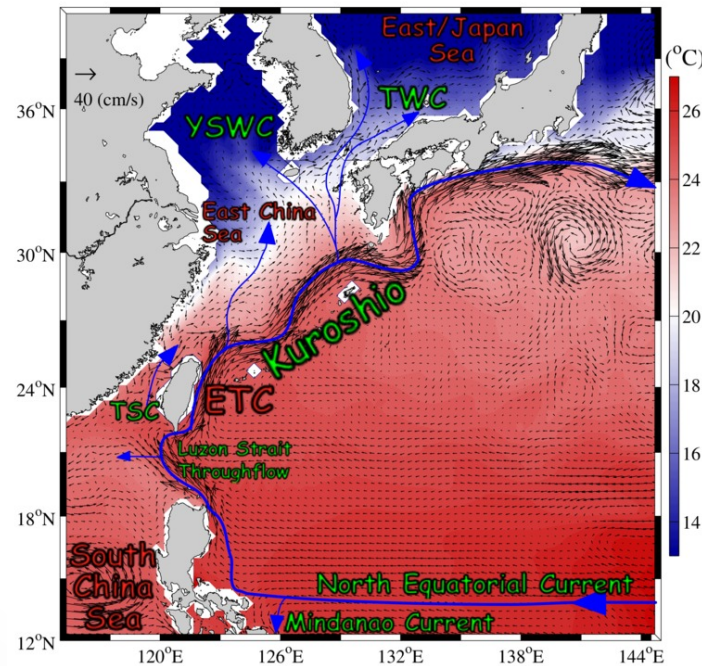


Operational eddy-resolving ocean model for the western Pacific and the coupled model simulation for the South China Sea



Yu-Heng Tseng^a, Chih-Chieh Young^b, Yi-chun Kuo^a, Yun-Chuan Shao^a

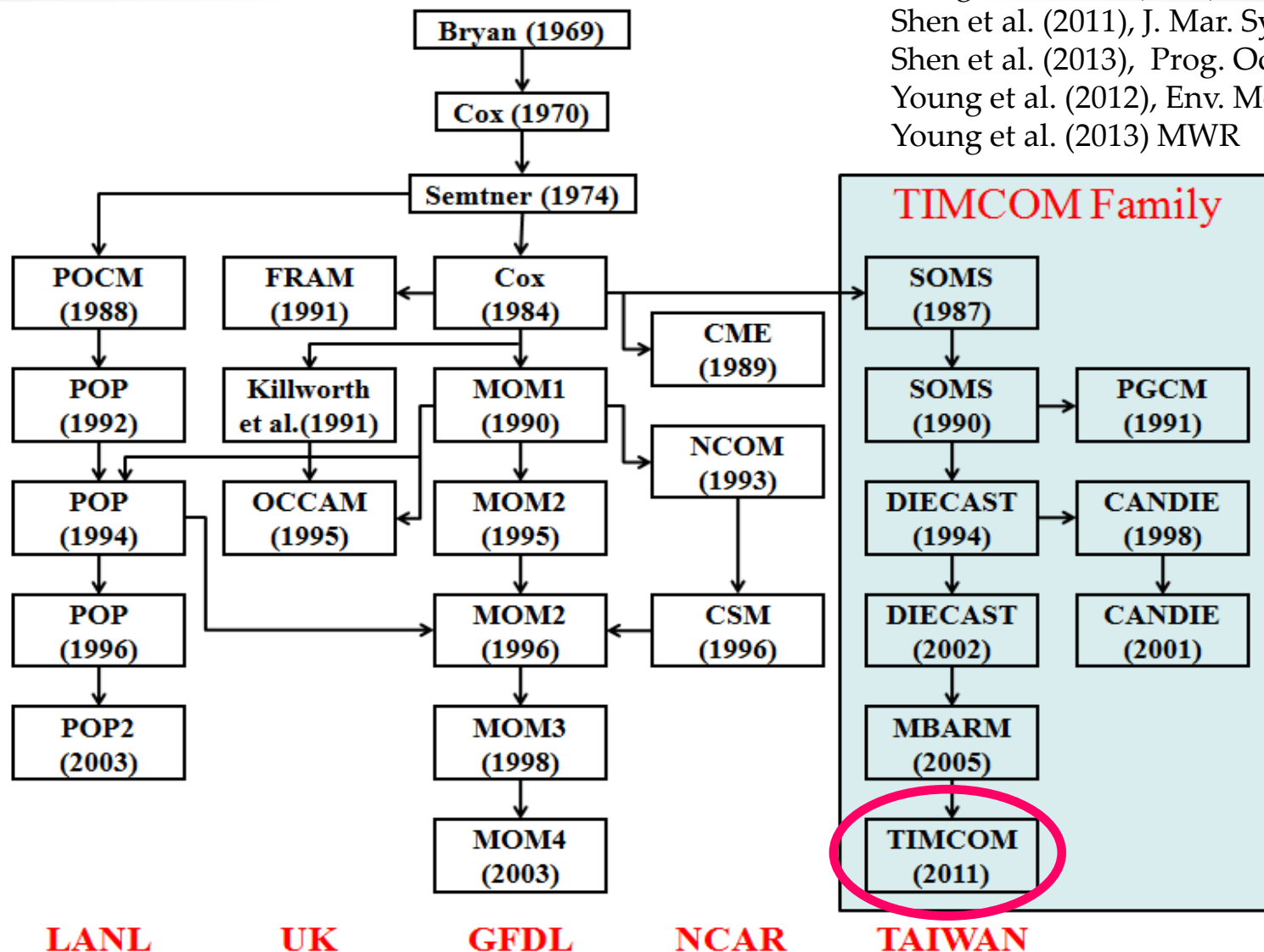
^a Institute of Oceanography, National Taiwan University

• ^b Department of Marine Environmental Informatics, National Taiwan Ocean

Multi-Scale Ocean Circulation System (TIMCOM)

<http://140.112.69.65/coda/research/timcom>

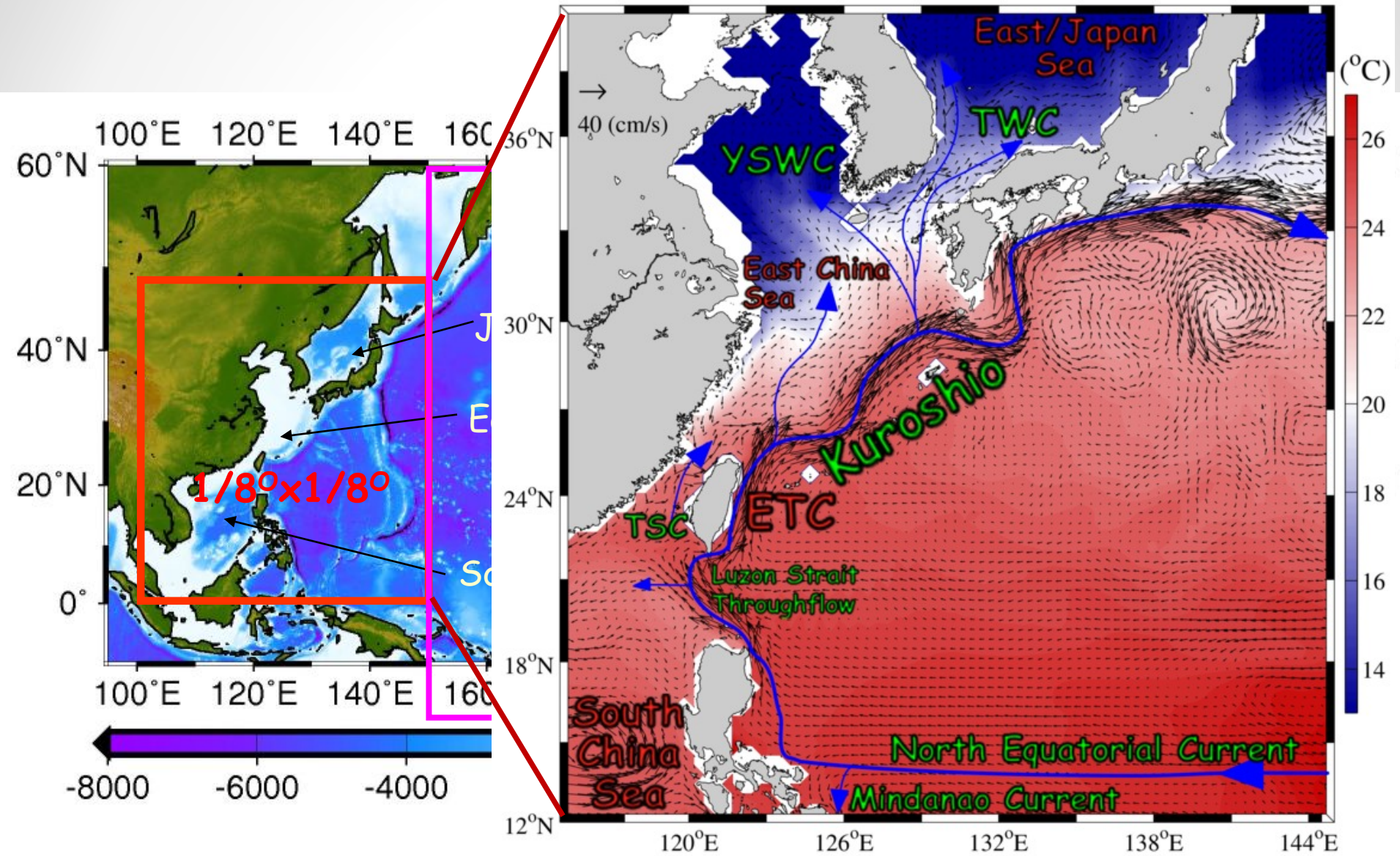
Tseng et al. (2012), Prog. Ocean
Tseng and Chien (2011), Comp. Fluids
Shen et al. (2011), J. Mar. Sys.
Shen et al. (2013), Prog. Ocean
Young et al. (2012), Env. Modell. Soft.
Young et al. (2013) MWR

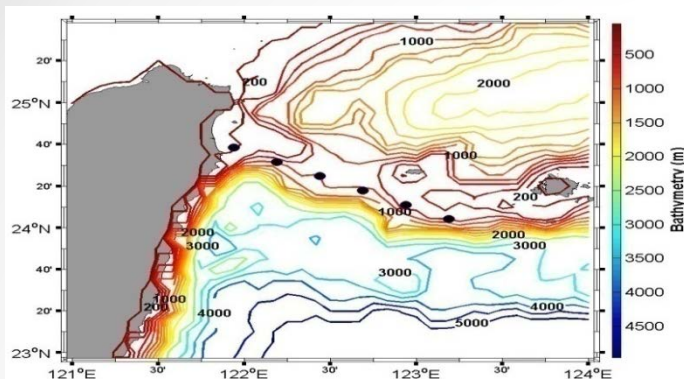


- 4th order accurate, Z-level, free surface (or rigid-lid)
- Mixed Arakawa "a" and "c" grids
- The control volume equations include fluxes of the conservation of momentum, heat and salt across control volume faces.
- Bathymetry:
 - Interpolated from unfiltered ETOPO2 depth data
- The vertical resolution ~ linear-exponential stretched grid, 26 layers
- Varying latitude and uniform longitude grid (Mercator grid).
- Surface forcing:
 - NCEP GFS atmospheric state
 - Use 1/12° HYCOM global model for the initialization.
- The northern boundary is closed. Insulated bottom, with non-slip conditions parameterized by a nonlinear bottom drag.
- Sub-grid scale vertical mixing is parameterized by eddy diffusivity/viscosity using a modified Richardson number based approach

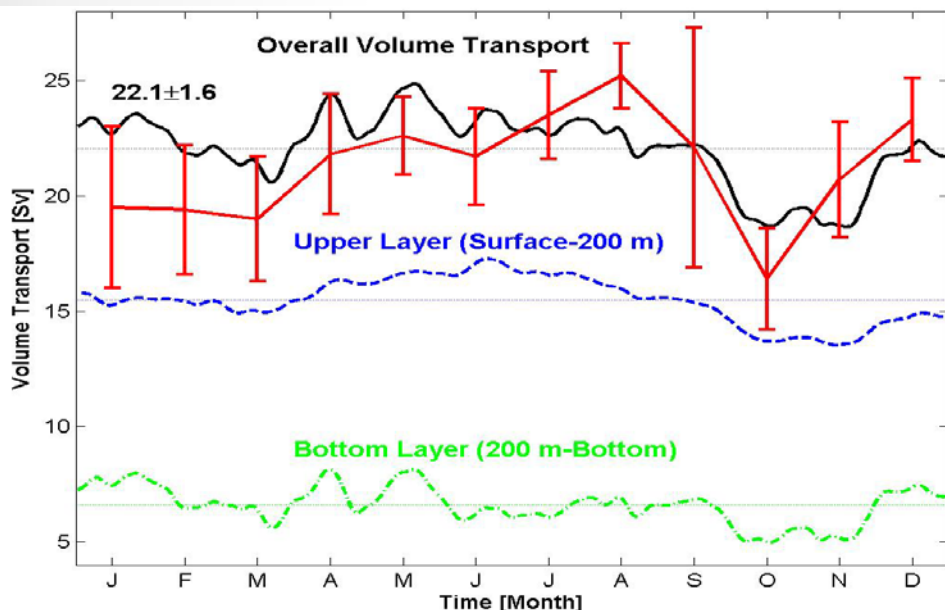
North Pacific Config.

NPB (North Pacific Basin) Domain:
30°S to 60°N and 150°E to 80°W
grid resolution 1/4°

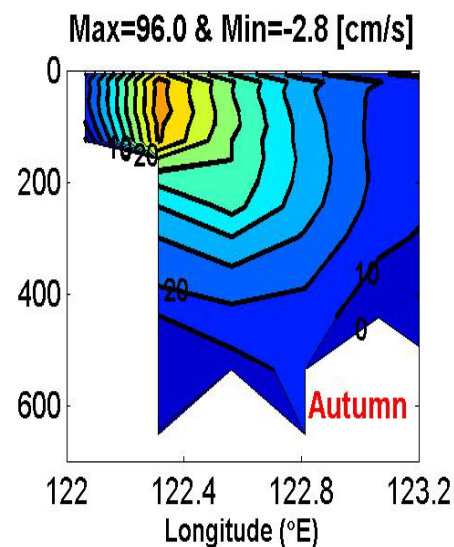
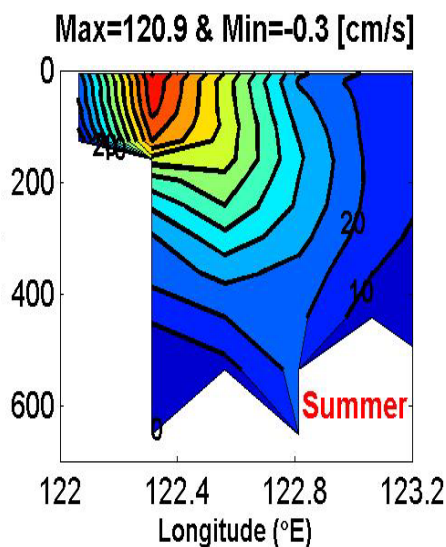
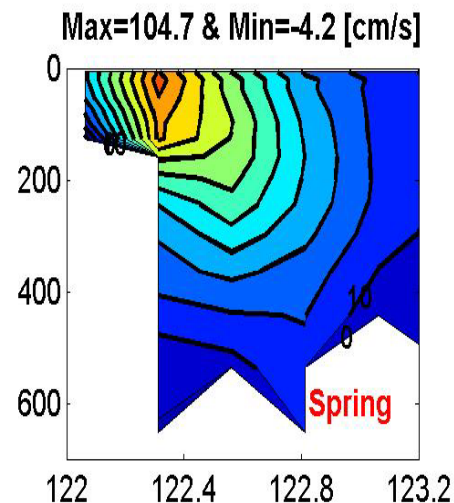
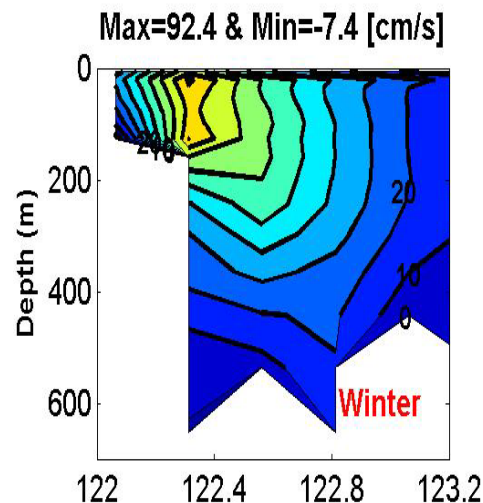




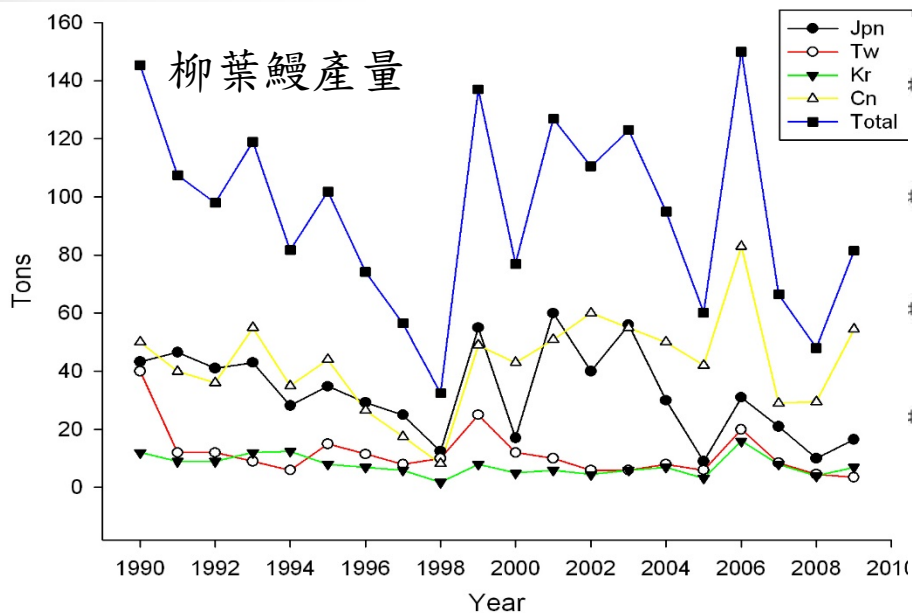
PCM1 Section



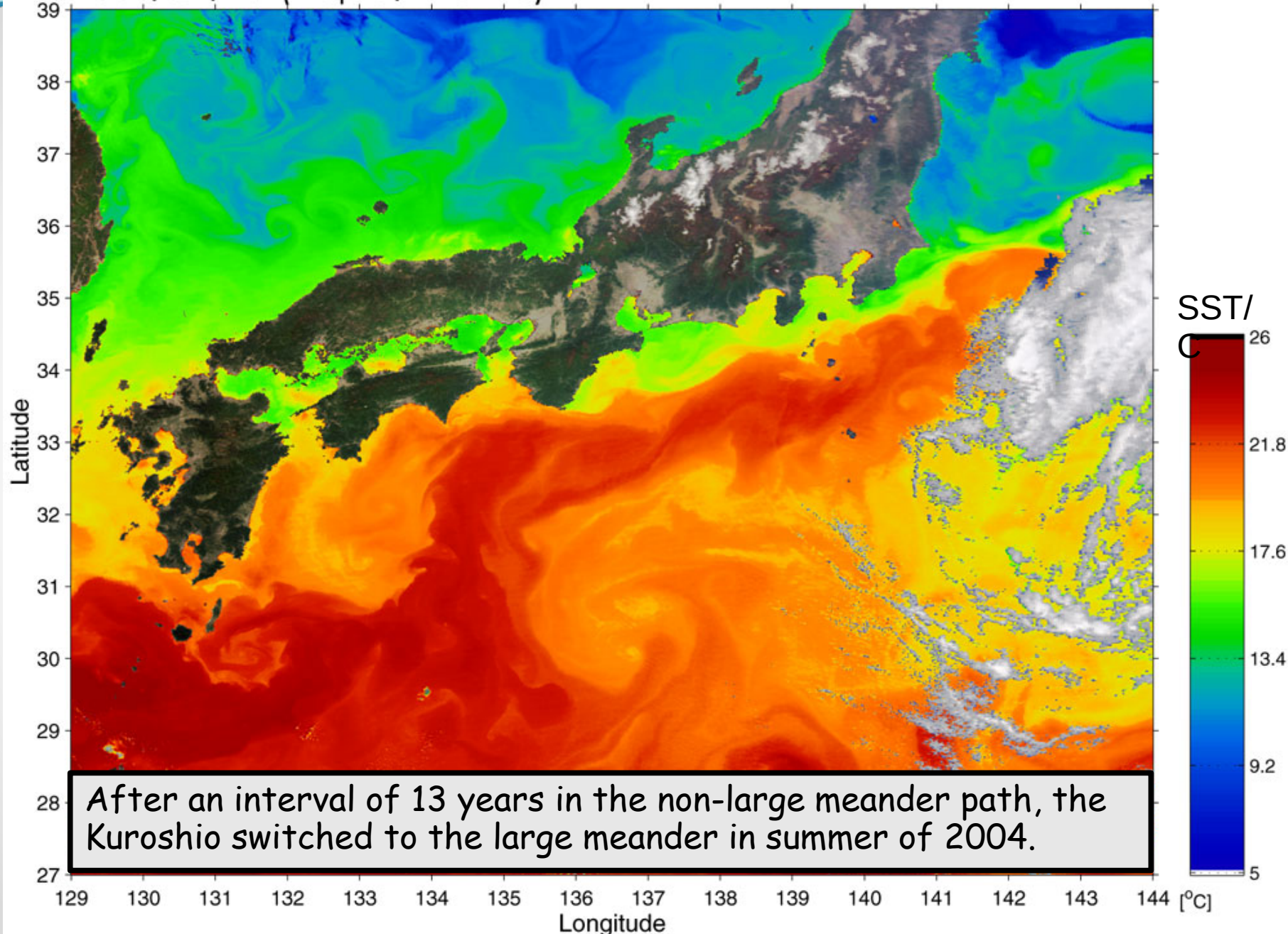
5-day running mean, averaged volume (year 37-39) transport across the PCM-1 section.



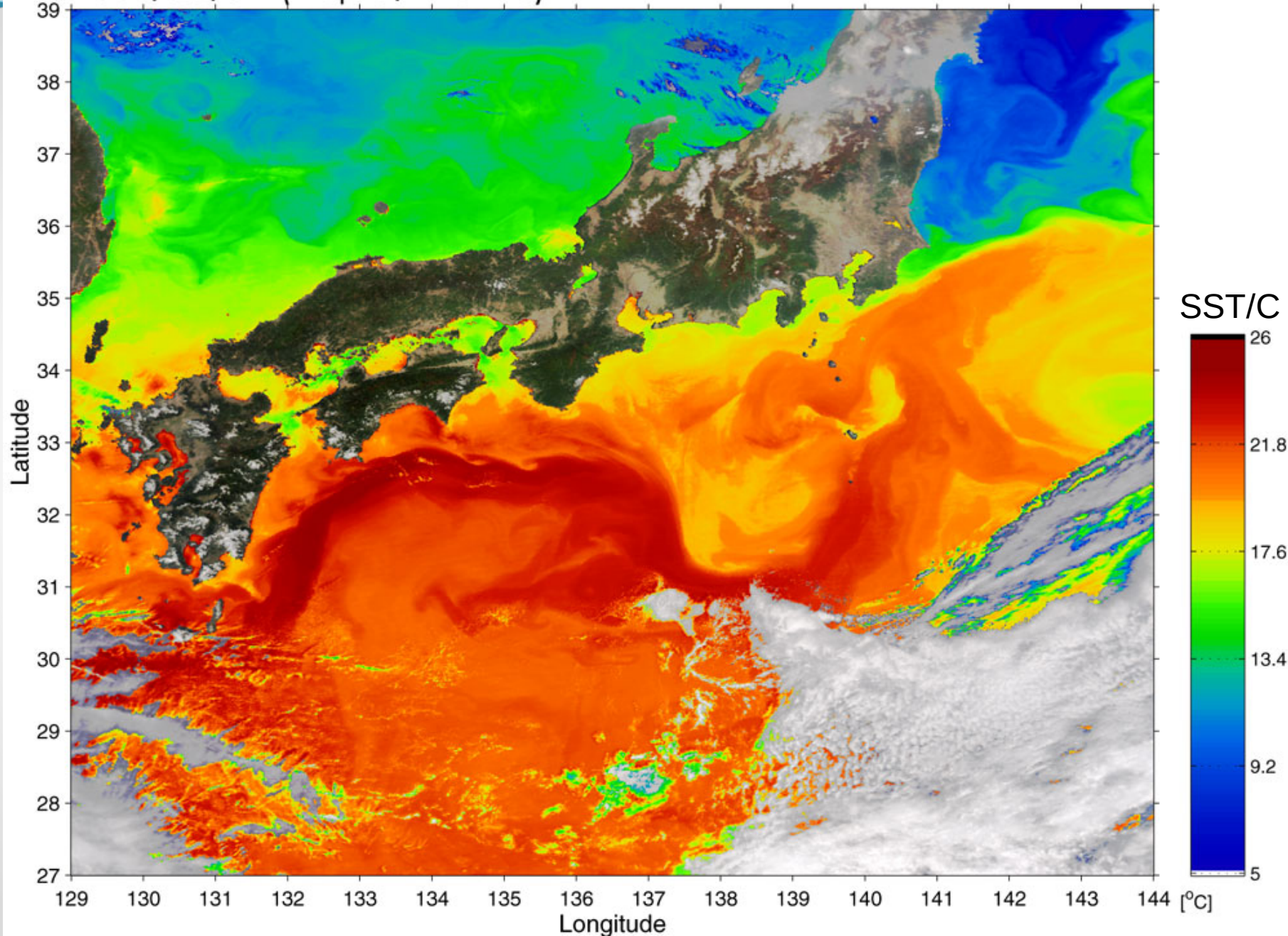
Seasonal mean (year 37-39) of the vertical current structure normal to the PCM-1 section.

[illegible]

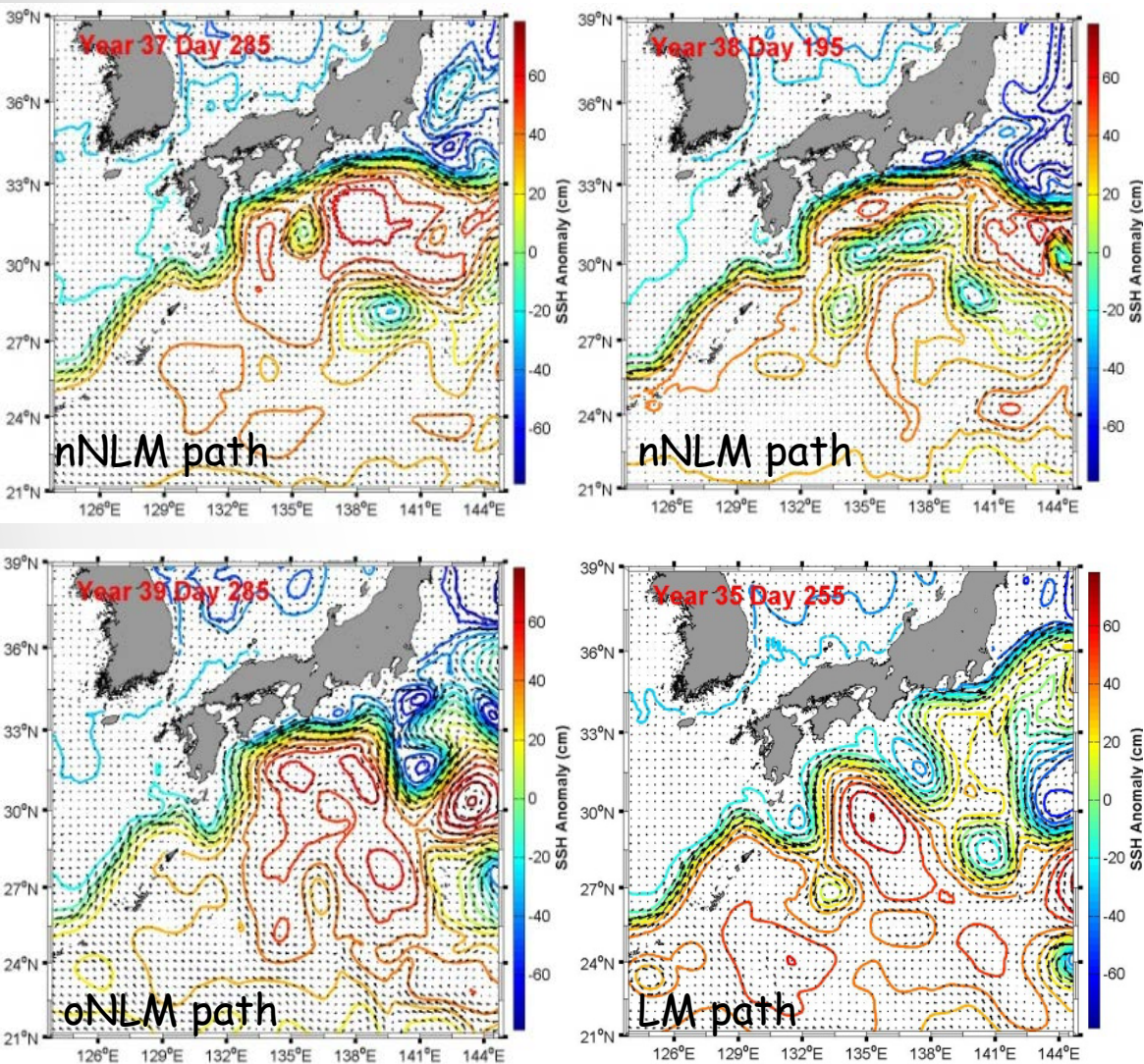
2004/04/29 (Aqua/MODIS)



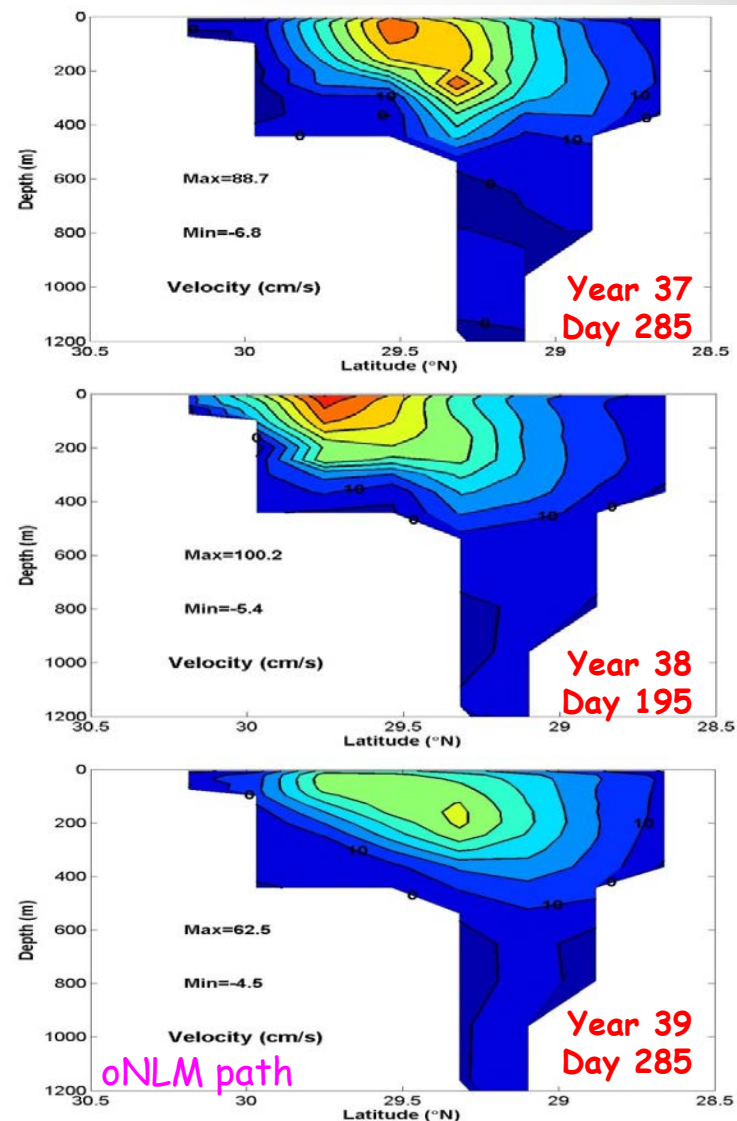
2005/05/04 (Aqua/MODIS)



Snapshot of the distribution of sea surface temperature and horizontal velocity at sea surface.



Snapshot of the vertical current structure normal to the TK section



Kuroshio Path position along 138°E

SSH anomaly (131-134°E, 30-33°N)

SSH anomaly along 138°E

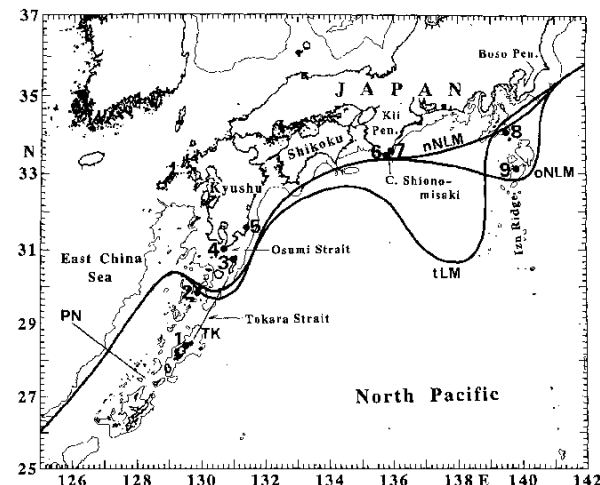
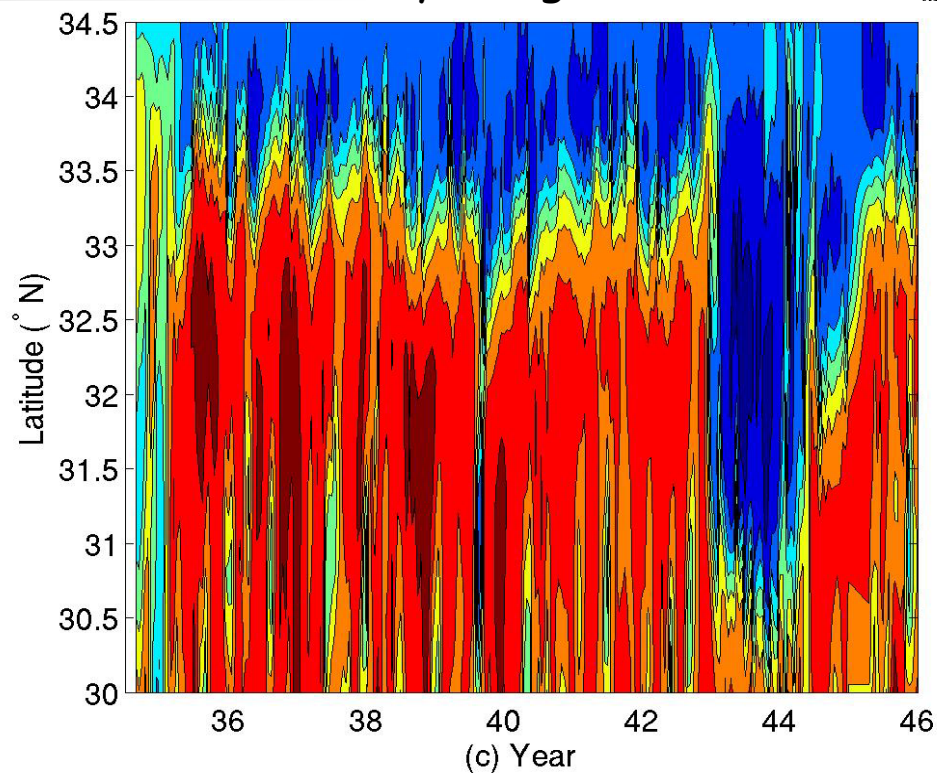
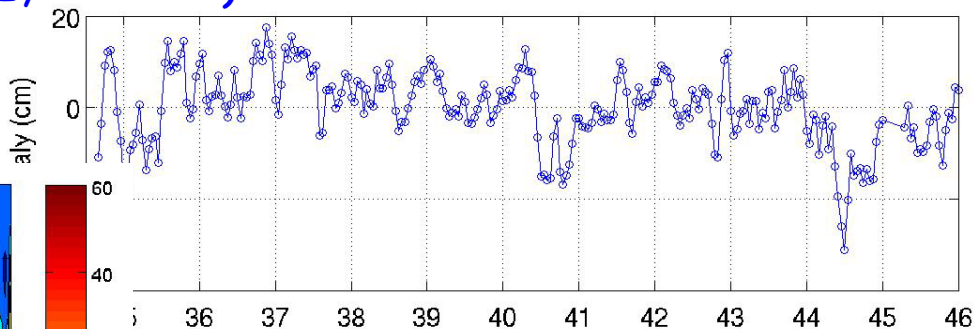
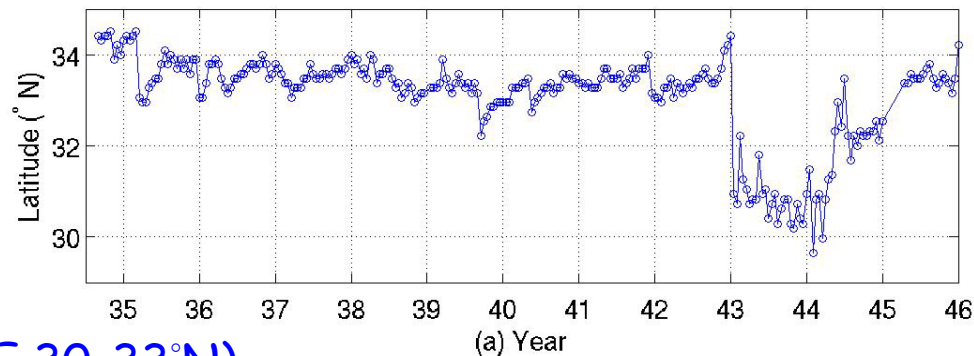
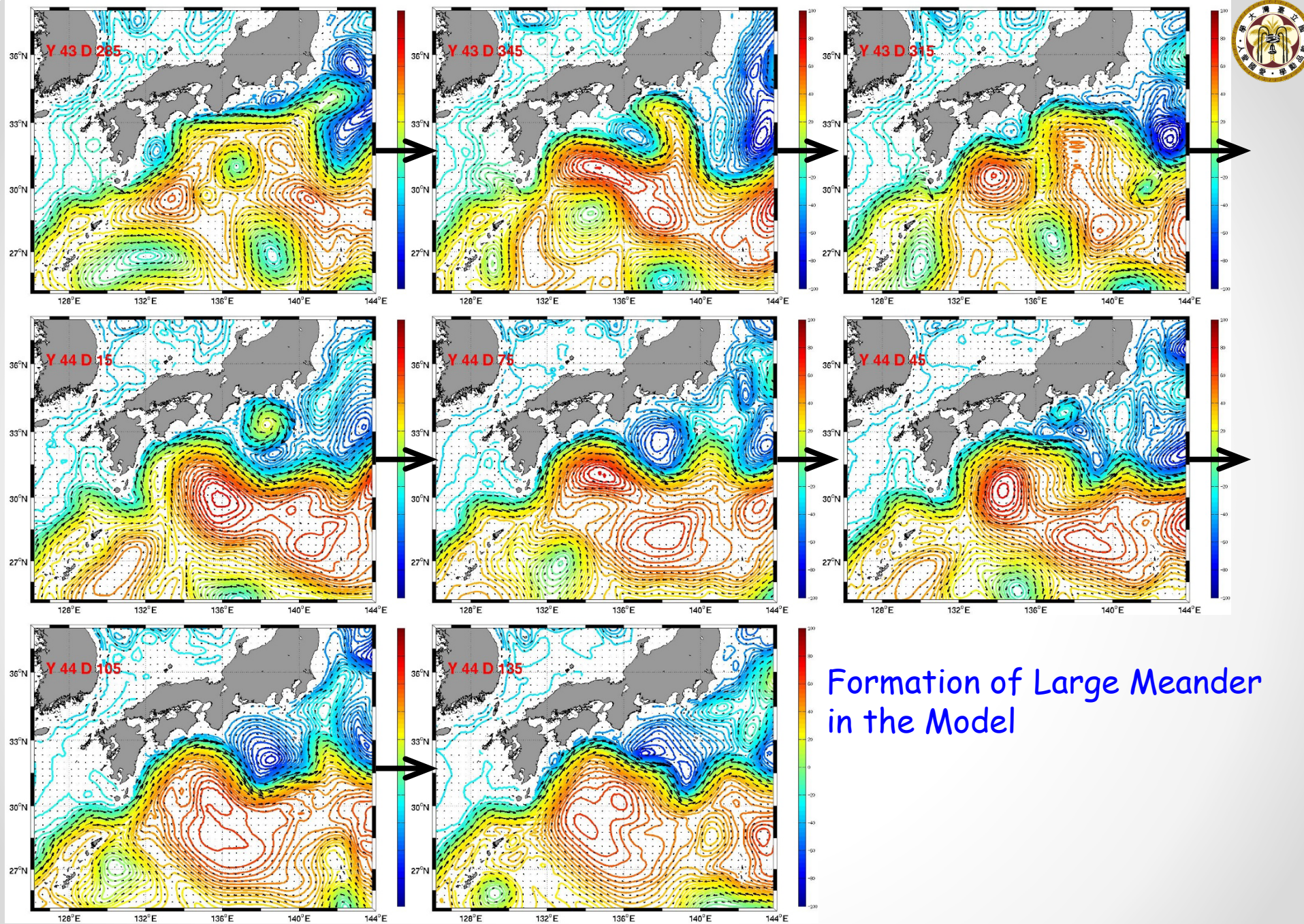
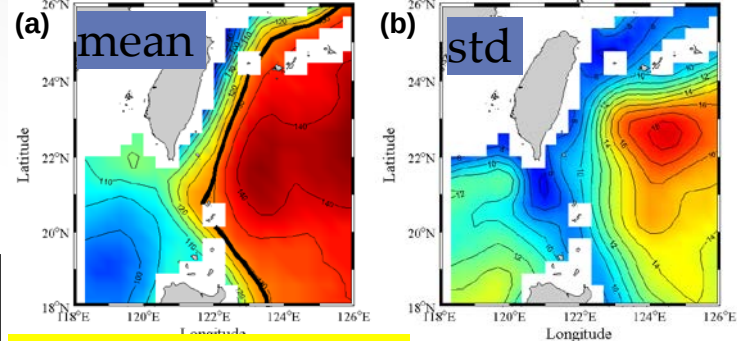
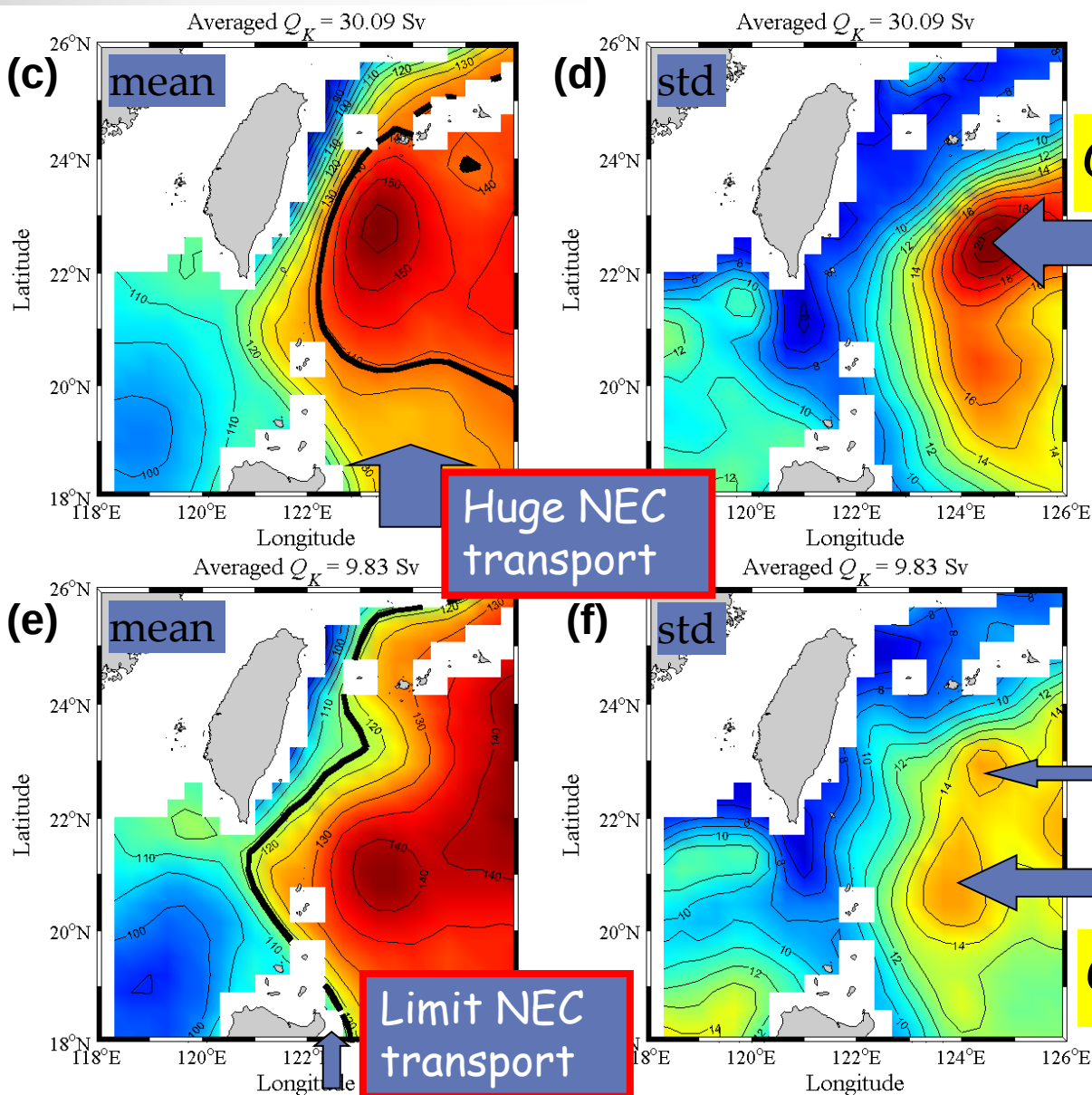


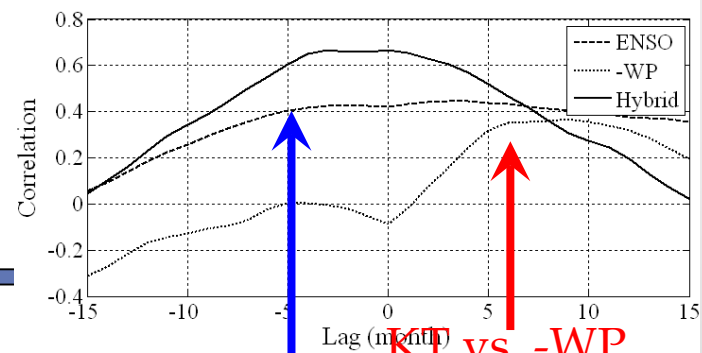
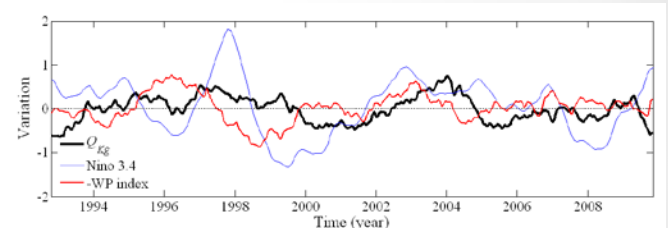
FIG. 1. Tide stations and the typical paths of the Kuroshio. Thin lines are 500-m isobaths. The lines of PN and TK are CTD lines of the JMA Nagasaki Marine Observatory's: 1) Naze, 2) Nakano-shima, 3) Nishinomoto, 4) Odomari, 5) Aburatsubo, 6) Kushimoto, 7) Urakami, 8) Miyake-jima, 9) Hachijo-jima. nNLM is the nearshore non-large-meander (NLM) path; oNLM is the offshore NLM path; tLM is the typical large-meander (LM) path.



Different KT Phases



$$Q_{Kg} > \bar{Q}_{Kg} + \sigma_Q$$



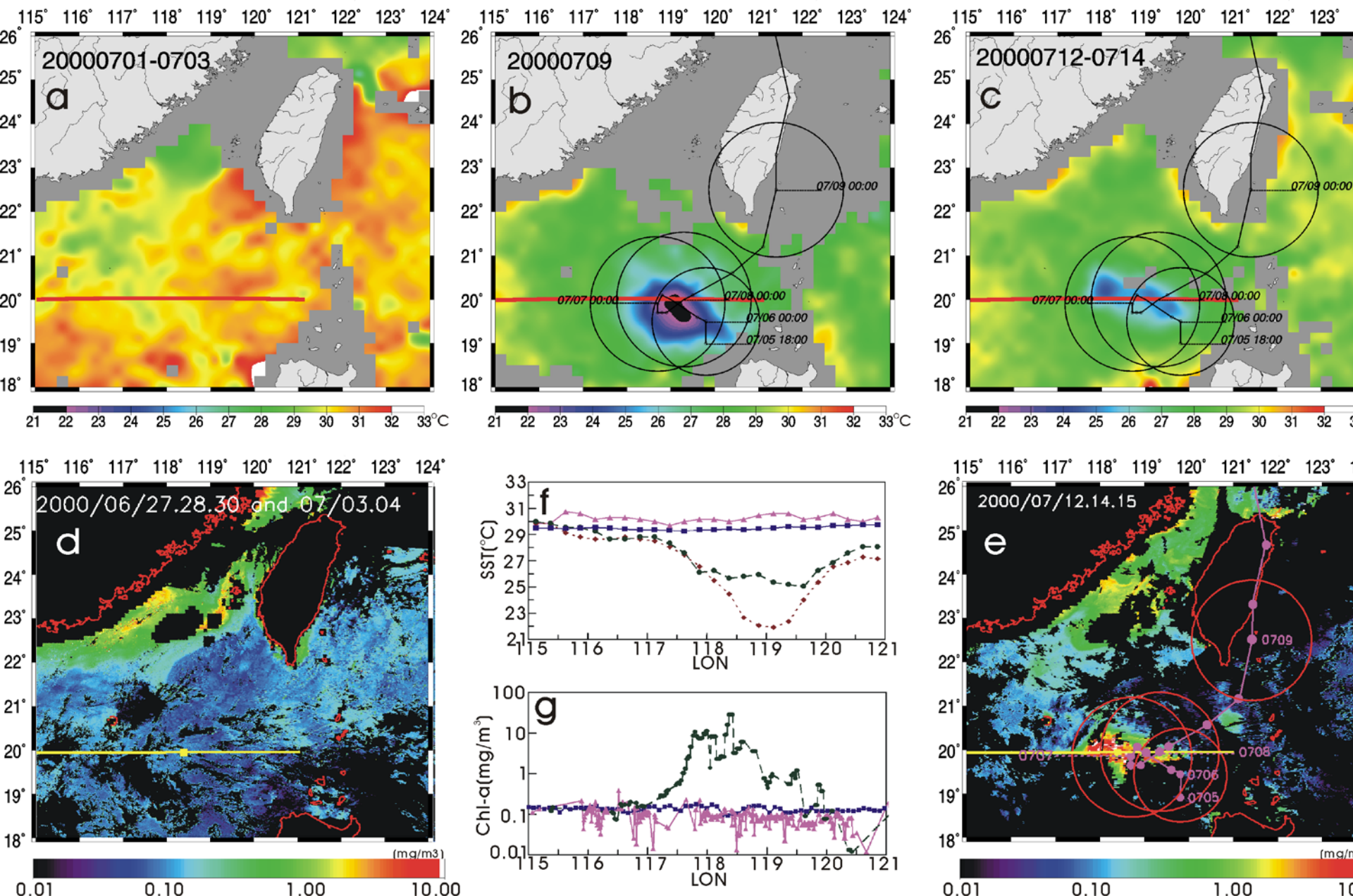
KT vs. -WP

KT vs. ENSO

$$Q_{Kg} < \bar{Q}_{Kg} - \sigma_Q$$

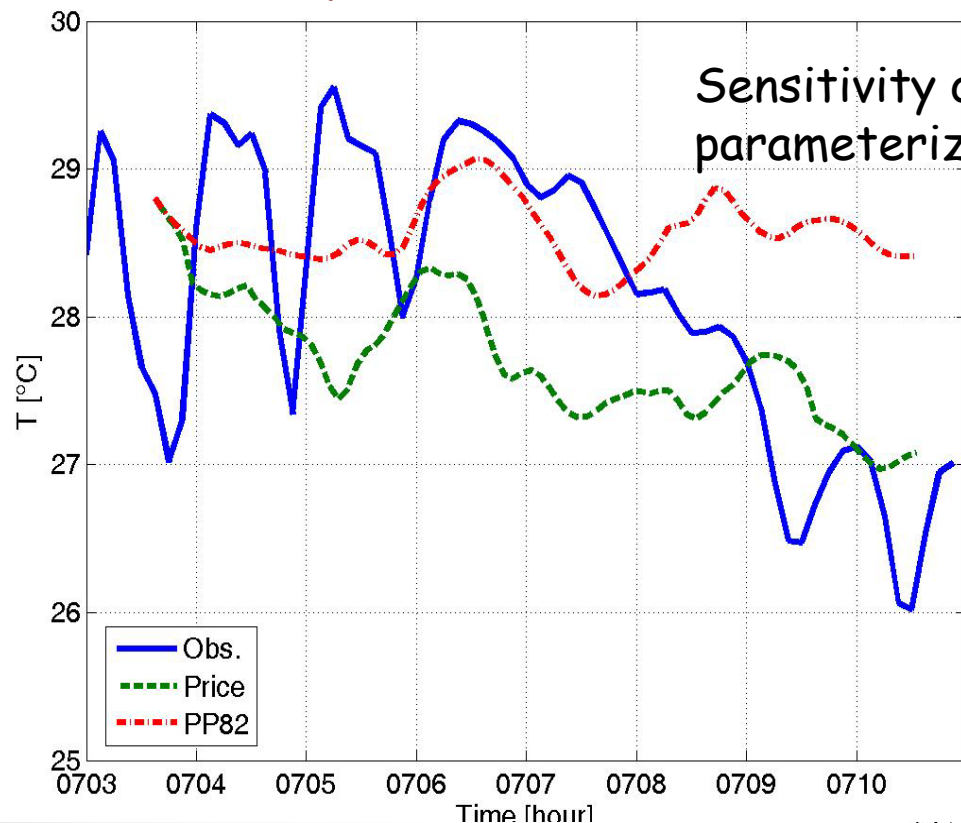
New Evidence for Enhanced Ocean Primary Production Triggered by Tropical Cyclone (Lin et al., 2003c; *GRL*)

Typhoon Kai-Tak



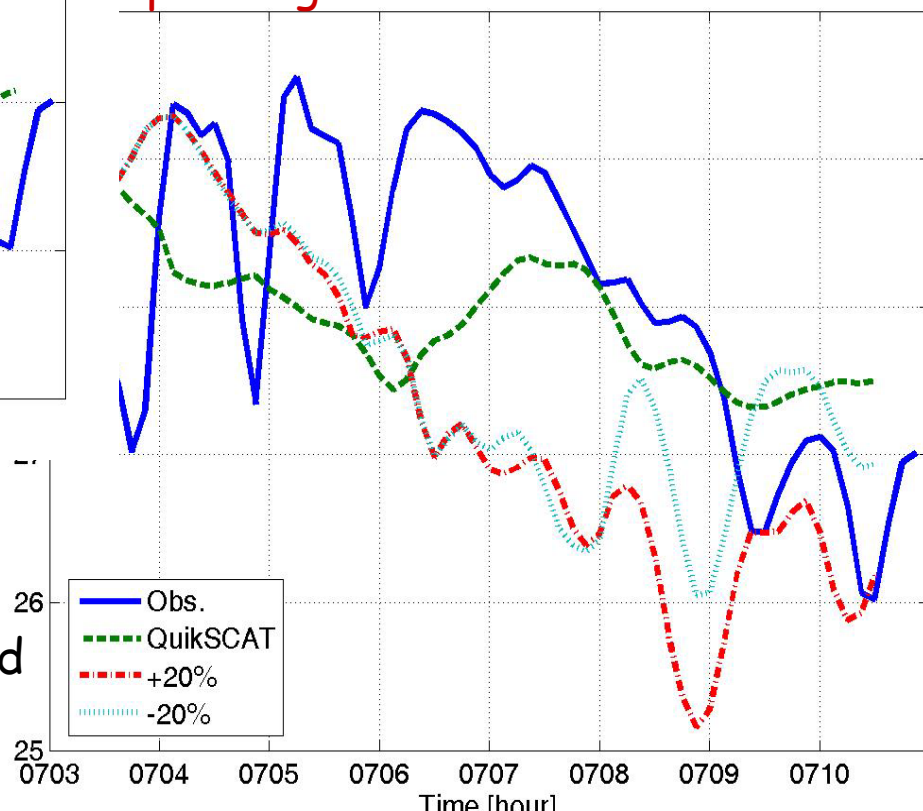
Modeled oceanic response to typhoon Kai-tak

Comparisons with observation (station: ST)

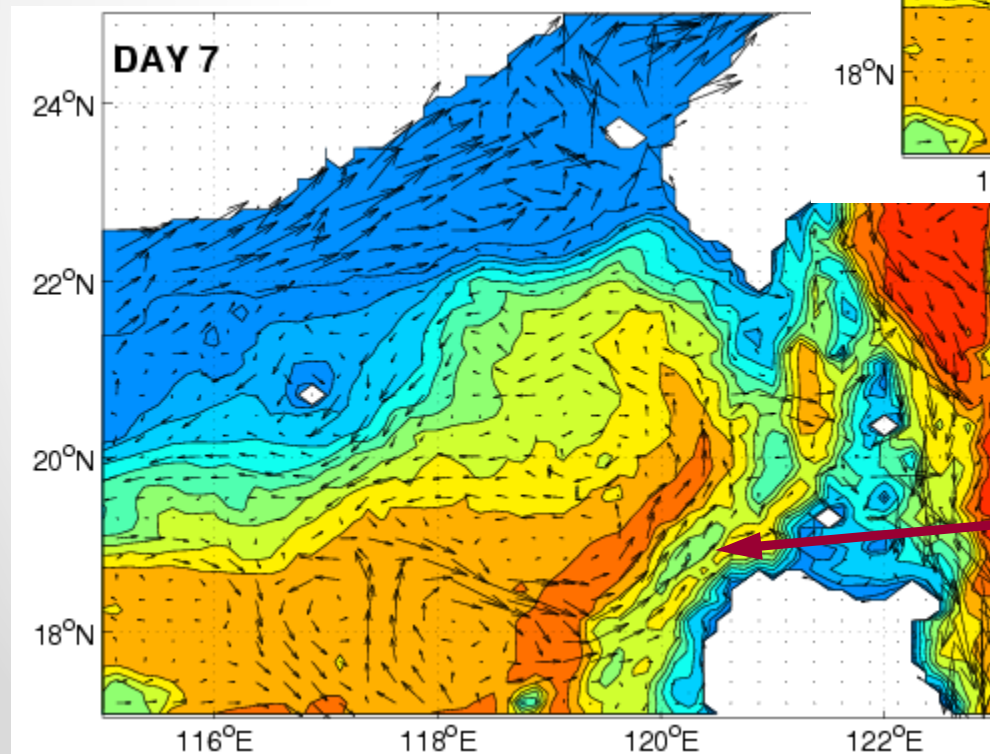
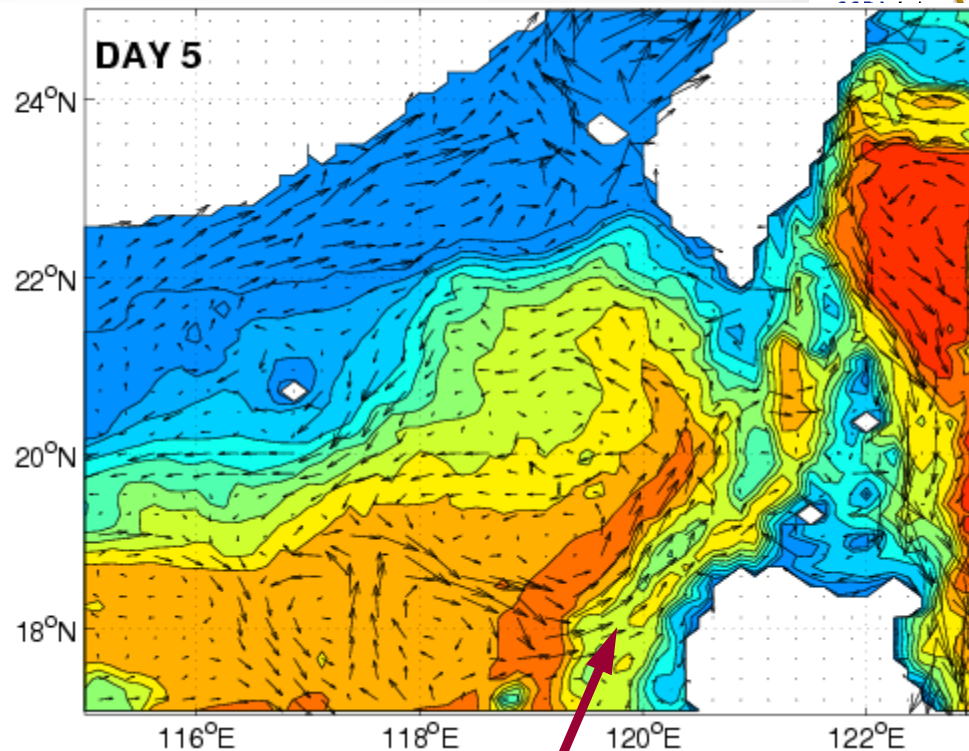


(Tseng et al., 2010)

Sensitivity of wind stress strength



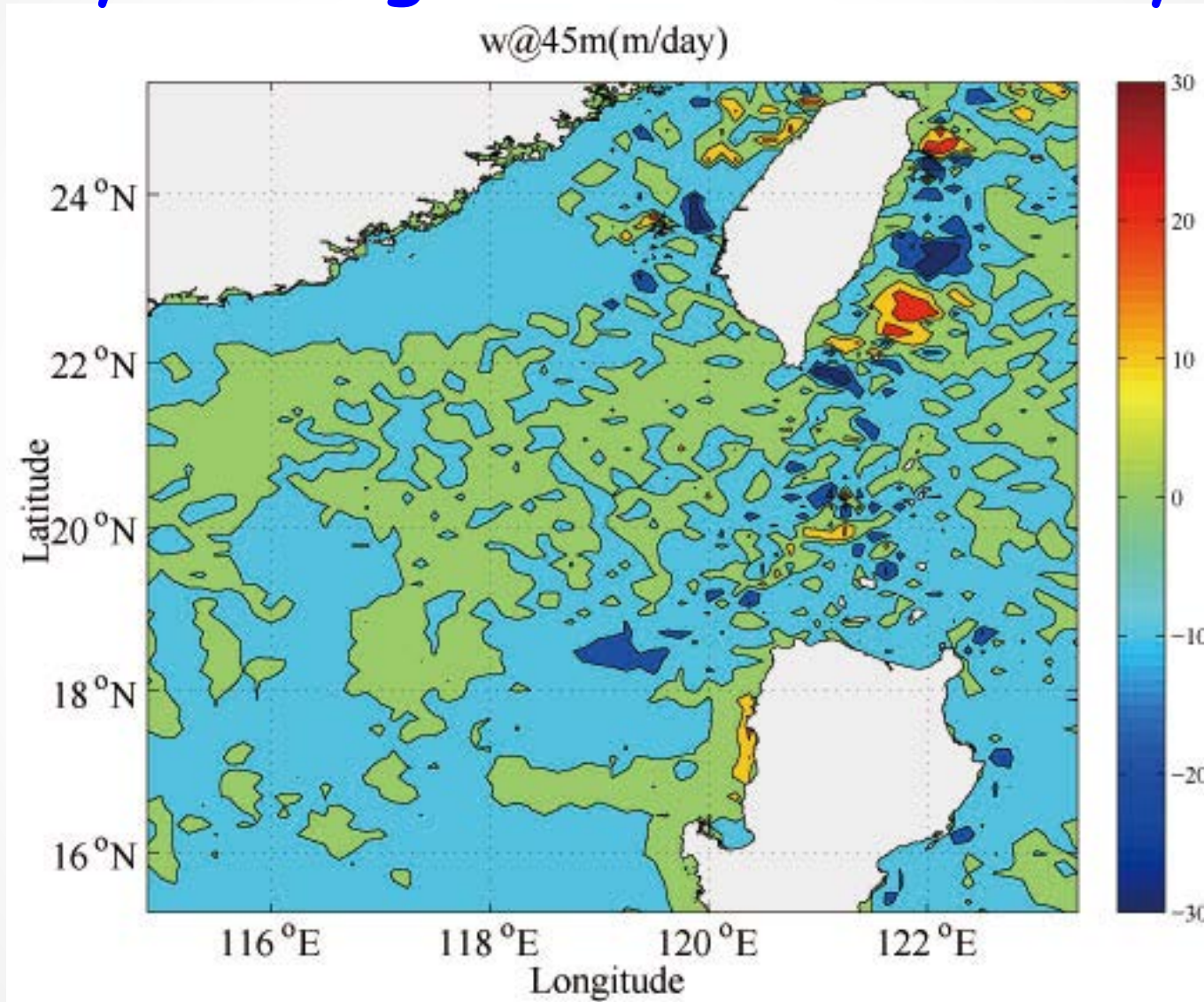
Bottom current vectors



Strong currents along topography

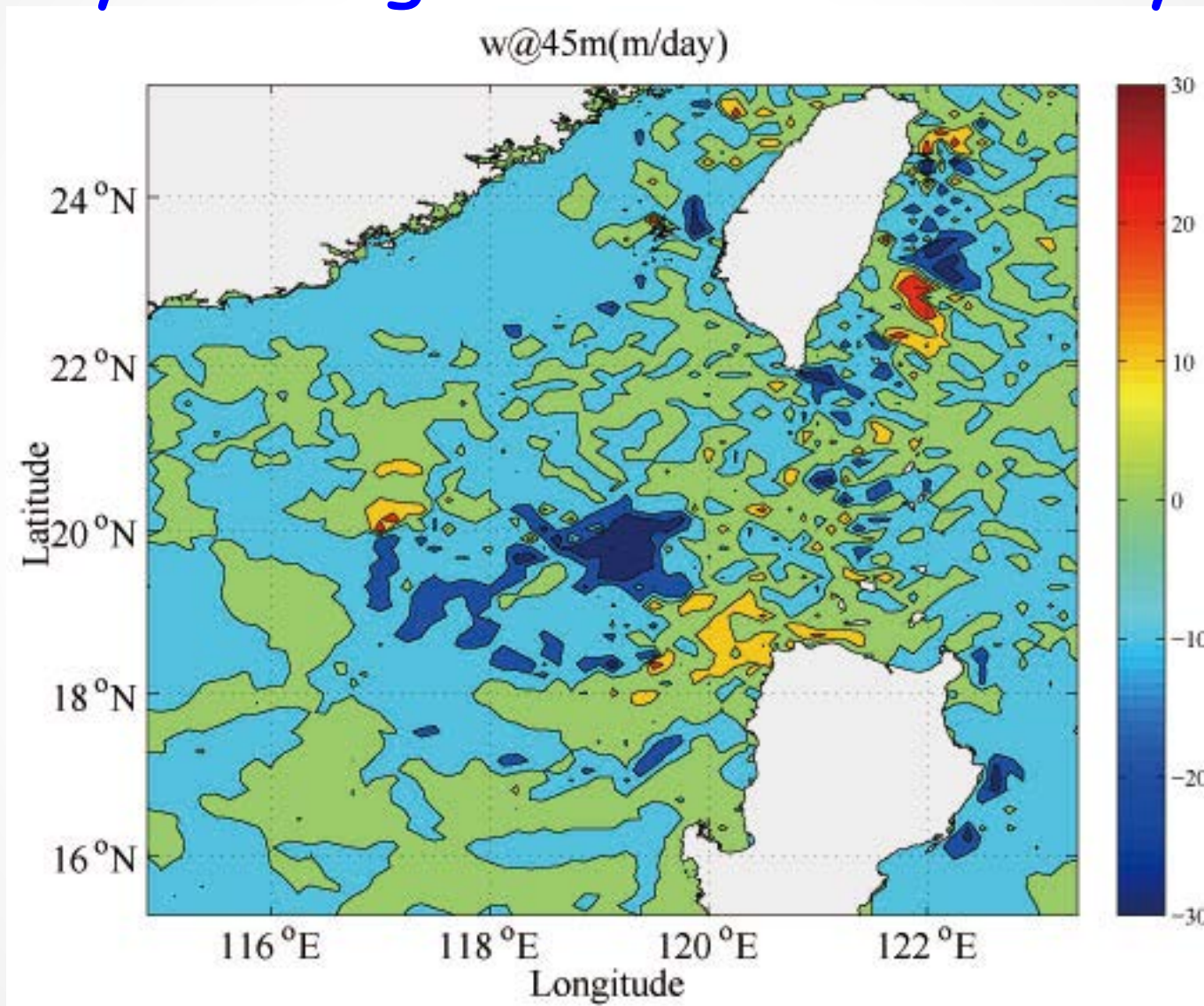
Daily-averaged vertical velocity

Day 1
(7/4)

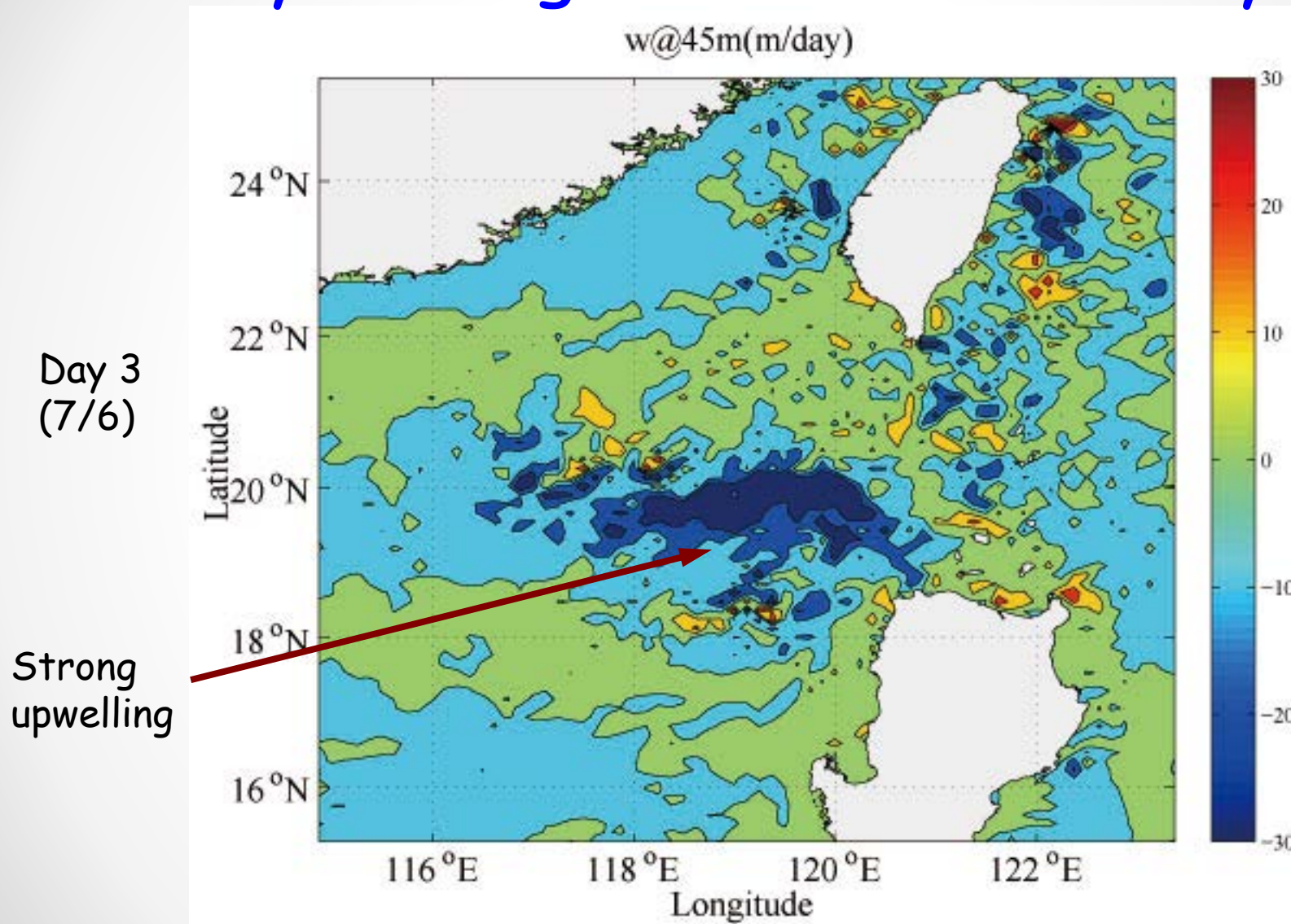


Daily-averaged vertical velocity

Day 2
(7/5)

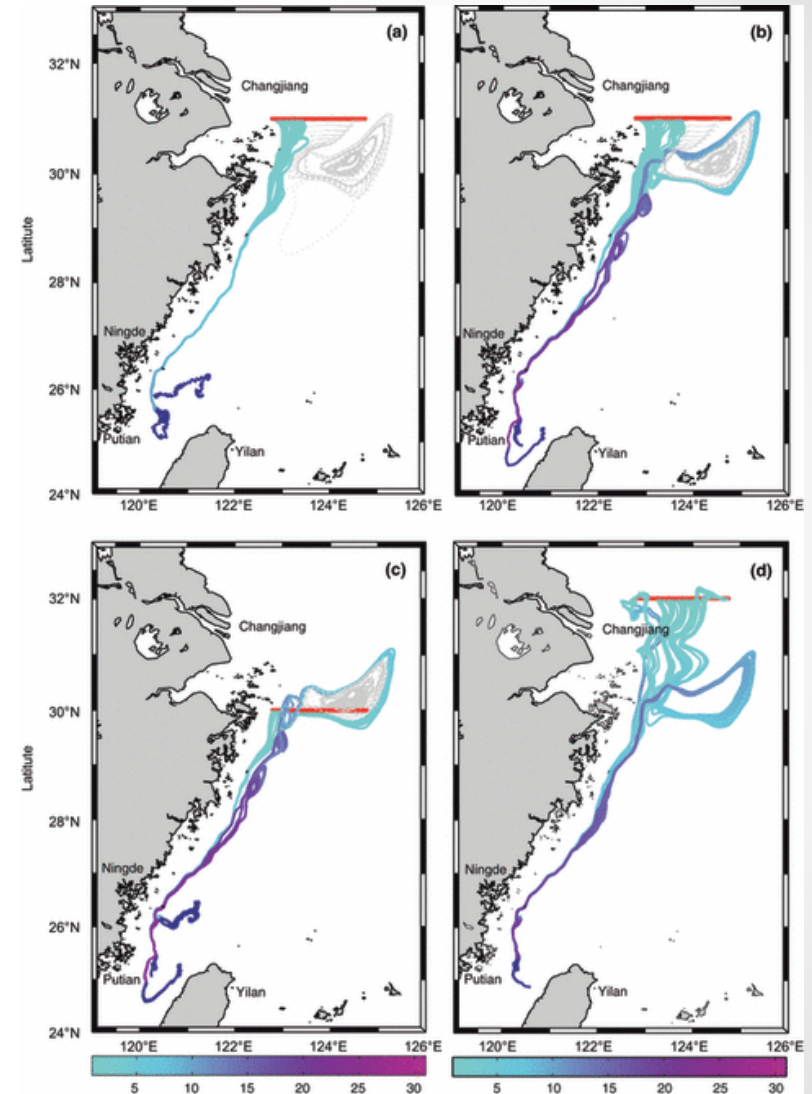
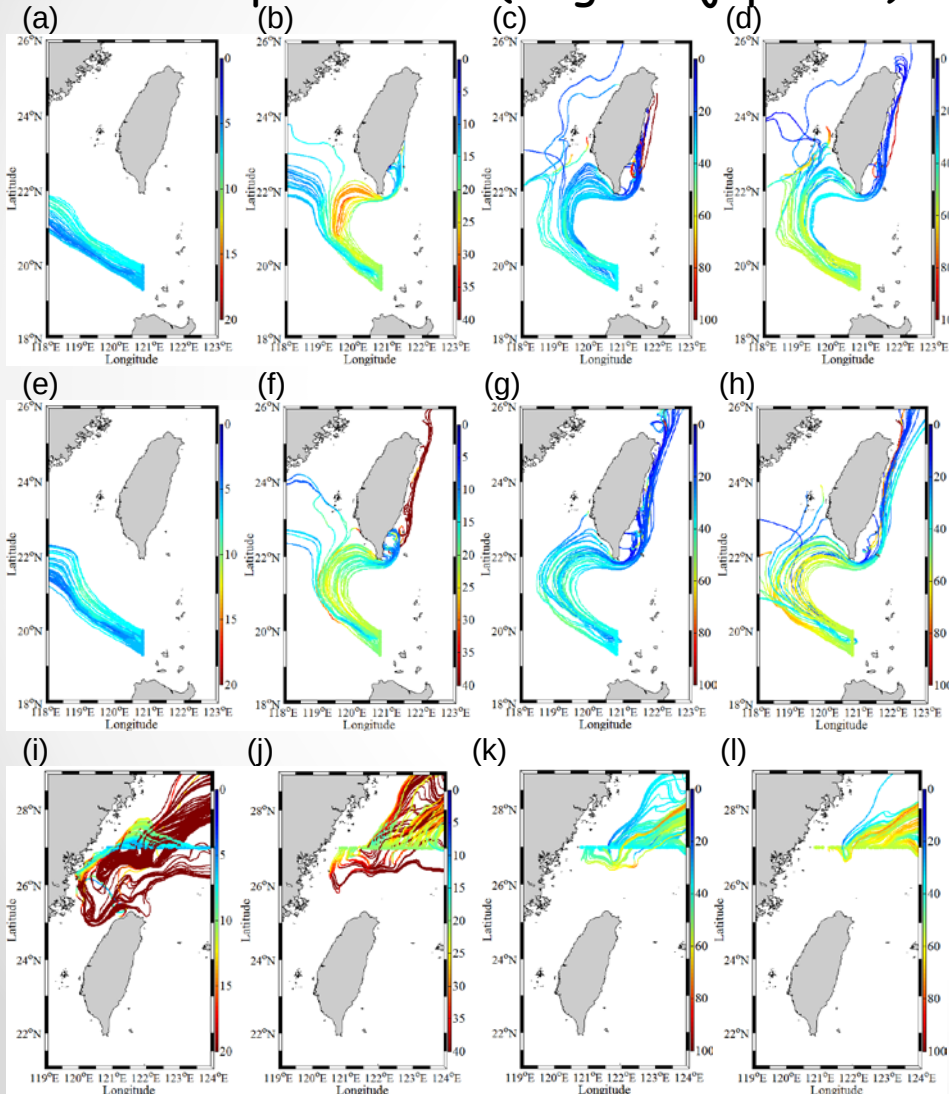


Daily-averaged vertical velocity



Passive tracers (drifters) releases in the model to study the fishery

Larval Japanese eel (*Anguilla japonica*)



Japanese anchovy (*Engraulis japonicas*)

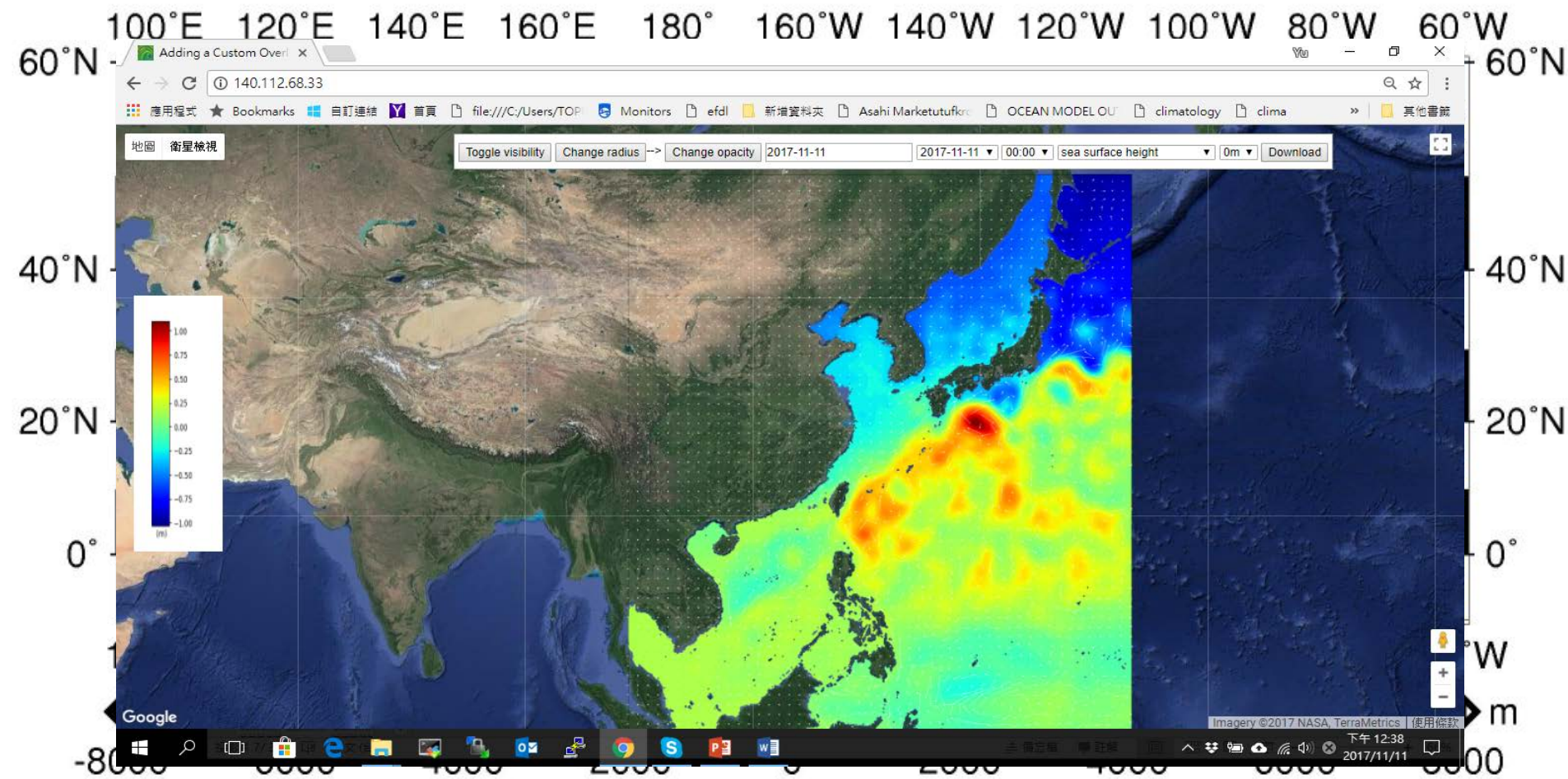
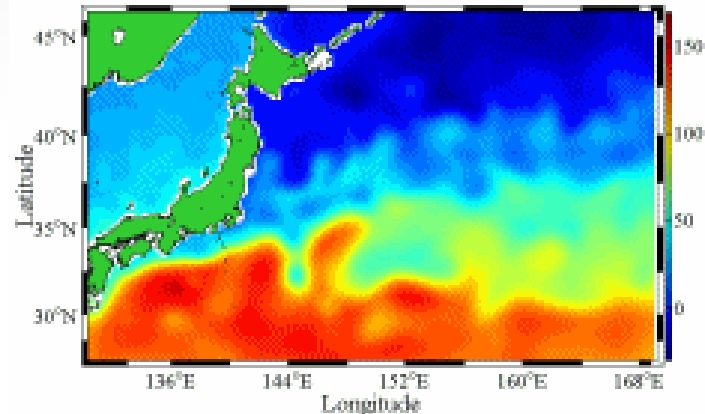


Real time ocean nowcast system

<http://140.112.68.33/>

TIMCOM-TAI domain

day 355, of model year 12, $H_{mx}-H_{mn}=185cm$, $V_{mx}=77cm/s$





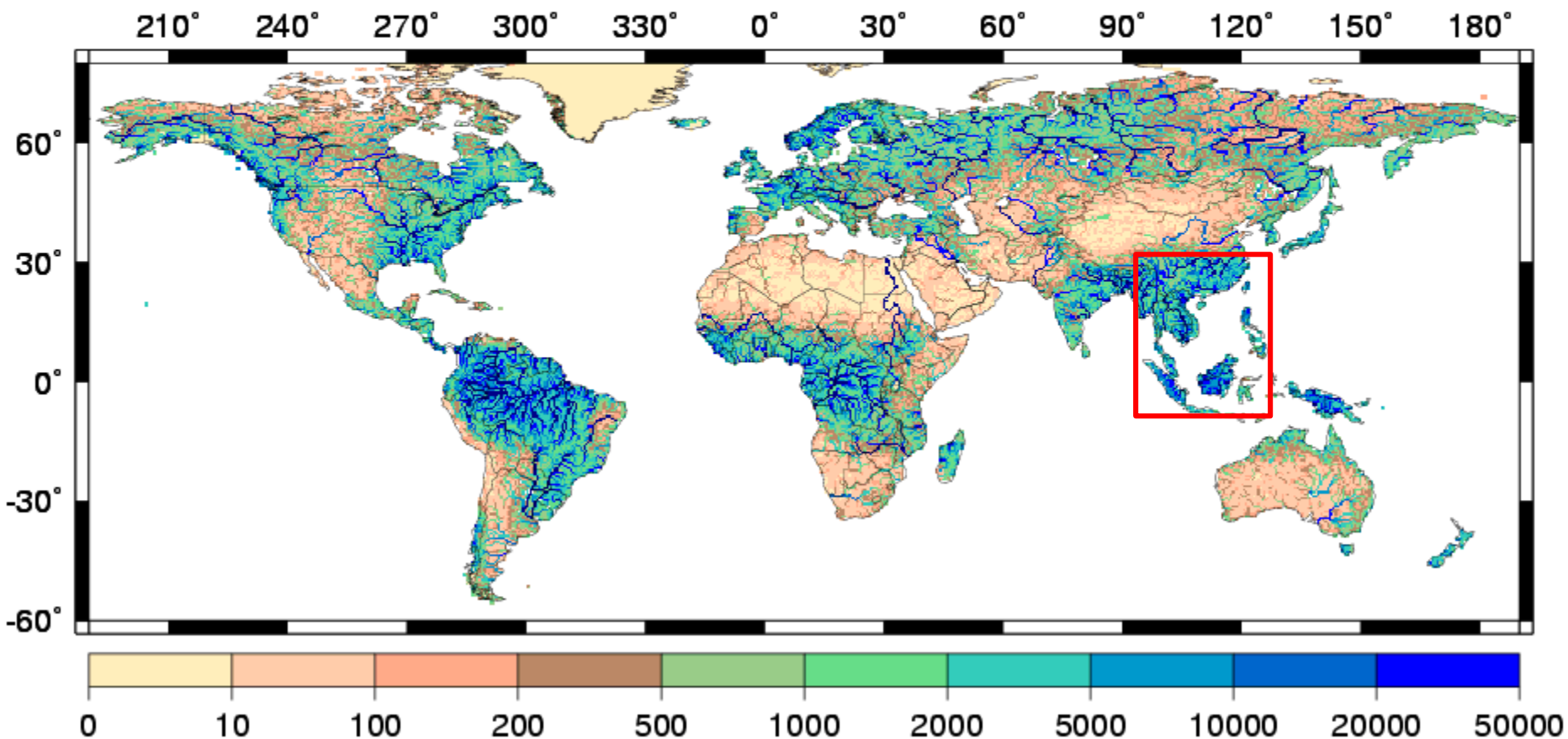
Crucial Role of the Coupled Land-Ocean-Atmosphere Interaction

Freshwater budgets in the land-ocean-atmos. interaction

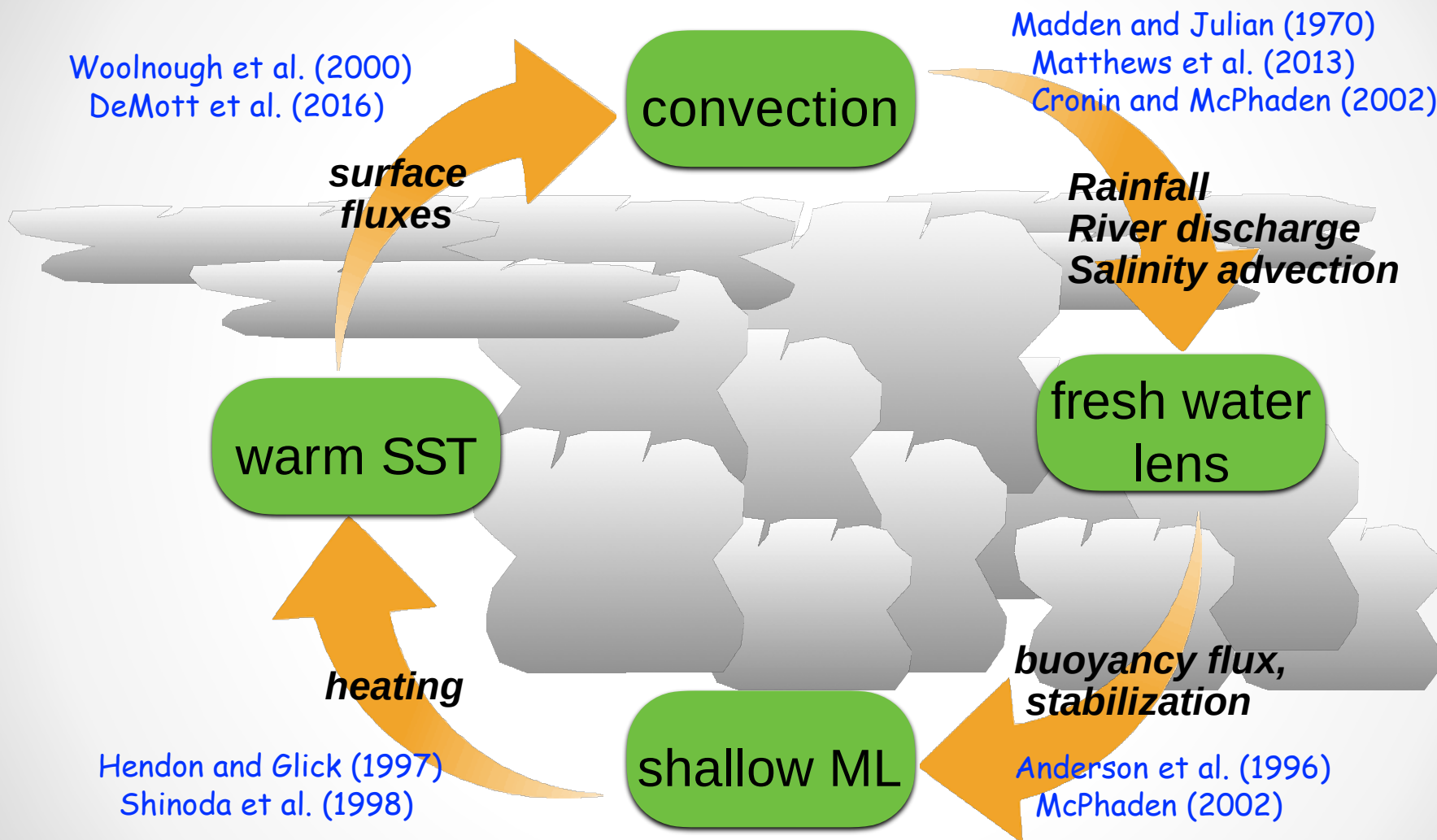
Annual River Discharge

[$10^6 \text{ m}^3/\text{year}$]

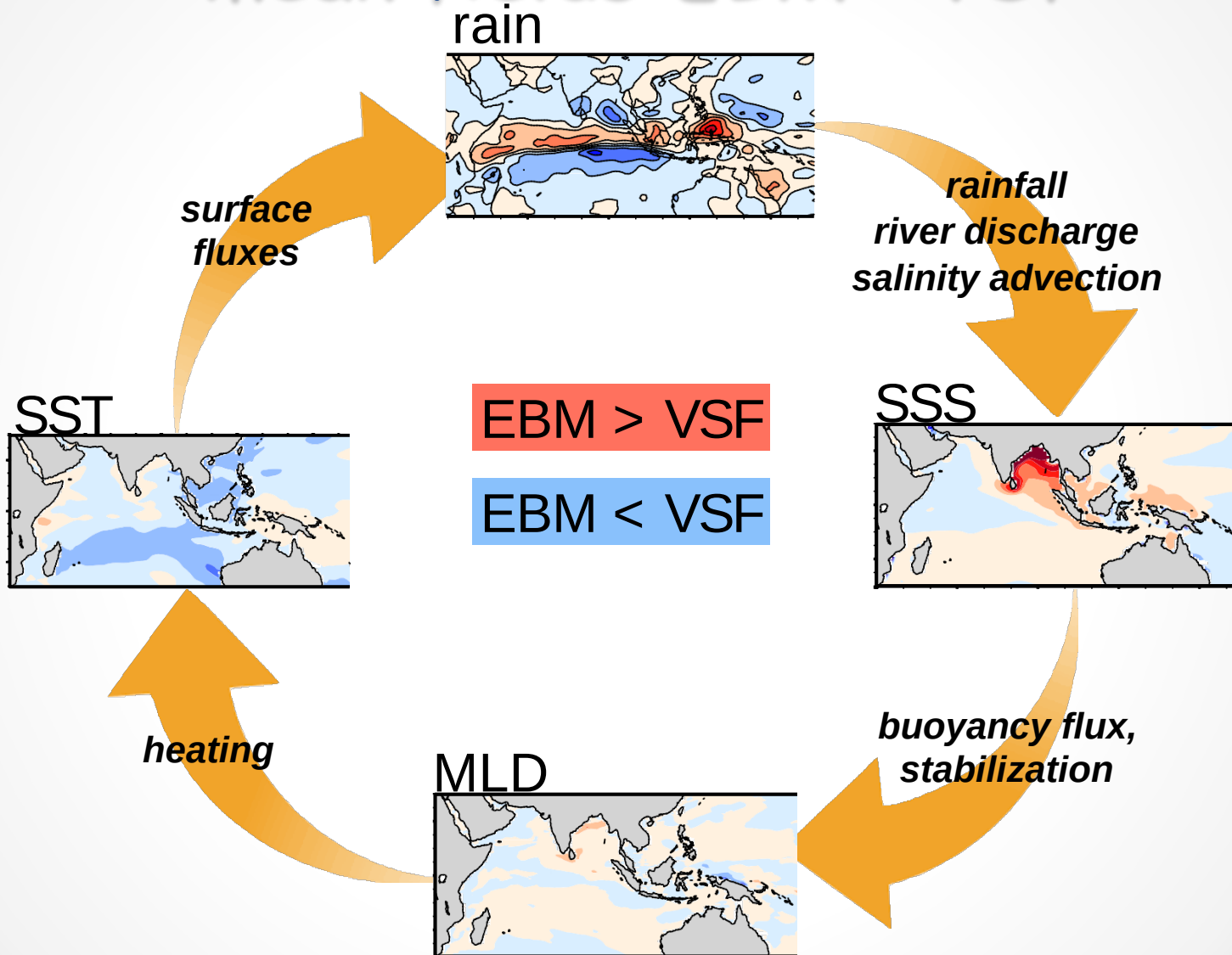
Modern
GSWP2-B0-CT-1



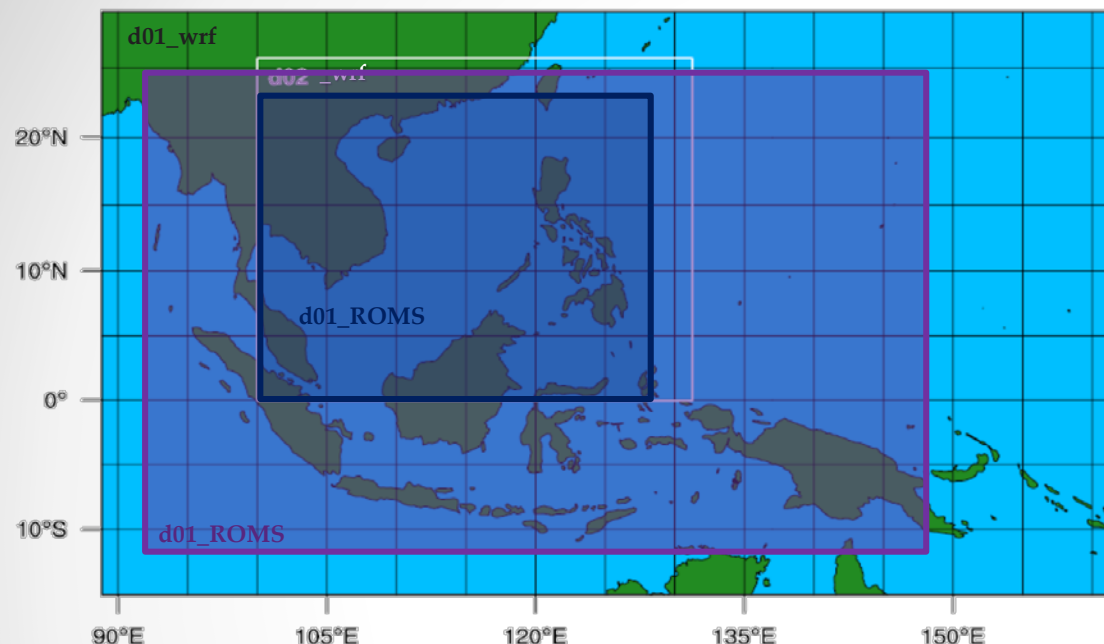
River discharge-convection interactions



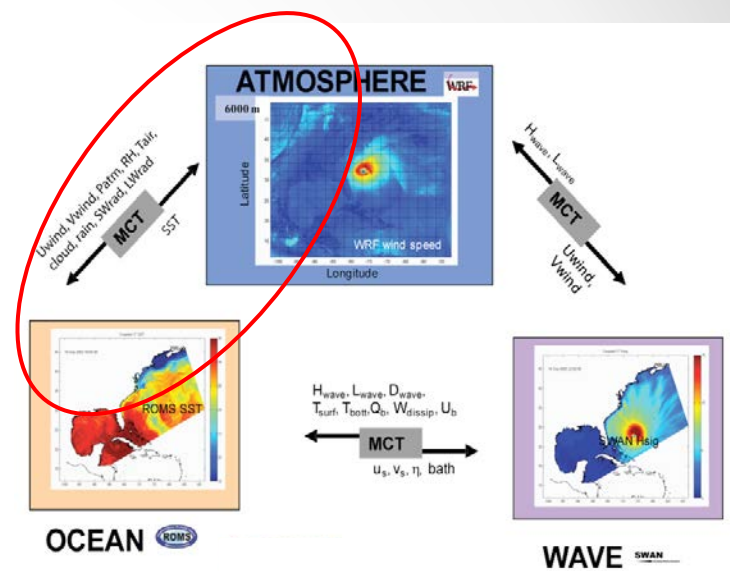
mean fields: EBM - VSF



Regional ocean-atmospheric interaction in the SCS



Model ran for 1 year (2016)



Weather Research and Forecasting Model (WRF)

Horizontal Resolution: Domain 1 =36km, Domain 2 =12km

Vertical : 36 levels

Data:

1. Geography:

http://www2.mmm.ucar.edu/wrf/src/wps_files/geog_complete.tar.bz2

2. Initial and boundary : [NCEP FNL Operational Model Global Tropospheric Analyses, continuing from July 1999](#) (ds083.2)

Regional Ocean Modeling System (ROMS)

Horizontal Resolution:

Domain 1 : 26~27 km

Domain 2 : 8~9 km

Vertical : 36 levels

Data:

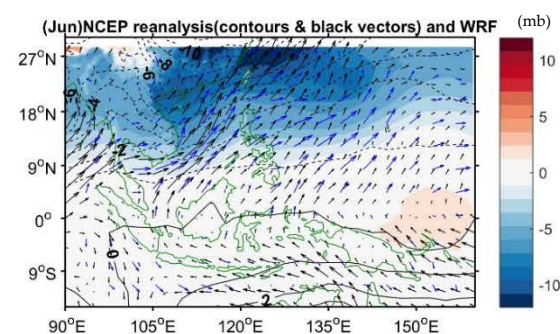
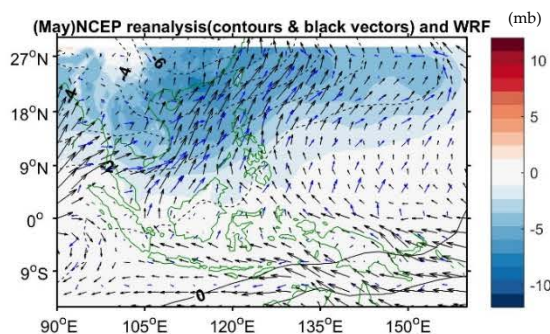
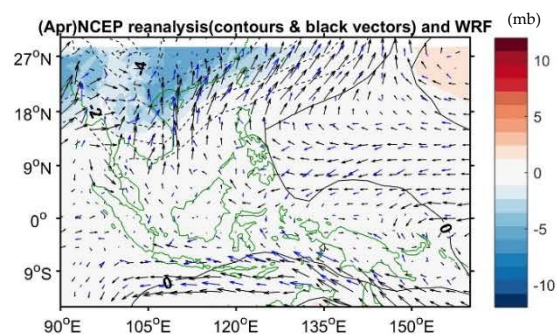
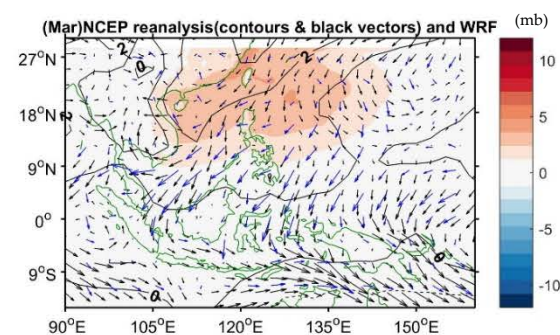
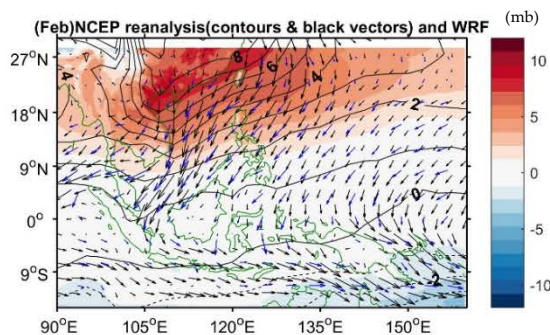
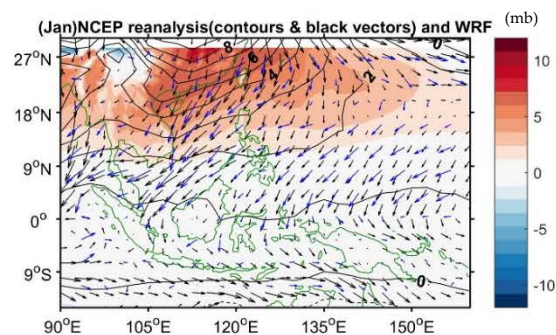
1. geography : ETOPO2

2. Initial and boundary : HYCOM

2016 monthly SLP and sea level wind anomaly

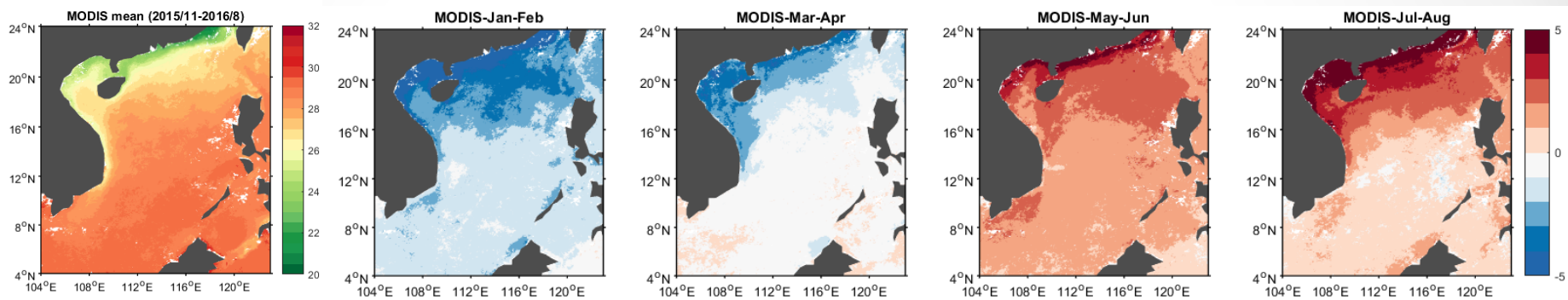
NCEP reanalysis (contours & black vectors)

WRF output (shading & blue vectors)

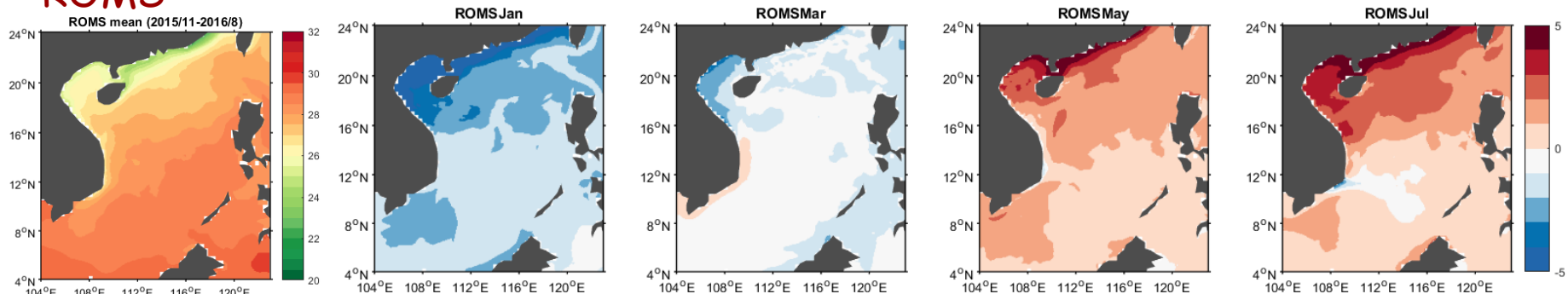


2016 SST anomaly ($^{\circ}\text{C}$, 2-month average)

MODIS

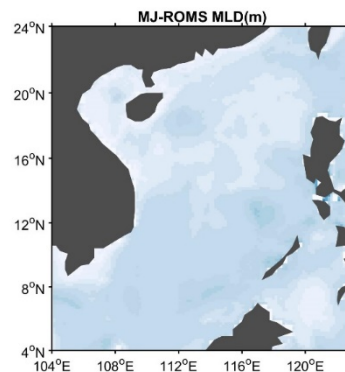
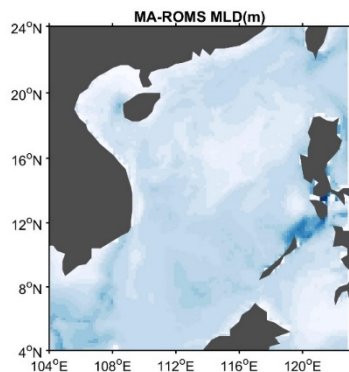
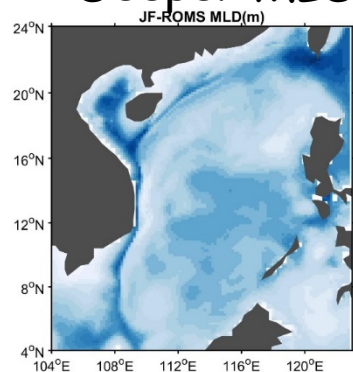


ROMS

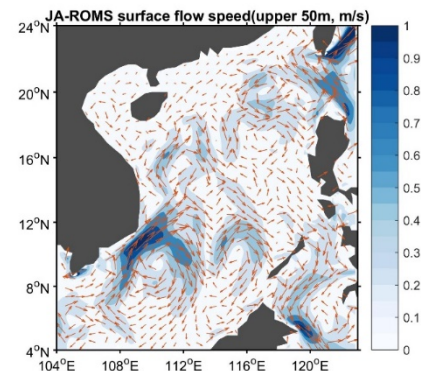
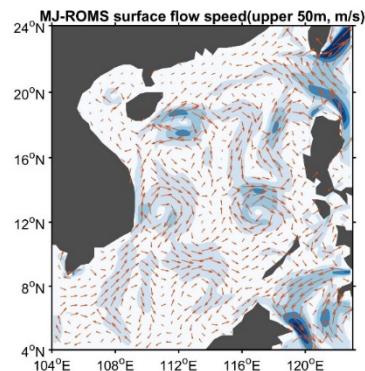
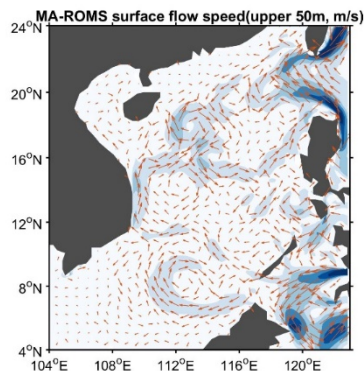
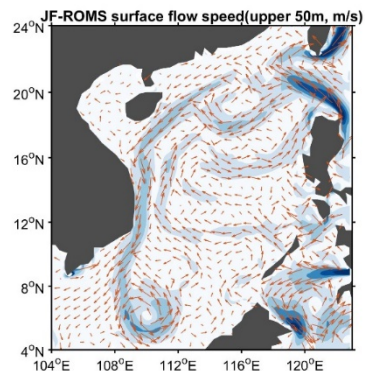
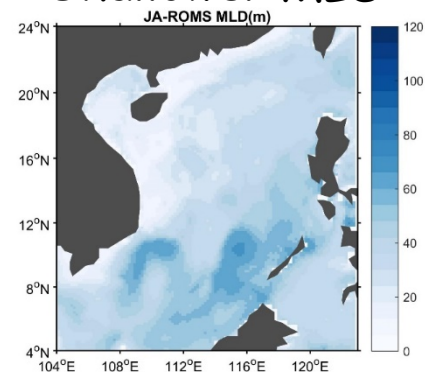


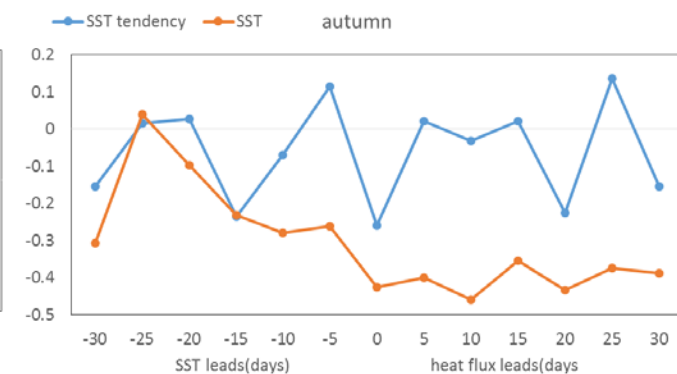
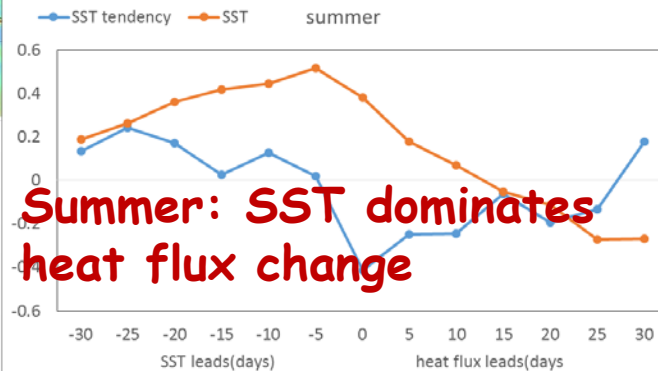
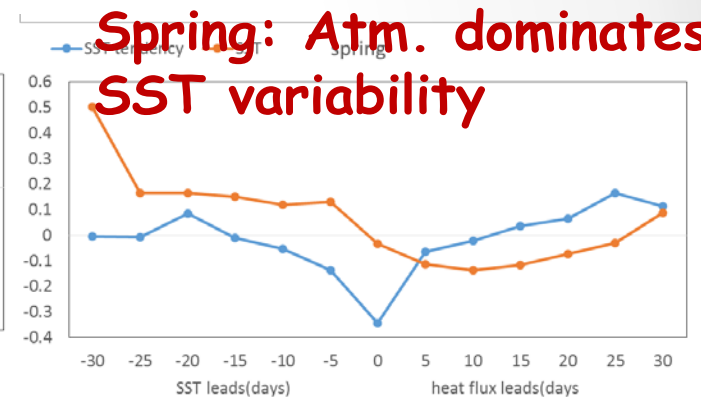
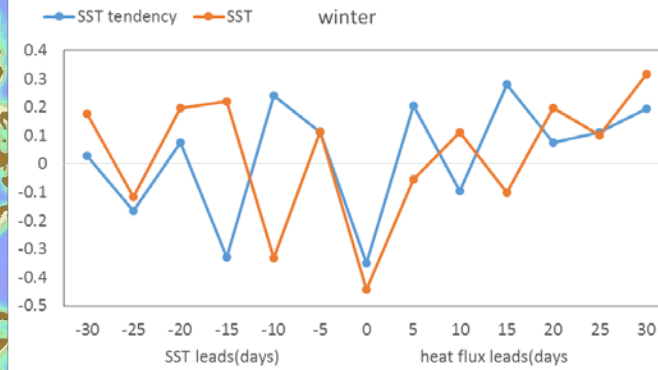
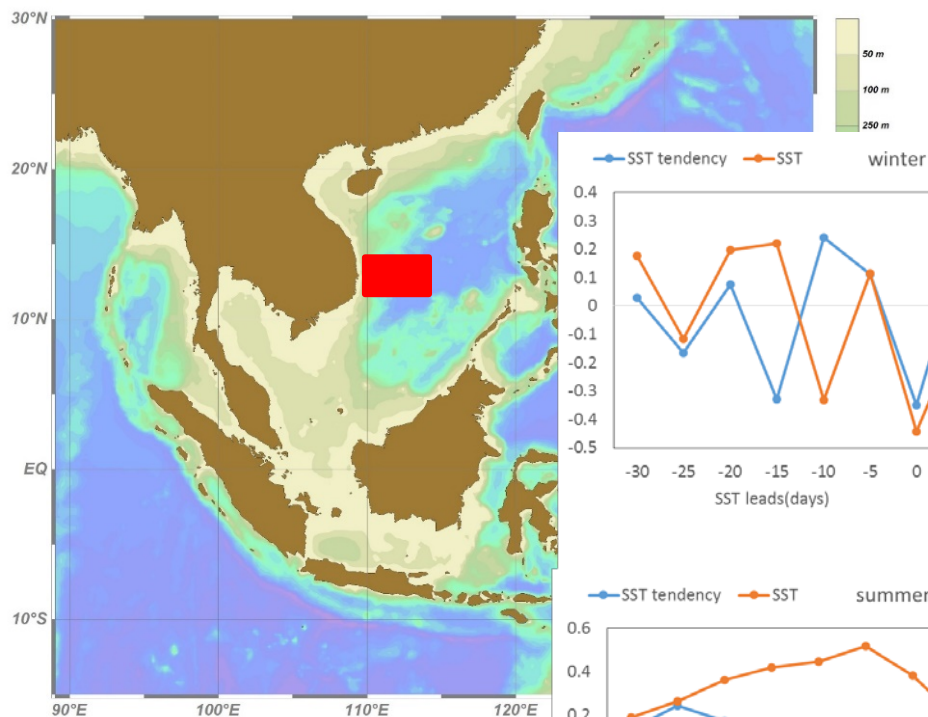
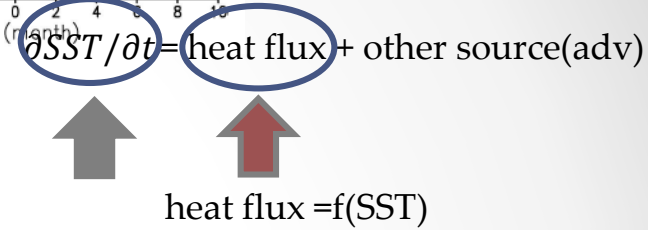
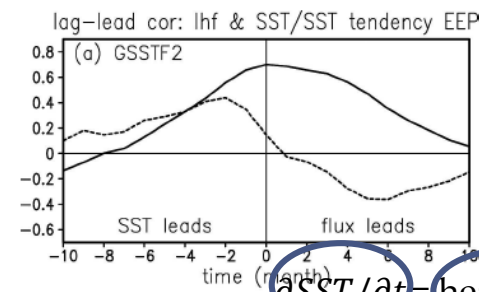
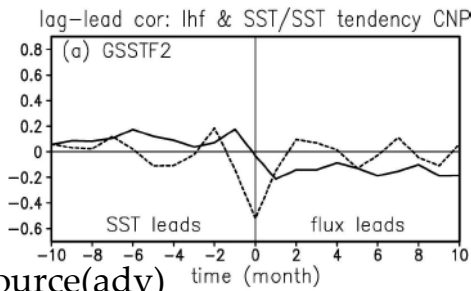
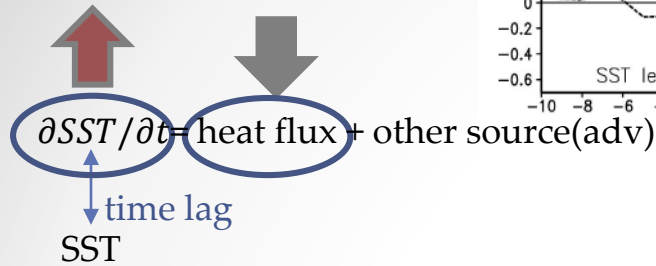
2-month average MLD/surface velocity

Deeper MLD



Shallower MLD





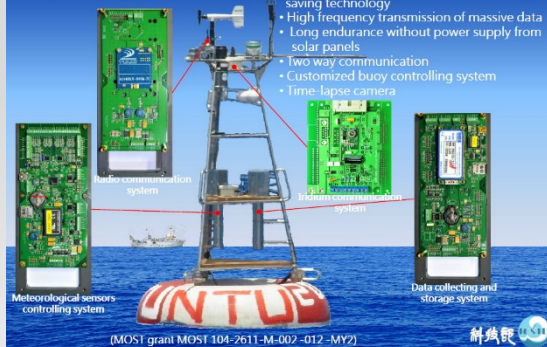
Summary

- Operational eddy-resolving nowcast/forecast system
 - Physical/typhoons/fishery/rescue
- Coupled ocean-atmosphere modeling
 - Distinct ocean-atmospheric interaction in the SCS
 - Link to the global climate system

Characteristics of the 2nd generation NTU buoy

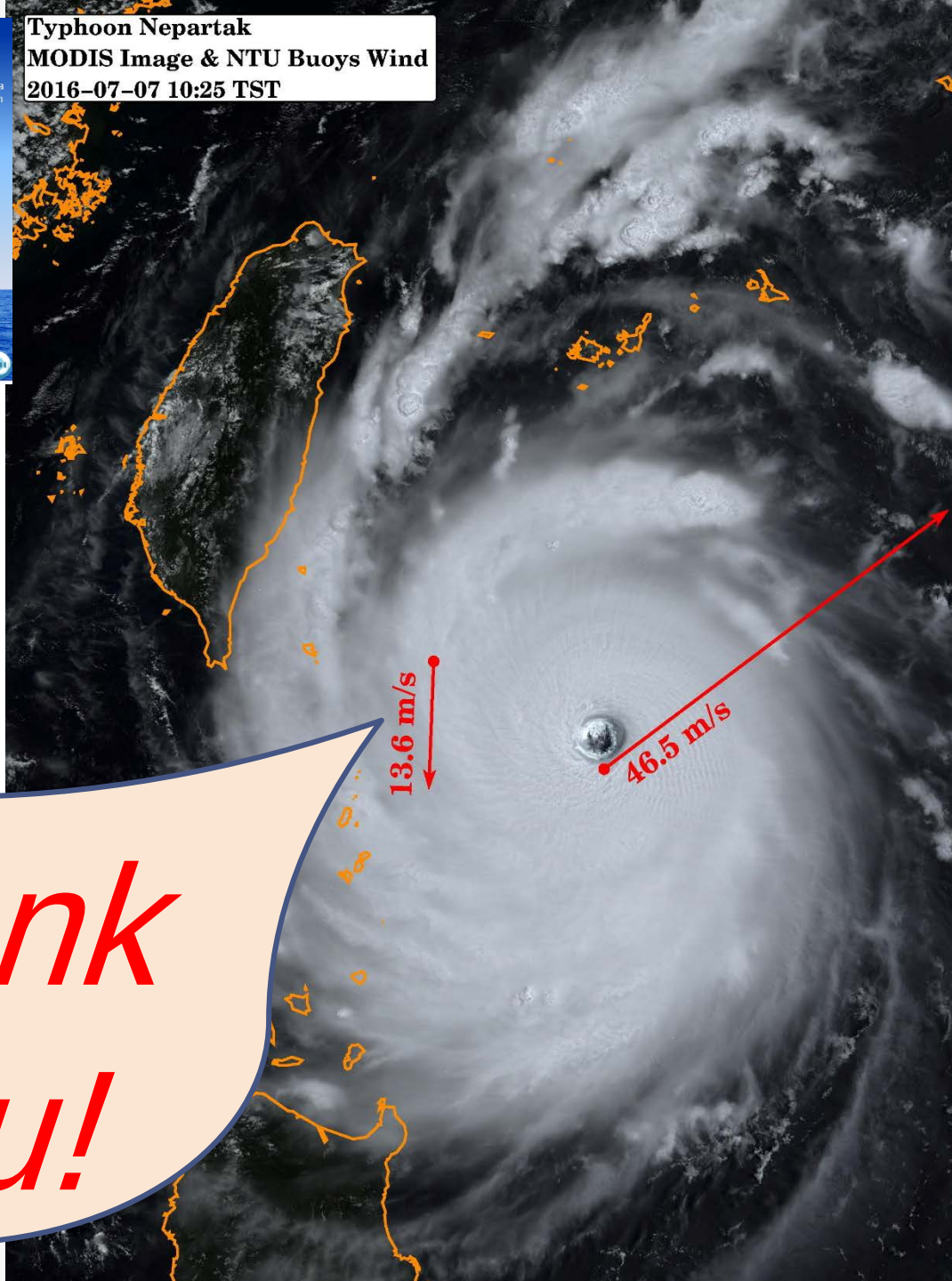
This year we upgraded the NTU buoy:

- Low power consumption with smart battery saving technology
- High frequency transmission of massive data
- Long endurance without power supply from solar panels
- Two way communication
- Customized buoy controlling system
- Time-lapse camera



Typhoon Nepartak MODIS Image & NTU Buoy Wind

2016-07-07 10:25 TST



*Thank
you!*