Authors' response to Reviewer #2 on the manuscript "Seasonal and Interannual Drivers of Sargassum Inundations in the Northern Gulf of Guinea"

We thank the reviewer for the careful and constructive assessment. Reviewer comments are reproduced in black, and our point-by-point responses and verbatim excerpts from the revised manuscript are shown in blue.

Reviewer #2 evaluation

This manuscript provides a welcome focus on sargassum in the northern Gulf of Guinea, with predominant attention until now on sargassum in the western tropical Atlantic, as implicit in the Introduction. The authors use an established modelling system (NEMO-Sarg), complemented with the Parcels tracking software, to explore the drivers, pathways and (in some cases) coastal fate of sargassum biomass in the region. The experimental design explores the relative influences of stranding and windage on the large-scale seasonal dispersal of sargassum, demonstrating the importance of both processes in understanding and predicting biomass distribution in the GoG. Backward and forward Lagrangian tracking is appropriately used, to explore source regions for n-GoG sargassum and to determine how much sargassum reaches the GoG with and without wind/wave influence.

We thank the reviewer for the assessment of our study. We revised the manuscript in detail following the comments below.

The data assembled in Fig. 2, and the evidence discussed in Sect. 3.1, is to my knowledge the first such synthesis and of particular value in itself. The difficult challenge of limited satellite coverage beneath the ITCZ is clearly evident in Fig. 3, although there is scope to further discuss how this compromises the simulations.

We expanded the discussion of observational limitations in Sect. 4.1. It now explains how sparse and uneven satellite sampling complicates direct model-satellite comparison and interpretation of individual events: [Sect. 4.1, lines 405–420.]

"*Direct quantitative validation remains difficult because published coastal records are sparse and uneven among countries and generally document only the presence and timing of strandings rather than standardized FC or biomass. Satellite observations provide broader coverage but are strongly limited by clouds, land contamination and optically complex coastal waters, particularly beneath the ITCZ. (Figure 3, right column). These limitations complicate the interpretation of several discrepancies. Satellite signals south of the main n-GoG region, including off the Congo coast (e.g., Figure 3), cannot currently be independently verified and may include false-positive detections associated with turbidity, river plumes or coloured dissolved organic matter. Similarly, the exceptionally high satellite peaks in September 2021 and November 2023 (Figure 2) lack corresponding reports in the available literature, but the absence of systematic coastal monitoring prevents determining whether they represent real extreme events or retrieval overestimates. The spring 2020 mismatch and the temporal offset from late 2022 to early 2023 could reflect errors in simulated transport or biological processes, satellite uncertainties, or both. Despite these limitations, the agreement among SARG12, satellite observations and published records in seasonal timing and broad spatial distribution supports the use of the simulation to investigate the mechanisms controlling Sargassum arrivals, although individual event magnitudes should not be regarded as quantitatively validated.*"

Analysis of the seasonal cycle in currents, winds and hydrography well explains the spring and autumn stranding of sargassum along the n-GoG coast. Exploring interannual variability of sargassum FC in n-GoG, a high fraction of variance is correlated with the AMM in both spring and autumn, and upstream sargassum FC preceding autumn. These clear links are well explained.

We thank the reviewer. The seasonal mechanisms remain central to Sect. 3.3, while the broader interpretation is now separated into Sect. 4.3 on the Guinea–Sierra Leone winter reservoir and Sect. 4.4 on AMM influence, improving the distinction between Results and Discussion. [Sect. 3.3, lines 283–323; Sects. 4.3–4.4, lines 442–467.]

Specific comments

Line 17 (and elsewhere, in Abstract and main text): The statement 'After crossing Cape Palmas, …' would be better written 'After passing south of Cape Palmas, …' or 'After crossing a transect south of Cape Palmas, …'

We agree and replaced the ambiguous wording throughout the manuscript. The Abstract now states: [Abstract, lines 15–16; see also line 300.]

"*After passing south of Cape Palmas, southerly winds drive Sargassum shoreward and help maintain it north of the Equator.*"

Figure 1: this is a bit too schematic, regarding currents, winds and the GASB; choosing a representative year, I recommend showing example GLORYS currents (shaded for speed, with the additional annotated arrows), example ERA5 winds (vectors at coarse resolution), overlaid with stippled fractional area above a threshold to highlight the GASB; also, two panels could be shown, earlier and later in the summer to reflect the seasonally reversing winds and ocean currents, and corresponding GASB migration.

Figure 1 was completely redesigned. It now contains separate early-summer (April–June) and late-summer (July–September) panels showing GLORYS surface-current speed, ERA5 10 m wind vectors, the seasonal *Sargassum* distribution, annotated principal circulation pathways, and the n-GoG, Cape Palmas and e-TA analysis domains (Figure 1, lines 33–41).

Introduction, last paragraph: ideally provide a more details and structured summary of the rest of the manuscript, explaining in particular the logical sequencing of your results section.

The final paragraph was expanded to describe the sequence of the Methods, Results, Discussion and Conclusions: [lines 87–95.]

"We investigate when and why Sargassum reaches the n-GoG and identify the physical and biogeochemical conditions associated with unusually strong coastal events. We combine 1/12° NEMO-Sarg simulations (Jouanno et al., 2021) with Lagrangian trajectories computed using Parcels (Delandmeter and Van Sebille, 2019). Sect. 2 describes the satellite product, numerical model, and analysis methods. Sect. 3 first evaluates the simulations against previous studies and remotely sensed Sargassum distributions. Backward Lagrangian analyses are then used to identify the main source regions and quantify transport times toward the Gulf of Guinea. The mechanisms controlling the seasonal cycle and interannual variability of Sargassum arrivals are subsequently investigated by relating the NEMO-Sarg modeled distribution to environmental forcing and through a suite of sensitivity experiments. Sect. 4 discusses the physical mechanisms underlying the modeled variability, together with the main limitations of the study, and Sect. 5 summarizes the principal conclusions and their broader implications."

Sect 2.2: In briefly describing NEMO-Sarg, please specify the modelled variable the represents sargassum biomass – presumably the associated carbon?

We now explicitly identify carbon as the prognostic biomass variable and explain its conversion to dry mass and FC: [Sect. 2.2, lines 115–121.]

"The model transports carbon (C), nitrogen (N), and phosphorus (P) contents in a two-dimensional surface layer and represents carbon uptake, nutrient quotas, temperature-, light-, and salinity-dependent growth, mortality, sinking, and coastal stranding. Carbon content is the prognostic variable used to represent Sargassum biomass. As in Jouanno et al. (2025a), it is converted to wet biomass using a carbon-to-dry-weight ratio of 0.27, a dry-to-wet ratio of 0.15, and then to FC using an assumed areal density of 3.34 kg wet weight m $^{-2}$. Model outputs are reported here as dimensionless FC for comparison with satellite observations."

Line 107: Stokes drift should be capitalized here.

"Stokes drift" is now capitalized consistently throughout the manuscript. [throughout; see, e.g., lines 129–131 and 160–163.]

Line 119: In suppressing strandings, what then happens to the sargassum biomass? Is it shifted to the nearest ocean grid cell to ensure onward transport? It may be necessary to briefly explain the stranding algorithm.

We clarified the algorithm and the no-stranding experiment. The Methods now state: [lines 132–143.]

"*Stranding is implemented as a local carbon-biomass sink in ocean grid cells adjacent to land, at a rate of 0.08 d $^{-1}$. Stranded biomass is removed from the floating pool rather than shifted to another ocean cell.*"

"*In SARG12-nostranding, coastal biomass loss due to stranding is suppressed, allowing assessment of the role of stranding in shaping the simulated Sargassum distribution within the GoG.*"

Lines 228-229: stating 'Particles were seeded in areas where Sargassum was observed in the e-TA region' – it seems more logical that you back-track from where Sargassum was observed in the n-GoG region; please correct or clarify.

We agree; the previous wording was misleading. Backward particles are initialized in the n-GoG, whereas forward particles are initialized in the e-TA. The corrected backward-experiment description states: [backward experiment, lines 158–166; forward experiment, lines 168–176.]

"*For every simulation year, particles were released at mid-month in April and October from all n-GoG surface grid cells where simulated FC exceeded 2 × 10 $^{-5}$, and were then integrated backward for 120 days*."

Line 235: 'are transported' (not 'is transported').

The grammatical error was corrected.

Figure 10: it would be further helpful to label the left column 'MAM' and the right column 'SON', rather than mention this detail only in the figure caption.

The interannual relationship figure, now Figure 8 after restructuring, was revised so that its left and right columns are labelled directly "MAM" and "SON," respectively. [Figure 8, lines 372–376.]

Lines 461-465: It may be worth noting that sargassum is more directly (adversely) affected by low salinity (Hanisak and Samuel, 1987) although this dependence may not be included in NEMO-Sarg as used here; whether coastal salinity in the wet season falls low enough to impact sargassum along the n-GoG (Fig. 6b,e,h,k) is not clear but the authors could clarify and discuss.

We agree and revised both the model description and the Discussion. Salinity effects are explicitly represented in NEMO-Sarg through the carbon-uptake limitation formulation of Jouanno et al. (2025a). This representation is now specified in Sect. 2.2 (lines 117–118). We also added Figure H1, which shows the limitation function together with the modelled coastal SSS distributions and their seasonality in the Côte d'Ivoire–Ghana and Togo–Benin–Nigeria sectors. The implications for coastal biomass persistence are discussed in Sect. 4.2 (lines 432–440). The Methods and Discussion now state: [Figure H1, lines 595–600.]

"In particular, low salinity limits carbon uptake following the formulation of Jouanno et al. (2025a) (Figure H1)."

"Low salinity can adversely affect Sargassum physiology (Hanisak and Samuel, 1987); in NEMO-Sarg, this effect is represented by the limitation function described in Figure H1a, which reduces carbon uptake."

Line 750: Sowah et al. (2022) appears to be a repeated reference.

The duplicate Sowah et al. (2022) entry was removed. The bibliography now contains a single entry, and all corresponding in-text citations refer to that entry. [bibliography, Sowah et al. (2022) entry.]

We thank the reviewer again for these constructive suggestions, which improved the methodological detail, physical interpretation and presentation of the manuscript.