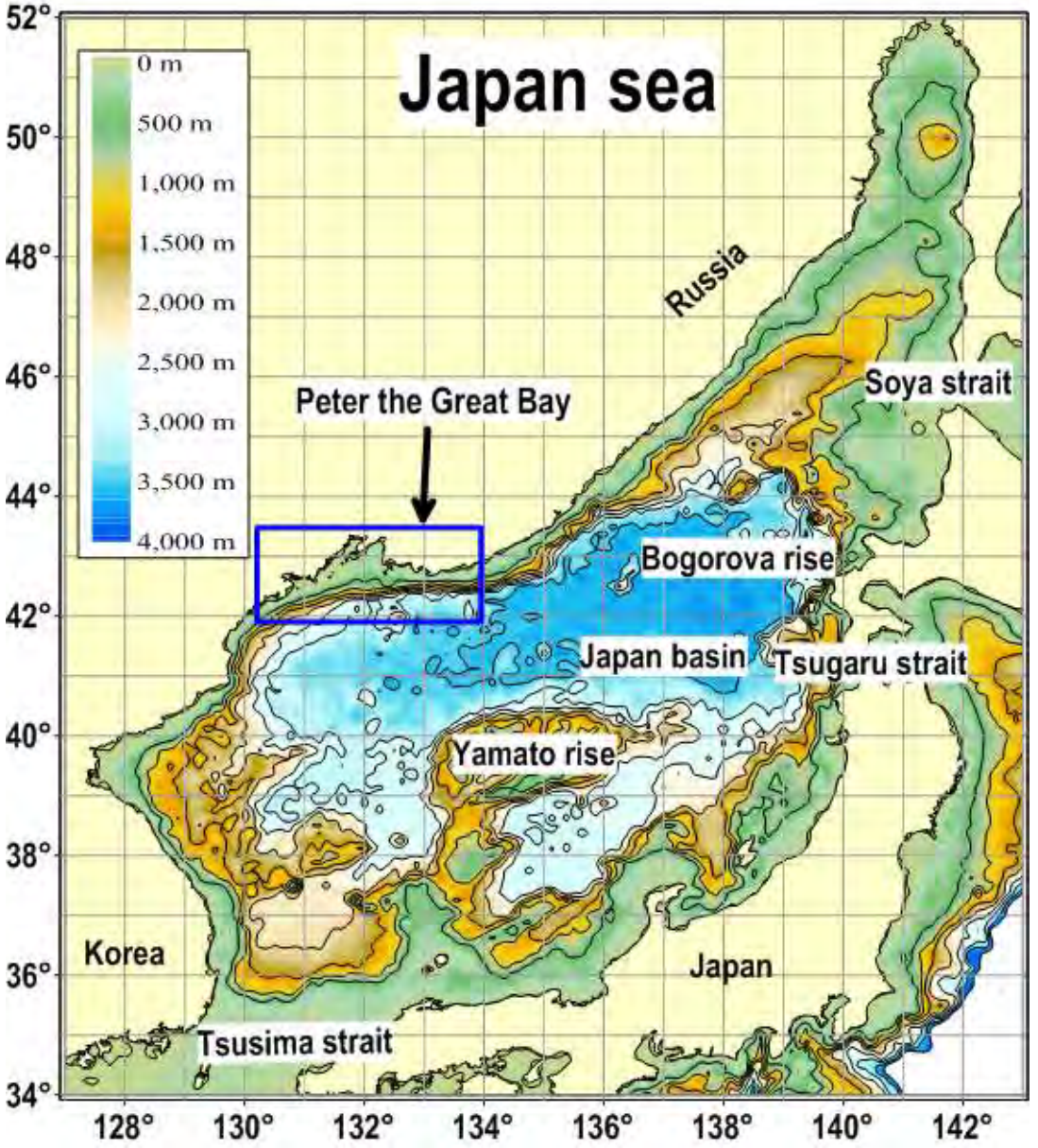
Submesoscale eddies of Peter the Great Bay

Pavel Fayman
Far Eastern Regional Hydrometeorological Research Institute, Vladivostok, Russia, Pavel.Fayman@gmail.com

Alexander Ostrovskii
P.P.Shirshov, Institute of Oceanology, Moscow, Russia, osasha@ocean.ru

Vyacheslav Lobanov
V.I.Il'ichev Pacific Oceanological Institute, Vladivostok, Russia, lobanov@poi.dvo.ru

Young-Gyu Park
Korea Institute of Ocean Science and Technology, Ansan, Korea
ypark@kiost.ac



Aim: to study the eddy dynamics in the Peter the Great Bay during the winter-spring period.

Task:

1) To create northwestern part of the Japan Sea circulation model based on Regional Ocean Modeling System (ROMS).

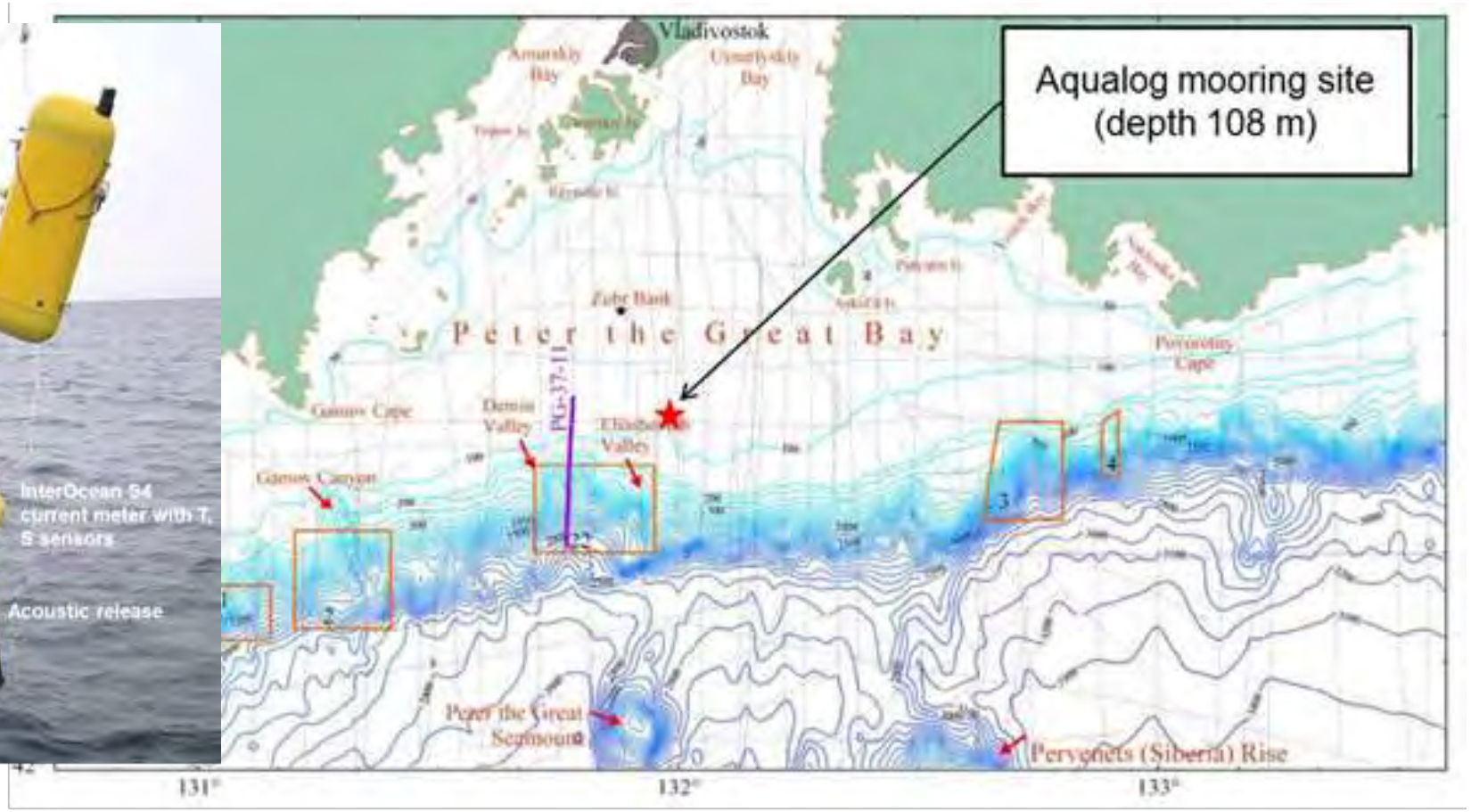
2) Numerical calculation for the period from 2009 to 2010

3) Analysis of ocean circulation for winter-spring 2010

4) Analysis of eddy dynamic for winter-spring 2010

5) Analysis of the advective transfer of passive particles back in time from the point of deploying the Aqualog profiling

The field experiment was carried out on Feb. 27 – Mar. 14, 2010

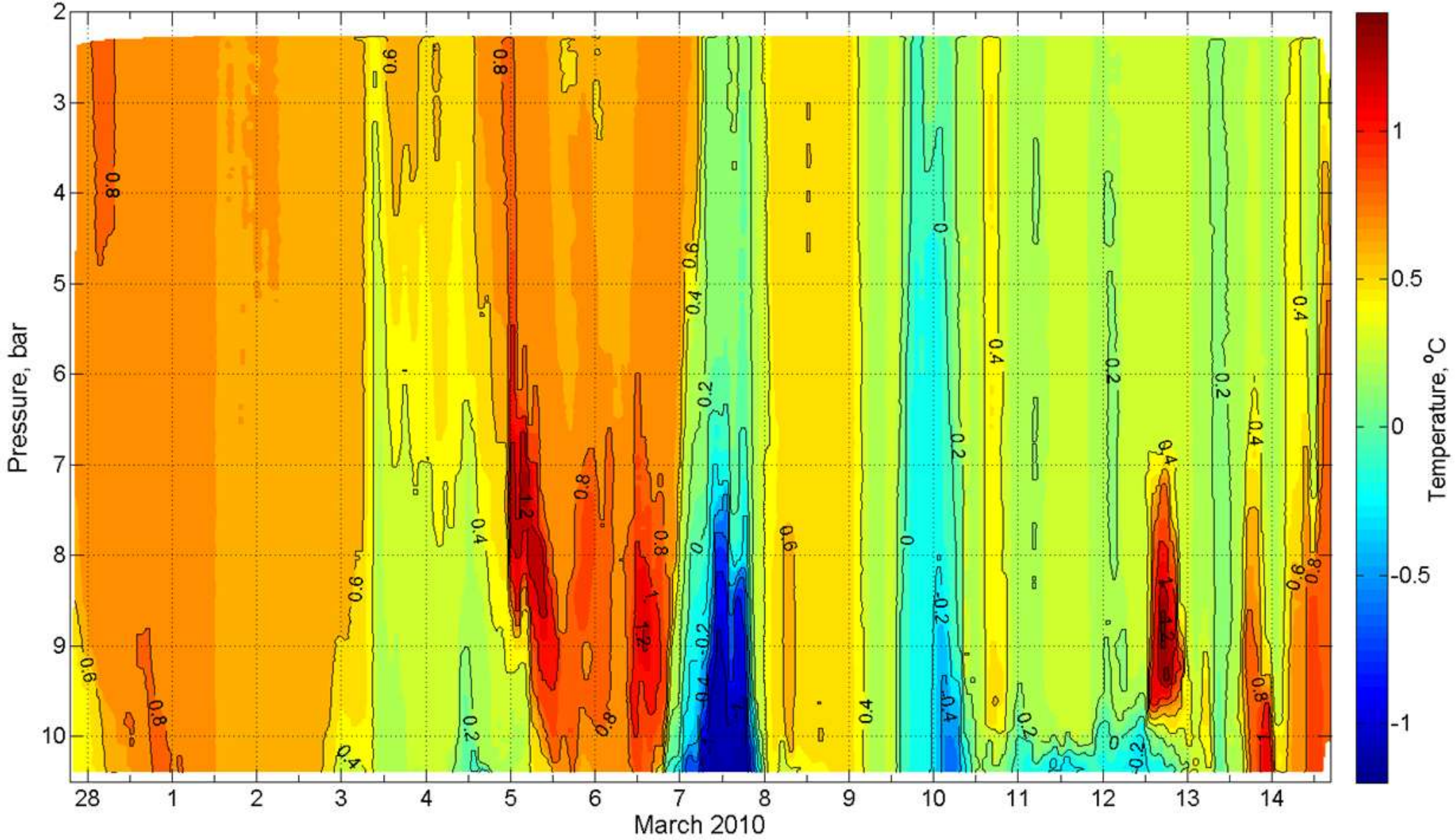


For mooring we employed the profiler Aqualog with the CTD probe and the acoustic doppler current meter that allowed for frequent observations of the vertical profiles of temperature, salinity, current velocity, and acoustic backscatter.

For the deployment and recovery of the mooring we used R/V Professor Gagarinskiy. This ship also made T,S casts using SBE CTD 911plus probe in the PGB area during the survey.

Also we used the AQUA satellite Moderate Resolution Imaging Spectroradiometer data and the Advanced Scatterometer (ASCAT) wind data of the METOP satellite.

Appearance of cold water near the mooring site



Time–depth diagram of sea temperature derived from the Aqualog profiler data from Feb. 27 through Mar. 14, 2010

Research area and numerical experiment

Model domain is 129.5° E – 135.5° E, 40.5° N - 43.5° N. Grid step is 600 m. Number of layers 32.

Used datasets

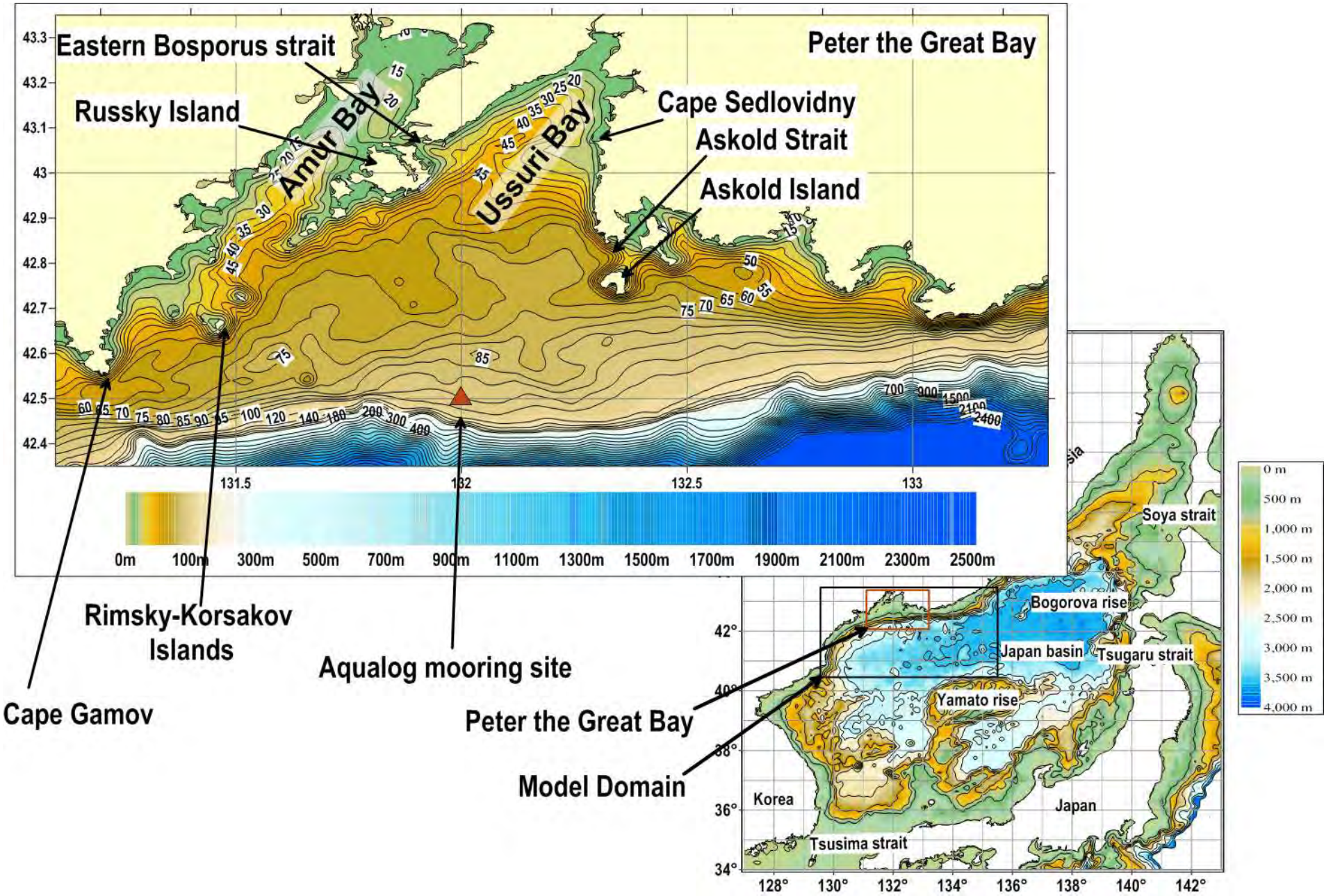
Depth: ETOPO2 [National Geophysical Data Center, 2006], and digitized navigation maps.

Initial and boundary conditions: JCOPE2 [Miyazawa, Y, 2004].

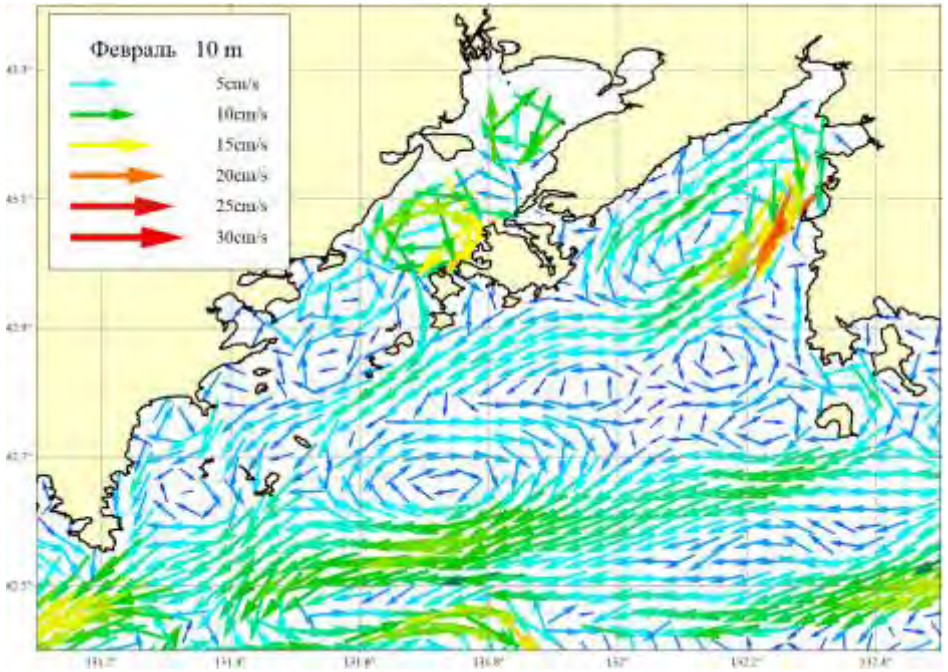
Heat and freshwater fluxes: NCEP-DOE AMIP-II Reanalysis [Kanamitsu M., 2002].

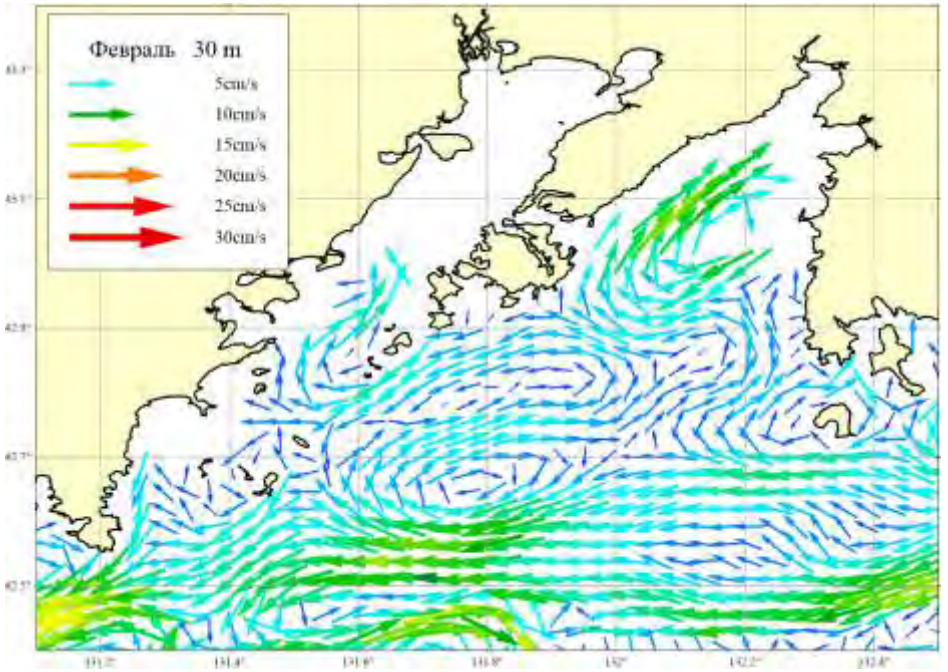
Wind: Daily ASCAT global wind field [Bentamy, A.; Croize-Fillon, 2010].

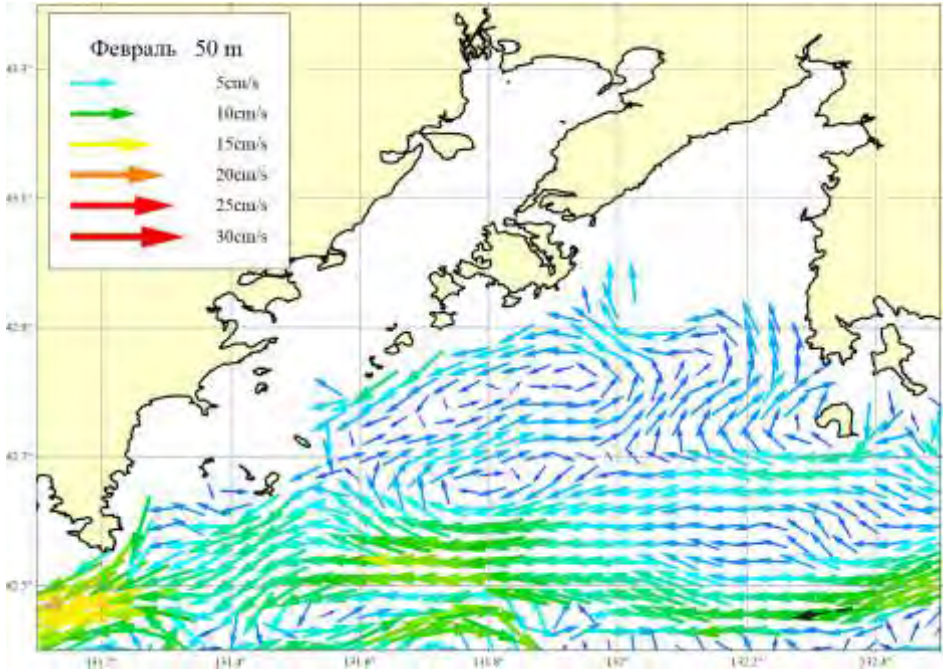
Period of calculation: 2009-2010

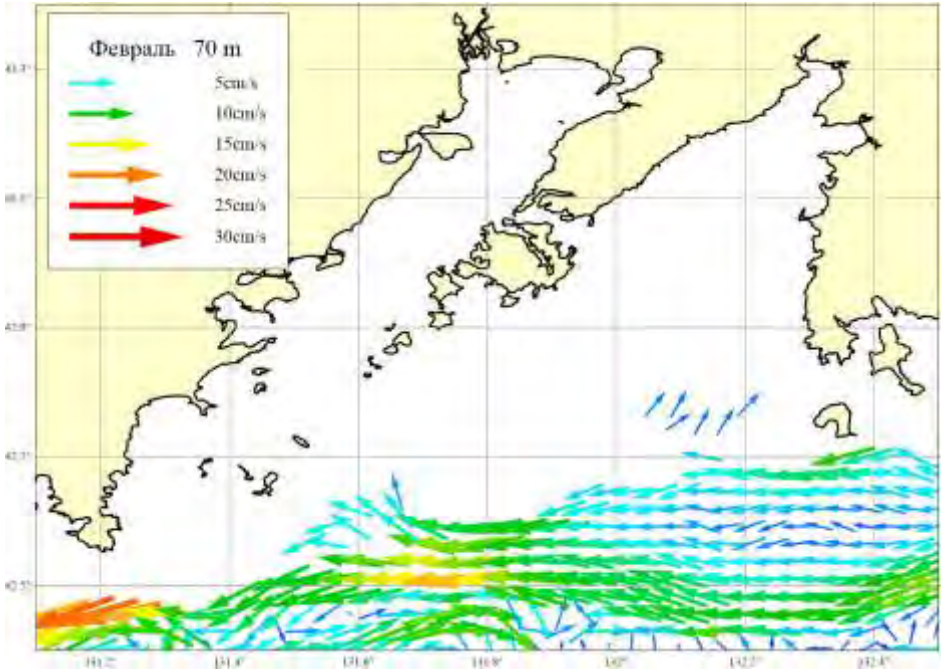


Model results. Monthly mean. February 2010

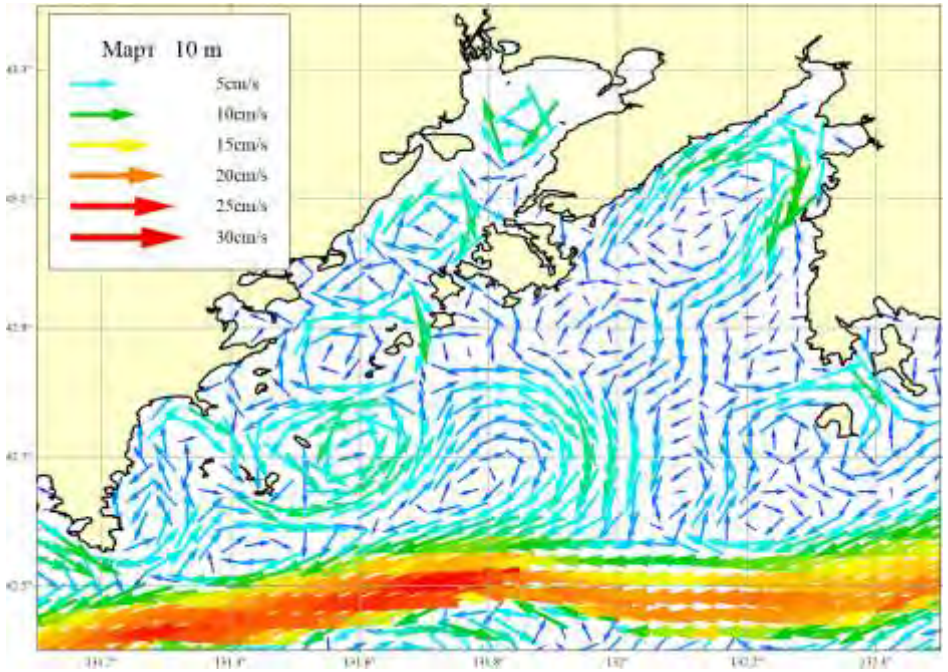


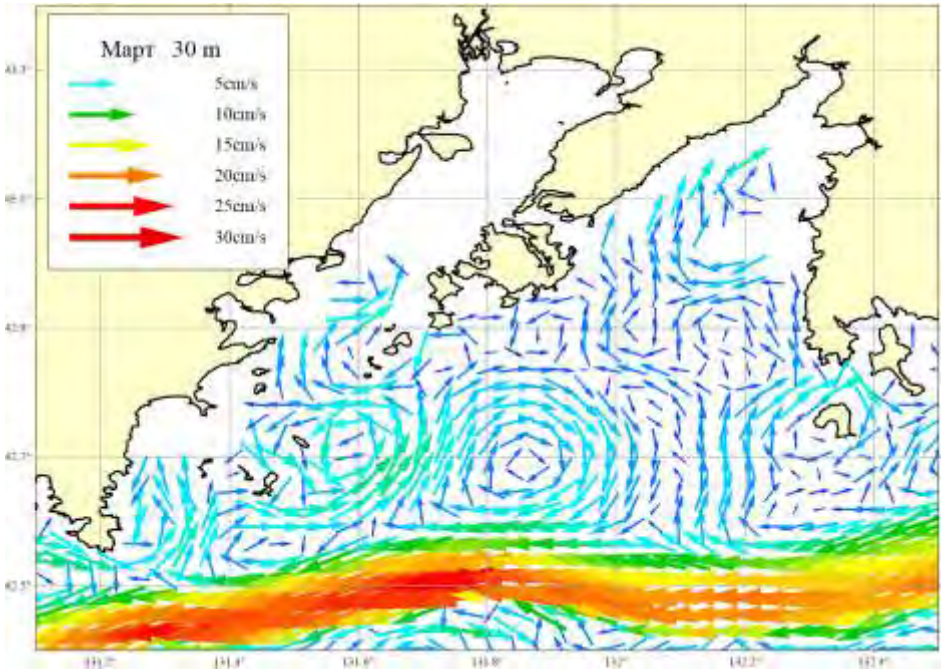


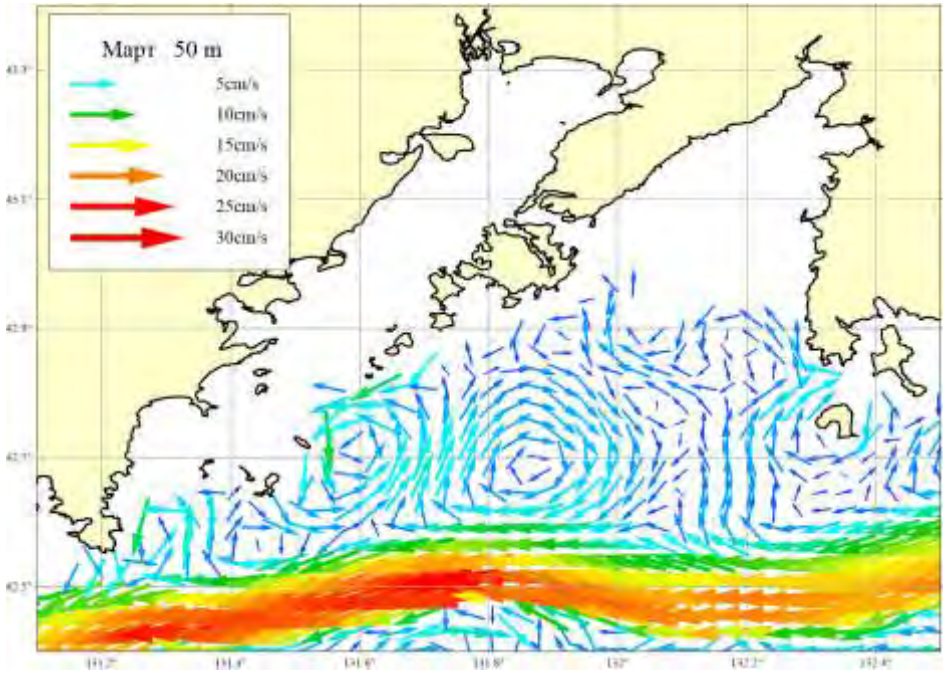


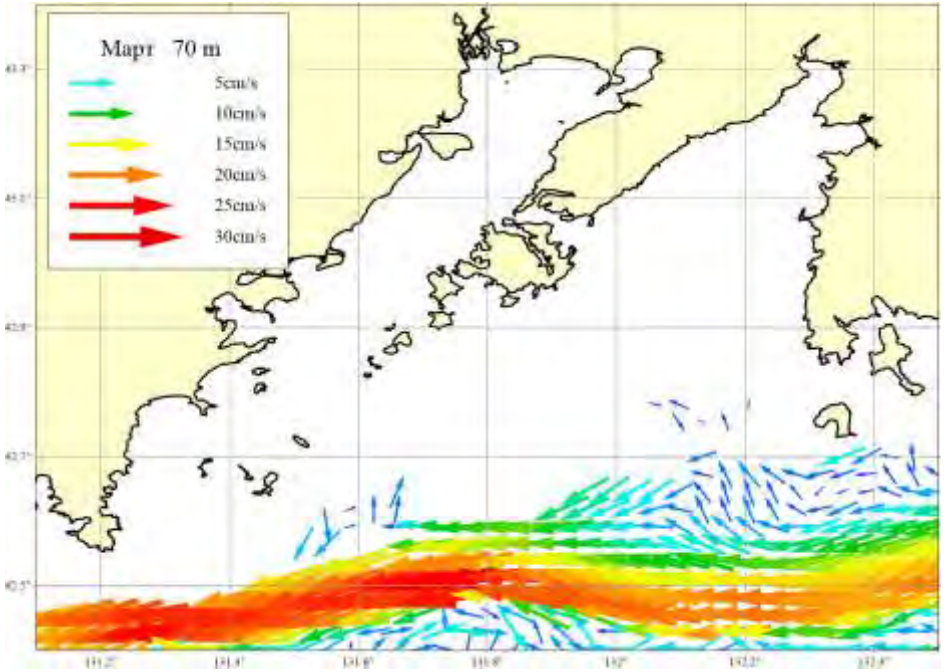


Model results . Monthly mean. March 2010

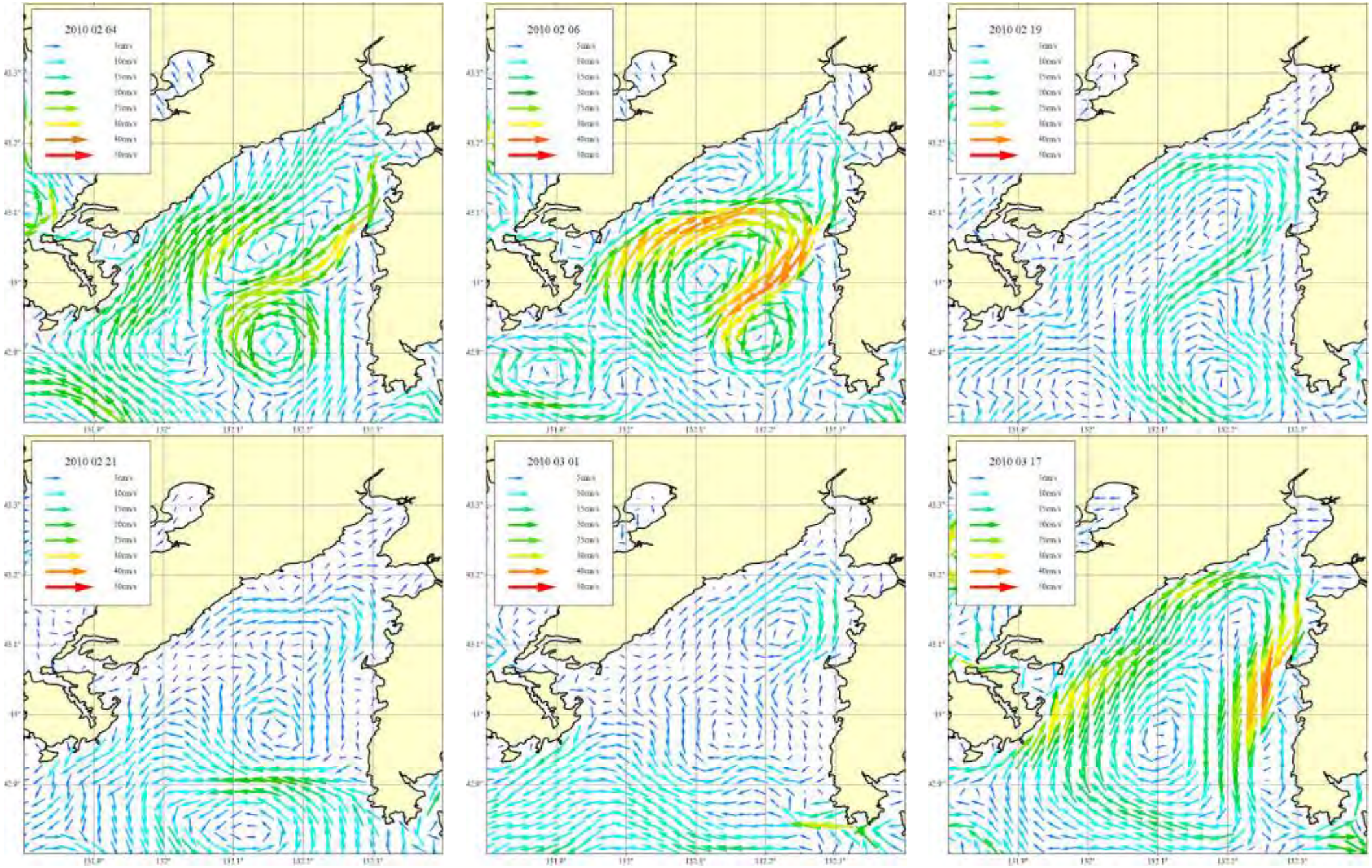






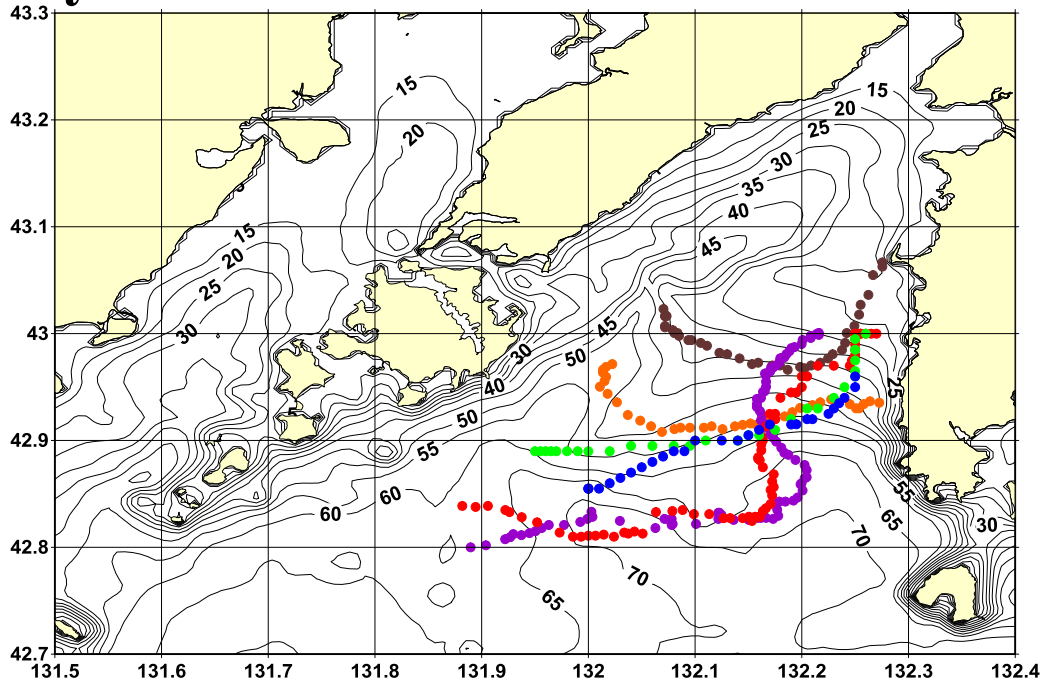


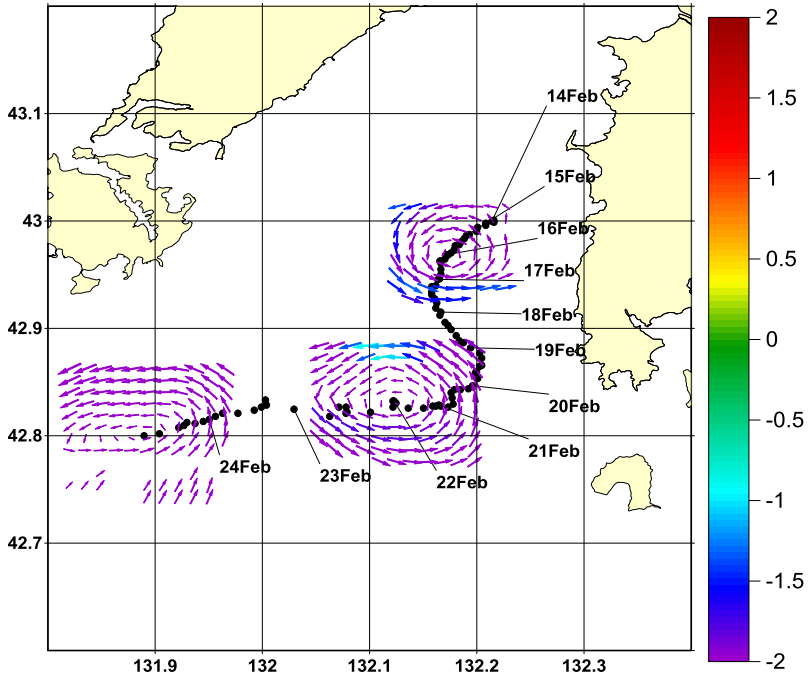
Model results. Circulation in Ussuri Bay in Feb-Mar 2010

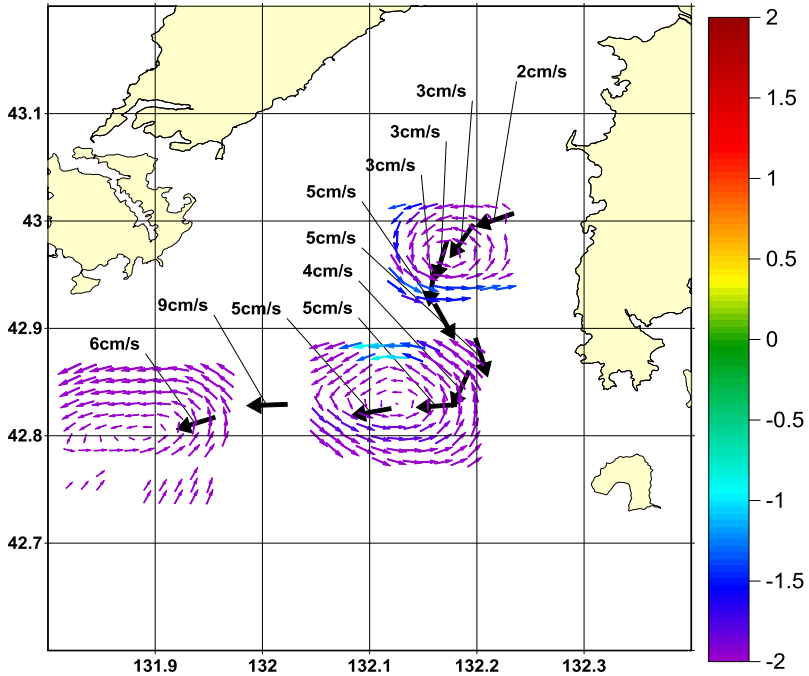


Eddies in the Ussuri Bay

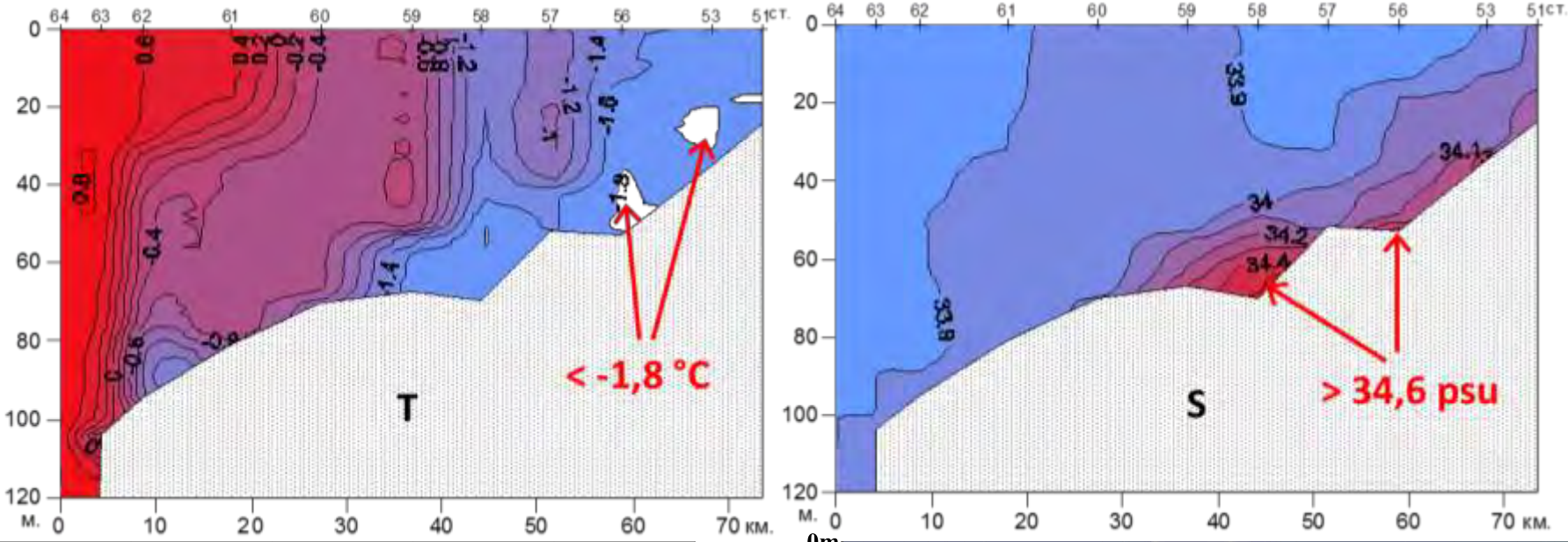
Eddy	Lifetime	Speed (cm/s)	Rate of temperature change (deg/day)	Rate of temperature change (deg/km)	Rate of salinity change (psu/day)	Rate of salinity change (psu /km)	Frequency (day^{-1})
blue	2-7 Feb	8	0.006	0.008	0.001	0.001	0.7
green	4-8 Feb	10	0.005	0.004	0.0009	0.0007	0.84
red	7-18 Feb	6	0.002	0.004	0.0004	0.0007	0.23
purple	13-25 Feb	5	0.001	0.004	0.0001	0.0005	0.34
orange	17-22 March	6.4	0.004	0.005	0.0007	0.0006	0.74
brown	20-25 March	7	0.004	0.002	0.0002	0.0002	0.54

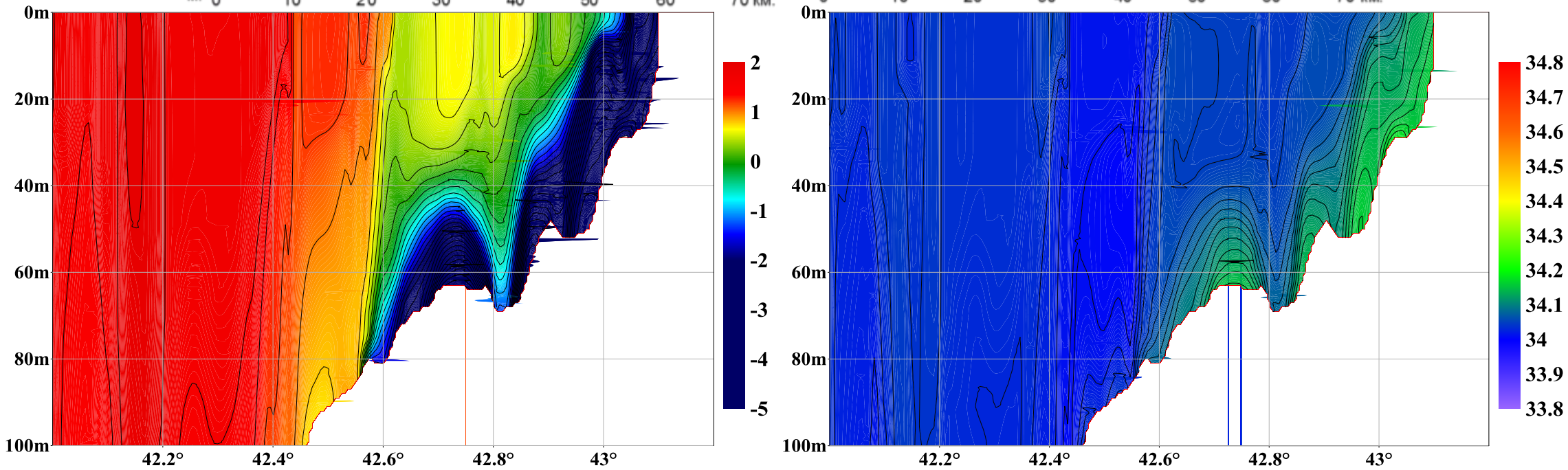






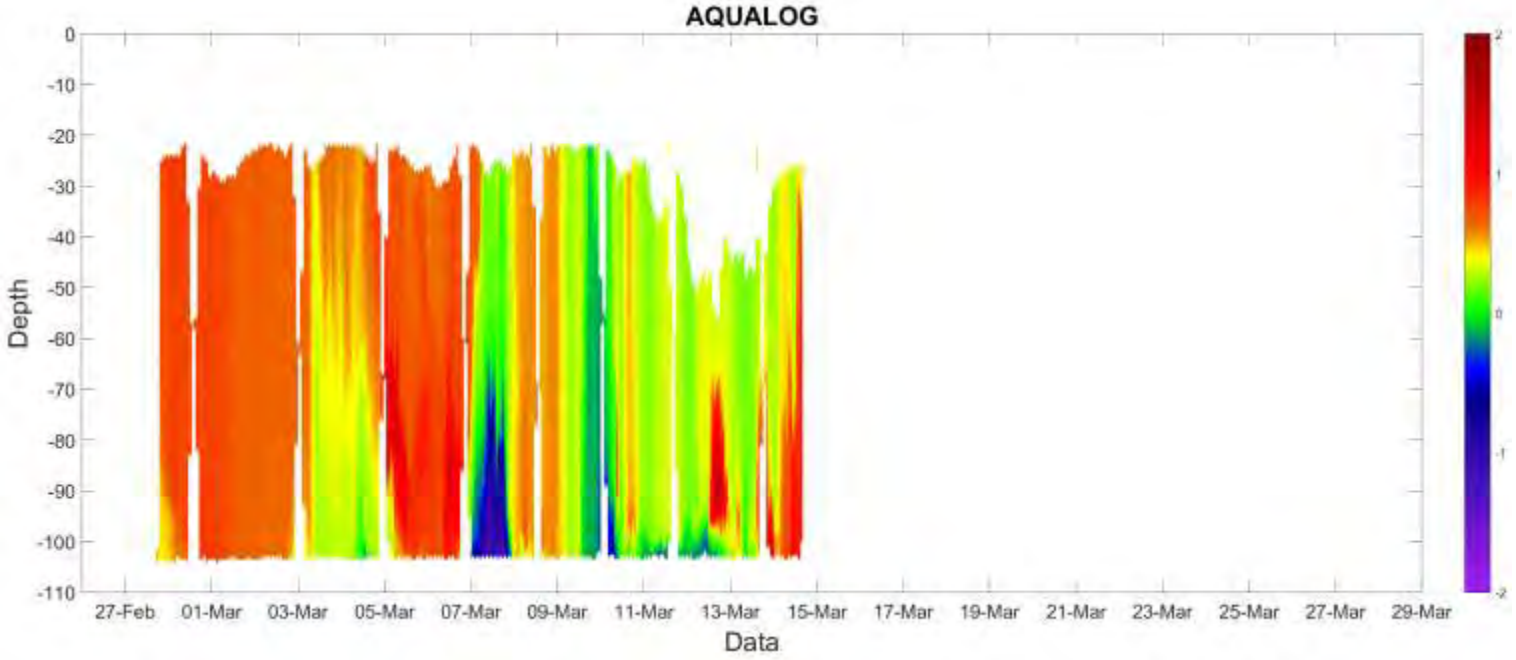
Higher salinity and colder water in the near-bottom layer in the northern part of the Ussuri Bay

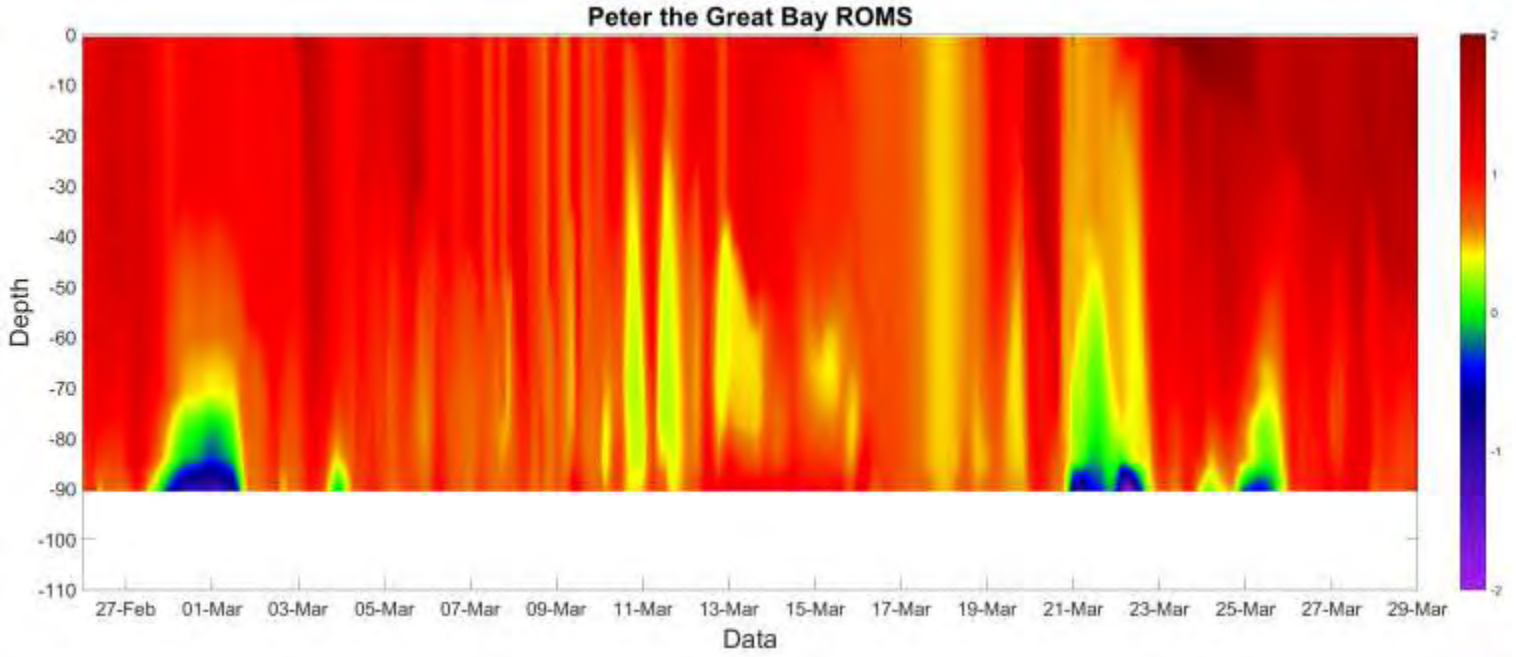




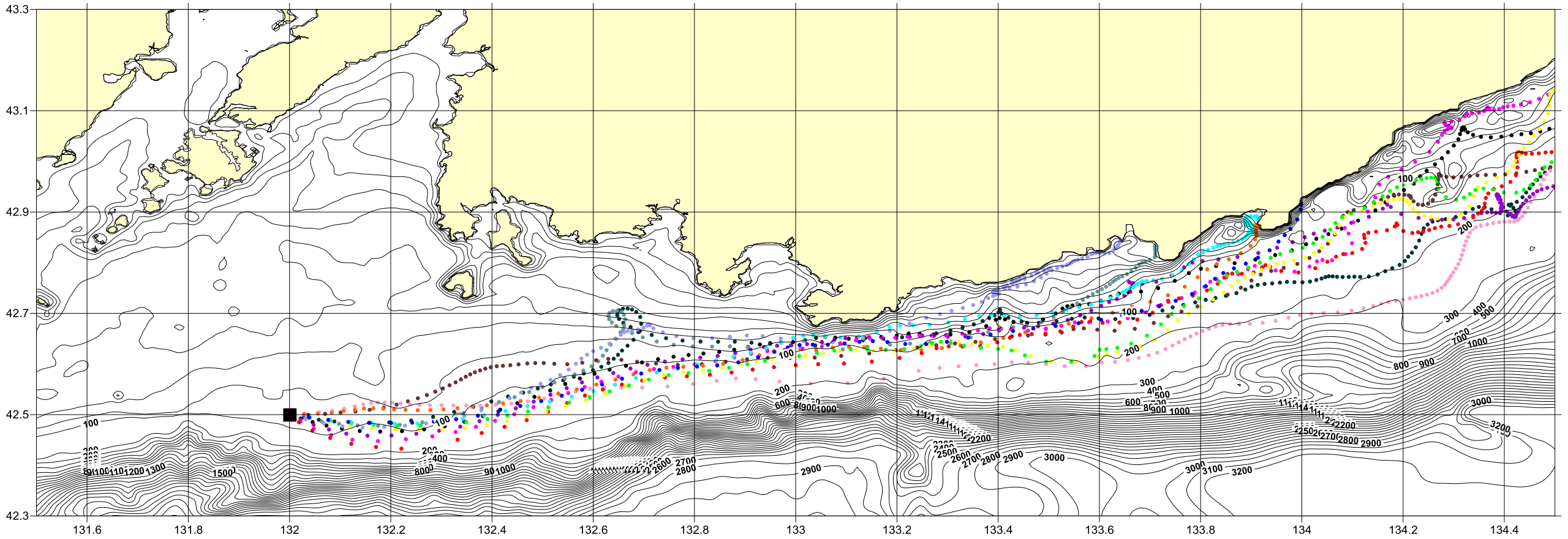
The temperature (left panel) and salinity (right panel) sections along 132°E 4 Mar 2010. Above – CTD, below - ROMS

Appearance of cold water near the mooring site



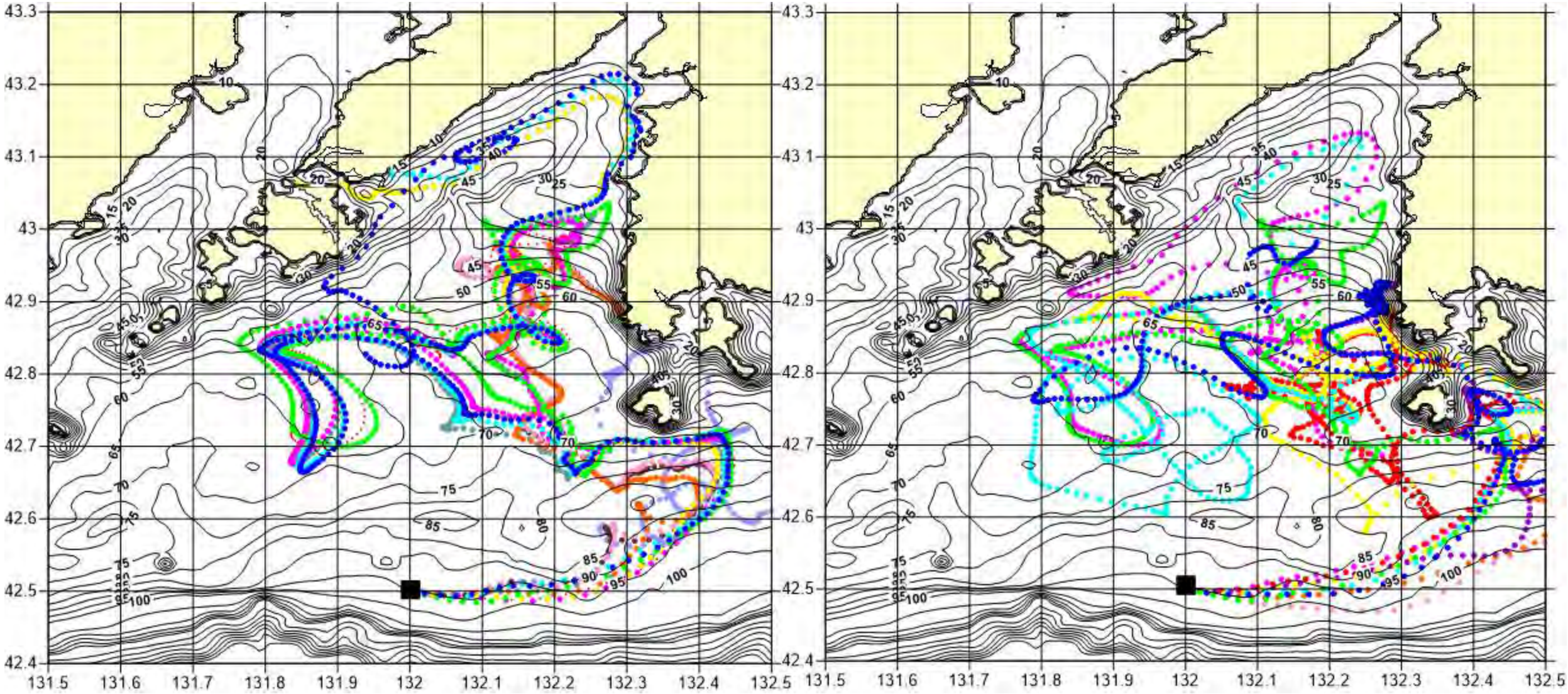


Trajectories of the particles



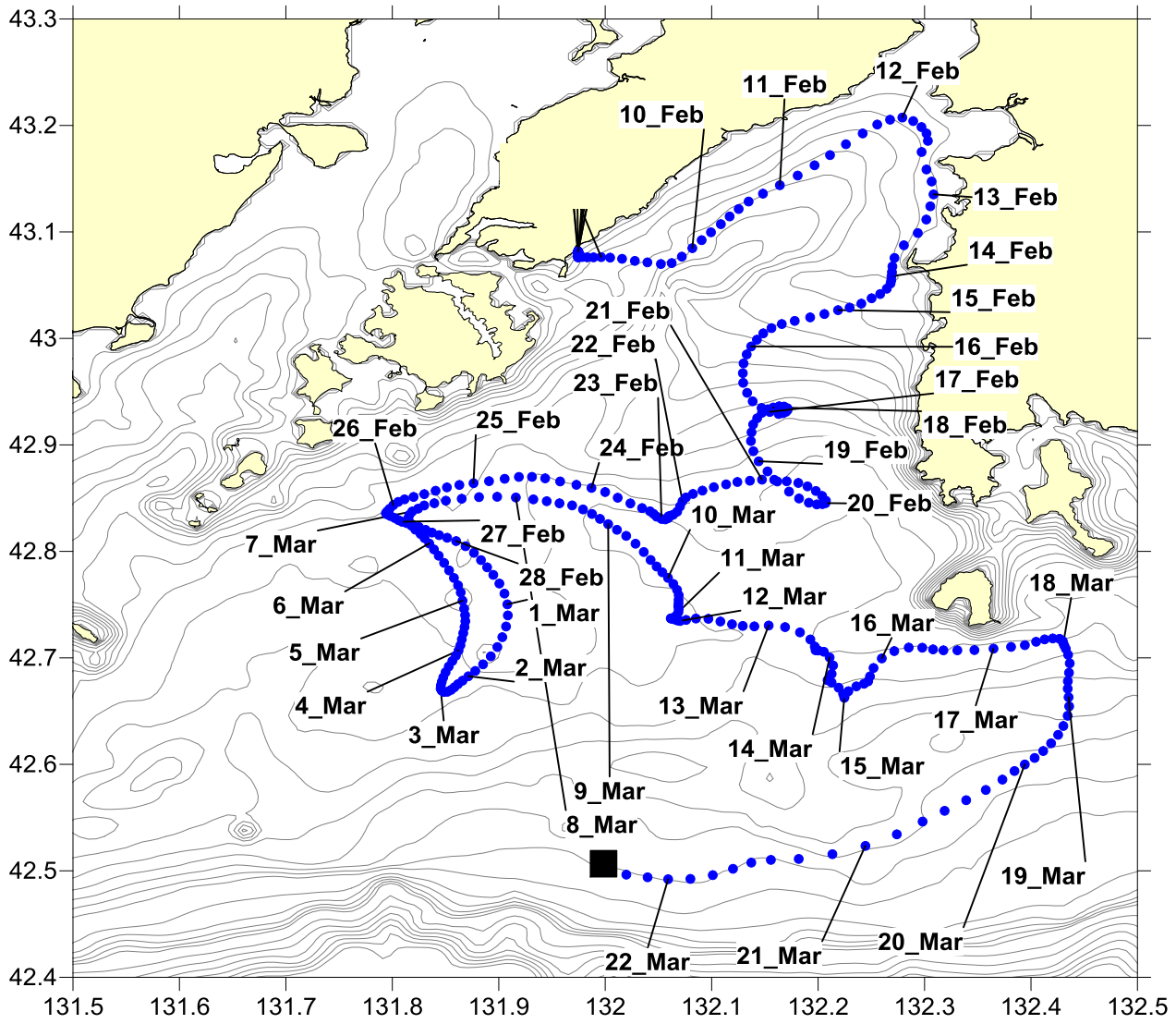
Trajectories of the particles that were brought to the model grid node, Node-A (shown by black square), nearest to the Aqualog profiler mooring site on the model day March 11-12

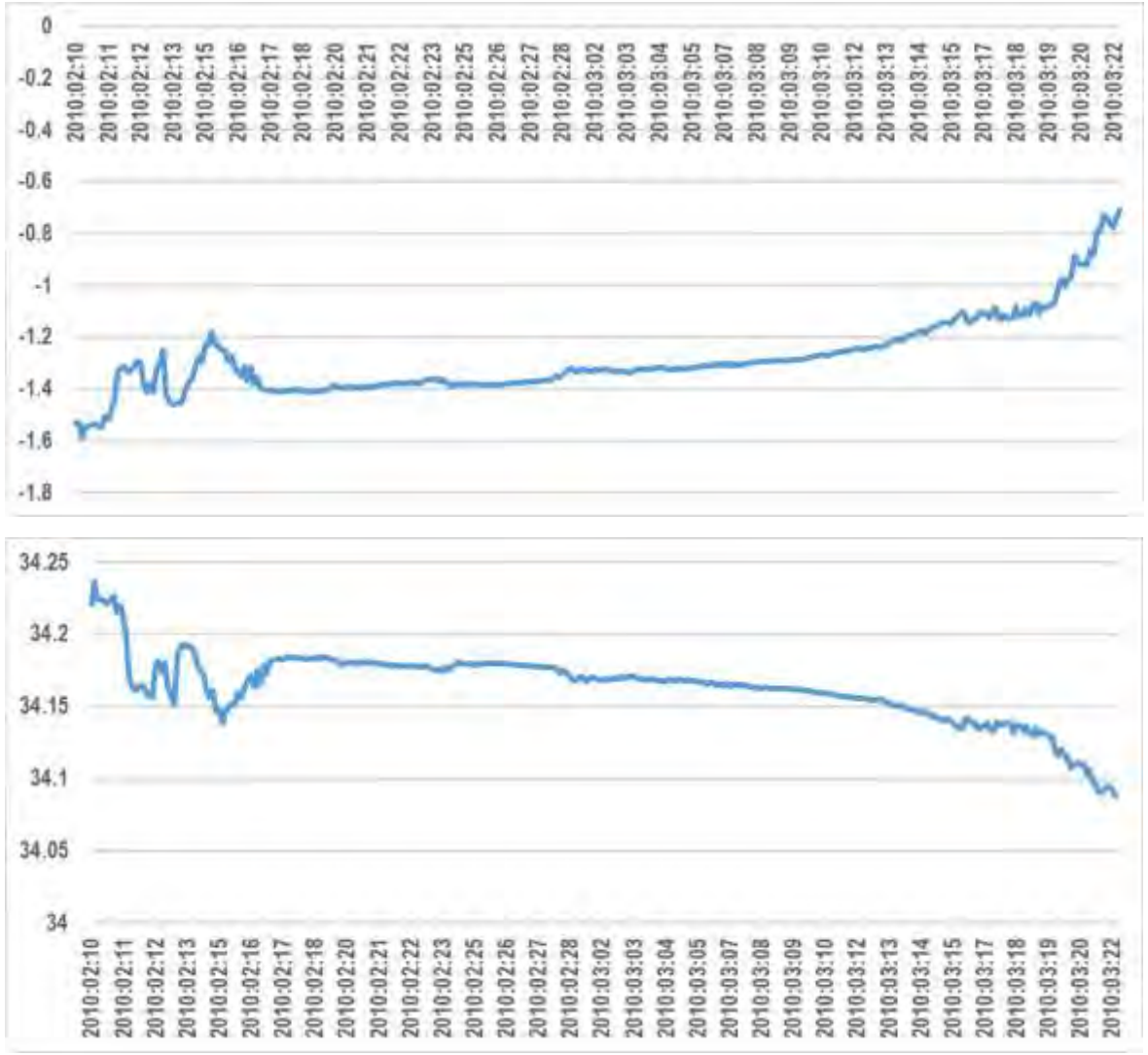
Trajectories of the particles



Trajectories of the particles that were brought to the model grid node, Node-A (shown by black square), nearest to the Aqualog profiler mooring site on the model day March 21-22 (left), March 25 (right)

Trajectory of the particle





Trajectory of the particle, and its temperature and salinity, that were brought to the model grid node, Node-A (shown by black square), nearest to the Aqualog profiler mooring site on the March 22 6 am.

Conclusions

The Regional Ocean Modeling System (ROMS) was adapted for the conditions of the Peter the Great Bay. 2009 and 2010 were calculated. The analysis of ocean circulation for winter-spring 2010 was made. Numerical experiments and AQUALOG measurements show:

1) Anticyclonic circulation is observed in the Ussuri Bay during the February-March 2010 (the period of deploying the Aqualog profiling). Cyclonic eddies are generated at the periphery of anticyclonic circulation , after than, move toward the continental slope. Its size, velosity and thermohaline properties was studied.

2) Short periods of the arrival of cold water (no more than two days) are fixed at the point 132E 42.5N (the point of deploying the Aqualog profiling).

3) Advective analysis of model results showed that this water came from the Ussuri Bay.

4) The transport of the waters, originated from the Ussuri Bay, is directly related to the vortex dynamics on the shelf of the Peter the Great Bay: mesoscale cyclonic eddies transfer cold water from Ussuri Bay.