



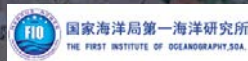
ESA-MOST Dragon Cooperation

中国科技部-欧洲空间局“龙计划”合作

2017 DRAGON 4 SYMPOSIUM

2017年“龙计划”四期学术研讨会

The Preliminary analysis of Sentinel-3 SRAL and HY-2A altimeter data in the China Sea and its adjacent area (ID.32292)



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Outline

I. Introduction

II. Analysis of Sentinel-3 SRAL data

III. Analysis of HY-2A RA data

IV. Conclusion

I. Introduction

Topic: Data validation and oceanic application of new satellite altimeters and SWIM.

- Data validation of Sentinel-3 SRAL, HY-2A RA and SWIM
- Improvement of the retrieval of SSH for the coastal zones
- Multi-altimeter SLA and SWH data fusion and their oceanic application
- Ocean wave spectra and wind speed inversion of SWIM

Team:

Chinese Partners (6 Persons)

- **Dr. Jungang Yang (PI) — First Institute of Oceanography**
- Dr. Yongjun Jia, National Satellite Ocean Application Service
- Dr. Yonggang Ji, The First Institute of Oceanography
- Mr. Chenqing Fan, The First Institute of Oceanography
- Pro. Ping Chen, National Satellite Ocean Application Service
- Dr. Weili Wang, the North China Marine Forecasting Center

European Partners (3 Persons)

- **Mr. Bernat Martinez (PI) — IsardSAT, Spain**
- Dr. Cristina Gonzalez — Telecom Bretagne, France
- Dr. Joana Fernandes — University of Porto, Portugal

Sentinel-3A

Sentinel-3A topography mission is the study of ocean topography including mean sea level, wave height, wind speed over the sea surface, sea-ice, ocean currents, eddies and tides.

The geophysical parameters to be measured are:

- **Sea Surface Height (SSH)**
- **Significant Wave Height (SWH)**
- **Wind Speed over ocean surface.**

SLA
SWH
Sigma0

Sentinel-3A SRAL has two main modes of operation:

- **High Resolution Mode** commonly called Synthetic Aperture Radar (SAR).
- **Low Resolution Mode (LRM)**



HY-2A altimeter

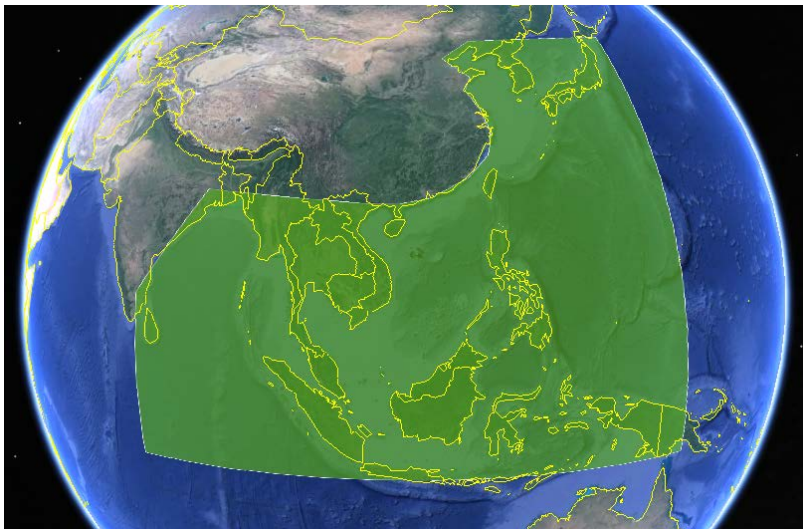
HY-2A Satellite is first Chinese marine dynamic environment satellite. It carried microwave scatterometer, radar altimeter, scanning microwave radiometer, calibration microwave radiometer.

- Bands: 13.58GHz, 5.25GHz
- Launch time: August 16, 2011
- repeat cycle: 14 days and 168 days (geodesic mission).
- 2016.3.30 geodesic orbit

SLA
SWH
Sigma0



Study area

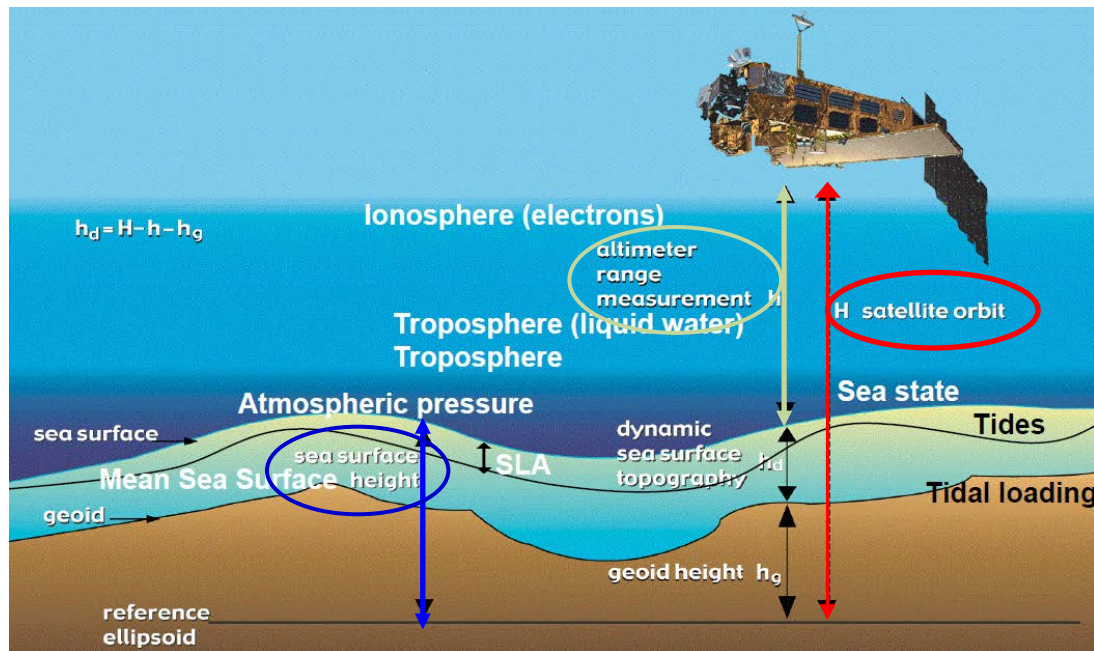


Coordinate: 78-145°E, 8°S-41°E.

Table. Data used in this study

altimeter	Data time period	cycle	Repeat cycle
Sentinel-3	01.02.2017~03.27.2017	12-16	27 d
Jason-2	01.04.2017~03.15.2017	314-320	10 d
Jason-3	12.30.2016~03.29.2017	33-41	10 d
HY-2A	3.30.2016~2.23.2017	12-16	168 d

The working principle of altimeter



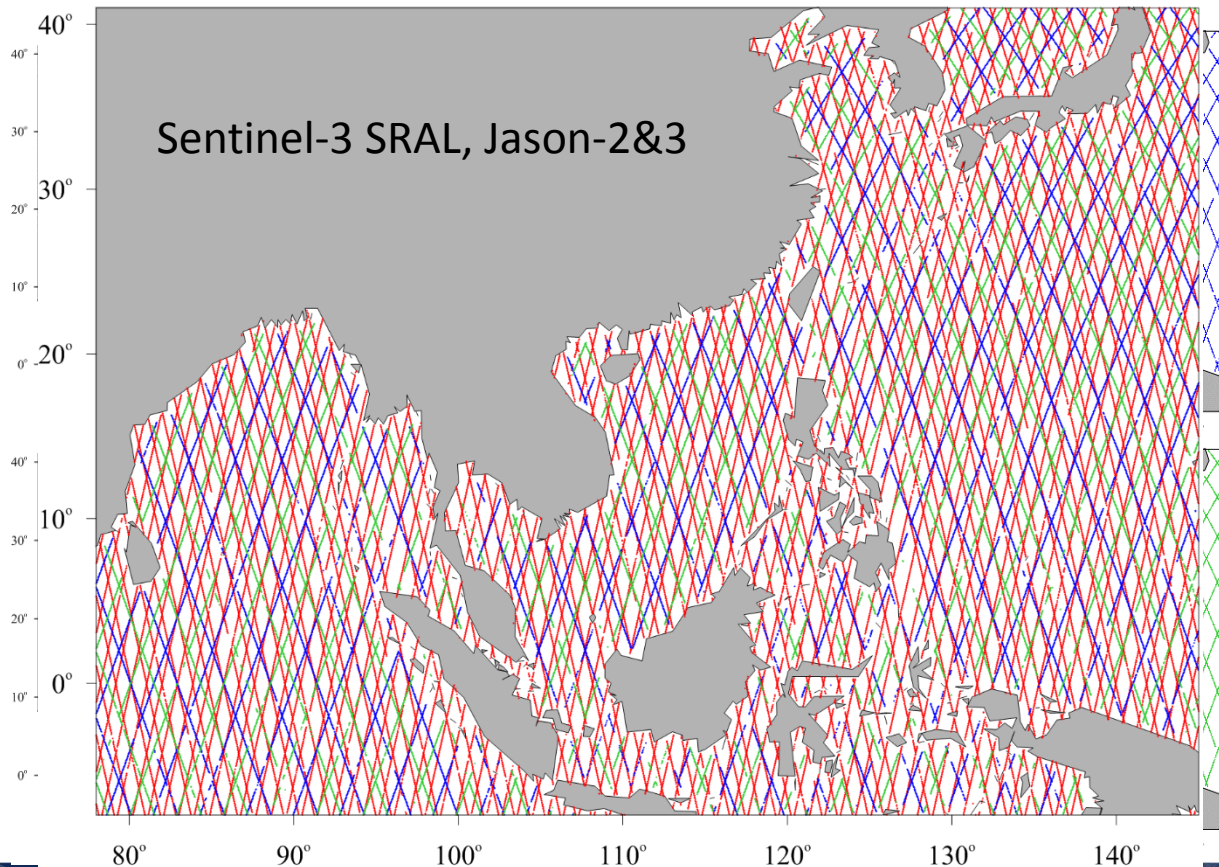
Range correction:

- Dry tropospheric correction
- Wet tropospheric correction
- Ionospheric correction
- Sea State bias correction
- Tide correction.

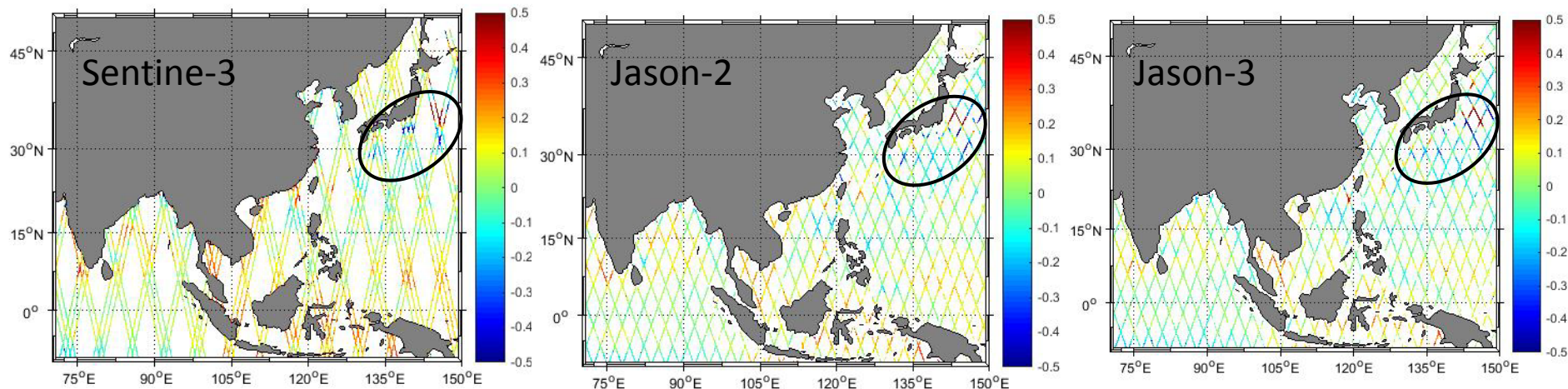
$SSH = \text{Altitude} - (\text{Range} + \text{corrections})$

$SLA = SSH - MSS$

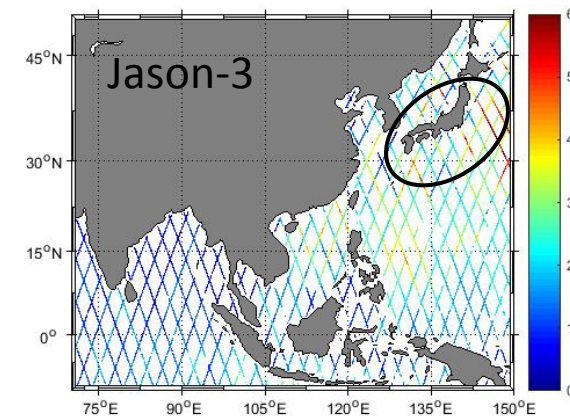
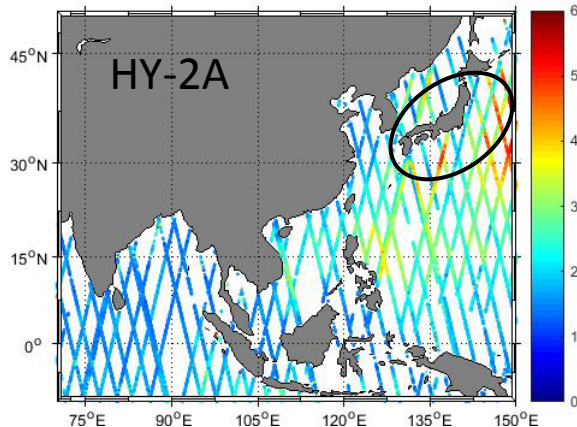
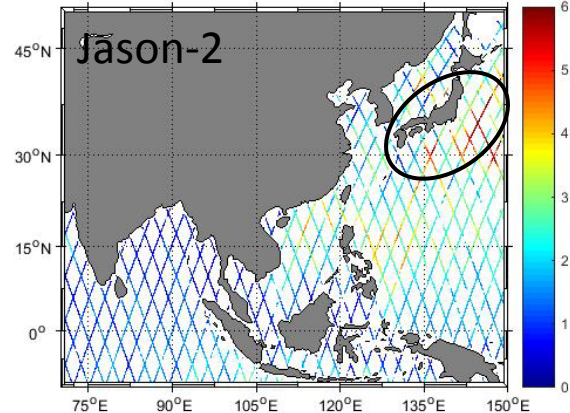
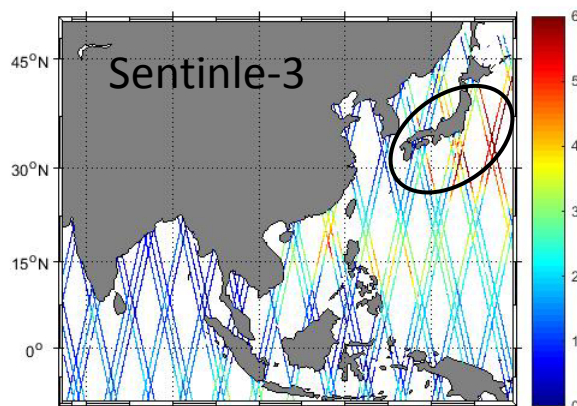
Ground track of altimeters



SLA distribution of different altimeters during Feb.1 2017 to Fe.10 2017

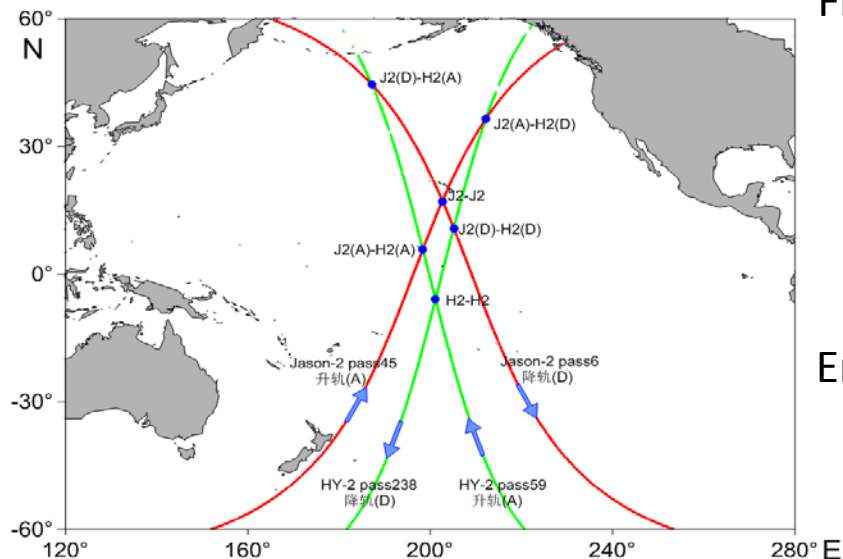


SWH distribution during Feb.1 2017 to Fe.10 2017



II. Analysis of Sentinel-3 SRAL data

The method of data analysis



Finding the crossover between different altimeters.



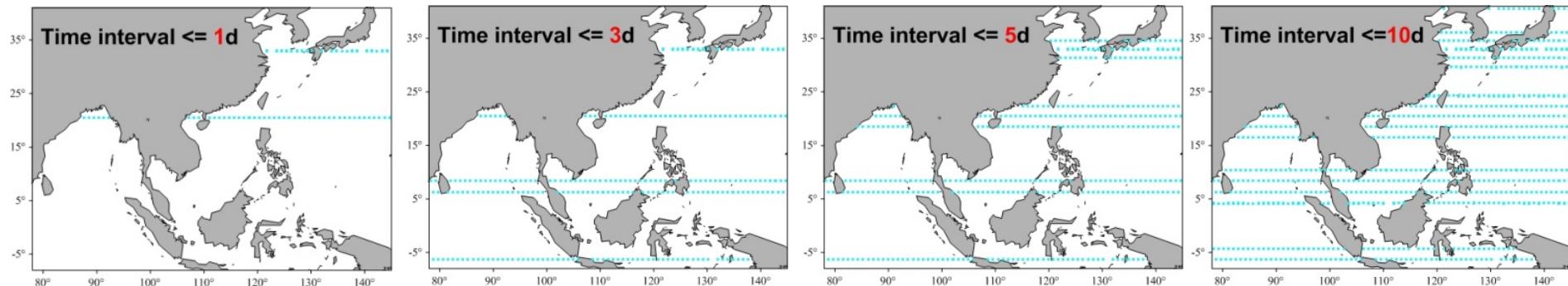
Comparing SLA, SWH and Sigma0 at crossovers



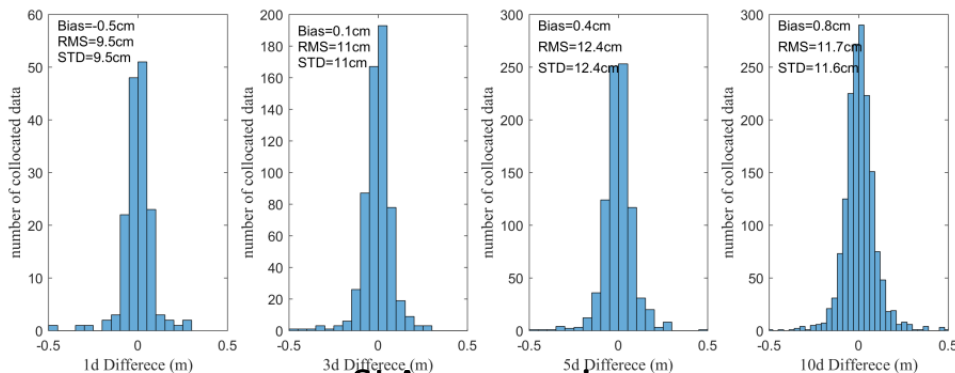
Error analysis:
$$bias = \frac{1}{N} \sum_{i=1}^N (A_i - B_i) \quad RMSE = \sqrt{\frac{1}{N} \sum_{i=1}^N (A_i - B_i)^2}$$

1. Self-crossover comparison of Sentinel-3 SRAL

Time interval of crossover data is 1, 3, 5 and 10 days.

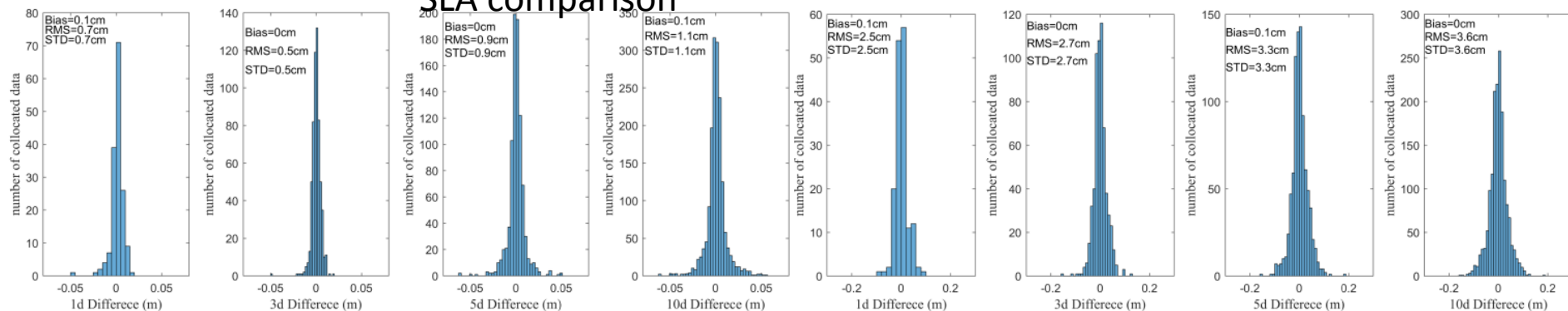


The distribution of self-crossover points of Sentientl-3



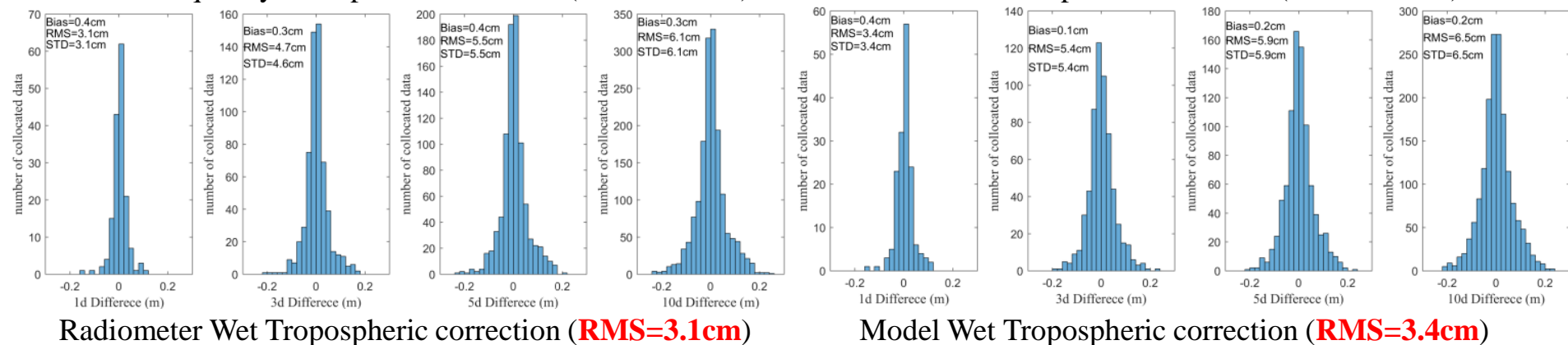
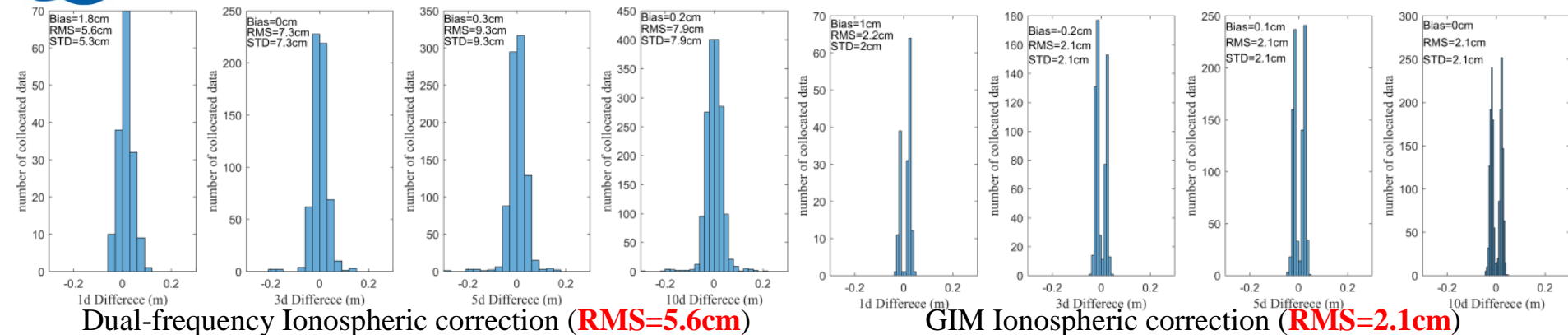
- The Bias and RMS increases with the time interval.
- The best result is the RMS of 9.5cm for 1 day time.
- SLA has a little difference at crossover.

SLA comparison

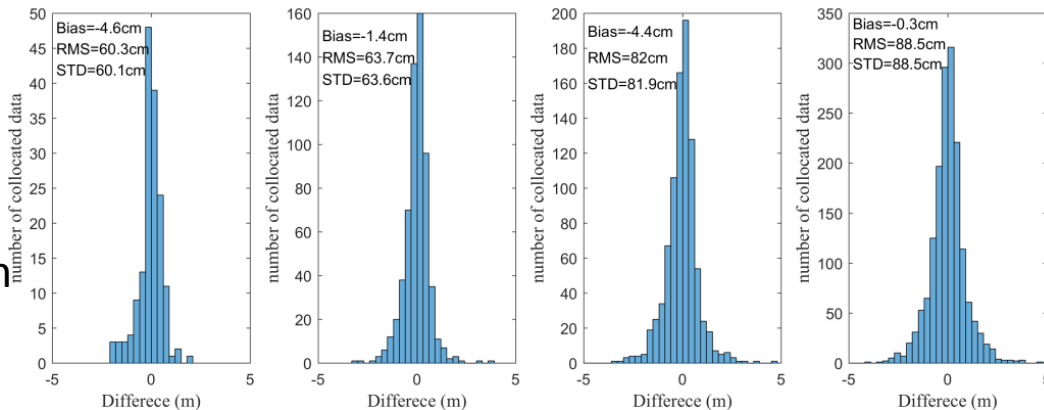


Dry Tropospheric correction (**RMS=0.7cm**)

SSB correction (**RMS=2.5cm**)

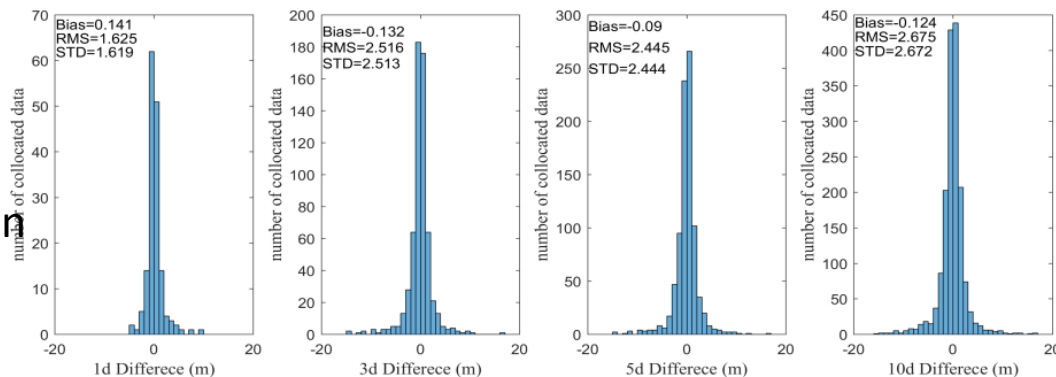


SWH comparison



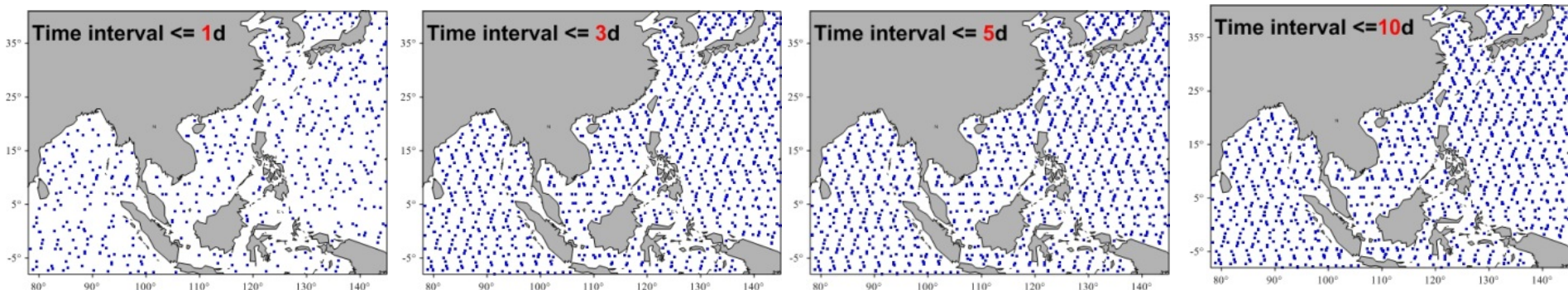
- The Bias and RMS increases with the time interval.
- The RMS is 60.3cm of 1 day interval.
- Difference of SWH at crossover is large.

Sig0 comparison

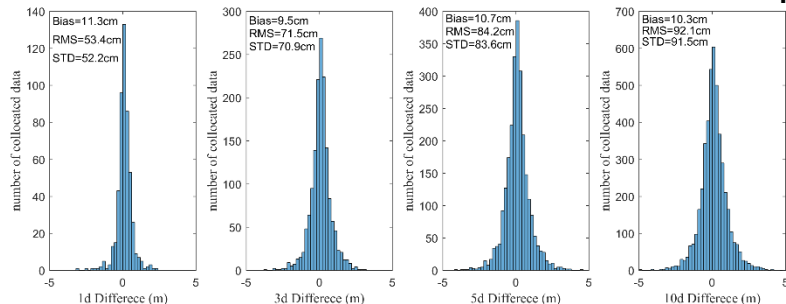


- The Bias and RMS increases with the time interval.
- The RMS is 1.62dB of 1 day interval.
- Sigma0 is similar at crossover.

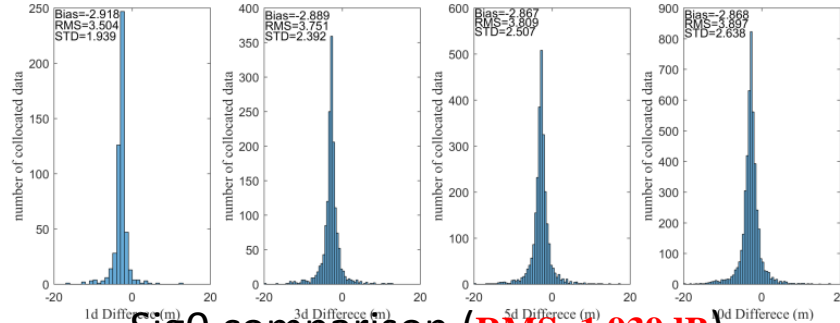
2. Crossover comparison of Sentinel-3 SRAL and Jaso-2 data



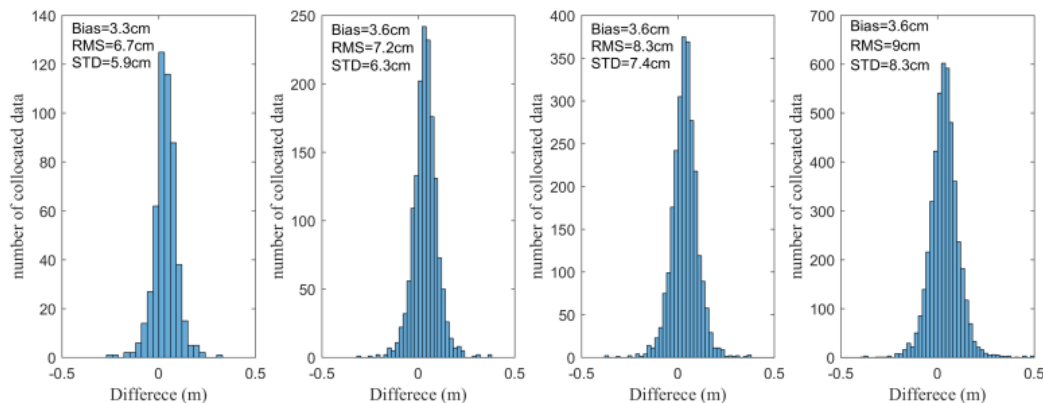
The distribution of crossover points of Sentinel-3 and Jason-2



SWH comparison (**RMS=53.4cm**)

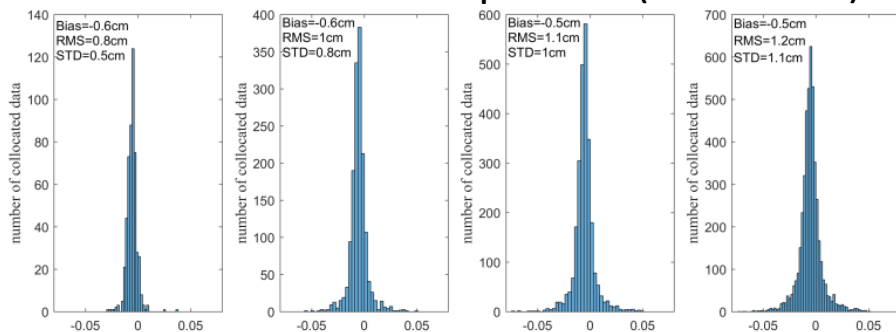


Sig0 comparison (**RMS=1.939dB**)

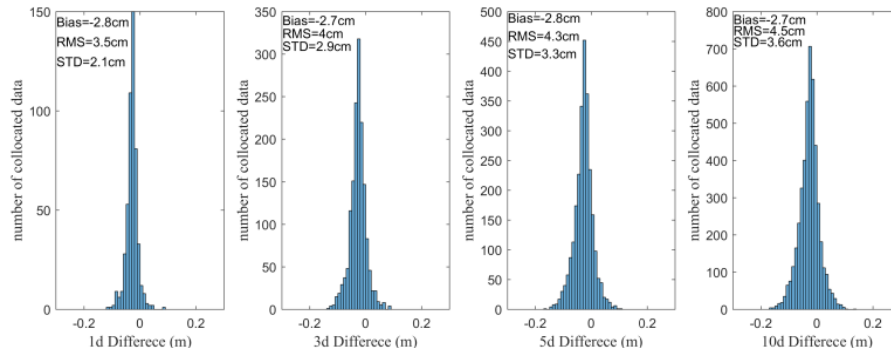


➤ The RMS is 6.7cm with the time interval of 1 day.

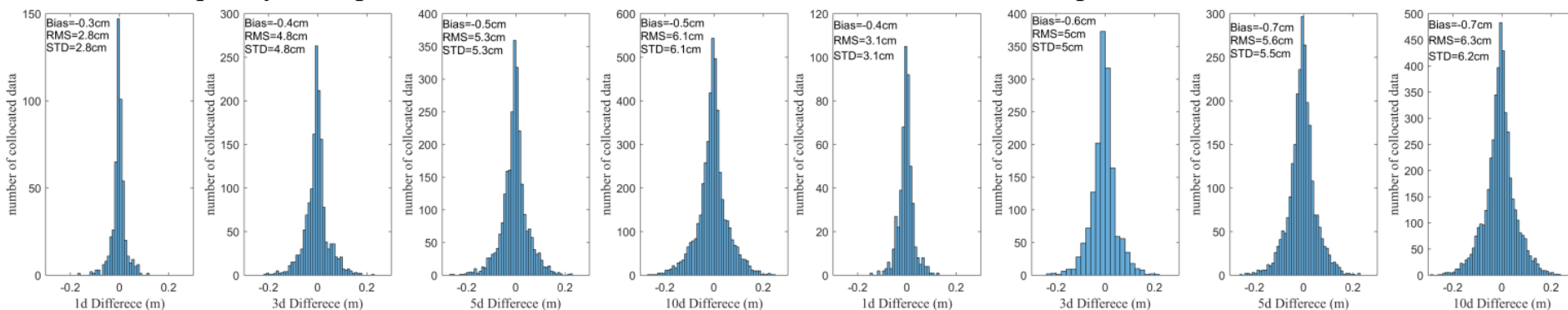
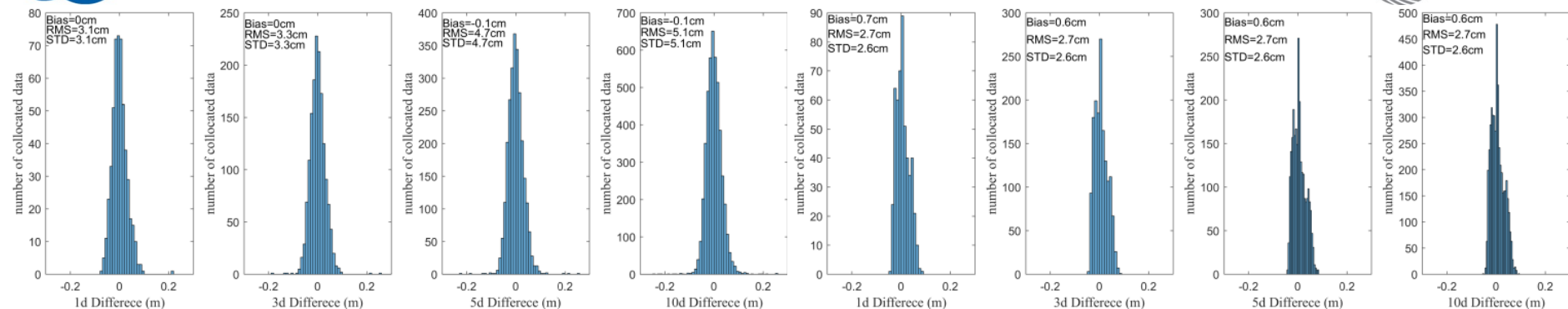
SLA comparison (**RMS=6.7cm**)



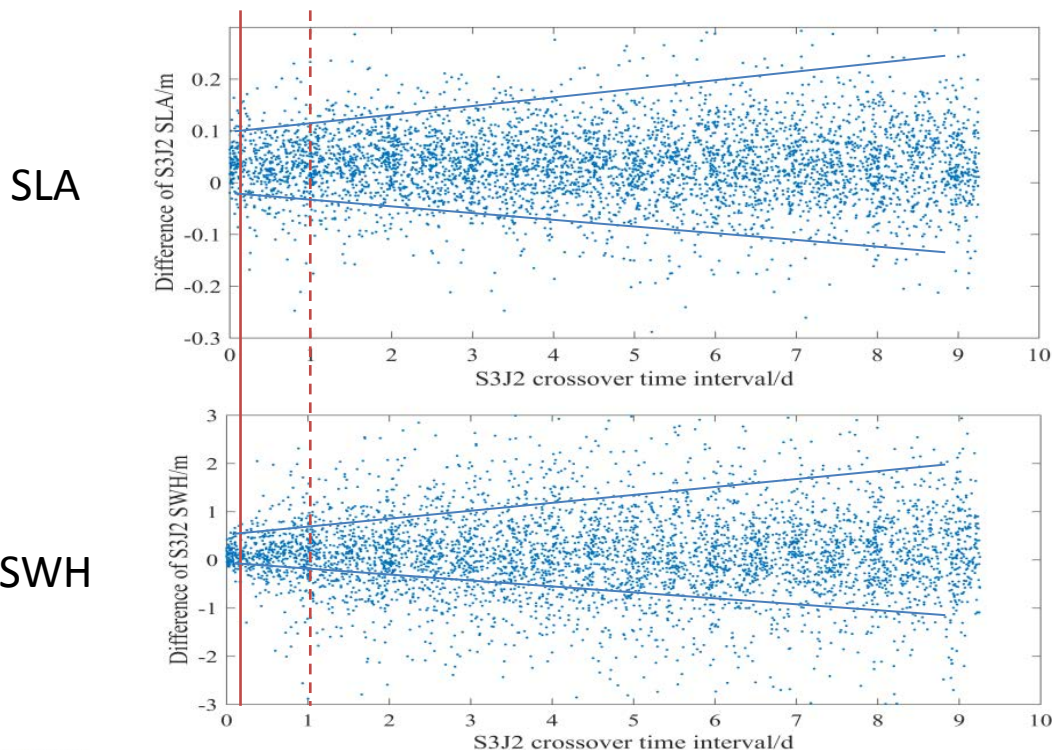
Dry Tropospheric correction (**RMS=0.5cm**)



SSB correction (**RMS=2.1cm**)

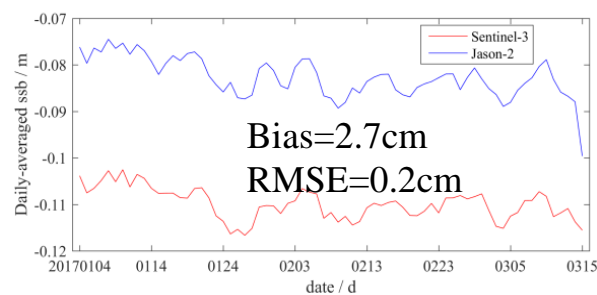
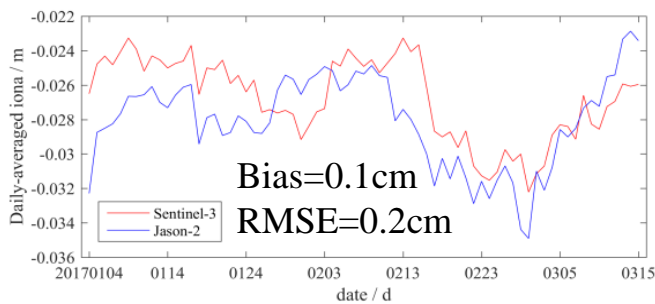
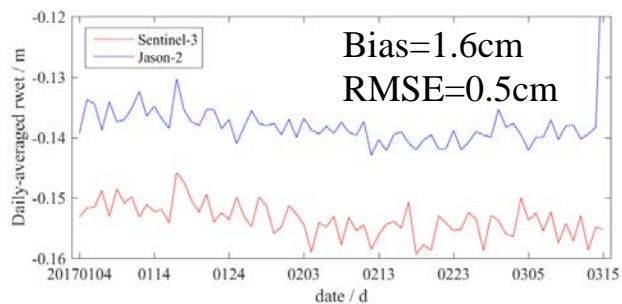
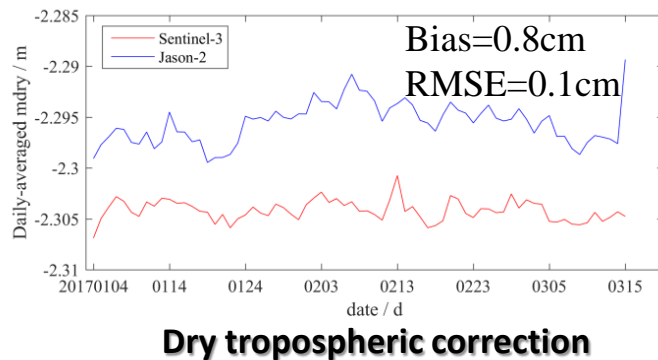
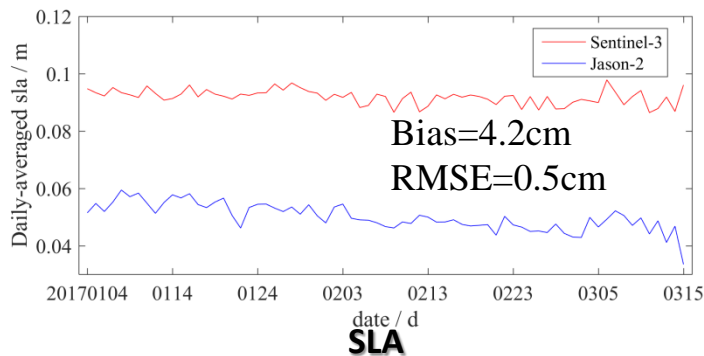


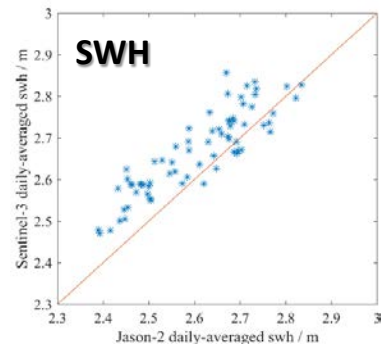
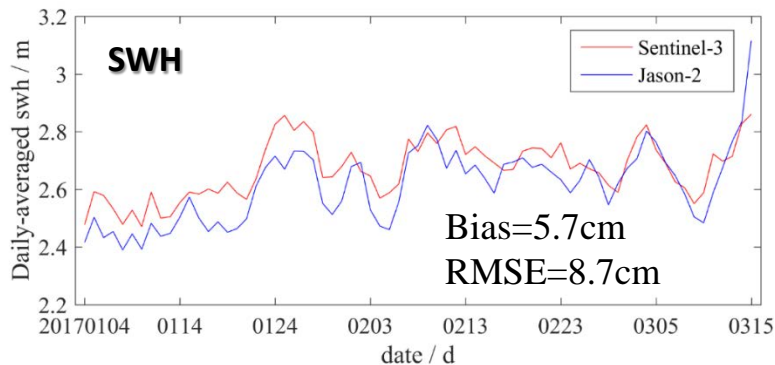
Variation of SLA and SWH difference with time interval



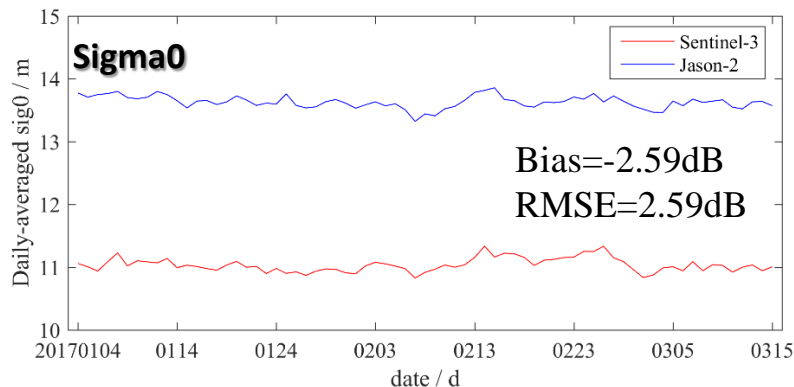
SLA and SWH difference becomes large with the increasing time interval.

3. Comparison of daily spatial average data of Sentinel-3 SRAL and Jason-2



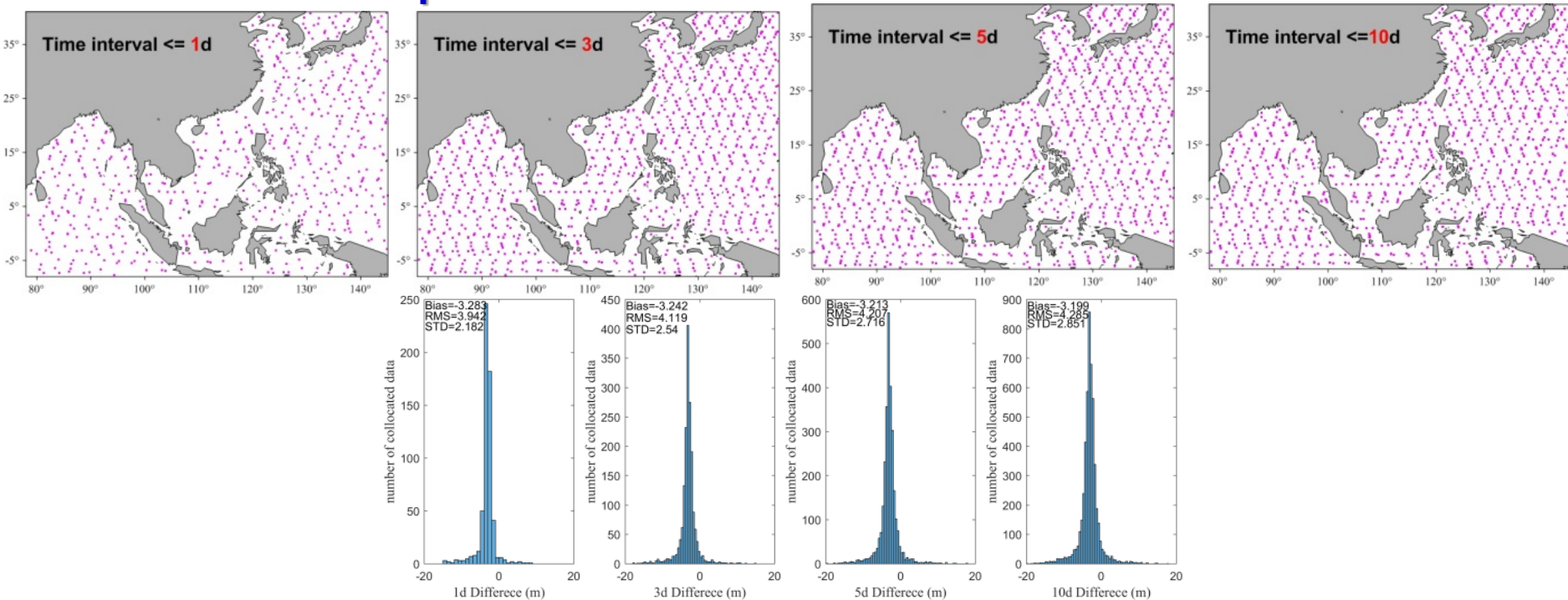


$SWH_{S3} > SWH_{J2}$

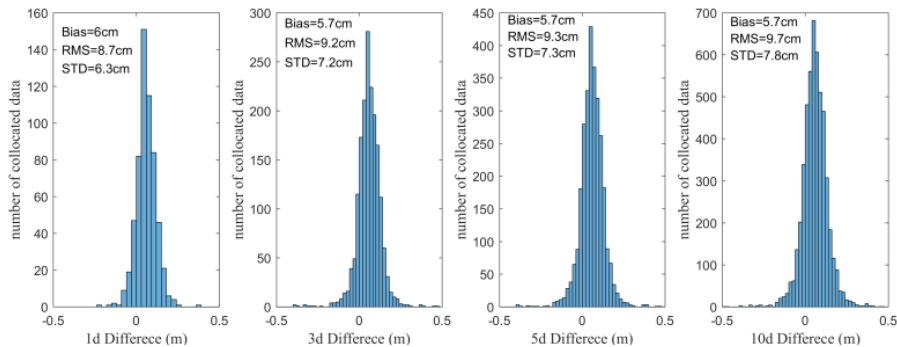


$Sigma0_{S3} < Sigma0_{J2}$

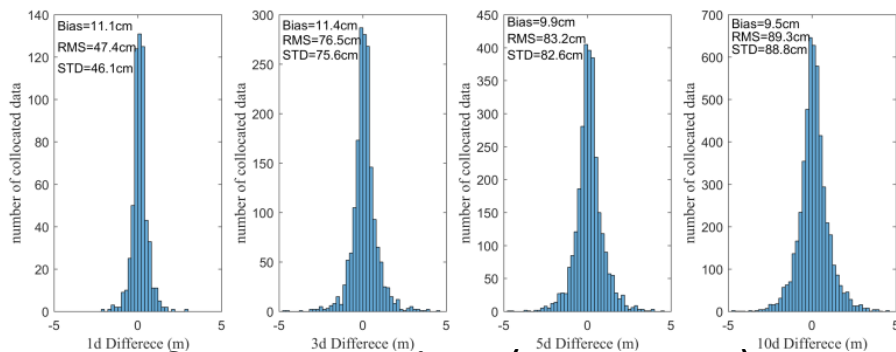
4. Crossover comparison of Sentinel-3 SRAL and Jaso-3 data



Sig0 comparison (**RMS=3.94dB**)

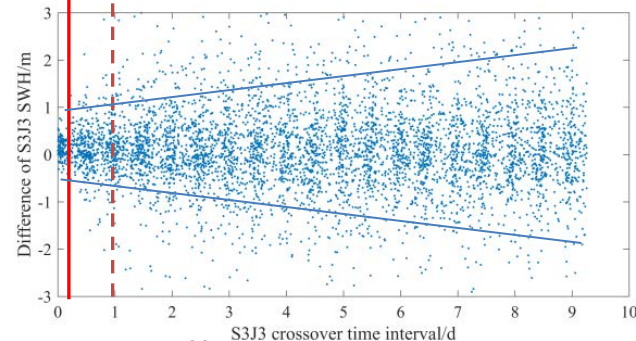
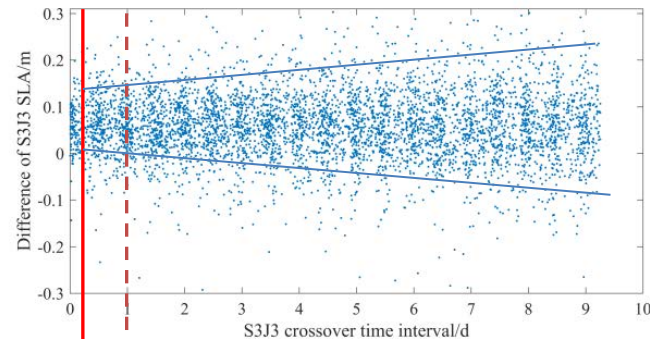


SLA comparison (**RMS=8.7cm**)



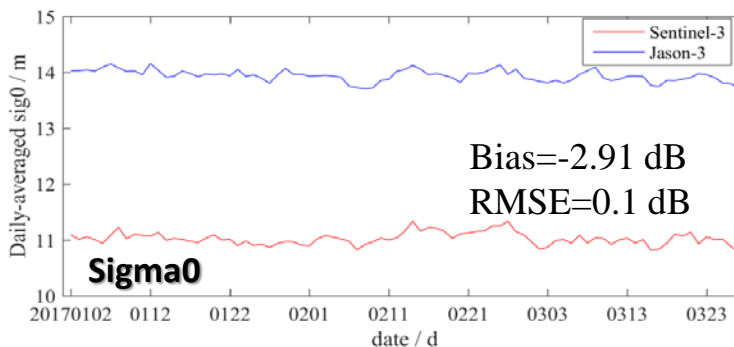
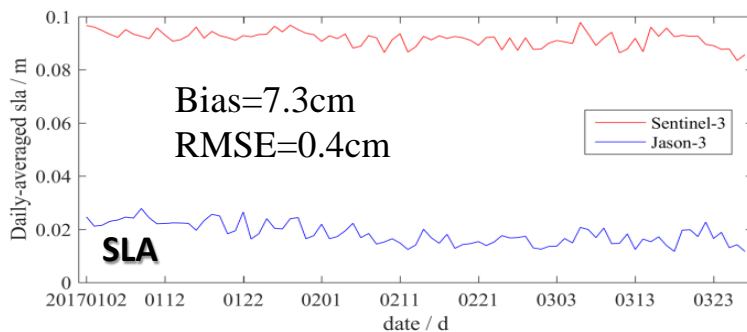
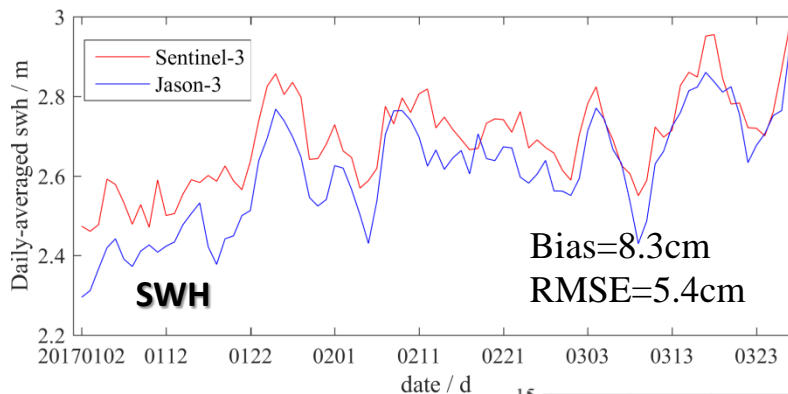
SWH comparison (**RMS=47.4cm**)

SLA difference with time interval



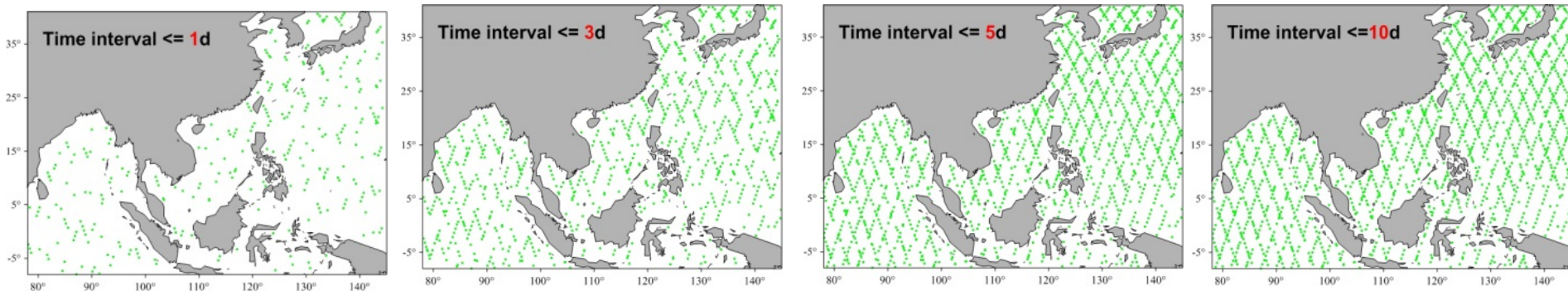
SWH difference with time interval

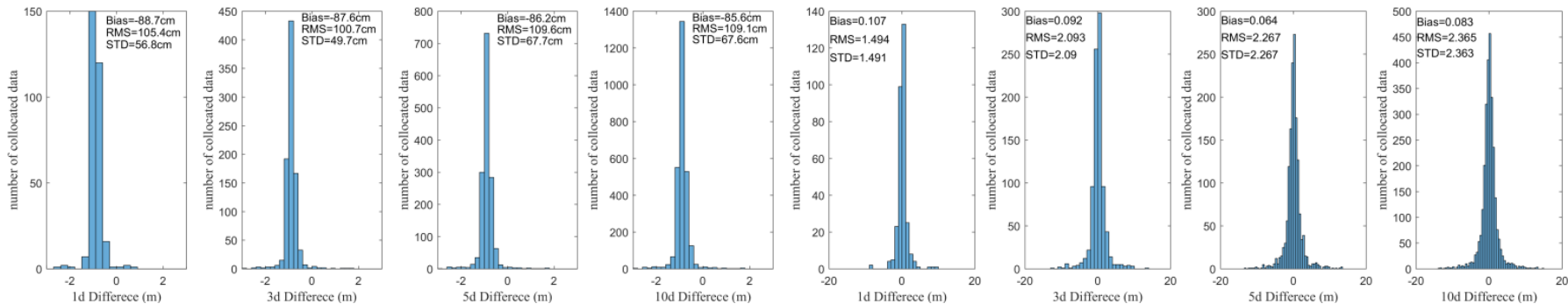
5. Comparison of daily spatial average data of Sentinel-3 SRAL and Jason-3



III. Analysis of HY-2A altimeter data

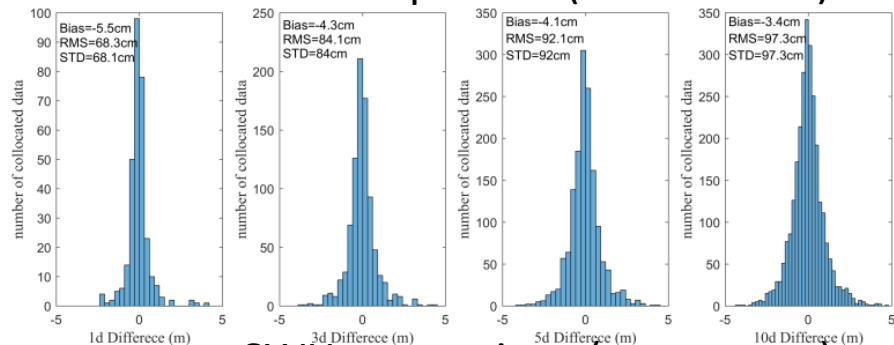
1. Crossover comparison of HY-2A and Jaso-2 data



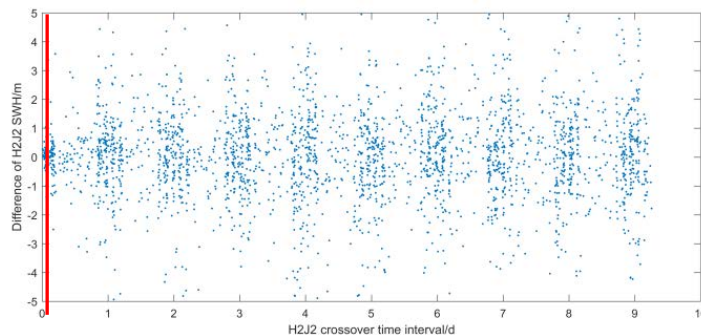


SLA comparison (**RMS=105.4cm**)

Sigma0 comparison (**RMS=2.1dB**)

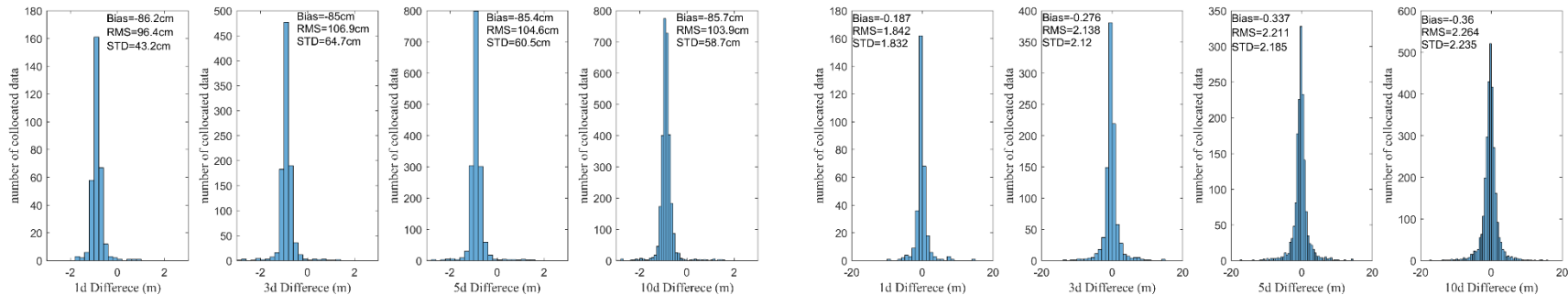


SWH comparison (**RMS=68.3cm**)



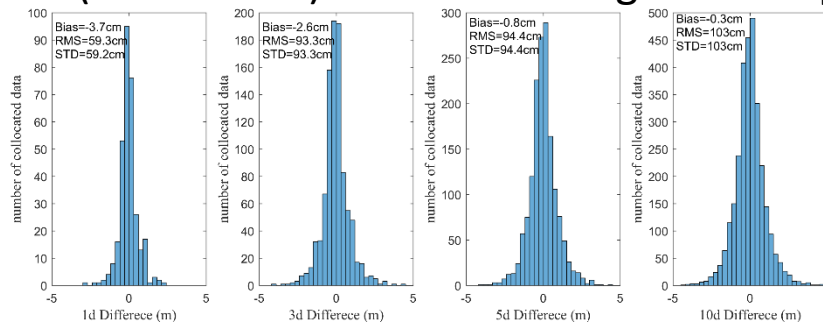
SWH difference with the different time interval

2. Crossover comparison of HY-2A and Jaso-3 data



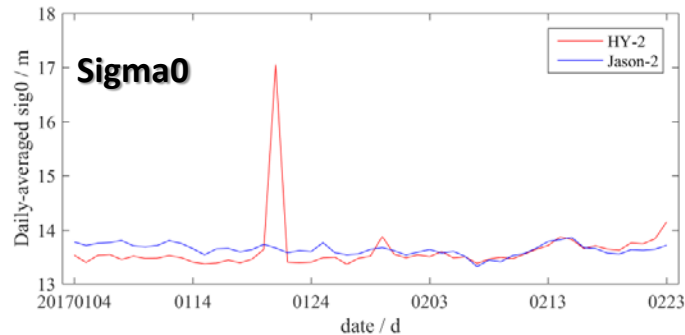
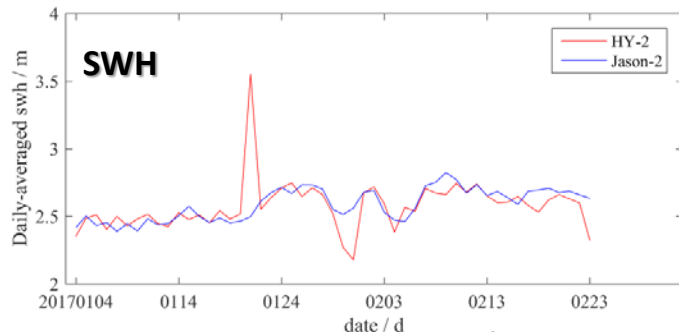
SLA comparison (**RMS=96.4cm**)

Sigma0 comparison (**RMS=1.8dB**)

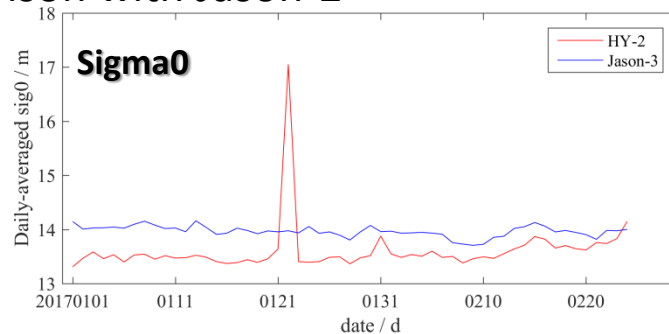
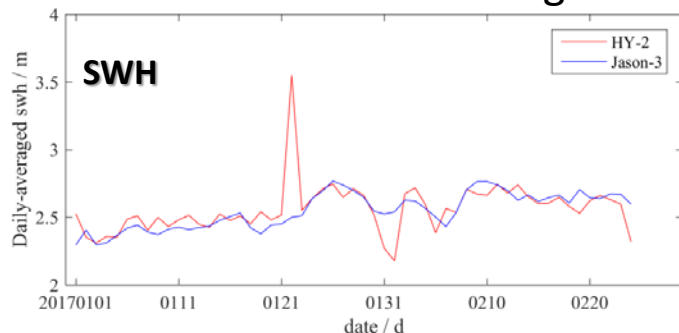


SWH comparison (**RMS=59.3cm**)

3. Comparison of daily spatial average data of HY-2A and Jason-2/3



SWH and Sigma0 comparison with Jason-2



SWH and Sigma0 comparison with Jason-3

IV. Conclusion

From the comparison between Sentinel-3 and Jason-2/3, it is concluded that:

- S3 has the same SLA and SWH spatial distribution during the same period.
- S3 Self-crossover comparison shows that the SLA has some differences at self-crossover because of the tropo-, iono-, SSB correction difference and orbit errors, and SWH has also the difference larger than 0.5m.
- The daily spatial average data comparison shows that S3 has a systemic SLA bias, $S3 > J2$. SWH of S3 is larger than that of J2/3.

From the comparison between H2A and J2/3, it is concluded that:

- For the absence of dry tropospheric correction, SLA of H2A has a large bias with J2/3 for the geodesic data.
- SWH and Sigma0 of H2A is similar to J2/3.

Next step of our work:

- Further analysis of S3 data, especial to the high resolution mode data.
- Multi-altimeter data uniform and fusion after the data analysis.
- Mesoscale eddies and geostrophic current study with the fusion data of S3, H2A and other altimeters.

Thanks for your attention!