Pacific Low Latitude Western Boundary Currents

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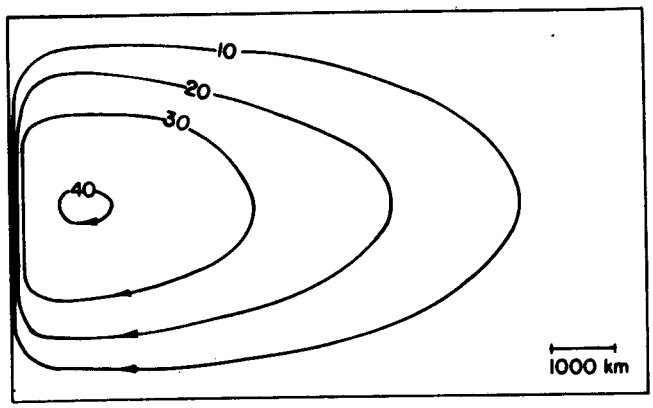
Major Features

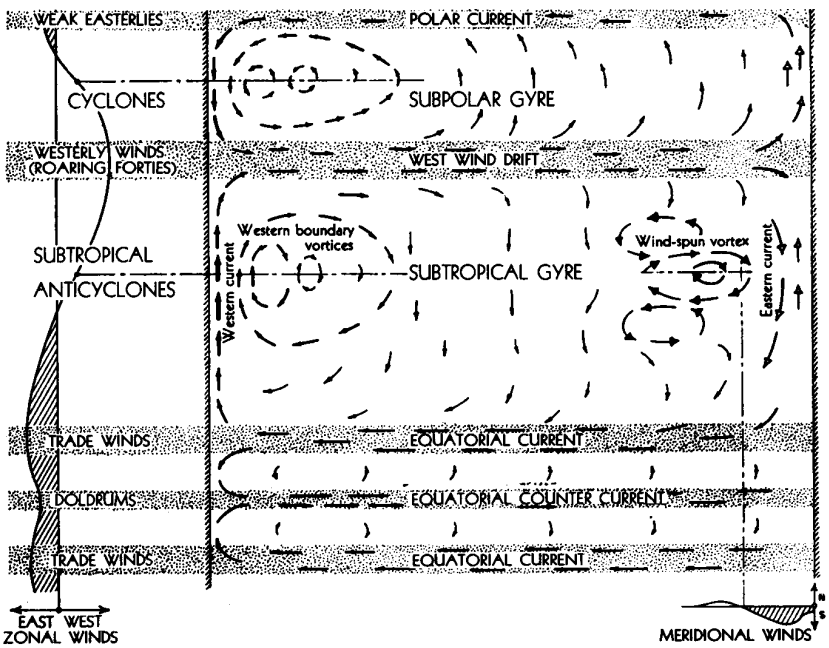
- Mindanao Current (Equatorward Flow) + Dual Eddies
- Indonesia Through Flow (TF)
- Kurorshio Intrusion into the South China Sea (SCS)
- Subtropical Counter Current (Eastward Flow)

Classical Theories

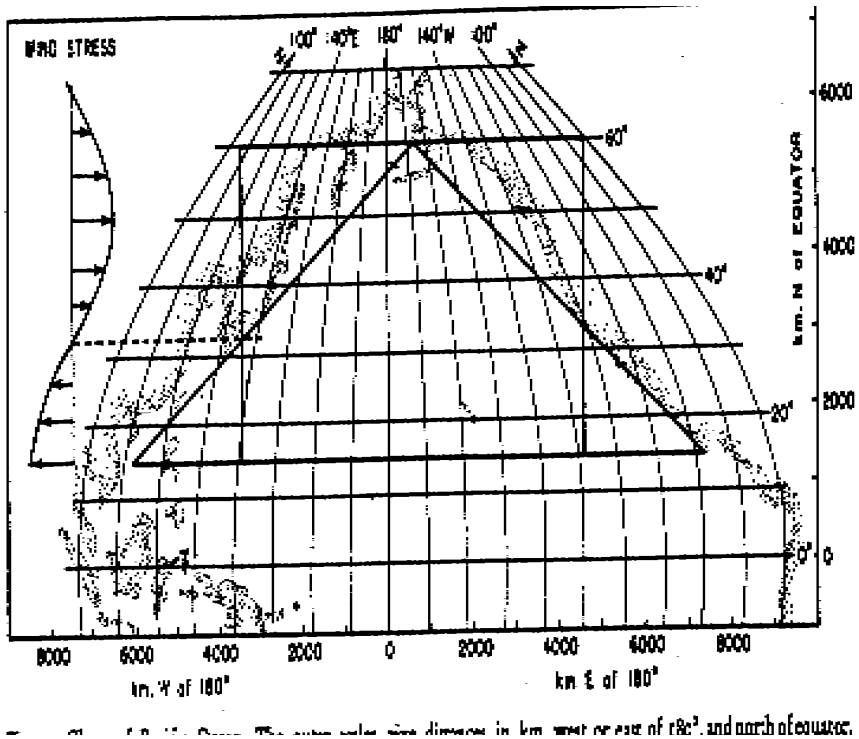
- Stommel (1948)

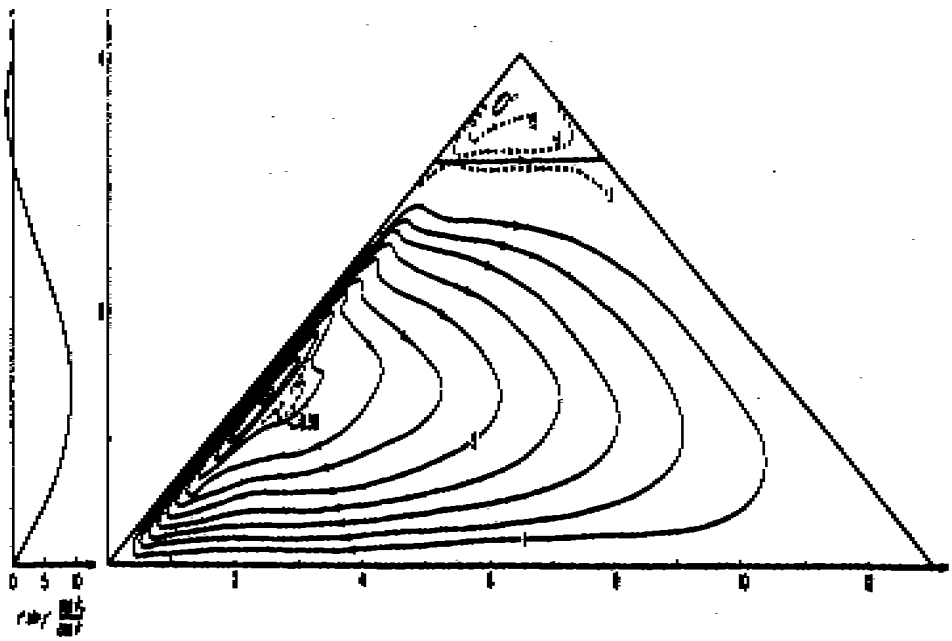


- Munk (1949)

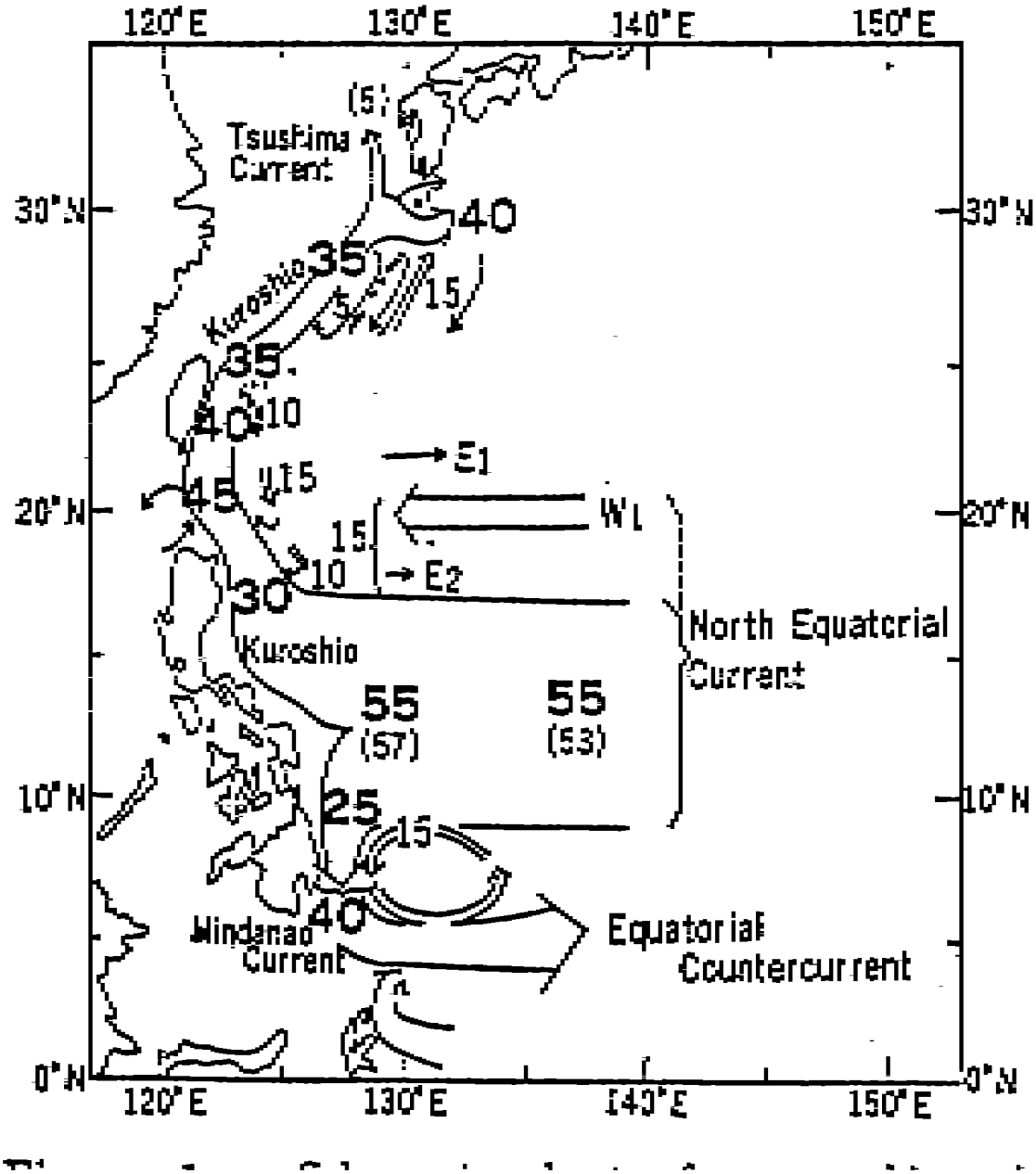


Pacific Circulation (Munk &Carrier1950)

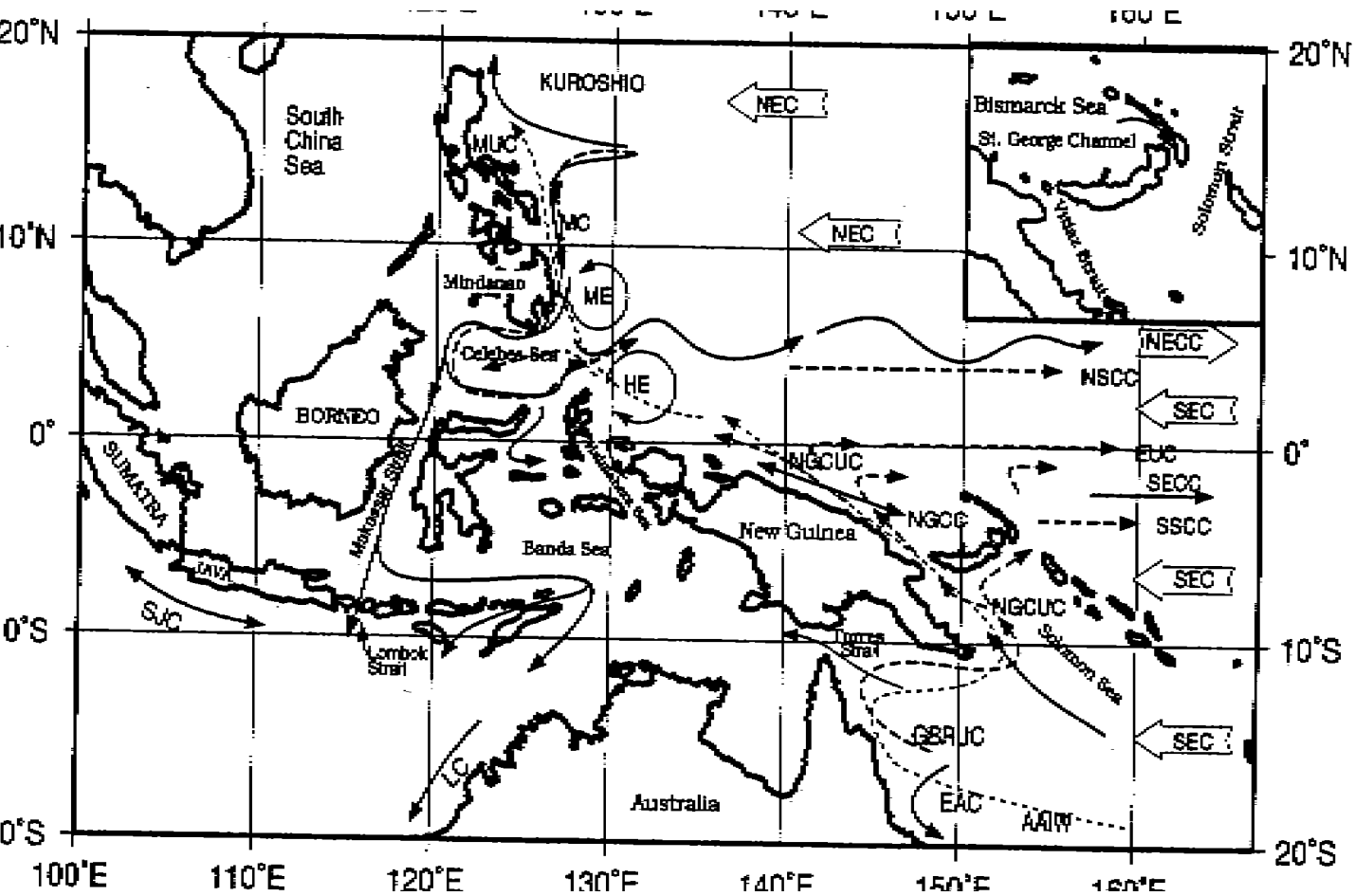




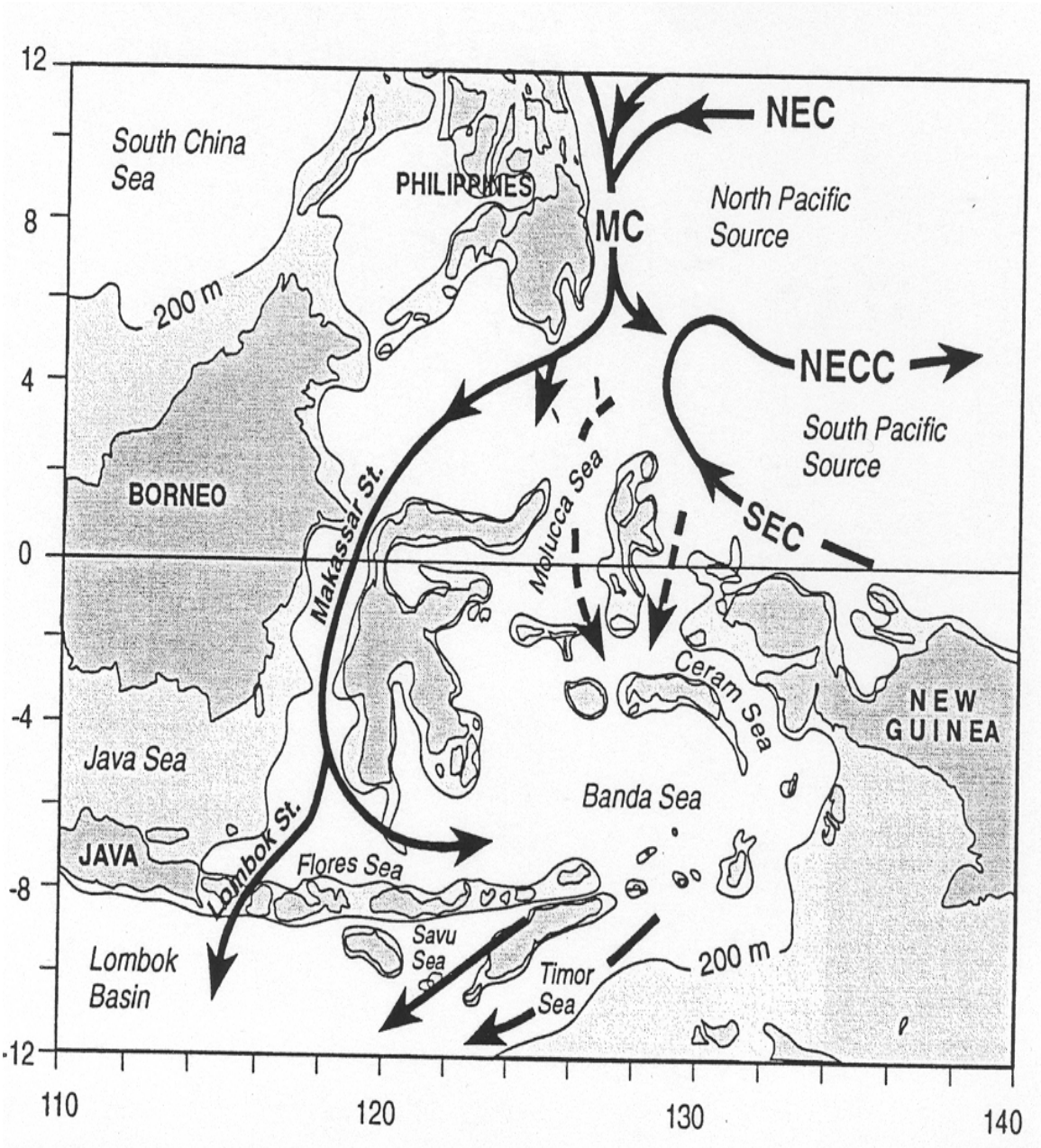
Geostrophic Volume Transport relative to 1200 dbar (Nitani, 1972)



Water Mass Crossroads (Fine et al. 1994)



(1) Indonesia TF (Ffield and Gordon, 1992)



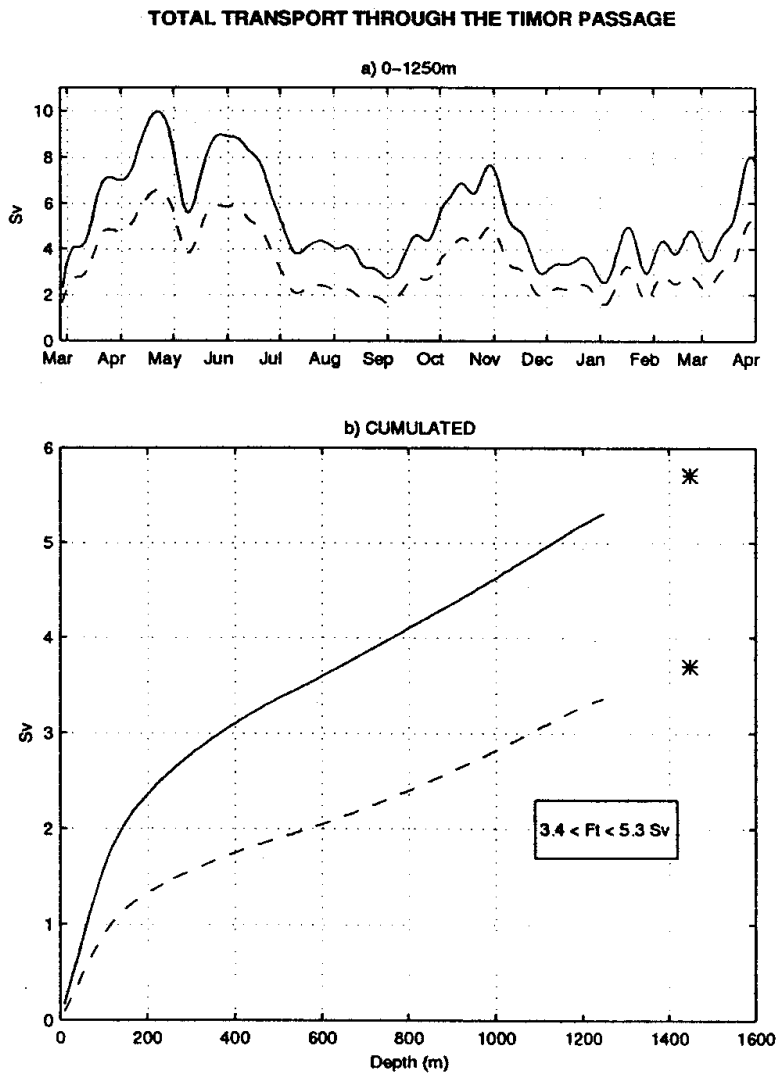
Volume Transport of the Indonesia TF

Table 1. Estimates of Mean Indonesian Throughflow Transport

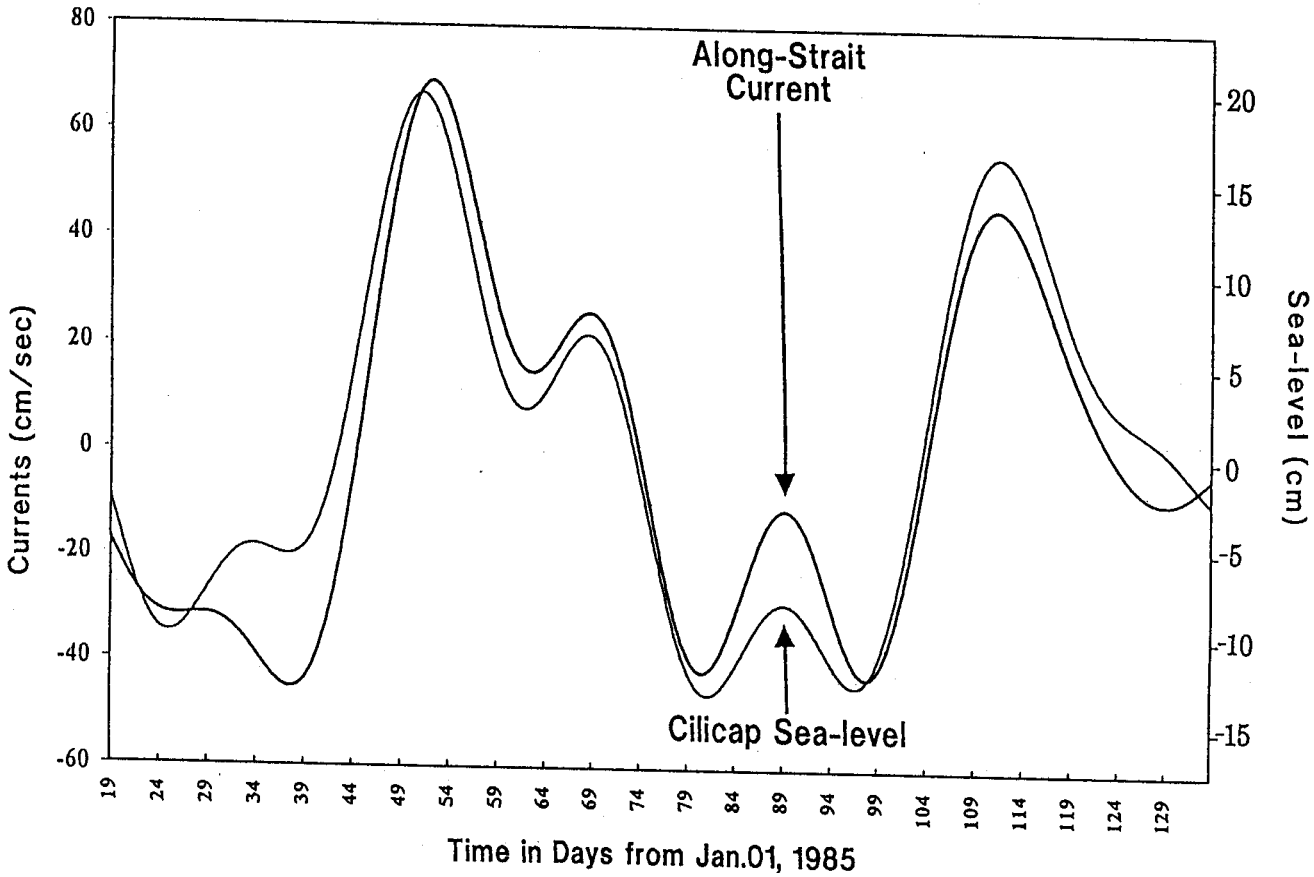
Reference	Method	Result, 10^6 m^3 s^{-1}	Remarks
Wyrtki [1961]	geostrophy	1.7	top 200 m
Godfrey and Golding [1981]	geostrophy, 11 Indian Ocean sections	10	sections unclosed, 32°S
Wunsch et al. [1983]	inverse calculation, 43°S and 28°S Pacific sections	<<10	
Piola and Gordon [1984]	freshwater budget, Pacific and Indian Oceans	14	
Fine [1985]	tritium budget	5	top 300 m
Fu [1986]	inverse calculation, Australia-Timor	7	Timor Strait only
Toole et al. [1988]	salinity budget, West Pacific	<5	sensitive to Indonesian salinity
Murray and Arief [1988]	current meter survey	1.5	Lombok Strait only
Godfrey [1989]	geostrophy, Australia-Sumatra, Levitus annual mean data	12	boundary currents unresolved
Toole and Warren [1993]	inverse estimate, Indian Ocean 32°S	7	
Wijffels et al. [1992]	heat budget, closed box, 14°S-165°E-10°N	0-8	
Fieux et al. [1994]	geostrophy, Australia-Bali, plus current meters	18.6±7	August 1989 snapsho
Fieux et al. [this issue]	geostrophy, Australia-Bali, plus current meters	-2.6±7	February-March 1992 snapshot
Meyers et al. [1995]	time series from expendable bathythermograph sections	5	top 400 m

Timor Strait (Molcard et al. 1996)

- Solid (upper bound)
- Dashed (Lower Bound



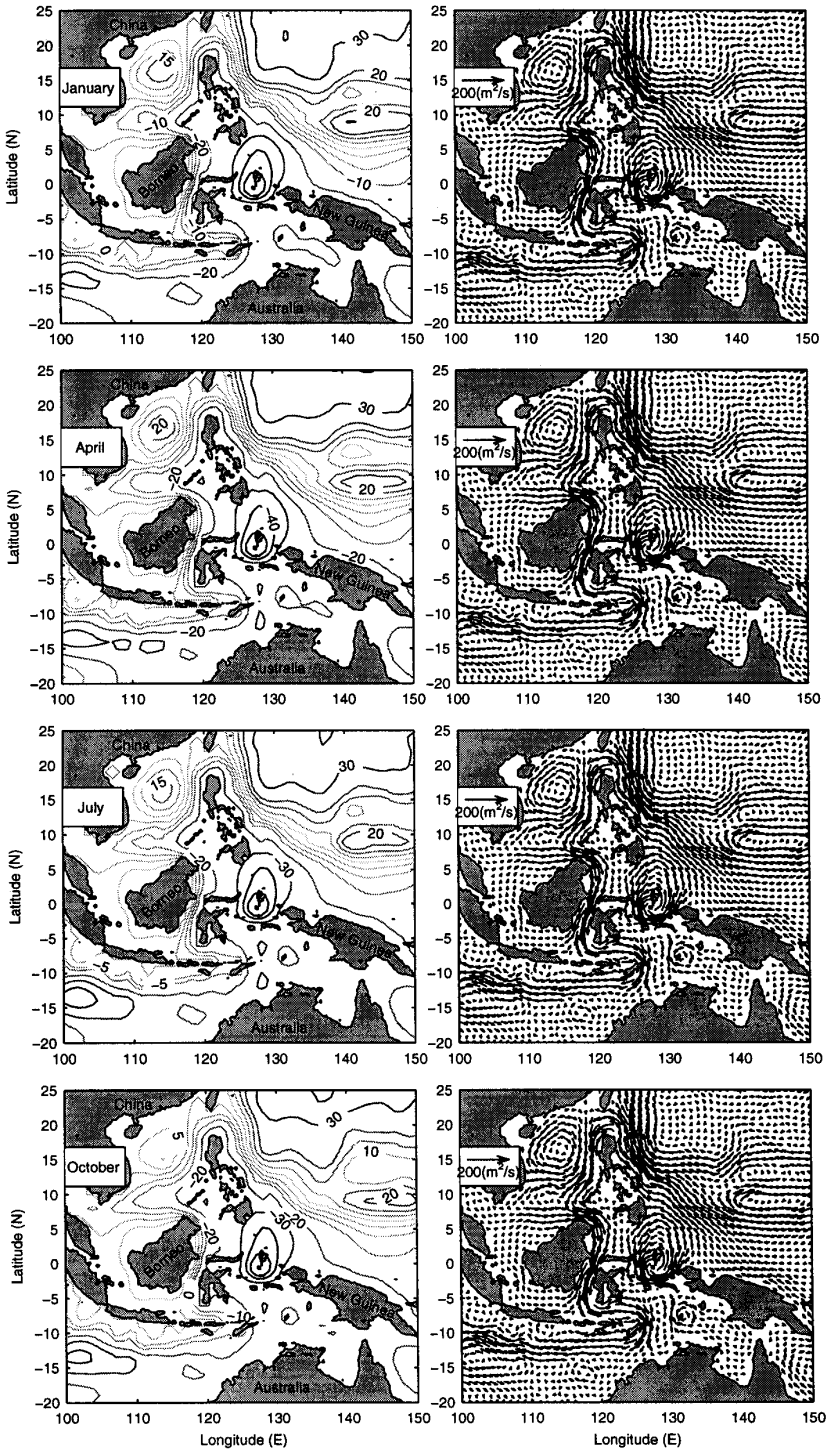
Current Through Lombart Strait (Arief & Murry 1996)



Inverse (Ekman-Munk) Model for Determining Volume Transport Streamfunction Ψ from Wind and Hydrographic Data (Chu and Fan 2001)

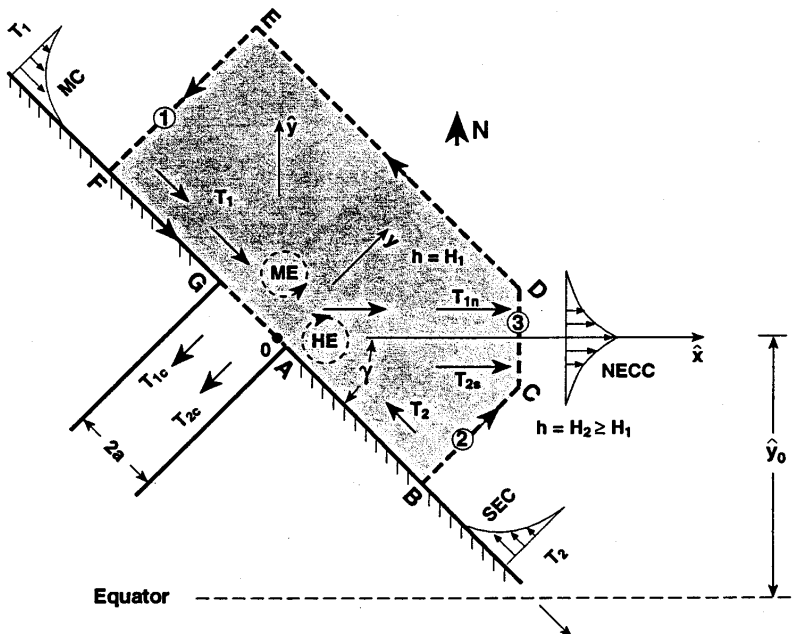
- Ekman Model for Extra-Equatorial Regions
- Munk Model for the Equatorial Region
- Stokes Theorem for Determining Ψ for Islands

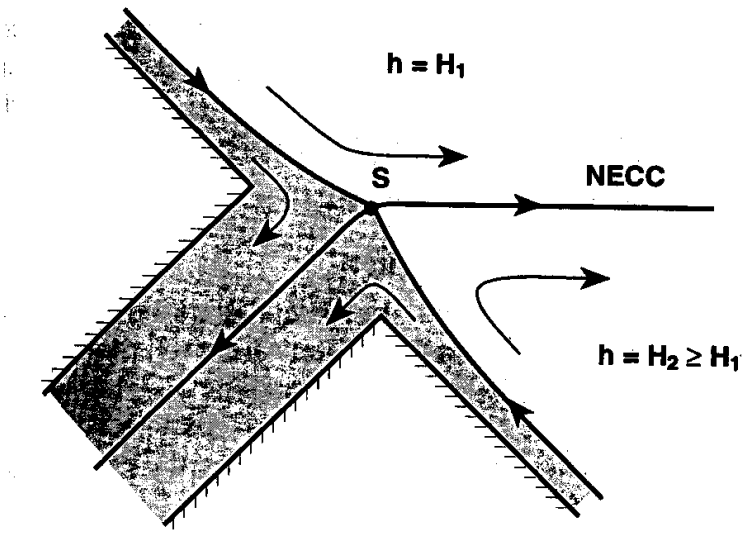
Volume Transport (~15 Sv) Calculated Using the Ekman-Munk Model (Chu and Fan 2001)



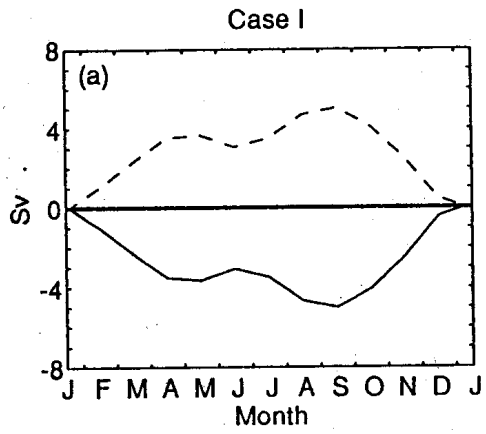
Analytical Model (Nof 1996)

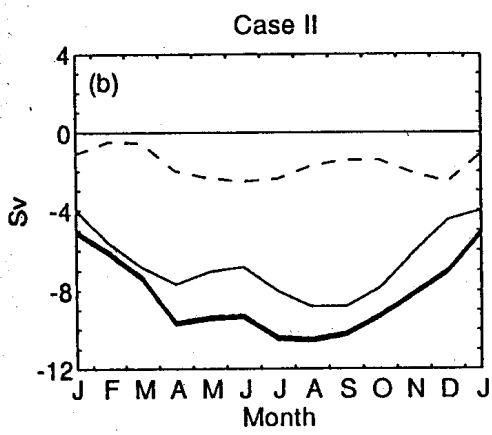
- Nonlinear effects resulting from retroflection of SEC cause most of TF

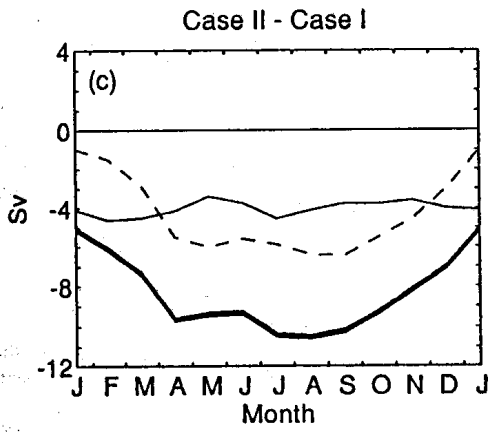


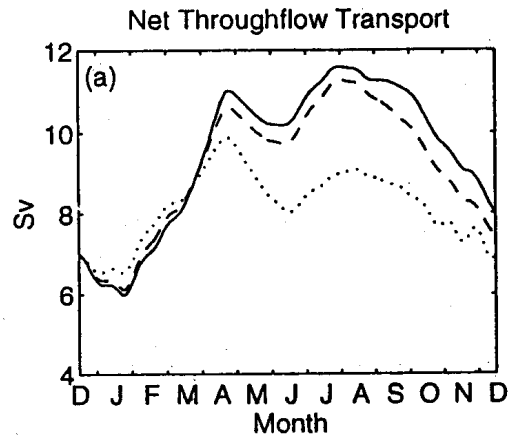


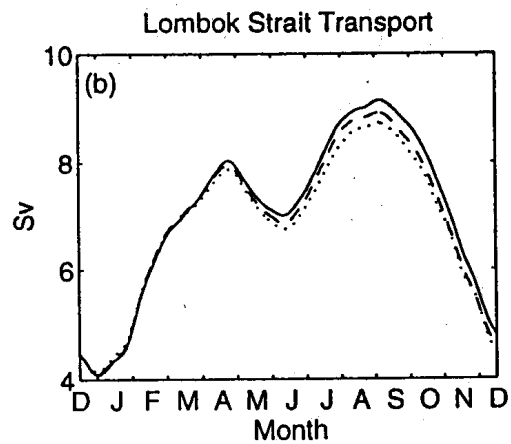
TF Volume Transport Calculated Using GCM (Masumoto & Yamagata 1996)

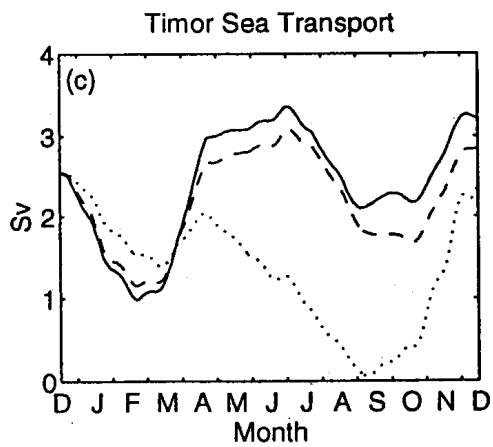




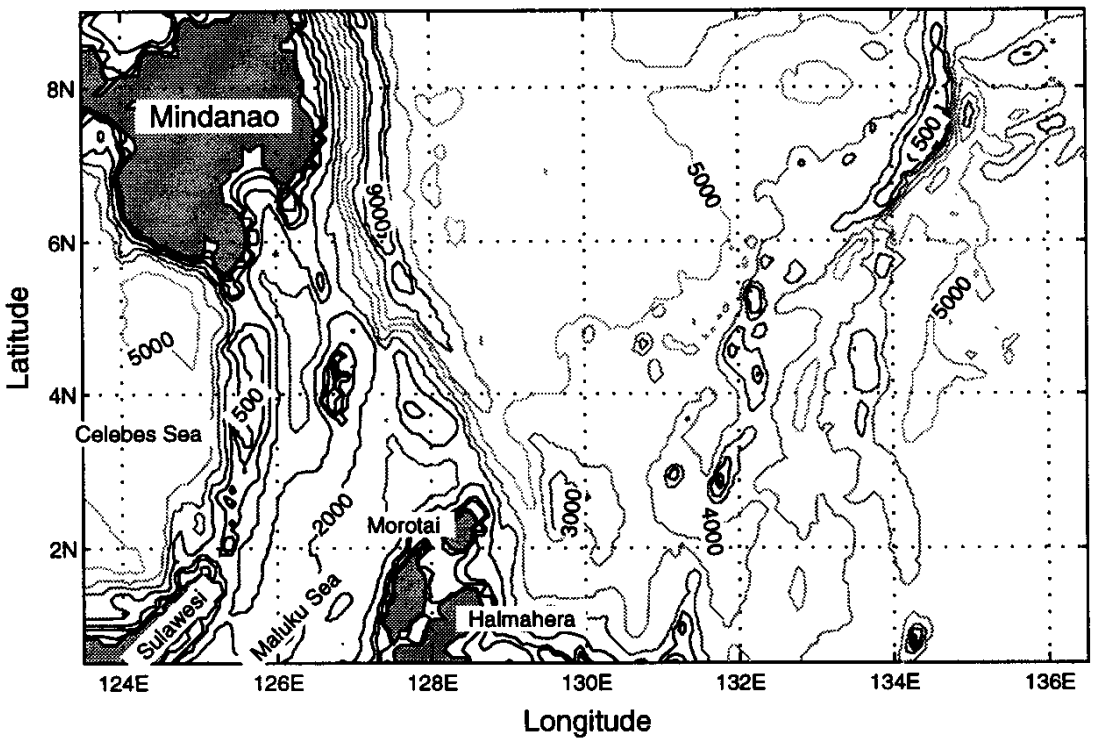






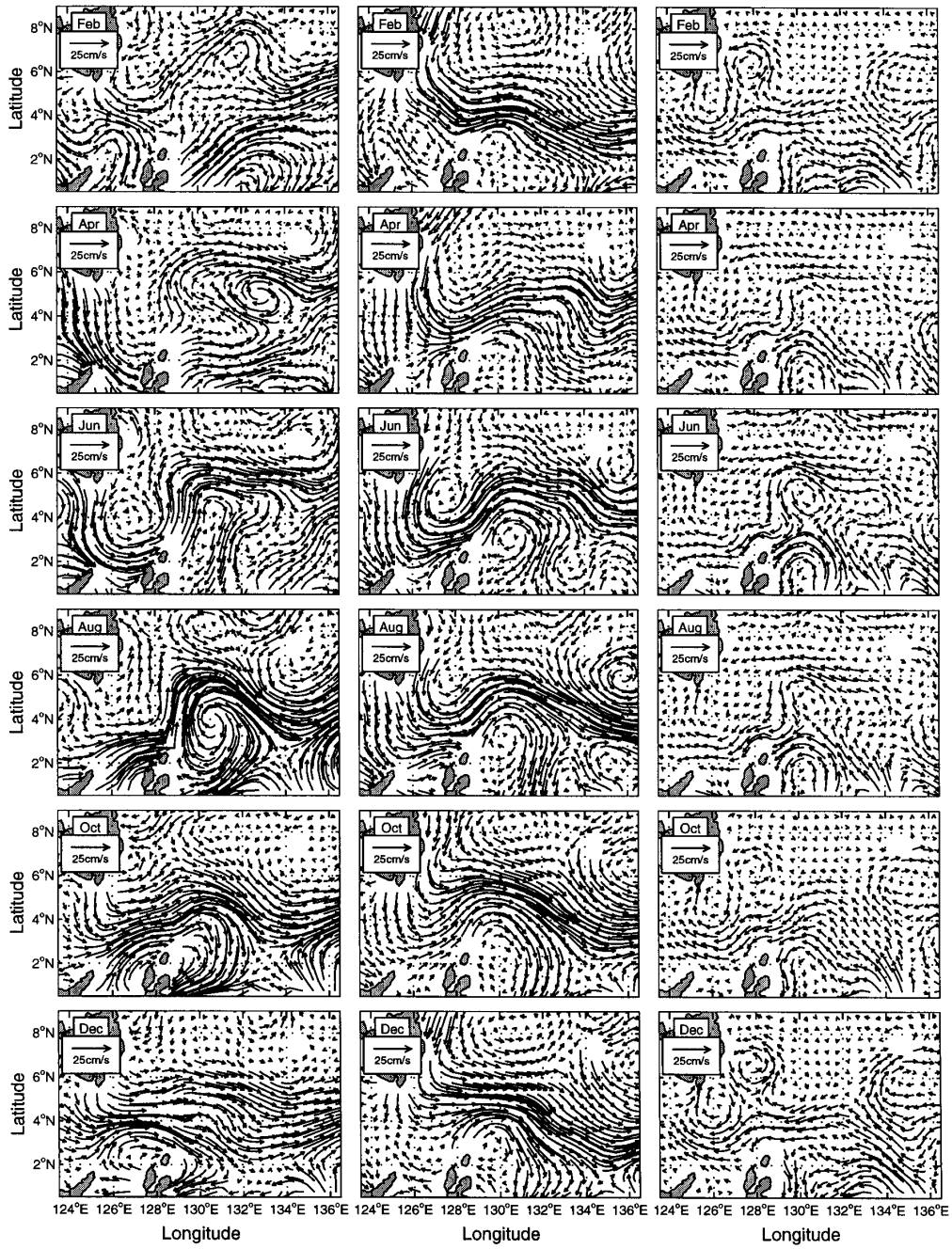


(2) Mindanao Current and Dual Eddies

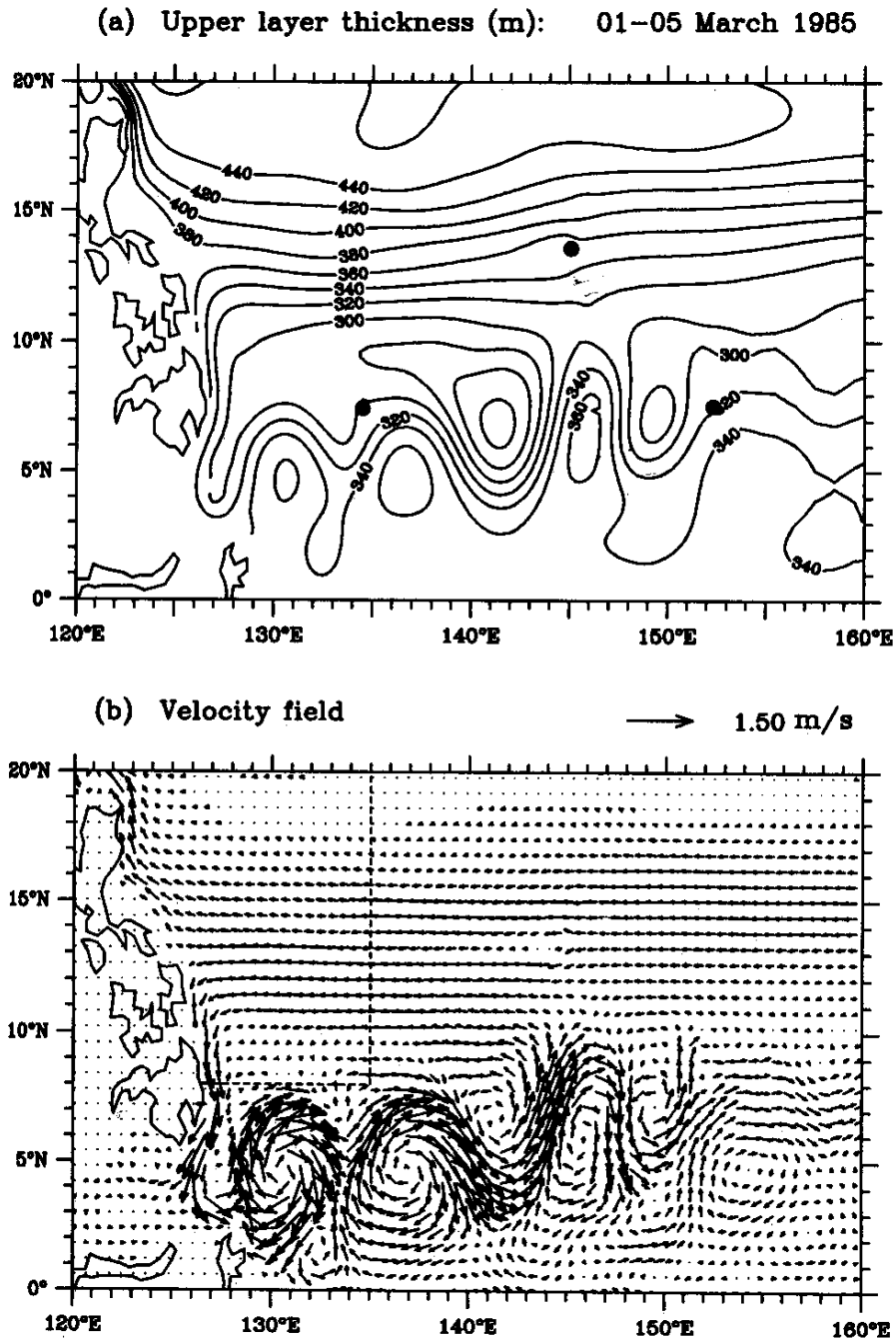


Isopycnal Surface Circulation Calculated from GDEM Data Using the P-vector Method (Chu et al. 2002)

- sigma theta
- 25.0 26.5 27.2



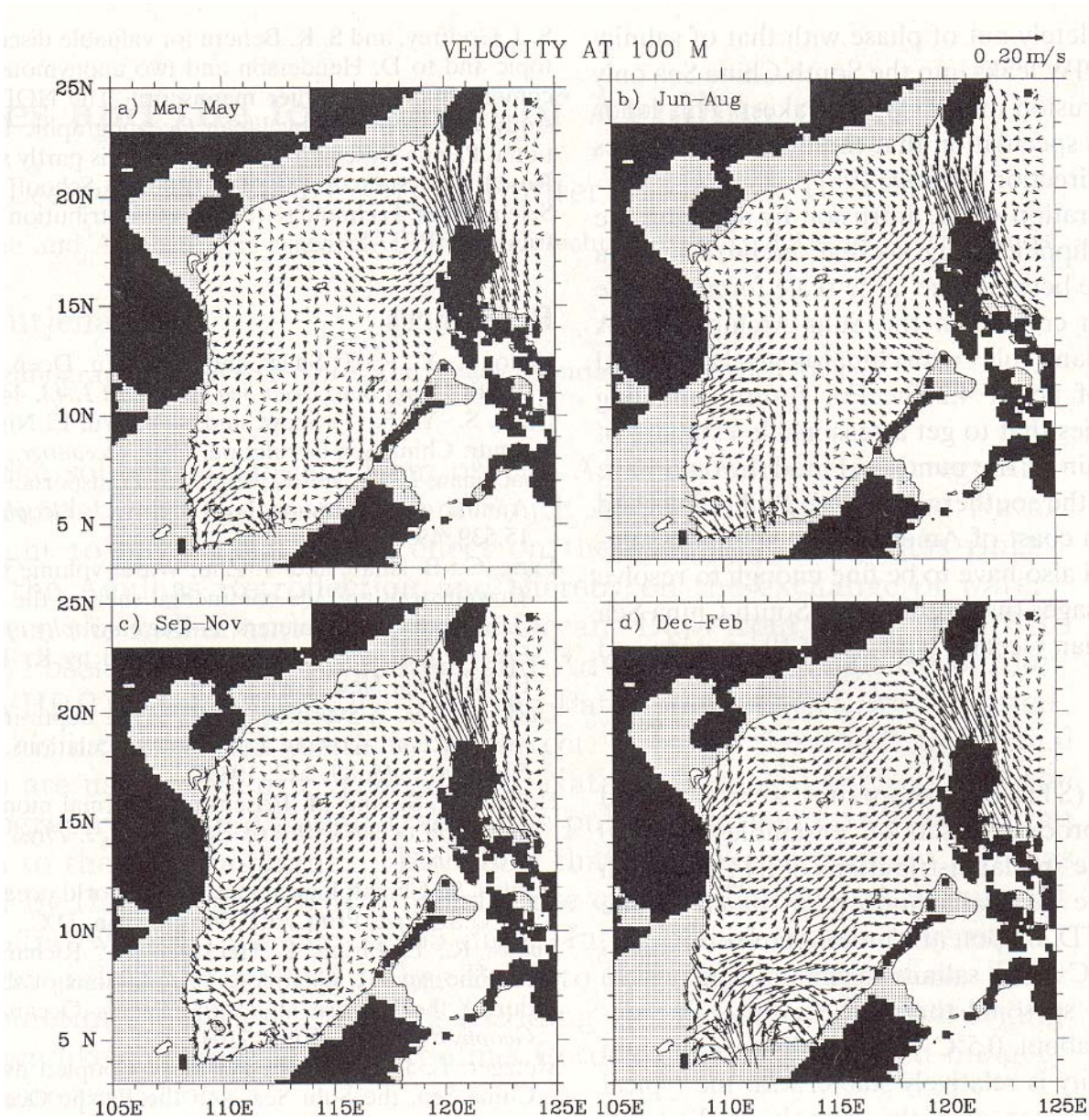
NEC Bifurcation Simulated Using a Reduced Gravity Model (Qiu & Lukas 1996)



(3) Kuroshio Intrusion into SCS

- Water Mass Characteristics (Shaw 1989, 1991)
- Geostrophic Calculation Relative to a Reference Level (e.g., Qu et al. 2000, 2001)
- P-Vector Inverse Calculation (Chu and Li, 2000; Chu and Fan 2001)
- Numerical Simulation (

Geostrophic Velocity at 100 m Relative to 400 db (Qu et al. 2000)



Isopycnal Surface (= 26.2) Circulation Calculated from GDEM Data (Climatology) Using the P-vector Method (Chu and Li 2000)

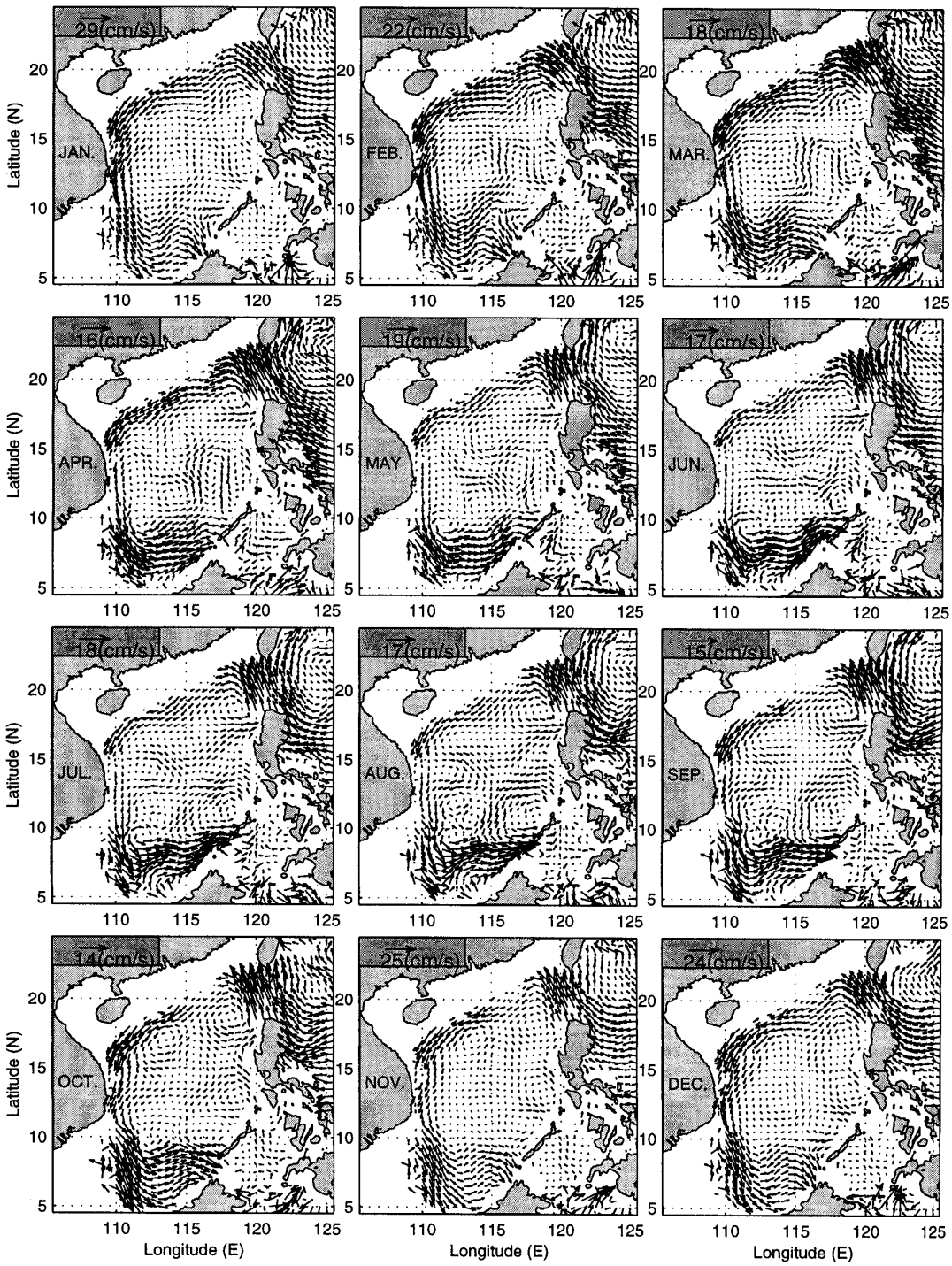
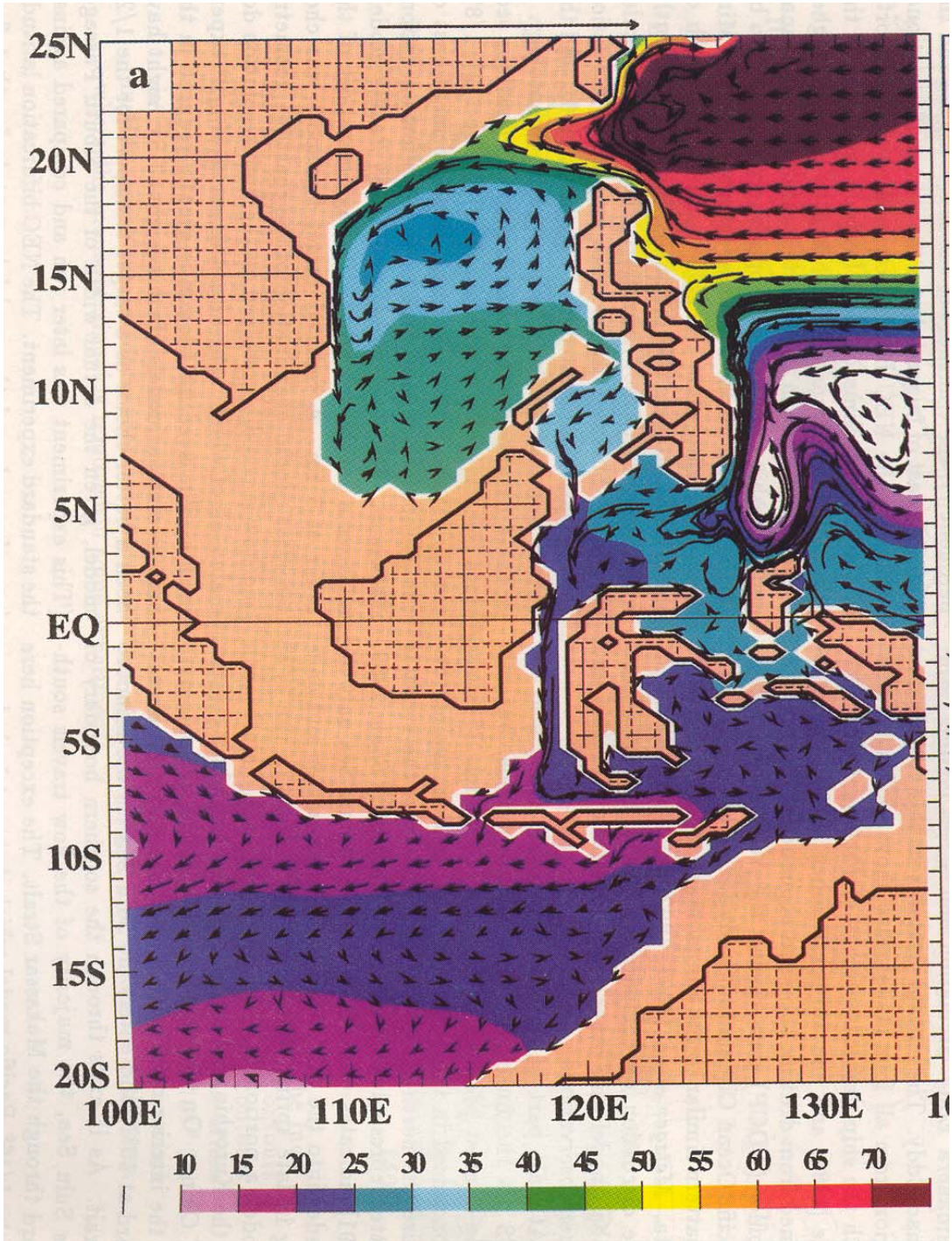


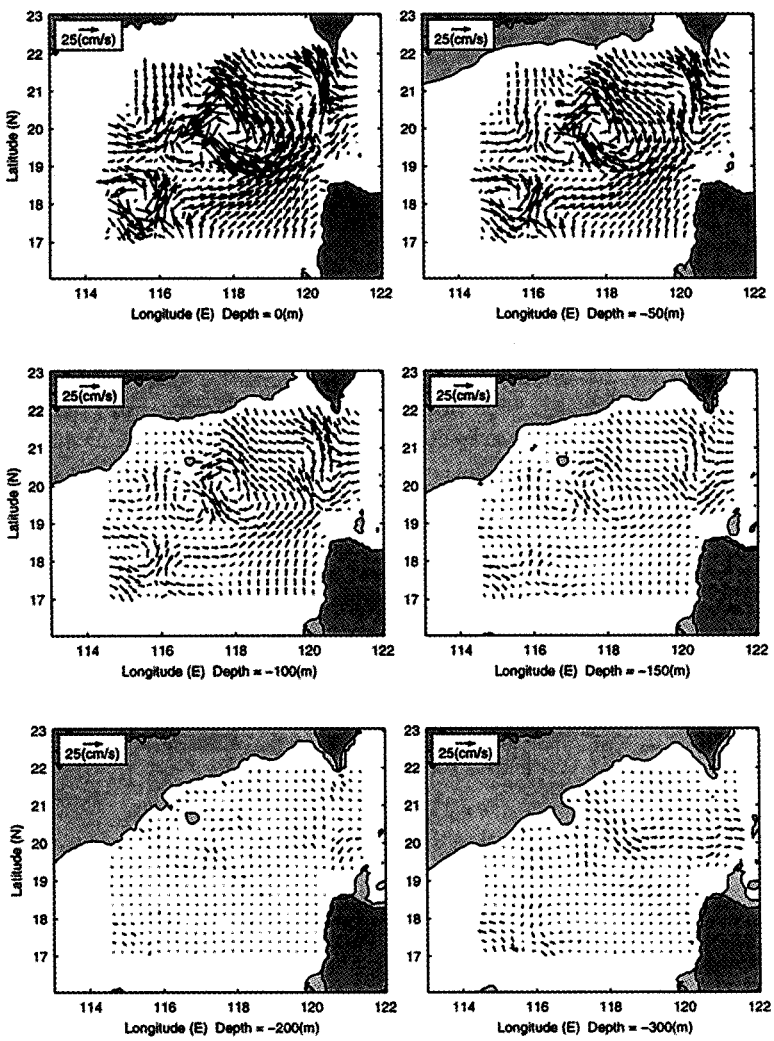
FIG. 9. Monthly mean intermediate level (σ_θ = 26.2 kg m^{-3}) velocity vector field.

Kuroshio Intrusion into SCS as a Loop Current Using Navy Layered Model (Metzger and Hurlbert 1996)

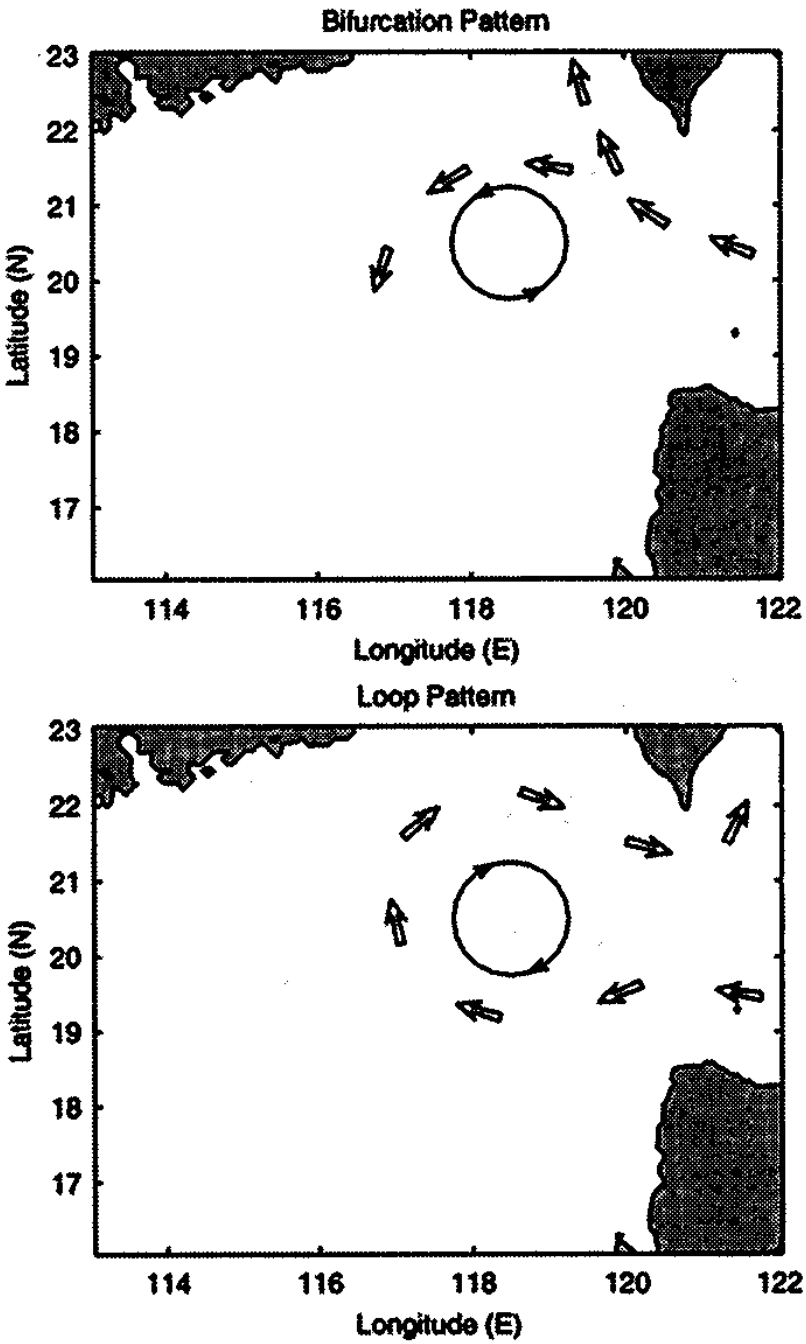


Cyclonic Eddy Detected by AXBT and AXCTD Measurements in July 1998

- Computed Using the P-Vector Method (Chu and Fan 2001)



Two Types of Intrusion (Chu and Fan 2001)



(4) STCC

Eastward current in subtropical region

(a) Observations:

Uda (1955), Uda, Hasunuma (1969), Keneko et al. (1998) :

STCC occurs North of 17.5^{o}-25^{o}N

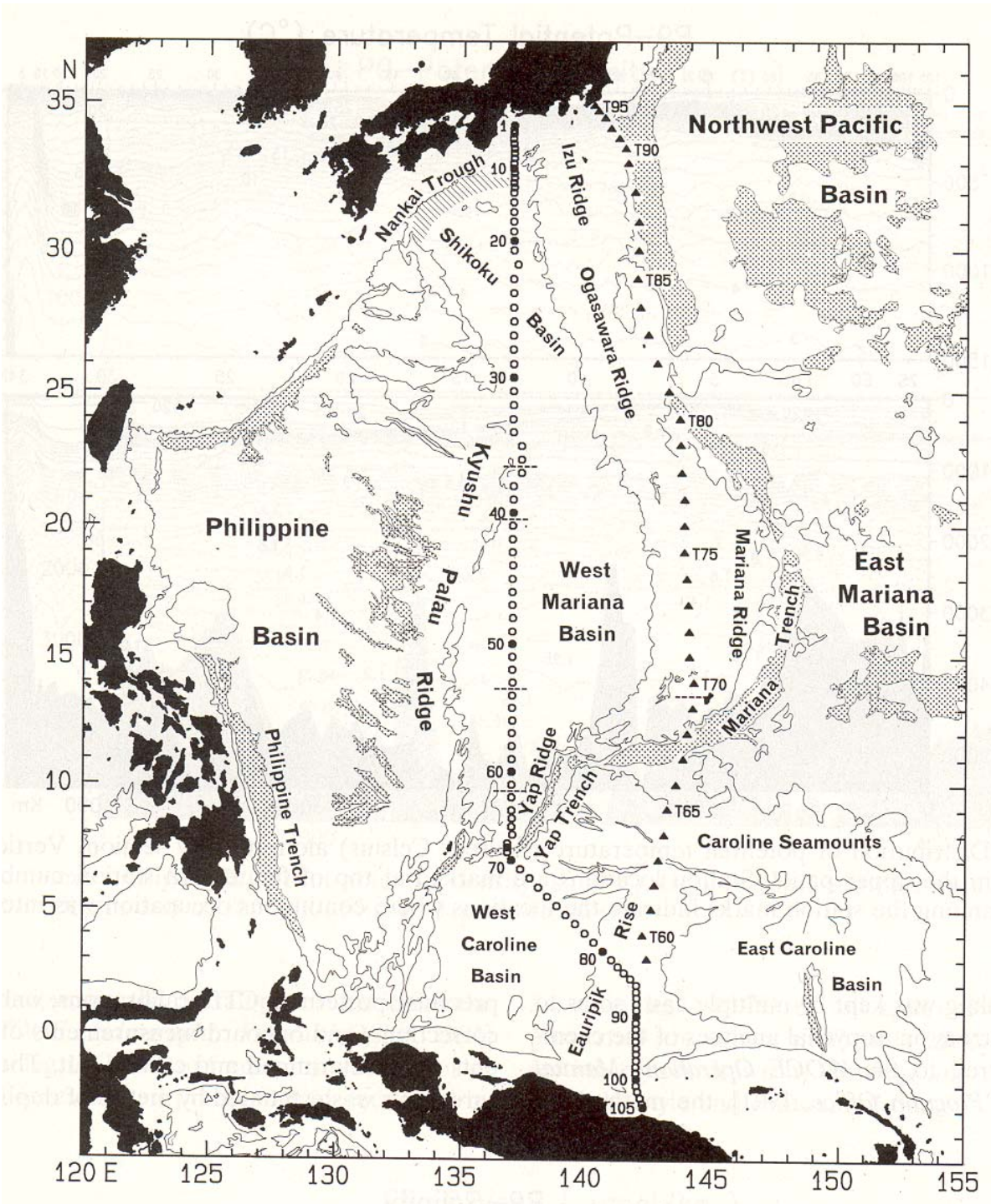
(b) Calculations

Geostrophic calculation using XBT data to 200 dbar (White et al. 1978):

Wind driven transport (Yoshida and Kidokoro 1967a,b)

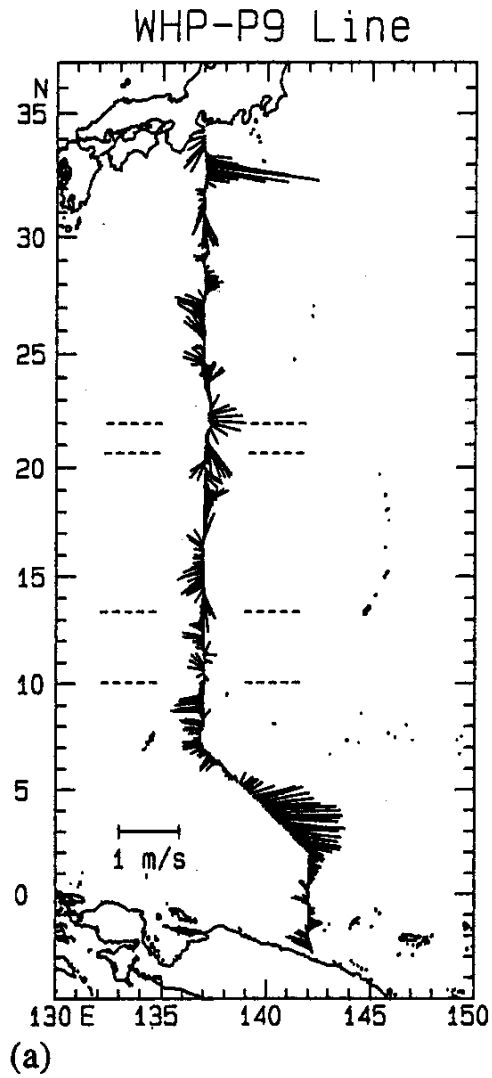
Isopycnal surface absolute velocity calculated from GDEM using the P-vector method (Chu et al. 2002)

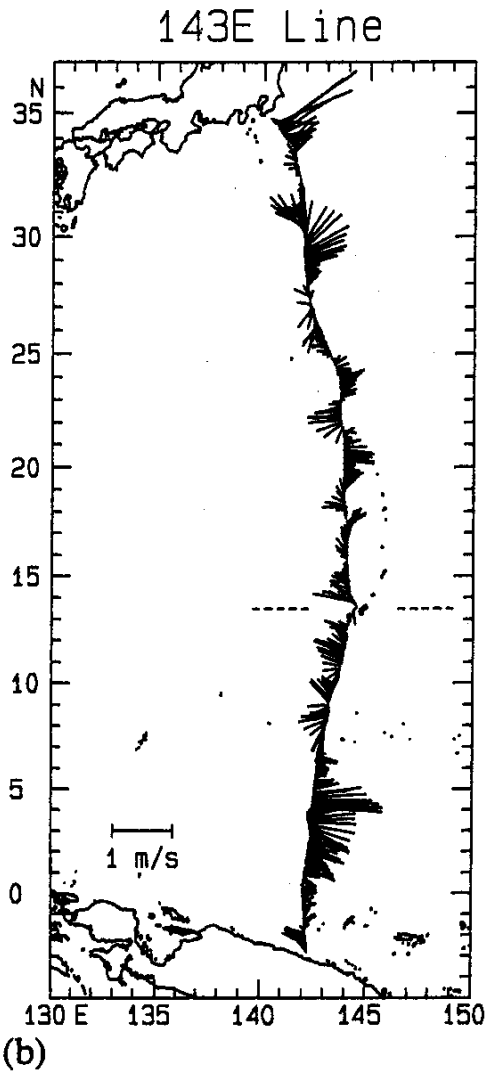
WOCE Observation



ADCP at 20 m Depth

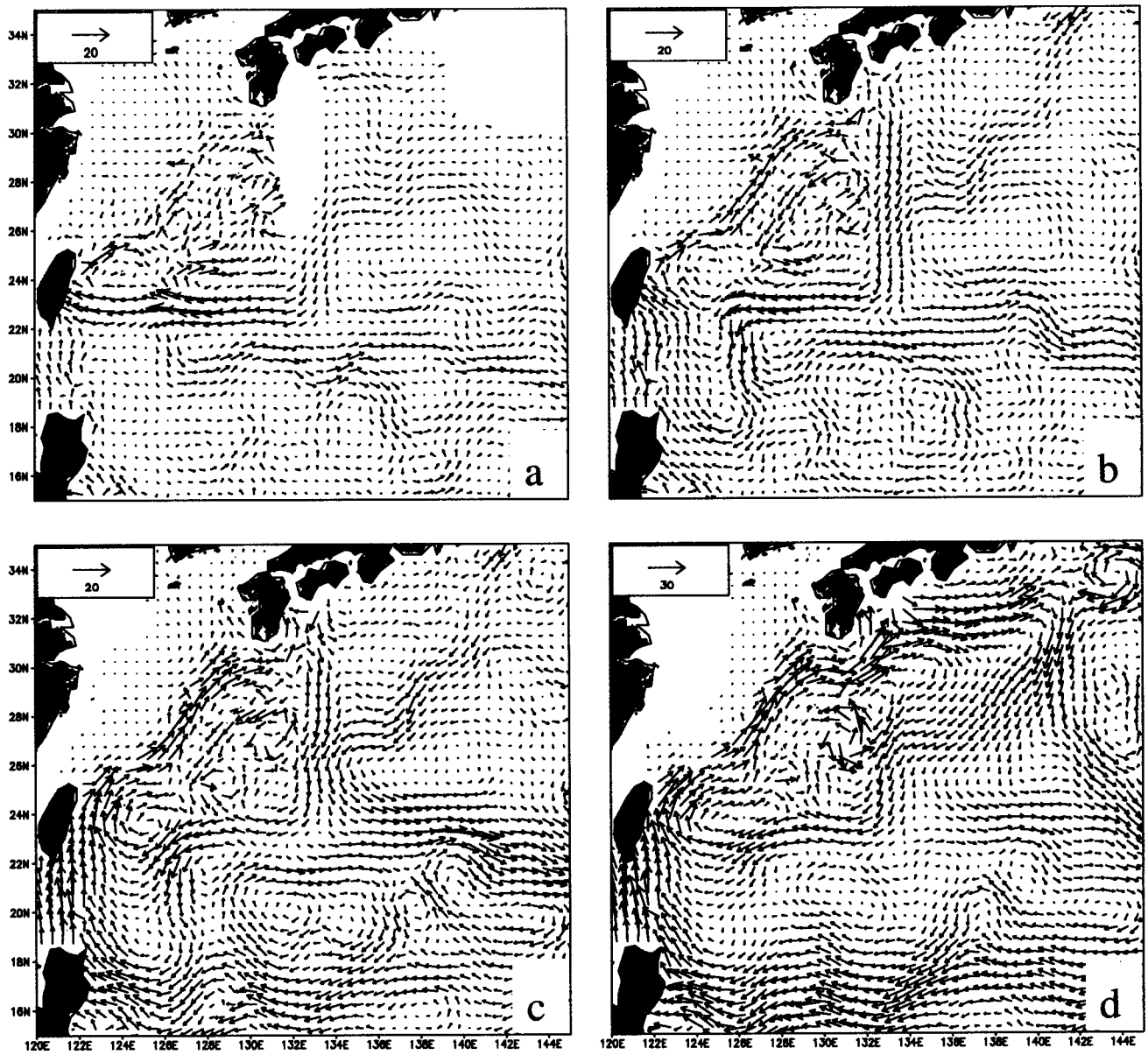
- (a) WHP-P9 (7/8-8/17/94)
- (b) 143°E (8/17-9/3/94)





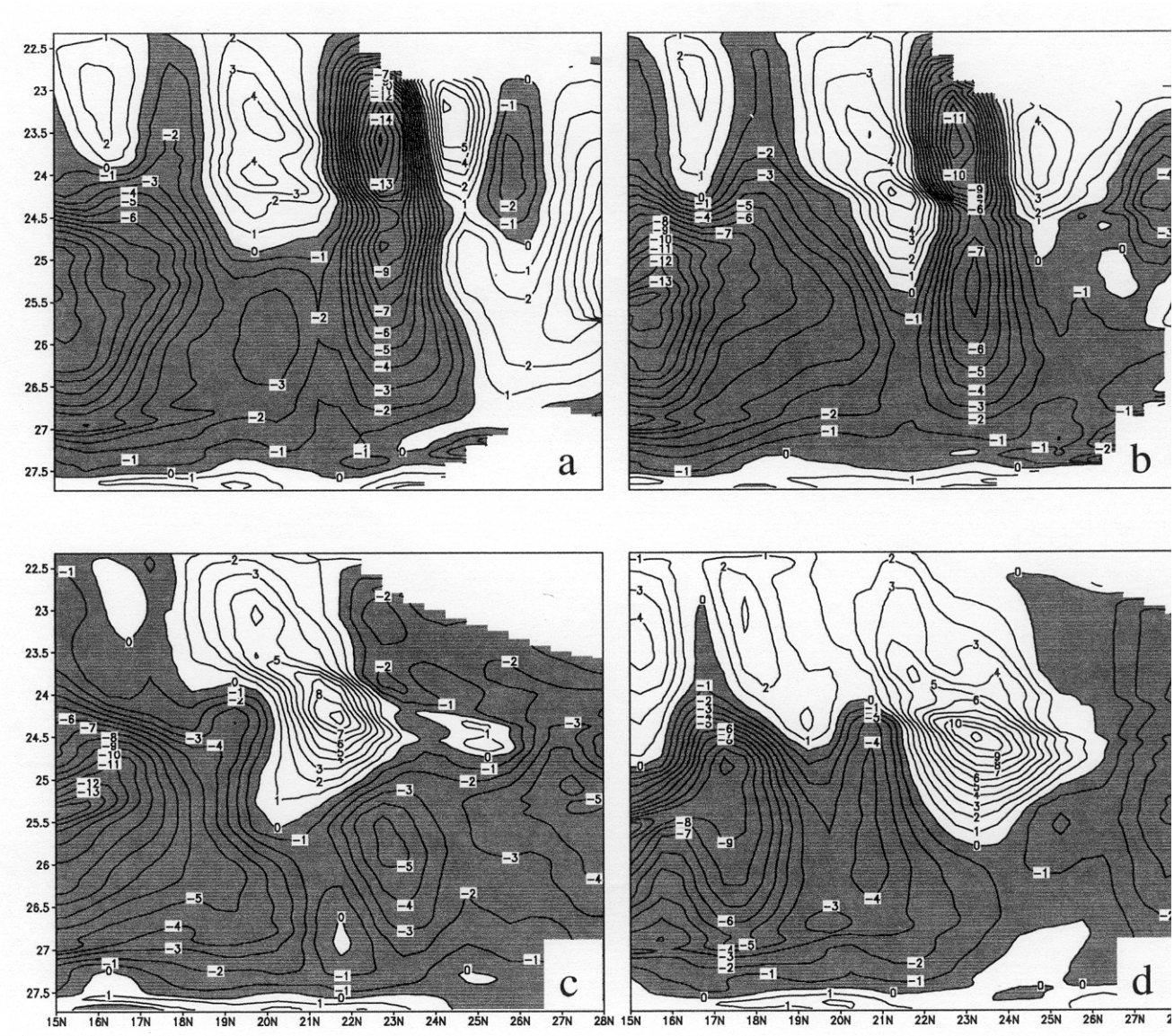
Isopycnal Surface Circulation Calculated from GDEM Data (June) Using the P-vector Method (Chu et al. 2002)

- Sigma theta
- (a) 23.5, (b) 24.0, (c) 24.5, (d) 25.0



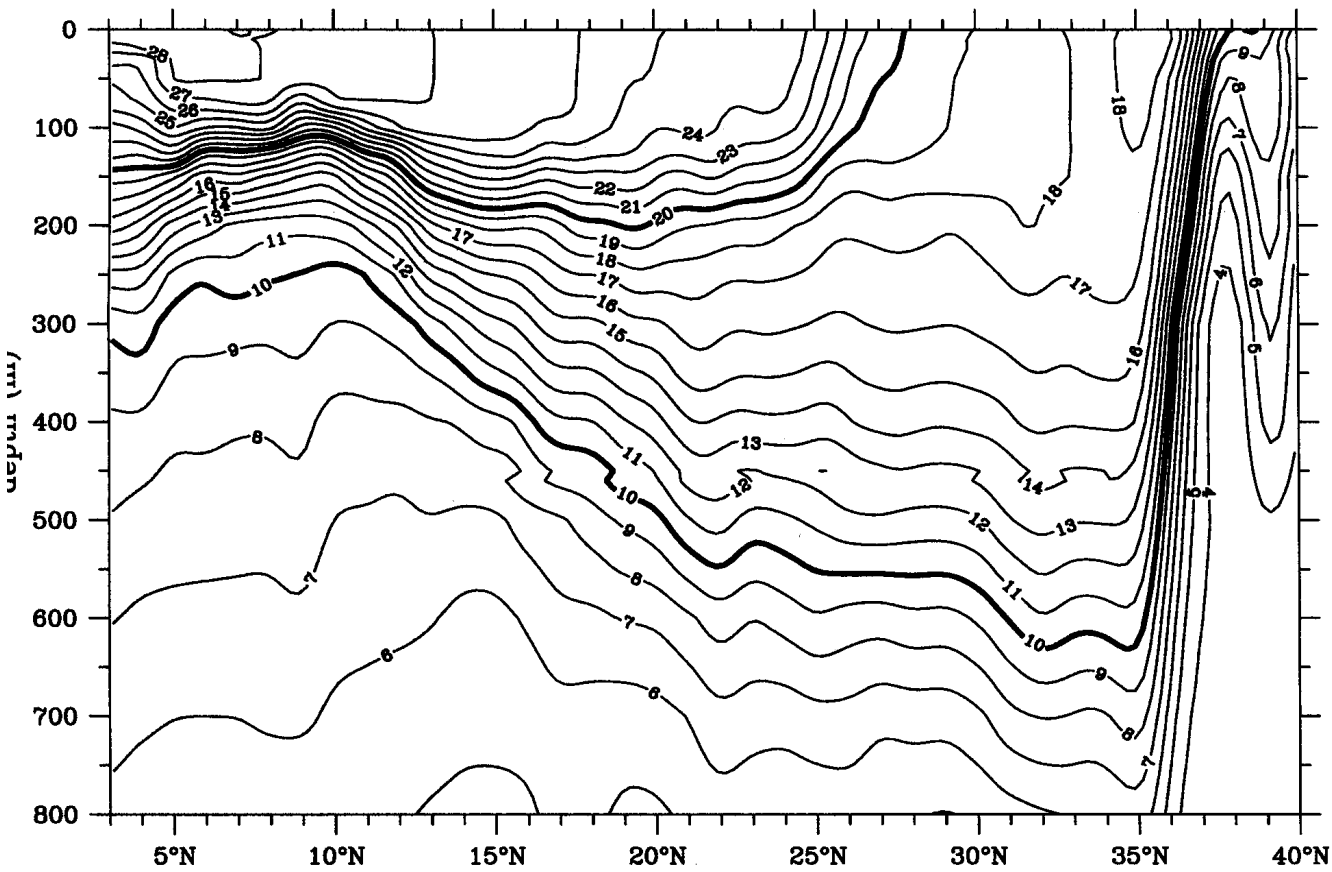
Calculated (June) East-West Velocity Component (cm/s)

- (a) 127.5 E, (b) 129.5 E
- (c) 133.5 E, (d) 138.5 E

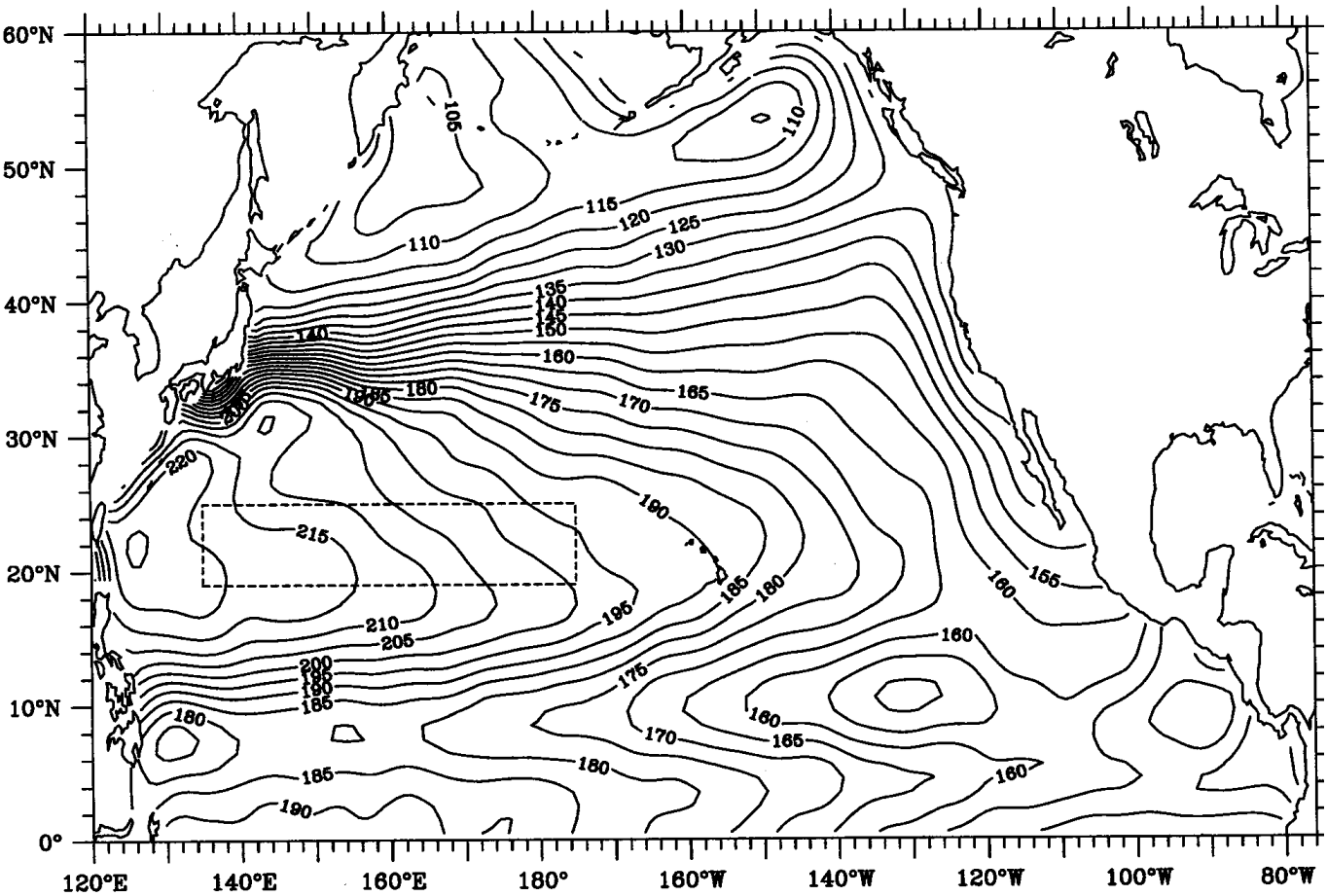


STCC Identified from Temperature Cross-section (144 E)

- XBT & CTD from R/V Takuyo and R/V Kaiyo-Maru
- Upward branch of thermocline is associated with STCC



STCC Area (Qiu 1999)

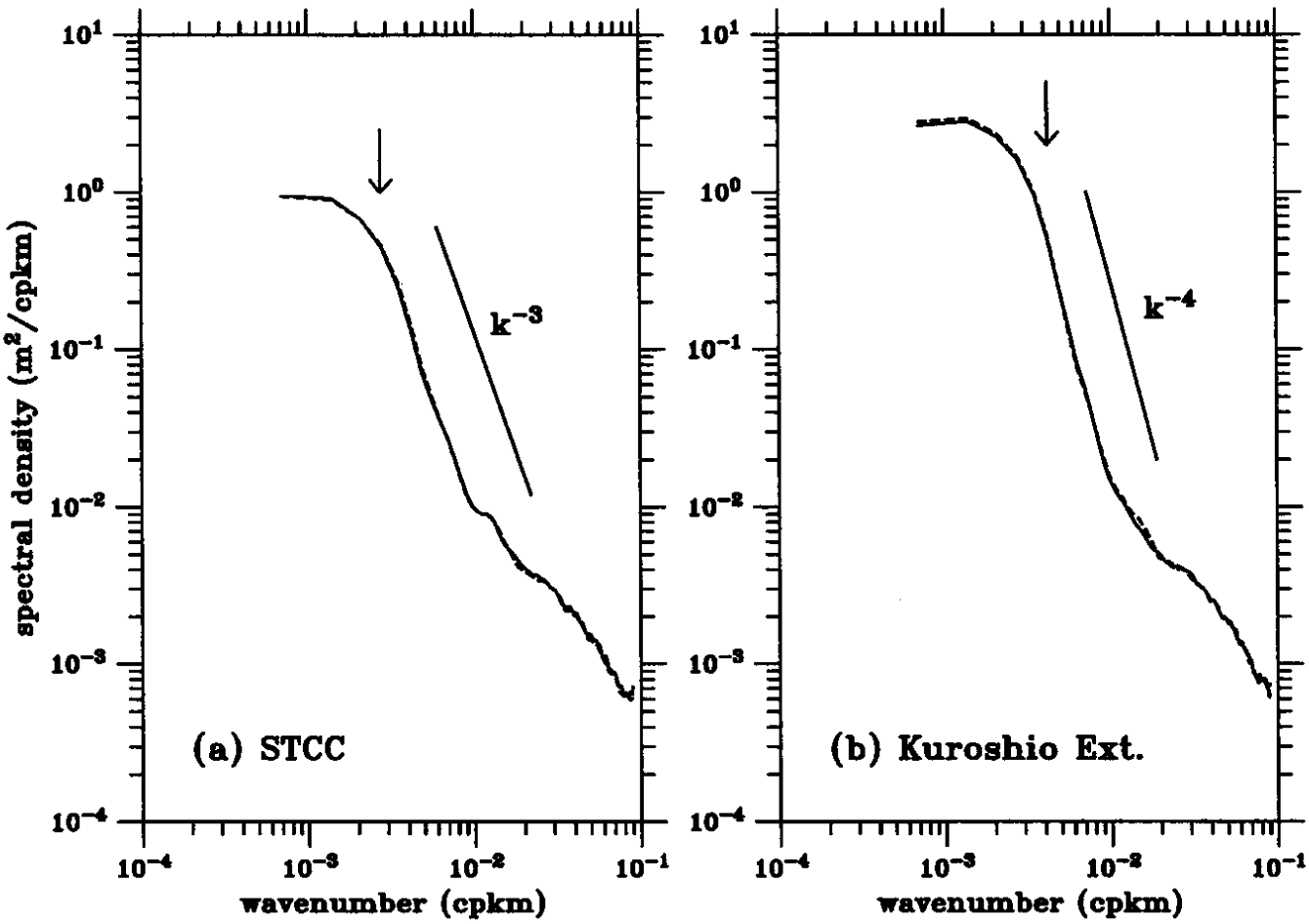


Kinetic Energy Spectra from T/P Data

- Qiu (1999)

STCC Region: 135E-175W, 19-25 N

Kuroshio Extension Region: 140E-170W, 32-38N



Conclusion

- Investigation on Pacific Low Latitude Western Boundary Currents is a rich research area.