

# Response to the editor

We thank the Editor for considering our response to the reviewers and for the opportunity to revise the manuscript.

We carefully addressed the Editor's recommendations and also identified additional modifications that were necessary. The changes made are described below.

We also applied minor changes here and there to improve the readability of the manuscript, such as the word "multimodel" which was changed in the whole manuscript for "multi-model".

## Description of the changes

### Reference to the appendix:

As mentioned in the response to each reviewer, we added figures in the appendix. However, we did not mention how we would add these figures in the paper. We therefore added several references to these figures in the following lines:

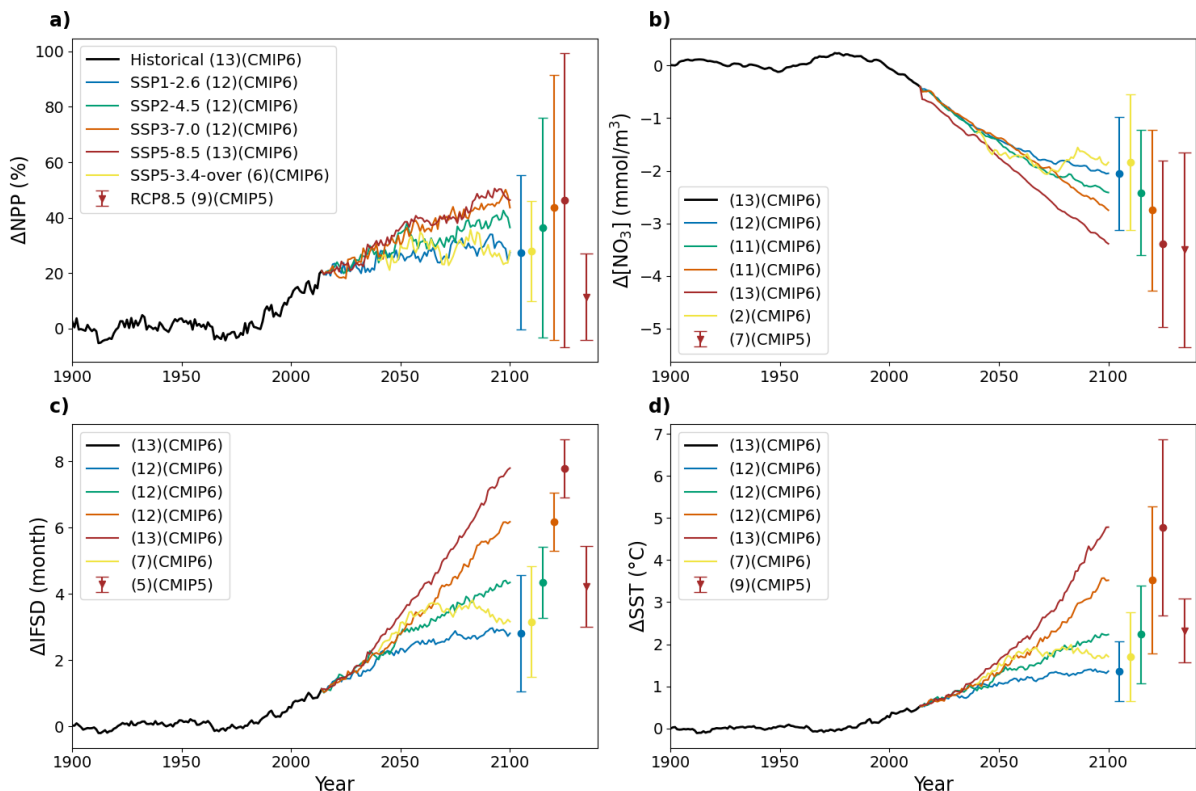
**P4L26** → Fig. A1

**P11L11** → Fig. A1, A2, A3, A4

**P16L16** → Fig. A5

**P20L10** → Fig. A6, A7, A8, A9

**Figure 3:** Following the recommendations of the Editor and Reviewer 1, we replaced the September Sea Ice Concentration (SSIC) with the Ice-Free Season Duration (IFSD) in the former Figure 3 (now Figure 5).



**Figure 5.** CMIP6 projected pan-Arctic Ocean anomalies of NPP (a), surface NO<sub>3</sub> (b), IFSD (c) and SST (d) over the period 1900-2100 relative to 1850-1899, in the different emission scenarios. Vertical bars represent multi-model means and standard deviation in 2100. The last vertical bar and triangle represent the value for RCP8.5 of CMIP5 in 2100. The numbers within parentheses give the number of available models.

This new diagnostic is more directly related to seasonality and better highlights the reduction in the duration of sea ice cover throughout the year. It clearly shows that the ice-covered period decreases substantially in CMIP6 compared to CMIP5.

The paragraph in the Results section describing the figure previously read:

“September sea ice area loss is lower in SSP5-8.5 than in RCP-8.5, reflecting the fact that there is more ice to lose in CMIP5, as the mean state present-day sea ice area is larger in CMIP5 than in CMIP6 (SIMIP, 2021) (Fig. 5c). The surface ocean warming is two times higher in SSP5-8.5 ( $4.78 \pm 2.09$  °C) than RCP8.5 ( $2.32 \pm 0.75$  °C) with higher associated uncertainty (Fig. 5d). Using anomalies, sea ice loss is larger in CMIP5 than in CMIP6. This could reflect the fact there is more ice to lose in CMIP5, as the mean state present-day sea ice area is larger in CMIP5 than in CMIP6 (Notz & Community, 2020).”

We changed it for:

“The increase in IFSD is higher in CMIP6 than in CMIP5, with values of 7.79 months and 4.23 months, respectively, reflecting a stronger reduction in sea ice duration in CMIP6 compared to CMIP5. However, when expressed as anomalies relative to the reference period, the magnitude of change is slightly lower in CMIP6 than in CMIP5 (Fig. 5d).”

**Table 2:** As we downloaded new monthly data of sea ice concentration of CMIP5 to calculate the IFSD, we had to change the table 2 that contain information about CMIP5 models we used, as we couldn't download SIC data for all the models we had.

**P21L19:** We added a paragraph in the discussion about the seasonality of the nutrient concentration:

“Beyond changes in mean nutrient concentration, CMIP6 projections point a reorganization of the seasonal dynamic of nutrient limitation in throughout the century in the Arctic Ocean. The lengthening of the oligotrophic period in CMIP6 projections suggests a progressive extension of nutrient limitation beyond the peak bloom phase, potentially affecting both magnitude and the phenology of phytoplankton production (Manizza et al., 2023). The intensity of the bloom is constrained by the seasonal depletion of nutrient, despite an enhanced light availability and warmer temperatures, while a delayed replenishment in autumn and winter could limit the recovery of nutrient inventories prior to the following growing season.”

**P23L3:** We changed a sentence in the conclusion by adding a precision:

“This is mostly due to the stronger climate sensitivity of CMIP6 models, leading to greater warming and earlier September sea-ice loss *and longer open-water season*, together with a lower limitation by nutrients.”

**Figure 1:** We changed the description of the figure 1 for:

“The upper black line in NO<sub>3</sub> represents the multi-model mean concentration in March, the middle one represents the annual mean concentration and the lower one represents the concentration in July.”