Dynamical downscaling from the basin scale to submesoscale with a triply nested ocean model

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Introduction

Kuroshio-Oyashio Current System

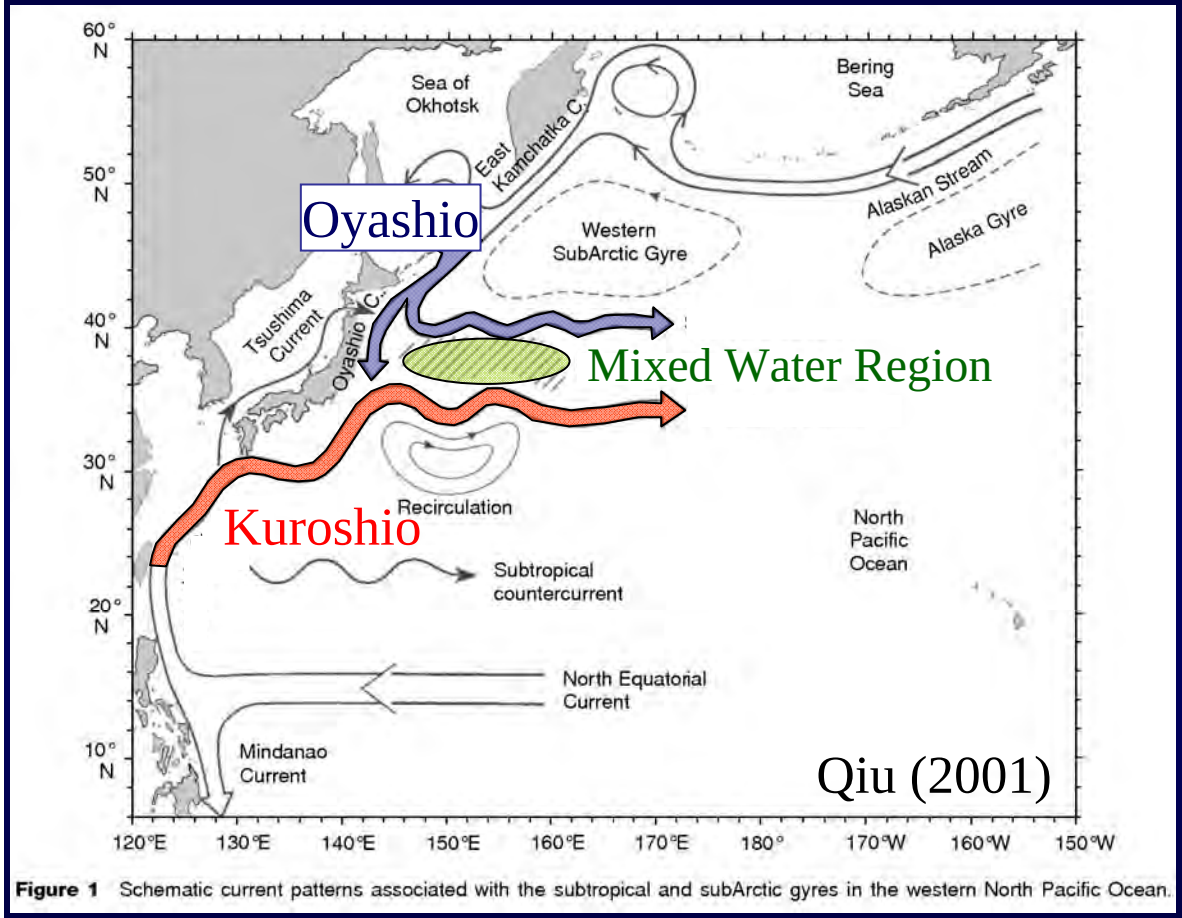


Figure 1 Schematic current patterns associated with the subtropical and subArctic gyres in the western North Pacific Ocean.

coastal waters around Japan

Narrow continental shelf

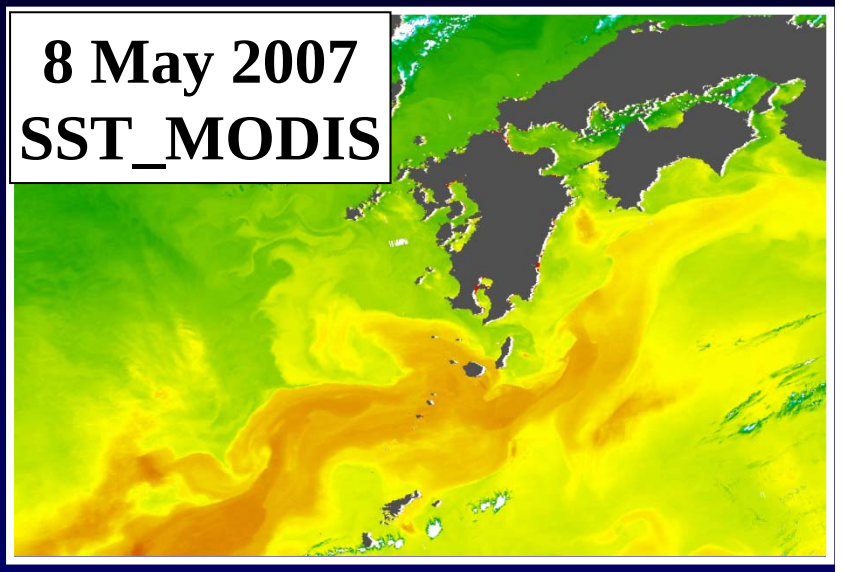
≥50km

direct impact

Kuroshio/Oyashio current & water

Introduction

Submesoscale variability
e.g., the Kuroshio frontal disturbances



http://kuroshio.eorc.jaxa.jp/ADEOS/mod_nrt/index.html

Effects of warm water spreading
due to the frontal disturbances
- coastal-offshore water exchange
- coastal-offshore transport/exchange of fish larvae/juvenile

→ e.g., recruitment (jack mackerel, white-spotted-conger…),
fishing-ground formation (sardine, anchovy,…), …

Numerical modeling approach
for studying each process, mechanism,
year-to-year variability, response to climate change, …

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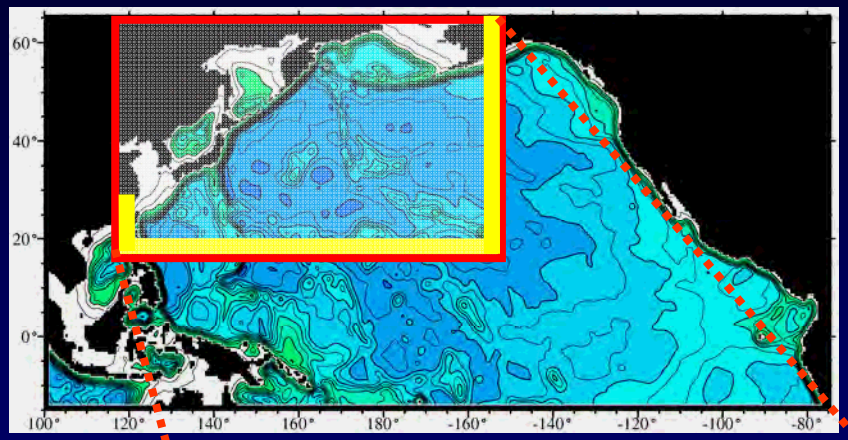
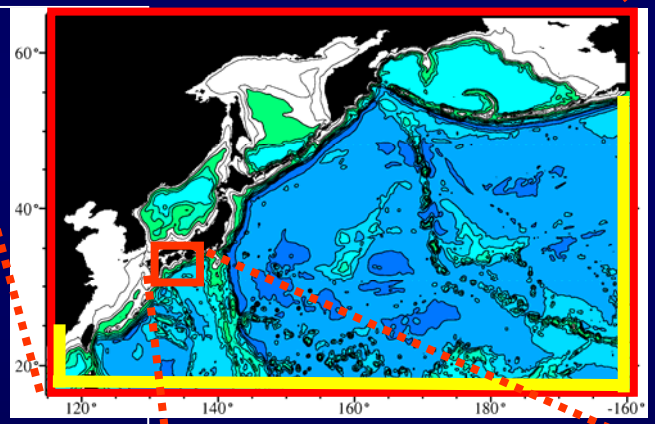
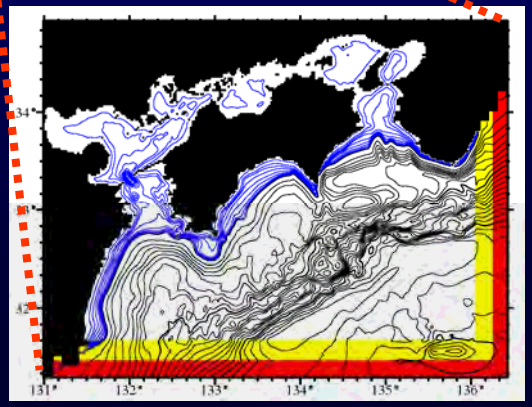
Dynamical downscaling system

one-way
nesting system







ROMS
Regional
Ocean
Modeling
System

External forcings;
Climatological Run
(monthly mean: JRA25)

1/2 degree
Basin-scale
(O(10^3) km)

1/10 degree
Mesoscale
(O(10^2) km)

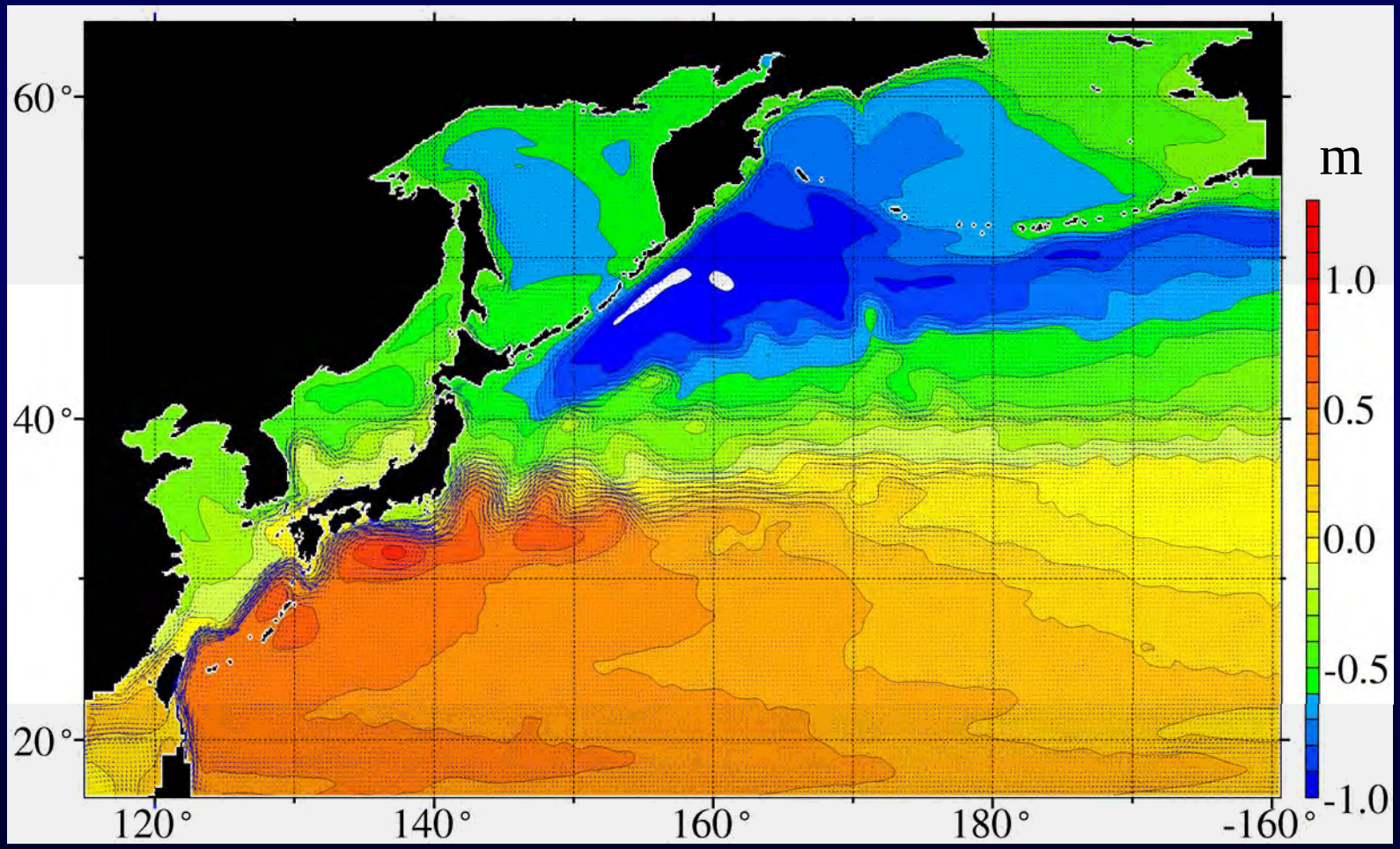
1/50 degree
Submesoscale
(O(10^1) km)

Basic Part

Exchangeable part

1/10-degree model for the Kuroshio/Oyashio system

4-year mean sea surface height
(a spinup experiment under monthly climatological forcings)
from 15th to 18th year



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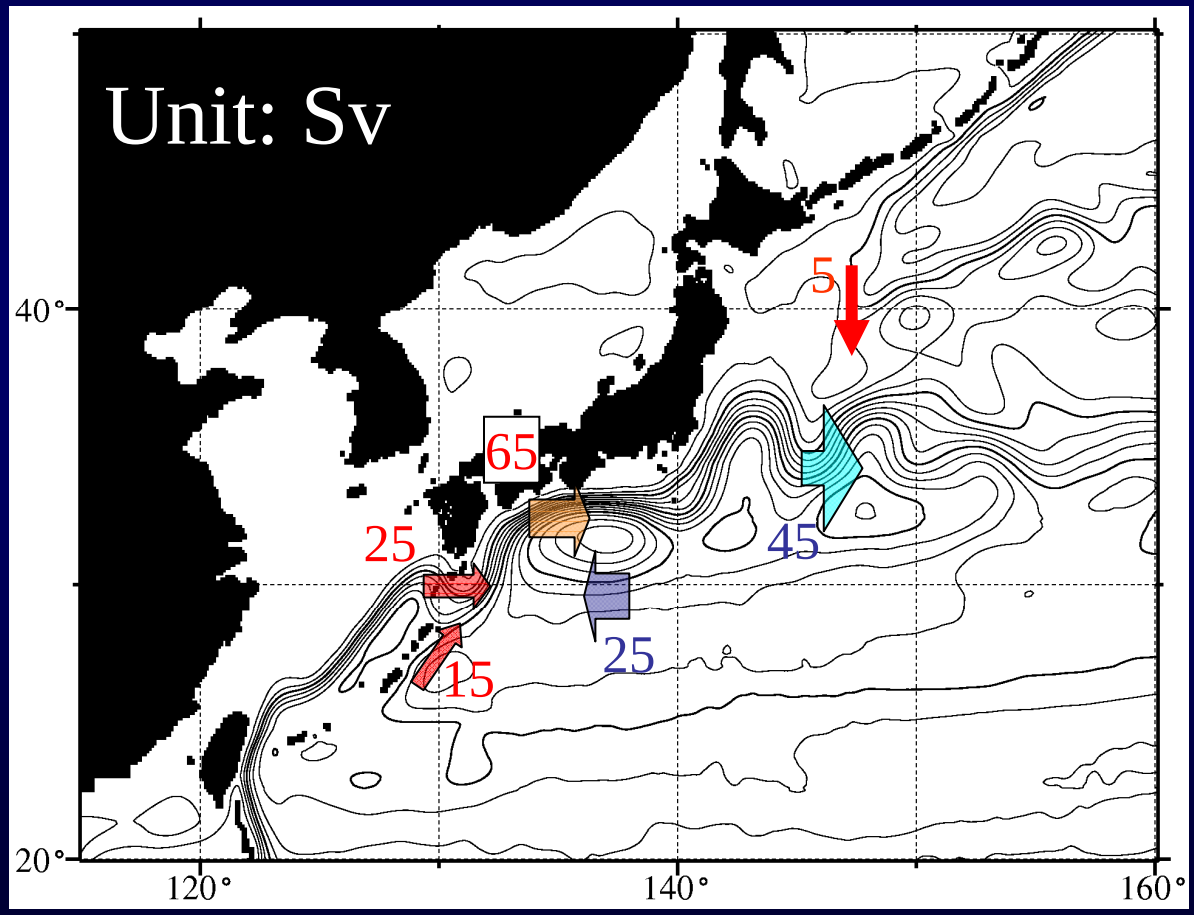
1/10-degree model for the Kuroshio/Oyashio system

4-year mean volume transport (0-1000m)
from 15th to 18th year
(a spinup experiment under climatological monthly forcings)



contour interval: 5Sv

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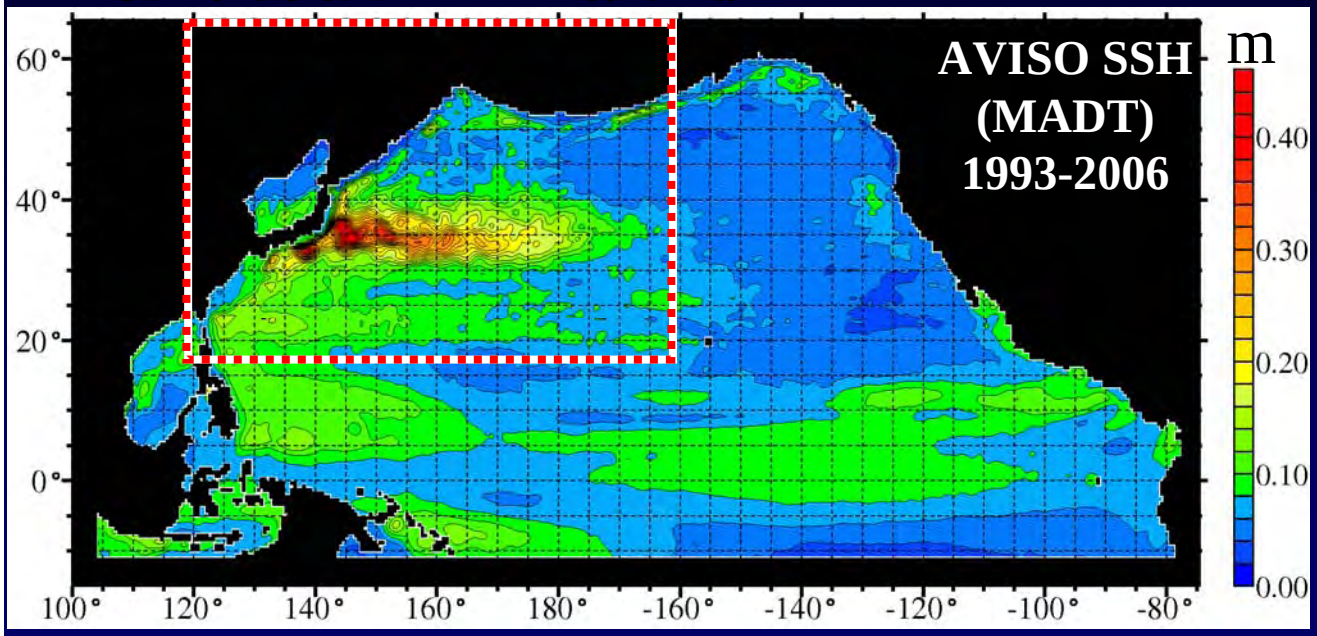
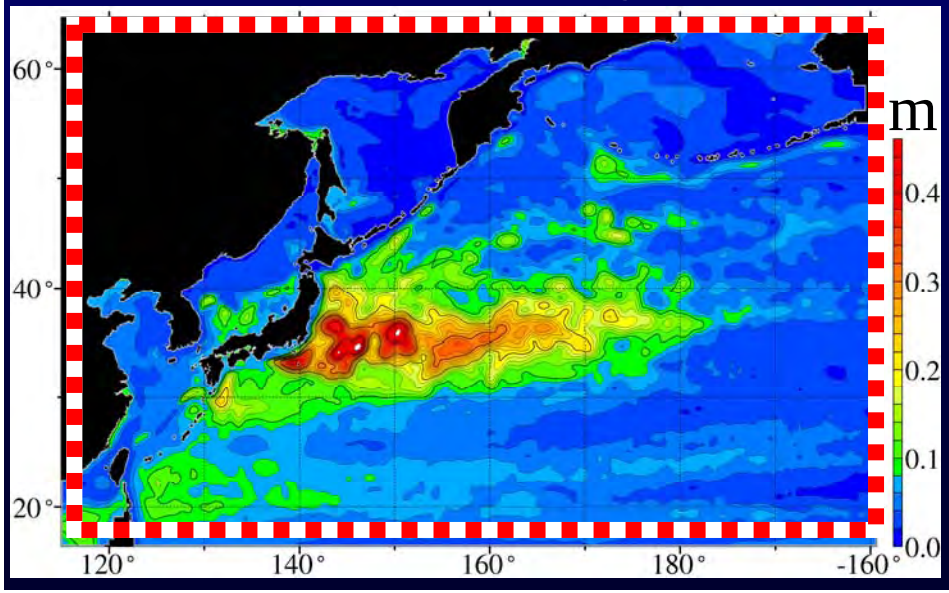
1/10-degree model for the Kuroshio/Oyashio system



MODEL (15th to 18th year under climatological monthly forcings)



SSH standard deviation
from monthly mean value

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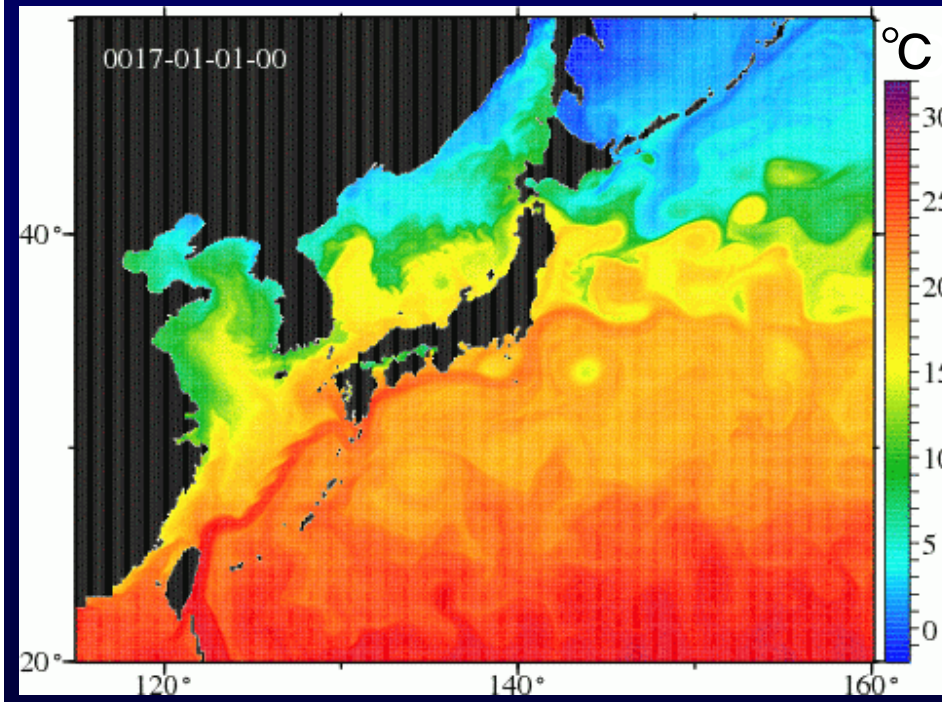
1/10-degree model for the Kuroshio/Oyashio system

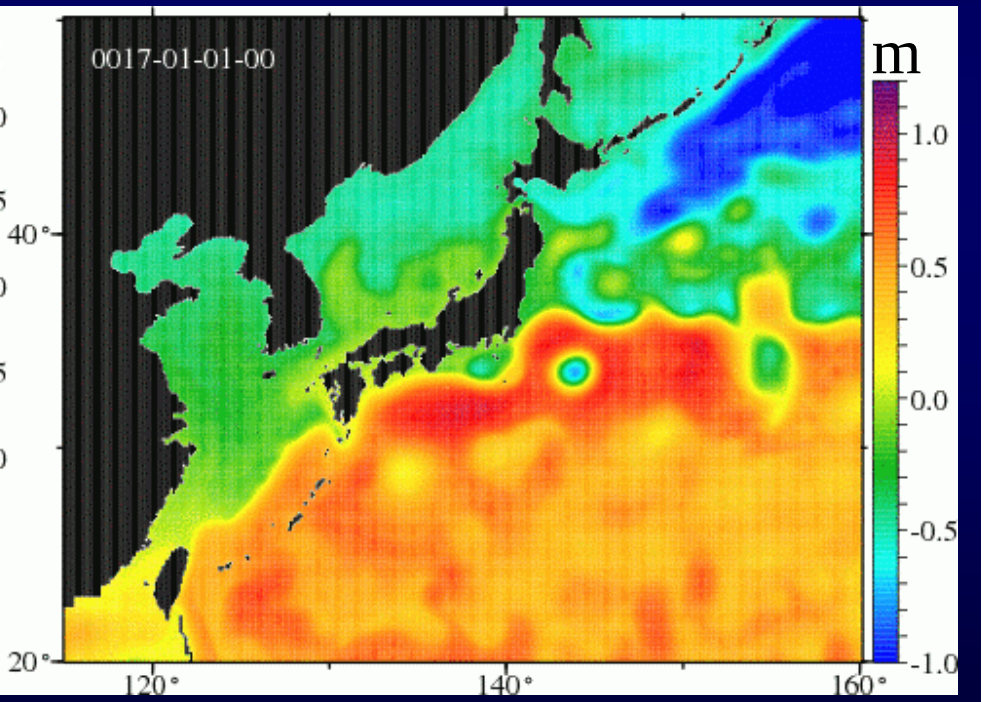
Animation in the 17th year

(a spin-up experiment under climatological monthly forcings)

Sea Surface Temperature



Sea Surface Height



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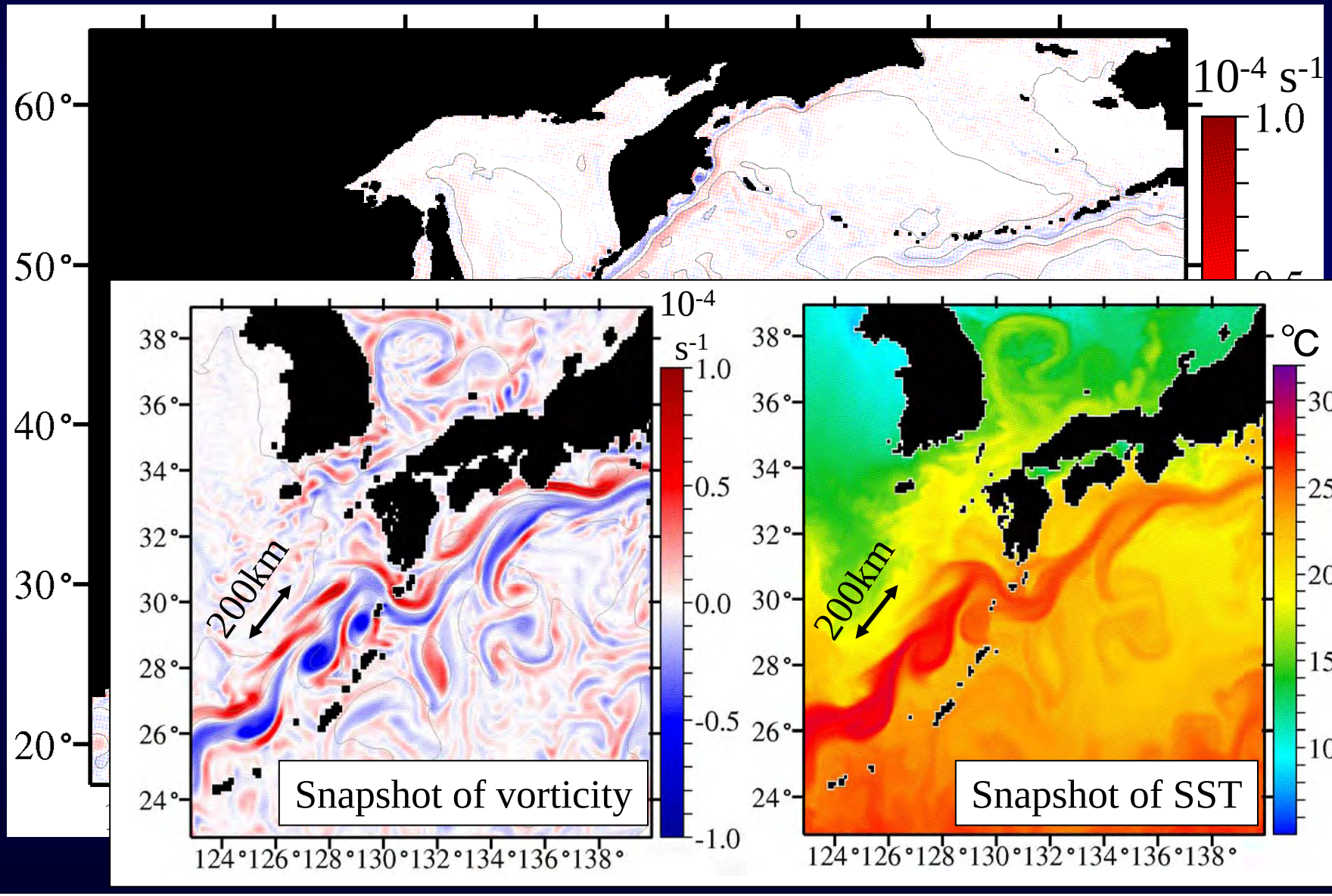
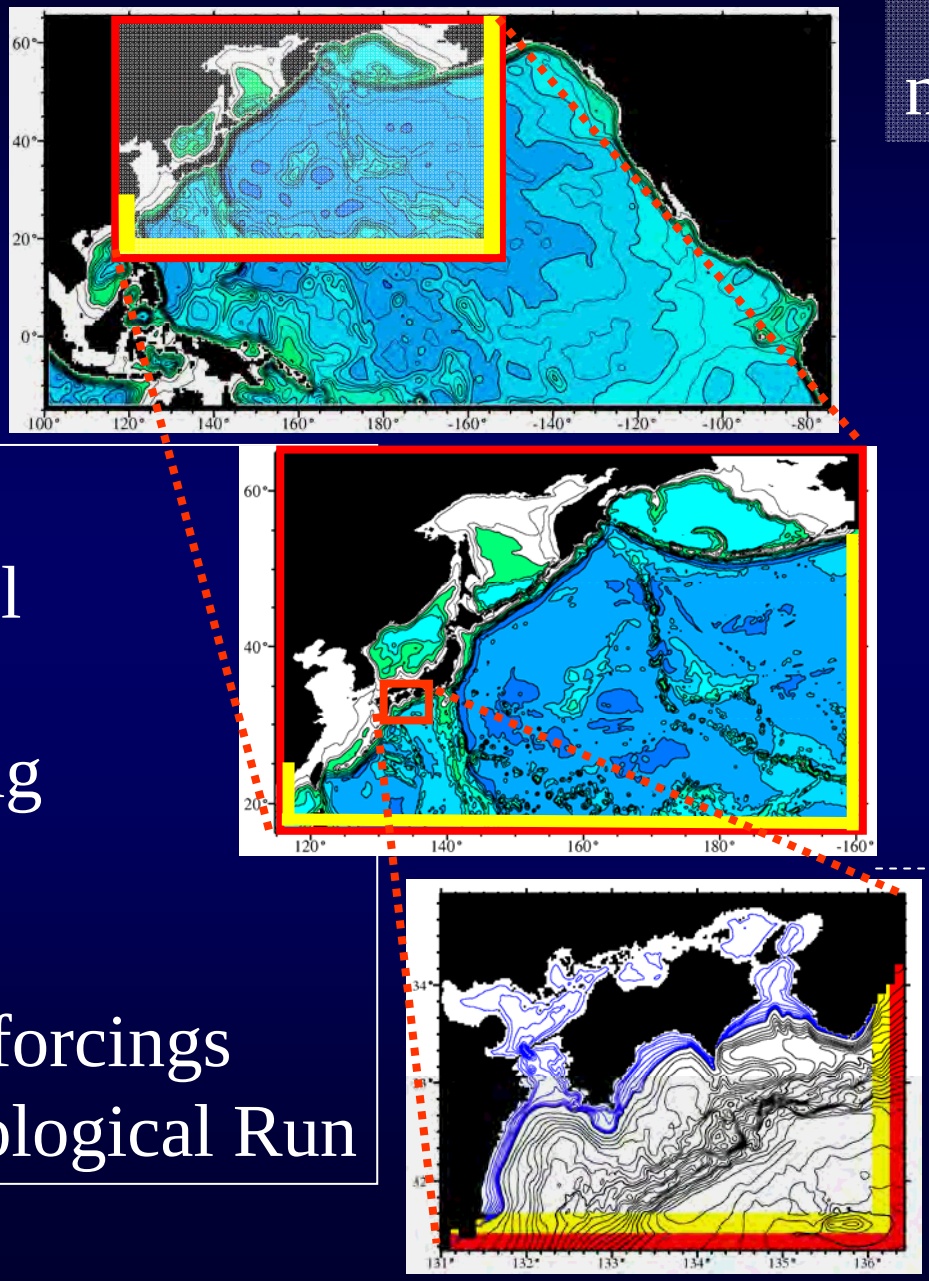
1/10-degree model for the Kuroshio/Oyashio system

Snapshot of simulated vorticity at the sea surface (1 May in the 17th year)



Dynamical downscaling system

one-way
nesting system



ROMS
Regional
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System

External forcings
- Climatological Run

1/2 degree
Basin-scale
($O(10^3)$ km)

1/10 degree
Mesoscale
($O(10^2)$ km)

1/50 degree
Submesoscale
($O(10^1)$ km)

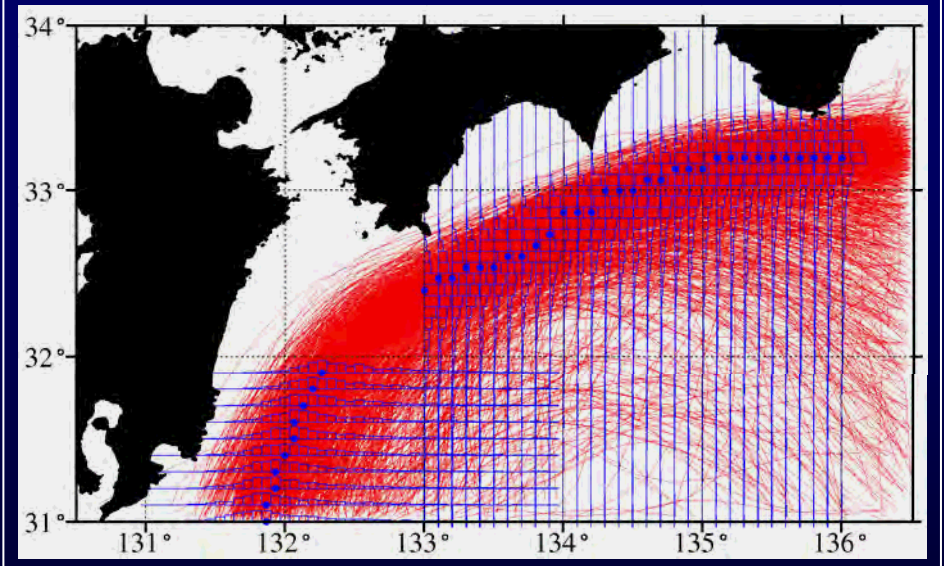
Basic Part

Relatively easily
exchangeable

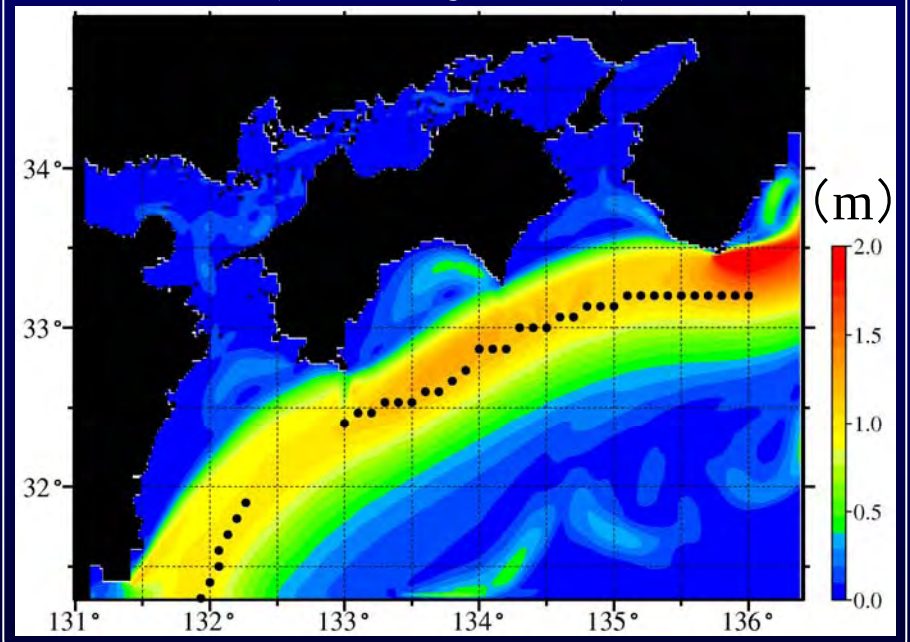
1/50-degree model for the submesoscale

A month
when the modeled Kuroshio takes a nearshore and stable path

DATA: Kuroshio-axis position
Red: years of 1967～2008
Blue closed circle: mode position



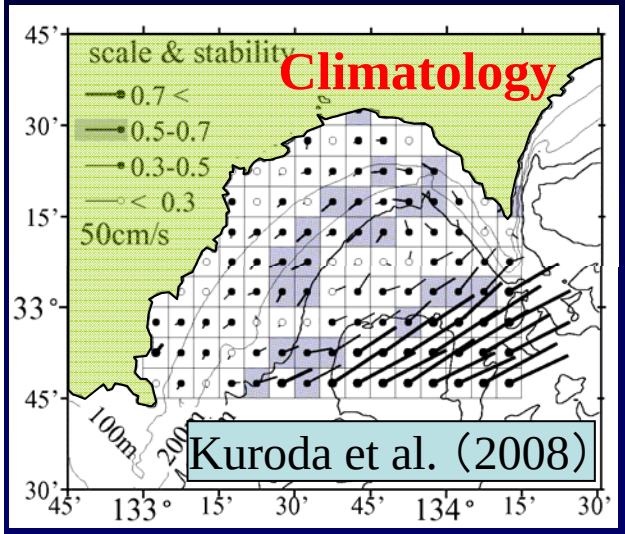
MODEL: surface velocity
(monthly mean)



May of 18th year in a spinup experiment

1/50-degree model for the submesoscale

OBSERAVTION I



OBSERAVTION II

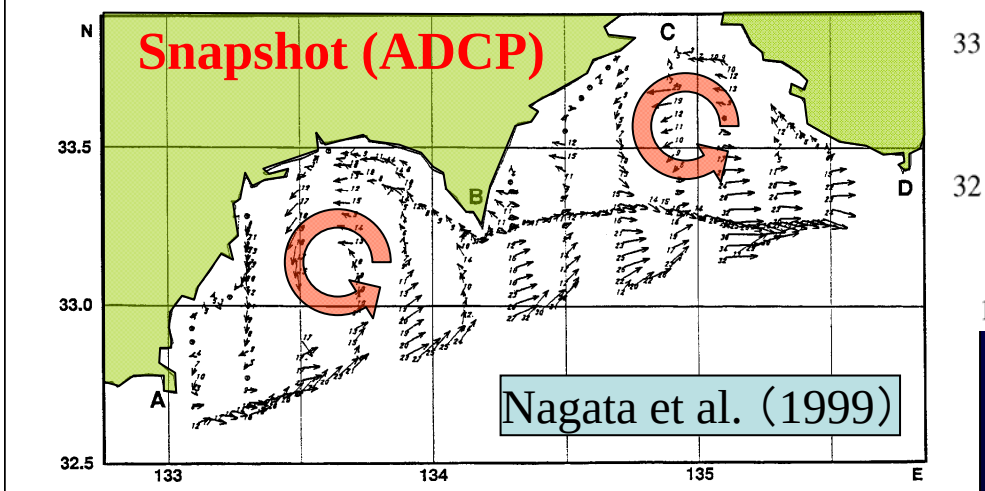
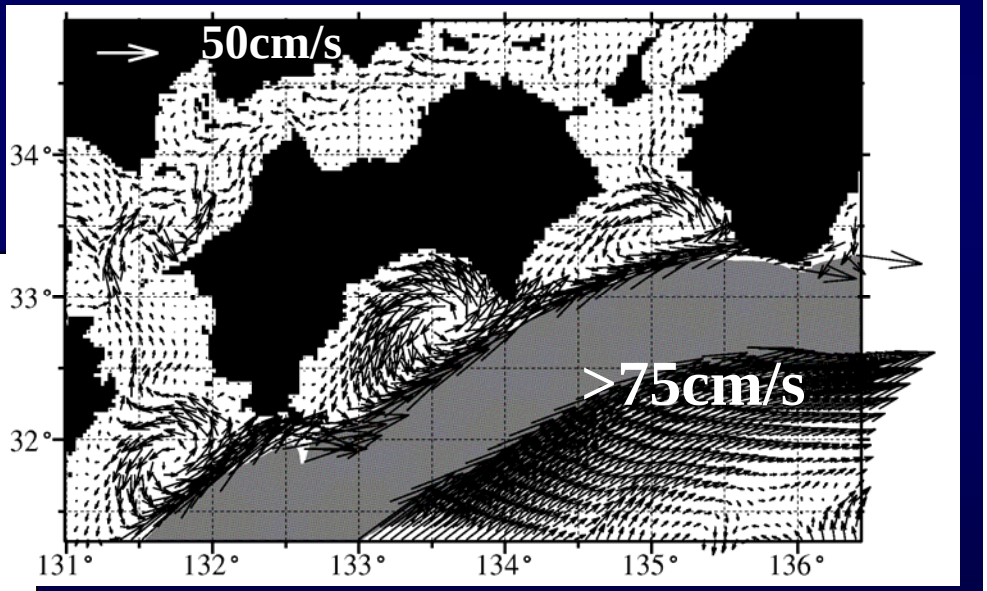


Fig. 10. Current distribution in Tosa Bay and near the Kii Channel at the depth of 10 m on Aug. 20–22, 1997 measured by ADCP. Numerals attached to arrows indicate current speed in 0.1 knots. A: Cape Ashizuri, B: Cape Muroto, C: Kii Channel and D: Cape Shionomisaki (courtesy of the 5th Maritime Safety Headquarters).

Sea Surface Current

MODEL
（monthly mean）



May of 18th year in a spinup experiment

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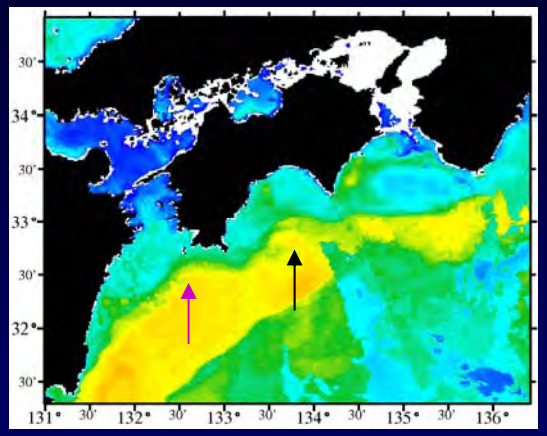
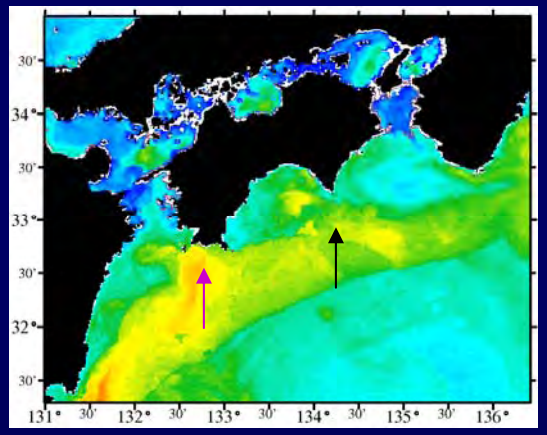
Satellite SST

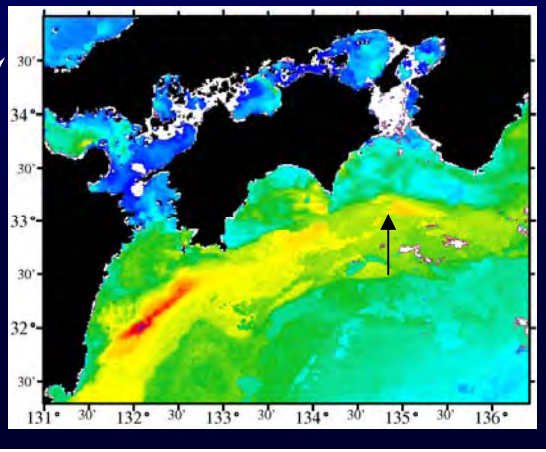
8 May 2009



9 May 2009

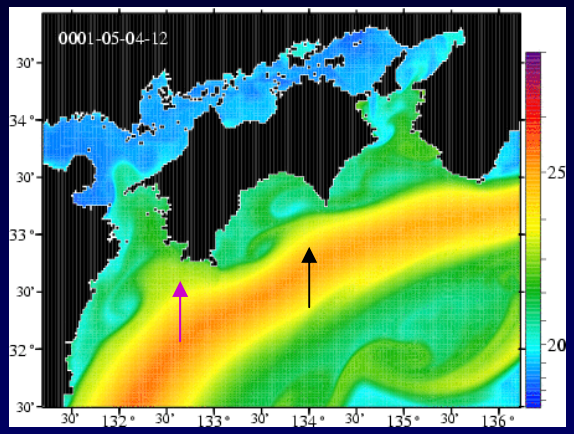


10 May 2009

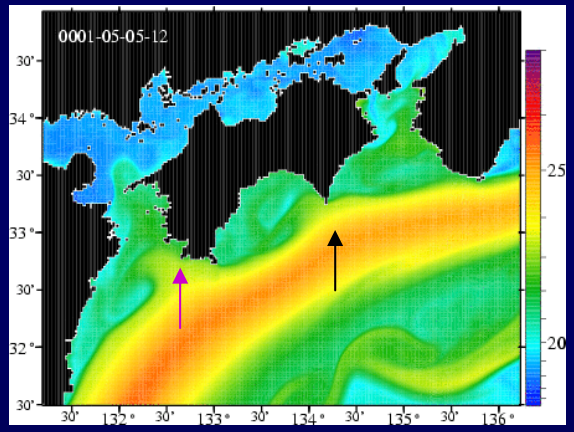


Modeled SST

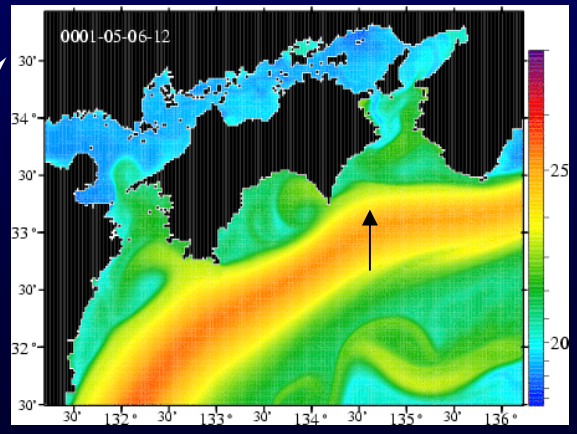
4 May 18th year



5 May 18th year

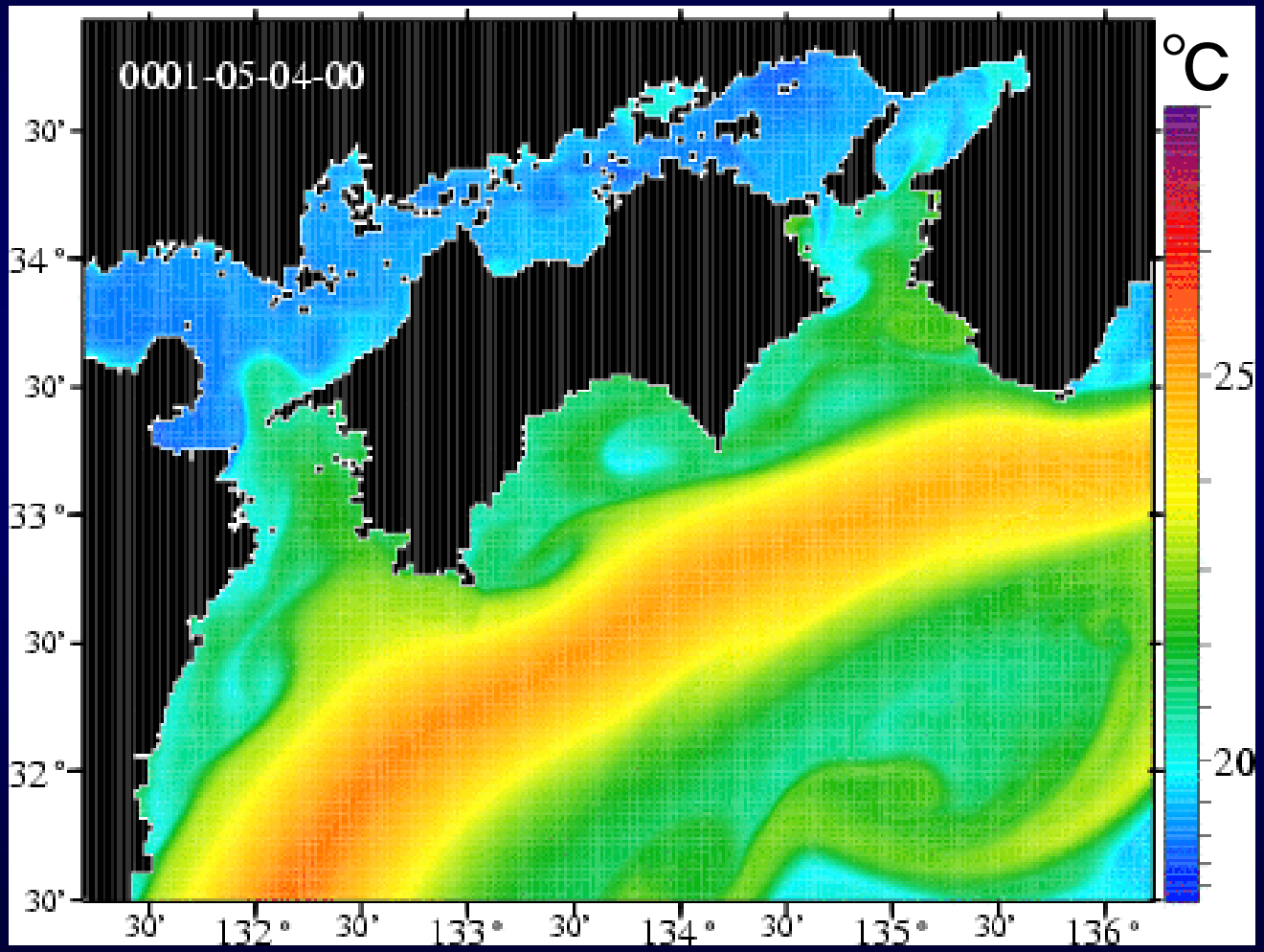


6 May 18th year



1/50-degree model for the submesoscale

Sea Surface Temperature



May in the 18th year

Key words

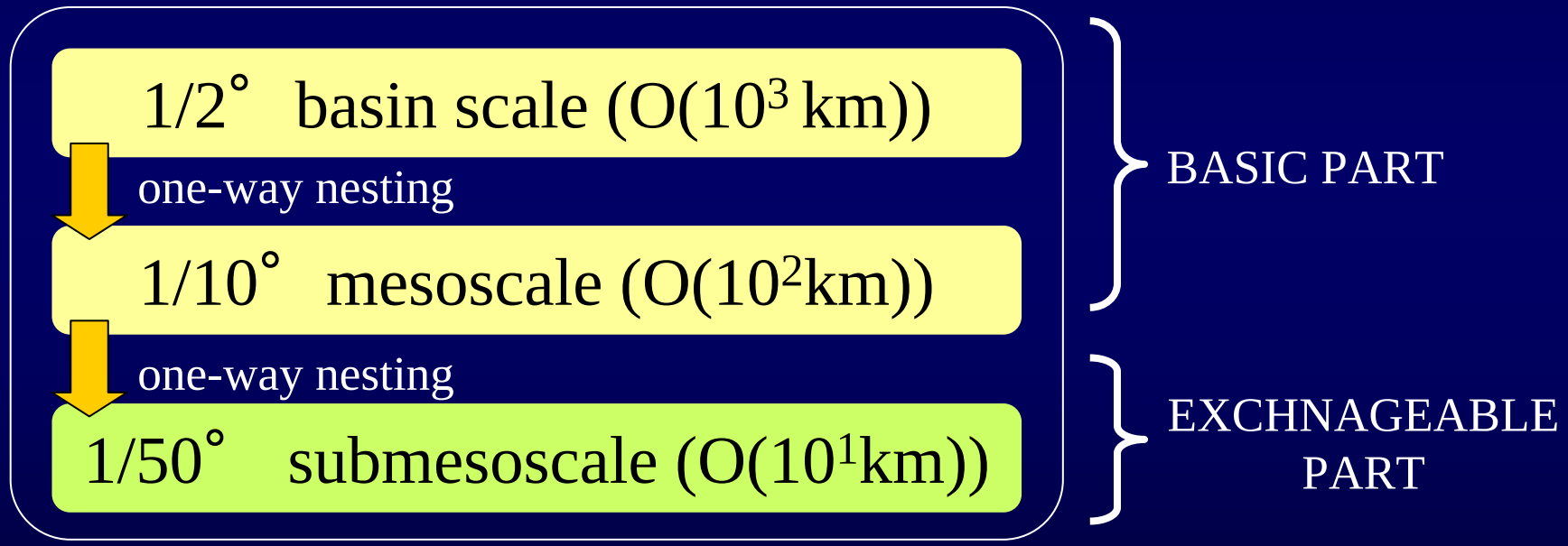
cyclonic circulation

frontal wave

warm water spreading

Summary

Dynamical downscaling system from basin scale to submesoscale has been developed for fisheries science.



Future work

Now, this system can be implemented by the climatological or historical forcings. When the forcings are replaced with those under the global warming state, this system is expected to evaluate downscaled effects on coastal waters around Japan.

The basic part of this system (1/2 & 1/10-degrree models) is coupled with a lower trophic ecosystem model by Ito and Kameda.

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Thank you for your attention.
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