

This study investigates the intraseasonal variability of the North Pacific Intermediate Water (NPIW) and its modulation by mesoscale eddies, using high-resolution, long-term mooring observations collected from three distinct in-situ sites in the western Pacific. By defining the thickness of the NPIW layer, the authors identify a pronounced dominant periodicity of 60-80 days in NPIW variability, and reveal a significant inverse correlation between NPIW thickness and isopycnal-averaged salinity. Through quantifying the vertical response of the intermediate water layer to mesoscale forcing, the authors conclude that surface mesoscale processes can drive structural variations of the NPIW over the 400 – 900 m depth range.

Overall, the core conclusions of this paper are scientifically reasonable. Nevertheless, several key issues regarding the methodology, data analysis, and mechanistic interpretation remain to be clarified to further improve the scientific rigor of the work. I recommend that this manuscript be considered for publication following a major revision.

### **Major Comments**

1. The definition of the NPIW appears inconsistent across different sections of the manuscript, with criteria cited including the salinity minimum, depth range, density range, and the 34.3 psu isohaline. This inconsistency introduces unnecessary ambiguity and markedly undermines the readability and academic rigor of the manuscript. Specifically, the authors are strongly recommended to add a dedicated Methods section in Chapter 2 of the manuscript. This section should explicitly and systematically document all core definitions and analytical methodologies adopted in the study, including but not limited to the formal quantitative definition of NPIW, the implementation details of the composite analysis, and the technical specifications of the wavelet analysis.
2. The authors establish an inverse correlation between the salinity and thickness of the NPIW via statistical analysis of observations from three mooring sites. However, the manuscript lacks an explicit discussion of the spatial representativeness of these three mooring locations. Notably, the findings and conclusions of this study are extrapolated to a broader spatial domain across the North Pacific. Accordingly, the authors are required to add a dedicated assessment of whether these three mooring sites can adequately represent the larger-scale variability of NPIW, and to explicitly justify the generalizability of their statistical results to the wider study region.
3. The authors have calculated numerous correlation coefficients throughout the manuscript, most notably the correlation between the salinity and thickness of the NPIW. However, the raw time series used for these correlation analyses contain superimposed variability across multiple timescales, including diurnal, monthly, and intraseasonal fluctuations. Critically, signals from different time scales may have confounding effects on the calculated correlation coefficients, making it impossible to verify whether the reported correlations originate specifically from

the intraseasonal variability that is the core focus of this study. All correlation analyses should be re-conducted exclusively using the filtered intraseasonal time series, to ensure the results directly align with the study's core scientific focus. Detailed specifications of the filtering procedure, including the selected passband, filter type, and implementation steps, must be fully documented in the dedicated Methods section recommended in prior comments. In addition, a rigorous statistical significance test is mandatory for all correlation coefficient calculations and must be supplemented in the revised manuscript.

4. The interpretation of salinity variability in relation to mesoscale eddies could be further clarified. The manuscript suggests a positive relationship between SLA and salinity, implying that anticyclonic eddies are associated with higher salinity. However, given that NPIW is characterized by a salinity minimum, it would be helpful to explicitly clarify whether the observed changes represent modification of the NPIW core, vertical displacement of isohalines, or lateral mixing with surrounding waters.
5. Site M2 is located near the western boundary where the Kuroshio exerts dominant control over the local circulation. The interaction between westward-propagating eddies and the Kuroshio likely plays a significant role in the structural modulation of the NPIW. Has the potential effect of Kuroshio shear been considered, particularly in terms of its ability to deform eddies and modify mixing efficiency of intermediate water masses in this region?

### **Specific Comments**

1. L80~81: There is an inconsistency in font size.
2. Line 101: No specific citations are given for the claim "Based on previous studies". Please add the corresponding references to the relevant works.
3. Line 102: The authors state that the results shown in Fig. 1 are similar to those reported in You (2003). First, it is unclear whether the Fig. 1 referenced here is the Figure 1 presented on pages 5 - 6 of the manuscript, as there is an excessive distance between this line and the figure's location, which disrupts the logical flow and readability of the text. Directly citing the results and conclusions from You (2003) to support the statement here is far more appropriate and consistent with standard academic writing conventions.
4. Throughout the manuscript (e.g., Line 135, Line 145): Inconsistent use of abbreviations. Some abbreviations (e.g., "IW" in Line 135) are used without defining their full names, while already defined abbreviations (e.g., NPIW in Line 145) are redundantly reintroduced with their full terms.
5. Lines 187 - 188: No technical details are provided for the depth conversion procedure described here. Please explicitly specify the interpolation method used for this step (e.g., linear interpolation or spline interpolation), and supplement the full processing details in the Methods section.
6. Figure 3: The referenced "green points" and "blue dashed box" are entirely absent

from the submitted figure.

7. Line 325: No specific citations are provided for the vague reference to "previous studies".
8. Lines 329-333: Inconsistent salinity thresholds (34.2 psu for M1, 34.3 psu for M2 and M3) are used to define NPIW across the three mooring sites. This non-uniform definition undermines the credibility of the subsequent analysis of NPIW thickness variability.
9. Figure 4: Inconsistent color is present throughout the figure.
10. Figure 5: Inconsistent depth ranges are used for the averaged salinity calculations in this figure. Please unify the depth range definition to ensure valid cross-site comparison, and explicitly document the exact depth ranges used in the main text (and dedicated Methods section) in the revision.
11. Line 379: No discussion of eddy processes has been provided prior to this line, making the "eddy-related" premature and uncontextualized. It is recommended that this descriptor be deleted from the sentence in the revision.
12. Lines 427-432: No statistical significance test results are provided for the correlation coefficients calculated in this section. Please explicitly report whether these correlation coefficients pass the 95% confidence level significance test
13. Lines 511-512: The authors claim the 60 – 80 day periodic variability aligns with the westward-propagating mesoscale eddy signals in the region, but do not confirm whether these eddy signals also have a 60 – 80 day dominant period, nor provide any supporting references for this statement.
14. Figure 9: The data source for the results in this figure is not clearly documented.
15. Throughout the manuscript: Three inconsistent definitions are used for depth-averaging calculations (500 – 800m, 26.4 – 26.9  $\sigma_\theta$ , 500 – 700 m), with no explanation provided for these repeated changes. This severely undermines readability and analytical consistency. Please either unify the depth-averaging definition across the full manuscript, or provide a clear physical justification for each definition.
16. Throughout the manuscript: Two inconsistent salinity thresholds (34.2 psu and 34.3 psu) are used to define NPIW layer thickness across different analyses, with no explanation provided for this discrepancy. This non-uniform definition eliminates the consistent baseline required for valid cross-site and cross-analysis comparisons of NPIW thickness. Please either unify the NPIW thickness definition across the full manuscript, or provide a clear physical justification for the divergent thresholds.
17. Figure 11: It is not explicitly stated whether the data in this figure has undergone 20 – 120 day band-pass filtering. Please clearly clarify the filtering processing status of the data used for Figure 11
18. Line 542: For Figure 9e, ensure that the color bar for SLA is consistent across all panels to allow for direct comparison of eddy intensity between sites.
19. Figures 11 – 13: No detailed methodological specifications are provided for the composite analysis used to generate these figures. It is unclear whether the composites were constructed based on all AE and CE events at each mooring site; the expected AE/CE features are not evident in Figure 13, and the figure captions

use the ‘High-salinity/Low-salinity event’ terminology with no explicit link to AE/CE processes. Please comprehensively document the full implementation workflow of the composite analysis, and clarify the correspondence between all event types in Figure 13, supplement all methodological details in the Methods section.

20. Section 4.3: The authors state that NPIW salinity changes are driven by horizontal transport and mixing processes, but provide no supporting evidence for this core mechanistic claim.