This article assesses the impact of the sea surface height (SSH) observation for the global ocean data assimilation system. The observation system simulation estimations (OSSEs) are performed and compared the impact of constellation of two wide-swath altimeters and twelve nadir altimeters to the current operating three nadir altimeters. Nature run for the OSSEs is obtained from the results without assimilation based on the latest operational model configurations, while the OSSEs uses the previous version of the model settings. The OSSEs show that the error reduction of SSH in the 2Swaths experiment is larger than other experiments. The impacts are also evaluated through the error reduction of the temperature and salinity profiles and surface velocity. The satellite constellation proposed in this study will be a next generation for the altimetry mission. Thus, the OSSEs have significant role on the decision of the future mission. The article almost satisfies the quality for publication, but there are several issues and concerns which should be improved. The detail is described below.

Major comments

Please specify the background SSH variance from Nature Run in the Fig. 6. It can be a lead time of the SSH forecast. For example, if the background SSH variance is about 20 cm^2, the lead time is about 6 days (5days) in the 2Swaths (12Nadirs) experiment. Firstly, I expected that the large error reduction in the western boundary regions led to the more improvement of the separation distance (Figure. 16 B and C). However, the results show that the improvement is greater in the low latitudes not in the western boundary regions. Is it related to lead time for the OSSEs?

Figure shows the SSH variance of NatRun, we also show (as in Figure 6) the 7-day forecast score in 3 different regions (with signals of different frequencies). We note that the impact of the 2 Swaths is also significant over regions of high variability such as the Gulf Stream and less significant over the Kuroshio area as mentioned in our paper.

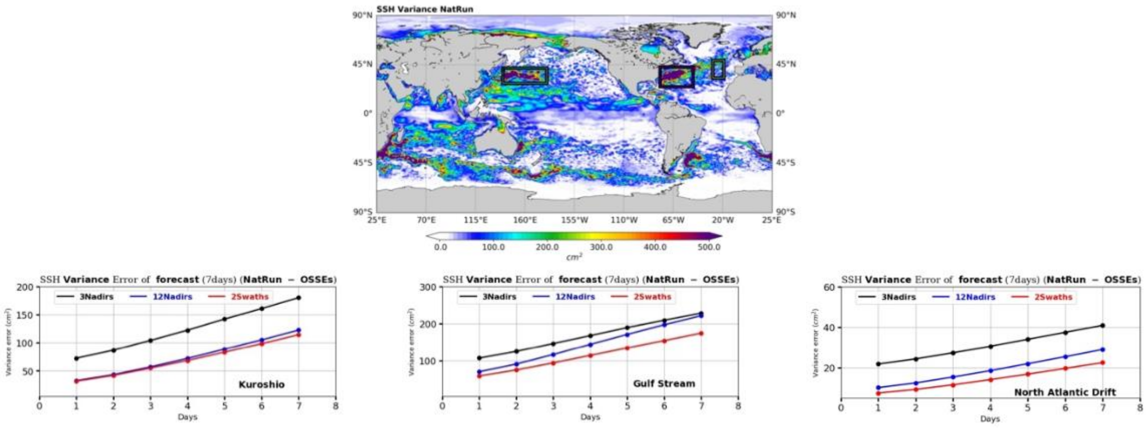


Figure 1: SSH variance (in cm2) in the NatRun over the period from February to December 2015. Variance of the error for each day of forecast (7 days, cm^2) considering the SSH in Kuroshio, Guls Stream and North Atlantic Drift areas

.

In Figure. 15, the surface velocities in the low latitudes have been improved. However, the additional SSH impact in the low latitudes is less effective compared to the middle and high latitude regions as shown in Figure 4 and 5. Why the surface velocities in the low latitudes are improved? There are two possible reasons. One is that the impact of SSH assimilation just on the low latitudes directly improves surface velocities. The other is that the SSH improvement in subtropical regions have adjusted the dynamical balance in the equator. Which is the more plausible reason?

Yes, the reduction in the error with the 2Swaths is more marked on surface velocities in low latitudes and subtropical regions for two reasons:

- Surface velocities control by SSH assimilation (your first assumption)
- with the assimilation of the 12 nadirs, the remaining error is already too small.

With respect to the surface velocity, there is another concern. Tchonang et a., 2021 shows that the OSSE with single swath data had negative impact on the zonal velocity error in the equator in their Figure 12. However, Figure 15 in this study shows the improvement of the surface velocities in the low latitude. Does it mean that the more observation data obtained from the altimeter constellation can explain the improvement?

Anyway, there seems to be no explanation and discussion about Figure 15 in the manuscript. Please also check this point.

Yes, with SWOT data assimilation (1Swath with a 21-day cycle) the impact on zonal velocities at the equator was negative. This is essentially due to the coverage of SWOT data over one analysis cycle (7 days) given that we are in a region with fast signals. With 2Swaths, however, we have good coverage and better control of these fast signals.

How many SSH data are used for assimilation? Could you describe the number of SSH observation in the manuscript with respect to Figure 1? Which has more observations in Fig.1 C or D? As described in the manuscript, there is more improvement in 2Swaths run than 12Nadirs run. It will be related with the difference in the number of SSH data and/or the spatial area available for observation (swath v.s. nadir). Which is more efficient for reducing the SSH error?

In fact, the number of observations per analysis cycle (7 days) is very high. The figure below shows the number of observations per analysis cycle, in black for the 3Nadirs, blue for the 12Nadirs and red for the 2 Wide-Swaths. There is a factor of 3.5 between the number of 2Wide-Swaths observations and the 12Nadirs.

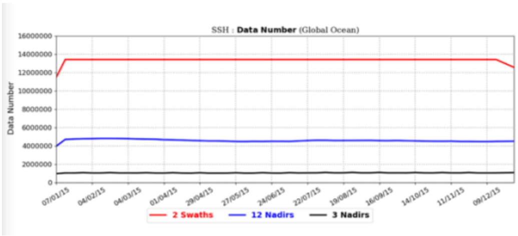


Figure 2 Observations Number by assimilation cycle (7days)

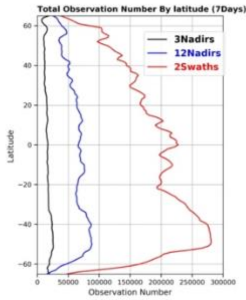
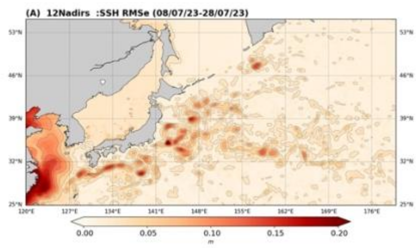


Figure 3: Observations Number by latitude during 7days

Figure 7 shows the interesting result, indicating the SSH variations in the Gulf Stream area is difficult to control by SSH assimilation comparing to the Kuroshio extension region shown in Figure 9. The SSH RMS error of the constellation experiments is almost similar to the 3Nadir experiment. What caused the comparable SSH error in early April for 2Swaths and in early July for 12Nadirs? Is it related with the position of the Gulf Stream axis?

Yes, indeed, SSH control is very difficult by assimilation over the gulf stream region because of the position of the stream and the frequency of the signals present in this area, as shown in figure 12 (wavenumber-frequency) compared to the Kuroshio area.

For figure 7, I looked in more detail at this point on the peaks on the SSH rmse (April, July and October...). I found the problem which comes from the residues of the fast signals in our NatRun (Benkiran at al. 2021). on the following figure (example over the period from 08/07 to 28/07/2015) we show the impact of these residues on the yellow sea (120°E-130°E). we have redone the same statistics by deleting this zone.



Minor comments

P2 L44: Benkiran et al., (2012) is (2021) or (2022)? update in the article

P3 L3: A random noise is set to 2 cm in the manuscript, but 3cm in the previous studies (e.g., Benkiran et al., 2021, 2011). Is this correct?

Yes, in this study we use Nadirs data in SAR mode, which is why we have them with a smaller error of 2cm.

P3 L19: The article focuses on the impact of the SSH assimilation. Therefore, it is better to describe the method of the assimilation scheme, especially for SSH variable. In Benkiran et al., (2021), SEEK filter, which is one of the sequential assimilation schemes, for the short-term variations is used for assimilation scheme. It will be easier for the readers to find out the forecast and analysis cycles. In addition, how was the mean surface height for the ocean model obtained? The mean surface height has a critical role of the SSH assimilation.

P5 L34: If the authors deal with the black box area in Figure. 7A, it is better to use "Kuroshio extension" to specify the area. update in the article

P6 L36 "Figures 15 B and C" is "Figures 16 B and C" update in the article

P8-9: Please check the order of the references. Sometimes the order should be reverse such as Vergara et al., 2019 and Ubelmann et al., 2015. update in the article

P12 Table2: The SSH variance error for wavelengths smaller than 500km in the 2Swatths experiment is 84 in Table 2. The value seems to be wrong. Sorry, typing error (8.4)

P14 & P15 Fig. 7 D and Fig. 9 D: Why does the figure start from February? update in the article

P15 Fig. 10: The title of the left figure is (A)? update in the article

P18 Fig. 16 and 17: Please add (A), (B), (C), etc in the figure title. update in the article