Improving the continuity of the Jason SSB time-series

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Background and objectives

Most of the operational versions of the Sea State Bias (SSB) correction are computed empirically with the nonparametric estimation technique based on kernel smoothing described in Gaspar et al [2002]. These solutions are derived from 10-day SSH differences (i.e. collinear analysis of repeat cycles of data or from crossover differences). Since only SSB differences are observed, the SSB solution can only be determined to within a constant when solving the equation system.

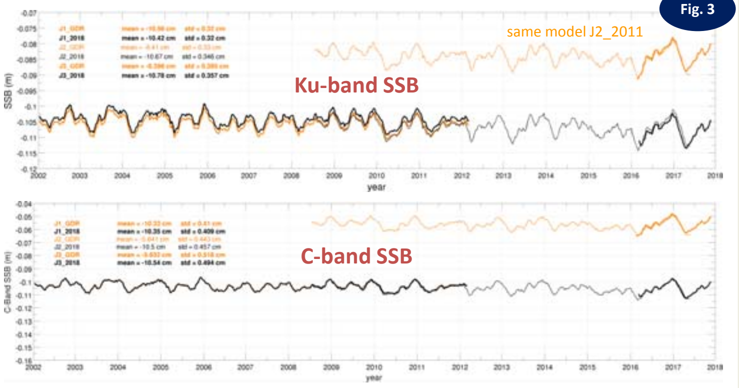
This leads to potentially observe some solution shift related to the imposed constraint to have a SSB value equal to 0 for a flat surface between two versions of the SSB correction. This (constant) shift can reach a few centimeters when the SSB correction version is updated to consider SSH standard changes due to large uncertainty in data-poor region close to (SWH=0, WS=0) to correctly constrain the estimation of SSB(0, 0).

This causes annoying disturbances every time that SSB solutions are updated for the monitoring of multi-mission altimeter biases at in-situ Cal/Val sites or for the intermission bias alignment needed to tie up the different global mean sea level time-series together.

We propose changes in SSB model development to tackle/reduce the SSB constant shift issue that exists between different correction versions for a same altimetric mission or for different missions all operating at a same radar frequency and having the same data processing. The work focused on the Jason altimeters time-series, both Ku-band MLE4 and C-band data, to better connect the past and current missions. Tests with other data have also been performed (Sentinel-3A data) along with update of the 3D SSB computation approach based on SSH differences data [Tran et al, 2016].

Jason SSB time-series

Fig. 3

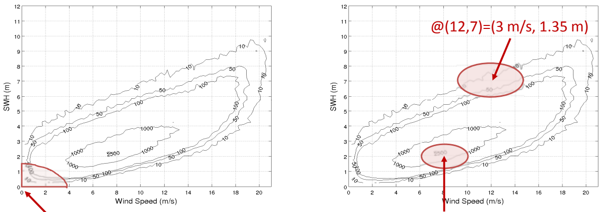


For the Jason missions (same instrument, same processing, same quality of the data), we observe very good consistencies between the 2018 versions and with the Jason-1 GDRE solutions (see **Fig. 3**). The differences in the time-series are in the mm level for both the Ku- and the C-band. Since the differences consist only in a bias, no change in term of variance reduction has been observed.

Updated approach

CLS non-parametric SSB solution consists in a 2D grid. At each grid point is associated a local kernel (ellipse) which size depends on data density and where the SSB value is determined by the resolution of an equation system based on data lying within the associated kernel (see **Fig. 1**).

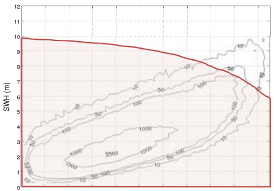
Fig. 1



@(0,0)=(3.6 m/s, 1.6 m)

@(8,2)=(2 m/s, 0.9 m)

Fig. 2



@(0,0)=(25 m/s, 11.25 m)

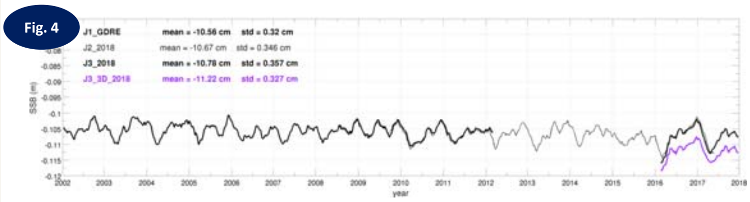
The proposed modification in the approach is to only change the kernel size at the grid point (0, 0). Instead of using the size (3.6 m/s, 1.6 m) where we have a small amount of data with not always good quality but that could also display large variability, we use a very large kernel (25 m/s, 11.25 m) that includes more than 90% of the data (see **Fig. 2**). When the SSB values at each grid point have been determined, the total grid of values is shifted to still have SSB(0, 0) = 0.

Previously, the SSB(0, 0) value depends on a small population that could change much from one dataset to another; now since we use a very large amount of data, the value at (0, 0) is more stable and is less dependent of the dataset used for the computation of the SSB solution. It depends on the processing and on the choice of the standards to compute the SSH.

The same kind of change has been performed for the 3D approach based on collinear differences data.

Jason-3 3D SSB for Ku-band data

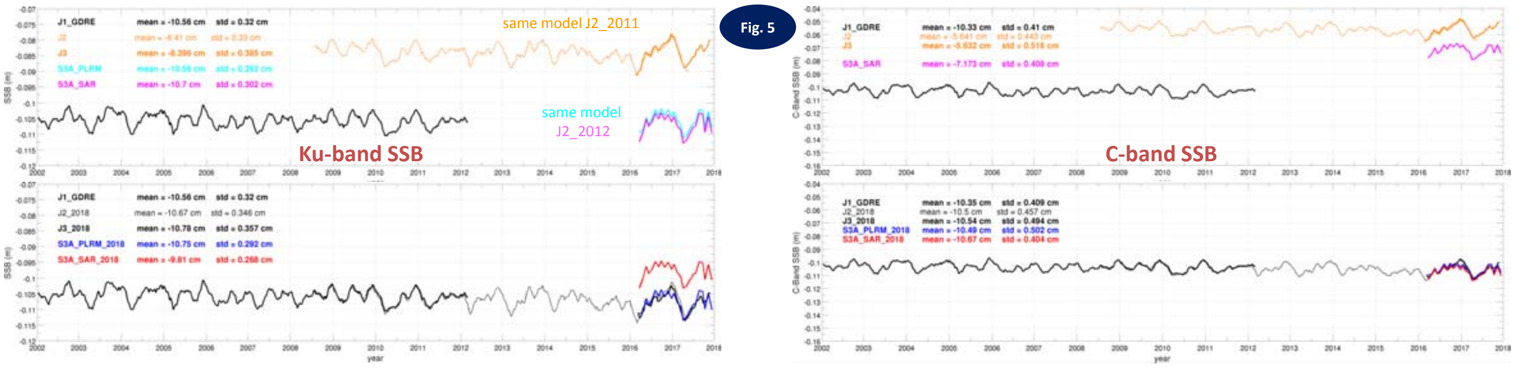
Fig. 4



As expected, the Jason-3 3D SSB is biased with respect to the 2D version. The inclusion of the mean wave period in the 3D SSB provides new insight to describe the SSB behavior which therefore do not display the same statistical characteristics (see **Fig. 4**).

Application to Sentinel-3A data

Fig. 5



In S3A GDR products, the SSB solution used is the Jason-2 2012 version. It is applied on both SAR and PLRM data (see top panels of **Fig. 5**). Adapted SSB solutions have been computed with the 2018 approach from the S3A data (both in PLRM and SARM). The PLRM SSB displays very good agreement with the Jason-3 2018 SSB as expected since the PLRM data are generated to provide continuity with historic data sets. The SAR 2018 version shows some bias shift as expected due to processing differences between SARM and LRM (bottom panels of **Fig. 5**) that change the derived range/SWH relationship [STM ESLs, 2018]. Finally, the new S3A C-band SSB are very similar to the corresponding Jason-3 2018 version since the C-band data are computed in a similar way.

Conclusion

When the processing of the altimeter data is the same for different missions in Ku-band, the associated SSB solutions computed with the 2018 version of the non-parametric approach display very good agreement at the mm level as shown by the Jason series.

References

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