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Interactive comment on "Thermodynamics of Saline and Fresh Water Mixing in Estuaries" *by* Zhilin Zhang and Hubert H. G. Savenije

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This manuscript describes the application of thermodynamics to the mixing of saline ocean water and freshwater from the river. The authors show that by maximizing the power associated with mixing, they can derive a dispersion relationship that very well compares to observed data from estuaries. I think this is a very well written manuscript, shows a very novel approach based on the energetics of mixing, and should be published after a minor revision.

Most of the derivation is easy to follow and is well explained. I have one suggestion though that I think would help to better grasp the outcome. The maximum power state is invoked here as the consequence of a flux-gradient trade-off. One difference to other

max. power applications (e.g., turbulent heat fluxes) is that the boundary conditions are fixed (in terms of Q and Δh, and hence of the potential energy flux into the estuary). So I suspect that this trade-off essentially takes place along the x-axis of the estuary in some way, but I wonder how this trade-off would look like? I am not sure how this can be done, because you basically obtain a differential equation as the solution of the maximization. It would nevertheless be nice if the authors would find a way to illustrate this trade-off and what it would mean for the salinity profiles (i.e., how would the salinity profiles look like with sub-optimal dispersion).

Minor comments:

Abstract. A concluding sentence at the end of the abstract would be nice.

line 30: "increase of the salinity over the depth" – the depth of what?

A Table summarizing the variables and their description and units would be nice. Perhaps also a Figure that shows the geometry of a generalized estuary so that it is easier for a reader from outside the field to get better acquainted with the relevant variables.

line 118: Can you please explain what the difference is between water level and water depth? Does this refer to the horizontal dashed line (for h) and the blue line for z) in Fig. 1?

line 128: S' should be explained here (rather than line 132)

line 131: perhaps point out that this is the same as eq. 2?

line150: I cannot reproduce how this equation was derived. Can you please provide more explanation, and also define D'?

line 152: The solution S'=0 would only work if S = Sf, wouldn't it? I do not think it would be a solution for $S \neq Sf$.

line 163: It would be good to provide a reference to the Van der Burgh coefficient.

For matters of transparency, I want to disclose that I have seen and commented on a version of this manuscript before submission.

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