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Interactive comment on "Tidally-induced lateral dispersion of the Storfjorden overflow plume" *by* F. Wobus et al.

Anonymous Referee #2

Received and published: 21 May 2013

This is a very nicely written modelling paper providing new insight on the distribution of dense water exported from Storfjorden, investigating the influence of tidal dispersion of the Storfjorden overflow plume. I enjoyed reviewing it. The paper is skillfully structured, the text is concise and figures are clear, descriptive and illustrative of the results. The methodology is presented in sufficient detail. The authors demonstrate good knowledge of the literature and put their results into context using several other previous studies. This will be a valuable contribution to Ocean Science. I recommend publication subject to moderate revisions suggested below.

The main message of the paper builds on the fact that the horizontal diffusivity coefficient according to Smagorinsky scheme is correct and representative of the physics in the vicinity of the headland south of Spitsbergen. This is probably true, but needs

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a brief discussion on the associated caveats etc. to convince the readers (like myself) mainly dealing with observations.

Tracer concentration, tides or no tides, shows SFOW on the shallow shelves west of Spitsbergen. I am not aware of any observations supporting this. It appears that the bottom layers of the entire shelf in the southern half of west Spitsbergen is SFOW. This deserves a discussion. Probably this means TRC1+2+3 < 0.05 or 0.1 is rather "noise" than SFOW?

Tidal excursion distance is important in quantifying whether tide-induced shear dispersion is important in a system. This is not discussed. What is the tidal excursion around the headland? Your model horizontal resolution is 3 km; does this adequately resolve the tidal excursion?

According to the "shear dispersion" section of Geyer & Signell, longitudinal dispersion coefficient, K, in open channel flow with log velocity profile scales as Uh (U is the flow away from the bottom boundary layer and h is water depth). For the overflow plume, an analogy can apply; K scales with the volume flux per unit width of the plume. This is of course variable across the plume section (small at the edges of the plume, large at the core etc.). Is this important for the dynamics? How does plume Uh compare with tidal Uh?

If K due to tides scales as Uh (where U tidal flow and h depth), Uh is the tidal volume flux. Yes, the tidal velocities increase on shallows, but we cannot claim so for Uh.

Fig 2: I don't see the point with this figure. Tidal elevation will vary significantly within the domain and this time series near the southern boundary is probably not representative for the site of interest (the hatched box or section in Fig 7). It would be more interesting to show a map of contours of tidal excursion over a spring-neap cycle and another map of tidal velocity maximum over a spring-neap cycle.

P702, li16-24: A thicker plume does not mean increased mass flux or volume transport.

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Please clarify.

P703 li 14-19 & Fig7a. It would be nice to show a section similar to Fig6 but for the cross-section analyzed, shown in Fig 7a. I am curious whether the two-branched structure you sketch in Fig 10 appears in this average section. It will also clarify the "main " cascade and the remainder.

P703 li 20-25 & Fig7b. (Looking at the no wind cases) It appears like the relative difference between no tide and tide is amplified for moderate and high salinity overflow compared to the weak overflow. Is this because the weak overflow propagates in shallower water?

P706, li7: You haven't really showed plume thickness and volume transport in the early stage of the overflow (in Storfjordrenna), except perhaps the thickness in the cross-section of fig 6. Overall, there are several occurrences of claims that some properties have been shown (but not done so). Please tone done such comments.

P706, li 18-21: you have not confirmed that tides augment the downslope transport. Lower concentration left in the fjord area does not confirm this. Given that sill depth is about 120 m, your results showing elevated concentrations above 100 m on the Spitsbergen shelf suggest, on the contrary, augmented upslope transport.

P706, Discussion around DEk. I guess this depends on how you define the plume thickness. In Fig6 a-b the core of the plume (warm colors) leaning on the slope are of similar thickness, supporting this scaling. Ekman dynamics cannot be expected to account for what's going on in the diluted waters more than 100 m above the bottom.

P708, li 9: This two branch structure is not presented from the model data (before Fig 10). Perhaps the authors are referring to Fig5b? The structure is not so clear. Perhaps the suggested cross section figure above would help.

Minor comments:

P692, li 22-23: the latitudes are in degrees & minutes (not seconds)

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P694, li5: tidally-induced shear dispersion: the reader would benefit from a brief description here in the introduction (although you describe how it works later in discussion).

Eq1: what is Dhor ? (not clear from the text). If it is horizontal diffusion coefficient, what is kapp hor in fig 9a?

P698, li8: I suggest to remove Skogseth et al. 2009 reference which is an event based supercooling observation of high salinity, not representative of the context here.

P700, li22: ambient conditions are not described (except that we know they come from a global simulation)

P701, li28: somewhere around here please indicate your threshold of tracer concentration for detection plume thickness. Is it 0.01 as you mention above eq 2?

Interactive comment on Ocean Sci. Discuss., 10, 691, 2013.