

List of changes made in the manuscript following reviewer comments:

- Lines 118 & 123: Correction to Equation 1 and the text regarding the symbol for the latent heat of fusion.
- Line 129: Additional text with more details on the seasonal cycle of ZEMBA and its impact on the simulated climate
- Line 162: Additional text clarifying the value for water availability ( $W$ ) over land and ocean for the latent heat fluxes
- Paragraph beginning at Line 181: We clarify that for calculations of snowfall, surface air temperature is corrected for using a prescribed zonal-mean elevation. We also provide more details on  $f_{sf}$  as the geographic fractional area of the grid box over which precipitation falls as snow.
- Lines 228-232: Changes to Equations (18) and (19) to make equations for sensible and latent heat fluxes by the atmosphere more explicit.
- Lines 243 & 246 & 252: Changes to symbol for snowpack thickness over land to  $d_{sc}$
- Line 265: Additional text clarifying some assumptions regarding the albedo over land and the absence of vegetation influence or feedbacks.
- Line 296: Additional text that “ $z$ ” represents the vertical coordinate for the ocean domain of the model.
- Line 326: Deletion of repeated ‘the’ word
- Line 327: Specification for sea ice thickness.
- Paragraph beginning at Line 340: We removed sentence on sea ice thickness which is now stated earlier. We provide more detail on the tuning procedure, and reference additional sensitivity experiments on model parameters presented in the Appendix, which shows a heightened sensitivity to the cloud parameters. We also reference a table in the Appendix of all model parameters referenced in the text.
- Changes to Table 1 to include the prescribed sea ice thickness ( $d_{si}$ )
- Paragraph beginning at Line 426: We clarify the simulated atmospheric heat transport by NorESM2 is in keeping with estimates based on atmospheric reanalysis.
- Paragraph beginning at Line 535: We discuss more the limitations of ZEMBA regarding the simulated snow cover over land.
- Paragraph beginning at Line 585: We include an additional reference to a study (Kukla et al., 2023) involving an EBM with a hydrological cycle.
- Inclusion of Appendix A beginning at Line 685: We presents some additional sensitivity experiments of ZEMBA. Appendix A1 demonstrates the sensitivity of ZEMBA to the prescribed cloud cover for simulation of the pre-industrial. It includes new Figure A1. Appendix A2 presents the sensitivity of ZEMBA to key model parameters in ZEMBA and includes new Figure A2.
- Inclusion of Appendix B beginning at Line 752: We presents a long table of all model parameter referenced in the manuscript, including their symbols, definitions and units.
- Line 878: New reference to Kukla et al. (2023)
- Line 957: New reference to Trenberth and Fasullo (2017)