Estimated migration of scallop larvae in Funka Bay by using streamline visualization

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Our motivation

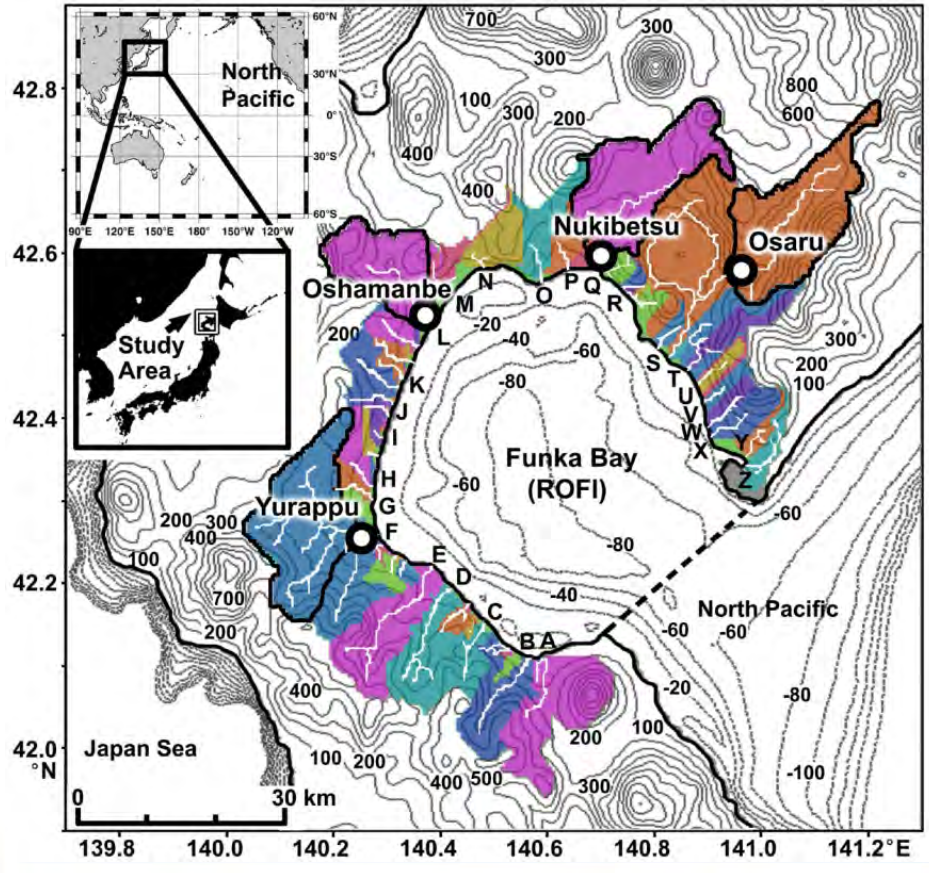
- Aquaculture currently contributes about 48% of aquatic animal food destined for human consumption [*Bondad-Reantaso et al.*, 2011]
- Migration of scallop larvae released from aquafarm should contribute to the yearly fishery production. If such information can be informed to fishers, the harvesting efficiency will be improved.
- We propose a new method for the daily migration of the scallop larvae by using streamline visualization based on the big datasets from high-resolution land-ocean coupled model in Funka Bay



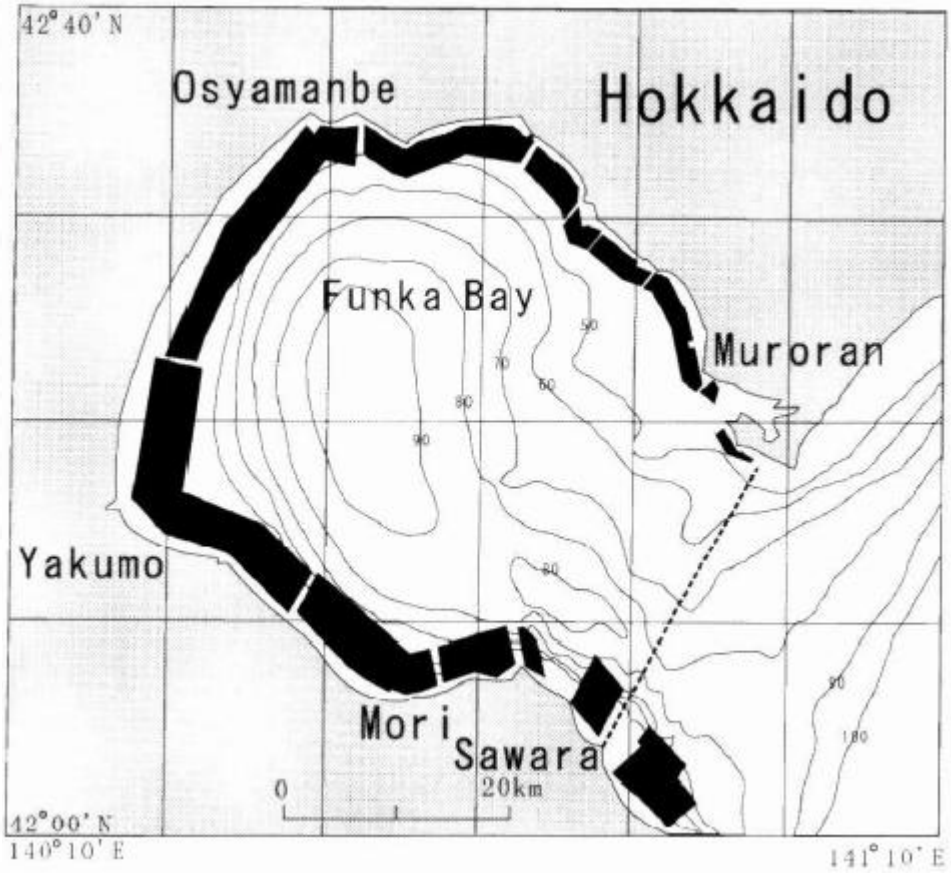
Funka Bay for scallop aquaculture

The Japanese scallop is cultivated along the coastal region (e.g. Funka Bay, total area 212.2 km^2; 10%), representing an important fishery resource in Japan (share 25-50%).

Geography and Watershed

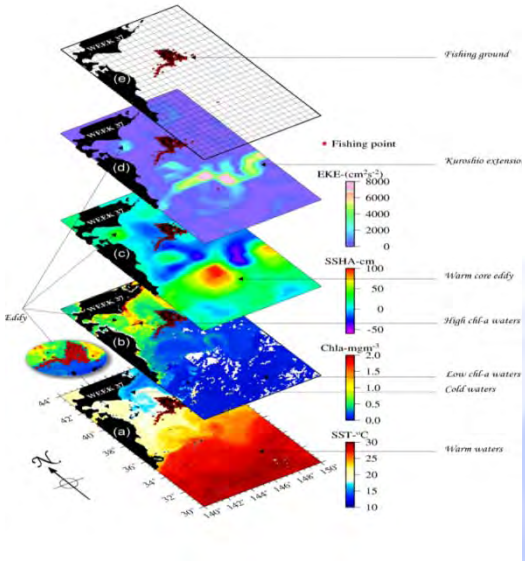


Aquafarm for scallop in Funka Bay



Challenge (problem) is …

High-end simulated results



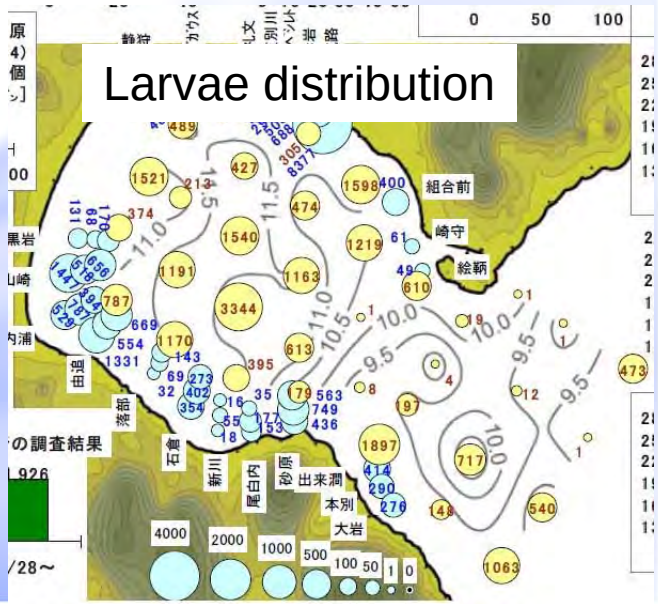
transmit

Stakeholders

?

feedback

We have to develop something to be compared with observation



LAND-OCEAN COUPLED SIMULATION SYSTEM

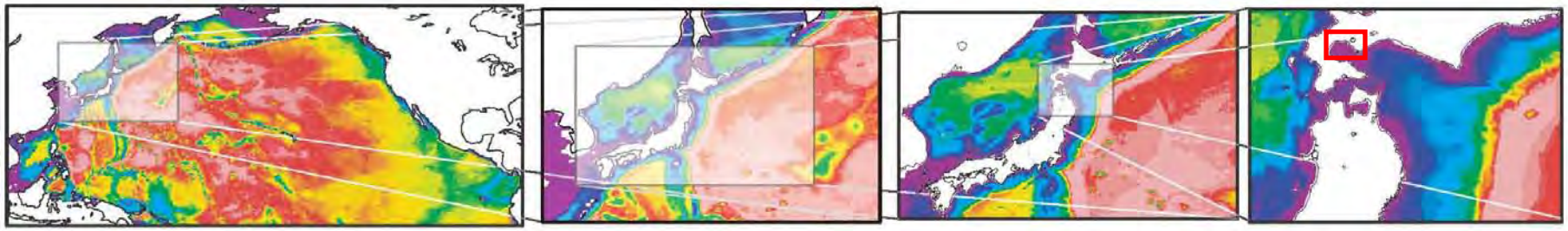
Nesting approach for high-resolution prediction

Nest0
Norh Pacific
climatological model

Nest1
Norhwestern Pacific
DA model

Nest2
Around Japan
Adjacent sea model

Nest3
Hokkaido-Tohoku
Coastal model



1/6 degree x 1/8 degree
Climatological surface flux

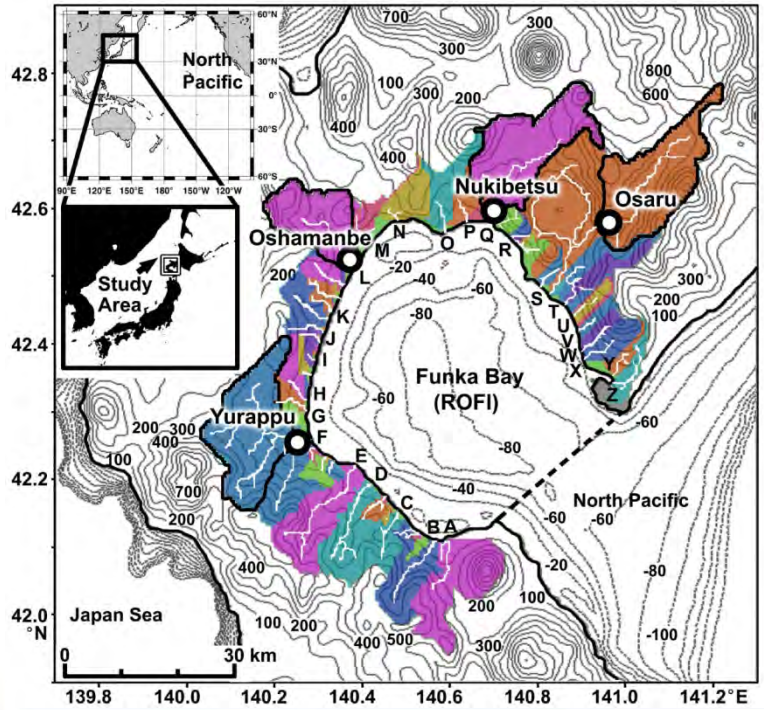
1/6 degree x 1/8 degree
(longitude) (latitude)
4D-Var

1/18 degree x 1/24 degree
(longitude) (latitude)

1/72 degree x 1/54 degree
(longitude) (latitude)
(1.55 km x 1.55 km grid size)

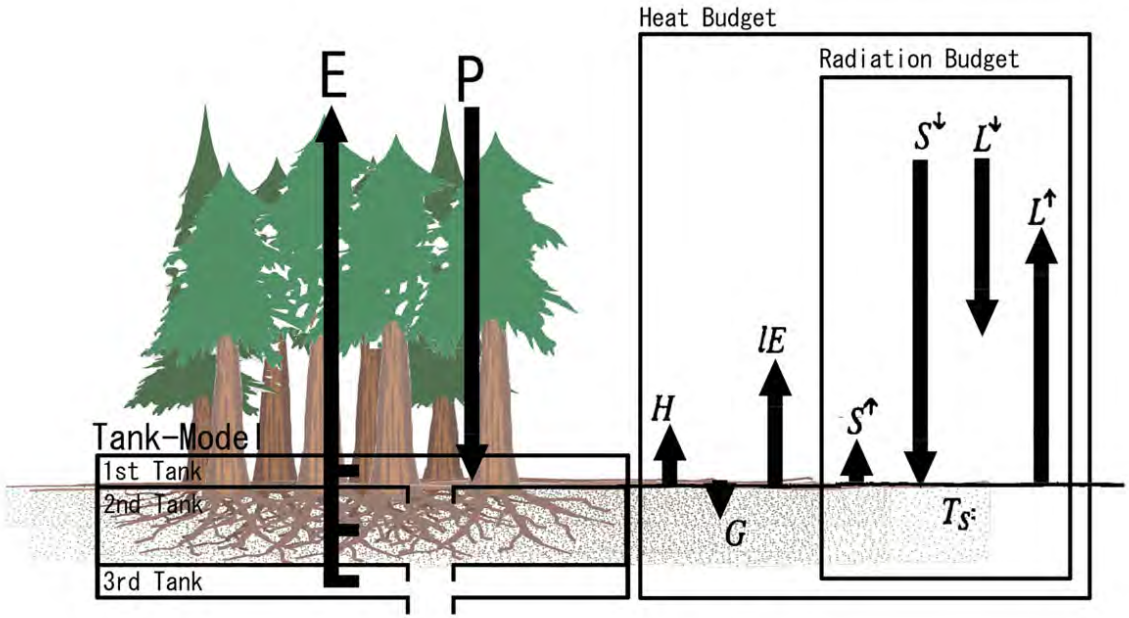
lateral open boundary
&
initial
conditions

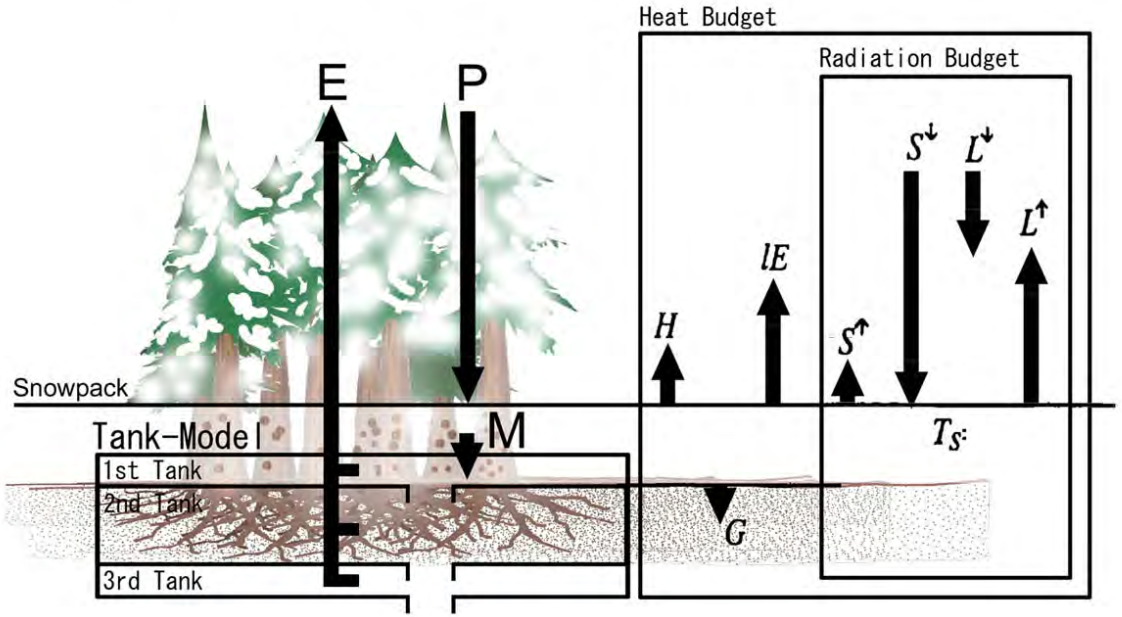
lateral open boundary
condition

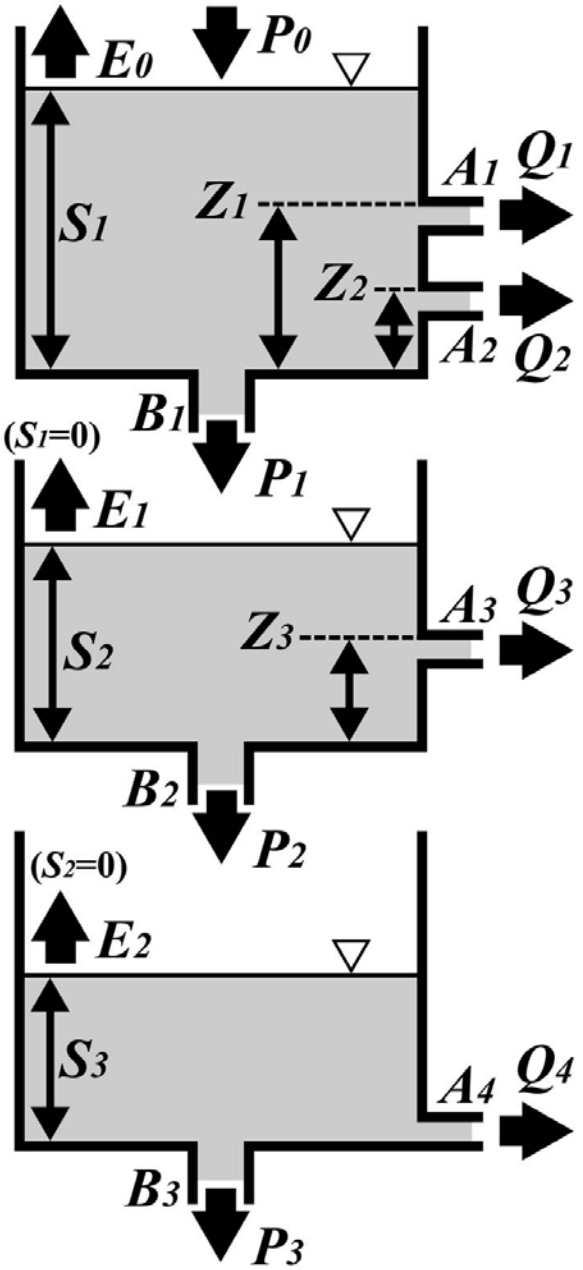


← Locally coupled with OGCM and hydrological models (HaRUM, nakada et al., 2012) around Funka Bay

Physics of Hydrometeological and Runoff Utility Model (HaRUM)

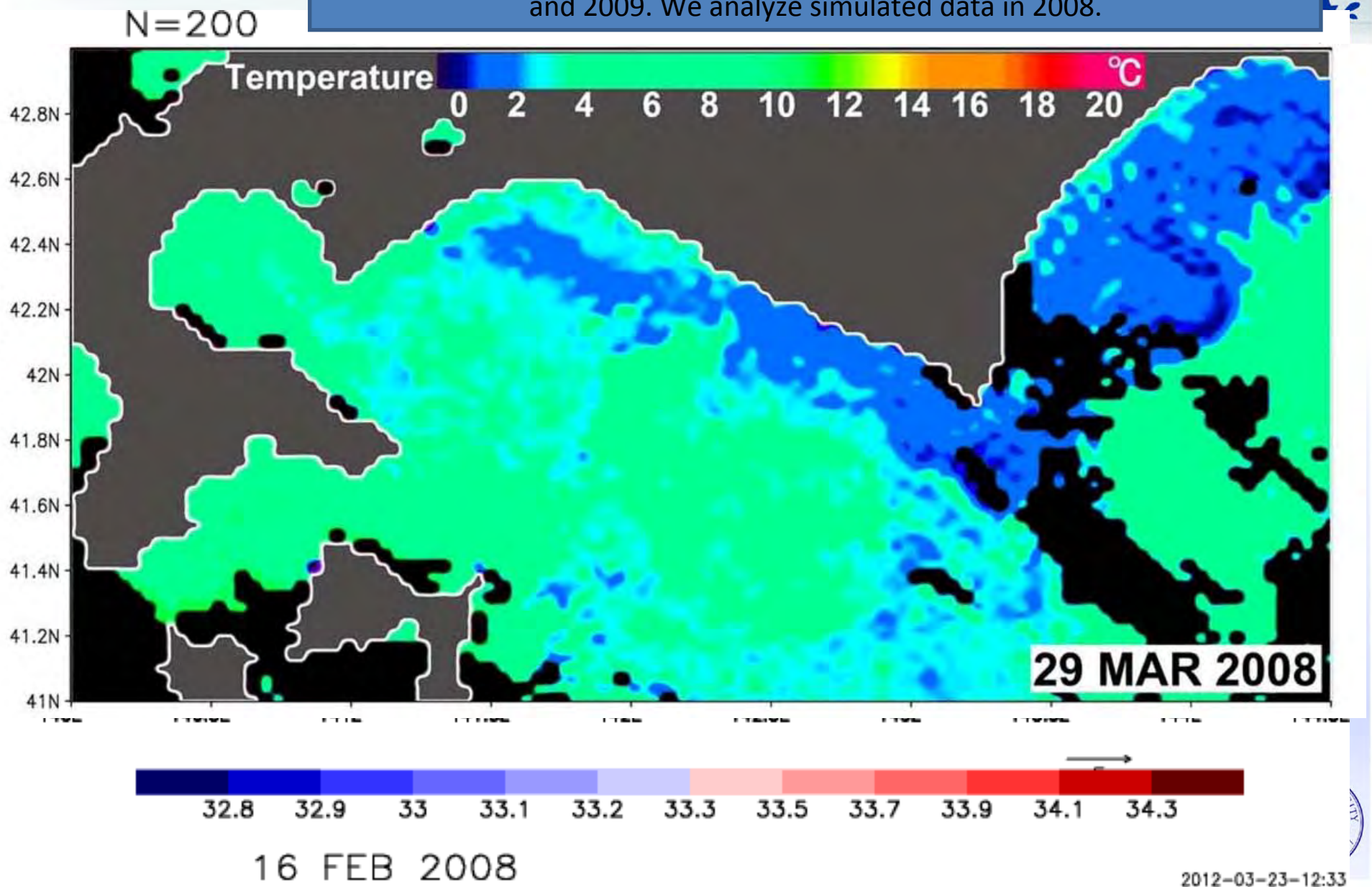






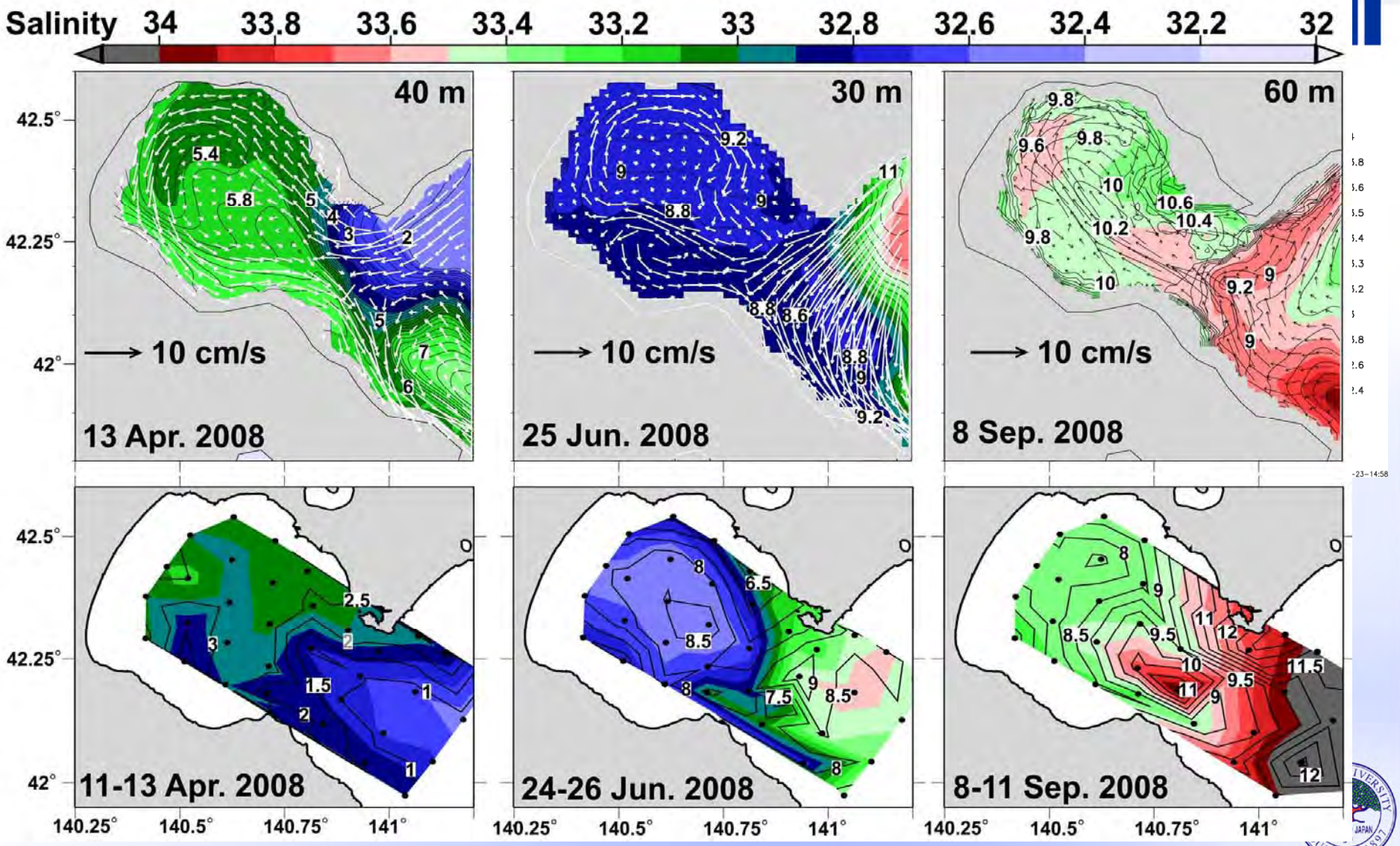
Results

Oyashio water inflow to Funka Bay was clearly observed in 2008, in contrast the inflow in 2009 was unclear, which led the decrease of kelp production in 2009. The our numerical results well reproduced the contrast between 2008 and 2009. We analyze simulated data in 2008.



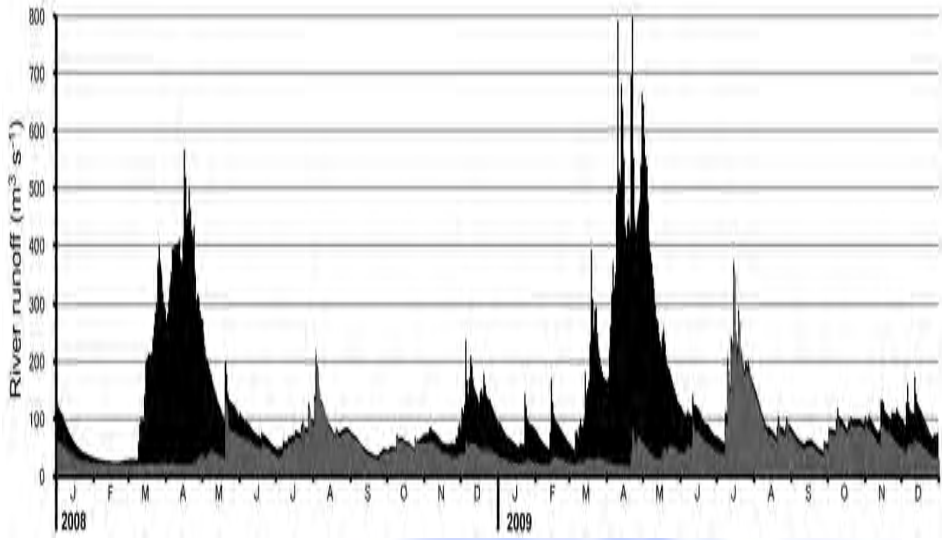
Simulated results of typical oceanographic phenomena around Funka Bay

Cold Oyashio Water　　Clockwise Circulation　　Tsugaru Warm Water

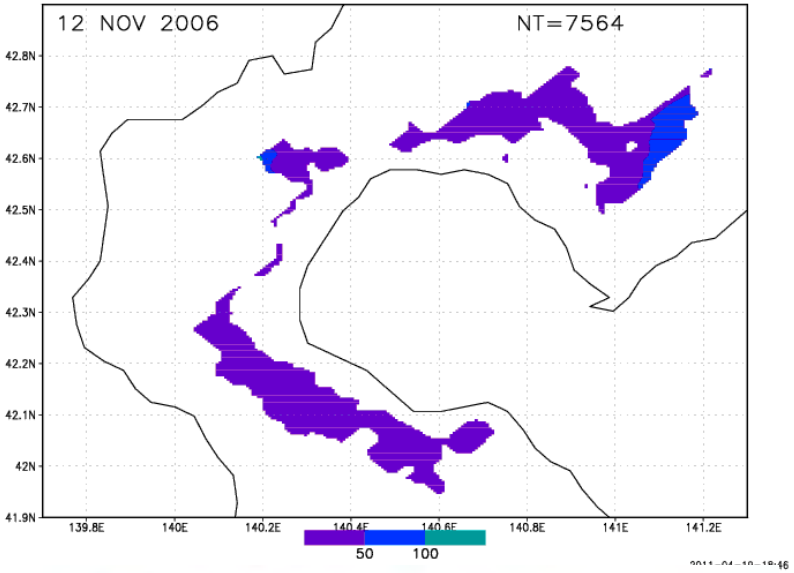


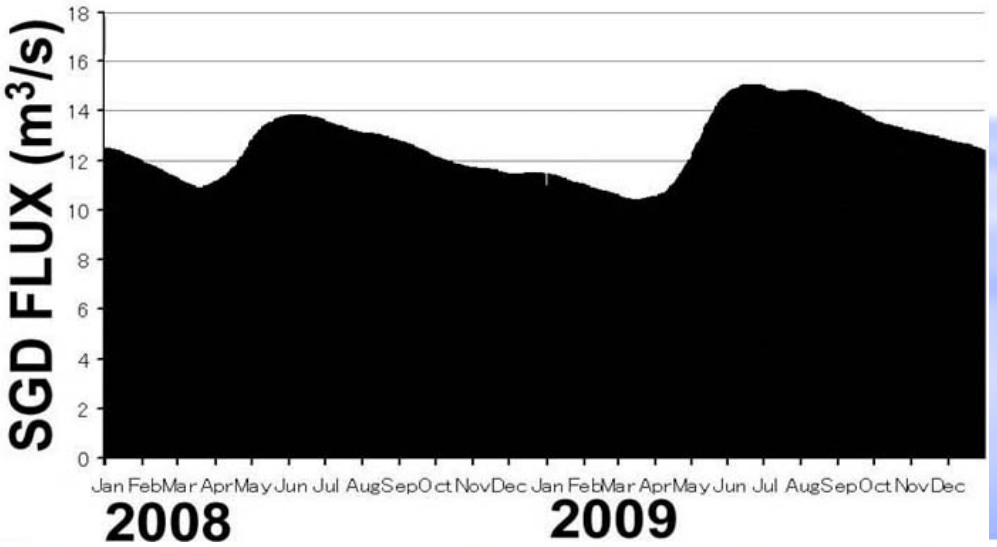
Runoff & Snow accumulation were well reproduced by the model

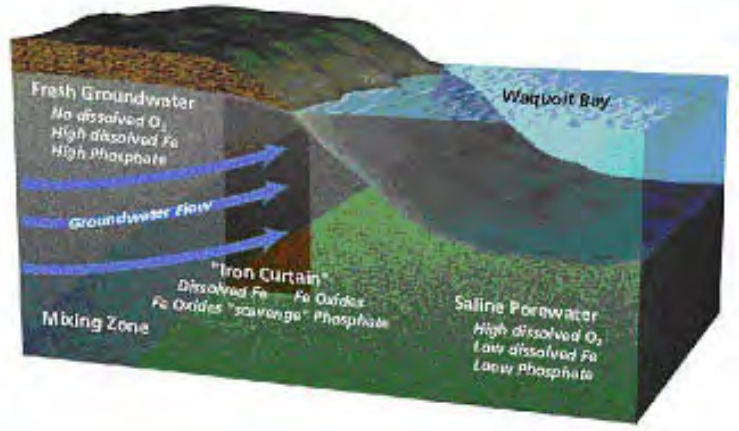
Good performance (Estimated Error < 3%, Cor. = 0.63-0.87)
Large amount of snowmelt runoff into the bay in spring (Mar. - May)



Snow Equivalent Water

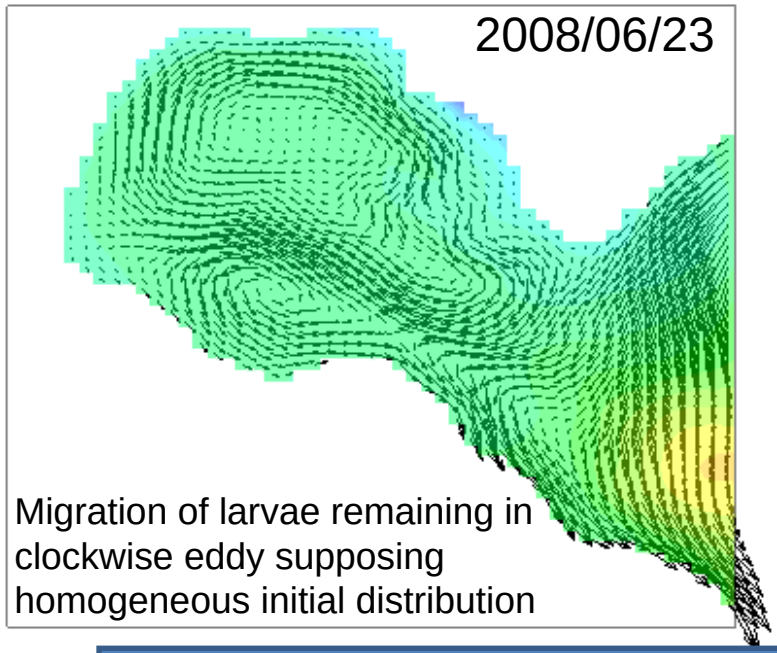




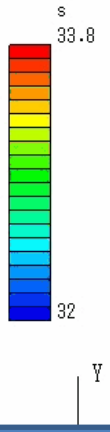


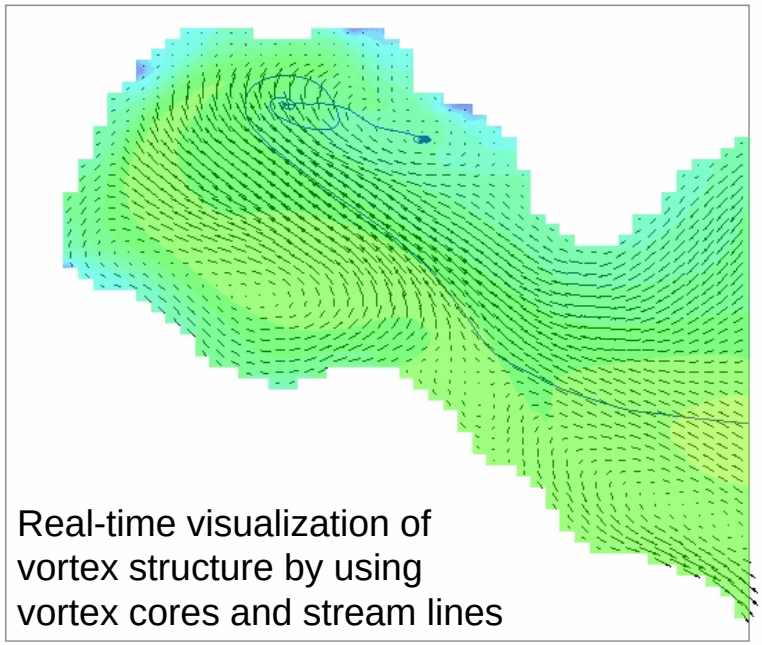
SIMULATION OF SCALLOP LARVAE TRANSPORT

A Real-time simulation of scallop larvae transport



Migration of larvae remaining in clockwise eddy supposing homogeneous initial distribution

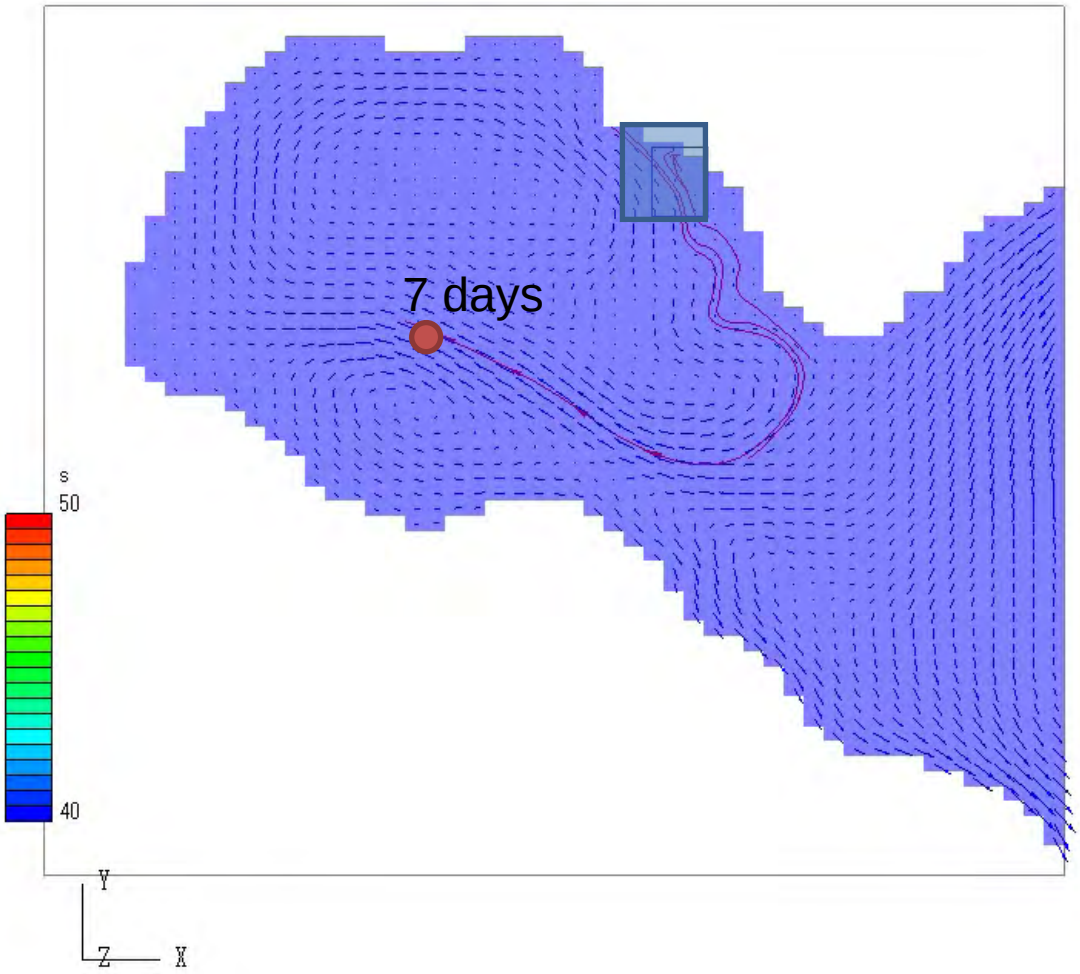


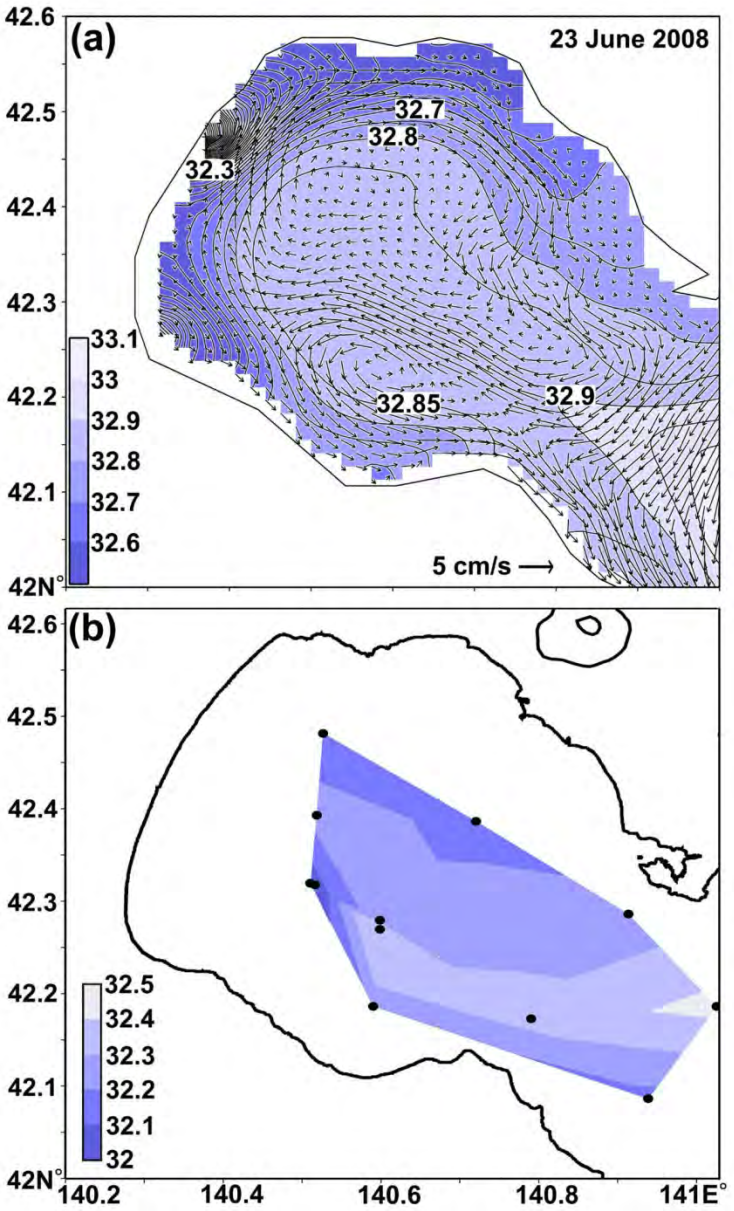


Real-time visualization of vortex structure by using vortex cores and stream lines

- This visualization can be used to gain instinctive understanding for spatial structures of eddies, its transport processes of larvae and nutrients, and its residence time.
- To directly and easily transmit information o fishers, real-time prediction and visualization can be conducted by using daily ocean prediction datasets.
- This application can be conducted on daily basis.
- To get more realistic model results, the core system can be developed by including the observation of larvae distribution and nutrients from ecosystem model.

A results of a trajectory over 7 days under the clockwise eddy in 23 June 2008





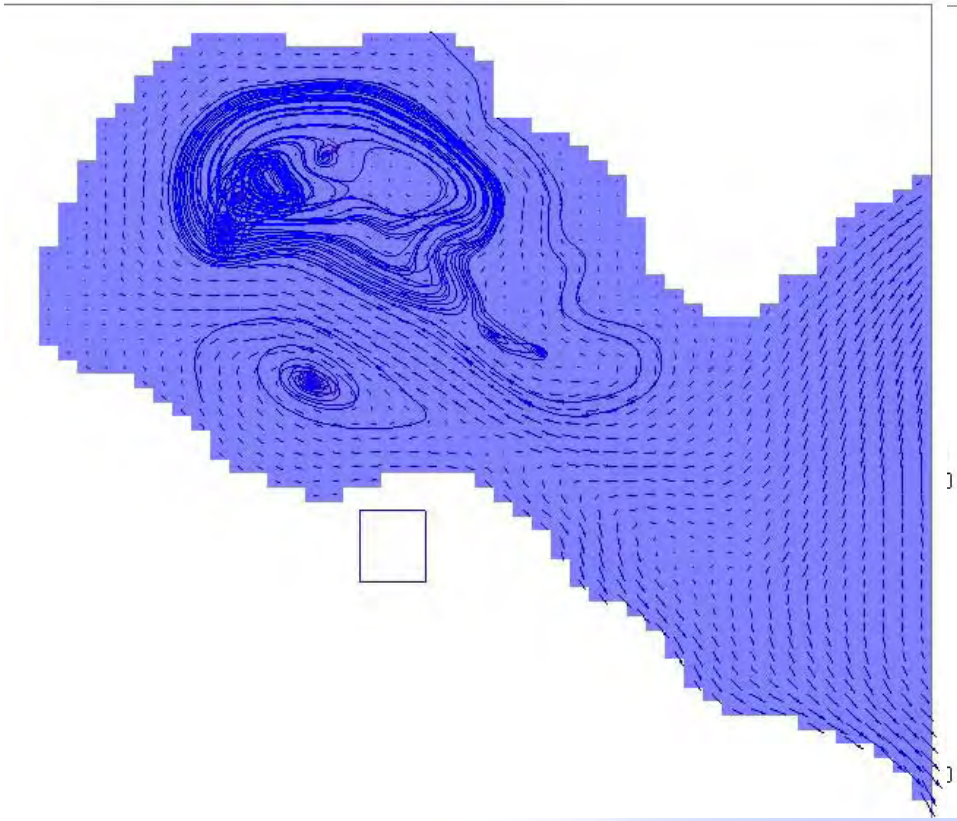
Stochastic description for probability density function of scallop larvae using stream lines

$$P(x,y) = \int_0^H \int_0^N \alpha C(x,y,z)\,dn\,dz$$

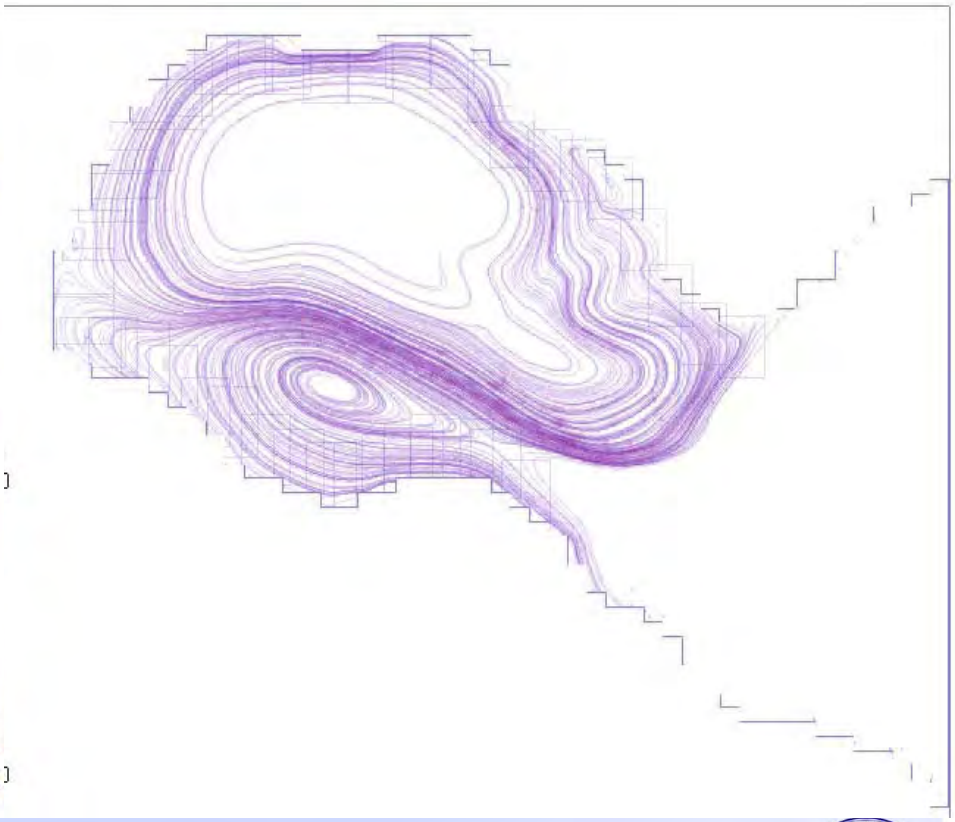
- P is a probability density function of larvae
- C is a stream line
- α=0.25 is opacity of stream lines
- H is bottom depth
- n is the number of stream lines
- N is maximum number of stream lines
- $x, y, and\ z$ are Cartesian coordinate

2008/06/23

Surface Current at 5m

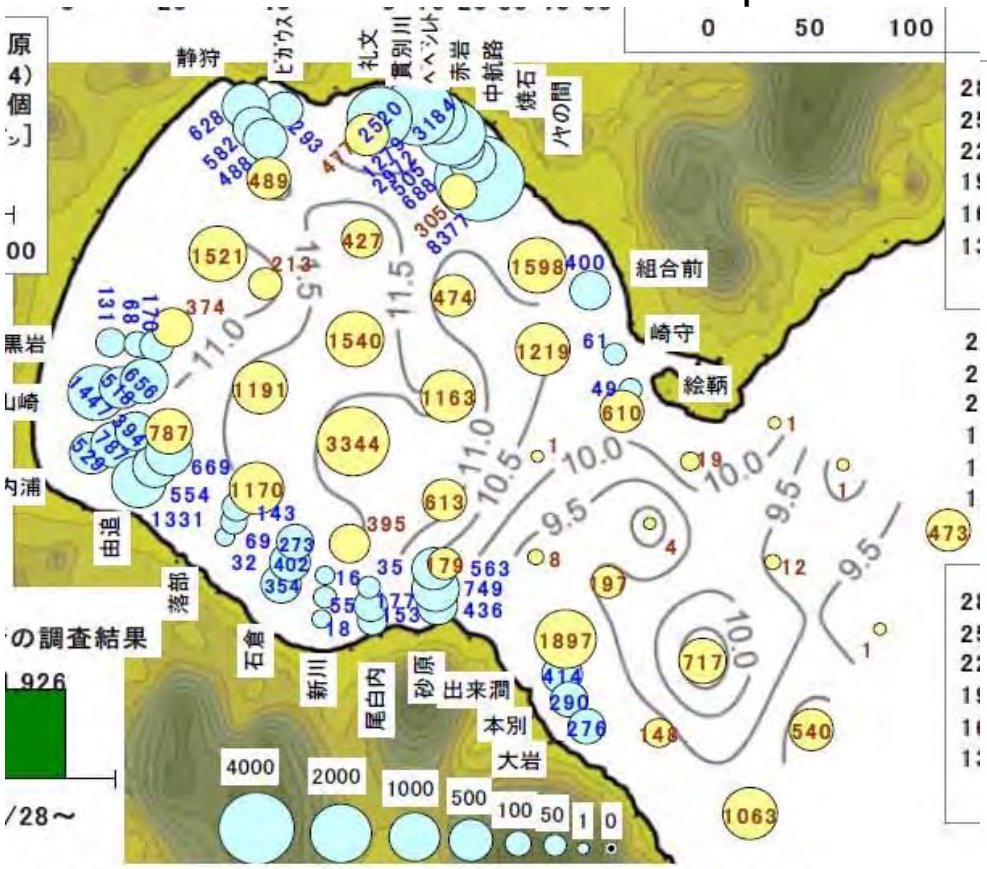


Probability density function of larvae

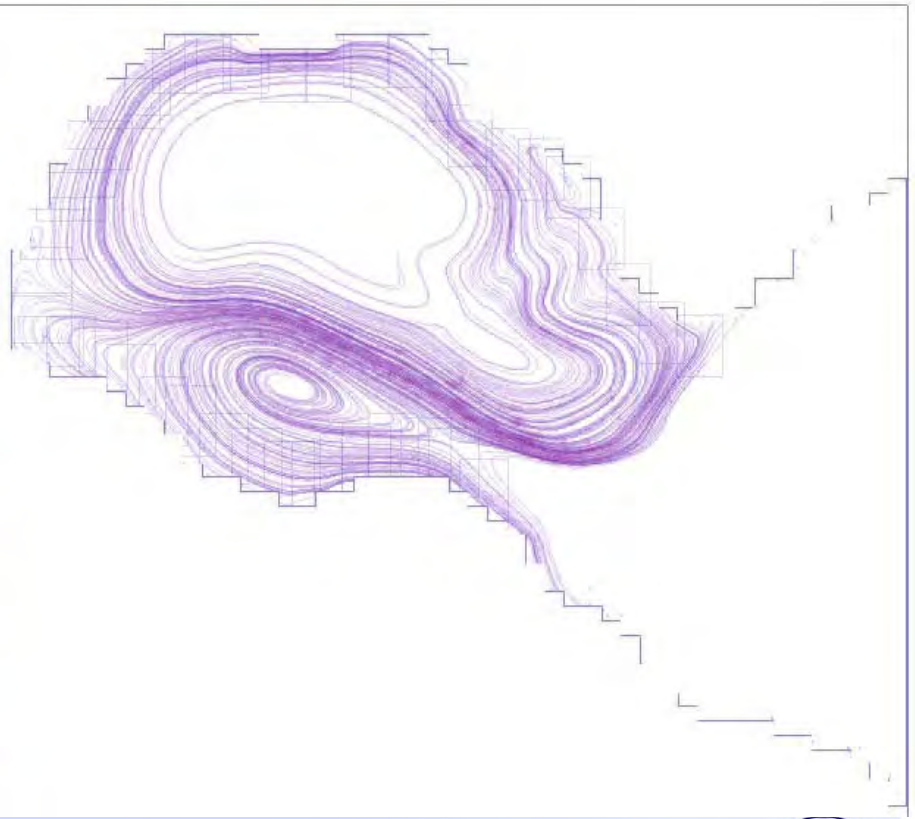


2008/06/23

Horizontal distribution of scallop larvae



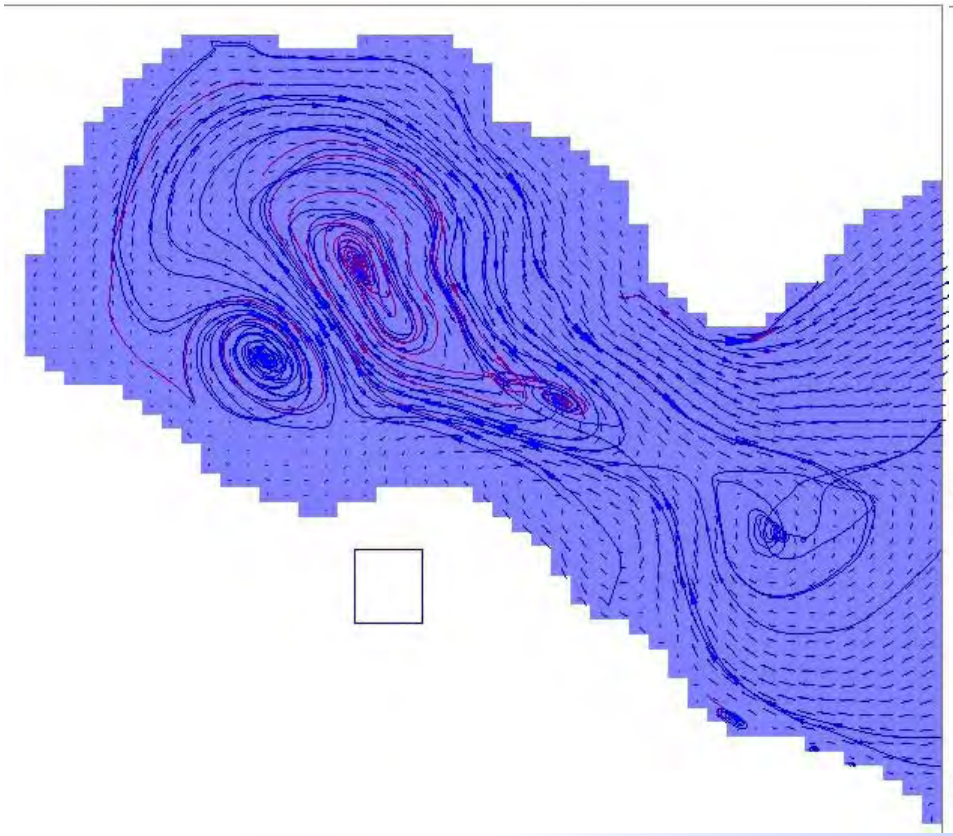
Probability density function of larvae



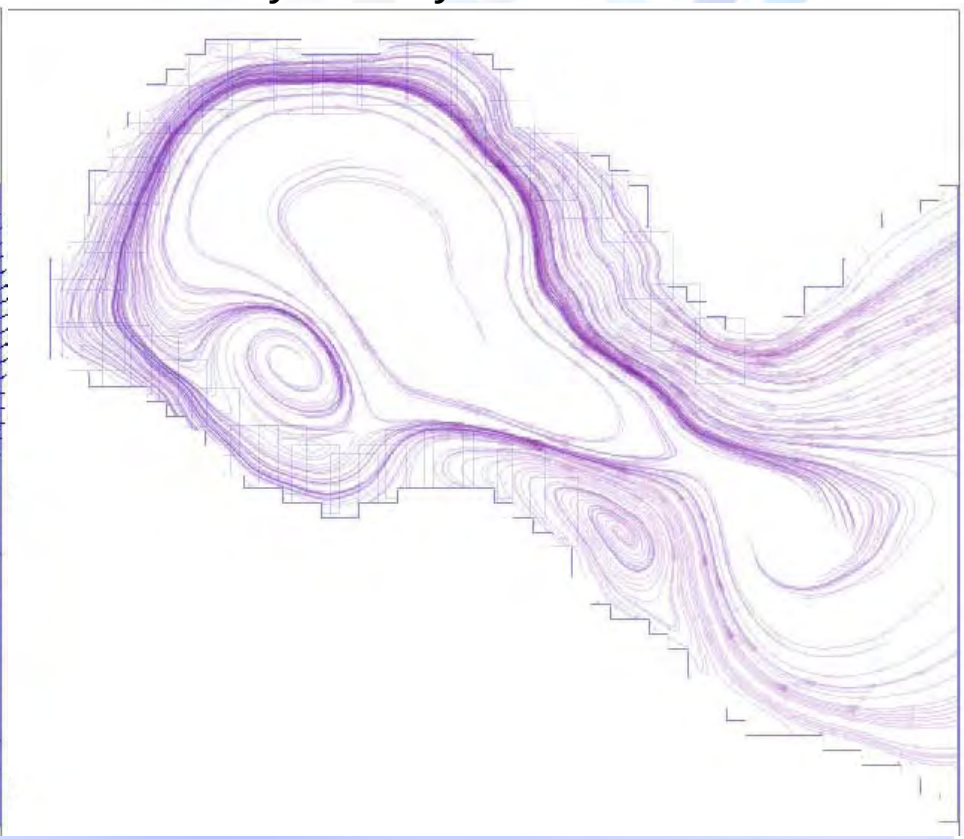
Denser colors indicate high density probability from trajectory of larvae released from scallop aquafarm

2008/06/11

Surface Current at 5m



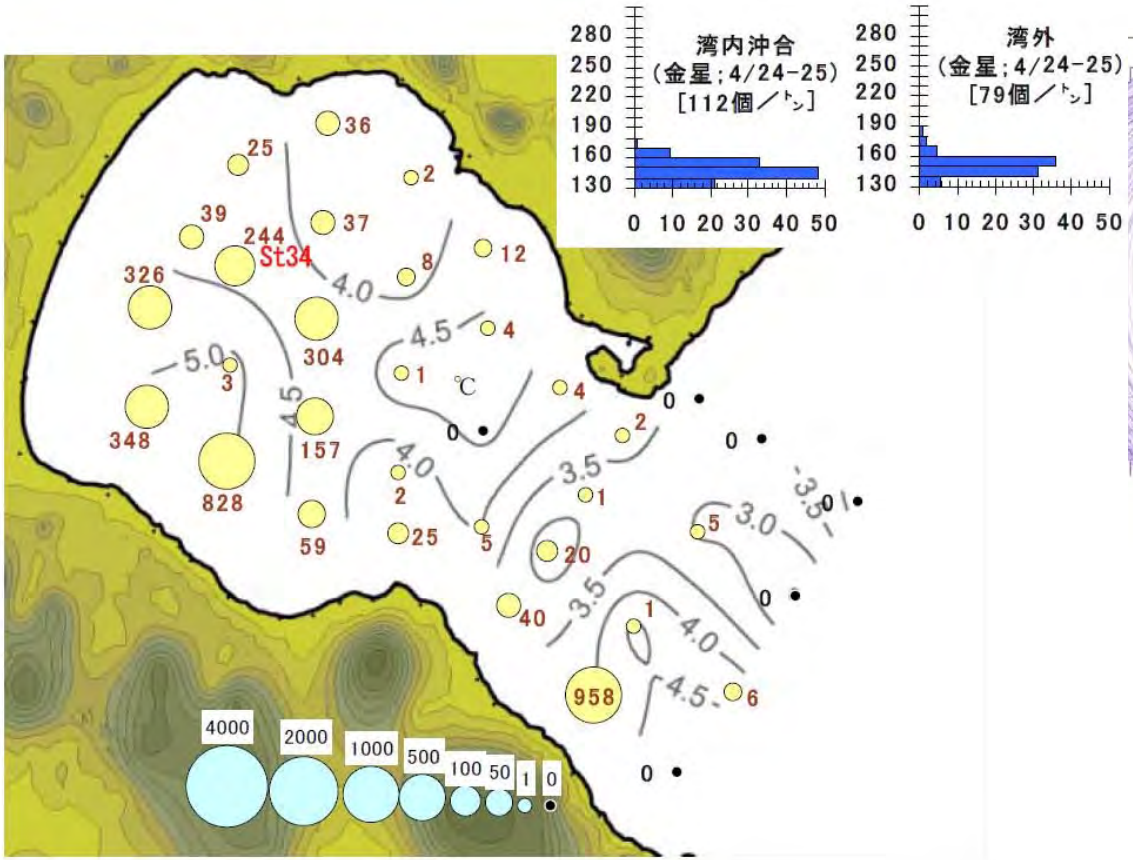
Probability density function of larvae

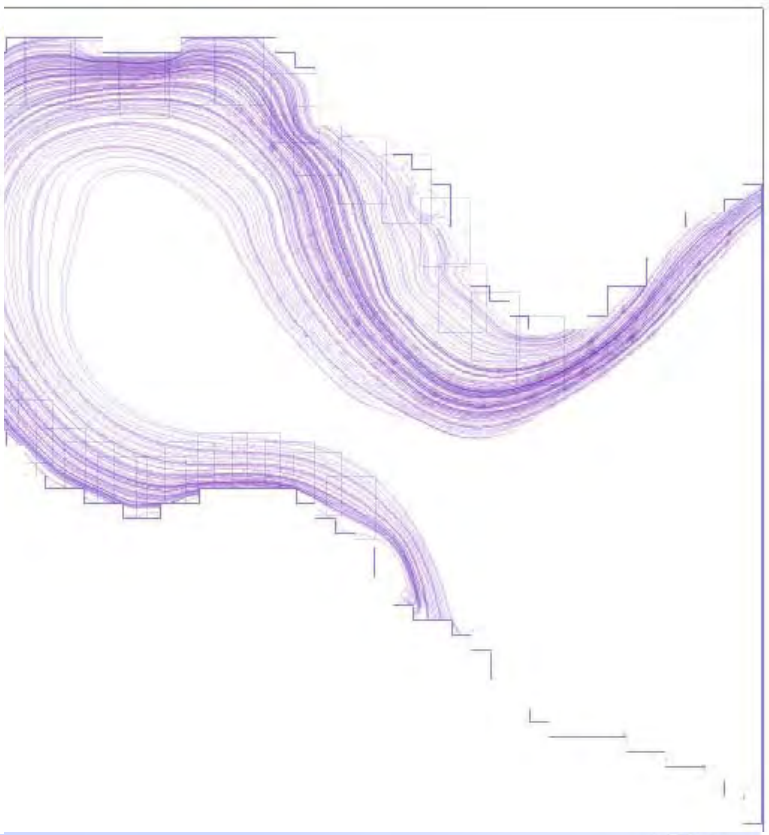


2008/04/15

Surface Current at 5m

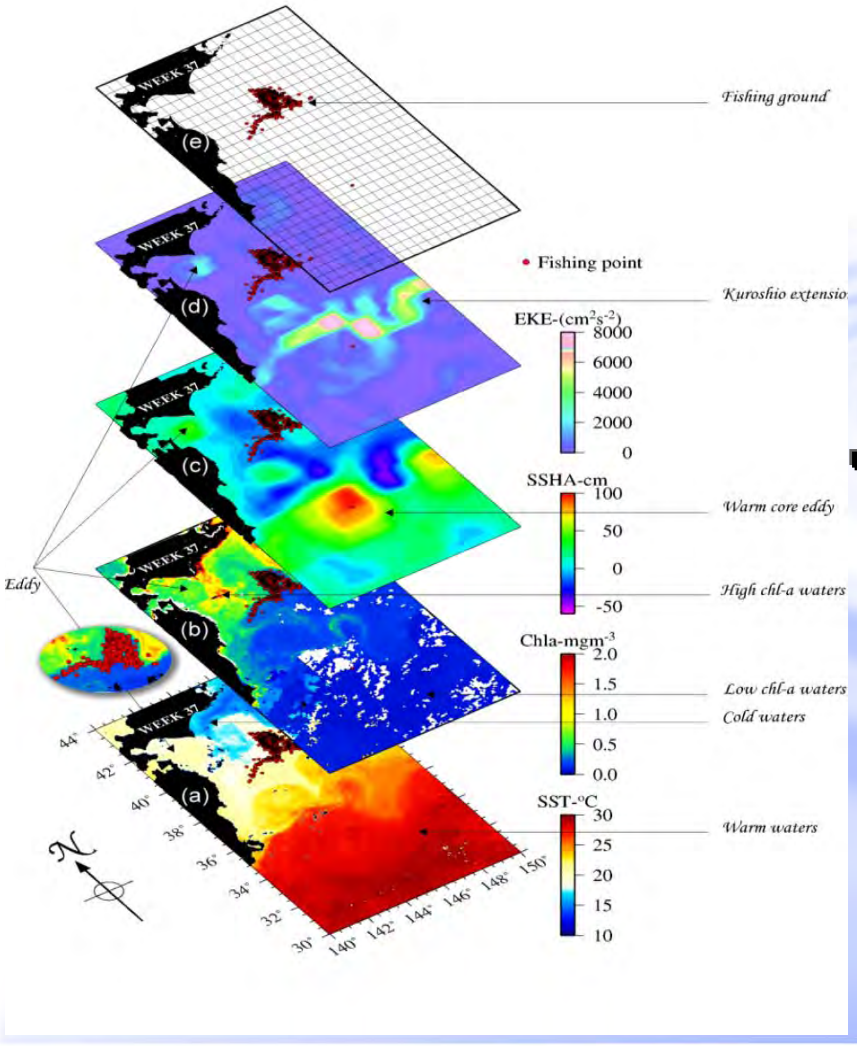
Probability density function of larvae



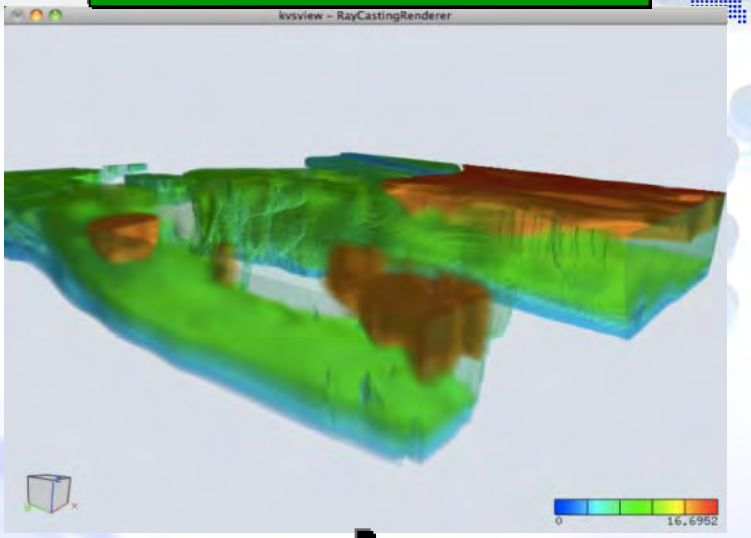


Visualization of operational ocean simulation

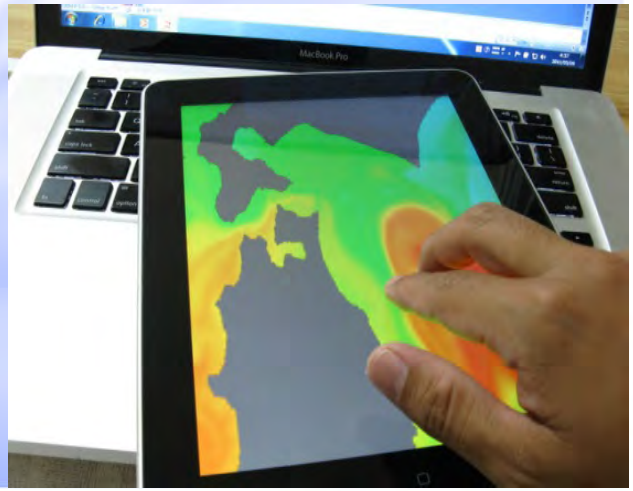
Observational data



Simulated data



Interactive operation using touch panel



Thank you for your interesting