Response to reviewers (reviewers' comments in blue)

Review RC1:

Two degrees is way too coarse to investigate tides. We're talking about a process that has a typical scale of fewer than 5 km at critical locations, and that is highly dependent on the correct representation of bathymetry.

The vertical diffusivity in the model is meant to represent a parameterisation of tidal and other mixing processes in the open ocean, rather than a parameterisation of tidal effects at very small coastal scales. Such a process is very widely used in ocean models. We have clarified the method to state that "all tidal energy is dissipated *at the 2° grid scale*.". See also Comment CC3 (Reply on RC1).

2.The model's biases

From line 111, you try and find an explanation for the seemingly "inconsistent" behavior of the Nordic Seas and later that of the Southern Ocean. From line 125, you report on potential but non-significant links with the modelled AMOC. Unfortunately, FORTE2, whose reference Blaker et al. (2020) was missing from the bibliography, has significant biases that most likely impact these two results:

- Warm bias in the Southern Ocean and in the northwest Atlantic;
- Deep mixed layer bias in the Nordic Seas and in the Ross Sea.

Similarly, you ought to verify the biases in the model's NAO before analyzing its response.

We thank the reviewer for spotting this unfortunate omission, and we have added the Blaker et al (2021) reference to the reference list. We note this is 2021, and not 2020, and have corrected the citation in the text.

The NAO and SAM (Southern Annular Mode) have been examined in Blaker et al (2021) (Figures 15 and 16 respectively) and the model does a good job of representing both. We have now changed the text to reflect this (new text in italics):

"The geographically varying phases suggest a potential for geographically varying temperature and circulation responses, *especially in the case of the North Atlantic Oscillation (NAO) and Southern Annular Mode (SAM), which are simulated quite well by FORTE2 (Blaker et al 2021)*."

3.The focus on temperature only

In regions that are salinity-controlled (Arctic, Nordic Seas, North Atlantic, Southern Ocean), the change in background diffusivity should primarily affect the salinity. A freshening would likely lead to a surface cooling, and a salinification to enhanced mixing so to a warming of the surface. Maps or timeseries of salinity changes should be shown. Similarly, there is currently no mention of sea ice changes in this paper.

We have now changed Figure 2 to include the variation of global salinity with lunar nodal cycle phase. We have examined Arctic temperature rather than sea-ice anomalies because of the relative simplicity of the sea-ice scheme in the model. We do now say in the discussion that future work should be conducted using a more complex sea-ice model:

A caveat in interpreting the above results, as well as results suggesting a large response on the northern edge of Antarctica, is that the sea-ice representation of FORTE2 is simplified, consisting of one slab (Blaker et al. 2021). Future work regarding the nodal cycle in the subpolar and polar oceans should be carried out with a more realistic sea ice model, with other forcings included to assess potential nonlinear combinations of response.

Other comments:

Inconsistent usage of "high latitudes". Line 69-70 for example, it excludes the Arctic (which is extremely stratified).

We have changed the text to say *Although the tidal modulation is largest (exceeding 10%) in the Arctic and Southern Oceans, high-latitude water columns are typically only weakly, or negatively, temperature stratified (i.e. the near-surface vertical gradient of temperature is either small or negative). So, counterintuitively, the effect of tidal modulation on climate in these regions might actually be small.*

Figures 5:8 are very hard to read. Use a pseudocolor plot, or at least filled contours.

We have changed Figures 5-8 to show filled contours for both data and contours for statistical significance to enhance readability. In particular Figures 6 and 8 have a cyclic colour scale for clarity. We have also corrected a mislabelling of the SSP Scenarios in Figure 10, and added model uncertainty for two future scenarios.

All figures are at the end of the document, and their captions are on a different page. It is really uncomfortable to view on a screen. The EGUsphere now (finally!) recommends that figures and their captions be in the text, closest to where they are discussed.

We have now moved all figures to the place in the text where they are discussed, and each figure is accompanied by its own caption.