HYCOM Modeling in the Japan/East Sea

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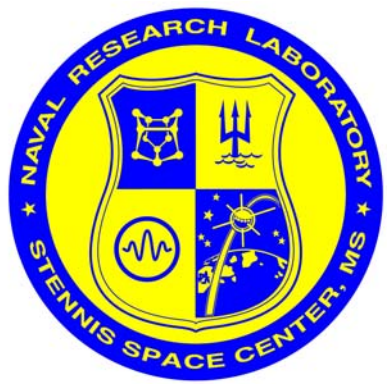


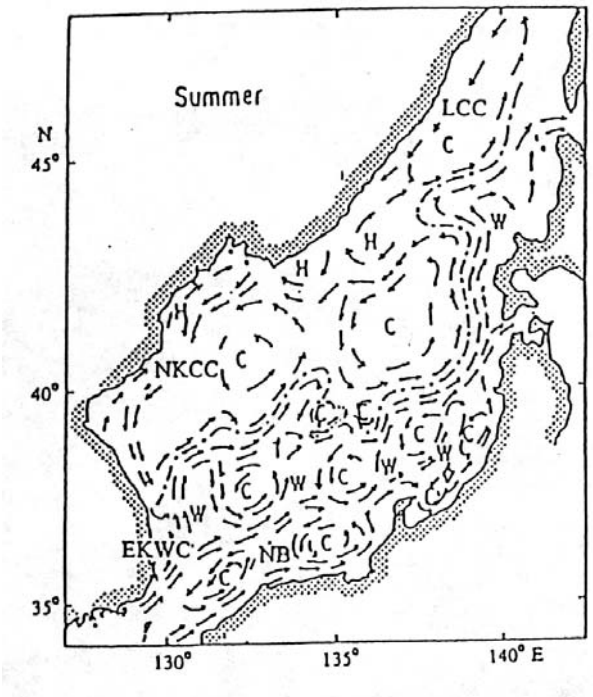
JES-HYCOM

- 1/8° (14 km), 1/16° (7.5 km), and 1/32° (3.4 km) horizontal resolution
- 10, 15, 20 layers in the vertical, most with 15 layers
- KPP mixed layer
- 2 Sv barotropic throughflow with seasonal (baroclinic) component (inflow through Korea Strait, outflow through Tsugaru and Soya straits)
- Relaxation to MODAS SSS (due to poor quality E-P fields)
- Biharmonic diffusion with Smagorinsky coefficient

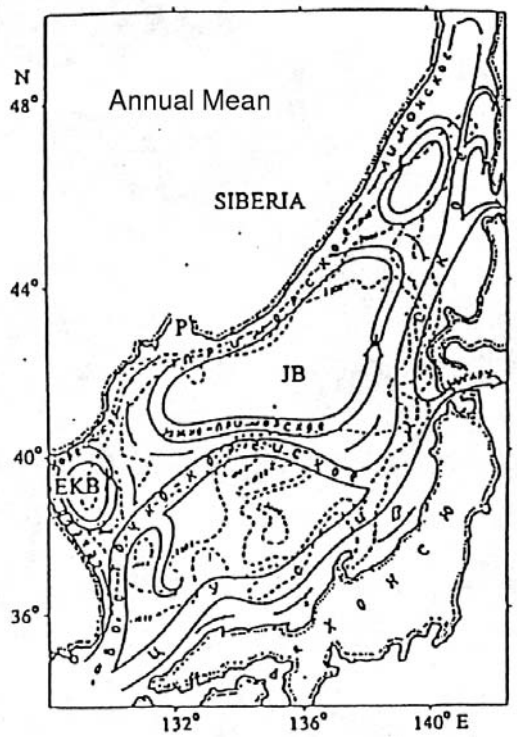
Typically,

- Run for 10 years with monthly ECMWF 10 m wind and heat flux forcing
- Continue with 6 hourly ECMWF 10 m wind and flux forcing
- Others have been used (COADS, NOGAPS, NCEP)

Observed surface circulation in the Japan/East Sea



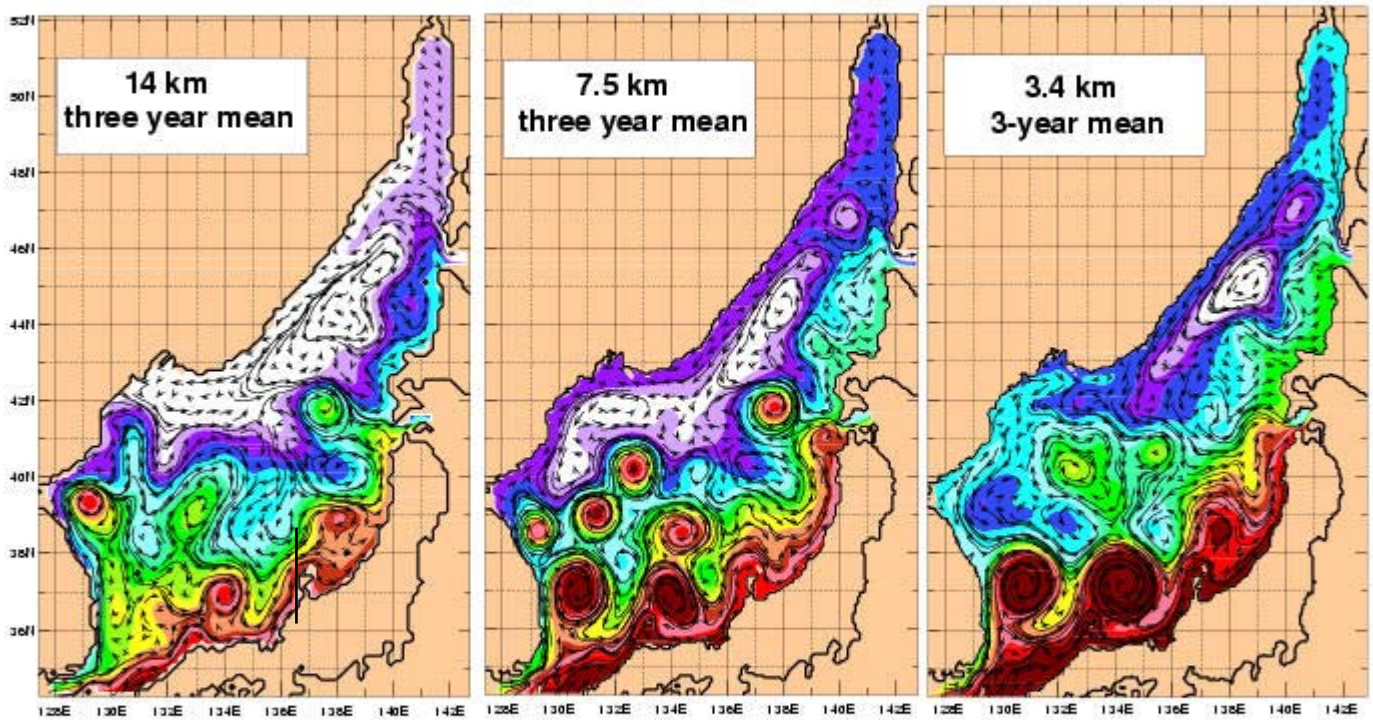
From Naganuma (1977)



From Yarachin(1980)

JES HYCOM - Impact of Horizontal Grid Resolution

Free Surface deviation and surface layer currents

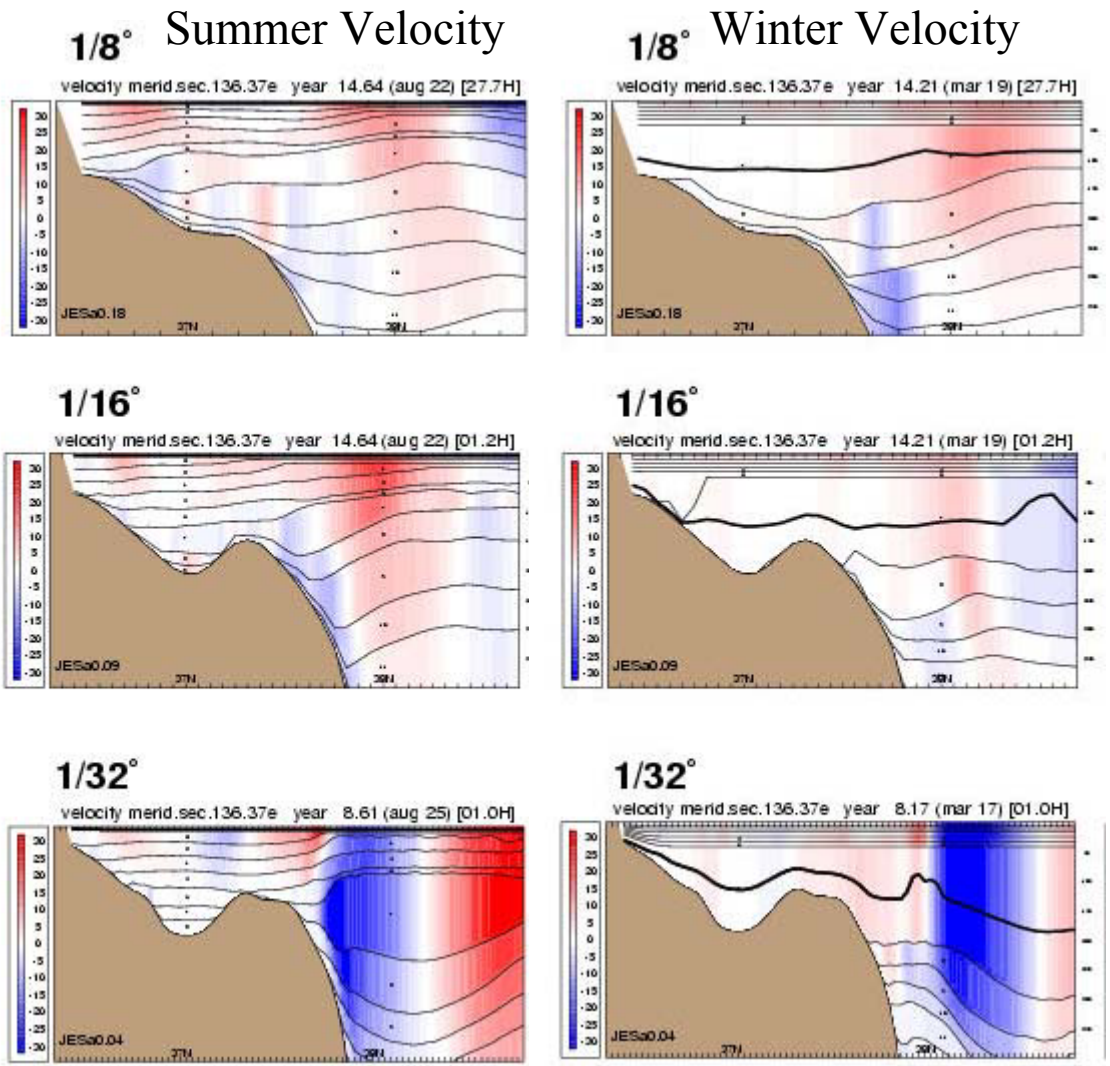


Forced by inflow/outflow through the straits and ECMWF 10 m atmospheric forcing (monthly + 6 hrly variab.)

CI = 2 cm

6 10 14 18 22 26 30 32 20 cm/s

Japan/East Sea HYCOM Velocity Cross-sections (136E)



Wintertime:
Barotropic flow
Topographic control

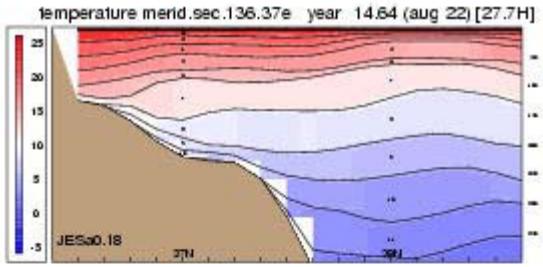
Summertime:
Baroclinic flow
Isopycnal outcropping

Red = eastward flow
Blue = westward flow

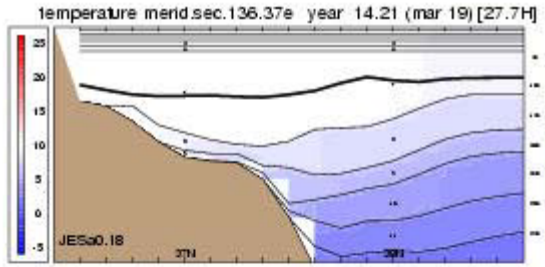
Forced by inflow/outflow through the straits
And 6 hourly ECMWF atmospheric forcing

Japan/East Sea Temp. Cross-sections (136E)

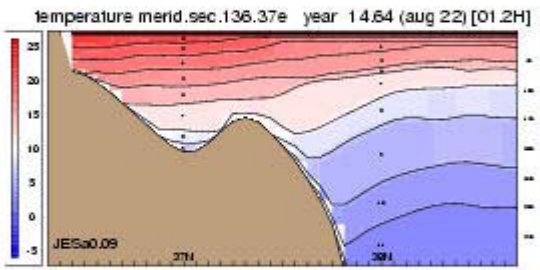
1/8° Summer Temperature

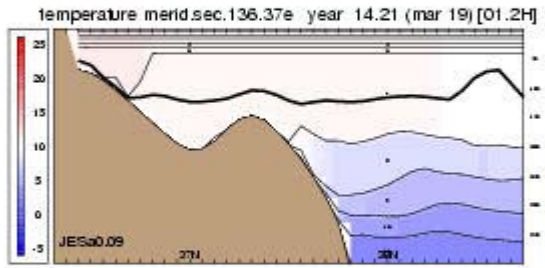


Winter Temperature

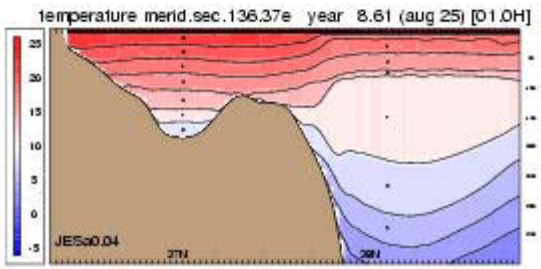


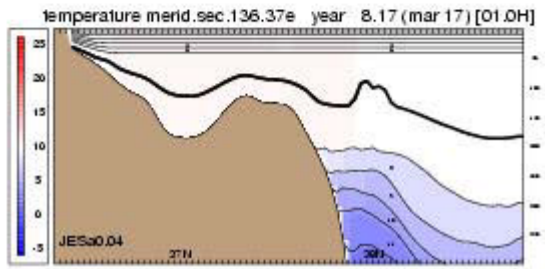
1/16°



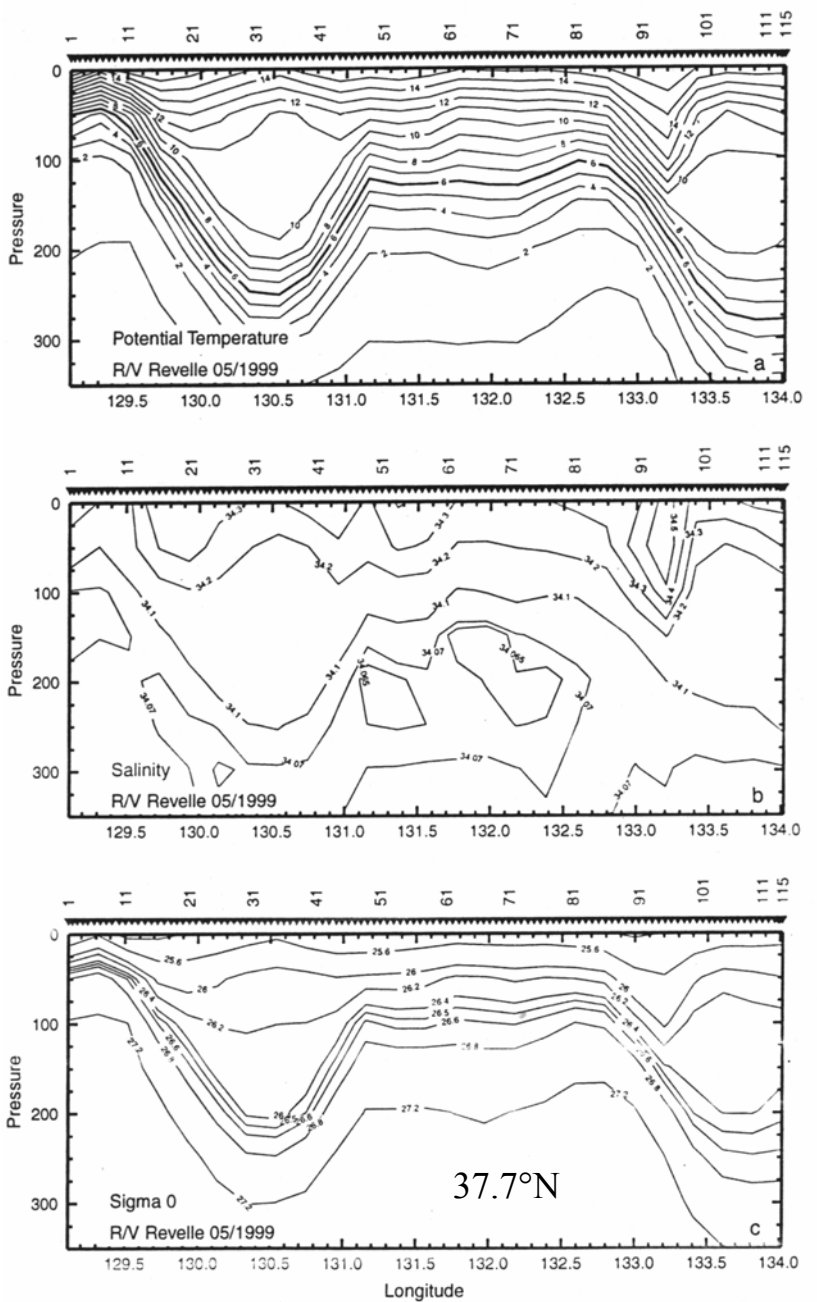


1/32°





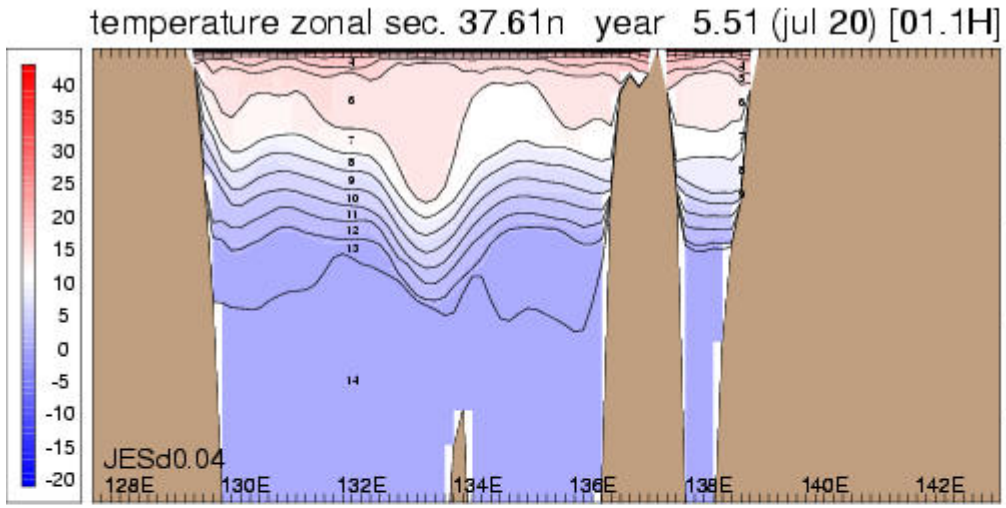
Forced by inflow/outflow through the straits
and 6 hourly ECMWF atmospheric forcing

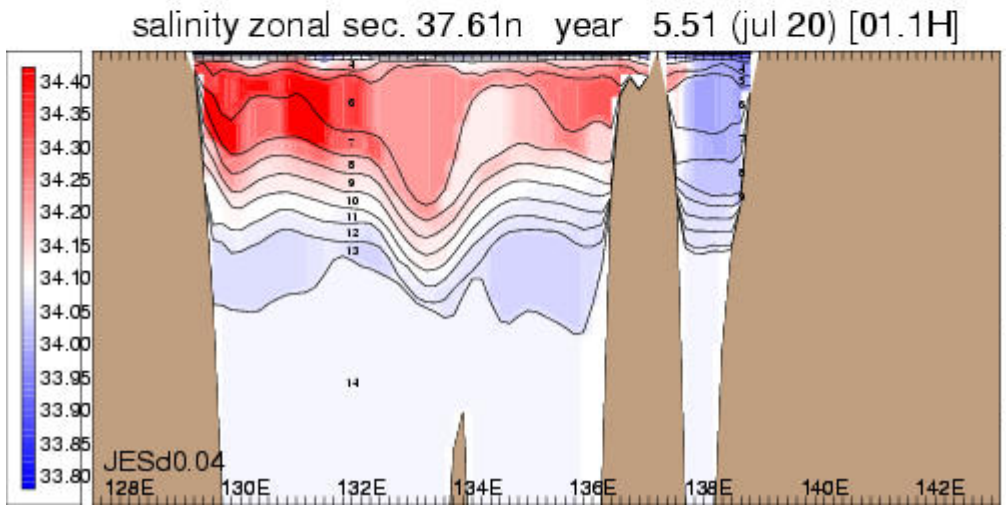


37.7°N

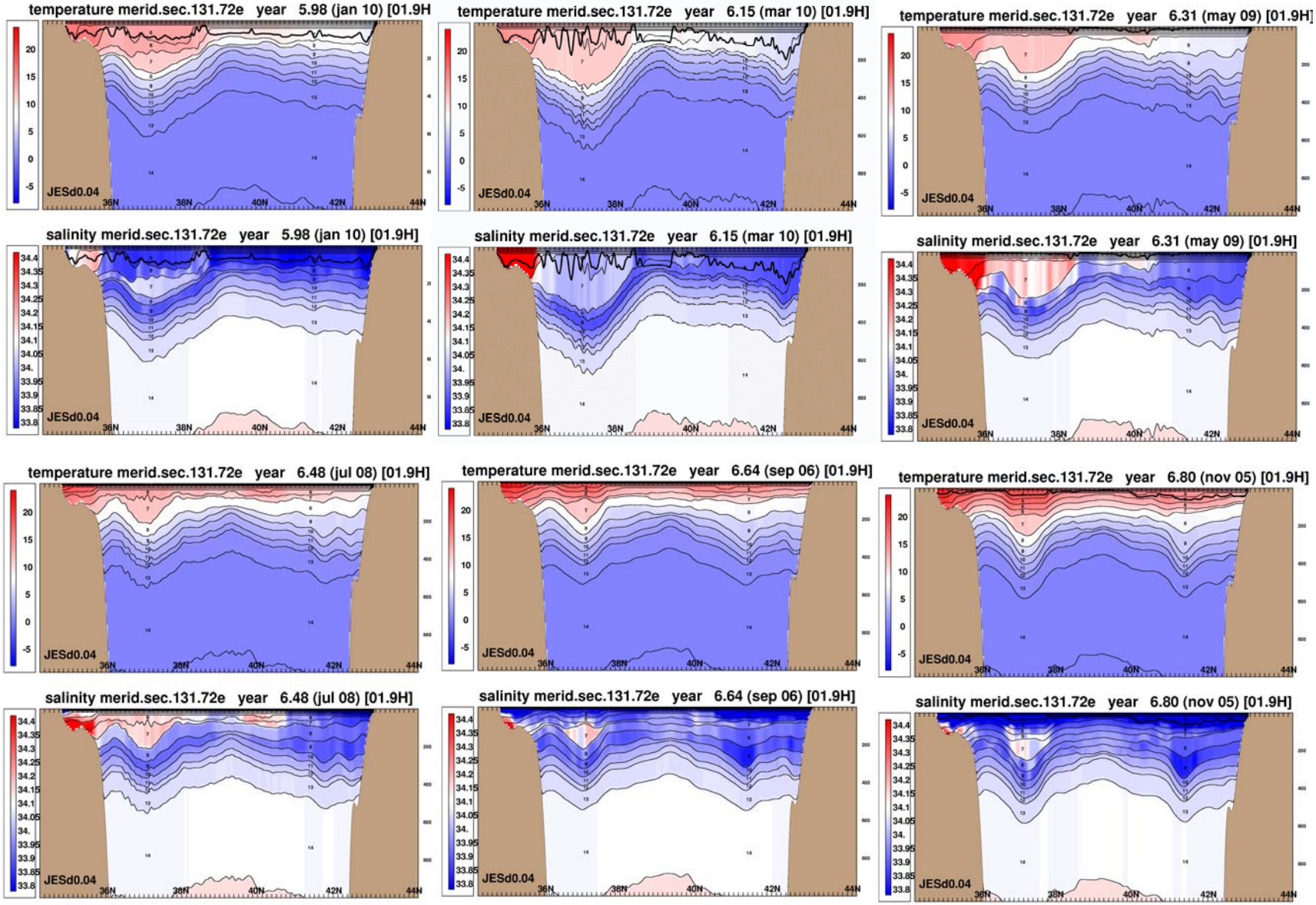
Gordon et al (in press)

1/8° JES HYCOM

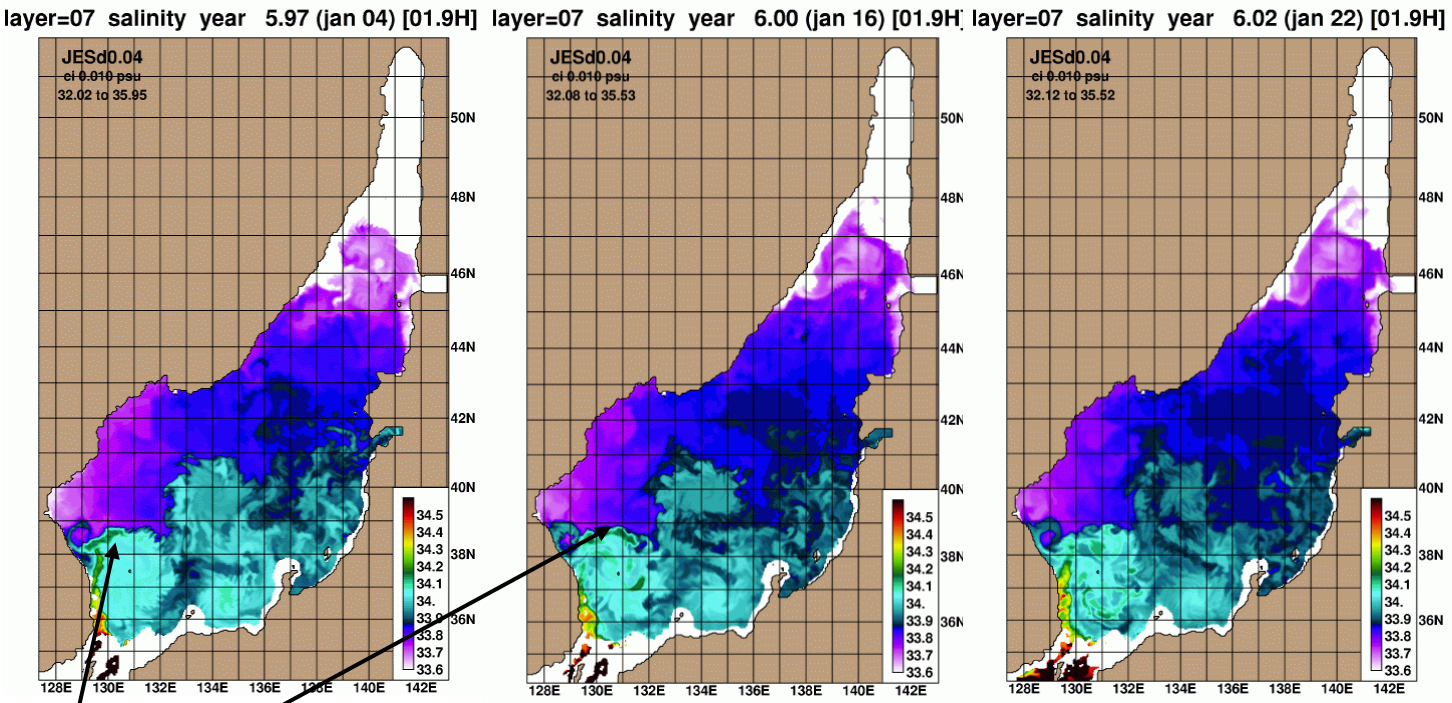




Snapshot cross-sections of temperature and salinity along 131.7E



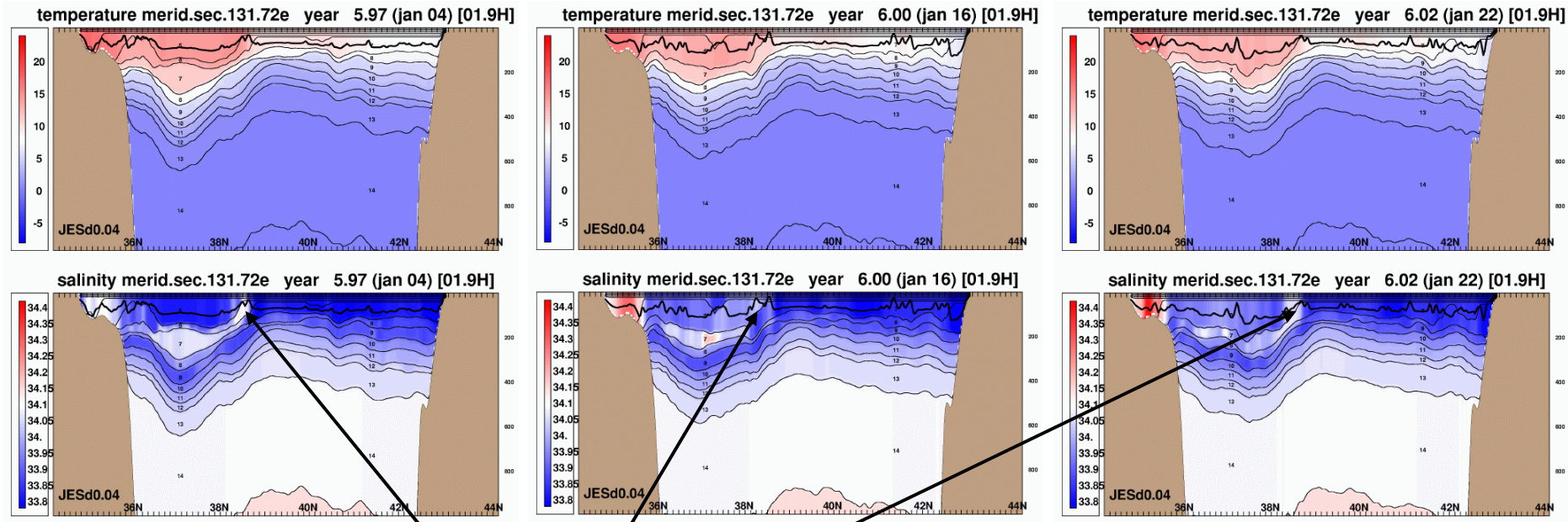
3.5 km Japan/East Sea HYCOM



Location of frontal subduction

Japan/East Sea HYCOM (3.5 km resolution)

Intra-Thermocline Eddy Formation



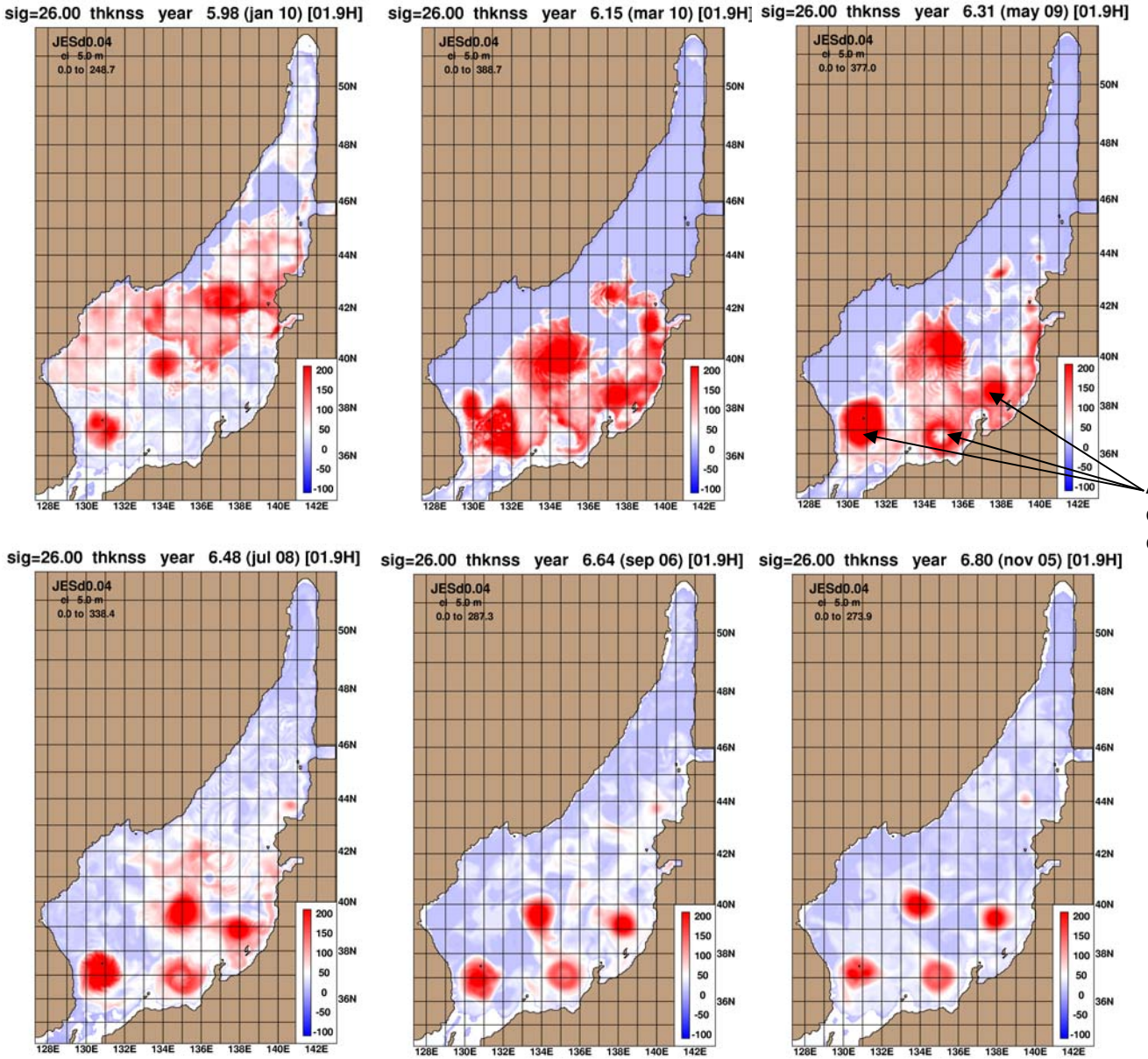
Jan 04

Jan 16

Jan 22

Frontal subduction of warm saline water

Bi-monthly snapshots of Layer 7 thickness

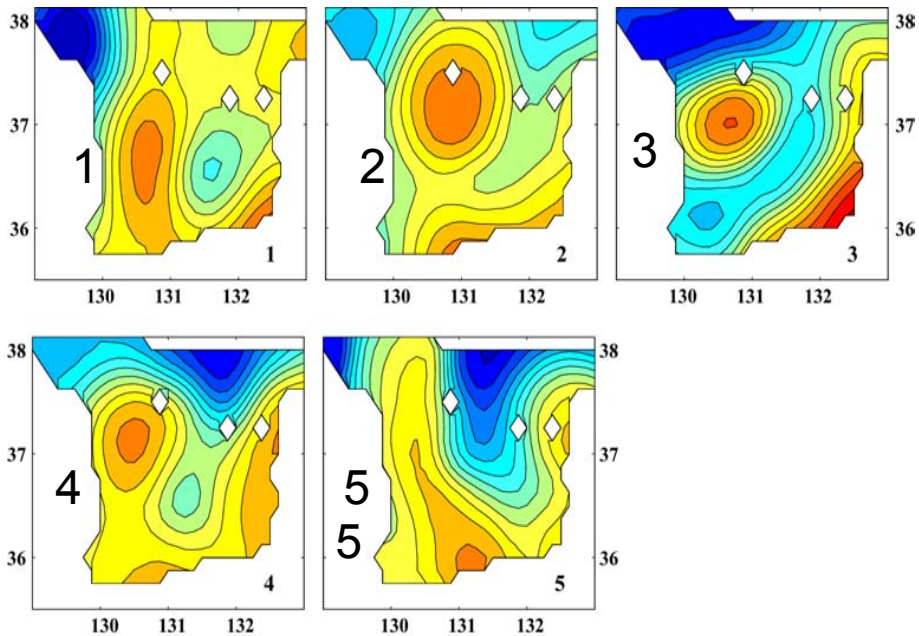


Approximate locations of the JES Intra-thermocline eddies

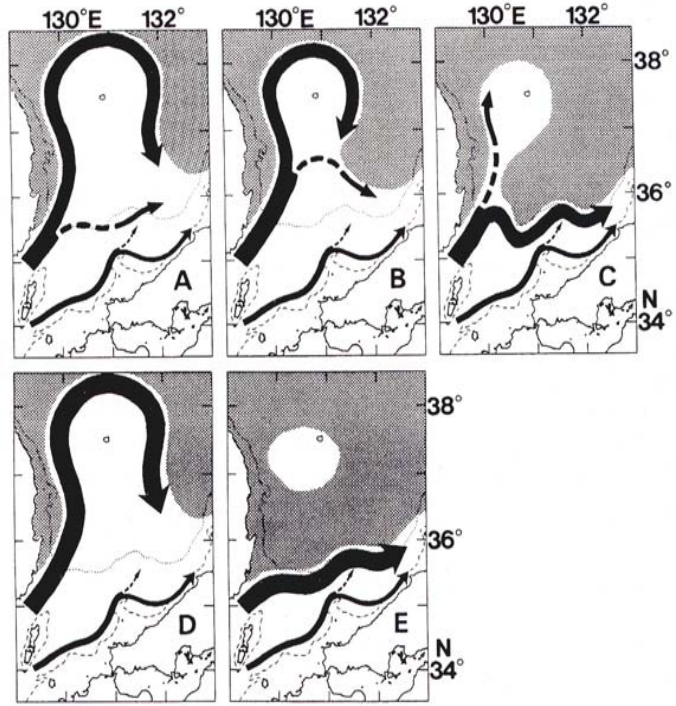
1/25° JES HYCOM; Straits and ECMWF forcing

Different states of the Ulleung Basin circulation

Surface Temperature (PIES data)

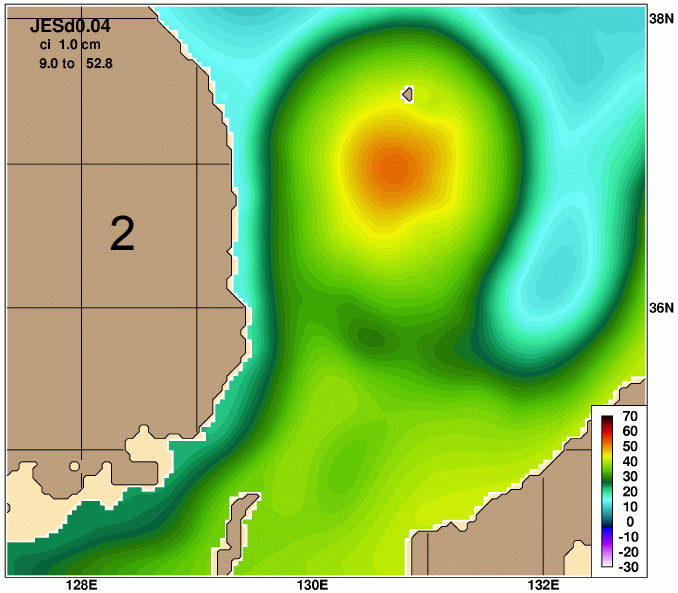


Mitchell et al. (submited)

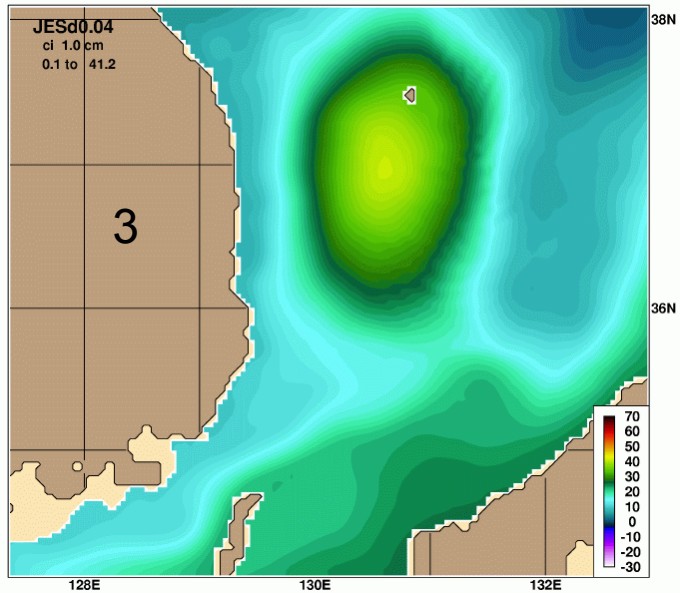


From Katoh (1999)

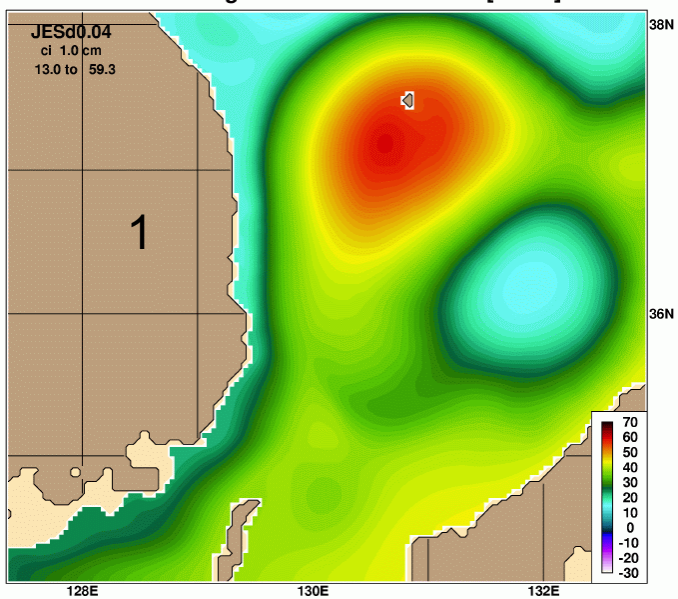
sea surf. height mean: 6.62- 6.71 [01.9H]



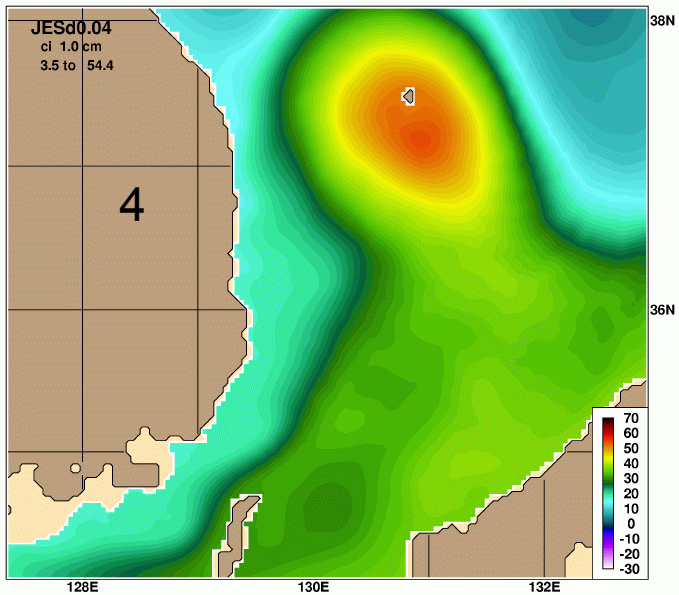
sea surf. height mean: 7.21- 7.30 [01.9H]



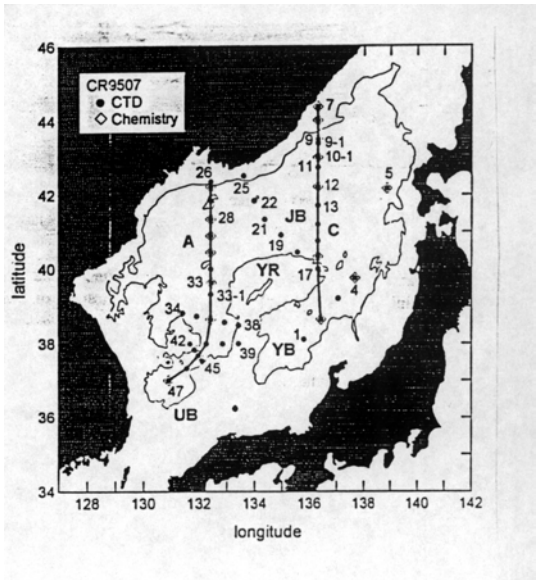
sea surf. height mean: 6.79- 6.87 [01.9H]

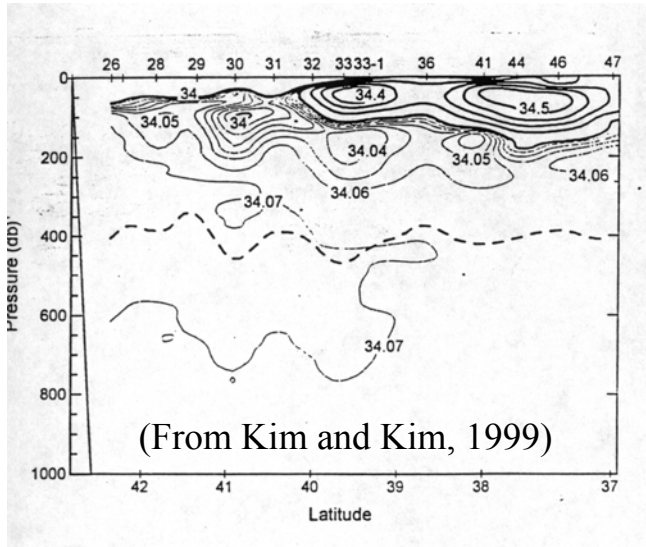


sea surf. height mean: 6.95- 7.03 [01.9H]



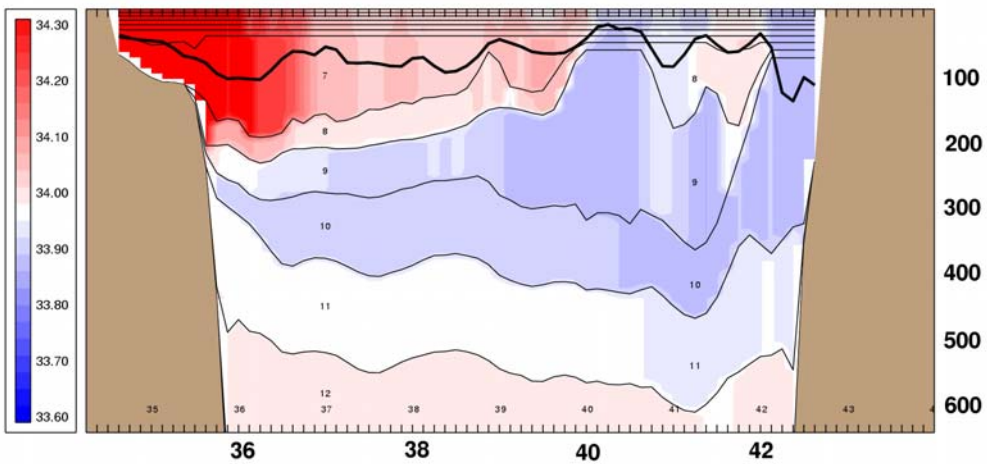
East Sea Intermediate Water





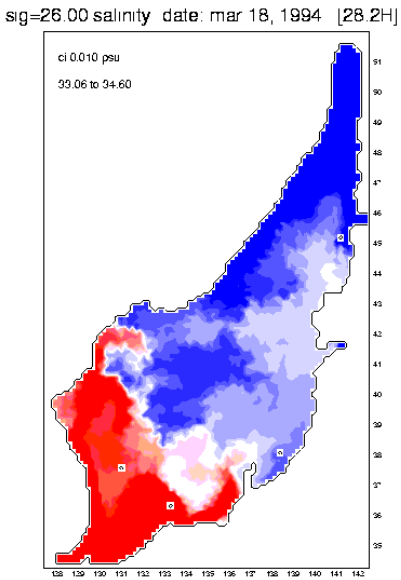
(From Kim and Kim, 1999)

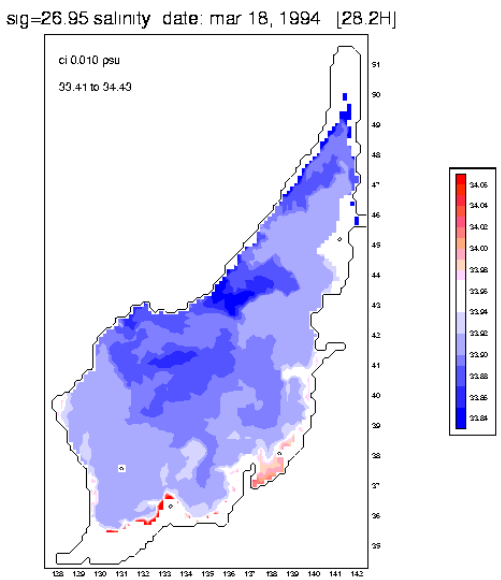
Salinity from 1/8 HYCOM along 132E

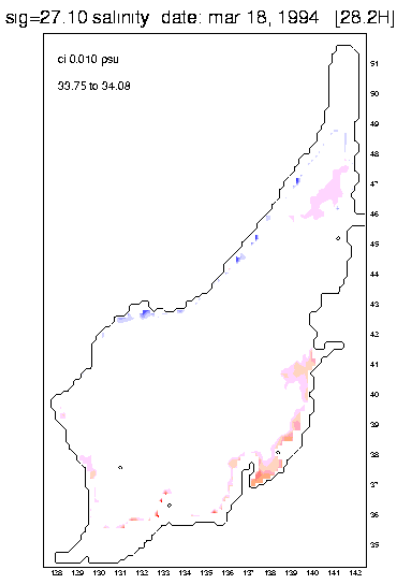


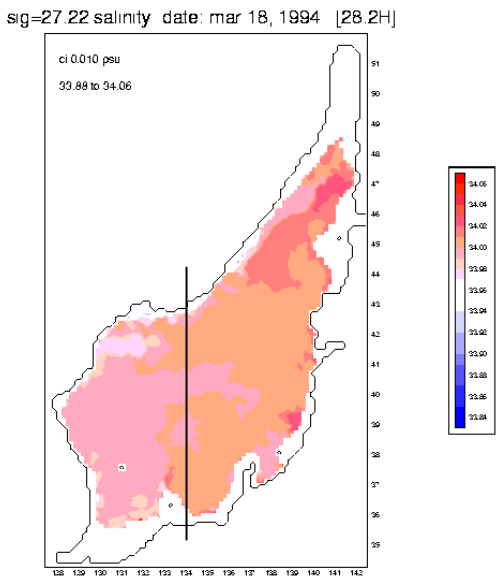
Forced by inflow/outflow through the straits and 6 hourly ECMWF 10 m atmospheric forcing

East Sea Intermediate Water Formation



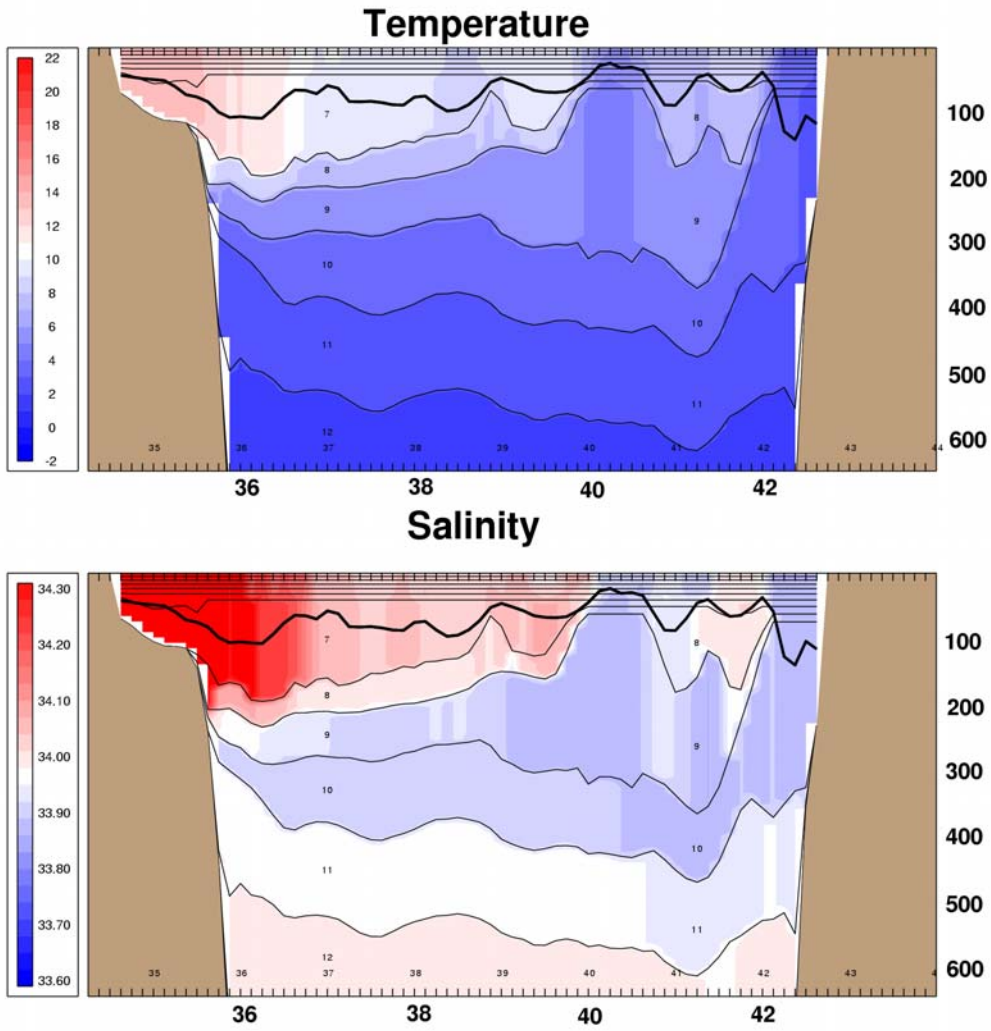






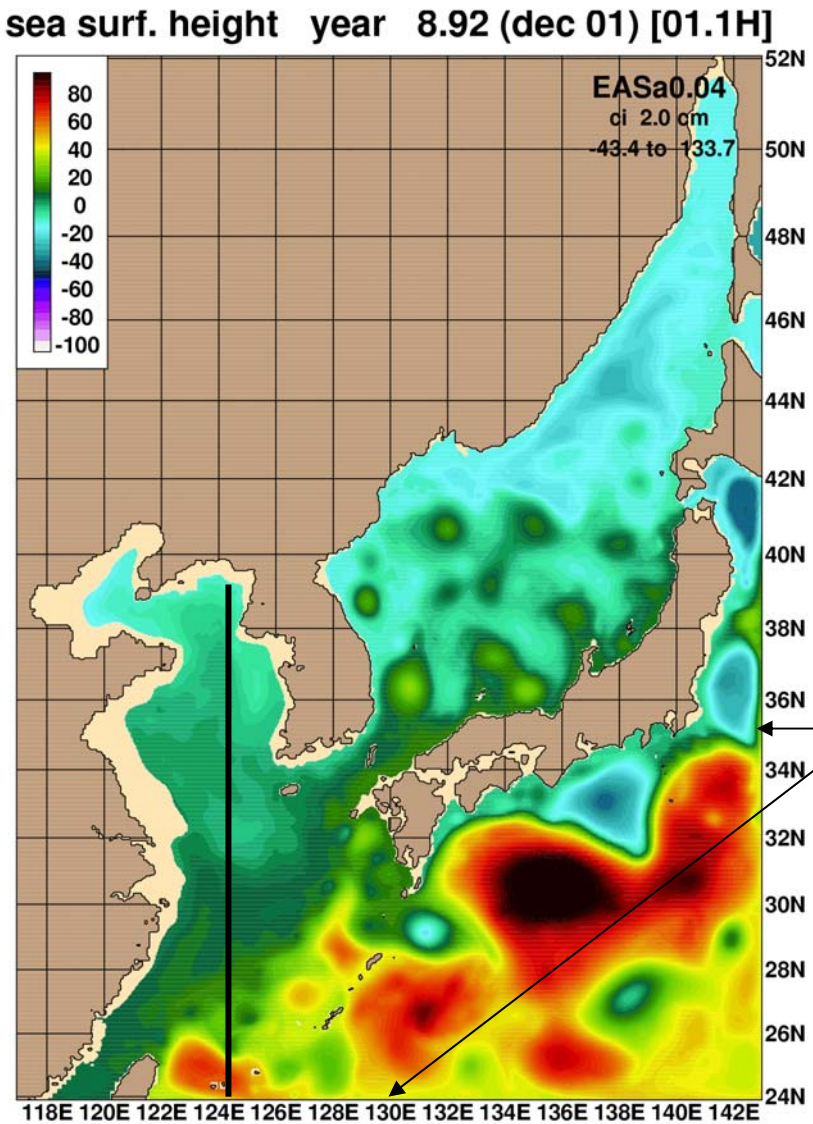
1/8˚ 15-layer JES-HYCOM

Cross-sections along 131.3˚E on March 21, 1994



Forced by inflow/outflow through the straits and 6 hourly ECMWF 10 m atmospheric forcing

1/25° East Asian Seas HYCOM
Nested inside 1/6 ° North Pacific HYCOM



open boundary conditions from 1/6° north Pacific HYCOM

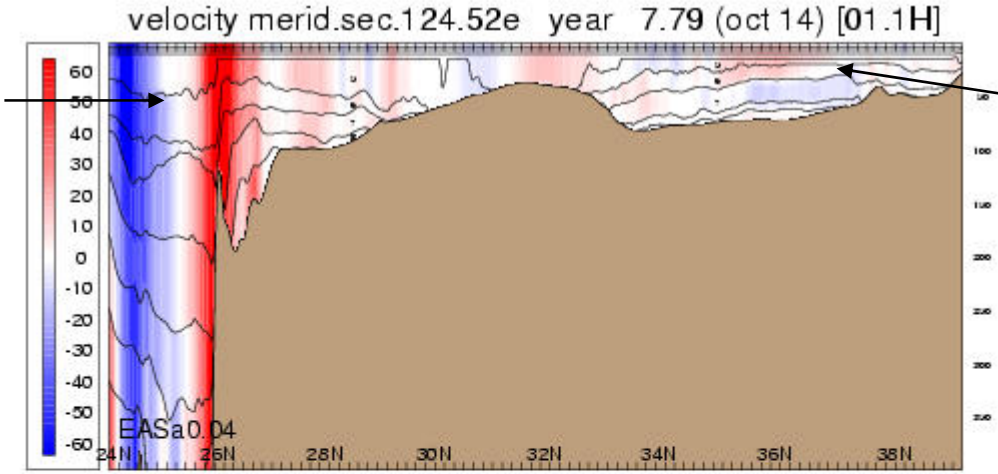
1/25° HYCOM East Asian Seas Model
(nested inside 1/6° North Pacific Model

North-south cross-section along 124.5°E

East China Sea

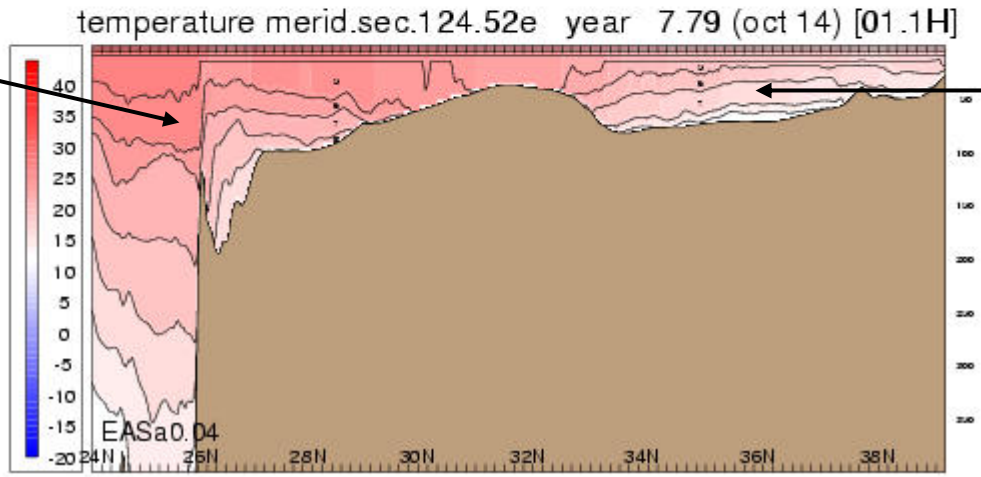
Yellow Sea

blue=westward flow
red=eastward flow



density front associated with sharp topo feature

Isopycnals over shelf region



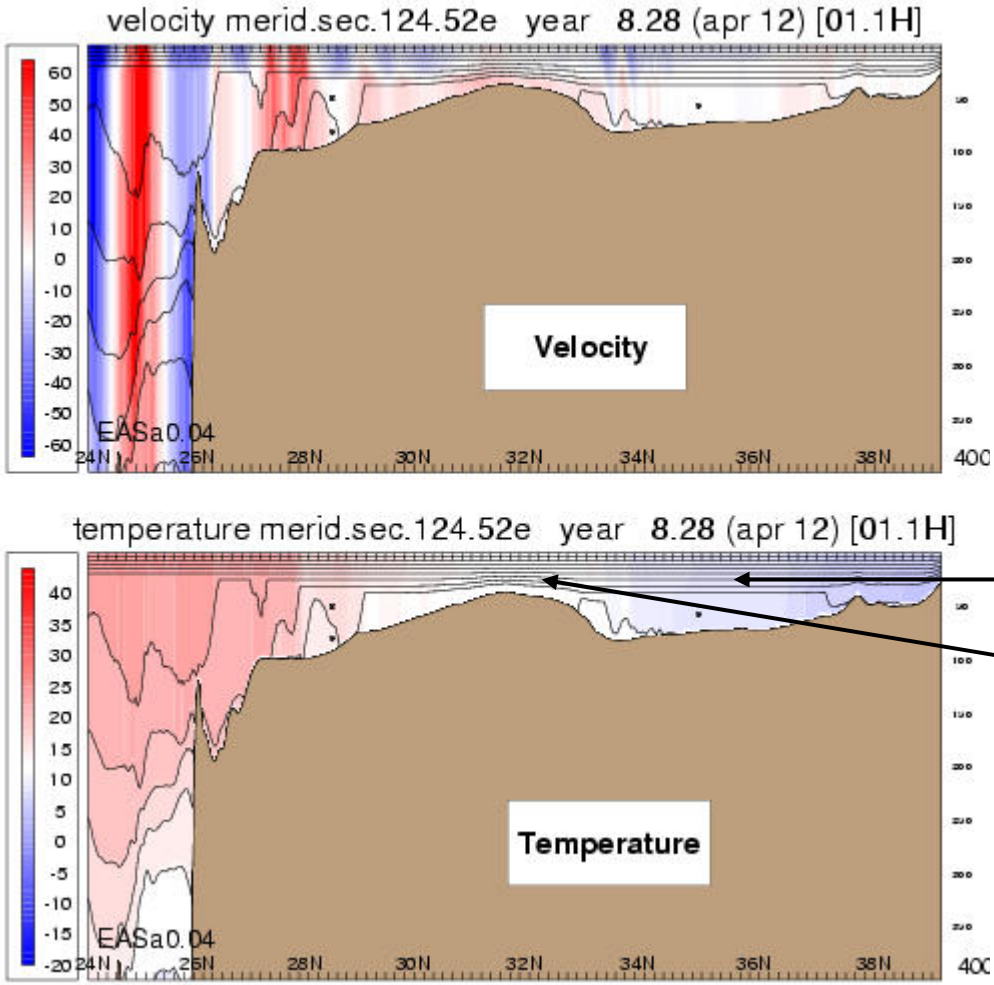
Snapshot on Oct. 14

1/25° HYCOM East Asian Seas Model
(nested inside 1/6° North Pacific Model

North-south cross-section along 124.5°E

red=eastward flow

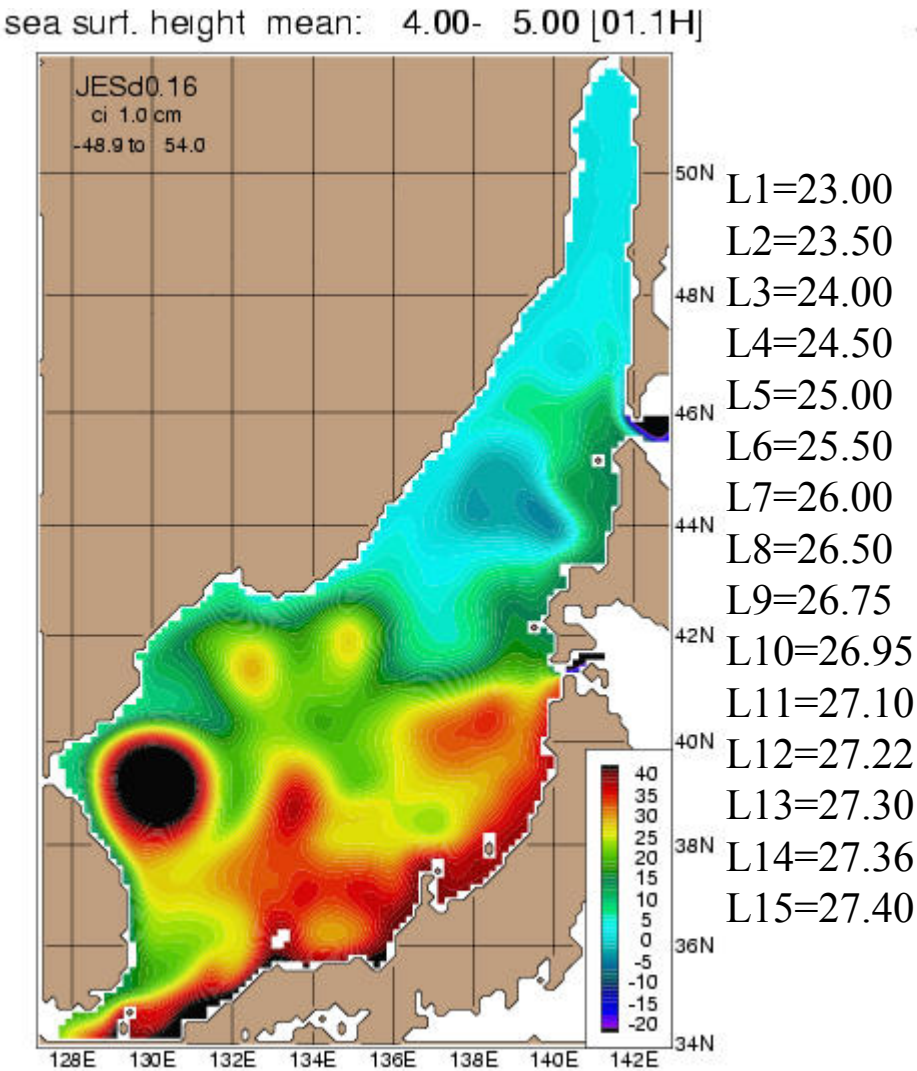
blue=westward flow



z-levels and sigmas over shelf and in mixed layer

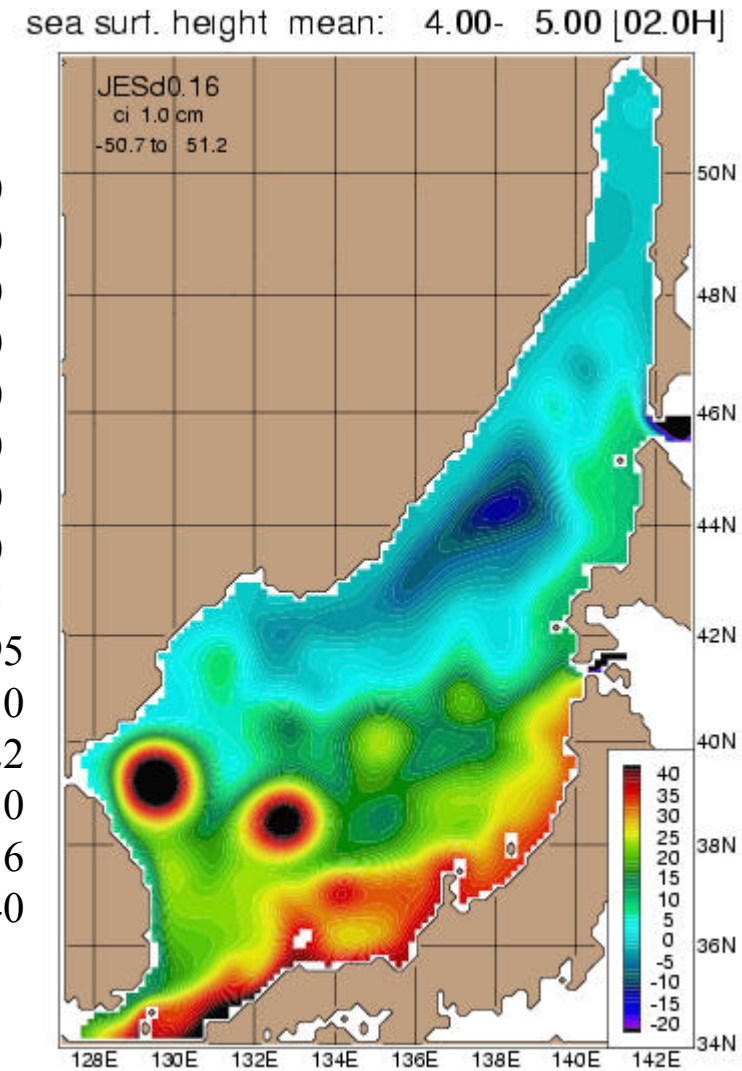
Snapshot on Apr. 12

1/8°, 15 layer



L1=23.00
L2=23.50
L3=24.00
L4=24.50
L5=25.00
L6=25.50
L7=26.00
L8=26.50
L9=26.75
L10=26.95
L11=27.10
L12=27.22
L13=27.30
L14=27.36
L15=27.40

1/8°, 20 layer



L1=17.0
L2=19.75
L3=20.75
L4=21.75
L5=22.50
L6=23.25
L7=24.00
L8=24.70
L9=25.28
L10=25.77
L11=26.18
L12=26.52
L13=26.80
L14=27.03
L15=27.22
L16=27.38
L17=27.52
L18=27.64
L19=27.74
L20=27.82

Future Plans for JES/EAS Modeling

1/32° Japan/East Sea (ONR JES DRI)

- Branching of Tsushima Warm Current
- Nearshore Branch Dynamics
- Water mass formation (ESIW)
- Model-data comparisons
- Impact Vertical coordinate configuration

1/32° East Asian Seas (LINKS)

- Ability of HYCOM to robustly simulate shelf (Yellow Sea) and deep (JES) environment
- Branching of Tsushima Warm Current from the Kuroshio (where, how, etc.)
- Interaction of coastal and large-scale currents