Validation and Calibration of Nadir SWH Products from CFOSAT and HY-2B with Satellites and in-situ Observations

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Outline

1 Data Set

2 Precision

3 Accuracy

4 Conclusion

2. Data Sets

Satellite	Time period	Retracker	Orbit	Altitude	Cycle duration	Local time of descending node	Inclin-ation
CFOSAT	2019/08/01–2020/04/14	Adaptive	sun syn. *	514 km	13 d	7:00 a.m.+/−30 min	97.5°
HY-2B	2019/01/21–2020/03/20	MLE4	sun syn.*	971 km	14 d	6:00 am	99.3°
Jason-3	2019/03/31–2020/01/05	MLE4	not-sun syn. *	1336 km	9.9156 d	/	66°

Mission Orbit and Retracker Parameters

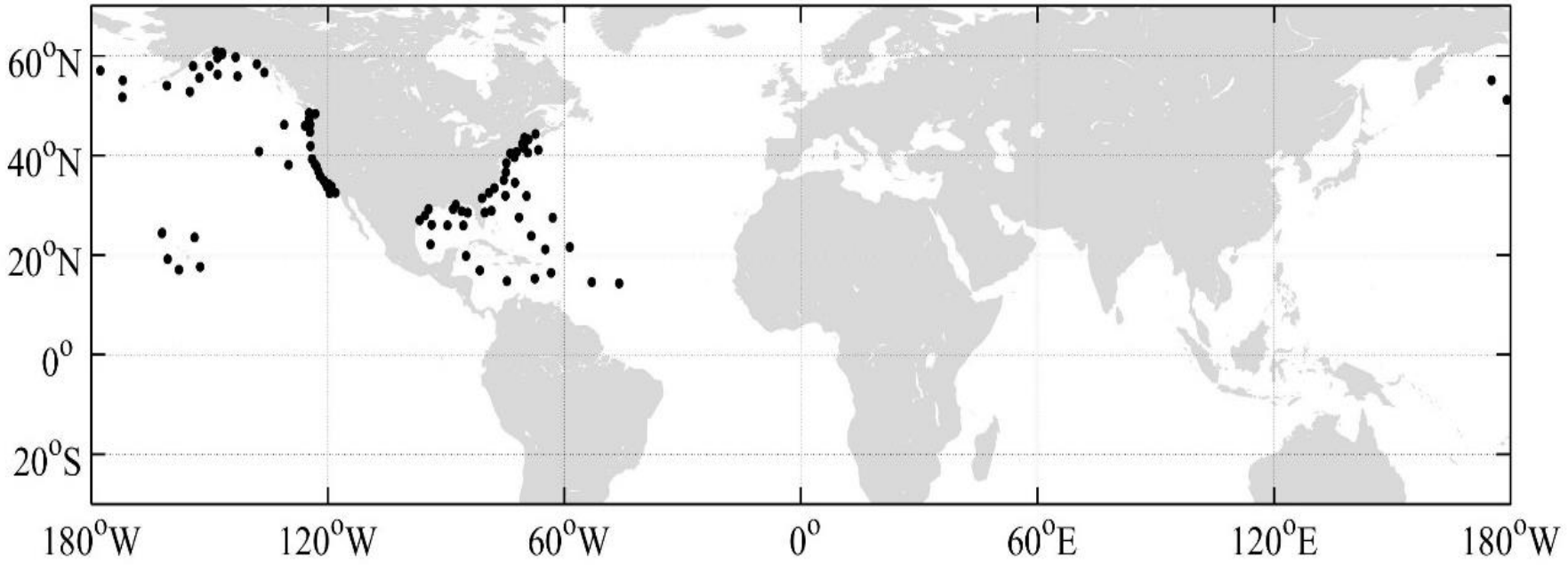
2. Data Sets

Differences between MLE4 and Adaptive Retrackers (Hauser et al., 2019).

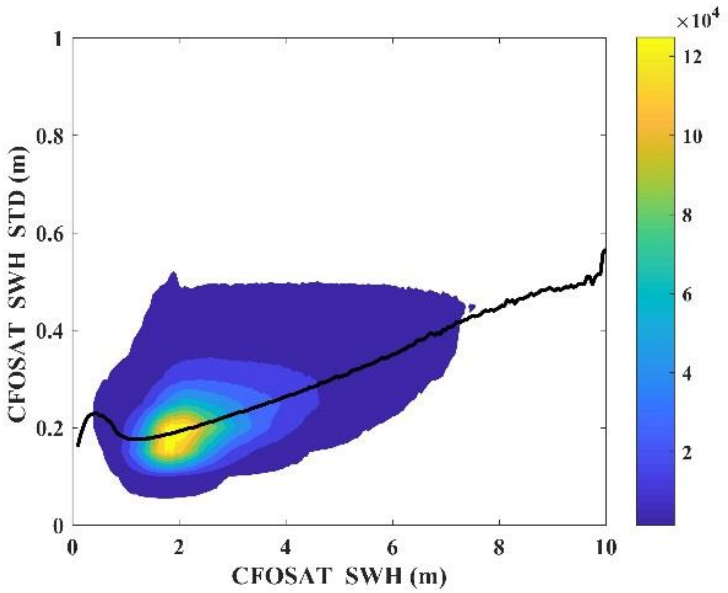
	MLE4	Adaptive
Geophysical parameters outputs	SWH, sigma0, pseudo-mispointing, epoch	SWH, sigma0, MSS
PTR	Gaussian approximation PTR; Look-Up Tables needed	Real PTR introduced numerically
Likelihood	Least-Squared	Real MLE

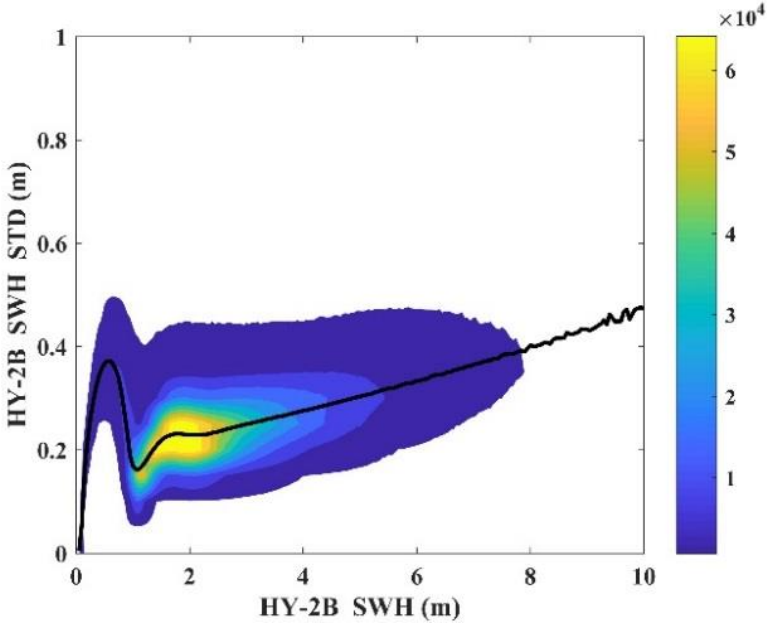
2. Data Sets

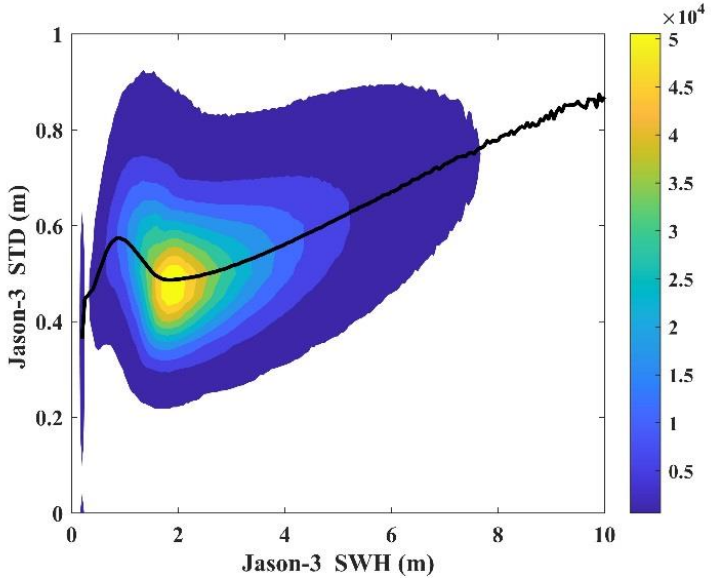
Locations of all 102 moored buoys used in this study.



3.1 Precision Analysis



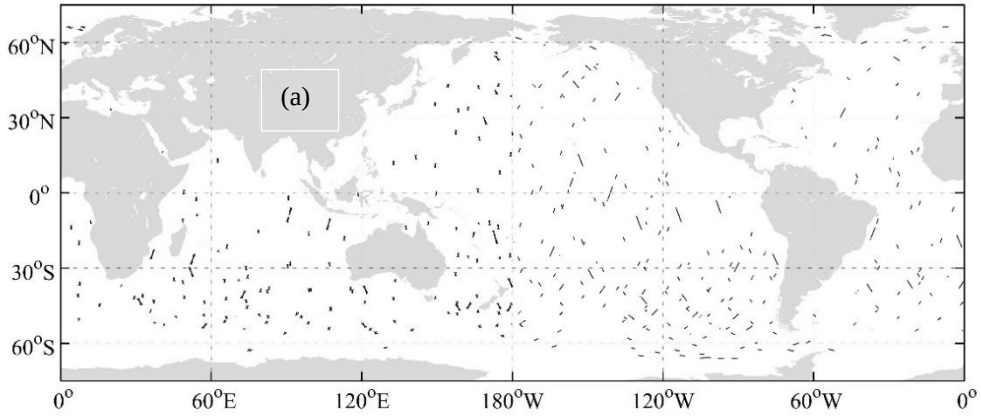


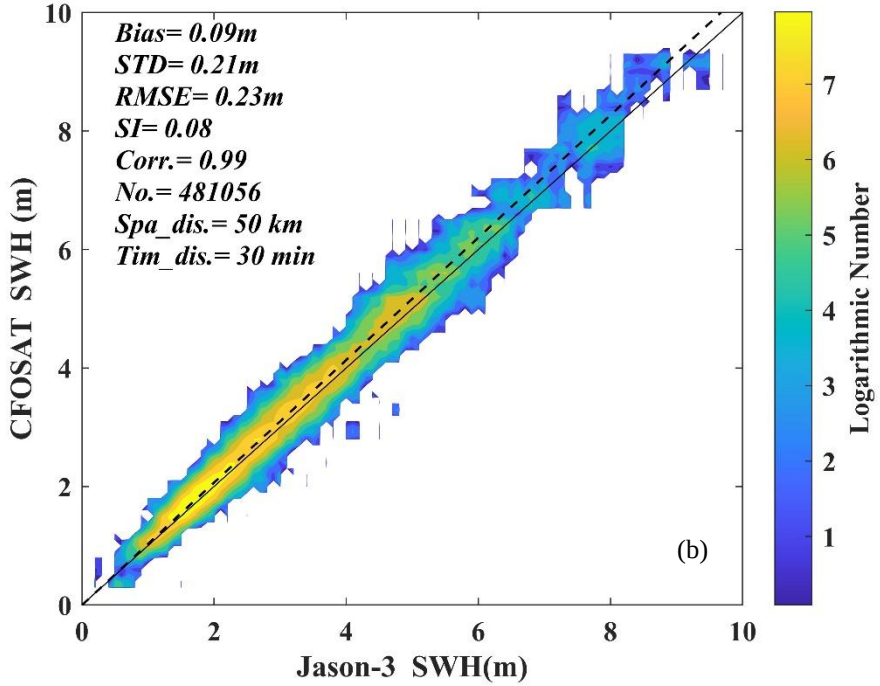


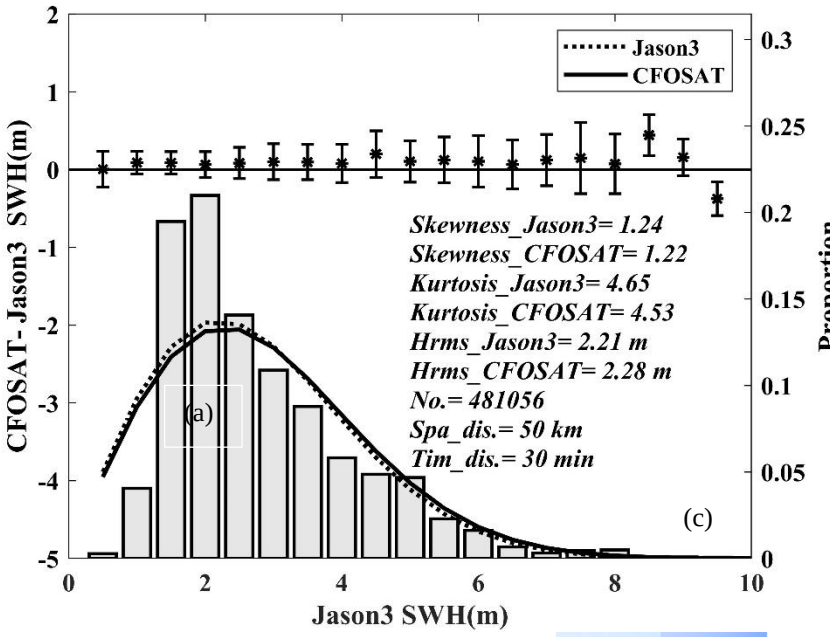
This analysis suggests that CFOSAT SWIM and HY-2B have nearly the same precision

3.2. Collocated CFOSAT and Jason-3 Data

30 min and 50 km：







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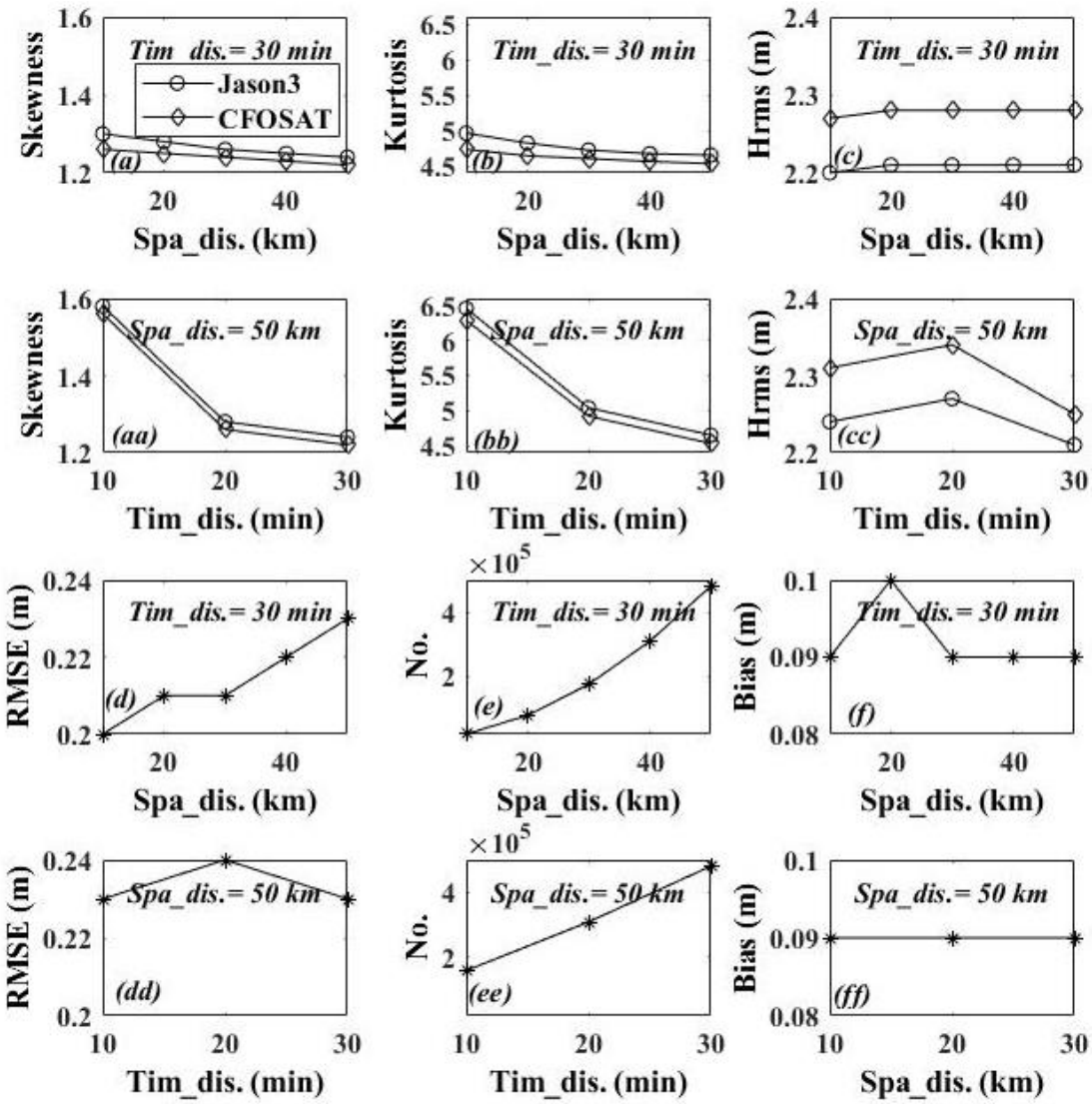


$$Skewness = \frac{E(x-\mu)^3}{\sigma^3} = \frac{\frac{1}{N}\sum_{i=1}^{N}(x_i-\bar{x})}{\left(\sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i-\bar{x})^2}\right)^3}$$

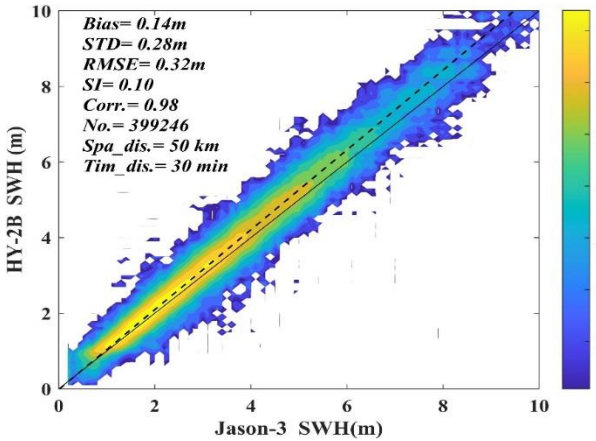
$$Kurtosis = \frac{E(x-\mu)^4}{\sigma^4} = \frac{\frac{1}{N}\sum_{i=1}^{N}(x_i-\bar{x})^4}{\left(\sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i-\bar{x})^2}\right)^4}$$

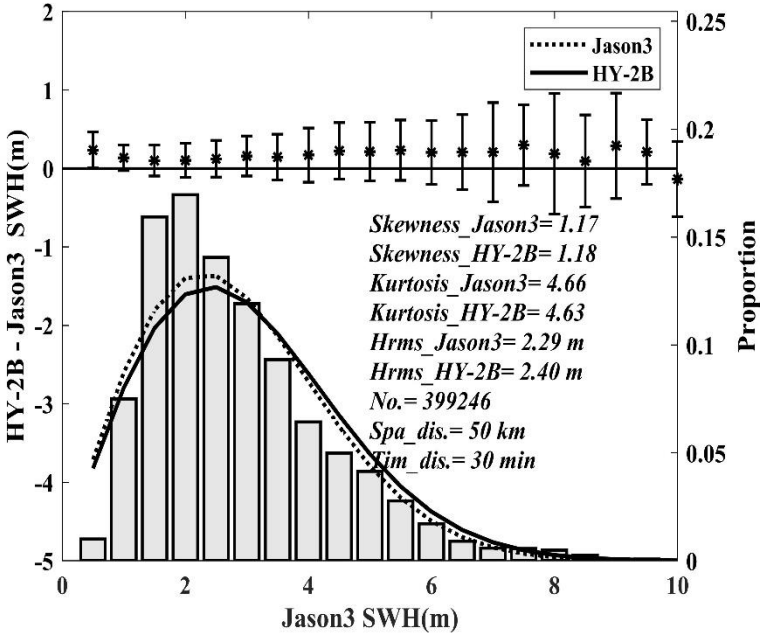
$$y = \frac{x}{H_{rms}^{\ 2}} e^{\left(\frac{-x^2}{2H_{rms}^{\ 2}}\right)}$$

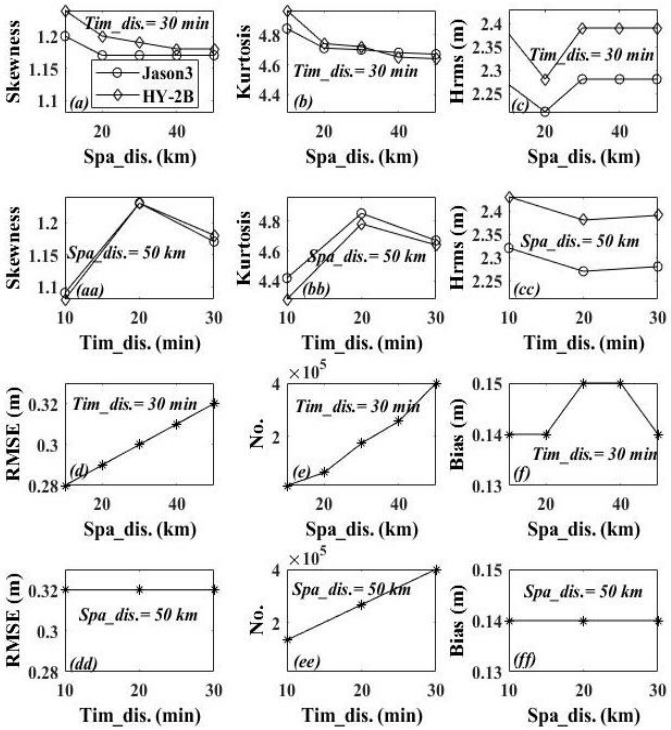
It indicates that within smaller temporal and spatial window, the SWH performs more skew and kurtosis during ocean waves evolution

3.3. Collocated HY-2B and Jason-3 Data

30-min and 50-km



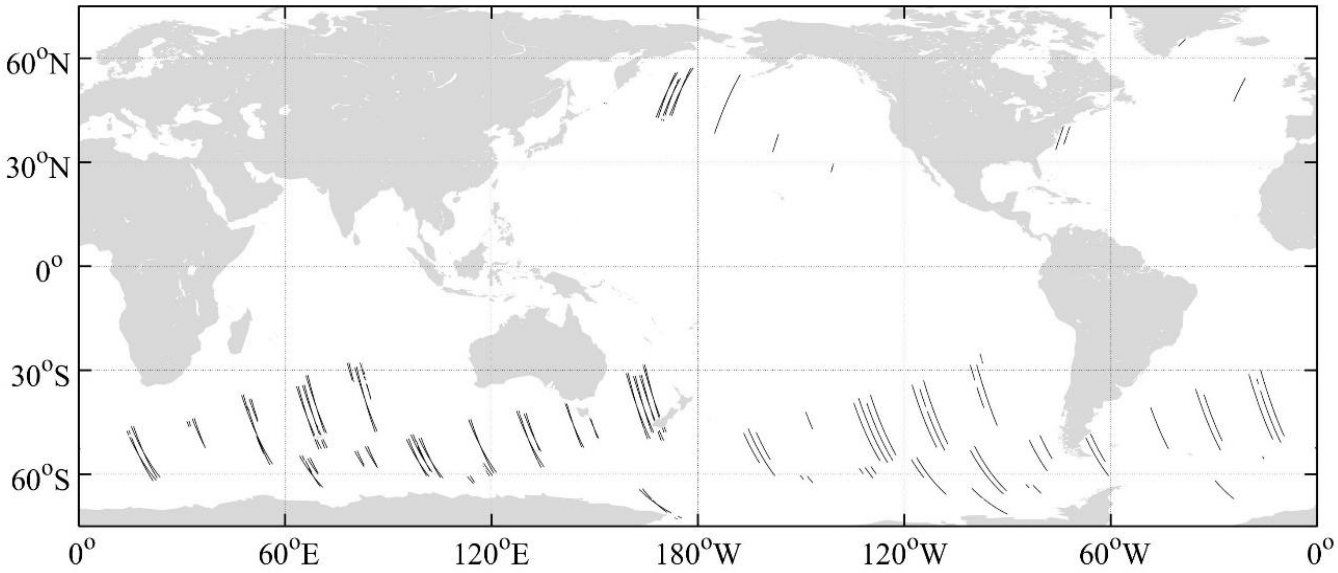


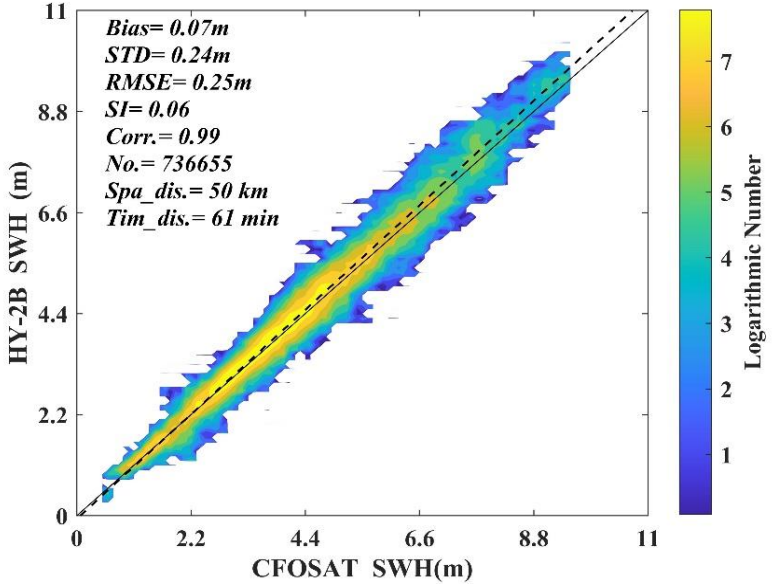


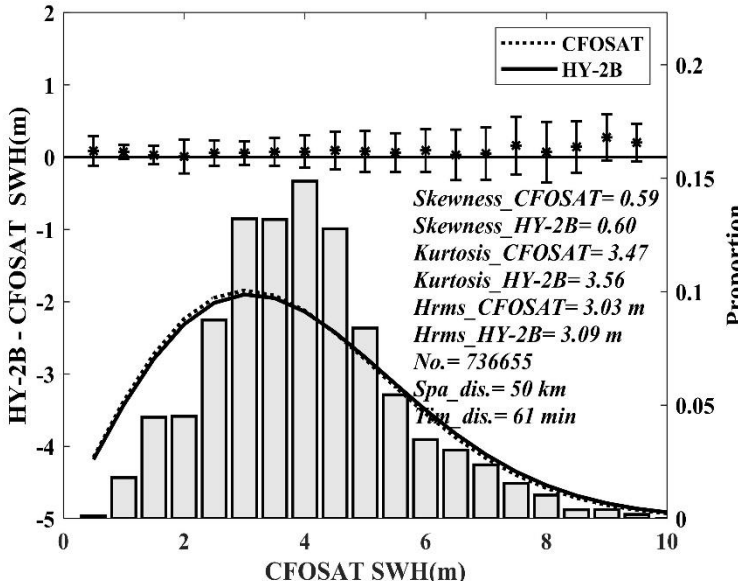
Both “Skewness” and “Kurtosis” are decreasing with increasing spatial distance, while they appear random dependency on the temporal distance. “Hrms” is generally invariable and also random dependency on spatial and temporal distance.

3.4 Collocated CFOSAT and HY-2B

61 min，50km

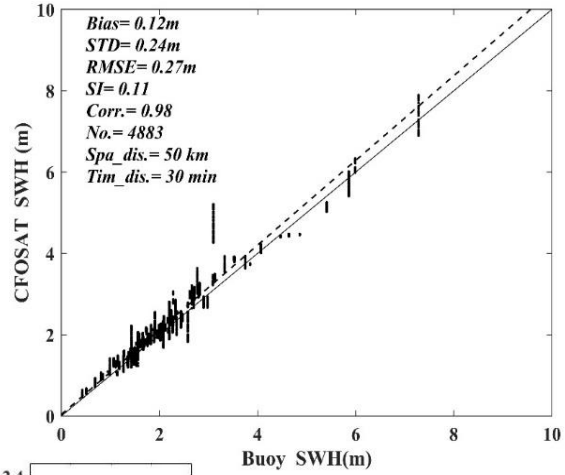


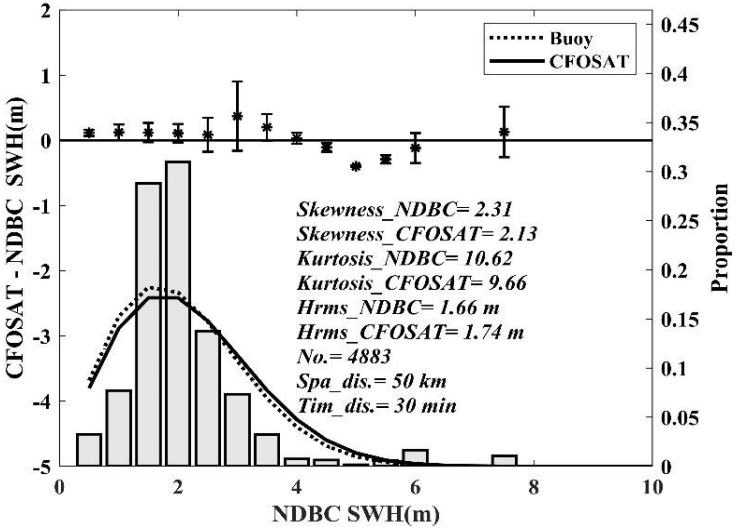


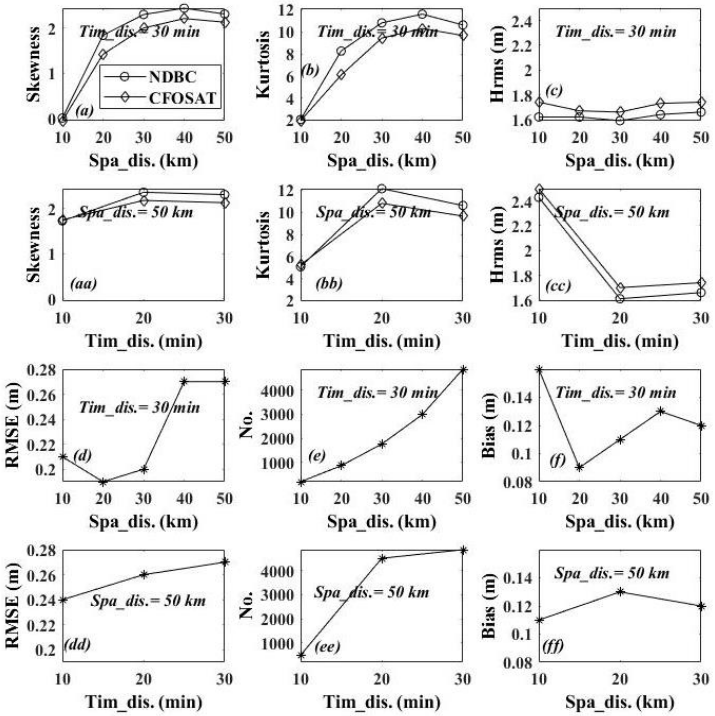


Generally, CFOSAT nadir SWH is nearly consistent with Jason3 SWH. HY-2B SWH is somewhat larger than that of Jason-3, while it is closer to CFOSAT. From the fitting lines, larger SWH results in larger bias, yet there is significant validation between all three satellites.

3.5 Collocated CFOSAT and Buoys

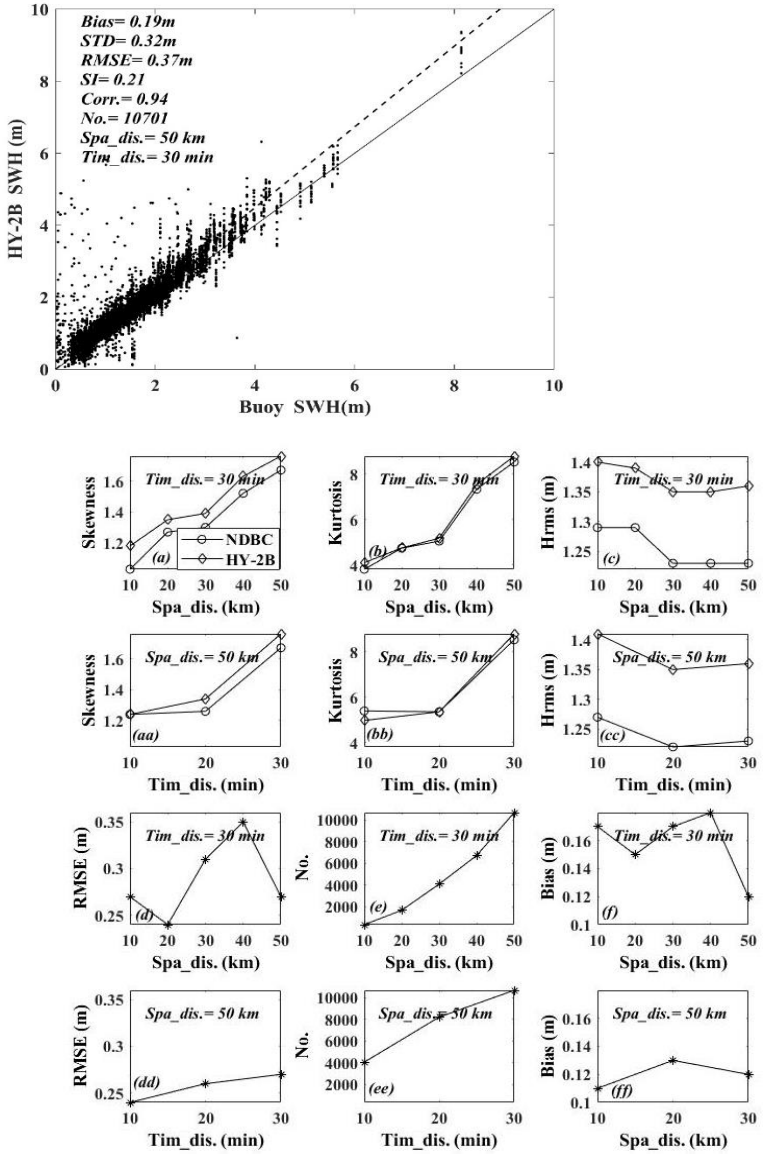


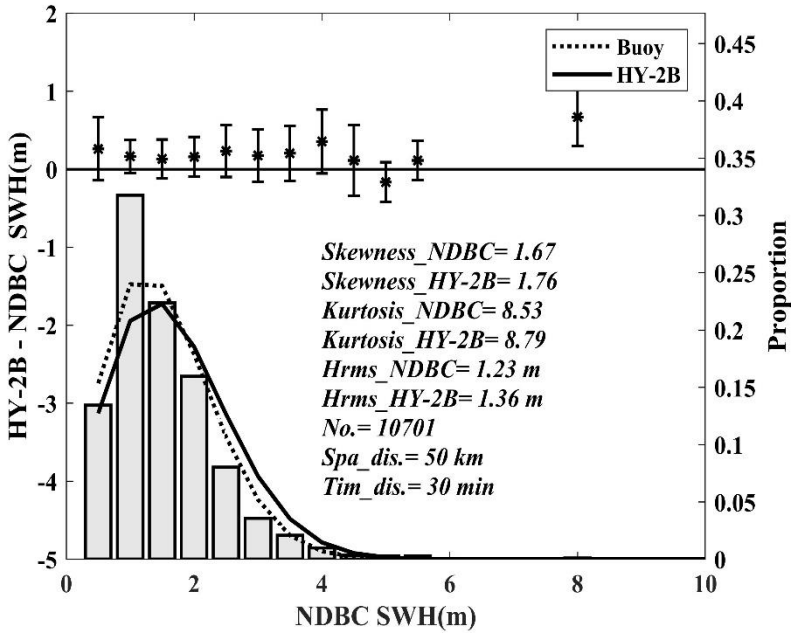




The “Skewness” is increasing with increasing spatial and temporal distances, which is opposite to satellites matchup. The “Kurtosis” increases first and then decrease a little with increasing temporal distance. “Hrms” is also random dependency on spatial and temporal distance.

3.6 Collocated HY-2B and Buoys





Both the “Skewness” and “Kurtosis” are increasing with spatial and temporal distance, which is opposite to satellites matchup and generally consistent with those from CFOSAT and buoys.

3.7 Calibration

$$SWH\_new = a \cdot SWH + b$$

Validation and calibration of CFOSAT and HY-2B by Jason-3

Satellite	Bias (m)	STD (m)	RMSE (m)	a	b	RMSE (m)
CFOSAT	0.09	0.21	0.23	0.967	0.0036	0.21
HY-2B	0.14	0.28	0.32	0.9467	0.0167	0.27

Validation and calibration of CFOSAT and HY-2B by NDBC buoys

Satellite	Bias (m)	STD (m)	RMSE (m)	a	b	RMSE (m)
CFOSAT	0.12	0.24	0.27	0.9601	−0.0358	0.23
HY-2B	0.19	0.32	0.37	0.8915	−0.0002	0.30
Jason-3	0.04	0.26	0.26	0.9869	−0.0188	0.25

An improvement in SWH performance can be accomplished following a simple calibration. For the three satellites, the CFOSAT SWIM nadir measurements are the best for comparison with the NDBC buoys after calibration.

4 Conclusions

The SWH of the CFOSAT, HY-2B, and Jason-3 nadir measurements are similar in value. The HY-2B Ku band measurement is somewhat larger than that for the Jason-3; however, the precision is good as expressed by the STD of HY-2B 20-Hz measurements.

The adaptive retracker should perform better than MLE4 due to extra mispointed values as inputs.

Both the “Skewness” and “Kurtosis” have undetermined characteristics on increasing spatial and temporal window, depending on the locations of measurements. The “RMSE”, “No.” and ”Bias” generally increase with the two windows as expected.