



ESA-MOST Dragon Cooperation

中国科技部-欧洲空间局“龙计划”合作

2017 DRAGON 4 SYMPOSIUM

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DRAGON 4 ID. 32405 PROJECT SUMMARY

**Monitoring Dynamics of Coastal Wetlands and Suspended Sediment with High
(Temporal/Spatial/Spectral) Resolution Satellite Images(32405)**

Dr. Tingwei Cui (LI)

First Institute of Oceanography, SOA, Qingdao, China

Dr. Shubha Sathyendranath (LI)

Plymouth Marine Laboratory, UNITED KINGDOM

Objective

- To explore and demonstrate the technical possibility and capability of high resolution remote sensing for monitoring:
 - coastal wetlands of the Yellow River estuary
 - suspended sediment in the Bohai Sea
- To develop new multi- and hyperspectral remote sensing methods to derive estuarine wetlands biomass, SPM, and carbon storage.

Sub-projects and themes:

32405_1: Synergistic ocean color observation based on polar-orbiting and geostationary satellite images

- a). Validating the SPM ocean color products from polar orbiting and geostationary satellite images
- b). Developing SPM retrieval method based on synergistic utilization of polar orbiting and geostationary satellite images
- c). Characterizing the spatio-temporal pattern and variability of SPM in the Bohai Sea by time series of satellite images

32405_2: Wetlands monitoring using high resolution remote sensing images in Yellow River estuary

- a). Estuarine wetlands classification using hyper-spectral remote sensing imagery
- b). Estuarine wetlands carbon storage monitoring using hyper-spectral remote sensing imagery
- c). Estuarine wetlands change monitoring using high resolution remote sensing images

Project's Partners and Roles

Dr. Shubha Sathyendranath(LI), Merit Scientist, Plymouth Marine Laboratory,UK (Remote sensing, ocean optics).

Dr. Tingwei CUI(LI), Professor, First Institute of Oceanography (FIO), State Oceanic Administration (SOA), China. Major: ocean optics and ocean color remote sensing;

Dr. Yi MA(PI), Professor, First Institute of Oceanography (FIO), State Oceanic Administration (SOA), China, Major: coastal zone optical remote sensing.

Dr. Stefan Simis, Plymouth Marine Laboratory, Senior scientist, Plymouth Marine Laboratory(Remote sensing of inland waters, phytoplankton ecology)

Dr. Guifen Wang Plymouth Marine Laboratory

Dr. Guangbo REN, First Institute of Oceanography (FIO), State Oceanic Administration(SOA), China, PhD Candidate, Major: optical remote sensing.

Dr. Yanfang Xiao, First Institute of Oceanography (FIO), State Oceanic Administration (SOA), China. Major: ocean color remote sensing.

Dr. Rongjie Liu, Associate professor, First Institute of Oceanography (FIO), State Oceanic Administration (SOA), China. Major: ocean color remote sensing.

Dr. Bing Mu, Ocean University of China. Major: ocean color remote sensing.

Dr. Ping Qin, Ocean University of China. Major: ocean color remote sensing.

Satellite data

ESA

- Sentinel-2/3, SPOT-5, SPOT-6, PROBA CHRIS.....

CHINESE

- GF-1/2/3/4, HJ-1 CCD, FY,.....

TPM

- GOCI, Landsat-8 OLI, Landsat TM/ETM+, ALOS,

Expected outcome

- **New method** of monitoring SPM by synergistic use of geostationary and polar-orbiting optical images.
- **New ocean color products** (e.g. SPM concentration) with high spatial and temporal resolutions will be developed for turbid waters along China coast.
- **Uncertainties** of ocean color products from Sentinel-2/3 products in the turbid waters along China coast.
- **New biomass/carbon storage hyper-spectral retrieval model** of estuarine wetlands types using new hyper-spectral remote sensing images.
- **Automatic wetland classification method** using high resolution remote sensing images.

Research progress

1. Evaluation, processing and application of China's geostationary optical satellite GF-4
2. Atmosphere correction of ENVISAT MERIS over European coastal turbid waters
3. Coastal wetland classification based on high resolution SAR and optical images
4. Estimation of coastal wetland carbon storage capacity by GF-1 WFV satellite image
5. Coral reef bleaching monitoring based on WorldView-2 and GF-2 satellite images

1. GF-4 evaluation, processing and application

Evaluation

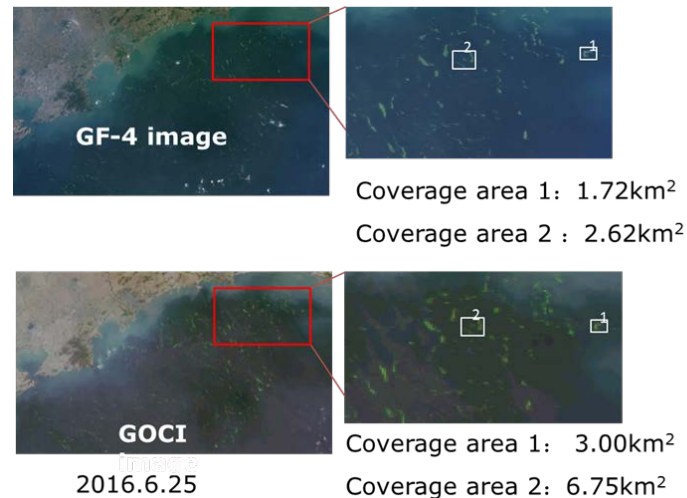
1. signal-to-noise ratio (SNR)
2. Georeference

Processing

1. Vicarious radiometric calibration
2. Atmospheric correction

Application

1. Macro-algal bloom monitoring (comparison with GOCI)
2. Red tide detection (comparison with GOCI)
3. SPM/turbidity retrieval (comparison with GOCI & MODIS)



2. Atmosphere correction of ENVISAT MERIS over high absorption waters

Six algorithms evaluated:

CC (v1.8.3), C2R-Lakes (v1.6), C2R-CC (v 0.15), FUB (v 2.2), MEGS (v 8.1) and POLYMER (v 3.5)

Research Area: the Baltic Sea

***In situ* data sources:**

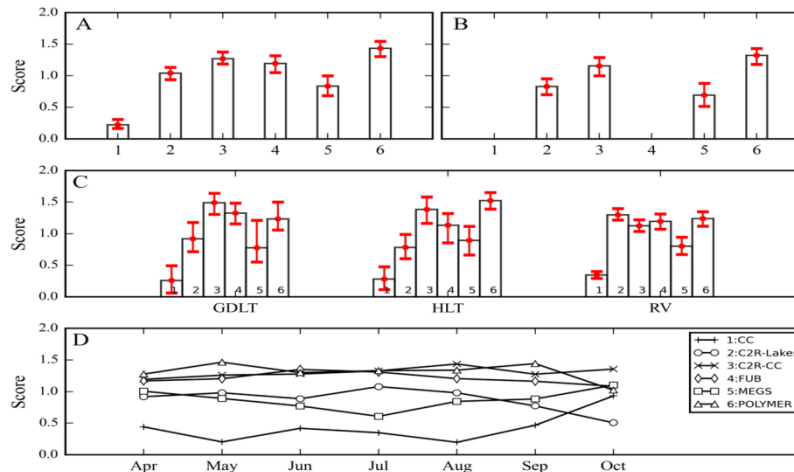
- shipborne autonomous platform
- AERONET-OC data

Match-ups:

3×3-pixel boxes and ± 3 -h window

Best algorithm: POLYMER

Reference for Sentinel 3 OLCI



3. Coastal wetland classification based on high resolution SAR and optical images

Research area:

Yellow River estuary wetland

Remote sensing images:

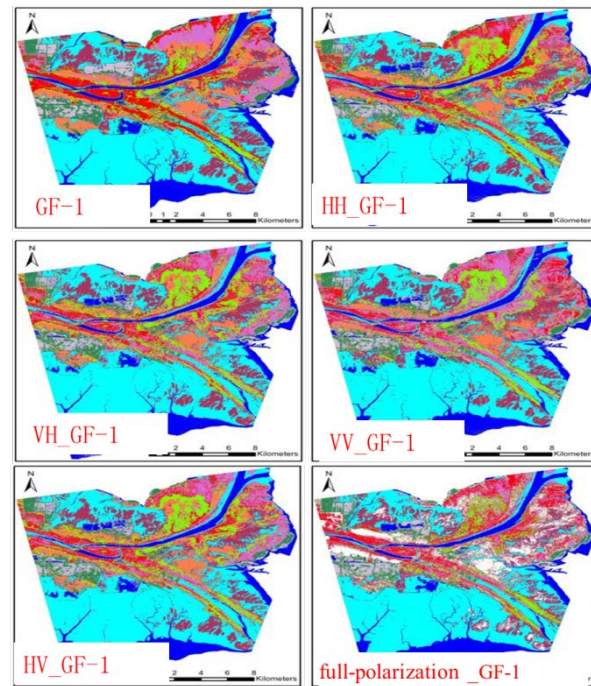
GF-1 WFV, Radarsat-2 SAR (Fine Quad Polarization)

Method:

Gram-Schmidt Fusion method, SVM classification method

Results:

The classification accuracy of tidal flat reed in the fusion image VV polarimetric SAR and GF-1, is better (3.6% higher) than that of original GF-1 images (57.6%).



4. Estimation of coastal wetland carbon storage capacity by GF-1 WFV image

Research area: Yellow River estuary wetland

Remote sensing images: GF-1 WFV

Method: Regression analysis

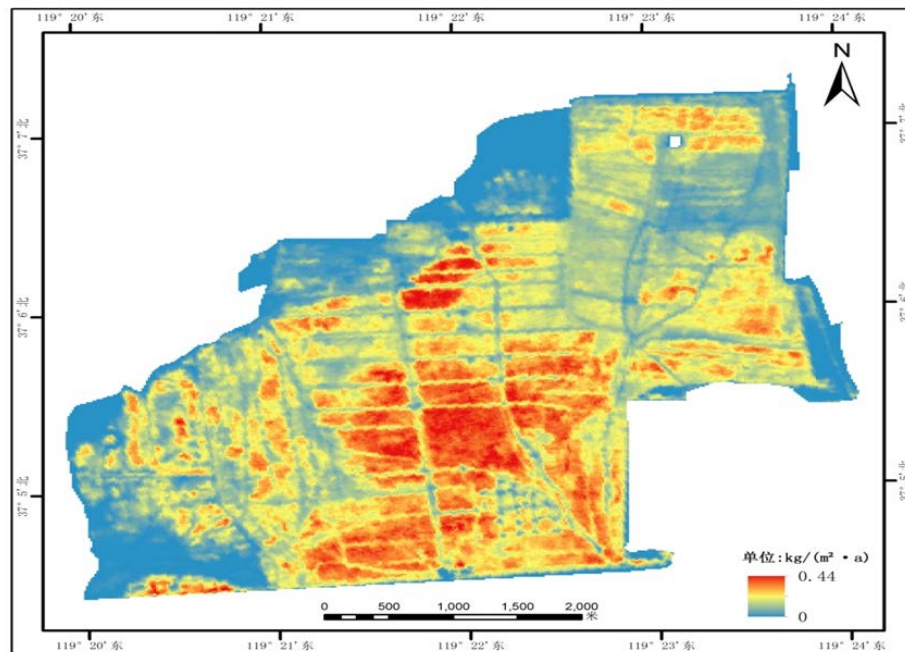
Results:

Carbon storage capacity model:

$$y = 2014NDVI^{3.810}$$

R^2 is 0.898, and RMSE is 3.9% .

Carbon storage capacity of the study area is $2.98 \times 10^3 \text{ t/yr}$.



5. Coral reef bleaching monitoring based on WorldView-2 and GF-2 images

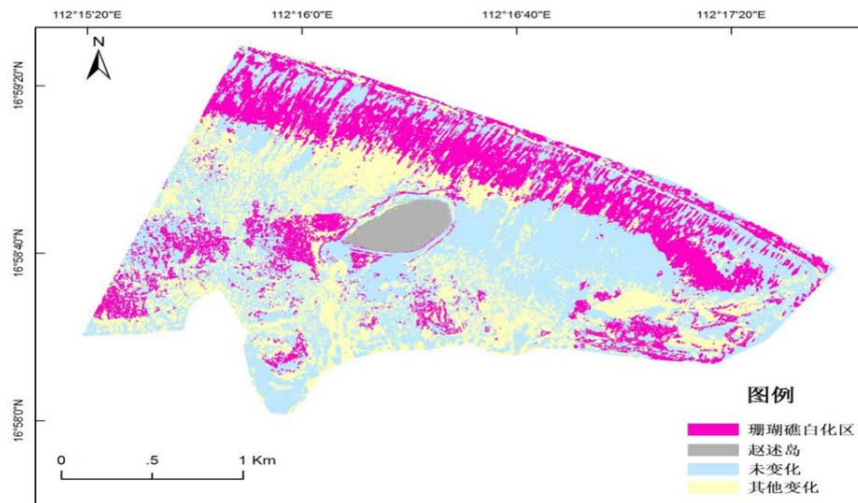
Research area: Zhaoshu Island and its adjacent waters in South China Sea

Remote sensing images: WorldView-2, GF-2

Method: Decision tree

Results:

About 1/4 of coral reef in the study area was bleached during 2010 and 2015, the total area of which was 152.29 hm².



Coral reef bleach monitoring result of study area for 2010-2015

EO data exploitation

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	200	Sentinel 1-A/B SAR		HJ-A/B	10
ASAR		Sentinel 2-A/B MSI		GF-1	15
MERIS		Sentinel 3-A OLCI		GF-2	
AATSR		Sentinel 3-A SLSTR		GF-4	20
SMOS		Sentinel 3-A SLAR		FY-1	
etc.		Etc.		Etc.	
TOTAL	200	TOTAL		TOTAL	45

Young scientists contributions

European YS

Application for YS funding pending.

Topic: image classification by machine learning for plume and bloom detection from Sentinel-2.

Dr. Xiao Yanfang

Dr. Mu Bing

Dr. Qin Ping

Mr. Liu Rongjie (Phd candidate)

Mrs. Chen Xiaoying

Mr. Gong Jialong (graduate student)

Mr. Liang Xijian (graduate student)

Mr. Yu Haocheng (graduate student)

Academic exchanges

- Academic exchange during DRAGON 4 KICK-OFF SYMPOSIUM held in Wuhan in 2016.
(Dr. Stephan , Dr. Wang Guifen, Mr. Liu Rongjie)
- Academic Visiting scientist (Dr. Qin Ping) to PML
Feb., 2016~Feb., 2017



Publications

1. Qin et al., MERIS atmosphere correction, submitted to RSE
2. Chen et al., GF-4 monitoring of macro-algal bloom, submitted to JRS
3. Cui et al., GF-4 evaluation and application, in prep.
4. Chen et al., Long-term changes of Chla in the Bohai Sea, in prep.
5. Cui et al., Environment issue of the Bohai Sea and its demands on optical remote sensing, in prep.
6. Liu et al., GF-4 monitoring of red tide in Bohai Sea, in prep.

Summary on progress and collaboration

- All works have been carried out as scheduled, exploring the satellite images from the Chinese and European sides, from the geostationary and polar orbits, and from the optical and microwave sensors.
- Collaboration mechanism between European and Chinese scientists has been built. Chinese young scientist (Dr. Qin Ping) has taken a one-year visit to PML for collaboration.

Plans for the next 2 years

- Collect the field and satellite data;
- Validate the ocean color products derived from Sentinel-3 and GOCI and GF-4 over the turbid waters along China coast.
- Improve the results and publish co-authored papers.
- Invite British colleagues to China to give lectures.
- Send Chinese young scientist to PML for a short visit.

Thanks for your attention!