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Ocean Science Discussions

Interactive comment on "Arctic Ocean circulation and variability – advection and external forcing encounter constraints and local processes" *by* B. Rudels

Anonymous Referee #2

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General comments

The manuscript gives an overview of the advances in understanding Arctic Ocean circulation since the early explorers. It is largely a review of the author's prior publications, based on his Nansen Medal lecture, with additional reference to other literature. The subject is of general interest to anyone working in the Arctic but also of wider significance due to the connection to the Nordic Seas and the North Atlantic via the Fram Strait. The manuscript combines descriptive results from hydrography with theoretical approaches to understand the Arctic Ocean circulation.

The author gives an interesting introduction with reference to the scientific achieve-

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ments of historical figures of the late 19th and early 20th centuries. At the end of the introduction he clearly formulates the ideas to be explored in the remainder of the manuscript. This is followed by fairly detailed theoretical arguments related to freshwater and heat giving the basis of arguments used later on in Section 6. Sections 2 and 3 are best understood by also consulting Rudels (2010), but ample reference to this paper is given in the manuscript. The more descriptive discussion in Sections 4 and 5 give a nice overview of what is currently known about the circulation at different depths in the Arctic Ocean. The readability of the manuscript would perhaps improve even further by placing Sections 4 and 5 prior to 2 and 3, as 3 is closely linked to 6.

I suggest to accept the manuscript subject to the following minor corrections:

Specific comments

1. P. 2320, l. 20: although these facts may be well known, it would be useful to add some references here, e.g. Dickson et al. (2000; J. Climate, doi: 10.1175/1520-0442(2000)013<2671:TAORTT>2.0.CO;2) for atmospherically driven ice export through the Fram Strait.

2. P. 2322, l. 9: add 'and ice export' after 'freshwater input'; m depends on f; hence, it not only depends on the freshwater input but also the ice export, as by the definition of F near the top of the previous page.

3. P. 2322, l. 11: the baroclinic Rossby radius should be $Ro = \sqrt{g' H_1}/f$.

4. P. 2322, l. 14: add 'and the ice export.' at the end of the sentence.

5. P. , l. 15: replace 'input' by 'export'; as stated in Rudels (2010;p. 112), the value of $F = 0.2\ Sv$ stems from a freshwater input of $0.29\ Sv$ and an ice export of $0.09\ Sv$.

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6. P. 2324, l. 2: should add a reference to 'Proshutinsky et al. (2010; JGR, doi: 10.1029/2008JC005104)', as they show variability in freshwater inventories in the Beaufort Gyre.

7. P. 2325, l. 4: can the author give a rough estimate of the freshwater transport due to a sea level difference between the Arctic Ocean and the North Atlantic?

8. P. 2328, Eq. 14: should add 'where G is some function independent of ϕ, and only the last...'.

9. P. 2329, l. 24: should this be 'according to Eq. (16)'? It appears that the effect of reducing temperature on α in Eq. (16) is stronger than the reduction in S_A, so that ϕ_0 would decrease. In this case a reference to the variability of α, similar to the one in Rudels et al. (2010), would be useful either here or just after Eq. (16).

10. P. 2332, l. 24: Kikuchi et al. (2005; GRL, doi: doi10.1.29/2005GL023982) describe more recent observations related to the subsurface Atlantic Water circulation around the Lomonosov Ridge.

11. P. 2342, Eqs. (24) and (25): understanding of these equations would benefit from a schematic, perhaps just annotating Figure 22.

12. Why is the observed transport in the upper East Greenland Current (Figure 23) less than the theoretical ones considered in Section 6 and depicted in Figure 22? Is this, perhaps, due to friction on the shallow shelf (as opposed to the assumed vertical wall)?

Technical corrections

1. The lines and colors in the figures are not always clear; for example, Figure 18 is barely legible. Thicker lines and larger font sizes would help to better understand

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most figures. Further, the readability of the scanned or embedded images in Figures 2, 15, 16 and 23 would benefit from enhanced contrast.

2. P. 2314, l. 15: this is a very long sentence, perhaps split into two parts?
3. P. 1315 , l. 1 and 3: add 2 ‘,’ before ‘and’. This applies to various other parts of the manuscript where two sentences are joined by ‘and’.
4. P. 1315, l. 29: replace ‘was’ with ‘were’.
5. P. 2317, l. 17: replace ‘come’ with ‘came’.
6. P. 2318, l. 4: add ‘’s’ to Nansen, i.e. ‘Nansen’s’.
7. P. 2324, l. 2: the reference should be ‘Rabe et al. (2011)’.
8. P. 2331, l. 19: ‘cyclonically’.
9. P. 2333, l. 2: ‘describe’.
10. P. 2342, l. 6: replace ‘than’ by ‘then’.

Interactive comment on Ocean Sci. Discuss., 8, 2313, 2011.