Response to the comments of Anonymous Reviewer #2

We would like to thank the reviewers for their constructive and helpful comments! We give our response as:

Reviewer comment – Authors' response where needed – Changes to manuscript.

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 ln.490). I wonder why.

The wavelet coherence method we apply does not allow a quantification of the relative importance, so we cannot give actual numbers. We do give numbers for the second method, the direct dilution effect.

Sensitivity model simulations are necessary for the quantification of the drivers' influence, which we discuss in the outlook section. The given numbers represent guesses for the outcome of the presently running sensitivity experiments and are based on the assumption that our model results agree with those of Meier and Kauker (2003b), as we wrote: "This suggests that if the models agree, both direct and indirect effect of river runoff could explain about 50% of the salinity changes."

We add a sentence: "We will do so in future sensitivity runs."

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 BY15in 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).

For inflows into the Eastern Gotland Basin (Station BY15), not only the salinities at BY5 but also the volumes pushed across Slupsk Furrow are important. It is hard to tell because of lacking observations, but we suppose that these volumes are more important and better captured by our model.

Maybe Tab. 1 is wrong? It is hard to tell from Figure 5.

We have checked Table 1 and found it correct. The bad fit at BY5 may also be a result of the incompleteness of the observation data, which implies that the strong interannual variability in the salinities is misinterpreted as decadal variations when too few years of a decade contribute to the mean.

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.

We add a discussion in the online supplement.

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.

This is not possible for the wavelet decomposition method.

We add the explained variances at station BY15 and the number of 27% for the direct dilution effect to the abstract.

Maybe add a sentence on why interdecadal salinity changes in the Baltic are of interest.
We explained the importance of species' adaptation to brackish salinities for the Baltic Sea ecosystem. We see this as the major reason why salinity changes are important to understand.

We will add a sentence to the abstract which indicates this motivation for our study.

pg. 1 ln. 12 "spurious" replace with accidental, coincidentally ...
We will replace with coincidental.

pg. 1 ln. 10 "As a consequence ..." Please explain why this is a consequence. It is not obvious.
The salt budget of the bottom water requires that salt import due to inflows will be compensated for by salt export due to upward diffusion. We will not explain it in the abstract.

pg. 2 ln.48: "Still it is questionable ...": rephrase
Rephrased to "This does, however, not necessarily mean that the salinity variations are caused by a direct dilution effect."

pg. 3 ln. 57: We demonstrate ... allows fora new perspective": Sounds very elegant but is pretty meaningless. Please be morespecific here.
We replace "allows new perspectives on the influence of runoff on salinity" by "suggests a limited influence of runoff on salinity".

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.
We move this paragraph between lines 33 and 34.

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.
We will include an introductory sentence as suggested.

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 item2 3 and 4).
We will put the source in parentheses after each bullet point.

pg. 10 "3 Model validation": one wonders which model; please specify
Will be changed to "Numerical model validation".

Fig. 5.: By putting both surface and bottom salinities into one plot model-data misfits are dwarfed. This appears dodgy to me.
We do not want to introduce even more figures. The figure appears small as it is limited to a fraction of the page width.
We will ask the typesetter to print the figure larger. We will also use a broken y-axis where surface and bottom salinities deviate too much.

pg. 11 ln. 252: I do not understand this reasoning. Please explain more comprehensively.
We will (a) give a formula how we calculate explained variance and (b) refer to a discussion of this issue in the online supplement.

pg. 12 Table 1: the concept of negative explained variance is somewhat odd.
Explained variance is never negative in linear regression, where it is given as R^2. Our model is, however, not a linear one, so the variance in the residuals can be larger than that in the original data, resulting in negative explained variance.