

# **Tropical Indian Ocean Observing System**

## **- Present Status and Highlights of 2006 IOD -**

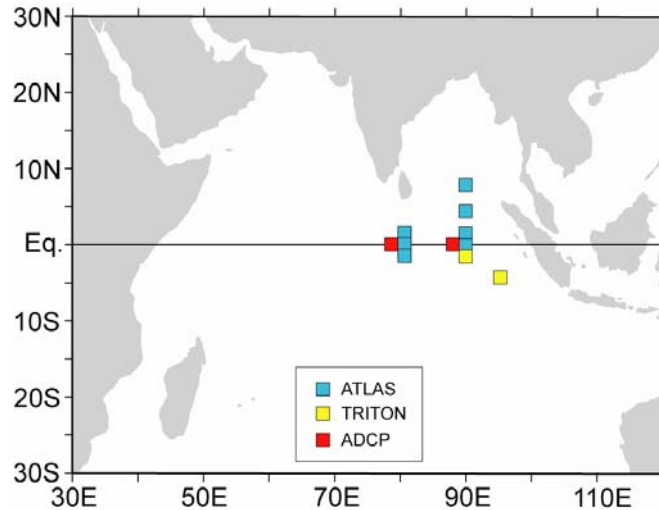
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Yosifumi Kuroda, Kunio Yoneyama, Keisuke Mizuno**

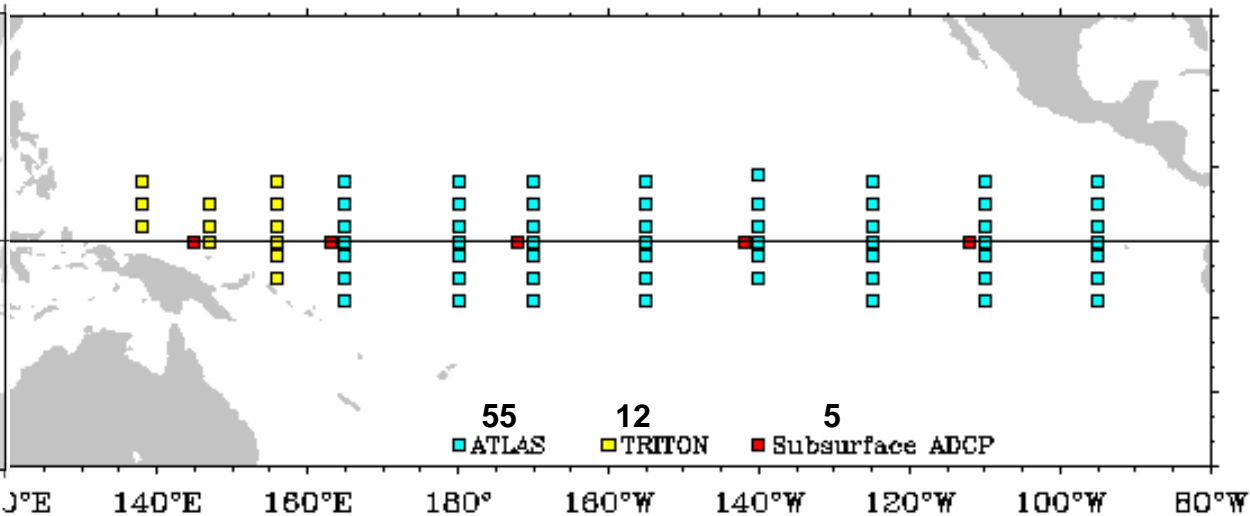
**Institute of Observational Research for Global Change,  
Japan Agency for Marine-Earth Science and Technology**

# Tropical Mooring Array

## IndOOS Array



## TAO/TRITON Array



- ✓ Limited coverage in the Indian Ocean (9 surface buoys, 2 subsurface ADCPs)
- ✓ Initial stage for implementing the array
- ✓ The array obtained the interesting data on 2006 IOD

- ✓ Pacific Ocean is well observed (67 surface buoys, 5 subsurface ADCPs)
- ✓ Subsurface T, S data are essential for high predictability of ENSO

# Outline

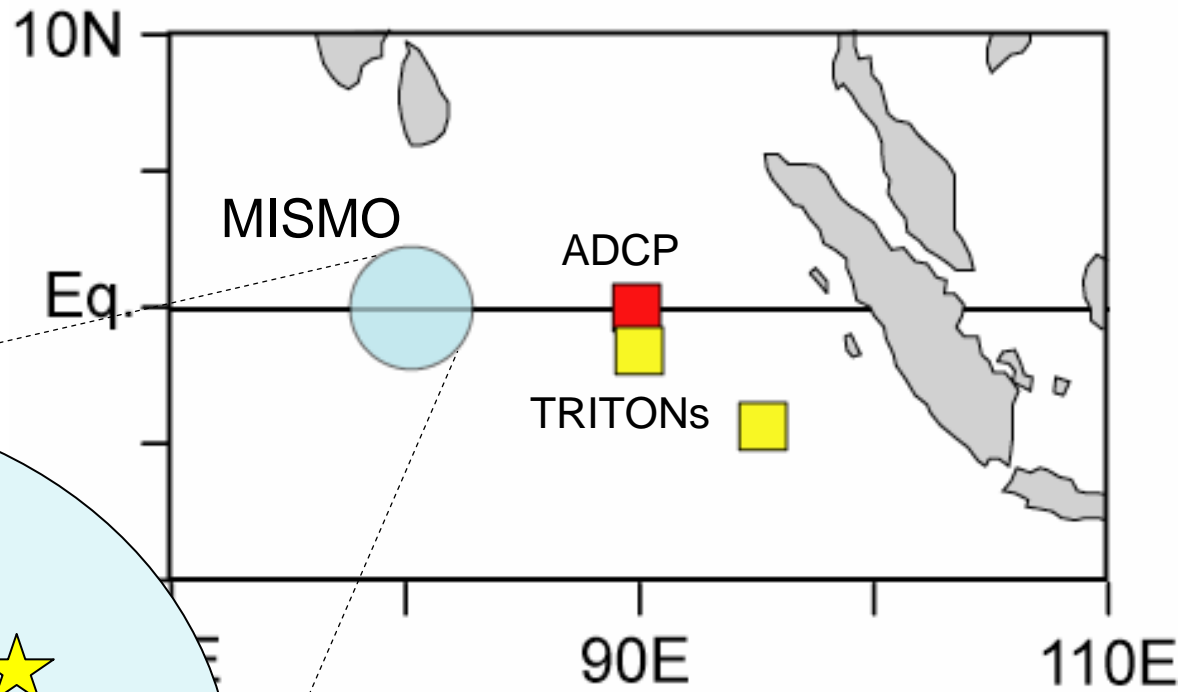
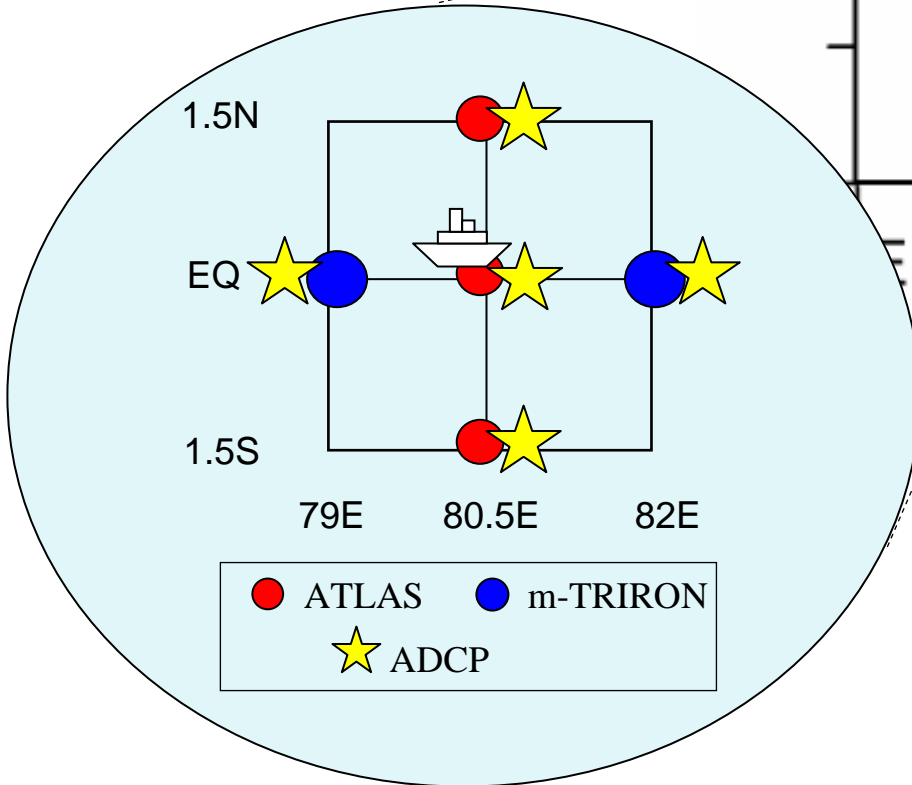
- **Present status of the Indian Ocean Observing System**
  - **Surface and subsurface mooring array**
  - **JAMSTEC observations**
- **Highlights of 2006 IOD event**
  - **Eastern moorings, long-term observations**  
(90E TRITON/ADCP, 95E TRITON etc.)
  - **MISMO-Ocean intensive observations**  
(~80E m-TRITON and ADCP array)
- **Summary**

# JAMSTEC Observations in IO

MISMO [ Oct.-Dec., 2006 ]

(Mirai Indian ocean cruise for the Study of the MJO convection Onset)

✓ Observation network to investigate upper-ocean responses to the intraseasonal disturbances

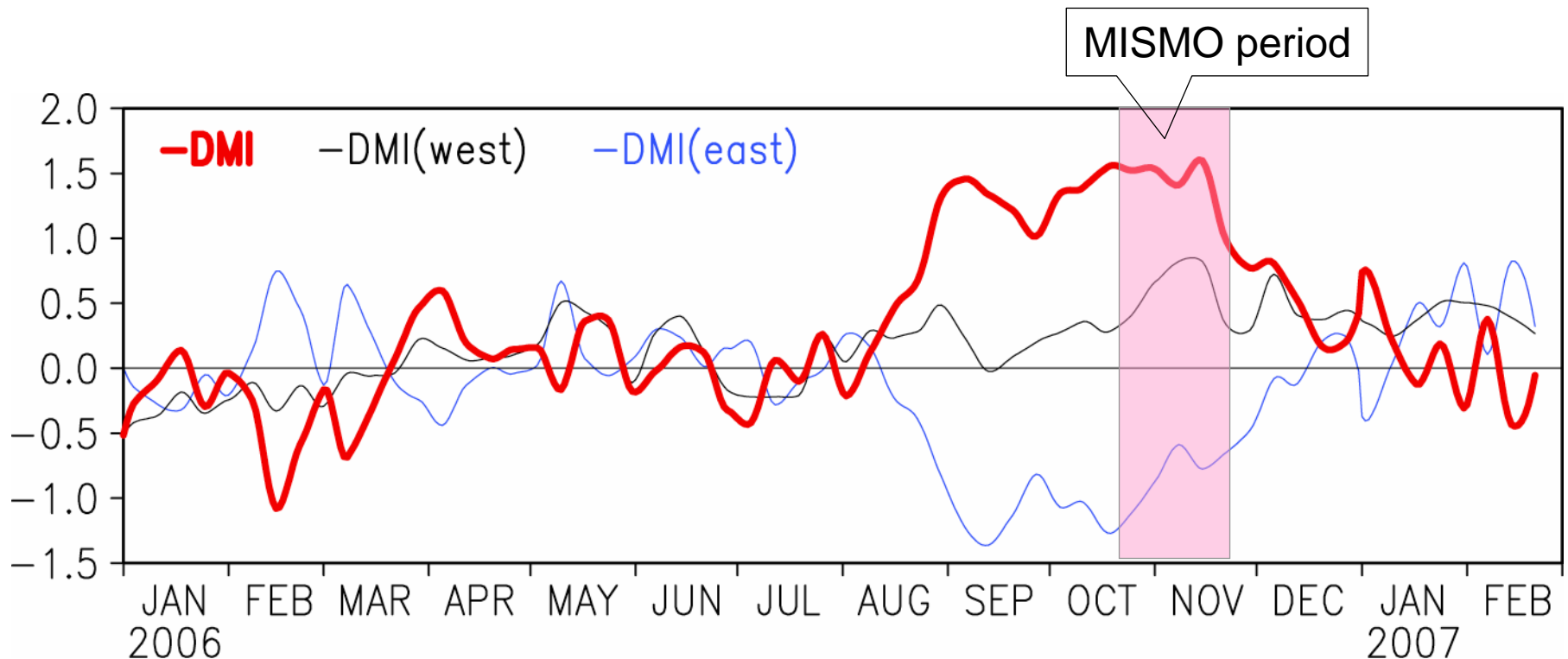


- Long-term observations

- ADCP  
(Eq., 90E) since Nov. 2000

- TRITON  
(1.5S, 90E) (5S, 95E)  
since Oct. 2001

# Dipole Mode Index (DMI)

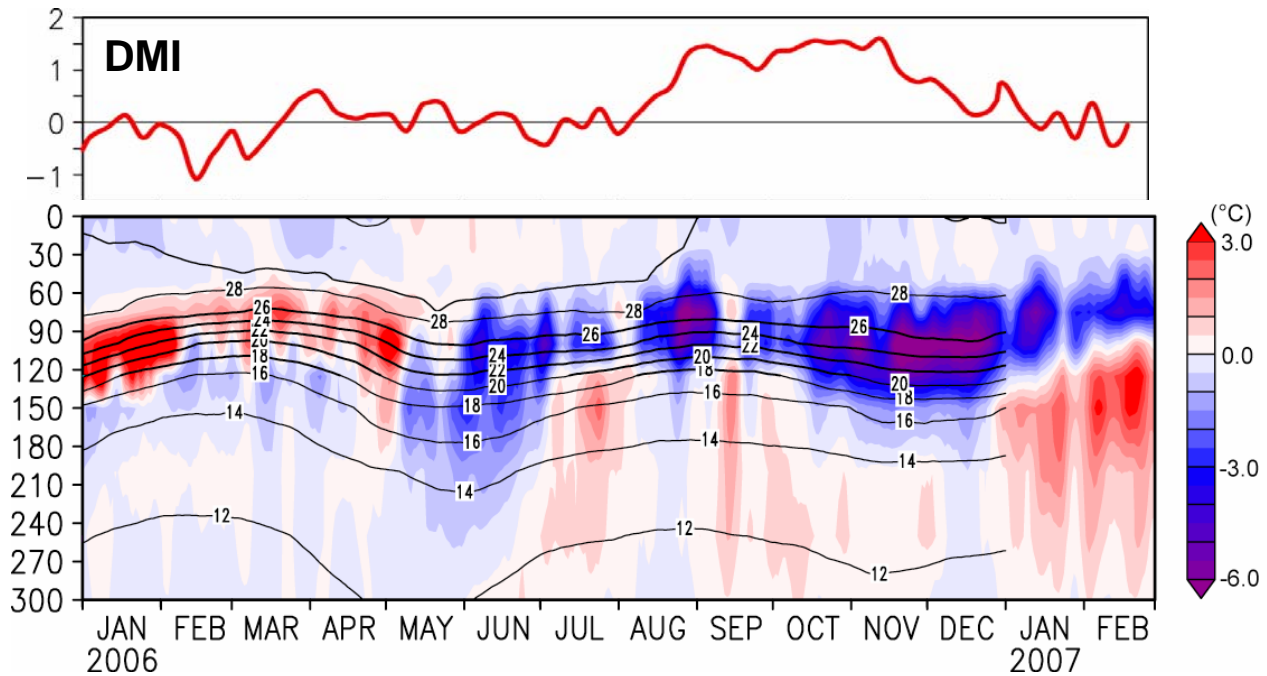


- **SST dipole structure started to develop in Aug. 2006**
- **MISMO observations were during the mature phase and the beginning of the decay phase of the IOD**

- **TRITON (1.5S, 90E)**

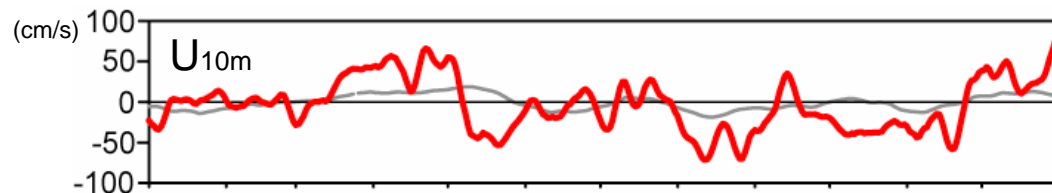
**T<sub>mean</sub> and T<sub>anom</sub>**

- ✓ Subsurface negative anomaly starts in May. Three months before DMI increase.



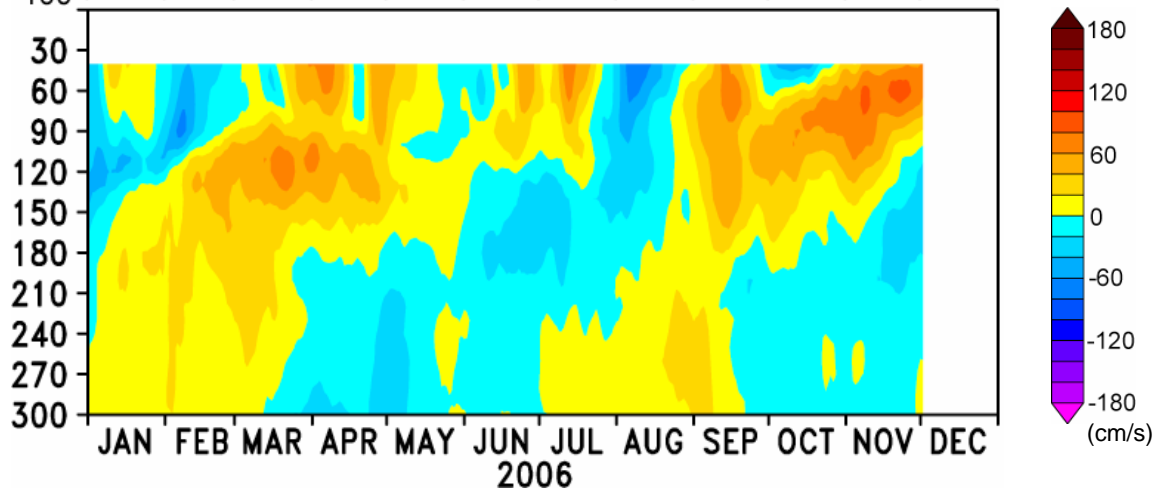
- **TRITON (1.5S, 90E)**

**U at 10m depth**



- **ADCP (Eq., 90E) U**

- ✓ Significant weakening of eastward subsurface current in association with the subsurface negative T anomaly in May.
- ✓ Strong baroclinicity during the last half of IOD.

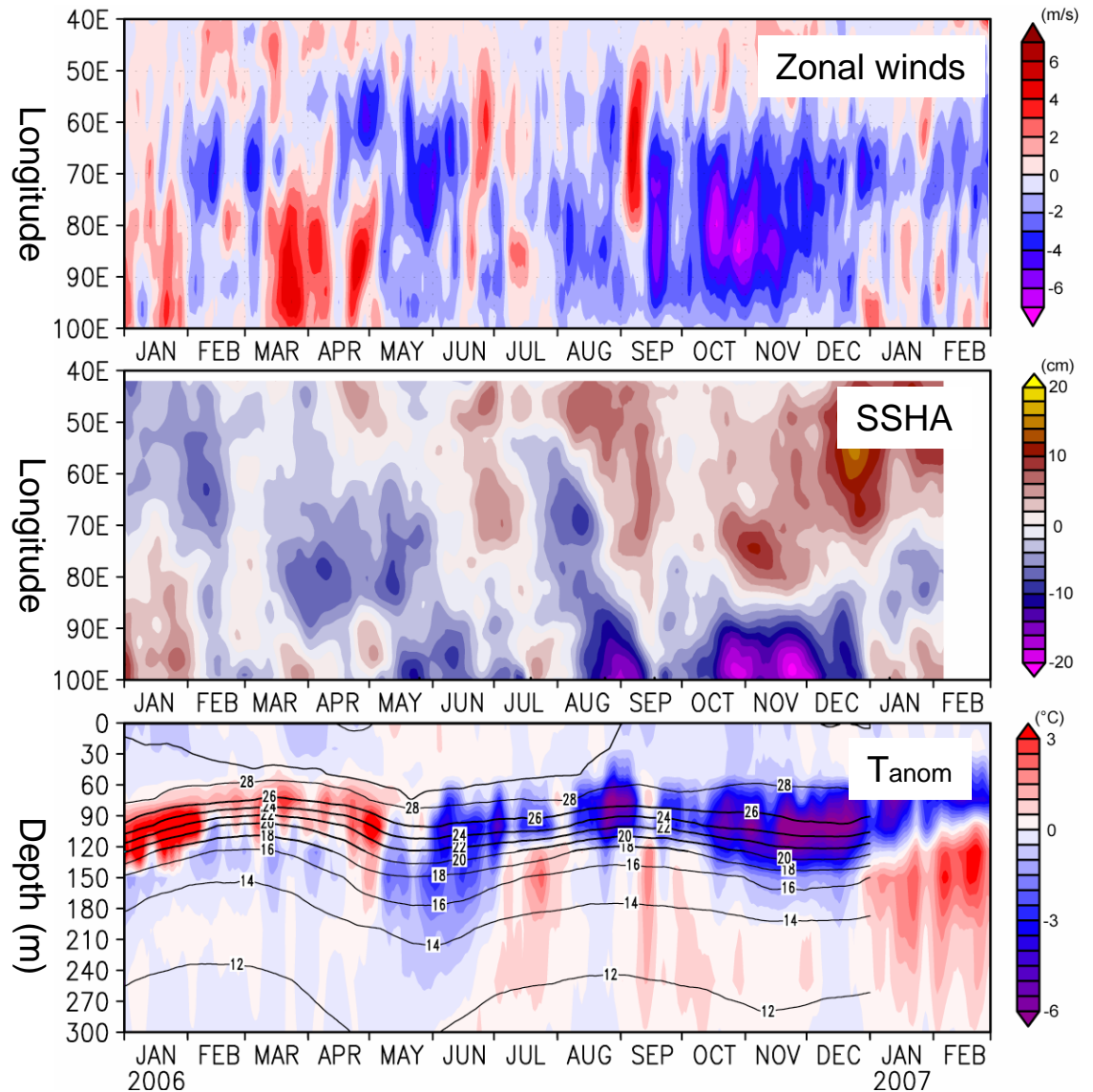


# Zonal winds - SSHA - Temp. Relations

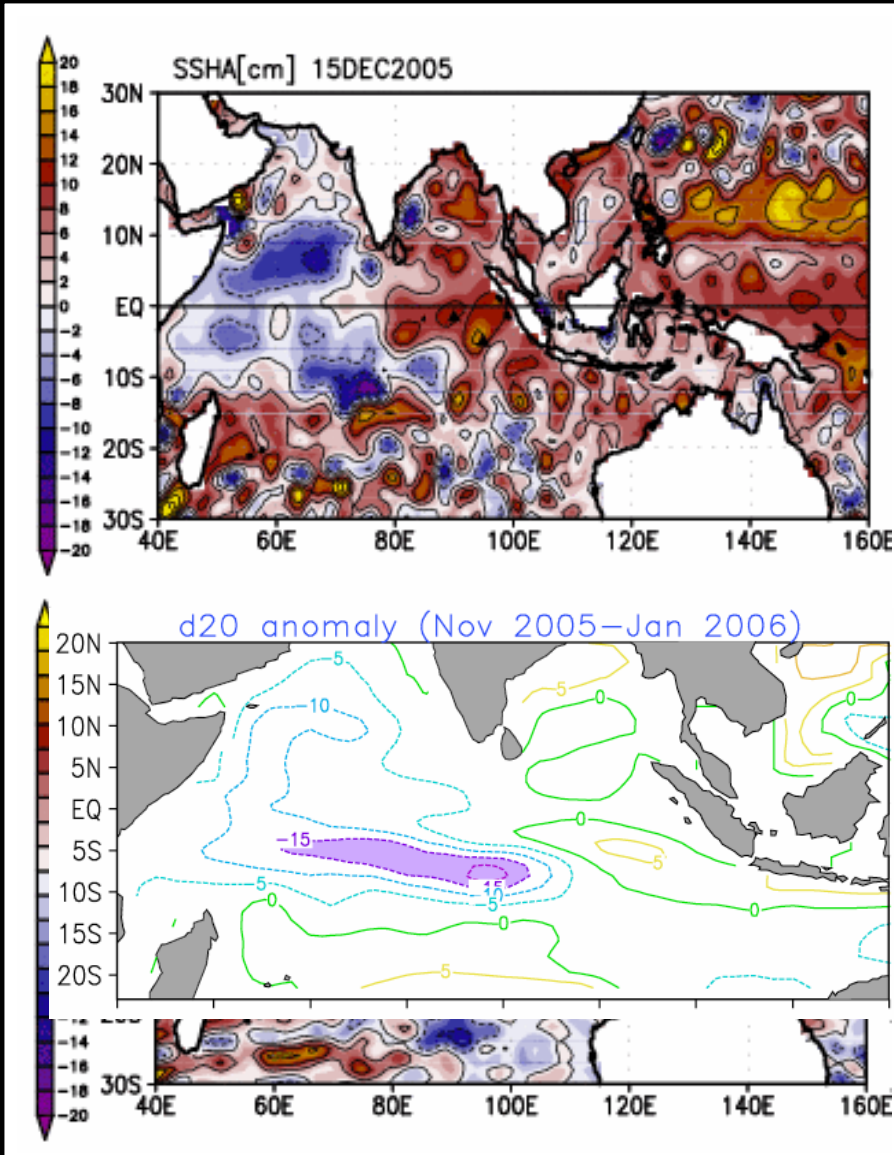
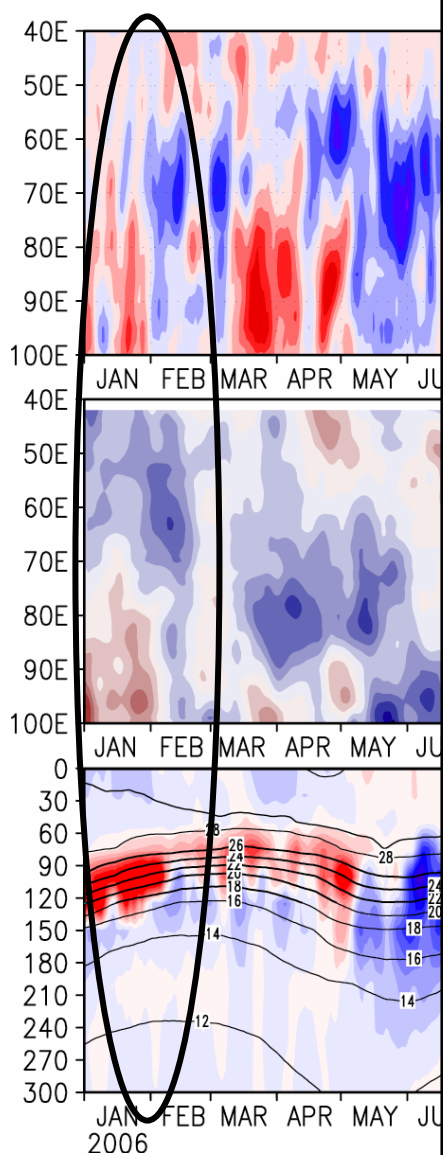
✓ No strong easterly anomaly in the western region in Jan/Feb.

✓ Direct wind forcing in May and Aug.

✓ Cold Kelvin wave propagation in Feb., May, and Aug.



# Subsurface pre-conditioning: 1st event



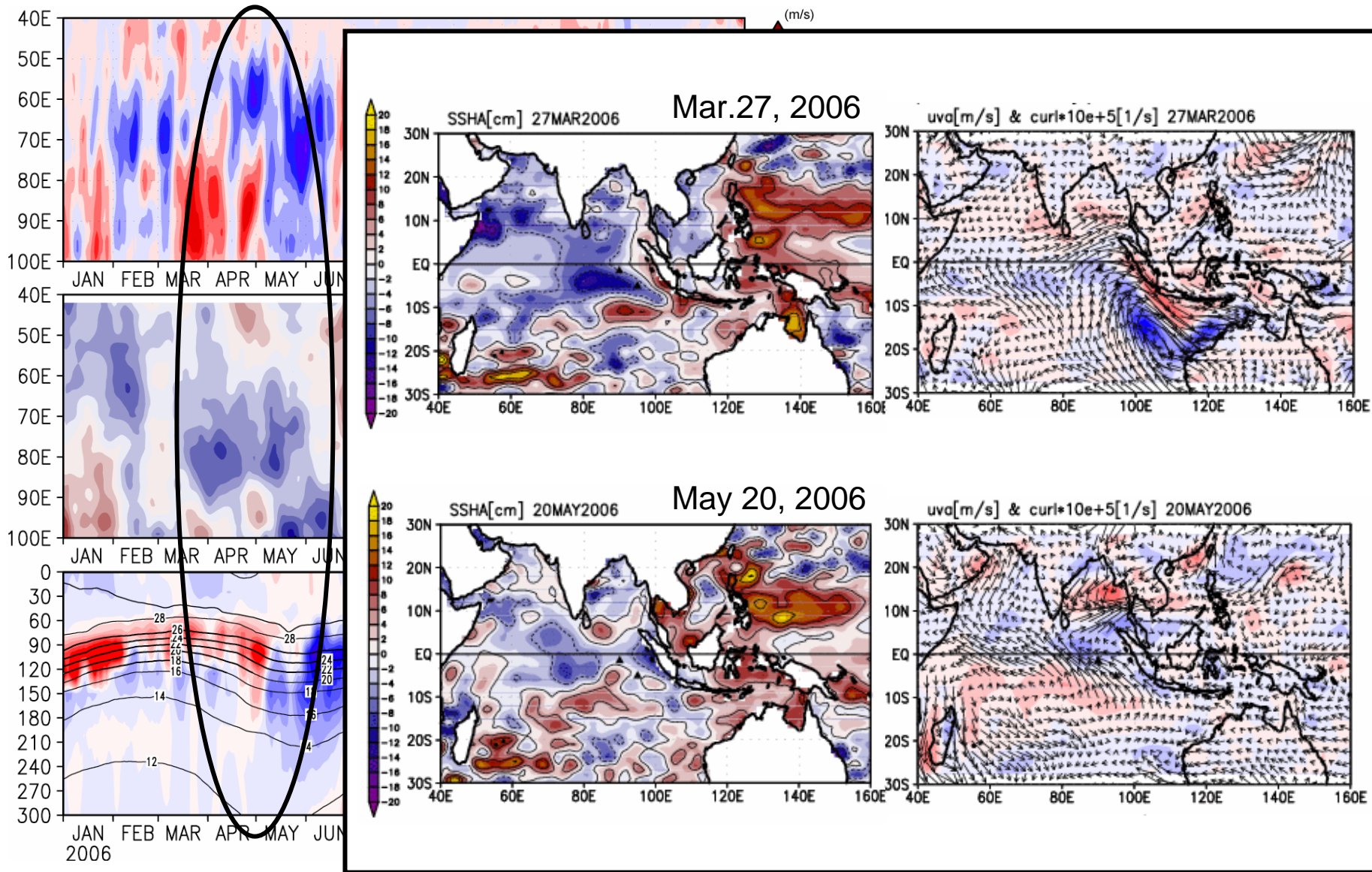
Dec.15, 2005

Cold Rossby waves  
in the western IO  
during the end of  
2005

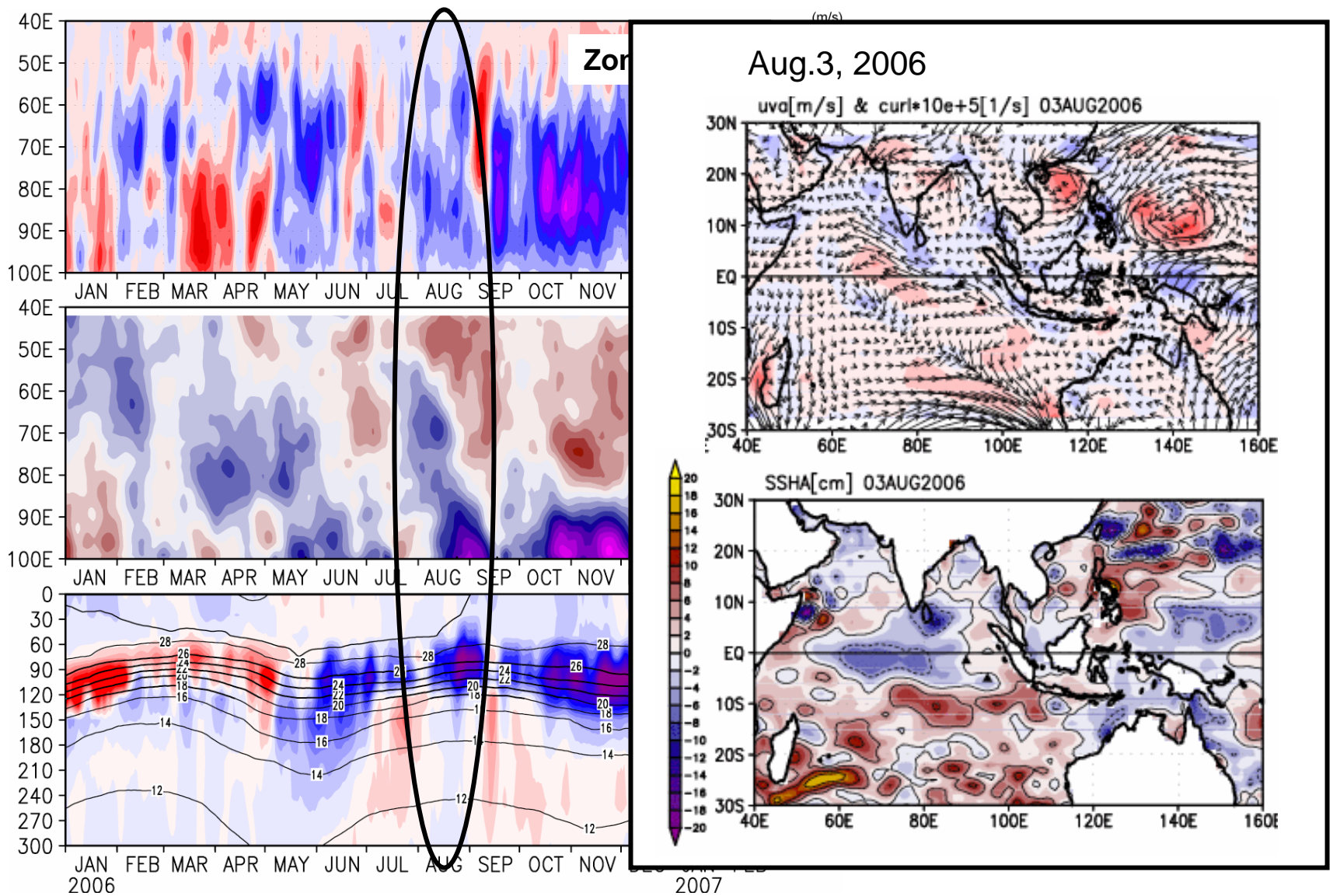
Feb.13, 2006  
Similar pattern in D20  
appeared as the IC of  
Western boundary  
reflection, and cold  
Kelvin wave event is  
predicted  
Feb 2006

(Luo et al., 2006)

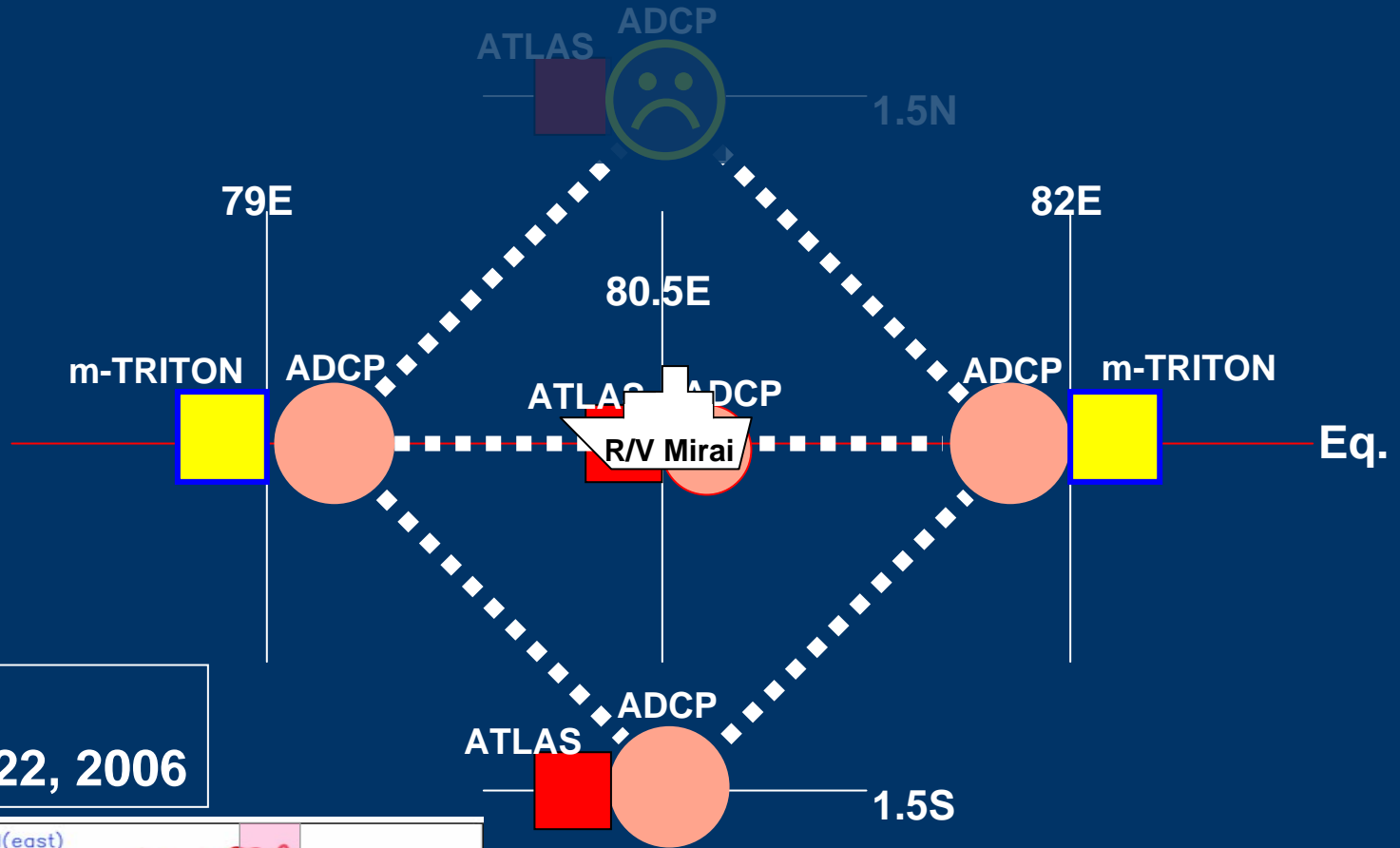
# Subsurface pre-conditioning: 2nd event



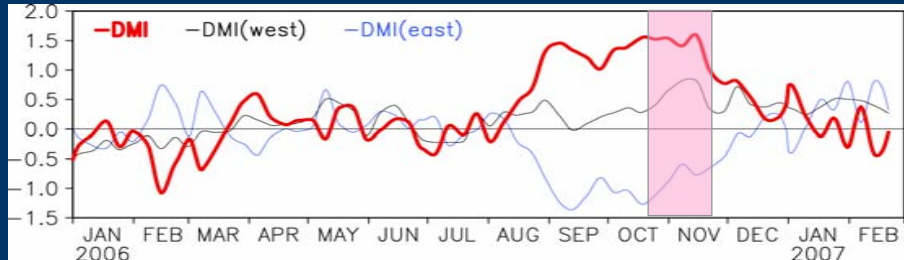
# Subsurface pre-conditioning: 3rd event



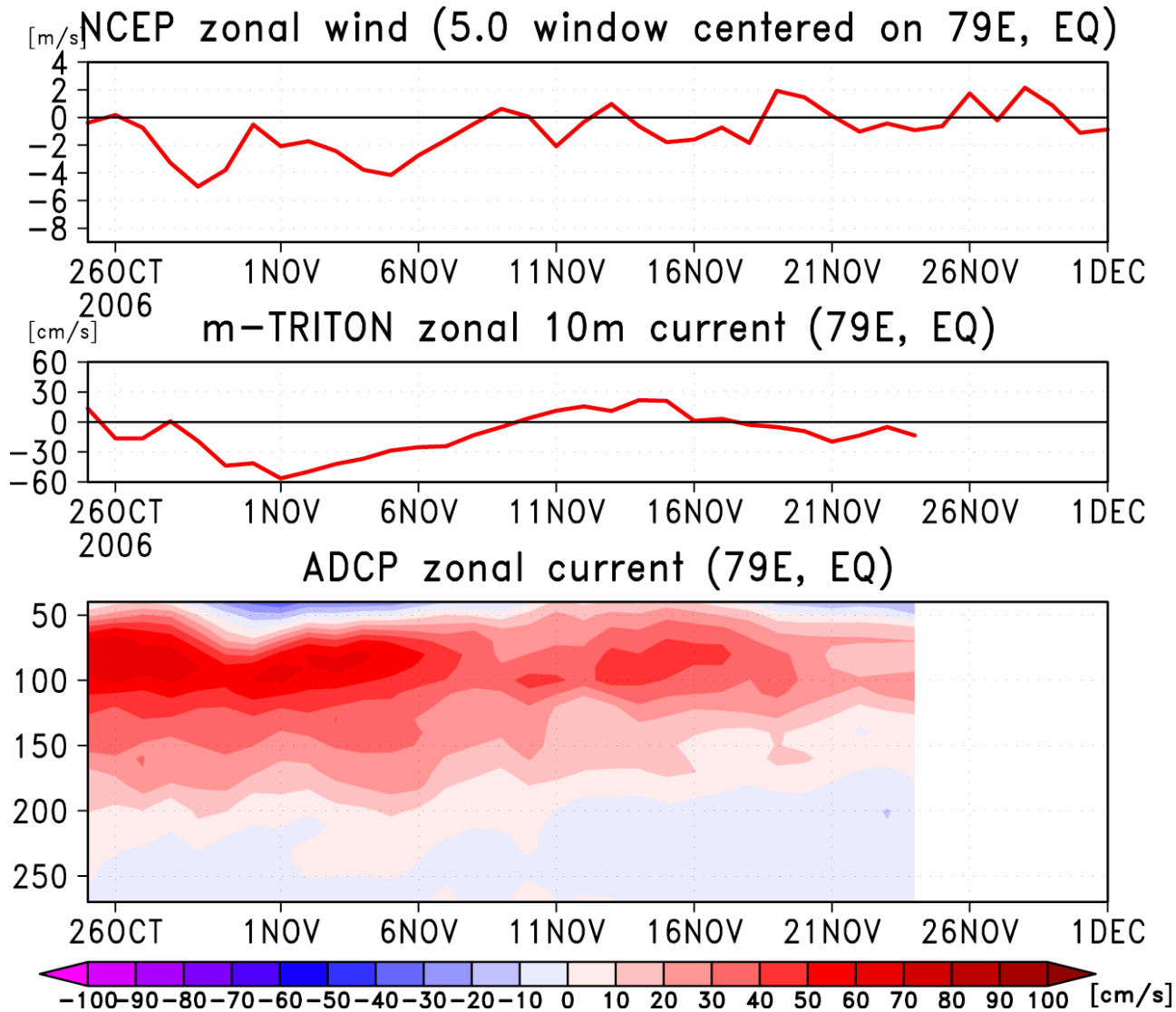
# MISMO-Ocean Network



**Core Period:  
Oct.27 - Nov.22, 2006**



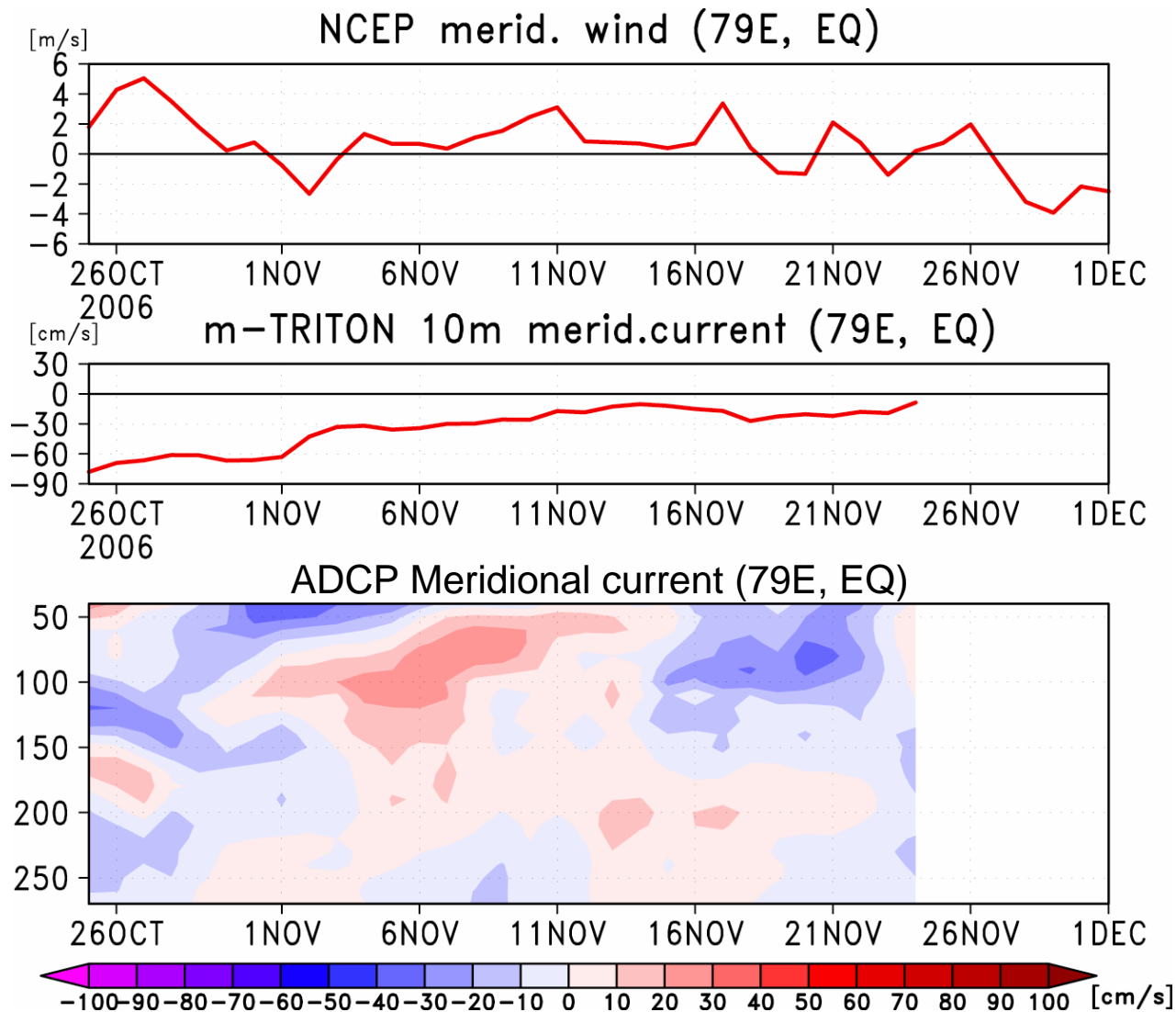
# MISMO: ADCP Zonal Current



✓ Subsurface eastward flow centered at 80m depth, with surface westward flow, during relatively strong easterly wind period.

✓ As the easterly wind weakens, the subsurface flow weakens as well.

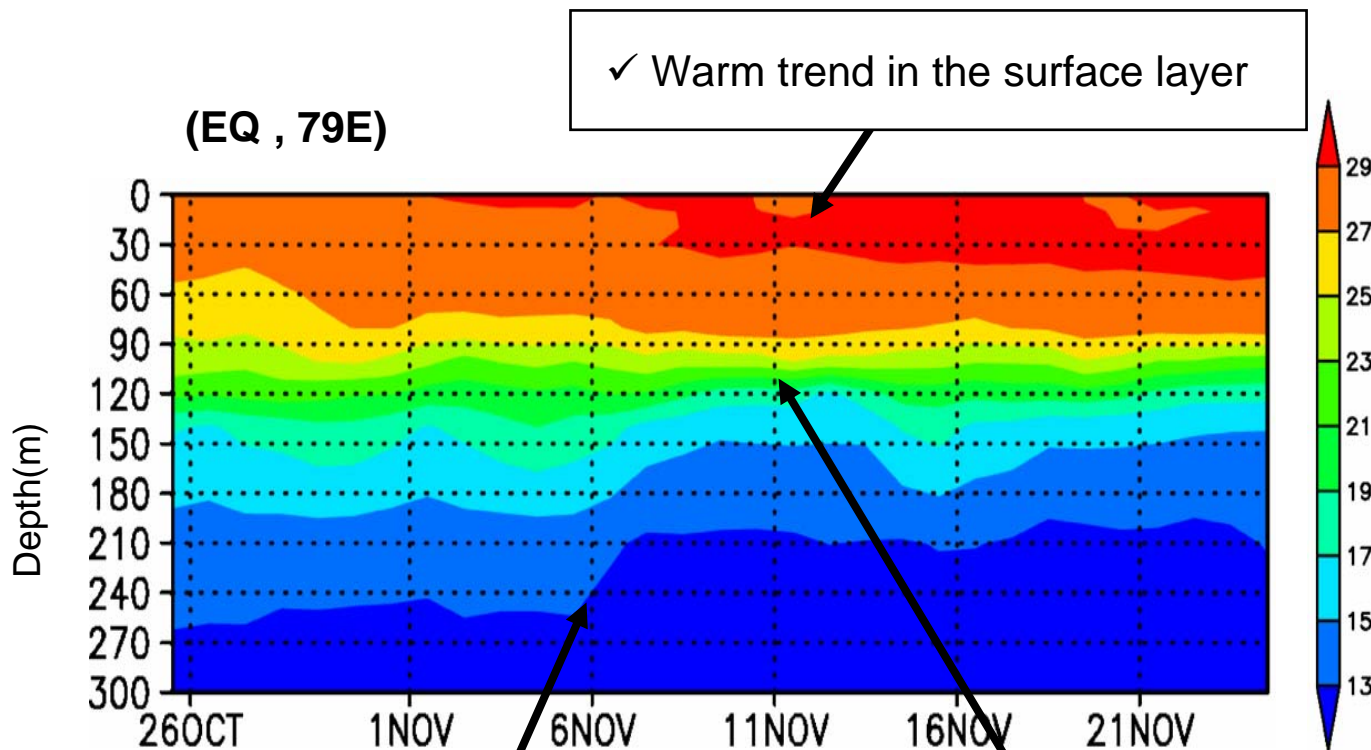
# MISMO: ADCP Meridional Current



✓ Strong biweekly variability is observed between 40m and 150m depth.

✓ Local meridional wind does not show the corresponding variability, suggesting the wave propagation.

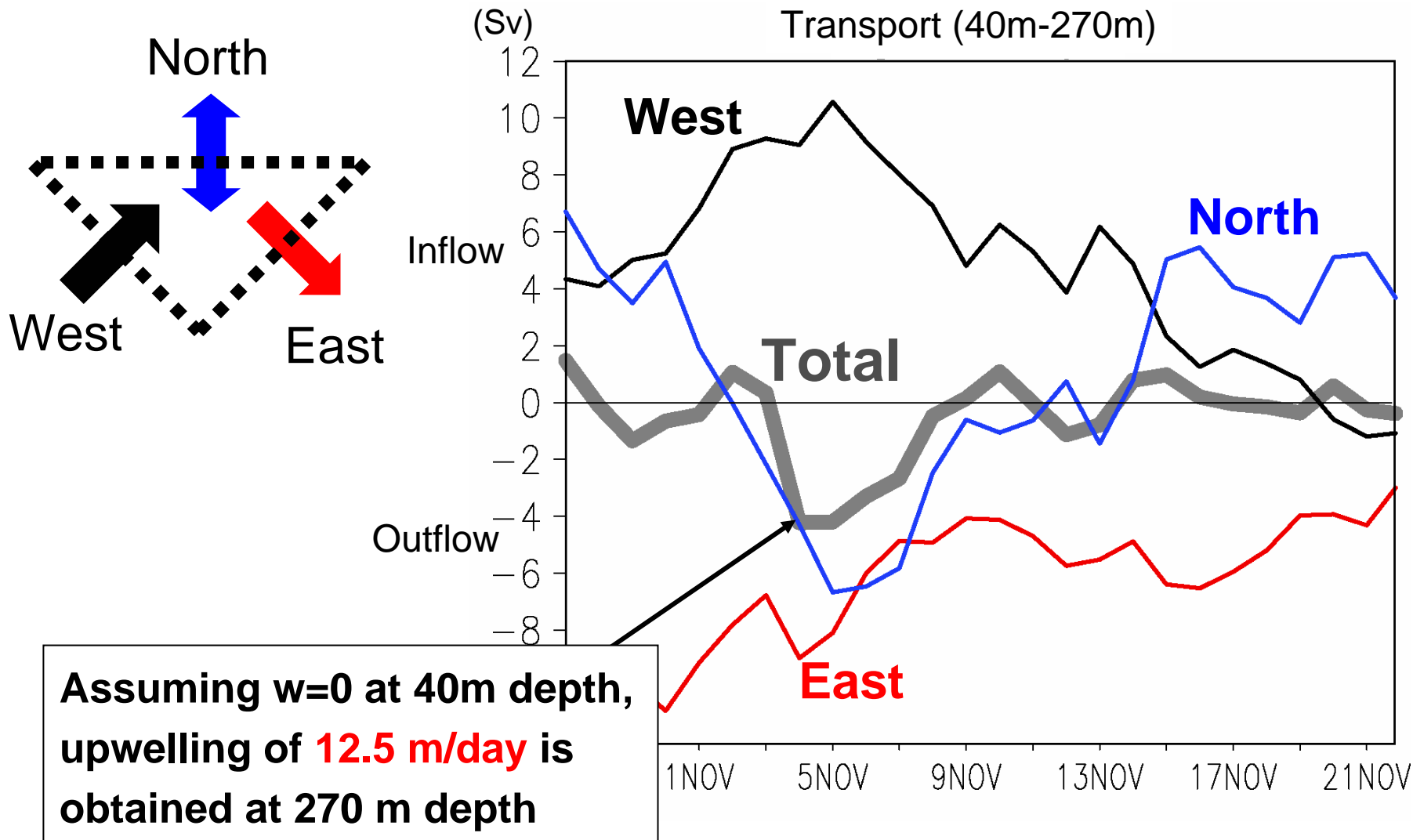
# MISMO: m-TRITON T variability



✓ Large upward movement of the isotherms  
( $> 10\text{m/day}$ , which is several times  
stronger than the strength of the typical  
equatorial upwelling)

✓ Tightening of the thermocline

# MISMO: Volume Budget

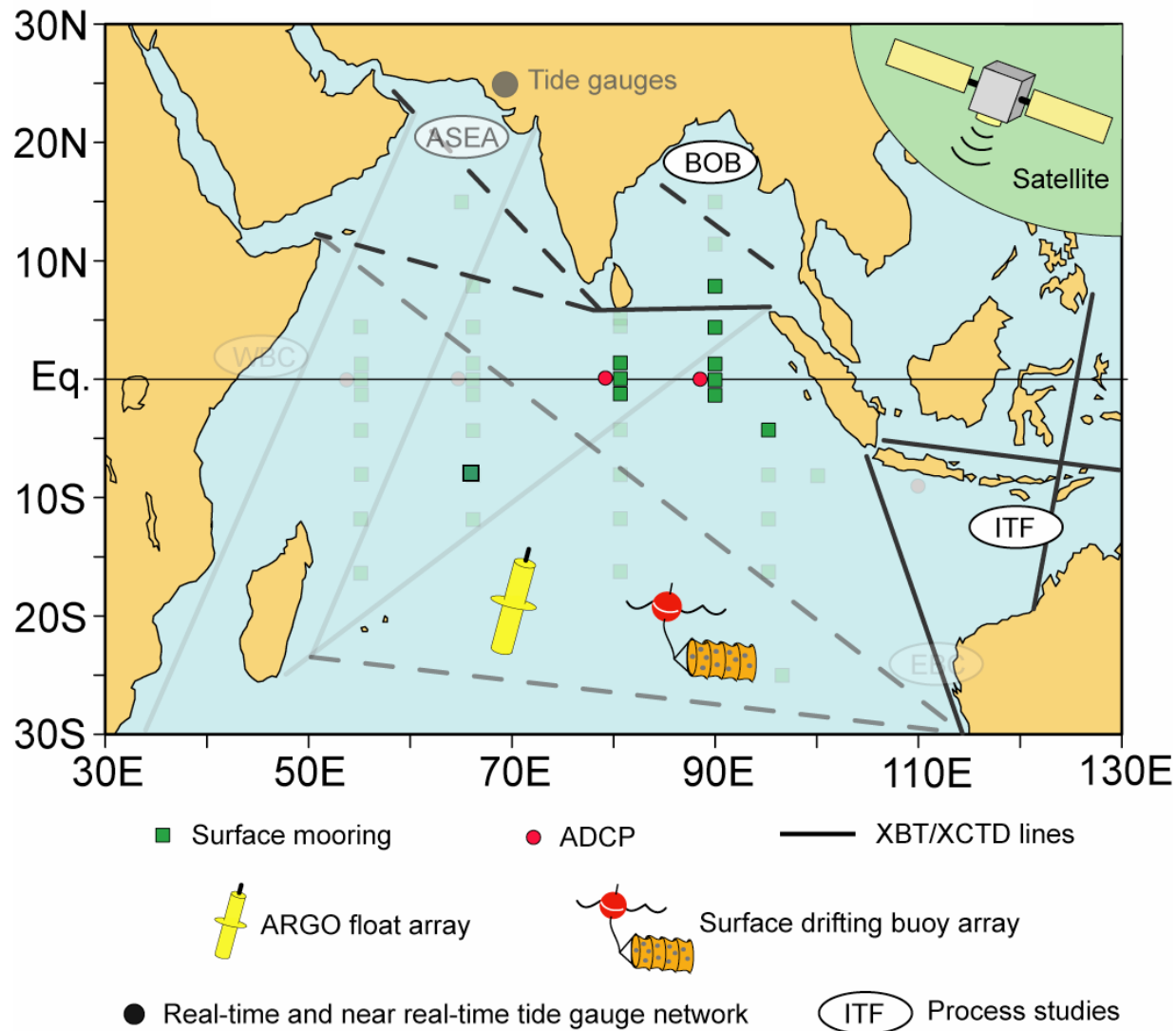


# Summary

**Long-term TRITON/ADCP at 90E and MISMO observations revealed that,**

- Subsurface negative temperature anomaly appeared in May 2006, about three months before the surface signals developed.
- During the height of the IOD, the thermocline is unusually shallow, and the vertical shear of the zonal currents is significantly increased.
- A series of the cold Kelvin waves in Feb., May, and Aug. may be responsible for the pre-conditioning of the IOD in 2006.
- Strong upwelling event of  $>10\text{m/day}$  occurred during MISMO in association with the intraseasonal variability.

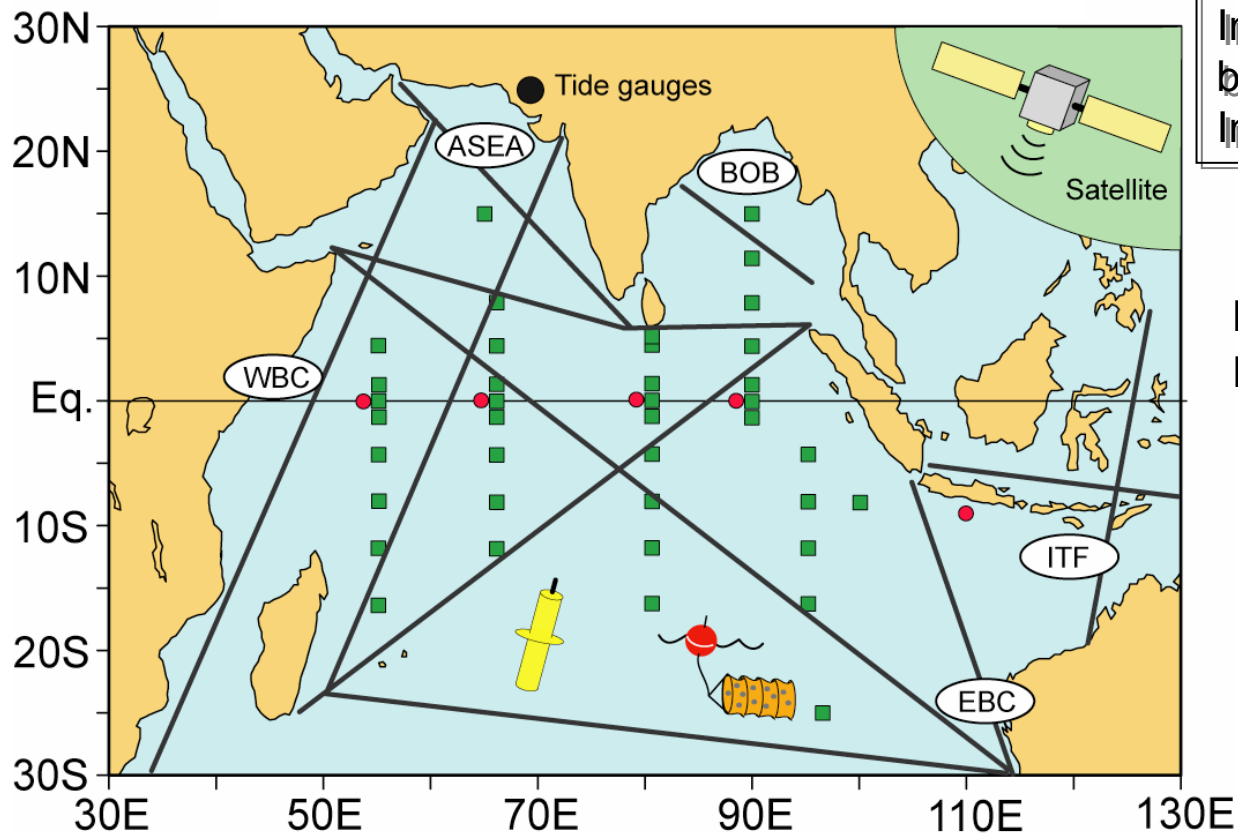
# Indian Ocean Observing System (IndOOS); Now



Eastern tropical Indian Ocean is now covered by the mooring array, under the cooperation among India, Indonesia, USA, and Japan.

However, **western equatorial Indian Ocean still remains unobserved**, despite its importance on the pre-conditioning of the IOD event.

# Indian Ocean Observing System (IndOOS)



IndOOS plan developed by the CLIVAR/IO-GOOS Indian Ocean Panel (IOP)

Full implementation of IndOOS is necessary.

- Surface mooring
- ADCP
- XBT/XCTD lines
- ARGO float array
- Surface drifting buoy array
- Real-time and near real-time tide gauge network
- ITF Process studies