Review of "Constructing a SWOT Internal Wave Dataset using deep learning"

by Xinyuan Xi et al, for publication in EGU ESSD.

This paper presents a dataset of internal solitary waves in thirteen hotspots for such signals in the world's oceans, created using a new deep-learning algorithm (SWOT_IWD) on SWOT KaRIN data. The resulting dataset contains SWOT L2 passes with detected ISW packets, as well as the corresponding detection bounding box. These results are of great interest to the physical oceanography community, as ISWs play a key role in ocean dynamics, impacting energy transfer and dissipation, associated mixing and ocean biogeochemistry. As far as I can tell, the dataset and proposed methodology are valuable and the manuscript worthy of publication as a data paper describing the dataset and underlying methodology. However, the paper contains many imprecisions and a few incorrect (or ambiguous) statements regarding ISW dynamics. It also contains a lot of irrelevant information or information that is very poorly organised. Consequently, the paper is much longer than necessary. A critical issue is section 4 (and more specifically section 4.1), which is very long without providing any new information and contains many imprecise statements and insufficient or inadequate references. Furthermore, this section sits between a detailed presentation of the dataset, which is within the scope of the journal, and some unclear interpretations of the results, which are outside the scope of the manuscript. This section renders the paper not suitable for publication in its current form. My detailed comments are below.

Major comments

- Title, line 15, and throughout the rest of the paper: 'Internal solitary waves' (ISW) are a specific type of 'internal waves' (IW), which are non-linear and behave like solitons. There is a whole continuum of internal waves, including internal tides, which are mostly linear and cannot be called internal solitary waves. The authors should make it very clear that this dataset is about internal solitary wave packets and not internal waves in general. For example, they could replace 'IW' with 'ISW' or 'NLIW' throughout the text and rewrite the first sentence of the introduction.
- SWOT_IWD: It is unclear whether this is a new algorithm, in which case validation is lacking, or an adaptation of an existing algorithm, for which the corresponding references are missing. The only validation metric proposed in the paper is "detection availability" and average accuracy (i.e. detections that are not false positives), as discussed in Sect. 2.4. Crucially, I could not find any information on how this number is computed. Section 3 is entitled 'IW signature extraction and validation', but does not discuss validation thoroughly. Has the produced dataset been compared with an existing dataset (such as

the one distributed by the Internal Wave Service)? Finally, to ensure reproducibility of the results, is the deep-learning model also accessible? Looking at the different detections in the dataset (see also Fig. 7), I noticed that: 1) Some ISW packets are not detected, a topic that is not discussed at all; 2) Different ISW packets are detected in a single bounding box. This topic would be interesting to discuss, even if the authors' scientific objective is not to separate distinct wave packets; 3) In some cases, a single ISW has two bounding boxes attached, meaning a detection is counted twice.

- Section 4.1 (pp. 13–20) is very long, brings very little essential information. Furthermore, it might be partially out of scope. Indeed, according to the official journal webpage (https://www.earth-system-science-data.net/about/aims_and_scope.html), 'Any interpretation of data is outside the scope of regular articles.' This section appears to offer a statistical analysis of the dataset combined with interpretations of the results in relation to the underlying dynamics, but it contains little new information. The section mostly reviews the various hotspots of ISWs and reminds the reader of the topographic features responsible for their generation. There are many vague considerations, such as 'when tidal currents interact with underwater ridges, the originally linear internal tide waves become steeper and eventually evolve into internal wave packets', which then repeated in several locations. Similar explanations of the generation of NLIWs are not very precise or referenced, and should only appear once in the introduction, if at all. In my opinion, this section should be significantly shortened and rewritten to highlight that the model enables the recovery of the ISW signature in all well-known hotspots, while retaining a few metrics that provide information on the method's performance.
  The most relevant information in this subsection is the geographical distribution of detections, compared with state-of-the-art knowledge, and it could be summarised in one page of text. Some of the sentences in this subsection are incorrect. For example, line 274 states: 'The generation of internal waves is intensified by nonlinear amplification of internal tides' -> non-linear internal waves result from non-linear effects either modifying internal tide generation (baroclinic conversion) or propagation (after generation); line 366: 'As tidal currents pass over seafloor undulations, [...] causing internal tides to evolve into internal waves' — vertical stratification and non-linear effects do not increase as a result of tidal currents passing over seafloor undulations, and ITs do not evolve into non-linear IWs.
- sect. 4.3: It is unclear whether the same machine-learning detection algorithm is used for SAR and optical images as for SWOT KaRIN data. If so, is it trained differently? Is it intended to work optimally with this type of data?
- I think these statements are incorrect with regard to SWOT capacities. It does not improve the temporal resolution (lines 69, 521 and 559): the revisit time remains very long at 21 days, the same as for conventional altimeters. Furthermore, it is sensitive to weather conditions; in particular, data are unavailable under heavy rain (line 524), although not as sensitive as optical images, for example.
- l.566-568: This statement about transitioning from 2D to 3D (spatially?) characterisation based on remote observations is highly speculative and not supported by any references or evidence to suggest that it is plausible. Please consider either removing this statement or providing additional evidence.

Minor comments

- l.6: “downloaded” is not very relevant for the abstract
- l.12: “detection availability” is not very clear as it has not been defined yet
- l.12: I do not understand this sentence: this is a deep-learning based ISW dataset that can provide support for deep-learning based ISW detection?
- l.25: “three-dimensional” can be misleading: is it 2D + time?
- l.95: since this is a data paper, and SWOT is central here, I guess the authors want to be very precise. I suggest mentioning that the KaRIN swath is not continuous, but rather consists of two 50 km-wide swaths separated by a 20 km gab (with a NADIR altimetry track at its center, which is not used here as far as I understand).
- Figure 1: what is the duration corresponding to this orbit coverage? One full cycle (21 days)?
- Figure 2: although informative, this kind of composite image can be a bit misleading, as it corresponds to non-sequencial paths merged together. Please add further information, at least the time of the different paths (e.g. min and max), and/or the cycles included.
- l.140: I think it is widely accepted, or at least debatable, that the term ‘artificial intelligence’ is inappropriately used to refer to the concept of ‘intelligence’. Therefore, I would strongly advise against using the adjective ‘intelligent’ in any scientific paper when referring to an automated machine learning algorithm, such as the one presented in your study and used to build the NLIW dataset.
- l.218 - 223: please add details about the FFT and DWTs used in the study: first, is it 1D or 2D. l.221: spatiotemporal is likely wrong (it is just “spatial”, isn’t it?).
- Figure 5: I cannot really see any NLIW packet except in the upper half of the red box. Is there something else to see?
- l.398: I think you are describing the generation of internal tides, but not of solitary waves, which are also generated at the Amazon shelf break.
- l.409: Grigorenko et al 2016, Vic & Ferron 2023 are not about ISWs.
- l.417: Authors claim that (nonlinear) IW can be generated by TIWs. I was not aware of that. Is there any reference on the subject?
- l.477: the fact that “a single remote sensing dataset is inadequate for monitoring the continuous variation of (nonlinear) internal waves” has not been explicitly discussed, and by no means “demonstrated”.
- Fig. 10 and 11: Fig 11 is not very informative compare with Fig 10. Maybe the paper could be shortened by merging the two figures (or removing Fig 11). Besides, I do not see the point of the (very short) discussion dedicated to Fig 10 (l. 482 - 484). Besides, Fig 12 and text l. 510 to 517 is also redundant with these 2 Figures and associated discussion (apart from the fact that it compares SWOT to optical images, not SAR images)
- l.492: It should be made very clear as soon as possible that the different snapshots show different ISW packets as these propagate fairly rapidly (a few metres per second). This is the first explicit mention of this and it may mislead the reader. In particular, this information is lacking in l.255 and below, and the captions of Figures 5, 6 and 7 are strongly misleading in this regard.
- l.511: ‘Surprisingly’: this is not surprising at all. The paper refers to the periodicity of ISW packet generation multiple times (essentially reflecting the period of barotropic tidal forcing), so this repeatability at one M2 time period interval is very much expected.

Line 528: Is it Level 3 or Level 2 SWOT data? Line 97: The authors mention that Level 2 data is used in this study.

- l.541: The 'complexity of the internal wave generation mechanism' does not favour observations of nonlinear internal wave (IW) packets. IW generation can be fairly complex while remaining in the linear regime, or it can occur in fairly simple situations (strong tidal flow and marked topography) and consistently give rise to nonlinear internal wave (NLIW) packets.

Typos, etc.

- l.120: replace comma by a point at the end of the line
- l.156: math mode is missing for "pt"