



# Typhoon Kai-Tak: A perfect ocean's storm

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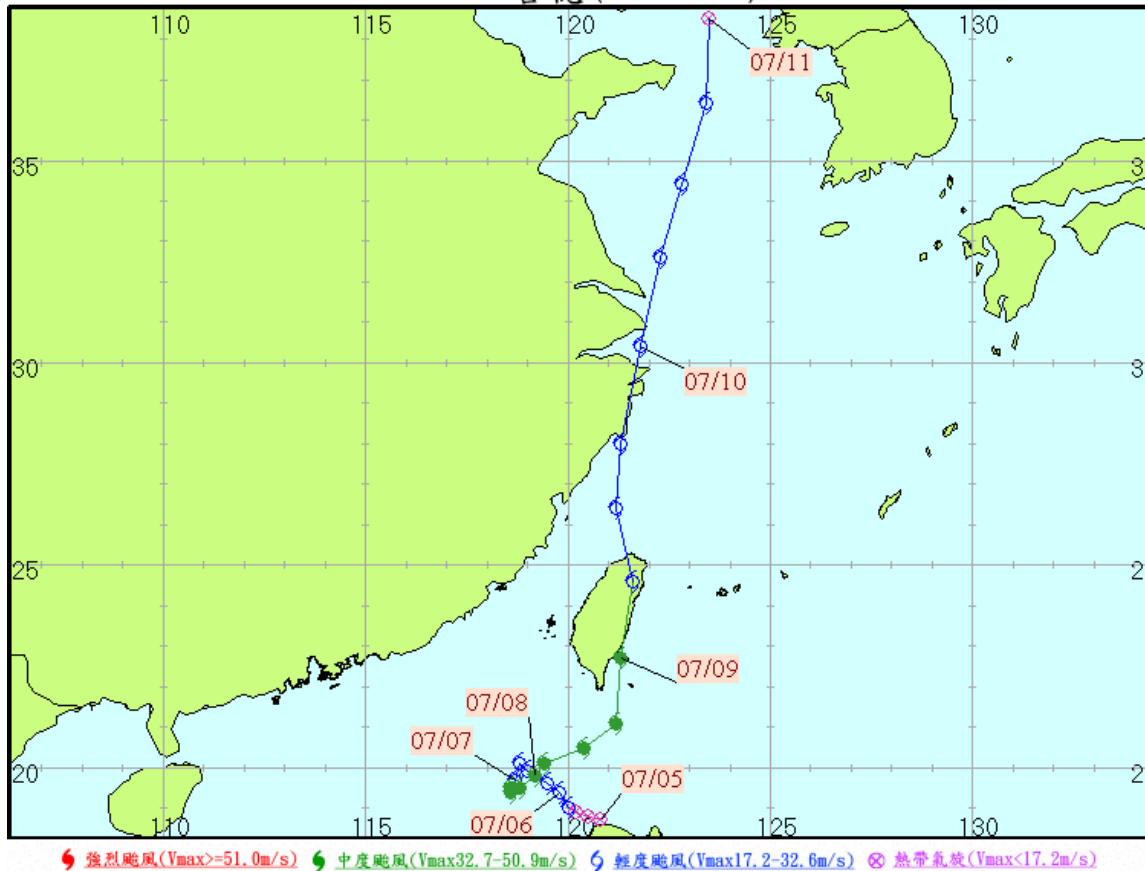
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<sup>2</sup>Program in Atmospheric and Oceanic Sciences, Princeton University, USA

2nd IWMO, Norfolk  
May 25, 2010

# 2000\_Kai-Tak

2000 啓德 (KAI-TAK)

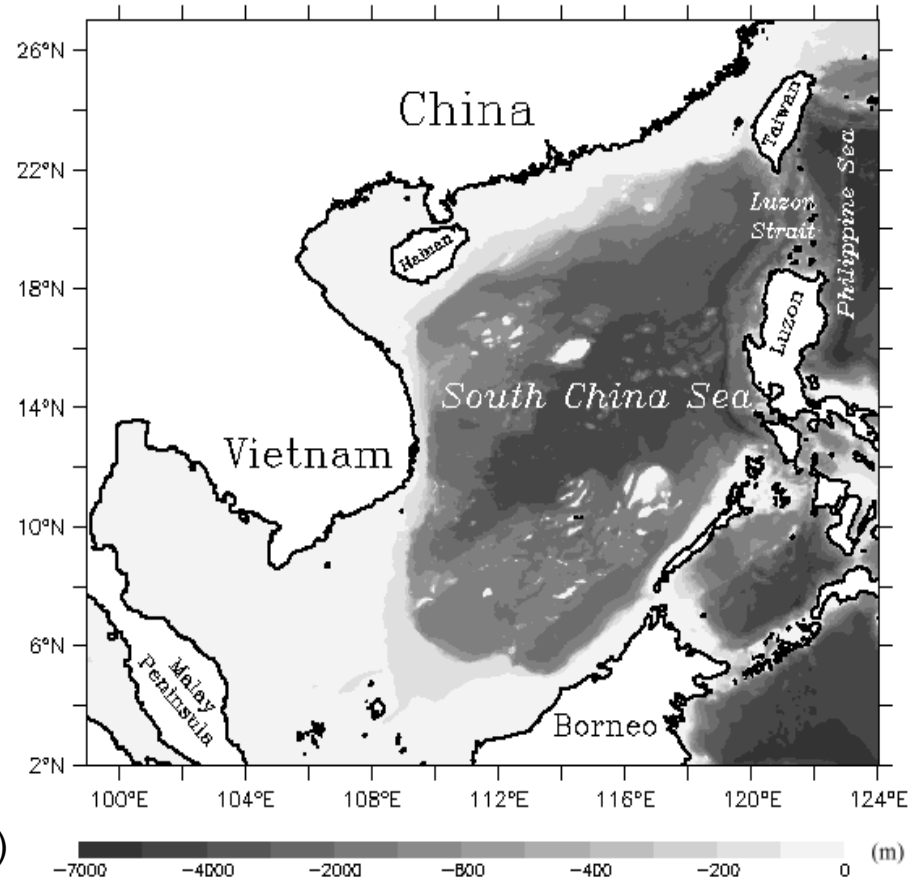


- July/3 - July/11, 2000
- Max. wind speed: 38.6 m/s
- Saffir-Simpson hurricane scale: **Category-1**
- Propagation speed: **0.65~1.96 m/s** (during July 6~8, 2000)
- Lin et al. (2003) reported that Kai-Tak triggered a **30-fold** increase in surface chlorophyll-a concentration.

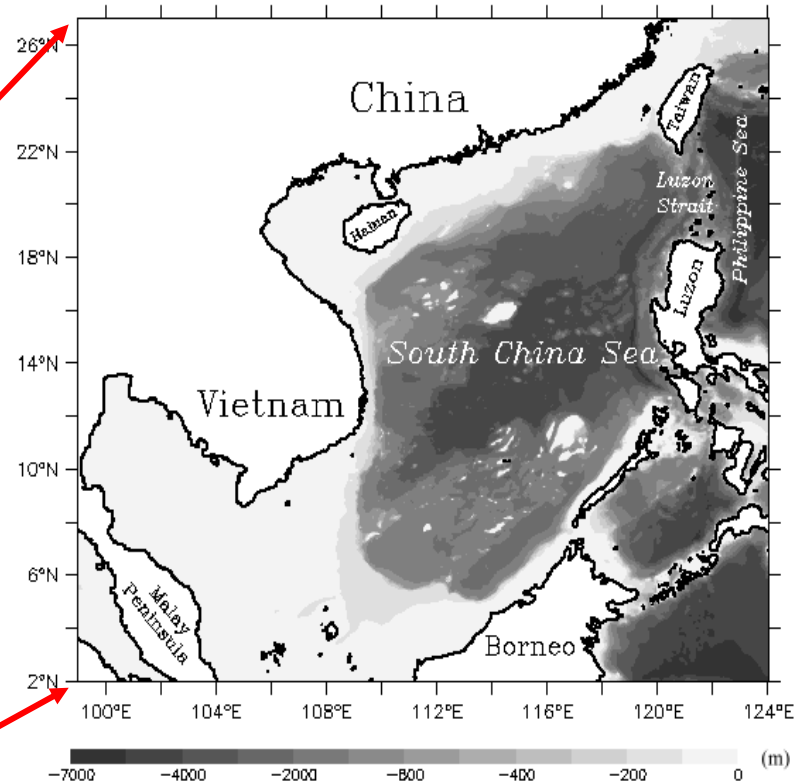
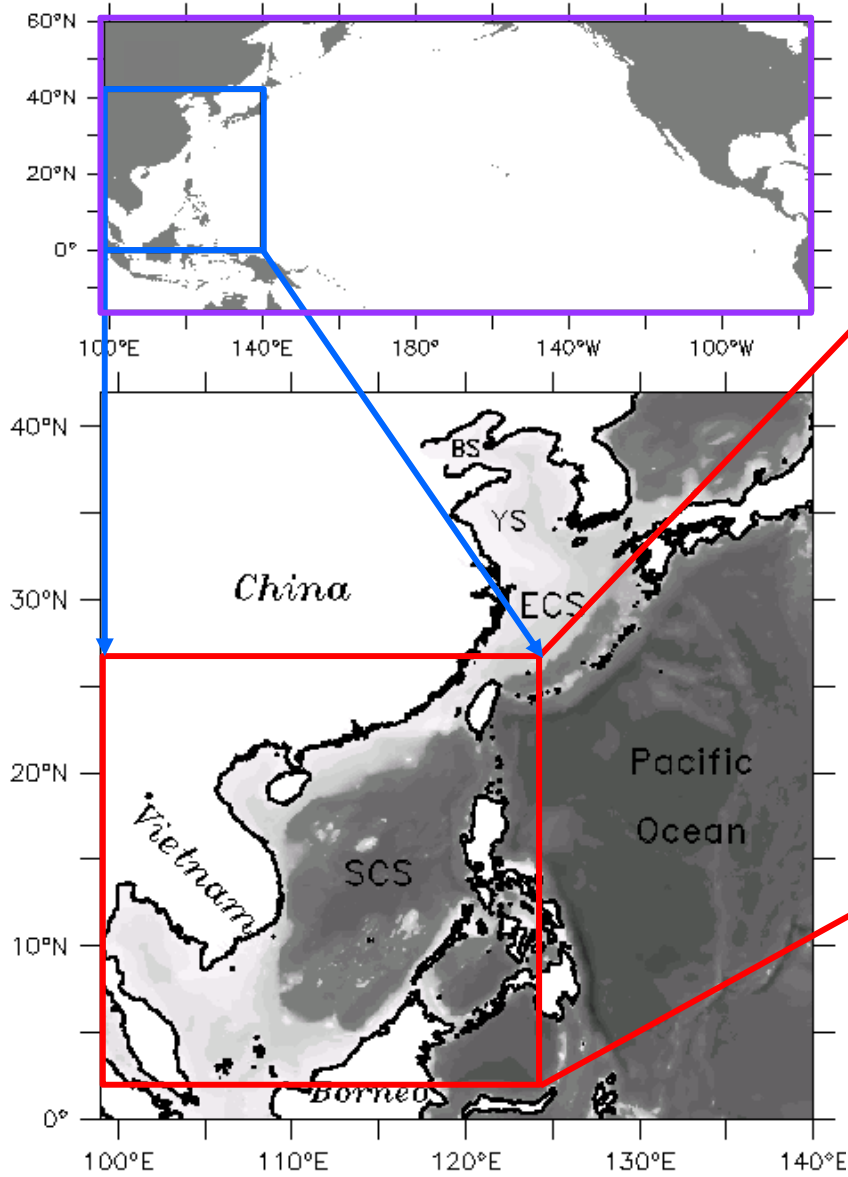
# The South China Sea model (POM)

(Wu and Chiang, 2007; Chiang et al., 2008)

- **Domain :**  
99° E~124° E, 2° N~27° N
- **Resolution :**  
horizontal: 1/16° (~6.25 km)  
vertical: 26 sigma levels
- **Forcing :**  
6-hourly 0.5° × 0.5°  
QSCAT/NCEP blend wind  
product  
(Milliff et al., 1999)
- **SST :**  
weekly 1° AVHRR SST
- **IC & BC :**  
daily output of EAMS model  
(Wu and Hsin et al., 2005; Hsin et al., 2008)



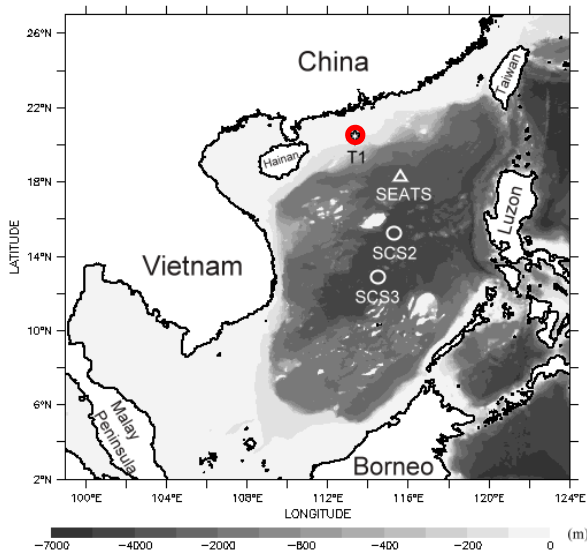
# The South China Sea model



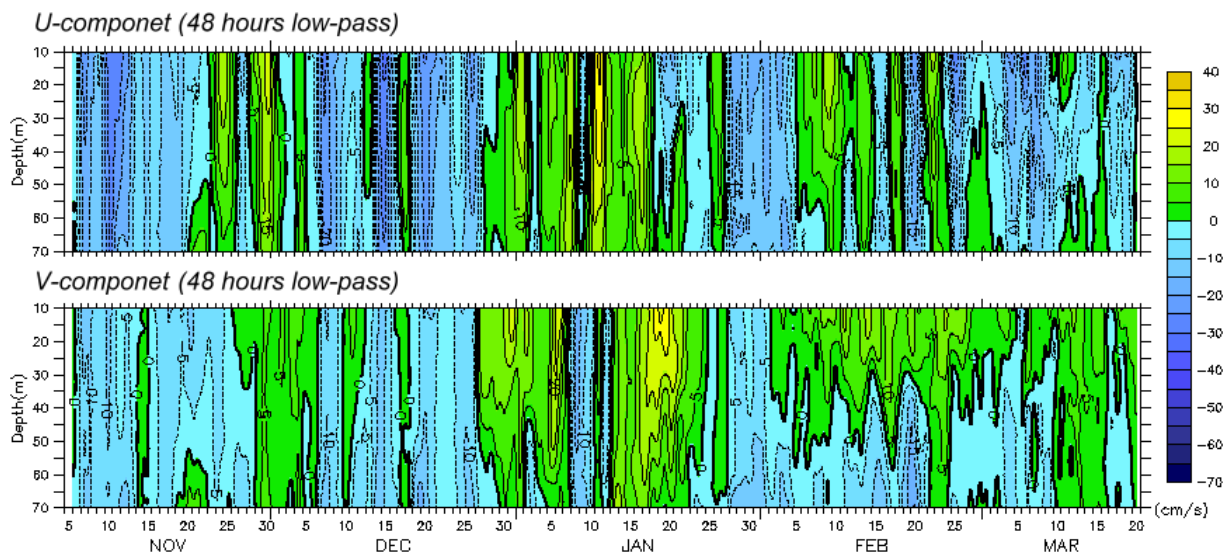
IC & BC :

daily output of EAMS model

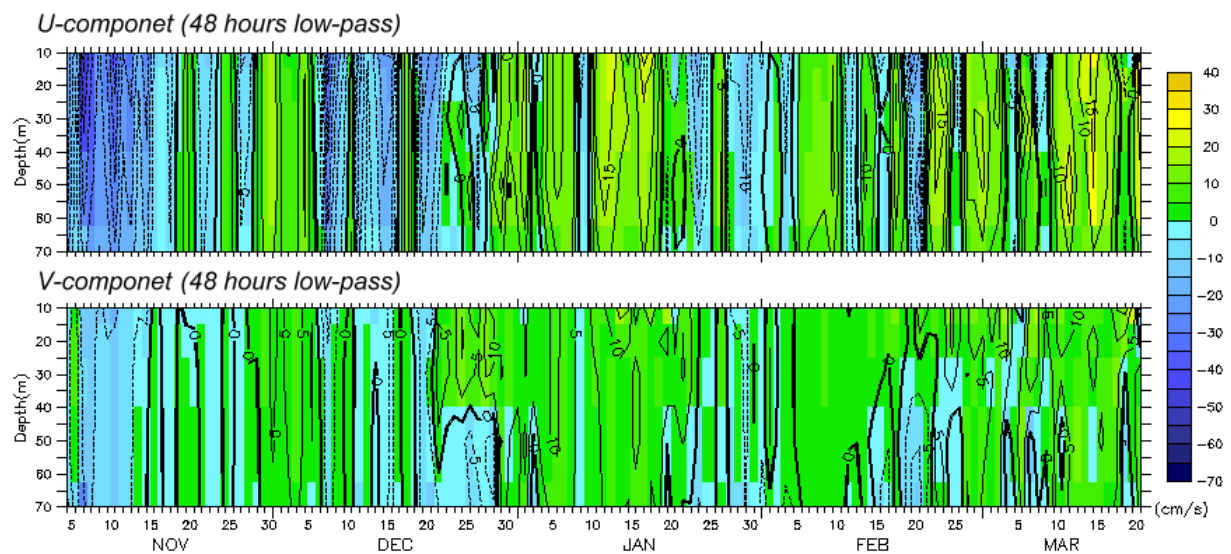
(Wu and Hsin et al., 2005; Hsin et al., 2008)



Obs.

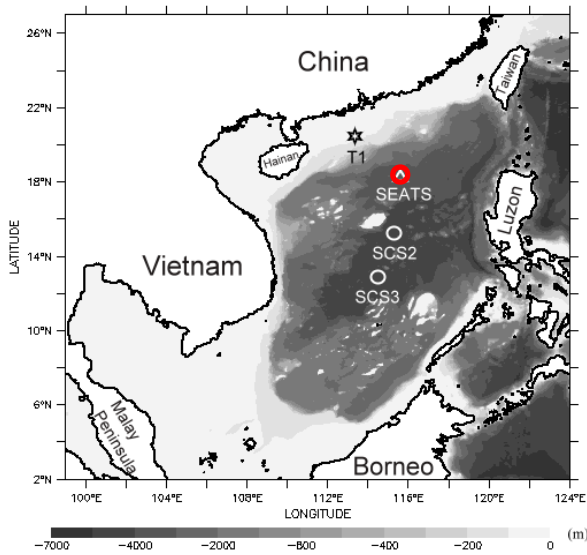


Model

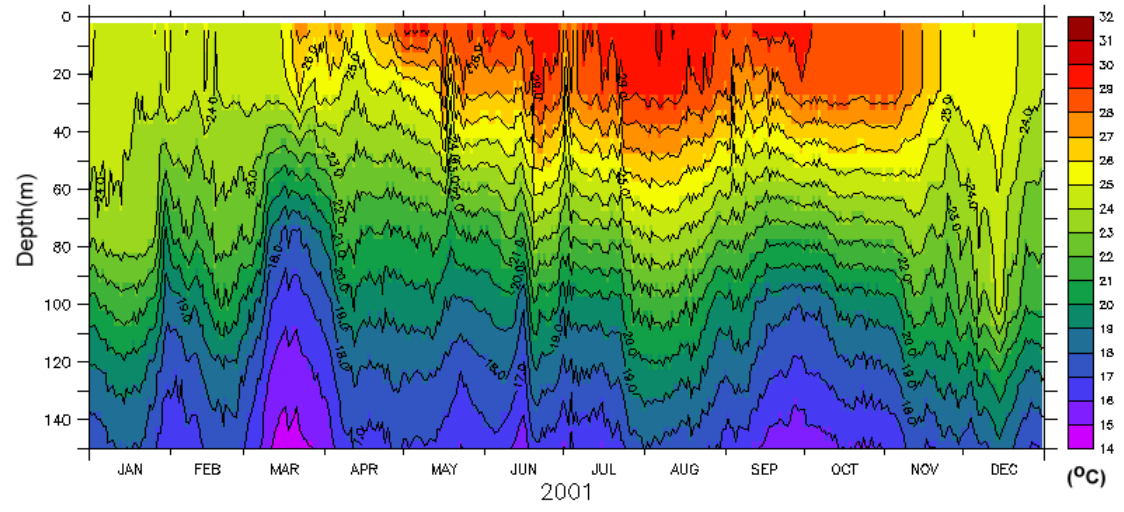


# Velocity

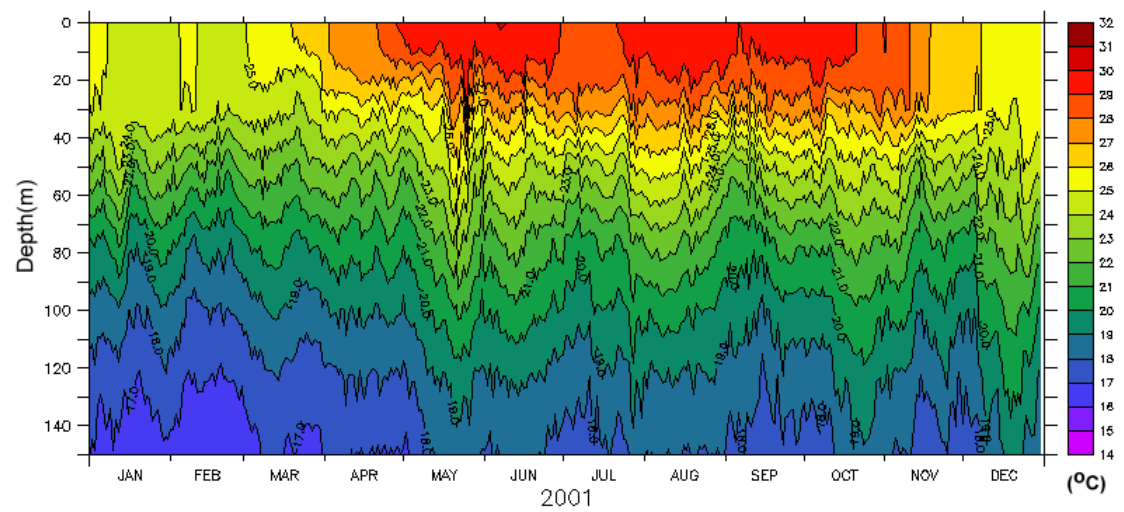




Obs.



Model



# Temperature



# Cf. drag coefficient formula

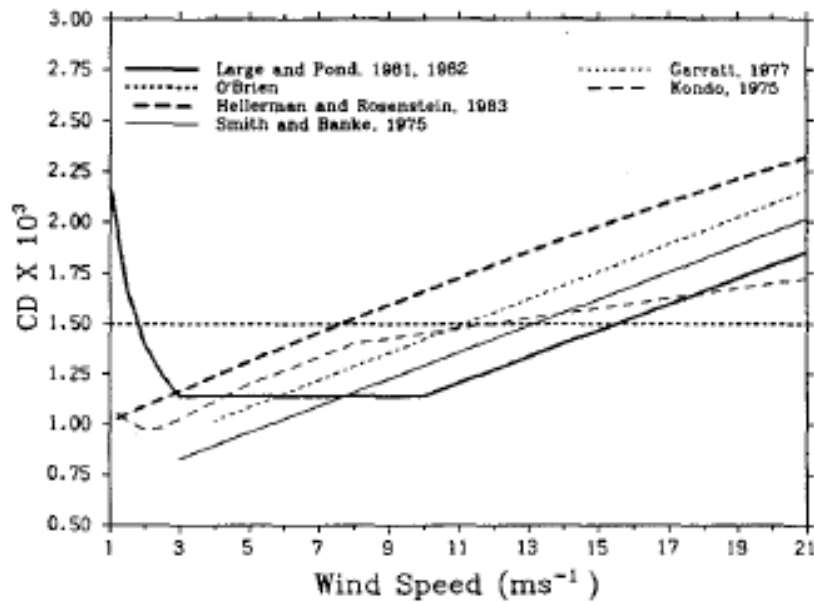
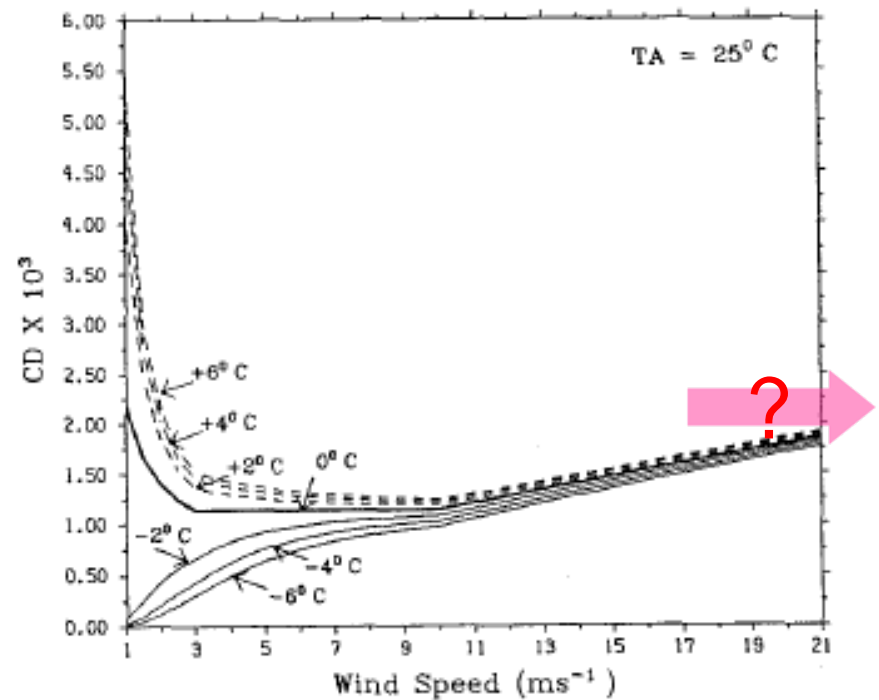


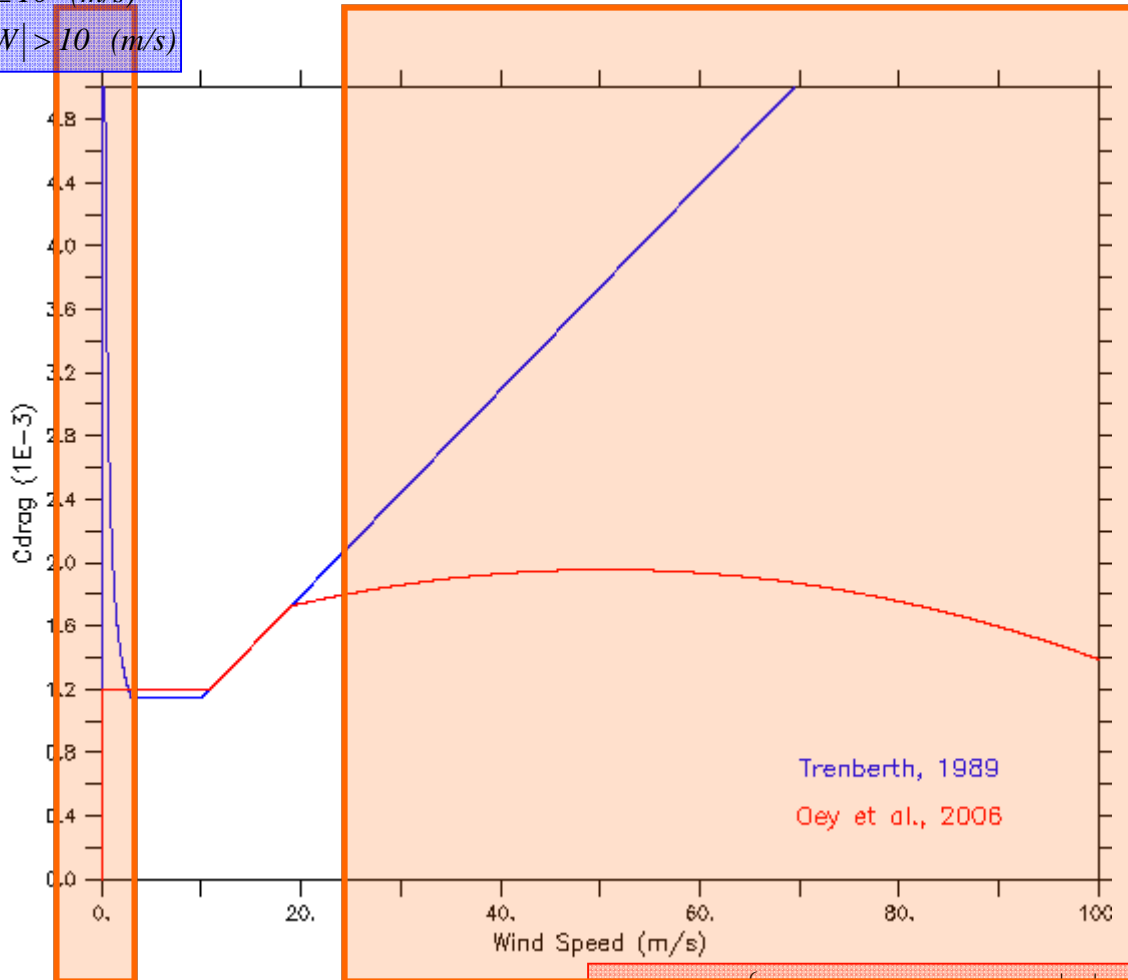
Fig. 2. Neutral drag coefficient from different studies.



(Trenberth, 1989)

# Cf. drag coefficient formula

$$C_d = 10^{-3} \times \begin{cases} (0.62 + 1.56/W), & |W| < 3 \text{ (m/s)} \\ 1.14, & 3 \leq |W| \leq 10 \text{ (m/s)} \\ 0.49 + 0.065W, & |W| > 10 \text{ (m/s)} \end{cases}$$



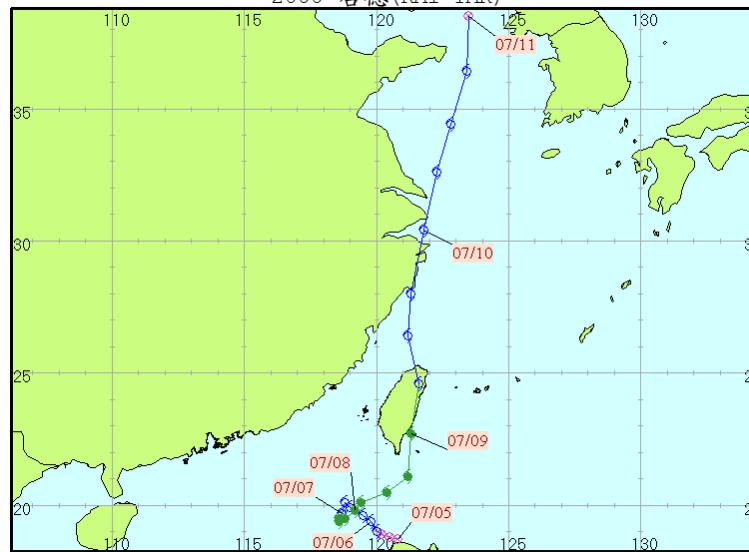
Trenberth, 1989

Oey et al., 2006

$$C_d = 10^{-3} \times \begin{cases} 1.2, & |W| \leq 11 \text{ (m/s)} \\ 0.49 + 0.065W, & 11 < |W| \leq 19 \text{ (m/s)} \\ 1.364 + 0.0234W - 0.0023158W^2, & 19 \leq |W| < 100 \text{ (m/s)} \end{cases}$$

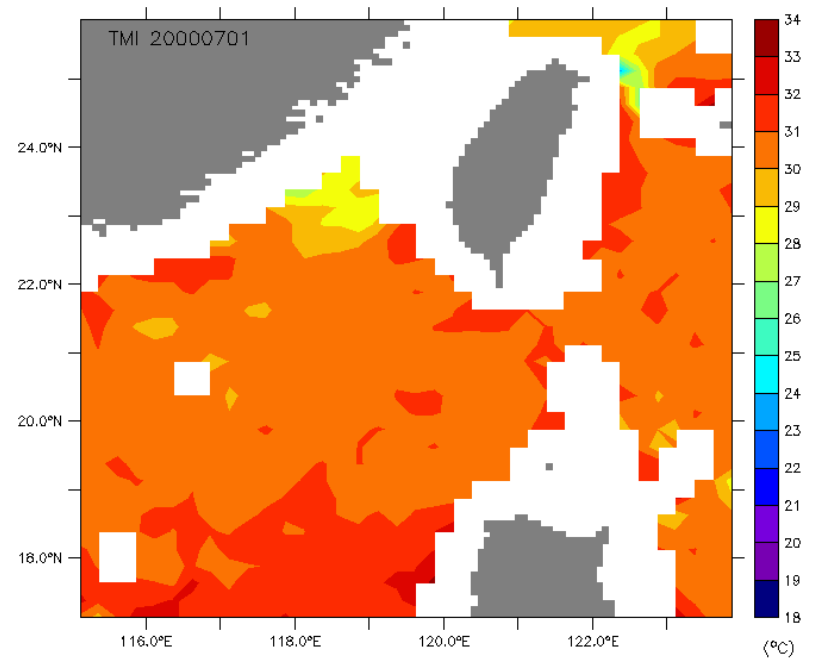
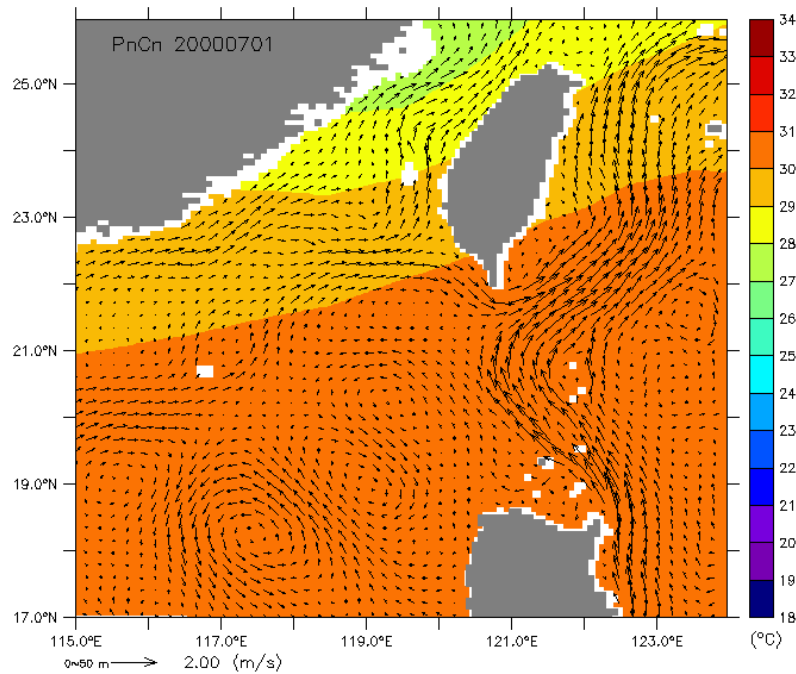


2000 啓德 (KAI-TAK)



PnCn  
UV&SST

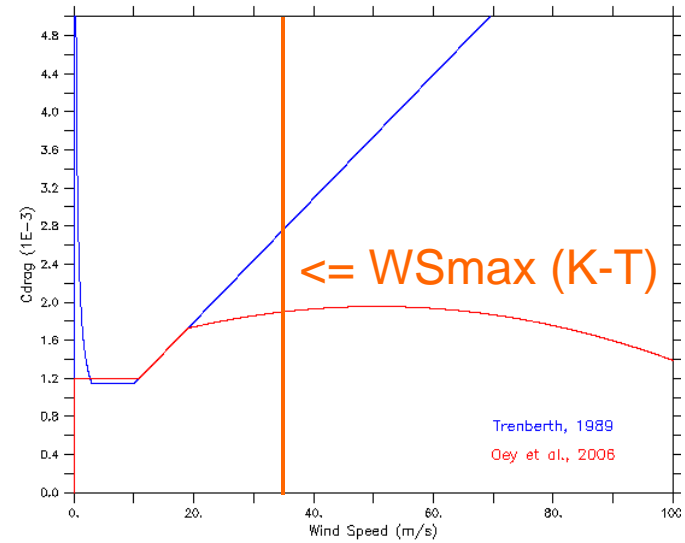
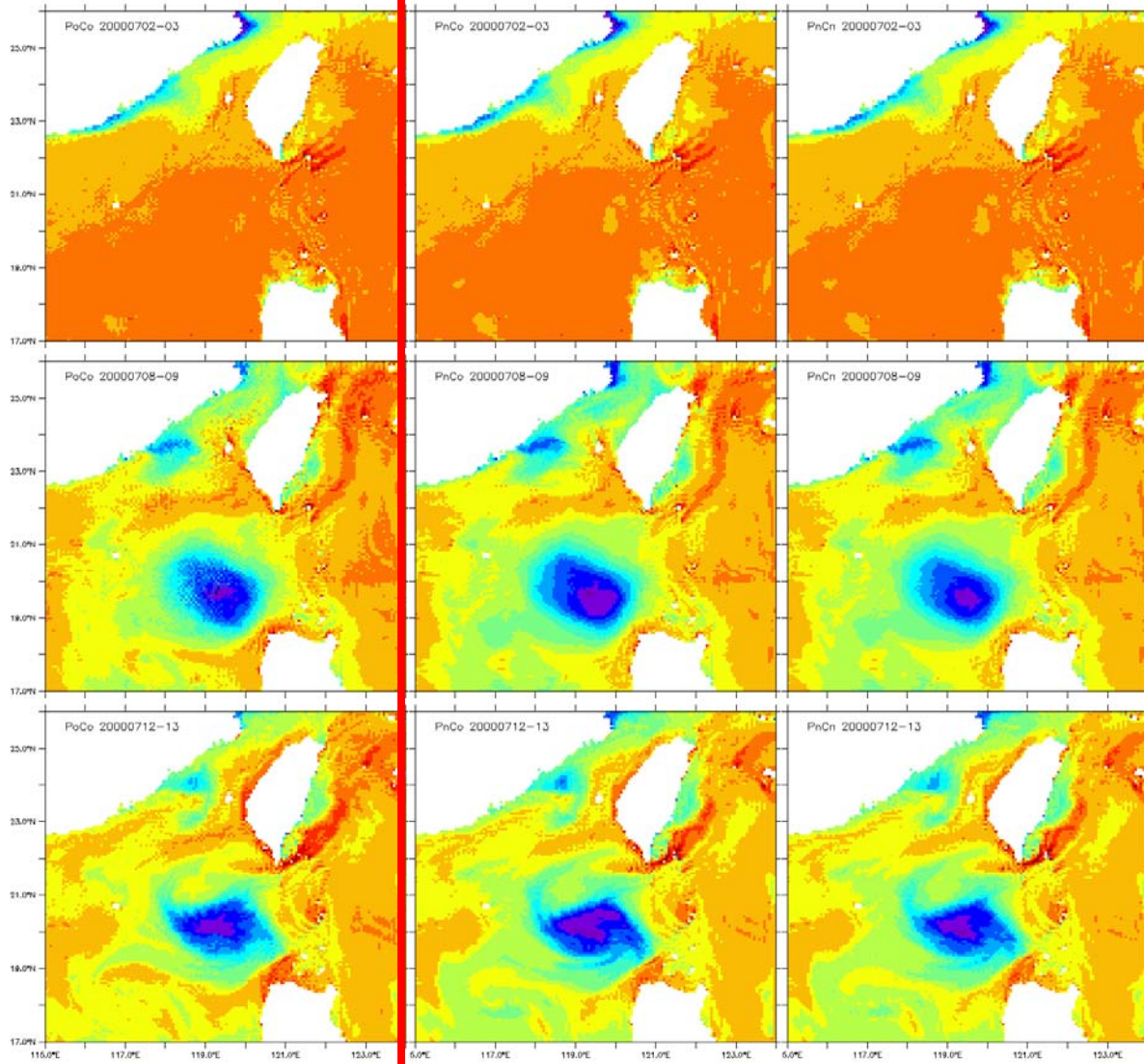
TRMM  
TMI/SST



PoCo

PnCo

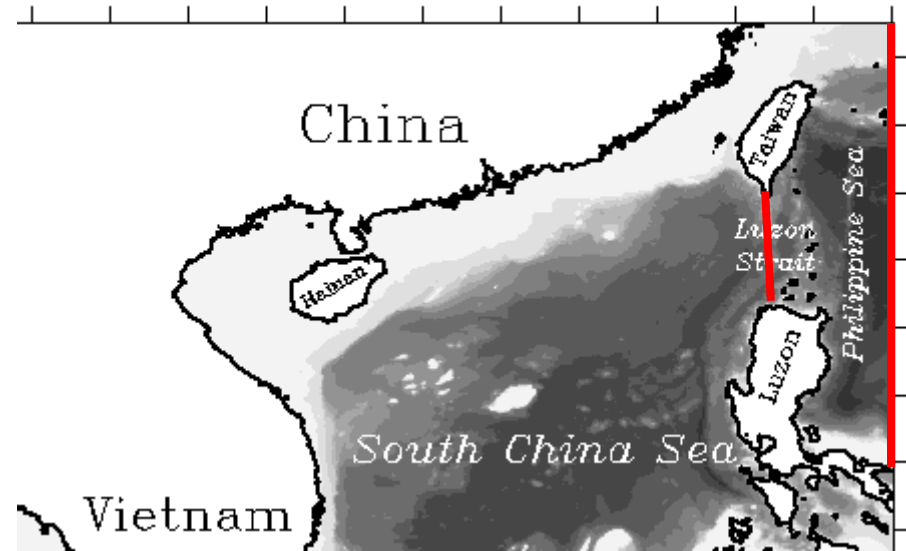
PnCn



Trenberth, 1989

Oey et al., 2006

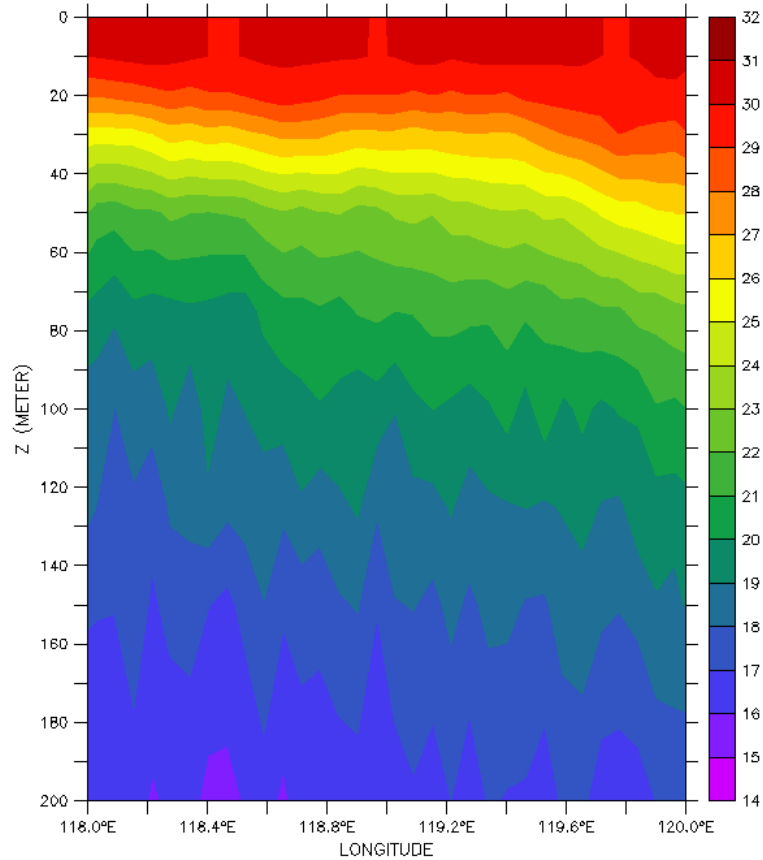
# SCS case study



Case Study		WS	KC
WoKo	standard run	C+L	Y
WoK <sup>c1</sup>	blocked LS	C+L	N
WoK <sup>c2</sup>	blocked EBC	C+L	N
W <sup>c</sup> Ko	climate WS	C	Y
W <sup>l</sup> Ko	local WS	L	Y

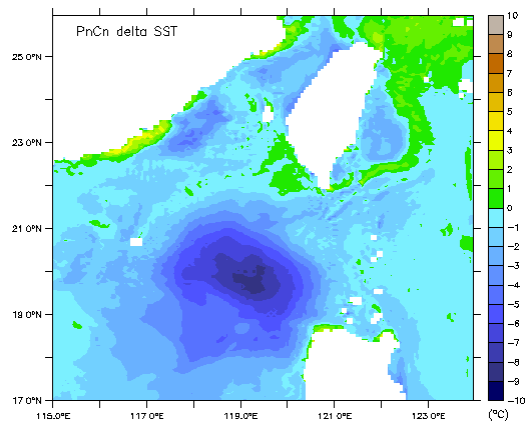
LATITUDE : 20N  
TIME : 04-JUL-2000 23:59

FERRET Ver. 6.1  
NOAA/PMEL-TMAP  
Dec 15 2000 08:52:41  
DATA SET: st200007

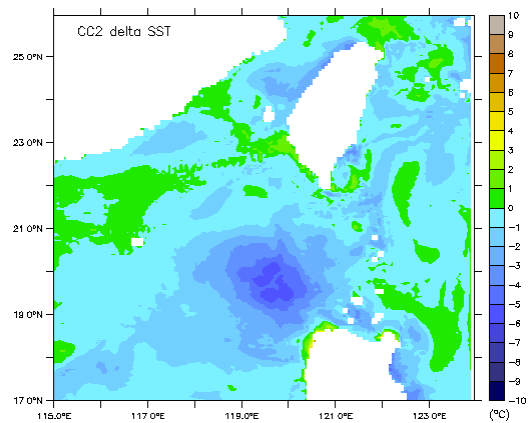


Temperature on z-level (DegC)

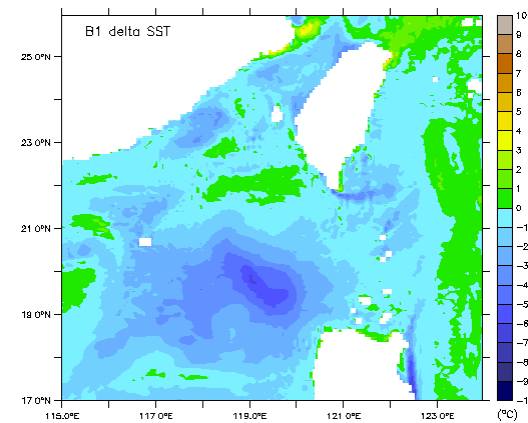
2000WS+2000TS  
8.7



2000WS+WOA01-JulyTS  
4.1



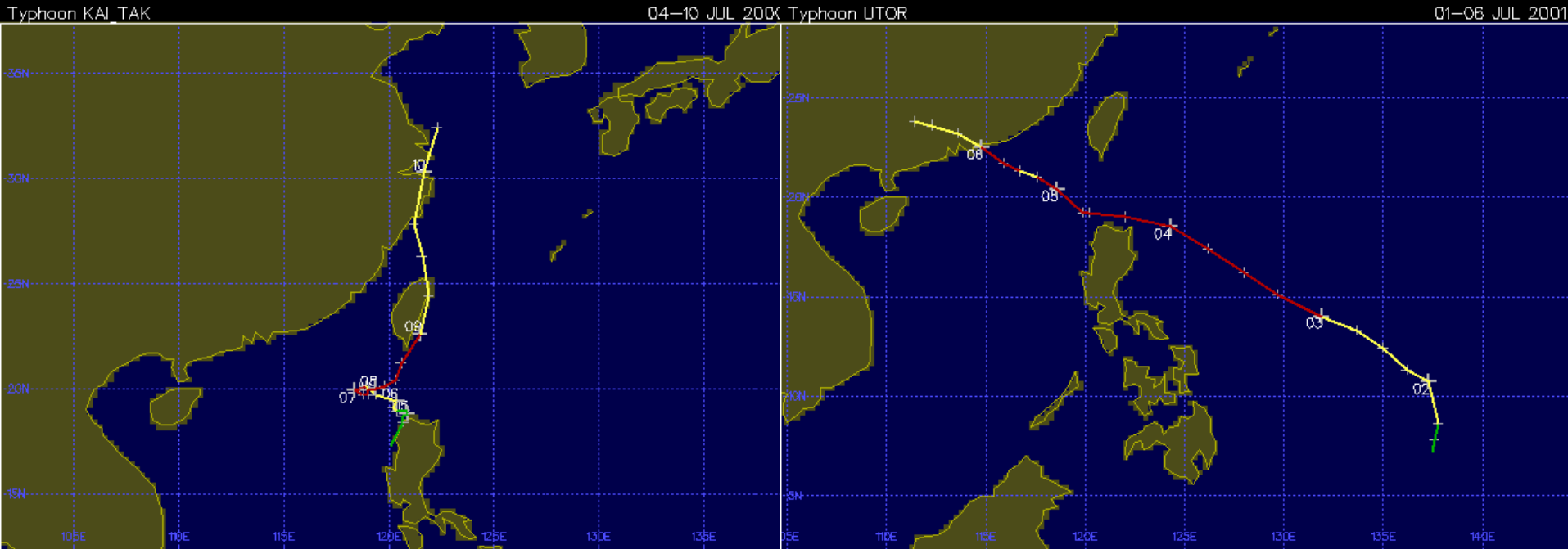
2000WS+2001TS  
5.1



Kai-Tak (2000)  
0.65~1.85 m/s  
C1; 10.8°C

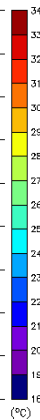
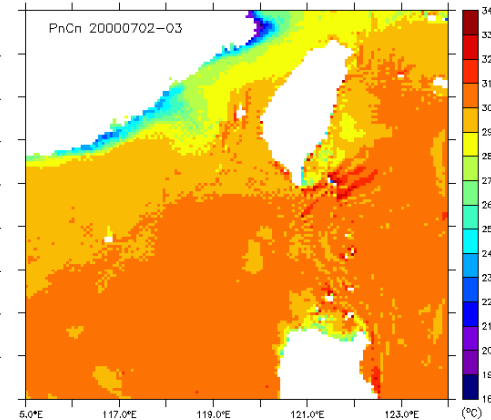
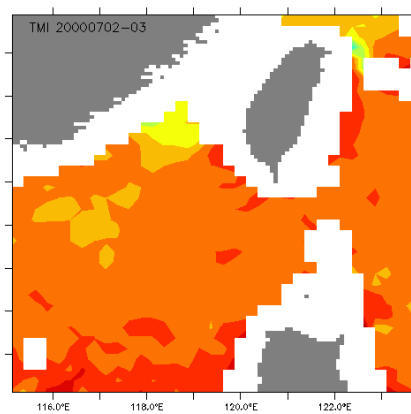
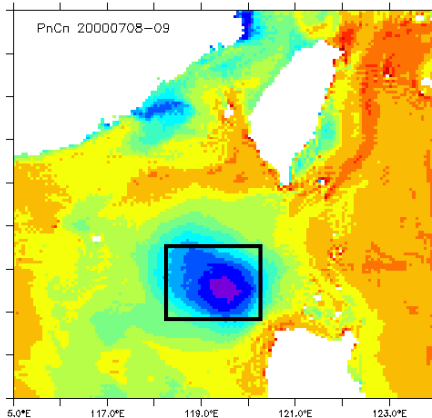
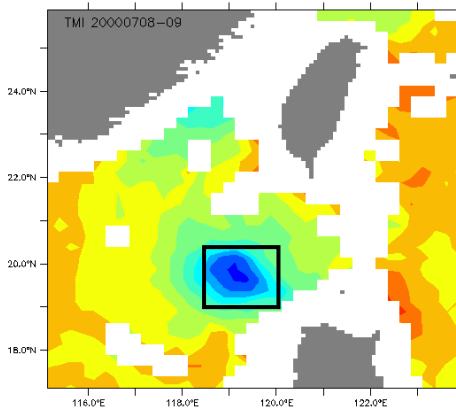
Utor (2001)  
~7.5m/s  
C1; 3.8°C

•Utor belongs to a medium moving storm during July 5~6, 2001, and the maximum SST drop was about 3.8°C.



# cf. obs. & model

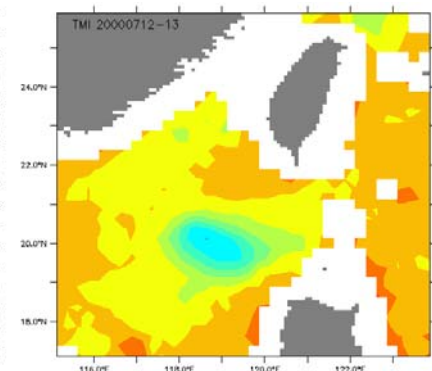
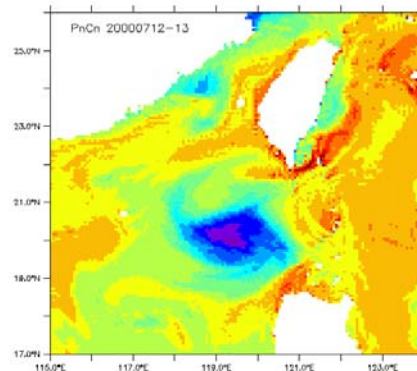
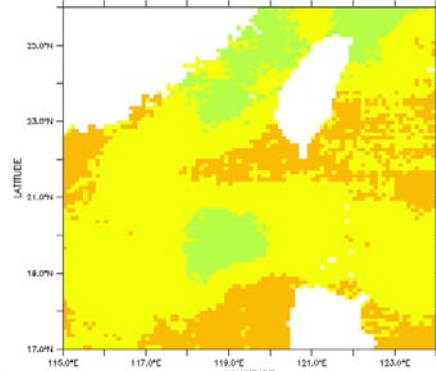
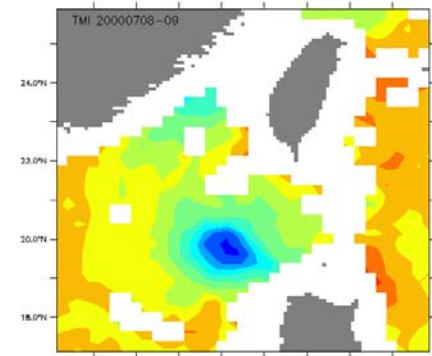
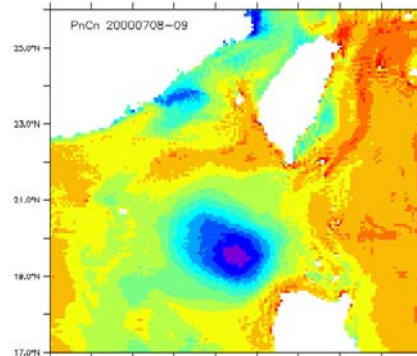
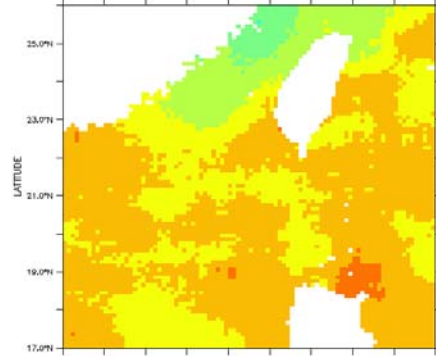
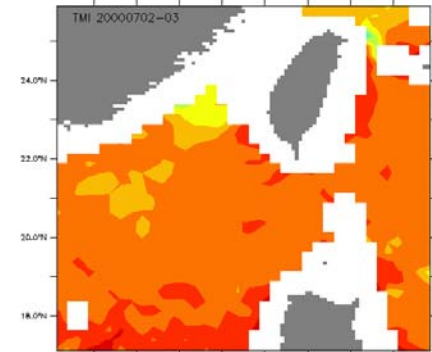
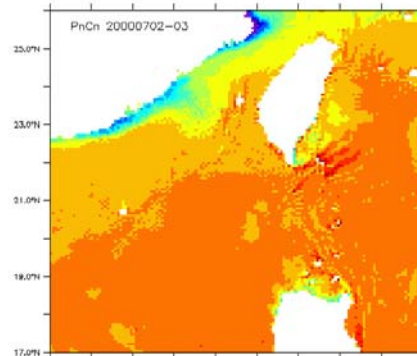
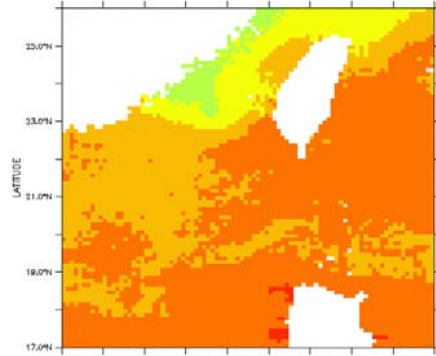
	cold SST pool (degree C)	min SST (20000708-9)	pre-typhoon condition (20000702-03)	delta SST
TRMM TMI/SST	118.5-120E, 19-20.5N 21-24	118.9E, 19.9N ~21.8	~30.7	~9
SCSM SST	118.2-120.2E, 19-20.7N 19-24	119.3E, 19.7N ~19.9	~30.2	~10



# GHRSSST

# PnCn SST

# TRMM TMI/SST

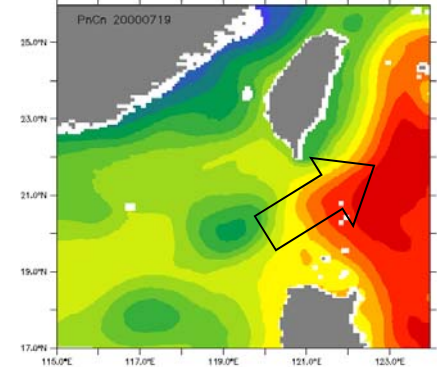
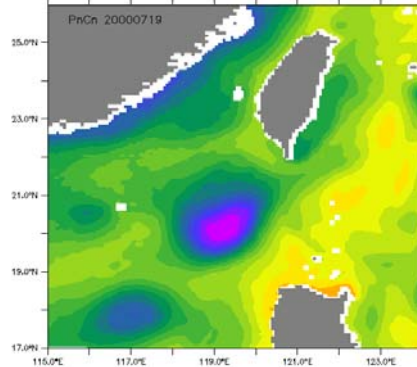
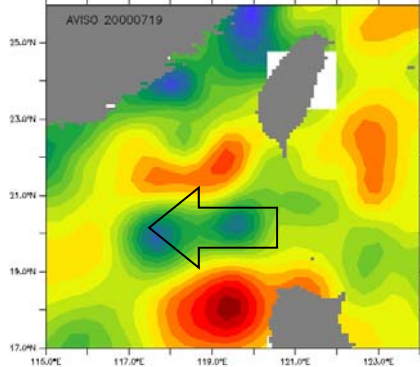
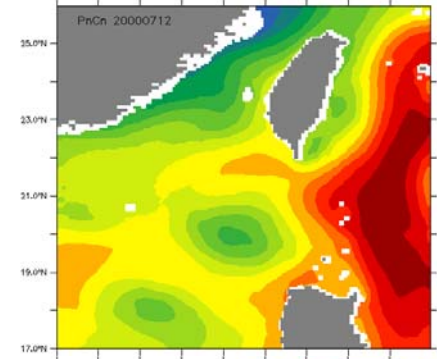
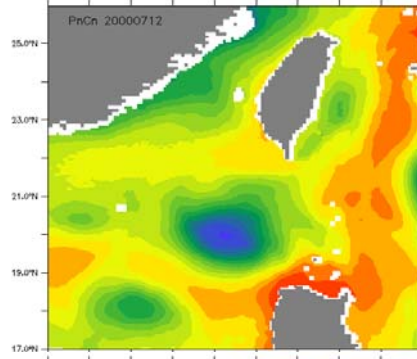
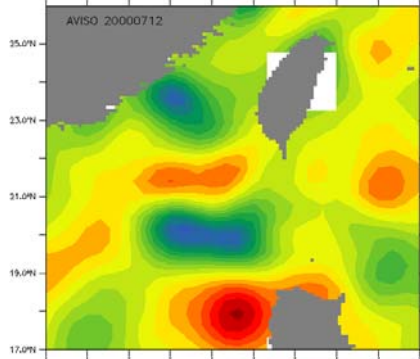
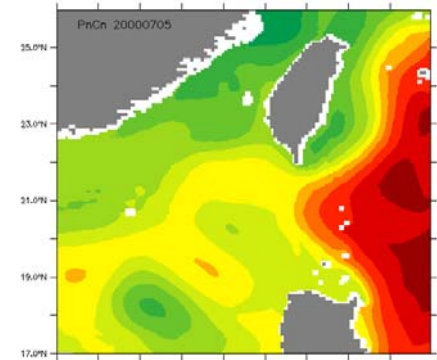
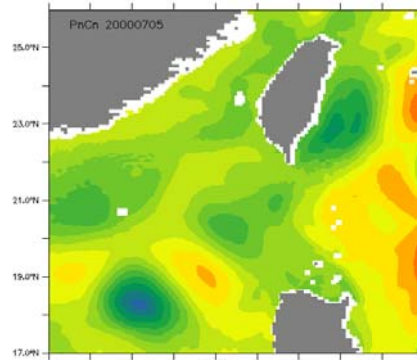
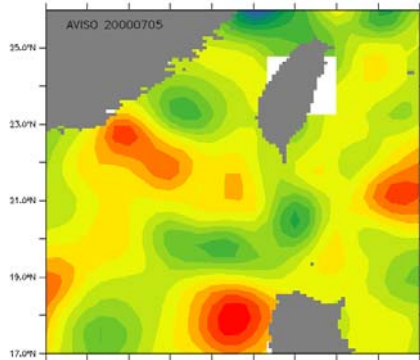


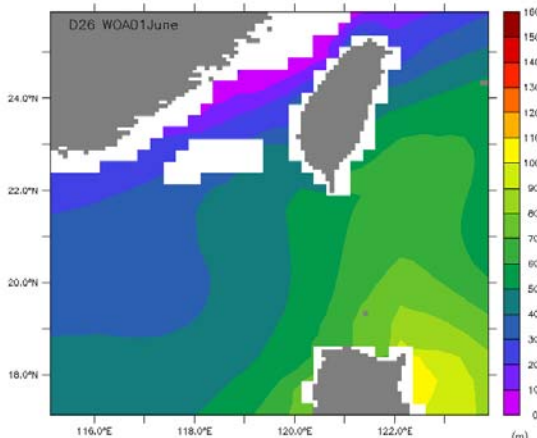


# AVISO SSHA

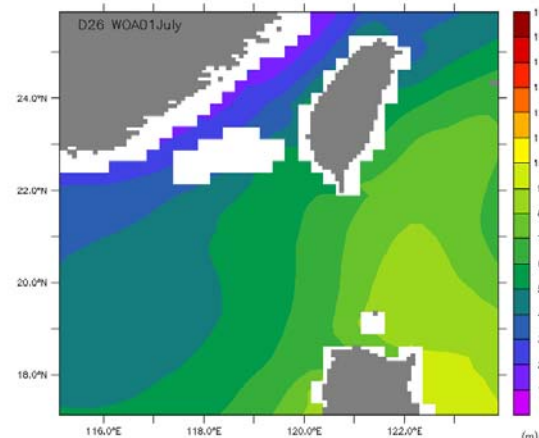
# PnCn SSHA

# PnCn SSH



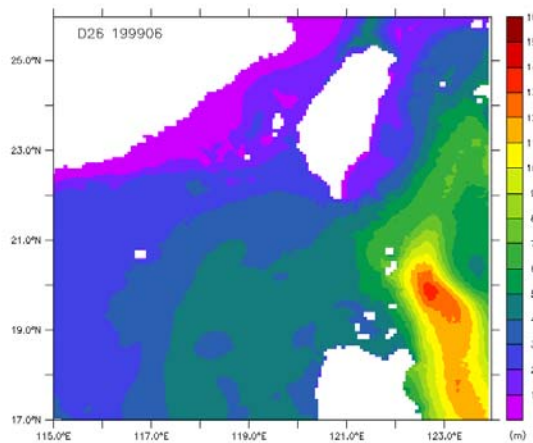


WOA01-June  
43.86

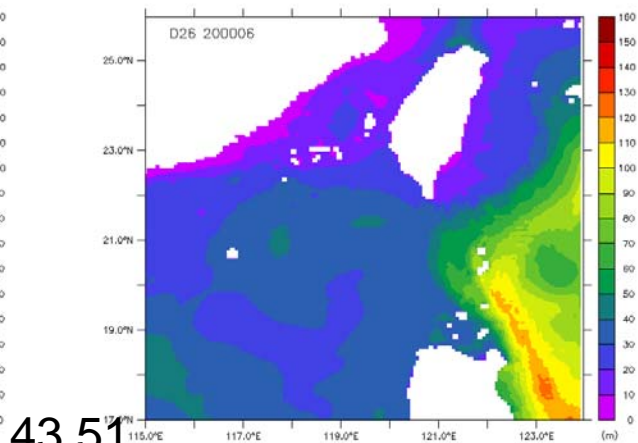


WOA01-July  
54.50

42.94  
1999-June



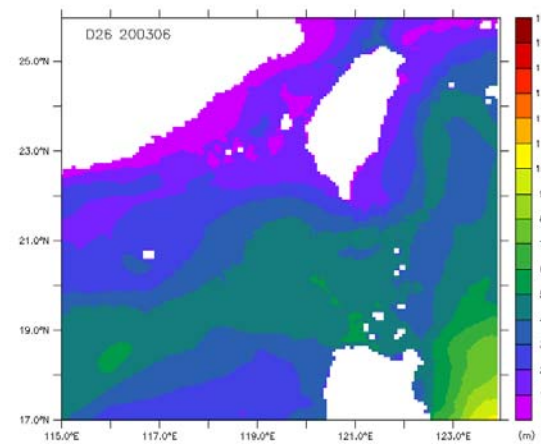
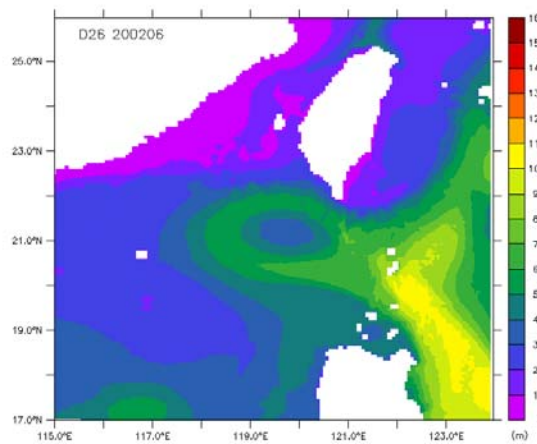
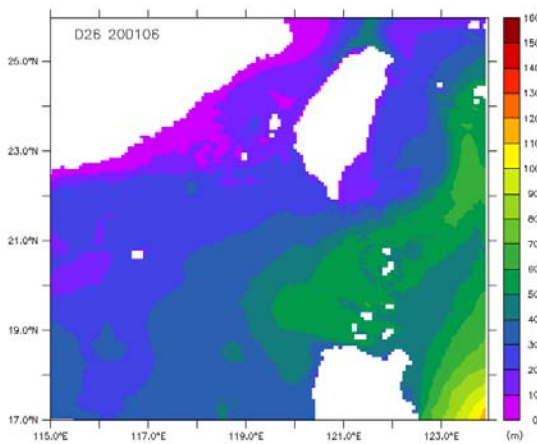
42.44  
2001-June

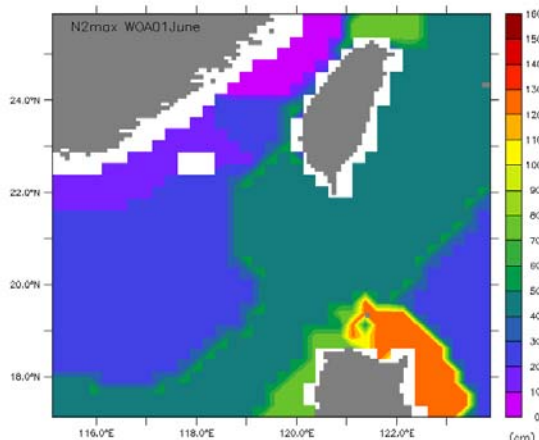


29.14  
2000-June

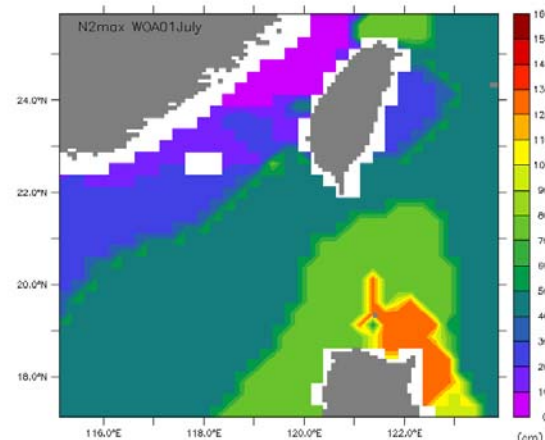
43.51  
2002-June

47.49  
2003-June





WOA01-June  
30.00



WOA01-July  
50.00

