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Dear Anonymous Referee,

Thank you so much for taking the time to review the manuscript and to provide comments that will clearly help improving the manuscript. Please find below our response to your comments and how we plan to integrate them in the manuscript.

Best regards,

Ulysse Lebrec, on behalf of the authors.

Digital Elevation Model (DEM) vs Bathymetry

Throughout the manuscript there seems to be alternating use of the concept of a digital elevation model/elevation and a bathymetry model/depth. Initial description in line 63 describes a DEM, but most figures and discussion thereafter refer to bathymetry/depth. This leads to thing being mixed up (e.g. Figures 4, 9 and 11) where images use depth/bathymetry and the profile charts use elevation. Sticking with just bathymetry/depth I think would help with consistency and interpretation. I would also specify the datum in each figure (MSL).

We agree that the alternating use of bathymetry/ depth and DEM can be confusing. We will use 'bathymetry/ depth' consistently in the next revision of the manuscript apart from the compilation that will remain in 'elevation' given that it includes onshore SRTM data.

The concept of Extinction depth

I think the work would benefit from a better discussion around the use of the concept of Extinction depth. Firstly, a description of what this concept physically means, and how this relates to similar concepts such as Optical Depth used by other satellite derived bathymetry methods would be helpful to the non-remote sensing reader. References around these concepts and statements (e.g line 340) should be included.

Optical depth and depth of extinction refer to the same concept: the maximum depth at which the SDB is valid. It appears that authors generating SDB using the physical approach are often using the term optical depth whereas authors using the empirical method are mostly using the term depth of extinction. Physically, this means that the change in satellite images reflectance cannot be related to the water depth beyond a certain depth. We suggest doing to following modification to the text:

The resulting averaged values were then plotted against the depth measurements from the calibration points. This reveals a linear correlation between the band ratio values and the calibration depth, up to a certain depth which is referred to as the depth of extinction. The depth of extinction (sensu IHO, 2018) corresponds to the depth beyond which changes in the satellite image reflectance can no longer reflect changes in water depths, and effectively indicates the maximum depth of validity of the method. The depth of extinction varies depending on environmental factors such as the met-ocean conditions and the turbidity of the water

Second, a bit more clarity around the target coefficient of correlation (line 344), how this is decided, and if it is the same for each image (why/why not) is needed.

The script tries to find the depth of extinction with a minimum r2 of 0.95, if it does not work, it tries again with 0.90 etc. Suggested modification:

To allow the batch processing of satellites images, the determination of the depth of extinction was automated via python scripts and the use of a threshold coefficient of correlation (Fig. 7): a linear regression was calculated using all data points; if its coefficient of correlation r2 was higher than ~~a specific threshold~~ 0.95, the regression was validated, else it was recalculated using all water depth, minus one meter. This maximum depth boundary corresponds to the theorical depth of extinction being tested (Fig. 7). The process was repeated until the target coefficient of correlation was achieved or a minimum depth of extinction of 15 m is reached. ~~Similarly, if the targeted coefficient cannot be reached, the threshold is iteratively lowered.~~ In such instance, the target coefficient of correlation was iteratively lowered by 0.05 and the process presented in Figure 7 (i.e., the iterative lowering of the theorical depth of extinction being tested) was repeated all over again and so forth until a target coefficient of correlation was validated. Ultimately each satellite image is associated to a depth of extinction and a coefficient of correlation.

Filtering images in the stack and deriving the correlation coefficient

In section 5.3.4 a process is described that essentially filters images that have outlier 'temporal effects' present (as illustrated in Figure 9). There does need to be more clarity in lines 379-383 around how a correlation coefficent threshold for each image is determined. Is there a lower threshold for an image near a river mouth with a regular sediment plume. If so, doesn't that still make that data less reliable?

The threshold was defined based on the authors judgement to find the best balance between the number of images included in the stack and their accuracy. For example, south west of Dampier all images have r2 values in excess of 0.9 whereas offshore DeGrey the highest r2 is of 0.8. This indeed suggests that the SDB generated in front of a river mouth is less reliable. The effect of a regular sediment plume is however minimised by the error model used to correct the SDB. See next comment for suggested modifications.

I think the authors also need to discuss/acknowledge how this process relates to the error correction process described in 5.3.3. As the error correction already corrects the bathymetry based on a surface error model in comparison to the calibration points, if you are then looking at a correlation model based on this corrected bathymetry, the process is at risk of becoming circular and less valid. For example, it seems that in a turbid estuary, the error model process would do its best to correct the underestimated bathy values (in a regional surface sense) back to the calibration points. Running a correlation then for image QA/QC on these already corrected outputs needs a bit more justification I think.

The coefficient of correlations used here are the ones obtained from the derivation of the initial bathymetry presented in section 5.3.2 and which are therefore calculated before the error model correction. We are not calculating any coefficient of correlation on corrected images as this would provide meaningless values and basically be, as you describe, a circular self-correlation.

We suggest doing the following modification to the text:

For each tile, a minimum coefficient of correlation between the predicted depth and the calibration points is determined and images with a coefficient below that threshold are discarded. Coefficients of correlation values used here to determine if an image should or should not be included in the stack are the values calculated during the derivation of the initial bathymetry, before the application of any types of correction, to avoid circular correlations. The threshold varies from one tile to another to reflect their respective specificity: a tile located in front of a delta, where the seabed is rapidly changing, will have overall lower coefficient of correlation values than an area with no sediment supply. In that regard it was not possible to establish a firm rule and the threshold was subsequently determined for each tile by the authors to obtain the best ratio between the number of images integrated in the stack and their respective coefficient of correlation. On average, the threshold is set at 85%. In total, 222 images from 26 tiles met their respective selection criteria.

Use of pixel based Standard Deviation layer

The inclusion of a pixel based standard deviation layer in the data product is a very useful tool, and I think should be used more in the manuscript, as it is only mentioned as an afterthought in line 418 and Section 8. Already in Figure 9(c), we can see the expected increased variance in the single image solutions as depth increases. Showing an image illustrating this based on the standard deviation layer would be very informative. Likewise, an image figure would help illustrate how a higher variance of the product would be expected in dynamic and/or turbid estuaries, helping to back up statement such as line 443.

In my opinion, this SD layer is as useful in terms of the user assessing the accuracy of the SDB product as the validation to the LADS data. To add further value to the statement on mean SD in line 419, I would suggest extracting a graph/table that shows the mean SD for pixels based on depth intervals (ie. Model depth SD for pixels 0-2m, 2-5m, 5-10m etc etc). This would be extremely helpful to the end user.

Agree, interestingly one could use the STD layer to assess bedform mobility. We suggest adding (and commenting in text) the following figure and table. Overall, the standard deviation increases:

- With depth.
- In areas with potential mobile bedforms including near river mouths and tidal channels.
- In areas with high tidal range (the standard deviation increases eastward along with the tidal range. The only exception is a tile which includes an insufficient number of images in the stack to generate meaningful metrics due to the high turbidity of the area.
- In turbid/ muddy areas.
- Potentially where major change of seabed type occurs (i.e., sea grass meadows).

It should be noted that the standard deviation is however very sensible to the number of images included in the stack. Areas where only a few images were included in the stack tend to show lower standard deviation values which does necessarily means that they are more accurate.

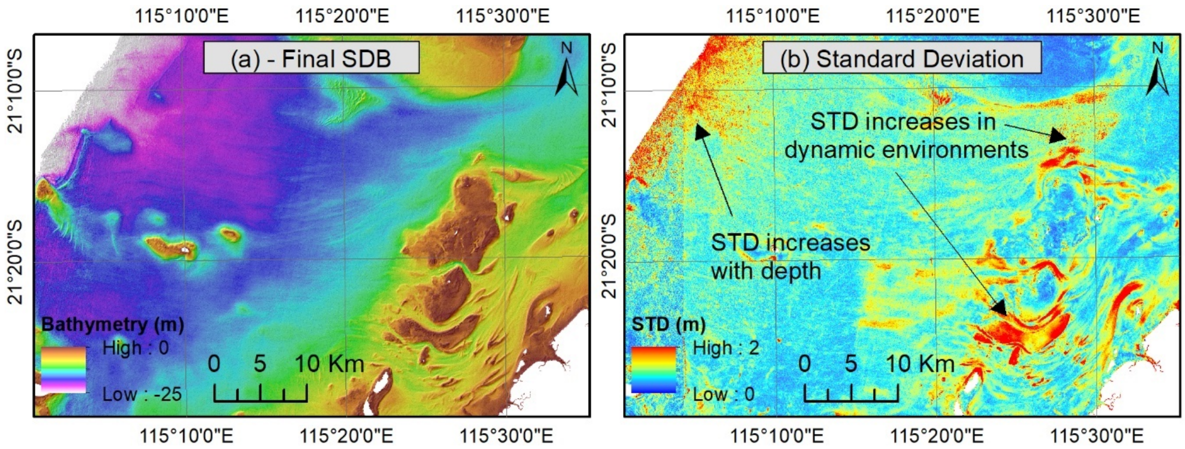

Figure 1 Illustration of the final satellite-derived bathymetry (a) and of the associated standard deviation (b), south of Barrow island. The standard deviation is calculated for each pixel using the values from all individual bathymetry grids included in the stack. The resulting grid provides an estimate of the vertical accuracy of the final bathymetry at any given points. The standard deviation increases (and hence the accuracy reduces) with increasing water depths (b) and in dynamic environments that are changing under modern oceanic conditions such as in the vicinity of tidal sand bars and channels (b).

Table 1 Mean standard deviation per depth range.

Depth range (m)	0 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30
Mean standard deviation (m)	0.90	1.04	1.11	1.23	1.18	1.53

Technical Corrections

***Line 49** – Please explain 'indirect' datasets, the meaning is not particularly clear.*

As per suggestion from Robin Beaman, we will change it to 'multi-source'

***Figure 6** – In description, it should be made clearer that the Australian Bathymetry and Topography refers to the Regional Data in panels b and c.*

Figure label was modified to AusSeabedTopo.

***Lines 288, 323 and elsewhere** – Including the band centre wavelengths for the Sentinel 2 bands described would be helpful.*

Ok.

***Lines 305 – 312** – A rewording and perhaps further explanation I think would help to explain what is meant by abnormal values and the rational for avoiding them (ie. Dry season in the North?)*

Abnormal values refer to pixel values from the input satellite images that are affected by seasonal environmental factors (e.g., water turbidity increases during wet season) and may therefore not be representative of the water depth. We will clarify this point in the text. The rational for avoiding them is explained the next paragraph.

***Line 325** – Please elaborate on what is meant by speckles (ie pixel based glint, signal/noise artefacts)*

Pixel based glint. Such filtering is recommended by the IHO cookbook. We will update sentence accordingly.

Figure 8 *– I think 'seismic' may meant to be 'satellite'*

Indeed.

Line 376 *– Perhaps 'statistical analysis' instead of 'statistics'*

Ok.

Figure 9 *– Would benefit from inclusion of the true colour image of this example to visually show the temporal artefacts concept the author is trying to highlight.*

We can add another 'row' to the figure with three insets showing three insets from true colour image illustrating each of the three points (ships, clouds, turbid water, Fig. 2).

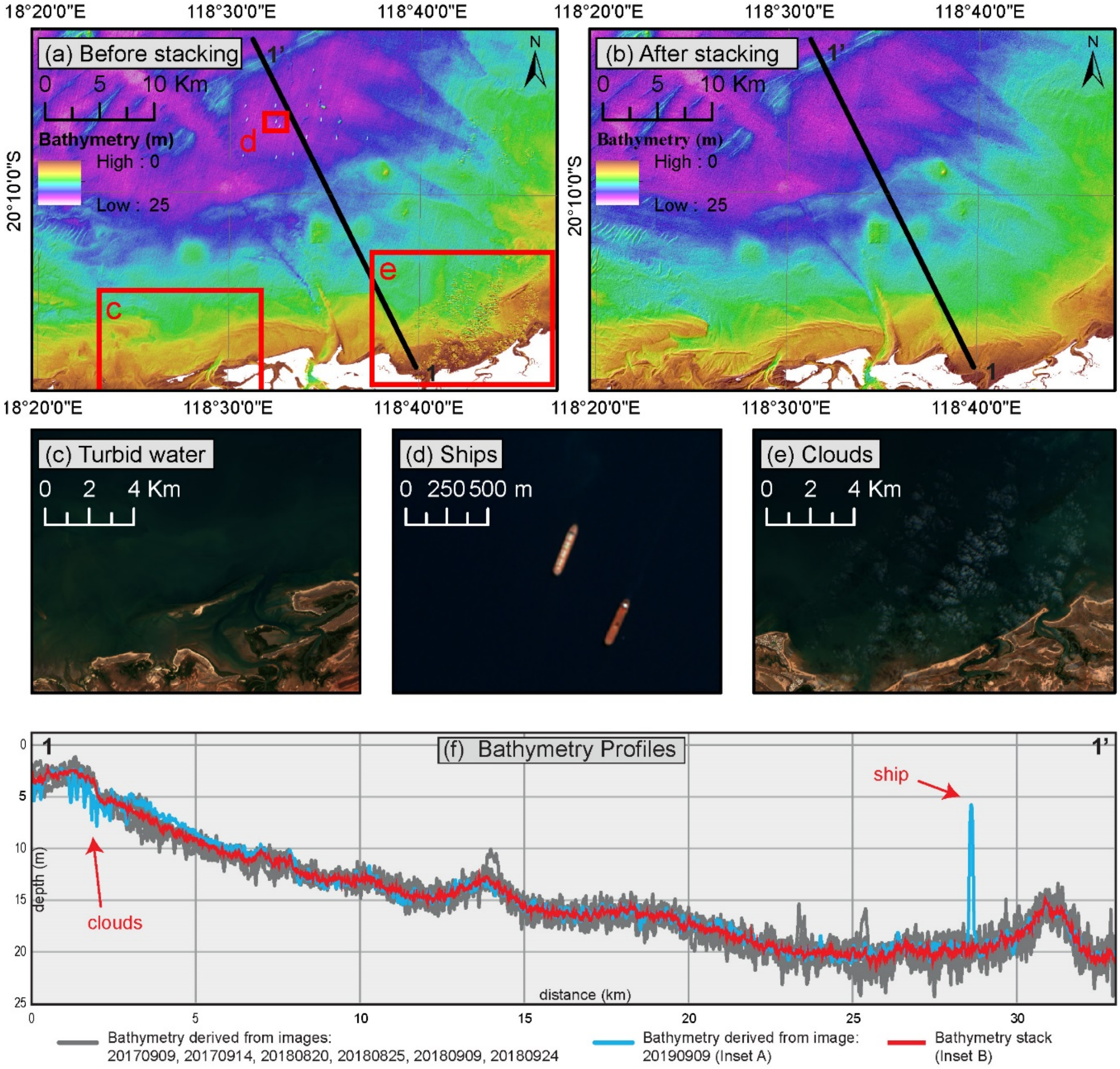

Figure 2. Updated figure

Line 433 *- use of 'constrained' rather than 'tied' perhaps*

Ok.