9:40-10:00, October 17, 2005

The formation of the Tsushima Warm Current in a high resolution ocean circulation model

Young-Gyu Park, Chang-Hwan Park, Sang-Wook Yeh

Korea Ocean Research & Development Institute

ypark@kordi.re.kr

Introduction

- Tsushima Warm Current
  - Supplies heat and salt to the East/Japan Sea
  - Origin (Nitani, Qiu, Beardsley, Fang, Lie, Isobe, Teague, Ichikawa …)
    - Kuroshio
    - Continuation of the Taiwan Warm Current

Beardsley et al., 85
Fang et al., 91

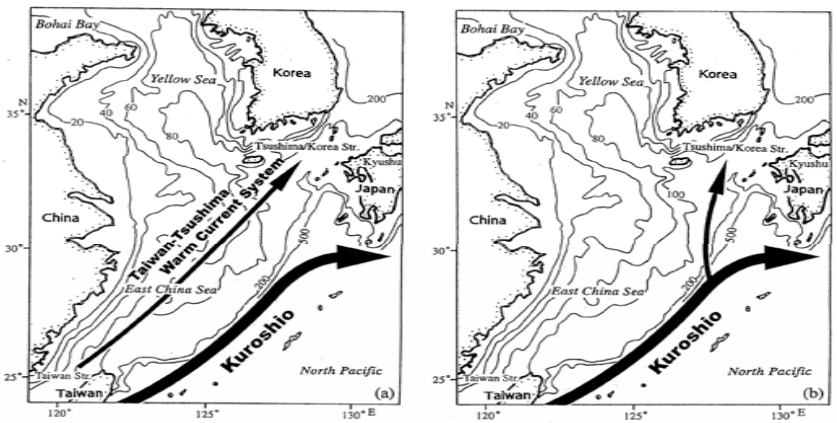


Fig. 1. Schematic views of the origin of the Tsushima Warm Current as (a) a part of the Taiwan–Tsushima Warm Current System, and (b) a separation branch of the Kuroshio. Numerals on the solid lines show the depth in meter.

Figure from Isobe, 99, CSR

Nitani, 72
Lie and Cho, 94
Lie et al., 98

Isobe, 99, CSR

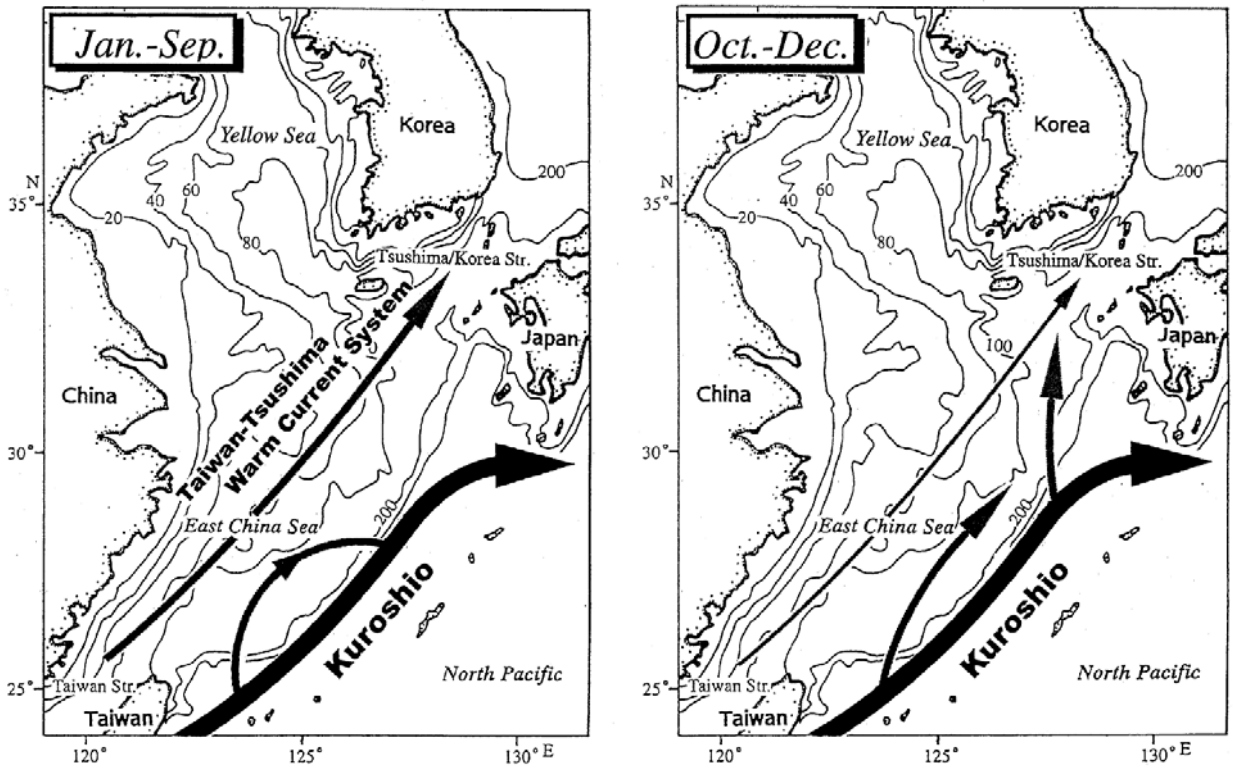


Fig. 10. The revised schematic views of the origin of the Tsushima Warm Current in (a) season except the autumn, i.e. January–September and (b) autumn, i.e. October–December.

Teague et al., 03: 1999 Fall

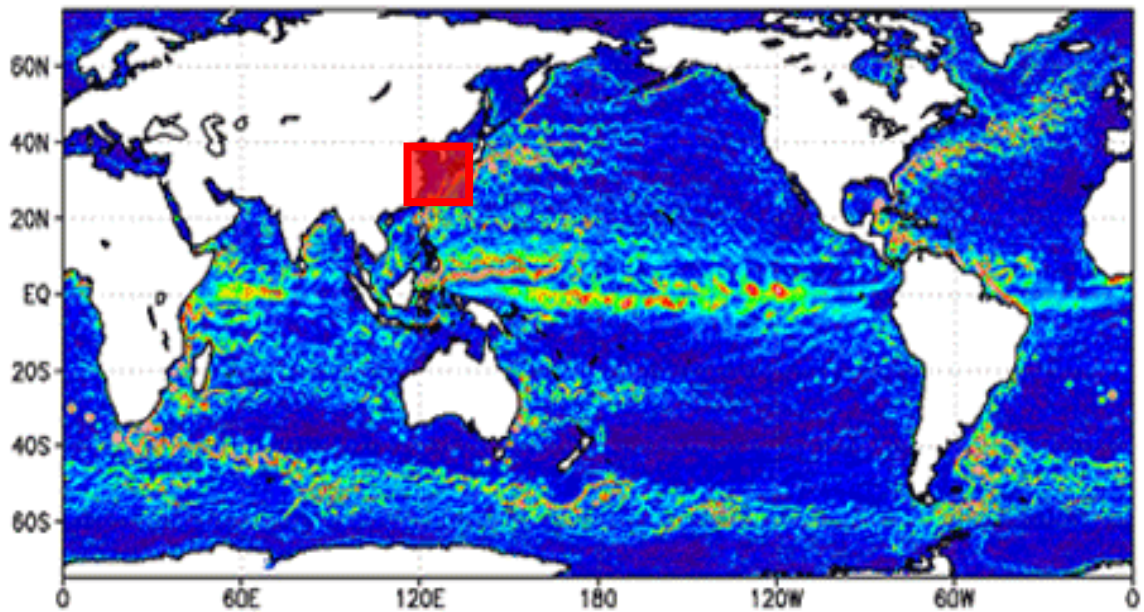
Kim et al., 05: April 1988

Previous Studies

- Complexity of the area
  - Lack of data
  - Short term observation
- Modeling (regional)
  - Fixed open boundary (inflow/outflow: Tshusiham and Taiwan Warm Currents, Kuroshio) conditions
    - Can we investigate the origin properly?

High resolution modeling results

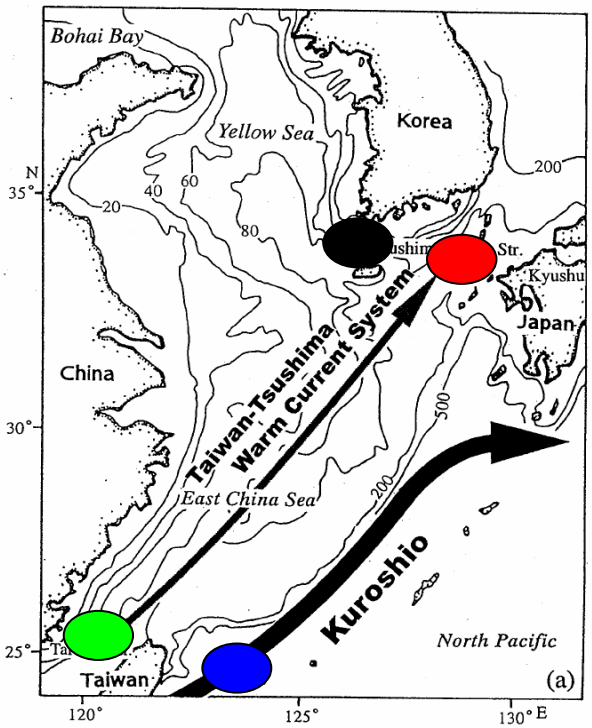
- http://www2.es.jamstec.go.jp/ofes/eng/index.html
- Model: Ogcm For Earth Simulator (MOM3-based optimized code for ES)
- Domain:75S-75N, 0.1 horizontal resolution, 54 vertical levels
- Surface bc:
  - Momentum, heat and salt flux: NCEP/NACR reanalysis data set, SSS restoring to WOA98
- IC: WOA98
- Mean of the last 5 years from 50 years long simulation



Purpose

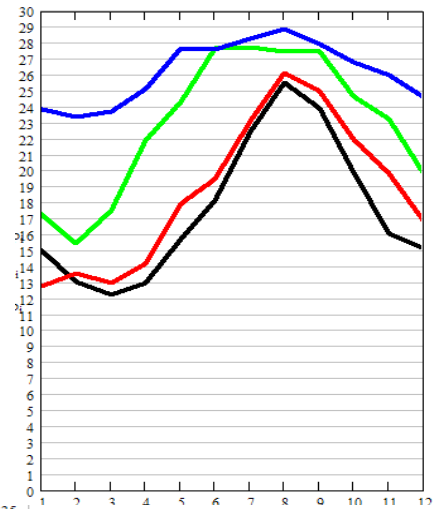
- From the high resolution model results
  - The origin of the Tsushima Warm Current
  - East China Sea Circulation

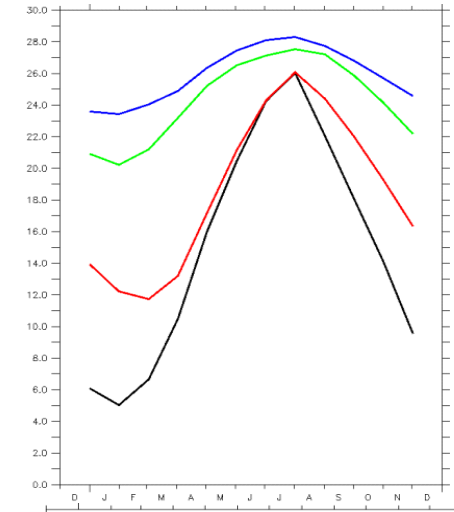
Validation



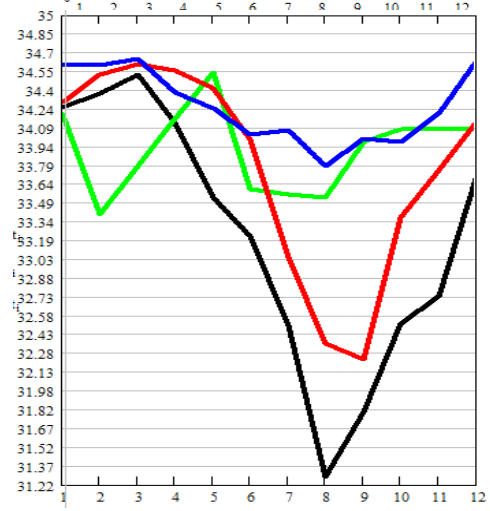
WOD Model

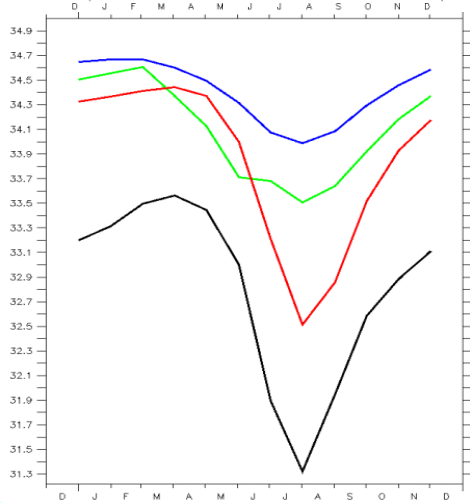
T

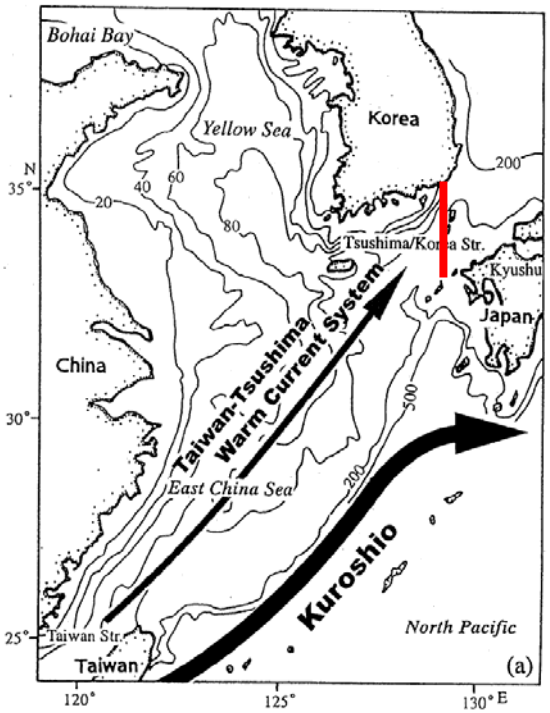


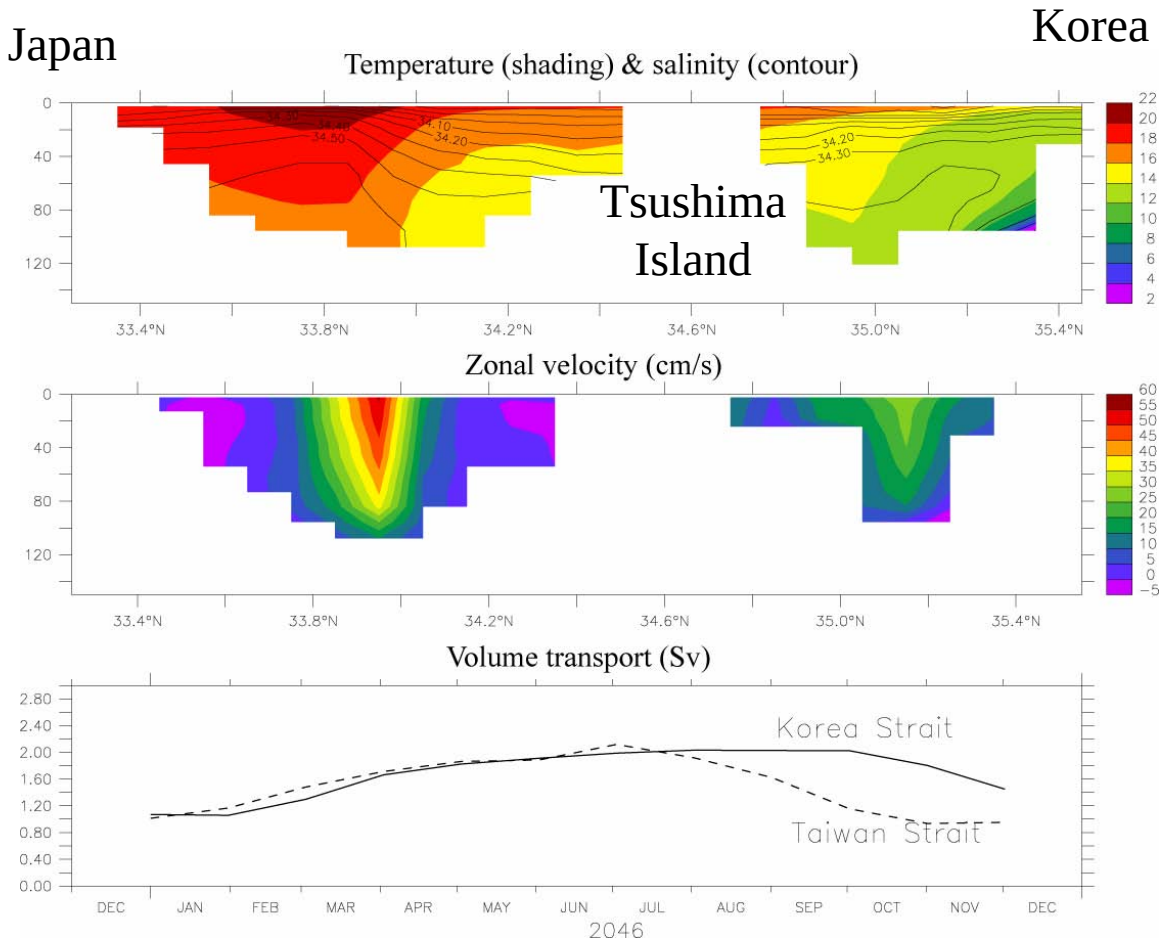


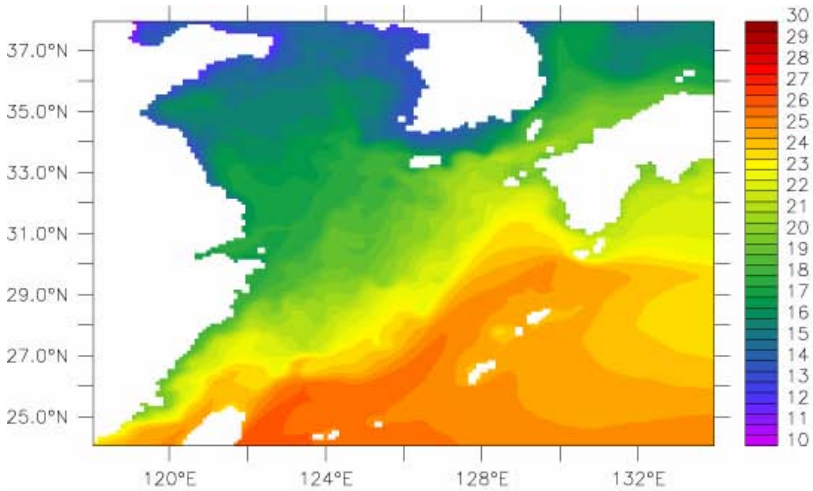
S



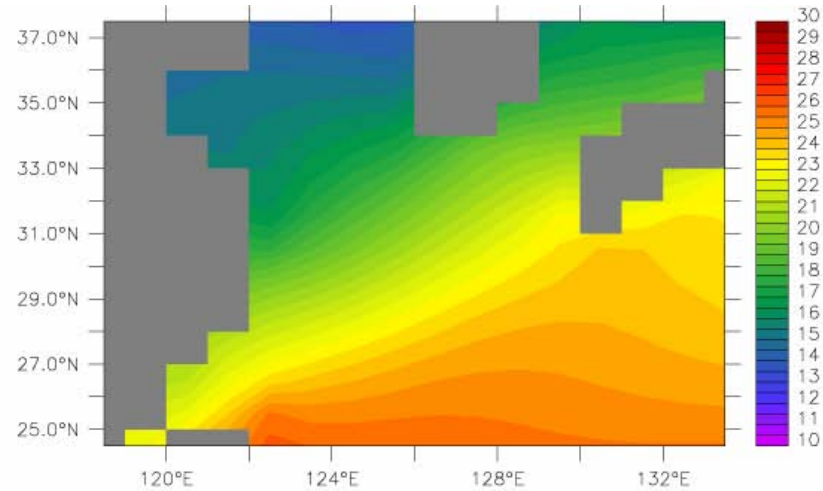



Bohai Bay
Yellow Sea
Korea
Tsushima/Korea Str.
Kyushu
Japan
China
Taiwan-Tsushima Warm Current System
East China Sea
Kuroshio
North Pacific
Taiwan Str.
Taiwan
(a)
N
35°
30°
25°
120°
125°
130° E
20
40
60
80
200
500

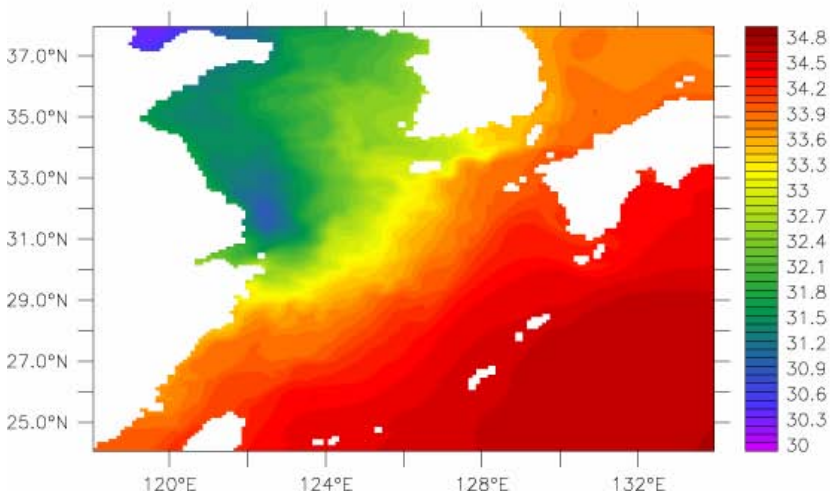

Japan
Korea
Temperature (shading) & salinity (contour)
Tsushima Island
Zonal velocity (cm/s)
Volume transport (Sv)
Korea Strait
Taiwan Strait
33.4°N
33.8°N
34.2°N
34.6°N
35.0°N
35.4°N
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
2046

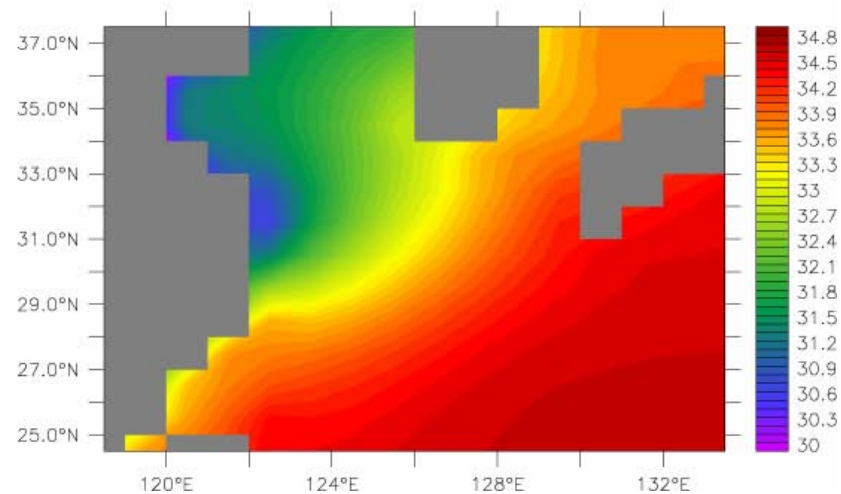


Model (surface, annual mean)

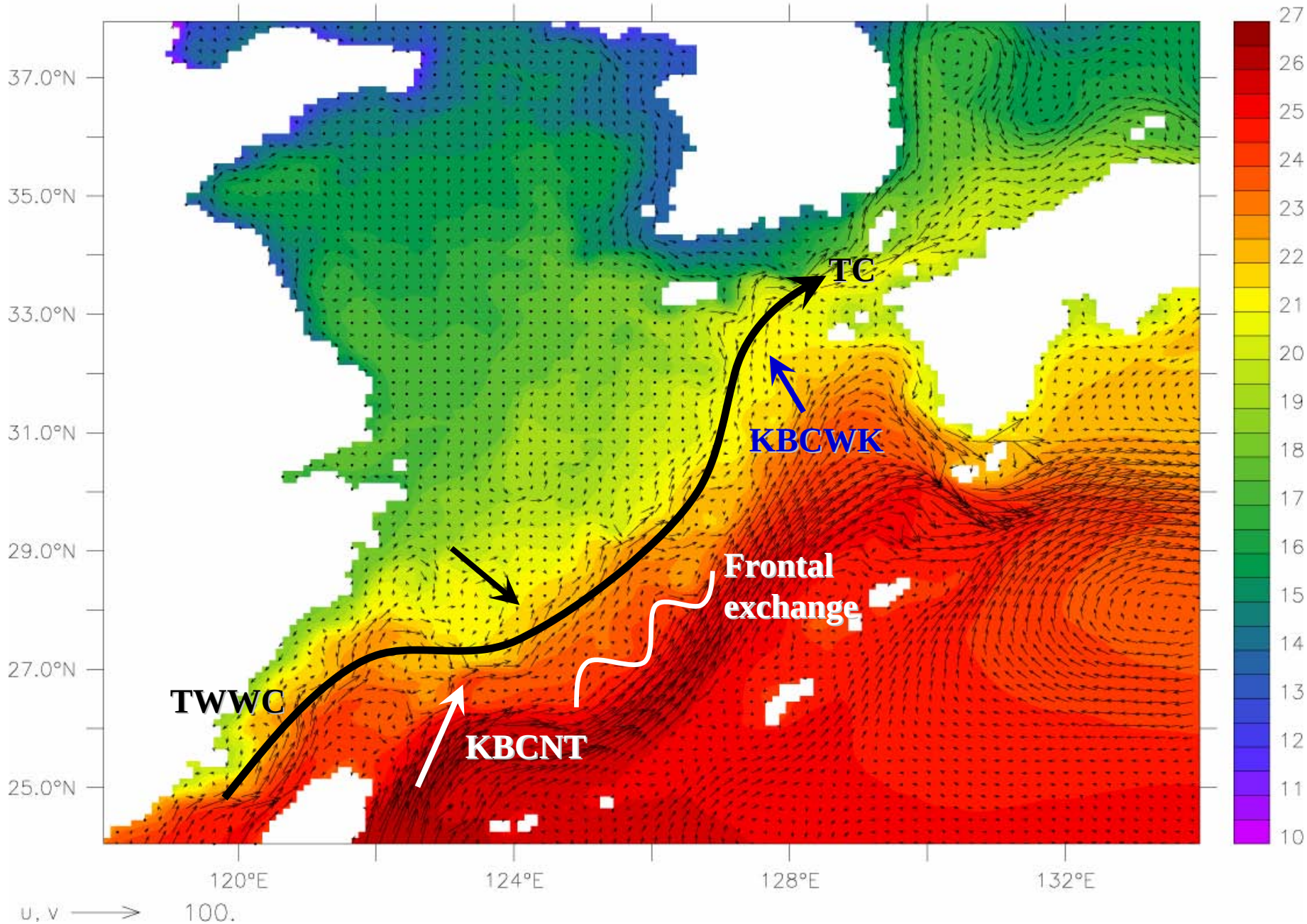


Levitus (surface, annual mean)



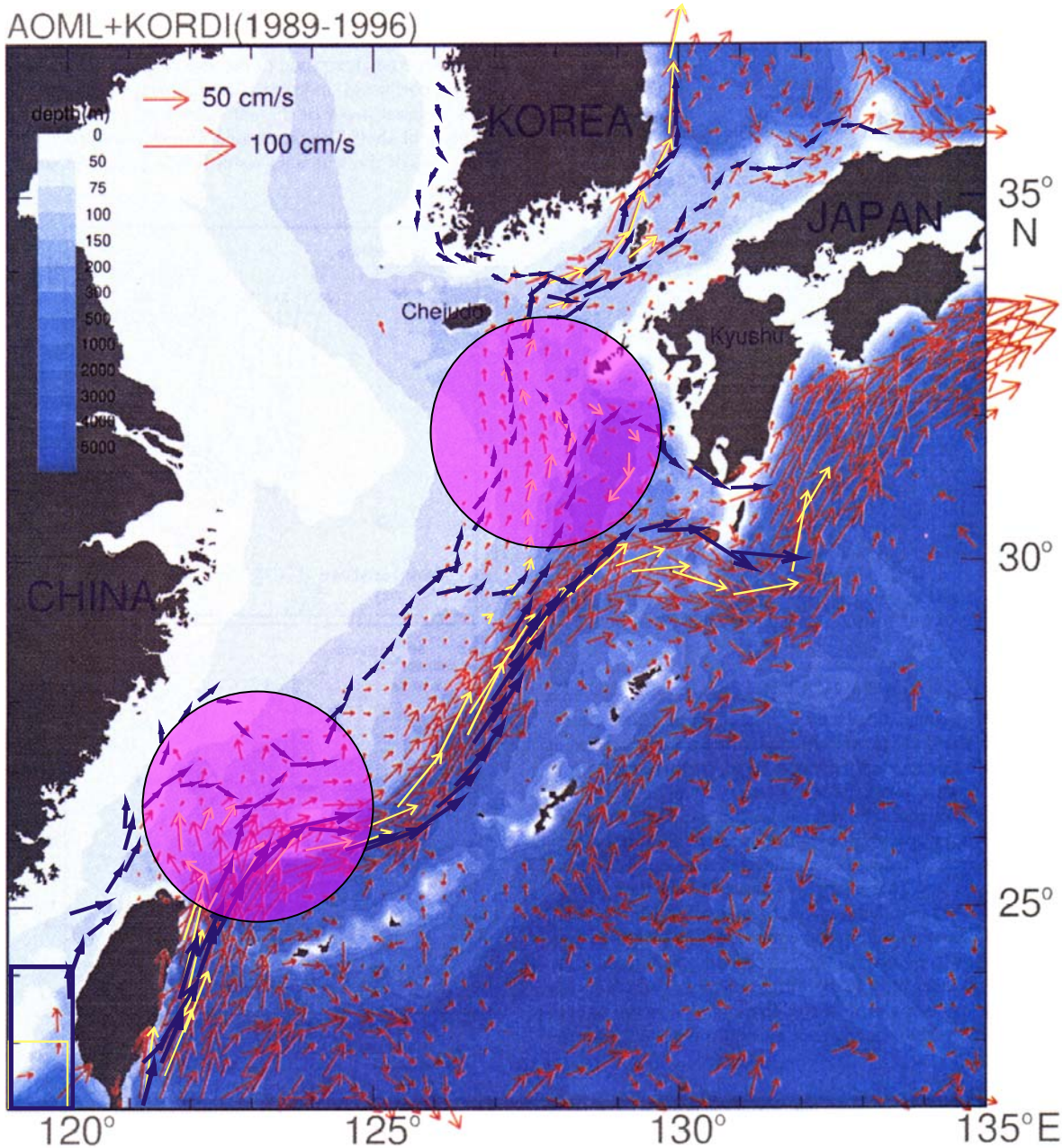


Mean annual surface velocity and temperature

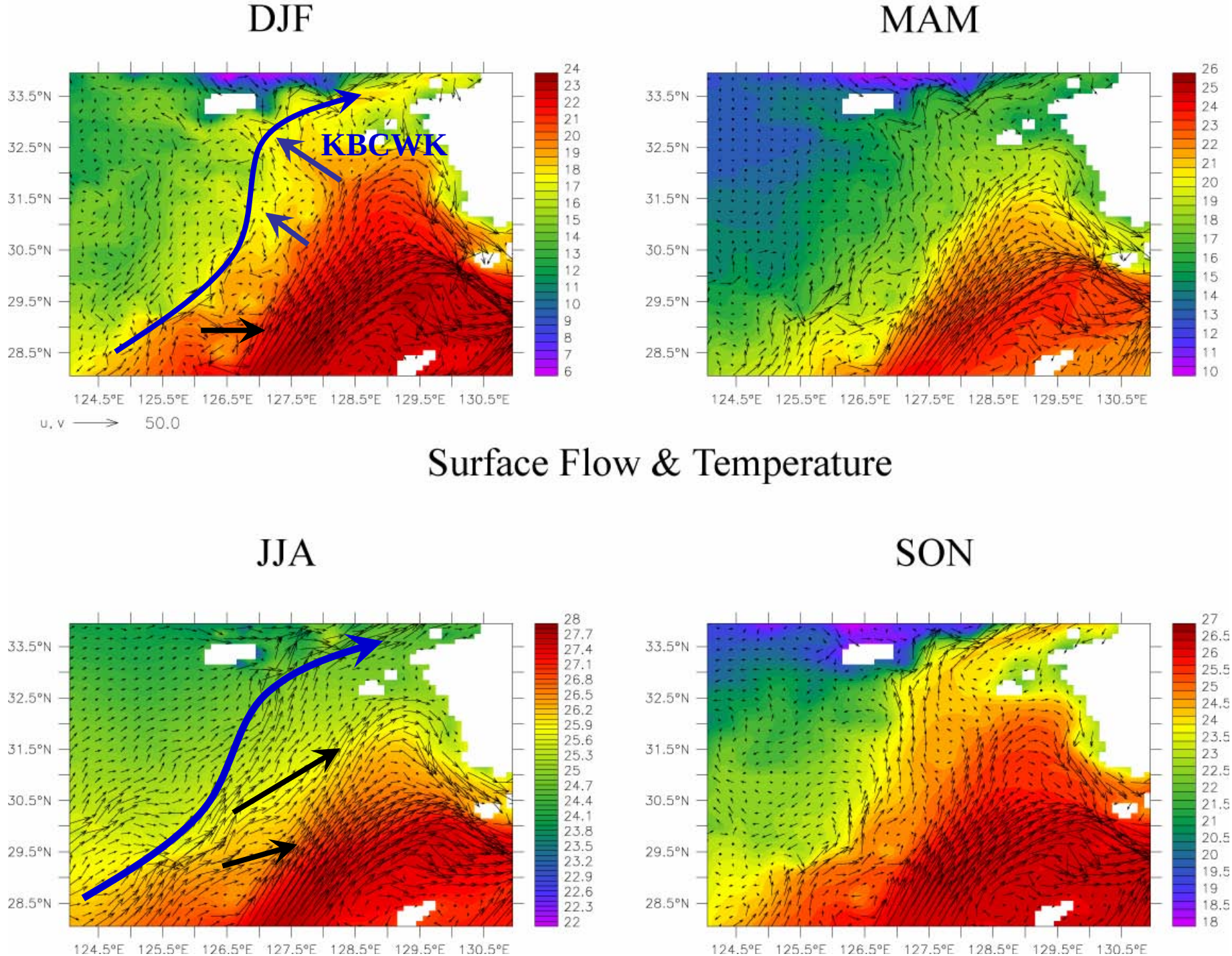


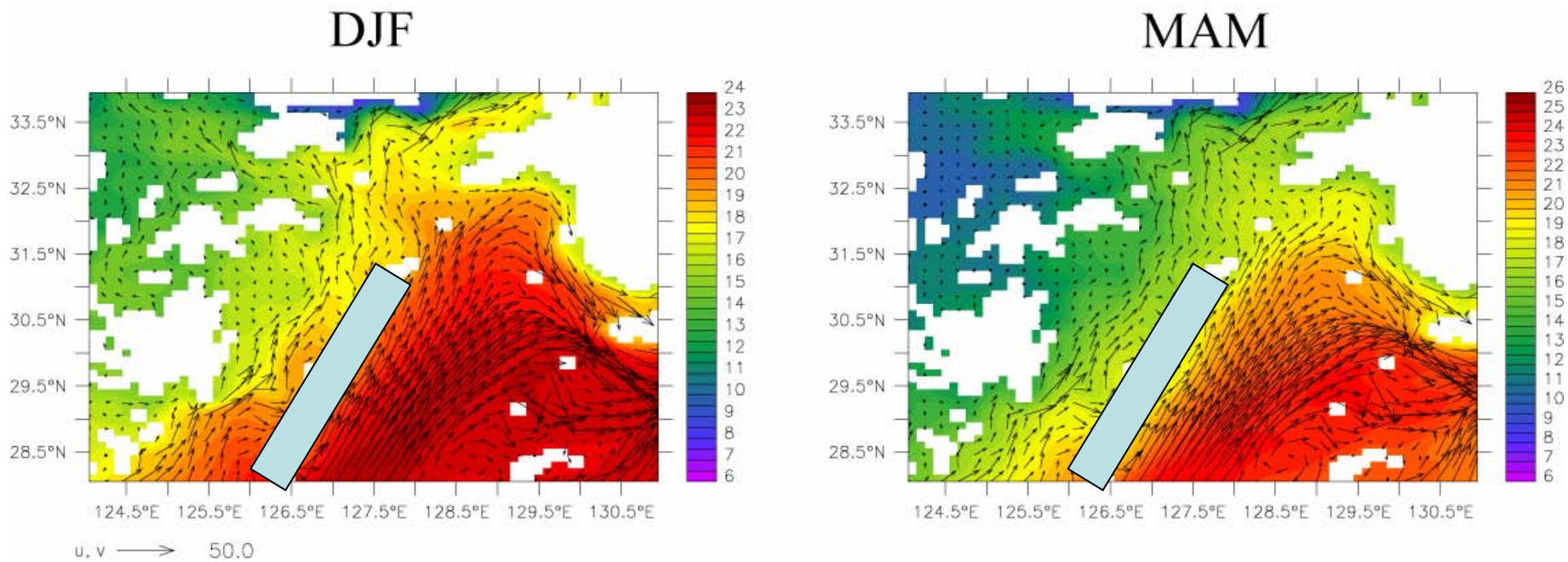
Model results

Surface flow from drifters
(Lie et al., 98)

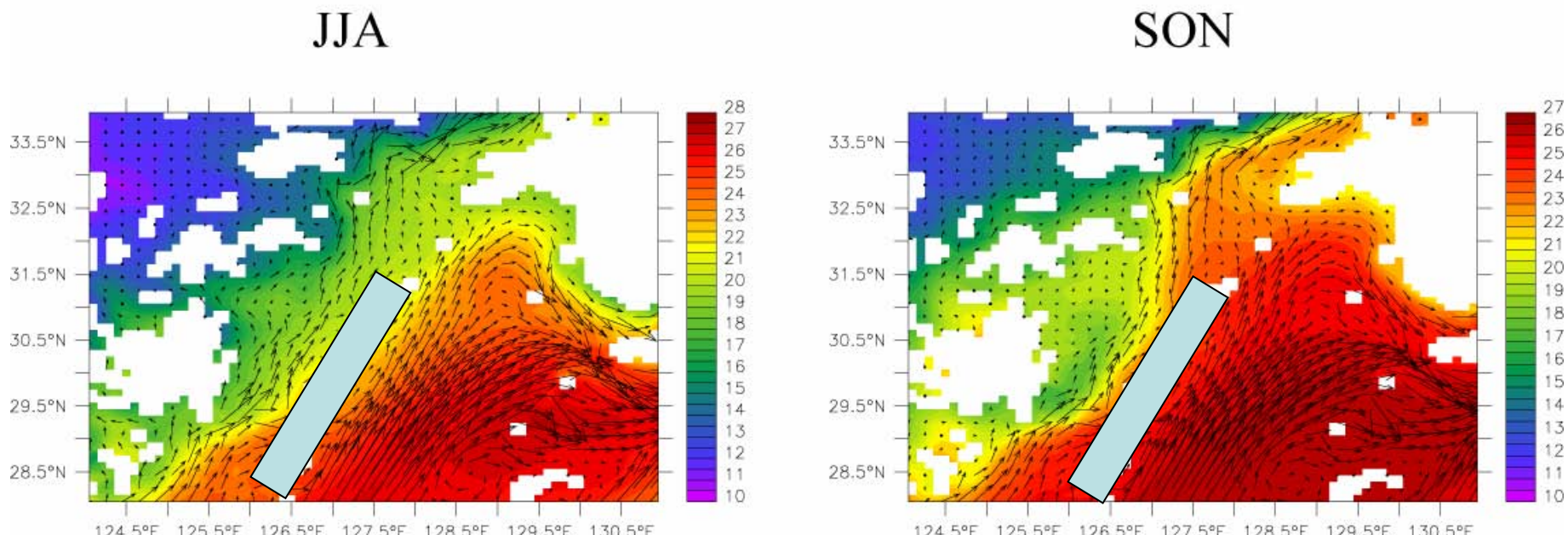


West of Kyushu

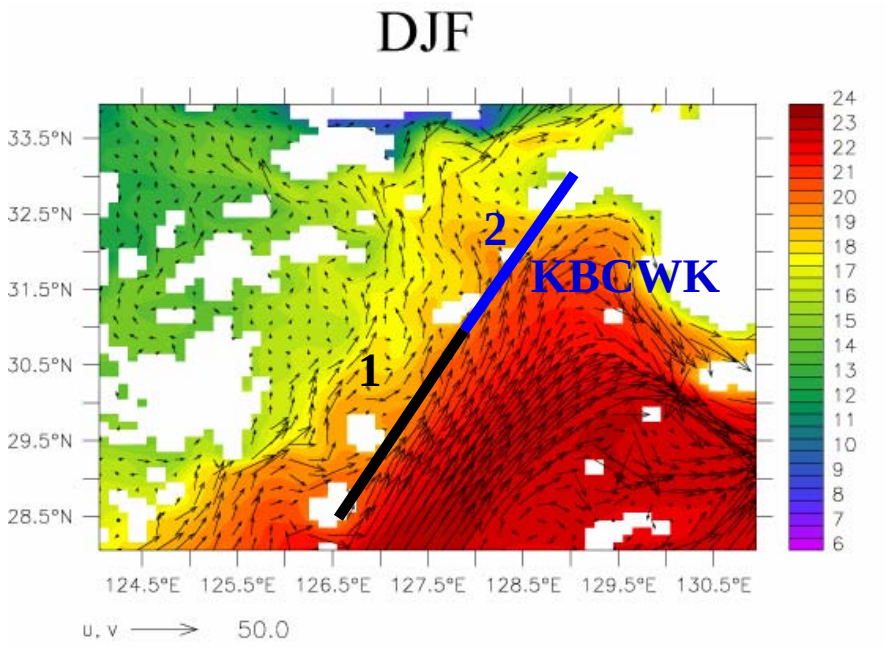

DJF
MAM
KBCWK
33.5°N
32.5°N
31.5°N
30.5°N
29.5°N
28.5°N
124.5°E 125.5°E 126.5°E 127.5°E 128.5°E 129.5°E 130.5°E
u, v 50.0
Surface Flow & Temperature
JJA
SON



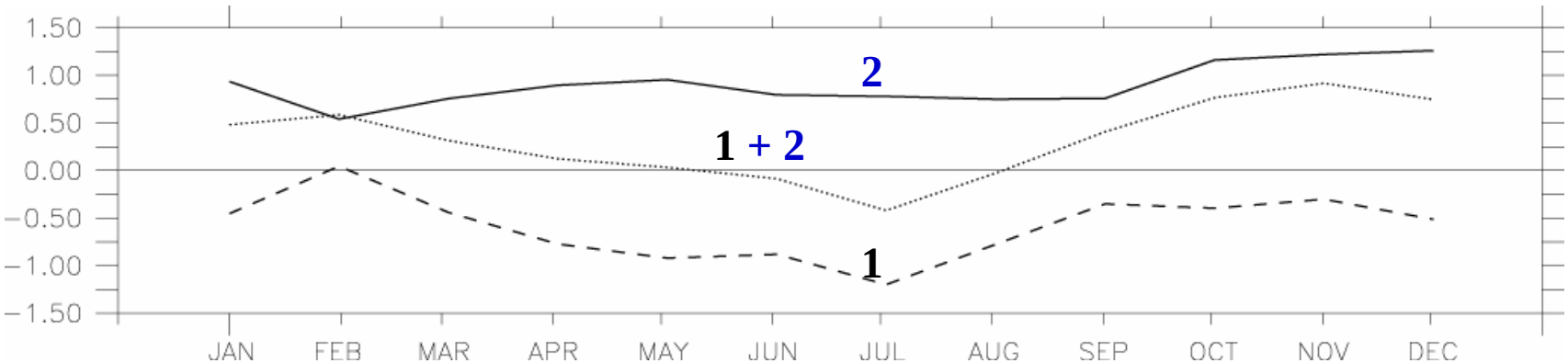
Flow & Temperature at 45m



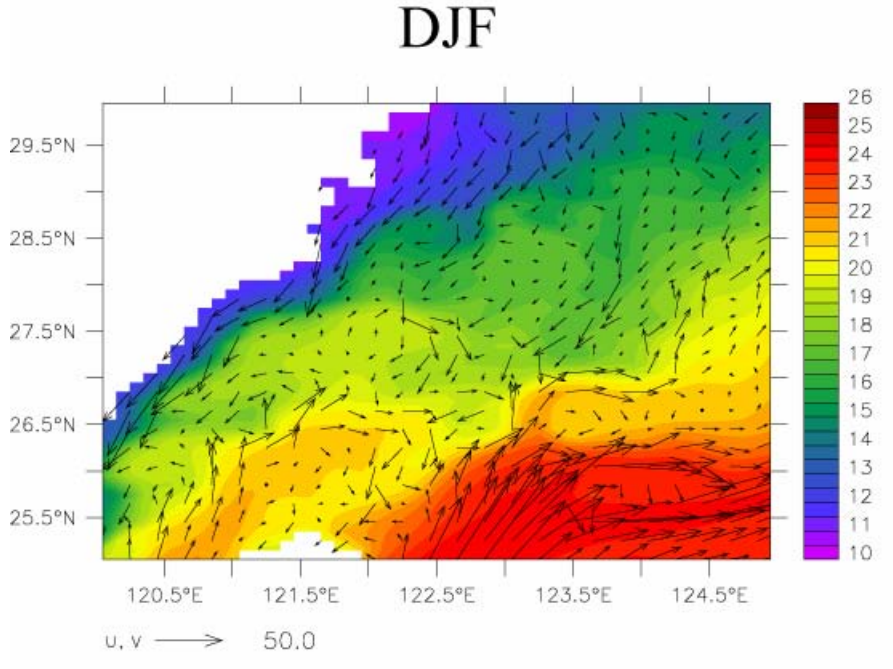
Mass Budget



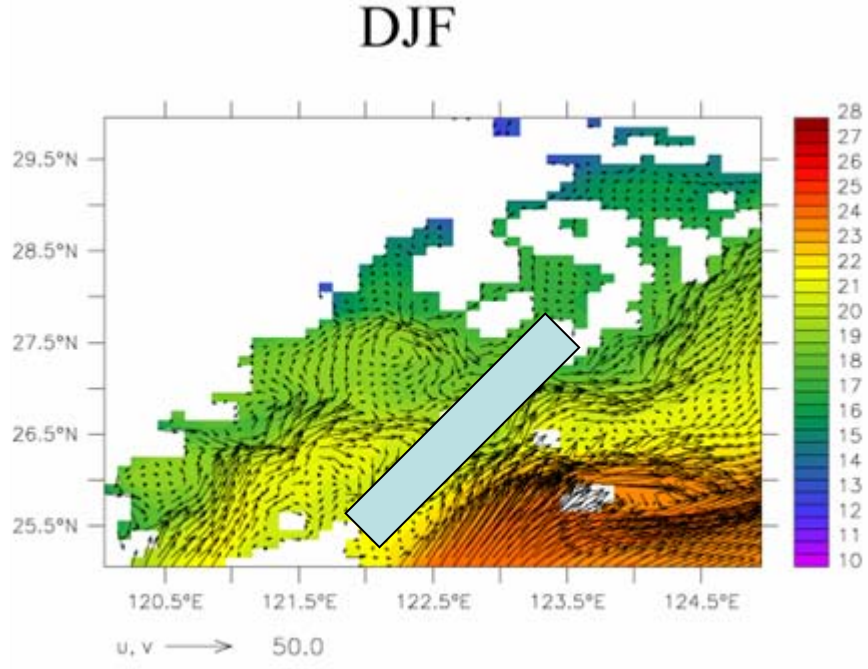
+: from Kuroshio
-: toward kuroshio



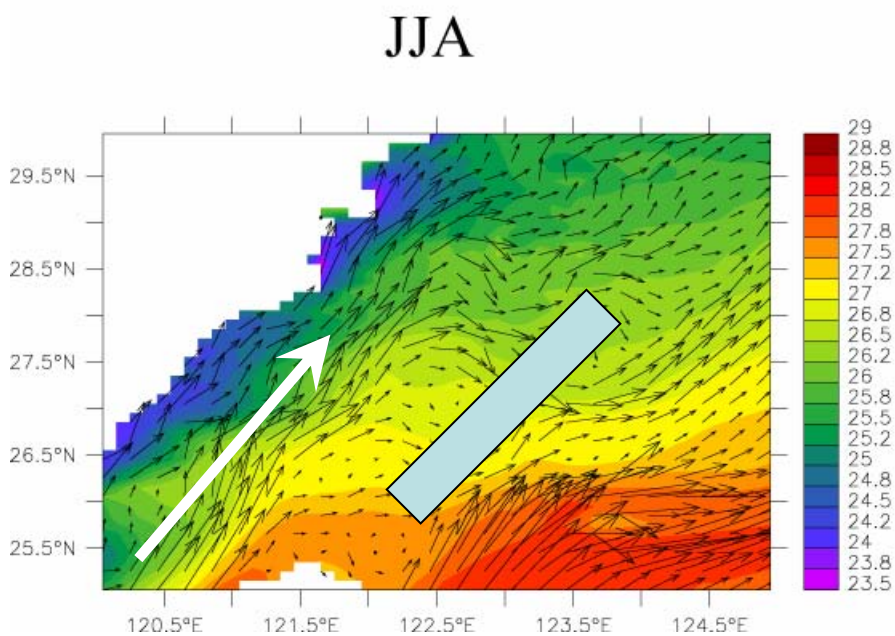
North of Taiwan

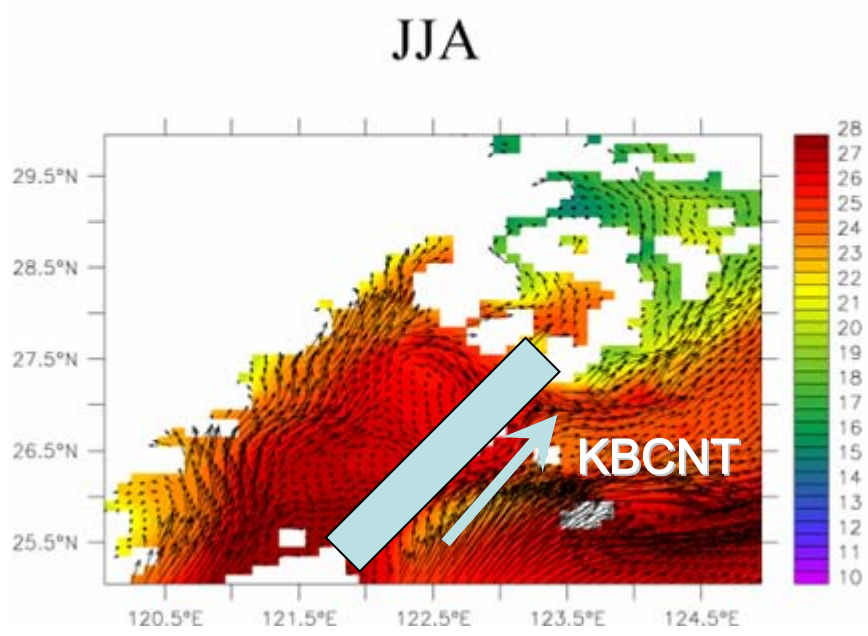

DJF
29.5°N
28.5°N
27.5°N
26.5°N
25.5°N
120.5°E
121.5°E
122.5°E
123.5°E
124.5°E
u, v
50.0
26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10

Surface

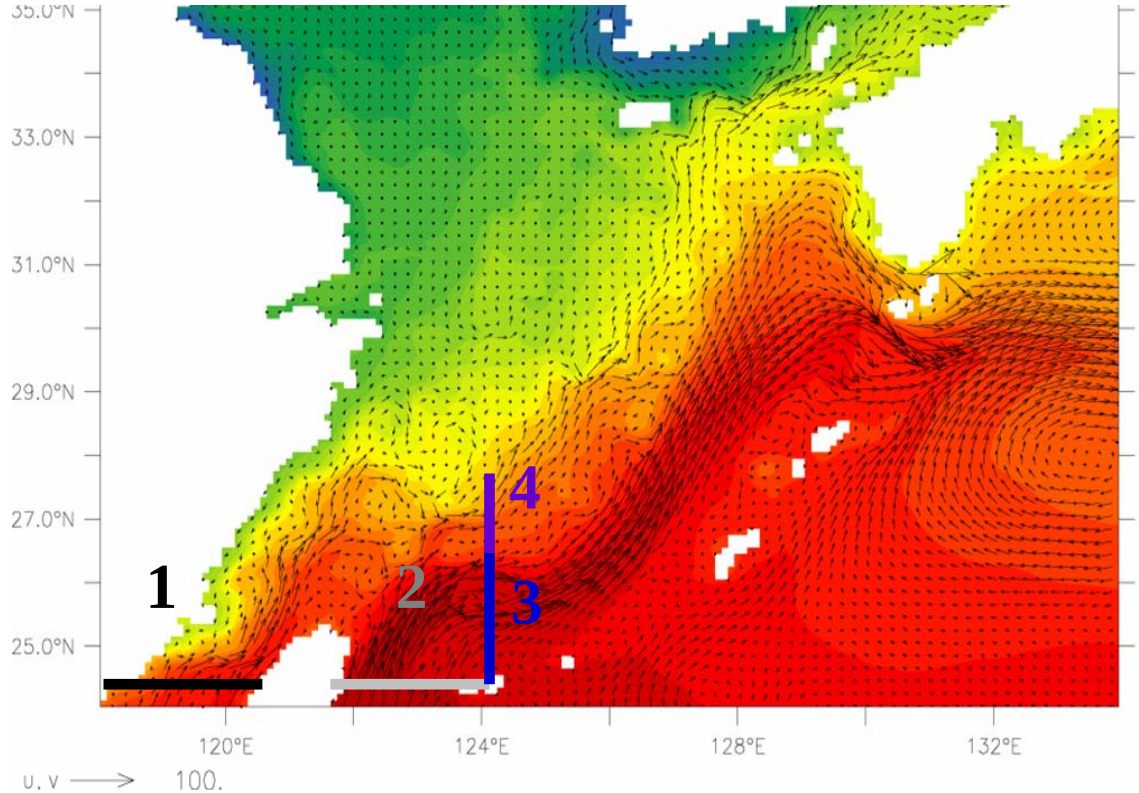

DJF
29.5°N
28.5°N
27.5°N
26.5°N
25.5°N
120.5°E
121.5°E
122.5°E
123.5°E
124.5°E
u, v
50.0
28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10

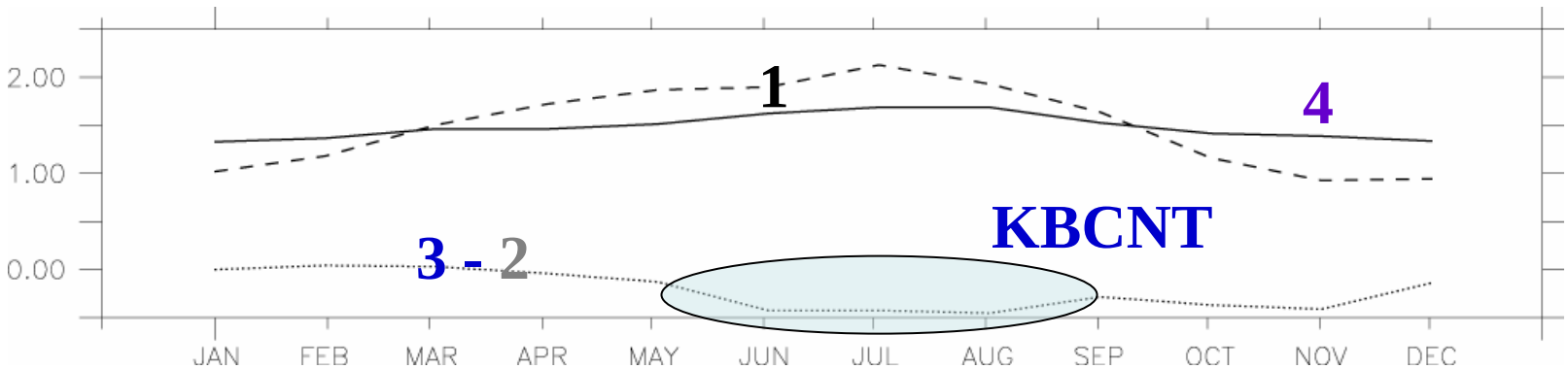
45m


JJA
29.5°N
28.5°N
27.5°N
26.5°N
25.5°N
120.5°E
121.5°E
122.5°E
123.5°E
124.5°E
29 28.8 28.5 28.2 28 27.8 27.5 27.2 27 26.8 26.5 26.2 26 25.8 25.5 25.2 25 24.8 24.5 24.2 24 23.8 23.5

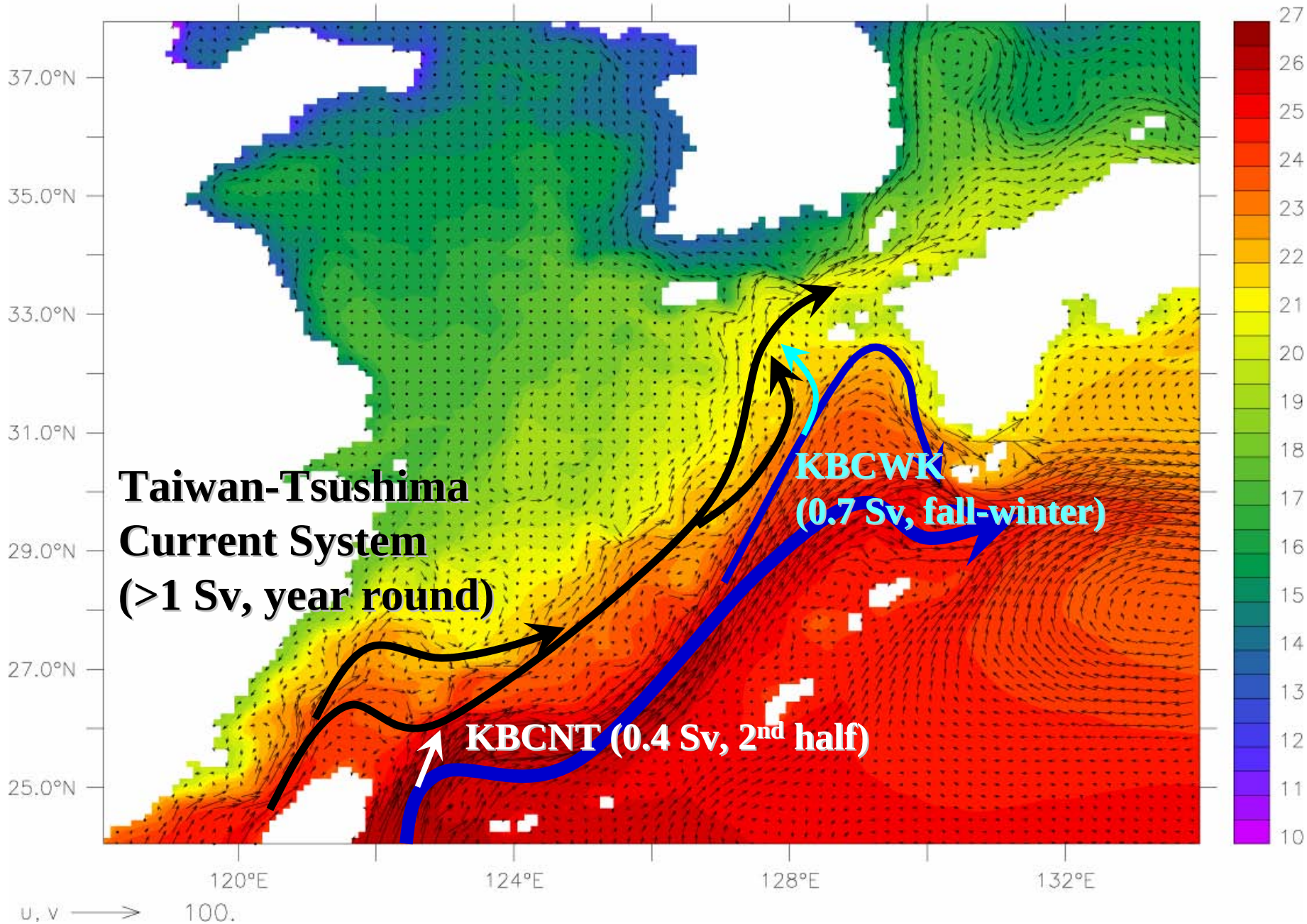

JJA
KBCNT
29.5°N
28.5°N
27.5°N
26.5°N
25.5°N
120.5°E
121.5°E
122.5°E
123.5°E
124.5°E
28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10

Mass Budget


35.0°N
33.0°N
31.0°N
29.0°N
27.0°N
25.0°N
120°E
124°E
128°E
132°E
u, v
100.
1
2
3
4


2.00
1.00
0.00
1
4
3 - 2
KBCNT
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

Mean annual surface velocity and temperature



Summary & Conclusion

- Taiwan-Tsushima Current system exists through a year
  - Stronger at the subsurface level
  - Topographic steering
- KBCWK: stronger during the colder half

  a part of Taiwan-Tsushima Current system?
- KBCNT: stronger during the 2nd half

  a part of the Taiwan current system?
- Tsushima Current is weaker than the observation

  Lack of the Kuroshio Frontal wave (Isobe and Beardsley 06)?

Thank you