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Interactive comment on "Arctic freshwater fluxes: sources, tracer budgets and inconsistencies" *by* Alexander Forryan et al.

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Dear authors,

I have a couple of comments on your paper.

My first comment regards the implementation of the N:P ratio method used to identify Pacific Water. Figure 7 in your paper shows low fractions (10 – 20 %) of Pacific Water along much of the boundary section in places that seem unlikely. For example, much of Fram Strait is filled with low fractions of Pacific Water below 1000 m. Pacific Water is buoyant and enters the stratified Arctic through a 60 m deep channel, so it seems unlikely that Pacific Water should be found at the bottom of Fram Strait. I think these apparently-spurious Pacific Water fractions might need be addressed before we can

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expect good results from the inverse model. There are a couple of ways in which this might be achieved:

1) Some of the apparently-spurious low Pacific Water fractions might arise from uncertainties in the end-member properties. If the low fractions are not significantly different from zero it might be justifiable to suppress them.

2) An alternative approach could be to apply the N:P technique only in the depth range where Pacific Water is likely to be found, assuming fractions below some depth threshold to be zero. The N:P ratio method has a large errors associated with it and if it is applied indiscriminately over large areas where we would not expect to find Pacific Water the accumulated systematic errors probably become quite significant.

However, the limitations of the N:P ratio technique are perhaps not the main reason that the inverse model does not balance for Pacific Water. My second comment regards the application of the inverse technique to Pacific Water in the Arctic Ocean. I'm not very familiar with inverse modelling, but I think the technique assumes that the system is in a steady state. The repeated Pacific Water sections in Dodd et al., 2012 (cited in your paper) indicate that the flow of Pacific Water through the Arctic is not in a steady state. At least in Fram Strait, Pacific Water is released in pulses with peak Pacific Water fractions of up to 80 % interspaced with periods where peak Pacific Water fractions barely exceed 20 %. The duration of pulses is probably of the order of 2 years, which is quite short relative to the time required for Pacific water to cross the Arctic. I'm not exactly sure how this can be best addressed, but I think the paper should at least discuss this steady-state issue.

One reason that the inverse model might balance for salinity/freshwater, but not for Pacific Water, could be that in years when Pacific Water is not present in a given location it tends to be replaced by another halocline water mass of similar density (ie: rather similar salinity).

There is some denitrification in the Arctic and I agree that when using the N:P ratio

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technique, some Atlantic Water will apparently be transformed into Pacific Water over the shallow shelves. That is indeed a fundamental limitation of the technique. However, if the steady-state issue is as serious as I think it is, then I'm not sure that the results of the inverse model give us much new information about the reliability of the N:P technique. Please do correct me if I am wrong about something here though!

Incidentally, I'm inclined to agree with the first reviewer's suggestion that this paper might be better suited to Ocean Science Discussions than The Cryosphere.

Regards,

Paul A. Dodd

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