声学多普勒流速剖面仪（ADCP）
应用案例：从浅海到深海
ADCPs application cases : From shallow sea to deep ocean

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Beijing, China

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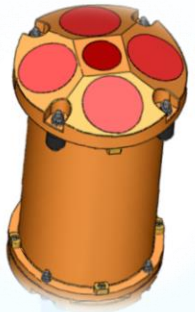
Outline

1. Introduction
2. Offshore and shallow sea cases
3. Deep ocean & polar region application
4. Sum

1. Introduction

1.1 Objects and methods

- **Acoustic Doppler Current Profiler（ADCPs）**
- **are the most universal sensor packages in Ocean and River Observing Systems in the world.**



conventional

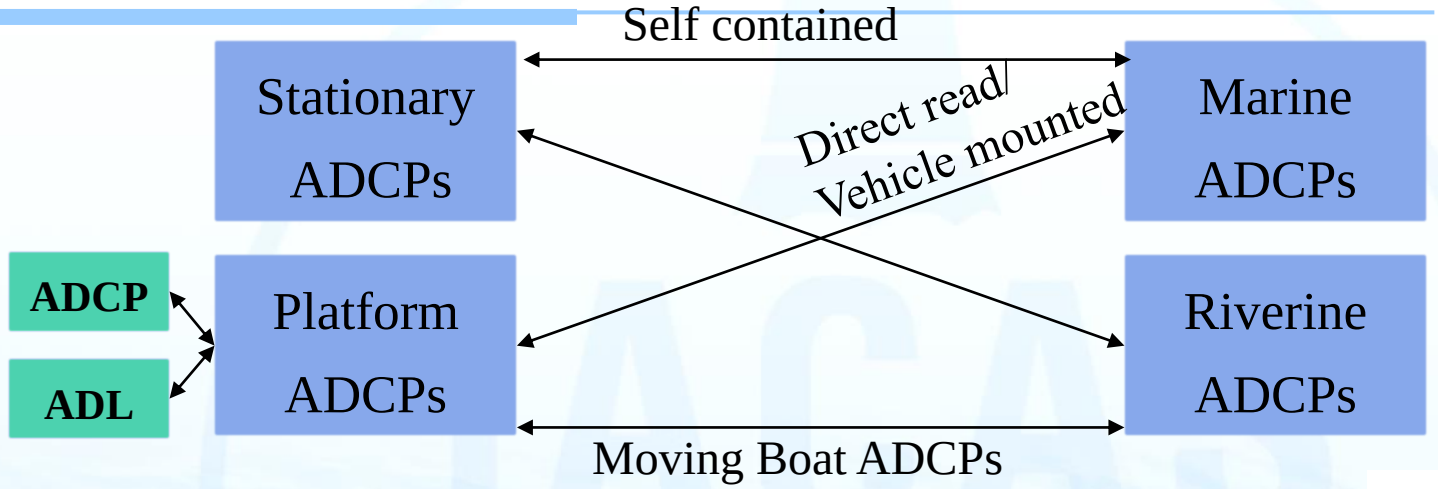
1. Current profiling
2. Acoustic Ranging

present

1. Water Resource Management - flow in rivers and channels
2. Environmental Monitoring
3. Hydraulic Engineering
4. Scientific Research: sediment transport, environmental Impact studies, modeling

prospective

1. Turbulence
2. Wave
3. Echo profiling - particle or plankton concentration



（1）Moving Boat ADCPs

- **Velocity profiling**
- **Flow measurement with bottom tracking / GPS**
- **bottom depth**

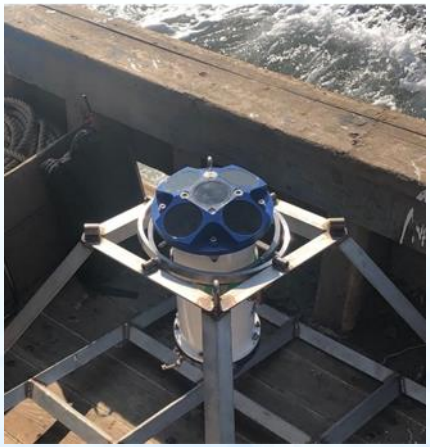
Trimaran

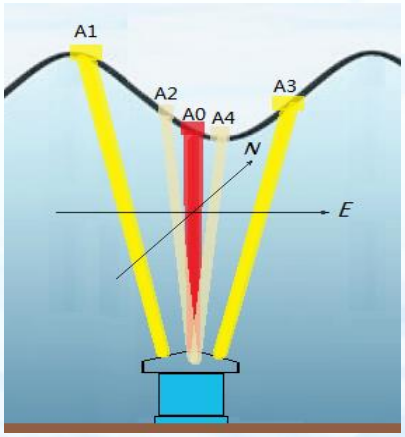
Autonomous Vehicle

Manned vessel

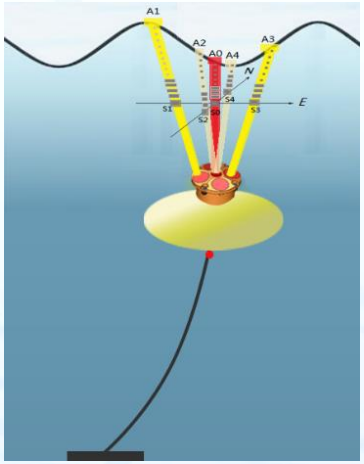
（2）Platform ADCP / ADL

❑ Seabed based platform(Stationary)

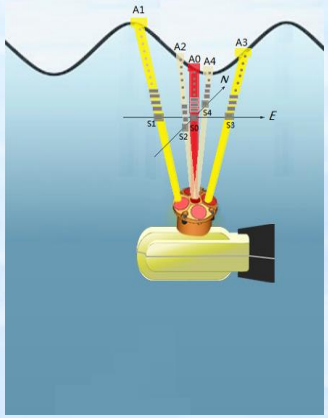




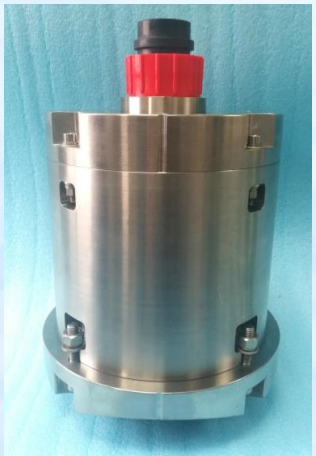
❑ Submerged buoy



❑ Vehicle mounted ADCP



❑ Vehicle mounted ADL



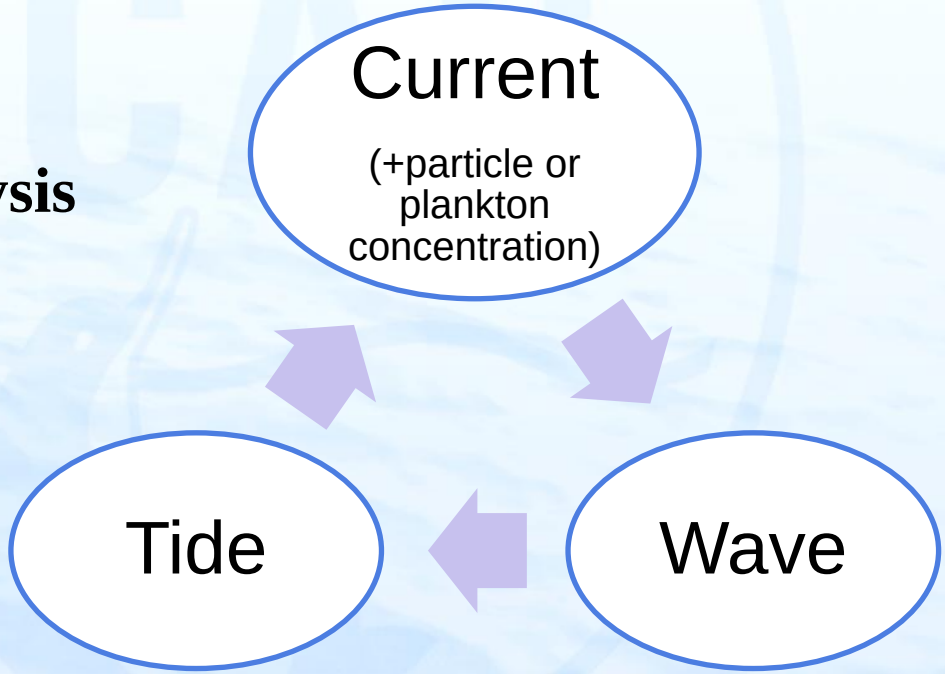
1.2 Chinese domestic ADCPs

- **Chinese Domestic ADCP has been applied in China's territorial waters, the global oceans, and the polar regions.**

- **Cooperative Research with Marine research units:**
  - The National Center of Ocean Standards and Metrology
  - The National Marine Technology Center
  - Xiamen University, Ocean University of China,
  - South China Sea Institute of the Chinese Academy of Sciences
  - Institute of Oceanology of the Chinese Academy of Sciences
  - etc.
- **From Marine ADCPs to Riverine ADCPs**
- **Multiple operating frequencies**
- **broad scale of profiling range & resolution**

2. offshore and shallow sea cases

- **2.1 Current & Tide**
- **2.2 Harmonic analysis**
- **2.3 Wave**



2.1 Current & Tide

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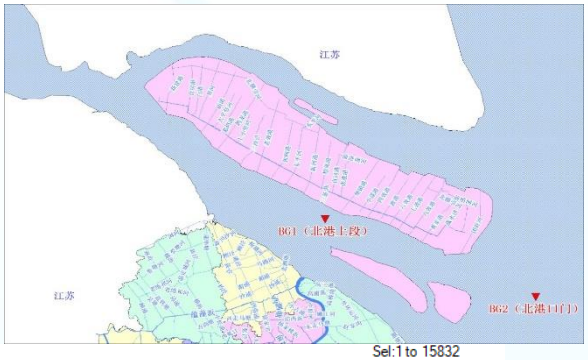
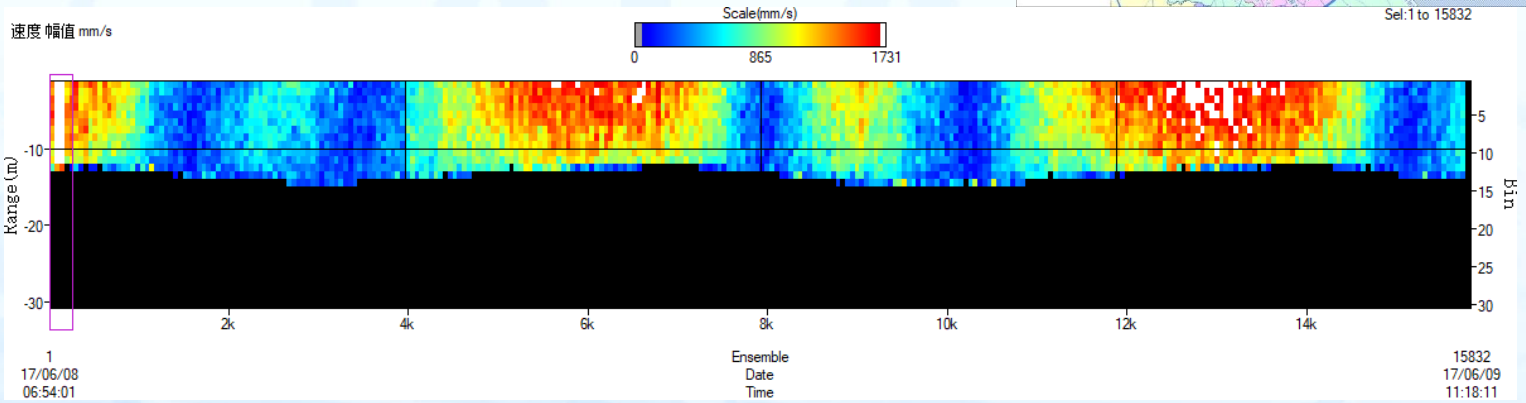
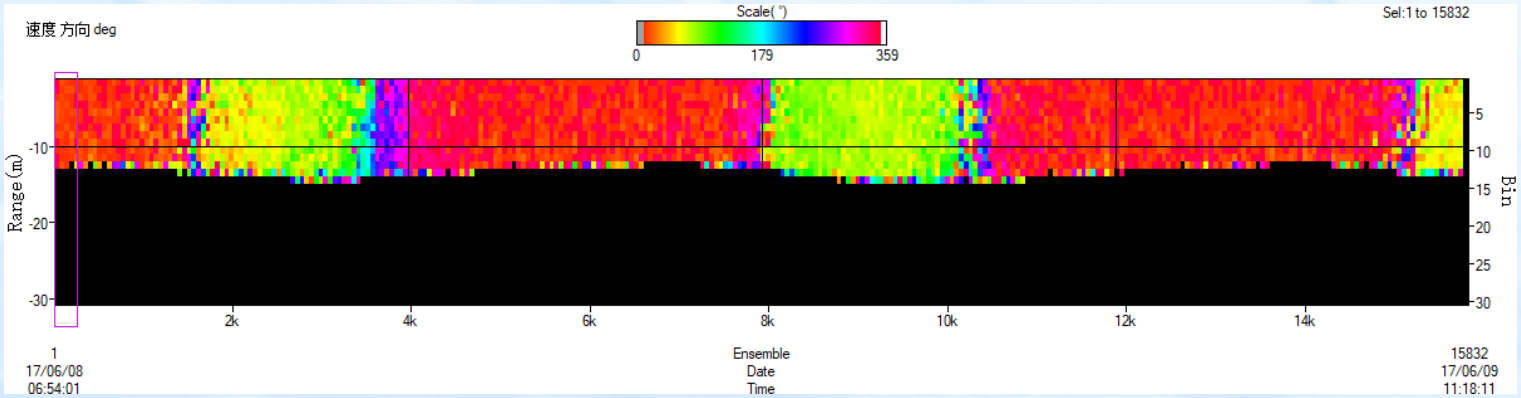
- Estuary tidal current observation
- Conventional mature solutions







2.3 Harmonic analysis of tide

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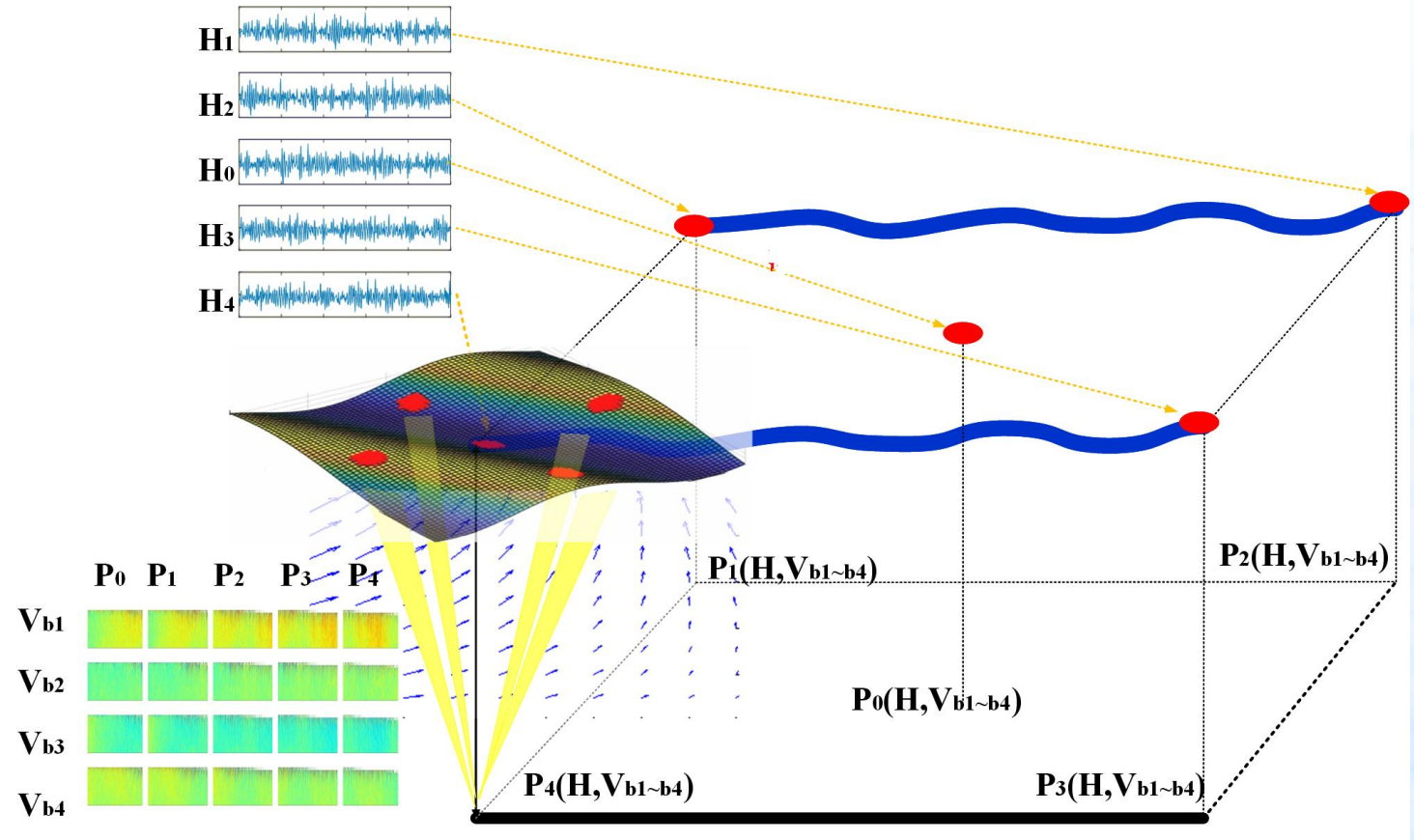
❑ Multiple ADCPs, Arrays Layout

- ❑ **2022.3 & 2022.7, with OUC, array pitch: ~1~10 km (No precise value)**
- ❑ **100 Bin*1 m , 1 Hz Continuous sampling**
- ❑ **Depth 80 m, ADCP@10 m from seabed, Upward Looking**



❑ The timer mode: starts working simultaneously

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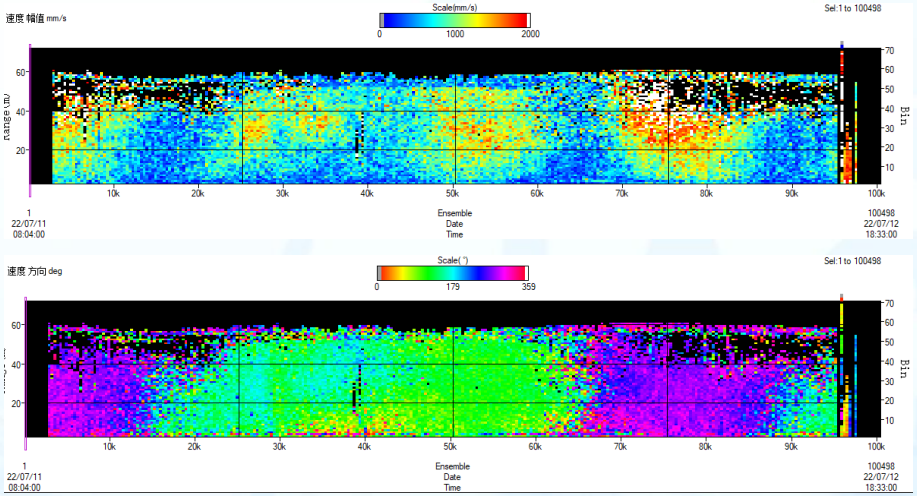
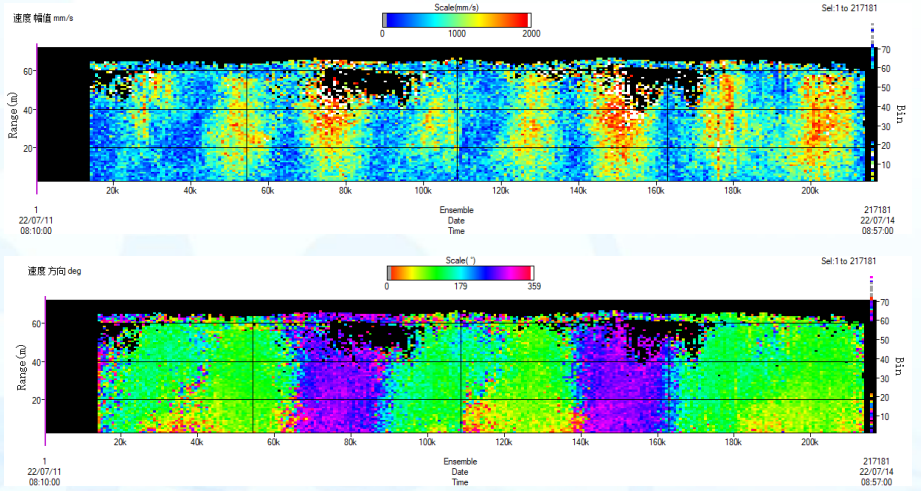
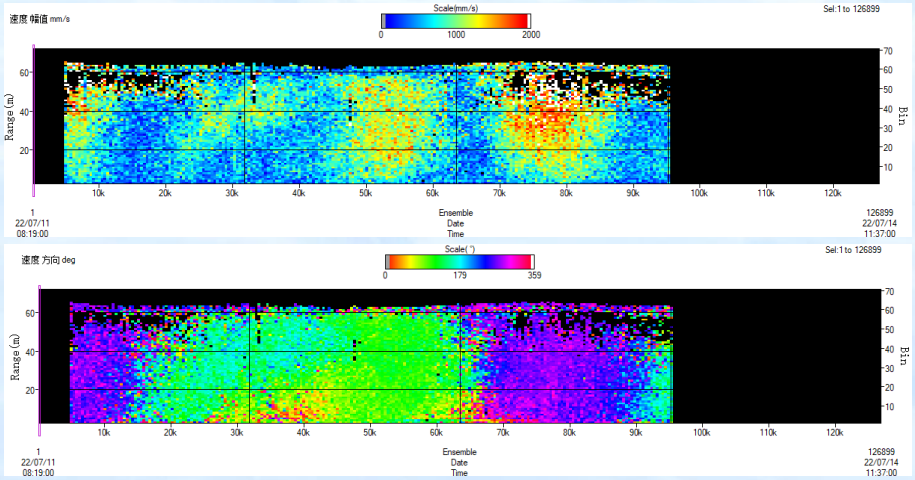


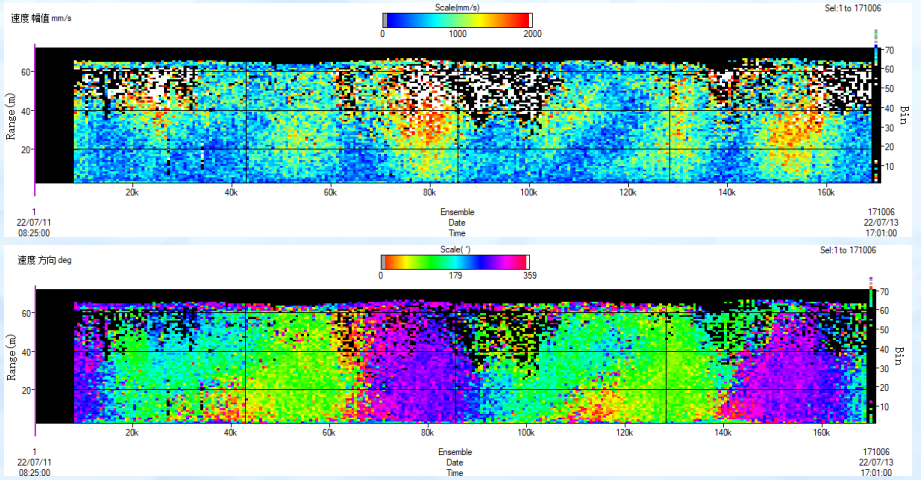
ADCP No. 1 (34h)



ADCP No. 2 (72h)



ADCP No. 3 (33h)



ADCP No. 4 (56h)

2.4 Wave observation

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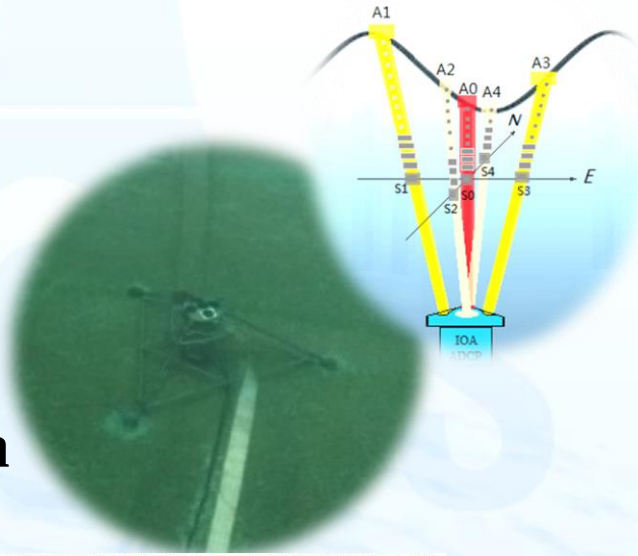
- **Surface Tracking Feature**

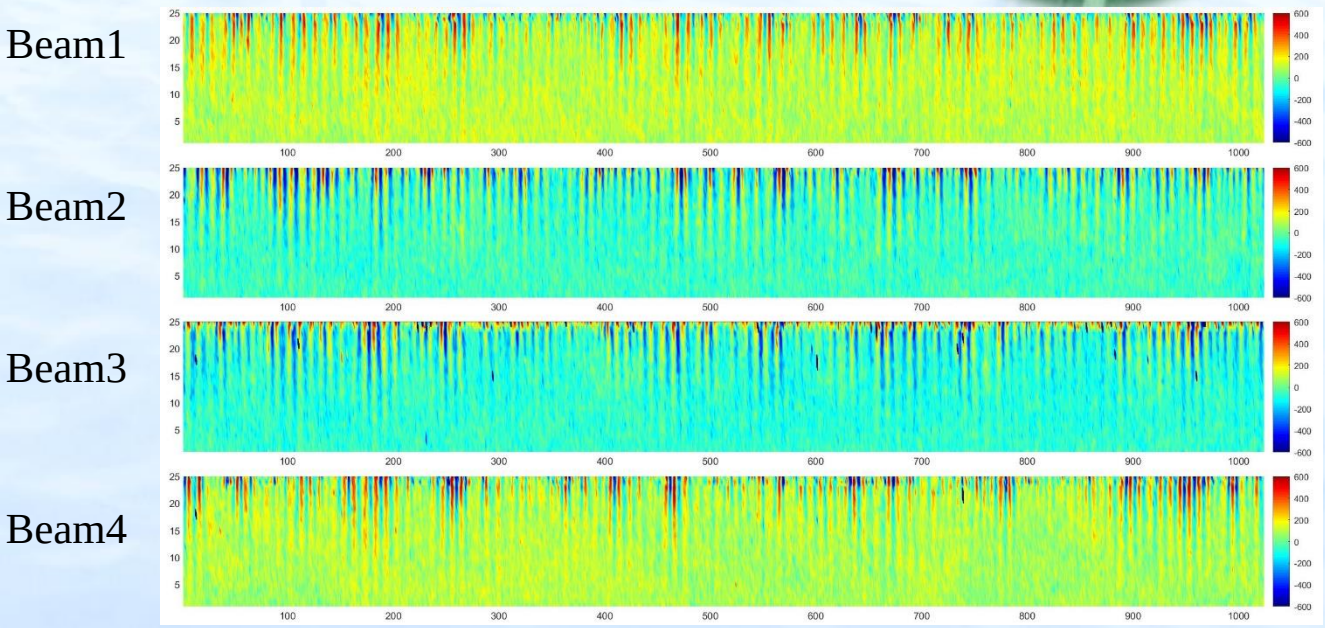
  （Acoustic ranging）

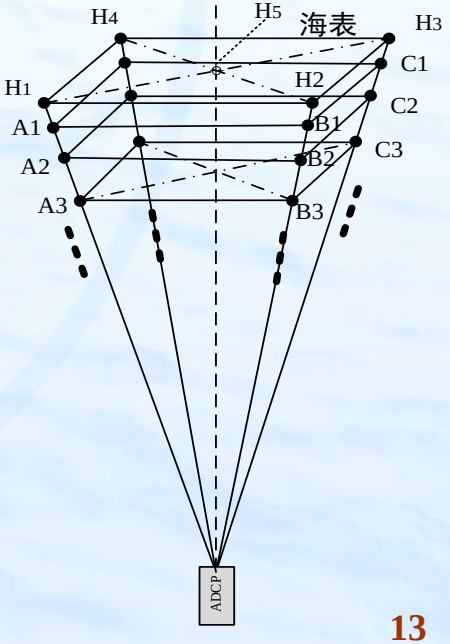
- **Waves induced currents fluctuation**

  （Doppler velocimeter）

- **2019-2021, @Weihai, China**



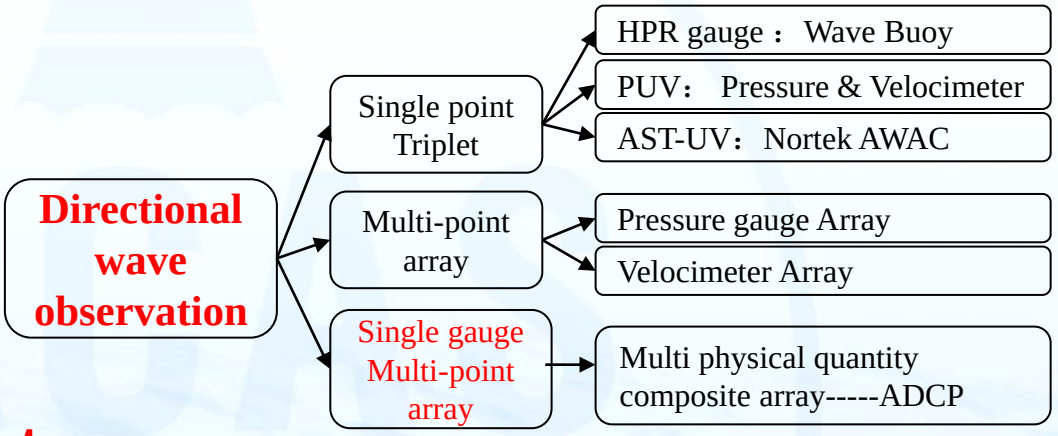




❑ Advantages, Disadvantages and Dilemma

❑ Advantages

- ❖ Remote sensing
- ❖ Virtual array
- ❖ Multiphysical quantity
- ❖ Waves and Currents



Classification diagram of wave direction measurement approach

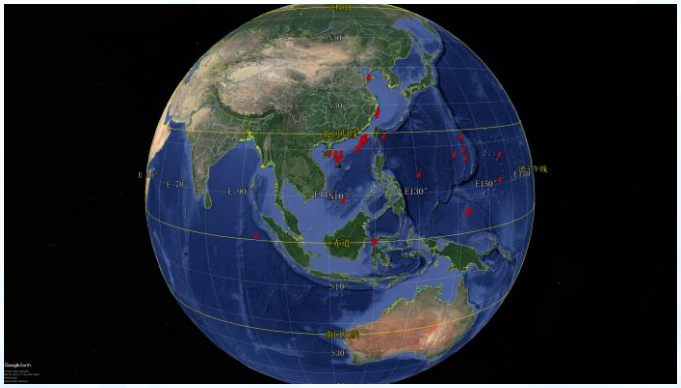
❑ Disadvantages

- ❖ Self state
- ❖ Sampling length and rate

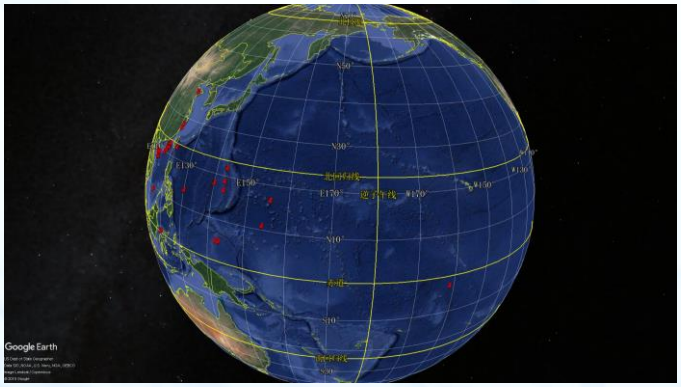
❑ Dilemma

- ❖ Short-time characteristic of Sea level state
- ❖ Sampling scheme and target matching---coherence

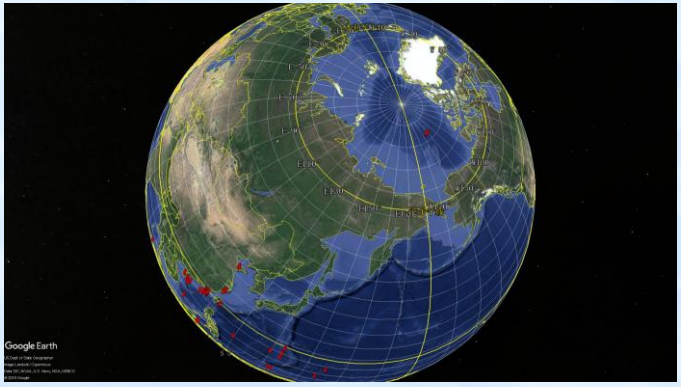
3. Deep ocean & polar region application



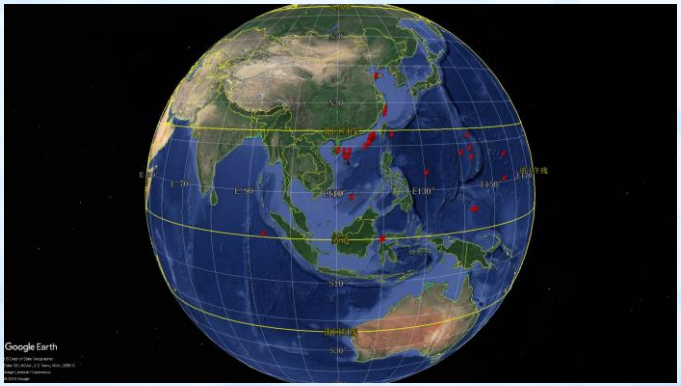
3.1 Deep water application
@ South China Sea



3.2 Deep water application
@ Western Pacific



3.3 Subglacial survey
@ Arctic Ocean



3.4 Uniform & multi-annual observation
@ Eastern Indian Ocean

3.1 Deep water application

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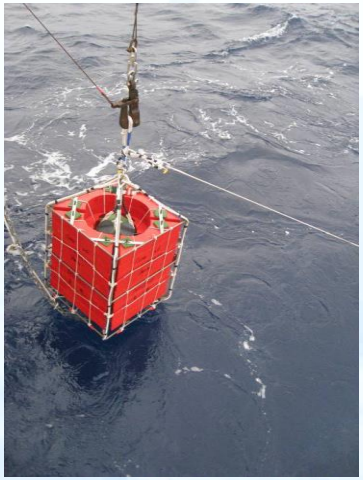
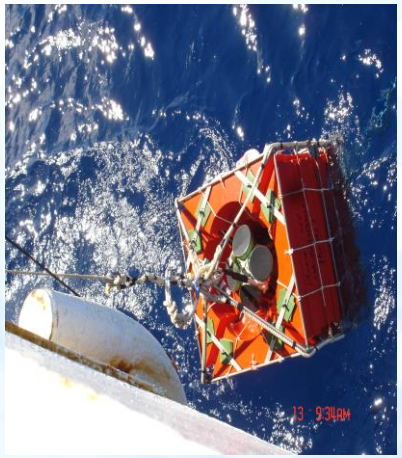
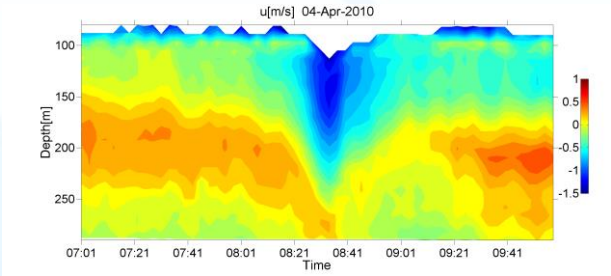
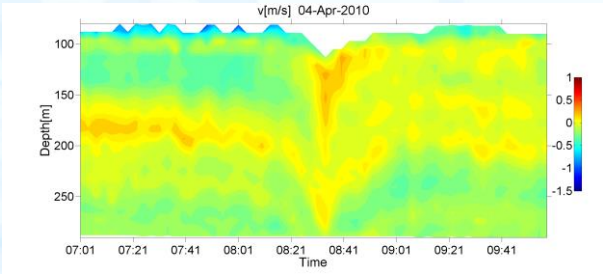
❑ Reliability verification test on submarine buoy





self contained ADCP on submersible buoys





An example of internal solitary wave

- over 5 months, 1000 m depth, ADCP at 250 m below sea surface
- observed several internal wave processes
- ADCP transducers, structure and hardware have verified at actual deep-sea environment

3.1 Deep water application

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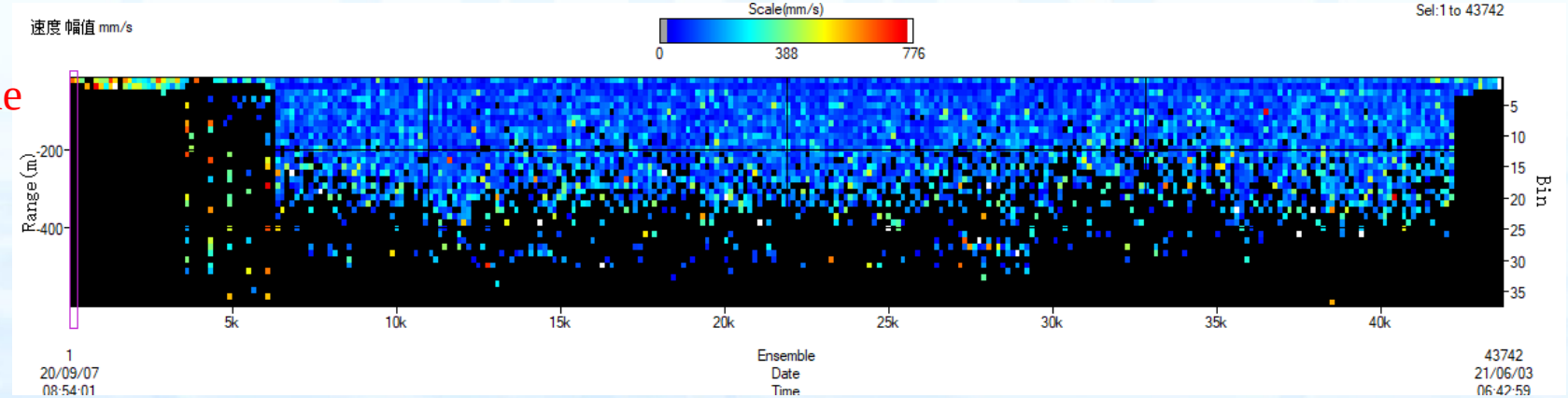
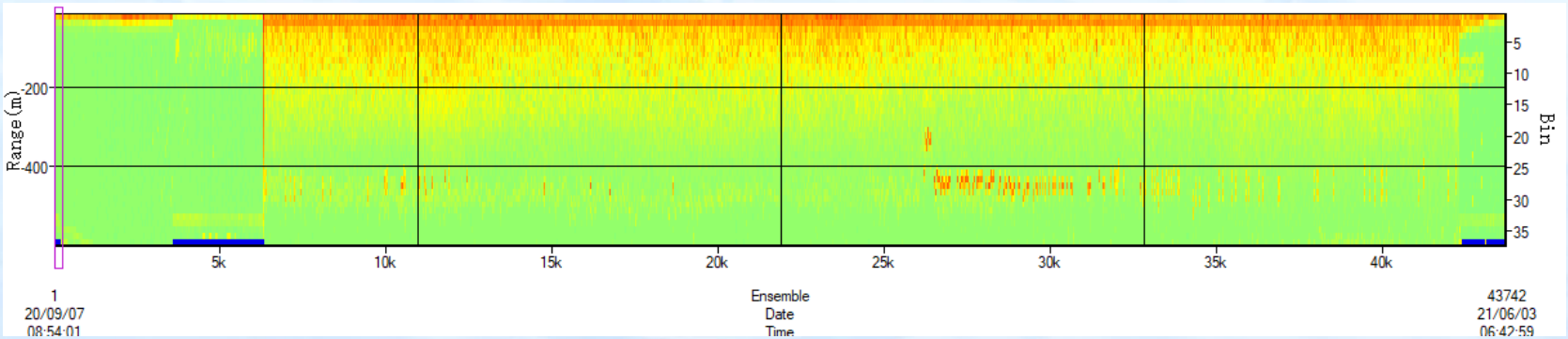
- **Long-term deployment of self contained ADCP on submersible buoys**

@ 1540m
Downward looking

Velocity amplitude



Echo intensity



3.2 Submarine Anchor Chain

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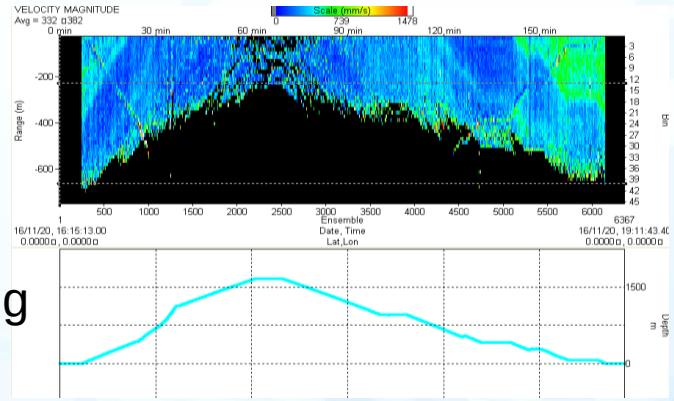
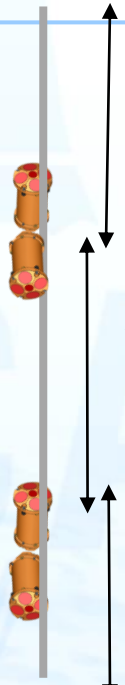
L-ADCP test

profiling Range change

Lowering depth





ADCP Chain, refer to Current Meter Chain, resemble candied haws on sticks

4-ADCPs Chain

- 2020, Two pairs of 75 kHz ADCPs
- The maximum flow measurement profiles of 4-ADCPs are 616m, 600m, 600m, and 400m, respectively from shallow to deep
- **Weak acoustic scattering in deep water**
- Narrowband increases by 96m compared to broadband (560m to 656m)
- Scientists scientist focus on near bed region

3.3 Subglacial Survey @ Arctic Ocean

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- In 2014, during the Sixth Arctic Expedition ,
- 300 kHz domestic SC-ADCP, for Subglacial Survey
- On large floating or fixed ice in the Arctic Ocean
- The reliability of instrument

  the continuity of battery supply @ 0~4 ℃ seawater temperature

  Heading error @ polar magnetic field & magnetic interference

Drill hole

Power on

Mounting ADCP

Put into subglacial water

Subglacial currents and echo intensity

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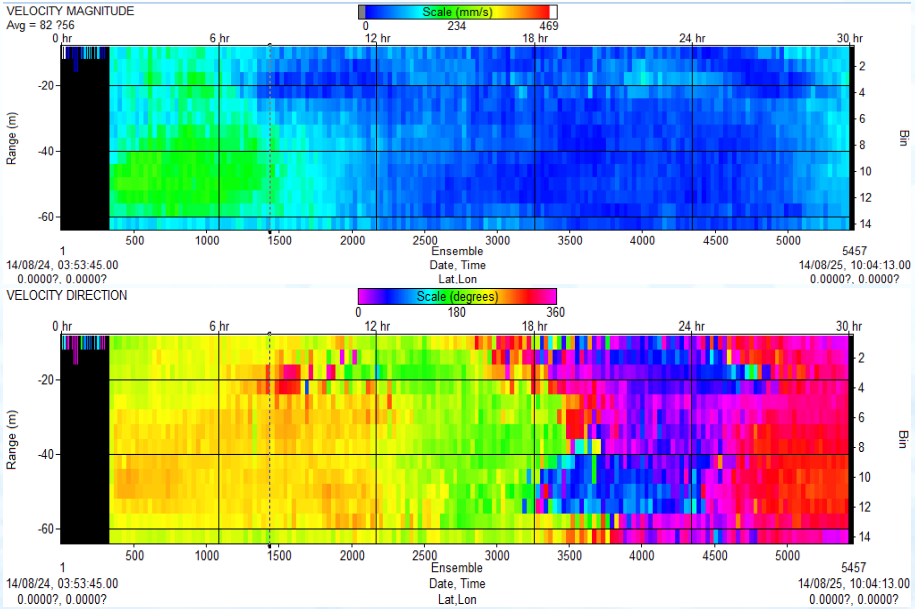
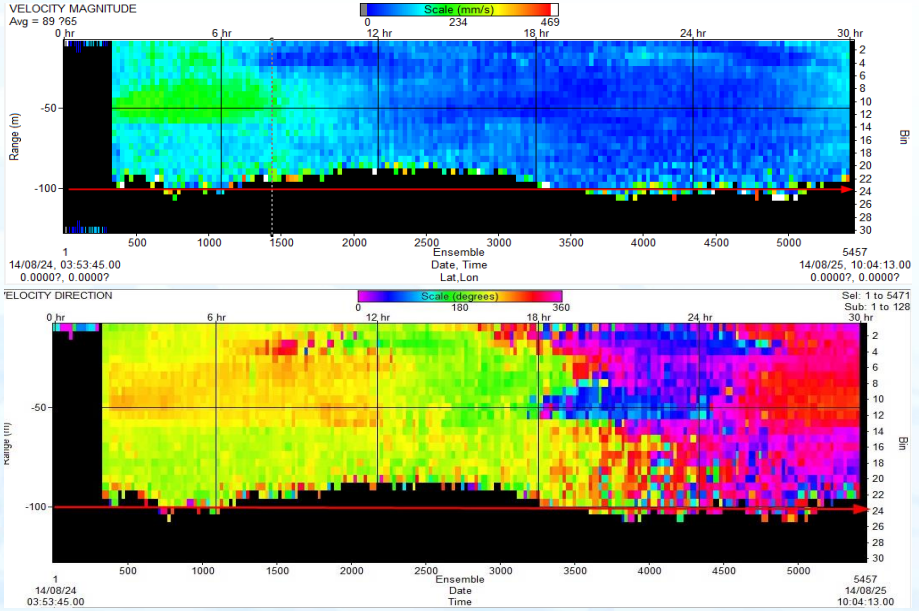
Subglacial downward,1 Hz, 30 bins * 4 m, first bin 8 m



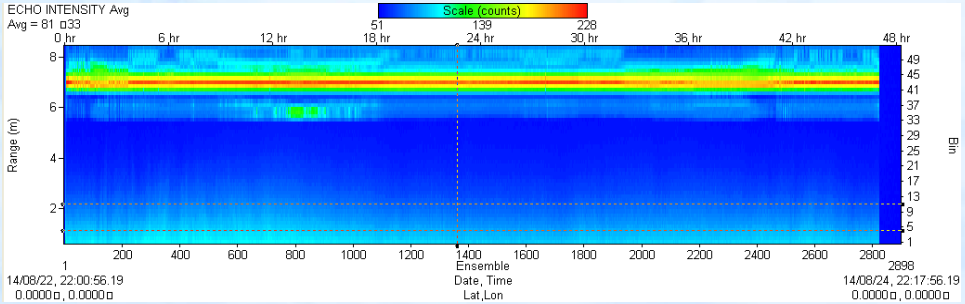


2014 – 08 - 24~25, (1) Stable Bins

(2) Maximum effective Bins

Echo intensity profile:

Research on ice echo characteristics, ADCP signal TVC compensation strategy



3.4 Uniform & multi-annual observation

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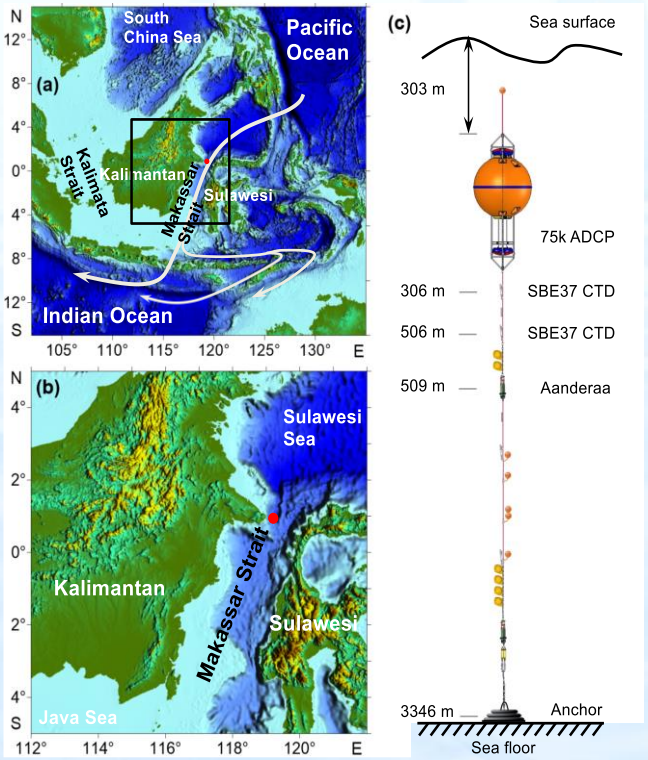
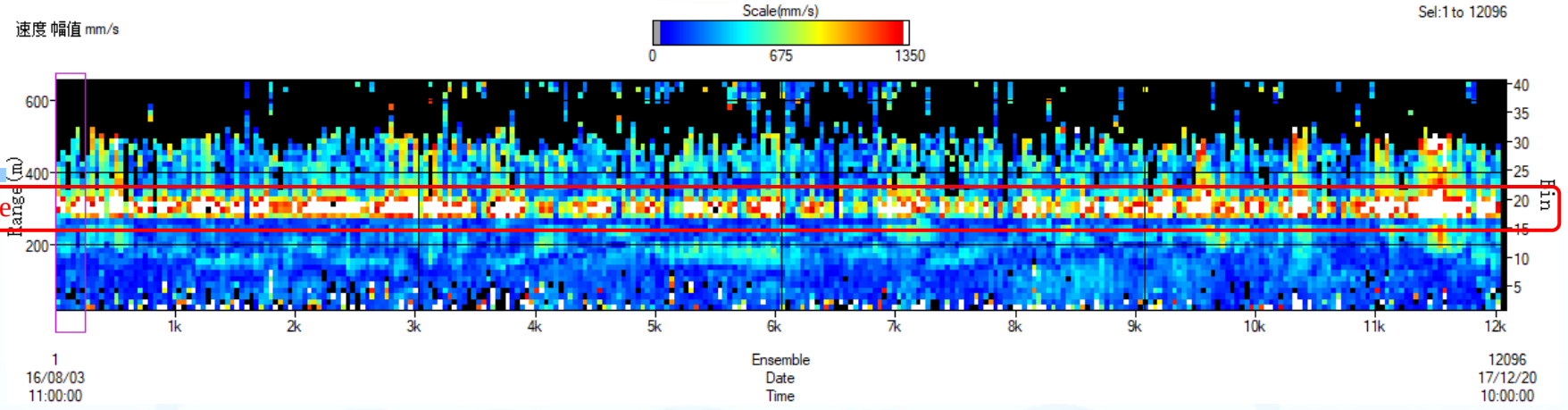
- 2016-2018, East Indian Ocean, by Submarine anchor chain
- ‘Transport, Internal Waves and Mixing in the Indonesian Throughflow regions (TIMIT) and Impacts on Marine Ecosystem’ project



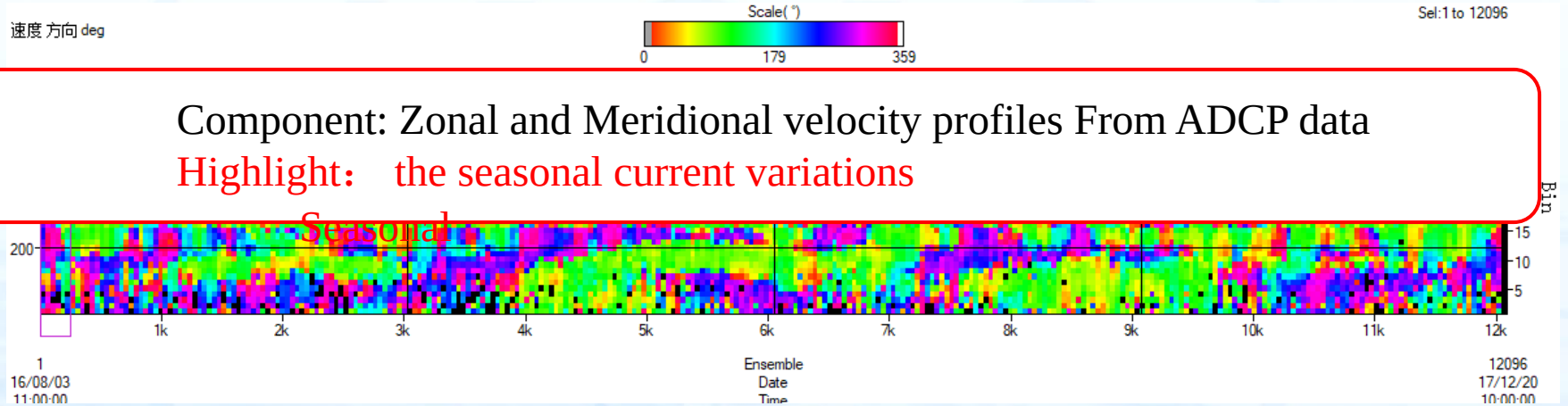
Location and application frame

Highlight the seasonal variations

Amp



Surface



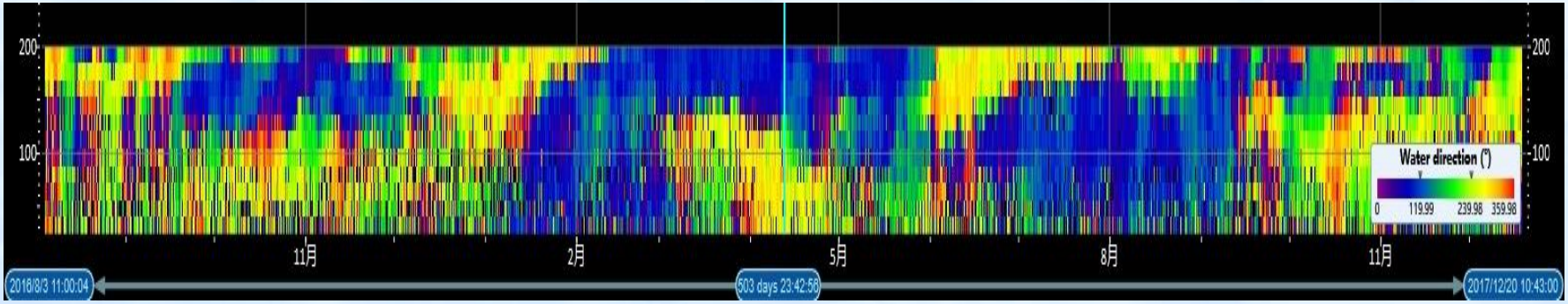
Dir

Component: Zonal and Meridional velocity profiles From ADCP data

Highlight： the seasonal current variations

Seasonal

Seasonal



4. Contact Us

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- **1. ADCP's offshore and shallow sea observation**
- High sampling rate continuous observation of tidal, current and wave, aim at offshore hydrological observation, disaster prevention and mitigation, and ocean engineering information services.
- **2. ADCP in the deep ocean & polar application**
- The observation results of the underwater application of the submerged buoy platform ADCP at over 1000 m.

Core Conclusion

(1) ADCPs network observation : Array or Chain

(2) Under unconventional conditions: Adaptive mode

谢谢

Thanks!