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The Improvement of HY-2B Satellite Altimetry Range Corrections in Coastal Area

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ABSTRACT

The HY-2B satellite was launched in October 2018 as China second marine dynamic environmental satellite. It is equipped with a traditional dual-frequency altimeter, which can accurately observe marine dynamic environmental elements including sea surface height, wind field and significant wave height. In coastal areas, the precision of range corrections such as sea state bias, ionospheric delaying correction and tropospheric delaying correction provided by SGDR data have declined due to the influence of coastal "pollution" on the altimetry system. For this problem, this poster carries out a study about the improvement of the coastal altimetry range corrections for HY-2B altimeter. Based on the 20hz sea surface observation, the high-frequency sea state bias model is constructed, the deviation of the wet troposphere correction is modified by a composite method, and the noisy of the ionosphere correction is reduced by low-pass filtering. Finally, the effectiveness of the new range correction is validated by comparing and analyzing the SLA before and after improving range corrections.

INTRODUCTION

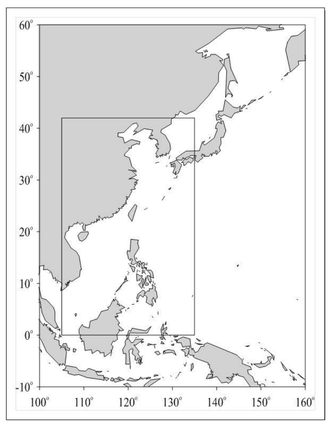
Satellite altimetry is designed for observing global sea surface. This technology directly measure the range between the altimeter and the nadir point by transmitting the pulse signal, then a series range corrections is applied to get an accurate sea surface height. The main range corrections are sea state bias correction, ionospheric path delay correction, dry and wet tropospheric path delay correction.

In coastal area, the whole altimetry system is affected by the land, the most of range corrections are needed to reprocess. For sea state bias correction, due to the high-frequency sea surface height data is used in coastal analysis, so the 1hz SSB correction provided in SGDR data is need to be replaced by the 20hz SSB correction. Ionospheric path delay correction is inversed by the difference of the range that measured by the Ku-band signal and C-band signal. Due to the measurement footprints of two band signals are not same and the changing of ionospheric delay is depended on solar activity and local hour, so more steadier correction with less noise is needed. The wet tropospheric delay is provided by the model correction or the measurement of radiometer, the radiometer provides more valid correction but polluted by the coastal land, and model correction is calculated by the ECMWF data. Therefore, the model values are taken as the succedaneum for the coastal radiometer measurements.

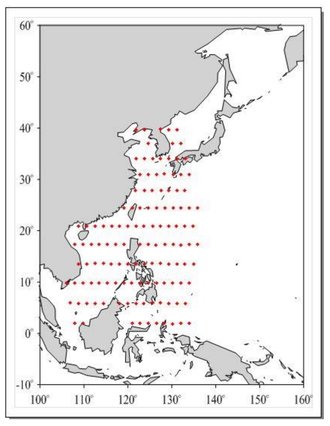
In this poster, we are interested in the reprocessing of the range corrections of HY-2B SGDR data, and the improvement to the quality of SSH data for applying the new range corrections.

OBJECTIVE

The HY-2B Sensor Geophysical Data Records (SGDR) data is used in this poster for calculating the 20hz SSB correction, filtering the ionospheric correction and handling the composite wet tropospheric correction. Besides, we record the information of the 20hz along-crossover points during each cycle of all passes within the range (Lon:105°-135°,Lat:0-42°) as the dataset for fitting the SSB model. And the validation of reprocessed data is in that range, too.



Area of study



Location map of along-crossover points

METHODS

According to the problems of range corrections, this poster takes different ways to reprocess the range corrections.

➢ SSB

The 20hz SSB correction is given by recalculating the SSB model by the dataset of crossover points based on the two-parameter SSB model. Based on analyzing the component of the SSH signal, the height difference at crossover point is used to calculate the parameters of SSB model by a linear least square sense, and choosing the model parameters that maximizes the variance explained of the crossover points.

SSH Signal

$$SSH' = H - h_a' = h_g + \eta + SSB$$
$$\Delta SSH_m' = \Delta SSB + \Delta\eta - \Delta\varepsilon_{h'}$$

SSB Model

$$SSB = \hat{\alpha}\, SWH\left(g\frac{SWH}{U_{10}^2}\right)^{\hat{d}}$$

Linearization

$$\Delta SLA = \hat{\alpha}\, X_o - \hat{\alpha}\, X_e + \varepsilon \qquad X_i = SWH_i\left(g\frac{SWH_i}{U_{10,i}^2}\right)^{\hat{d}}$$

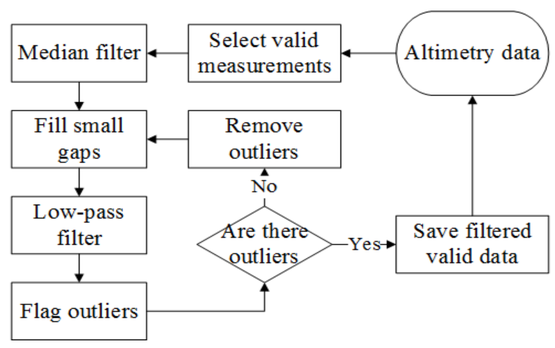
i is the crossover point

The process of SSB model build

Usually, the value of *d* is around zero.

➢ Ionospheric Delay Correction

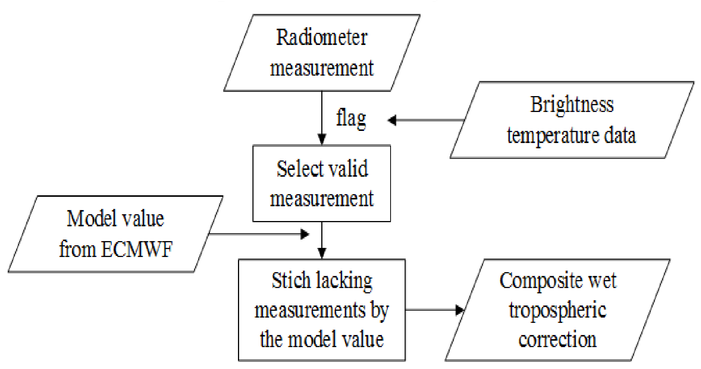
The processing of ionospheric correction is removing the outliers as much as possible, then smoothing the dual-frequency correction according to the changing features of the ionosphere by low-pass filter.



Flowchart of the dual-frequency ionospheric correction filtering scheme

➢ Wet Tropospheric Delay Correction

Due to the pollution of the coastal land, the radiometer measurement is inaccurate within a certain range. Hence, we strictly pick the valid measurement out and replace the outliers by the model values.



Flowchart of the composite wet tropospheric correction

DISCUSSION

To analyze the improvement from the whole reprocessing of range corrections, we choose some data randomly in cycle 76 to check the RMS of 1Hz SLA data before and after correcting.

Pass name	2	30	45	99	127	168	252	265	334
RMS (m) (raw correction)	0.153	0.139	0.080	0.144	0.088	0.114	0.069	0.100	0.114
RMS (m) (new correction)	0.147	0.128	0.072	0.140	0.095	0.092	0.091	0.113	0.096

Comparison of RMS from the SLA data with different correction

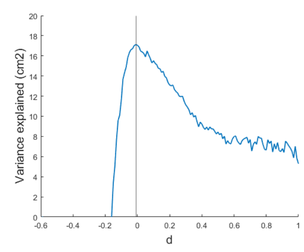
The RMS values of some SLA data are slightly bigger, such as the 127 pass, 252 pass and 265 pass, which are caused by the deviation of local SSB model. The new SSB model rebuilt in this poster is too bigger and rough for the some smaller local areas of the whole study area.

RESULTS

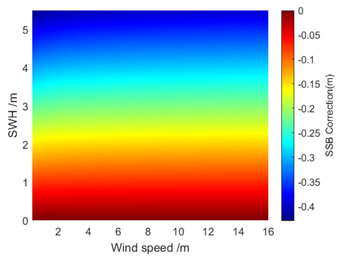
According to the above methods, the range corrections are reprocessed to reduce the noise of along-track sea surface height observation. The results are showed as the following.

• 20hz SSB correction

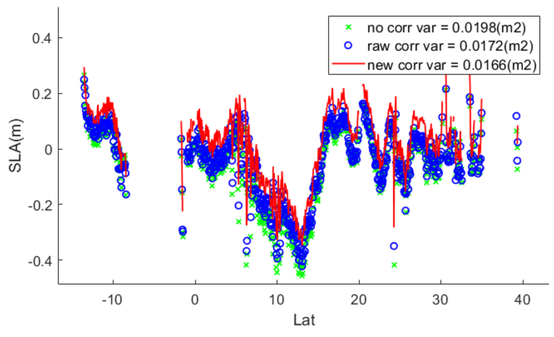
In certain range, giving one value of α for each *d*. According to the variance explained curve, choosing the best α and *d* for the crossover points dataset, then conforming the SSB model for the local area.



Different d with the variance explained



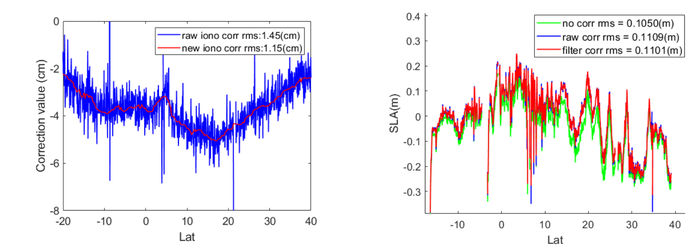
SSB Correction 2D-map



Validation of the SLA data of HY-2B 153 pass in 12th cycle

• Ionospheric filtered correction

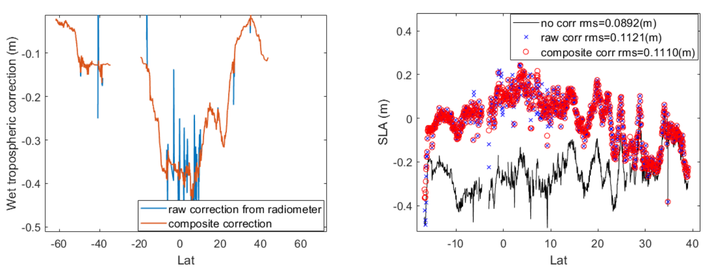
By the new editing strategy and the filters, smoothed ionospheric correction is obtained.



The results of ionospheric correction reprocessing and SLA validation of HY-2B 43 pass in 40th cycle

• Wet tropospheric composite correction

The main process of wet tropospheric correction is removing the obvious outliers and replacing by the model values.



The results of wet tropospheric correction reprocessing and SLA validation of HY-2B 43 pass in 40th cycle

CONCLUSION

By reprocessing the range corrections of HY-2B altimetry, the improvement of HY-2B range corrections reduces the noise of the along-track sea surface height data. For the filtered ionospheric correction, it is steadier than the raw correction. For the composite wet tropospheric correction, it expand the number of measurement in coastal area. For the 20hz SSB model, it supports the correcting of 20hz SSH data, however, the local difference of model should be considered adequately in different areas, which is decided by the SSH data.

REFERENCE

Birol, F. , et al. "Coastal applications from nadir altimetry: Example of the X-TRACK regional products." Advances in Space Research (2017).

Birol, F. , et al. "The X-TRACK/ALES multi-mission processing system: New advances in altimetry towards the coast." Advances in Space Research 67.6(2021).