This manuscript set out to evaluate spatial and temporal variability of surface N_2O concentrations and estimates of air-sea flux as well as evaluate the drivers of N_2O concentration and air-sea flux from three sites located among the Balearic Islands Archipelago. The monitoring period was relatively extensive ranging from 2018 to 2023, and as far as I know these are among the first observations of N_2O concentrations and estimations of air-sea flux from these specific sites.
The authors found that N_2O concentrations were mainly driven by seasonal temperature fluctuations, with no significant site or yearly differences. The system description with respect to N_2O concentration and estimated fluxes, along with length of the dataset warrant publishing this manuscript, but the manuscript needs some additional analyses and polishing as there are some issues that need to be addressed before publication.

We appreciate the reviewer for her/ his constructive and thoughtful comments, which have enabled us to enhance the clarity and scientific quality of the manuscript. We have thoroughly addressed each of the points raised and made the necessary changes in the revised version of the manuscript. Below, we offer a detailed, point-by-point response to each comment. All changes in the manuscript are highlighted using track changes for easy reference.

General Comments:

1. Please include the sampling depth in the description of the study area. From the onset, it was hard to contextualize results from the different sampling sites without understanding the depth water was taken from in the Bay of Palma. It is unclear if Bay of Palma samples were also collected from the buoy sensor depth as the only mention of N_2O sample collection depth is at the bottom of the second paragraph in the section (line 106) which discusses sampling depth at the bay of Santa Maria site. Moreover, this description is separated from the description of the Bay of Palma sampling (1^{st} paragraph in the section), so the authors might also consider indicating sampling / sensor depth in the first paragraph and on Figures 2 and 3.

We thank the reviewer for this valuable suggestion. We have clarified the sampling depth for each site in the "Study Area" section (lines 99, 106 and 117). Specifically, we now indicate that both the sensor and water samples at the Palma Bay (PB) were collected at a depth of approximately 1 m. Similarly, we have reiterated the sampling depth of 4 m at the Bay of Santa Maria (CA) and specified that the sampling depth at Cape Ses Salines (CS) is approximately 0.5 m. We also clarified that water samples were collected at the same depth as the sensors at all three stations. Additionally, we will update Figures 2 and 3 footnotes to indicate the sampling and sensor depths as suggested.

2. Quantifying air-sea flux in many marine N_2Ostudies is often undertaken using parameterizations of gas transfer velocity (*k*), in the absence of direct measurements on site. Commonly these parameterizations include wind speed, but in some instance's other variables such as current speed, heat flux, or even rainfall can be used. The *k* parameterization used by the authors in this manuscript was described in Dobashi and Ho (2023) and was developed using $^3He/SF_6$ tracer release in a shallow (<3.5m) seagrass bed in Florida Bay, USA. This certainly seems to be an appropriate parameterization for two of the three study sites in this manuscript as they were located in relatively shallow water (Bay of Santa Maria site ~8m deep; Cape Ses Salines lighthouse site 2m deep). The other site (Bay of Palma) however, was described as being approximately 30m deep, so Dobashi and Ho (2023) may not be the most appropriate parameterization here. I would recommend including at least 2 additional parameterizations used for deeper (> 10m) coastal areas in Table 2 for this site.

We appreciate the reviewer's insightful observation. Following the suggestion, we have now included two additional gas transfer velocity parameterizations that are commonly used in deeper coastal waters: Wanninkhof (2014) and Cole & Caraco (1998). These parameterizations were applied to all three sites to enable comparison, but they are particularly relevant for the Bay of

Palma (PB) station, where the water depth reaches approximately 30 m. The description of these additional parameterizations has been incorporated into the "Flux estimation and other calculations" Lines 192-195 of the Methods section. Additionally, the resulting annual fluxes calculated using all three parameterizations are now included in Table 2.

3. I think the examination of the drivers of [N_2O] would gain context by examining drivers of N_2O% saturation as well. It is well known that dissolved gas concentrations are driven by temperature, but I believe a more useful question is what is driving N_2O% saturation in coastal systems. Examining the drivers of N_2O % Saturation should be included before publication. I do not see the results any analysis investigating drivers of N_2O in this manuscript and the explanation of the analysis is made vague by the use of the term "N_2O levels" (line 181, line 288, Figure 4) and "N_2O" (line 190) instead of more precise terms "N_2O concentrations" or "N_2O % Saturation". I would like to see this, and other instances of vague language (*e.g.* "N_2O variability" line 283), clarified before publication. Also, I would like to see N_2O % Saturation included in Figure 3.

We appreciate the reviewer for this constructive suggestion. We completely agree that analyzing the factors influencing N_2O saturation percentage offers valuable ecological context, especially in dynamic coastal systems where various physical and biogeochemical processes impact gas exchange and concentrations.

In response, we conducted an exploratory analysis to assess the potential drivers of N_2O % saturation (Sat%N_2O). The results were indeed consistent with those observed for N_2O concentrations. Specifically, temperature and salinity emerged as the dominant explanatory variables, with relative importance values of 41.9% and 15.7%, respectively. The remaining environmental predictors (NO_3^-, NO_2^-, DOC, Chl-a) exhibited comparable secondary contributions (see the table below).

Feature	**Importance**
Temperature	41.865173
Salinity	15.659371
NO3	12.119104
Chla	11.971512
DOC	10.928545

While N_2O % saturation provides insights into the degree of equilibrium with the atmosphere and is highly relevant for interpreting air–sea fluxes, we chose to focus the primary analysis on absolute N_2O concentrations for comparability with literature: Most published studies examining spatial and seasonal trends, as well as biogeochemical drivers of N_2O in marine systems, report absolute concentrations, facilitating meaningful comparisons.

That said, we agree that the inclusion of saturation metrics strengthens the ecological interpretation of our findings. Therefore, to address the reviewer's suggestions, we have:

- Clarified terminology throughout the manuscript by replacing vague or ambiguous terms such as "N_2O levels" or "N_2O variability" with precise descriptors, e.g., "N_2O concentration" and "N_2O % saturation" where appropriate.
- Included N_2O % saturation in Figure 3, to visualize its spatiotemporal patterns alongside N_2O concentrations, thereby offering a more holistic representation of the system's N_2O dynamics.

We believe these adjustments enhance both the clarity and scientific rigor of the manuscript while preserving a focused analytical framework.

4. Quantification of uncertainty should also be addressed, especially considering N_2O observations are made from duplicate samples. Please specify how uncertainty was propagated

through the estimations of air-sea flux (uncertainty can come from many sources including variability between replicates, wind speed variability, temperature variability etc.).

We thank the reviewer for pointing out the importance of uncertainty quantification. In the revised manuscript, we have included an estimation of the propagated uncertainty in the calculation of air-sea N_2O fluxes, based on the variability between duplicate N_2O measurements. This approach accounts for the analytical uncertainty associated with the gas concentration measurements, which is the main experimental source of variability in our dataset.

In addition, we recalculated annual N_2O fluxes using a trapezoidal integration approach over time, which—although it did not significantly alter the magnitude of the annual flux estimates—provides a more robust and continuous representation of seasonal variability. Both the uncertainty propagation method and the revised flux calculation approach are now described in the Methods section.

In this vein, there should be some indication about which N_2O % saturation observations are and are not significantly different than 100% (should be indicated in Table 1). What appears to be slight under saturation at sites CA and CS may not be significantly lower than 100%, but if they are I think this warrants some additional discussion about what might be driving this. The same should be indicated for air-sea fluxes shown in Figure 6 (which of these are significantly greater than 0, and which are just artefacts of statistical noise?)

Thank you for the suggestion. We have now conducted one-sample t-tests to evaluate whether the observed N_2O % saturations are significantly different from 100%. This information is reported in the footnote of Table 1. We also applied the same statistical approach to air–sea N_2O fluxes. Fluxes that are significantly different from zero are indicated in the legend of Figure 6. These clarifications allow for a more robust interpretation of undersaturation or net fluxes.

Specific Comments:
Line 40: Not all nutrient inputs are “solid”, recommend removing this word and retain as “land-derived nutrient inputs”.

Thank you for the suggestion. We agree that not all land-derived nutrient inputs are solid. We have revised Line 40 accordingly and now refer to them simply as “land-derived nutrient inputs”.

Line 43: recommend rephrasing “which also stimulates the generation of N_2O” to “which can stimulate the generation of N_2O”.

Thank you for your suggestion. We have updated the sentence to: “which can stimulate the generation of N_2O” for a more cautious interpretation.

Line 91: What is the sensor depth?

The sensor depth is now specified in the Methods section.

Line 155: Need to show airport wind station on the map on Figure 1.

Thank you for pointing this out. We have added the location of the airport wind station to Figure 1.

Line 204: Have you defined which months are indicated by “summer”, “spring”, “winter”, “autumn”? Is this “June to Aug” or “July to Sep”? Please define.

We now clarify the seasonal definitions in the text: *“winter” refers to December–February, “spring” to March–May, “summer” to June–August, and “autumn” to September–November.*

Line 362: “N_2O variability” is vague. Need to explicitly say what metric of N_2O is being described: “variability of N_2O concentration” or “variability of N_2O % saturation”.

Thank you for the comment. The sentence has been revised to specify the metric being described: “variability of N_2O concentration”.

Line 366: I think the term “impacted” should also be cautiously used here. There are some major depth differences between the stations, and I assume seagrass coverage differences as well.

We agree that “impacted” may be too strong or ambiguous in this context. We have replaced it with “influenced”, which we believe better reflects the range of possible environmental factors, including depth and seagrass coverage differences.

Line 366: Without showing which estimates of N_2O flux are significantly greater than 0, it is hard to justify saying the sites are weak sources of N_2O to the atmosphere. They could well be in equilibrium.

We acknowledge this concern and have revised the text to avoid overinterpreting the flux estimates. We now note that *“some sites appear to be weak sources of N_2O, although many fluxes are close to equilibrium and not significantly different from zero.”*

Technical Corrections:

Line 31: Please include a reference for this sentence.

A reference has been added to support this sentence.

Line 51: Please include a reference for this sentence.

A reference has been included for this sentence as well.

Line 74: “N_2O” has already been defined as “nitrous oxide”. Just use “N_2O”.

Line 103: “N_2O” has already been defined as “nitrous oxide”. Just use “N_2O”.

Line 117: “N_2O” has already been defined as “nitrous oxide”. Just use “N_2O”.

Lines 74, 103, 117:

As suggested, we have replaced the repeated full name “nitrous oxide” with “N_2O” in all instances after the term was first defined.