

Review of manuscript “Response of a semi-enclosed sea to perturbed freshwater and open ocean salinity forcing” by Arneborg et al. 2025

This study uses high-resolution model sensitivity experiments to examine how the Baltic Sea’s steady-state salinity responds to variations in freshwater forcing and salinity at the boundary of North Sea. From these experiments, the authors constructed a second-order polynomial that relates the basin-mean steady-state salinity to changes in freshwater forcing and boundary salinity. Results show that the Baltic Sea’s response to freshwater forcing is large and non-linear, whereas its response to boundary salinity is more linear but less significant. The authors also analyze the impact of freshwater forcing and boundary salinity changes on the freshwater volume fluxes in and out of Baltic Sea driven by circulation changes.

Overall, the manuscript presents some important results, but it needs some revising and reorganizing before it can be considered for publication. The detailed comments are provided below:

1. The study examines the sensitivity of Baltic Sea salinity to net freshwater input into both the Baltic and the North Sea, as well as to variations in salinity at the North Sea boundary. However, it is not clear which specific boundary of the North Sea is used for prescribing or evaluating the boundary salinity. Could you clarify this, and indicate the location on Figure 1? Additionally, it is very likely that changes in the net freshwater forcing would influence the boundary salinity in the North Sea itself. If so, how do you separate the individual impacts of the freshwater forcing and boundary salinity within your analysis?
2. The figure captions are vaguely written. For example, in Fig.2, it is not clear during which period the observed salinity profiles are compared with the hindcast profiles? Are these averaged over a period?
3. Figure 2: I suggest plotting the observed salinity profiles in thin lines rather than dots. The multiple grey dots at each depth level
4. Figure 3: Please report quantitative statistics for these comparisons. How do the mean and standard deviation of salinity differ between the observations and the hindcast experiments? It would be helpful to list metrics such as bias, root-mean-square error (RMSE), and correlation coefficients.

From the figure, it appears that the bias in the hindcast salinity increases with depth. To better illustrate this, you could include a vertical profile of correlation coefficients (with statistical significance indicated) to show how model–observation agreement varies with depth.

5. Figure 4 needs more explanation. Note that the salinity trends are different RP- and RP-SB- runs as compared to the CTL and all other runs. Can this be explained? When you say yearly salinities, do you mean the mean salinity values averaged over each year? The caption is not clear.
6. Figure 5: How do these salinity anomaly maps for different runs compare with the CTL run?
7. Figure 6 caption is too vague. Specify the units.
8. Figures 8 and 9: Over what period have these volume and salt fluxes been integrated? Is there no inflow of salt into the Baltic sea, given all positive values of F in Fig. 9?
9. Figure 11: In the caption, you need to mention that these are the differences in fluxes between the RP+ and RP- experiments.
10. I recommend moving the equations and the calculations estimating percentage changes in salinity due to variations in inflows, outflows, and related terms from the Summary section to the Results section. The final section should focus primarily on synthesizing and highlighting the main findings.
11. The manuscript would be strengthened if the authors placed their results in better context with previous studies. In the Introduction, the authors state that their work differs from earlier studies because the model includes the North Sea domain. Could the authors elaborate on what difference this inclusion makes for the analysis and interpretation of salinity variability in the Baltic Sea? How do the results compare with those from previous studies that did not include the North Sea?