Thank you for your review. We agree with nearly all your points and have revised a new draft of our paper accordingly as described below. In response to reviewer 1 we have added an additional section (new section 3) which describes ocean models at an “intermediate” level. We have also added some references to section 2.2.

This is a very short, elementary overview of ocean modeling, targeting mainly "large-scale" simulations of the ocean circulation. Given the limited space, the manuscript is necessarily subjective, especially in the choice of references, which is fine. Several in-depth review papers (and reference texts) are cited, which is good. I think the manuscript is a useful short introduction. I do have a few comments which should be addressed prior to publication.

Yes it is difficult not to be subjective. The last paragraph of the introduction now draws attention to other introductions to ocean modelling which emphasise different things. The last section of the paper is aimed at expert model users and deliberately focuses on some more advanced technical detail.

Around line 45:

In addition to the 7 equations, it might be useful to also mentioning the surface, bottom, and lateral boundary conditions (the surface being the most relevant one)

Yes! We should certainly have done that. In the new version after the list of physical principles we have now written “Together with information about the momentum, heat and fresh-water exchanged with the atmosphere and sea-ice at the sea surface, and the ocean’s bathymetry which constrains its motions, these 7 sets of constraints are sufficient to determine how the 7 fields will evolve from given initial conditions.” The paper does not say much about surface fluxes, which is a very large topic in its own right but the final section now refers to Yu (2019) and Storto et al. (2024).

Yu, L.: Global Air–Sea Fluxes of Heat, Fresh Water, and Momentum: Energy Budget Closure and Unanswered Questions. Annu. Rev. Mar. Sci., 11, 227–48, 2019.

Storto, A., Frolov, S., Slivinski, L., and Yang, C.: Correction of Air-Sea Heat Fluxes in the NEMO Ocean General Circulation Model Using Neural Networks, Geosci. Model Dev. Discuss. [preprint], https://doi.org/10.5194/gmd-2024-185, in review, 2024.

line 45-51:

A distinction between "resolution" and "grid" spacing might be appropriate. The two aren't the same but are treated as such. It takes multiple (at least 4) grid spacings to "resolve" a process, such that for a given grid spacing dx, we may begin to resolve a processes of size 4*dx.

Yes that is right. We have revised the relevant sentences slightly. They now say: “ Motions at scales comparable to or smaller than the grid are not resolved. The effects of these sub-grid scale (SGS) motions on the resolved scales are calculated by parametrisation schemes”. Later in the paper, between lines 132 and 133 in the old version, we have added: “The effective resolution of the model also depends on how scale-selective the dissipation of variance is near the grid scale (Soufflet et al. 2016).”

Soufflet Y., Marchesiello P., Lemarie F., Jouanno J., Capet X., Debreu L., and Benshila R.: On effective resolution in ocean models. Ocean Modelling, 98, 36–50, https://doi.org/10.1016/j.ocemod.2015.12.004, 2016.

line 50:

You mention that parameterizations are inevitably limited. Please spend one sentence as to why? (Structural and parametric uncertainty, lack of calibration, discretization errors).

Well, the fundamental issue with most parametrisations in ocean models is that they are trying to represent the effect of motions that are not resolved. We have already said that. Structural and parametric uncertainty are consequences of that issue. As the discussion here is intended to be at a non-technical level we believe the current text is appropriate.

line 60 on MOC:

It is not only convective mixing in high lats, it is also boundary mixing, as revealed in the OSNAP East measurements.

Furthermore, closure of the global MOC is also through a range of mixing processes.

Some of the mixing in the boundary currents will be convective mixing. But some of the mixing in the open ocean will be at least partly driven by wind stirring. So on reflection we think it is better to omit the word “convective”. We have re-organised the sentence somewhat so it now reads “meridional overturning circulations (MOCs) associated with heat loss and stirring of mixed layers at high latitudes and wind driven upwelling and heat uptake in the Southern Ocean and near the equator (Srokosz et al. 2021);” We believe Srokosz et al 2021 is a good reference as it introduces a series of recent reviews of the MOC.

Srokosz, M., Danabasoglu, G., Patterson, M.: Atlantic Meridional Overturning Circulation: Reviews of observational and modeling advances - An introduction. *Journal of Geophysical Research: Oceans*, **126, 1**, https://doi.org/10.1029/2020JC016745, 2021.

line 62 on boundary currents:

Those have nothing to do with the MOC, i.e., they exist regardless of the MOC. Please remove “MOC” mention here (westward intensification goes back to the models by Stommel (1948) and Munk (1950)).

It was not very clear what we meant in the old version. So we have rewritten this bullet point distinguishing more carefully between depth mean WBCs associated with the wind-driven gyres and vertically varying WBCs that are part of the MOCs: “western boundary currents (WBCs); the depth mean WBCs are associated with the wind-driven gyre circulations (Pedlosky 1982, chapter 5) and oppositely directed surface and deep WBCs (Hogg 2001) with MOCs;”

Hogg, N. G.: Quantification of the deep circulation, 259-270. In Siedler,G., Curch, J., Gould, J. Ocean circulation and climate: observing and modelling the global ocean, International Geophysics Series vol 77, San Diego, Academic Press, 2001.

Pedlosky, J.: Geophysical Fluid Dynamics New York, Springer-Verlag, 624 pp, 1982.

line 70:

I think you mean "mass balance", not "heat balance".

We could have written mass balance or heat balance here; the advection of warm water affects how much ice melts. We prefer to retain “heat balance” .

line 75-78:

You could reference papers here on data assimilation and sea ice modeling that will appear in the same issue as part of OceanPrediction.

Yes. We have included a reference to the companion paper by Martin et al. (2014) . We haven’t referenced the sea-ice modelling paper.

line 90:

"...the elliptical geoid of the Earth’s bulge follows a spherical surface"

This is a bit obscure. The geoid proper deviates from the reference ellipsoid (by about +-80 metres).

I think what you mean is that the centrifugal term is absorbed in the gravitational term by means of a geopotential).

It would be good to clarify your sentence.

Yes this sentence was not entirely clear for the reason you give. The Earth’s bulge due to its rotation is 20 km (equatorial radius = 6378 km; polar radius = 6357 km). So the geoid does follow a nearly elliptical surface. We have rewritten the sentence so that it says “... the centripetal acceleration is not included in the equations because they have been transformed so that the geoid, which is nearly elliptical because of the Earth’s bulge, follows a spherical surface (Vallis 2017)”.