Responses

Thank you for your revised manuscript that answers quite exhaustively the remarks of the 2 reviewers. However, I would like you to still consider the following points that I still have (of course based on the two reviews) :

Thank you for going through our responses so carefully, and for raising the additional issues. We have addressed these as detailed below.

Reviewer 2, remark 1 : I think that the functioning and impact of what you call the A4D initiative is still not clearly described in the text. After reading the paper, I don't really know what the A4D is in practice. In section 2, the paper details that A4D is a set of best practices in model development (e.g. regular group meetings, systematic documentation and tracking of model issues through Gitlab, engagement of all group members through group-wide acceptance of new ESM versions, etc.) but it seems that it also includes a common set of automatic diagnostics (see the 2nd objective described in section 2). ….

If you want to put emphasis on the A4D initiative, you should better describe in Section 2 not only the objectives but also the practical implementation in terms of procedures and software. Possibly you could make a reference to an internal report describing the different aspects of the initiative, if such a report exists.

Thank you for this insightful comment. We have reorganized and rewritten parts of Section 2 to better describe the practical implementation of the A4D initiative. Specifically, the objectives are now followed by the phrase 'To this end', after which the actions taken to meet the objectives are described in detail.

Finally, on line 109, it is written that the "rest of the paper documents results from the first phase of the A4D activity"; why the first phase? What would be the next phases?

We have removed 'the first phase' from lines 109 and 689, as the definition of a phase is subjective and not further discussed in the paper.

Also the A4D software or "automatic package" (see line 95) must be made available on Zenodo like the CanESM sources.

We have added the A4D standardized diagnostics software package to Zenodo, which is now bundled with the reports. In addition, we have included a link to the Zenodo archive in the code and data availability section.

L 440-442 : As a reply to Reviewer 2, you write “The atmospheric retuning in CanESM5.1-p2 resulted in an even lower BCS and hence a slightly smaller high bias relative to observations, which contributes modestly to CanESM5.1- p2’s lower climate sensitivity.” If I understand well, you are not sure of the exact relation between BCS and climate sensitivity. Therefore I suggest to add a “probably” in that sentence: “… , which probably contributes modestly to CanESM5.1- p2’s lower climate sensitivity.”

Rephrased as:

> **Given the multi-model relationship between BCS and EffCS evident from Figure 14c and other studies (Brient et al., 2016; Liang et al., 2022), it is likely that this slight BCS reduction contributes modestly to CanESM5.1-p2’s lower climate sensitivity.**

L455: I agree with Reviewer 2 that excessive sea-ice and fresh bias in SSS is counter intuitive. Please add some of the explanation you provided to Reviewer 2 in the final version of your manuscript.

We have added the following footnote to line 455:

> **[7]While a high sea ice bias is often associated with a high salinity bias in regions where sea ice forms, the low salinity bias simulated in the North Atlantic is associated with enhanced stratification, preventing convection and vertical mixing of heat, possibly driving the high bias in sea ice**

L 156: I think “The syntax changes are bit-identical (i.e., they preserved the bit pattern of the model).” should be “The syntax changes provide bit-identical results (i.e., they preserved the bit pattern of the model results).

You are correct, we have corrected this.

L480: The sentence “and hence inherent ocean surface biases cannot be excluded as a possible cause” needs to be rephrased ; the inherent ocean surface biases are the cause of what? Of the ocean and sea ice biases? Please rephrase or simply remove

“and hence that inherent ocean surface biases cannot be excluded as a possible cause”.

We have rephrased this; the new text now reads (line 478-480):

> **While it would be tempting to attribute the ocean and sea ice biases to CanESM5.0 forcings, it is important to realize that the CanESM5.0 forcings themselves have an imprint of the ocean surface biases in CanESM5.0. Therefore, we cannot exclude the possibility that the ocean surface biases are due to deficiencies in the ocean model.**

L561: I am not sure why you added an hyphen in “CanESM2 simulated a too-weak polar vortex”

Rephrased to:

> **… to correct for the weak bias in the polar vortex simulated by CanESM2**

Table 3: Please replace “therodynamics” with “thermodynamics”

Corrected, thank you.