

Study of the Ocean Circulation at the Entrance of Indonesian Throughflow

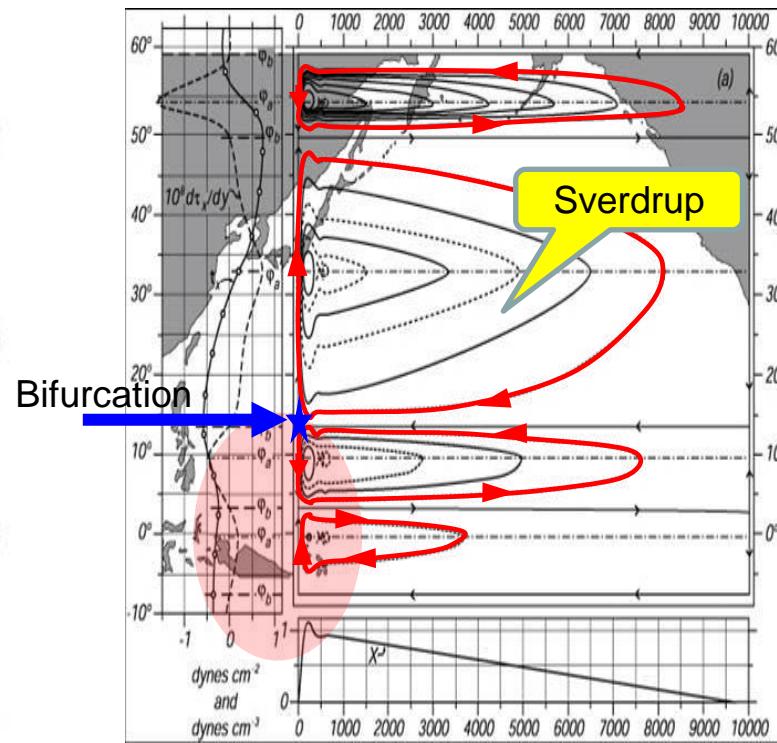
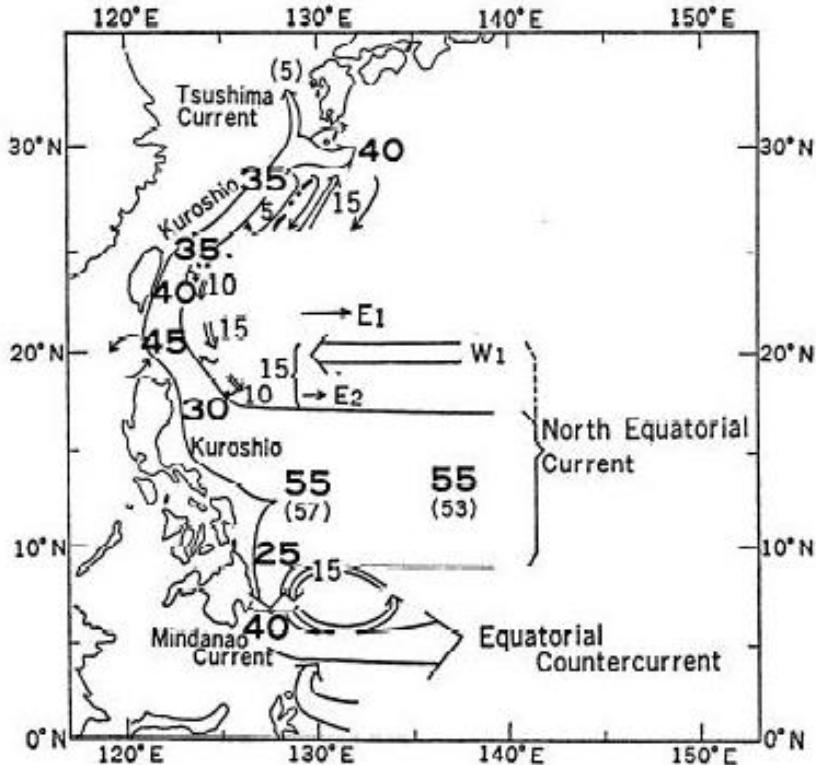
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CAS Key Laboratory of Ocean Circulation and Waves
Institute of Oceanology, Chinese Academy of Sciences

CLIVAR Seminar at FIO/SOA

QIngdao, May 22, 2015

Historical study



CSK study (Nitani 1975) disclosed the Western Pacific Ocean circulation to be consistent with the Munk theory

Munk (1950) J. Meteor.
Linear dynamics theory

ENSO discharge-recharge paradigm

NEC bifurcation

El Niño:

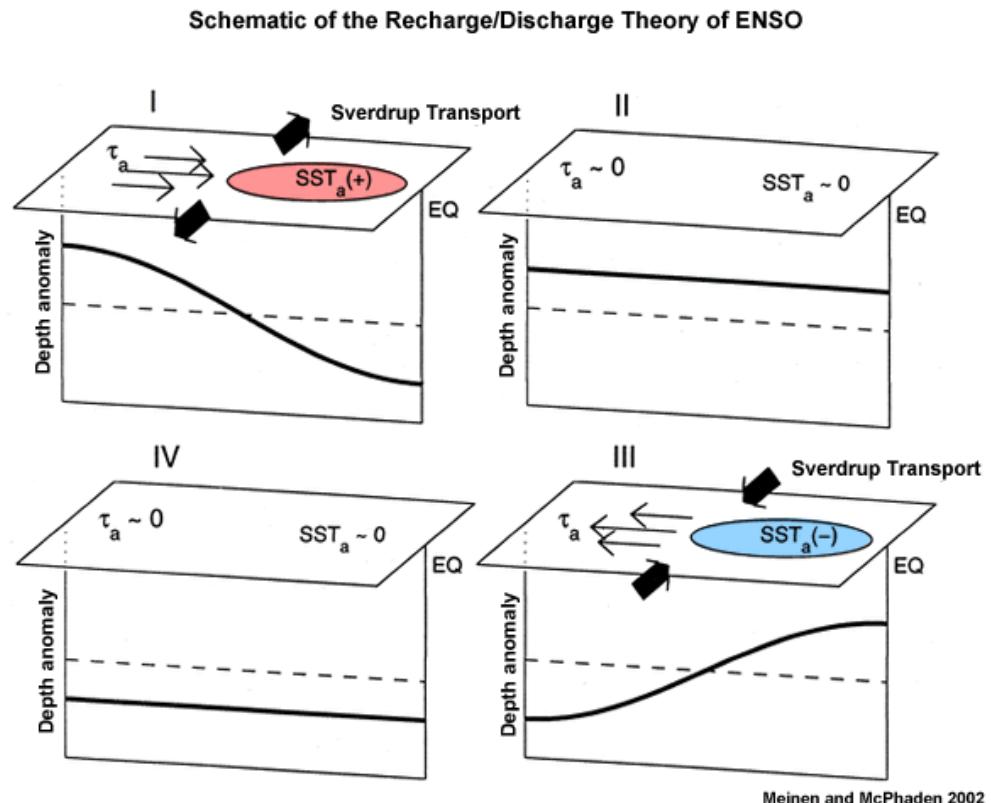
Kuroshio↓、MC↑；

La Niña:

Kuroshio↑、MC↓

(Qiu and Lukas, 1996; Kim, 2004; Qiu and Chen, 2010)

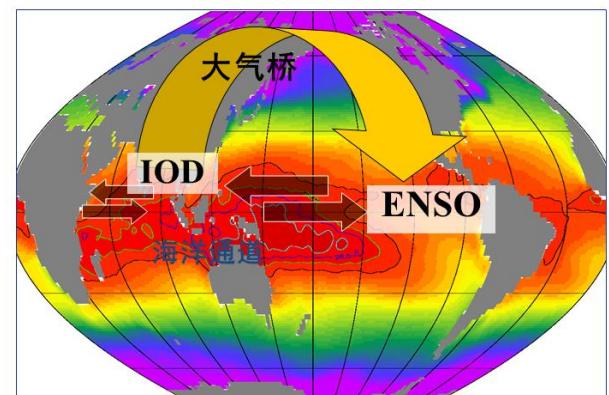
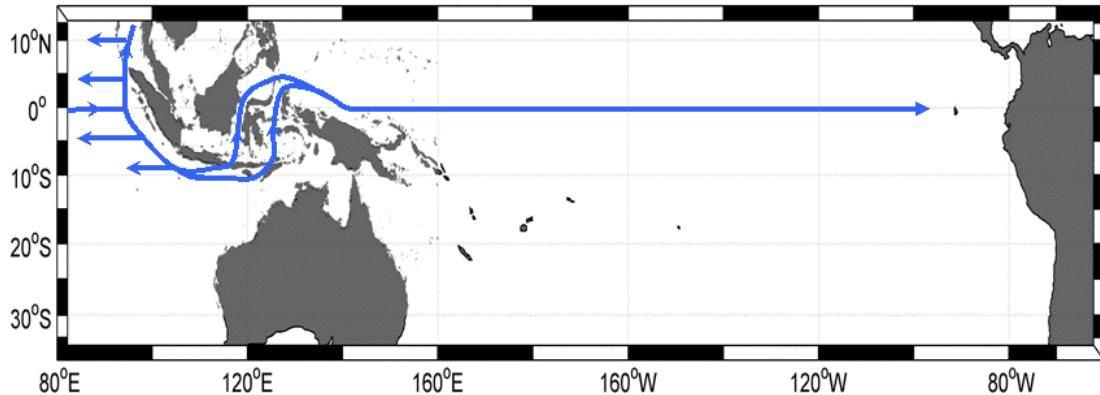
WBC is believed to damp the warm pool recharge and discharge



Role of the WBCs in the warm pool variability not clear due to lack of observations.

IOD–ENSO teleconnections

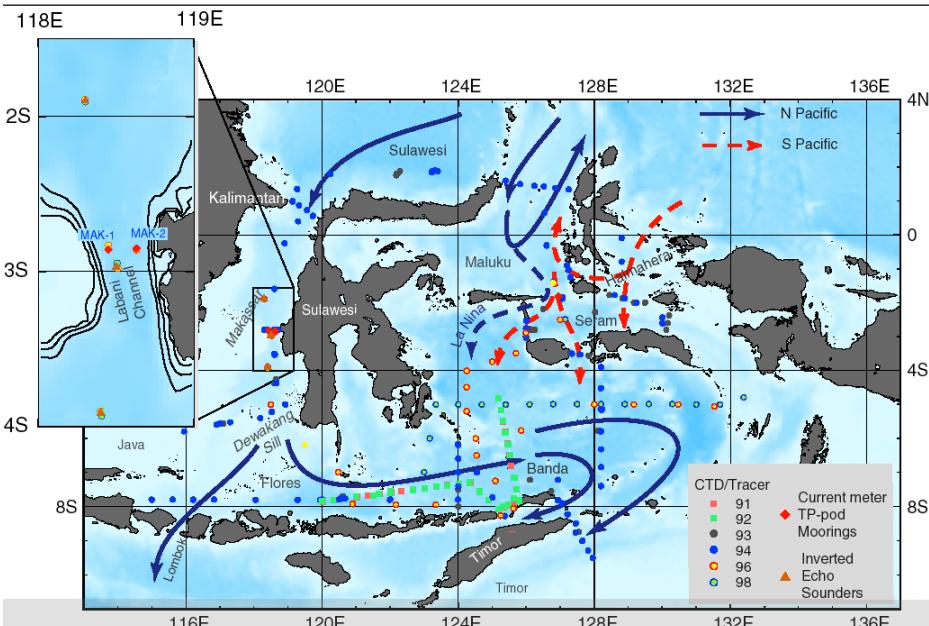
IOD can impact ENSO through Itf, the so-called “Oceanic Channel” dynamics



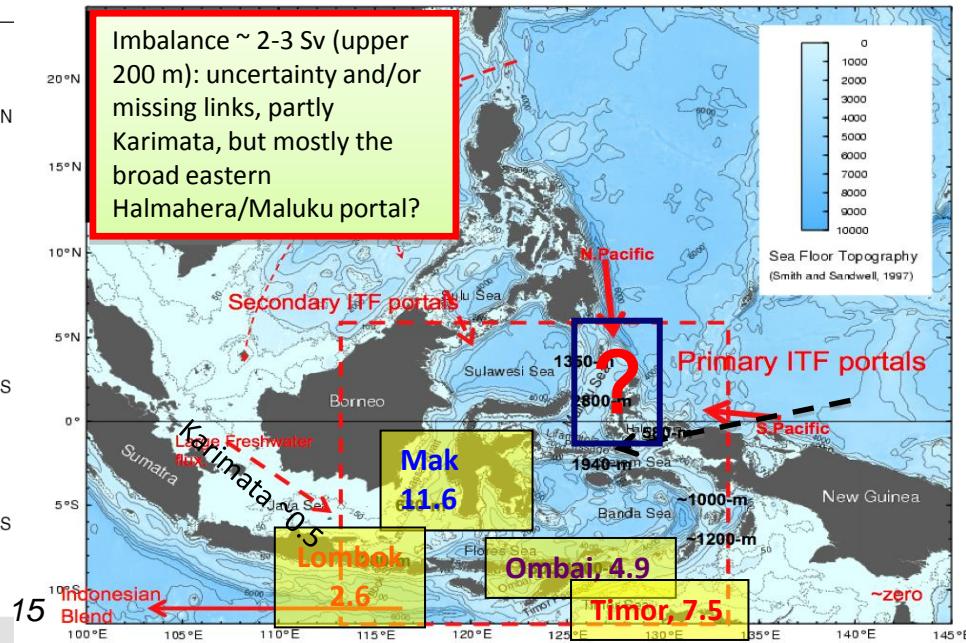
Yuan and Han 2006 JPO
Yuan and Liu 2009 JPO
Yuan et al. 2013 J Clim.
Yuan et al. 2011 J Clim.

International Observations of the Indonesian Seas

Arlindo

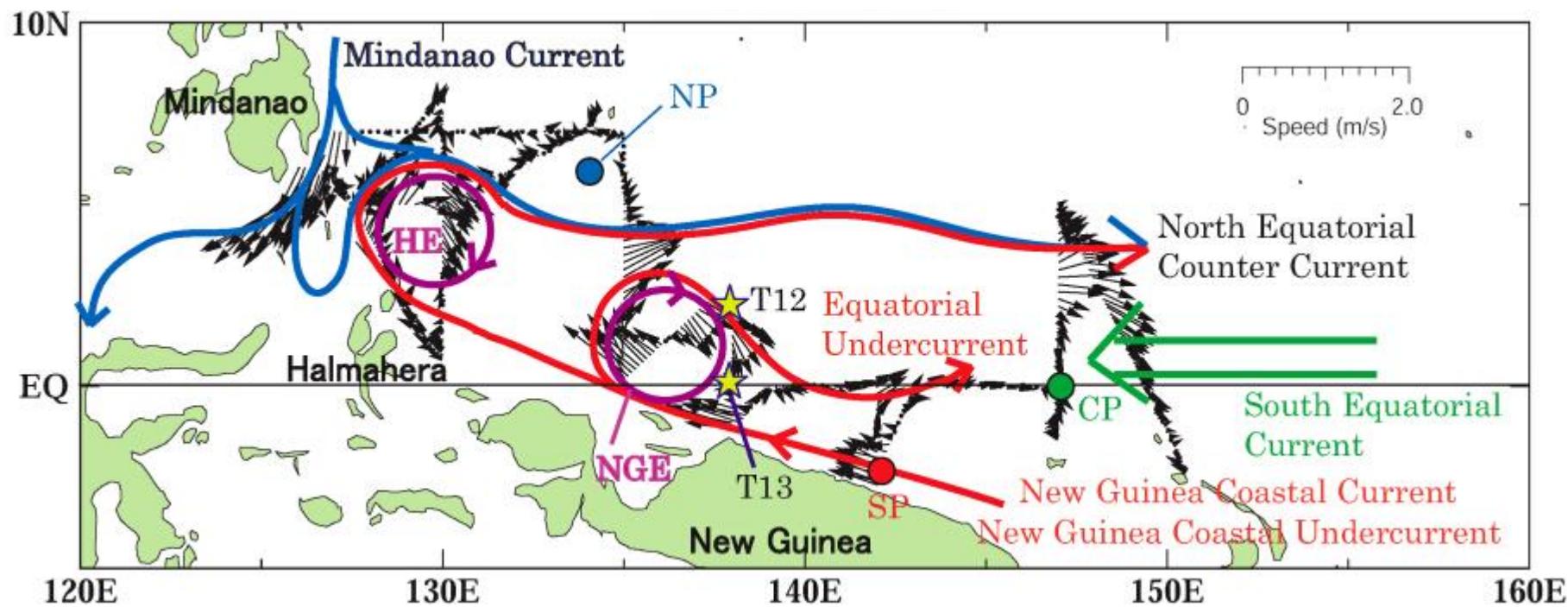


INSTANT



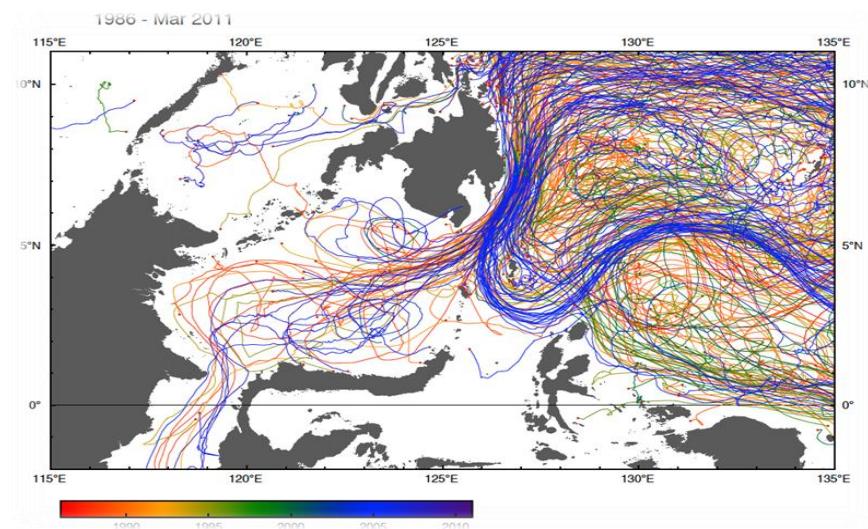
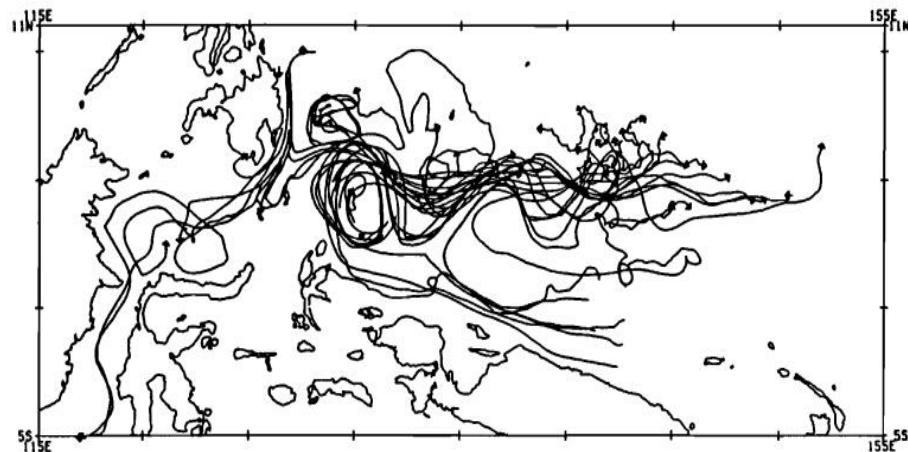
Ocean Circulation at the ITF entrance

Kashino et al., 2007



Surface drifters

Jul-Sep, 1988

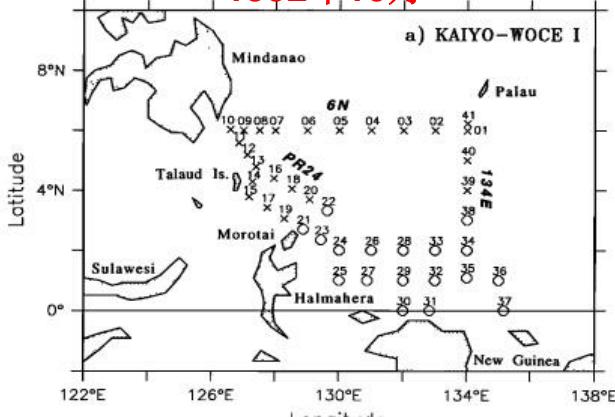


WEPOCE III (summer 1988)
(Hacker et al., 1989; Lukas et
al., 1991)

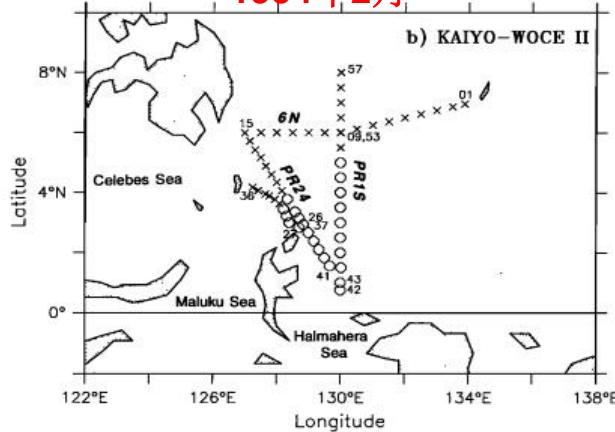
Cruise surveys

Kashino et al. (1996)

1992年10月

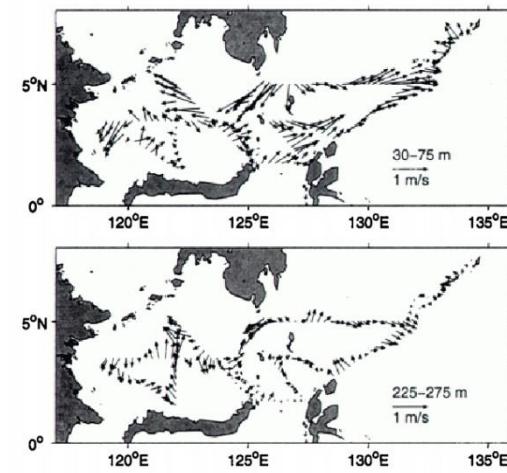
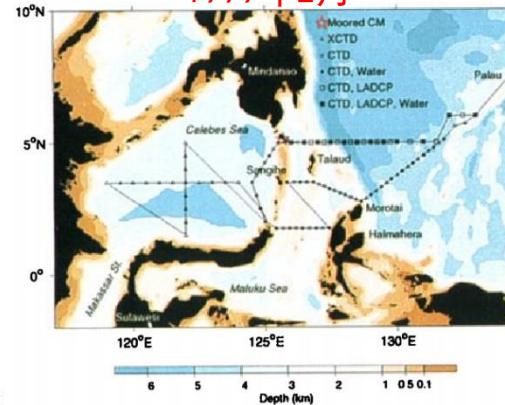


1994年2月



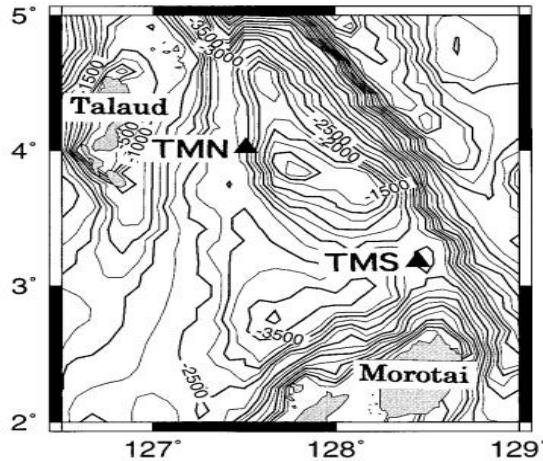
Kashino et al. (2001)

1999年2月

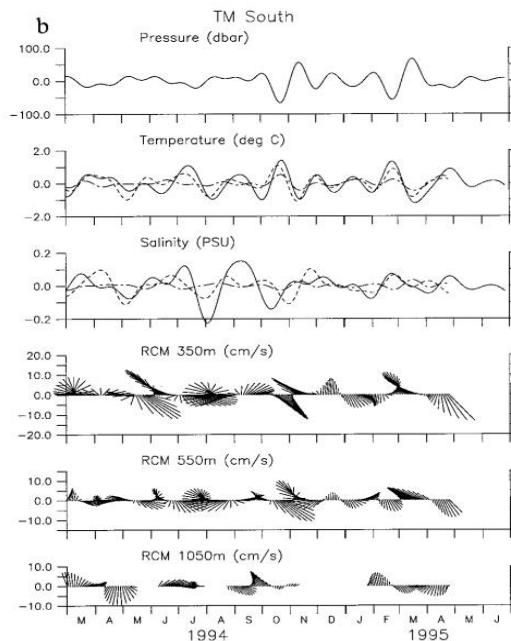
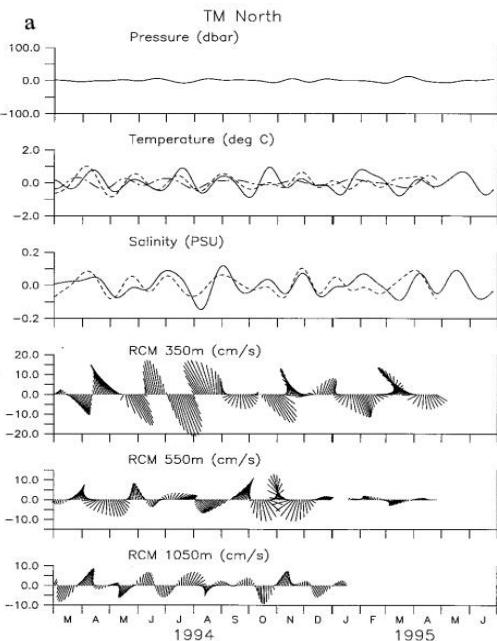


Moor ing measurements

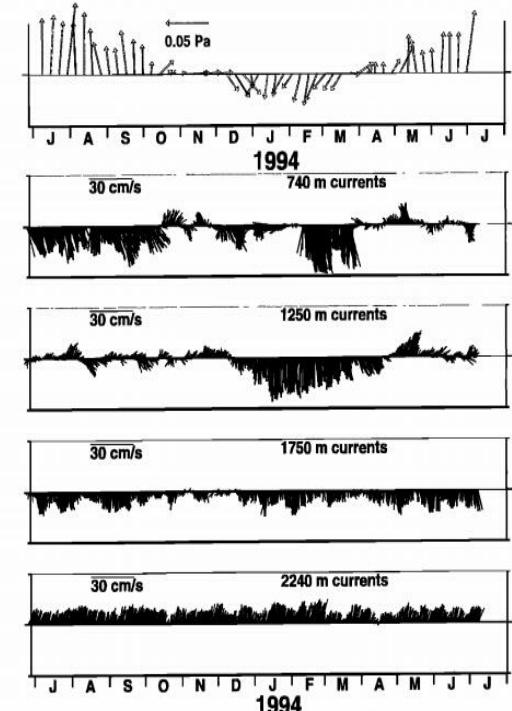
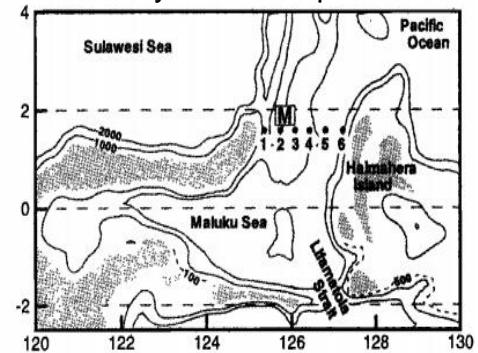
WOCE IV



- WOCE IV (Kashino et al., 1999)
- June 1993-July 1994 (Cresswell and Luick, 2001)



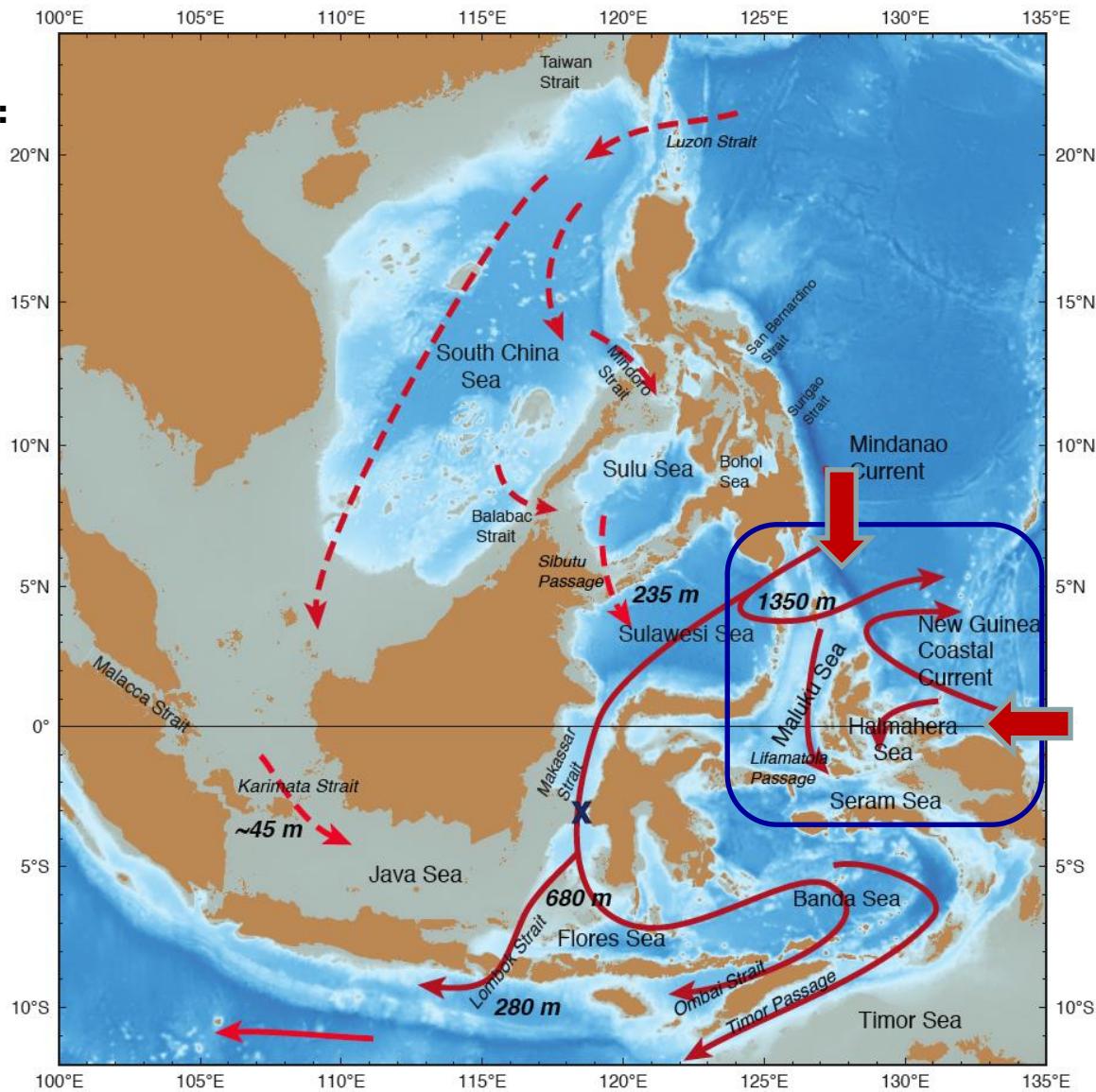
ASEAN-Australia Regional Ocean Dynamics Expeditions



ITF entrance

Major scientific questions:

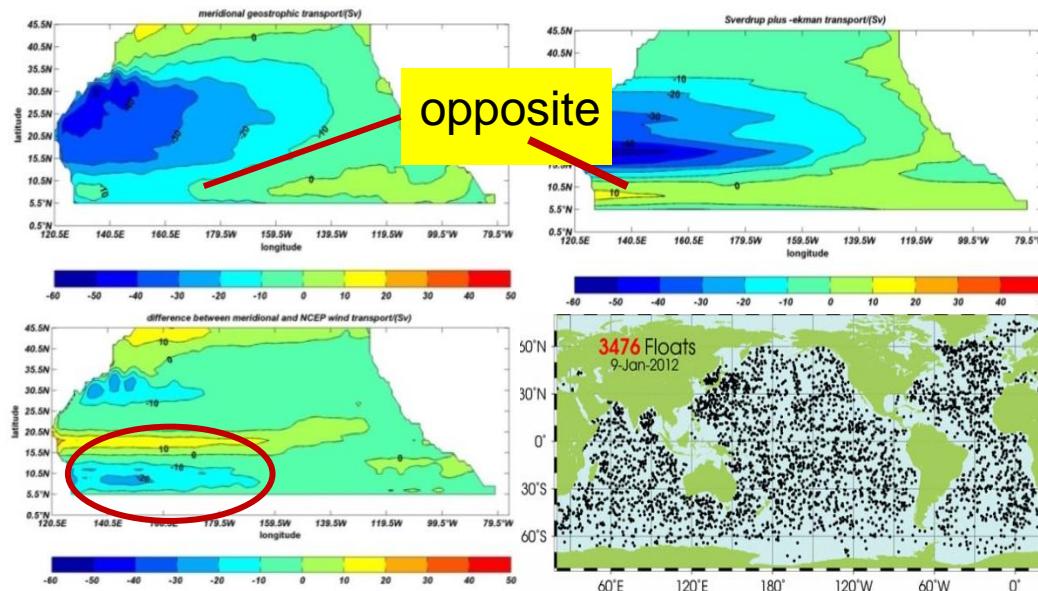
- MC transport and its interannual variations;
- SEC and transports from S. hemisphere;
- Circulation and variability of the WBC confluence;
- ITF eastern channel transports;



Defect of the Sverdrup theory

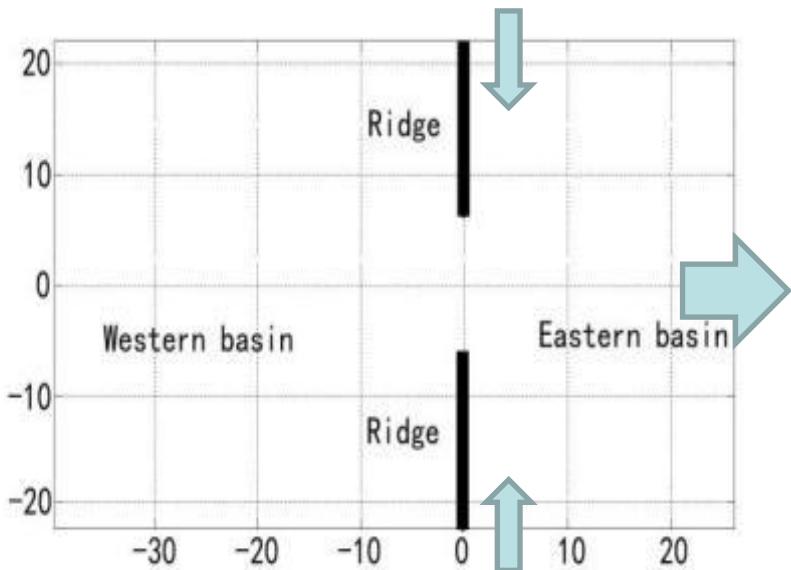
$$\int_{x_E}^{x_W} \int_{-H}^0 v_G \, dz \, dx = \frac{1}{\beta \rho} \int_{x_E}^{x_W} \nabla \times \tau \, dx + \frac{1}{f \rho} \int_{x_E}^{x_W} \tau^x \, dx.$$

Meridional geostrophic transoport Sverdrup and -Ekman



Yuan et al. 2014 JPO

WBC confluence



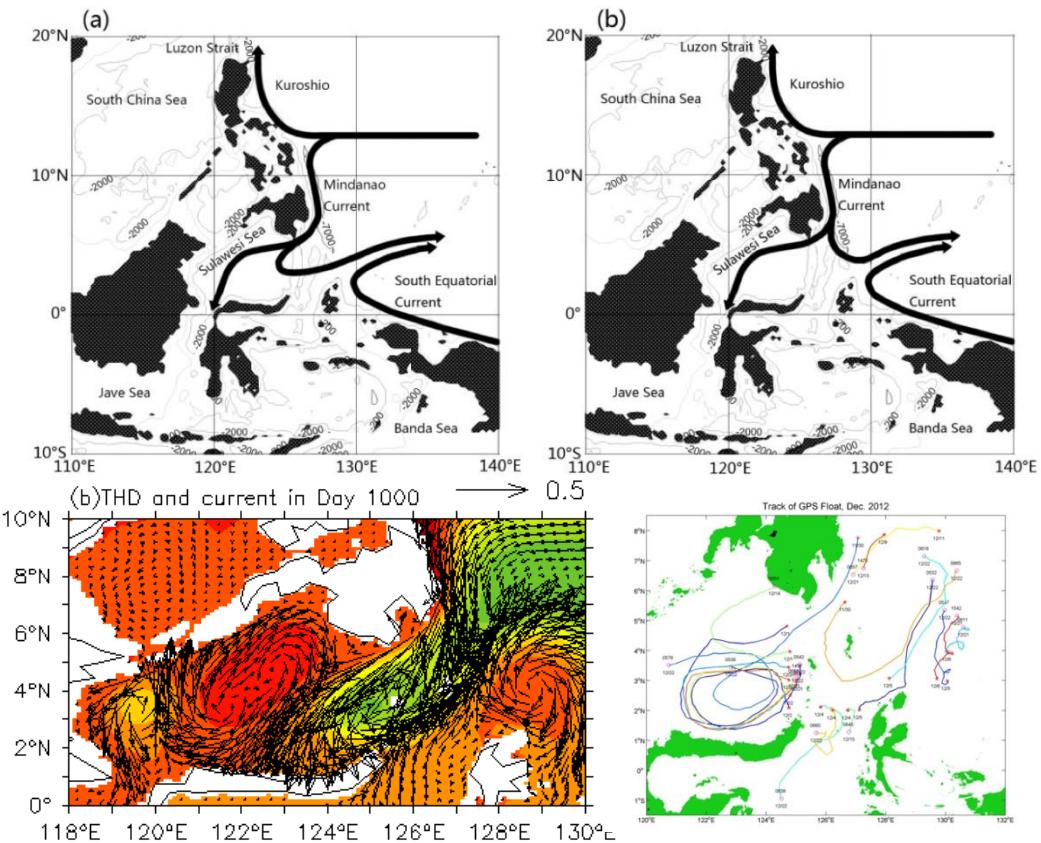
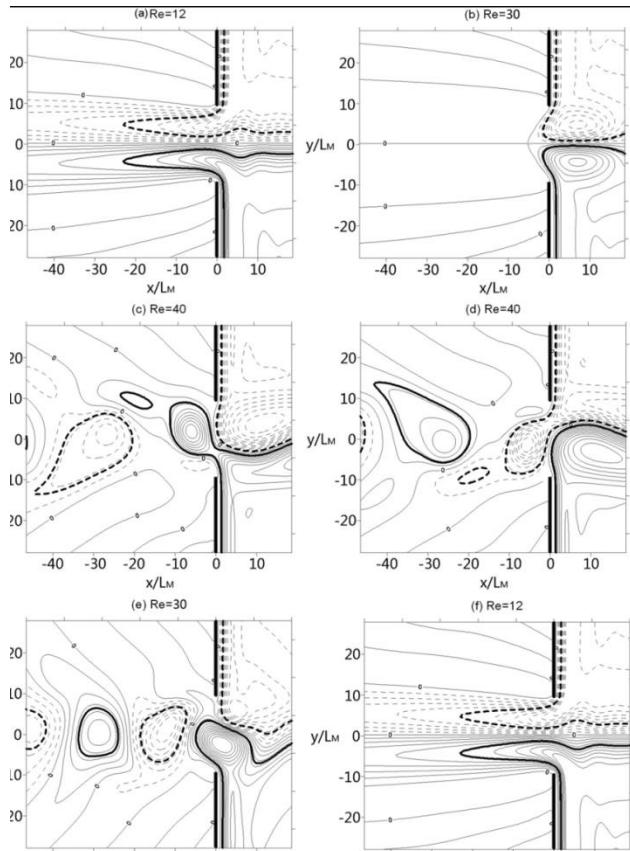
reduced-gravity, quasigeostrophic model
governed by the potential vorticity equation,

$$-\frac{1}{L_R^2} \psi_t + \zeta_t + J(\psi, \zeta) + \beta \psi_x = A_H \nabla^2 \zeta,$$

- L_R Rossby deformation radius
- ψ streamfunction of a depth-averaged flow
- ζ relative vorticity,
- A_H horizontal viscosity coefficient
- β gradient of the Coriolis parameter
- $J()$ Jacobian operator.

Circulation at the entrance of the ITF

Observe and simulate the eddy shedding in the eastern Sulawesi Sea for the first time

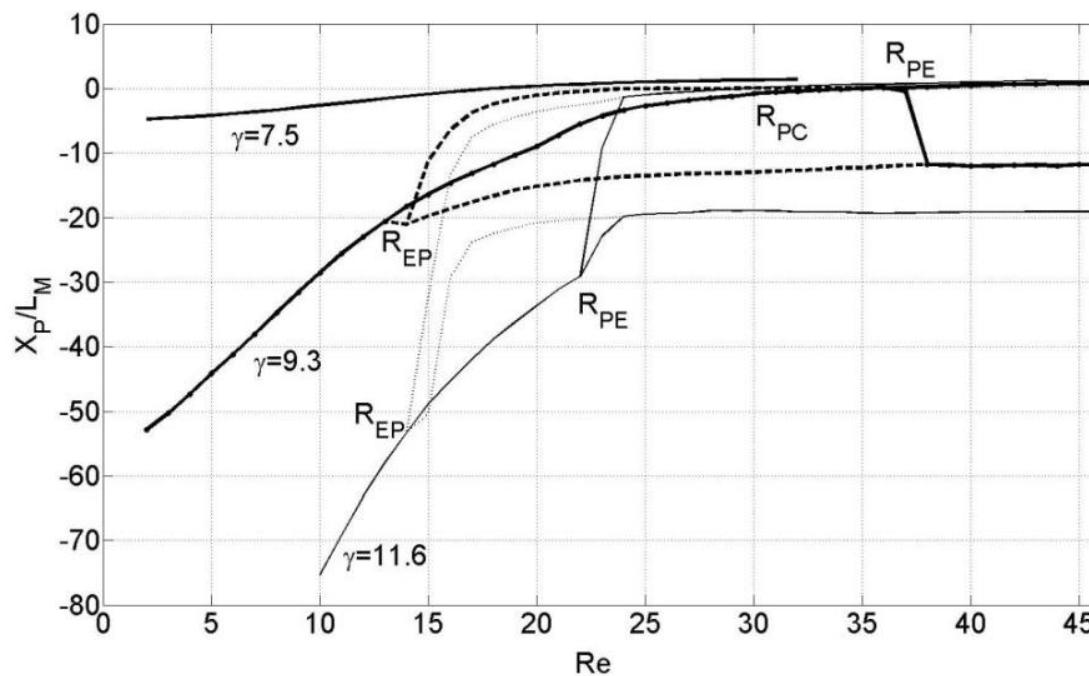
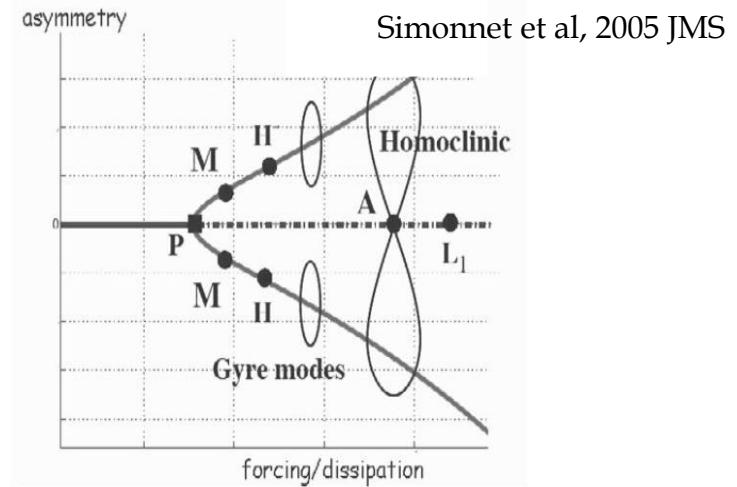
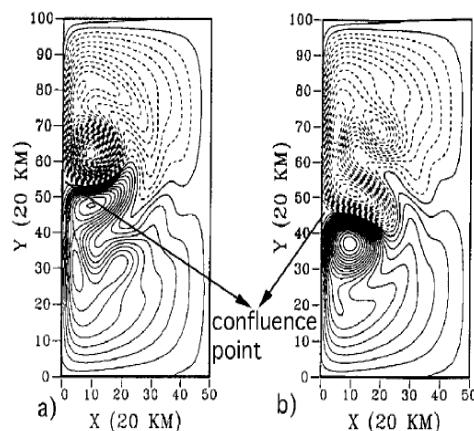


Nonlinear collision of WBCs at a gap

Wang and Yuan, 2012, 2014
(JPO)

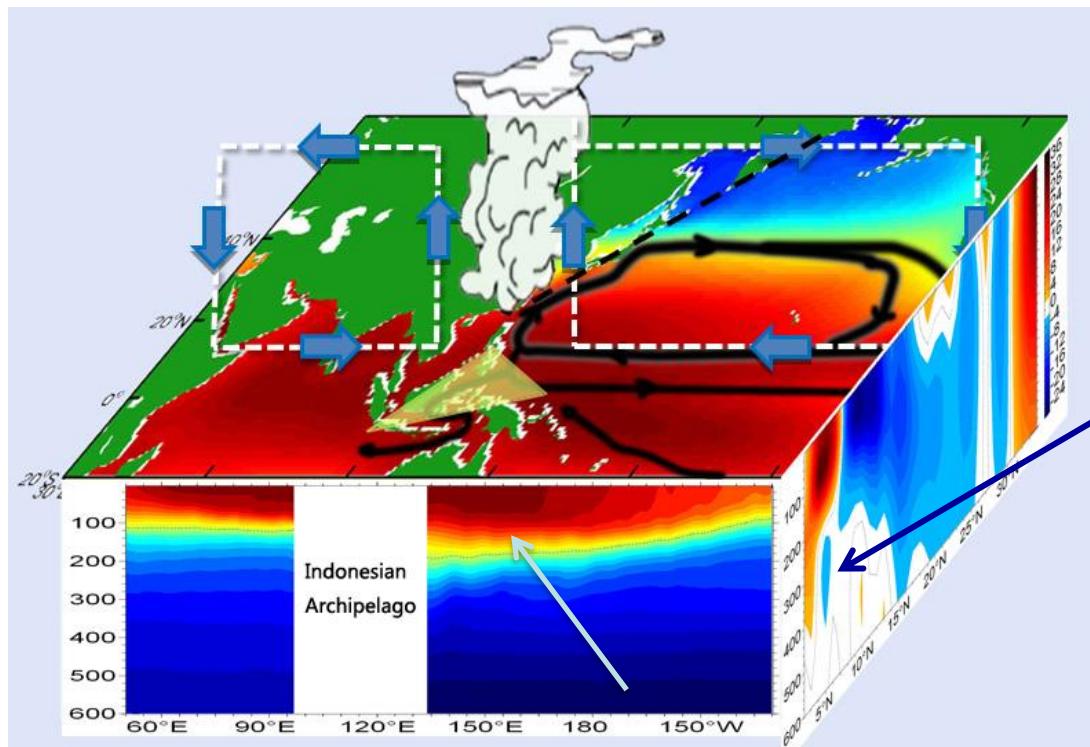
Double-Gyre WBC theory

Jiang et al, 1995 JPO

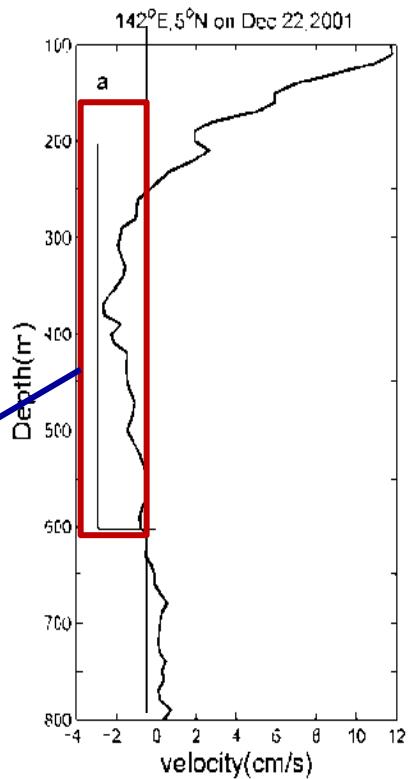


Wang and Yuan,
2012, 2014, JPO

New undercurrent in W. Pacific

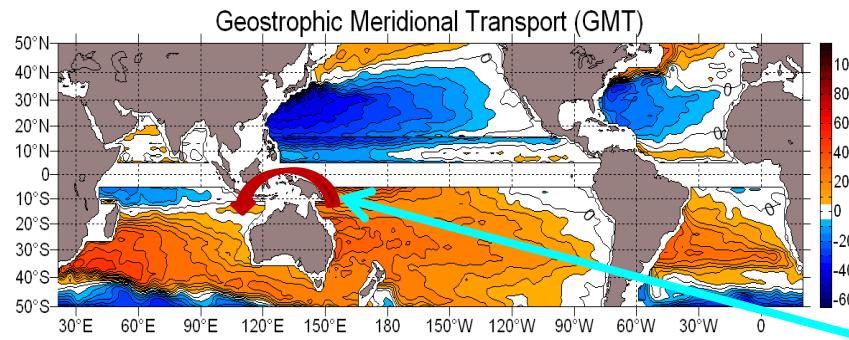


NESC

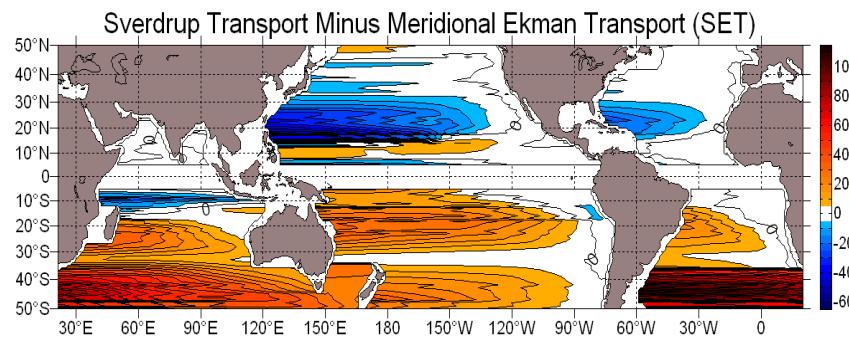


Yuan et al. 2014 JPO

Global general circulation

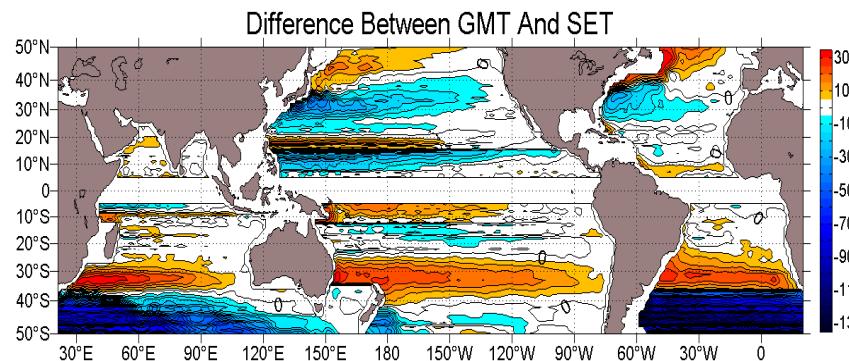


AGC MVT



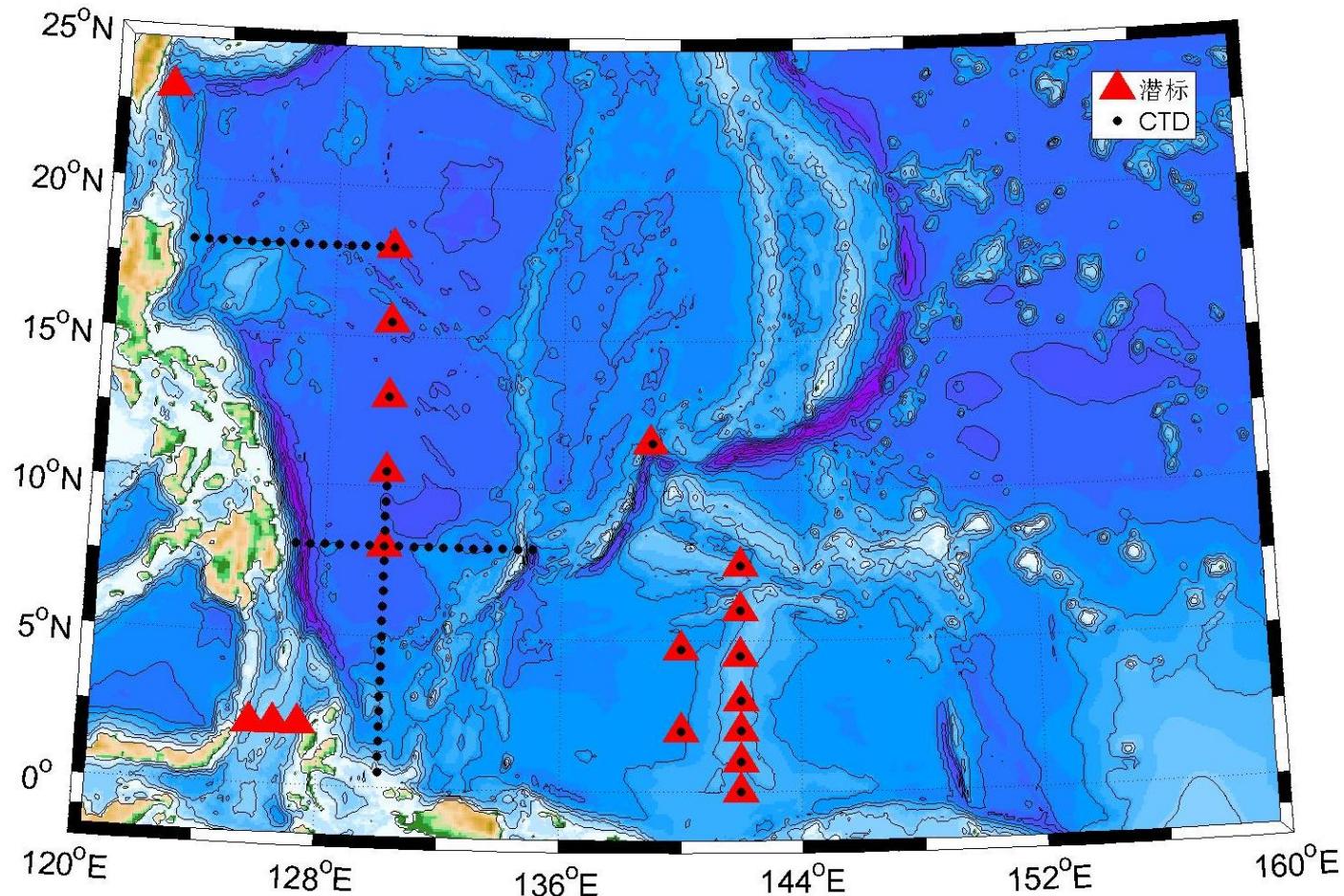
Super Gyre?

Wind-driven MVT

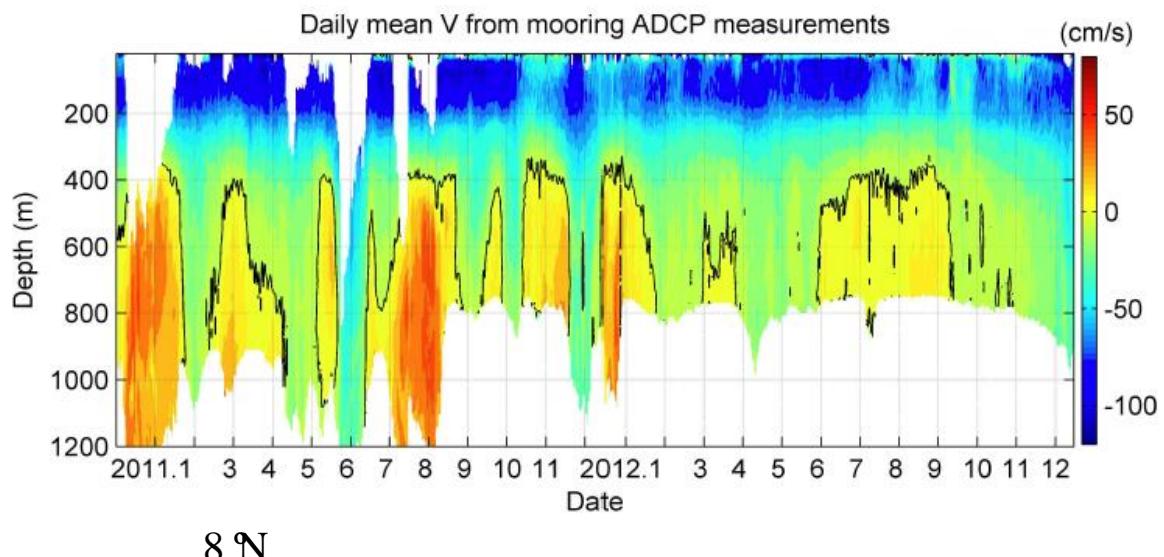


Difference

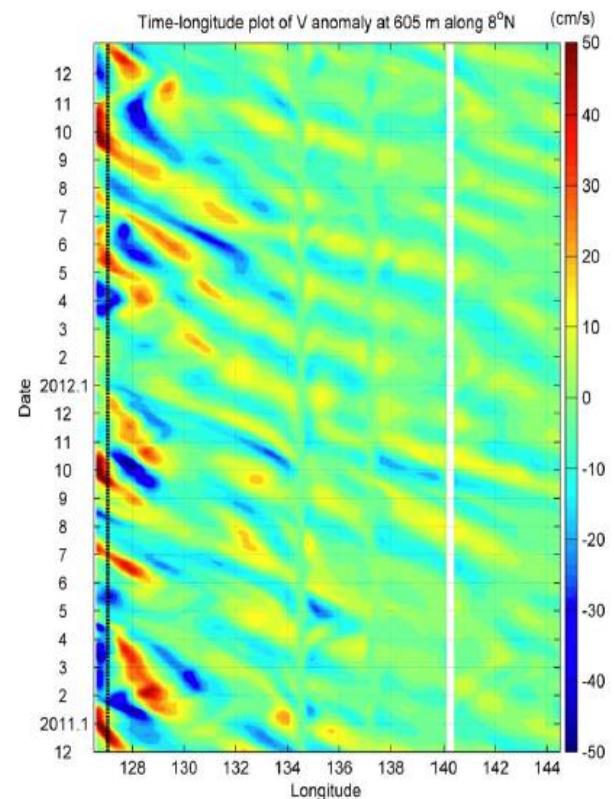
Western Pacific mooring array



MUC and its ISV

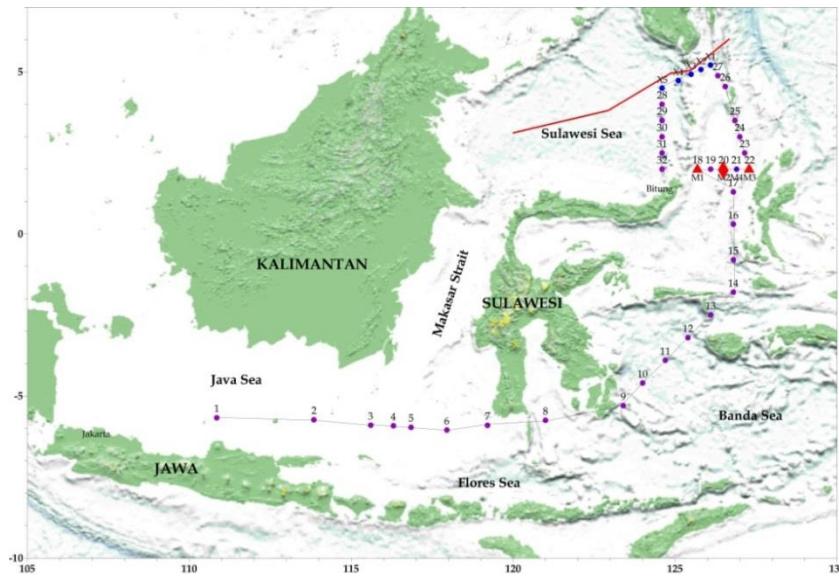
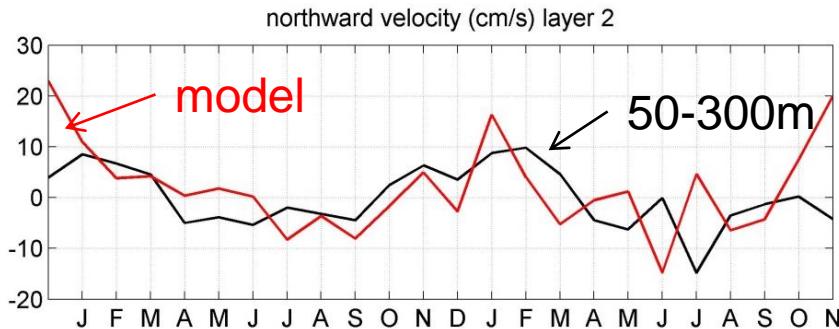


Zhang, Hu, et al., 2014, JGR

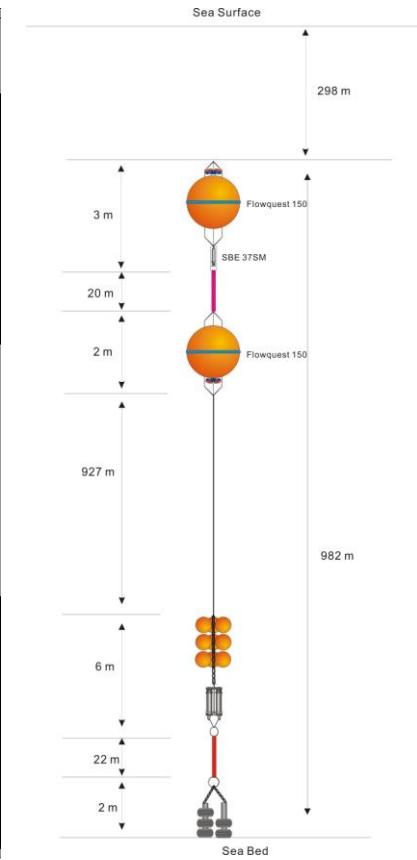
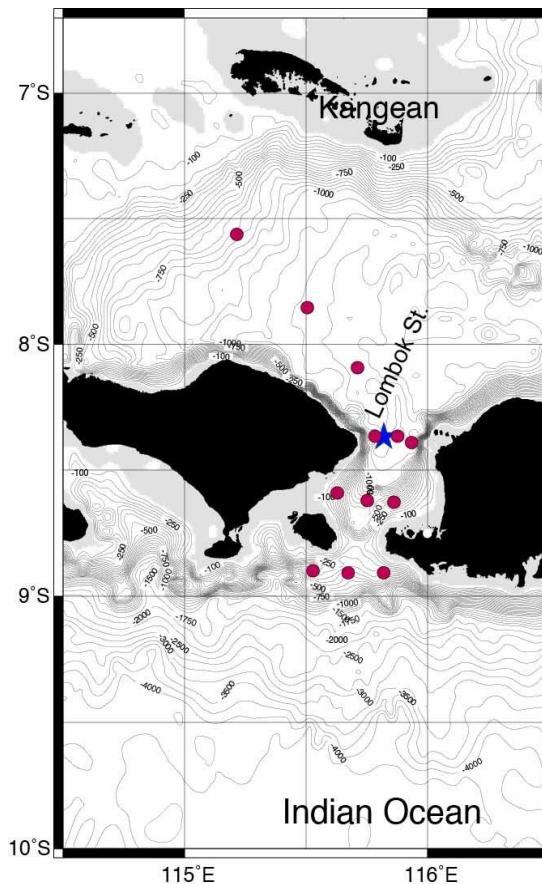
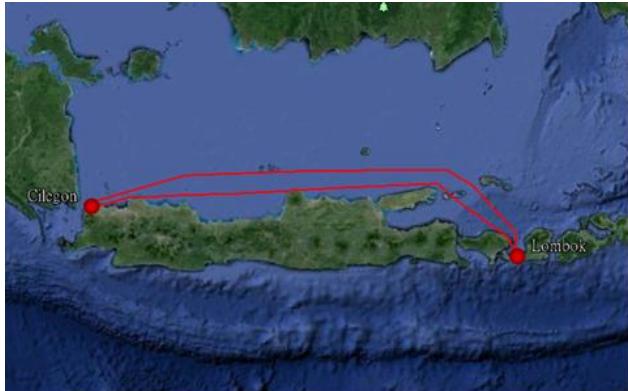


2014 RCO/LIPI-IOCAS Joint Cruise

Nov. 14-29, 2014, retrieve a mooring deployed in the Maluku Strait in Dec. 2012 with 2 years of time series.



Lombok mooring

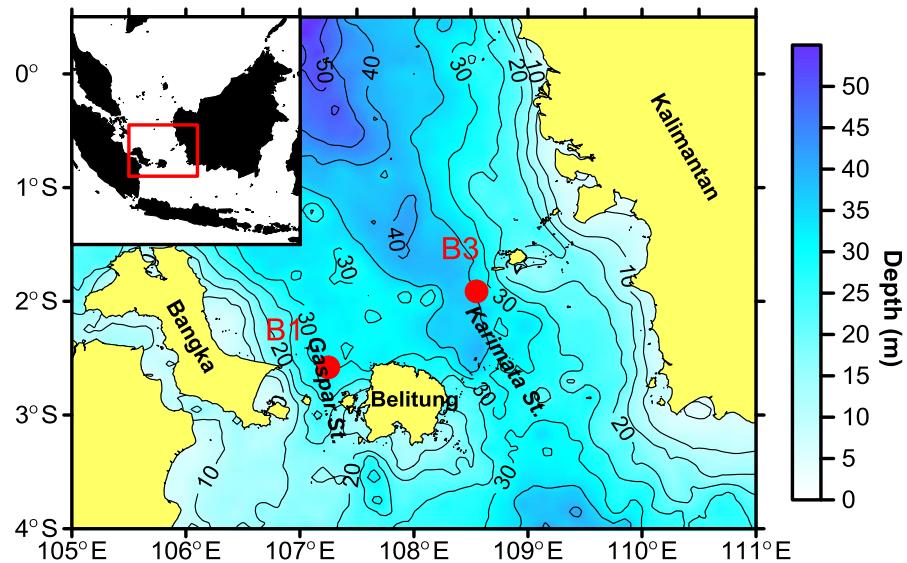


Mooring station

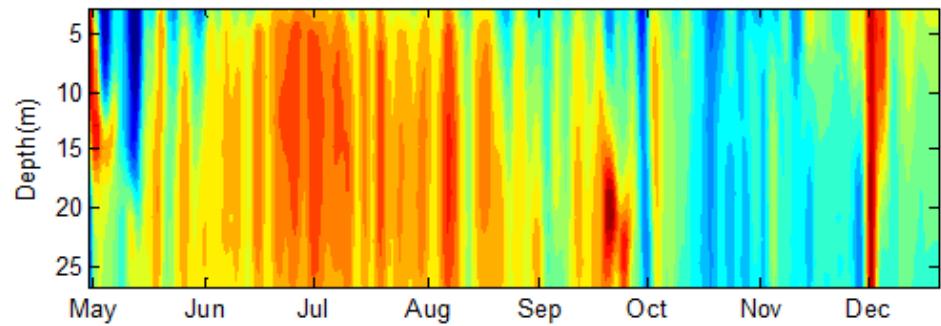


CTD cast

Karimandan Strait



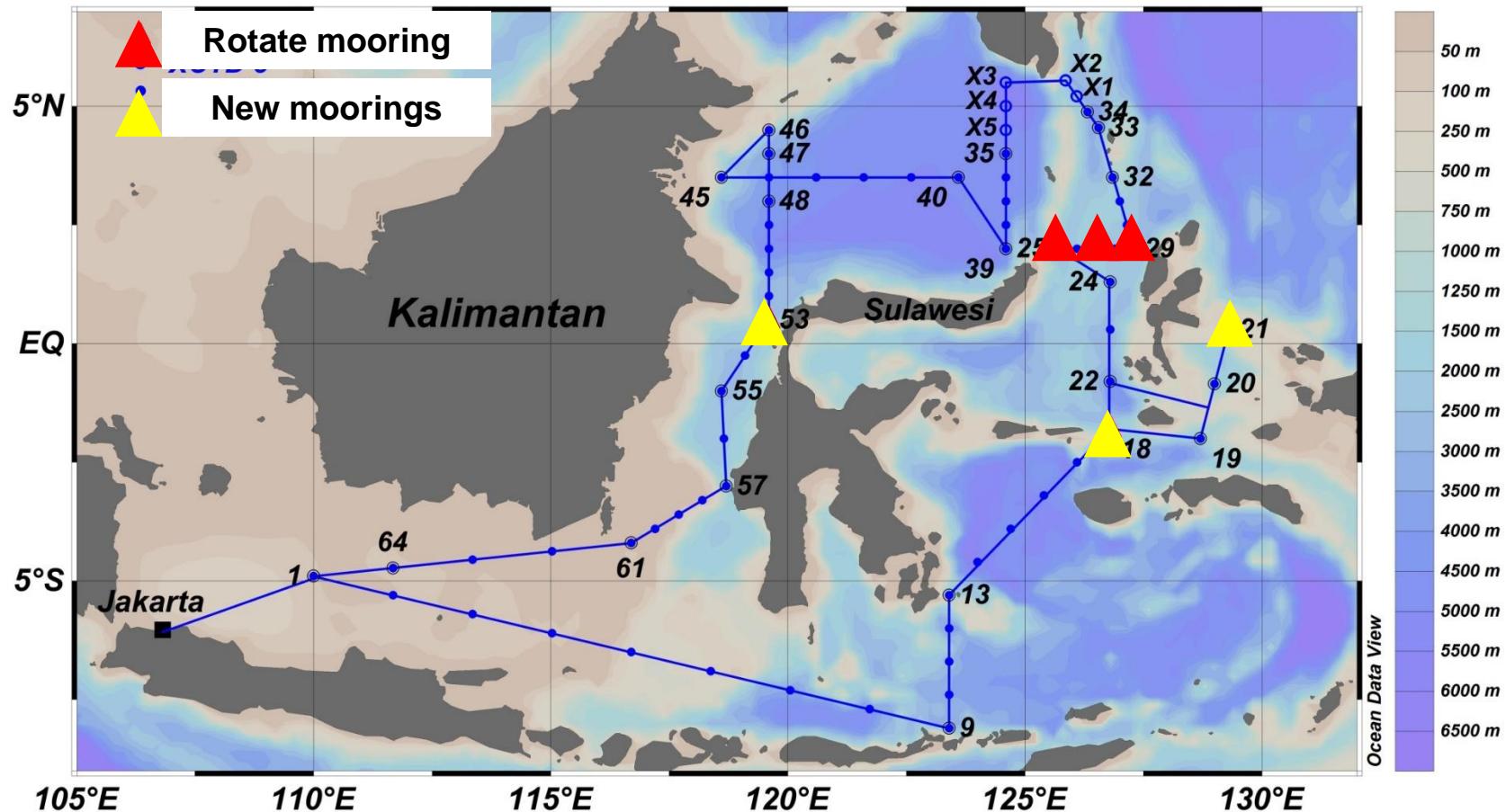
Accumulate 7 years of time series



获取的海流连续观测资料

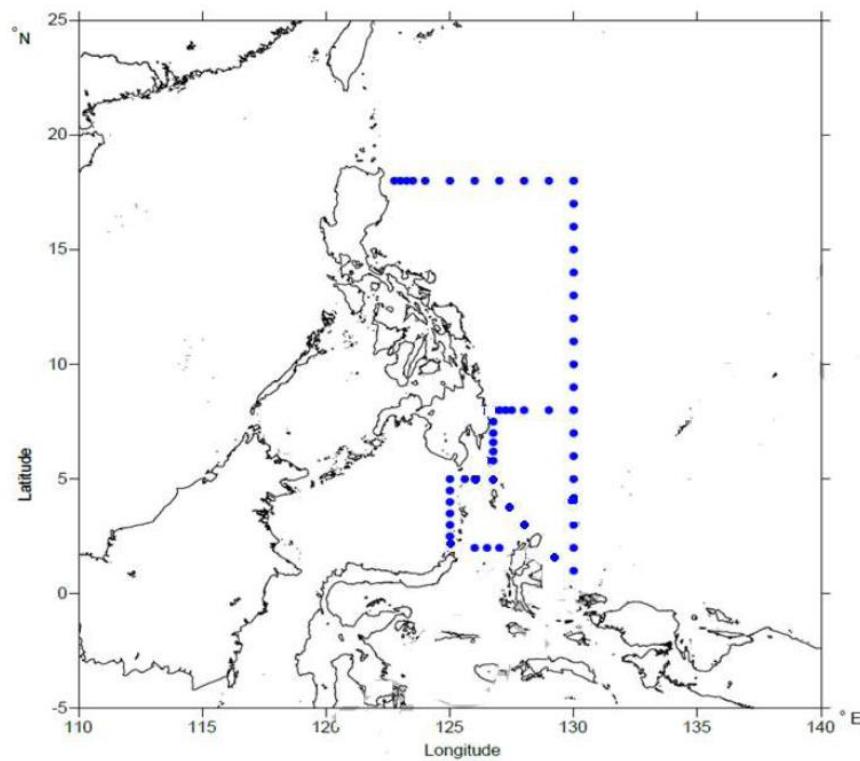
2015 cruise plan

Agreement signed (2014-2018)



2015 NSFC Shared Open Cruise

Aug. – Oct. 2015

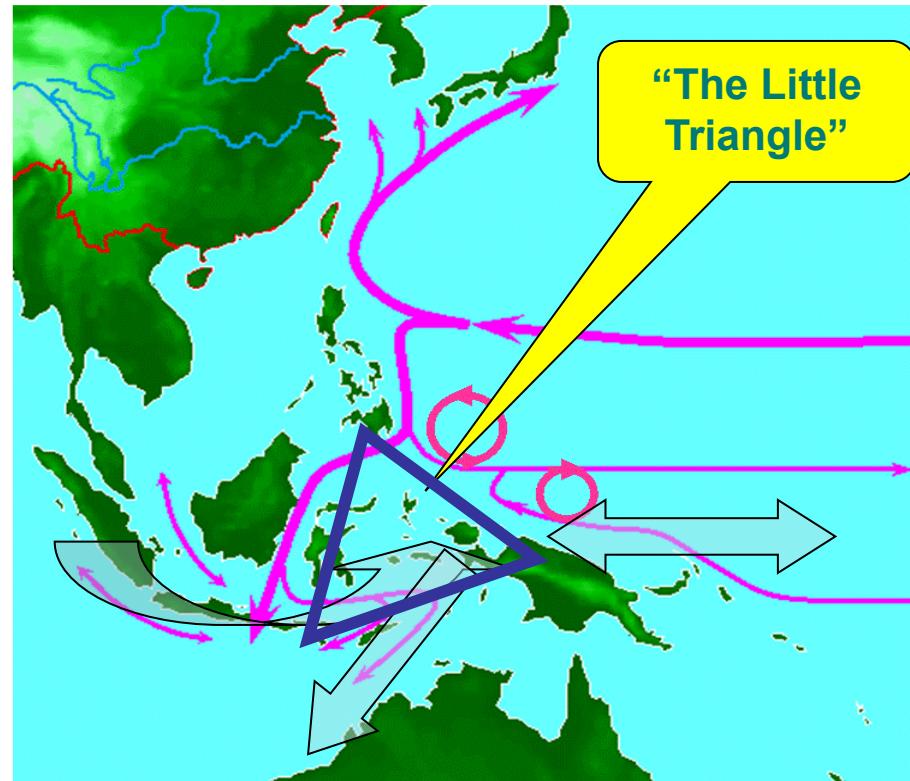


Importance of the “Little Triangle” circulation

Cross road of different masses and oceanic waves;

Path of the ITF;

One of the most complicated circulation system in the world ocean.



Due to lack of observations, the ocean circulation at the Pacific Entrance of ITF have not been studied well.

Mean transport of ITF: 8-10 Sv;
Interannual anom. of ITF: <0 – 26 Sv;
IA of heat transport: ~net heat flux over WP

IOCAS/RCO-LIPI cooperation

