Response to Reviewer #3 (Reviewer's original text is in blue italics and author response is in black.)

Review of "The Module and Integrated Data Assimilation System at Environment and Climate Change Canada (MIDAS v3.9.1) by M. Buehner et al.

We thank the reviewer for their careful reading and for providing helpful comments that led to an improved manuscript.

Page 1: Is there a reference for this algorithm?

This comment refers to the text "(specifically, version 2.0c of the limited memory quasi-Newton solver of Gilbert and Lemaréchal 1989 modified to work with data distributed over MPI tasks)" which already includes a reference (Gilbert and Lemarechal 1989) for the quasi-Newton solver that is used. An additional reference in the form of a footnote is now also included to provide the website where the original software and documentation is available. The modifications made for MPI data distribution are relatively trivial by modifying the length of all arrays that are in control vector space such that they contain only a subset of local data for each MPI task and adding *mpi_allReduce* calls for all summation and inner products of these distributed arrays so that the results are still global.

Page 9: Please specify large.

It is now specified that 256 ensemble members are used in the ECCC system.

Page 14: I would like to learn more how you store weights on the reduced grid.

I think the reviewers question is already answered later in the same section by the text: "Therefore, to ensure that the computational load is distributed relatively evenly across all MPI tasks, the weight calculations are assigned to MPI tasks using a round-robin approach. Once all of the coarse-grid weights are computed, the values for each grid point are communicated to one or more MPI tasks where they are needed to perform bilinear interpolation to obtain the full resolution weight fields distributed with respect to the latitude-longitude tiles. The resulting full-resolution weights can then be applied to the background ensemble perturbations (that are already distributed with respect to the latitude-longitude tiles) to obtain the analysis ensemble."

Page 14: At what resolution and on how many cores?

The requested information is now included in the text: 25km resolution and 2352 cores.

Page 15: Would it be possible to make a figure supporting this paragraph? Actually the next two paragraphs each can benefit from a figure.

A new figure is now included that shows the process of splitting and recombining the observation files, respectively, just before and after the execution of the MIDAS program. Another new figure shows an example of how the spectral space control vector used for global variational data assimilation applications is distributed over the two MPI dimensions.

Page 16: How coarse?

The LETKF weights in the current operational global system with 25km model resolution are computed every 9th grid point in both horizontal directions. Therefore, the weights are horizontally spaced by approximately 225km. This information is added to the text.

Page 16: What is your strategy of getting the relevant observations to this MPI task? it seems like the two grid and the obs are not collocated

Only a limited amount of information in observation space is required for the LETKF weight calculation, mainly the background ensemble values in observation space and the horizontal/vertical location of each observation. Once computed, these quantities are communicated to all MPI tasks, as now described in the text. This facilitates the calculation of the LETKF weights on any MPI task without the need for any additional communication.

Page 21: There is a lot of technical detail here that is not immediately obvious. Any chance you could add a reference? Alternatively, consider providing less information that might require a reference.

References are now provided in the text: “More details about the sea-ice analysis system are available in Caya et al., (2010), Buehner et al., (2012 and 2016).”

Page 22: Specifically, I would appreciate a reference to this method.

More information on the approach for estimating analysis error variances is given in Buehner et al. (2016): “Assimilation of SSMIS and ASCAT data and the replacement of highly uncertain estimates in the Environment Canada Regional Ice Prediction System.” Q. J. Roy. Meteor. Soc., 142: 562-573. https://doi.org/10.1002/qj.2408