MS No.: egusphere-2025-283
Title: Enhancement of near-inertial waves by cyclonic eddy in the northwestern South China Sea during spring 2022

Point-by-Point Response to Reviewers

In this point-by-point response, we reproduced the comments (**black font**), provided our responses (**blue font**), and highlighted the corresponding revisions in **red**.

Specific Comments

1. The paragraph newly added in response to my previous comment is unclear and does not appear to fully address the concern I raised. I would recommend removing it.

What I intended is that the expression “significant energy transfer” is vague, and I am concerned that the estimated value of 6 x 10^-10 m^2/s^3 may be too small to represent a meaningful contribution to near-inertial energy. This paper assumes that changes in near-inertial energy are due to energy transfer between cyclonic eddies and near-inertial waves. To support this, it is necessary to compare the estimated energy transfer rate with the changes in near-inertial energy.

In Section 4 (Discussion), the authors cite Jing et al. (2017) and Liu et al. (2023), who report that the energy transfer efficiency from mesoscale eddies to near-inertial waves can be 2 % or 13 % of the wind input. Alternatively, the authors might consider estimating what fraction of the observed near-inertial energy during Period 1 (or 2) could be attributed to the energy transferred from the eddy (or to the eddy). Would it be possible to evaluate the magnitude of the energy transfer in such a quantitative manner?

Response: Thanks for this comment. Since the units of energy transfer rate and near-inertial energy differ, we referred to the comparison between energy conversion rate and wind work by Jing et al. (2018) and the comparison between the time integral of wind work and near-inertial energy by Voet et al. (2024). We multiplied the net energy conversion rate by density, integrated it over the upper 200 meters and the "Before strongest" time period, and then compared it with the change in near-inertial energy during this period. The integration equation is as: $\int_{T_{strongest}-7days}^{T_{strongest}} \int_{-200\mathrm{m}}^{0\mathrm{m}} \rho_0 \bar{\varepsilon}\, dzdt$. In addition, we found that the data of energy transfer rate was excessively time-smoothed which leaded too small values of 10^{-10} m^2/s^3, so we recalculated the results which can reach about 10^{-8} m^2/s^3. We revised the old Figures 8 and 9 accordingly (see Figures R1 and R2). After the correction, results show that there were 79 J/m², 346 J/m², 47 J/m², and 115 J/m² energy transferring from the eddy to the NIWs at the Q1-Q4 during the "Before strongest" period, respectively, which accounted for about 16%, 88%, 27%, and 47% of the net NIKE increases (492 J/m², 394 J/m², 175 J/m², and 245 J/m²) .

We have revised the figures and descriptions related to the energy transfer rate in the manuscript.

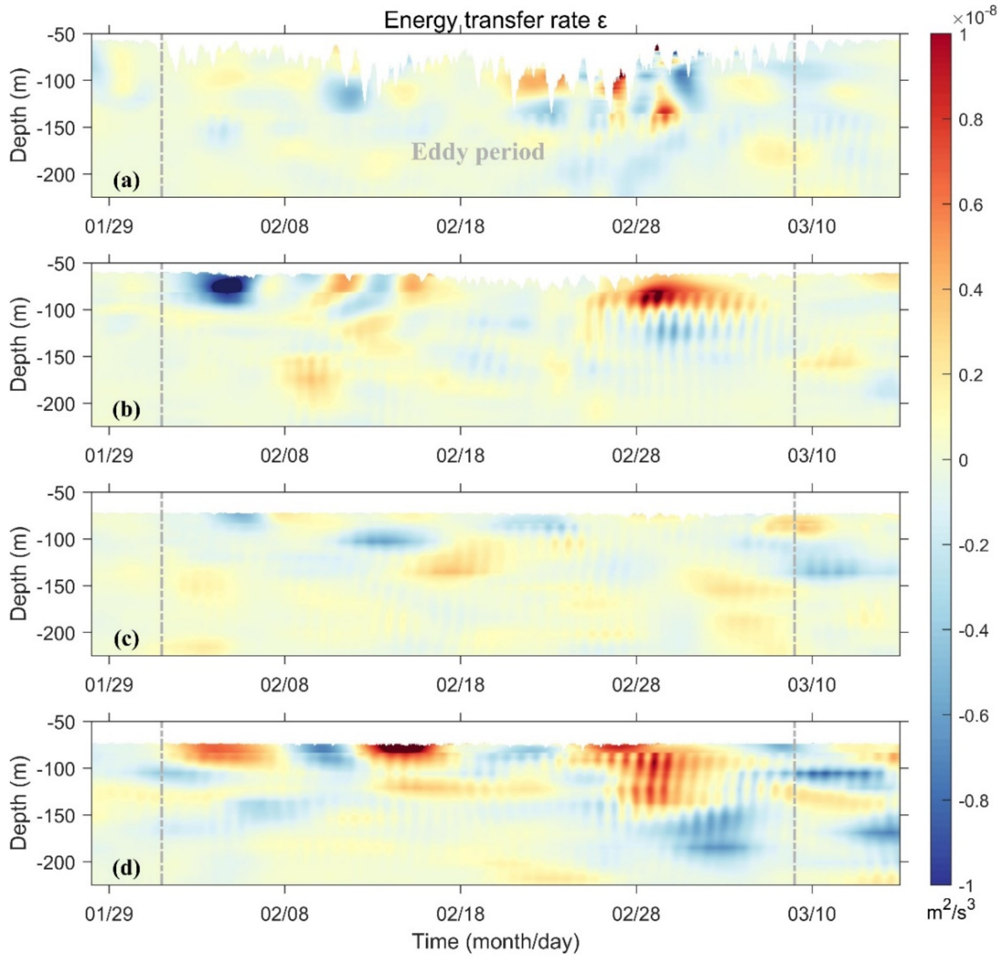

Figure R1: (a-d) Vertical distribution of energy transfer rate between the CE and NIWs at Q1-Q4 during eddy period.

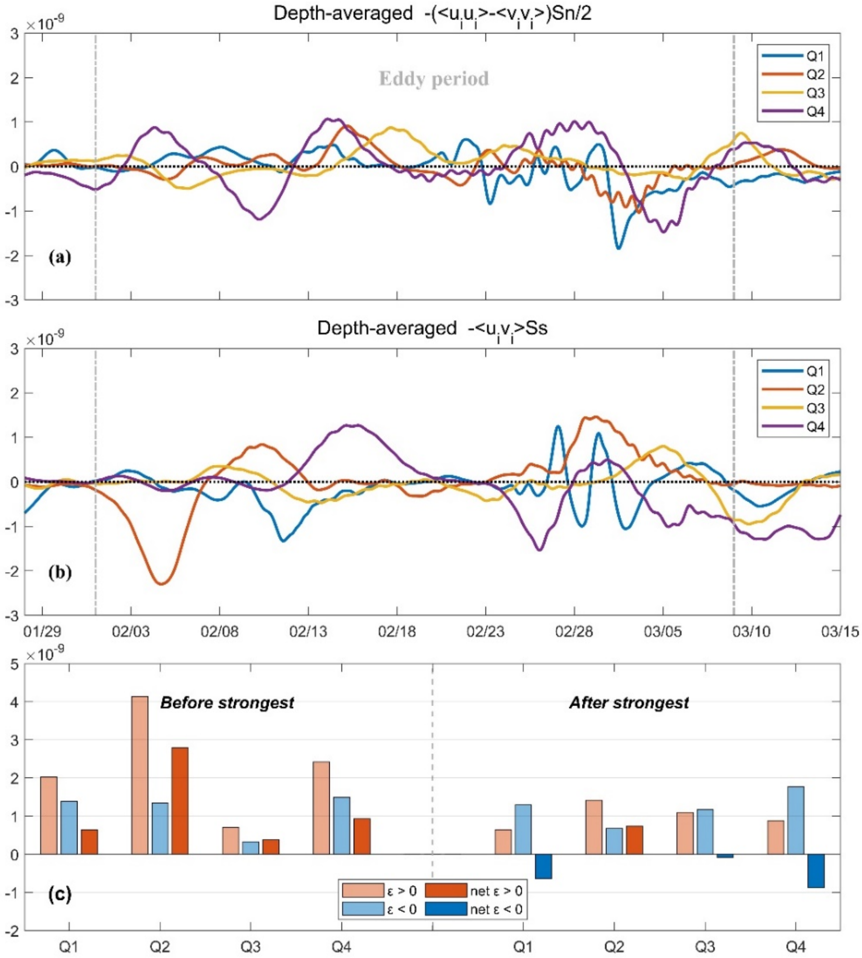

Figure R2: (a) Time series of depth-averaged (above 200 m) normal strain ($-(\langle u_i u_i\rangle - \langle v_i v_i\rangle)\frac{S_n}{2}$) of the CE for each mooring. **(b)** Time-series of depth-averaged (above 200 m) shear strain ($-\langle u_i v_i\rangle S_s$) of the CE for each mooring. **(c)** Time- (7 days) and depth-averaged (above 200 m) positive (light red), negative (light blue) and net transfer rate (dark red and blue indicate positive and negative values) before and after the NIKE reaching its peak at Q1-Q4.

Revisions to the manuscript text:

(1) In the Abstract, the description of the energy transfer rate magnitude was revised to "reach a magnitude of 10^{-8} m^2/s^3".

(2) The description in last version about "The percentage changes in the averages of NIKE and EKE for two time periods, before February 16th and from February 16th to March 8th, were 115.2% and -71.6%, respectively" was removed.

(3) In the Discussion section, the description of the energy transfer rate was updated to reflect the corrected results:"Both positive and negative transfer rates can reach a magnitude of 10^{-8} m^2/s^3 in the study area, in which they are of same order of magnitude as the results reported by Chen et al. (2023) in the Northwestern Pacific Ocean, but they are significantly stronger than the results of Jing et al. (2018) in the Gulf of Mexico."

(4) In the Discussion section, we revised the discussion regarding the energy comparison:"Moreover, we compared the energy transferring from the CE to the

NIWs with net NIKE increasement during “Before Strongest” period. Here, we multiplied the net energy transfer rate by density, then integrated them over the 0-200 m depths during “Before strongest” period as: $\int_{T_{strongest}-7days}^{T_{strongest}} \int_{-200m}^{0m} \rho_0 \bar{\varepsilon}\, dzdt$, in which $\bar{\varepsilon}$ represents net energy transfer rate. Results show that there were 79 J/m², 346 J/m², 47 J/m², and 115 J/m² energy transferring from the CE to the NIWs during the period at Q1-Q4, respectively, which account for about 16%, 88%, 27%, and 47% of the net NIKE increasements (492 J/m², 394 J/m², 175 J/m² and 245 J/m² at Q1-Q4, respectively). In average, they account for approximately 45% of the net NIKE increasement (325 J/m²) in this area indicating a key role of mesoscale eddy on NIWs in the Northwestern SCS.”

2. I think the description of the frequency peak shift being consistent with the cyclonic eddy’s relative vorticity should be included in the manuscript.

Response: We have added the description in the manuscript as follow: “Meanwhile, we calculated the relative vorticity based on surface geostrophic currents and the local inertial frequency, and found that the average spectral peak frequency reached about 0.69 cpd during the eddy period. This value is very close to our observed ω_p.”

3. Unless there is a specific reason to use only the meridional component, I think it would be more natural to show the wavelet spectrum of horizontal velocity by combining the power spectral densities of the zonal and meridional components.

Response: We have renewed the wavelet analysis in Fig.3 (Figure R3) with combining the power spectral densities of the zonal and meridional components.

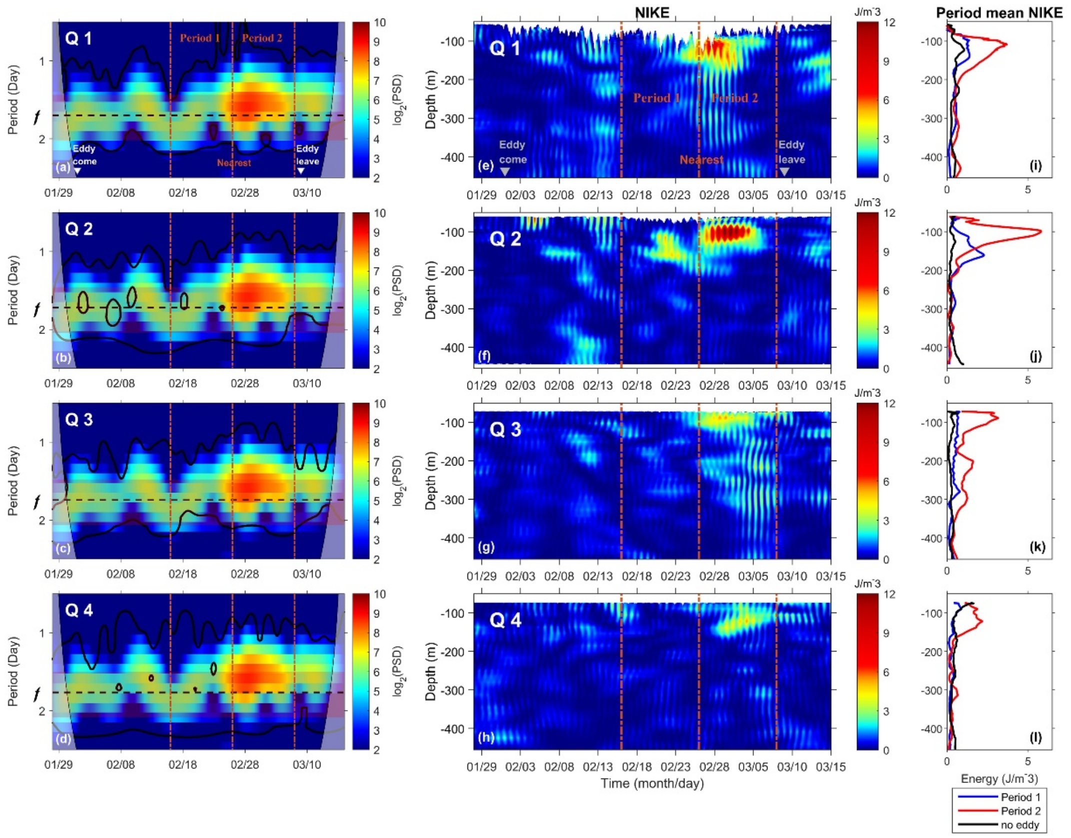

Figure R3: (a-d) 100 m-depth horizontal velocity wavelet power spectra at Q1-Q4 during eddy period. **(e-h)** Vertical distribution of NIKE at Q1-Q4. The gray triangles indicate the time when the CE edge contacts and leaves the mooring array. **(i-l)** Vertical distribution of time-averaged NIKE during 'no eddy period' (black line), 'Period 1' (blue line), and 'Period 2' (red line) at Q1-Q4. The red dashed lines mark two periods of the CE.

4. This sentence is still unclear. Do you mean that NIWs draw energy from the background flow when NIKE is small compared to the background flow?

Response: Yes. To make it clear, we have revised the sentence as: "NIWs draw energy from the background flow when the energy of NIWs is small compared to that of the background flow, and release energy to the background flow when the energy of NIWs is large compared to that of the background flow."

5. My suggestion was to plot the net flux at each location (Q1, Q2, Q3 and Q4), rather than separately averaging the positive and negative fluxes. The cumulation bars may not be necessary because adding the results from the four locations does not appear to be meaningful in this context.

Response: We have added the net flux at each location instead of showing the cumulation bar in Fig 9 (Figure R2).

6. Please check for typos.

Response: We have checked for typos, and corrected grammatical and spelling errors carefully.

7. Equation (6): I missed this point in the first review. Near-inertial wind work refers to the dot product of the near-inertial component of the wind stress and the near-inertial component of the surface current velocity (e.g., Voet et al. 2024). Please verify this in your analysis.

Response: Thanks for this comment, we have revised this sentence as: "The averaged wind work during the eddy period is about 0.03 mW/m^2, which is nearly two orders of magnitude smaller than that affected by typhoons (Ouyang et al., 2022; Yuan et al., 2024) and several times smaller than the wind work results of Voet et al. (2024) in the Iceland basin."