# Comment on the revised manuscript 'Exploration of Antarctic Ice Sheet 100-year contribution to sea level rise and associated model uncertainties using the ISSM framework'

**by Schlegel et al.**

Thank you for your thorough revision of the manuscript and addressing most comments from both reviews! However, I think that the major comment raised about the UQ methodology has not been addressed fully:

I agree with you, that climatological uncertainties are more complex than error maps because of the strong spatial correlation and the large spread and I appreciate that you added discussion on this to the manuscript. However, I think an important point is missing. The spatial correlation of the variables sampled makes the use of the UQ method as presented in the manuscript questionable, since the UQ method is based on the assumptions that the variables can be sampled independently (here 'variable' relates to one of the four physical variables, i.e., basal melting, surface accumulation, ice viscosity, basal friction, sampled in one of the partitions). This assumption that the variables are independent of each other is certainly not true for climatological uncertainties in two ways: 1) the physical variables are spatially correlated, i.e., if atmospheric warming causes surface accumulation increases in the Bellingshausen Sea, surface accumulation will likely also increase in the Amundsen Sea region; and 2) the physical variables are not independent from each other, i.e., their changes will be some kind of monotonic function of mean global temperature changes. Hence, applying the UQ method as presented in the manuscript is methodologically questionable. I think that it would be better to re-design the experiments (see below) or at least to test and discuss the effects of this (also for the IB experiments).

Testing: I understand that changing the partitions is difficult since IB are chosen on a partition-level (see response on page C12). However, testing the combination of the low and high surface elevation partitions for the IBs should be possible in the IBMeltOnly experiment: in this case, only melt rates are sampled and these bounds are assumed to be similar in the coastal and the

adjacent upstream partitions, as explained on page 24, line 14-15. If I understood this correctly, this would provide a simple case to test and discuss the effect of violating the basic assumption of the UQ method about independent variables. For other experiments, the bounds of to-be-joined partitions could be combined so that the variables are sampled in the same manner within both partitions but still within the original bounds, e.g., the physical variable is perturbed in both partitions by the value at $x\%$ of the interval between the lower and upper bound of the corresponding partition.

Testing this is especially important, since, as you point out in your response (page C12): 'We would like to point out that the distributions shown do already include realizations where changes in proximal regions correlate with each other. They just also happen to include a number of samples where these partitions do not correlate, as well.' I agree with you, that these realizations are already included in the results, however, by including these 'neutral outcomes' (where partitions are uncorrelated), your resulting probability density functions could be strongly biased.

Experimental redesign: A better way to apply the UQ method could be on the basis of 'error maps'. The experiments are designed as continent-wide forcings with climate warming scenarios, e.g. based on the different RCP scenarios, and by using the UQ methodology to analyse the effect of uncertainties imposed on these forcings. In this case, I think that it would be more plausible to assume that the uncertainties can be sampled like 'error maps' and are independent from each other.

Further issues:

- p1, line 6: Large uncertainties come also from the future GHG emission pathway taken by societies.
- p1, line 9: 'model simulations' rather than projections.
- page 6, line 7 and page 15, line 15-17: This is surprising, since the sampling method used (i.e. LHS or another method) should theoretically not influence the results, as it is only a technique to reduce the number of samples required to obtain a reliable uncertainty distribution. You state that you tested a larger number of samples - did you find convergence of the resulting PDFs for increasing the sample size? Or could this be related to the fact that you use a rather small number of samples for the large number of variables tested (e.g. 108 variables in the case of 4 physical variables and 27 partitions)?
- At the same time, it is interesting that you find the distribution of the variables sampled to have no affect on your results. Do you have an idea how this could be explained?
- Please add to the discussion the point raised above: "The UQ methodology is based on the assumption that the physical variables can be sampled independently from each other and in-between the partitions. This is in contrast to the fact that climatological

uncertainties, as tested here, are spatially correlated. In consequence, the distributions of SLE contribution obtained here could be strongly biased and, for example, significantly underestimate the spread in uncertainties."

- page 10, line 30: This seems to be a misunderstanding, since I did wonder if also the other RCP scenarios $(2.6, 4.5)$ are included?