This manuscript focuses on gas transfer velocity, a factor which has frequently been overlooked in previous studies of air–sea CO_2 fluxes in coastal environments. I believe this study has the potential to be a milestone in this field. In particular, directly estimating gas transfer velocity using the aquatic eddy covariance technique is a promising approach that could substantially improve the accuracy of CO_2 flux estimates, especially in coastal environments, where local topographic and hydrodynamic conditions strongly influence gas transfer velocity.

However, the primary focus of this manuscript is not immediately clear. The CO_2 flux estimates for VCR are based on existing empirical parameterizations and the results themselves are not particularly novel. In my opinion, this study's greater scientific value lies in demonstrating the importance of directly measuring gas transfer velocities and comparing the results with existing empirical parameterizations.

I believe this manuscript could make a significant contribution to the field. I would be willing to recommend it for publication once the authors have satisfactorily addressed the following comments.

Major comments

#1

The main objective and novelty of this study are unclear. The diurnal variability of CO_2 fluxes and the effects of storms in VCR are likely to exhibit similar general patterns, regardless of the existing empirical parameterization used. Furthermore, despite directly measuring gas transfer velocity, the authors ultimately adopted one of the existing parameterizations (N00) to calculate CO_2 fluxes. This approach diminishes the novelty and potential significance of direct measurements.

Therefore, I would suggest that the authors consider developing a new, site-specific empirical parameterization using the measured gas transfer velocities, wind speed, current speed and water depth. The results of this study suggest that current speed contributes more to gas transfer velocity than wind speed. Therefore, a new parameterization incorporating these three explanatory variables, with coefficients calibrated against the observations, could potentially provide a more accurate quantitative representation of gas transfer velocity in VCR.

Comparing CO_2 flux estimates derived from this new parameterization with those obtained using existing parameterizations would clarify the implications of directly measuring gas transfer velocity for CO_2 flux estimation. Such a comparison could also help to determine whether the overestimation associated with existing parameterizations that account for current speed, such as B04c, is primarily due to the dependence of the parameterization on wind speed or current speed. I believe that such an analysis would considerably strengthen

the originality and scientific contribution of this manuscript.

#2

An important and novel aspect of this study is the application of the aquatic eddy covariance technique to estimate in situ gas transfer velocity. However, the manuscript should provide further information to enable readers to evaluate the accuracy and reliability of these measurements.

For instance, I suggest including ogive plots or other relevant diagnostic analyses to illustrate the accuracy and reliability of the eddy covariance measurements. This is particularly important because these direct measurements form the basis of this study's main scientific contribution.

Minor comments

L102: The statement 'an average water depth of 1.0 meters below mean sea level' is ambiguous. Does it refer to the average water depth or the seafloor elevation? Please clarify.

L107: How far below the water surface is the seagrass canopy? Could the seagrass have interfered with the aquatic eddy covariance measurements? Please clarify the relative positions of the seagrass canopy and the measurement instruments.

L133: What is the justification for assuming a surface roughness length of 0.002 m? Please provide an appropriate explanation or reference.

L150: What is the basis for assuming that the gas transfer velocity measured at SB-152 is representative of the entire South Bay? Justify this assumption.

L213: Please explain why salinity measurements were unavailable in 2021.

L274: Please use consistent terminology throughout the manuscript, either 'SD' or 'standard deviation'.

L275: Why were the deployments restricted to low-tide conditions? How might the results differ under high-tide conditions? Please discuss the potential influence of tidal stage on the measurements.

L365: The discussion section contains several passages that simply reiterate the results presented earlier. Such repetition makes the discussion unnecessarily lengthy. I recommend removing or substantially shortening these passages and focusing more on interpreting and considering the implications of the results.