Facing the Future and Sustainability Through Connecting the Coastal and Open Oceans:

*Center for Mega-Science, Chinese Academy of Sciences (COMS, CAS)*

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Outline

01 Background

02 COMS, CAS introduction

03 Long term observing networks and new findings
Increasingly heavy influence of human activities on coastal sea

内陆省份

Inland Provinces

沿海11个省/市

Eleven Coastal Provinces & Cities

- 面积
  - 内陆省份：87%
  - 沿海11个省/市：13%

- 人口
  - 内陆省份：58%
  - 大城市：50%

- 大城市
  - 内陆省份：13%
  - 沿海11个省/市：50%

- GDP
  - 内陆省份：40%
  - 沿海11个省/市：60%

- 外资
  - 内陆省份：21%
  - 大城市：50%

- 出口
  - 内陆省份：11%
  - 沿海11个省/市：89%
Increasingly heavy influence of human activities on coastal sea

- Ports, bridges, sea reclamation, aquaculture, fishery, dams, industrialization, fertilization, urbanization

- Red, green, brown, ... tides caused by different algae blooms, jellyfish, hypoxia, ...
Low and declining oxygen levels in the open ocean and coastal waters affect processes ranging from biogeochemistry to food security. The global map indicates coastal sites where anthropogenic nutrients have exacerbated or caused O$_2$ declines to $<2$ mg liter$^{-1}$ ($<63$ μmol liter$^{-1}$) (red dots), as well as ocean oxygen-minimum zones at 300 m of depth (blue shaded regions). Breitburg et al. 2018, Science
Polygons denote hypoxic extent in previous studies (Li et al., 2002; Wei et al., 2007; Zhou et al., 2010; Zhu et al., 2016a).

Zhang et al. 2016
Major red tide events, China, last 20 years

(Yu and Liu, 2016)
Linkage with open ocean

Coastal and Open Oceans Connecting

East China Sea is largest marginal sea in western Pacific with a broad continental shelf. Complex interaction between open ocean and coastal waters.
Linkage with open ocean

Western Pacific Warm Pool

Center of action for interannual climate mode - El Nino Southern Oscillation
Impact on global through atmosphere “tele-connections”
Western Pacific is the most active tropical cyclone basin on Earth
Global Ocean Observation Network
Outline

01 Background
02 COMS/CAS introduction
03 Long term observing networks and new findings
Marine science is closely linked with sustainability
Background of the COMS, CAS

• **Marine science is “Mega Science”**
  - National demands: environment protection, ecological civilization, sustainability
  - Multi-disciplinary study: physical, chemical and biological process interactions
  - Major facilities supporting observations and analyses: money, money, money, ...

• **New organization of CAS reformation, new engine for further development**
  - Coordination of RVs, observing networks, and instrumental analysis: maximizing utilization and sharing of facility resources
  - Integration of IOCAS and YICCAS: crossing the border between coastal and open ocean researches
  - Integration of 13 CAS institutes and College of Marine Science, UCAS: connecting scientific research, technical development and application, and education
Structure of the COMS, CAS

- **Central Platform**
- **Supporting Platforms**
- **Core Research Unit**
- **Multi-disciplinary Research Units**

Supporting Platforms:
- Analysis and Testing Center
- Observation Networks
- Big Data Center

- IO-YIC + other CAS institutes + CMS, UCAS: Integrated section of marine research and education
- IO-YIC Integration: marine resources, coastal ocean environment, and deep sea researches
- **R/V fleet**: 10 research vessels
### Central Platform: R/V Fleet

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<th>No.</th>
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<th>Working area</th>
<th>Gross Tonage</th>
<th>Management Institute</th>
<th>year</th>
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Supporting Platforms

Observation Networks

- Yellow River Estuary
- Jiaozhou Bay
- Changjiang River Estuary

Supporting Platforms:
Supporting Platforms

Analysis and Testing Center

IOCAS
QBECAS
YICCAS
IACAS
IGCCAS
SCSIO
Supporting Platforms

Big Data Center

- Data collection (combination of data obtained from RV Fleet, Observation Networks and, Analytical and Testing Center)
- Data products and visualization: Supporting policy-making and social development
Structure of the COMS, CAS

- **Central Platform**
- **Supporting Platforms**
  - IO-YIC Integration
  - Supporting Platforms: Analysis and Testing Center, Observation Networks, and Big Data Center
- **Core Research Unit**
- **Multi-disciplinary Research Units**
  - IO-YIC
  - + other 11 CAS institutes
  - + UCAS
- **R/V fleet**: 10 research vessels
Institutes in Marine Science in CAS

- Yantai Institute of Coastal Zone Research (2006)
- Institute of Oceanology (1950)
- South China Sea Institute of Oceanology (1959)
- Sanya Institute of Deep-sea Science and Engineering (2011)

Integrated development of IOCAS and YICCAS since March 2017
Core Research Unit of COMS, CAS

Three Tasks

- Ocean health: Mechanisms, Strategies and Solutions
- Multi-spherical Interactions in Indo-Pacific Convergence Zone
- Marine Life Process and Green Development of Bio-resources
Ocean Health: Mechanisms, Strategies and Solutions

**Ecosystem Observation and Simulation**
- Automated acquisition of integrated observation data
- Simulation of coastal ocean dynamics

**Ecosystem Health Assessment**
- Development of carrying capacity assessment method

**Ecological Disaster Prevention and Mitigation**
- Developing prevention and control technology of ecological disasters.
- Developing capabilities in predicting and early warning of ecological disasters

Central and Regional Govt Strategies and Planning

Management Solutions
- Land use options
- Marine use option
Multi-spherical Interactions in Indo-Pacific Convergence Zone

Integrated Observation and Exploration
- Full-depth ocean observation and Real-time data transmission technology

Multi-spherical interaction Study
- Key process and mechanism of multilayered mass and energy exchange in Ocean-Atmosphere-Geosphere-Biosphere

Modelling and Simulation
- Develop simulation and prediction methods on the effects of climate change

Multi-spherical interaction theory

- Exploration & observation facilities
- Earth system model
Marine Life Process and Green Development of Bio-resources

Marine life in Deep Sea
- Marine biodiversity and marine life in deep sea
- Exploitation of biological resources from the deep ocean

New varieties & Species
- New varieties of economic important species
- Core technologies on genome sequencing

Green Mariculture Modes
- Monitoring & observation techniques
- Stands and facilities for marine ranching
- Remediation of degraded habitat

Theory on Life in the Deep Sea
Sustainable Mariculture Industry
- new understandings on marine life in deep sea
- New varieties or species
- environment-friendly mariculture modes
Marine medicines and Marine biological products
New marine energy
Seawater desalination
Marine mineral resources

Marine resource exploitation
Marine engineering & equipment
Prevention and control of marine disasters

marine equipment
marine engineering
Marine disaster prevention and control

3 directions, 7 R&D centers
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Observation Networks of COMS, CAS

Four Stations:
- Jiaozhou Bay Station (1981, State station)
- Muping Station (2011)
- Yellow River Estuary Station (2011)
- Changjiang River Estuary Station (2014)

Three Arrays:
- Yellow Sea Buoy Array (2007)
- East China Sea Buoy Array (2007)
- Western Pacific Subsurface Mooring Array (2014)

Goals: To provide high-resolution, long-term, and multi-variable observational datasets
Yellow Sea and East China Sea Buoy Networks
CAS Scientific Observing Network (CASSON) in the Western Pacific Ocean

- 30 Sets of Deep-Sea Subsurface Moorings
- 121 sets of T, S, Current Instruments
- 1000 Sets of Temperature, Salinity, and Ocean Current Data
- 3-4 years

Succeeded in releasing and retrieving subsurface moorings.
Time-Depth Variation of Zonal Currents at 142° E, 0°
During Aug 2014 – Nov 2017
By August 2017, the real-time transmission of deep-sea data had successfully been conducted for more than 280 days in a row.
Two Functional Developments in 2017: Real-time Network and 3000 m depth transmission

Year 2017

Pressure

Temperature at ~3200 m

Zonal Current at ~3200 m
The Concept of Marine Ranching
Biodiversity and marine ecosystem studies
Systematic solutions on marine ecological and environmental problems

Strategies to prevent green tides in the Yellow Sea

Mitigation of Harmful algal blooms with modified clay
The coastal Algal blooms are closely influenced by the timing and location of the phosphate-rich, cold Kuroshio branch current (NKBC).

Yang et al., JGR, 2011, 2012, GRL, 2018
Research Findings

Structure and Variability of WBCs, WBUCs, NEC/UC from Mooring Measurements at 8N, 18N, 130E

(Hu et al., 2013; Wang et al., 2014)

(Zhang et al., 2014; Hu et al., 2016)

(Hu et al., 2013; Wang et al., 2014)

(Zhang et al., 2017)
Research Findings

Structure and Variability of North Equatorial Countercurrent, Equatorial Undercurrent, etc. in upper 1000 m at 140E
(Wang et al., 2016, JGR)
Positioning and goals of the COMS, CAS

- A comprehensive research center with global influence and contribution
- An opening and sharing facility cluster of S&T innovation
- An elite talent cultivation base
- A platform for collaborations with domestic and international institutions

The COMS, CAS will act as the bridges connecting the coastal and open ocean study, science and technology, and academic and social/industrial requests, based on integrating, coordinating and sharing the advanced platforms and task teams of the CAS.
THANKS

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