## Responses to comments from referee #2

Review on “Assimilation of satellite swaths versus daily means of sea ice concentration in a regional coupled ocean-sea ice model”, by Marina Durán Moro, Ann Kristin Sperrevik, Thomas Lavergne, Laurent Bertino, Yvonne Gusdal, Silje Christine Iversen, and Jozef Rusin, submitted for publication in The Cryosphere.

**General comments :**

The paper presents experiments where sea ice concentration observations (retrievals) are assimilated in a coupled ice-ocean model. The assimilation follows the method of the Ensemble Kalman Filter (EnKF). The goal of the study is to measure the impact of assimilating individual satellite observation swaths as opposed to assimilating daily average sea ice concentration derived from the same data set. The paper is very well written.

Three runs are performed. The first is a control run without data assimilation (or free run), the second run assimilates daily average sea ice concentration every 2 days (SYN), and the third run assimilates the sea ice concentration retrievals from satellite observation swath (ASYN).

*Response: We appreciate the comments and suggestions the reviewer provides on this manuscript. We address each of these comments and present answers and a description of the changes realized in the manuscript below.*

One concern I have is the use of the mean error of the ensemble members instead of the error of the ensemble mean. I am wondering about this choice, since the ensemble spread should correspond to the error of the ensemble mean, and not to the mean error of the ensemble members. Please comment.

*Response: We agree that the ensemble spread should estimate the error of the mean instead of the mean error of the ensemble members. We therefore have updated the RMSE equation in Section 2.4 defined as RMSE^2 = (<X>-Y)^2 with <X> the ensemble mean and Y the observation. The computed RMSE values have been updated accordingly in the text as well as figures 10, 11 and 15. The associated reduction of the RMSE improves the agreement between the ensemble dispersion and the actual errors and puts our results in a more favorable light with a consistent lower (~4%) RMSE compared to the non-updated RMSE values.*

**Specific comments:**

Line 144: Please provide a reference for DFS, maybe Cardinali et al. (2004)

*Response: The citation of Cardinali et al (2004) has been added in Line 144.*

Line 223: What is the “K-factor” ? Is the observation-error covariance matrix diagonal ? If the observation-error variances are increased by a factor 20 (R-factor = 20), what is the based sea ice concentration observation-error variance ? Is the observation-error variance homogeneous ?

Some of these questions are answered later in the text in detail, but it could be nice to have general info upfront for the readers.

*Response:*

*The K-factor is an adaptive moderation factor which reduces the impact of observations incompatible with the background/priori. This is performed by gradually increasing the observation error as a function of the magnitude of the innovation.*

*The observation-error covariance matrix (R) is assumed to be diagonal by the EnKF-C. SIRANO observation errors present weak spatial correlations ("systematic errors" discussion in Lavergne et al, 2019), and we believe that the assumption of a diagonal R matrix is applicable.*

*The R-factor corresponds to a scaling coefficient which multiplies the observation error variances, leading to an increase of the observation impact when R-factor decreases. The R-factor multiplies the variances in the observation-error matrix R in equation (6) defined in Sakov et al. (2010) leading to scaled ensemble observation anomalies.*

*The SIRANO observation errors are high in the ice-edge area, decreasing with the distance to it as shown by Fig.3d-f in the manuscript. The observation-error variance is therefore not spatially homogeneous.*

*We have added a description of the K-factor in Line 141. In lines 226 to 228, we have extended the discussion regarding the EnKF parameters. More technical details on these parameters are presented in the EnKF-C documentation (Sakov, 2014).*

Line 333: The fact that the ensemble spread does not reduce to zero does not mean that the system is well tuned. It is a necessary but not a sufficient condition. For a well-tuned system, we would expect some overlap of the shadows of the model spread and the observations uncertainty in figure 6.

*Response: We agree that the ensemble is not well tuned and rather use the expression "not collapsing". We suggest further improvements of the ensemble in the conclusions (Section 6), including an objective measure of the ensemble spread with the RCRV (Reduced Centered Random Gaussian) introduced by Candille et al (2015).*

**Technical corrections**

Line 279: "are are" typo, repetition

*Response: corrected in manuscript.*

Line 367: "with a slight larger" should be "with a slightly larger"

*Response: corrected in manuscript.*

Line 370: SSS should be replaced with salinity since that is the term used throughout.

*Response: corrected in manuscript. SSS is replaced by sea surface salinity (SSS).*

Figure 8: Replace SSS with salinity or define SSS = Sea Surface Salinity

*Response: SSS is kept in Figure 8, previously in the text (Line 370) we write "sea surface salinity (SSS)".*

***References:***

*Candille, G., Brankart, J.-M., and Brasseur, P.: Assessment of an ensemble system that assimilates Jason-1/Envisat altimeter data in a probabilistic model of the North Atlantic ocean circulation, Ocean Science, 11, 425–438, https://doi.org/10.5194/os-11-425-2015, 2015.*

*Cardinali, C., Pezzulli, S., and Andersson, E.: Influence-matrix diagnostic of a data assimilation system, Quarterly Journal of the Royal Meteorological Society, 130, 2767–2786, https://doi.org/10.1256/qj.03.205, 2004*

*Lavergne, T., Sørensen, A. M., Kern, S., Tonboe, R., Notz, D., Aaboe, S., Bell, L., Dybkjær, G., Eastwood, S., Gabarro, C., Heygster, G., Killie, M. A., Brandt Kreiner, M., Lavelle, J., Saldo, R., Sandven, S., and Pedersen, L. T.: Version 2 of the EUMETSAT OSI SAF and ESA CCI sea-ice concentration climate data records, The Cryosphere, 13, 49–78, https://doi.org/10.5194/tc-13-49-2019, 2019*

*Sakov Pavel, Geir Evensen & Laurent Bertino (2010) Asynchronous data assimilation with the EnKF, Tellus A: Dynamic Meteorology and Oceanography, 62:1, 24-29, DOI: 10.1111/j.1600-0870.2009.00417.x*

*Sakov, P.: EnKF-C user guide, https://doi.org/10.48550/ARXIV.1410.1233, 2014*