

Interactive comment on “Explaining interdecadal salinity changes in the Baltic Sea in a 1850–2008 hindcast simulation” by Hagen Radtke et al.

Anonymous Referee #2

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Radke et al use a combination of observations and numerical models to both detect and explain a dominant 30-year cycle in the Salinity of the Baltic Sea. Their findings are: (1) Enhanced River runoff (at the surface) comes with reduced saline inflows (originating from the much more saline North Sea) at depth. (2) At depth, the dominant process determining salinity variations is the inflow dynamics (which brings in saline waters). (3) At the surface, the dominant process determining salinity variations are a combination of inflow dynamics and river runoff. The runoff effect is direct, i.e., surface waters are diluted with fresh river water. The inflow effect is indirect: by affecting the deep salinities as described in (2), the supply of salt from depth to the surface is affected.

Major comments: My understanding of the paper is: A 3-D model of the Baltic Sea has

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been compared against available observations. The fit of the model to observations has been deemed good enough such that the model - instead of the sparse observations - can be investigated. The major results of this exercise are the identification of two major processes driving salinity changes. These two major processes happen to be (probably coincidentally as the authors point out) correlated. The major processes driving a 30-year cycle in the Salinity of the Baltic Sea in their model are river runoff and inflows of saline waters from the North Sea.

I find the quantification of the effects of river runoff and inflows on the salinity variation in the Baltic are of interest to the scientific community. The main benefit of the study could be to present actual numbers. The authors appear to refrain so in both the abstract and the conclusions. Oddly they present numbers in the Outlook (pg. 28 In. 490). I wonder why.

In addition, I am worried by the model results summarized in Table 1: The Baltic is essentially a number of basins interconnected by shallow sills. Saline inflows (which are found by the authors to be a major process setting salinity variability) enter via the Danish Straits, travel at depth via the Arkona Basin, the Bornholm Basin into the Baltic Proper. In the Bornholm Basin simulated deep salinities are anticorrelated to observations (Station BY5 in Tab. 1). This suggests that simulated deep waters flowing out of the Bornholm Basin into the Baltic proper have the wrong salinities. This, in turn, suggests a deficient representation of inflows in the model. The fact that the fit to observations increases further downstream in the Baltic Proper (Station BY15 in Tab. 1) even though it is so bad upstream suggests: (1) inflows do not dominate deep salinities in the Baltic, or (2) two deficient processes (deficient inflow and maybe mixing) add up to a reasonable result (i.e. fit to observed salinities).

Maybe Tab. 1 is wrong? It is hard to tell from Figure 5. I recommend to discuss the evolution along the typical path of a saline inflow event from initially worsening (Station BY2 to BY5) and subsequently increasing (Station BY5 to BY15) fit to observed deep salinities.

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Minor comments: Abstract: Would be nice if some numerical metric could be included such as e.g.: Our model explains xx% of the variance inherent to available observations. We find that xx% of the variance in our model is associated to process A and yy% to process B. Maybe add a sentence on why interdecadal salinity changes in the Baltic are of interest.

pg. 1 ln. 12 "spurious" replace with accidental, coincidentally ... pg. 1 ln. 10 "As a consequence ..." Please explain why this is a consequence. It is not obvious. pg. 2 ln. 48: "Still it is questionable ...": rephrase pg. 3 ln. 57: "We demonstrate ... allows for a new perspective": Sounds very elegant but is pretty meaningless. Please be more specific here. pg. 3 ln. 64-67: Remains unclear if you do that in the paper. If it is only meant to justify what you are doing in the paper then maybe put it more towards the beginning of the introduction. pg. 6 Model simulation: someplace earlier in the text you have been talking about two different models (a 3d and a box model) so I would have expected: "Model simulations" or at least an introductory sentence concerning the number of different models used in the study. pg. 8 ln. 182: I like the list. Maybe add some more information as to where the data originates from (such as e.g. to item 2 3 and 4). pg. 10 "3 Model validation": one wonders which model; please specify Fig. 5.: By putting both surface and bottom salinities into one plot model-data misfits are dwarfed. This appears dodgy to me. pg. 11 ln. 252: I do not understand this reasoning. Please explain more comprehensively. pg. 12 Table 1: the concept of negative explained variance is somewhat odd.

Interactive comment on Clim. Past Discuss., <https://doi.org/10.5194/cp-2019-105>, 2019.