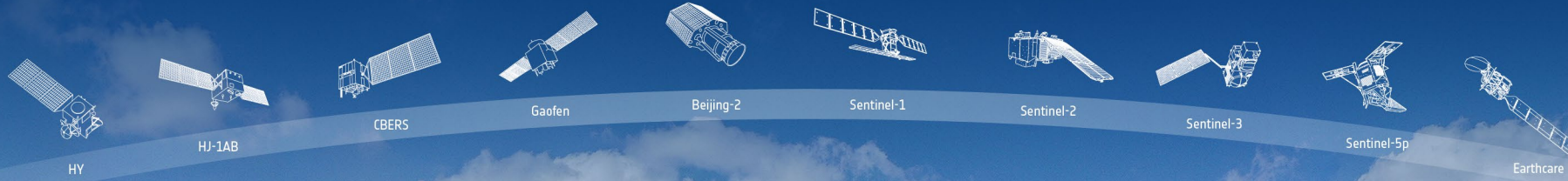




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2025 DRAGON 6 SYMPOSIUM

14-18 JULY 2025

PROJECT ID: 95368

SAR MONITORING OF SMALL-SCALE DYNAMICS IN MARGINAL SEAS (SADYMAS)





WEDNESDAY, 16/JULY/2025 09:45

PROJECT ID: 95368

PROJECT TITLE:

SAR MONITORING OF SMALL-SCALE DYNAMICS IN MARGINAL SEAS (SADYMAS)

Principal Investigators:



Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

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AIRCAS, China

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Aerospace Information Research
Institute Chinese Academy of Sciences

Co-authors:

Zhikun Huang, Nannan Zi

Presented By: Martin Gade

Dragon 6 SADyMaS: Overview



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EO Data

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Eddy Detection

5

YS Training Course





❑ SADyMaS: SAR Monitoring of Small-Scale Dynamics in Marginal Seas

❑ Objectives:

- **Promote exploitation of Copernicus Sentinels, ESA, ESA TPM and Chinese EO data:**
Better understanding of the ways, in which **marine ecosystems** are exposed to and react on **dynamic ocean processes of various scales**
- **Stimulate scientific exchange:**
Bi- or multi-lateral research or educational activities; **joint Sino-European research packages**
- **Publish co-authored results:**
Joint publications at the Midterm and Final Dragon 6 Symposia, and in leading peer-reviewed scientific journals
- **Provide training to young European and Chinese scientists:**
Teaching and training activities, educational courses, **summer schools**



□ SADyMaS: Small-Scale Dynamics generated by Zi Nannan



Dragon 6 SADyMaS: Overview



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Dragon 6 **SADyMaS**: Project Team



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UHH Hamburg University , Hamburg, Germany



HEREON Helmholtz Zentrum Hereon, Geesthacht, Germany



AIR Aerospace Information Research Institute, Beijing, China

HATIC Hainan Aerospace Technology Innovation Center, Wenchang, China



HNTOU Hainan Tropical Ocean University, Sanya, China

Dragon 6 SADyMaS: Project Team



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ROLE	TITLE	NAME	SURNAME	INSTITUTION	COUNTRY	TEAM (EU/CH)
PI	Dr.	Martin	Gade	Universität Hamburg		
CO-PI	Dr.	Daniel	Carlson	Helmholtz-Zentrum Hereon		
YS	Mr.	Zhikun	Huang	Universität Hamburg		
PI	Prof.	Xiaoming	Li	Aerospace Information Research Institute, CAS		
CO-PI	Dr.	Jianjun	Liang	Aerospace Information Research Institute, CAS		
CO-PI	Dr.	Jin	Sha	Aerospace Information Research Institute, CAS		
CO-PI	Prof.	Haiyun	Yang	Hainan Tropical Ocean University		
YS	Ms.	Chunbo	Li	HATIC		
YS	Mr.	Xing	Li	HATIC		
YS	Mr.	Ning	Wang	HATIC		
YS	Ms.	Shuqi	Liu	HATIC		
YS	Mr.	Shuai	Wu	HATIC		
YS	Ms.	Nannan	Zi	Aerospace Information Research Institute, CAS		

Dragon 6 SADyMaS: Overview



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EO data access since July 2024

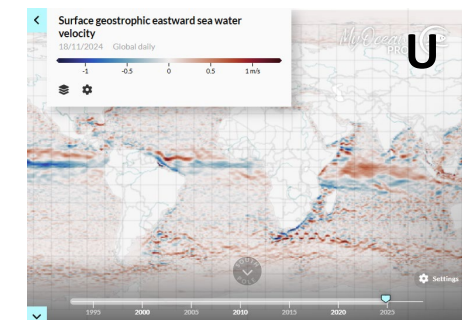
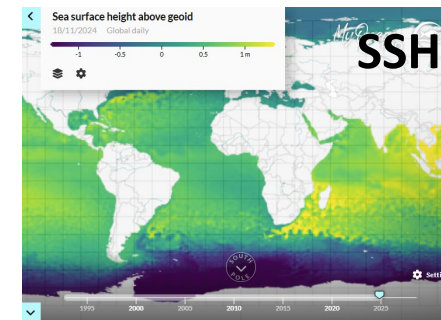
Copernicus Sentinels, ESA data	No. Scenes
1. Sentinel-1 A/B	>100,000
2. Sentinel-2 A/B	>100
3. Sentinel-3 A/B	>100
4. ENVISAT / ERS	>2000

Through ESA's Sentinel Hub and from local archives at UHH and DTU.

Chinese EO data	No. Scenes
1. GF-1	>800
2. GF-3	>100
3. SDGSAT-1	>3200
4. HaiShao-1	>200

SDGSAT-1 freely available: <https://www.sdgsat.ac.cn/>
GF-1, and GF-3 data available: <https://data.cresda.cn/>
HaiShao-1 data available: <https://sso.airsat.com.cn>

Altimeter satellite product from Copernicus Marine Service:
sea level anomaly | absolute dynamic topography |
geostrophic velocity ...
<https://data.marine.copernicus.eu/>





HaiShao (sea whistle) Satellite constellation



□ HaiShao-1

was launched in Dec. 2024

- X-band SAR | Low orbit (~43 degree)
- Multi-/compact polarized SAR
- SAR + Nightlight integration

Focus on Low-latitude application

□ HaiShao-2

To be launched in August 2025

- Sun-synchronous orbit
- Fully polarized SAR
- "R.S.-COMM-NAV" integration

Focus on Global ocean & Polar application

□ HaiShao-3

□ HaiShao-4

are currently in production





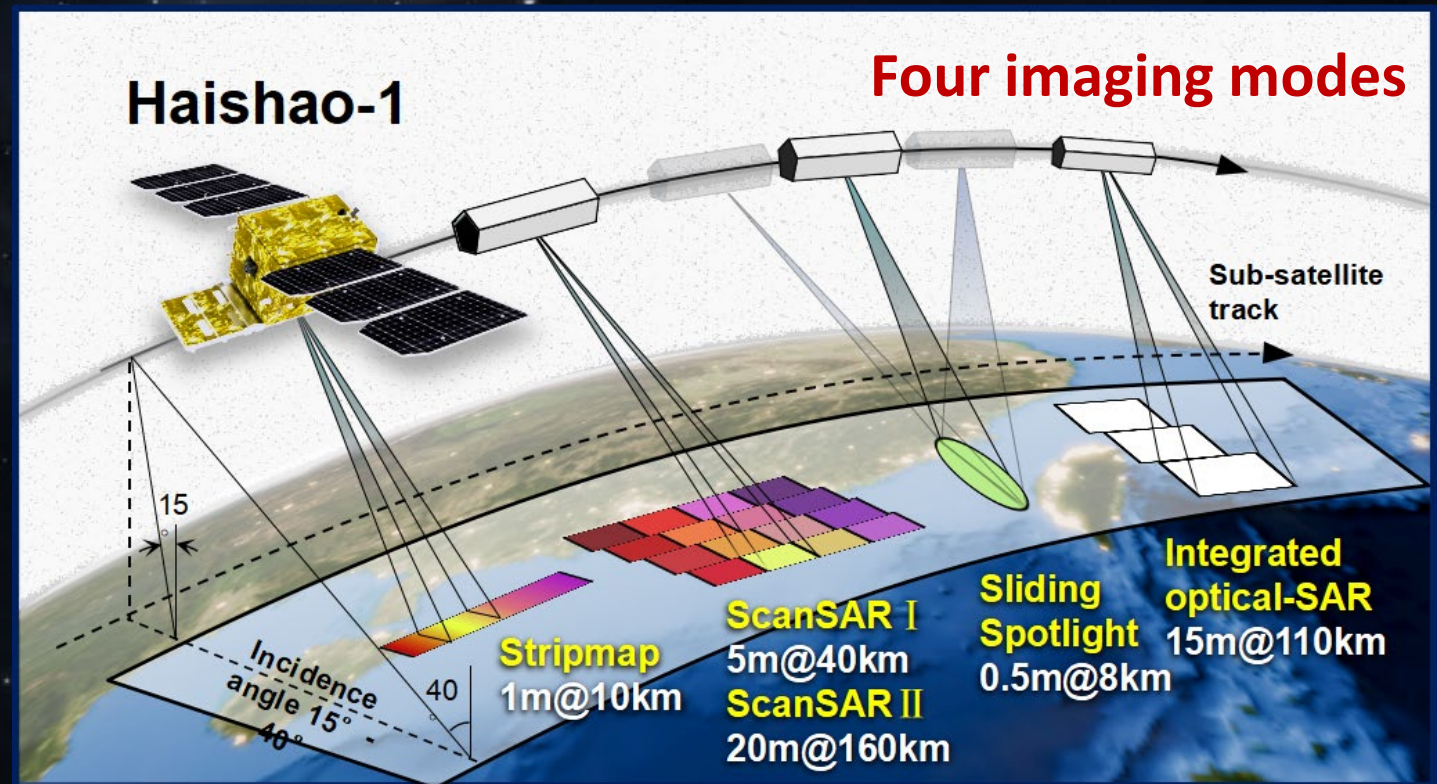
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HaiShao-1

First low-inclination-orbit spaceborne SAR in China





HaiShao-1

First low-inclination-orbit spaceborne SAR in China



VideoSAR mode

2m resolution

Duration 22s

89 fps



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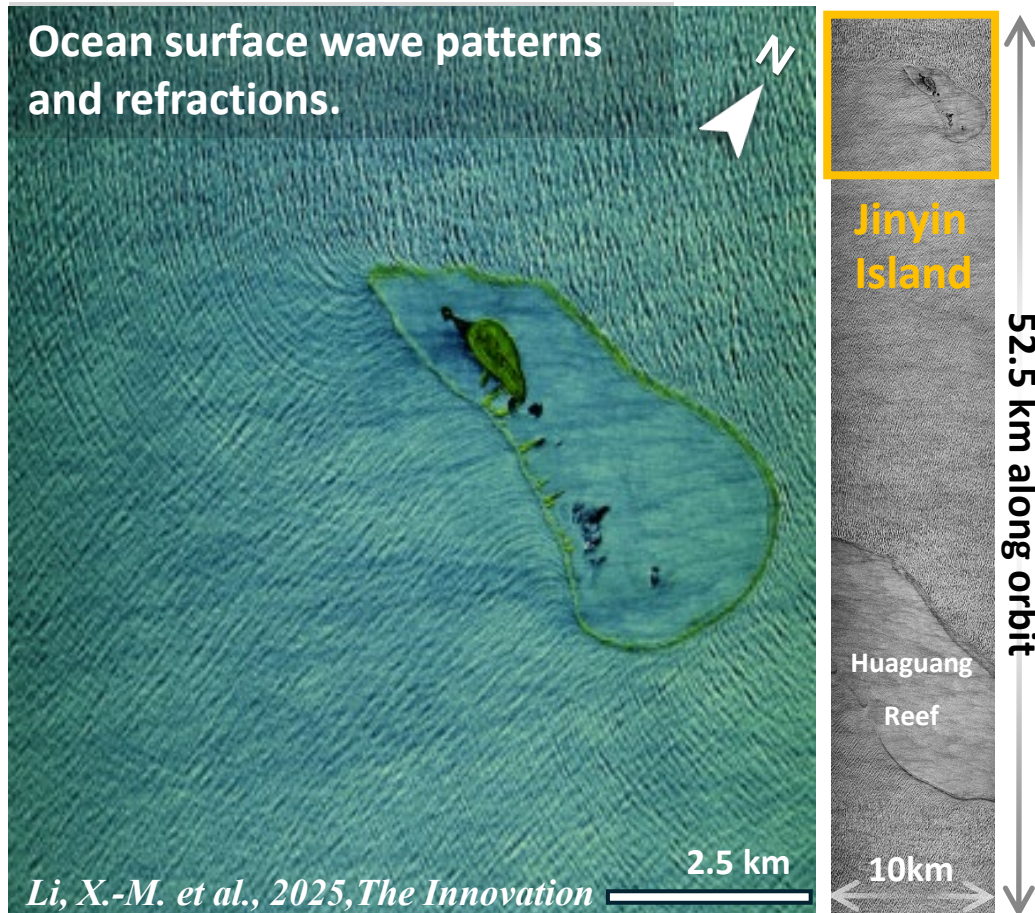
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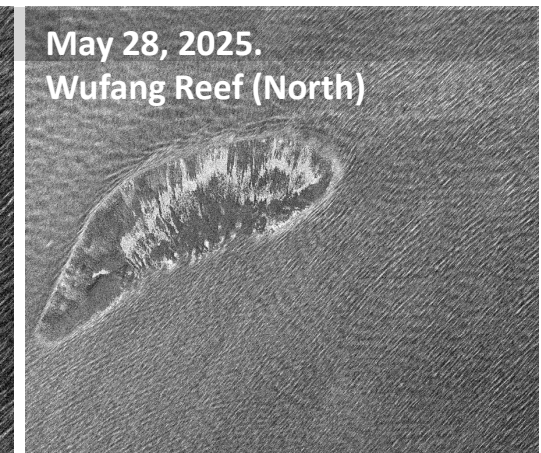
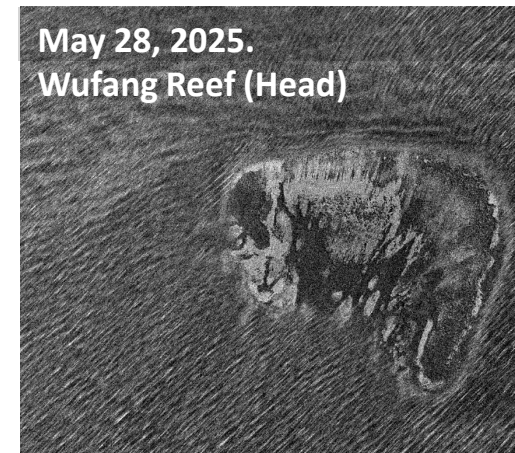
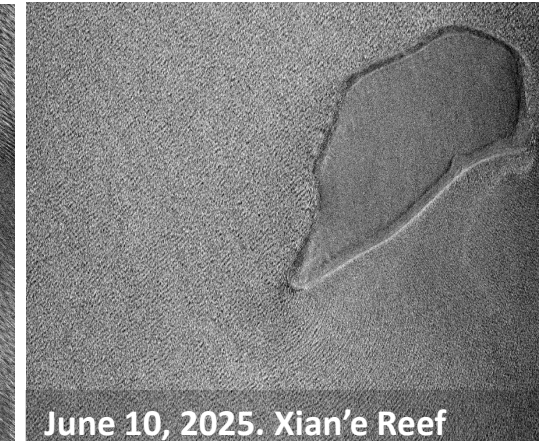
HaiShao-1: Ocean Observations



Credit: Shuqi Liu,
Ning Wang, Xing Li



➤ False-Color map of Xisha Island
(1-m resolution, Stripmap Mode, VV)



➤ Island and Reefs of South China Sea
(1-m resolution, Stripmap Mode, VV)



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HaiShao-1: Ocean Observations



Credit: Shuqi Liu,
Ning Wang, Xing Li

Yongxing Island

- Airport
- Buildings
- Vegetation
- Stadiums
- Harbor

Surrounding Sea

- Reef Plate
- Wave Stripes



Yongxing Island

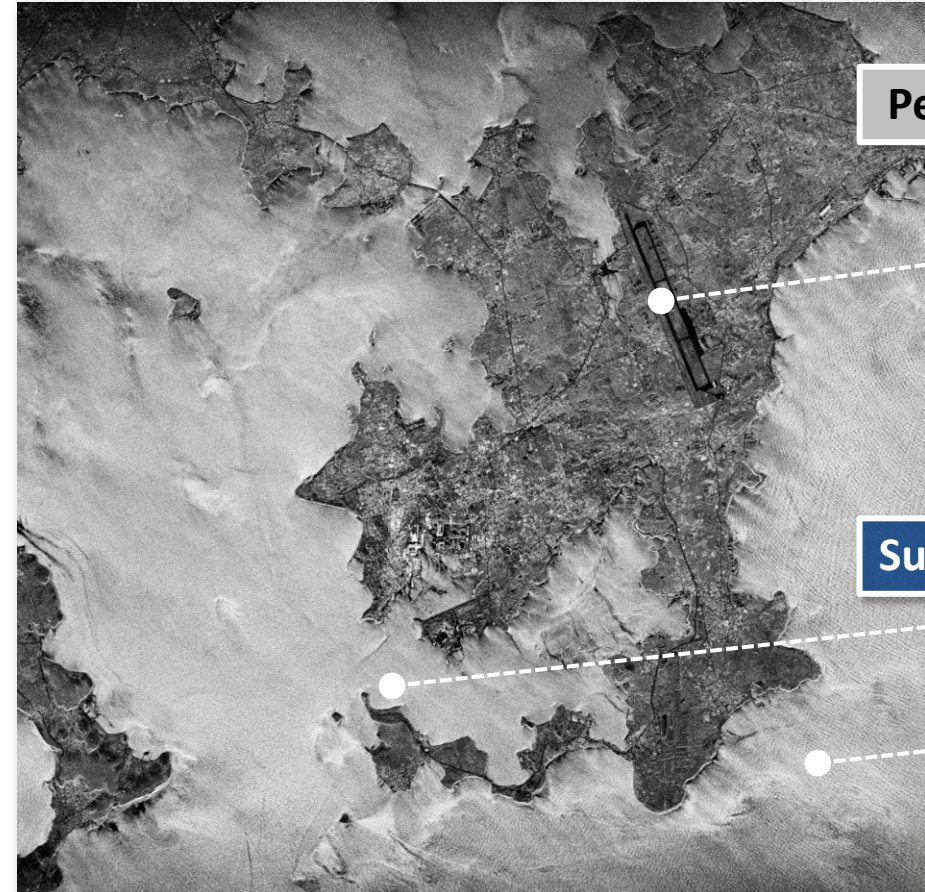
(1-m resolution, Stripmap Mode, VV)

Penghu County

- Urban Rail
- Airport
- Fishing Port
- Building Complex

Surrounding Sea

Wave Patterns and the Shallow-Water Topographic Features



Penghu Islands

(1-m resolution, Stripmap Mode, VV)



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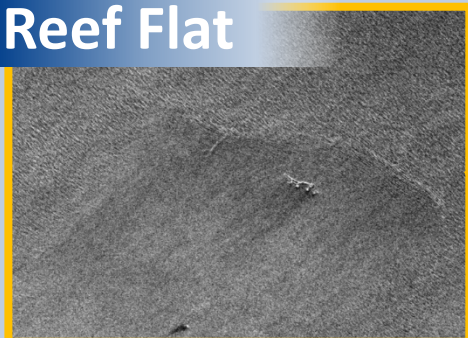
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HaiShao-1: Ocean Observations

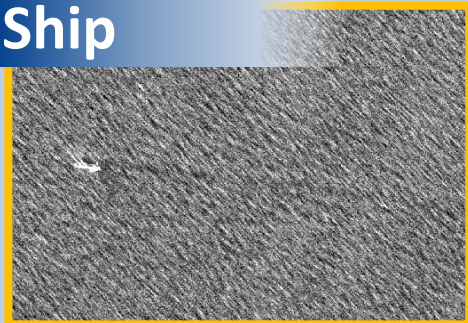
Island



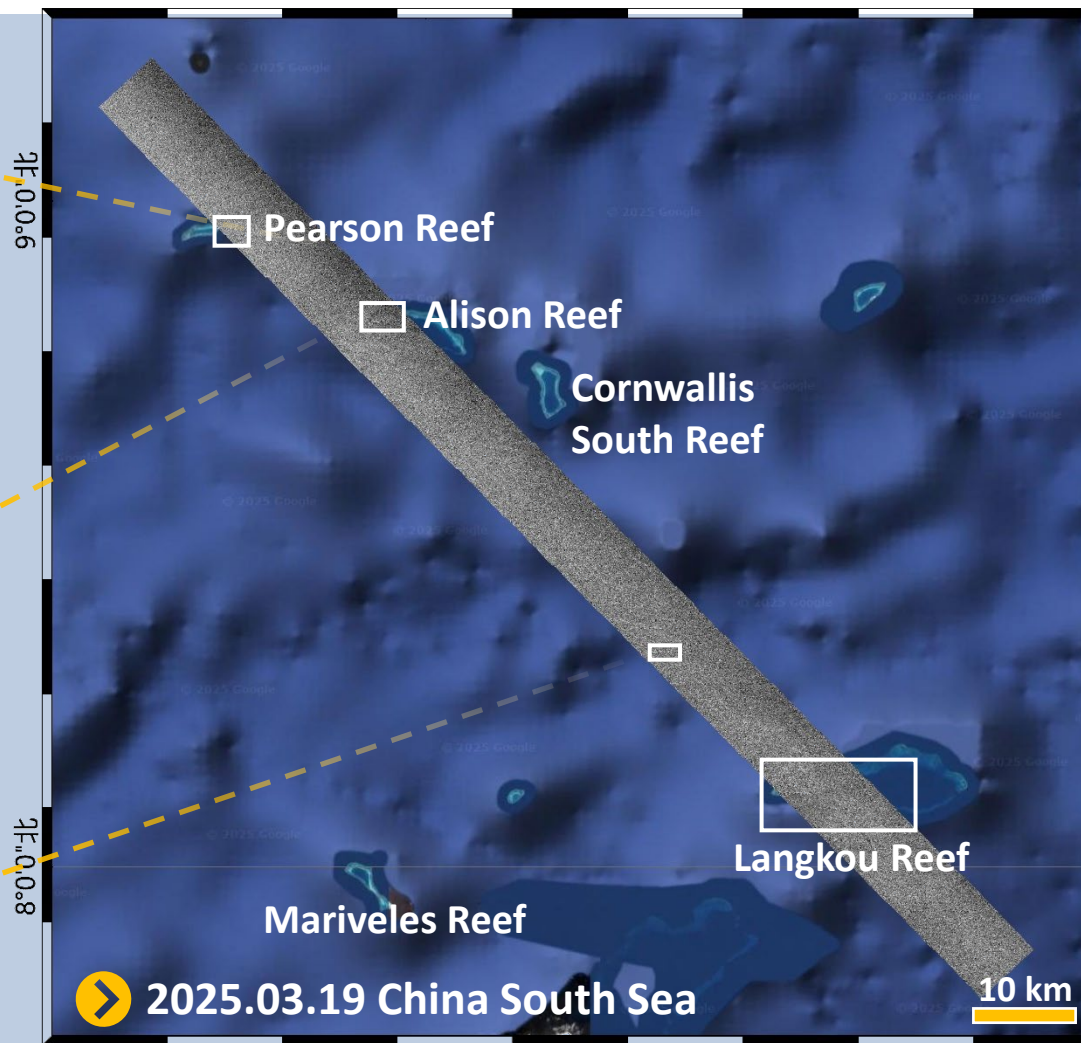
Reef Flat



Ship



Marine Target



114°0'0"东

Credit: Shuqi Liu,
Ning Wang, Xing Li

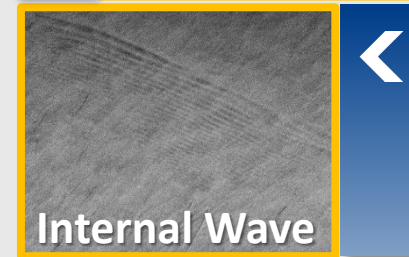
Wind Streak



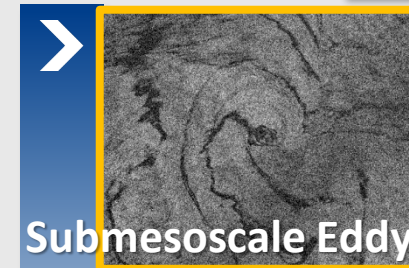
Wave Patterns



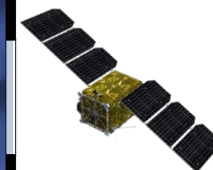
Internal Wave



Submesoscale Eddy



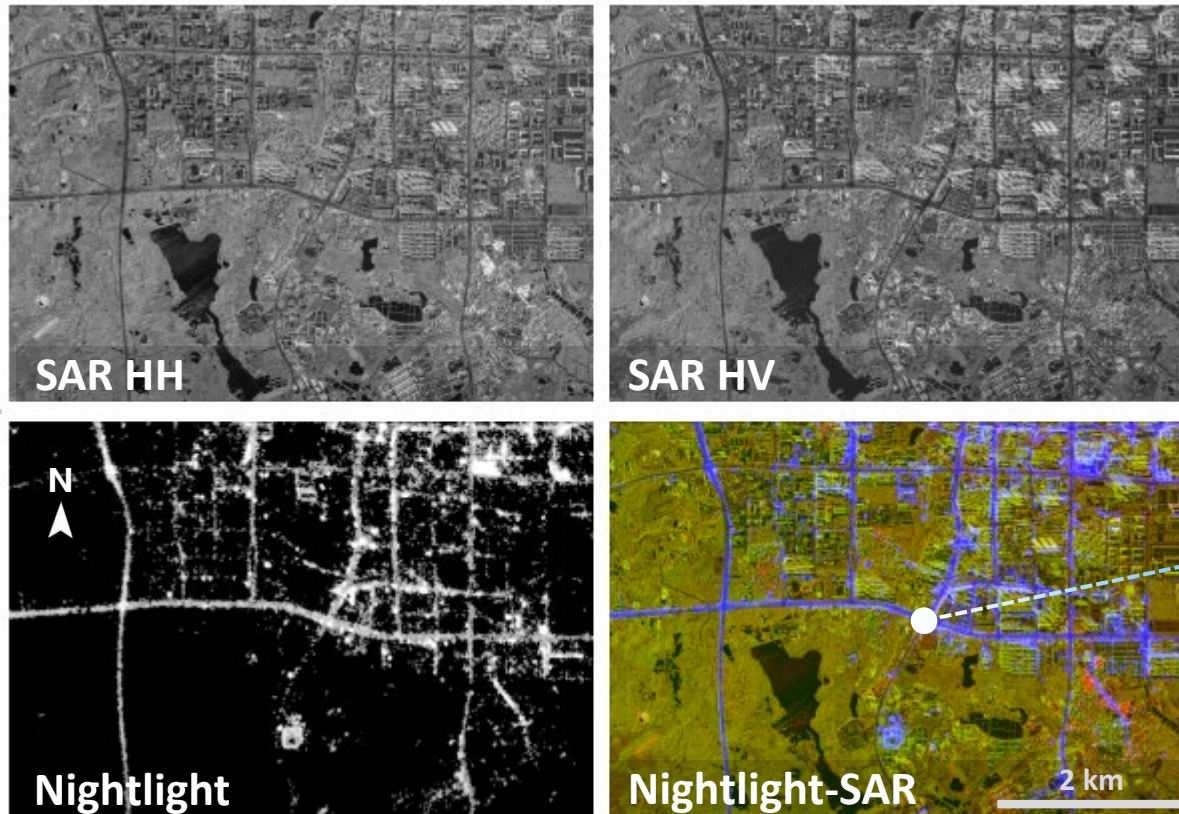
Ocean Dynamics Process





/// HaiShao-1: Nighthlight-SAR Observations ///

Integrated optical-SAR mode data of Haikou city, CN



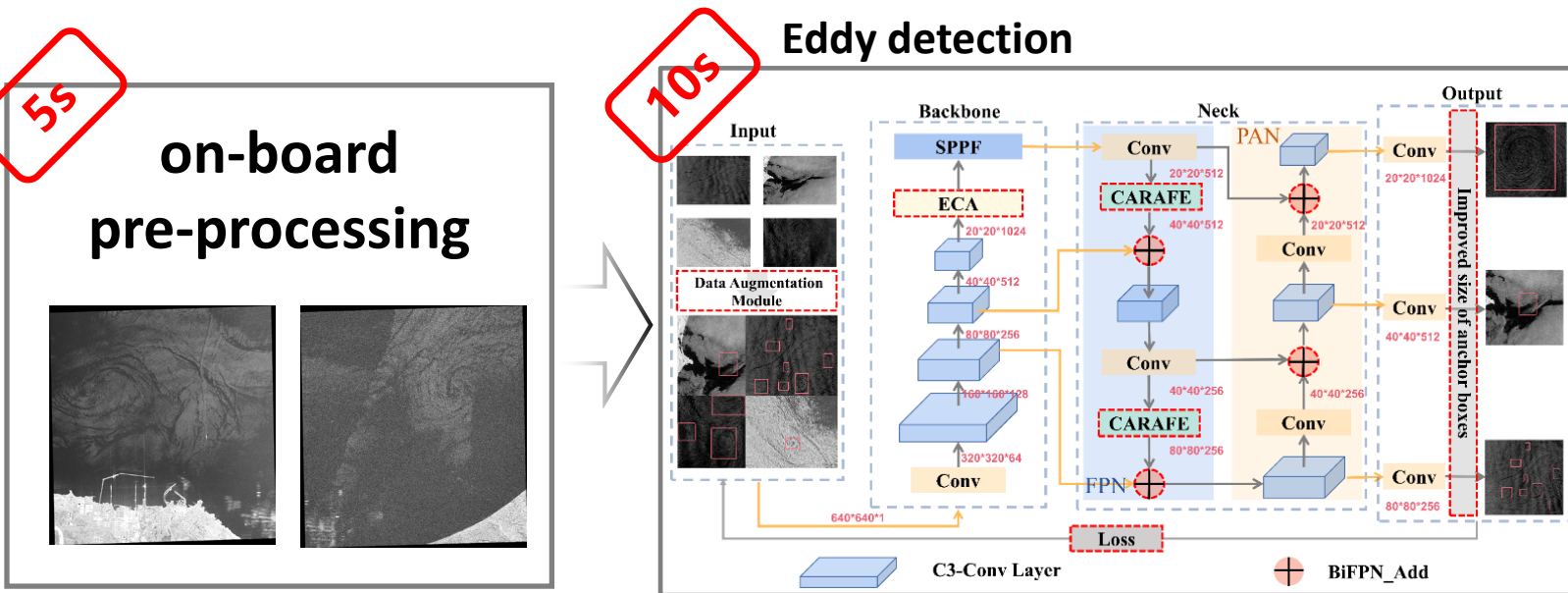
Credit: Shuqi Liu,
Ning Wang, Xing Li

Red band - SAR HH polarization data
Green band - SAR HV polarization data
Blue band - nightlight data

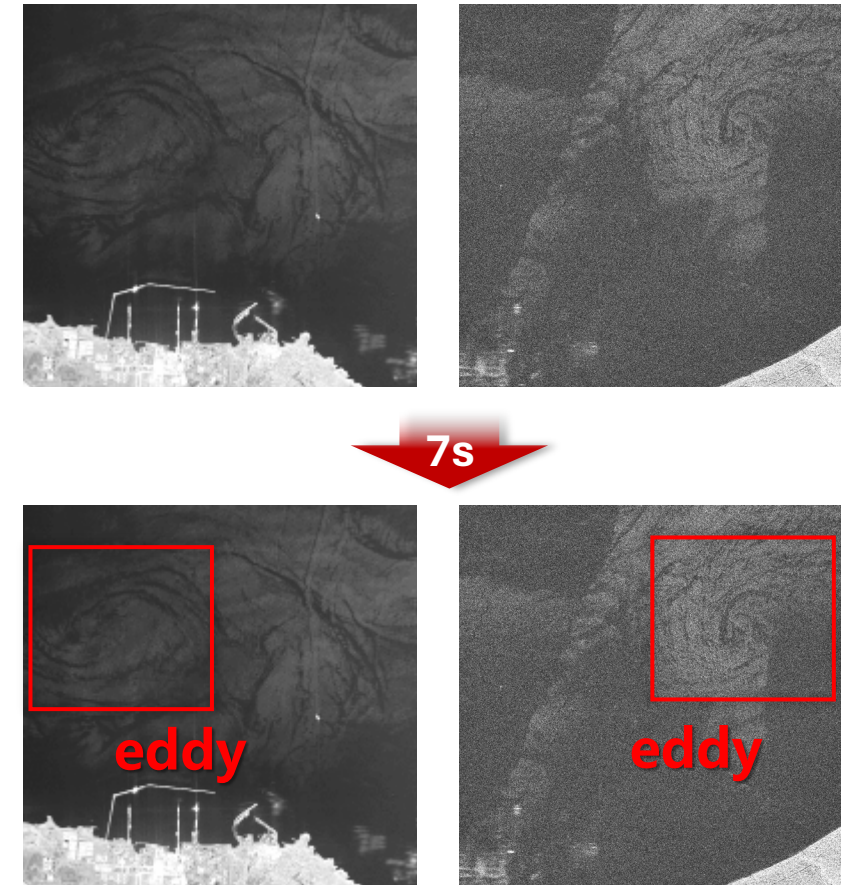
Nighttime human activity within urban
infrastructures (blue color)



Integrated in HaiShao-1 On-board fast eddy detection



Fast, lightweight, and easily extensible



Dragon 6 SADyMaS: Overview



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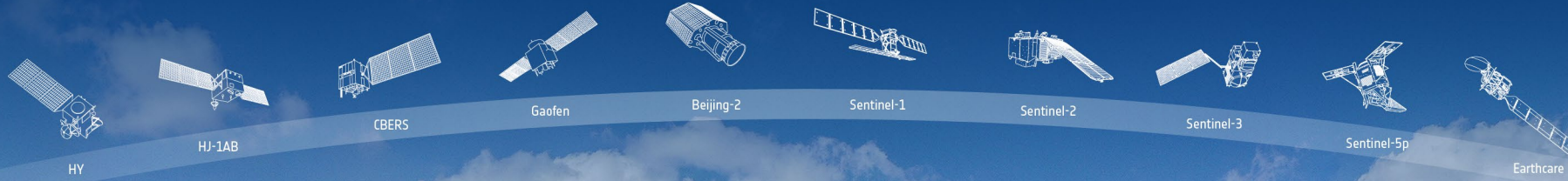
YS Training Course



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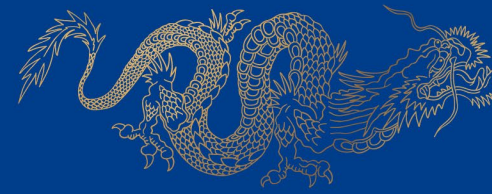
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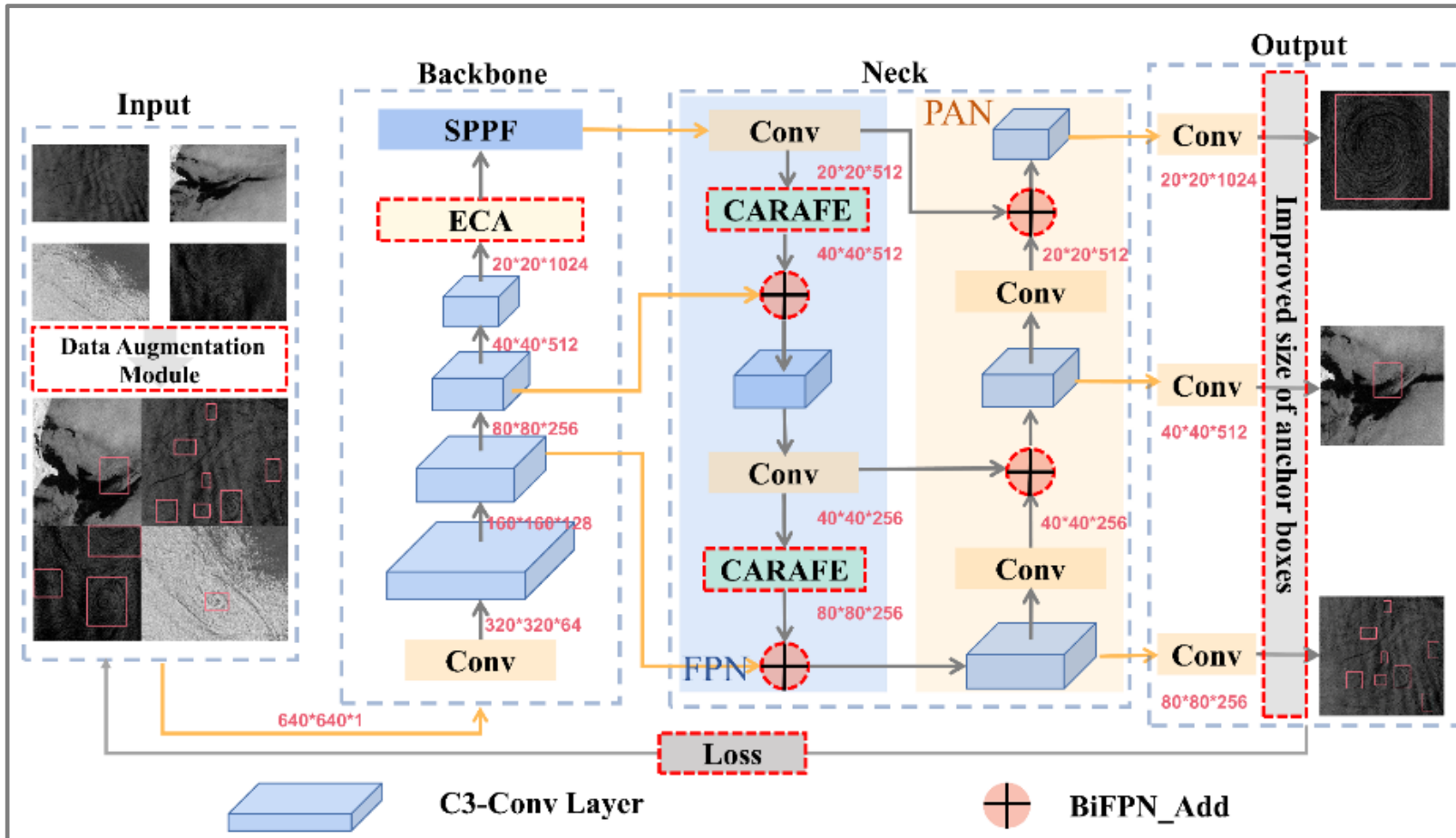
Deep learning for eddy detection in the Arctic marginal ice zone by spaceborne SAR

Credit: Nannan Zi, Xiao-Ming Li





YOLOv5 → **EOLO**: Eddy detection in open regions based on YOLO



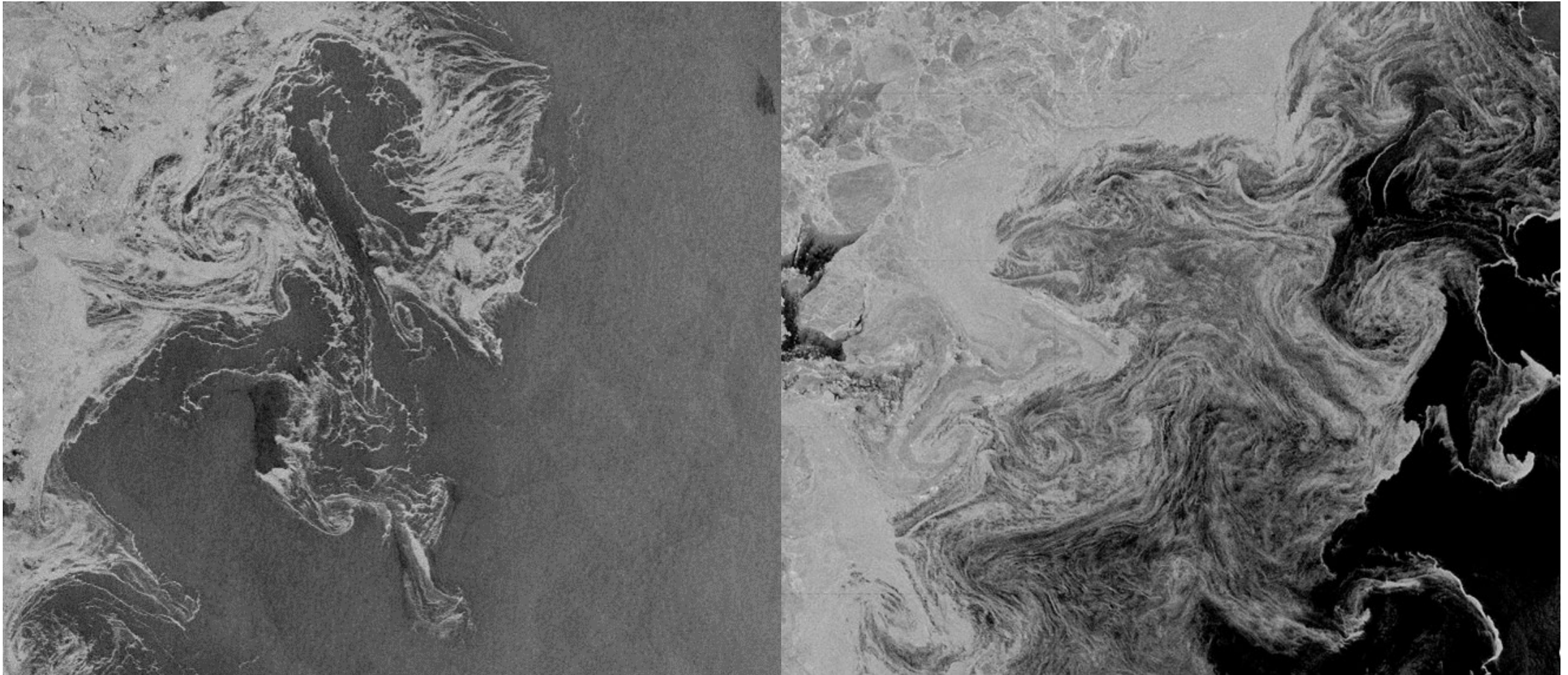
Extensive testing in three seas

Region	Precision	Recall
Red Sea	96.6 %	88.2 %
Baltic Sea	98.8 %	93.6 %
Western Med Sea	98.9 %	96.7 %

Zi et al., RSE, 2024



Ice eddies coexist with the complex and variable sea ice, making it challenging to distinguish ice eddies from complex backgrounds.



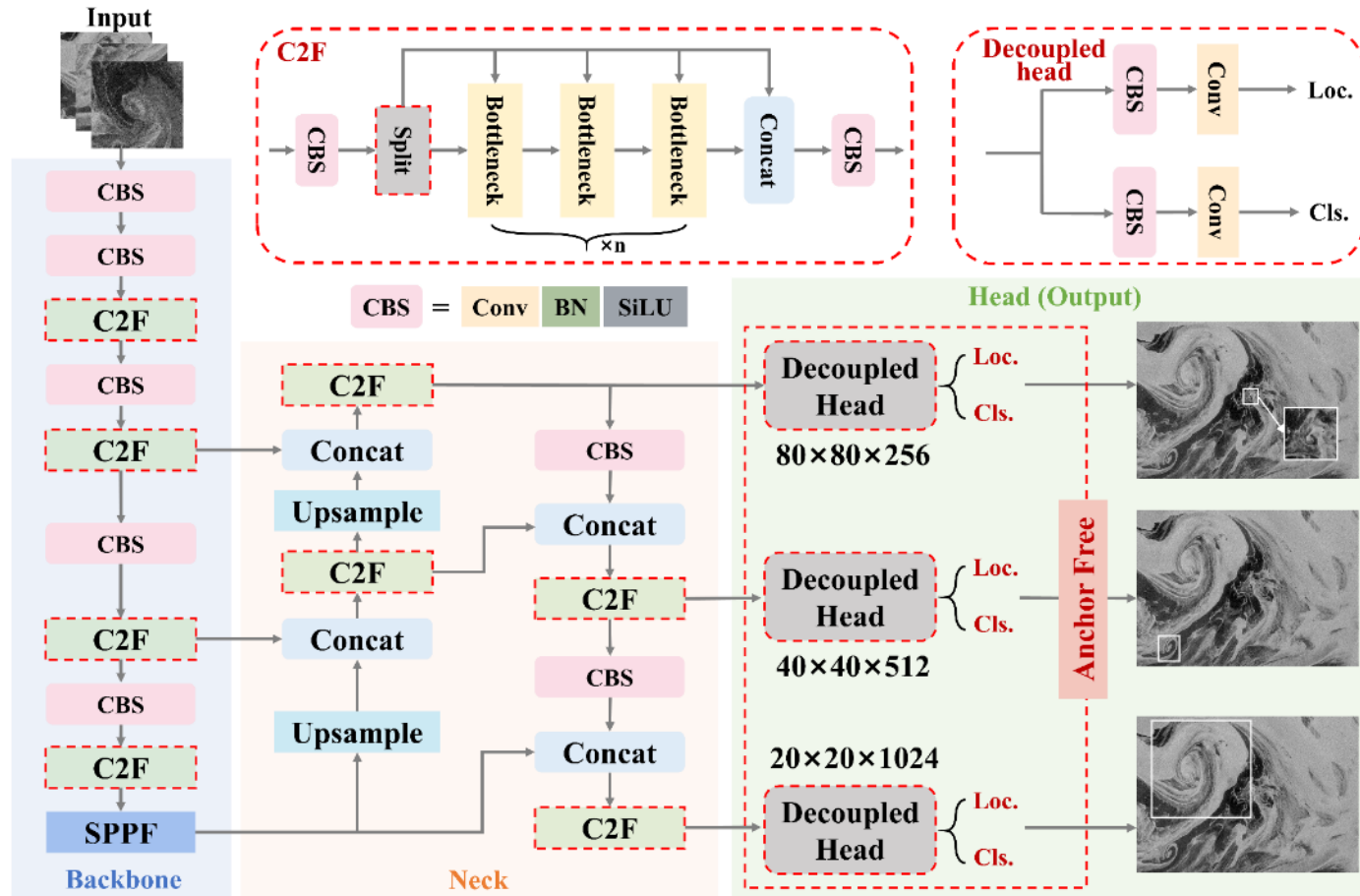
Dragon 6 SADyMaS: Eddy detection in MIZ



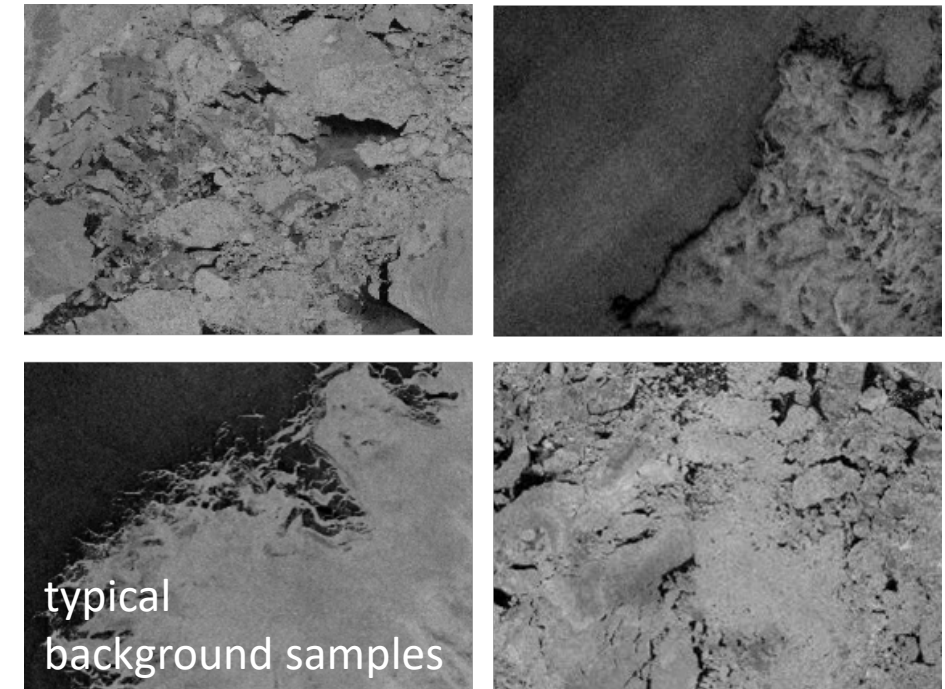
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S1 data, Ice eddy dataset,
1339 ice eddies



YOLOv8 VS YOLOv5:

C3 → C2F | Coupled Head → Decoupled Head
suppress background features

iterative training → **EOLO-ice**

Zi et al., JSTARS, 2025

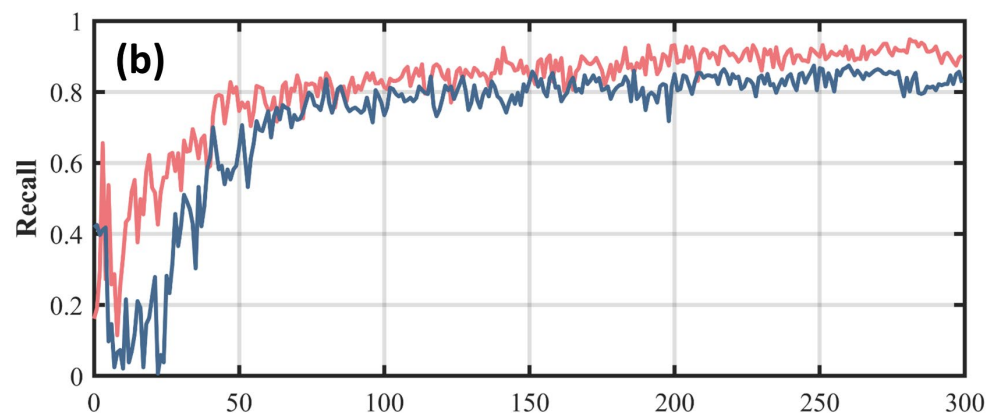
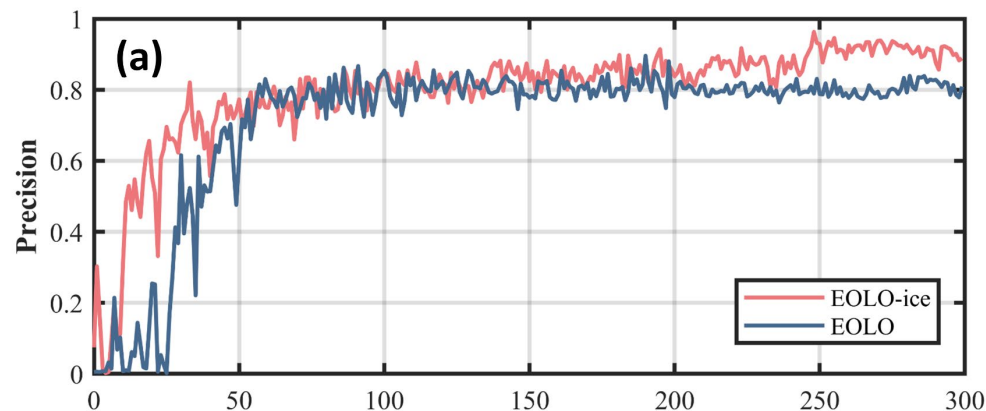
Dragon 6 SADyMaS: Eddy detection in MIZ



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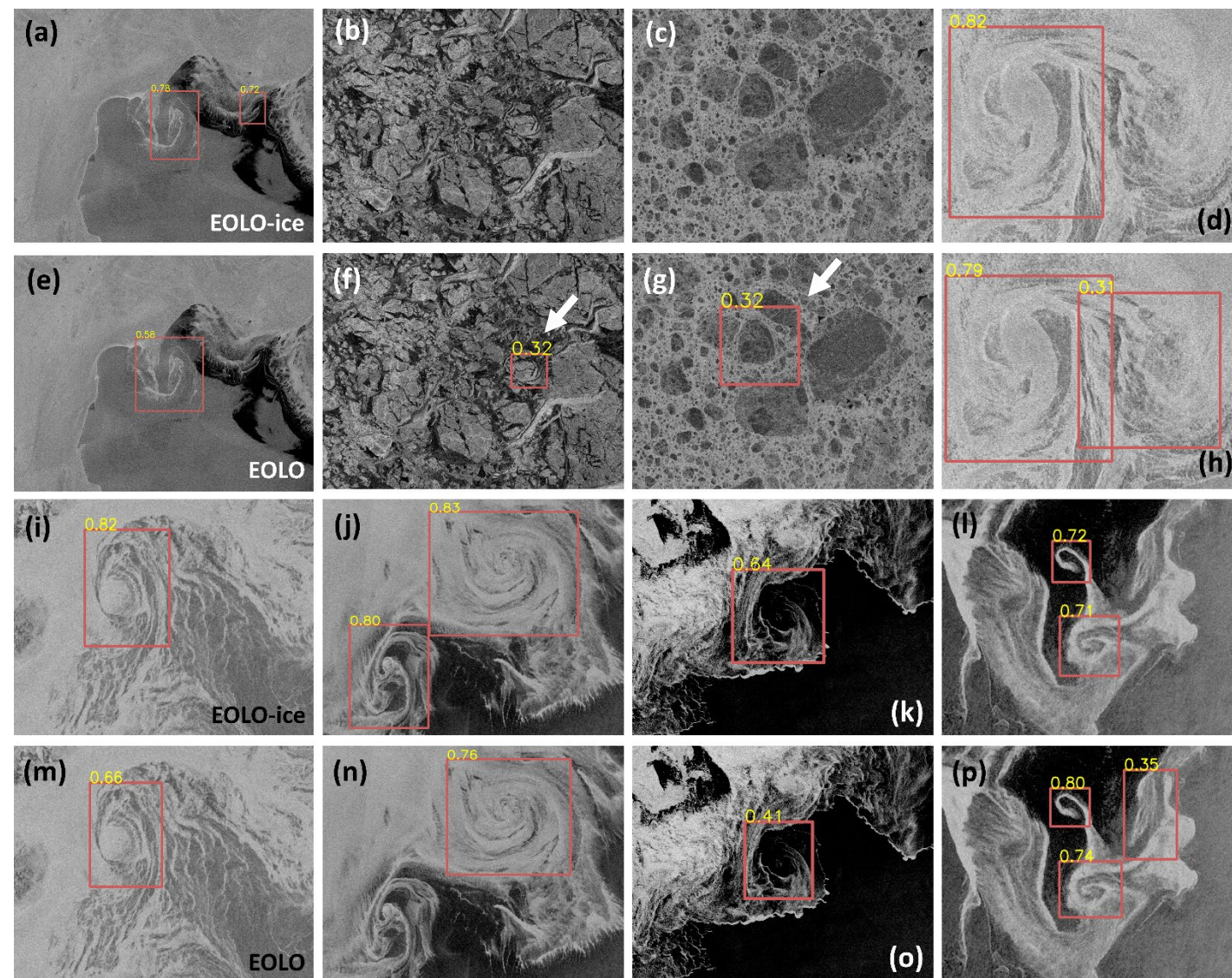


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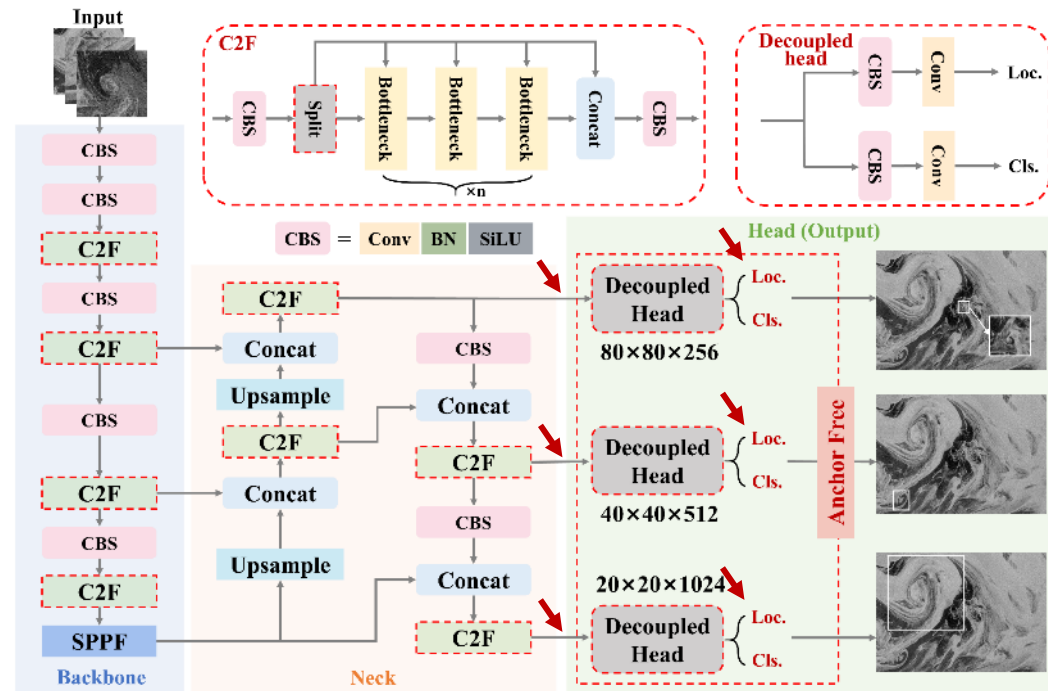


P: 96.30%, R: 91.55%

Zi et al., JSTARS, 2025



EOLO - more false detections and miss detections than EOLO-ice



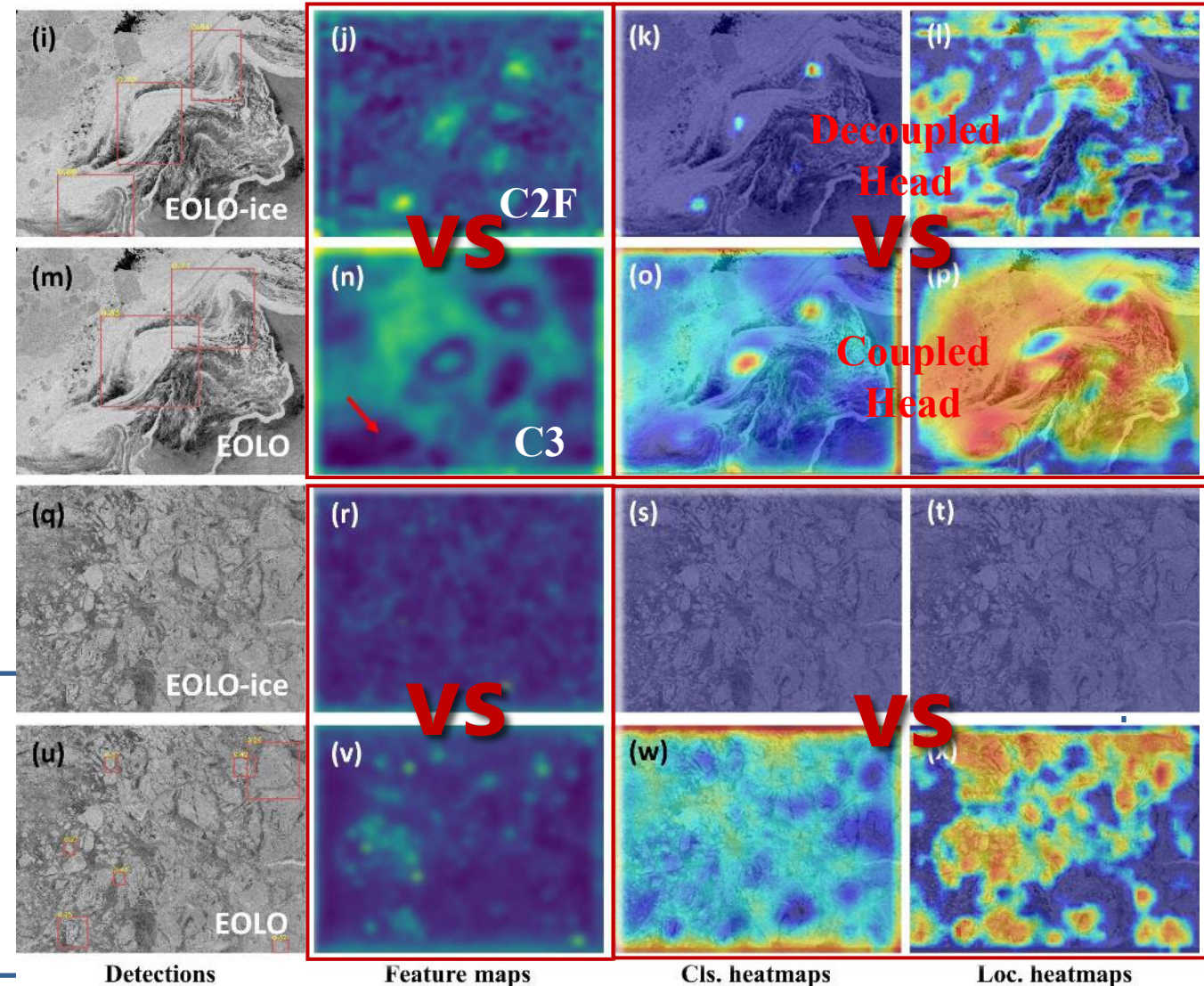
C2F: suppress background features

Cls. : separates eddies from backgrounds

Loc. : adjust coordinates of detection boxes by surrounding backgrounds

Zi et al., JSTARS, 2025

Classification Localization

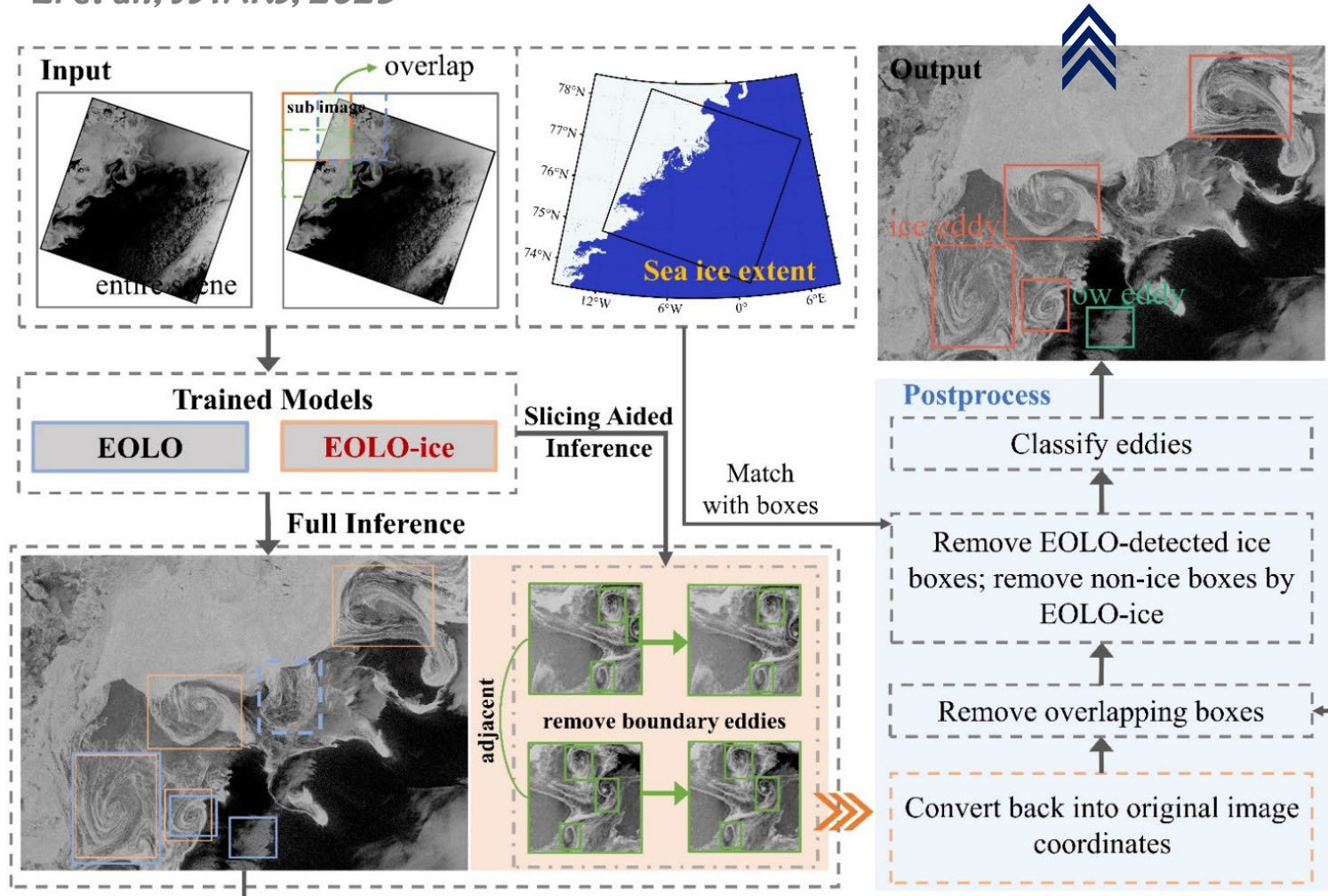


EOLO vs EOLO-ice



Integrated Eddy Inference Framework

Zi et al., JSTARS, 2025



□ multi-scale detection

Full inference: large eddy

Slicing-aided inference: Small eddy

□ Eddy classification

Dragon 6 SADyMaS: Eddy detection in MIZ

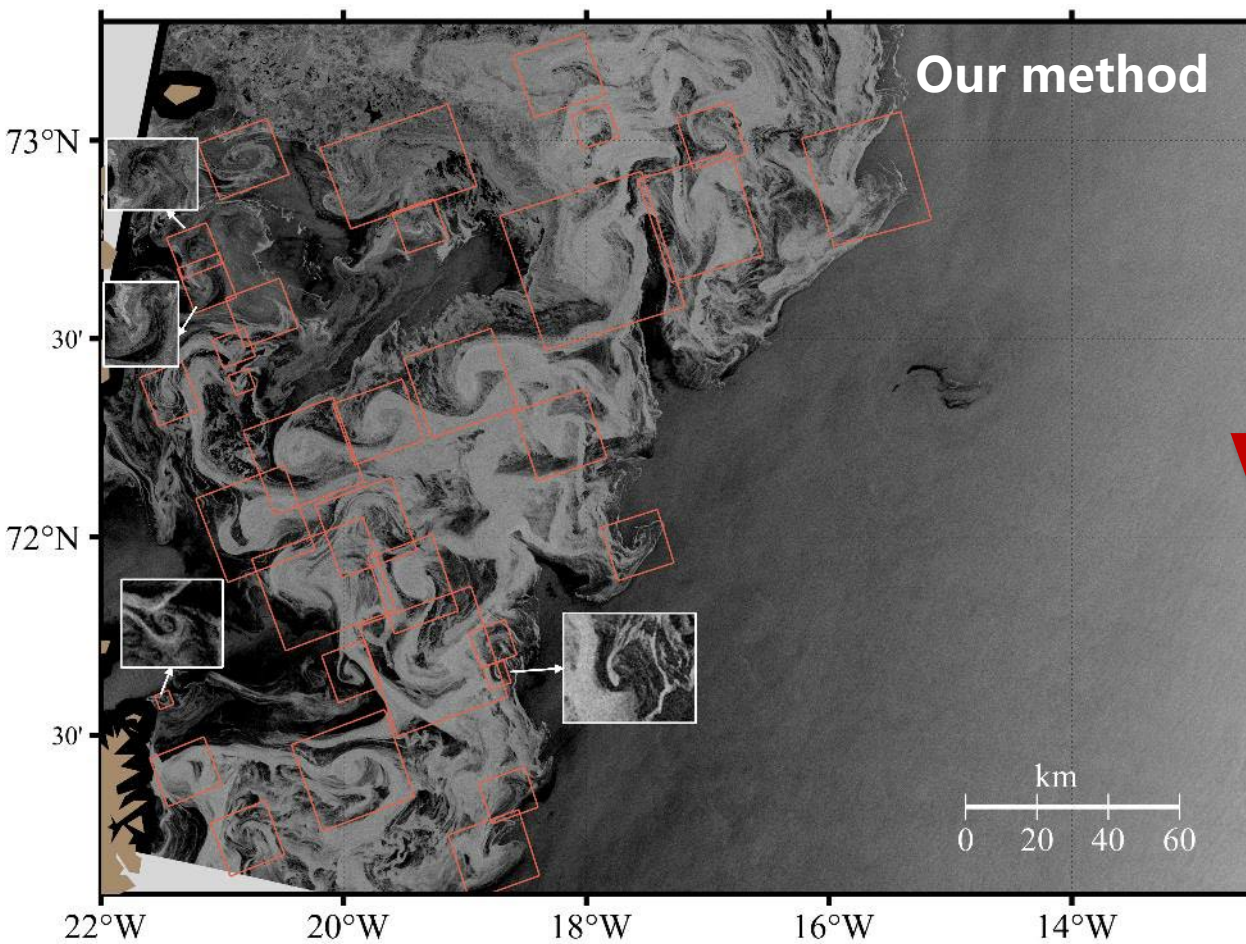


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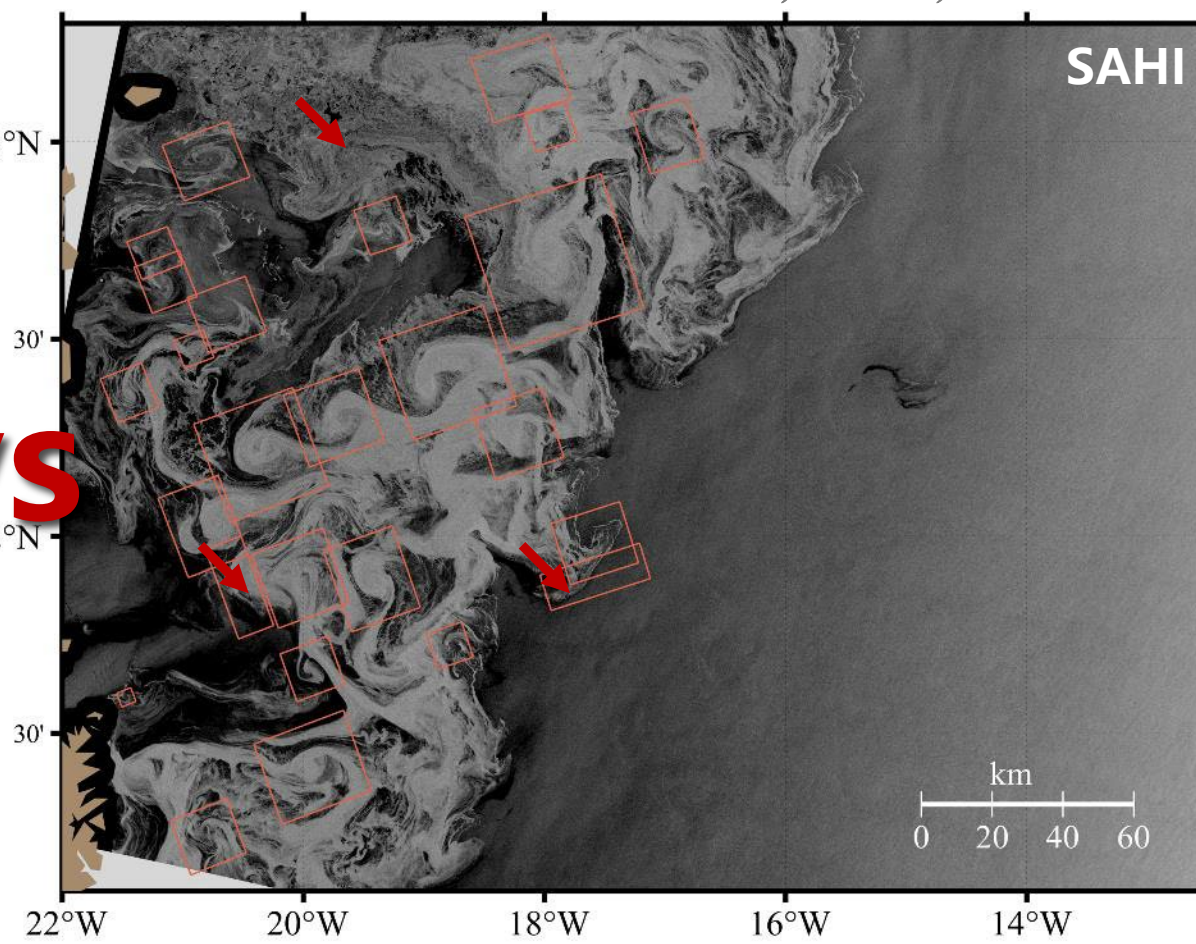
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Zi et al., JSTARS, 2025



Large eddy detection ↗

VS



False detection ↘

Dragon 6 SADyMaS: Eddy detection in MIZ



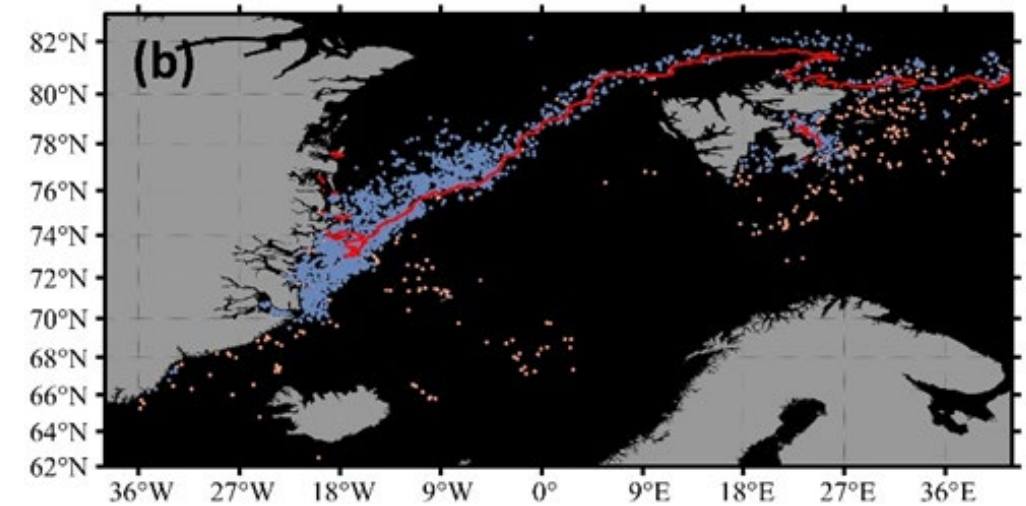
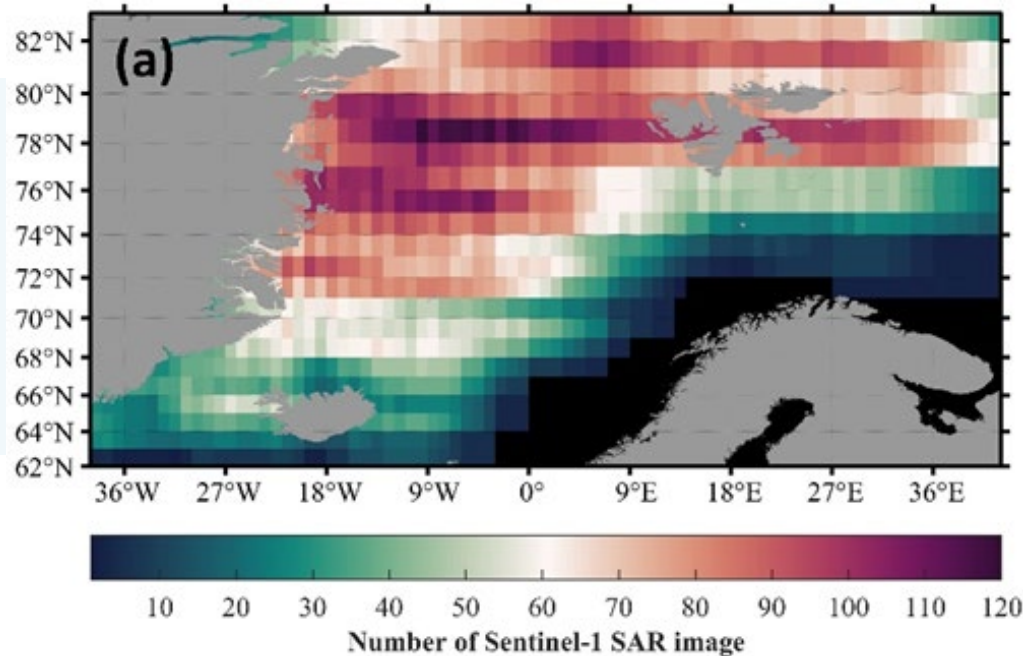
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S1, October 2019
912 Scenes

P - 94.22%
 R - 96.61%



There is a good spatial correlation between the ice edge position (red line) and the areas of eddy high occurrence

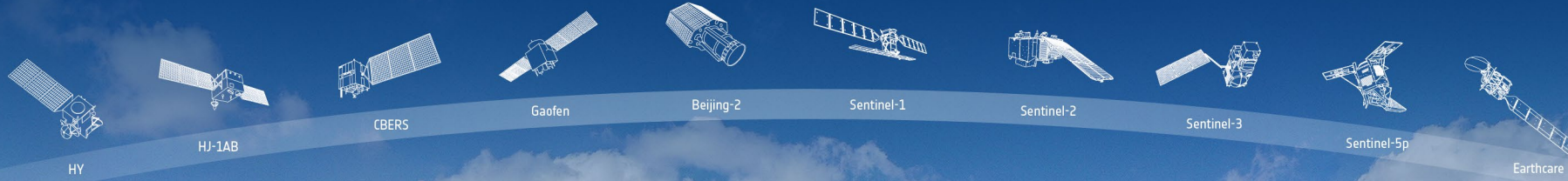
1. Integrated eddy inference framework provides a methodological basis for global sub-mesoscale eddy studies.
2. Expand the application and conduct studies of global the sub-mesoscale eddy generation mechanism.



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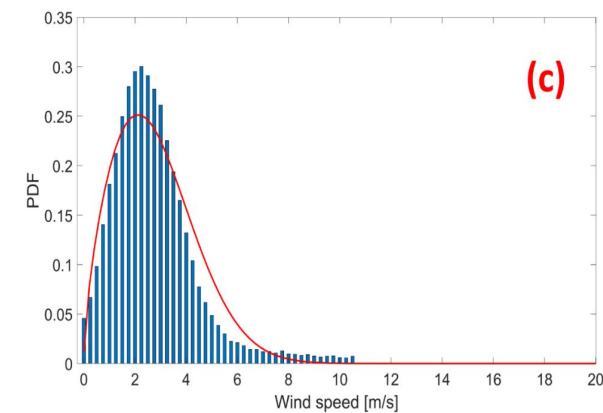
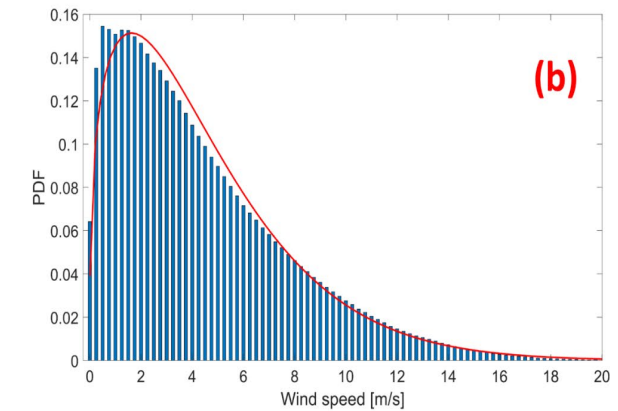
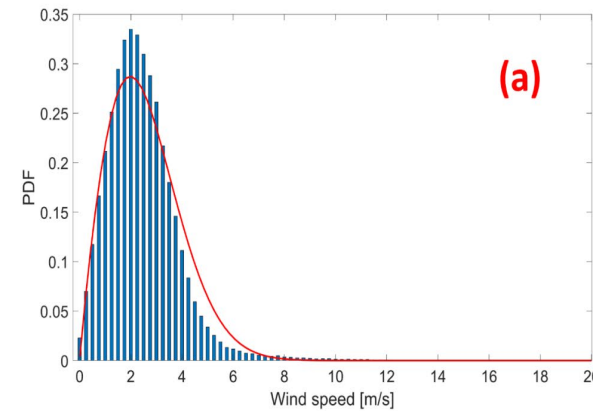
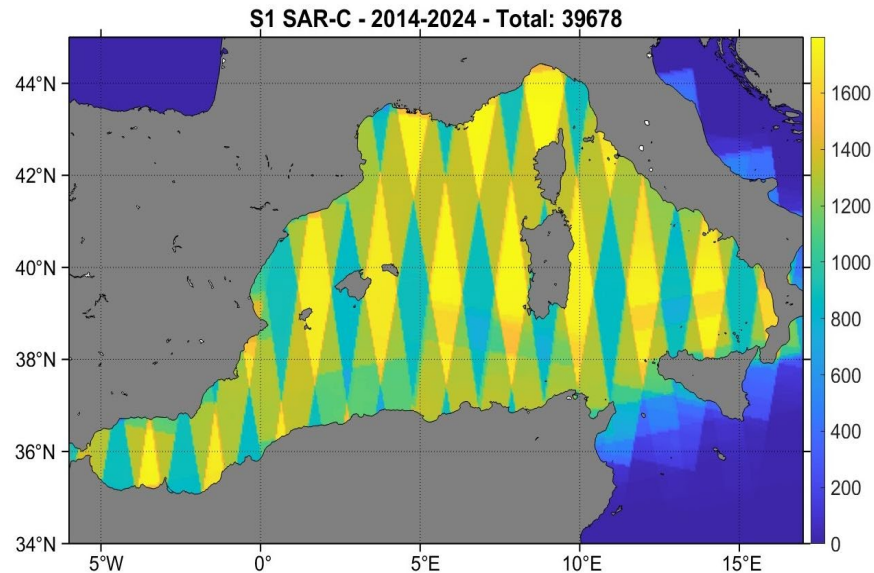
SAR Eddies in the Western Mediterranean Sea: Visual Observations vs. Automated Detection

Credit: Martin Gade, Zhikun Huang





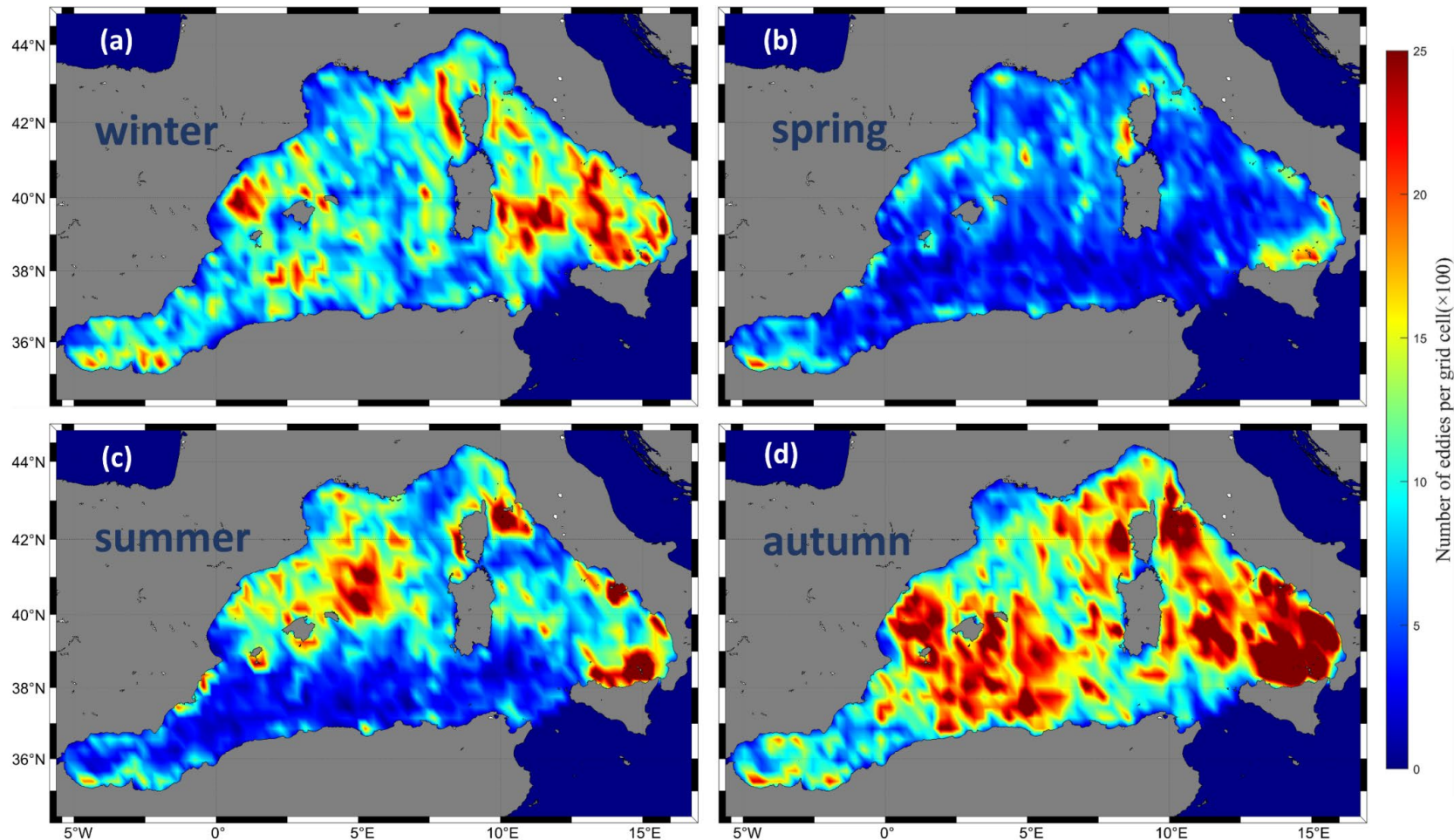
Automated eddy detection on 10 years of Sentinel-1 data of the Western Mediterranean Sea using **EOLO**



normalized wind speed range for all eddies: 0.3 m/s – 5.8 m/s

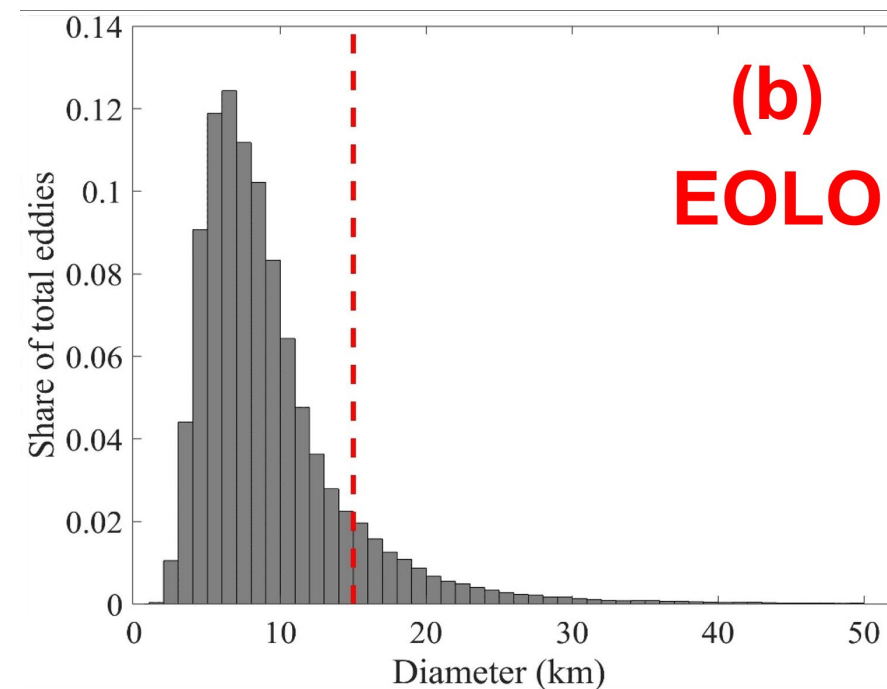
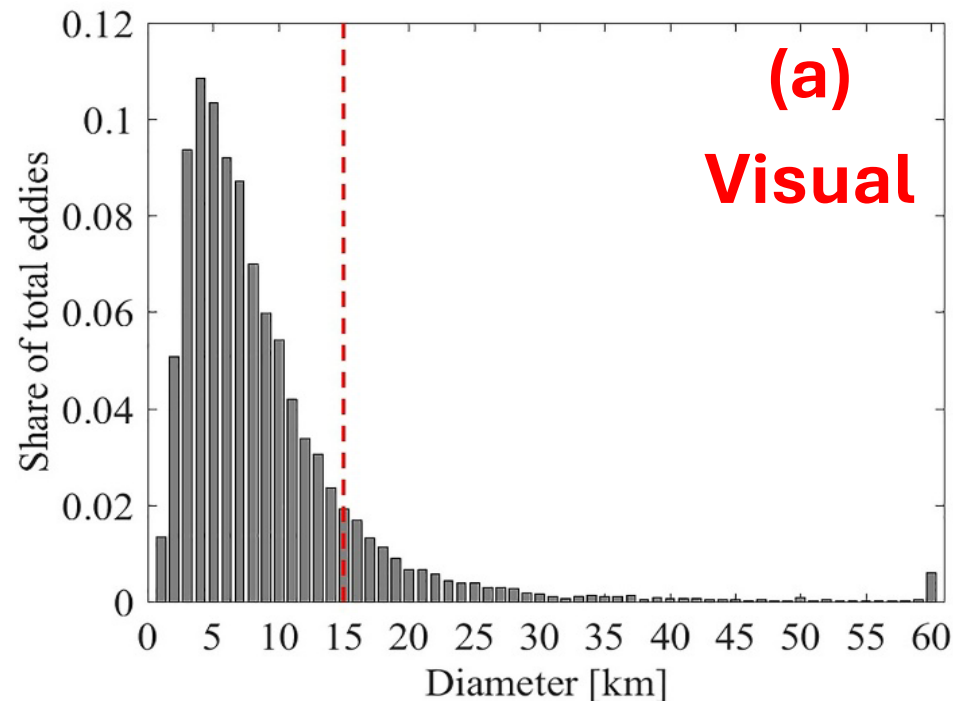


Automated eddy detection on 10 years of Sentinel-1 data of the Western Mediterranean Sea using **EOLO**



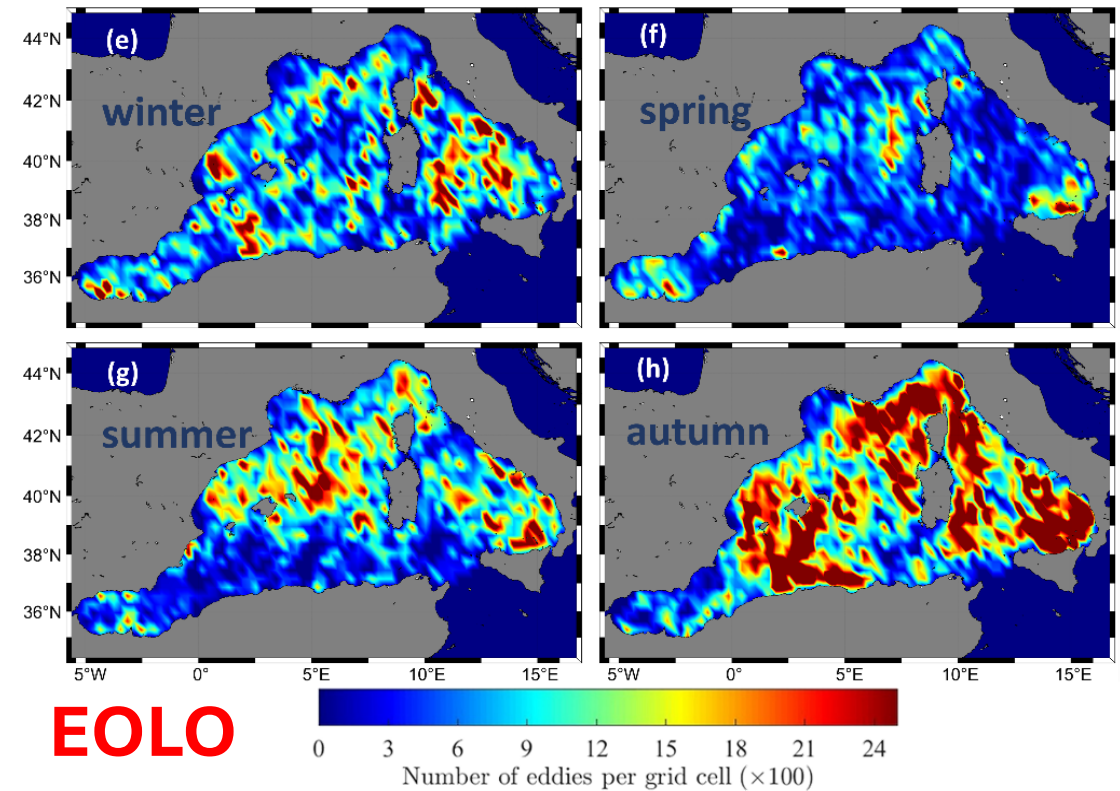
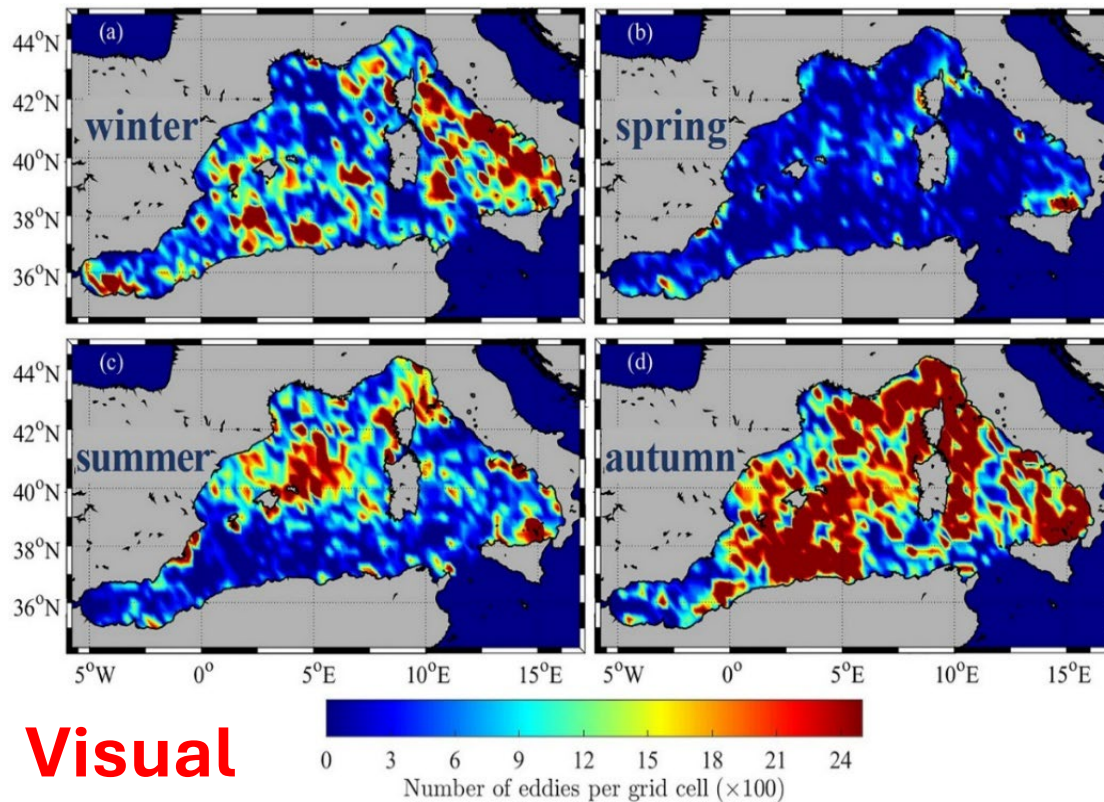


Comparison of results obtained through visual inspection and **EOLO** detection Oct 2014 – Sep 2017



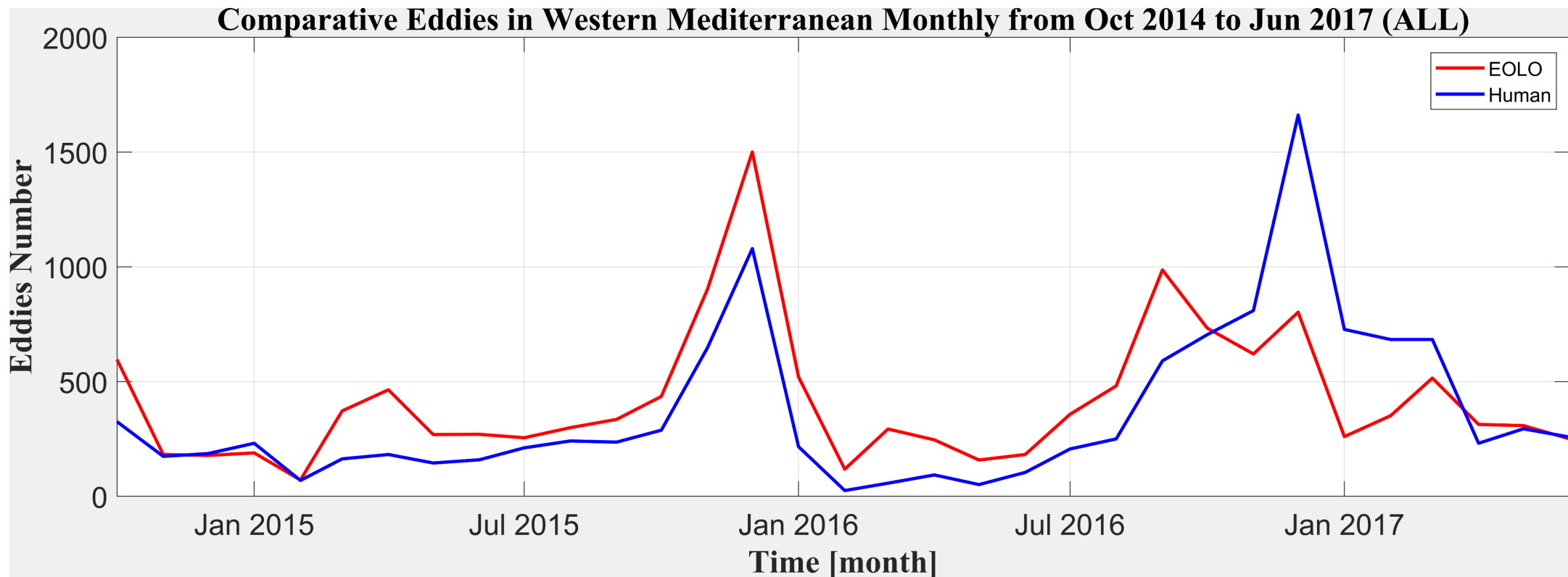


Comparison of results obtained through visual inspection and **EOLO** detection Oct 2014 – Sep 2017



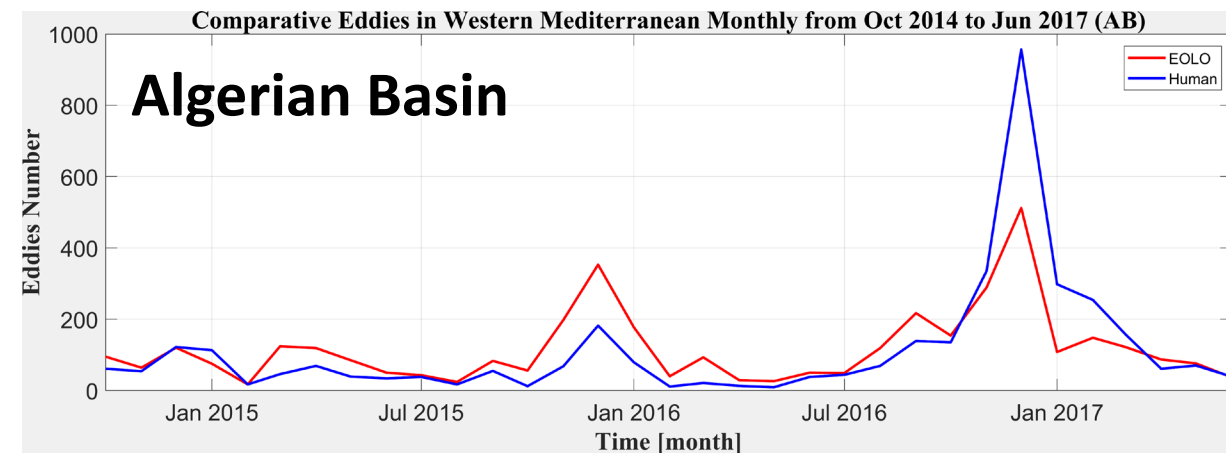
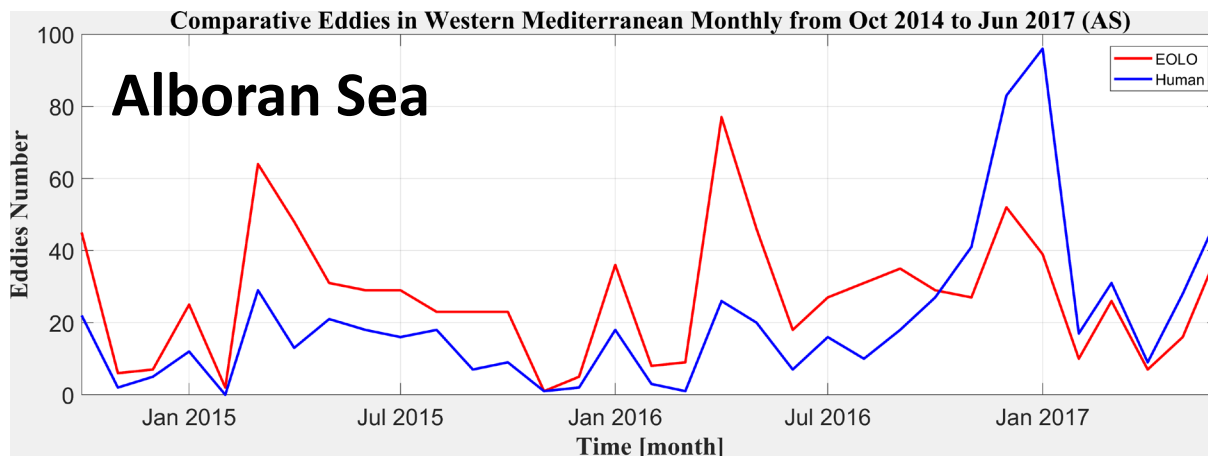
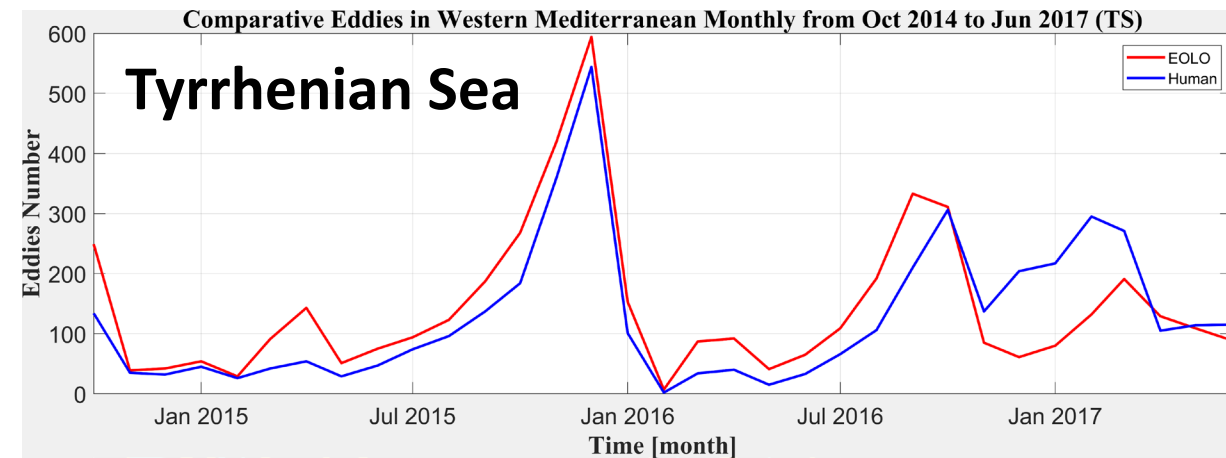
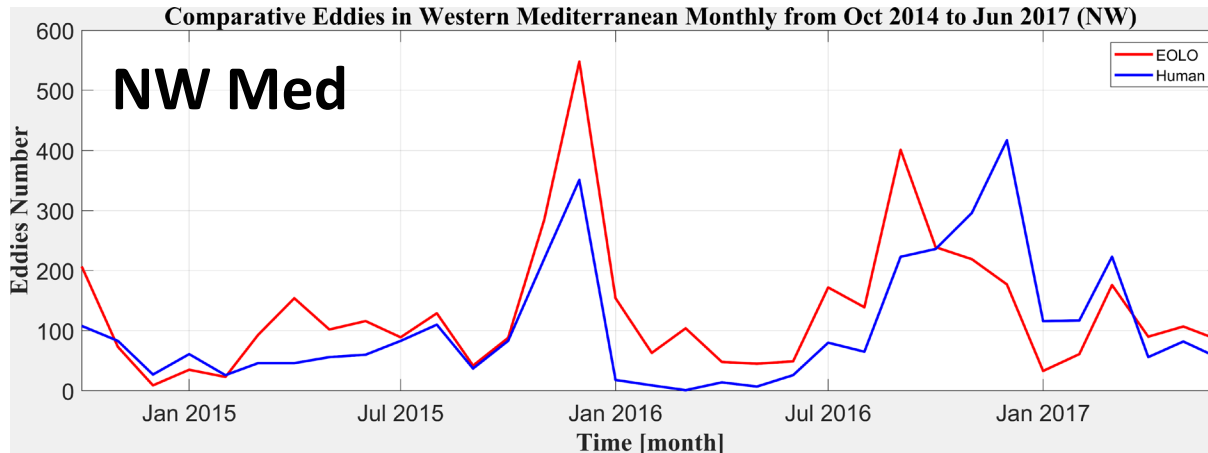


Comparison of results obtained through visual inspection and **EOLO** detection Oct 2014 – Sep 2017





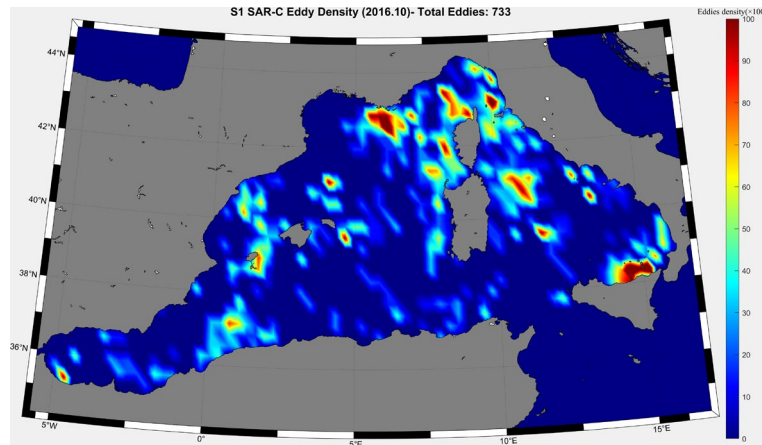
Comparison of results obtained through visual inspection and **EOLO** detection Oct 2014 – Sep 2017



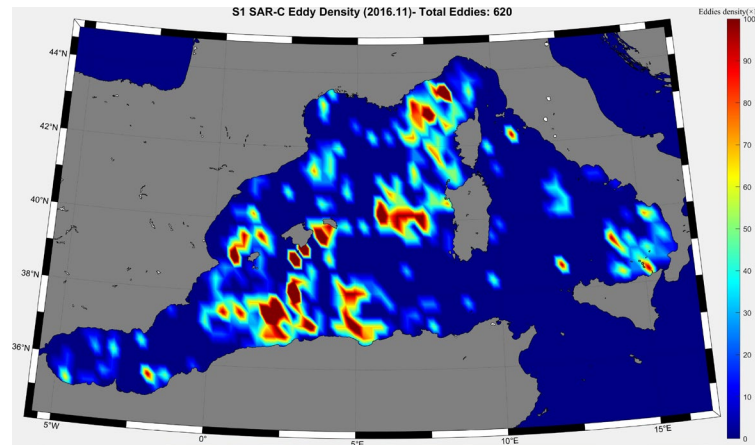


Comparison of results obtained through visual inspection and **EOLO** detection Oct 2014 – Sep 2017

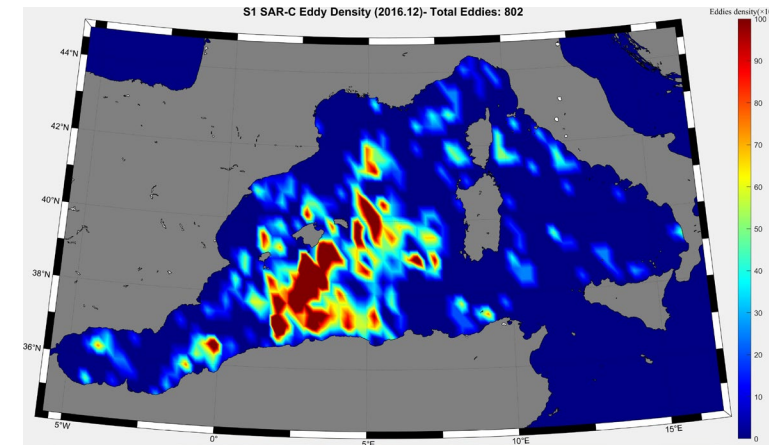
EOLO



Oct 2016

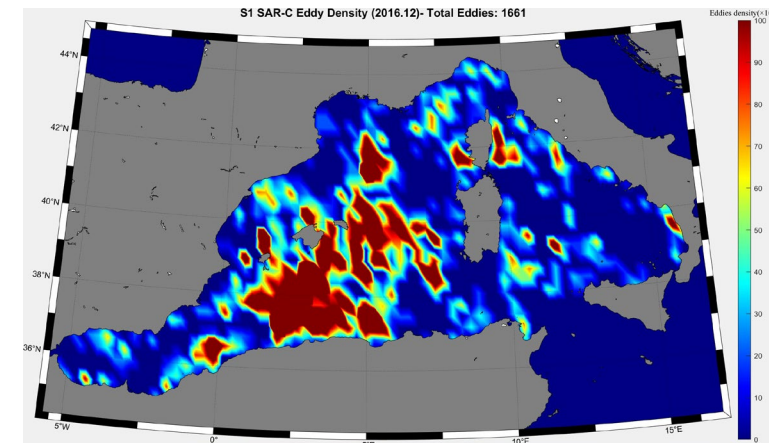
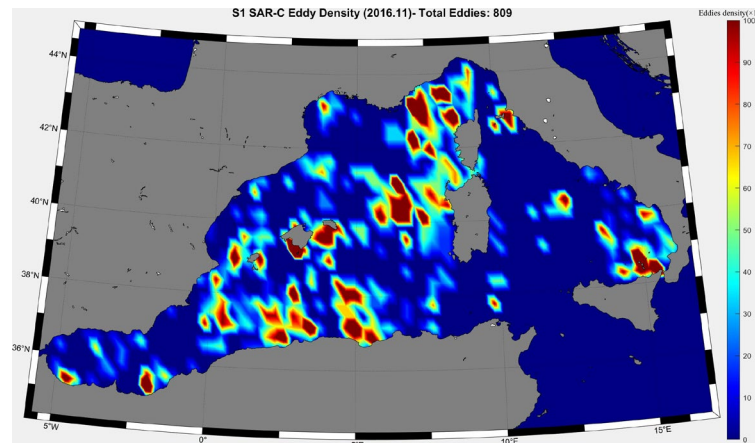
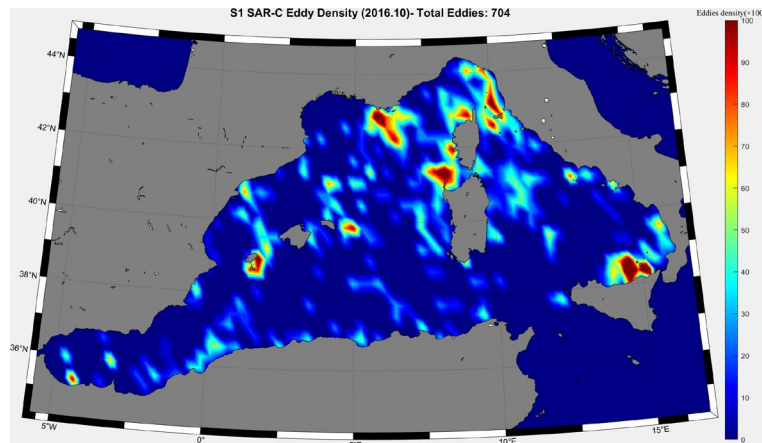


Nov 2016



Dec 2016

Visual



Dragon 6 SADyMaS: Overview



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The **2024 Advanced Training Course in Ocean Remote Sensing** was held in **Sanya, Hainan**, from **Nov. 11 to 16, 2024**, which was jointly sponsored by the **European Space Agency** and the **China Science and Technology Exchange Center**, and co-organized by the **Hainan Aerospace Information Research Institute** and the **Hainan Aerospace Technology Innovation Center**.

The 6-day training consisted of **8 Chinese experts** and **4 European scientists** as mentors, and nearly **60 Ph.D. students, post-doctoral researchers and early-career scientists** from more than **30 top universities and research institutes** participated in the training.



➡ Group Photo at the Opening Ceremony of 2024 Advanced Training Course



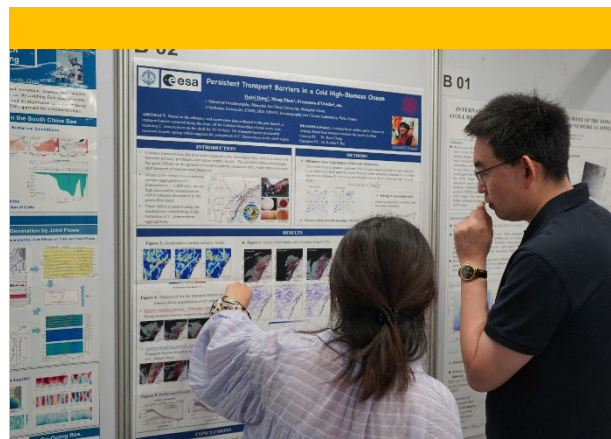
Dragon 6 SADyMaS: Training Course



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Theoretical and Practical Courses on SSS, SST, OC, Sea Ice Monitoring and AI Oceanography, etc.

Poster Presentation and Selection Activities

Visiting the Sanya Remote Sensing Ground Station

Representatives from Both China and Europe Attended the Opening and Closing Ceremonies and Delivered Speeches.

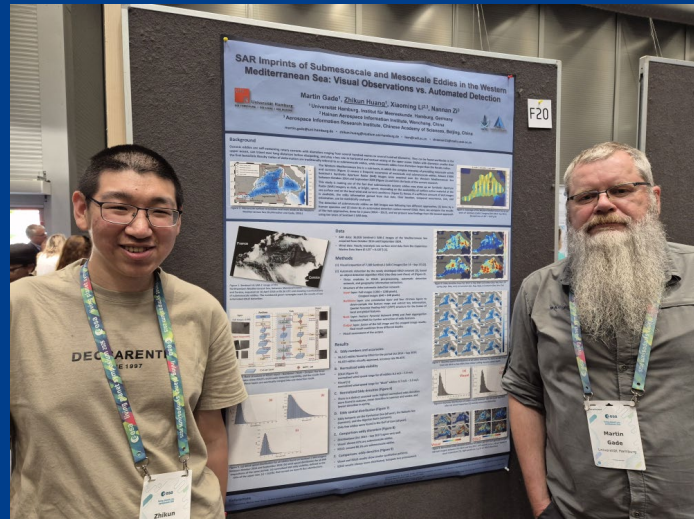
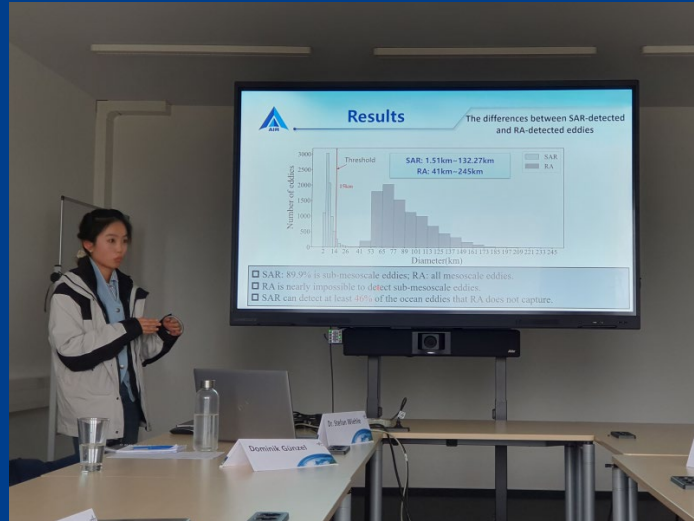
Dragon 6 SADyMaS: YS Training



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Scientific Exchange and Training



Cultural Exchange and Training

Dragon 6 SADyMaS: YS Training Plans



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Sep 2025: Offshore Excursion off Helgoland, Germany: perform oceanographic in-situ measurements in parallel to multiple satellite data acquisitions.





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- 1** Fruitful continuation of successful DRAGON collaboration
- 2** New techniques and methodologies
- 3** Exchange of (Big) EO Data
- 4** Training and education of Young Scientists
- 5** Long-standing Sino-German friendship

Dragon 6 SADyMaS: End



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谢谢！