3rd NPOCE webinar on
Roles of western Pacific Ocean circulation variability in warm pool

Currents off the Papua New Guinea coast during and after the El Niño of 2015-2016

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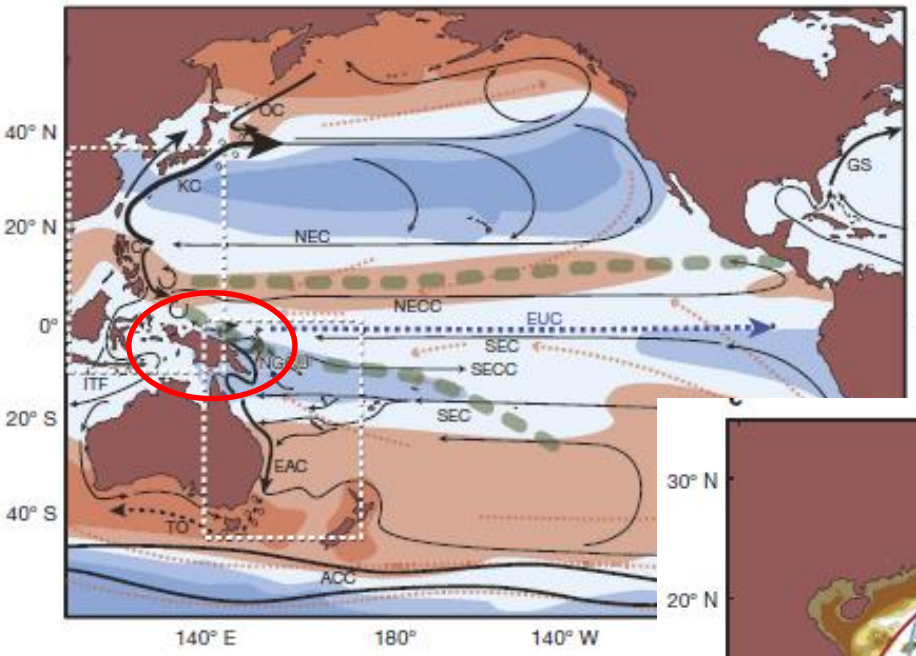
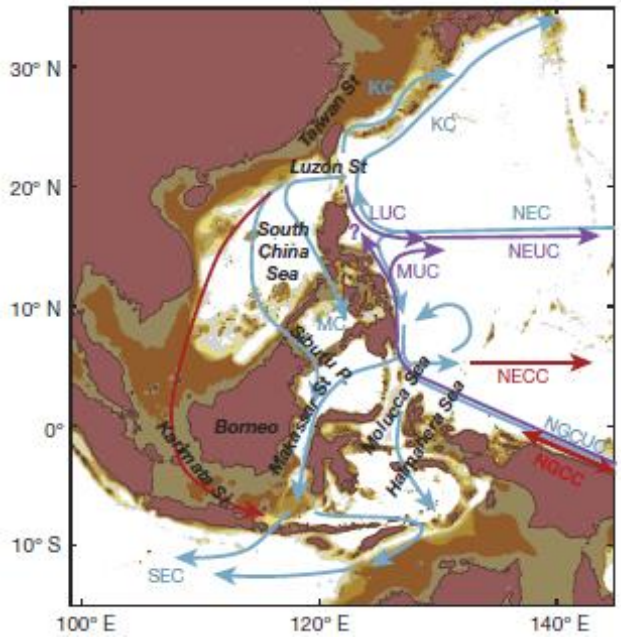
Complex circulation system in the western Pacific

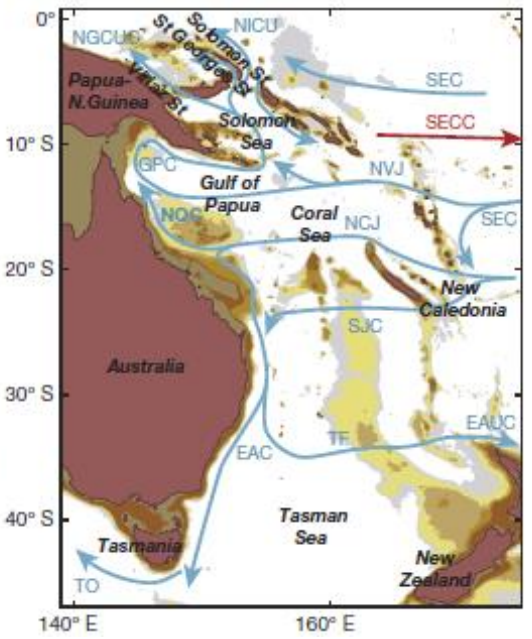


Hu et al., 2015

NPOCE
(Hu et al., 2011)

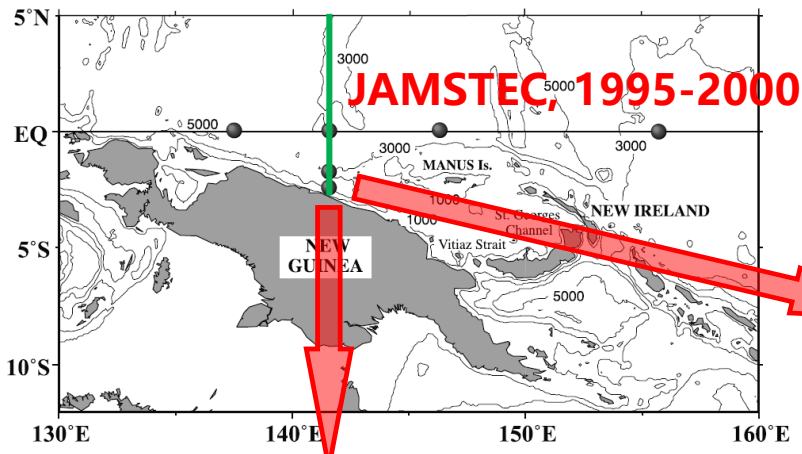


SPICE
(Ganachaud et al., 2014)

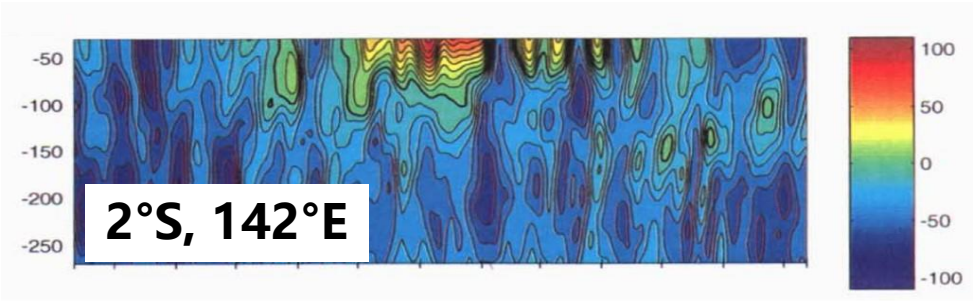


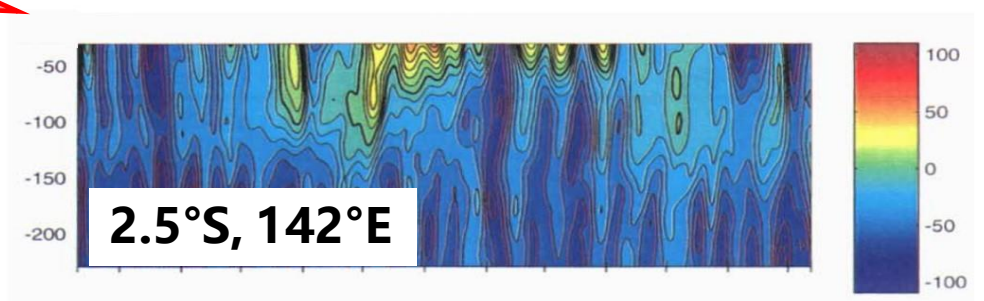
Papua New Guinea current system links the north and south Pacific

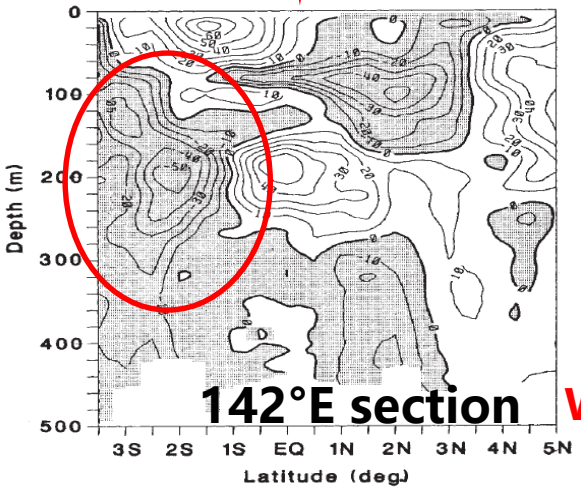
The mean coastal currents off PNG coast at 142°E



JAMSTEC, 1995-2000

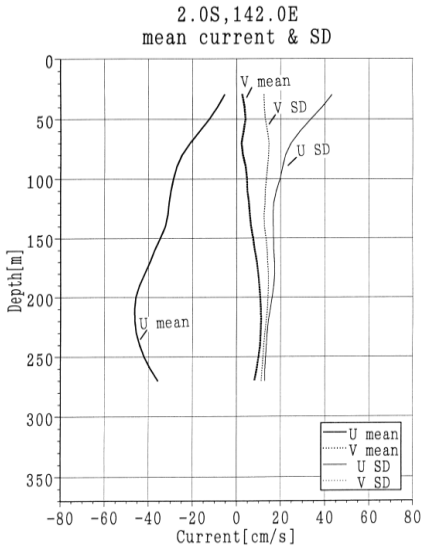


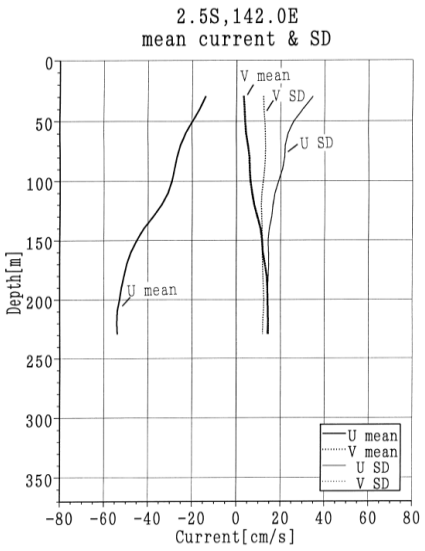




142°E section WEPOCS

Lindstrom et al., 1987

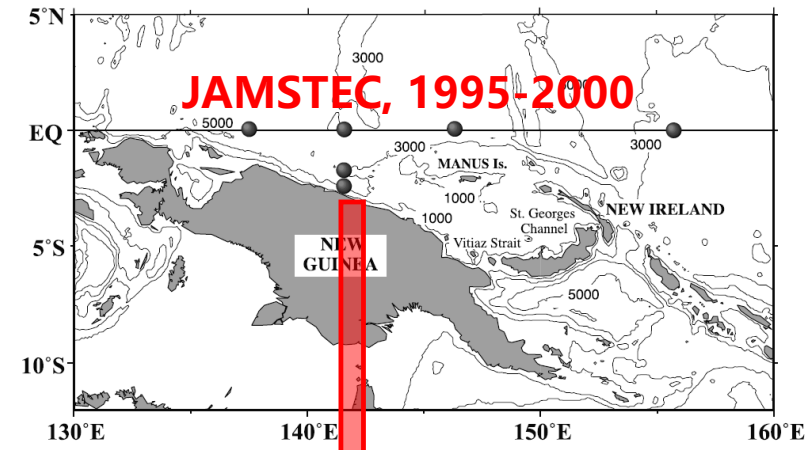


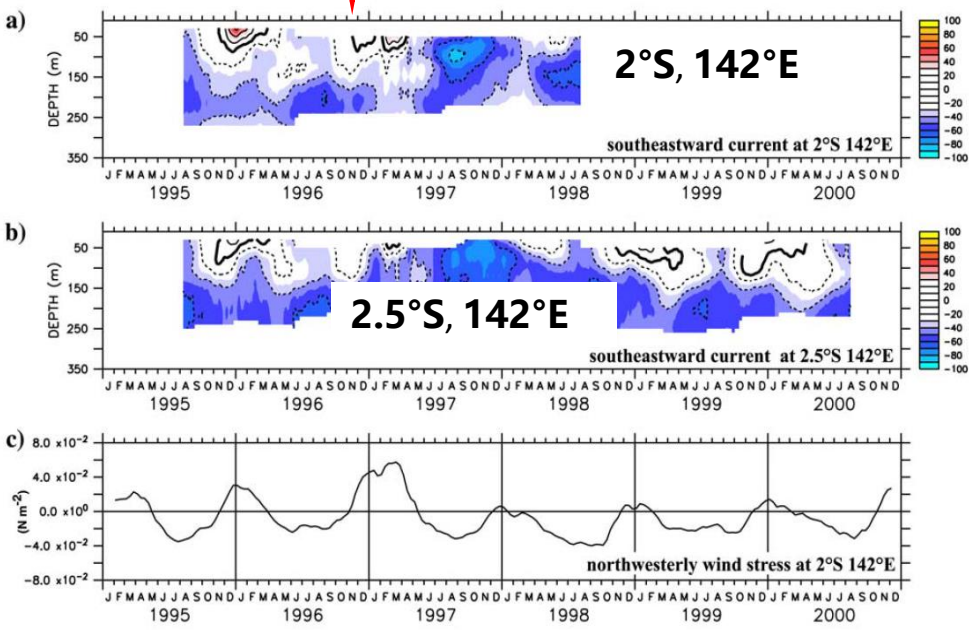


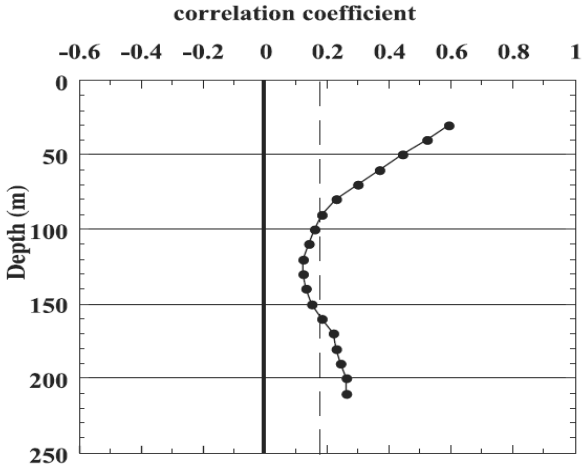
Kuroda et al., 2000

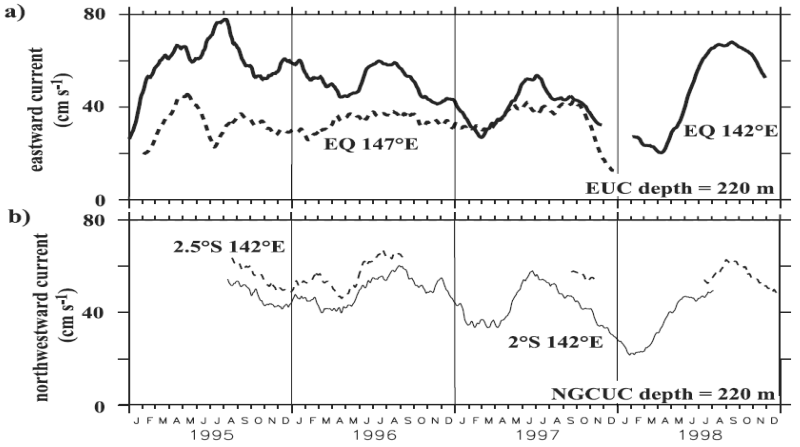
- seasonally reversing NGCC and northwestward NGCUC appear in the upper 200 m

Interannual variation of NGCC/NGCUC at 142°E





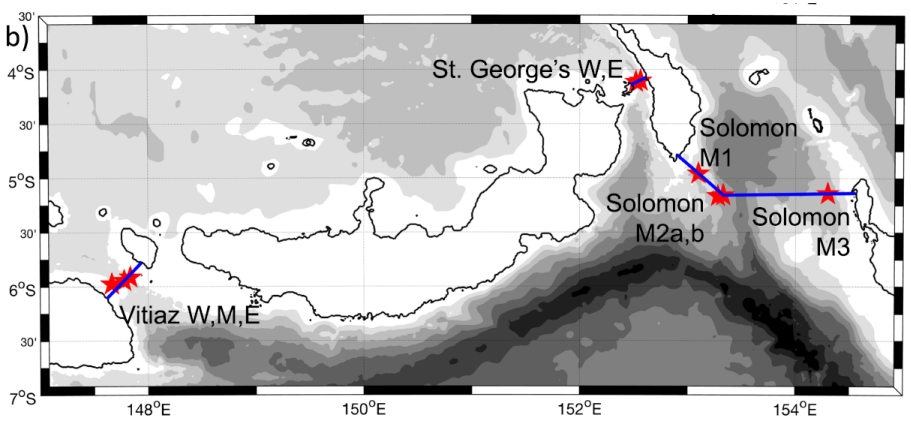




Ueki et al., 2003

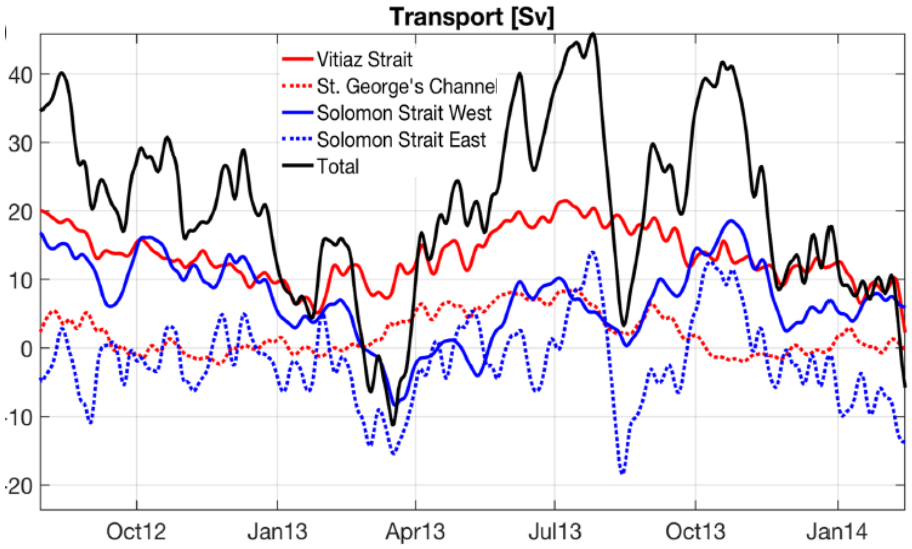
150k Hz ADCP only captures the currents in the upper 200 m

Mooring deployment during SPICE

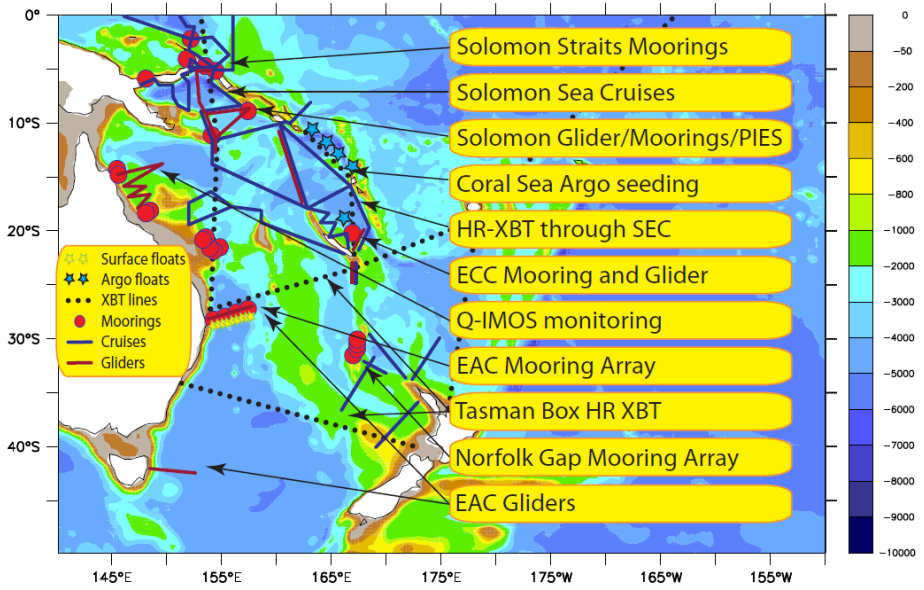


Jul. 2012-Mar. 2014

The surface to sill depth subinertial transport



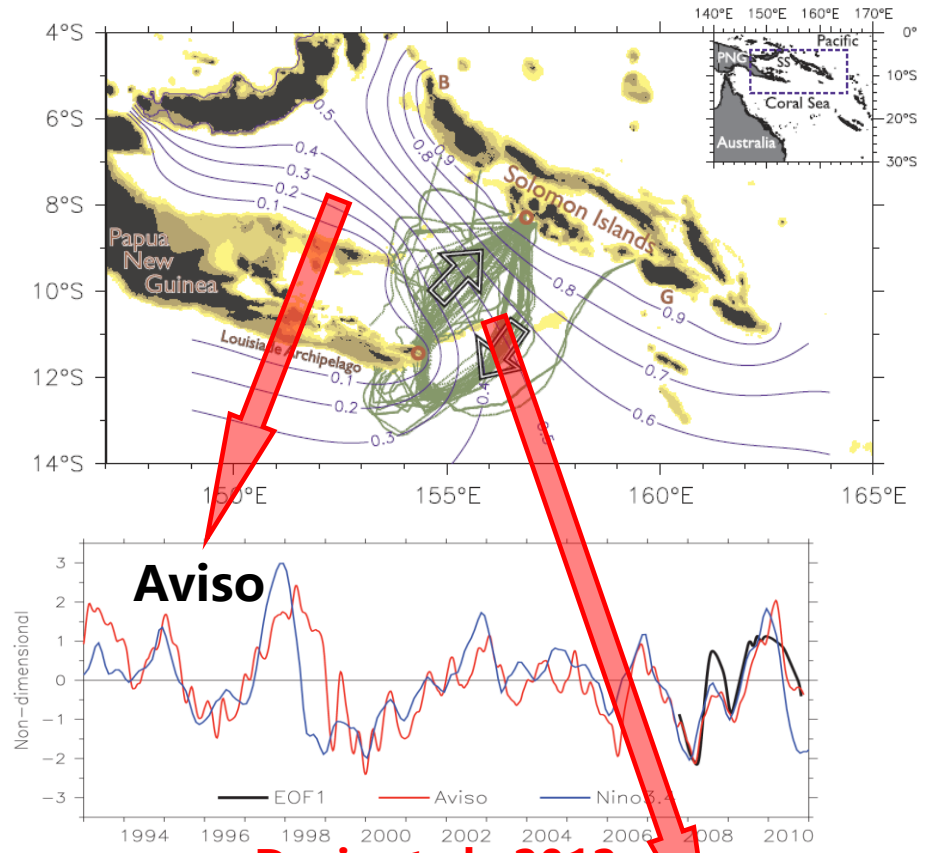
Alberty et al., 2019



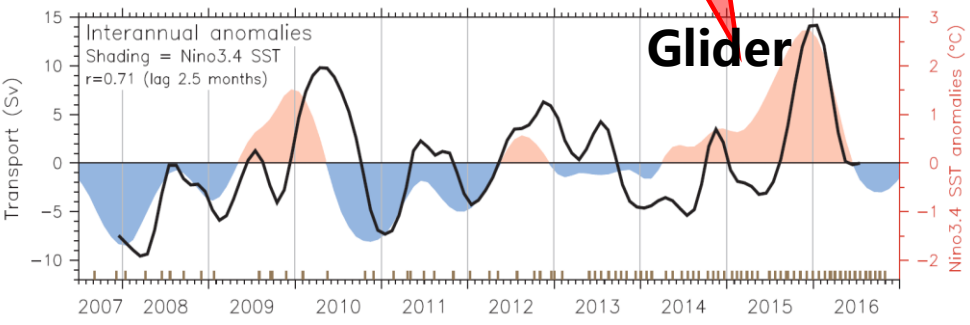
Ganachaud et al., 2014

- **Solomon Strait East displays large intraseasonal variations, While Other Straits exhibit seasonal variations**

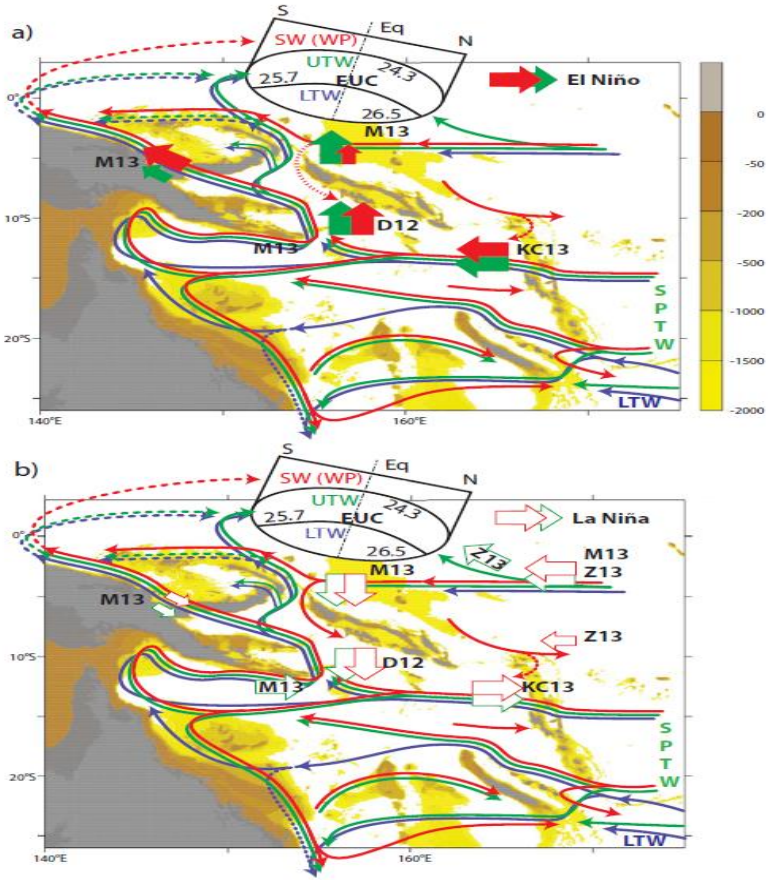
Interannual variation of LLWBCs in Solomon Sea



Davis et al., 2012



Kessler et al., 2019



Ganachaud et al., 2014

- Partition of interannual signals in Solomon Sea between three Straits ?
- Spatial pattern of the interannual signals along the PNG coast ?

Mooring and buoy array during NPOCE period

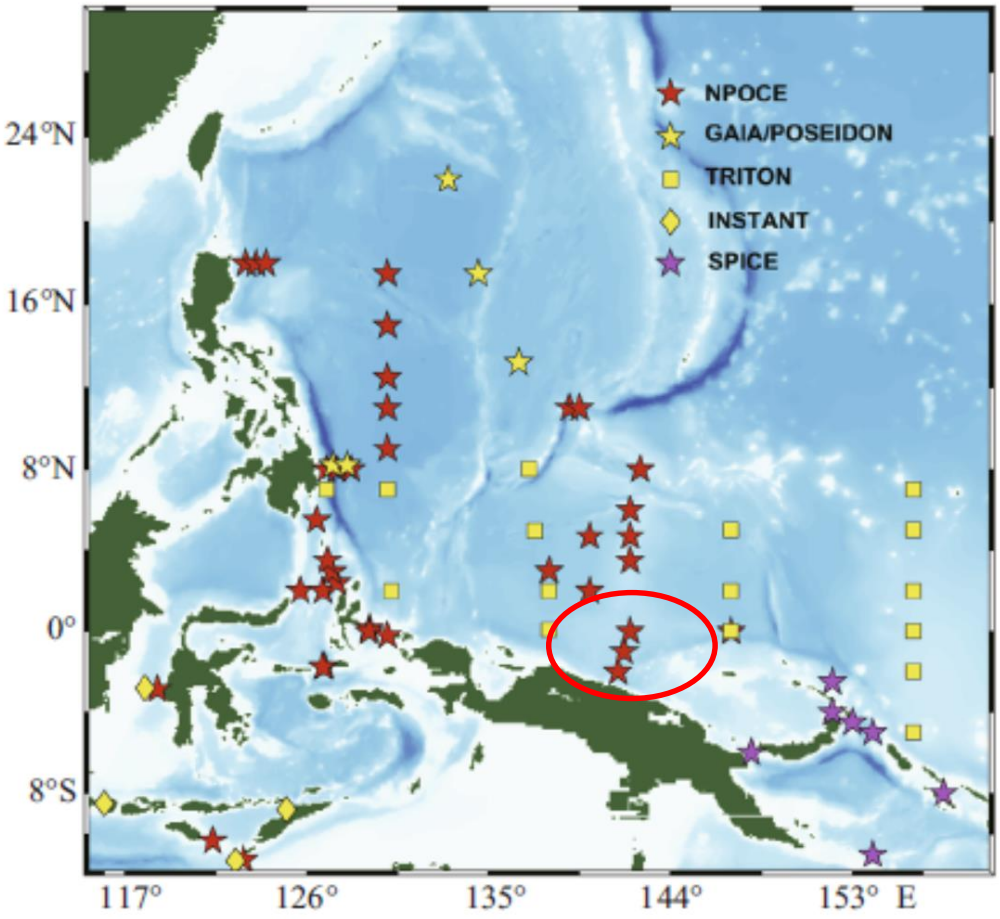
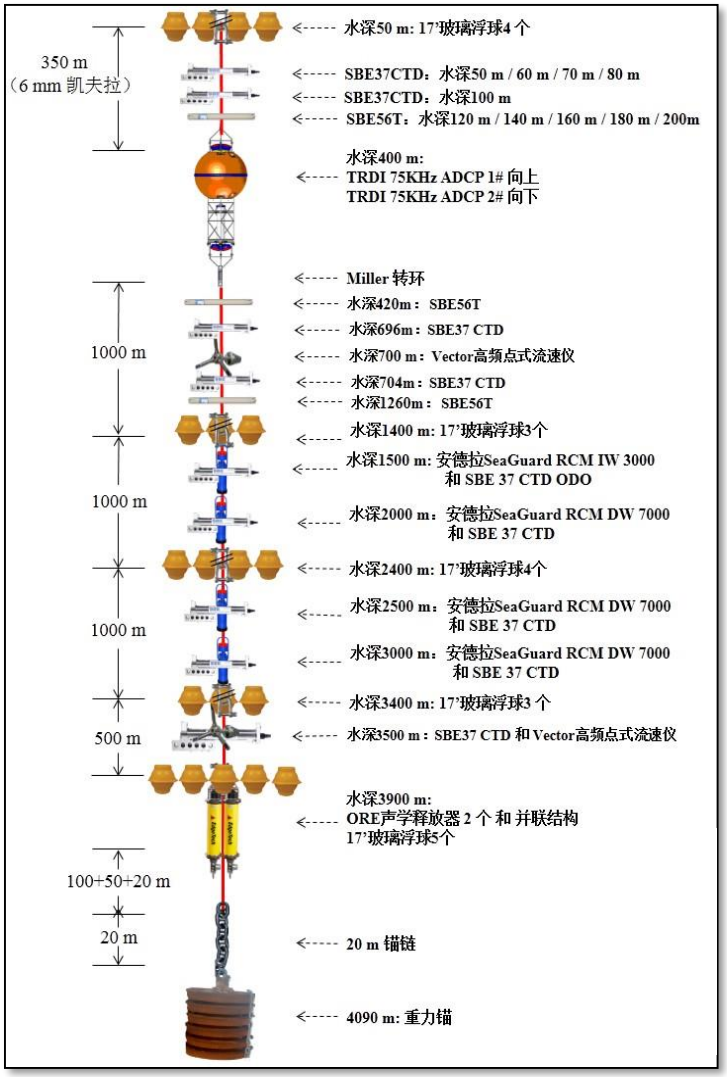


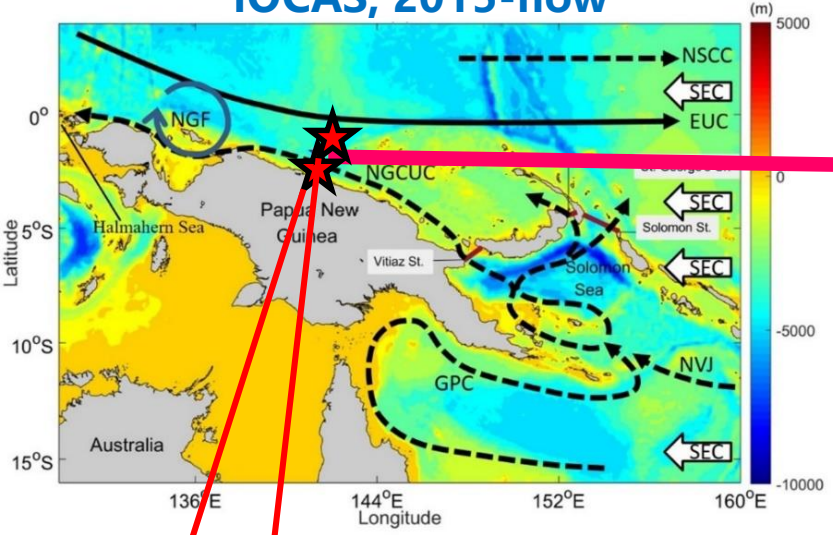
Fig.3 Mooring and buoy arrays during the NPOCE period

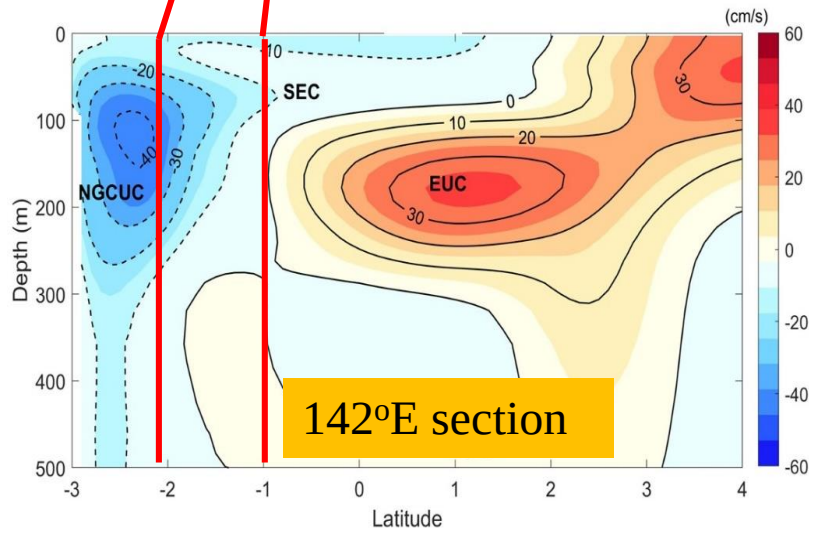
Hu et al., 2020

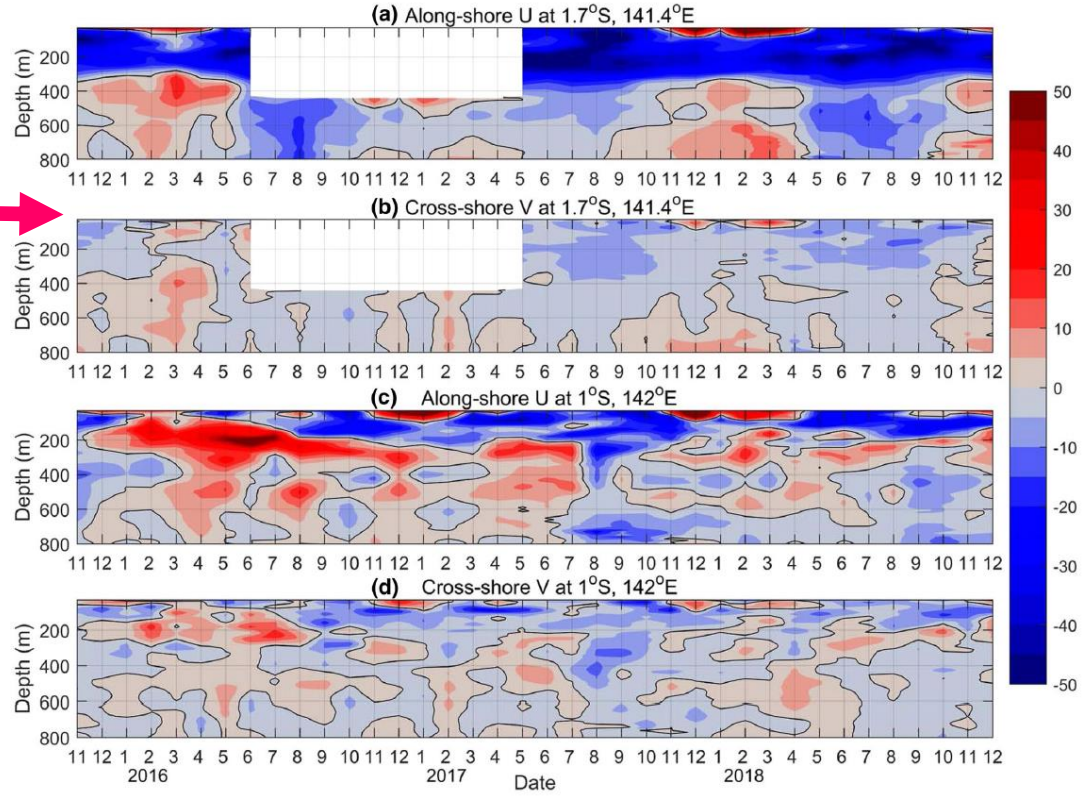


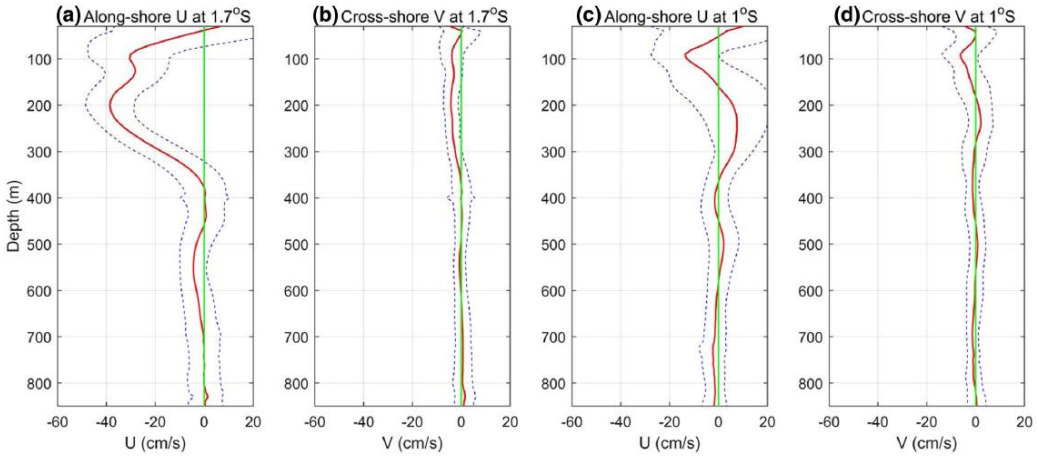
Monthly velocity time series measured by ADCP

IOCAS, 2015-now

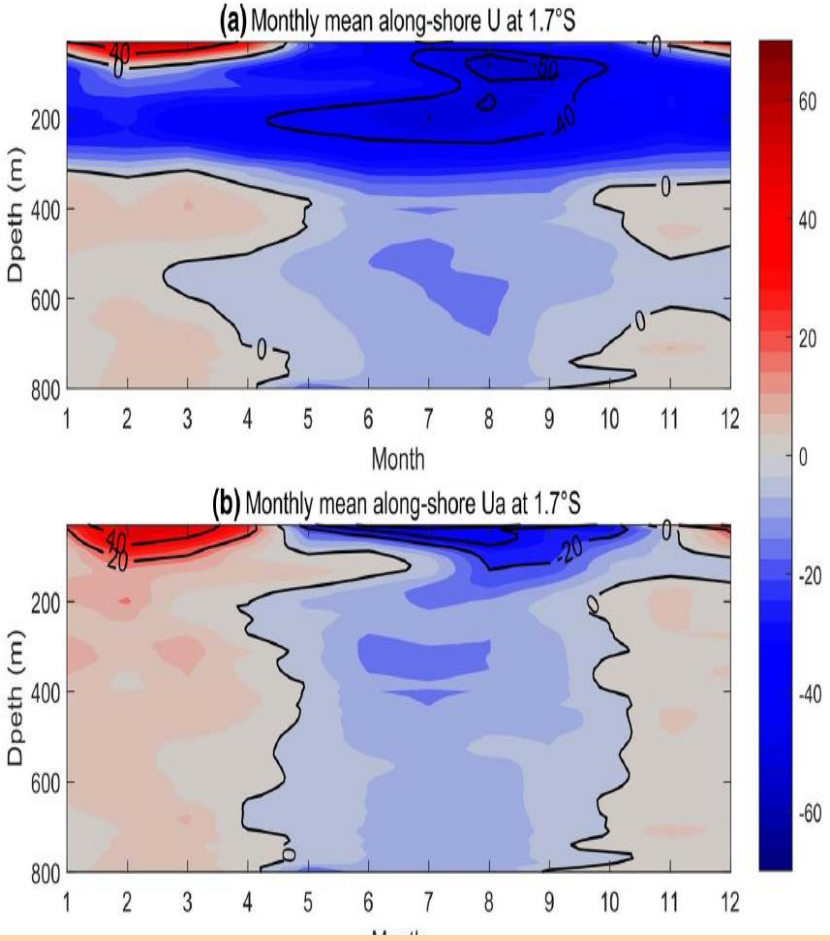


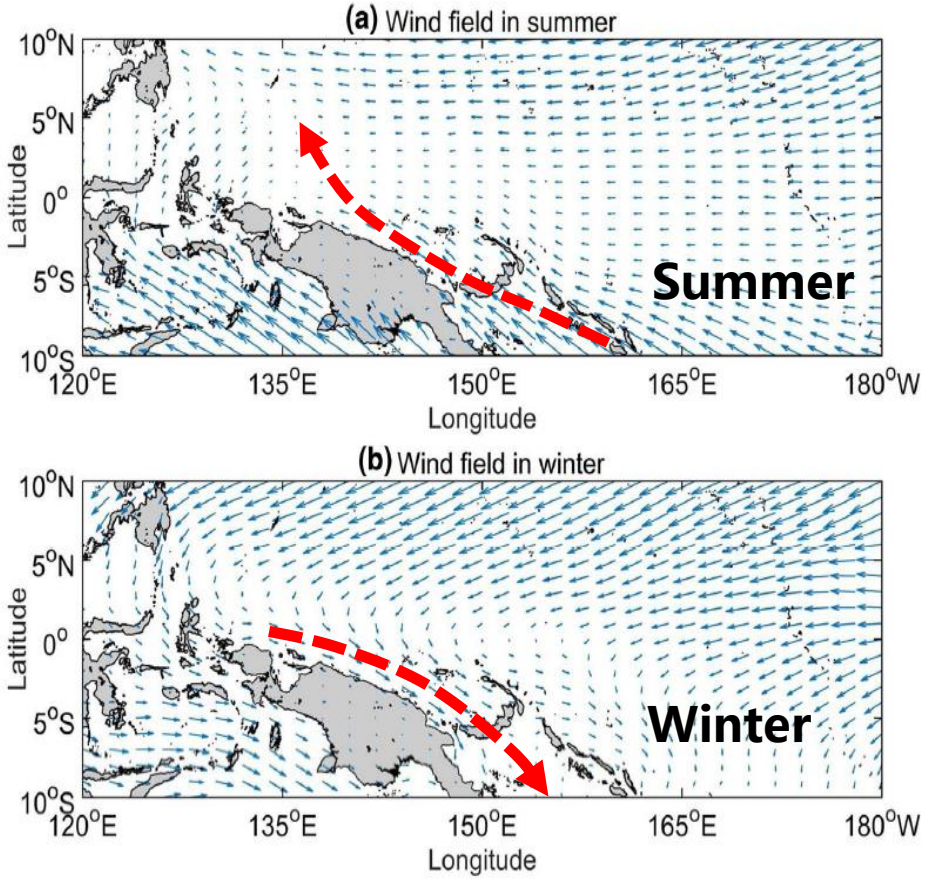






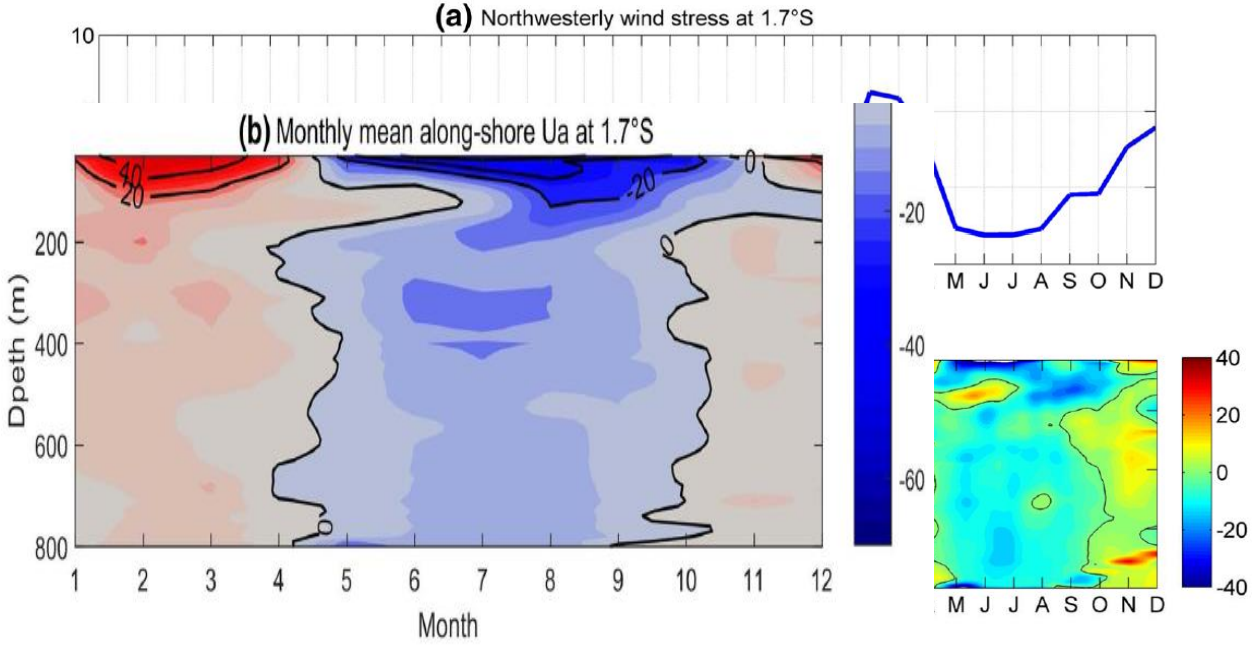
Monthly climatology of the NGCC/NGCUC from ADCP



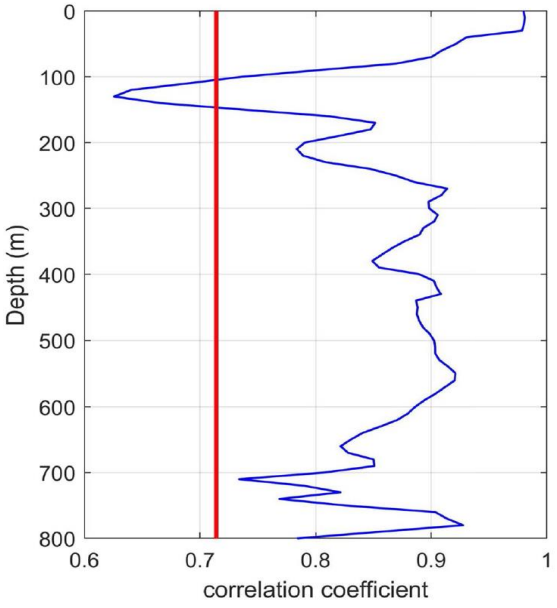


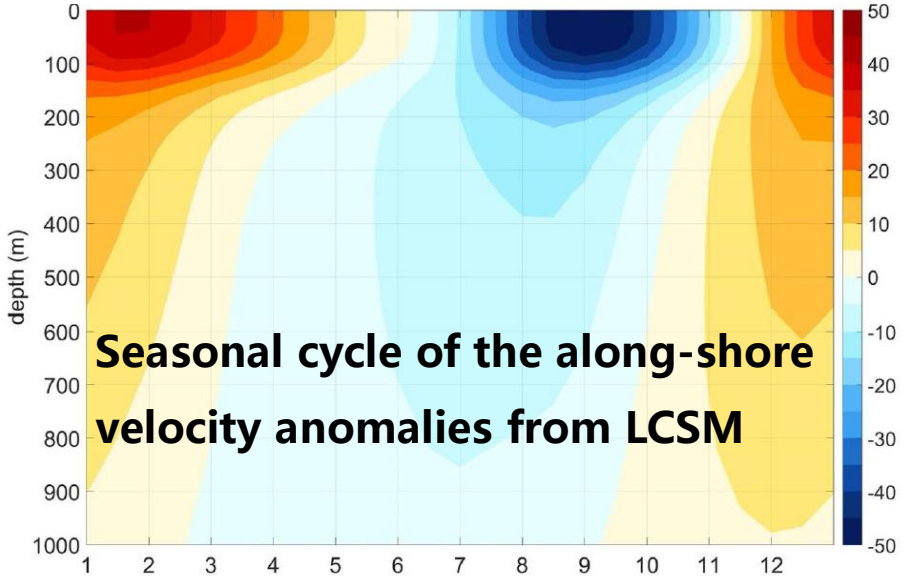
- Negative velocity anomalies above 800 m appeared from June to October and positive anomalies appeared from December to April of the following year
- Seasonally reversing New Guinea Coastal Intermediate Current (NGCIC) is detected below the NGCUC

Seasonal cycle is highly correlated with monsoon wind



Corr (U vs Wind stress)

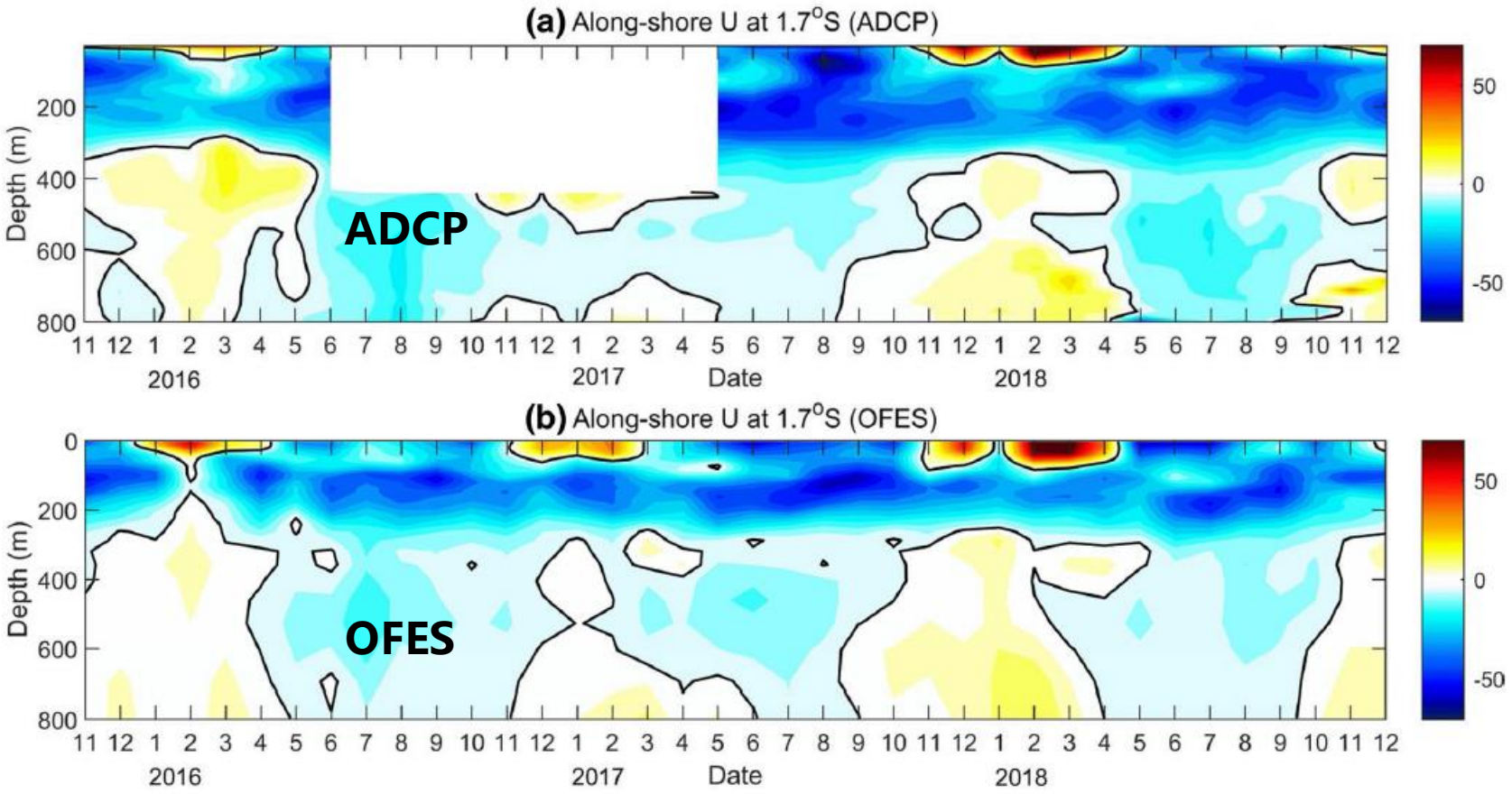




Seasonal cycle of the along-shore velocity anomalies from LCSM

- **Strong seasonal signal appear in the upper 800 m, and the effects of monsoon wind forcing could reach the depth of 800 m**

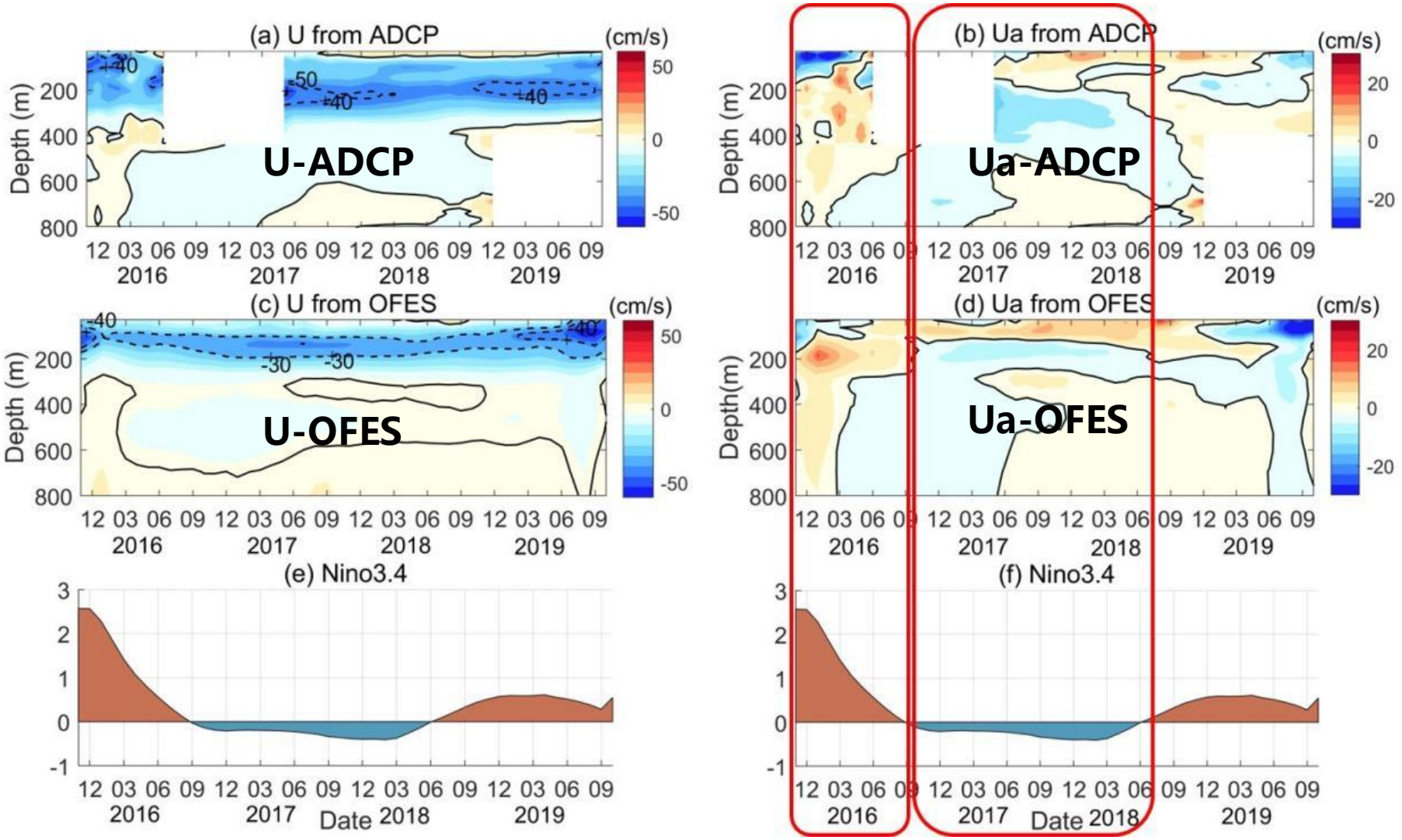
Seasonal cycles in ADCP and OFES model



Corr (ADCP vs OFES)> 0.88

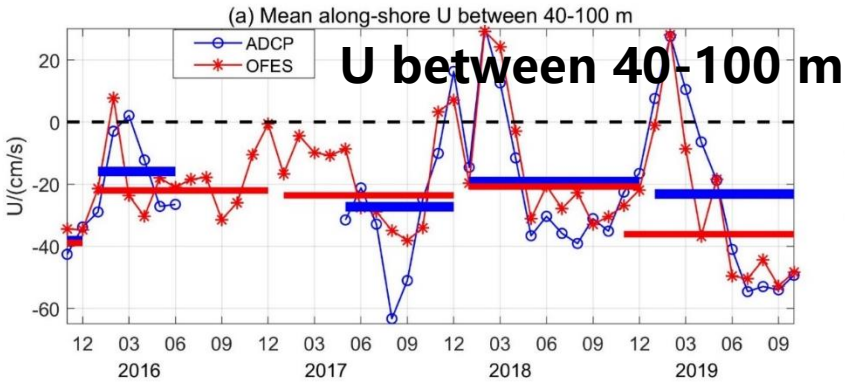
OFES model can simulate the seasonal cycle of NGCC/NGCUC well !

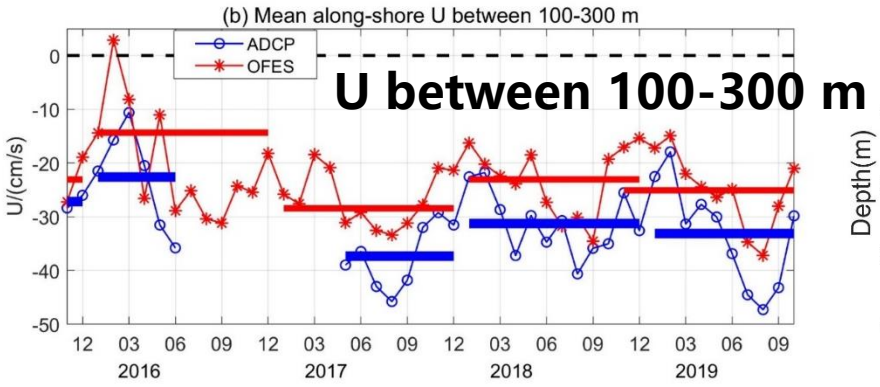
Significant interannual variation at 141.4E, 1.7S

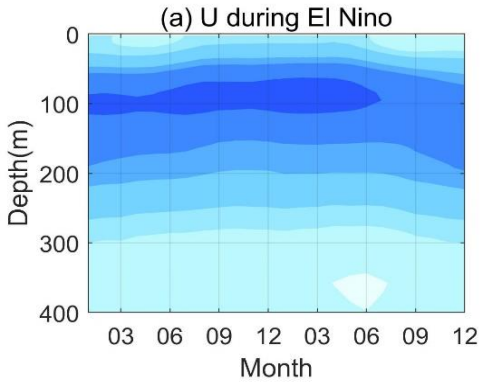


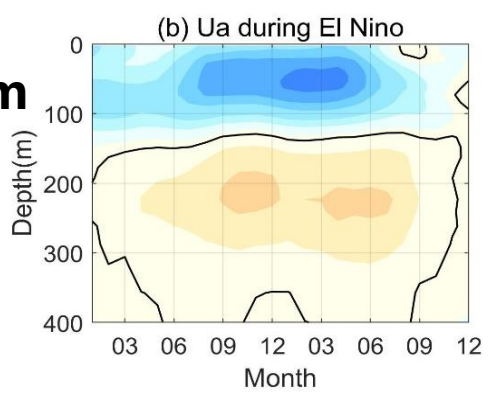
Striking interannual modulations of the NGCC/NGCUC system appeared in the ADCP measurements and OFES model.

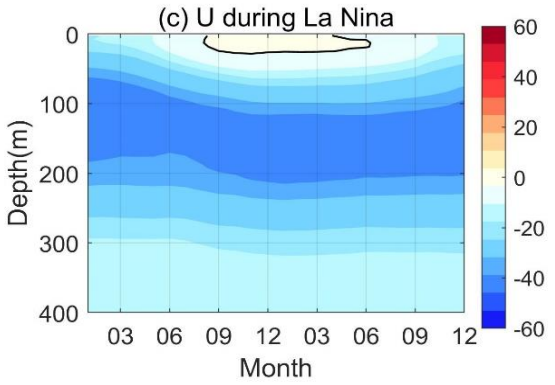
Interannual variation during different phases of ENSO

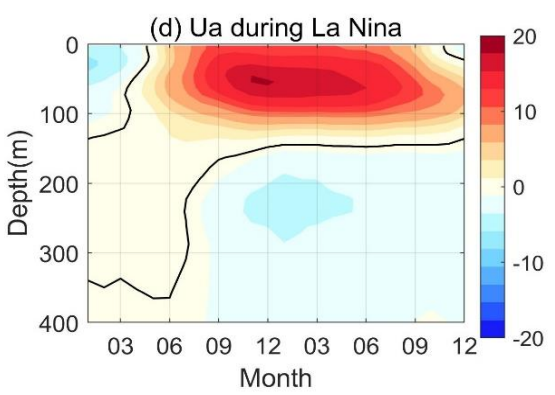






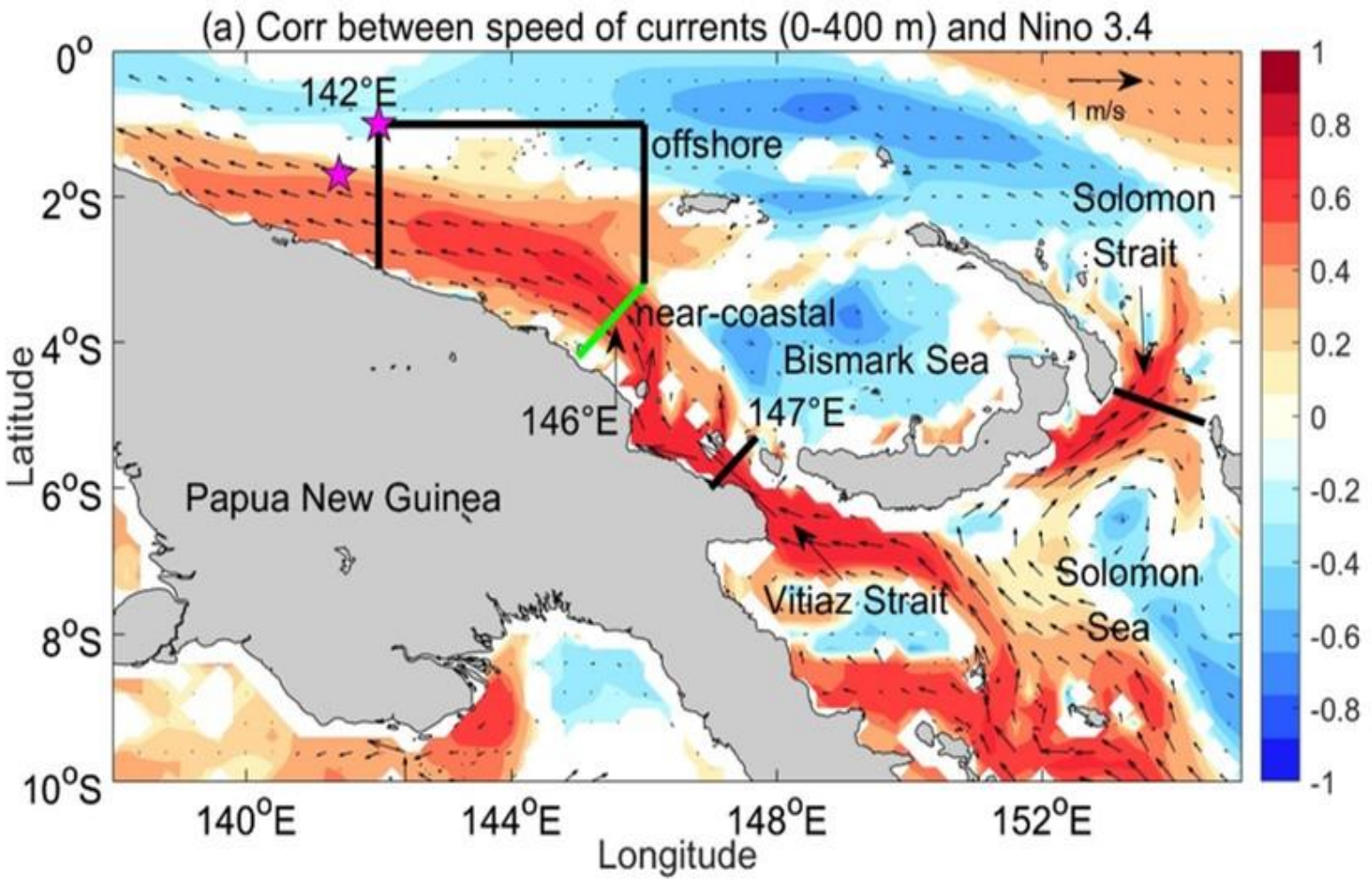






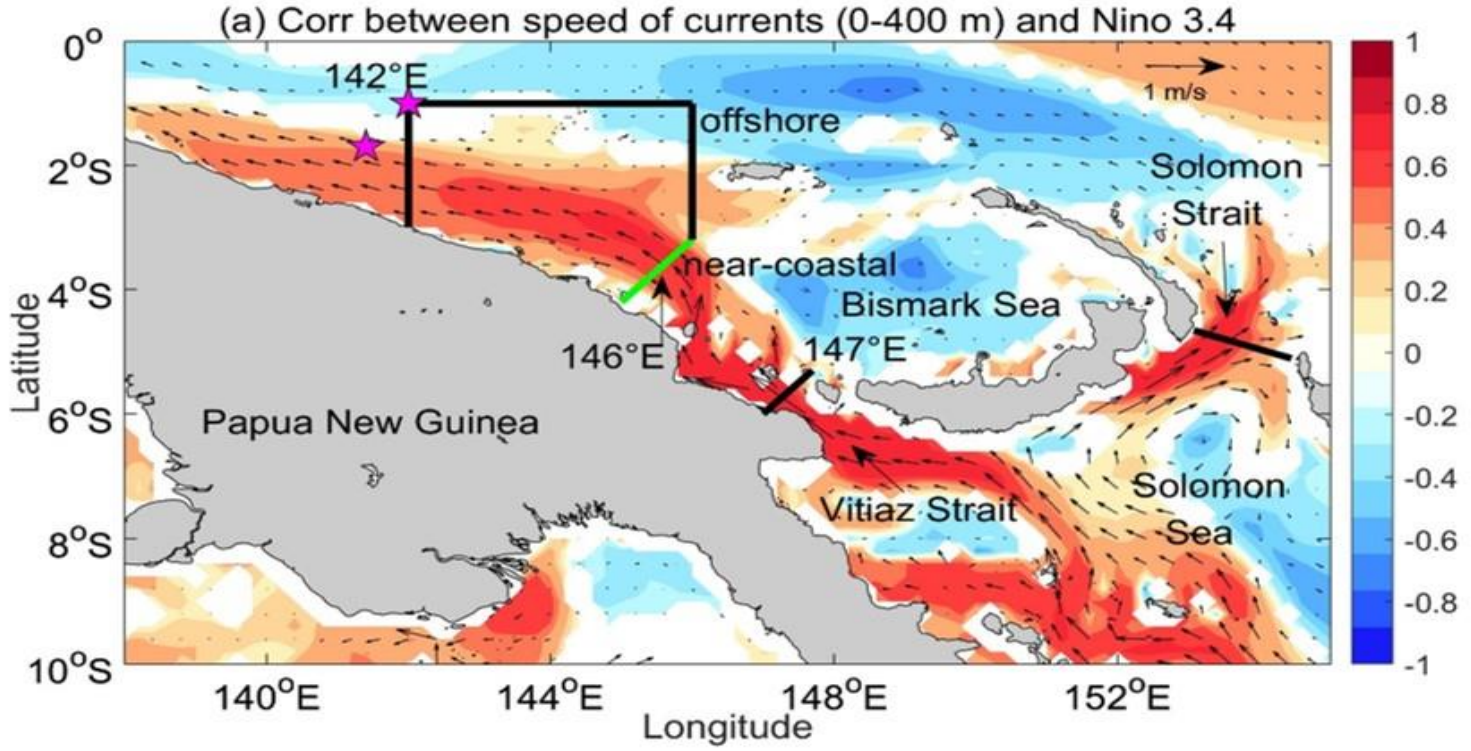
Interannual changes occur during the whole El Nino (La Nina) period, not only in the mature period of the observation period

Spatial pattern of the interannual signals



The ENSO-related interannual signal of NGCC/NGCUC transport along the PNG coast can be traced back to the Solomon Sea.

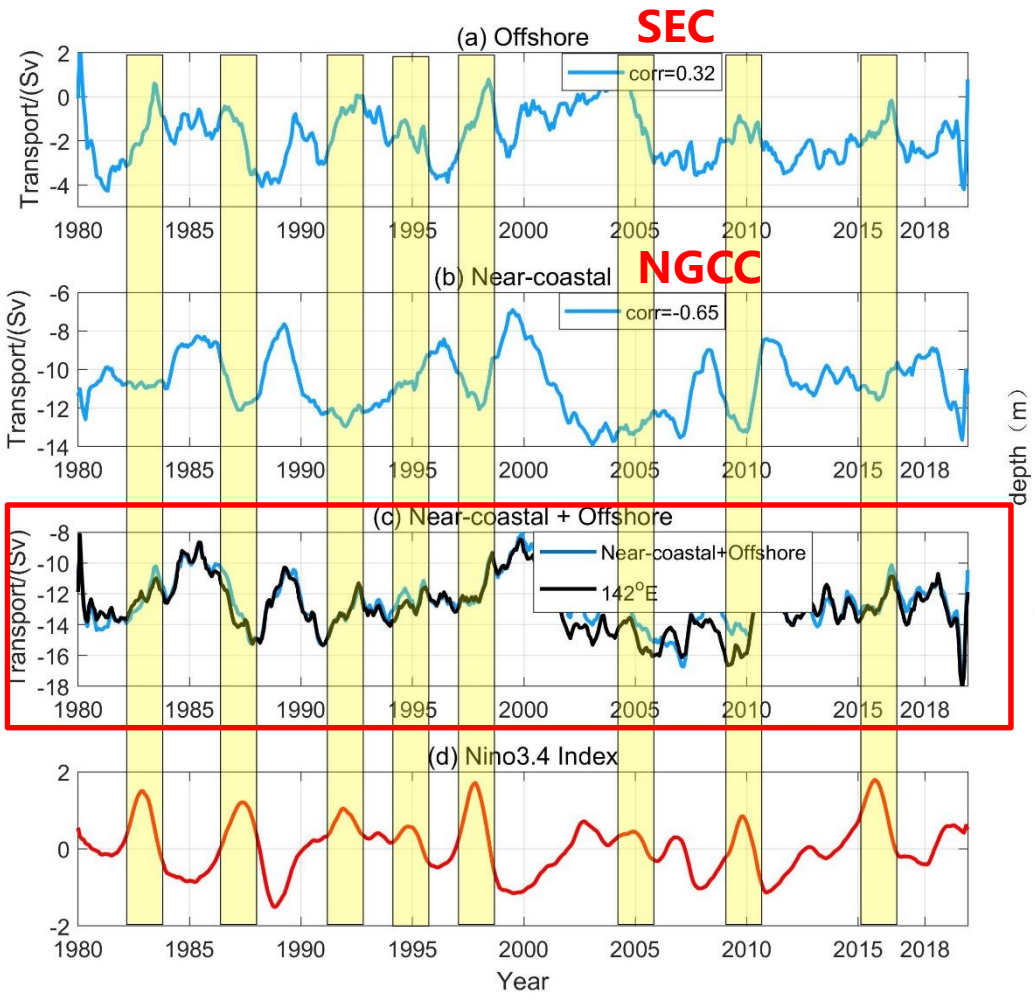
Transport partitioning through three Straits

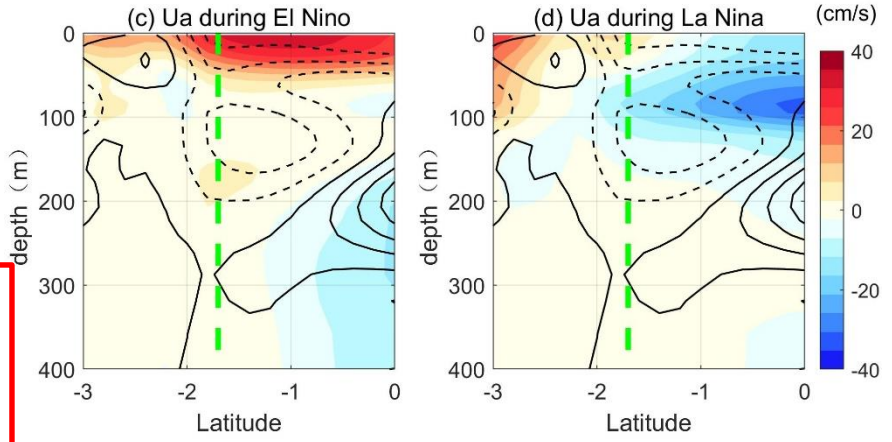


	142°E	Vitiaz Strait	Solomon Strait
SW (≥23.3σθ)	-3.21 (0.33)	-2.00 (0.39)	-1.34 (0.23)
UTW (23.3-25.7σθ)	-5.82 (0.38)	-4.33 (0.51)	-3.56 (0.62)
≥ 400 m	-12.90 (0.65)	-9.19 (0.84)	-8.21 (1.05)

The mean transport through the Vitiaz Strait is larger than that through the Solomon Strait, but a relatively larger proportion of interannual variation through the Solomon Strait

Transport budget within the box

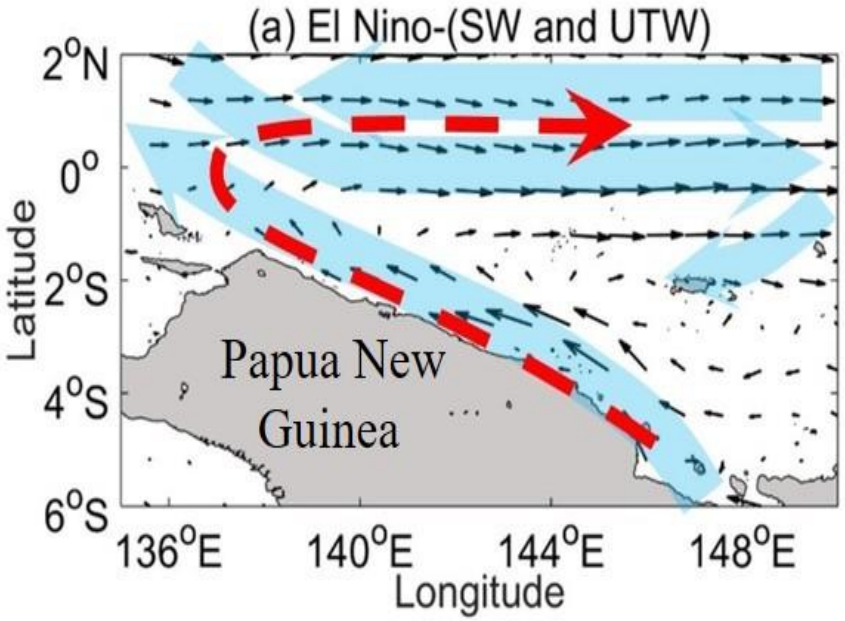


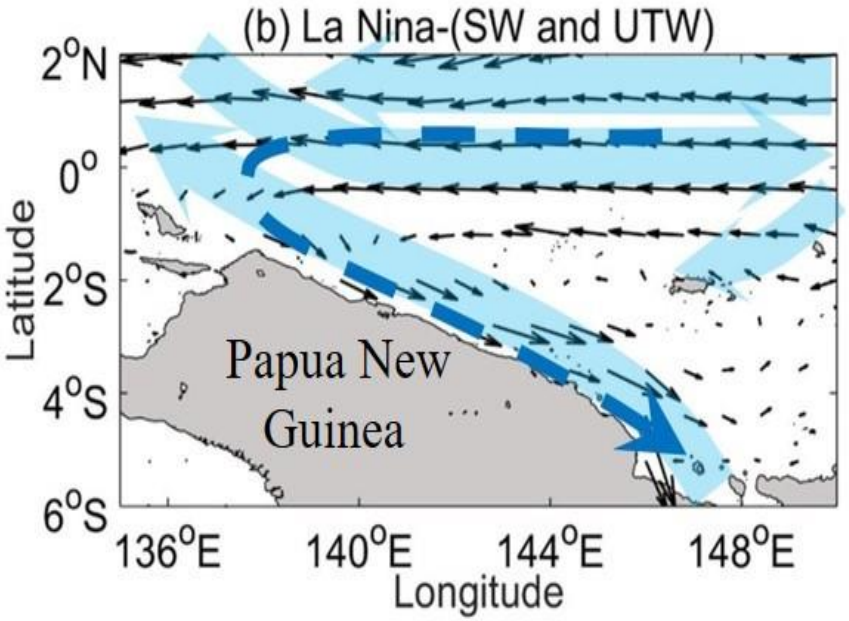


ENSO signals of NGCC/NGCUC weaken due to the feeding of SEC

SEC is positively correlated with ENSO

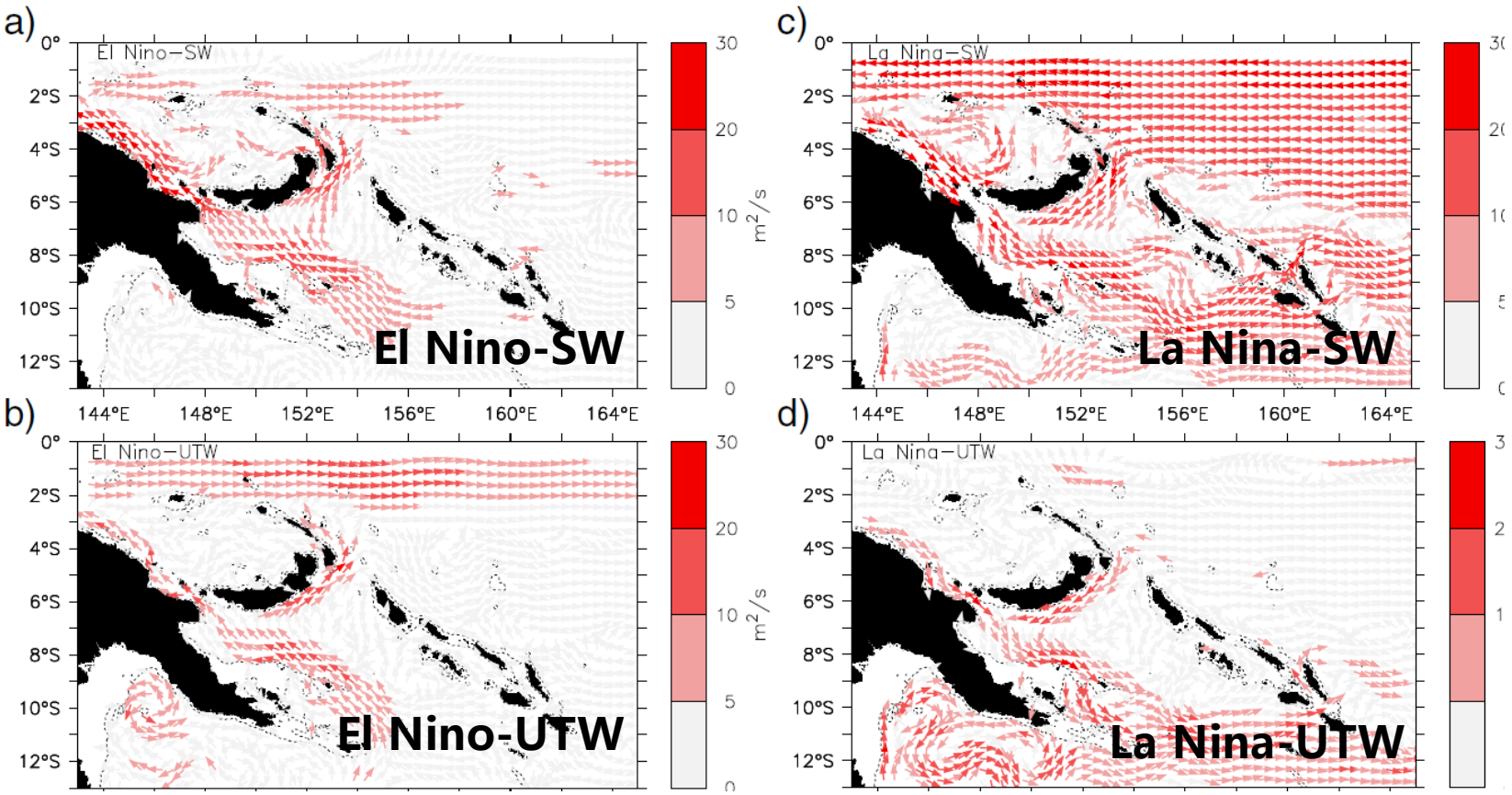
Large-scale ocean circulation anomalies during ENSO





The anomalous clockwise circulation straddling the equator appear above the thermocline respectively during El Niño

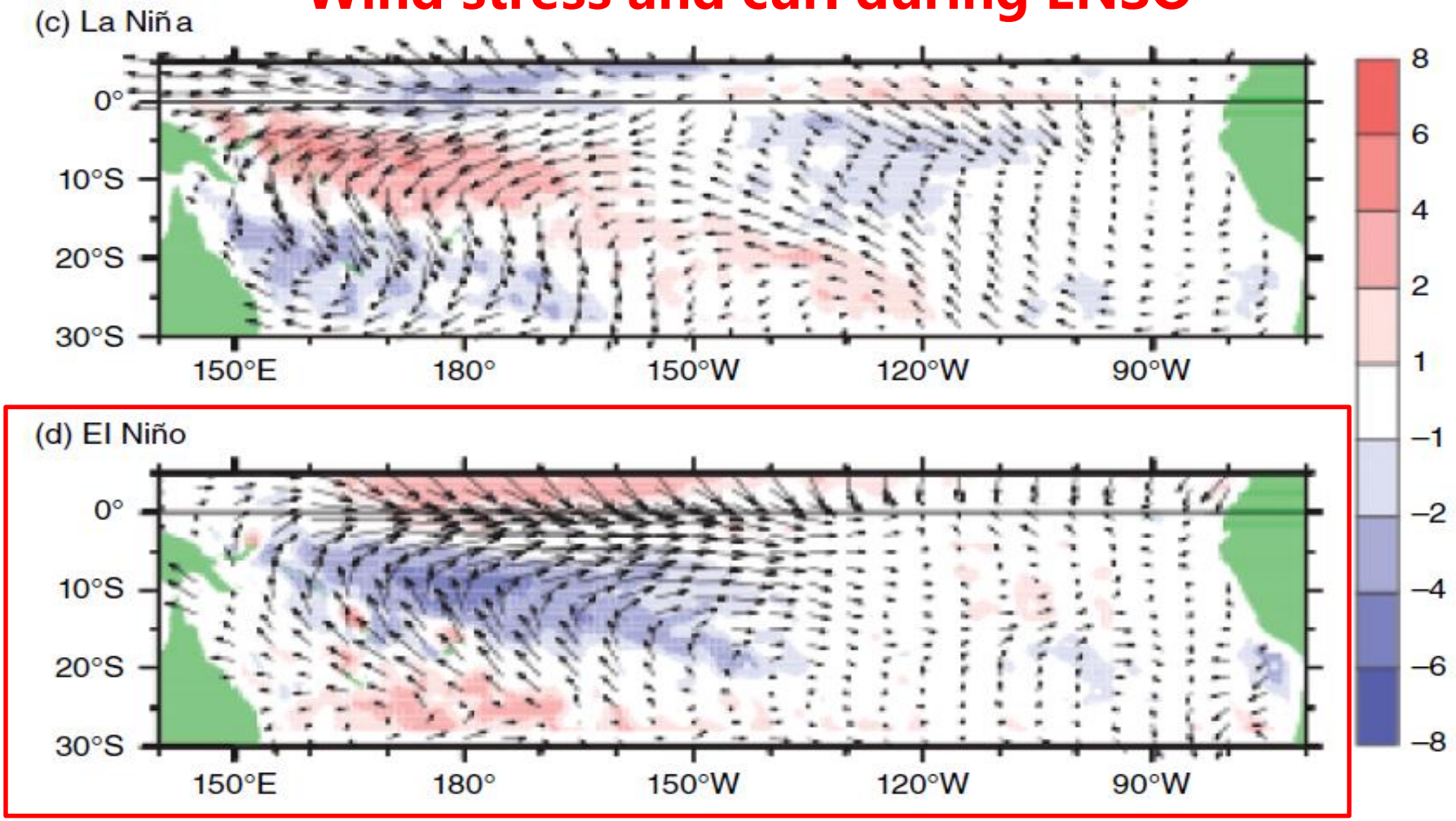
The anomalies of the Solomon Sea circulation from model



Melet et al., 2013

El Niño (left) and La Niña (right) composites of circulation anomalies vertically integrated in the surface (top) and upper thermocline (bottom) layers

Wind stress and curl during ENSO

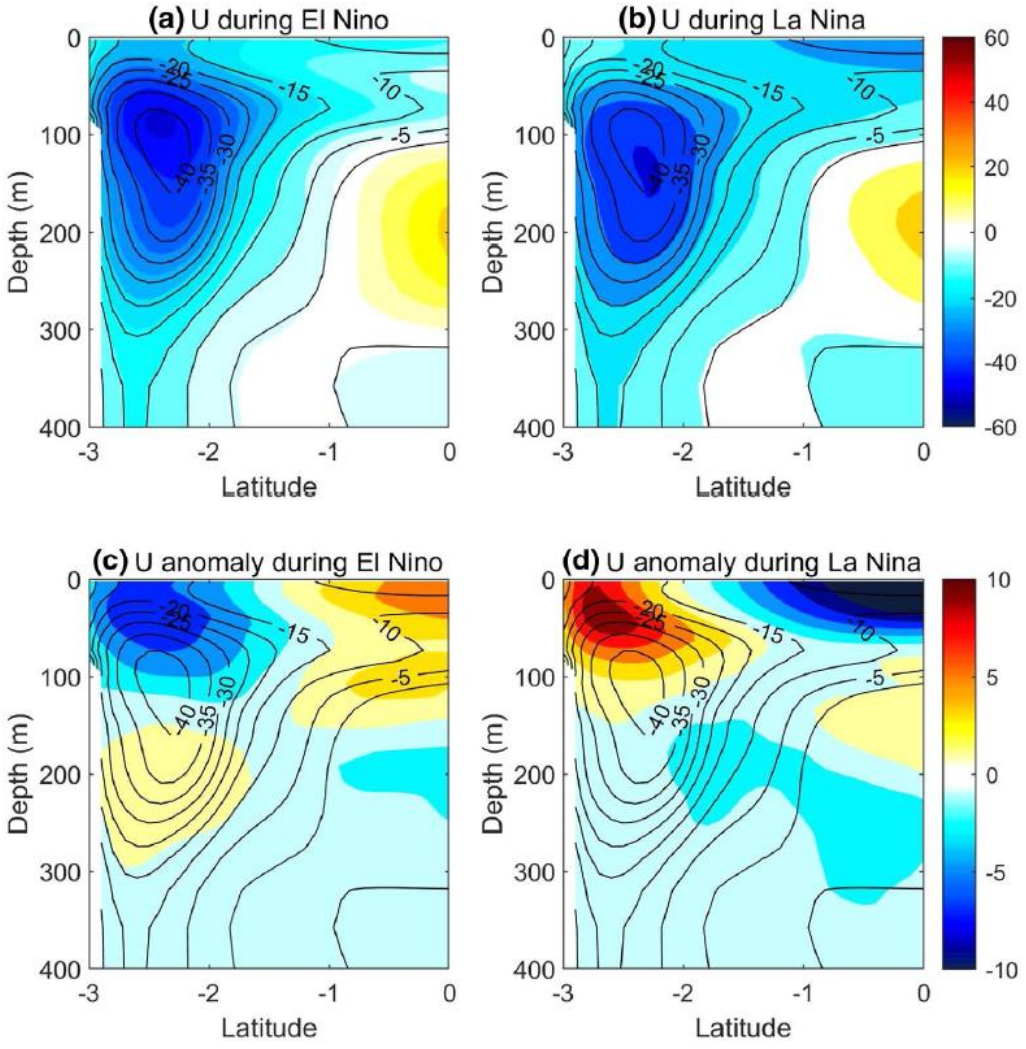


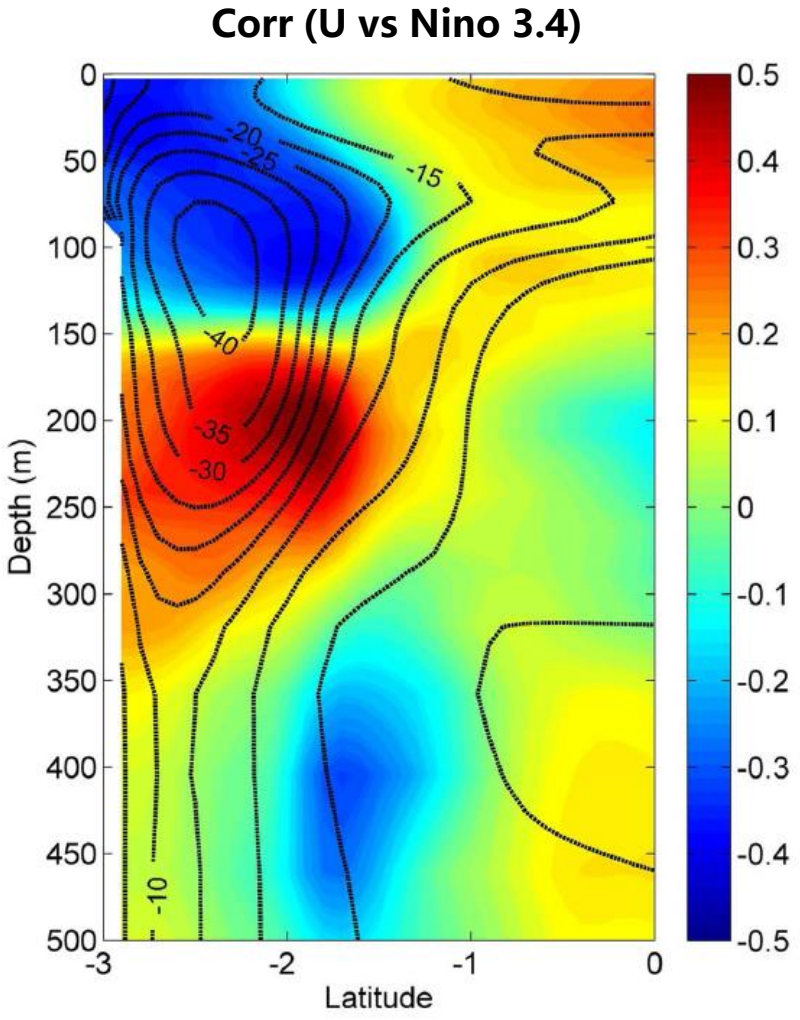
Kessler et al., 2019

wind stress curl anomalies over the South Pacific drive the LLWBC change

wind stress anomalies near the equator drive the equatorial SEC change

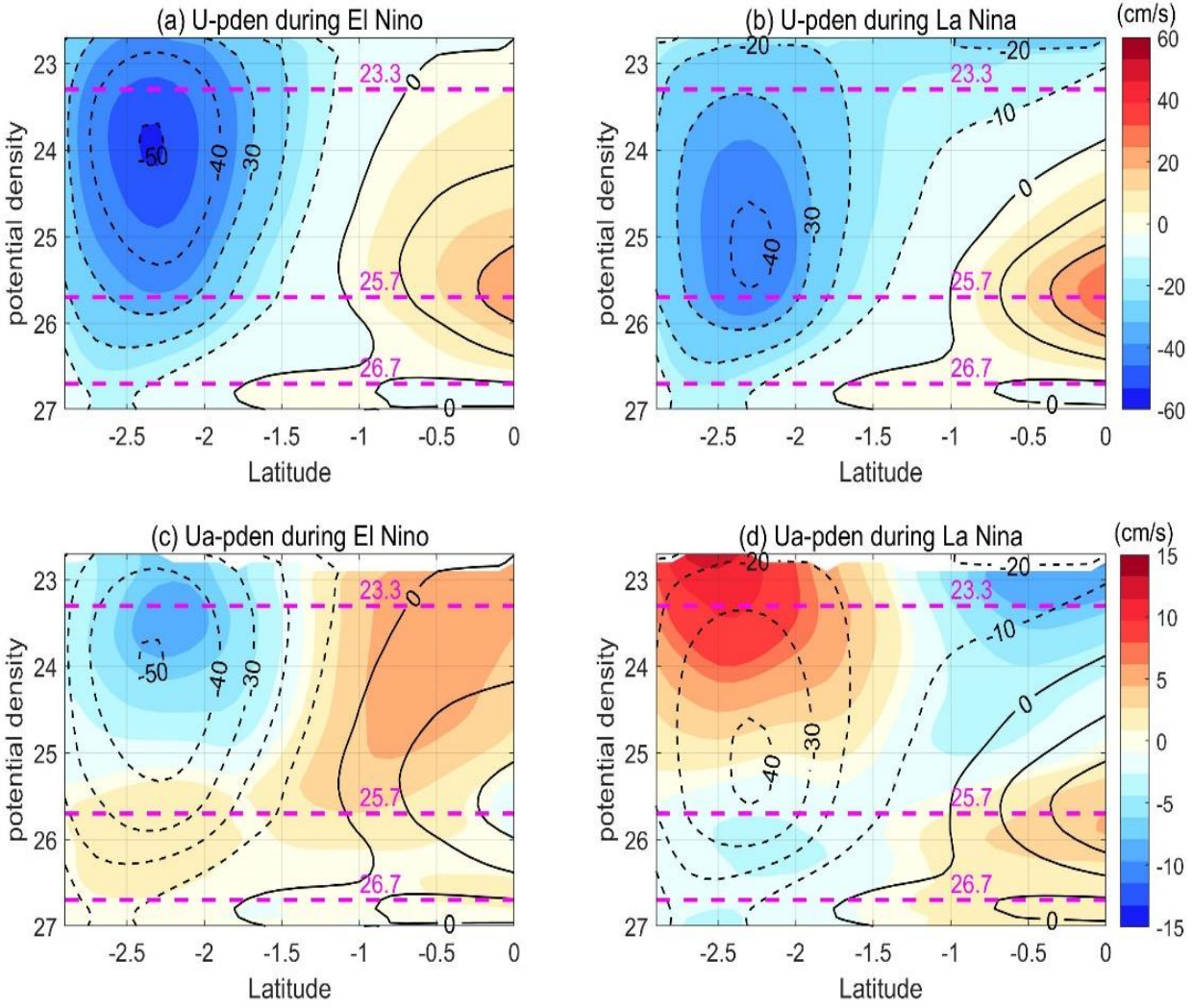
Dipole structure of the NGCUC velocity core during ENSO

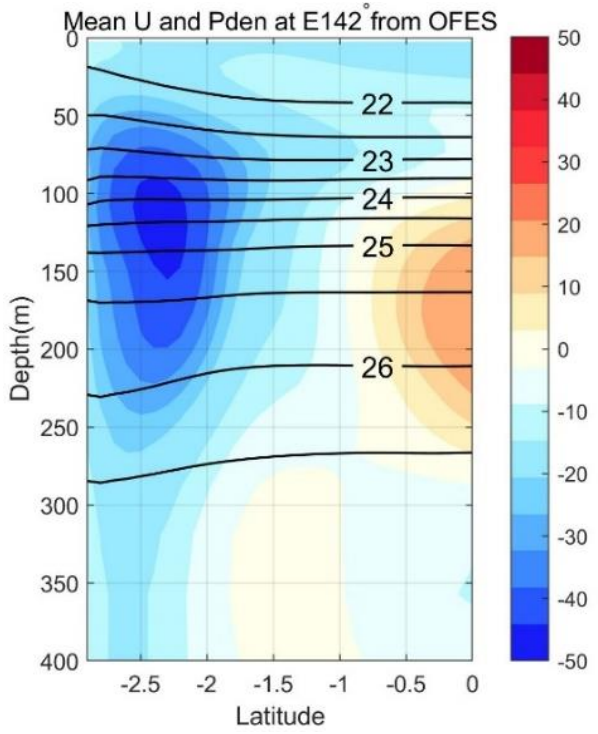




The velocity in the upper 150 m shows negative correlations with the Nino 3.4, and the velocity between 150-350 m shows positive correlations with the Nino 3.4

Significant interannual variability on isopycnals

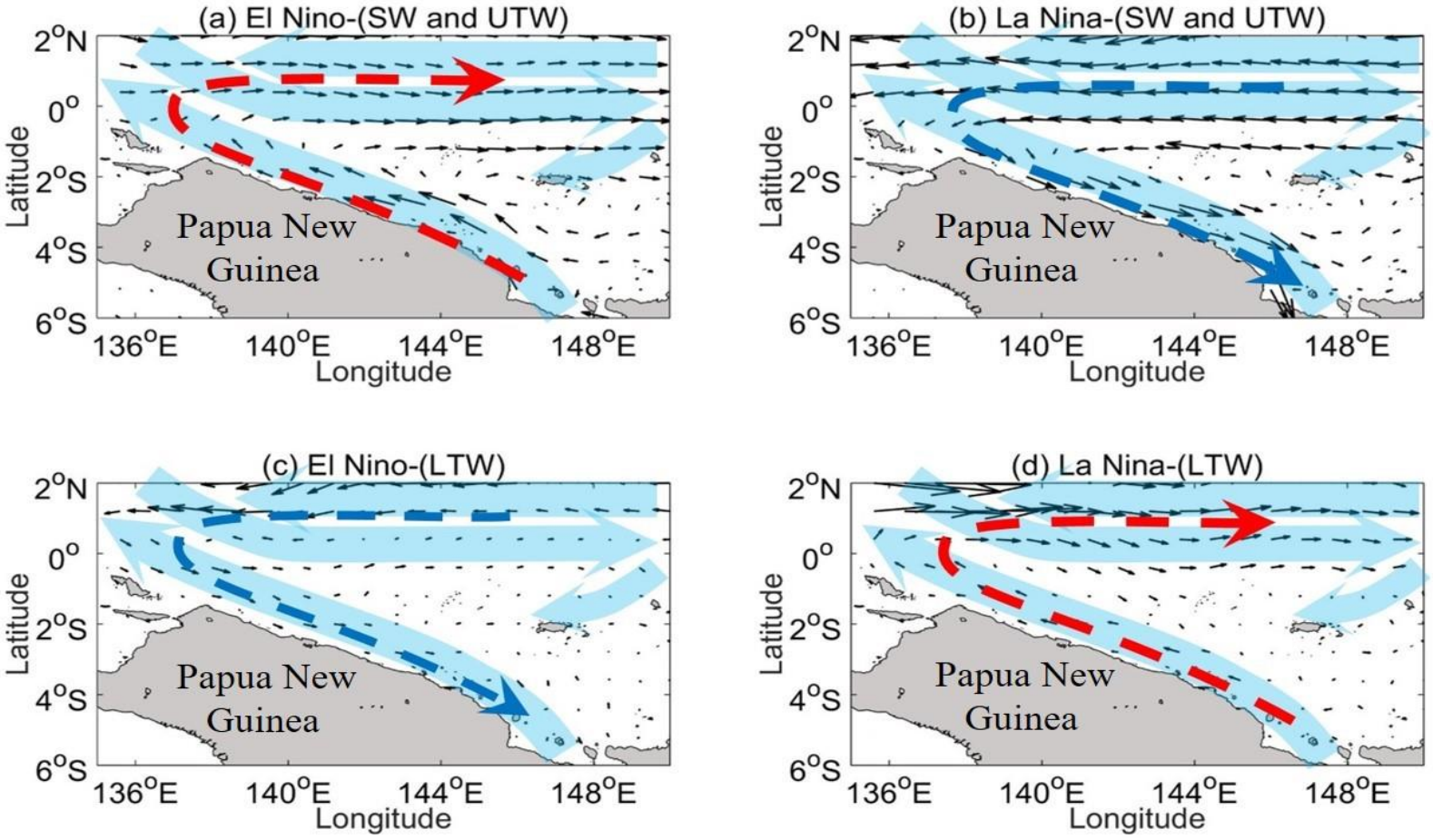




Water masses	Density
SW	σ_θ<23.3
UTW	23.3<σ_θ<25.7
LTW	25.7<σ_θ<26.7

The enhanced NGCUC and westward velocity anomalies appear above 25.4σ_θ during El Nino, and weakened NGCUC and eastward anomalies appear below 25.4σ_θ

Large-scale ocean circulation anomalies during ENSO



The anomalous clockwise and counterclockwise circulation straddling the equator appear above and below the thermocline respectively during El Niño

Summary

- Vertical structure of currents in the upper 800 m off the PNG coast is revealed with mooring measurements; Wind-induced seasonality is not trapped in upper ocean, a seasonally reversing flow is detected below NGCUC
- A relatively larger proportion of ENSO signal in the Solomon Sea is transmitted through Solomon Strait compared with Vitiaz Strait.
- ENSO signals of NGCC/NGCUC transport weaken northwestward along the New Guinea coast due to the feeding of SEC.
- Currents above and below the thermocline exhibit opposite interannual anomalies, being related to large scale circulation change during ENSO

- Zhang L., J. Wu, F. Wang, S. Hu, Q. Wang, F. Jia, F. Wang, and D. Hu, 2020, Seasonal and interannual variability of the currents off the New Guinea coast from mooring measurements, J. Geophys. Res., 125, 12, e2020JC016242. Doi:10.1029/2020JC016242.
- Wu J., L. Zhang, F. Wang, C. Kaluwin, and D. Hu, 2022, Currents off the Papua New Guinea coast during and after the El Niño of 2015-2016, submitted to J. Geophys. Res.

Thank You!