Review of egusphere-2025-4345
Dörr et al., 2025
Ocean Science

General comments

In this study, the authors analyze the overturning circulation and water mass transformation of the Arctic Ocean in a 1/12° global ocean model hindcast simulation over 1979–2015. The analysis of water mass transformation is performed both in density space and temperature–salinity space. In addition, pathways and timescales of the circulation are determined using Lagrangian virtual particle tracking. These approaches allow to quantify the contribution of surface forcing and mixing in different regions to the full water mass transformation. Results include the identification of the Barents sea as a major location of surface-forced dense water formation, and the time scales of different circulation routes in and out of the Arctic.

In my opinion, this paper provides an excellent and detailed overview of the circulation and water mass budgets of the Arctic (in this particular ocean model). The analysis is extensive and thorough, and the text and figures are of high quality and clarity.

I recommend that this paper be accepted for publication after addressing the minor comments below.

Specific comments

Literature The results of the WMT analysis in T-S space in this paper should be compared to the following study which employed a similar approach: Pemberton, P., J. Nilsson, M. Hieronymus, and H. E. M. Meier, 2015: Arctic Ocean Water Mass Transformation in S–T Coordinates. J. Phys. Oceanogr., 45, 1025–1050, https://doi.org/10.1175/JPO-D-14-0197.1.

Ln. 64 How does the use of monthly mean velocities (instead of a higher time resolution) affect the applicability of the Lagrangian tracking algorithm? Did the setup include some stochastic element to account for unresolved turbulence? This should either be detailed in the Methods or commented on in the Discussion.

Section 2.2 Since the many equations in this section make it look a bit "dense", it could be useful to separate it into two subsections (e.g., 2.2.1 "Density space" and 2.2.2 "T–S space"). I leave this choice to the authors of cours of coursee.

Ln. 80 Since you mention "previous studies", it would be good to explicitly cite them. Currently it is not clear whether these previous studies also applied the Walin framework to the Arctic ocean, or if they simply also used the Walin framework in some other way.

Technical corrections

Figure sizes In some of the figures, the text labels appear smaller than in others. In particular, the longitude labels on polar projection plots are so small as to be illegible in most cases. I recommend checking the consistency of font sizes across all figures.

General In all the mathematical symbols with "sfc" and "res" superscripts, you should probably use `mathrm` to avoid the superscripts looking like $s \cdot f \cdot c$. Example: F_Θ^{sfc} vs. F_Θ^{sfc}

Ln. 11 although “northern” overturning is clearly correct, perhaps writing “Atlantic” overturning would make the broader impact of this paper clearer (AMOC slowdown, etc.)

Ln. 86 Maybe explicitly state *volume* transport

Eq. 3 Are the units in this equation consistent? It seems that the last two terms currently have different units given their different denominator/differentiation variable.

Ln. 101 Use v instead of ν in the equation

Fig. 1 Consider adding a vertical line at $x = 0$. Also, the y-axis label σ_0 appears to be smaller than the rest of the text.

Ln. 191 The salinity range should not be in parentheses

Fig. 3 In the colorbar label, the salinity units should probably be inverted

Ln. 208 undergo → undergoes

Ln. 231 superfluous closing parenthesis

Fig. 8 caption Why is 50% sea ice concentration used as a threshold for sea ice extent (instead of the more common 15%)? In any case, since this is mostly for illustrative purposes in this figure, this is probably not important.

Ln. 364 “the AMOC lower branch” → the AMOC’s lower branch / the lower branch of the AMOC

Fig. 9 caption grid *cell* area

Ln. 372 at *a* rate