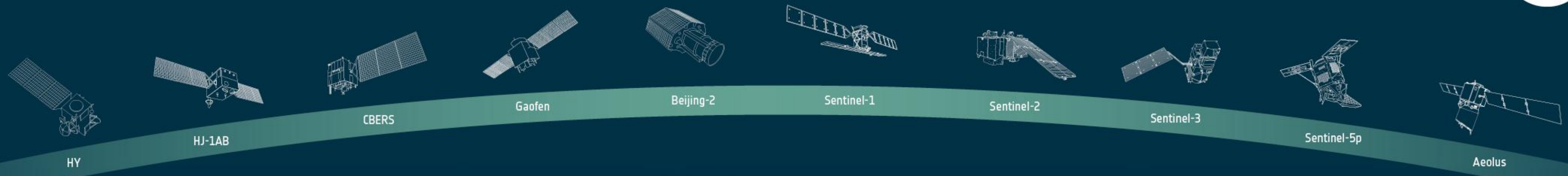

2022 DRAGON 5 SYMPOSIUM

MID-TERM RESULTS REPORTING

17-21 OCTOBER 2022

[PROJECT ID. 58009]

[SYNERGISTIC MONITORING OF OCEAN DYNAMIC ENVIRONMENT FROM MULTI-SENSORS]

<8:30-10:30AM,TUESDAY, 18/OCT/2022>

ID. 58009

PROJECT TITLE: SYNERGISTIC MONITORING OF OCEAN DYNAMIC ENVIRONMENT FROM MULTI-SENSORS

PRINCIPAL INVESTIGATORS: [JINGSONG YANG & BERTRAND CHAPRON]

CO-AUTHORS: [HE WANG, HUIMIN LI, XIAOHUI LI, LIN REN, ROMAIN HUSSON]

PRESENTED BY: [JINGSONG YANG]

Some Progresses of Synergistic Monitoring of Ocean Dynamic Environment from Multi-Sensors

Jingsong Yang[1], He Wang[2], Huimin Li[3], Xiaohui Li[1], Lin Ren[1], Romain Husson[4], Bertrand Chapron[5]

[1]State Key Laboratory of Satellite Ocean Environment Dynamics, Second Institute of Oceanography, MNR, Hangzhou, China
[2]National Ocean Technology Center, MNR, Tianjin, China
[3]Nanjing University of Information Science and Technology, Nanjing, China
[4]Collecte Localisation Satellites, Plouzané, France
[5]Laboratoire d'Océanographie Physique et Spatiale (LOPS), IFREMER, Plouzané, France

Project's objectives

(1) Assimilation studies of wind, waves and sea level in the context of hurricanes forecasts;

(2) The influence of swell on the studies of coastal extremes;

(3) Studies of vortex Rossby waves, asymmetric TC structures, rain bands, and sub-scale circulations by using high spatial resolution ocean wind data;

(4) Analysis of relationship between the above internal dynamical processes and TC intensity changes;

(5) Consistent analysis on winds, waves and storm surges in the context of hurricanes; and

(6) Consistent monitoring of ocean surface current and internal waves using multi-source satellite data.

Project's schedule

The overall progress of this project will be coordinated by the two PIs: Dr. Bertrand CHAPRON and Prof. Jingsong YANG. The obtained results will be accordingly reported at each annual symposium.

Current progresses: 5 joint publications

Year 1: Data preparation, methodology development;
Year 2: Data preparation, methodology development, calculation, analysis;
Year 3: Calculation, analysis, validation;
Year 4: Analysis, validation, pre-operation and demonstration.

Training of young scientists and academic exchanges

The online training of young scientists and academic exchanges with European scientist are still carried out during COVID-19.

EO Data Delivery

Data access (list all missions and issues if any). NB. in the tables please insert cumulative figures (since July 2020) for no. of scenes of high bit rate data (e.g. S1 100 scenes). If data delivery is low bit rate by ftp, insert "ftp"

ESA Missions	No. Scenes
1. Sentinel-1A WV	FTP
2. Sentinel-1B WV	FTP
3.	
4.	
5.	
6.	
Total:	
Issues:	

ESA Third Party Missions	No. Scenes
1. CYGNSS	FTP
2.	
3.	
4.	
5.	
6.	
Total:	
Issues:	

Chinese EO data	No. Scenes
1. CFOSAT SCAT	FTP
2. CFOSAT SWIM	FTP
3. HY-2 SMR	FTP
4. HY-2 SCAT	FTP
5. HY-2 ALT	FTP
6.	
Total:	
Issues:	

European Young scientists contributions in Dragon 5

Name	Institution	Poster title	Contribution
Alexey MIRONOV	eOdyn, France	Validation of Wave Spectral Partitions From SWIM Instrument On-Board CFOSAT Against In Situ Data	Second Author

Chinese Young scientists contributions in Dragon 5

Name	Institution	Poster title	Contribution
Xiaohui LI	State Key Laboratory of Satellite Ocean Environment Dynamics, Second Institute of Oceanography, MNR, China	Analysis of coastal wind speed retrieval from CYGNSS mission using artificial neural network **Pesented in the 1st YEAR RESULTS SYMPOSIUM**	First Author & Presenter
He WANG	National Ocean Technology Center, China	Characterizing Errors in the Swell Height Data Derived from Directional Buoys Via the Joint Analysis of Sentinel-1 SAR, CFOSAT/SWIM and WaveWatch III Simulations	First Author & Presenter
Huimin LI	School of Marine Sciences, Nanjing University of Information Science and Technology, China	Up-to-Downwave Asymmetry of the CFOSAT SWIM Fluctuation Spectrum for Wave Direction Ambiguity Removal	First Author & Presenter
Haoyu JIANG	China University of Geosciences, China	Validation of Wave Spectral Partitions From SWIM Instrument On-Board CFOSAT Against In Situ Data	First Author & Presenter
Lin REN	State Key Laboratory of Satellite Ocean Environment Dynamics, Second Institute of Oceanography, MNR, China	Validation of Wave Spectral Partitions From SWIM Instrument On-Board CFOSAT Against In Situ Data	Third Author

Dragon 4 (id. 32249) & Dragon 5 (id. 58009)

DRAGON 5 1st YEAR RESULTS SYMPOSIUM

Analysis of coastal wind speed retrieval from CYGNSS mission using artificial neural network

Poster

ID: 237

Dr4

YSPS.2.1:

Time:

Monday, 19/July/2021: 10:15am - 1:00pm

Xiaohui Li[1,2], Dongkai Yang[1], Jingsong Yang[2,3], Gang Zheng[2,3], Guoqi Han[4], Yang Nan[5], Weiqiang Li[6,7]

[1] School of Electronic and Information Engineering, Beihang University, Beijing, China
[2] State Key Laboratory of Satellite Ocean Environment Dynamics, Second Institute of Oceanography, Ministry of Natural Resources, Hangzhou, China
[3] Southern Marine Science and Engineering Guangdong Laboratory (Zhuhai), Zhuhai, China
[4] Fisheries and Oceans Canada, Institute of Ocean Sciences, Canada,
[5] Wuhan University, Wuhan, China
[6] Institute of Space Sciences (ICE, CSIC), Spain
[7] Institut d'Estudis Espacials de Catalunya, Spain

ABSTRACT

This paper demonstrates the capability and performance of sea surface wind speed retrieval in coastal regions (within 200 km away from the coastline) using spaceborne Global Navigation Satellite System Reflectometry (GNSS-R) data from NASA's Cyclone GNSS (CYGNSS) mission. The wind speed retrieval is based on the Artificial Neural Network (ANN). A feedforward neural network is trained with the collocated CYGNSS Level 1B (version 2.1) observables and the wind speed from European Centre for Medium-range Weather Forecast Reanalysis 5th Generation (ECMWF ERA5) data in coastal regions. An ANN model with five hidden layers and 200 neurons in each layer has been constructed and applied to the validation set for wind speed retrieval. The proposed ANN model achieves good wind speed retrieval performance in coastal regions with a bias of −0.03 m/s and a RMSE of 1.58 m/s, corresponding to an improvement of 24.4% compared to the CYGNSS Level 2 (version 2.1) wind speed product. The ANN based retrievals are also compared to the ground truth measurements from the National Data Buoy Center (NDBC) buoys, which shows a bias of −0.44 m/s and a RMSE of 1.86 m/s. Moreover, the sensitivities of the wind speed retrieval performance to different input parameters have been analyzed. Among others, the geolocation of the specular point and the swell height can provide significant contribution to the wind speed retrieval, which can provide useful reference for more generic GNSS-R wind speed retrieval algorithms in coastal regions.

Keywords: Global navigation satellite system reflectometry (GNSS-R); Cyclone GNSS (CYGNSS); Sea surface wind speed; Coastal; Artificial neural network (ANN)

Wednesday, 19/Oct/2022 9:50am - 10:00am
ID: 186 / P.2.1: 9
Poster Presentation
Ocean and Coastal Zones: 58009 - Synergistic Monitoring of Ocean Dynamic Environment From Multi-Sensors
Characterizing Errors in the Swell Height Data Derived from Directional Buoys Via the Joint Analysis of Sentinel-1 SAR, CFOSAT/SWIM and WaveWatch III Simulations

He Wang, Jingsong Yang, Bertrand Chapron, Jianhua Zhu

National Ocean Technology Center, China, People's Republic of

Characterizing the uncertainties in buoy ocean wave records is critical not only for understanding the limitations of in situ wave measurements, but also for interpreting the implied accuracies of the remotely sensed products in which these buoy data are used as validation references. This letter preliminarily assesses the error of long-period swell heights (Hss) representing specific directional wave partition energy observed from deep-water buoys moored in the northeast Pacific. We propose a buoy Hss error estimation method by combining dual and triple collocation using data derived from buoys, two kinds of space-borne radars and numerical simulations. Compared to traditional methods, the proposed approach can reveal "absolute" errors (with respect to the underlying truth) from buoy Hss, accepting and then confirming that swell heights from buoy, satellite and model are all uncertain. This study simultaneously employs ocean swell products derived from synthetic/real aperture radars (Sentinel-1A/B and CFOSAT/SWIM) and WaveWatch III ocean wave model hindcasts to diagnose the accuracy of the Hss values observed by buoys of National Data Buoy Center (NDBC) and Coastal Data Information Program (CDIP) during the period from July 2019 to October 2021. We quantify that the NDBC's 3-m heave-pitch-roll buoy (CDIP's Waverider buoy) recorded Hss have root-mean-square error of 0.17 m (0.12 m), or have about 10.65% (7.06%) uncertainty relative to the mean Hss value (approximately 1.6 m). Our findings imply that the reference value uncertainties should be taken into account when understanding direct satellite Hss validation against buoy in situ.

Wednesday, 19/Oct/2022 9:30am - 9:40am
ID: 108 / P.2.1: 7
Poster Presentation
Ocean and Coastal Zones: 58009 - Synergistic Monitoring of Ocean Dynamic Environment From Multi-Sensors
Up-to-Downwave Asymmetry of the CFOSAT SWIM Fluctuation Spectrum for Wave Direction Ambiguity Removal

Huimin Li1, Daniele Hauser2, Bertrand Chapron3, Biao Zhang1, Jingsong Yang4, Yijun He1

1School of Marine Sciences, NUIST, China, People's Republic of; 2Laboratoire Atmosphère, Observations Spatiales (LATMOS), UVSQ, Centre National de la Recherche Scientifique (CNRS), Université Paris-Saclay, Sorbonne Université, 78280 Guyancourt, France; 3IFREMER, Univ. Brest, CNRS, IRD, L aboratoire d' Oceanographie P hysique et Spatiale (LOPS), 29280 Plouzané, France; 4State Key Laboratory of Satellite Ocean Envi- ronment Dynamics, Second Institute of Oceanography, Ministry of Natural Resources, Hangzhou 310012, China

The surface wave investigation and monitor- ing (SWIM) aboard the China-France Oceanography Satellite (CFOSAT), a pioneer conically scanning wave spectrometer, was successfully launched on October 29, 2018. Its innovative configuration composed of one nadir and five rotating near-nadir beams is designed to simultaneously observe the directional wave spectrum at a global scale. In this study, we systematically implement the spectral analysis of the radar backscattering with the periodogram technique to obtain the fluctuation spectrum for each azimuth direction. The 2-D fluctuation spectrum of the three spectral beams ($\theta = 6^\circ$, 8°, and 10°) combines all the azimuth directions within one entire rotation of 360°. The case study demonstrates that the wave features (peak wavelength and direction) are roughly consistent between the estimated fluctuation spectrum and the collocated WaveWatch III wave slope spectrum. A marked up-to-downwave asymmetry of the fluctuation spectrum with larger spectral level in the upwave direction for all the three spectral beams is observed. A ratio is defined between the fluctuation spectrum within the [0°, 180°] sector relative to the [180°, 360°] sector. Statistics display that this ratio is greater than 1 when it denotes the up-to-downwave ratio and smaller than 1 for the down-to-upwave ratio. This observed spectrum asymmetry is linked to the asymmetric modulation from upwind to downwind. In addition, we employ such finding to help remove the 180° wave direction ambiguity from a practical point of view. Preliminary results of the direction ambiguity removal display a bias of 41.3°, 40.6°, and 36.7° for the beams. The 10° beam shows slightly better performance compared to the other two beams in terms of bias and standard deviation. This shall lay a strong basis for the operational implementation of such algorithm to resolve the direction ambiguity.

Wednesday, 19/Oct/2022 9:40am - 9:50am
ID: 109 / P.2.1: 8
Poster Presentation
Ocean and Coastal Zones: 58009 - Synergistic Monitoring of Ocean Dynamic Environment From Multi-Sensors
Validation of Wave Spectral Partitions From SWIM Instrument On-Board CFOSAT Against In Situ Data

Haoyu Jiang1, Alexey Mironov2, Lin Ren3, Alexander Babanin4

1China University of Geosciences, China, People's Republic of; 2eOdyn, France; 3State Key Laboratory of Satellite Ocean Environment Dynamics, Second Institute of Oceanography, Ministry of Natural Resources, China; 4The University of Melbourne, Australia

The Surface Waves Investigation and Monitoring (SWIM) instrument onboard the China France Oceanography Satellite (CFOSAT) can retrieve directional wave spectra with a wavelength range of 70~500 m. This study aims to validate the partitioned integrated wave parameters (PIWPs) from SWIM, including partitioned significant wave height (PSWH), peak wave period (PPWP), and peak wave direction (PPWD), against those from National Data Buoy Center (NDBC) buoys. With quasi-simultaneous spectra from two NDBC buoys 13 km away from each other near Hawaii, the methods of comparing PIWPs from two sets of spectra were discussed first. After cross-assigning partitions according to the spectral distance, it is found that wrong cross-assignments lead to many outliers strongly impacting the estimate of error metrics. Three methods, namely comparing only the best-matched partition, changing the threshold of spectral distance during cross-assignment, and maximum likelihood estimation of root-mean-square error (RMSE) of PIWPs, were used to reduce the impact of potential wrong cross-assignments. Using these methods, the SWIM PIWPs were validated against NDBC buoys. The results show that SWIM performs well at finding the spectral peaks of different partitions with the RMSE of PPWPs and PPWDs of 0.9 s and 20°, respectively, which can be a useful complement for other wave observations. However, the accuracy of PSWH from SWIM is not that good at this stage, probably because the high noise level in the spectra impacts the result of the partitioning algorithm. Further improvement is needed to obtain better PSWH information.

Progress 1/5

Remote Sensing of Environment 260 (2021) 112454

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Analysis of coastal wind speed retrieval from CYGNSS mission using artificial neural network

Xiaohui Li [a,b], Dongkai Yang [a], Jingsong Yang [b,c], Gang Zheng [b,c], Guoqi Han [d], Yang Nan [e], Weiqiang Li [f,g,*]

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[f] Institute of Space Sciences (ICE, CSIC), Barcelona 08193, Spain
[g] Institut d'Estudis Espacials de Catalunya (IEEC), Barcelona 08034, Spain

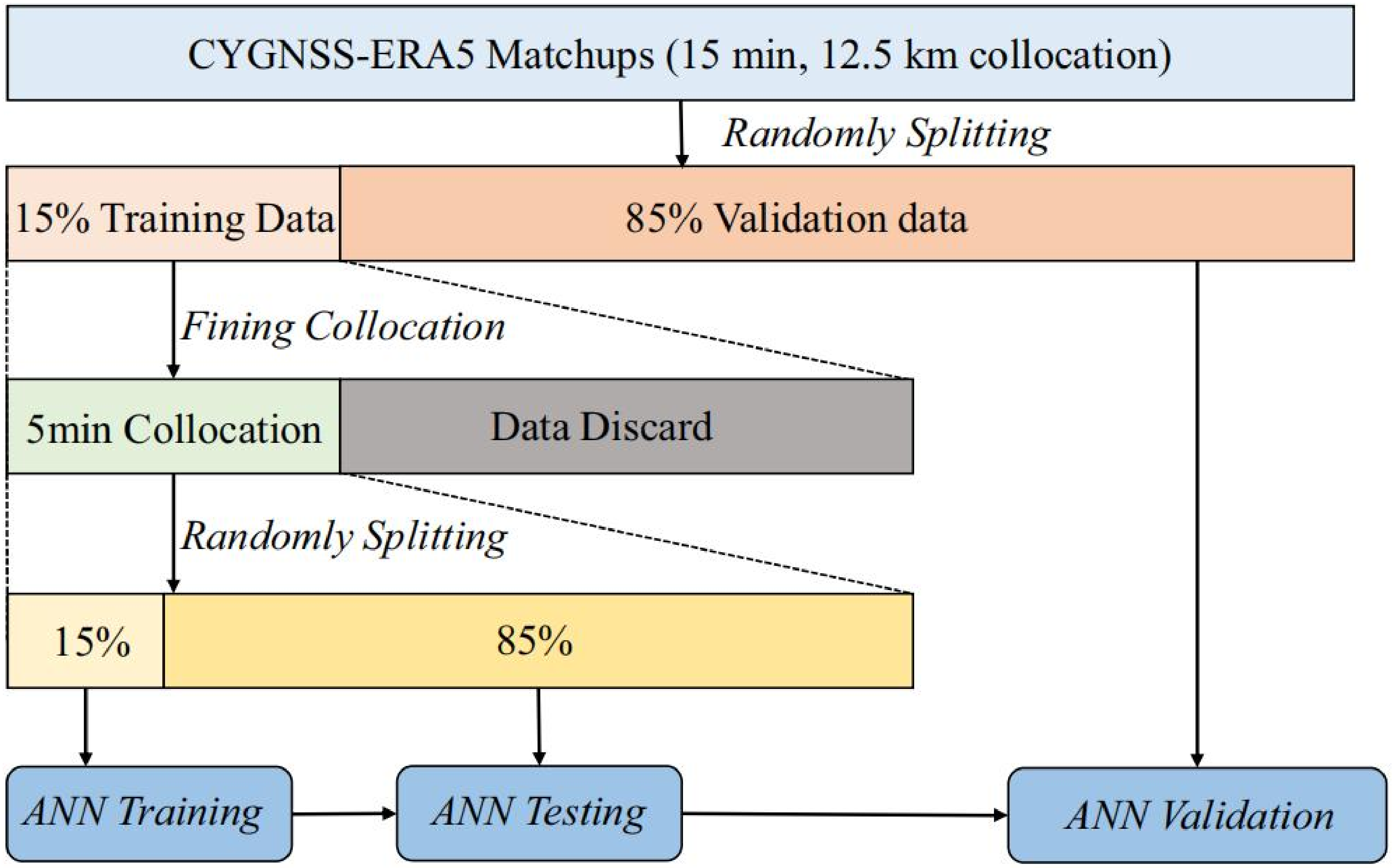

Fig. 2. Subsets selection of the CYGNSS-ERA5 matchups for ANN training and validation.

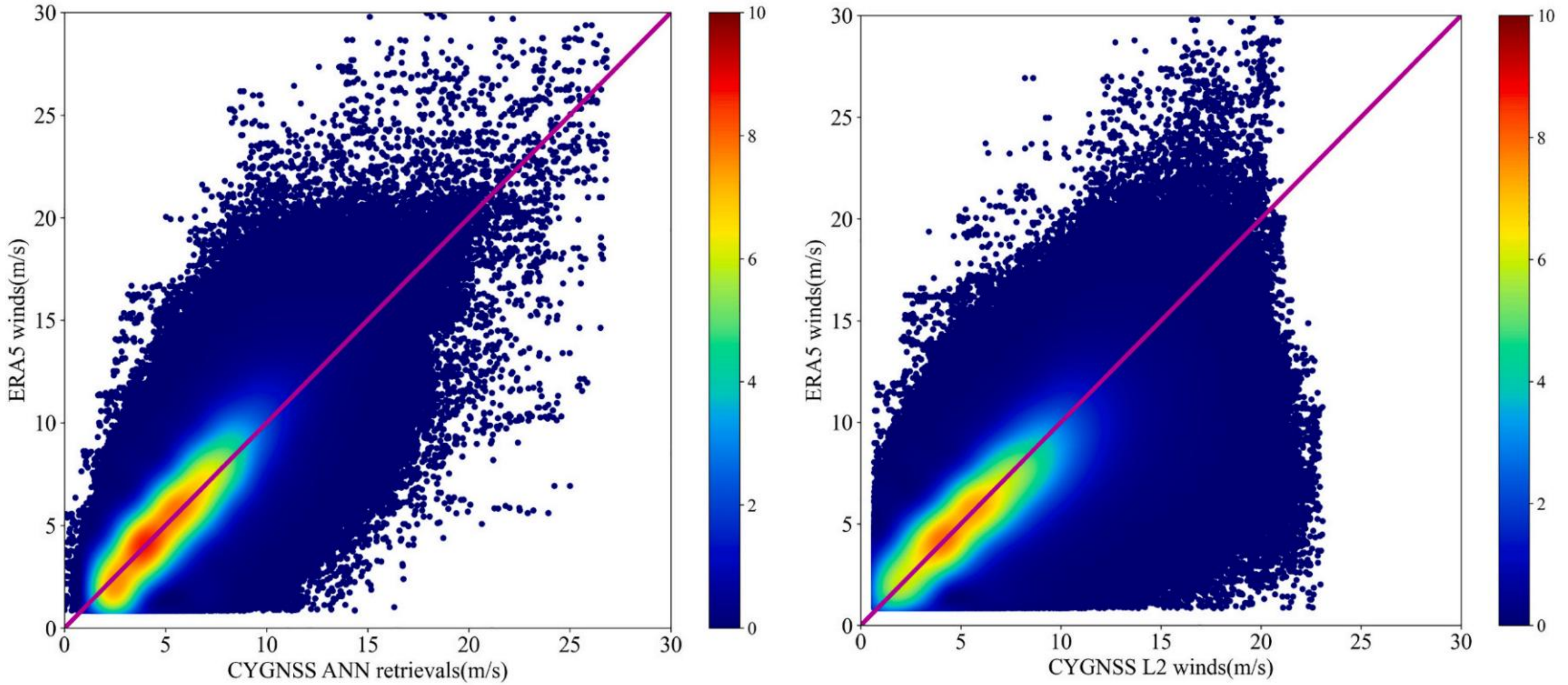

Fig. 4. Comparison between the CYGNSS ANN retrieved wind speed and the ECMWF/C3S ERA5 wind speed values (left). Comparison between the CYGNSS baseline L2 v2.1 wind speed and the ECMWF/C3S ERA5 wind speed values (right). The color scale is 1/100000 of the density of points. The purple line shows the 1:1 diagonal. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

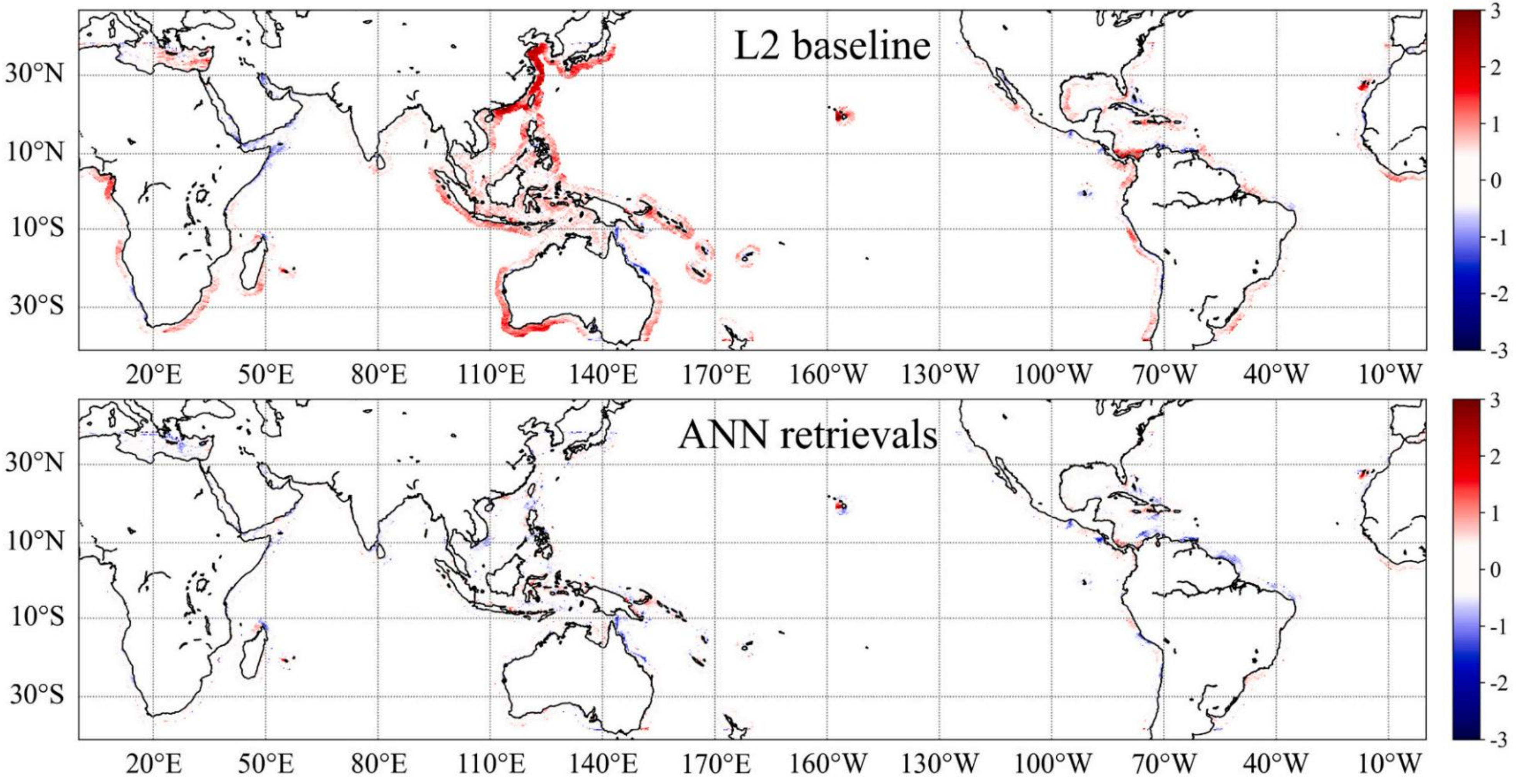

Fig. 7. Geographical map of the wind speed biases (CYGNSS wind speed - ERA5 wind speed) along the coastlines. Top: Wind speed bias of the CYGNSS Level 2 v2.1 products. Bottom: Wind speed bias of the ANN based retrieval.

Progress 2/5

remote sensing

MDPI

Article

Assessment of Ocean Swell Height Observations from Sentinel-1A/B Wave Mode against Buoy In Situ and Modeling Hindcasts

He Wang [1,2,*], Alexis Mouche [2], Romain Husson [3], Antoine Grouazel [2], Bertrand Chapron [2] and Jingsong Yang [4]

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3 Collecte Localisation Satellites, 29280 Plouzané, France; rhusson@groupcls.com
4 State Key Laboratory of Satellite Ocean Environment Dynamics, Second Institute of Oceanography, Ministry of Natural Resources, Hangzhou 310012, China; jsyang@sio.org.cn
* Correspondence: wanghe_sio@126.com; Tel.: +86-22-2753-0334

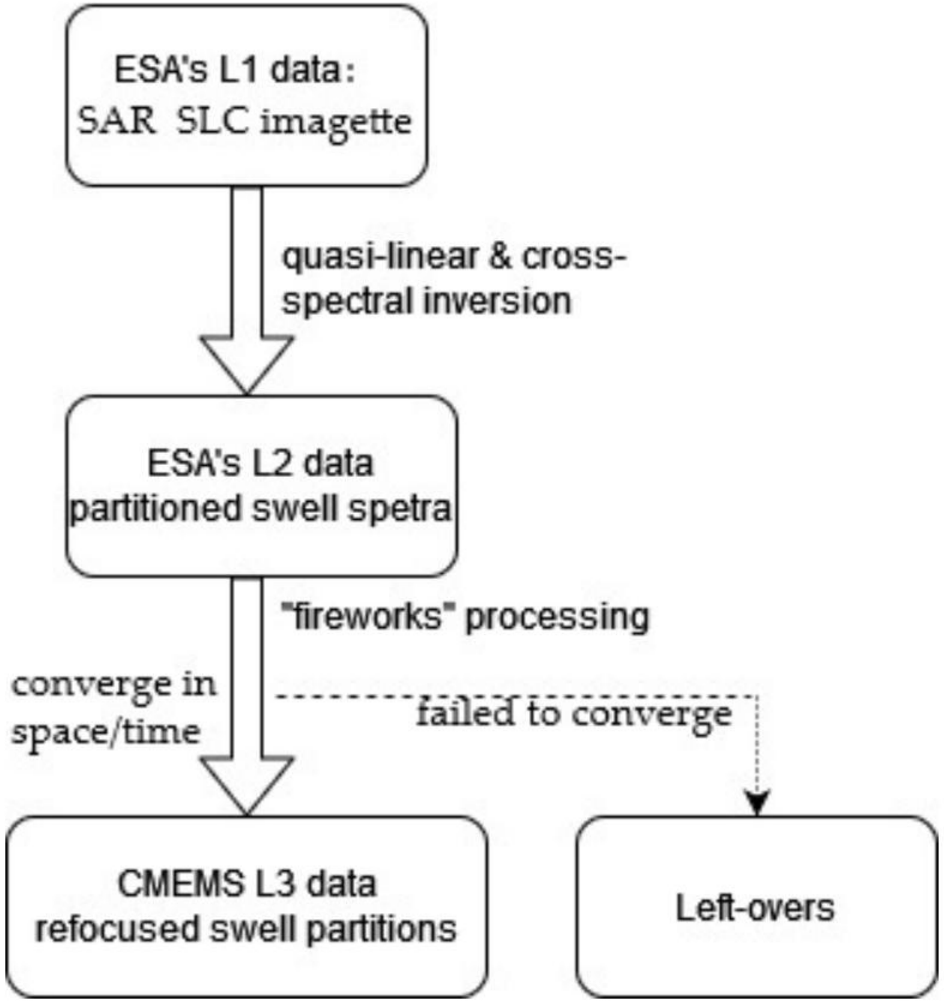

Figure 1. Flow chart of the processing of Sentinel-1A/B wave mode products from L1 to L3.

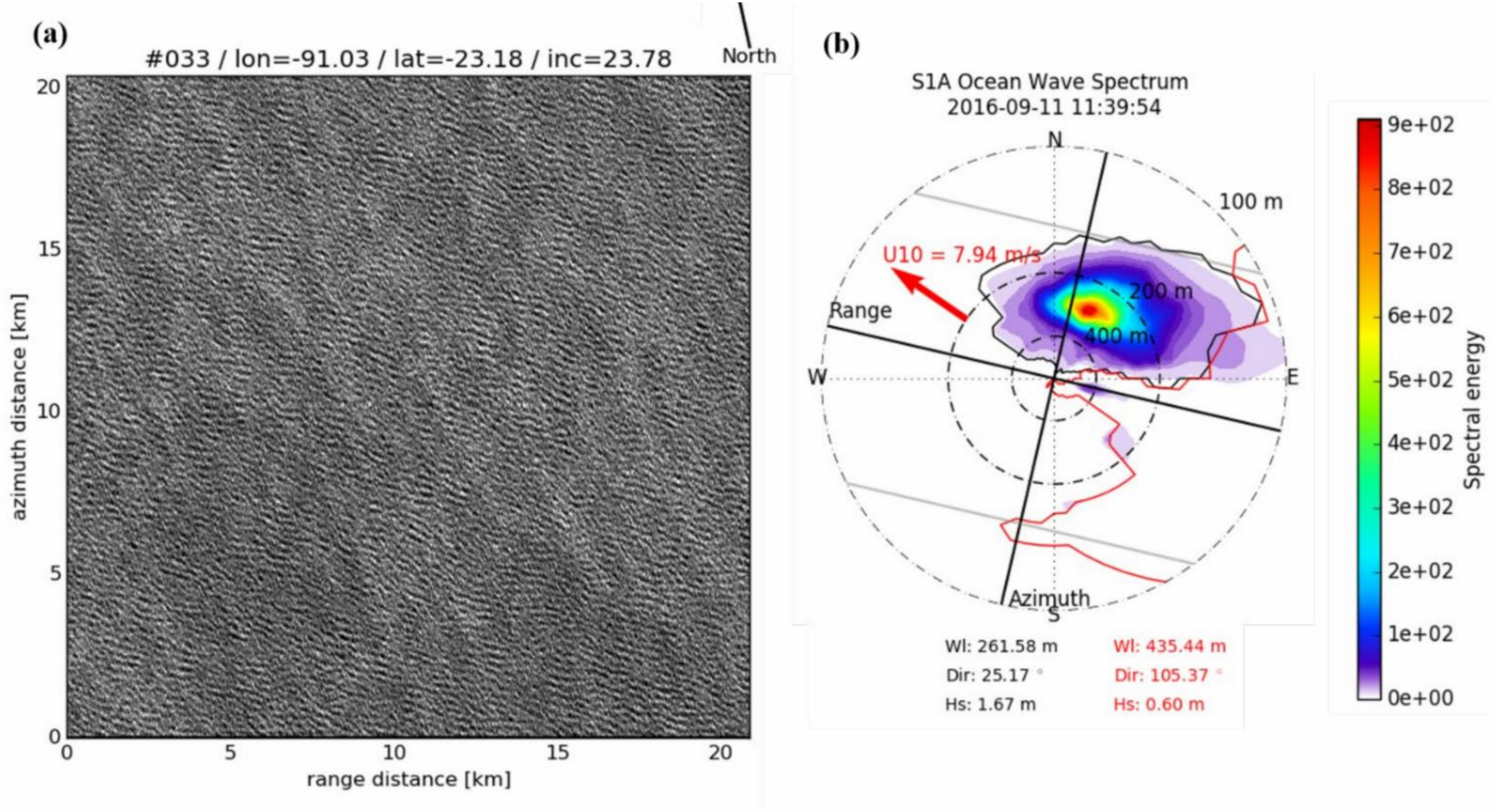

Figure 2. (**a**) Sentinel-1A wave mode roughness image acquired on 11:39:54 UTC 11 September 2016 at 23.18° S/91.03° W, and (**b**) corresponding Level-2 ocean swell spectrum.

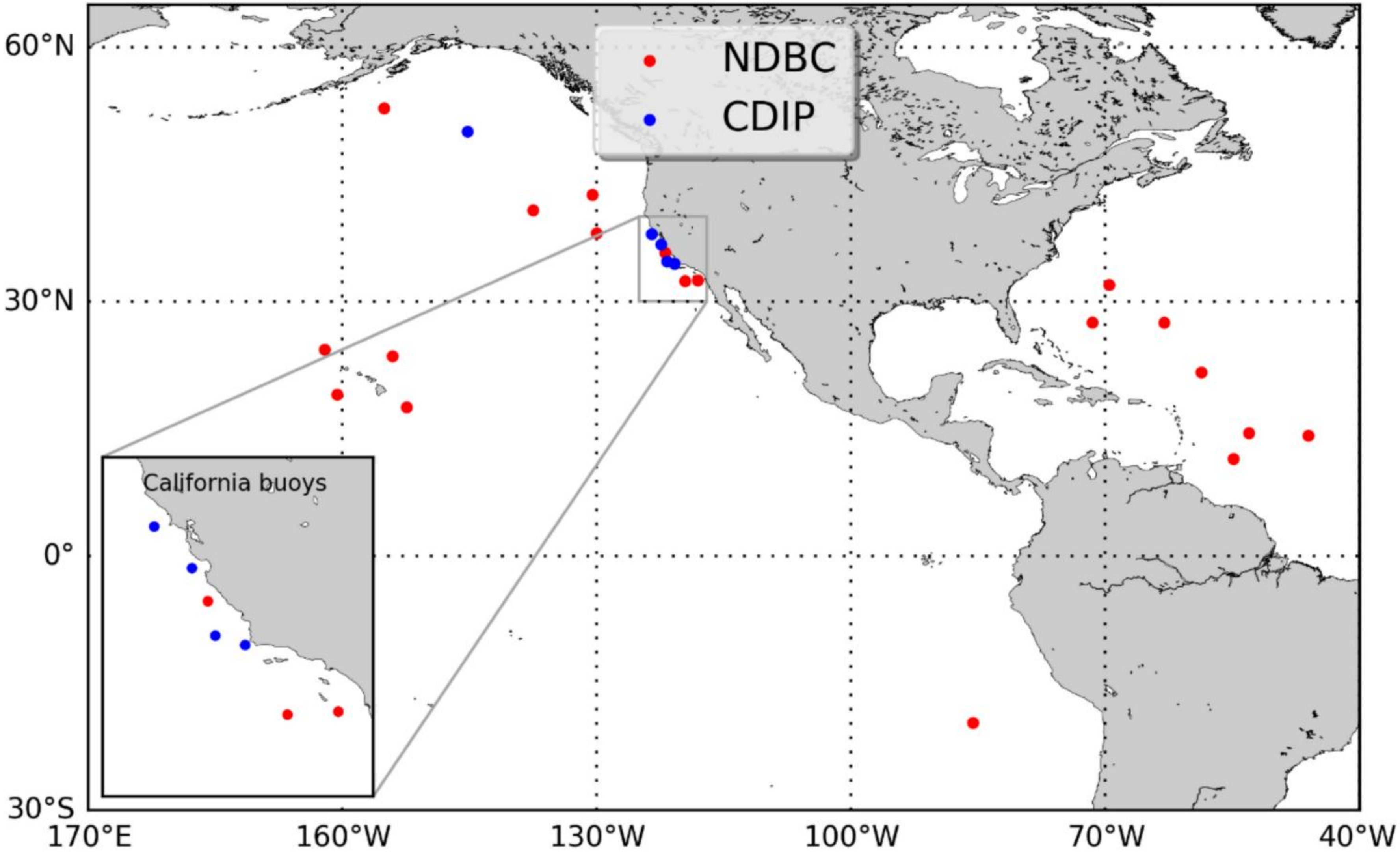

Figure 6. Location of directional wave buoys from the NDBC and CDIP networks.

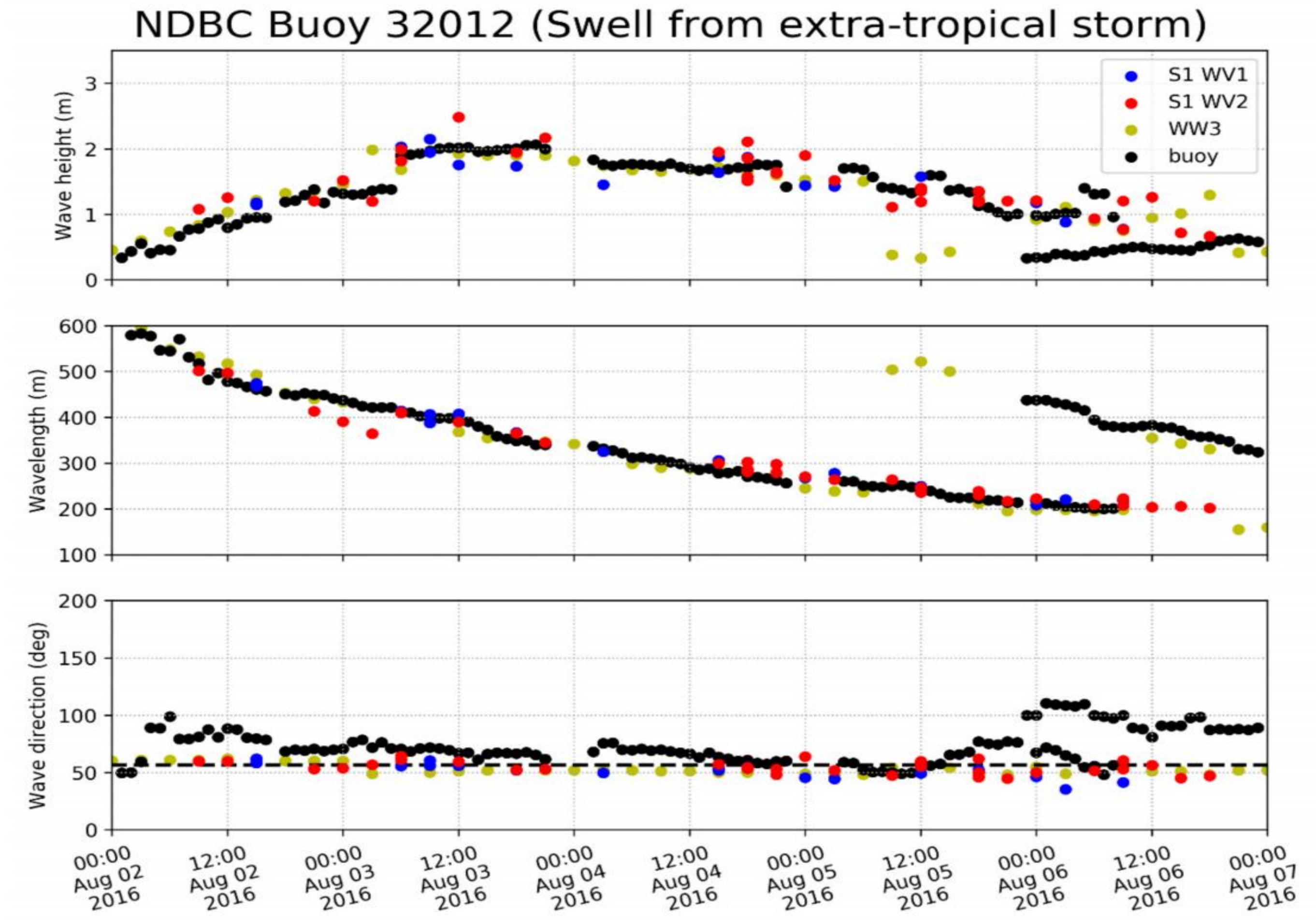

Figure 16. Comparison of significant wave height (**top**), peak wavelength (**middle**), and peak direction (**bottom**) from Level-3 CMEMS "fireworks" SAR products (red and blue dots representing Sentinel-1 SAR data in WV1 and WV2, respectively), buoy measurements (black dots) and WW3 model (yellow dots) at the Stratus buoy station #32012 (19.63° S/84.95° W) during the swell event generated by an extra-tropical storm on 28 July 2016.

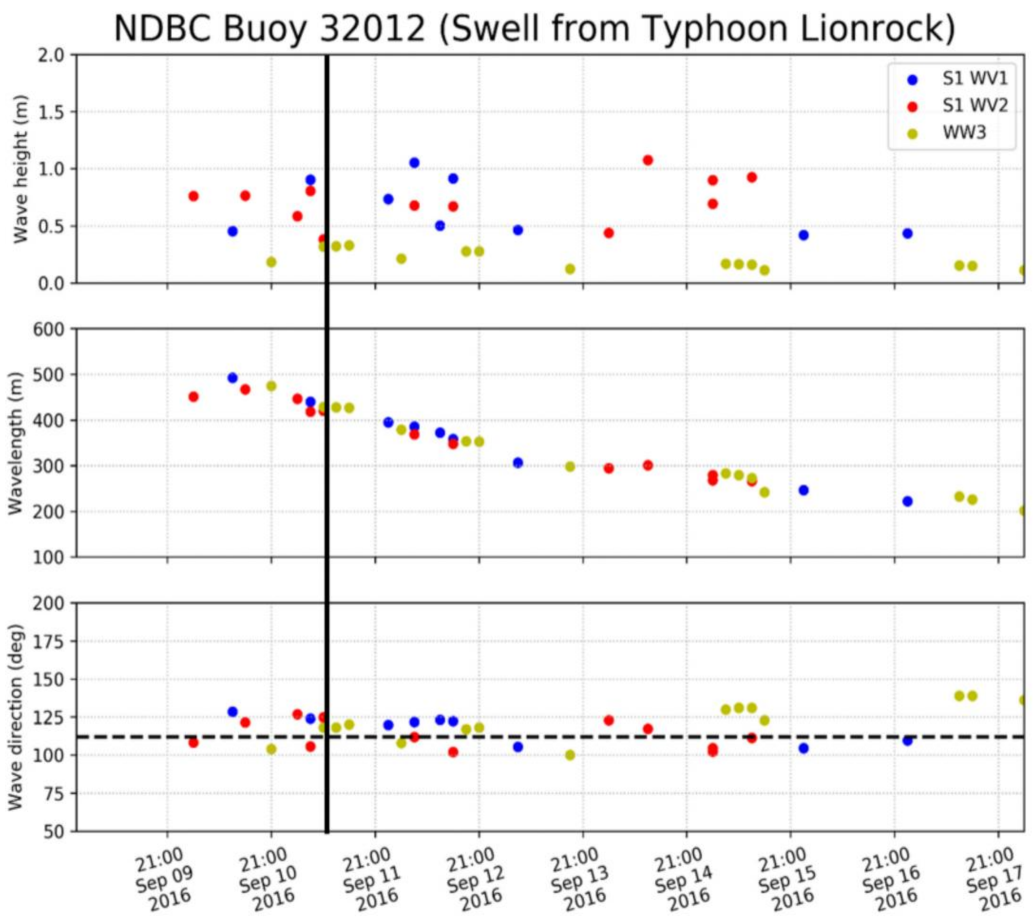

Figure 17. As in Figure 16, but for the case of a swell event originated from Typhoon Lionrock on 29 August 2016. The vertical black line corresponds to 12:00:00 UTC 11 September 2016 (the time of buoy observation presented in Figure 7).

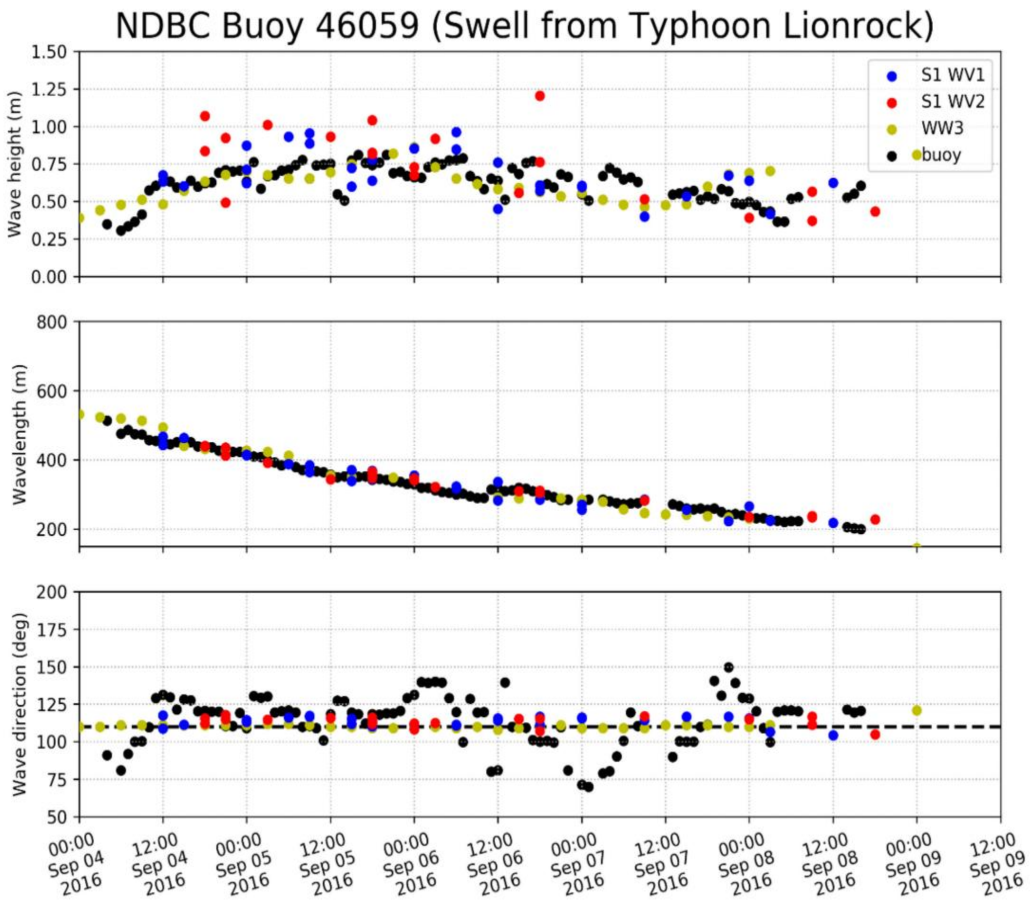

Figure 18. As in Figure 16, but for the case of a swell event originated from Typhoon Lionrock on 29 August at the buoy #46059 (38.05° N/129.90° E).

Dragon 5 Mid-term Results Reporting

Progress 3/5

Quantifying Uncertainties in the Partitioned Swell Heights Observed From CFOSAT SWIM and Sentinel-1 SAR via Triple Collocation

He Wang, Alexis Mouche, Romain Husson, Bertrand Chapron, Jingsong Yang, Jianqiang Liu, and Lin Ren

***Abstract*—Nowadays, Sentinel-1 (S-1) synthetic aperture radars (SARs) operating in wave mode and the real aperture radar (RAR) called Surface Waves Investigation and Monitoring (SWIM) onboard the China-France Oceanography SATellite (CFOSAT) are the only two kinds of spaceborne radars providing directional ocean wave information globally. To quantify the absolute uncertainties in the swell wave heights of a specific wave system (Hss) observed from these two spaceborne sensors, a triple colocation error model is exploited via WaveWatch III (WW3) cussed with respect to regional error characteristics along with a feasible explanation of error sources. The findings could be helpful for better understanding and synergistically exploiting the Hss datasets from these two spaceborne radars.**

***Index Terms*—China-France Oceanography SATellite (CFOSAT), Sentinel-1 (S-1), swell wave height, synthetic aperture radar (SAR), triple collocation, validation, WaveWatch III (WW3).**

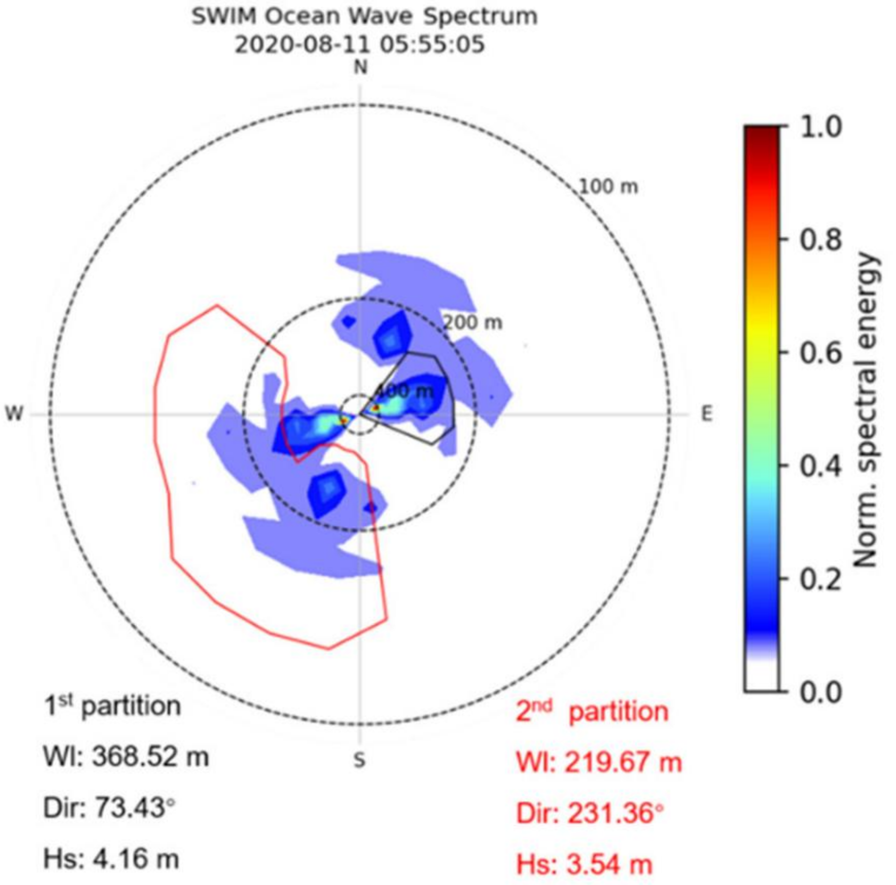

Fig. 2. Example of the SWIM (10° beam)-derived ocean wave spectrum on August 11, 2020, at 05:55:05 (UTC) at 57.29° S/150.0° W.

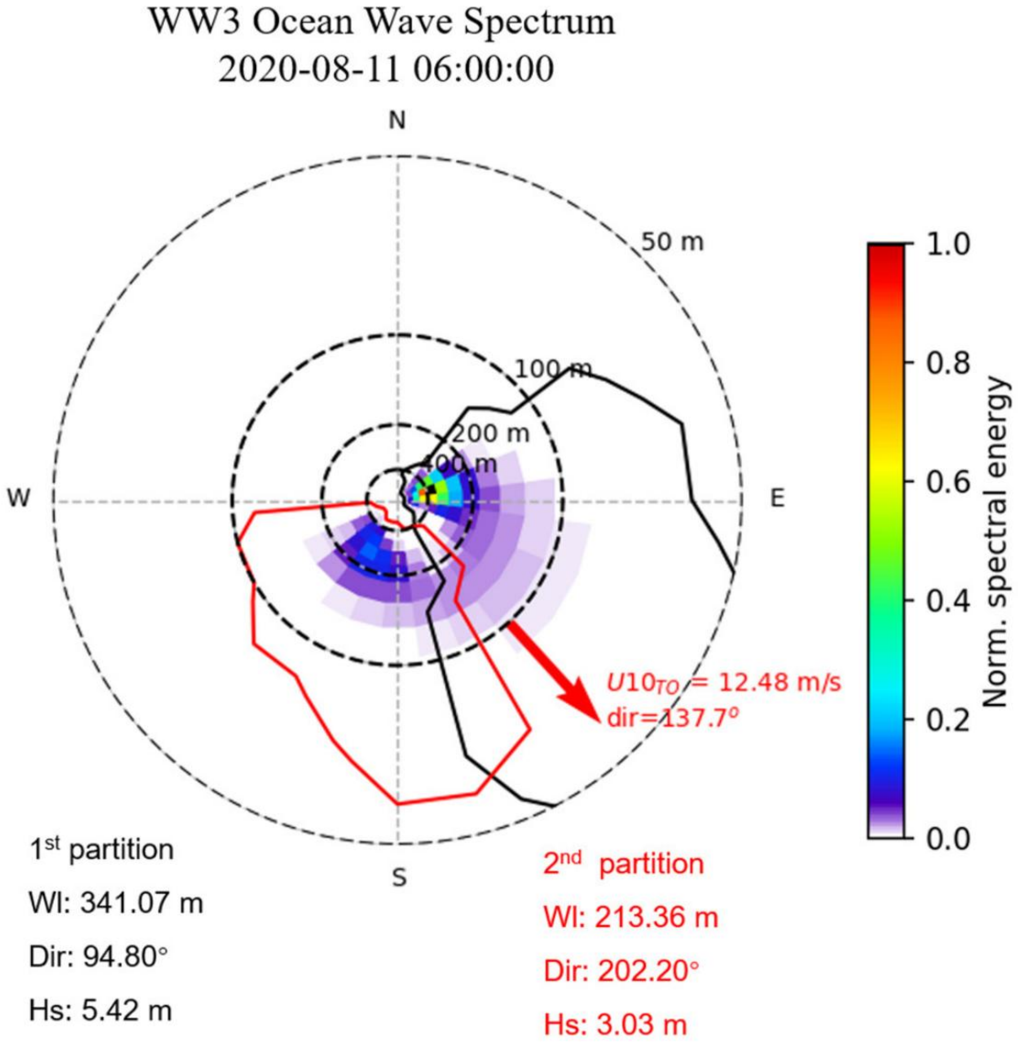

Fig. 3. Example of the WW3 hindcast spectrum on August 11, 2020, at 06:00 (UTC) at 57.5° S/150.5° W.

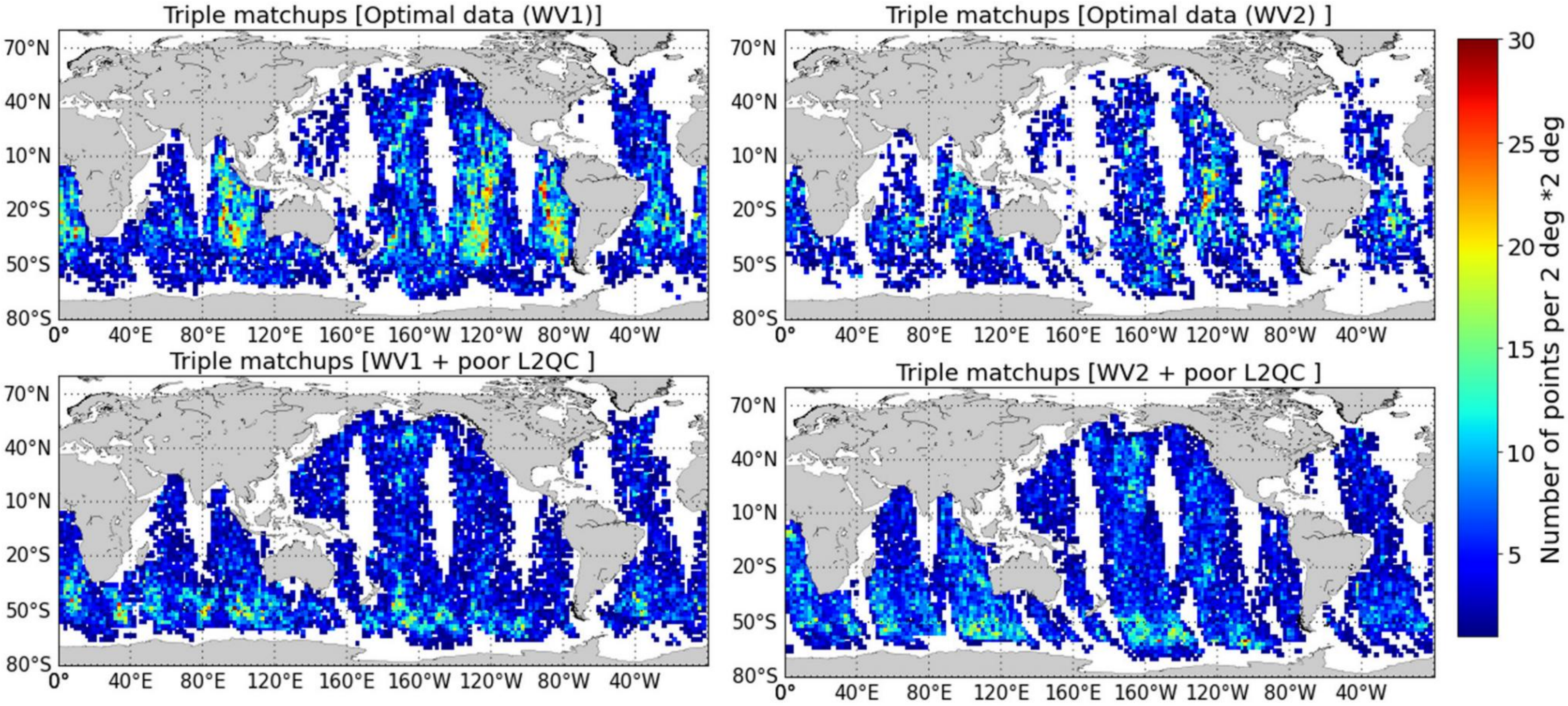

Fig. 9. Distributions of triplets (S-1 SAR WV, CFOSAT SWIM, and WW3) on a 2° × 2° grid.

TABLE II

ESTIMATES OF THE UNCERTAINTY METRICS FROM THE TRIPLE COLLOCATION ANALYSIS ON THE OPTIMAL-MATCHED HSS WITH THE LIMITS WITHIN 95% CONFIDENCE INTERVALS FOR THE CORRESPONDING VALUES GIVEN IN PARENTHESES

Datasets	RMSE (m)			Scatter index (%)			SNR (dB)		
	SAR	SWIM	WW3	SAR	SWIM	WW3	SAR	SWIM	WW3
SAR(**WV1**)-SWIM-WW3	0.35 (0.34, 0.37)	0.23 (0.21, 0.25)	0.42 (0.40, 0.44)	17.35 (16.71, 18.05)	11.32 (10.27, 12.38)	20.73 (19.77, 21.69)	6.34 (5.90, 6.79)	10.92 (10.06, 11.83)	7.88 (7.38, 8.39)
SAR(**WV2**)-SWIM-WW3	0.49 (0.48, 0.51)	0.22 (0.20, 0.24)	0.41 (0.39, 0.43)	23.58 (22.86, 24.30)	10.99 (9.88, 12.04)	19.42 (18.28, 10.61)	3.88 (3.46, 4.31)	11.22 (10.32, 12.24)	7.88 (7.27, 8.48)

TABLE III

SAME AS TABLE II BUT FOR THE SOUTHERN OCEAN (LATITUDES < −45°)

Datasets	RMSE (m)			Scatter index (%)			SNR (dB)		
	SAR	SWIM	WW3	SAR	SWIM	WW3	SAR	SWIM	WW3
SAR(**WV1**)-SWIM-WW3	0.49 (0.47, 0.51)	0.37 (0.34, 0.40)	0.66 (0.63, 0.70)	15.63 (15.02, 16.25)	11.93 (10.97, 12.88)	21.31 (20.16, 22.48)	4.65 (4.15, 5.17)	8.46 (7.68, 9.29)	6.03 (5.45, 6.62)
SAR(**WV2**)-SWIM-WW3	0.83 (0.80, 0.85)	0.33 (0.29, 0.38)	0.67 (0.64, 0.71)	25.00 (24.30, 25.73)	10.11 (8.71, 11.37)	20.22 (18.99, 21.41)	-2.89 (-3.27, -2.38)	9.20 (8.05, 10.62)	5.54 (4.90, 6.21)

Dragon 5 Mid-term Results Reporting

Progress 4/5

IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING, VOL. 60, 2022 5103012

Up-to-Downwave Asymmetry of the CFOSAT SWIM Fluctuation Spectrum for Wave Direction Ambiguity Removal

Huimin Li, Danièle Hauser, *Member, IEEE*, Bertrand Chapron, Frédéric Nouguier, Patricia Schippers, Biao Zhang, *Senior Member, IEEE*, Jingsong Yang, and Yijun He, *Member, IEEE*

***Abstract*—The surface wave investigation and monitoring (SWIM) aboard the China-France Oceanography Satellite (CFOSAT), a pioneer conically scanning wave spectrometer, was successfully launched on October 29, 2018. Its innovative configuration composed of one nadir and five rotating near-nadir beams is designed to simultaneously observe the directional wave spectrum at a global scale. In this study, we systematically implement the spectral analysis of the radar backscattering with the periodogram technique to obtain the fluctuation spectrum for each azimuth direction. The 2-D fluctuation spectrum of the three spectral beams ($\theta = 6°$, $8°$, and $10°$) combines all the azimuth directions within one entire rotation of 360°. The case study demonstrates that the wave features (peak wavelength and direction) are roughly consistent between the estimated fluctuation spectrum and the collocated WaveWatch III wave slope spectrum. A marked up-to-downwave asymmetry of the fluctuation spectrum with larger spectral level in the upwave direction for all the three spectral beams is observed. A ratio is defined between the fluctuation spectrum within the [0°, 180°] sector relative to the [180°, 360°] sector. Statistics display that this ratio is greater than 1 when it denotes the up-to-downwave ratio and smaller than 1 for the down-to-upwave ratio. This observed spectrum asymmetry is linked to the asymmetric modulation from upwind to downwind. In addition, we employ such finding to help remove the 180° wave direction ambiguity from a practical point of view. Preliminary results of the direction ambiguity removal display a bias of 41.3°, 40.6°, and 36.7° for the beams. The 10° beam shows slightly better performance compared to the other two beams in terms of bias and standard deviation. This shall lay a strong basis for the operational implementation of such algorithm to resolve the direction ambiguity.**

***Index Terms*—China–France Oceanography Satellite (CFOSAT) surface wave investigation and monitoring (SWIM), up-to-downwave asymmetry of fluctuation spectrum, wave direction ambiguity removal.**

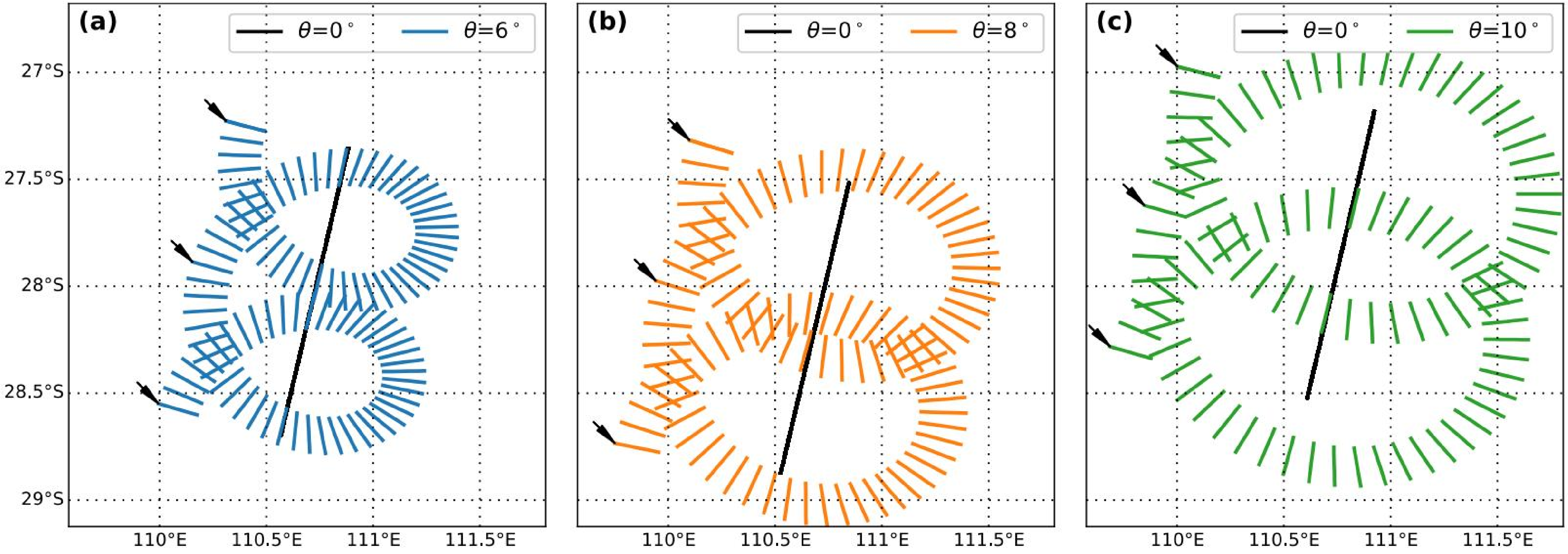

Fig. 1. Example for acquisition pattern of (a) 6°, (b) 8°, and (c) 10° beams within two rotations of 360°. Black curve denotes the footprint of the nadir beam. Note that the slightly varying coverage of these three incidence angles is due to their incontiguous azimuth directions at a given moment. The black arrow indicates the starting position of one entire rotation.

TABLE I

DETAILS OF SWIM OBSERVATION SWATH R_{SWATH} AND GROUND-RANGE RESOLUTION L_r

INC[°]	R_{swath} [km]	N_r	L_r [m]
2	18.1	4	53.9
4	36.3	4	27.0
6	54.5	2	9.0
8	72.9	3	10.1
10	91.5	3	8.1

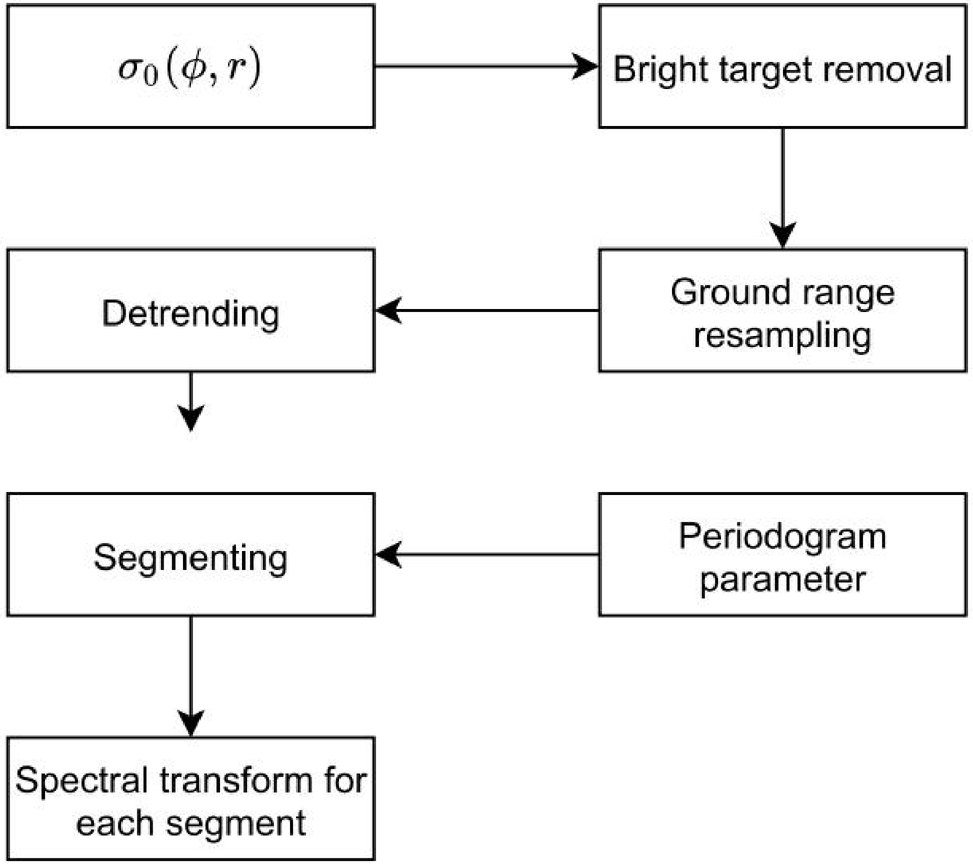

Fig. 2. Flowchart of the fluctuation spectrum estimate along each azimuth direction. The ground-range resampling spacing is set to be 5 m and the periodogram window is 512 pixels with 256 pixels overlapping.

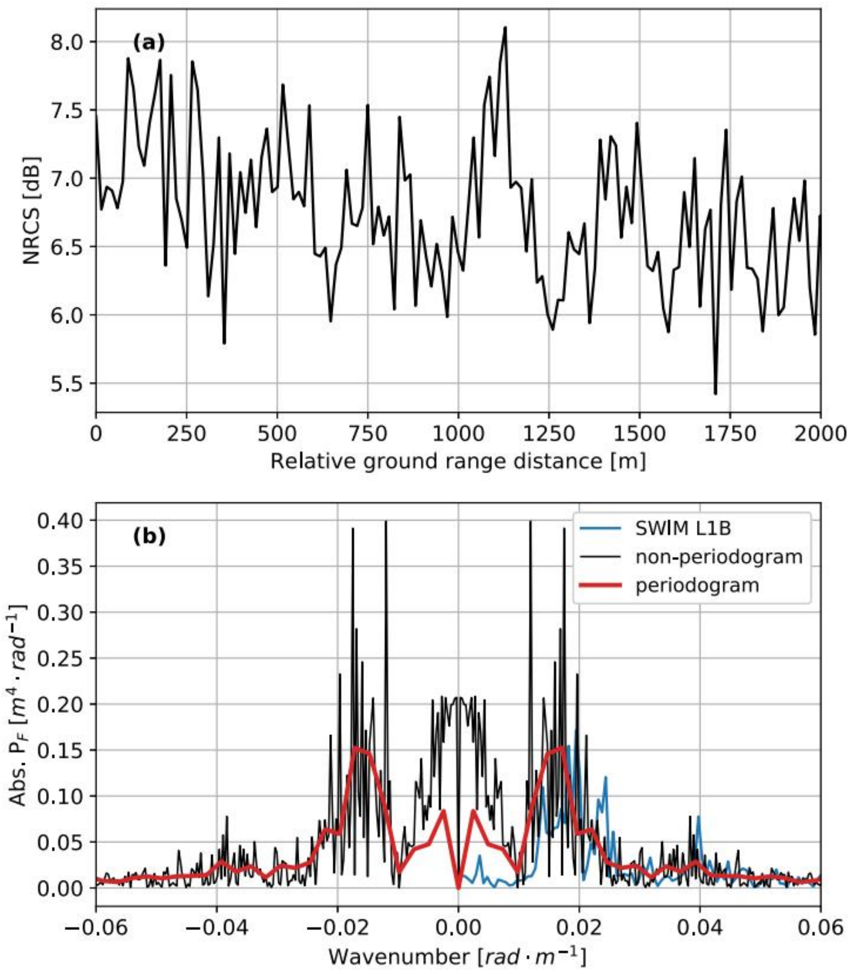

Fig. 3. Example for (a) SWIM measured σ_0 profile of 10° beam with respect to the relative ground-range distance. (b) Comparison of the obtained fluctuation spectrum using periodogram algorithm in Fig. 2 (red curve) and nonperiodogram method (black curve) and the results annotated in SWIM level-1B products (blue curve).

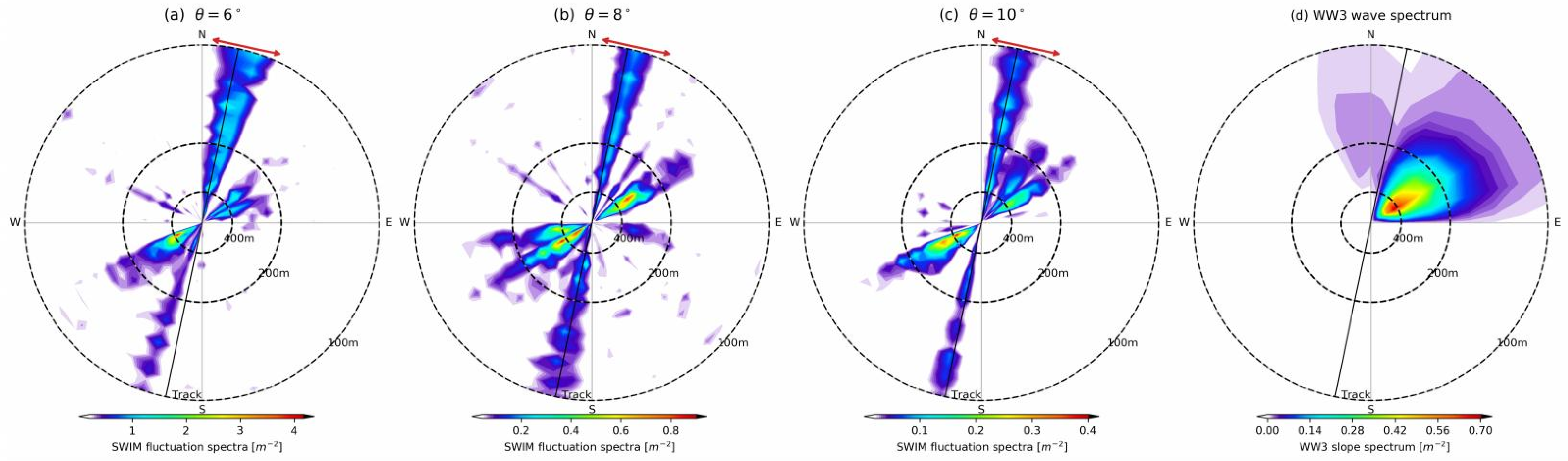

Fig. 4. 2-D fluctuation spectrum constructed from one rotation of 360° for the beam of (a) 6°, (b) 8°, and (c) 10°. (d) Collocated WW3 wave slope spectrum is shown for comparison. The WW3 spectra direction corresponds to the direction that the waves travel to. The red arrow denotes the directional sector where the signal is strong affected by the instrument noise.

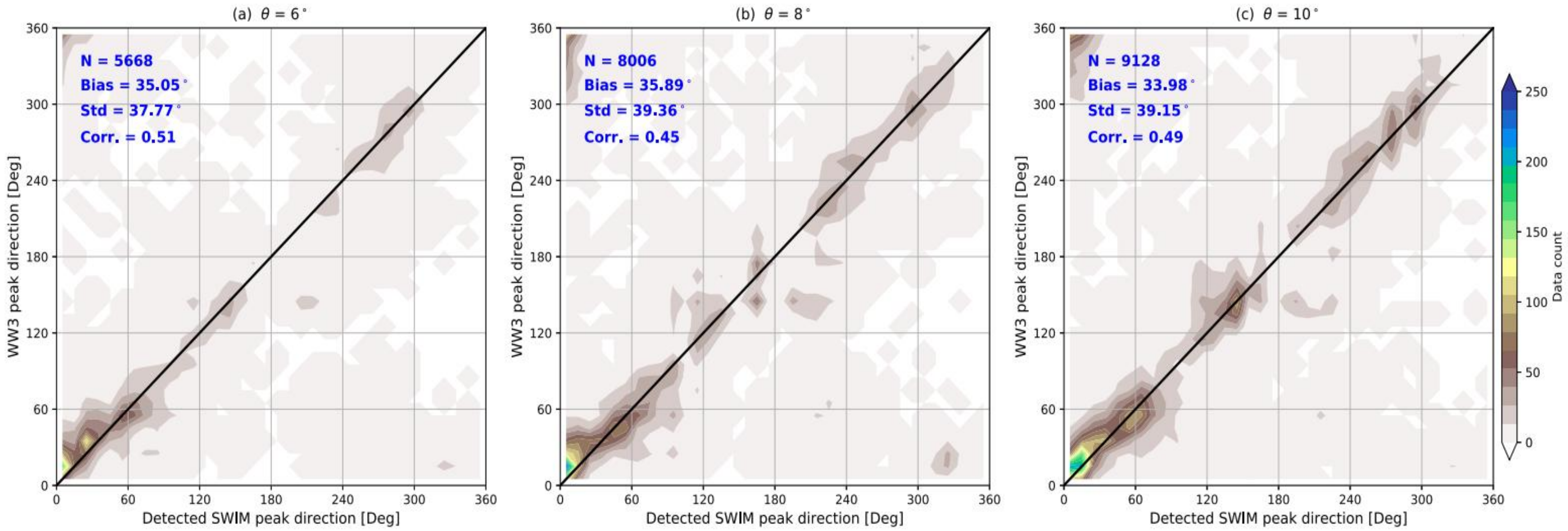

Fig. 9. Comparison of SWIM resolved wave peak direction with respect to the collocated WW3 wave peak direction for (a) 6°, (b) 8°, and (c) 10° beams. "N" annotated in each plot denotes the total number of valid peak pairs. Colors are the data count with directional bins of 10° for both axes. Result metrics are given on the top-left corner of each plot.

TABLE II

METRICS OF AMBIGUITY REMOVAL

INC [°]	Total			U10<15m/s			U10>15m/s			corr.
	N	Bias	STD	N	Bias	STD	N	Bias	STD	
6	6442	34.99°	37.69°	6195	34.28°	37.05°	247	52.83°	47.99°	0.51
8	8779	35.42°	38.90°	8543	34.94°	38.47°	236	52.84°	48.88°	0.46
10	8978	33.86°	39.25°	8798	33.40°	38.74°	180	56.40°	54.64°	0.50

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Validation of Wave Spectral Partitions From SWIM Instrument On-Board CFOSAT Against *In Situ* Data

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***Abstract*—The surface waves investigation and monitoring (SWIM) instrument onboard the China–France Oceanography Satellite (CFOSAT) can retrieve directional wave spectra with a wavelength range of 70–500 m. This study aims to validate the partitioned integrated wave parameters (PIWPs) from SWIM, including partitioned significant wave height (PSWH), partitioned peak wave period (PPWP), and partitioned peak wave direction (PPWD), against those from National Data Buoy of PSWH from SWIM is not that good at this stage, probably because the high noise level in the spectra impacts the result of the partitioning algorithm. Further improvement is needed to obtain better PSWH information.**

***Index Terms*—China–France oceanography satellite (CFOSAT), spectral partition, surface waves investigation and monitoring (SWIM), validation.**

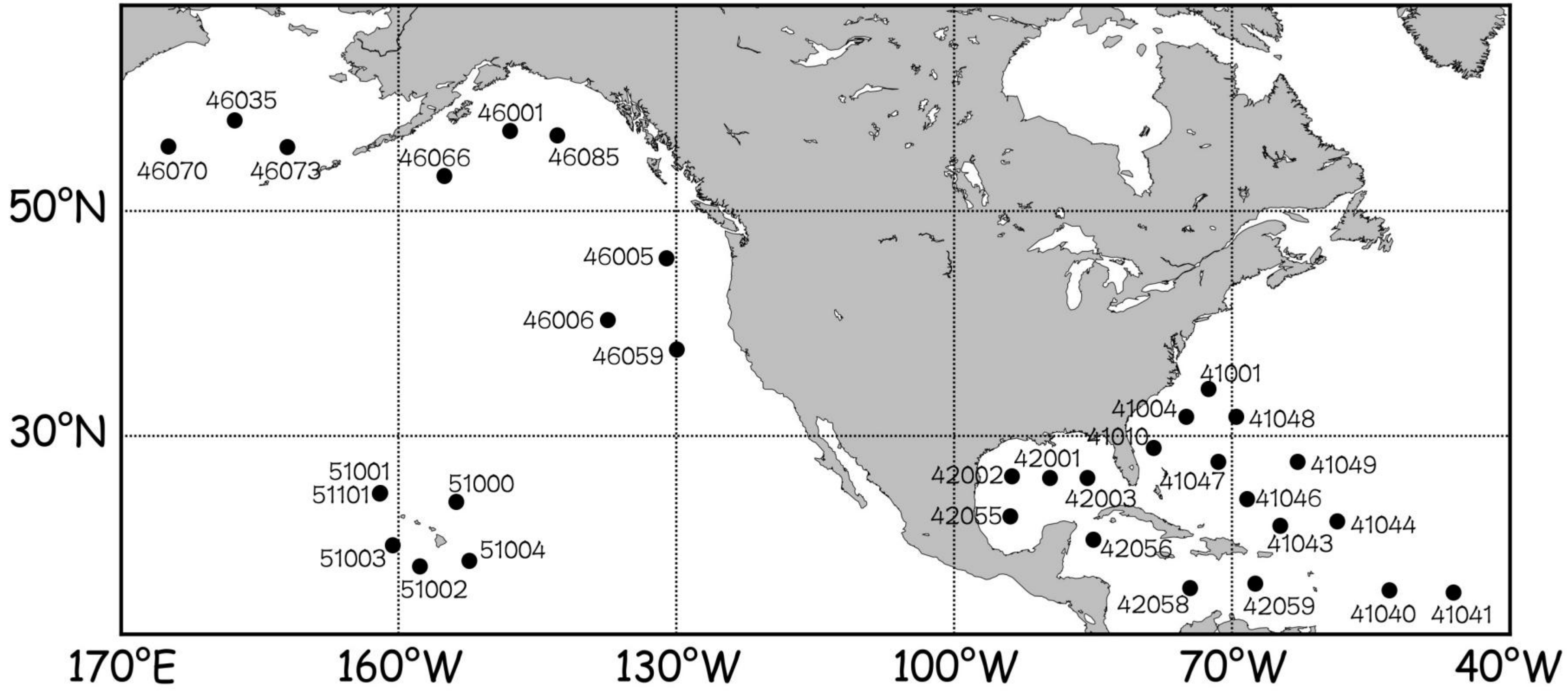
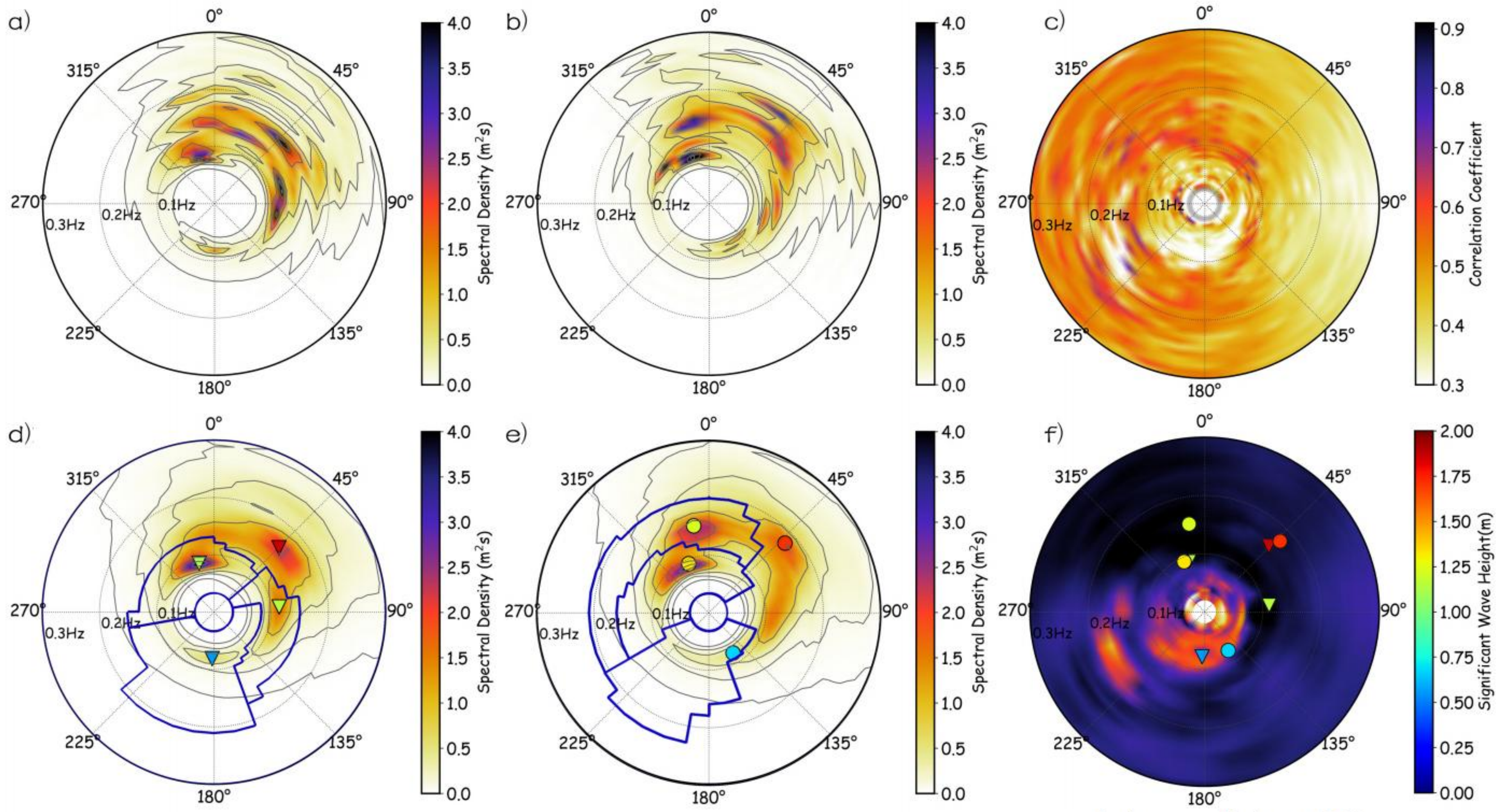


Fig. 1. Locations of the NDBC buoys used in the study.

Dragon 5 Mid-term Results Reporting



correlation coefficient (CC).

Fig. 2. Directional wave spectra obtained at UTC1700 May 9, 2019 from the buoy (a) 51001, (b) 51101, and (c) CC of spectral density between spectra from the two buoys over the period from May 2019 to April 2020. (d)–(f) is the same as (a)–(c), but after smoothing in spectral space. Subplot (c) and (f) use the same color bar in (c). Triangles in (d) and (f) and circles in (e) and (f) represent the partitions derived from the spectra from buoy 51001 and 51101, respectively. The colors of triangles and circles indicate PSWHs and the locations of them indicate PPWPs and PPWDs, and all PSWHs indicated by triangles and circles use the same color bar in (f). The blue solid lines in (d) and (e) are the boundaries on different identified partitions.

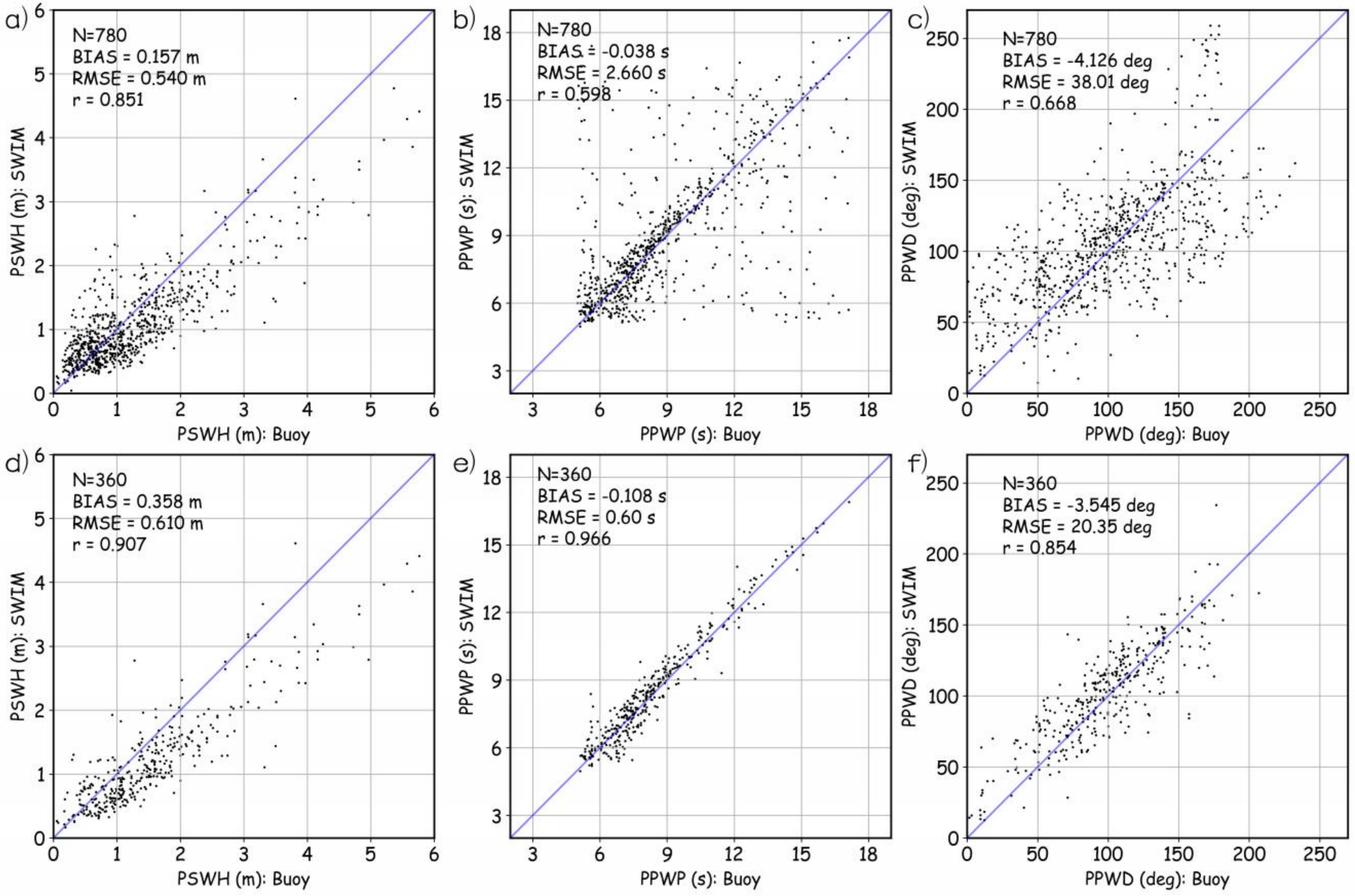


Fig. 8. Comparison of PIWPs (left column: PSWH, middle column: PPWP, right column: PPWD) between SWIM 10° beam and buoys over the period from May 2019 to April 2020. (a)–(c) All partitions are cross-assigned. (d)–(f) Only partitions with the minimum spectral distance for each pair of spectra are cross-assigned.

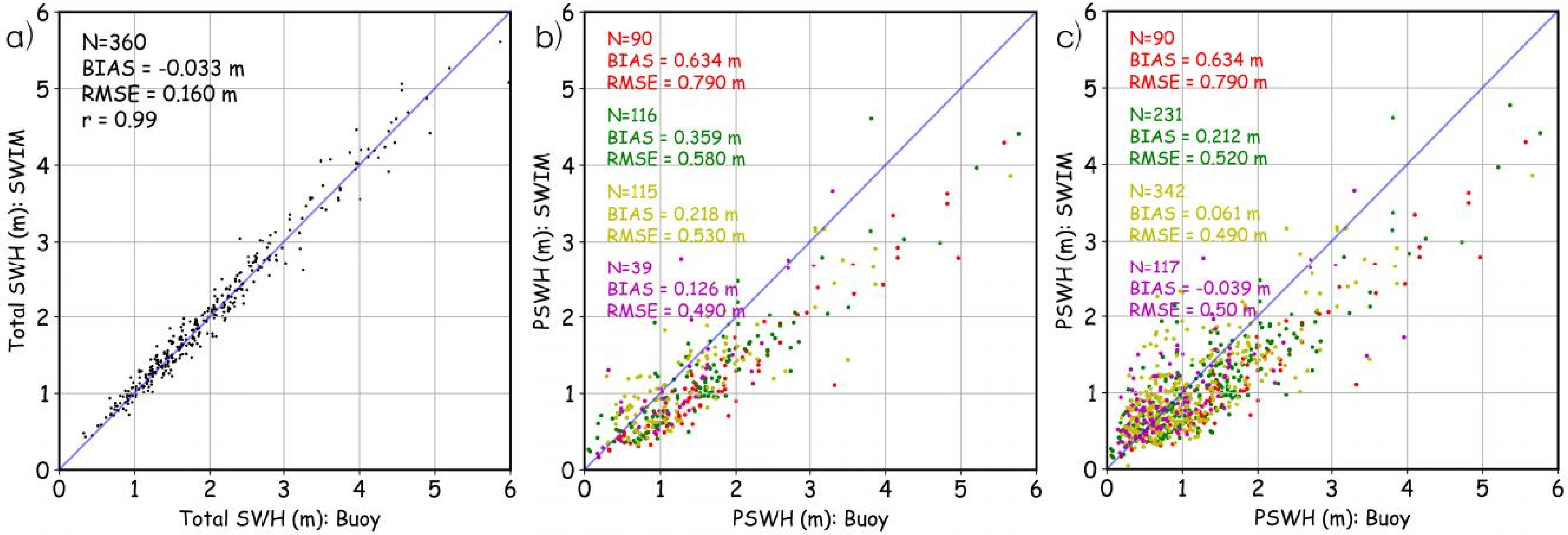


Fig. 12. Comparison of SWH between SWIM 10° beam and buoys. (a) Total SWH. (b) PSWH for best-matched partitions. (c) PSWH for all cross-assigned partitions. The colors of dots and texts in (b) and (c) indicate the number of partitions identified in the collocated buoy spectra (red: one partition, green: two partitions, yellow: three partitions, and purple: four partitions).

TABLE I

ERROR METRICS OF PIWPS FROM DIFFERENT BEAMS AND THE "WAVE BOX" OF SWIM FOR THE BEST-MATCHED PARTITIONS (ONLY PARTITIONS WITH THE MINIMUM SPECTRAL DISTANCE FOR EACH PAIR OF SPECTRA ARE CROSS-ASSIGNED) COMPARED WITH BUOY DATA FROM MAY 2019 TO APRIL 2020

	Beam 6°	Beam 8°	Beam 10°	Wave Box
No. Collocation	371	367	360	391
PSWH RMSE	0.66 m	0.60 m	0.61 m	0.63 m
PPWP RMSE	0.74 s	0.62 s	0.60 s	0.69 s
PPWD RMSE	23.2°	20.4°	20.4°	21.3°
PSWH Bias	0.46 m	0.35 m	0.36 m	0.33 m
PPWP Bias	-0.16 s	-0.16 s	-0.11 s	-0.19 s
PPWD Bias	-2.5°	-2.9°	-3.5°	-2.7°
PSWH CC	0.92	0.91	0.91	0.92
PPWP CC	0.96	0.97	0.97	0.96
PPWD CC	0.86	0.85	0.85	0.86

Project's schedule

The overall progress of this project will be coordinated by the two PIs: Dr. Bertrand CHAPRON and Prof. Jingsong YANG. The obtained results will be accordingly reported at each annual symposium.

Year 1: Data preparation, methodology development;
Year 2: Data preparation, methodology development, calculation, analysis;
Year 3: Calculation, analysis, validation;
Year 4: Analysis, validation, pre-operation and demonstration.

Future plan

Thanks for your attention