



**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

**Microwave satellite measurements for coastal area  
and  
extreme weather monitoring**

**Project ID: 32235**

**Xiaofeng Li, Shanghai Ocean University, China;**

**Ferdinando Nunziata, Università di Napoli Parthenope, Italy**

26-30 June 2017 | Copenhagen, Denmark

2017年6月26-30日, 丹麦 哥本哈根



The proposed project aims at exploiting microwave satellite measurements to generate innovative added-value products to observe coastal areas also under extreme weather conditions.



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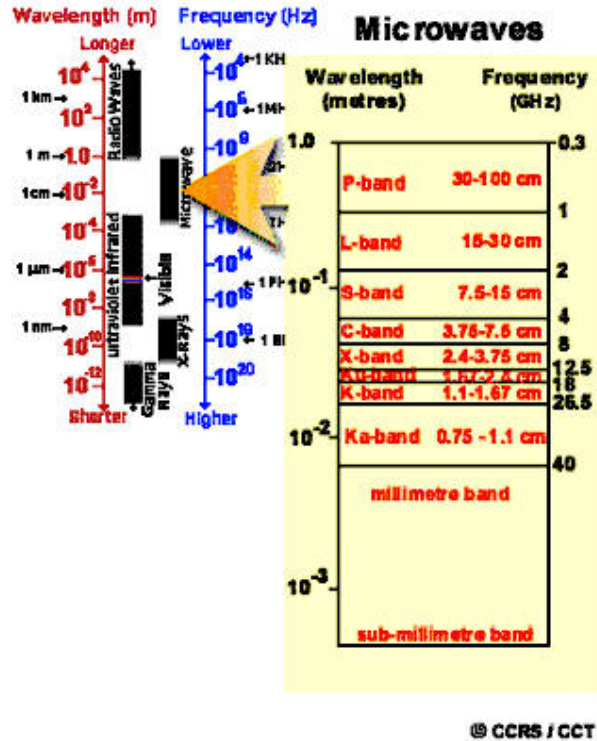
“龙”

2017年6月26-30日, 丹麦 哥本哈根



# Objectives

The proposed project aims at exploiting microwave satellite measurements to generate innovative added-value products to observe coastal areas also under extreme weather



Short range - SAR

Long range –  
Scatterometer,  
Radiometer



## Lead Investigators

**F.Nunziata, Università di Napoli Parthenope, Napoli, Italy**  
**X.Li, Shanghai Ocean University, Shanghai, China**

### Subtopic 1: SARCO – SAR based coast observation

**F.Nunziata, Università di Napoli Parthenope, Napoli, Italy**  
**Prof. Qing Xu, Hohai University, Nanjing China**

## SUMMARY

### Subtopic 2: SCoPeSAR - Ship and Coastal Water Pollution Observation with PolSAR Architectures

**A.Marino, The Open University, Milton Keynes, UK**  
**W.Shao, Zhejiang Ocean University, Zhoushan, China**

### Subtopic 3: SHENLONG - Sea-surface High-wind Experiments with Long-range (satellite) Observations using Numerical Geophysical methods

**M.Portabella, Institute of Marine Sciences (ICM, CSIC), Barcelona, Spain**  
**X.Yang, Institute of Remote Sensing and Digital Earth, CAS, China**

## Summary EO data exploitation – cumulative stats all subprojects

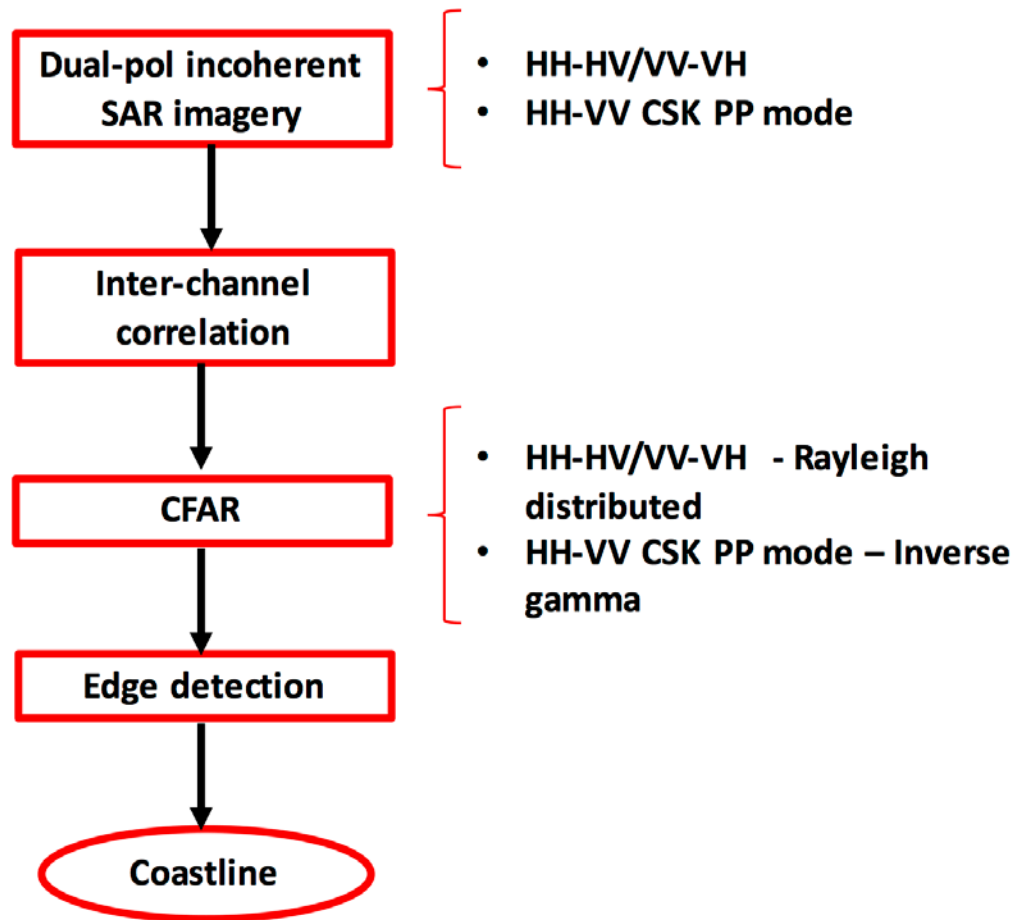
ESA & ESA TPM DATA	Nos. scenes or inform if by FTP	SENTINELS 1, 2 & 3 DATA	Nos. scenes	CHINESE EO DATA	Nos. scenes
ERS SAR		Sentinel 1-A/B SAR	50	HJ-A/B	
ASAR		Sentinel 2-A/B MSI		GF-1	
MERIS		Sentinel 3-A OLCI		GF-2	
AATSR		Sentinel 3-A SLSTR		HY-A	
SMOS		Sentinel 3-A SLAR		FY-1	
etc.		CSK	planned	Etc.	
<b>TOTAL</b>		<b>TOTAL</b>		<b>TOTAL</b>	





- 1) Map of inland changes/deformations --> Monitoring and observation of surface deformation phenomena related to natural and/or anthropogenic factors.
- 2) Map of the coastline and its changes (due to land deformation, erosion and relative sea level change) for the selected test sites --> Time series of multi-polarization SAR data, in situ observations and modeling data.
- 3) Generation of coastal risk and vulnerability maps

- Multipol/Multifreq SAR
- Optical data
- Modeling data
- GPS info



Physically-based approaches to improve land-sea separation under a broad range of radar and environment conditions



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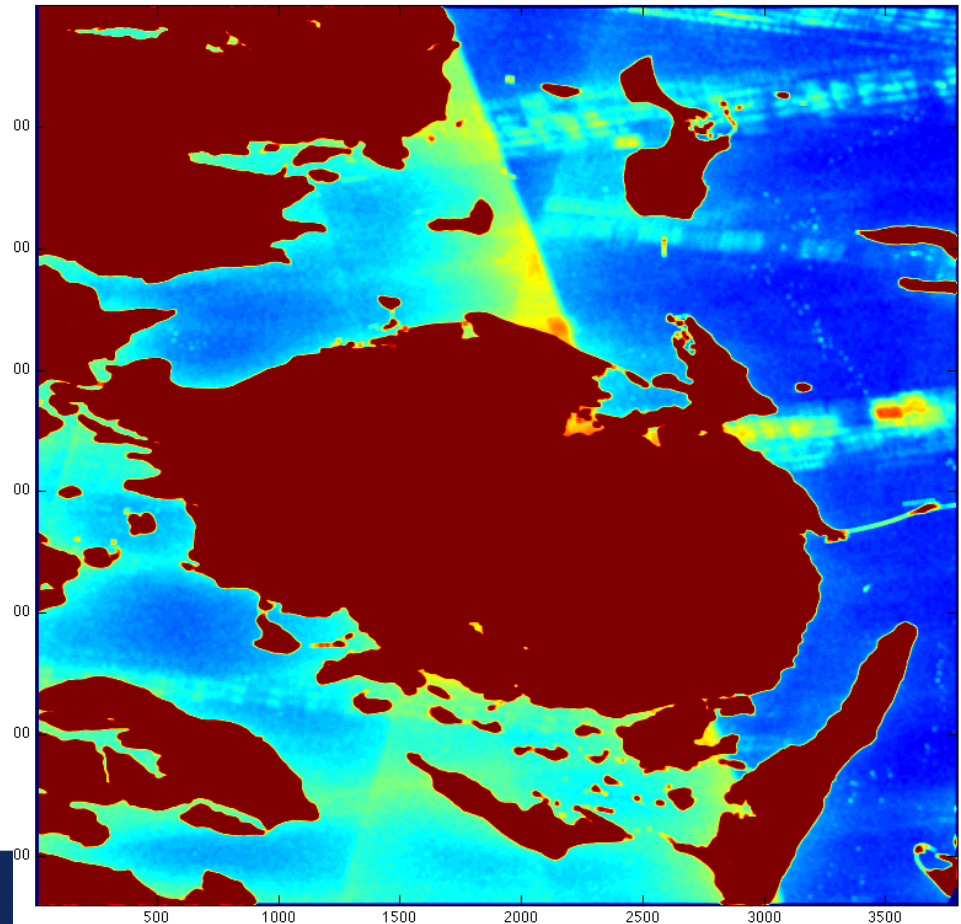
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## Analysis of best sites to locate wind farms in Denmark

- 12 HV S1 data: Jan-Dec 2016
- 1 dataset per month





- 1) Map of maritime traffic exploiting multi-polarization SAR data and Automatic Identification System (AIS).
- 2) Map of water pollution exploiting multi-polarization SAR and ancillary optical and in situ information.

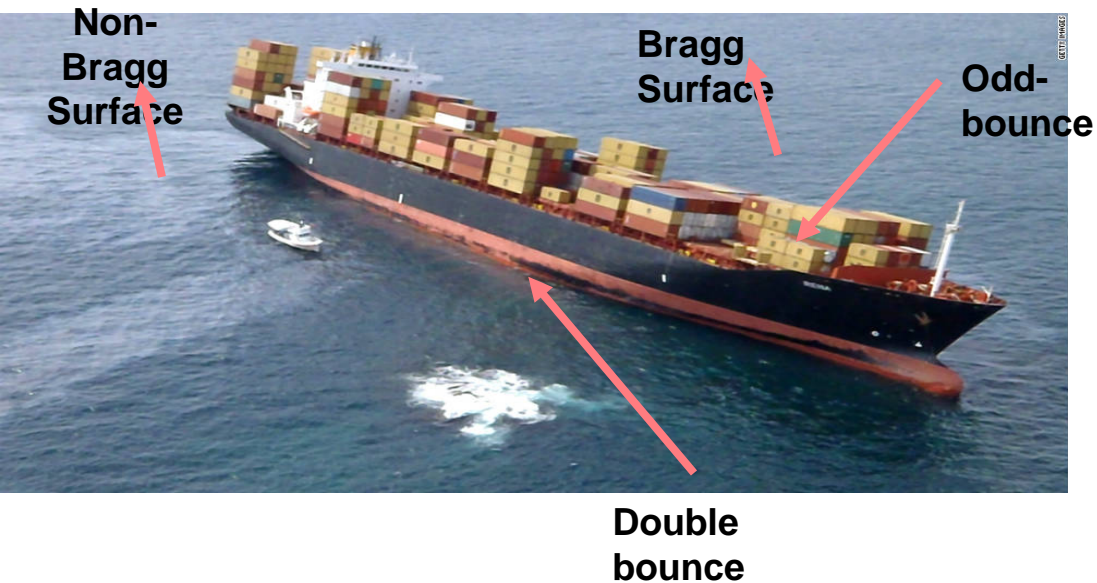


- Multipol/Multifreq SAR
- Optical data
- Ancillary ground truth

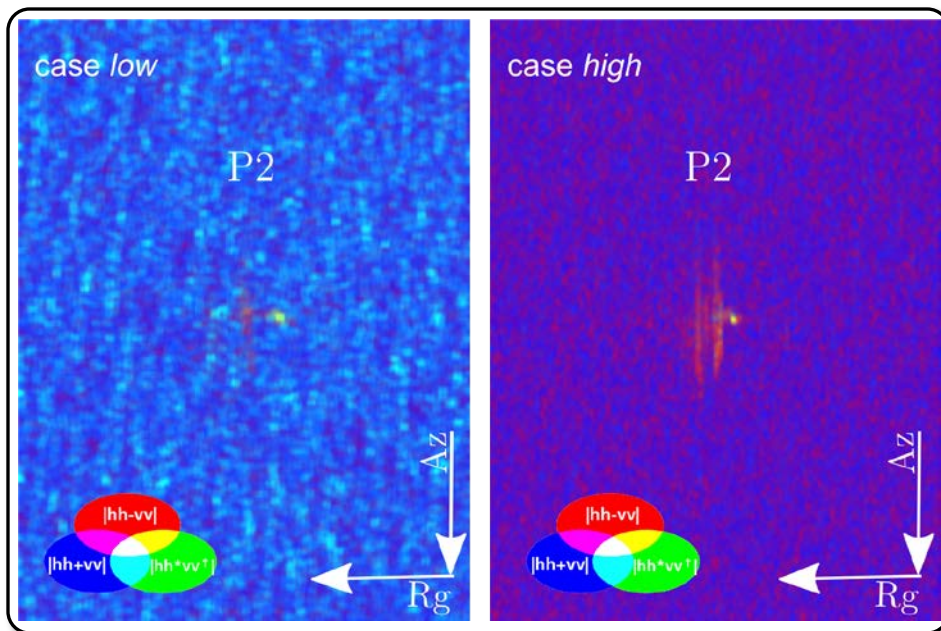
## Young scientists contributions

1. Armando Marino (the Open University) and Tao Zhang (Shanghai Jiao Tong University).
  - Dr Marino become the external supervisor of the PhD student Mr. Zhang.
  - The collaboration has lead to the preparation of a journal article to be submitted to JSTARS
2. Armando Marino (the Open University), Domenico Velotto (DLR), Ferdinando Nunziata (Parthenope University) and Xiaofeng Li (Shanghai Ocean University).
  - One PhD student from Dr Marino group, may visit Prof. Li group at SHOU.





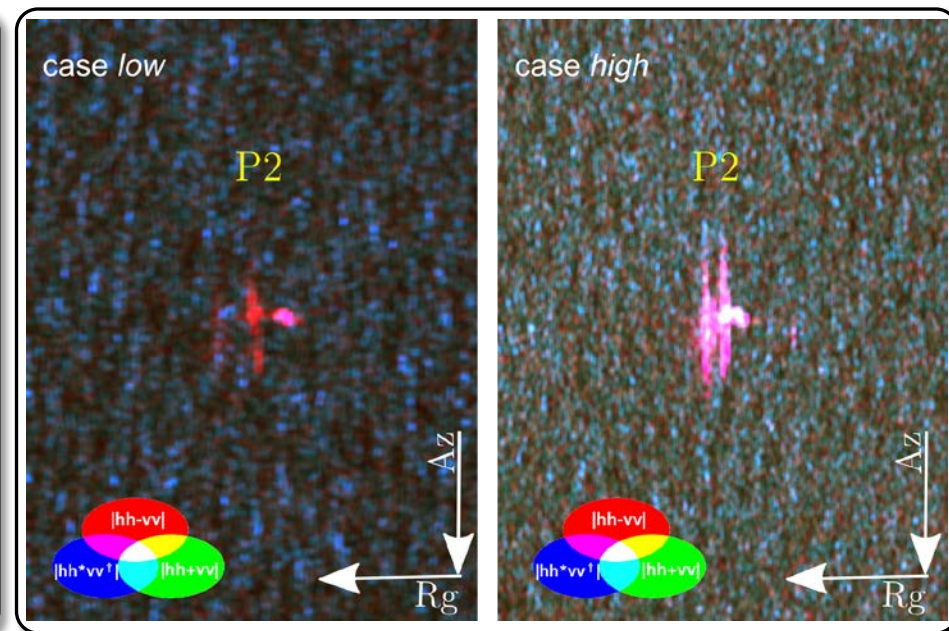
Methods to exploit multi-polarization SAR data for target classification purposes



RGB channels normalized → highlight the polarimetric content: **double reflection**, correlation and single reflection

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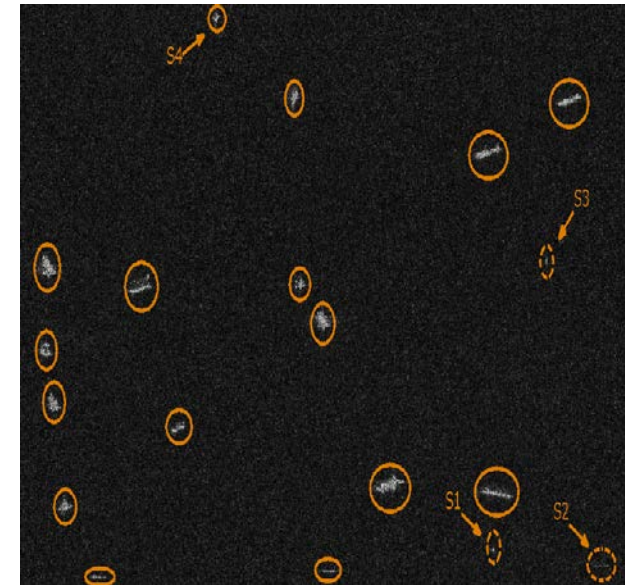
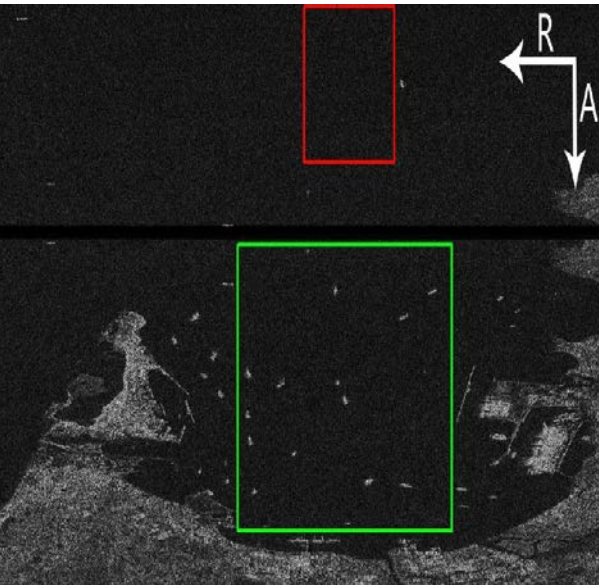
RGB channels scaled individually → highlight the power: **double reflection**, correlation and single reflection

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- ✓ A modification of the **Polarimetric Notch Filter** is introduced which performs a **Principal Component Analysis** on the polarimetric features





# Subtopic 3: SHENLONG: Sea-surface High-wind Experiments with Long-range (satellite) Observations using Numerical Geophysical methods



## Objectives

- 1) Improving both the physical and the empirical simulation accuracy of polarized sea surface backscattering. The new models will give better results under high winds and moist convection.
- 2) State-of-the-art wind verification and objective validation tools as well as auxiliary sources, to thoroughly assess the SAR wind retrieval quality under such conditions.
- 3) Map of location, surface winds, center pressure, rain bands, and other parameters of tropical cyclones from multi-



- Multipol/Multifreq SAR
- Scatterometer
- Ancillary ground truth

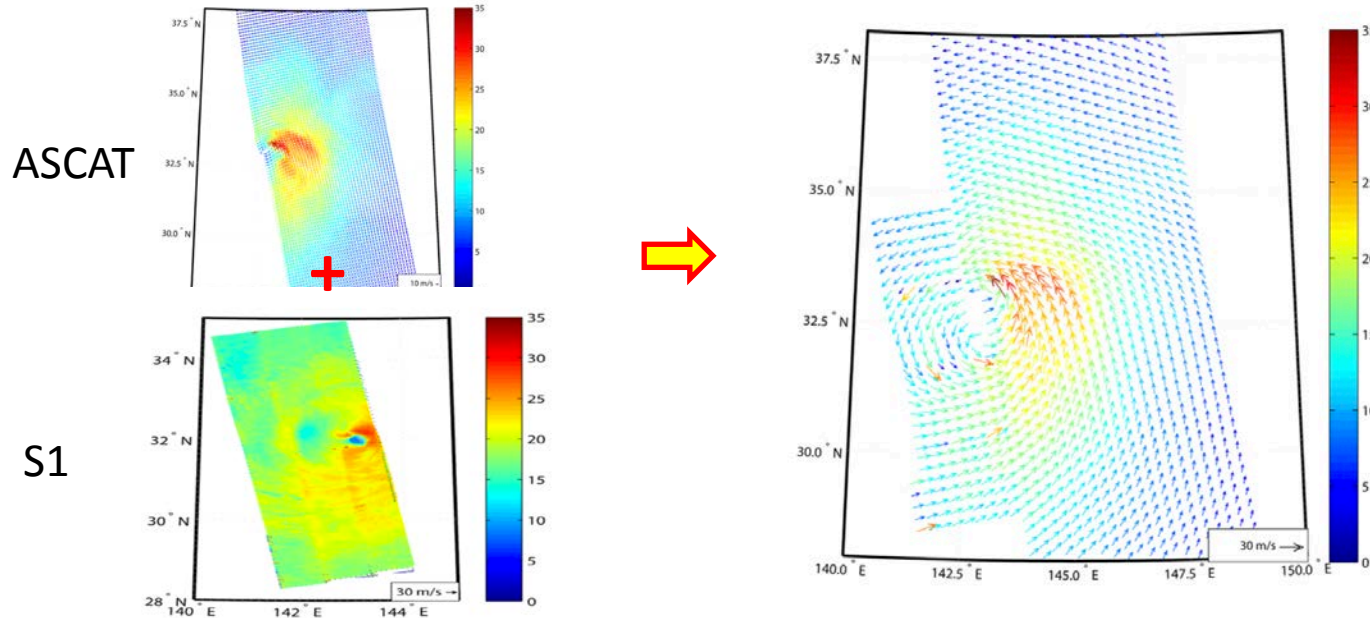
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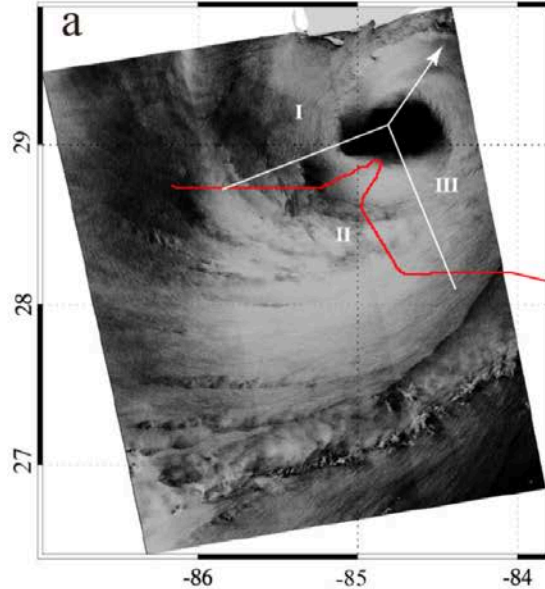
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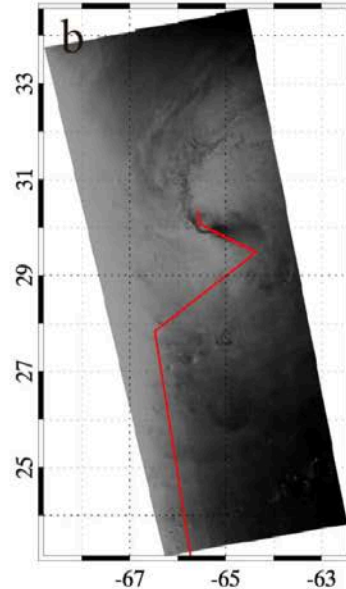
We combine the ASCAT wind field with the Sentinel-1 SAR winds. The overlapped wind field of the SAR synthesis wind is removed and the joint wind field is sparse to 25 km.



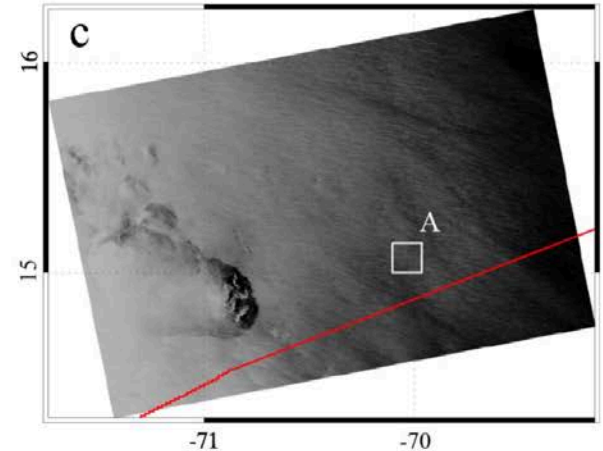
**Non-saturated wind wave info from SAR is used to obtain wind in TC**



Hermine 2016-09-01 23:45

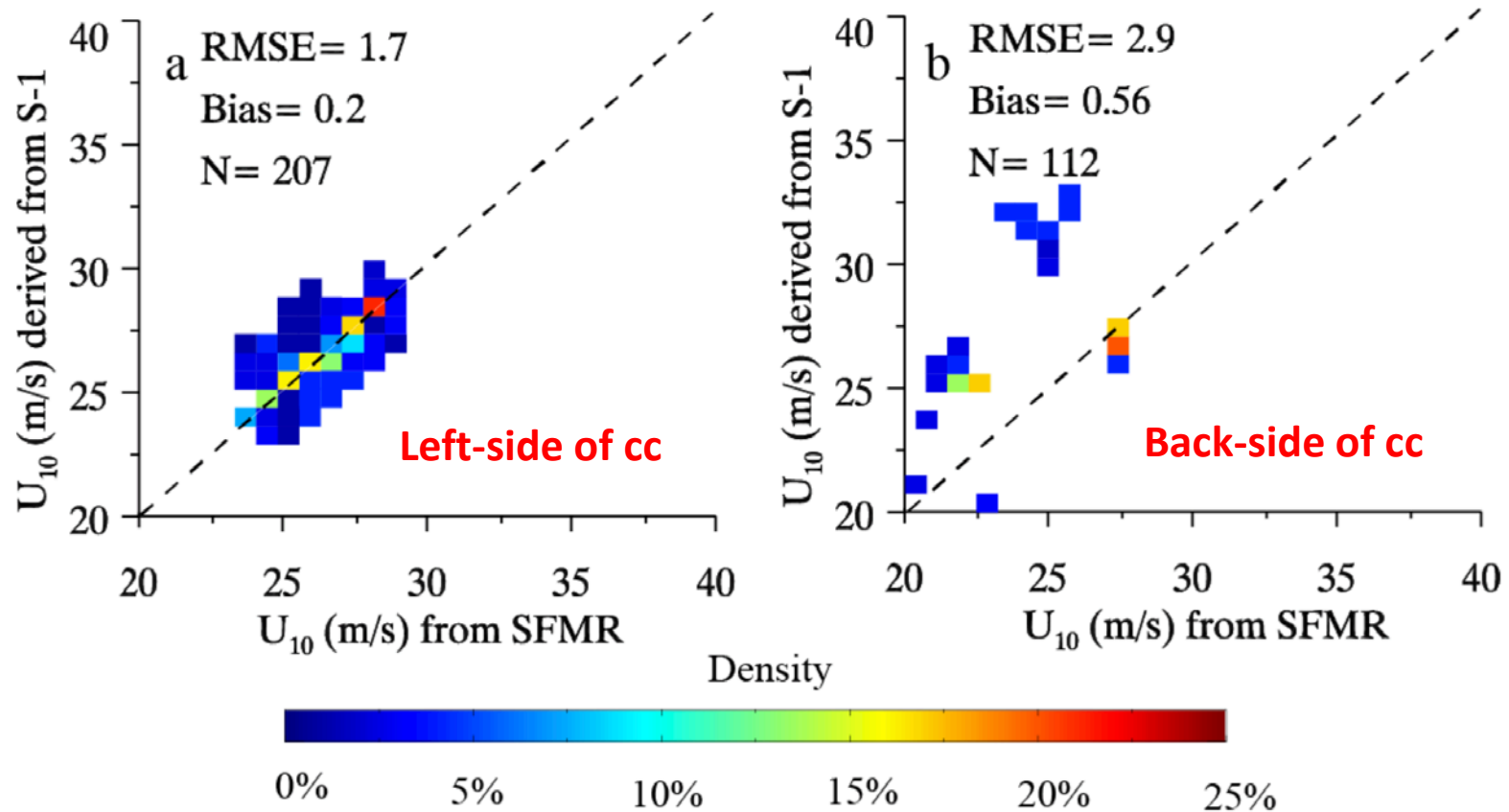


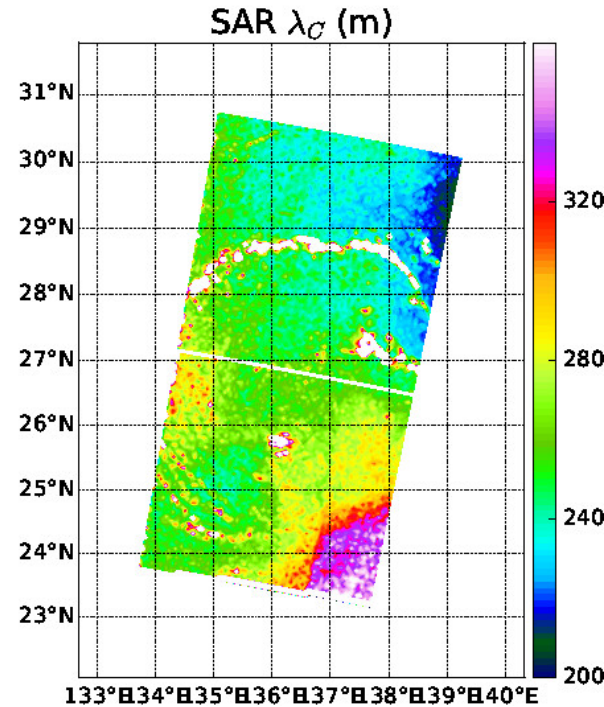
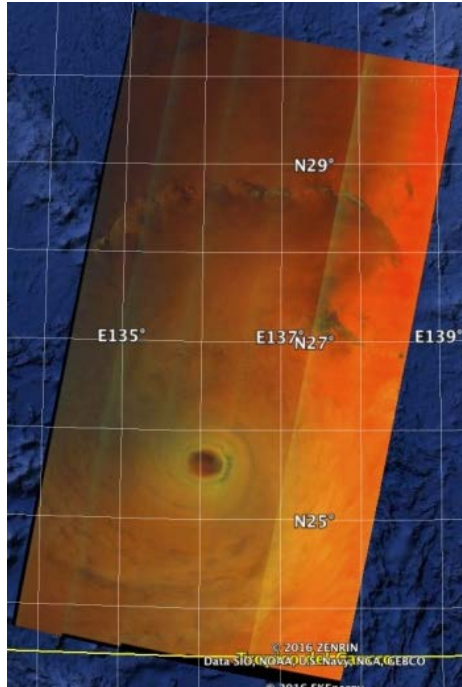
Karl 2016-09-23 22:21



Matthew 2016-10-01 22:51







Good agreement in  
FD state

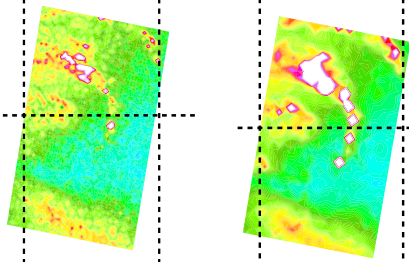
Not good in  
extreme cases.

Why? *Work in  
progress*

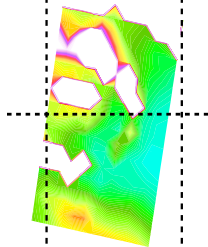
### Resolution 8 m

256x256

512x512



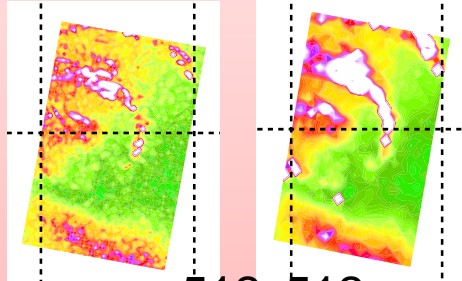
1024x1024



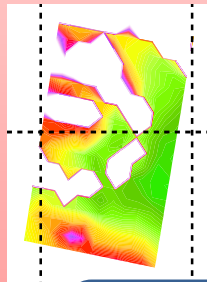
### Resolution 17 m

128x128

256x256



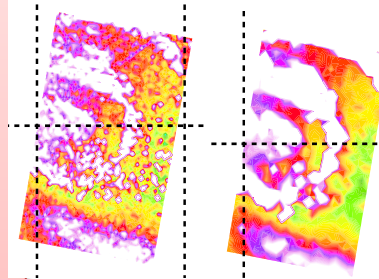
512x512



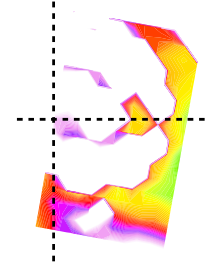
### Resolution 33 m

64x64

128x128



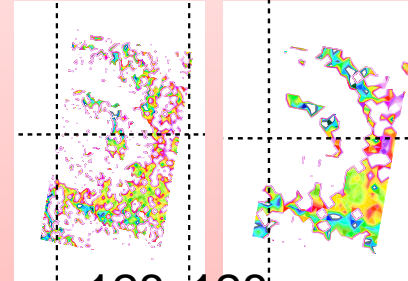
256x256



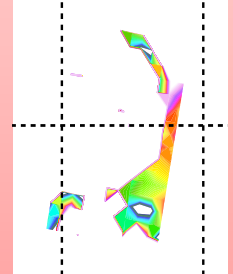
### Resolution 66 m

32x32

64x64



128x128





## Joint publications

### Joint publications

- 1) A. Marino, D. Velotto, and F. Nunziata, "Offshore platforms observation using dual-polarimetric TS-X/TD-X satellite imagery: a case study in the Gulf of Mexico," IEEE Journal of Selected Topics in Applied Earth Observation and Remote Sensing (JSTARS). In print.
- 2) V. Corcione, F. Nunziata, and M. Migliaccio, "Megi typhoon monitoring by X-band synthetic aperture radar measurements," IEEE Journal of Oceanic Engineering. In print.



## Message from the Guest Editors

Dear Colleagues,

We would like to invite articles on ocean-related studies using state-of-the-art SAR techniques, including:

- Ocean applications with SAR imagery
- SAR studies of physical and biological oceanography
- Coastline extraction and inland area classification of SAR imagery
- Methods for ship and other man-made objects' detection
- Remote sensing of oceanic surface and internal waves, upwellings, bathymetry, etc.
- Cyclone-related parameters retrieval from SAR satellite observations
- Marine atmospheric boundary layer process studies using SAR and remotely sensed data
- Remote sensing modelling over complex sea surfaces
- Oil spill and seep detections with SAR
- PolSAR and InSAR application for coastal research issues

Dr. Xiaofeng Yang

Dr. Xiaofeng Li

Dr. Ferdinando Nunziata

Dr. Alexis Mouche

Guest Editors

## Author Benefits

**Open Access:** free for readers, with publishing fees paid by authors or their institutions.

**High visibility:** indexed by the Science Citation Index Expanded (Web of Science), Compendex (E) and other specialized databases.

**Rapid publication:** manuscripts are peer-reviewed and a first decision provided to authors approximately 34 days after submission; acceptance to publication is undertaken in 8 days (median values for papers published in this journal in 2015).



remote sensing



## Article

### Underwater Topography Detection in Coastal Areas Using Fully Polarimetric SAR Data

Xiaofeng Yang<sup>1,2</sup>, Yun Shao<sup>1</sup>, Wei Tian<sup>1</sup>, Shiang Wang<sup>1</sup>, Chunyan Zhang<sup>1,\*</sup>, Xiaochen Wang<sup>1,2</sup> and Zhixin Zhang<sup>1,2</sup>

<sup>1</sup> Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences, Beijing, 101000, China (X.Y.: xiaofeng@radi.ac.cn; Y.S.: yunshao@radi.ac.cn; W.T.: tianwei@radi.ac.cn; S.W.: wangshiang@radi.ac.cn; C.Z.: zhangchunyan2014@radi.ac.cn; X.W.: wangxiaochen@radi.ac.cn)

<sup>2</sup> University of Chinese Academy of Sciences, Beijing, 100049, China

<sup>3</sup> National Ocean Technology Center, Tianjin, 300112, China

\* Correspondence: zhangchunyan@radi.ac.cn; Tel.: +86-10-64688-9214

Academic Editors: Xiaofeng Yang, Xiaofeng Li, Ferdinando Nunziata, Alexis Mouche and P. Received: 27 February 2017; Accepted: 31 May 2017; Published: 4 June 2017

**Abstract:** Fully polarimetric synthetic aperture radar (SAR) can provide detailed scattering mechanisms that could enable the target or structure to be identified. This method to detect underwater topography in coastal areas using high resolution SAR data, while less prior information is required. The method is based on the shoal of long surface gravity waves as they propagate shoreward. First, the surface scatter obtained by polarization decomposition. Then, wave fields are retrieved from the (2D) spectra by the Fast Fourier Transformation (FFT). Finally, shallow water depth from the dispersion relation. Applicability and effectiveness of the proposed method, by using C-band fine quad-polarization mode RADARSAT-2 SAR data over the near Hainan province, China. By comparing with the values from an official electronic (ENC), the estimated water depths are in good agreement with them. The average detected results from the scattering mechanisms based method and single polar are 9.73% and 11.53% respectively. The validation results indicate that the scatter based methodology is more effective than only using the single polarization SAR data topography detection, and will inspire further research on underwater topography fully polarimetric SAR data.

**Keywords:** shallow water; swell waves; water depth; dispersion relationships; q Bragg scattering

## 1. Introduction

Underwater features and ocean bathymetry is an indispensable information for engineering and management and coastal resources exploitation and protection [1]. Safely navigating, offshore fishery and aquaculture, research on tide and biodiversity, seawalls and wharf and other human activities are carried out in these areas with less than 100 m. Detailed knowledge of water depth is very useful for them. Conventional depth surveying are carried out by sonar measurements from dedicated vessels, while point-measurement, but are not only expensive and time consuming but also difficult areas, especially in some special water areas where routine surveying cannot be achieved. Synthetic aperture radar (SAR) is an active microwave remote sensor that has 24 targets on the earth in both day and night, and for almost all weather conditions. SAR is widely applied in earth observation, especially in ocean observation. SAR [2]

### Ku-Band Sea Surface Radar Backscatter at Low Incidence Angles under Extreme Wind Conditions

by Xuzhong Li, Biao Zhang, Alexis Mouche, Yijun He and William Perrie

Remote Sens. 2017, 9(5), 474; doi:10.3390/rs9050474

Received: 14 March 2017 / Revised: 18 April 2017 / Accepted: 9 May 2017 / Published: 12 May 2017

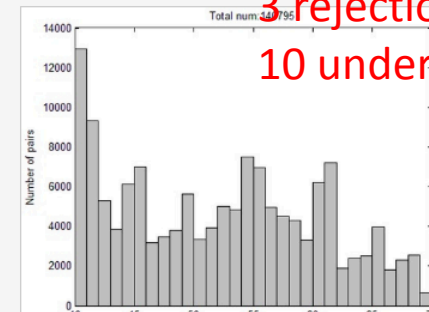
Cited by 1 | PDF Full-Text (1811 KB) | HTML Full-Text | XML Full-Text

## Abstract

This paper reports Ku-band normalized radar cross section (NRCS) at low incidence angles ranging from 0° to 18° and in the wind speed range from 6 to 70 m/s. The precipitation radar onboard the tropical rainfall measuring mission and Jason-1 and 2 have been used to validate the results. [...]

(This article belongs to the Special Issue Ocean Remote Sensing with Synthetic Aperture Radar)

## ▼ Figures

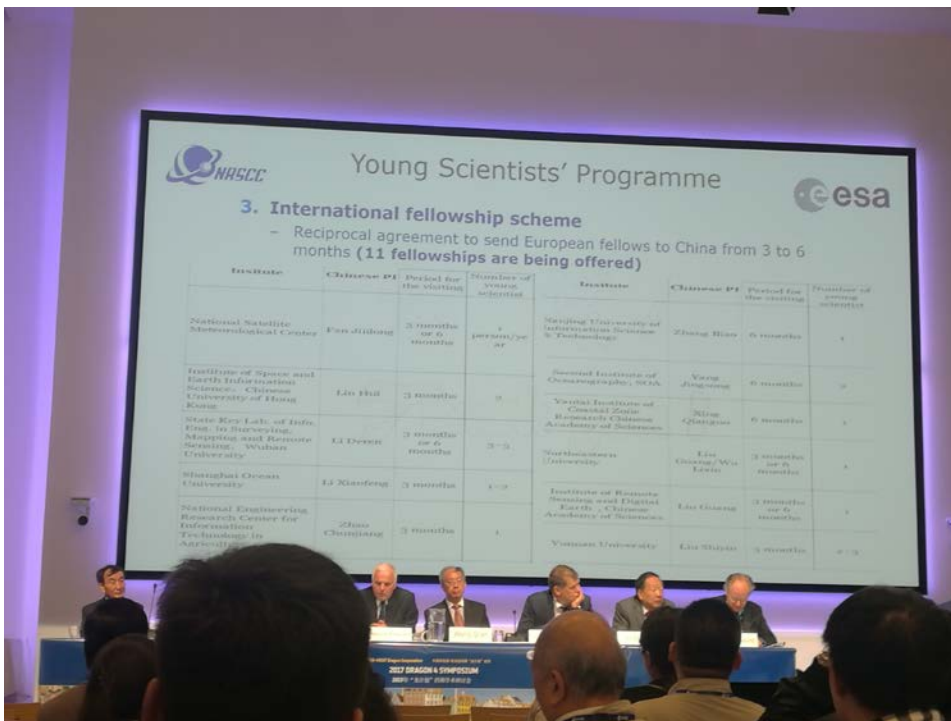


21 submissions  
8 accepted  
3 rejections  
10 under review

# Summary on progress and collaboration

To strengthen EU-China cooperation:

- PhD students will be shared.
- Visiting EU students to China.



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## Plans for the next 2 years

### Joint studies:

- Analysis of backscattering and multi-polarization features in complex coastal environments for classification purposes;
- Analysis of time-series of waterlines extracted over major lakes in Italy;
- Analysing different estimation techniques for wind retrieval under extreme weather conditions;
- Assessing the extra-benefit of multi-polarization information to observe metallic targets ta sea.
- Observing oil spills and industrial/run-off waters using multi-polarization data

### Education:

- Establishing a 3y PhD program on subjects involving observing high winds and its effect of coastal areas (including wetlands) by SAR.