Ocean Sci. Discuss.,
https://doi.org/10.5194/os-2017-22-AC2, 2017

Ocean Science
Discussions

Interactive comment on "Internal hydraulic control in the Little Belt, Denmark. Observations of flow configurations and water mass formation." *by* Morten Holtegaard Nielsen et al.

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Received and published: 12 July 2017

COMMENTS FROM REFEREE: The manuscript "Internal hydraulic control in the Little Belt, Denmark. Observations of flow configurations and water mass formation" by Nielsen et al. investigates obser-vations in the northern part of the Little Belt during two-layered, southward flow and connect them to hydraulic control. Two configurations are described, where either the upper or the lower layer is the active and accelerating one. These configurations are dependent on the depth of the pycnocline on the upstream side. The finding of this study are interesting and worth publishing, after following comments are addressed. Line 25: Although many readers may be familiar

with the concept of hydraulic con-trol, it would be useful to give a short definition (with reference) of this concept in the introduction as it is the main topic of this study. AUTHORS' RESPONSE AND CHANGES IN MANUSCRIPT: We will add a definition and list important aspects of hydraulic control with suitable references.

COMMENTS FROM REFEREE: Line 48-49: please include references to these studies. AUTHORS' RESPONSE AND CHANGES IN MANUSCRIPT: These reference are listed in the paragraph in question (lines 48-64). But since this is unclear, we shall clarify.

COMMENTS FROM REFEREE: Line 119ff: Baltic→Baltic Sea (several times) AUTHORS' RESPONSE AND CHANGES IN MANUSCRIPT: Instead of 'Baltic' we shall write 'Baltic Sea'.

COMMENTS FROM REFEREE: Method section: It would be great to have all observations used in this study shortly described in form of a table including information about location (refer to figure 1 using the station/transect numbers), the observation period, what was observed and how, and important notes (e.g. that there was an inflow during the observation period). AUTHORS' RESPONSE AND CHANGES IN MANUSCRIPT: This is a good point. We believe that we can briefly describe all the relevant information concerning the observations by modifying the text at the beginning of the Methods section. By adding the timing of the different observations to Fig. 3 the reader can get an overview that a table would otherwise provide.

COMMENTS FROM REFEREE: The name of section 3 (Methods) should be renamed to "Observations" and the name of section 4 (Observation and discussion) to "Results" AUTHORS' RESPONSE AND CHANGES IN MANUSCRIPT: Section 3 is concerned with instrumentation and how data were collected and handled, not observations. Section 4 contains both observations and discussion pertaining to these. Section 5 contains a more general discussion. Therefore we do not agree with the referee and would like to keep the section headings.

COMMENTS FROM REFEREE: How do other processes, for example wind mixing, may have impacted the observed signals and their interpretation? AUTHORS' RESPONSE AND CHANGES IN MANUSCRIPT: Under most circumstances mixing due to hydraulic control is going to be the most important mixing agent by far. We will add a brief discussion on this question, including situations where wind mixing is actually the more important one.

COMMENTS FROM REFEREE: Line 205-206: please explain in more detail why effects, such as mixing can be ruled out. AUTHORS' RESPONSE AND CHANGES IN MANUSCRIPT: Yes, this could probably use a bit of explanation. We will explain and clarify.

COMMENTS FROM REFEREE: Line 209: please quantify "short enough" AUTHORS' RESPONSE AND CHANGES IN MANUSCRIPT: The length scale to be considered is the distance over which the width changes, which is about 2 km in this case. For the flow to be quasi-steady, this length scale should be well below the distance travelled by a baroclinic wave (at a speed of about 1 m s-1) during a period equal to the time scale (about 12 hours), i.e. more than 10 km. We will try to clarify this in the text.

COMMENTS FROM REFEREE: Line 229: please discuss the "considerable adjustment" in more detailed AUTHORS' RESPONSE AND CHANGES IN MANUSCRIPT: Despite the cross-strait variability in the two transects (due to geostrophy), the observations clearly show a deepening of the interface. We shall clarify this in the text.

COMMENTS FROM REFEREE: Line 233ff: the definition of the two layer system in the cross-strait transects in Figure 5 is somehow unclear. Which case, described here, is assigned to the situation in Figure 5? Please clarify. AUTHORS' RESPONSE AND CHANGES IN MANUSCRIPT: That may be a good point. We shall modify the text to clarify this.

COMMENTS FROM REFEREE: Line 260ff: The computed Froude numbers indicate a change from subcritical to su-percritical flow. Please discuss in more detail how this

finding gives evidence that the situation is subject to hydraulic control. AUTHORS' RESPONSE AND CHANGES IN MANUSCRIPT: If the flow is quasi-steady then a change from sub to supercritical flow implies that the flow passes a point that is critical, at which the flow is subject to control. The definition of hydraulic control to be added to the introduction should help to understand this, but we will clarify further at this point in the text.

COMMENTS FROM REFEREE: Line 267-268: How is the location of the point of control be influenced by fric-tion/entrainment? AUTHORS' RESPONSE AND CHANGES IN MANUSCRIPT: Friction and/or entrainment shift the point of control away from the top of the slope. This is explained in detail in the two references, and so further explanation should not be necessary.

COMMENTS FROM REFEREE: Line 310ff: The description of the distributions of chlorophyll a is somehow confusing. Please first describe Figure 7 and then Figure 8. AUTHORS' RESPONSE AND CHANGES IN MANUSCRIPT: With respect to the chlorophyll concentration, Figs. 7 and 8 show essentially the same picture. So describing first Fig. 7 and then Fig. 8 would imply repeating the description, which we should avoid. However, we will try to modify the text to express more clearly what is observed.

COMMENTS FROM REFEREE: Line 381: How can hydraulic control be used to quantify the transport of water masses, the mixing between them and also the influence of other processes? AUTHORS' RESPONSE AND CHANGES IN MANUSCRIPT: Given a 'weir formula', cf. Pratt (2004), the production of kinetic energy and a mixing efficiency it should ideally be possibly to quantify mixing. We will revise the text to explain this.

COMMENTS FROM REFEREE: Figure 1: To more easily identify the position of the stations, it would be great if the station positions could be more highlighted and the transects should be given a num-bering. The depth contours are difficult to distinguish.

AUTHORS' RESPONSE AND CHANGES IN MANUSCRIPT: To better show the locations of the stations we will change the symbol of these. It shouldn't be necessary to number the transects since there are only two and they appear in separate parts of the figure. When printed or scaled on the computer screen (which is probably what most readers do) the figure becomes much easier to read.

COMMENTS FROM REFEREE: Figure 2: In the title it is written that the length of the transect being measured from the northern end (assuming distance=0), but looking at the figure itself and the text, it looks like the approximately two layered water masses are located at 50 km distance. Please include in the figure, where north and south is or the starting/ending coordinates. AUTHORS' RESPONSE AND CHANGES IN MANUSCRIPT: We are somewhat confused here. Maybe the referee misunderstood something. In Fig. 2 at 50 km there is only one contour line of density, showing that the water column is almost fully mixed. So, clearly the strongly stratified water masses are near 0 km. We will be modifying Figs. 2 and 4 to show detailed TS diagrams. This should limit any further confusion.

COMMENTS FROM REFEREE: Figure 3 The different curves are difficult to distinguish and need to be clarified AUTHORS' RESPONSE AND CHANGES IN MANUSCRIPT: We agree that the different curves in Fig. 3 are difficult to distinguish. However, we would like to avoid adding more details as this would clutter the figure even more. Also, we would like to avoid adding colors. However, we will add a short description on how to better read the figure. Notably, when the curves are nearly coinciding and thus most difficult to distinguish, it implies that there is no velocity shear or stratification.

COMMENTS FROM REFEREE: All figures showing salinity: The unit is missing everywhere, is it g/kg? AUTHORS' RESPONSE AND CHANGES IN MANUSCRIPT: We are using Practical Salinity Units (dimensionless) everywhere, cf. our reference to UNESCO (1981). We will be more specific about this in the figures and throughout the text.

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