



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

26-30 June 2017 | Copenhagen, Denmark

2017年6月26-30日, 丹麦 哥本哈根

DRAGON 4 ID. 32281 PROJECT SUMMARY

LIs: Sven Jacobsen and [Xiao-Ming Li](#)

Teams:

China:

CAS-RADI: Xiao-Ming Li, YongZheng Ren, and Jin Sha

OUC: Prof. Ming-Xia HE, Kan Zeng and Lianbo Hu

YIC: Jie Guo

ZJOU: Weizeng Shao

UCAS: Haiyan Li

NSOAS: Lijian Shi

European:

DLR-IMF: Sven Jacobsen, Susanne Lehner, Domenico Velotto, Suman Singha and Anja Frost.

University of Aegean: Konstantinos Topouzelis

BIO (Canada): William Perrie

University of Kiel: Robert Mayerle

Sub-projects and themes:

Id. 32281_1

Derivation of ocean dynamics parameters from spaceborne SAR

- - SAR – sea surface wave, wind, current retrieval and internal wave dynamics

Id. 32281_2

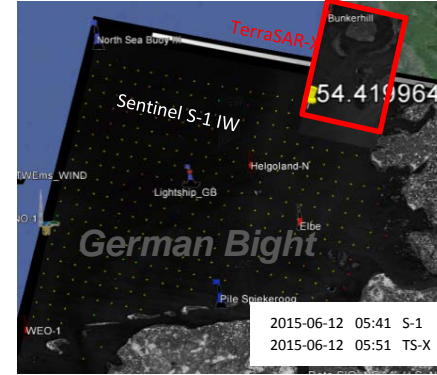
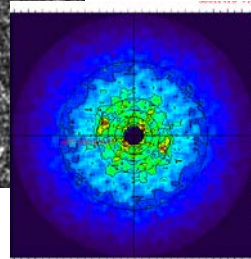
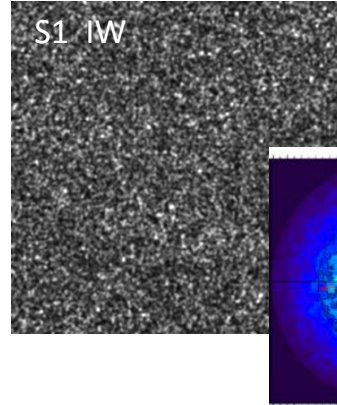
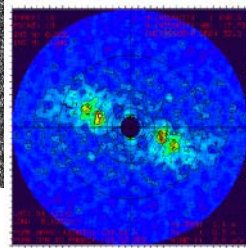
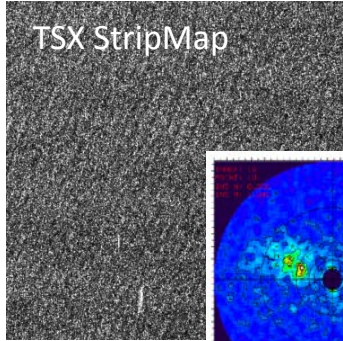
Marine pollution detection and tracing based on satellite observation and modeling

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	~138	Sentinel 1-A/B SAR	> 1000	HJ-A/B	
ASAR	~125	Sentinel 2-A/B MSI		GF-1	65
MERIS		Sentinel 3-A OLCI	24	GF-2	
AATSR		Sentinel 3-A SLSTR		HY-2 Scatterometer	2010 - 2015
SMOS		Sentinel 3-A SLAR		FY-1	
TPM	>100 scenes	Etc.		Etc.	
TOTAL		TOTAL		TOTAL	

Results summary id. 32281_1

- Development and validation of an ocean wave retrieval algorithm for Sentinel-1 data;
- Improved Polarization Ratio Model for X-band SAR (TerraSAR-X) SSW retrieval;
- Improved Cross Polarization Model for Radarsat-2 SSW retrieval;
- Tidal current retrieval from the TerraSAR-X pursuit monostatic mode data;
- Preliminary test of GF-3 data for oceanography study;
- Study of internal wave dynamics in Dongsha Atoll based on SAR observation and numerical model simulation;
- Val/Cal of the Chinese HY-2 Scatterometer wind data in the global oceans

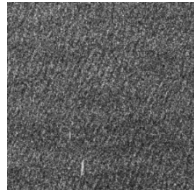


TerraSAR-X
StripMap VV
1.25m Pixel

SENTINEL S-1
IW VV 10m
Pixel

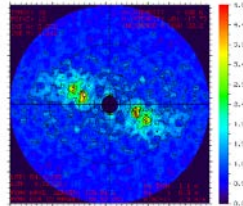
sea state parameters estimation

SAR subscene

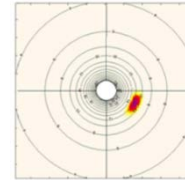


FFT

Image spectra



Transfer
functions



integration

empirical functions

using also local wind information

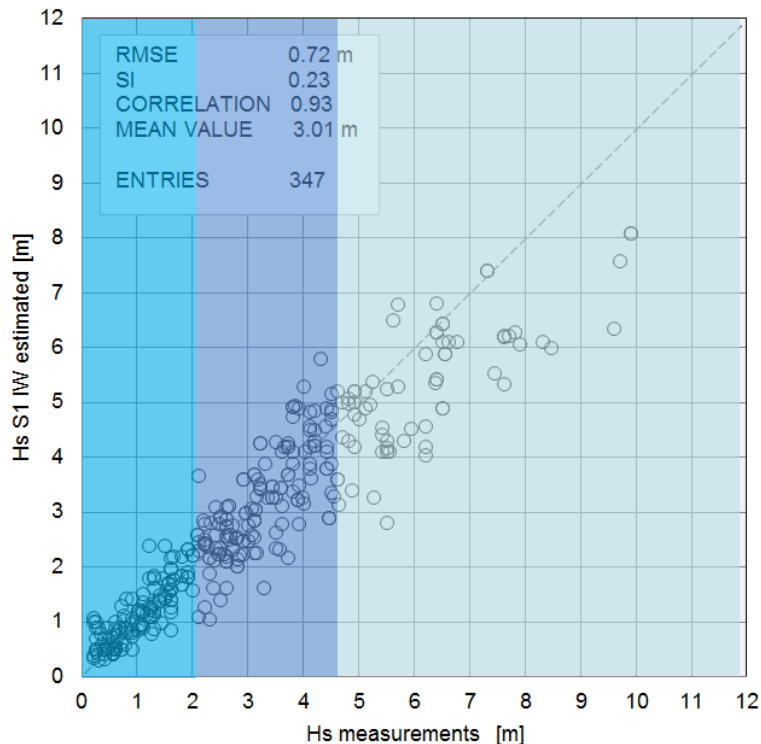
Integrated
parameters:

Wave height,
mean period,
etc.

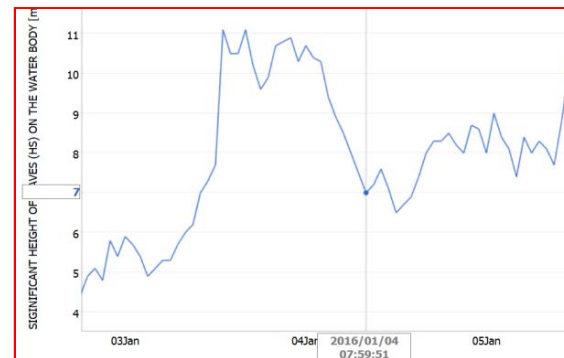
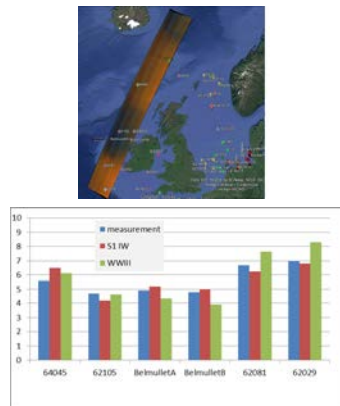
Image feature analysis **GLCM (Grey Level Co-occurrence Matrix)**

Entropy, Contrast, Dissimilarity, etc.,

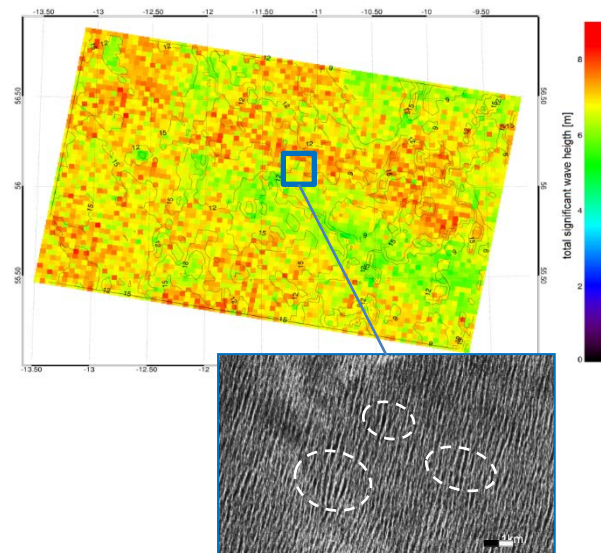
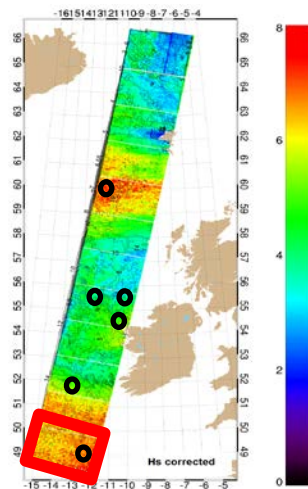
Total Significant Wave Height
S1-IW / Measurements Buoy (interpolated)



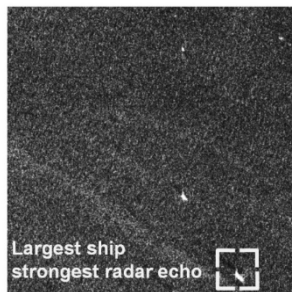
Atlantics 2016-01-04 07:02



0 < Hs < 2		2 < Hs < 4.5		4.5 > Hs	
RMSE	0.31 m	RMSE	0.62 m	RMSE	1.25 m
SI	0.31	SI	0.19	SI	0.20
MEAN VALUE	1.03 m	MEAN VALUE	3.26 m	MEAN VALUE	6.02 m



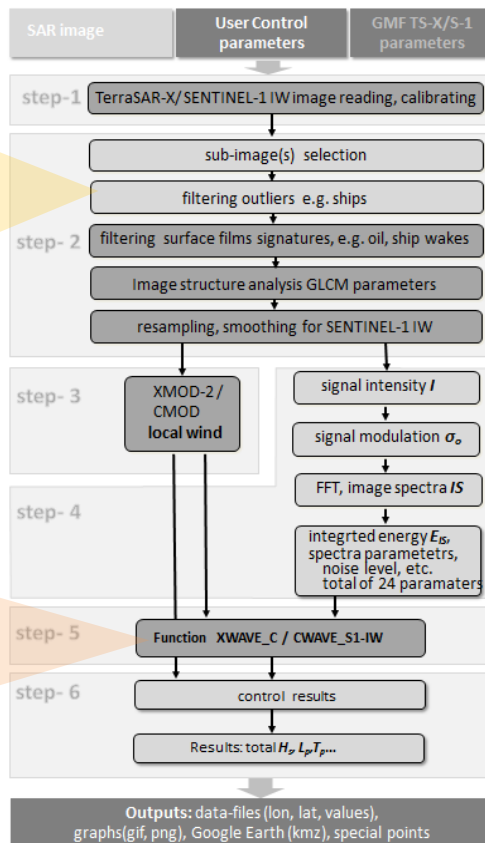
artefact pre-filtering



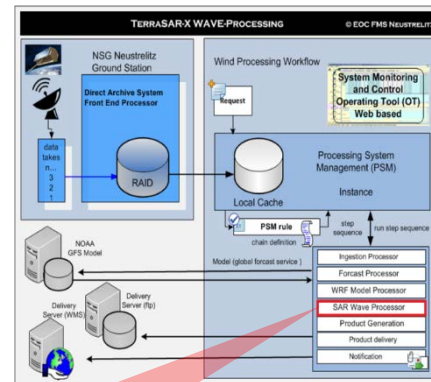
Sea State Functions
TerraSAR-X
Sentinel-1

- Spectral parameters
- Local wind
- GLCM parameters

Sea State Processor

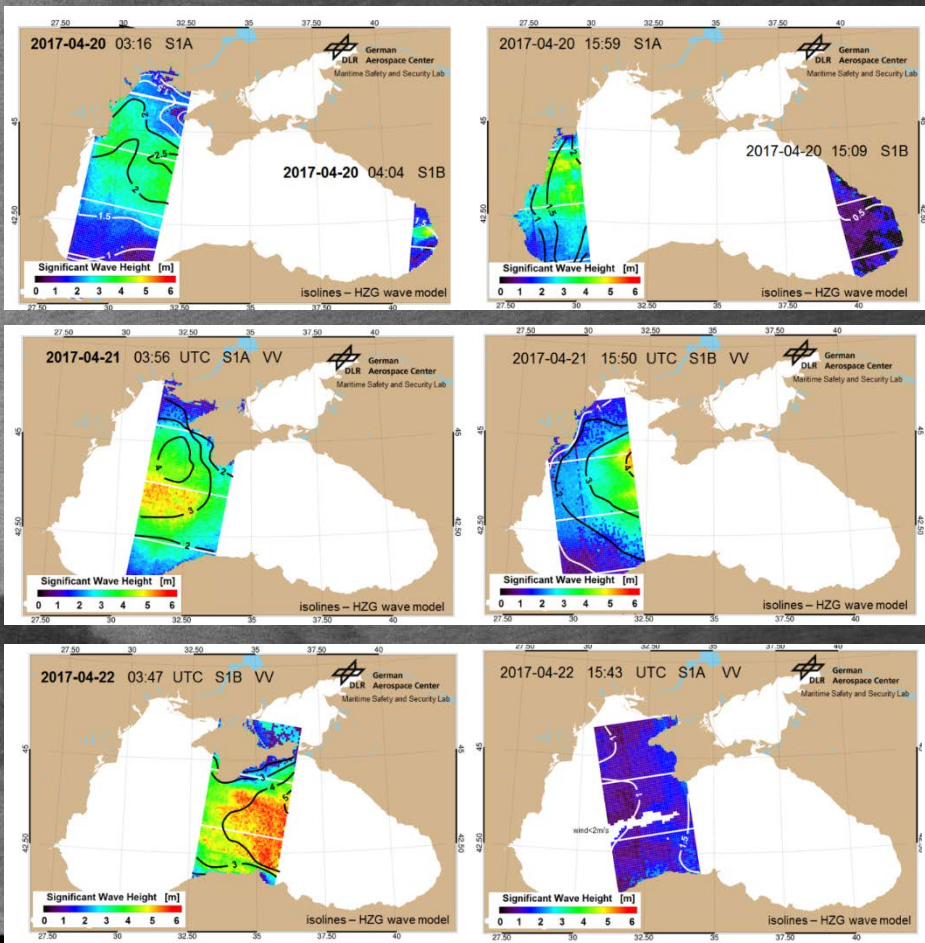


NRT chain, Ground Station Neustrelitz



Tracking a storm in the Black Sea

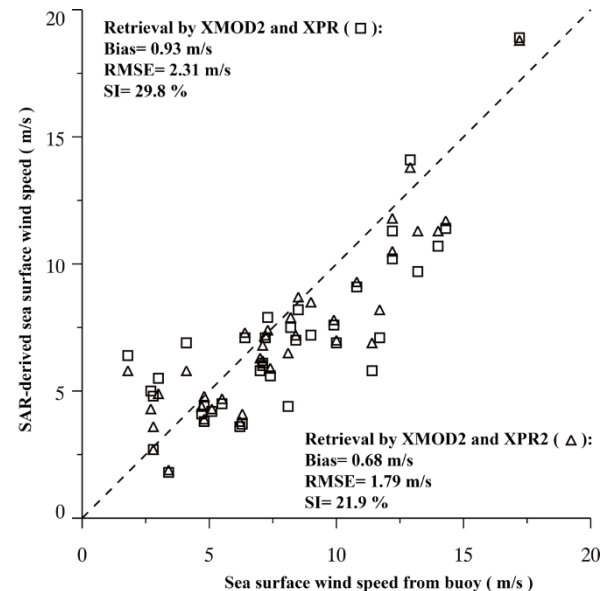
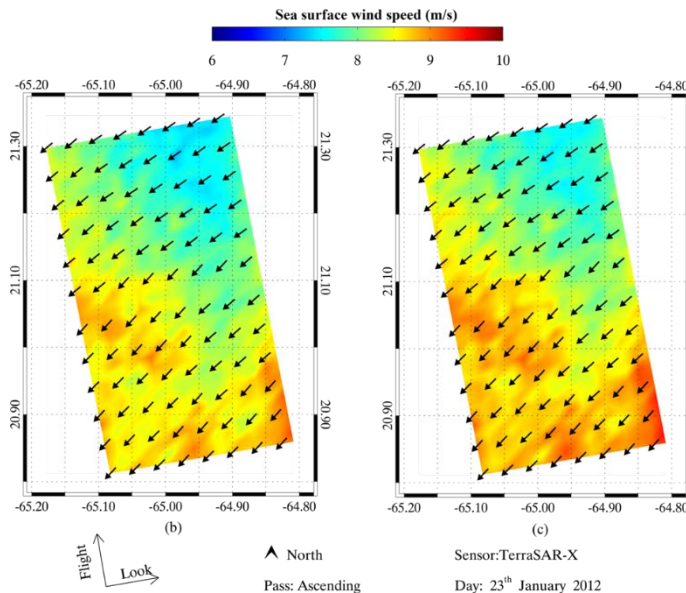
Total Significant Wave Height | Black Sea storm 20-23.04.2017 | SENTINEL-1 SAR C-band IW mode | processing mesh 6km×6km



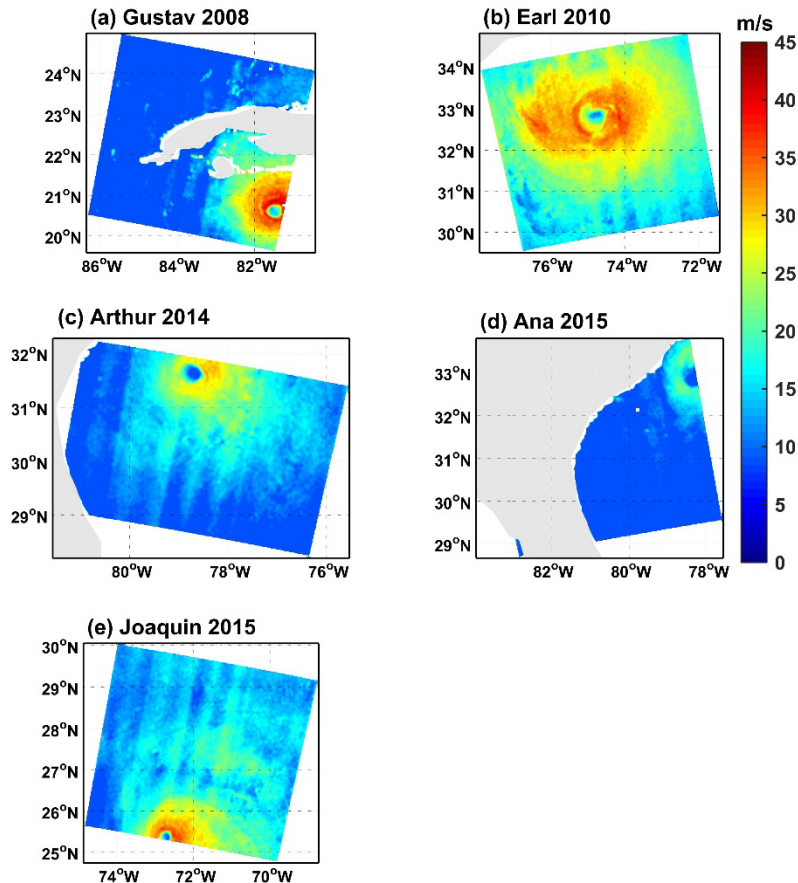
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学术研讨会
日, 丹麦 哥本哈根

Normalized Radar Cross Section (dB)



Improved Cross Polarization Model for Radarsat-2 SSW retrieval



- C-3PO**

C-band Cross-Polarization Coupled-Parameters Ocean (C-3PO) model: $\sigma_0 = A(U_{10}) \cdot [1 + b_1(\theta)]$

$$b_1(\theta) = n_b * \frac{\theta - \theta_{middle}}{\theta_{middle}}$$

linear: $A(U_{10}) = p_1 \cdot U_{10} + p_0$

quadratic: $A(U_{10}) = p_2 \cdot U_{10}^2 + p_1 \cdot U_{10} + p_0$

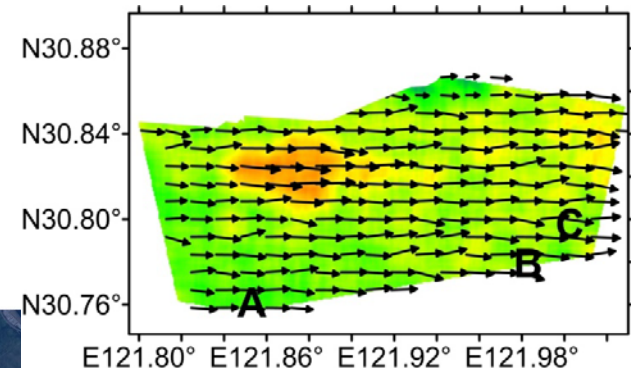
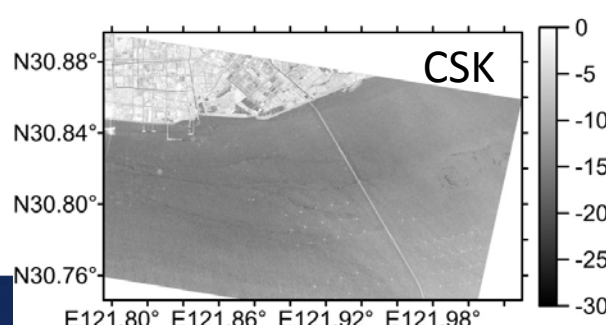
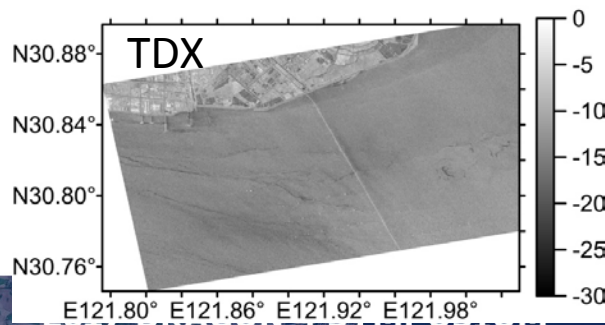
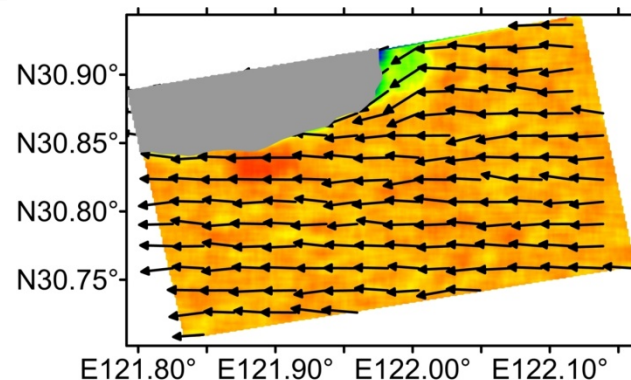
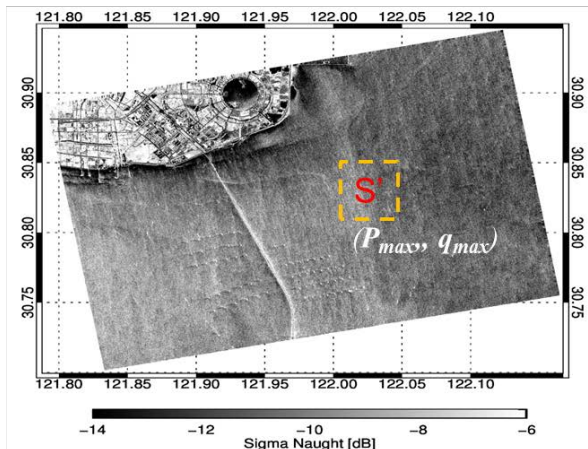
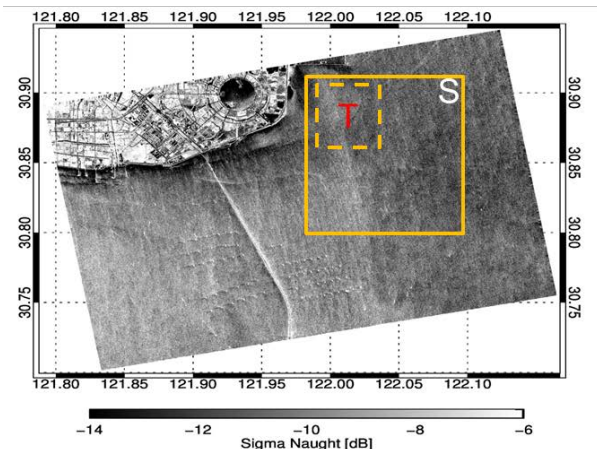
Hurricane surface wind speed retrieved by C-3PO model for the 5 SAR images for:

- a) Hurricane Gustav (11:28 UTC, 30 August 2008),
- b) Hurricane Earl (22:59 UTC, 2 September 2010)
- c) Hurricane Arthur (11:14 UTC, 3 July 2014),
- d) Hurricane Ana (23:24 UTC, 9 May 2015),
- e) Hurricane Joaquin (10:45 UTC, 3 October 2015).

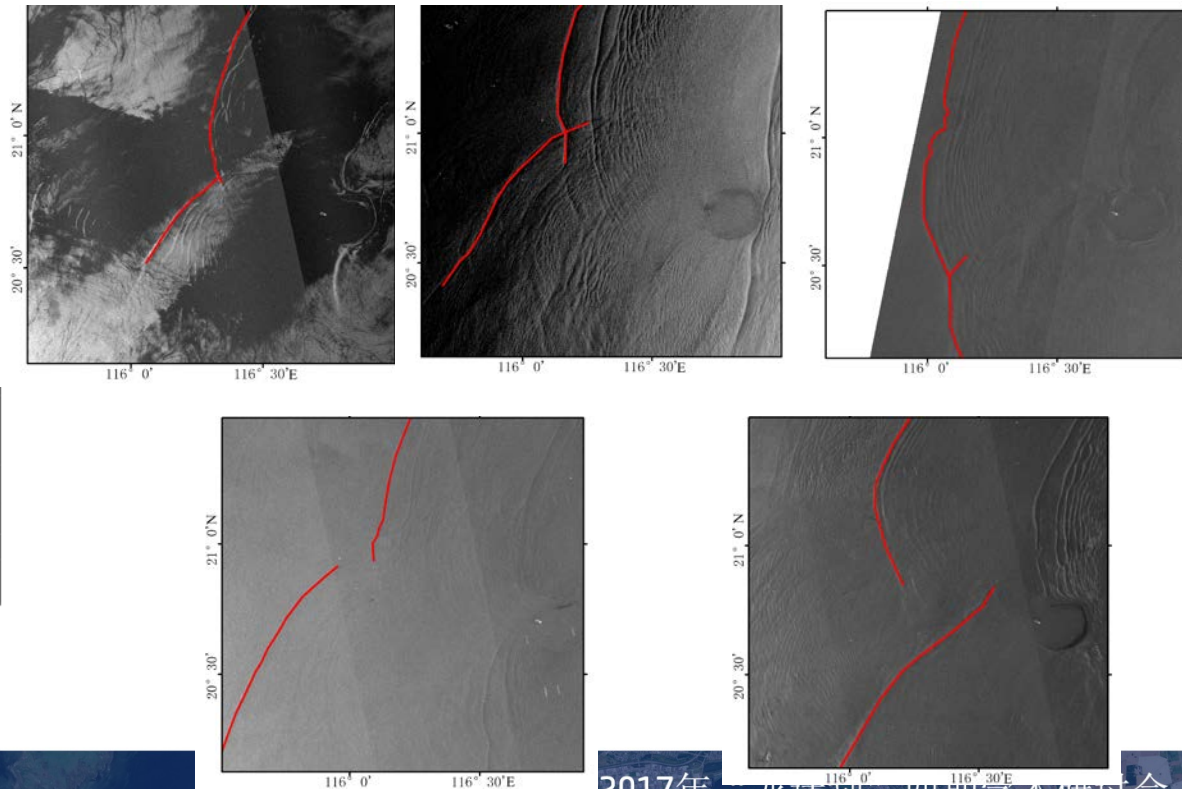
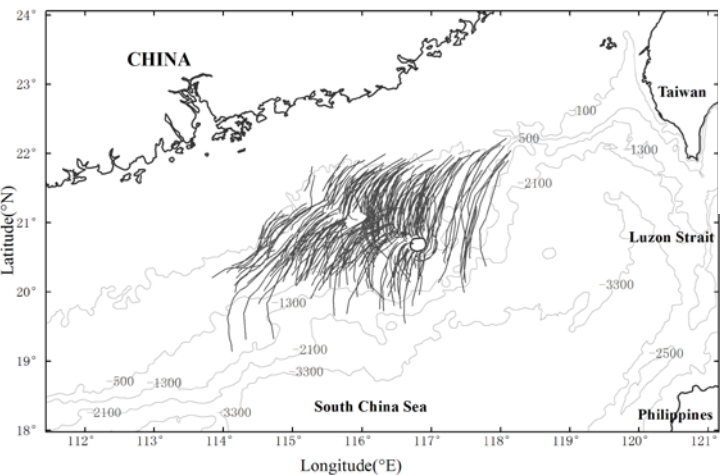
Tidal current retrieval from the TerraSAR-X pursuit monostatic mode data

TSX image@ 9:44:44UTC

TDX image@ 9:44:54UTC



Study of internal wave dynamics in Dongsha Atoll ---SAR observation



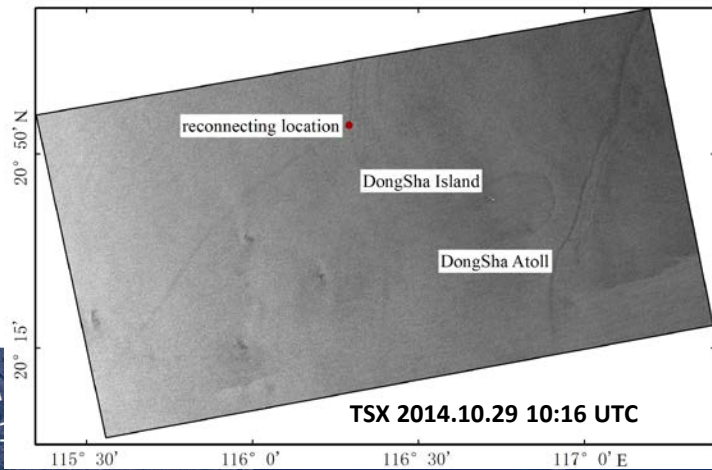
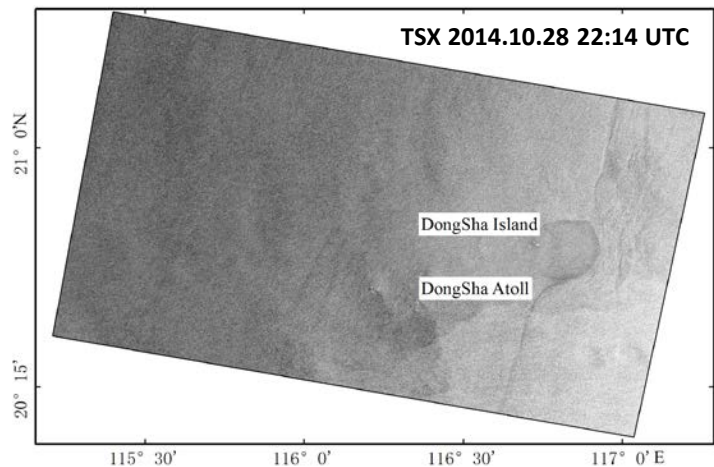
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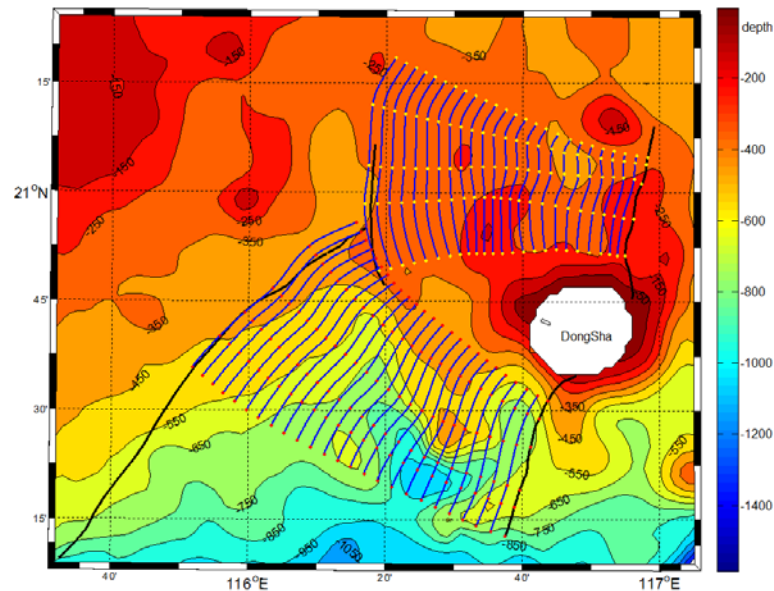
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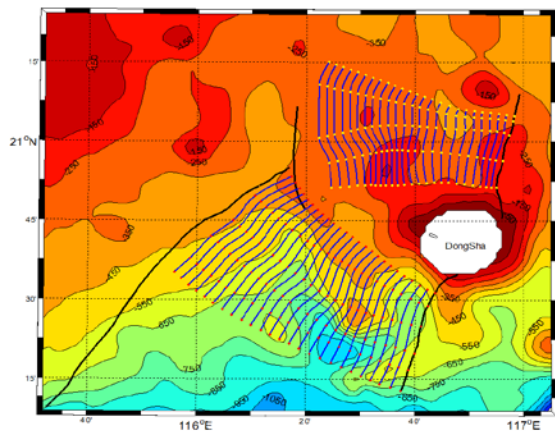
TSX observation



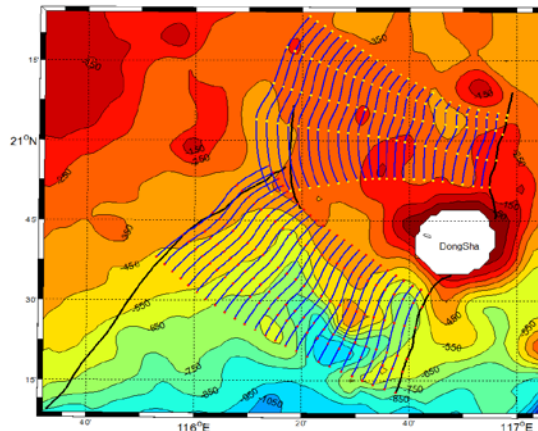
Numerical simulation of IW refraction and reconnection in DSA



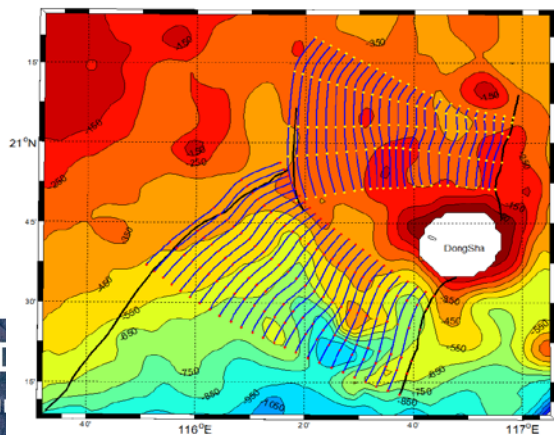
Study of internal wave dynamics in Dongsha Atoll ---numerical model simulation



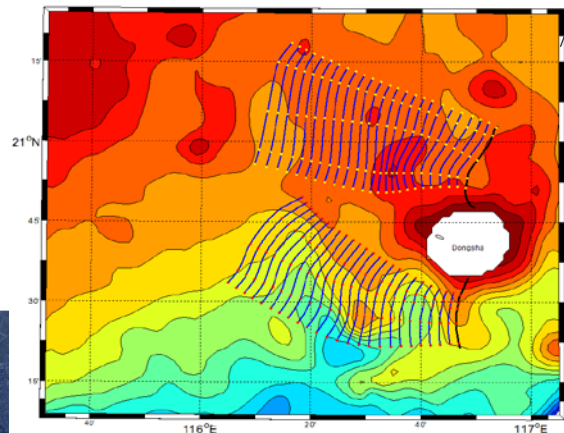
**Changing
background
current**



**Changing
Stratification**

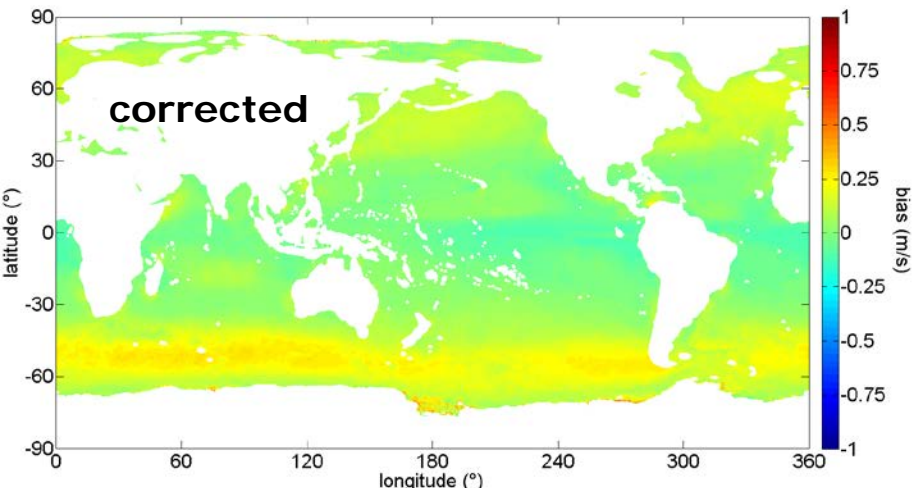
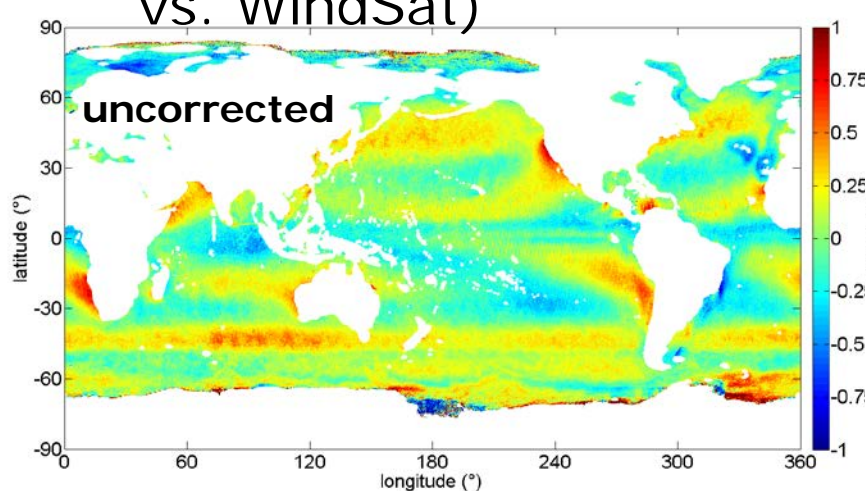


**Changing
Initial IW
amplitude**

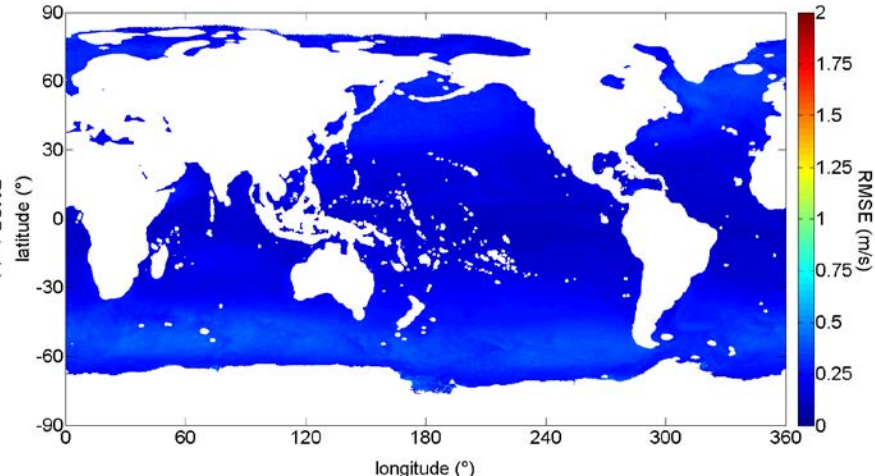
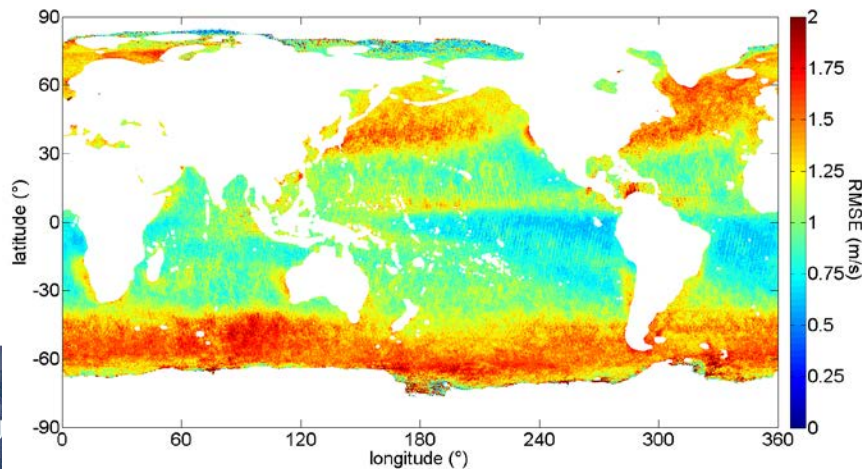


**Changing
incident wave
location and
shape**

Bias



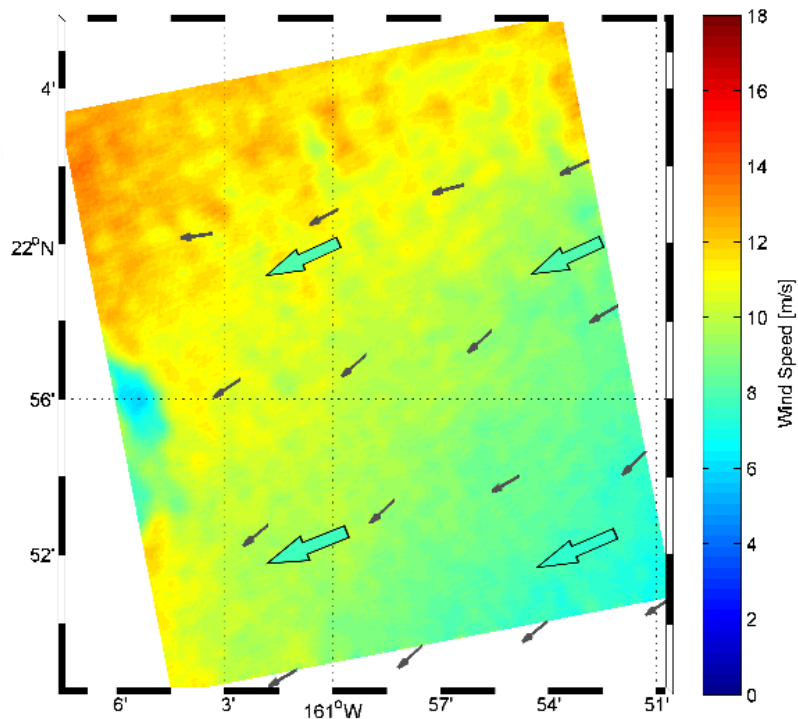
RMSE



2017

26-30

Preliminary test of the GF-3 for oceanography study

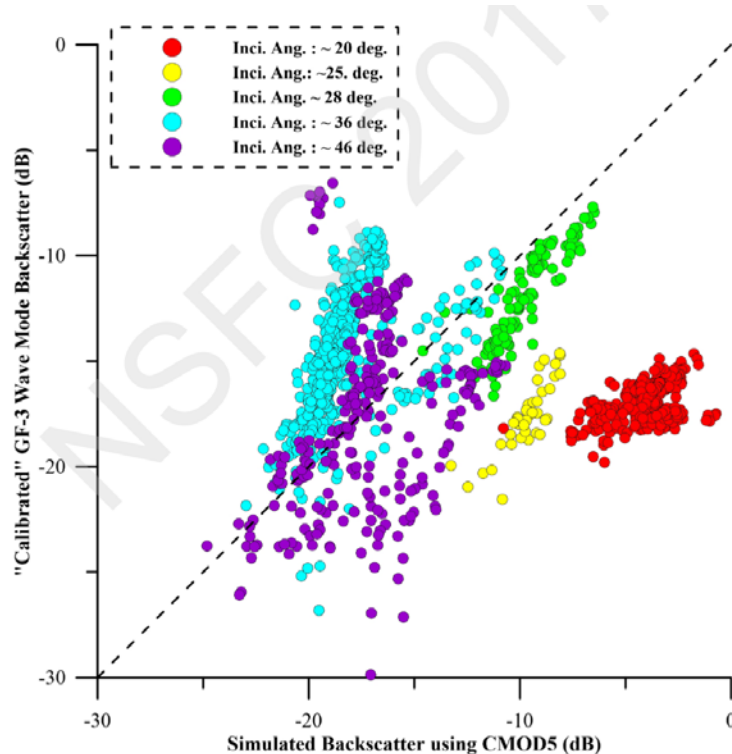


Quad-Pol. 37.4 incidence angle

@Nov.15, 2016

In-situ measurement at FINOT : 7.0 m/s

25.8 deg. incidence angle



GF-3 wave mode data: Dec.2016 – Jan.2017

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Google earth

Image BGAO

▲
N

术研讨会

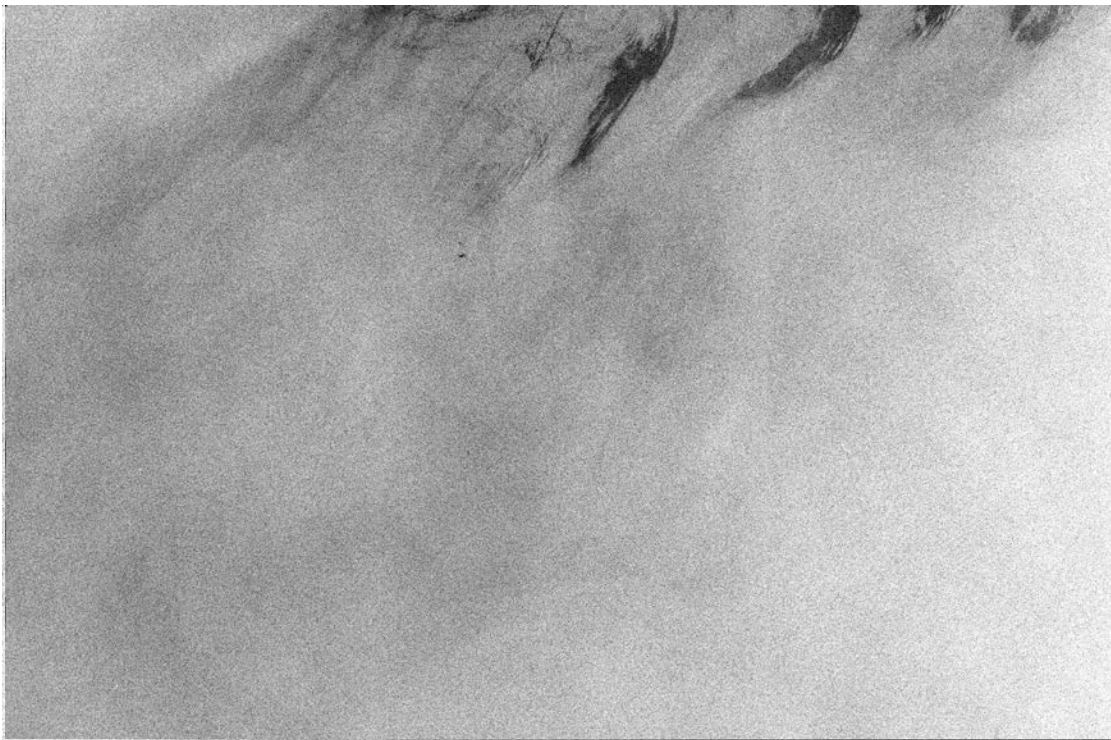
麦哥本哈根

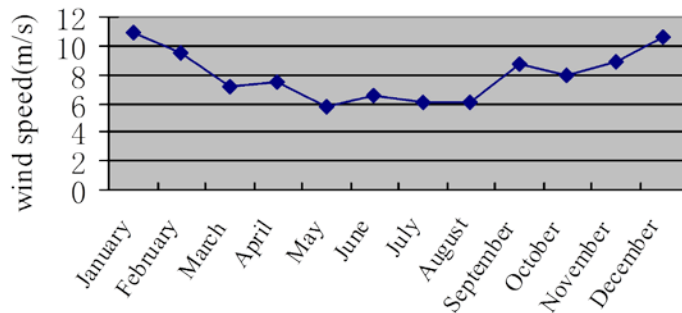
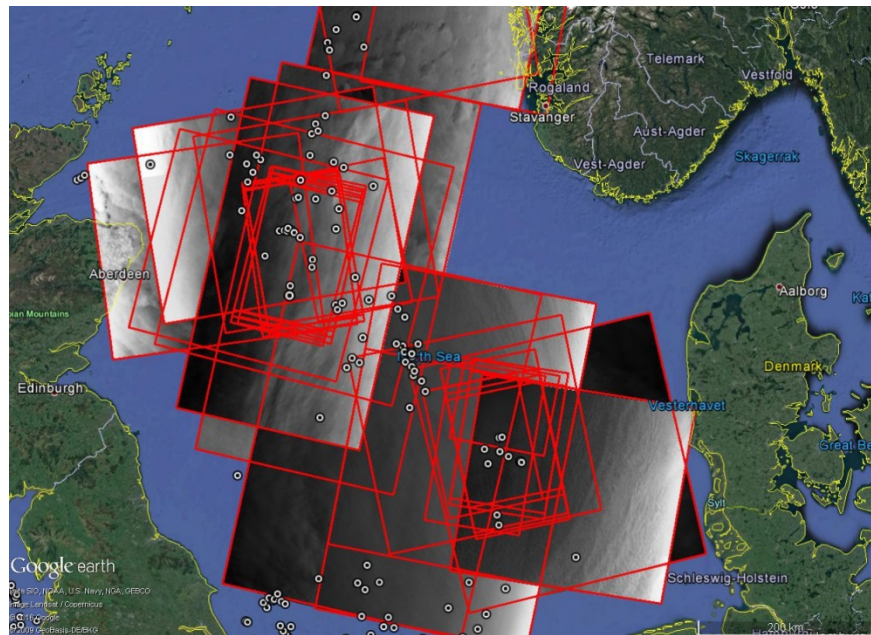
10 km

Results summary id. 32281_2

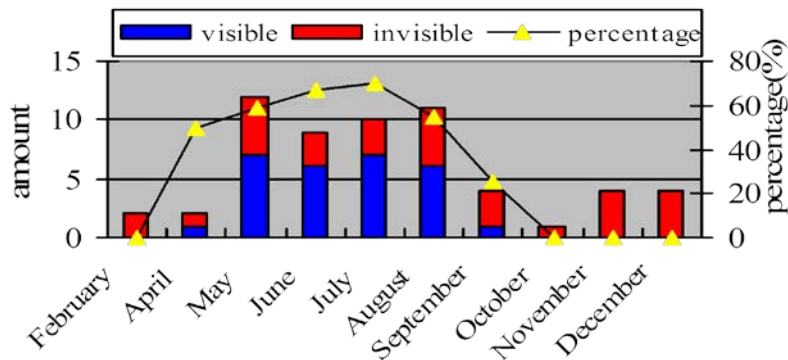
- Development and validation of pre-operational offshore platform pollution monitoring system based on SAR imagery;
- Seasonal trends of detected potential spill in North Sea are in agreement with previous literature;
- Both SAR consecutive observations and numerical simulation were conducted to understand oil spill dynamics (drift) in the north sea platforms;
- Developed a pre-operational SAR-oil spill automatic monitoring system;
- Developed a novel model for macroalgae biomass (i.e. wet weight per unit area) estimation based on optical remote sensing data.
- Developed a simple but effective method of normalization of SAR image with large swath for “dark area” (oil spill) detection.

S1B_IW_GRDH_1SDV_20170624T041531_20170624T041556_006187_00ADED_0993





2013 - Statistics



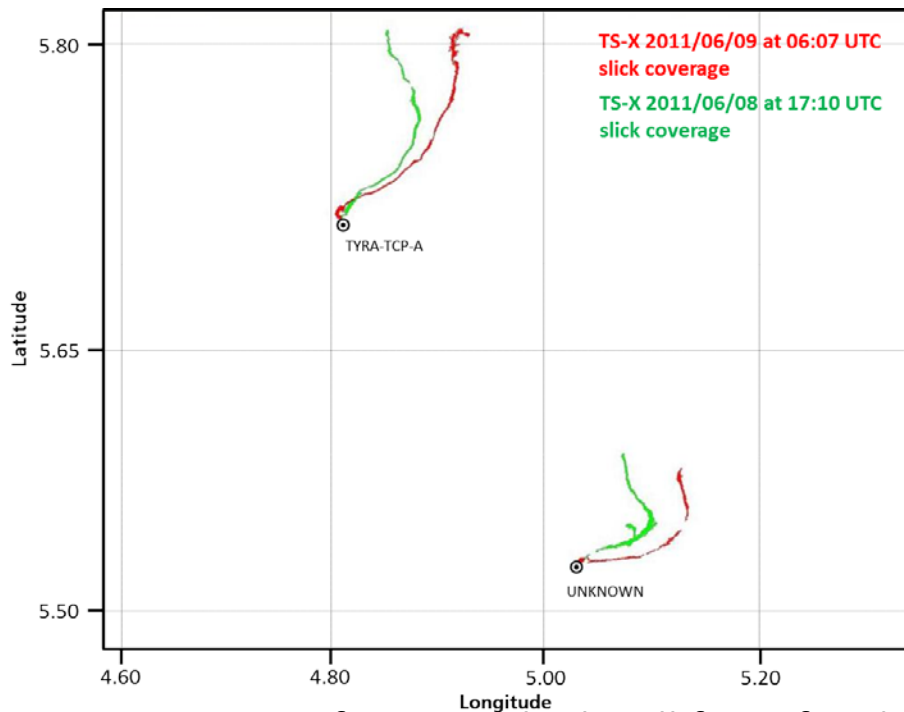
North Sea monitoring of platform's pollution –
medium resolution SAR images > 100 scenes

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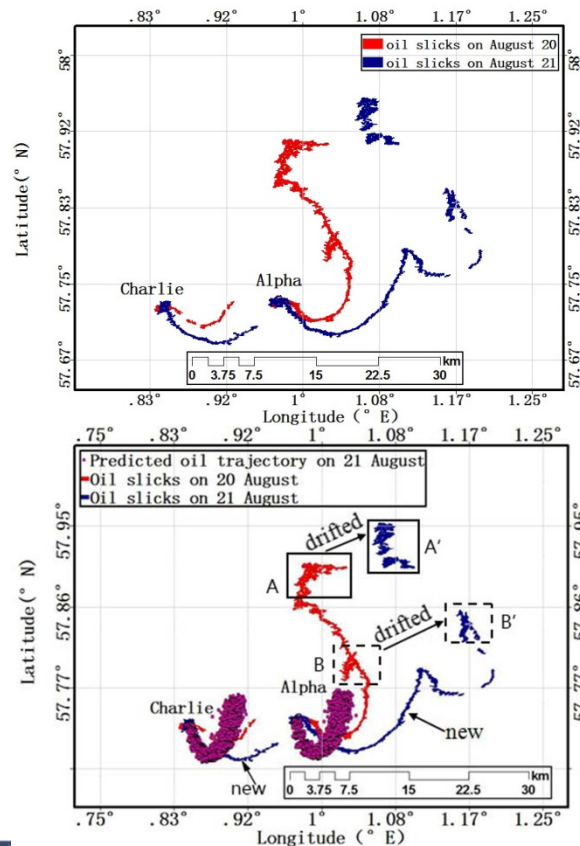
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Detection of potential oil spill from fixed platforms



Pre-operational system for oil spill automatic monitoring



卫星SAR海面溢油自动监测业务化系统 version 1.0

数据上传

选择文件 开始上传 取消上传

已选择文件: C:\fakepath\ASA_WSM_1PNBEI20110613_135428_00000573103_00269_48559_0573.zip

23%

注意: 上传过程中请不要关闭浏览器, 否则上传会中断。

文件名	只来源	上传者
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ASA_WSM_1PNBEI20110613_135428_00000573103_00269_48559_0573.zip	用户上传	万福阳
ASA_WSM_1PNBEI20110613_140123_00000573103_00384_48674_0554.zip	用户上传	万福阳
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ASA_WSM_1PTDPA20100625_035437_000000732090_00348_43488_2603.zip	用户上传	李海宇
ASA_WSM_1PTDPA20100512_155538_000000732089_00226_42865_2592.zip	用户上传	李海宇

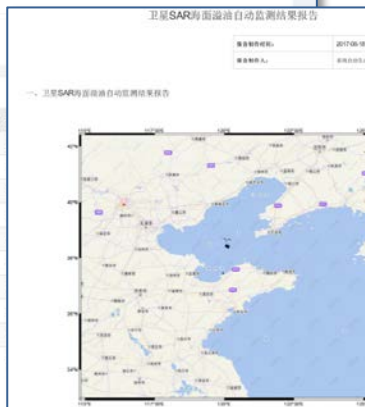


图1 海面溢油监测结果

时间 (UTC)	总面积 (km²)	溢油面积 (km²)
2014-06-13 12:04	296.27	1.17

本系统为海面溢油自动监测系统, 检测精度: 80%, 漏检率: 20%, 误报率: 10%, 识别率: 90%, 对海面溢油面积检测精度: 0.1 km²。

本系统为海面溢油自动监测系统, 检测精度: 80%, 漏检率: 20%, 误报率: 10%, 识别率: 90%, 对海面溢油面积检测精度: 0.1 km²。

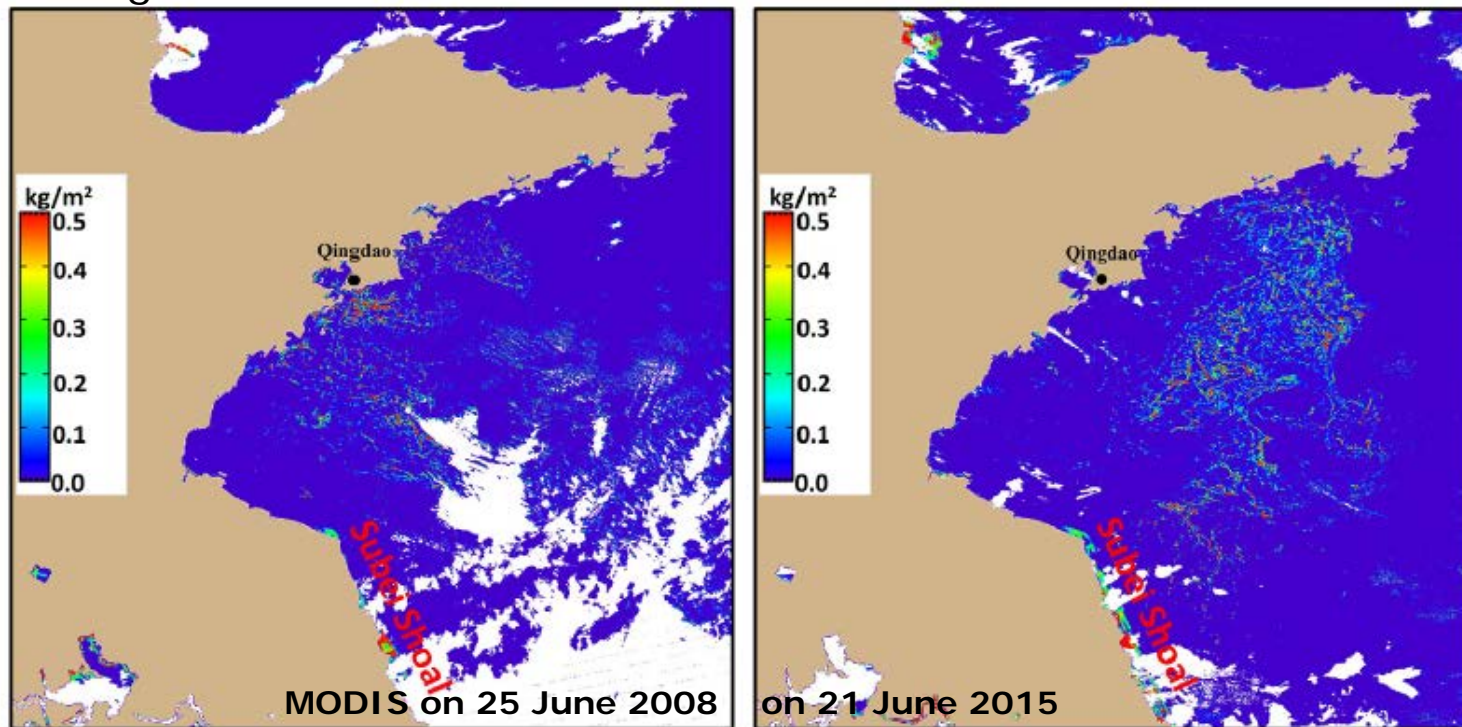
表2 海面溢油检测结果列表

序号	海面溢油样本	中心经度	中心纬度	面积 (km²)
1		E 119°52'55"	N 38°45'25"	2.26
2		E 119°54'29"	N 38°43'26"	6.56
3		E 119°57'12"	N 38°41'42"	3.79
4		E 120°00'21"	N 38°38'42"	1.68
5		E 120°00'23"		
6		E 120°01'22"		
7		E 120°11'11"		
8		E 120°04'01"		
9		E 120°04'26"		
10		E 120°04'42"		
11		E 119°10'32"		

Detection rate 81.2 %
False alarm rate 5.0 %
False discovery rate 19.5 %
Recognition rate 92.3 %

Data set: 23768 targets

An unique model was established to link the *U. prolifera* biomass (wet weight) per unit area to the reflectance-based floating algae index (FAI) derived from optical remote sensing data.



Young scientists contributions

European YS

Dr. Domenico Velotto: Contribution to the image processing and calibration of the oil spill detector. Support and evaluation of the model tracking results.

Chinese YS

Ms. Tong Jia: Contribution to study of IW dynamics in the Dongsha Atoll based on spaceborne SAR observation and numerical modelling.

Ms. Minwei Zheng: Contribution to Cal/Val of the Chinese HY-2 Scatterometer wind measurements

Academic exchanges & Cooperation

The Chinese RADI team and the German DLR team submitted a joint proposal
“**Polar Earth Observation for Arctic ice - ocean dynamics**” under the
framework of collaboration between NSFC and DGF.

国家自然科学基金 国际(地区)合作与交流项目申请书

(组织间合作研究—NSFC-D79(中德))

项目名称: 卫星遥感之北极海冰-海洋动力过程研究

合作国别(地区, 国际组织): 德国 合作起止日期: 2018-01-01—2020-12-31

项目申请人: 李晓明 申请日期: 2017-03-18

依托单位: 中国科学院遥感与数字地球研究所 实验室名称:

通讯地址: 北京市海淀区邓庄南路9号 邮政编码: 100094

联系电话: 010-82178168 传真:

Email: lixm@radi.ac.cn

Joint proposal for
“Polar Earth Observation for Ice and Ocean Dynamics”
(PERIOD)
under the collaboration
between
Remote Sensing Technology Institute, German Aerospace Center (DLR)
and
Institute of Remote Sensing and Digital Earth (RADI), Chinese
Academy of Sciences (CAS).

German Principle Investigator:
Dr. rer. nat. Sven Jacobsen
German Aerospace Center
Earth Observation Center | Remote Sensing Technology Institute | Maritime
Safety and Security Lab.
Henrich-Focke Str. 4, 28199 Bremen, Germany.

Joint publications

- Li, X. –M., Jia, T. and Velotto, D. (2016), Spatial and temporal variations of oil spills in the North Sea observed by the satellite constellation of TerraSAR-X and TanDEM-X, *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, 9(11), pp.4941~4947
- Jia, T., Velotto, D., Li, X. –M. (2016), Study on oil spills in the North Sea forties field observed in TerraSAR-X and TanDEM-X imagery, *Geoscience and Remote Sensing Symposium (IGARSS)*, 2016 IEEE International, Beijing, China
- Shao, W.Z.; Zhang, Z.; Li, X.M.; Wang, W.L. (2016), Sea surface wind speed retrieval from TerraSAR-X HH-polarization data using an improved polarization ratio model. *IEEE J. Sel. Topics Appl. Earth Observ. Remote Sens.* 9, 4991–4997.
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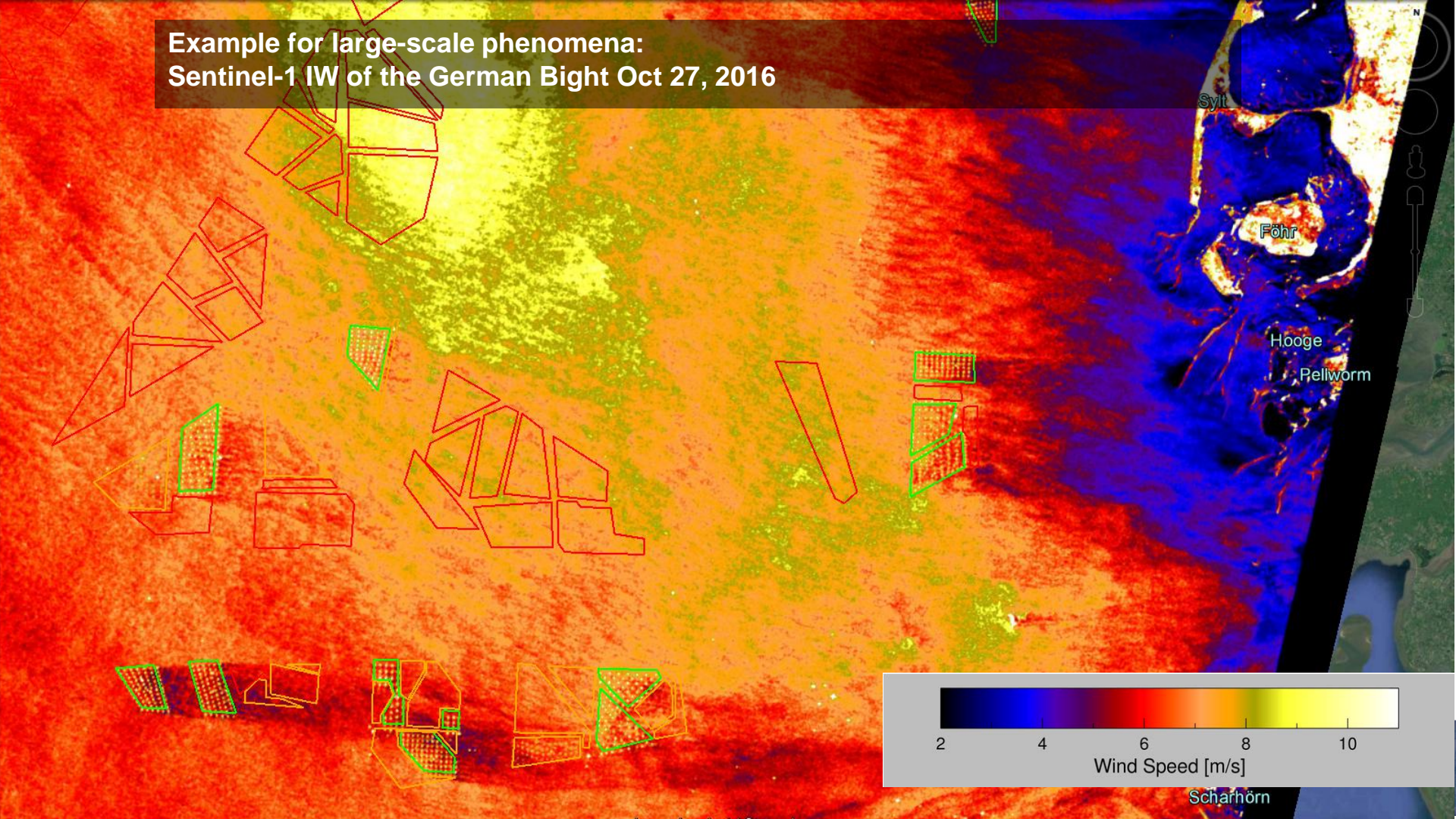
Summary on progress and collaboration

- The team has made great progress on deriving marine-meteo parameters from ESA's and the TPM data, including Sentinel-1, TerraSAR-X, GF-3 and Radarsat-2. Some have been implemented in NRT service.
- Besides algorithm development, the SAR data have been used for offshore wind farm monitoring, dynamics of internal wave in the SCS.
- Developing various methods, models and software to detect and track marine pollution from space;
- The European and Chinese teams are working closely under the framework of this project. Based on this, we have submitted a joint proposal to NSFC and DFG, as well as a Sino-Greece collaboration proposal is under preparation.

Plans for the next 2 years

- (1) Focusing on SAR marine-meteo parameters retrieval and observation of ocean dynamic processes in multiple scale;
- (2) Conducting multiple SAR observation experiments on ocean monitoring.
The ESA's and the TPM SAR, as well as the Chinese GF-3 data will be included for such joint experiments;
- (3) Possible academic exchange of postgraduates and young scientists;
- (4) Promoting joint publications;
- (5) Organizing a medium-size workshop on ice-ocean dynamics to be funded by the Sino-German science center.

Example for large-scale phenomena:
Sentinel-1 IW of the German Bight Oct 27, 2016



Thank you for your attention