what coherent and incoherent means for readers which are not familiar.

**Figure 1 and 2:** Figure 1 and 2 could be merged to one figure with two subplots?

**line 129:** MIOST maps include SWOT KaRIn and nadir observations. Do the authors expect that submesoscale and wave-like motion is contained in ADT (when SWOT swaths are available and used for the multiscale, multivariate mapping), which was used to apply the mesoscale eddy tracking? In other words, when studying mesoscale dynamics should one not exclude the SWOT KaRIN observations? I think that there is a dataset provided by AVISO/CMEMS which provides ADT maps but without SWOT. I do not expect big differences for the final eddy tracking, but this contrasts with what was being sad in lines 91-94, i.e. SWOT should be used with caution when studying mesoscale and geostrophic currents. However, in **line 138** it is implied that ADT maps consist of nadir-pointing data only. Please clarify how SWOT data (KaRIn and nadir) is implemented in ADT maps.

**Figure 2:** It seems like, transparency has been added to the colorbar, but the shading in the actual plot has no transparency? I could be a nice addition to plot all ISWs identified in this manuscript on top of those from Macedo et al. (2023)?

**line 145:** across the track?

**Section 2.2:** I assume that the authors used the 250 m (unfiltered) product? Please clarify. If yes, also mention in the introduction in **line 87** that observations are at disposal down to 250 m. Did the authors compare the 250 m and 2 km products? If yes, are there big differences between these two? I expect that the ISWs might have a stronger (unsmoothed) signature in the 250 m product?

**line 158:** Specifically state what is included in the high-resolution signal, e.g. tidal and non-tidal IGWs, submesoscale, etc.

**line 181-183:** Is this commonly done when applying eddy tracking in near-equatorial regions? Why not using SLA maps when focusing on mesoscale eddies?

**line 202:** Fig. 3A?

**Figure 3:** I would enlarge the figure/subplots for the better visibility.

**Figure 6:** I leave it to the authors whether they want to keep this figure. For me the text is sufficient.

**Section 4.3:** ISW propagation is interpreted using surface geostrophic velocities, mainly representative of mode-1. What role could higher-baroclinic current velocities play (see Duda et al., 2020, Guo et al., 2023)?

**Section 4.3.1:** ISWs are highly anisotropic. The significance/meaningfulness of (along-track) wavenumber spectra depend on whether the selected tracks are aligned with the primary propagation direction. The latter seems mostly to be the case. Whatsoever, I believe that this is worth mentioning. SWOT cycle 20, for the most easterly pass it could be possible that the tracks used for the spectral analysis are partly aligned with the wavecrests?

**Caption Figure 8:** Subplots D-F are not mentioned.

**Section 5.2.3:** Important section discussing the NECC. Why is there a big interest in separating effects of NECC and eddies? Does it matter whether the NECC or eddies refract/diffract ISWs? A ray tracing experiment could possibly separate these two effects when modeling the propagation of tidal rays in climatological/annual mean background current fields (which represent the NECC?) and daily ADT/SLA maps (which represent eddies).

**lines 446-450:** Following a comment from above, it would be very helpful to show something from Kouogang et al. (2025b, 2025c in preparation).

**lines 450:** Duda et al. (2018) is a modeling study, isn't it? In that case prevent using "observed".

**lines 552-553:** Not as detailed as in the presented study, but I think it is worth mentioning the studies Xie et al. (2015), Xu et al. (2020), and Huang et al. (2024) who simultaneously observed ISWs and mesoscale eddies. These references might be also added to the introduction.

**lines 630-632:** There is now a peer-reviewed version: https://doi.org/10.5194/os-21-1943-2025

**lines 650-653:** Remove the doi of the preprint.

**lines: 715-719:** To be double checked with the Copernicus editorial service whether work which is not submitted/published should be in the reference list.

## References

Bendinger, A., Cravatte, S., Gourdeau, L., Rainville, L., Vic, C., Sérazin, G., Durand, F., Marin, F., and Fuda, J.-L.: Internal-tide vertical structure and steric sea surface height signature south of New Caledonia revealed by glider observations, Ocean Sci., 20, 945–964, https://doi.org/10.5194/os-20-945-2024, 2024.

Huang, H., S. Qiu, Z. Zeng, P. Song, J. Guo, and X. Chen, 2024: Modulation of Internal Solitary Waves by One Mesoscale Eddy Pair West of the Luzon Strait, J. Phys. Oceanogr., 54, 2133–2152, https://doi.org/10.1175/JPO-D-23-0244.1, 2024.

Le Vu, B., Stegner, A., and Arsouze, T.: Angular momentum eddy detection and tracking 1029 algorithm (AMEDA) and its application to coastal eddy formation, Journal of Atmospheric and 1030 Oceanic Technology, 35 (4), 739–762, https://doi.org/10.1175/JTECH-D-17-0010.1, 2018.

Vic, C. and Ferron, B.: Observed structure of an internal tide beam over the Mid-Atlantic Ridge, Journal of Geophysical Research: Oceans, 128, e2022JC019509, https://doi.org/10.1029/2022JC019509, 2023.

Xie, J., Y. He, Z. Chen, J. Xu, and S. Cai: Simulations of Internal Solitary Wave Interactions with Mesoscale Eddies in the Northeastern South China Sea, J. Phys. Oceanogr., 45, 2959–2978, https://doi.org/10.1175/JPO-D-15-0029.1, 2015.

Xu, J., He, Y., Chen, Z., Zhan, H., Wu, Y., Xie, J., Shang, X., Ning, D., Fang, W., Cai, S.: Observations of different effects of an anti-cyclonic eddy on internal solitary waves in the South China Sea, Progress in Oceanography, 188, 102422, https://doi.org/10.1016/j.pocean.2020.102422, 2020.