A New Smart Weighted Fitting Algorithm of Retrieving SWH in China's Offshore Waters Based on Data from the SWIM Radar on Board the CFOSAT

Jiasheng Tian[1], Zhiya Yao[1], Zongrui Tian[2], and Jian Shi[3]

- 1 School of Electronic Information and Communications, Huazhong University of Science and Technology.
- 2 College of Information Science and Engineering, Hunan Normal University.
- Corresponding author: Zhiya Yao (yzyjkcs421@163.com)
- Corresponding author: Zongrui Tian (microwavetjs@163.com)

Motivation

The nadir echo waveforms of Surface Ware Investigation and Monitoring (SWIM) are similar to those provided by satellite radar altimeter: both are affected by land echoes in coastal waters. For this reason, geophysical parameters (i.e., significant wave height (SWH)) derived from the nadir echoes retrieved over coastal waters have relatively large errors and are reliable only to a certain extent.

Key Points

1. Coastal echo waveforms were simulated by electromagnetic scattering models.

2. A new smart weighted fitting algorithm varied smartly weighted coefficients according to the number of bins contaminated by land echoes.

3. The new algorithm was able to provide the SWH in China's offshore waters and reduce the unusable distance to ⩽5 km.

Part1:A new SWPF algorithm for coastal waters

- **The main idea of SWPF algorithm:**
- Identify and ignore the parts of echo waveforms that are seriously polluted by land echoes (i.e., that provide a smaller weighted value), and for focusing on ocean echoes by setting a larger weighted value.

$$W(i)=\begin{cases}1+\exp(-\Delta p(i)) & \Delta p(i)>0\\ 1+\exp(\Delta p(i)) & \Delta p(i)<0\end{cases}$$

- where $\Delta P(i)=P(i)-P(i-1)$

- **Inversion algorithm：**
- The SWPF algorithm can retrieve the ocean parameters by combining the Brown model or MLE4 with equation

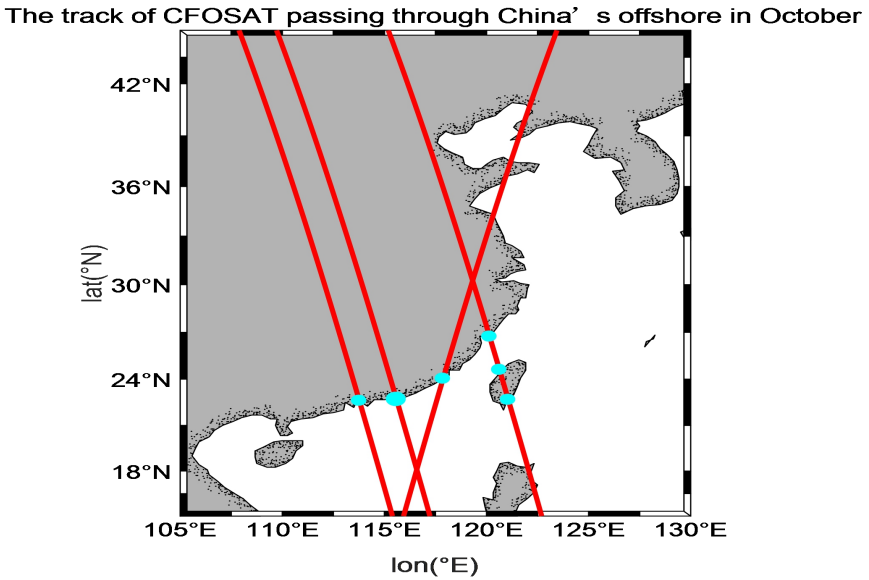
Part2:Classification and simulation of echoes

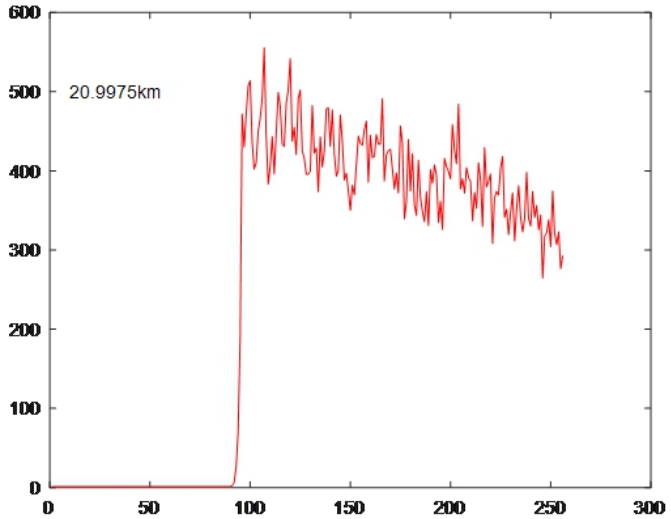
- Several orbits of CFOSAT were selected, as shown in the next page.The blue points shown in the Figure were used as reference to calculate the distance of some echo waveforms.

- We classify waveforms into three types :
- **(1)Ocean echoes (2)Coastal echoes (3)Land echoes**

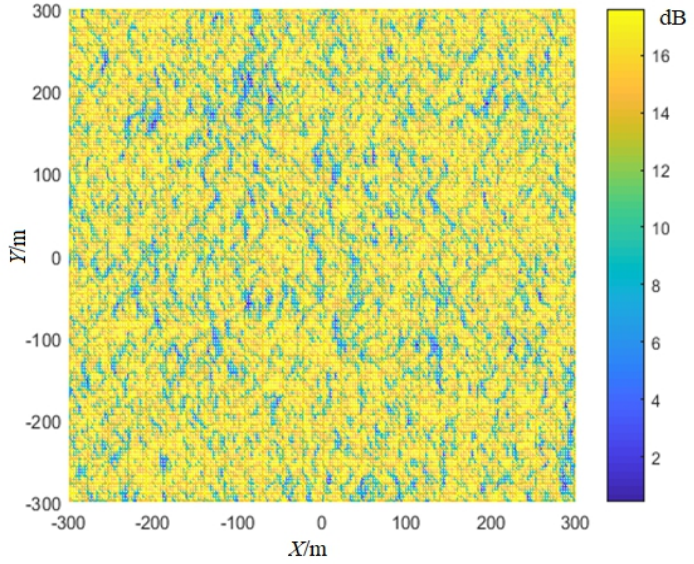
- The coastal echoes are classified into three typys:
- **(1)Distorted failing edge (2)Distorted leading edge (3)Distorted noise area**

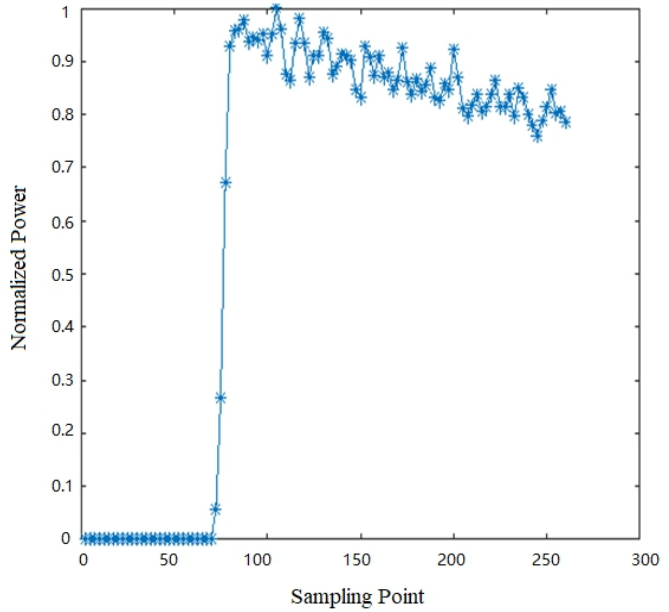
Ocean echoes





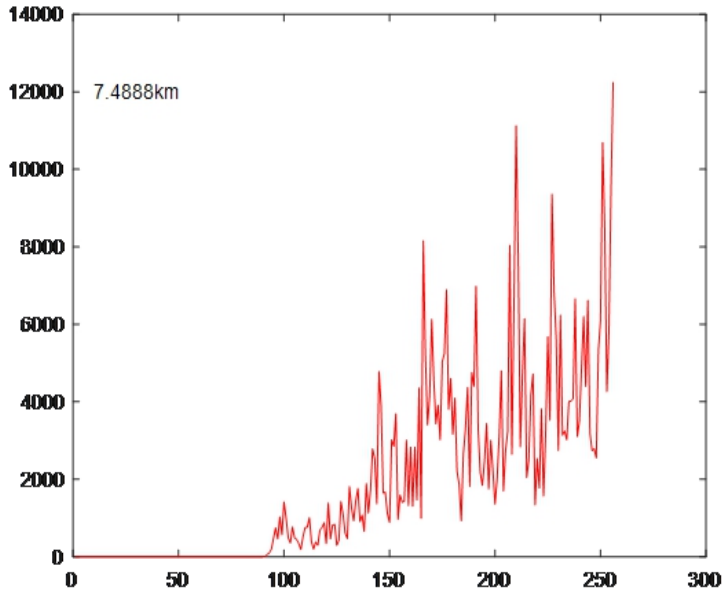
measured waveform from SWIM



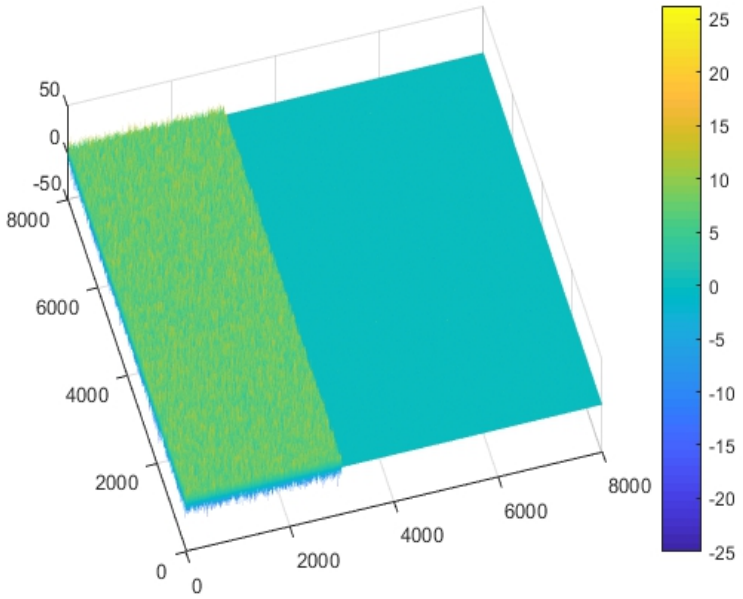


Simulated waveform

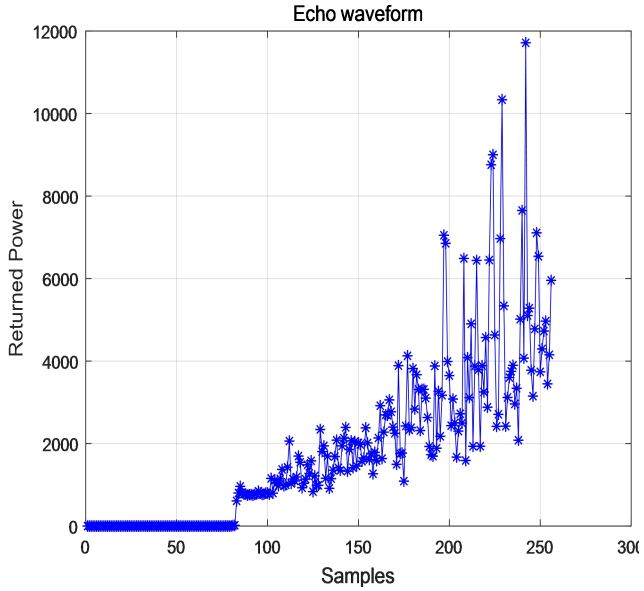
Coastal echoes--Distorted failing edge



measured waveform from SWIM

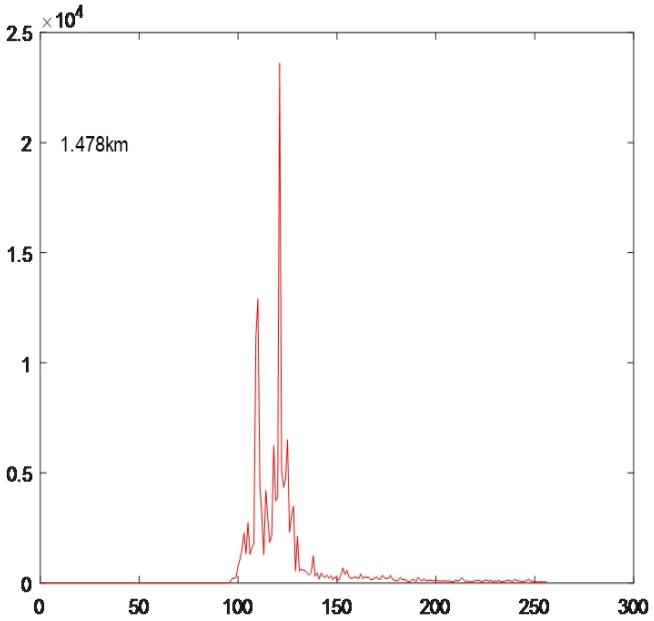


Simulation model

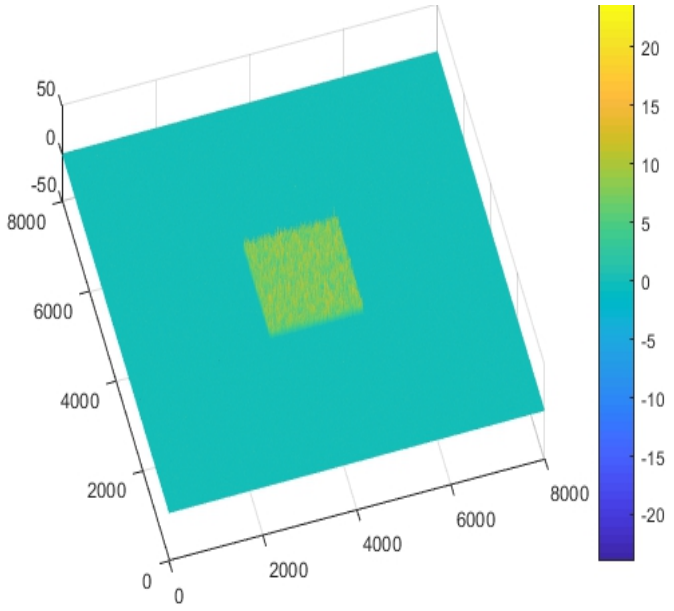


Simulated waveform

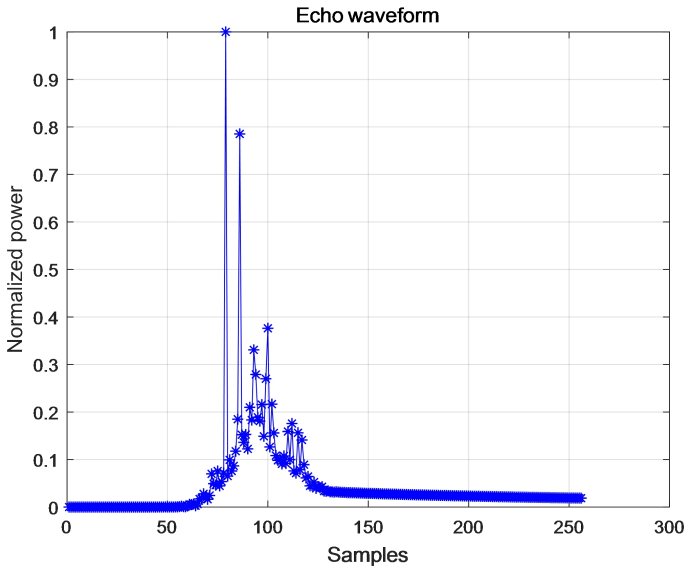
Coastal echoes--Distorted leading edge



measured waveform from SWIM

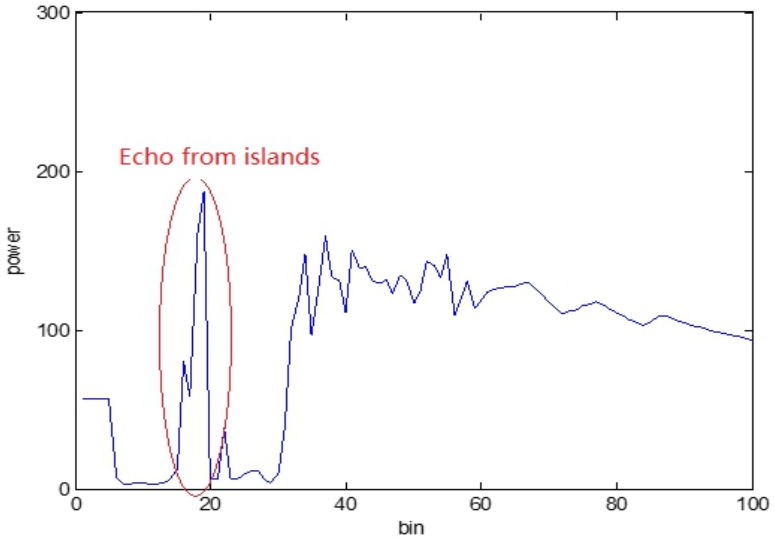


Simulation model

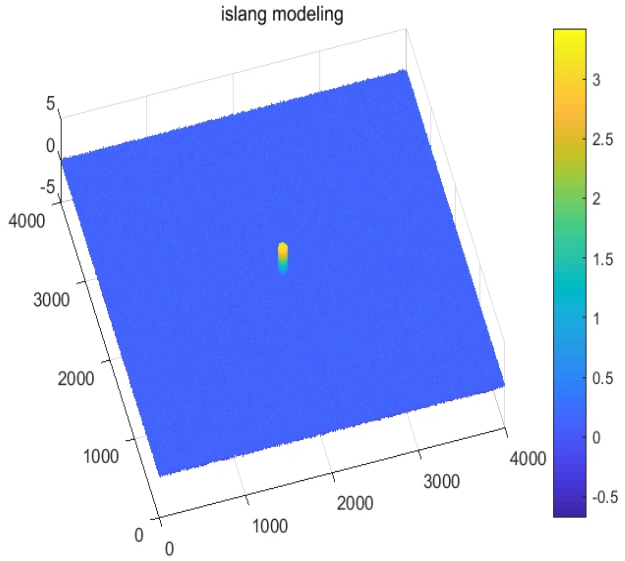


Simulated waveform

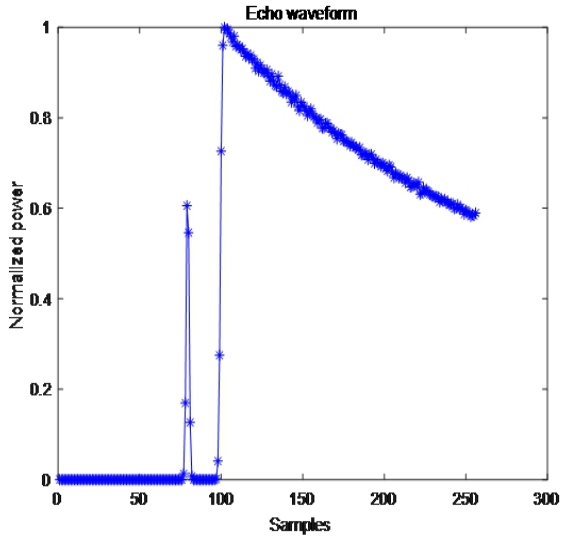
Coastal echoes--Distorted noise area



measured waveform from SWIM



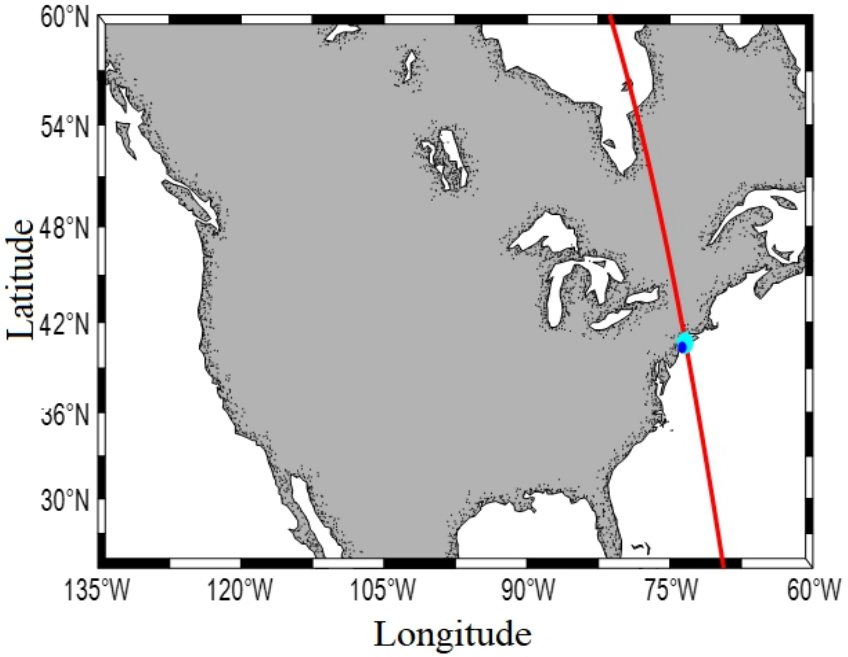
Simulation model



Simulated waveform

Part3:Verification and application of the SWPF algorithm

- Comparison between the computed results and the buoy data



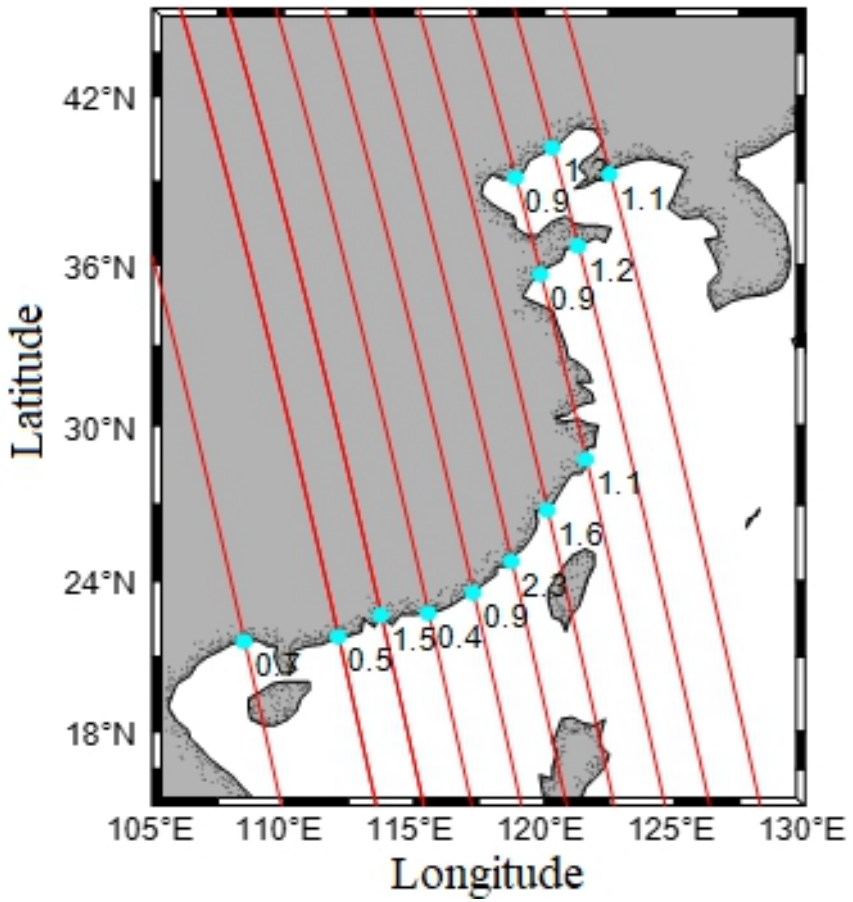
Distance from the reference point km	7.512	6.0277	4.5435	2.9505	1.4672
Retrieved SWH (m	1.1467	0.9946	1.0428	0.9096	0.91336
SWH from the buoy data (m)	0.9~1.2				
Retrieved σ^0 (dB)	23.8017	23.8055	22.6213	22.7138	23.7071
σ^0 (dB) from the CFOSAT	22.6779	22.7190	22.5099	23.7148	25.6757

Part3：Establishment of the empirical speckle noise spectrum model

- Comparison between the retrieved results and AUX forecast data

Distance from the near-shore point (km)	9.0854	7.4986	4.5428	3.0647	1.4780
Inversion of SWH (m)	2.0120	2.3521	2.0291	2.2312	2.3204
AUX forecast data (m)	2.1900	2.1900	2.2000	2.2100	2.2200
distance from the near-shore point (km)	38.9611				
SWH L2aBOX data (m)	2.3290				
Inversion of σ^0 (dB)	25.6951	18.5256	28.0016	26.0194	24.7388
σ^0 measured by L1a (dB)	26.4330	16.8741	27.3369	25.8879	23.5746

Retrieval of the SWH by the SWPF algorithm near Chinese coastal waters



No. of orbit	5063	5078	5093	5184	5214
Nearest distance (km)	1.5875	3.0655	1.4780	6.0005	2.9737
Retrieved SWH	0.7729	0.5120	0.4720	1.6340	1.5928
Nearest distance for L2 BOX	7.4802	7.4802	38.9305	7.3481	22.8371
L2 BOX SWH	0.2300	0.3390	0.3745	1.6900	1.7890

No. of orbits	5229	5305	4729	4744	4805
Nearest distance (km)	1.4701	4.5397	4.4245	2.9717	1.4776
Retrieved SWH	1.2031	2.3506	1.1520	1.1623	0.9540
Nearest distance for L2BOX	38.9611	16.9830	15.4214	33.6321	20.6732
L2BOX SWH	1.2200	2.4000	1.0959	1.1345	0.8795

Part4: CONCLUSION

- The coastal echoes were divided into three types of ones and simulated by supposing several scattering models.

- The behaviors of the echoes contaminated by land echoes were analyzed and understood according to the scattering physical models and the corresponding σ^0 values. The return powers from land surfaces were very large: several times than the ocean echo powers. The σ^0 values from the land echoes fit well with the Gauss and exponential distributions and were generally much more random and mutable than the ocean echoes.

- The SWPF could effectively retrieve the SWH by choosing smartly the weighted value of a sampling point according to the difference between successive return powers.

Thank you for listening!

谢谢!

Merci!