



Supplement of

Lessons for multi-model ensemble design drawn from emulator experiments: application to a large ensemble for 2100 sea level contributions of the Greenland ice sheet

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Supplementary Material S1 Complementary analysis for Sect. 3.2

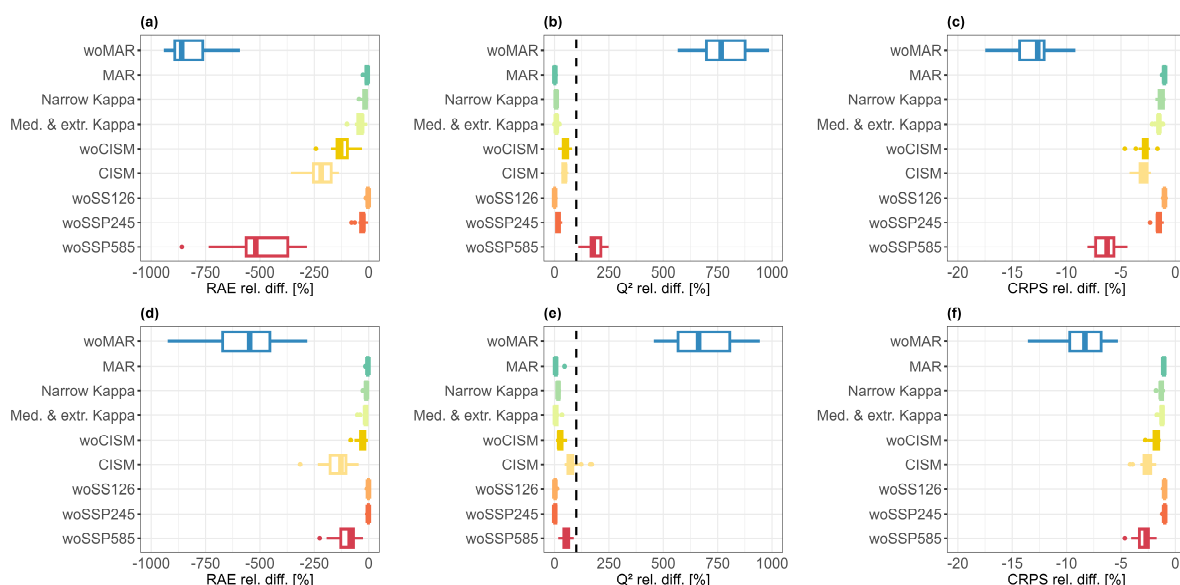


Figure S1: Relative difference (in %) of the performance criteria considering GSAT values between 2.14°C and 3.34°C (top) and GSAT change values between 3.34 °C and 3.83°C (bottom) for RAE (a, d), Q^2 (b, e), and $CRPS$ (c, f).

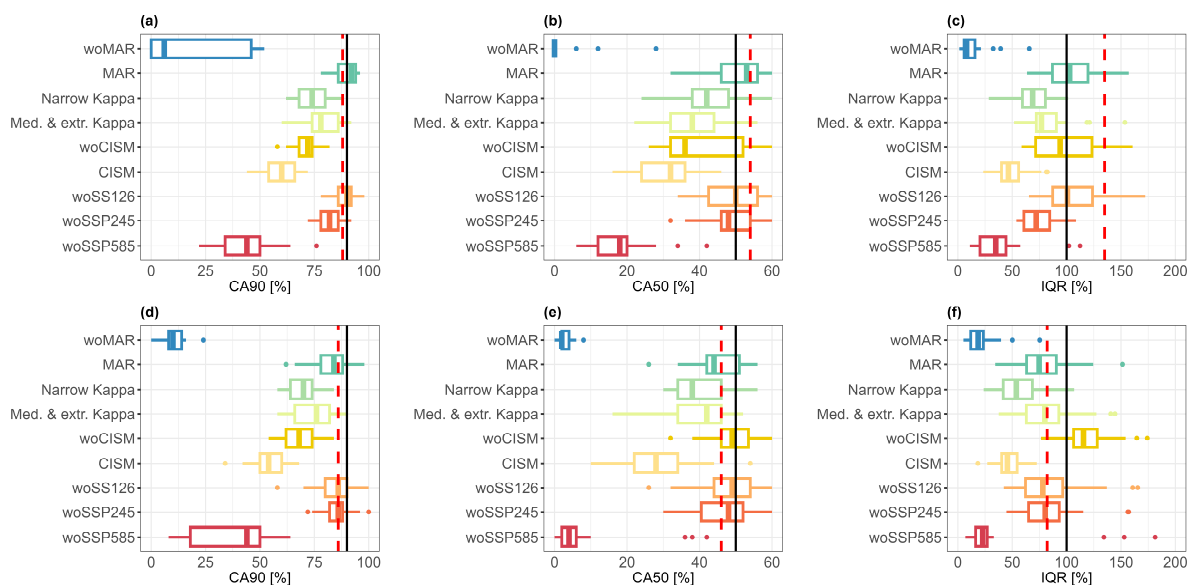


Figure S2: Evolution of the performance criteria considering GSAT values between 2.14°C and 3.34°C (top) and GSAT change values between 3.34 °C and 3.83°C (bottom) for CA at level 90% (a, d), CA at level 50% (b, e), and IQR (c, f). The red dashed line indicates the median value of the RF reference solution. The black line indicates the threshold against which the performance criterion should be compared.

Supplementary Material S2 Analysis of the probability distributions

We complement the analysis of Fig. 10 with the qualitative inspection of the cumulative distribution functions (CDF). Figures S3 and S4 provide a series of different CDFs (in red); each of them is a realisation of the random procedure described in Appendix B to propagate the emulator uncertainty. The variability between the CDFs reflects the impact of this type of uncertainty. Fig. S5 gives a zoom for the emulator experiment ‘woMAR’ for the GSAT scenario of 4°C. Overall the emulator uncertainty is of moderate magnitude.

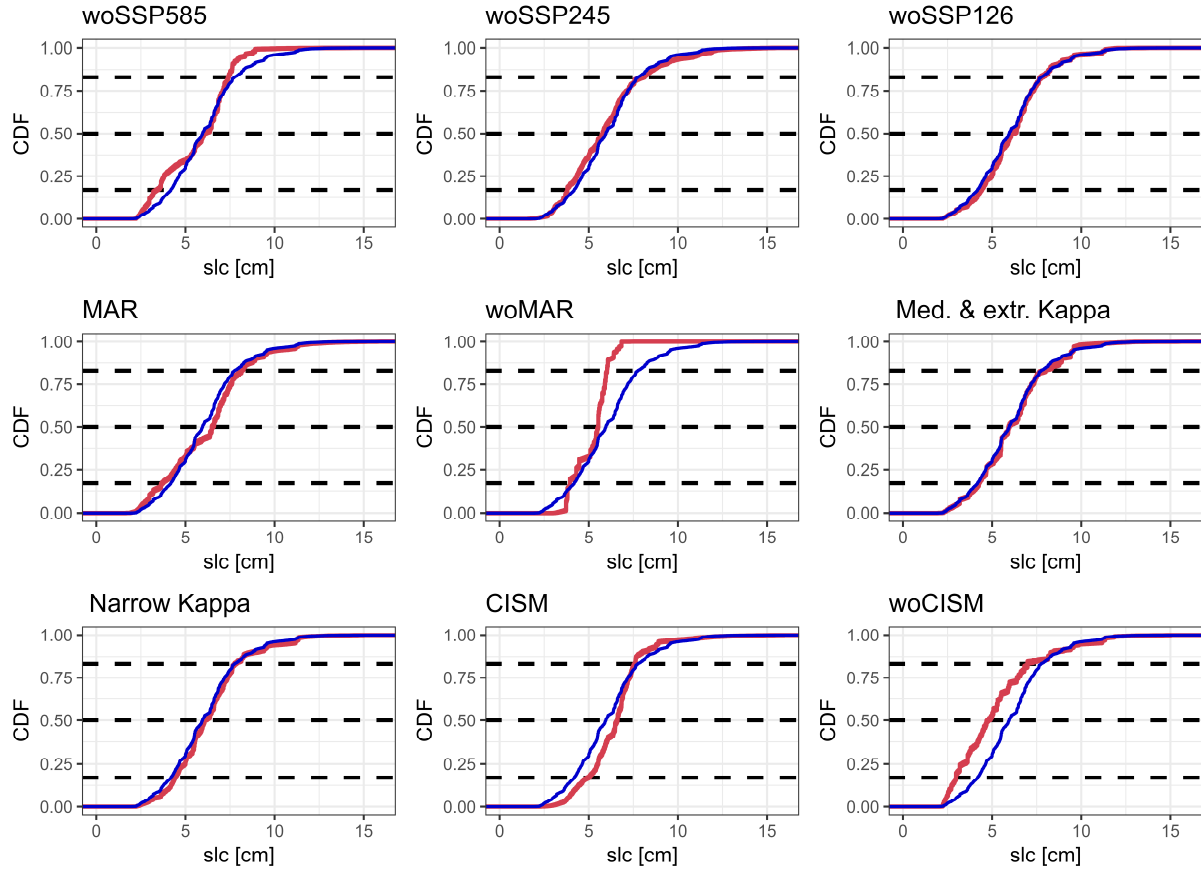


Figure S3: CDFs resulting from the uncertainty propagation procedure described in Appendix B considering the GSAT change scenarios at 2°C (+/-0.5°C) using the unperturbed RF emulator (in blue) and using RF emulators trained by applying the experiment described in Table 2 (in red). The horizontal dashed lines indicate the levels of quantiles analysed in Sect. 3.2.

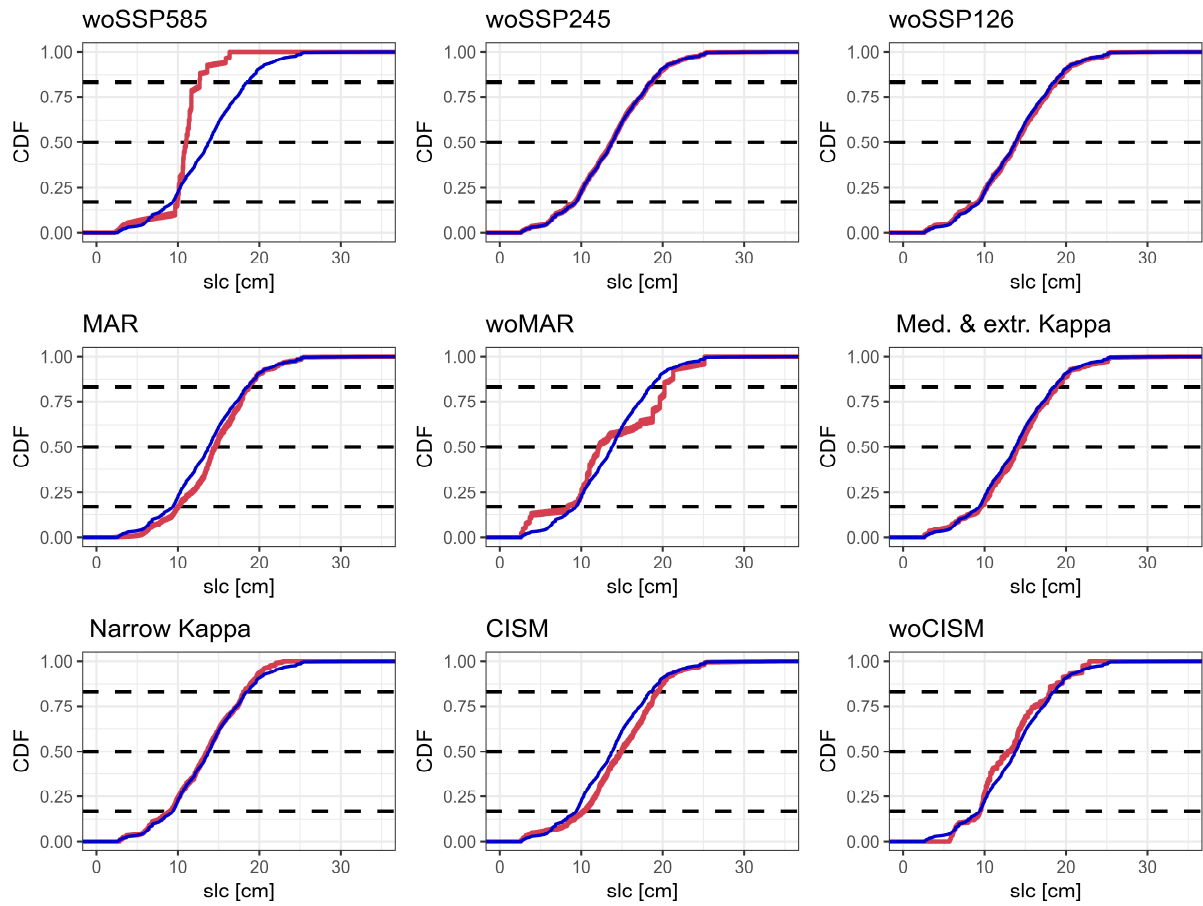


Figure S4: CDFs resulting from the uncertainty propagation procedure described in Appendix B considering the GSAT change scenarios at 4°C (+/-0.5°C) using the unperturbed RF emulator (in blue) and using RF emulators trained by applying the experiment described in Table 2 (in red). The horizontal dashed lines indicate the levels of quantiles analysed in Sect. 3.2.

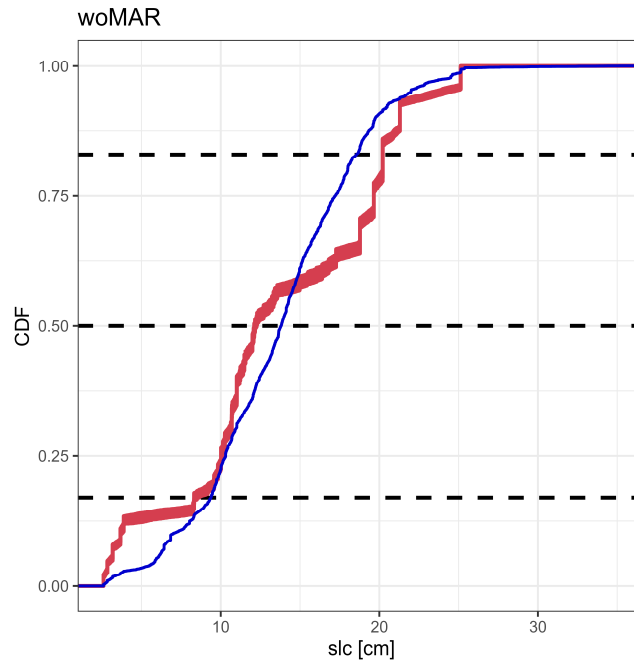


Figure S5: CDFs for the emulator experiment 'woMAR' for the GSAT scenario of 4°C. The set of red CDFs are the realisations of the uncertainty propagation procedure described in Appendix B.

Supplementary Material S3 Analysing the linearity of the κ - s/c relationship

We analyse the partial dependence plot PDP of the RF emulator (Fig. S8), which models the relationship between the input variable (here κ) of interest and the response (here s/c) while accounting for the average effect of the other input variables (see Friedman (2001) for technical details). The high Pearson correlation derived from the PDP >90% confirms the evidence of quasi-linear behaviour.

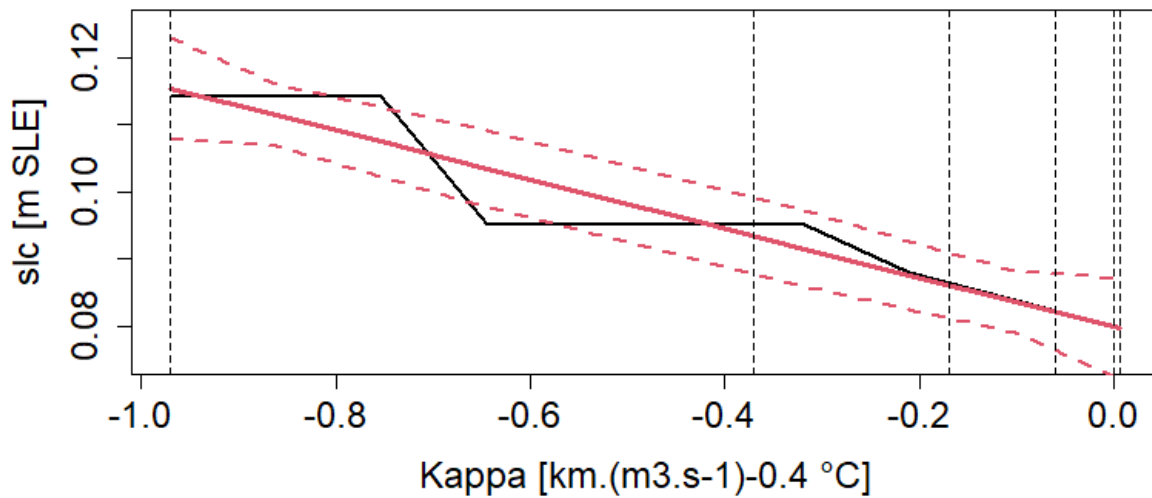


Figure S6: Partial Dependence Plot derived from the trained RF emulator (black) for modelling the κ - s/c relationship. The red line indicates the linear model fitted to the PDP together with the confidence envelope at 95% (dashed line). The vertical black dashed lines indicate the κ values available in the MME.

Reference

Friedman, J. H.: Greedy function approximation: A gradient boosting machine, Annals of statistics, 29(5), 1189-1232, doi:10.1214/aos/1013203451, 2001.