Review of “Influence of model spatial resolution on Sargassum beaching predictions along the Mexican Caribbean coast”

Summary of the Manuscript

This manuscript investigates how ocean model horizontal resolution affects short-term predictions of Sargassum transport and coastal strandings in the Mexican Caribbean. The authors compare 5-km and 1-km ROMS simulations and use the resulting surface currents, together with ERA5 winds, to drive Lagrangian particle simulations in OpenDrift. Four 10-day cases representing different circulation regimes are examined, and forward and backward FTLE fields are used to characterize transport pathways and attracting/repelling structures.

The results suggest that the two model configurations generally produce similar large-scale transport pathways and comparable overall stranding percentages and arrival times, while larger differences occur during the tropical cyclone case and near regions with complex coastal geometry. The authors therefore argue that a 5-km model may be adequate for short-term regional Sargassum forecasting under typical conditions, whereas a 1-km model provides additional value during extreme events and in complex coastal regions.

The topic is relevant and the modelling framework is potentially useful for operational Sargassum forecasting. However, several methodological and interpretational issues should be addressed before the main conclusions can be fully supported.

Major Comments

1. The operational conclusion appears too strong given the limited number of cases. This conclusion is based on four selected 10-day cases rather than a systematic evaluation over the full simulation period, and the particle beaching predictions are not directly validated against observed Sargassum landings. The drifter comparison in Appendix A is useful for evaluating particle advection and windage, but it is not a validation of Sargassum beaching forecasts. I suggest moderating the operational claim (e.g., 'may be sufficient for reproducing broad regional transport patterns under the conditions examined here') or expanding the analysis to a larger set of events and, ideally, comparing predicted landing patterns with available observations.

2. The comparison does not isolate horizontal resolution as the only difference between the two model configurations.
The manuscript frames the experiment primarily as a 5-km versus 1-km resolution comparison, but the two ROMS configurations also differ in domain size, number of vertical levels, bathymetric/coastline representation, and boundary forcing: the 1-km model is nested within the 5-km simulation, whereas the 5-km model is forced by Mercator. These differences may influence circulation and coastal transport independently of nominal horizontal grid spacing. The

authors should clearly acknowledge this limitation and, where possible, demonstrate that the reported differences are primarily attributable to horizontal resolution rather than other configuration differences. The wording throughout the manuscript should be adjusted accordingly.

3. The temporal resolution of the ocean currents needs clarification, especially given the interpretation of submesoscale processes.

The Methods state that daily surface currents are used for particle simulations, whereas later the manuscript states that currents are updated every 6 h. This inconsistency should be resolved. If daily currents were used, the interpretation of storm-induced and submesoscale variability should be reconsidered because important high-frequency processes may not be represented.

4. The interpretation of mesoscale/submesoscale effects requires stronger support and should be better connected to recent Sargassum literature.

Several differences in particle trajectories and landings, particularly during Tropical Cyclone Lisa, are attributed to mesoscale/submesoscale structures and their associated retention or dispersion. These interpretations are plausible but appear to rely largely on visual inspection of the FTLE fields. FTLE structures alone may not be sufficient to demonstrate that these features are submesoscale or wind-driven. The authors could provide additional dynamical diagnostics, such as relative vorticity or Rossby number, or otherwise use more cautious terminology. The discussion would also benefit from recent studies directly examining the role of ocean currents and eddies in Sargassum transport and aggregation, such as Zhang et al. (2024) and Zhang et al. (2025). These two studies also provide relevant support for the statements made in the first sentences of the second and third paragraphs of the Introduction.

Zhang, Y., Hu, C., McGillicuddy Jr., D. J., Barnes, B. B., Liu, Y., Kourafalou, V. H., et al. 2024. Pelagic Sargassum in the Gulf of Mexico driven by ocean currents and eddies. Harmful Algae, 102566.

Zhang, Y., Barnes, B. B., McGillicuddy Jr., D. J., and Hu, C., 2025. Sargassum Enrichment in Mesoscale Eddies of the Great Atlantic Sargassum Belt. Geophysical Research Letters, 52(7), e2025GL114601.

5. The definition of particle stranding and the release strategy require stronger justification.

Particles are considered stranded when they cross the 50-m isobath, which is not necessarily equivalent to actual beaching. Since the study draws operational conclusions about Sargassum beaching, this proxy should be better justified and its limitations discussed. In addition, the uniform release of particles along 85°W is useful for transport-pathway analysis but does not represent the highly heterogeneous spatial distribution of real Sargassum. The authors should clarify that the simulations primarily assess potential transport sensitivity rather than realistic Sargassum biomass or beaching probability.

6. The validation results deserve more discussion.

Appendix A shows that the 5-km configuration generally has higher Liu–Weisberg skill scores than the 1-km configuration when compared with undrogued drifter trajectories. This is an important result because it demonstrates that higher spatial resolution does not necessarily produce more accurate trajectories. The authors should discuss this finding more explicitly in the main text and explain its implications for the main conclusions.

Minor Comments

1. Please use the terms “beaching”, “landing”, “stranding”, and “nearshore accumulation” more consistently, especially because the numerical criterion is crossing the 50-m isobath rather than actual coastline contact.
2. The authors should clarify whether 1 km and 5 km refer to nominal grid spacing or effective model resolution.
3. Please provide a clearer quantitative definition of the four cases, especially the “Mean Circulation” and “Large Ro” cases. A small table summarizing wind speed, current speed, Rossby number, and relevant eddy properties would be useful. The selection criteria for the four case studies should be made more quantitative. In particular, explain how 'Mean Circulation' and 'Large Ro' were objectively defined and whether these periods are representative of their respective regimes.
4. It is unclear whether tidal forcing is included in the ROMS simulations. This should be stated explicitly, given the importance of nearshore and channel circulation in the study region.
5. The omission of horizontal diffusion should be discussed more carefully. Unresolved dispersion may be particularly important in the coarser-resolution model.
6. Please clarify whether particles are deactivated immediately after crossing the 50-m isobath.
7. The statement that the 1-km model can improve “associated biomass estimates” should be reconsidered, since biomass is not explicitly simulated in this study.
8. For the Tropical Cyclone case, the manuscript attributes changes to wind-driven submesoscale structures. It would be helpful to clarify whether the daily/6-hourly ocean-current forcing used in OpenDrift can adequately retain the relevant rapidly evolving circulation signals.
9. Several statements infer likely Sargassum landing locations directly from high FTLE values. Please make clear that FTLE identifies attracting/repelling Lagrangian structures, whereas actual landing also depends on coastal geometry, particle forcing, and the adopted stranding criterion.

10. Lines 68-69: The authors are encouraged to add the following reference to support the description “Multidisciplinary efforts have been undertaken to develop Sargassum forecasting systems at basin and seasonal scales, mainly focused on the tropical Atlantic”.

Putman, N. F., R. T. Beyea, E. G. Ackerman, J. Trinanes, M. L. Henaff, C. Hu, and R. Lumpkin (2025). Systems to monitor and forecast pelagic Sargassum inundation of coastal areas across the North Atlantic: present tools and future needs. Harmful Algae, 149, 102933, https://doi.org/10.1016/j.hal.2025.102933

Triñanes, J., C. Hu, N.F. Putman, M.J. Olascoaga, F.J. Beron-Vera, S. Zhang, and G.J. Goni. 2021. An integrated observing effort for Sargassum monitoring and warning in the Caribbean Sea, tropical Atlantic, and Gulf of Mexico. Pp. 68–69 in Frontiers in Ocean Observing: Documenting Ecosystems, Understanding Environmental Changes, Forecasting Hazards. E.S. Kappel, S.K. Juniper, S. Seeyave, E. Smith, and M. Visbeck, eds, A Supplement to Oceanography 34(4), https://doi.org/10.5670/oceanog.2021.supplement.02-26.

Hu, C., B. Murch, B. B. Barnes, M. Wang, J-P. Marechal, J. Franks, D. Johnson, B. Lapointe, D. S. Goodwin, J. M. Schell, and A. N. S. Siuda (2016). Sargassum watch warns of incoming seaweed, Eos, 97(22):10-15, http://dx.doi.org/10.1029/2016EO058355