Chinese EO Programmes for Ocean Remote Sensing

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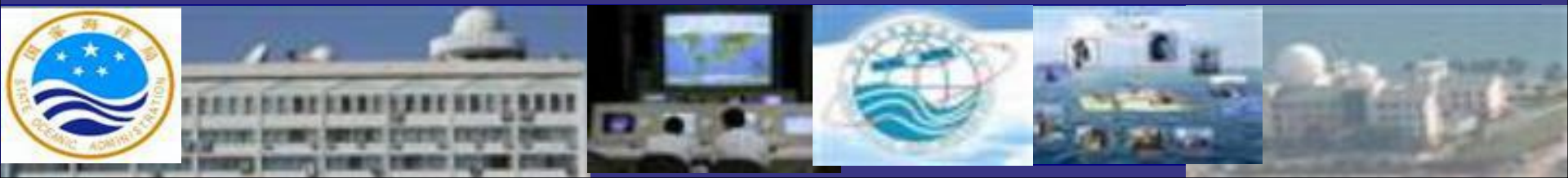
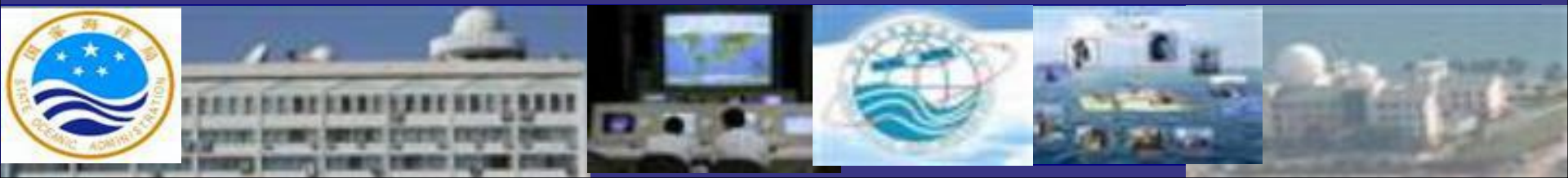
2. Key Lab of Space Ocean Remote Sensing and Application, SOA

12 November, 2018, Shenzhen, Shenzhen University



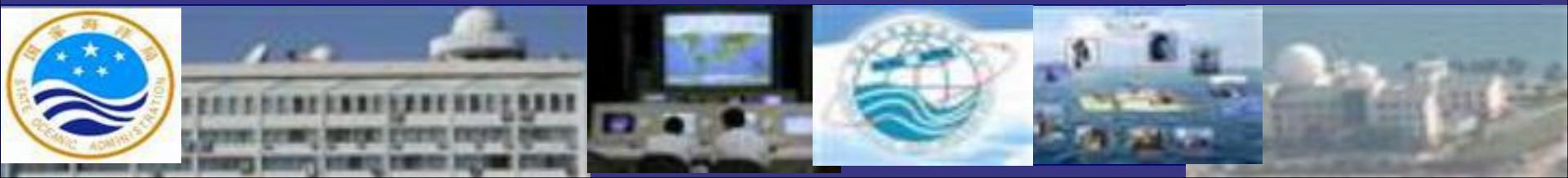
Outline

1. Overview
2. Current satellite missions
3. Satellite missions in 2018
4. Satellite missions by 2025



Civil satellite programs in China

1. The earth observing system (EOS) missions in China are managed by China National Space Administration (CNSA)
2. Different types of satellites are operated by a few national departments and Chinese Academy of Sciences.
3. The meteorological satellite missions are operated by China Metrological Administration (FY satellite series; F—wind, Y--cloud)
4. The ocean satellite missions are operated by the State Oceanic Administration (HY satellite series; HY—ocean).



NSOAS

The National Satellite Ocean Application Service (NSOAS) was founded in 2000. It is a scientific research and operational service center administrated by the State Oceanic Administration (SOA).

The main functions of NSOAS include:

---To propose strategy and development program for Chinese oceanic satellites.

---To operate ground segments for Chinese ocean satellites

---To conduct scientific research on ocean satellite applications

---To be responsible for receiving, processing, distributing ocean satellite data.

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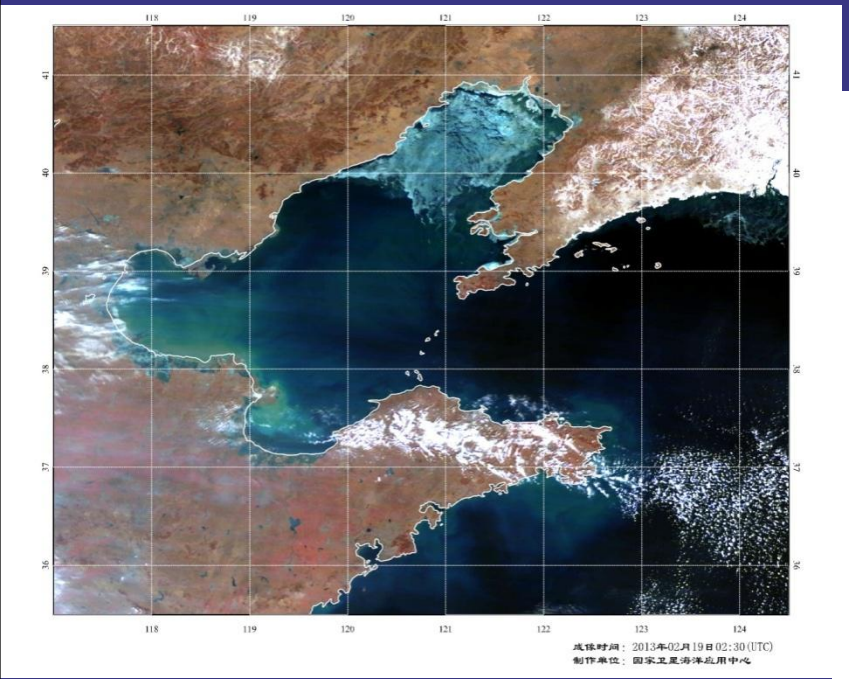
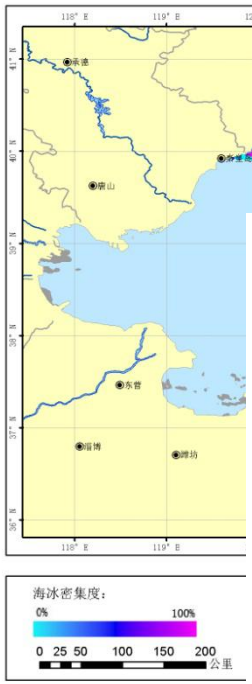
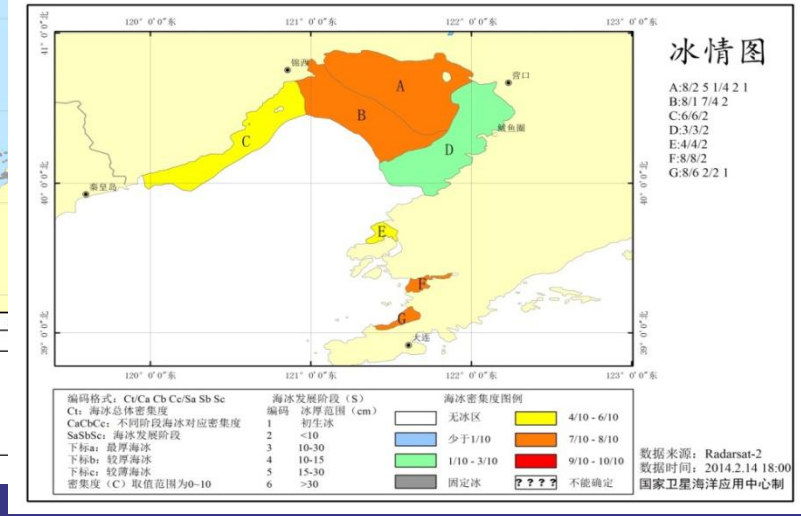
The Application in Ocean Disaster monitoring

Sea ice monitoring based on satellite data in the Bohai Sea



Oil and gas exploration and production and other maritime activities are rapidly increasing in the Bohai Sea. Since sea ice occurs every winter in this region, it poses serious threats to these activities. Sea-ice hazard causes serious harm to aquaculture, marine navigation, offshore oil production and other activities in the Bohai Sea of China.





Sea ice coverage in the Bohai Sea based on satellite remote sensing technique

The Application in Ocean Disaster monitoring

Oil spill monitoring based on satellite data

In recent years, With growing offshore oil exploration, transportation, various types of oil spill accidents occur frequently.

- *Australia oil platform leaked in 2009*
- *Platform exploded in the Gulf of Mexico in 2010*
- *Oil spill of Penglai 19-3 platform in 2011*

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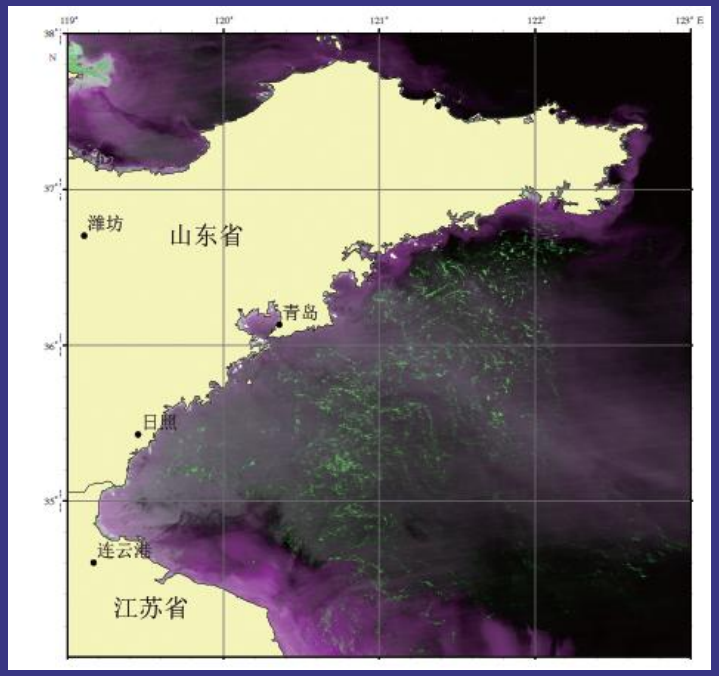
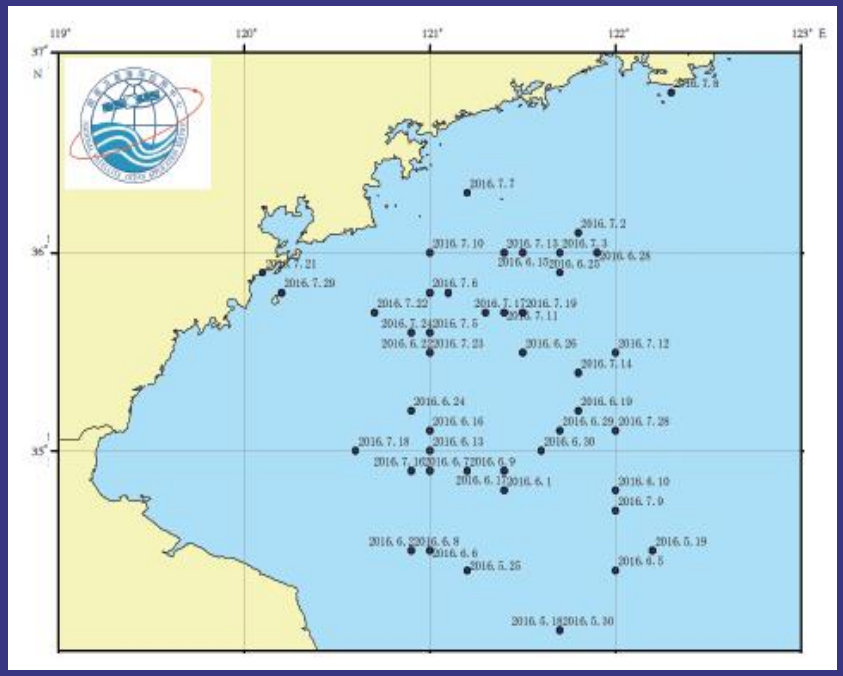
Green Tide Monitoring

- The data of HY-1 and MODIS are used to operationally monitor green tides. The detected green tide information is severed for drift path forecast and green tide mitigation.



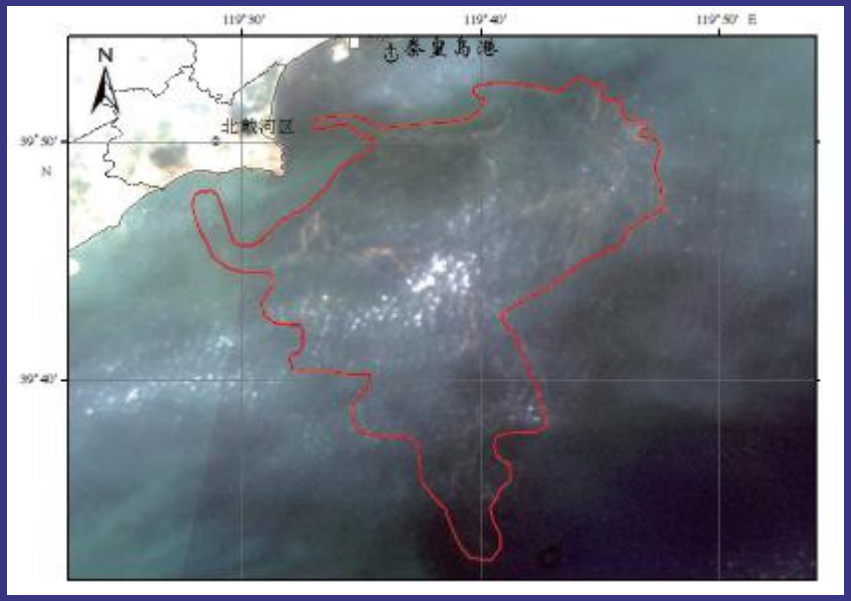
A satellite image of green tides derived on June 25, 2016.



Green tide Centers of 2016

Red Tide Monitoring

- The data of HY-1B and MODIS are used to operationally monitor red tides.



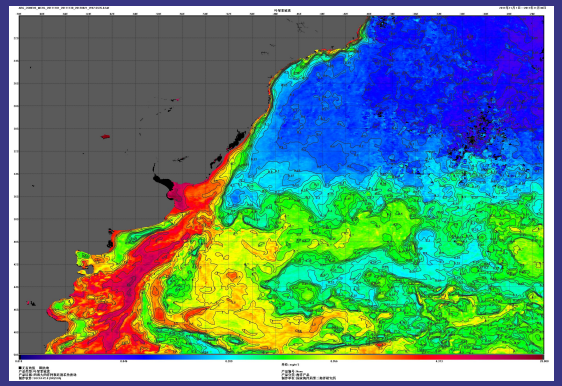
A red tide remote sensing image derived on Aug. 4, 2016 (Sea area of Hebei Province)

A photo of the scene for verification

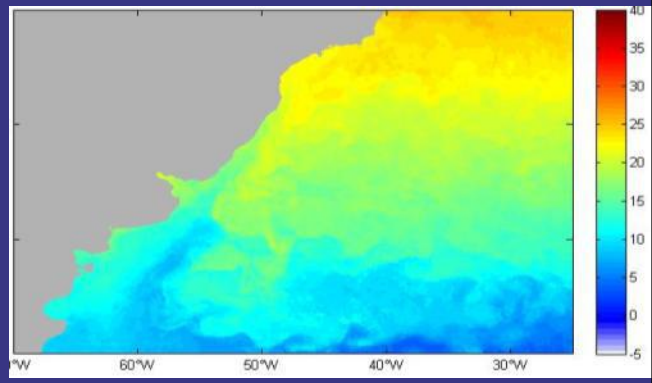
Fishery environmental information

Chl-a, SST, SSH, current, SWH, Wind

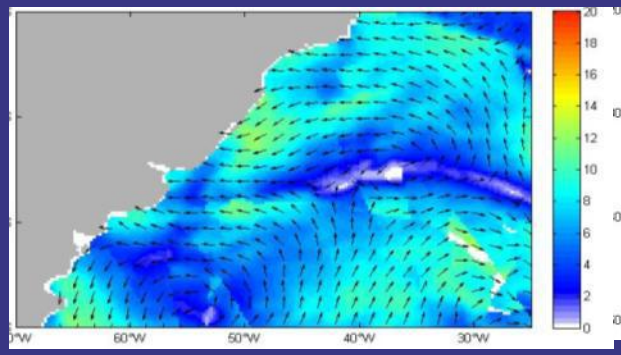
Once a week



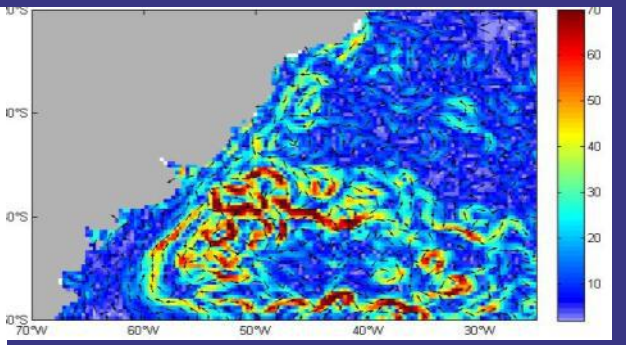
The Chl-a from multple data



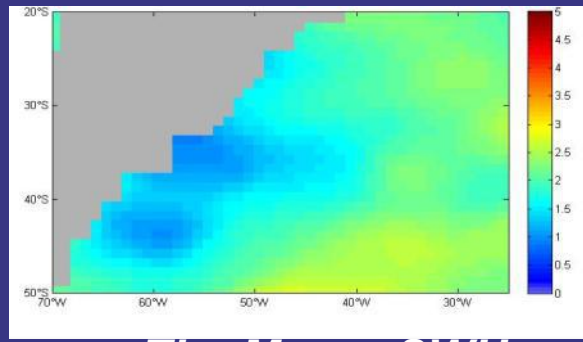
The merged SST



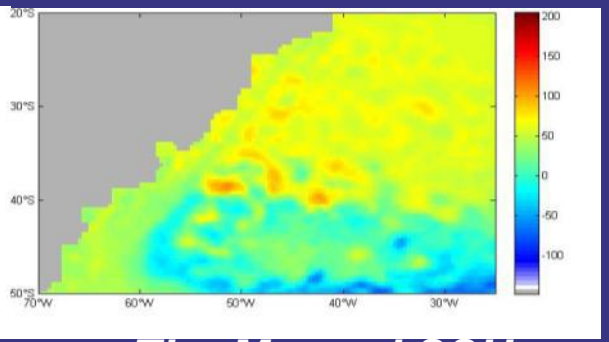
The Merged Wind Field



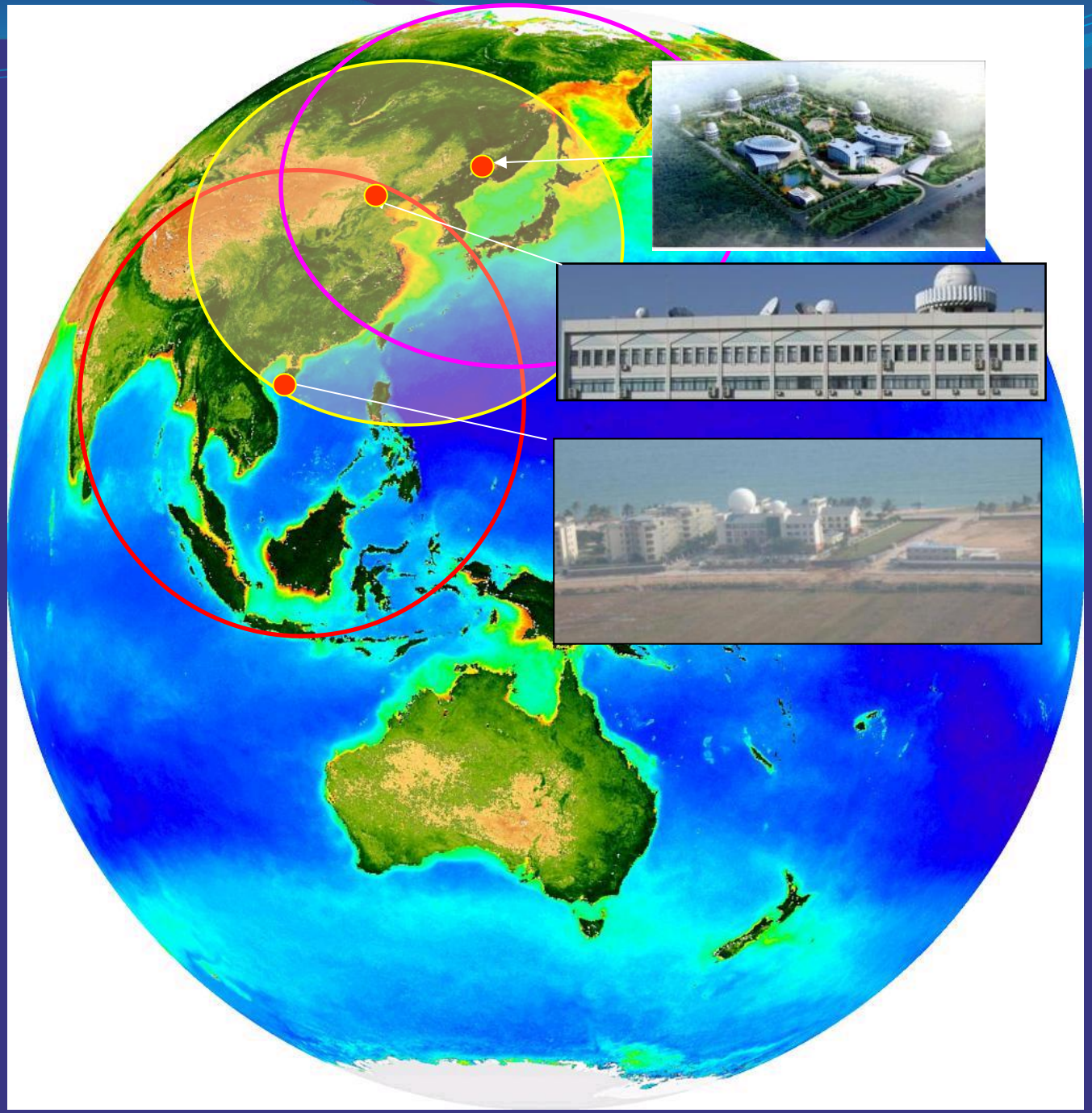
The Merged Surface Curr



The Merge SWH



The Merged SSH

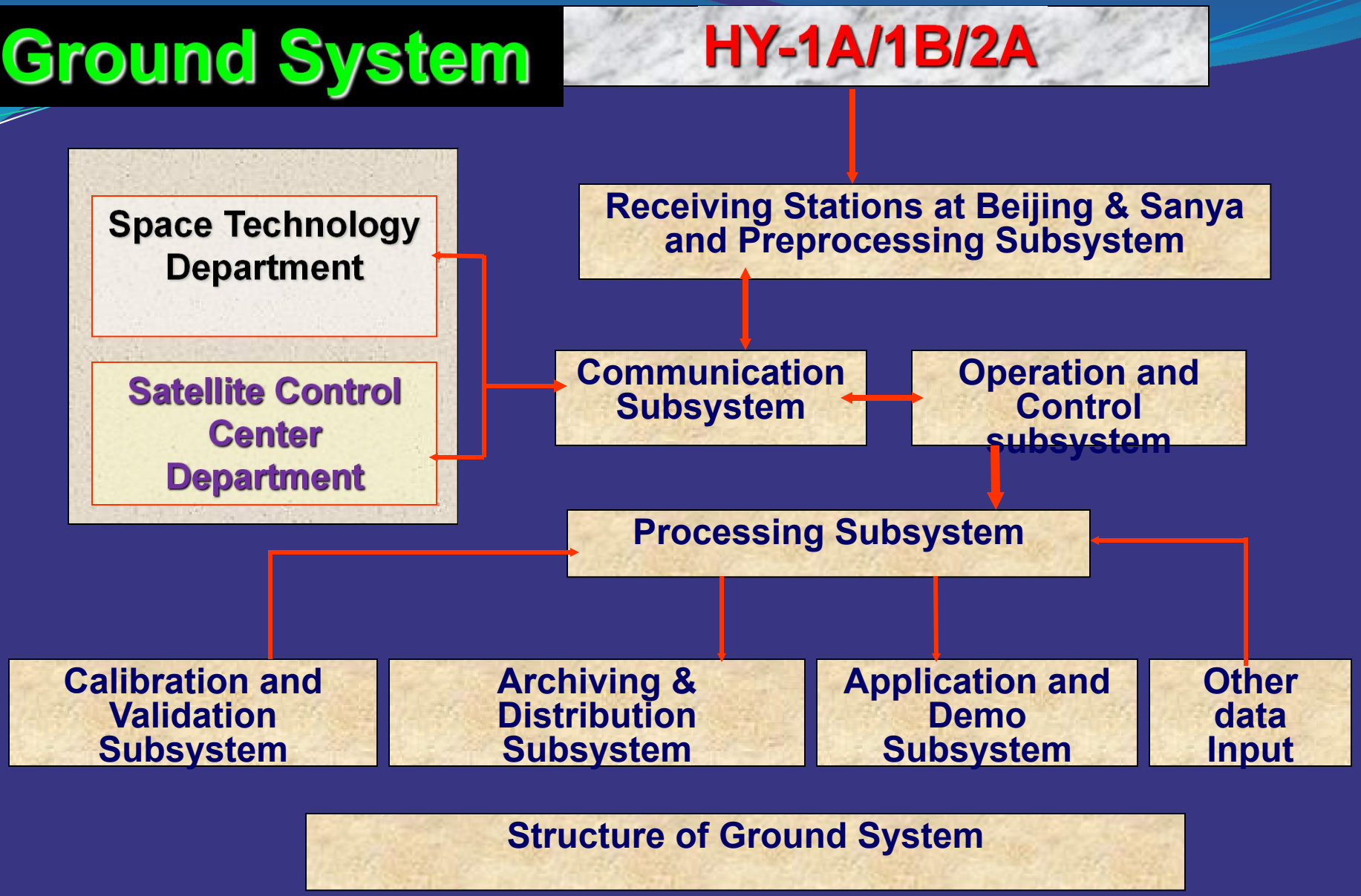


Beijing Ground station

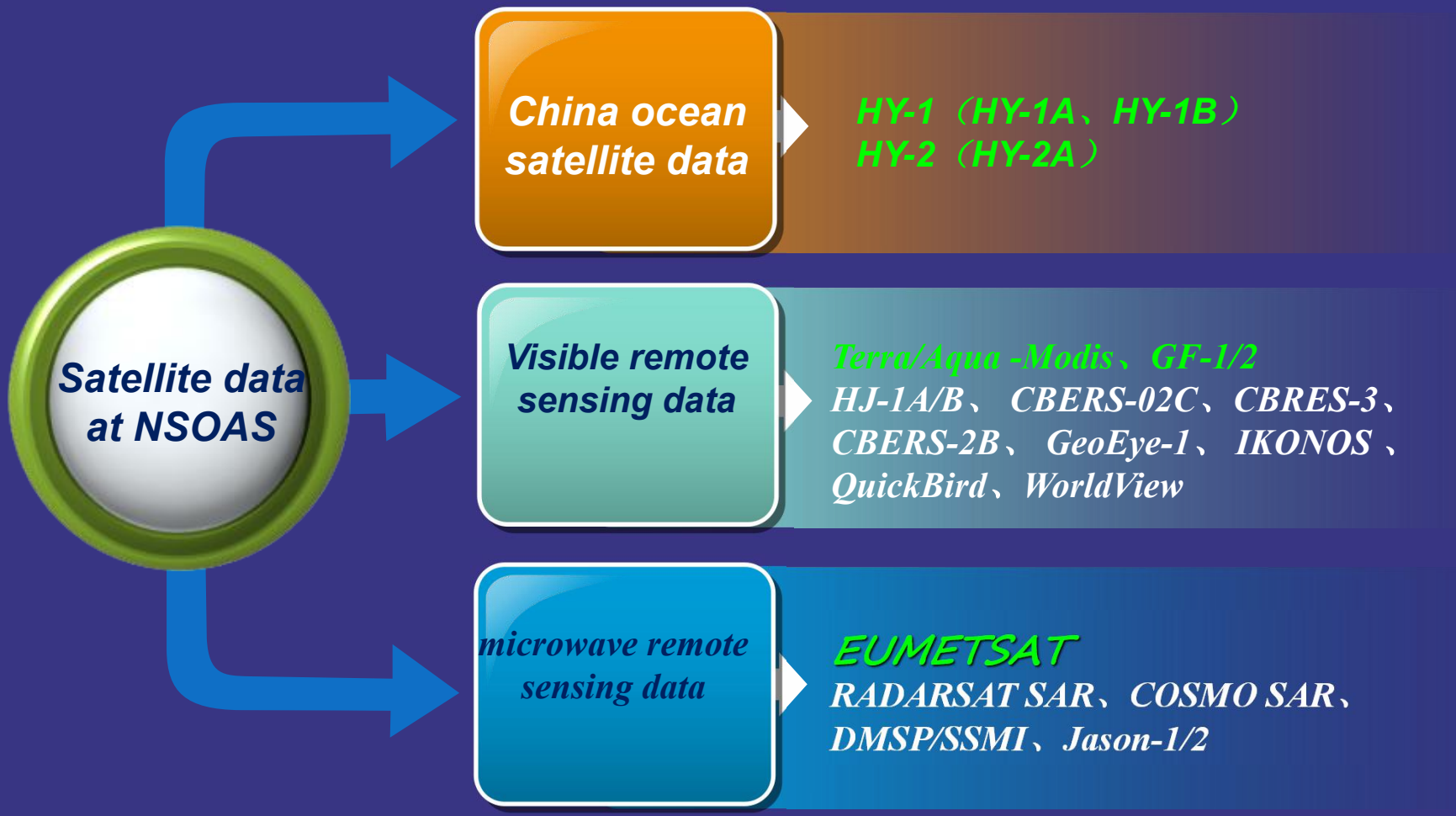
Sanya Ground station

Mudanjiang Ground station

Ground System



Structure of Ground System


Satellite data at NSOAS
China ocean satellite data
HY-1（HY-1A、HY-1B）
HY-2（HY-2A）
Visible remote sensing data
Terra/Aqua -Modis、GF-1/2
HJ-1A/B、 CBERS-02C、CBRES-3、
CBERS-2B、 GeoEye-1、 IKONOS 、
QuickBird、WorldView
microwave remote sensing data
EUMETSAT
RADARSAT SAR、COSMO SAR、
DMSP/SSMI、Jason-1/2

Three types of ocean satellites in China

HY-1	Ocean Color Satellite Missions
HY-2	Ocean Dynamic Environment Satellite Missions
HY-3	Ocean Surveillance Satellite Missions

FYI, the "HY" denotes "HaiYang" which means "ocean" in Chinese.

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Current Status

- Ocean Color Satellite Missions (HY-1)
  - Objective
    - To measure the ocean color, sea surface temperature, and coastal zone dynamic changing information of global oceans.

Satellite	Launch date	Design Life	Nature	Status
HY-1A	May 15, 2002	2 years	Experimental	Stopped working on Mar. 31, 2004
HY-1B	Apr. 11, 2007	3 years	Operational	Out of service

- HY-1A was launched together with FY-1D by a CZ-4B rocket at the Taiyuan Satellite Launching Center in north China's Shanxi Province, on 15 May 2002, and stopped on 30 March 2004.

- The main use of HY-1 satellite is to detect the marine environmental parameters of the China Seas, including chlorophyll concentration, suspended sediment concentration, dissolved organic matter, pollutants, as well as sea surface temperature.

Follow on mission of HY-1a:HY-1B.
launched on 11 April 2007

Current Status

- Ocean Dynamic Environment Satellite Missions (HY-2)
  - Objective
    - Globally monitor ocean dynamic environment parameters in the microwave region, including ocean surface winds, sea surface height, significant wave height and sea surface temperature, etc.
  - Launched Satellites

Satellite	Launch date	Design Life	Nature	Status
HY-2A	Aug. 16, 2011	3 years	Experimental	In orbit

- *HY-1A 2002.5.15 (out of service)*
- *HY-1B 2007.4.11 (out of service)*
  - *For Ocean color, SST, Coast zone*
  - *Sensor are COCTS (Chinese ocean color and temperature scanner) ,CZI (Coast zone imager)*
- *HY-2A 2011.8.15 (experimental)*
  - *For Ocean dynamic environment parameters (Wind, SSH, SST)*
  - *Sensor are ALT, SCA, MR, GPS, DORIS*
- *HY-3 2016 (operational)*
  - *C-band SAR*
  - *Wind, waves, oil spill, sea ice*

HY-2A Radar altimeter

Frequency	13.58 & 5.25 GHz
Pulse-limited footprint	< 2 km
Frequency bandwidth	320 MHz
PRF	2 KHz

HY-2A Microwave scatterometer

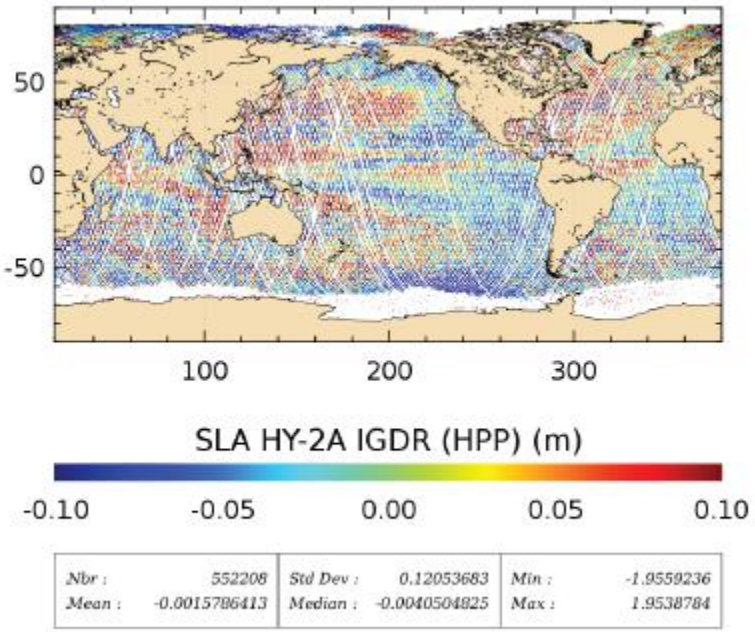
Frequency	13.256GHz
Transmit power	120 W
Pulse width	1.5 ms
Swath	1,350/1,750 km
Polarization	HH / VV
Look angle	34.8° / 40.8°
Incidence angle	41° / 48°
Scanning mode	conically scanning
σ0 measurement accuracy	0.5 dB
σ0 measurement range	-40 dB ~+ 20 dB
Wind cell resolution	25 km
Wind speed accuracy	<2.5 m/s
Wind direction accuracy	<20° rms

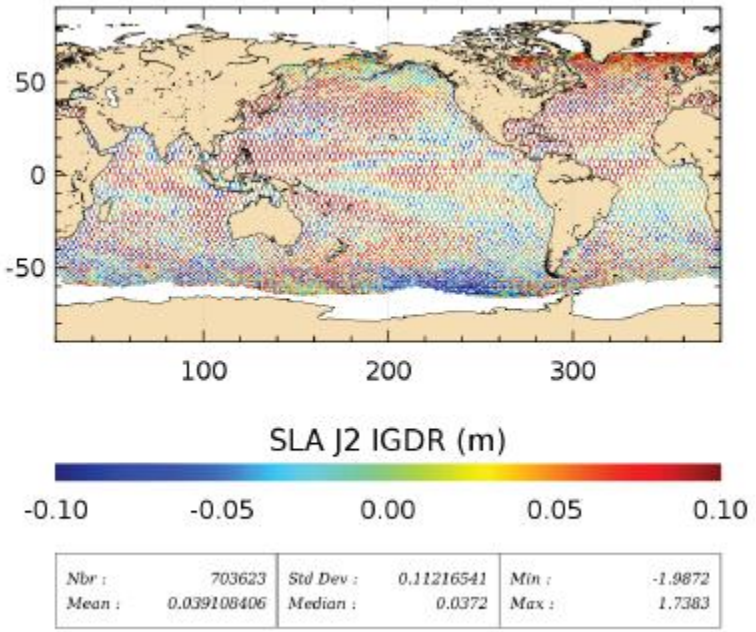
HY-2A Scanning microwave radiometer

Frequency (GHz)	6.6	10.7	18.7	23.8	37.0
Polarization	V H	V H	V H	V	V H
Scan width	1,600 km				
Footprint size(km)	100	70	40	35	25
Sensitivity(K)	<0.5	<0.5	<0.5	<0.5	<0.8
Dynamic range	3-350 K				
CAL precision	1 K（180~320 K）				

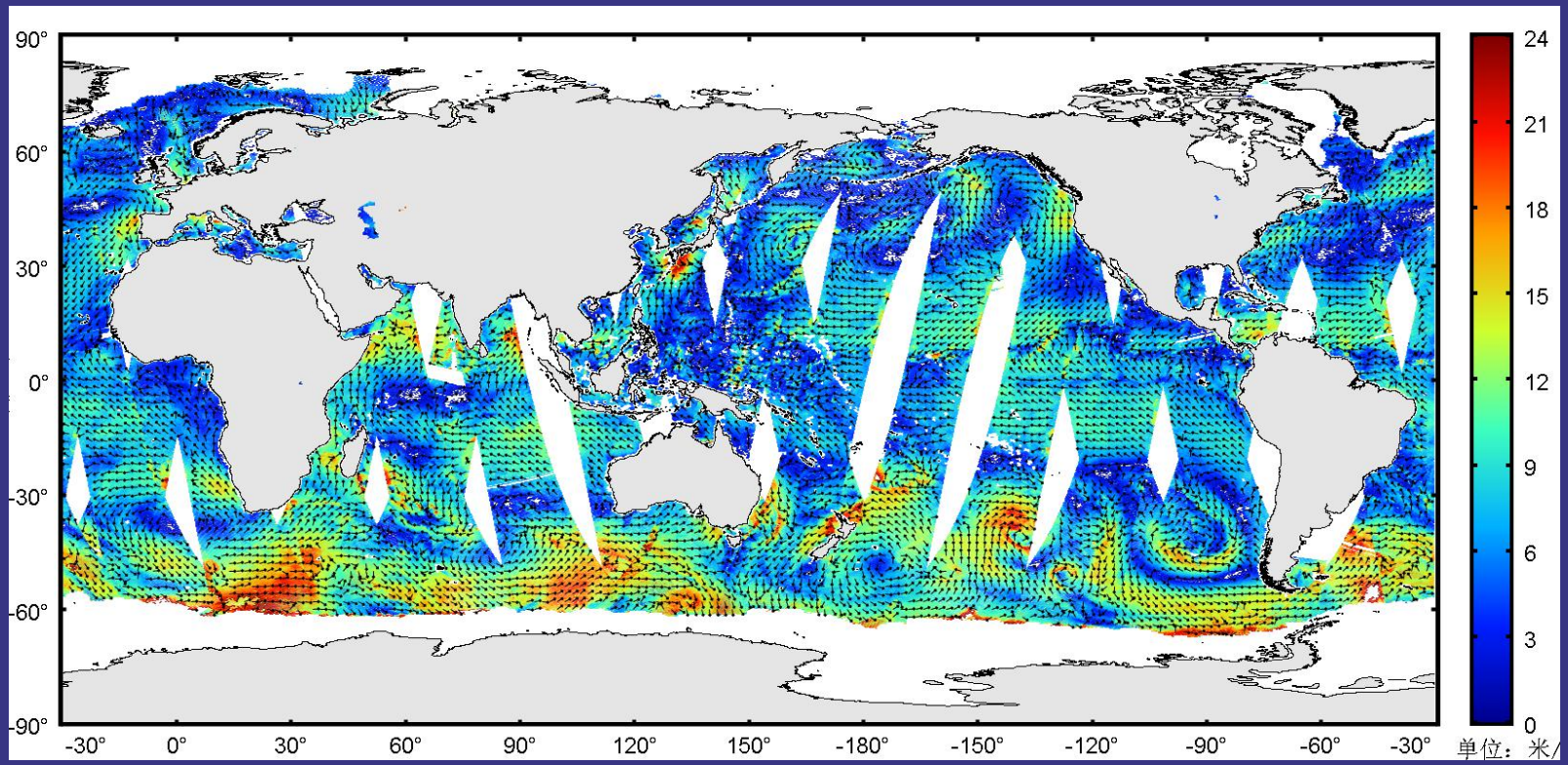
HY-2A Sea Surface Height

- the HY-2A sea surface height anomalies compared to Jason-2



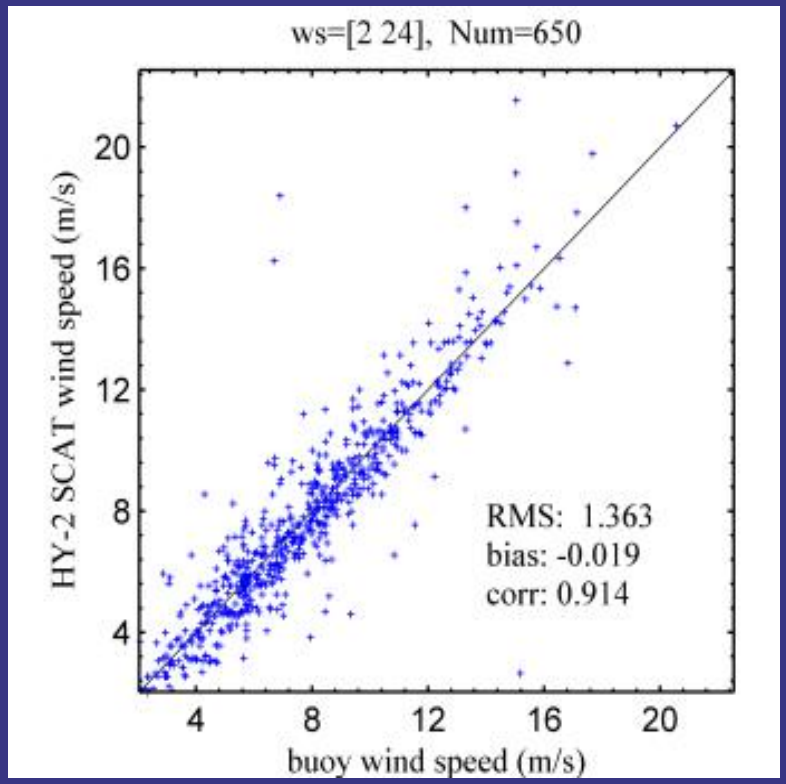


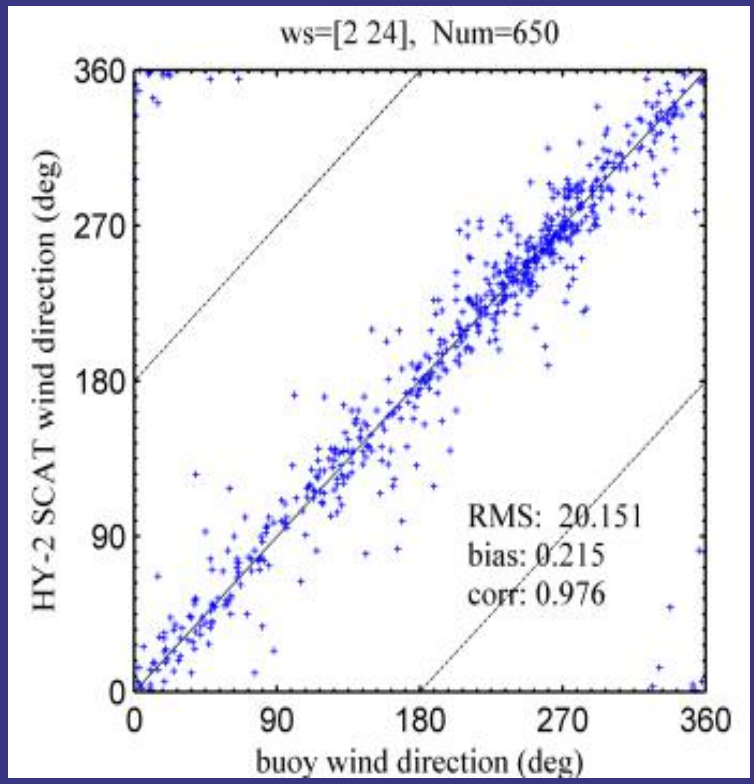
HY-2A winds



90 percent of the world's sea surface will be covered every 24 hours

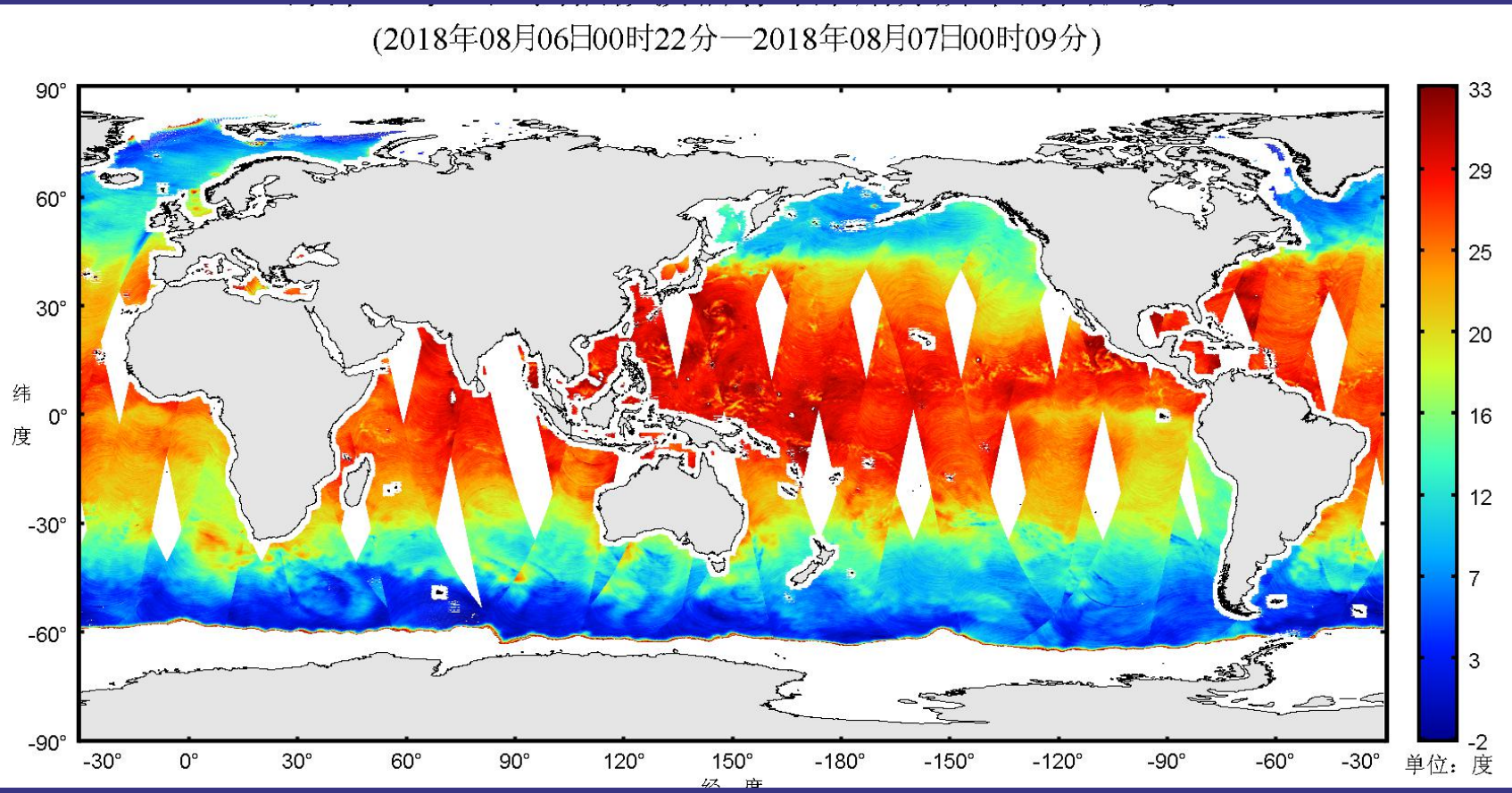
HY-2A wind validation, after quality control



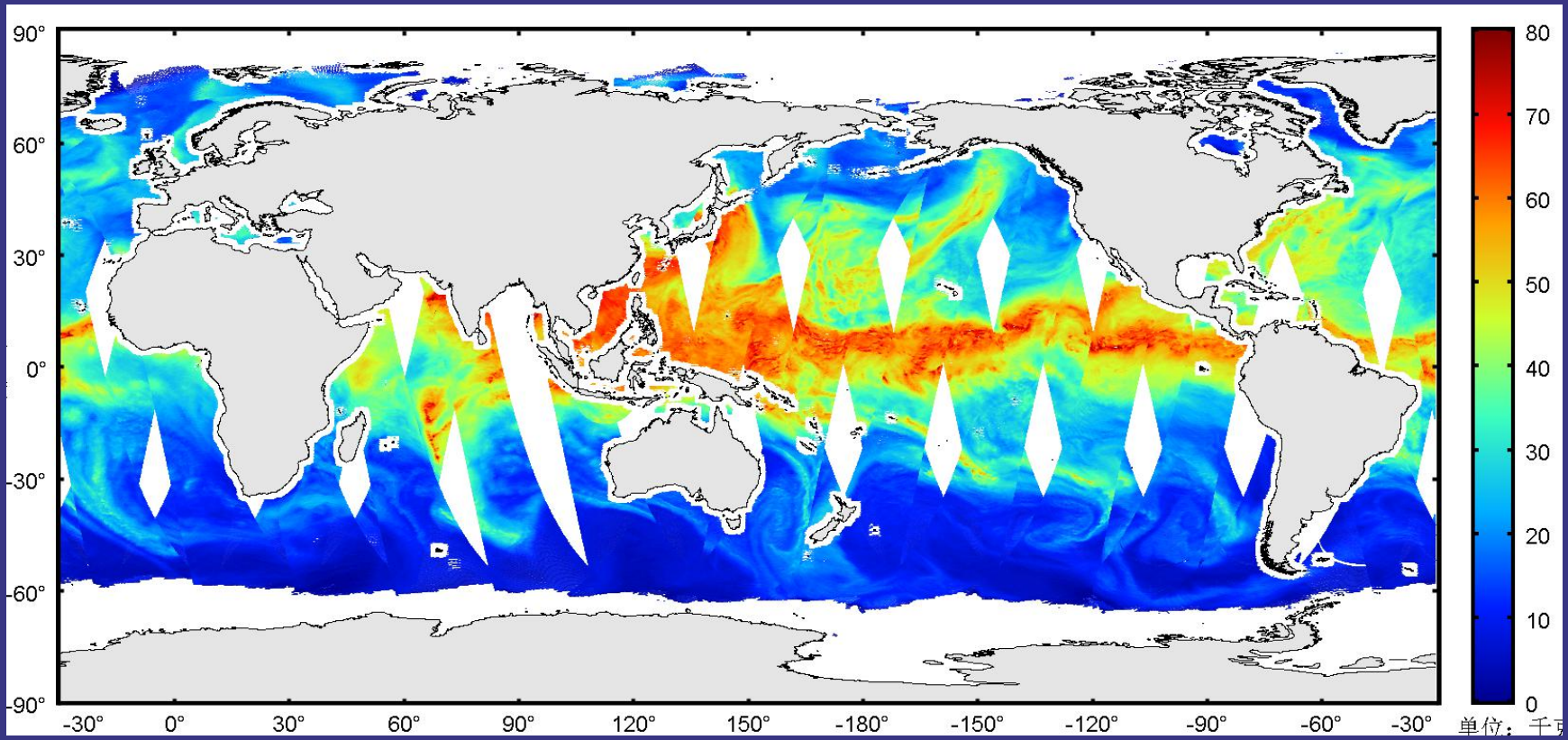


In-situ observations from the NDBC, TAO, and JMA buoys are used to validate HY2-SCAT wind. The r.m.s error of wind speed and wind direction are 1.3 m/s and 19.5° , respectively.

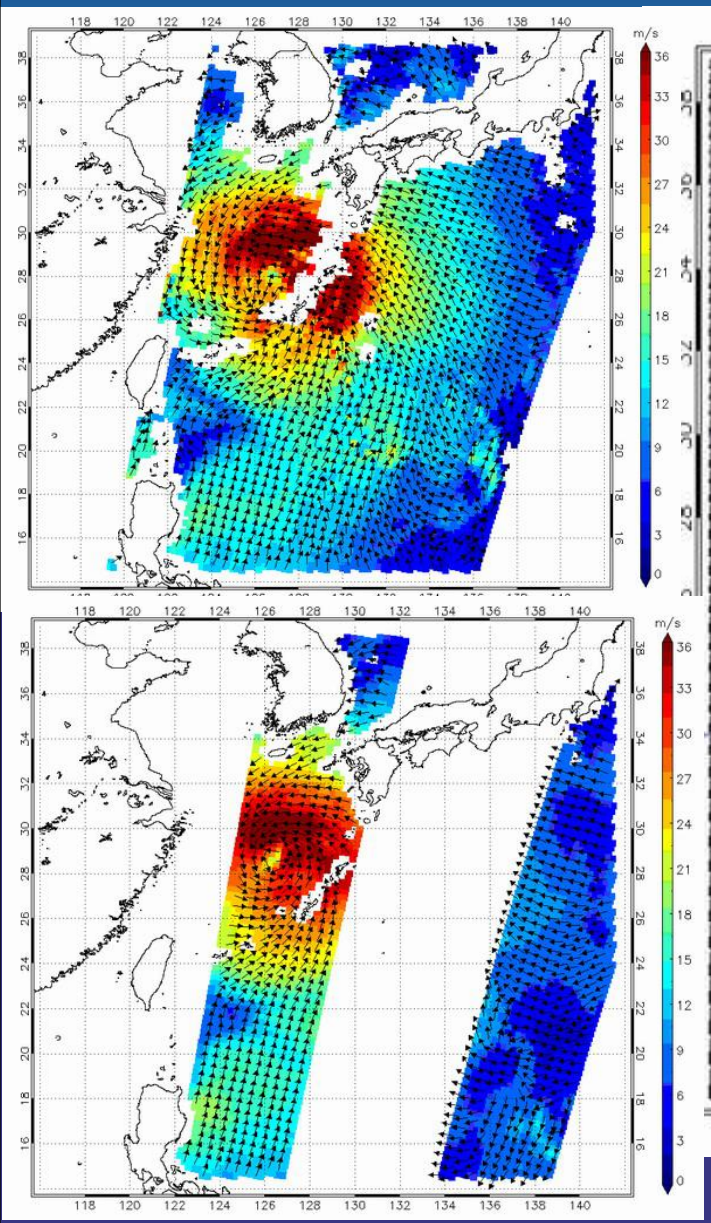
HY-2A SST

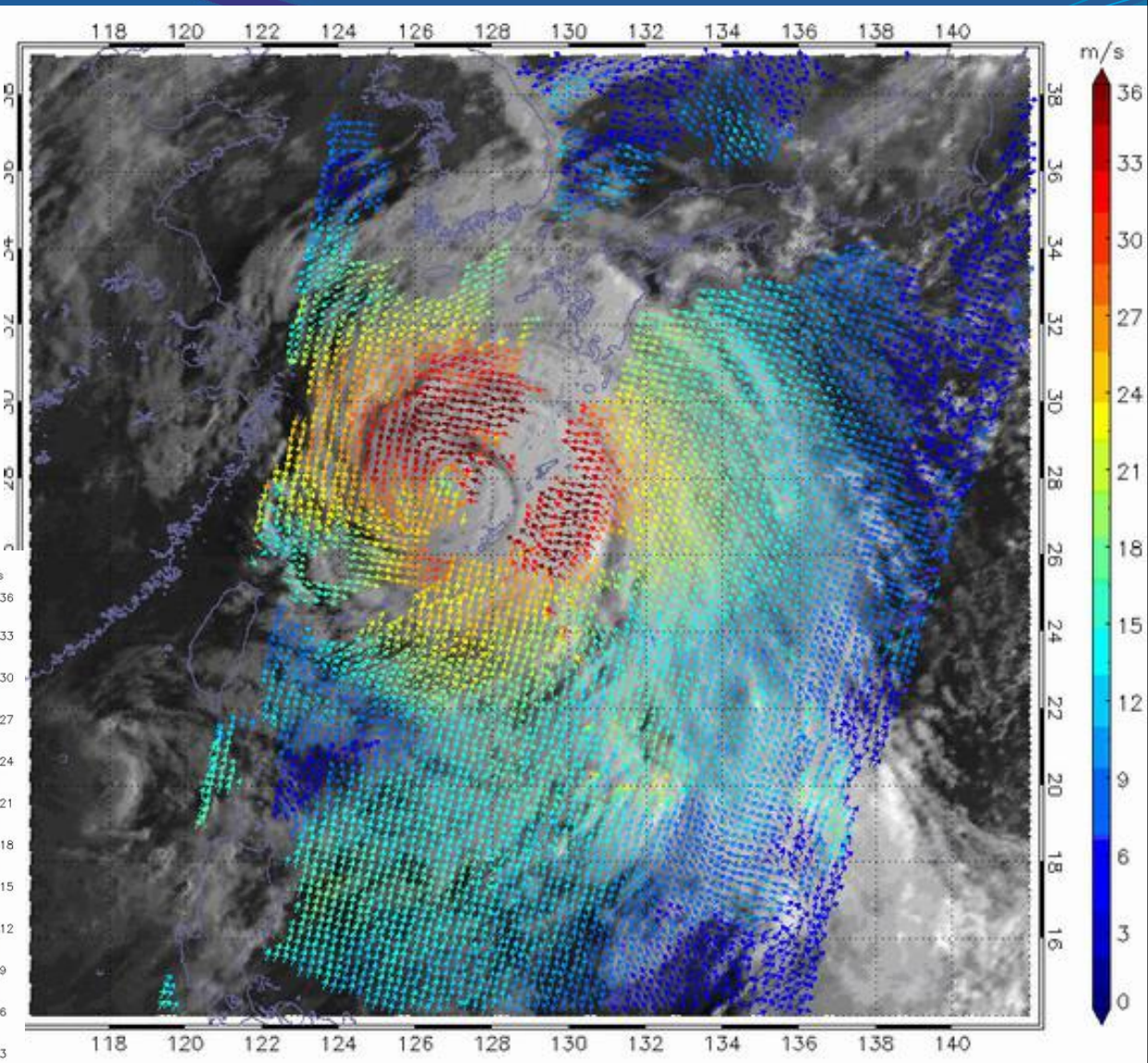

(2018年08月06日00时22分—2018年08月07日00时09分)
90°
60°
30°
0°
-30°
-60°
-90°
纬度
-30°
0°
30°
60°
90°
120°
150°
-180°
-150°
-120°
-90°
-60°
-30°
经度
33
29
25
20
16
12
7
3
-2
单位：度

Atmospheric water vapor content



Comparison between HY-2 scanning radiometer and NCEP re-analysis data, the r.m.s error is smaller than 2.1948 Kg/m²





Typhoon Bolaven observed by HY-2A/SCAT

2012-8-26

Data fusion of HY-2A Radar altimeter and scatterometer

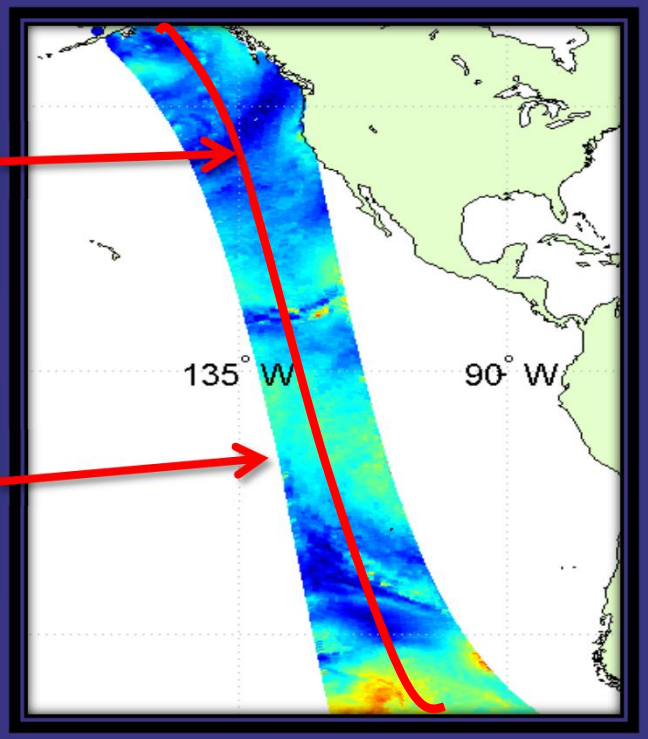
Radar altimeter

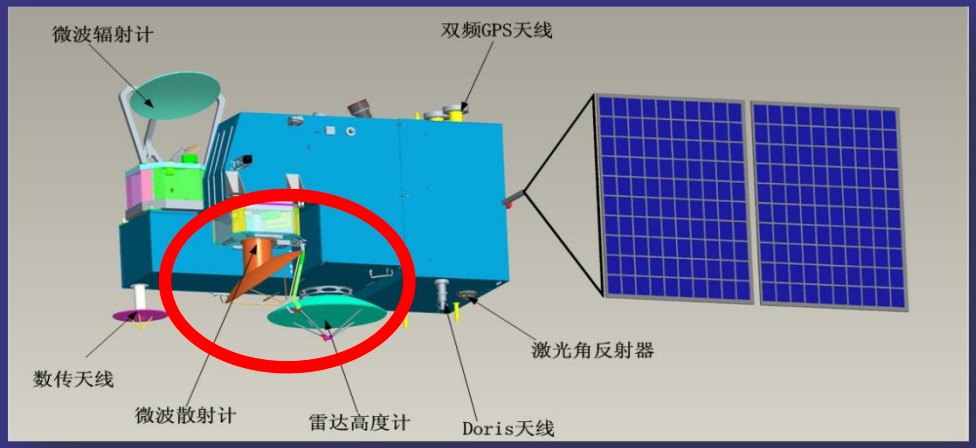
+

Scatterometer

- **Advantage:** Accurate
- **Limit :** Low spatial coverage (Only a track of wave height)

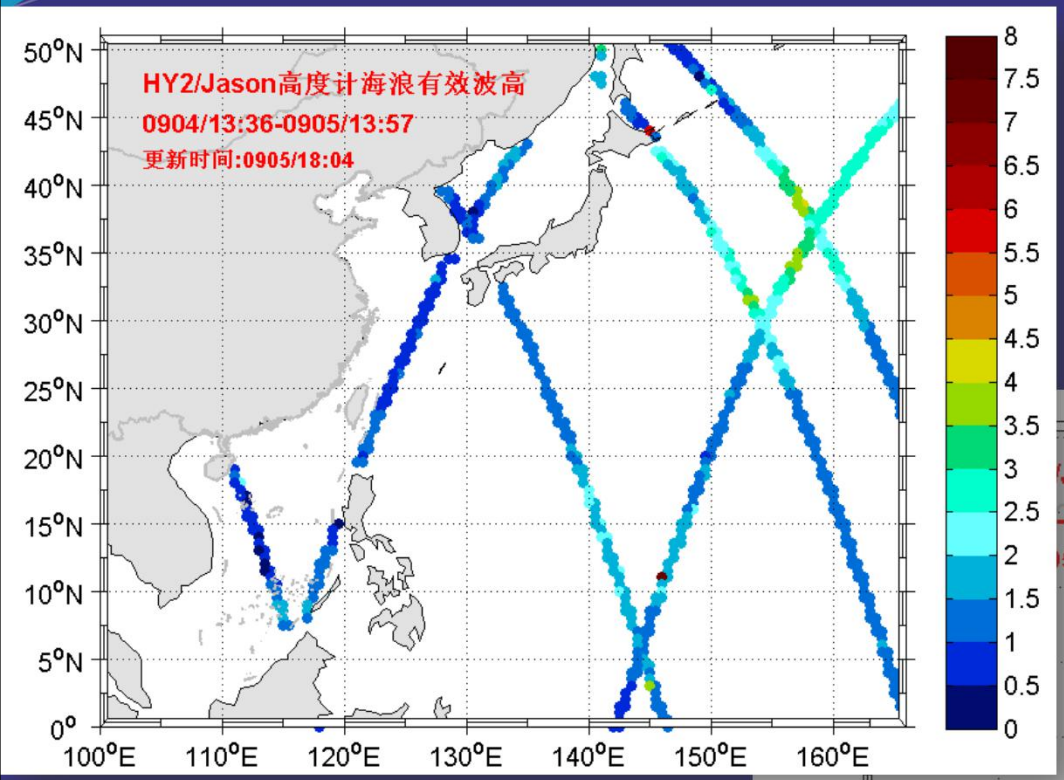
- **Advantage:** Wide observations
- **Limit :** Wind, not wave height





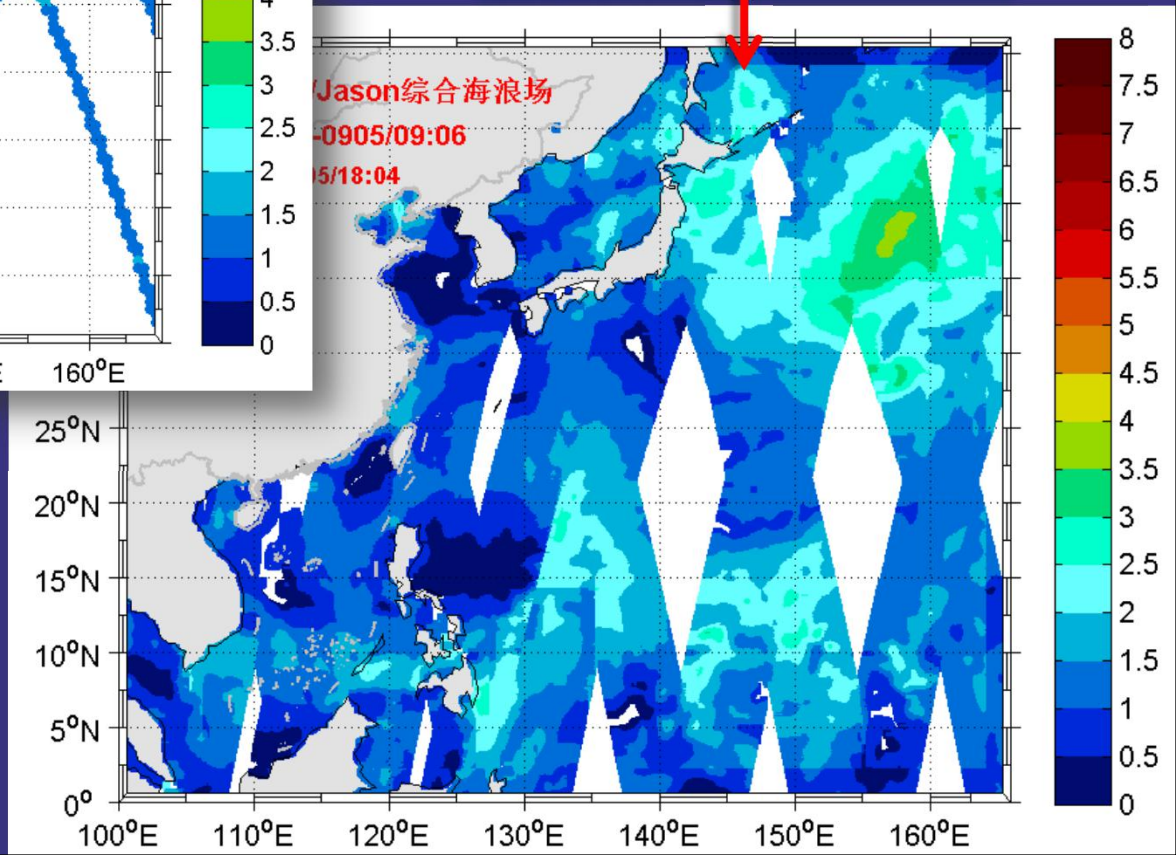
- **Platform:** Haiyang-2A
- Launched in August, 2011
- Carrying **BOTH** radar altimeter and scatterometer

Fusion of altimeter and scatterometer to achieve spatial coverage



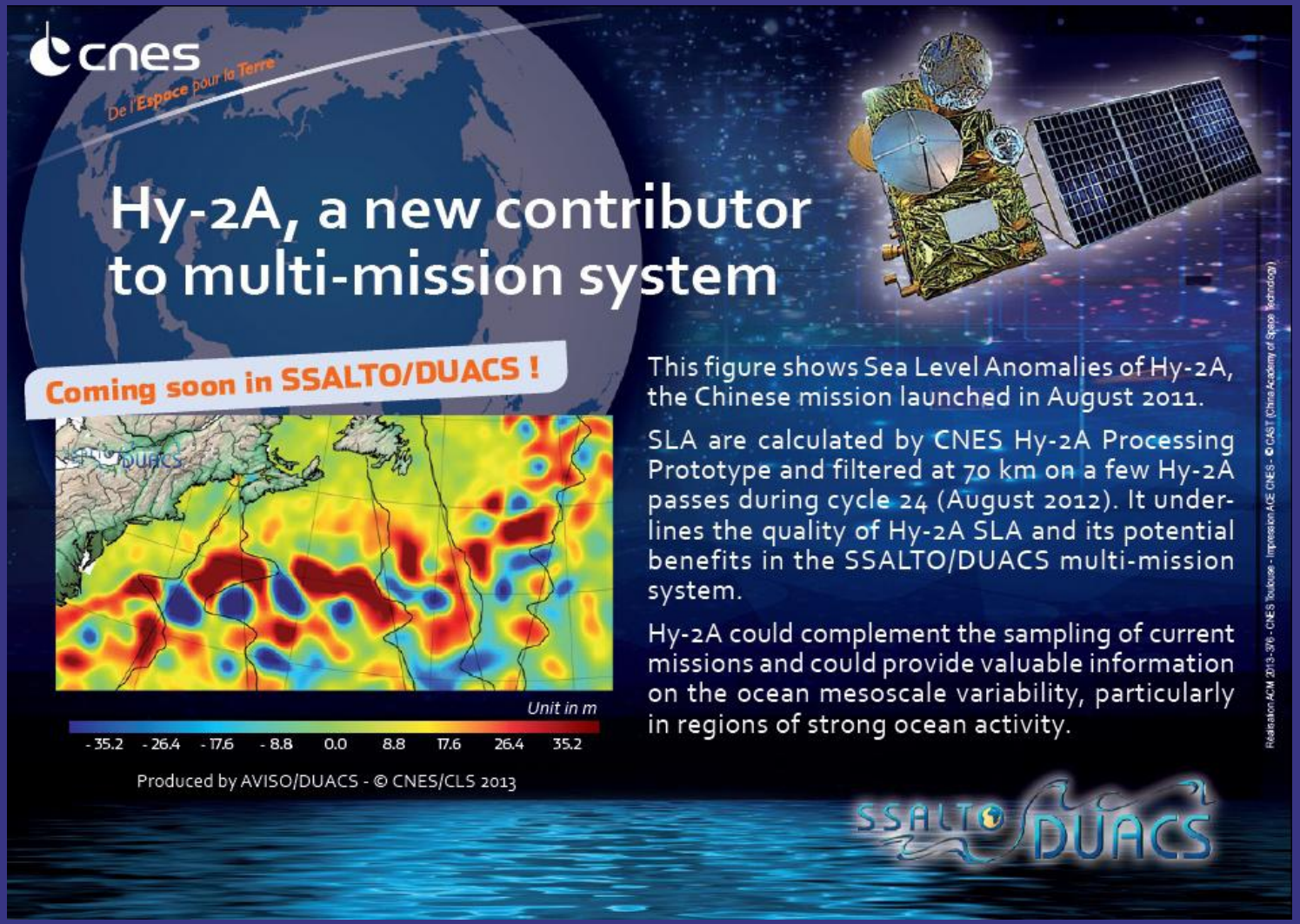
Wave field of Northwest Pacific on Sep. 5th, 2014

Fusion of ltimeter and scatterometer

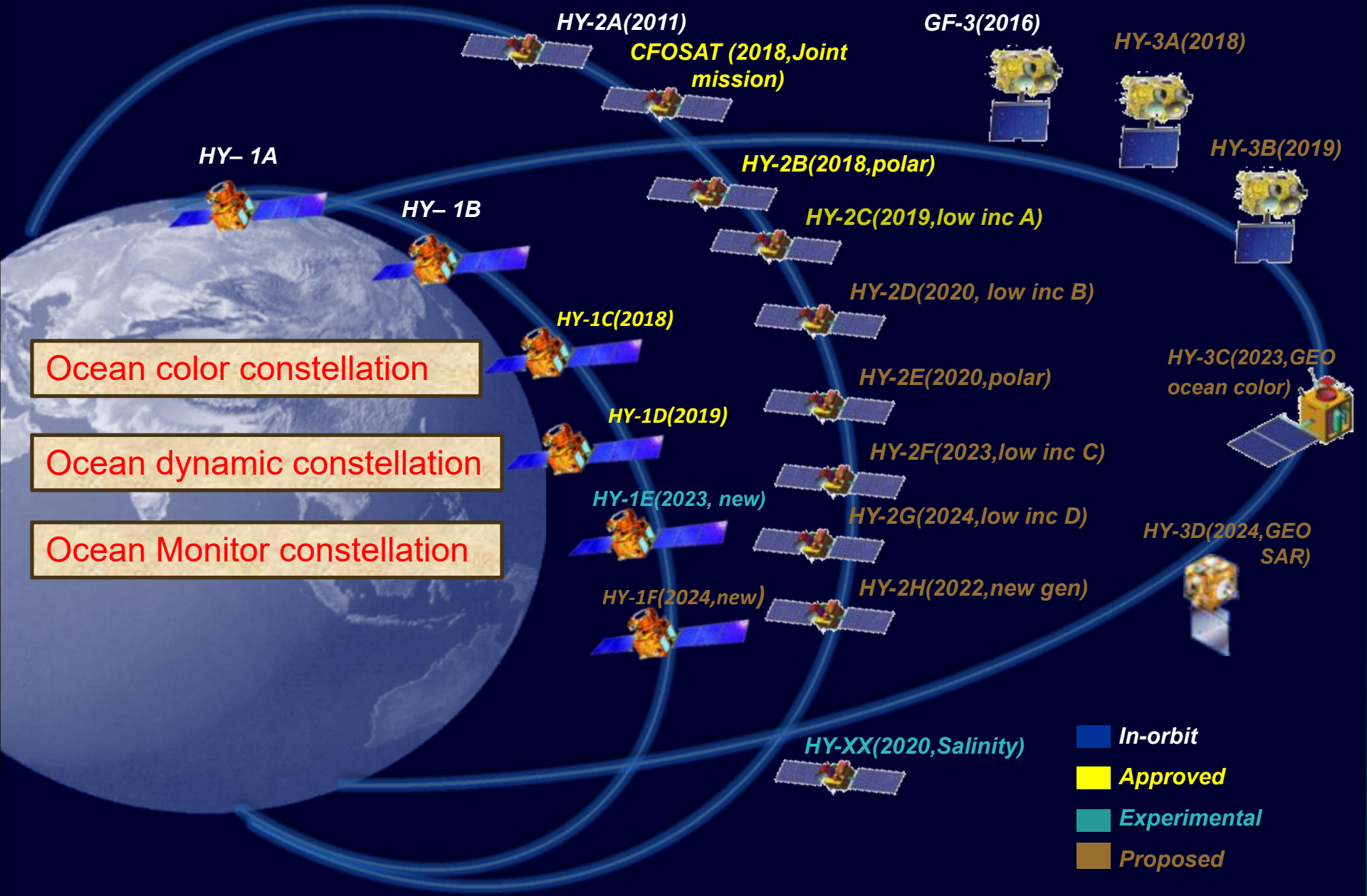


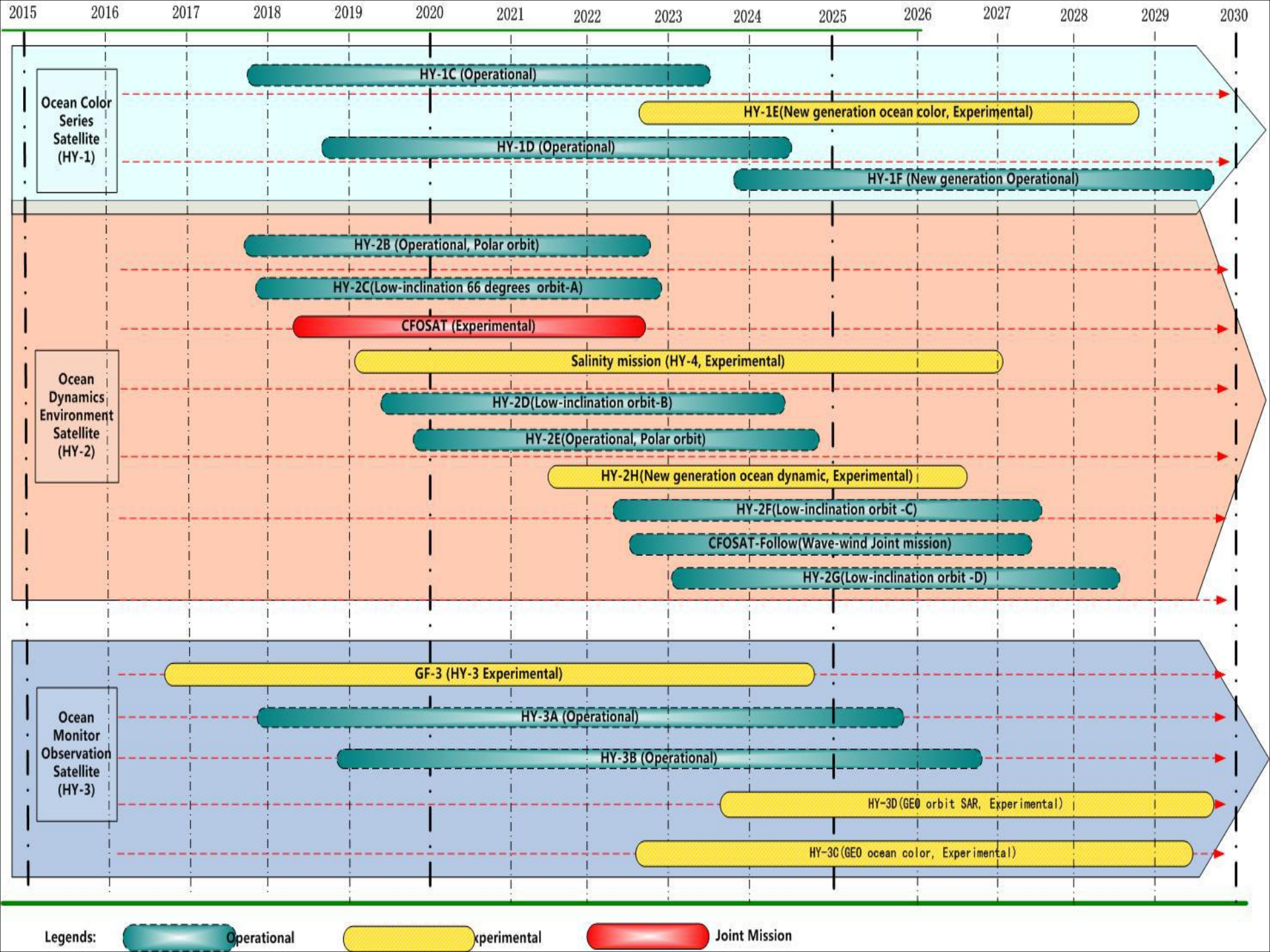
Wave field from altimeter

contribution to multi-mission system



Ocean satellite missions in China by 2025




2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
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2030
Ocean Color Series Satellite (HY-1)
HY-1C (Operational)
HY-1E(New generation ocean color, Experimental)
HY-1D (Operational)
HY-1F (New generation Operational)
Ocean Dynamics Environment Satellite (HY-2)
HY-2B (Operational, Polar orbit)
HY-2C(Low-inclination 66 degrees orbit-A)
CFOSAT (Experimental)
Salinity mission (HY-4, Experimental)
HY-2D(Low-inclination orbit-B)
HY-2E(Operational, Polar orbit)
HY-2H(New generation ocean dynamic, Experimental)
HY-2F(Low-inclination orbit -C)
CFOSAT-Follow(Wave-wind Joint mission)
HY-2G(Low-inclination orbit -D)
Ocean Monitor Observation Satellite (HY-3)
GF-3 (HY-3 Experimental)
HY-3A (Operational)
HY-3B (Operational)
HY-3D(GEO orbit SAR, Experimental)
HY-3C(GEO ocean color, Experimental)
Legends:
Operational
xperimental
Joint Mission

HY-1C launched on 7 September 2018 1115BT (0315UTC)

1) Orbit： Sun-synchronous
2) Altitude：782 km（nominal）；
3) Local：
a. HY-1C：descending 10:30AM±30min
b. HY-2D：descending 1:30AM±30min（in 2019）
4) Data released in March 2019 after on-orbit test.

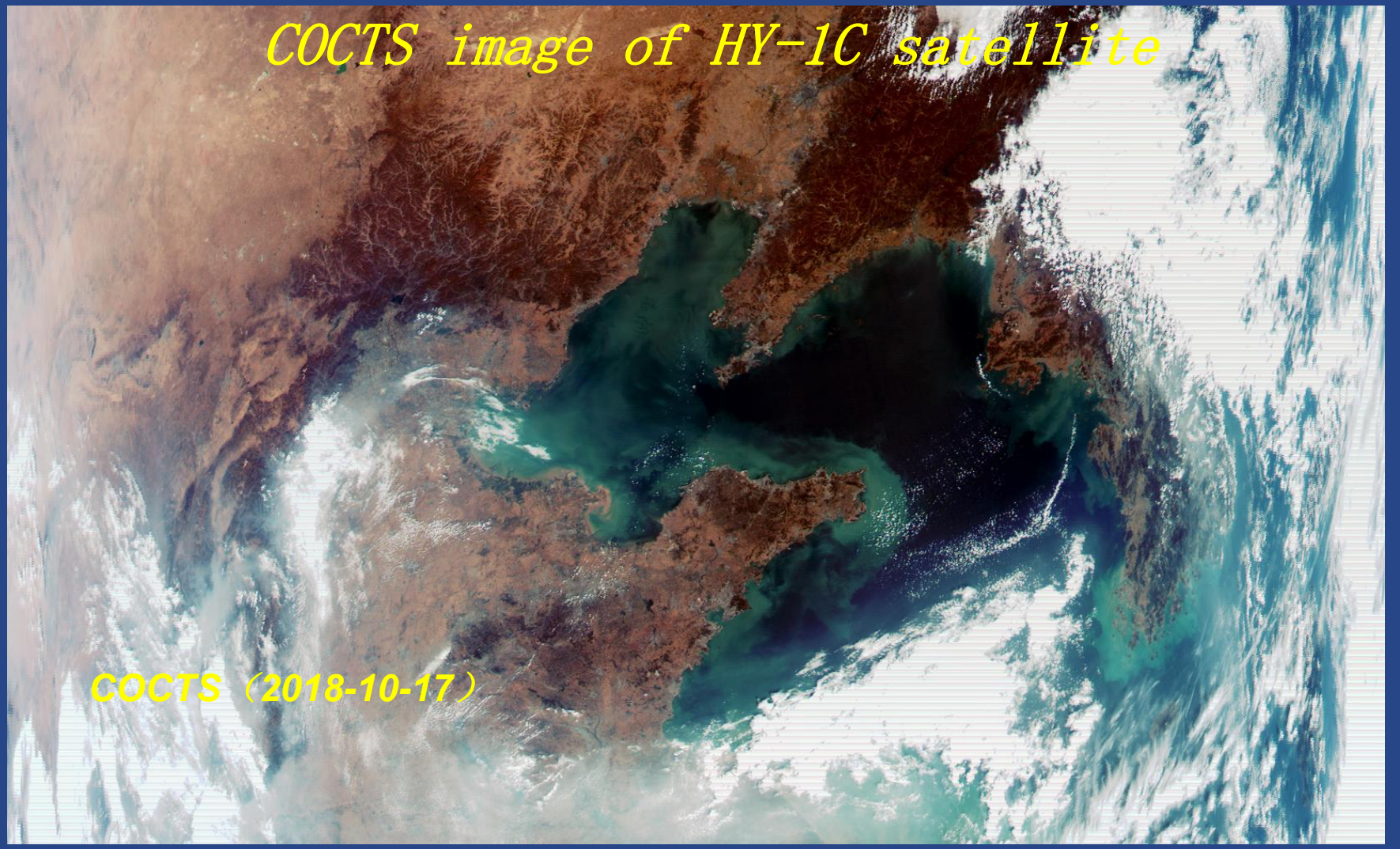
Payloads of HY-1 satellites

- ***Chinese Ocean Color and Sea Surface Temperatrue Sensor (COCTS),***
- ***Ultraviolet imager（UVI）***
- ***Coastal Zone Imager (CZI)***
- ***Satellite calibration spectrometer（SCS）***
- ***Automatic Identification System（AIS）***

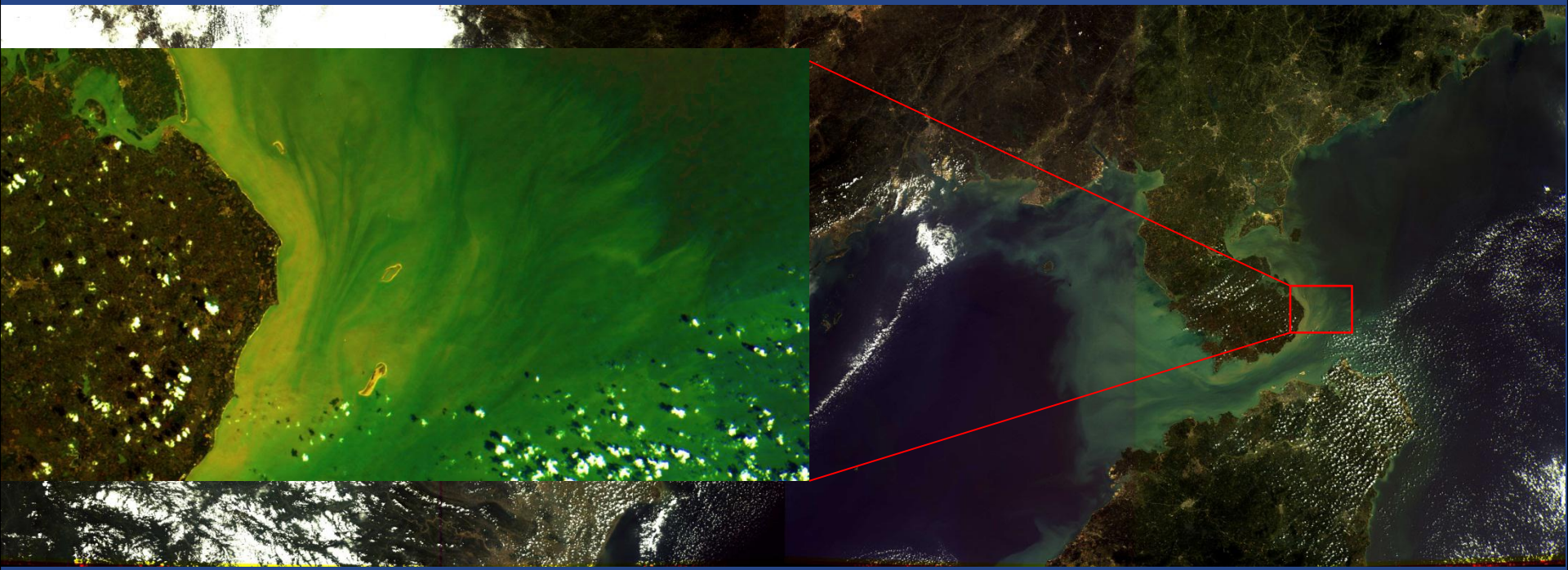
Payloads of HY-1C/D satellites

- ***COCTS: 10 bands, swath width: ≥2900 km, resolution: 1.1 km, global coverage: 1 day (single satellite)***
- ***UVI：2 bands, swath width: ≥2900 km, resolution: 1.1 km or 550 m, global coverage: 1 day***
- ***CZI: 4 bands, swath width: ≥950 km, resolution: 50 m, temporal coverage: 3 days***
- ***SCS: swath width: 11 km, spectral resolution : 5 nm in 400 ~ 900 nm***

COCTS image of HY-1C satellite

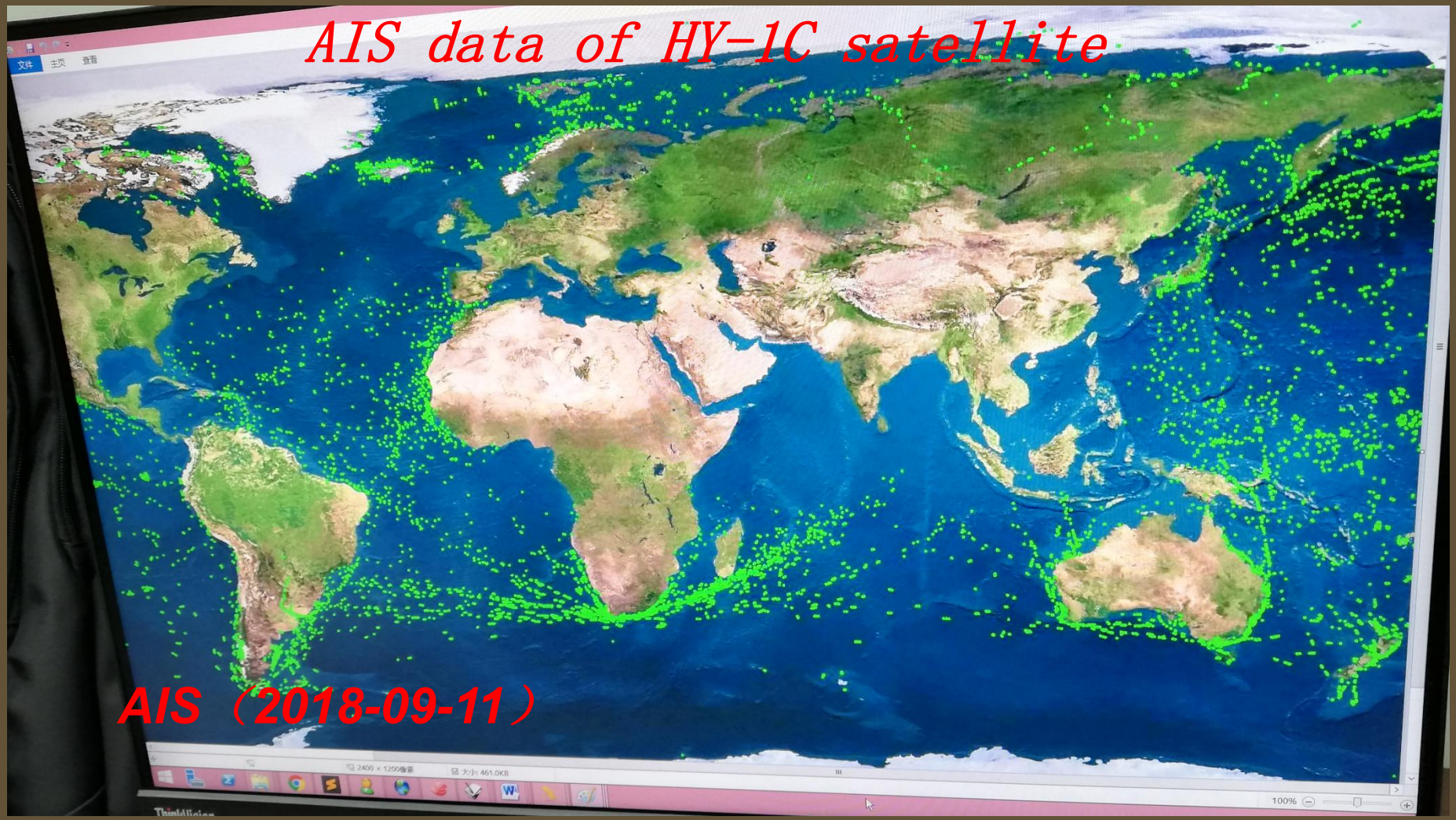


CZI image of HY-1C satellite



CZI（2018-10-07）

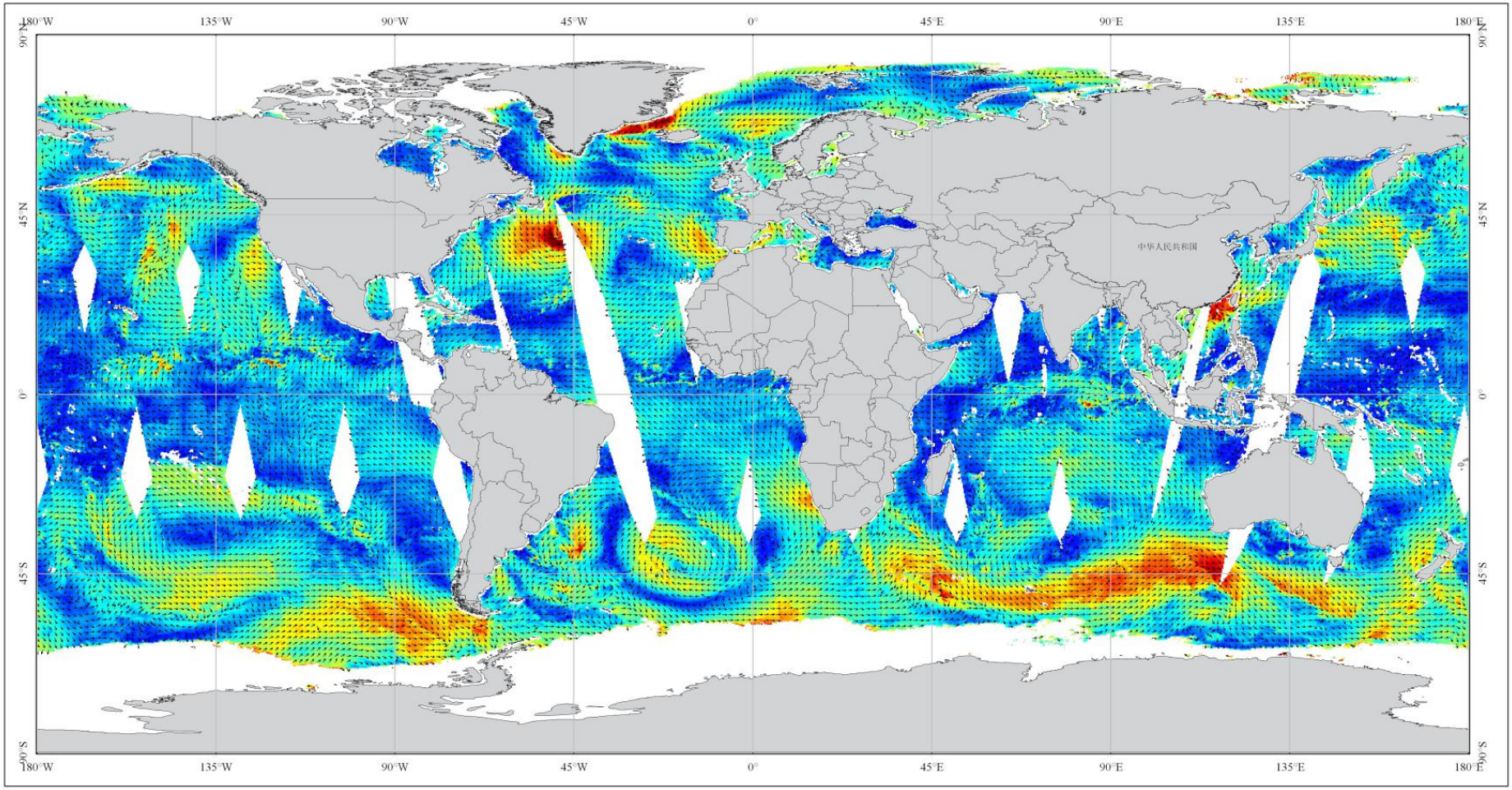

CZI image of HY-1C satellite
CZI（2018-10-02）

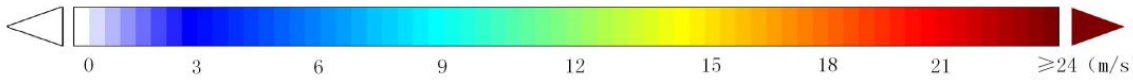

AIS data of HY-1C satellite
AIS（2018-09-11）

HY-2B launched on 25 October 2018 0607BT

海面风场全球分布专题图

(20181030T22:09:30 UTC -- 20181031T23:50:08 UTC)





制图单位：国家卫星海洋应用中心

制图时间：2018年11月01日

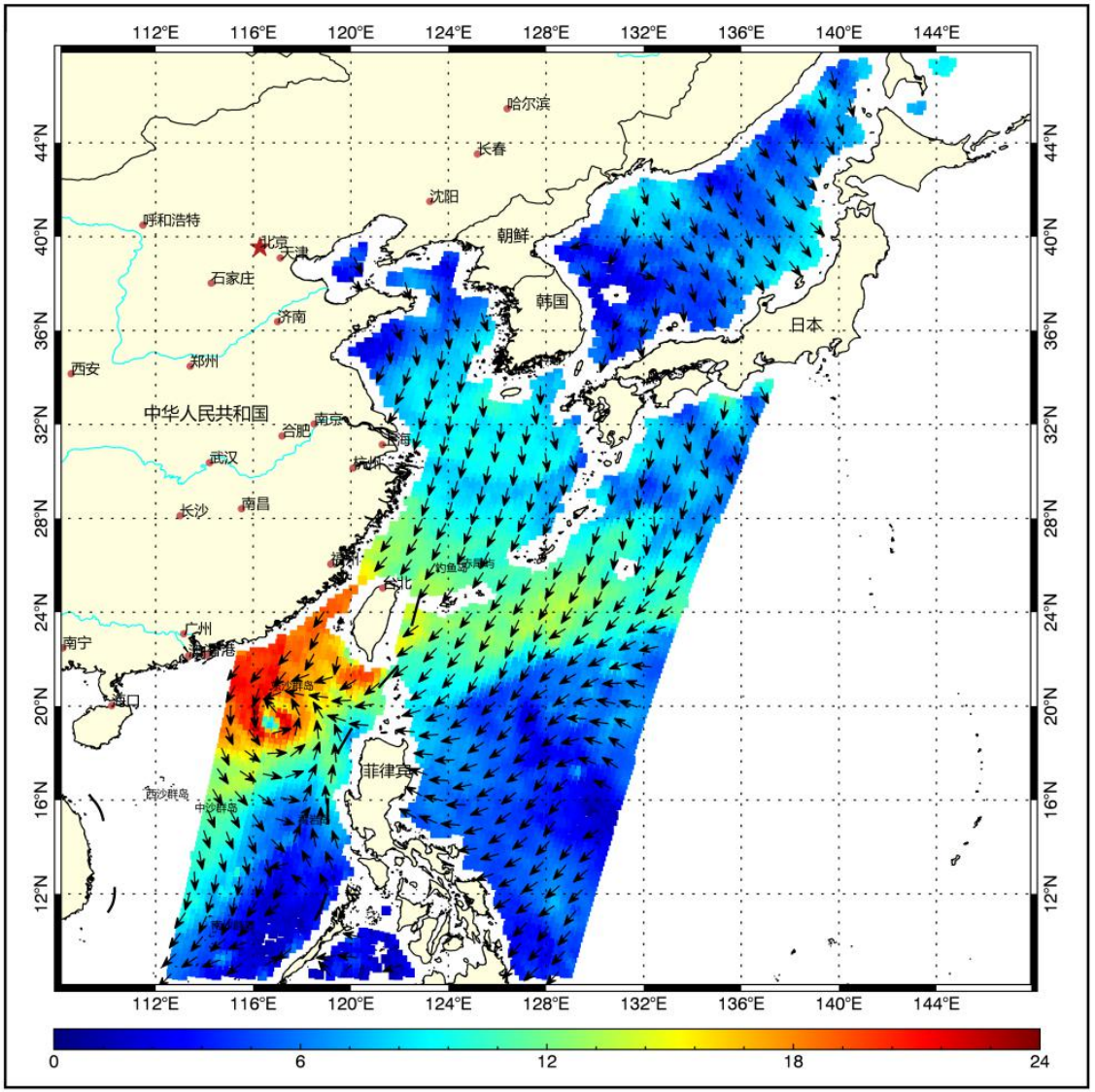
坐标系：CGCS2000

比例尺：1:100,000,000

卫星名称：HY-2B

传 感 器：微波散射计

卫星遥感台风监测专题图



观测时间: 201811011700 (BJ)

卫星数据源: HY-2B 微波散射计(HSCAT)

制图单位: 国家卫星海洋应用中心(NSOAS)

台风名称: 玉兔(Yutu)

台风编号: 20182613

风速单位: 米/秒(m/s)

CFOSAT launched on 29 October 2018, 0843 BT

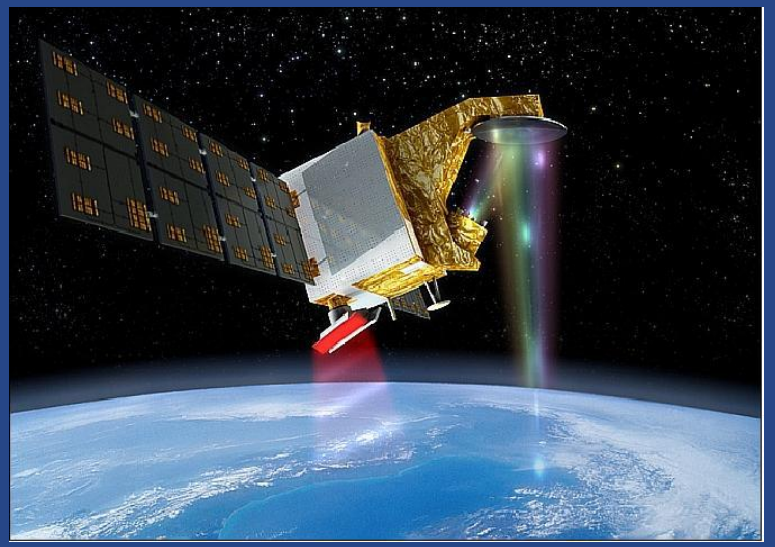
The spacecraft has a launch mass of ~ 650 kg, the primary structure has a size of ~1.4 m x 1.4 m x 1.2 m, the mission design life is 3 years.

Orbit: Sun-synchronous near- circular orbit, altitude of 519 km, inclination = 97º, LTDN (Local Time on Descending Node) = 7:00 hours, the revisit time is 13 days

With their respective geometry SWIM and SCAT will provide a global coverage within 3 days for wind fields (SCAT) and almost global for waves within 13 days (SWIM).

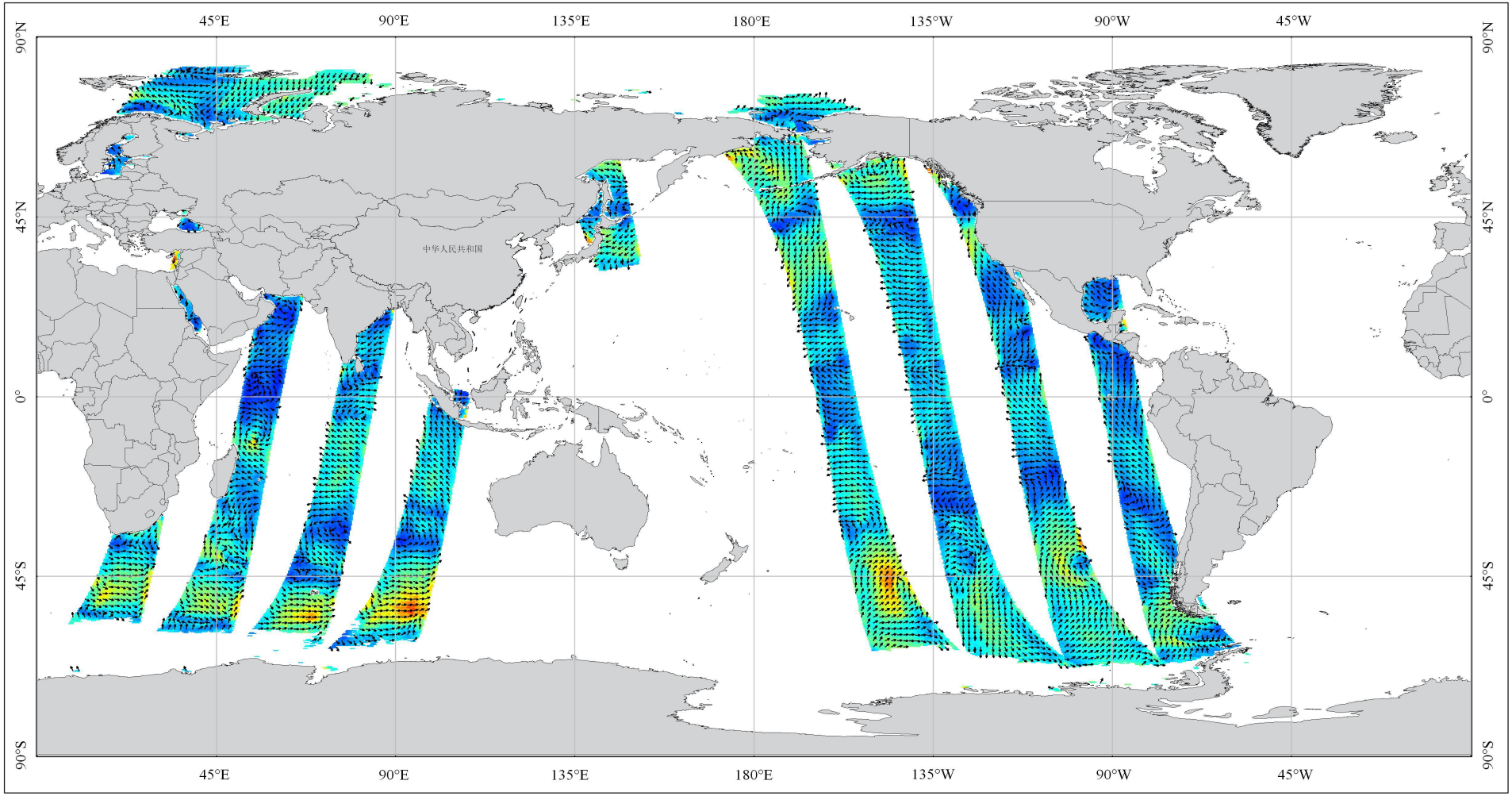
- CFOSAT
  - China-France Oceanography Satellite (CFOSAT) is a joint mission of China and France
  - Global coverage of ocean surface winds and waves
  - Winds: 25 km grid
  - Wave spectrum: 60~70 km grid

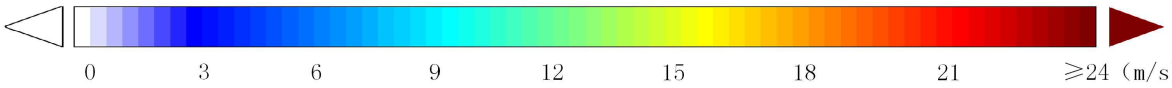
- ***Main payloads***
  - ***SCAT (Rotating Fan-beam Scatterometer)***
  - ***SWIM (Surface Waves Investigation and Monitoring instrument)***



海面风场全球分布专题图

(20181108T00:07:39 UTC -- 20181108T09:07:18 UTC)





制图单位：国家卫星海洋应用中心

坐标系：CGCS2000

卫星名称：CFOSAT

制图时间：2018年11月09日

比例尺：1:100,000,000

传 感 器：微波散射计

Summary

- The satellite missions are categorized as three types: ocean color satellites (HY-1 series, optical and infrared), ocean dynamic environment satellites (HY-2 series, microwave) and ocean surveillance satellites (HY-3 series, synthetic aperture radar).
- The satellite observations are expected to significantly improve the temporal and spatial sampling frequencies of the surface ocean parameters and have great potential to maintain a long time series of satellite observations.
- 3 satellites will be launched in 2018 and 18 satellites by 2025, if all the mission programs are approved and the economy is fine.


Thank
You!