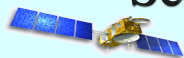


Sea state bias for retracked TOPEX-Side B altimeter data



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Objectives

- Understand details of the retracked TOPEX GDR-F dataset provided by JPL in early 2019
- Develop TOPEX 2D/3D (2/3 Dimensional) Sea State Bias (SSB) correction models for the GDR-F products at both Ku and C band
- Provide a comprehensive evaluation of the newly developed SSB models
- Recommend SSB models for applications
- Provide SSB models for community use

Data and Methods

- Datasets: there are a set of retracked GDR-F products including “mle4” and “mle3”, retracking schemes for Ku and C band TOPEX. This study focuses on mle4Ku and mle3C.
- SSB estimation method: Spline(SP) nonparametric estimator (Feng et al., 2010) using direct SSHA data (Vandemark et al., 2002)
 - Side B data: **cycles 240-481(1999-10/2005)**. The 1st 21 cycles are NOT used for SSB
 - SSHA (sea surface height anomaly) is calculated with the latest geophysical corrections, mean sea surface, etc.
 - Ensembles of single-year SSB model(s) were estimated, including SSB2d (sw, altU10) and SSB3d (sw, altU10, Tm₀₂) where Tm₀₂ is the mean wave period from a global wave model (Rascle and Ardhuin, 2013)
- SSB assessment: standard metrics and also the Jason1 (J1) SSB model as a reference baseline

Results overview

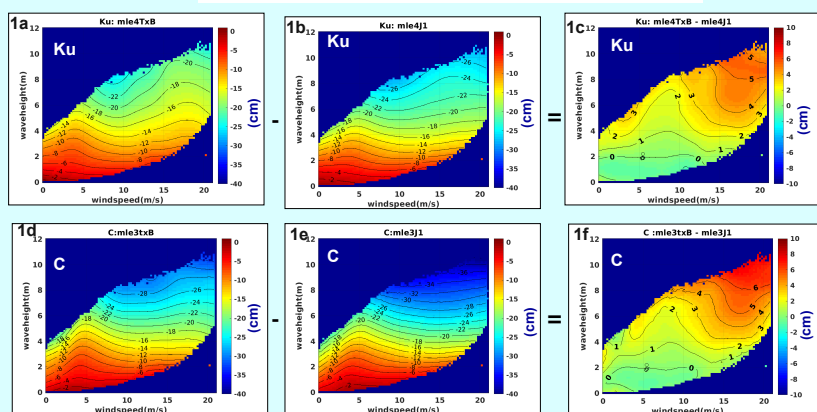
PART 1: 2D SSB model comparisons – new TOPEX_B mle4Ku and mle3C 2DSSBs are compared to the Jason1 counterparts, estimated by Linear Kernel Smoothing on collinear data (Tran et al. 2010)

PART 2: Variance reduction (new SSB3d and SSB2d) against Jason1 SSB2d

PART 3: J1/TxB assessed for the cal/val phase (J1 cycles 1-21; Tx 344-364) in terms of SSHA without SSB & SSHA with SSB corrections.

Summary

PART 1: 2D SSB model comparisons

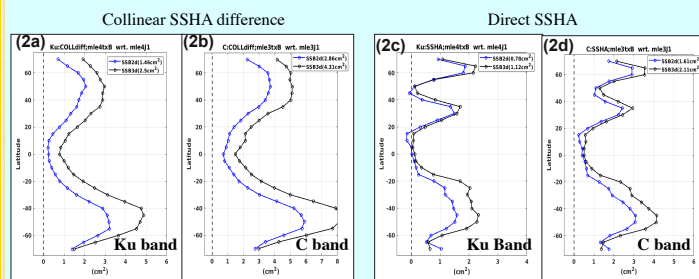


PART 1: Summary

- TxB mle4-Ku SSB2d(1a) and mle3-C SSB2d(1d) show some significant differences when compared to corresponding Jason1 models (1b) and (1e). The respective differences are given in (1c) and (1f), show:
 - difference patterns are similar for Ku- (1c) and C-band (2c)
 - in the domain of SWH>4.5 m & U10 >10m/s, the TxB SSB is lower than Jason-1
 - in the domain of SWH>4.8m & U10 in [7-10m/s], TxB SSB displays more variation

PART 2: Latitude-dependent variance reduction

TxB mle4Ku and mle3C SSB2d/SSB3d vs. corresponding J1 SSB2d



PART 2: Summary

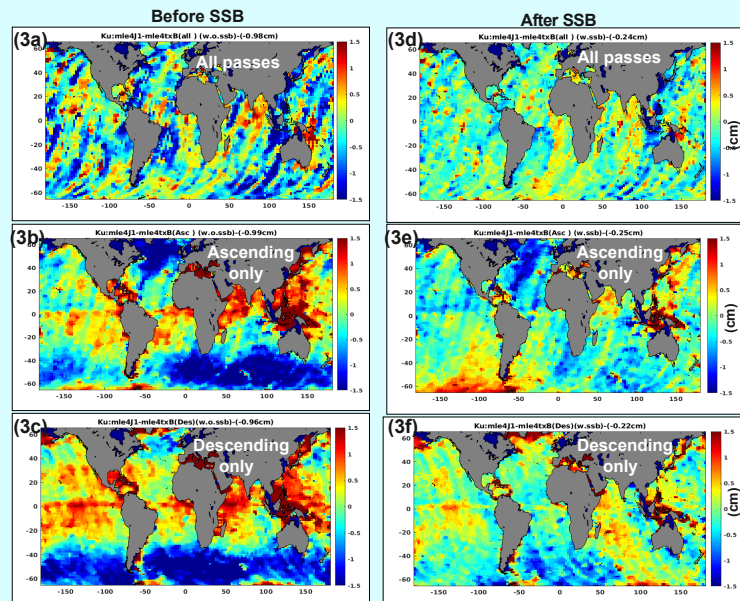
Variance reduction (cm²; positive indicates performance gain) obtained using new TxB 3DSSB and 2D SSB models with respect to the J1 2DSSB. This is for two data metrics - i) the collinear SSHA difference in (2a) and (2b) and ii) direct SSHA in (2c) and (2d) in Ku and C band, respectively. Note that this analysis is based on one-year (2001) data (cycles 306-342).

Briefly, one can see:

- at almost all cases (particularly in high latitudes, TxB SSB3d and SSB2d perform better than J1 SSB2d for these RGDR data, this for both Ku- and C-band and for both metrics.
- the performance improvement in SSB3d versus SSB2d is apparent.
- clearly one also needs new TxB SSB models to improve SSHA from these retracked data

PART 3: Tandem cal/val phase evaluation (J1: cycles 1-21; TxB: cycles 344-364)

Difference: J1 minus TxB: SSHA = ORBIT-RANGE - MSS in mle4 Ku band



PART 3: Summary

SSHA in J1 and TxB were calculated using similar geophysical corrections and mean sea surface

before the SSB (3a, 3b, 3c) is applied, sea state related differences exist between J1 SSHA and TxB SSHA, particularly for separate Ascending and Descending passes (3b, 3c). This indicates sea state bias characteristics that differ between J1 and TxB

Once the respective J1 and TxB mle4SSB is applied, differences between J1 and TxB SSHA (3d, 3e, 3f) are greatly reduced, particularly for the case of all data (3d)

For the case of the separate Ascending and Descending passes (3e, 3f) some differences remain

Summary

We have developed TxB mle4-Ku SSB2d/SSB3d and mle3-C SSB2d/SSB3d models for the newly released TxB retracked dataset

The newly developed SSB models are assessed in comparison to respective Jason-1 SSB models, used as a reference baseline with the following notes:

- the SSB characteristics in TxB and J1 clearly differ
- differences between J1 and TxB SSB2d in Ku(1c) and in C (1f), appear particularly for high sea states where the TxB SSB is lower than J1 SSB (see PART 1)
- the model performance improvement is apparent when using the SSB3d vs. SSB2d, i.e. wave model data help (see PART 2)
- in Tandem J1/TxB cal/val phase evaluations (PART 3), once the respective J1 and TxB SSB are applied, the SSHA difference between J1 and TxB (3d, 3e, 3f) is greatly reduced with little obvious sea state dependency, particularly when averaging ASC and DESC pass data (3d)

It is clear that new TxB SSB2d models will improve the SSB correction, and that new TxB SSB3d would also improve SSHA data in any future release.

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