Minor Revision of Manuscript EGUSPHERE-2025-4511 "*Technical note: A framework for causal inference applied to solar radiation and temperature effects on measured levels of gaseous elemental mercury in seawater*"

Dear Aurélien Dommergue,

We thank you and the reviewers for the evaluation and the helpful and constructive suggestions on how to improve our manuscript.

In response to Reviewer 2's suggestion on clarifying the difference between causal modelling and conventional scientific modelling, we added a new paragraph within Section 6.3 (Page 34, #735-745).

In this paragraph we explain that scientific modelling focuses on predicting system dynamics using calibrated mathematical models that may implicitly embed causal assumptions. Causal inference, on the other hand, focuses on estimating direct and indirect effects under explicitly stated causal assumptions represented by graphical models. We also emphasise that the two modelling approaches are complementary and both rely on observational data for estimation and evaluation. We agree with the reviewer that this addition strengthens the conceptual positioning of the proposed framework.

In addition, following the journal's instructions, we carefully rechecked the manuscript and corrected the following minor issues:

- Typographical error (page 34 #722): "trails" -> "trials".
- Inconsistent mediation percentage in the Conclusion (page 35 #764): Corrected from 34% to 32% (as stated in Section 5 and the Abstract). This correction does not affect the interpretation of the results.
- Sign error in Table F1 (parameter $b_{c,r}$): Values are now consistent with Table 4, Table G1, and the data in the replication package. The error resulted from a copying error during table preparation and does not affect the reported conclusions.
- Typographical error in Table G1: Pump Speed ($b_{c,s}$) -> Pump Speed ($b_{c,r}$).

Again, we thank you and the reviewer for the support in improving our manuscript. We hope that the revised version is now suitable for final publication.

With best regards

Hans-Martin Heyn, on behalf of the authors.

Added paragraph in Section 6.3 (#735-745):

In addition to workflows developed in other disciplines, it is important to distinguish the proposed causal inference framework from conventional scientific modelling in environmental science. Scientific modelling aims to formalise the understanding of researchers into mathematical or computational models (physical, empirical, statistical, or hybrid) that generate verifiable predictions of system dynamics (Beven, 2018). Such models are calibrated and validated against observational data and progressively refined as new data becomes available. In these models, causal assumptions are embedded implicitly in functional forms and governing equations. In contrast, the primary aim of the causal inferences framework is not the predictive reproduction of system dynamics but the quantification of direct and indirect effect sizes under explicitly stated causal assumptions represented by graphical models. Similar to conventional modelling, parameter estimation and model evaluation are governed by real observational data. The two approaches therefore address complementary research questions. While scientific modelling aims to predict how a system behaves, causal inference aims to disentangle and quantify the causal contributions of different factors to observed outcomes.