Dear Editor and Anonymous Referee #2,

We are pleased that our response to the first round of revisions was sufficient for most of the comments, and that you are considering accepting our manuscript for publication after minor revisions.

Below, we quote from the Referee's report (marked by **R**) and we provide our corresponding answers (**A**).

R: The authors have addressed most of my previous comments satisfactorily, especially regarding the methodological explanation, section structure, and additional visualization of quantile biases. However, I still find the response to the comment on spatial gradients and spatial integrity insufficient (Comment 5). I understand that there is no true gridded observational MDA8 field, and that using an interpolated observation field as the reference may be misleading. Nevertheless, since a key claim of PIQB is that it better preserves model-resolved spatial structures while incorporating station-based bias information, this point should be supported by some quantitative evidence rather than only visual inspection. I suggest adding at least one simple diagnostic that does not require a gridded observational truth, such as the preservation of model spatial anomalies. This would help demonstrate more objectively whether PIQB preserves high-resolution spatial variability better than Obs. IDW and avoids the large-scale artifacts of Adjoint PDFs.Apart from this remaining issue, I consider the other comments to have been adequately addressed.

A: We are pleased to read that you are satisfied with most of our answers to your previous comments. We understand the issues of purely qualitative discussions, and we agree to provide some quantitative results. As opposed to other quantitative plots in the manuscript, the newly generated figure (Fig. 9 in section 3.3.2) does not compare the performance of individual strategies in terms of accuracy, but rather their ability to preserve modeled spatial anomalies. It displays the Pearson correlation coefficient for the original simulation and each strategy of the spatial distributions of MDA8 fields in quantiles 5, 50 and 95 (consistently with Fig. A2 and Fig. A3). As Pearson correlation is already de facto calculated from anomalies from the mean values, we decided to address the large-scale variability as well by including the correlation of anomalies from its first-guess estimate represented by a simple regression model. While the correlations corresponding to Adjoint PDFs are almost perfect (the spatial variability did not change at all), the interpolating strategies show lower values due to incorporating station spatial variability. The lowest correlations correspond to Obs. IDW as it does not consider the fine model structures at all, and both PIQB IDW and PIQB gauss represent a compromise of the other two strategies. The correlations of

anomalies with respect to the regression models mostly show (especially for quantiles 50 and 95) how the mismatch of large-scale variabilities seen by the models and by the stations penalizes the overall spatial integrity. Therefore, these results support our claims in the unchanged text that PIQB preserves regional spatial variability (as opposed to Obs. IDW) while correcting the large-scale spatial variability (i.e., using interpolation from stations). Other than the new figure, we added two paragraphs at the end of section 3.3.2 addressing the new results and one more paragraph at the end of section 2.5 explaining the principle of the regression model and the role of Pearson correlation in addressing the preservation of spatial variability.

We sincerely hope to have addressed your comment satisfactorily enough and we are looking forward to hearing your response.

Kind regards,

Jan Peiker & the co-authors