Mesoscale structures and Pacific saury fishing grounds in the Northwestern Pacific

Elena I. **Ustinova**[1] and Viktor N. Filatov[1,2]

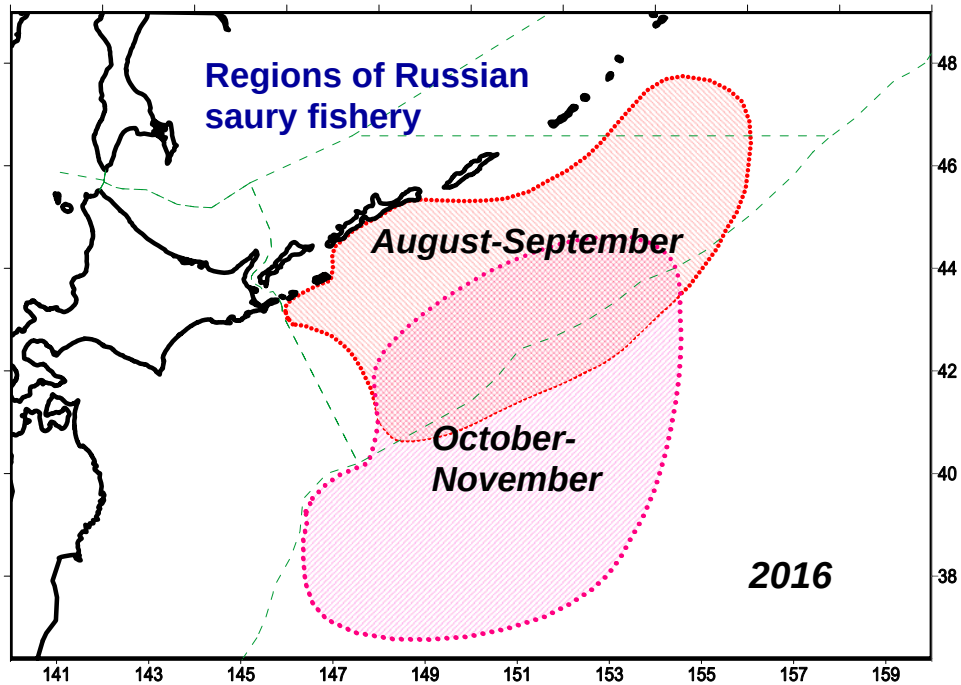
[1]Pacific Fisheries Research Centre (TINRO- Centre), 4 Shevchenko Alley, Vladivostok, 690091, Russia

[2]Southern Scientific Centre RAS, 41, Chekhova St., Rostov-on-Don, 344006, Russia

E-mail: eustinova@mail.ru







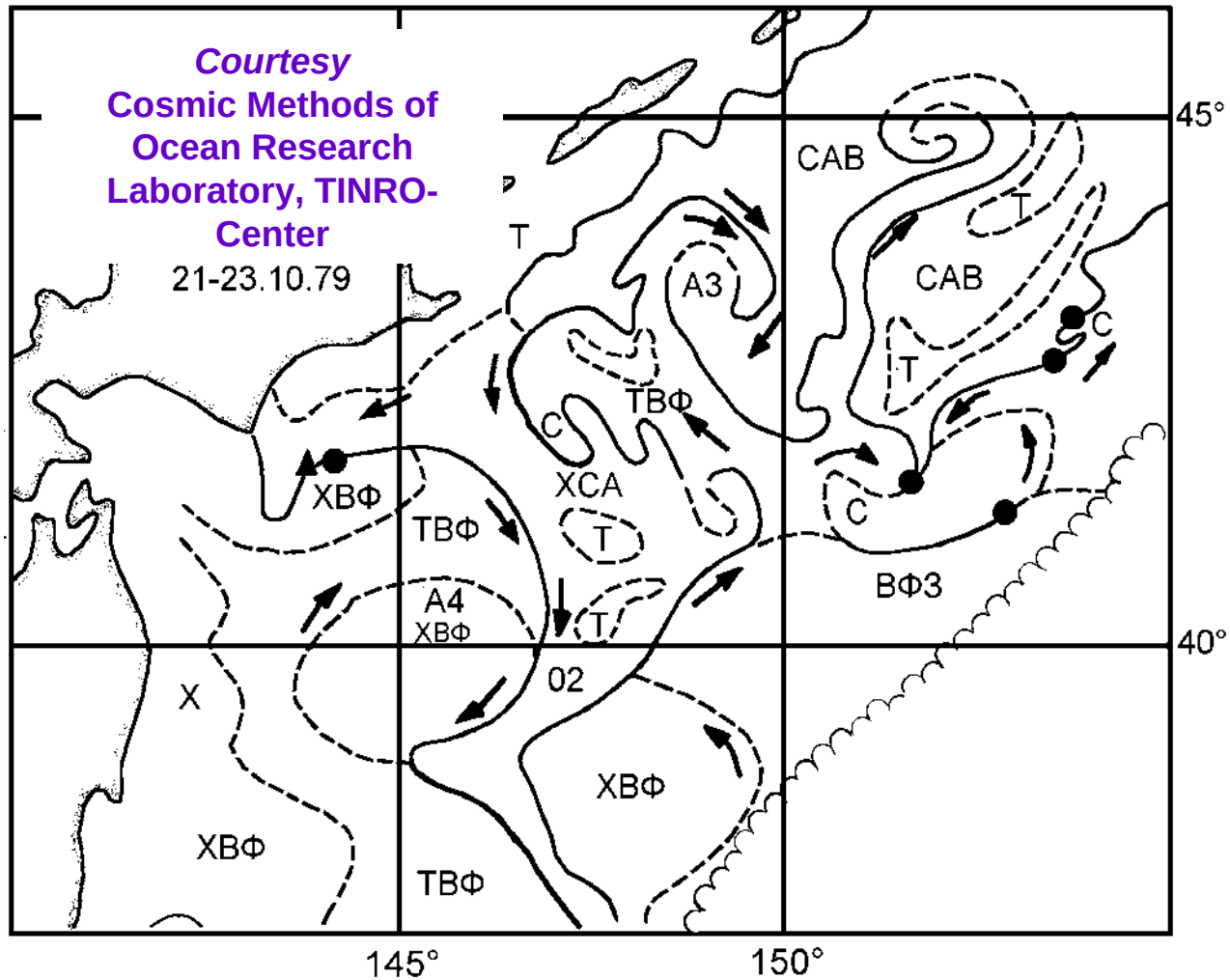
The effectiveness of the Pacific saury fishery depends on the ability of operational analysis and forecasting of hydrometeorological conditions, since fishing activities are related to oceanic fronts of different scales.

There is the monitoring system of oceanographic and biological conditions in the period of the saury fishery (from June to the beginning of December) in the Northwestern Pacific.

In recent years, practical experience of creating and using new information technologies, operational scientific support, including the collection and assimilation of data, analysis and diagnosis of the situation near real-time, forecast, visualization and distribution was obtained.

Some history

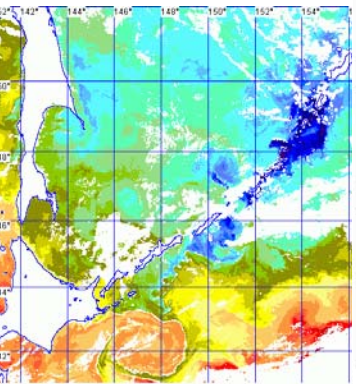
Since 1973, early studies of mesoscale structures and their impact on fishery by satellite data began in TINRO. In 1976, Cosmic Methods of Ocean Research Laboratory was established.



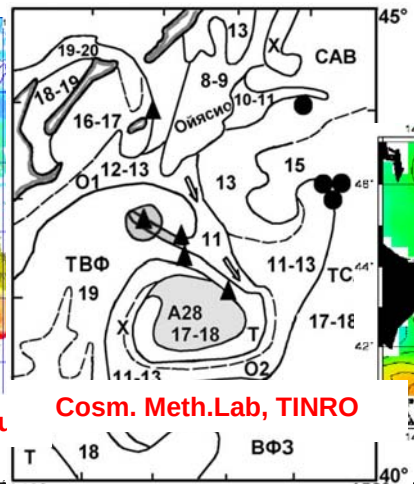
Historically, many useful relationships between mesoscale inhomogeneities and fish spatial distribution and the fishing grounds formation were found during the scientific programme "Polygon" in 1978-1990 (high-resolution surveys by 3-5 R/Vs synchronously).

Oceanographic and meteorological data

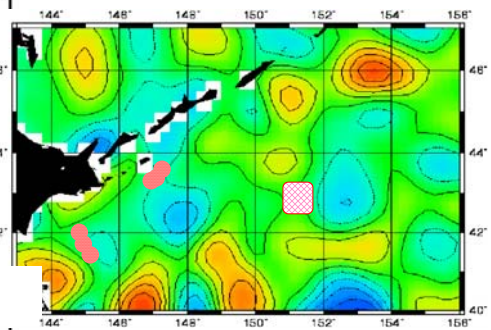
1. Data on SST: satellite information and data obtained *in situ* by temperature measuring system “Thermotrack”
2. CTD data (research vessels)
3. Satellite SSHa
4. Standard meteorological observations by scientific group
5. Meteorological observations by crew of fisheries vessel (4 time per day)

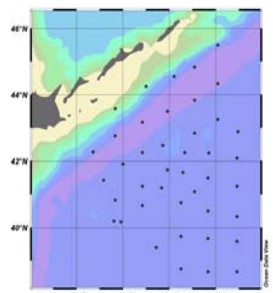


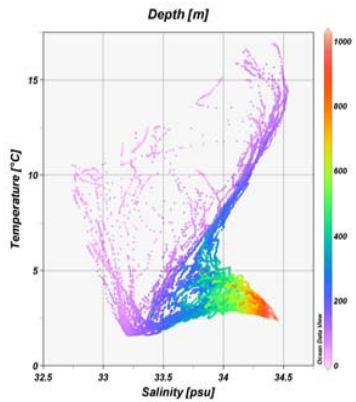
http://www.satellite.dvo.ru

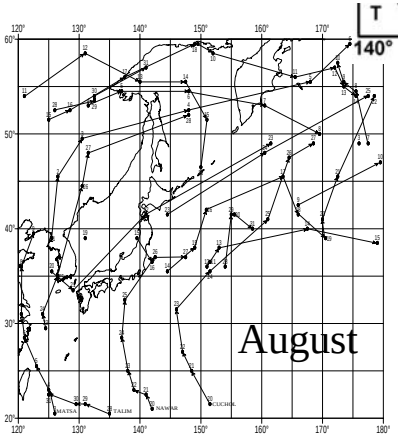


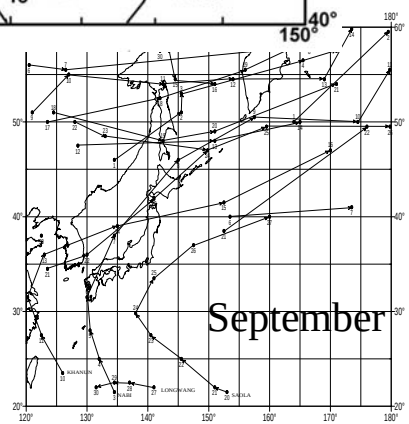
Cosm. Meth.Lab, TINRO

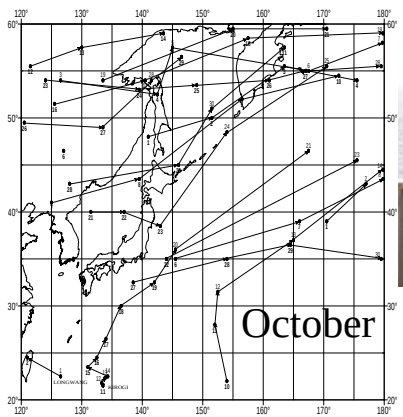




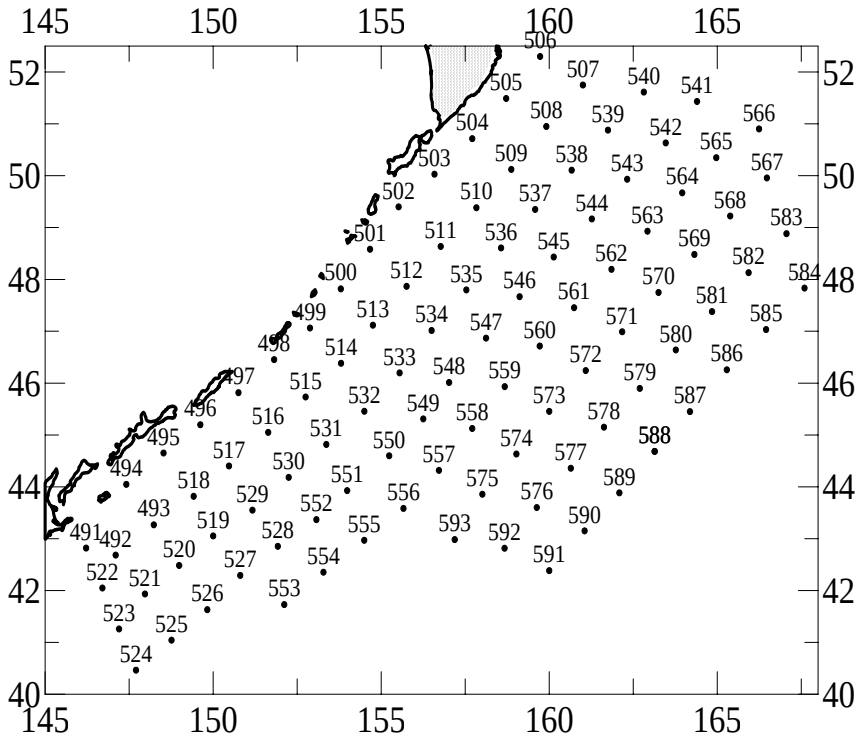




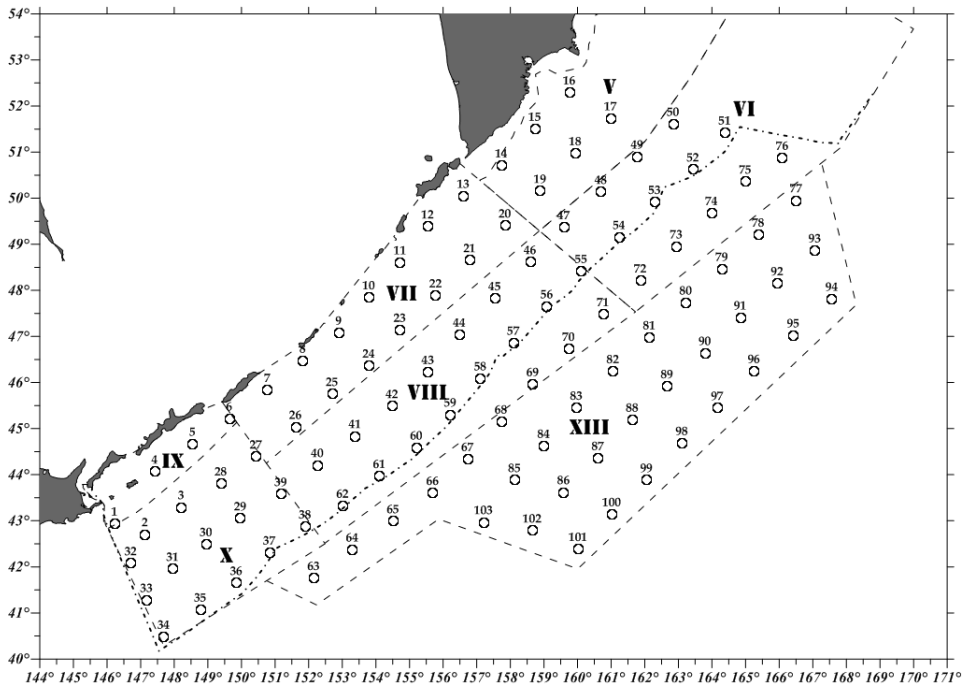




R/V "Professor Kaganovsky" survey in 2014 (June 2–July 8): CTD, plankton net, pelagic trawl, acoustic survey



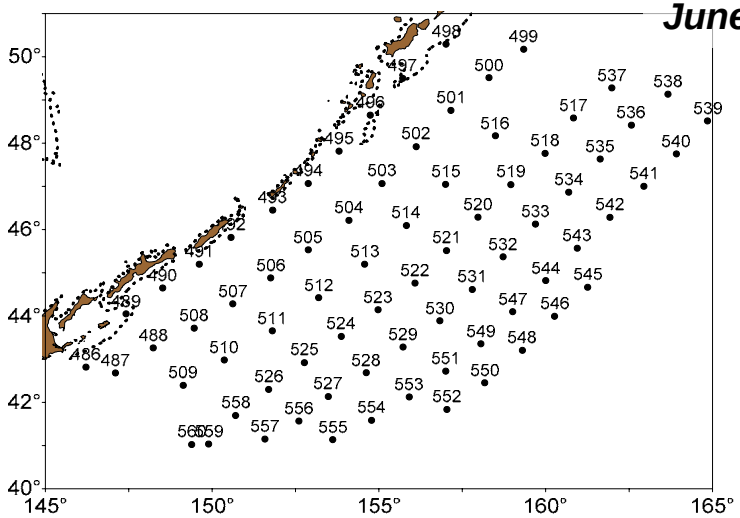
Oceanographic stations



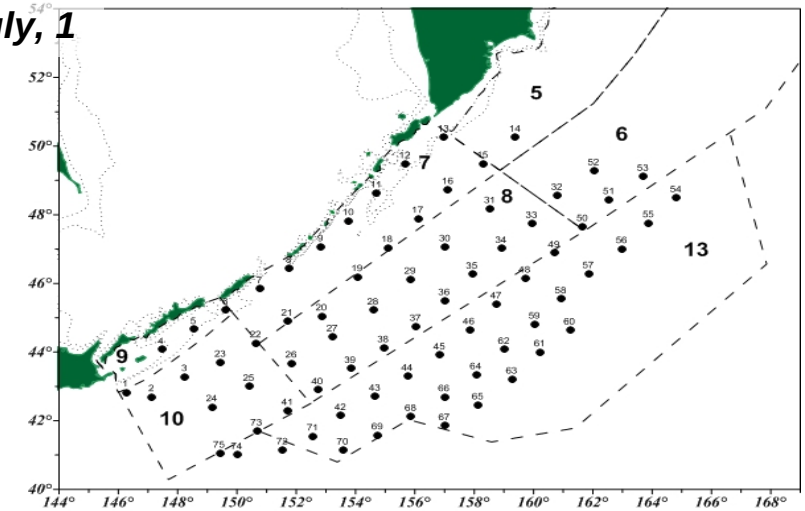
Trawl stations

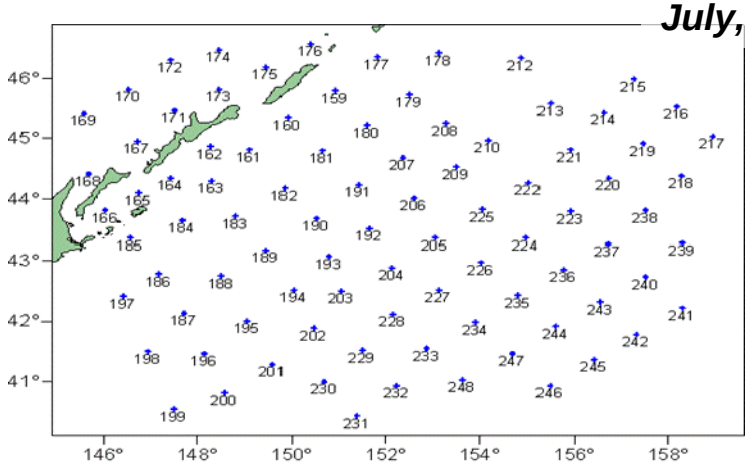
Roman numerals: biostatistical areas number.
Dotted lines: boundaries of the areas

R/V "Professor Kaganovsky" and *R/V "Professor Levanidov"* surveys in 2015 : CTD, plankton net, pelagic trawl, acoustic survey

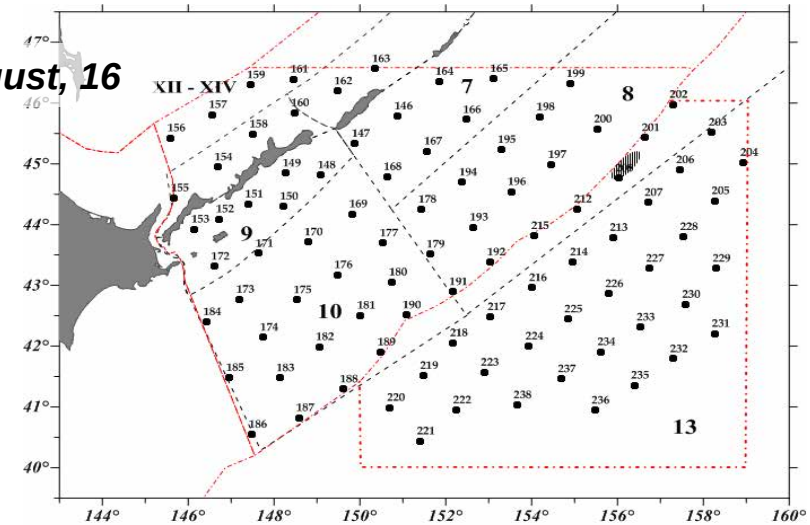


June, 1 – July, 1





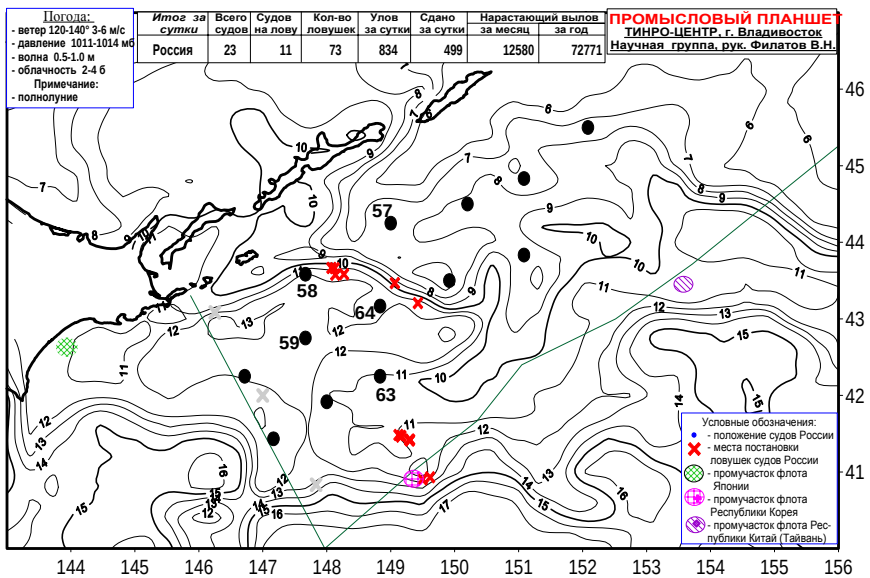
July, 22 – August, 16

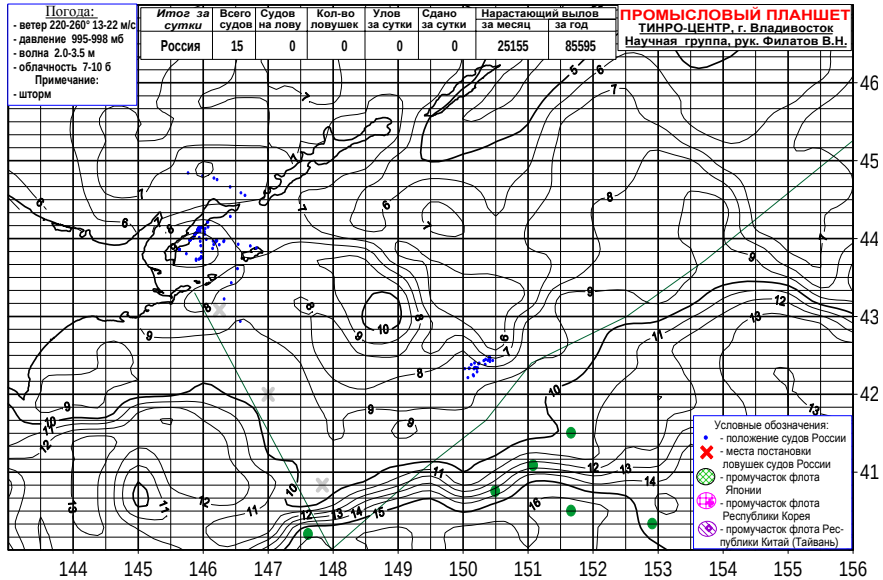


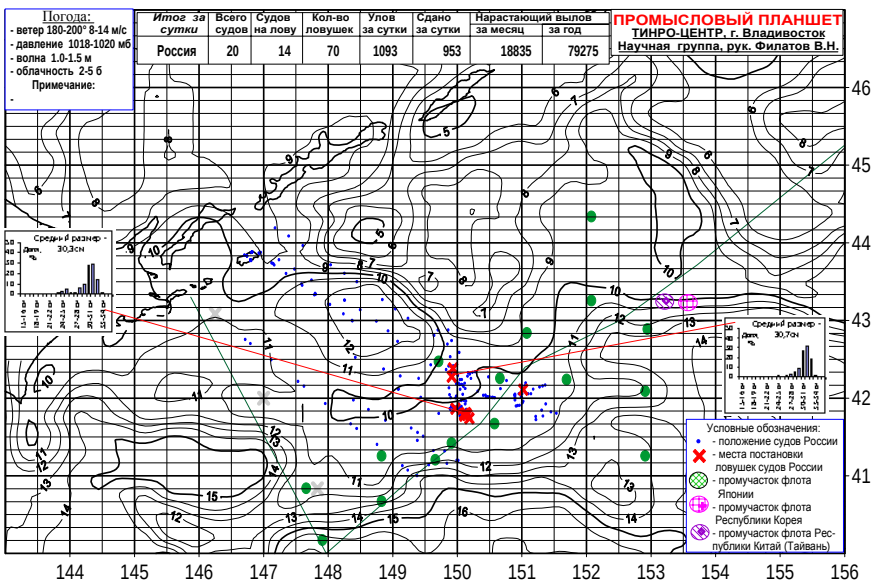
Oceanographic stations

Trawl stations

Oceanographic stations of R/V «Professor Kaganovsky» on the Fishery worksheets

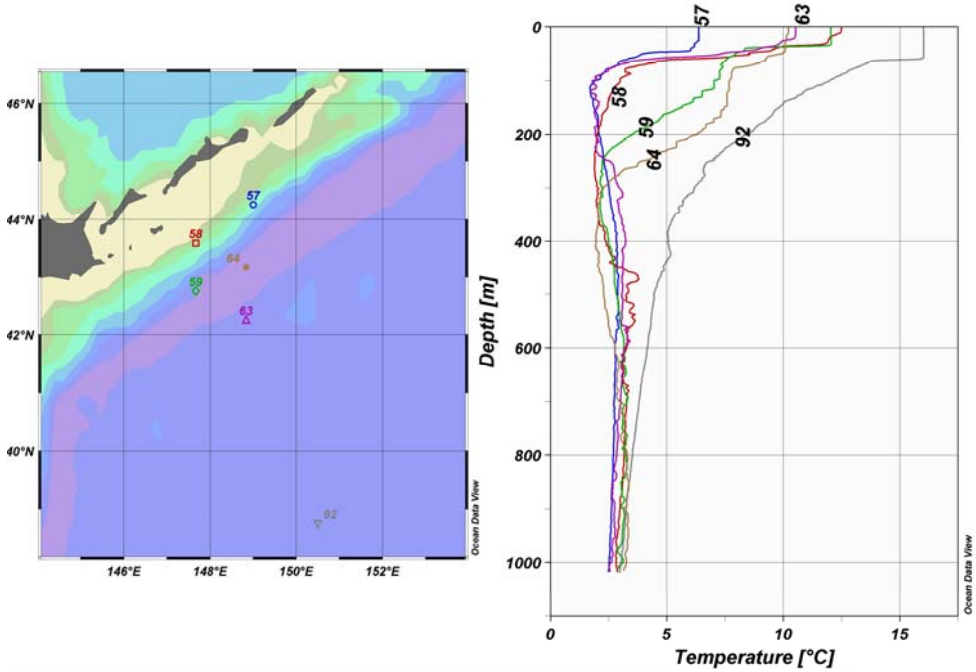






Although the surveis are not eddy-resolution, we can analyzed waters properties in the different mesoscale structures.

Hydrological station are shown by circles.

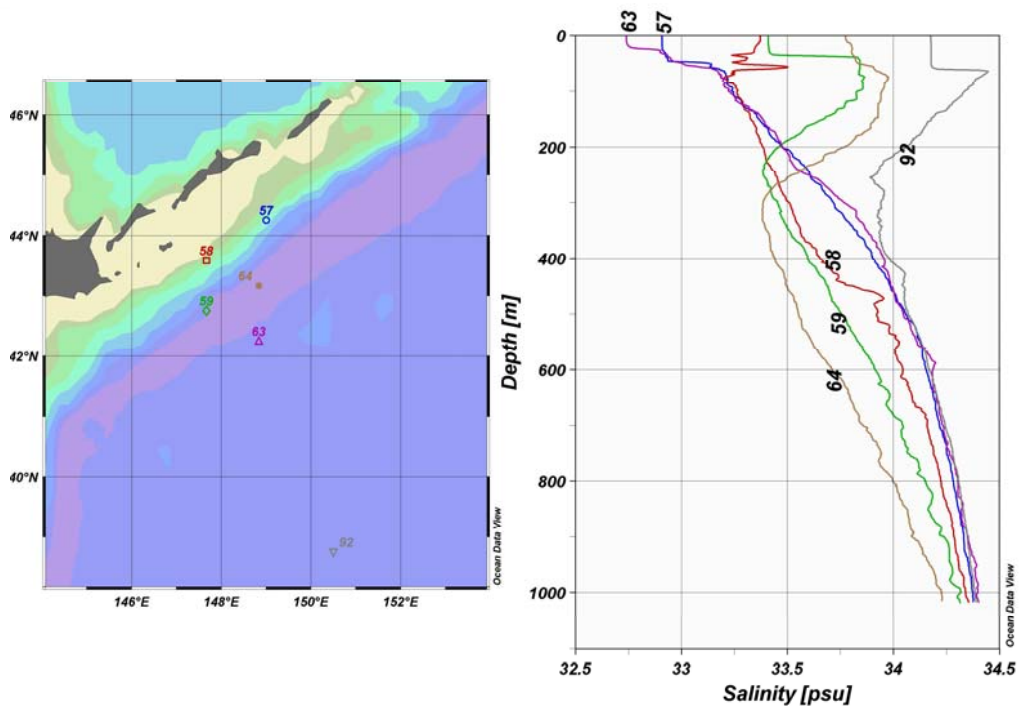


Vertical distribution of T and S in the subtropical waters (St 92),

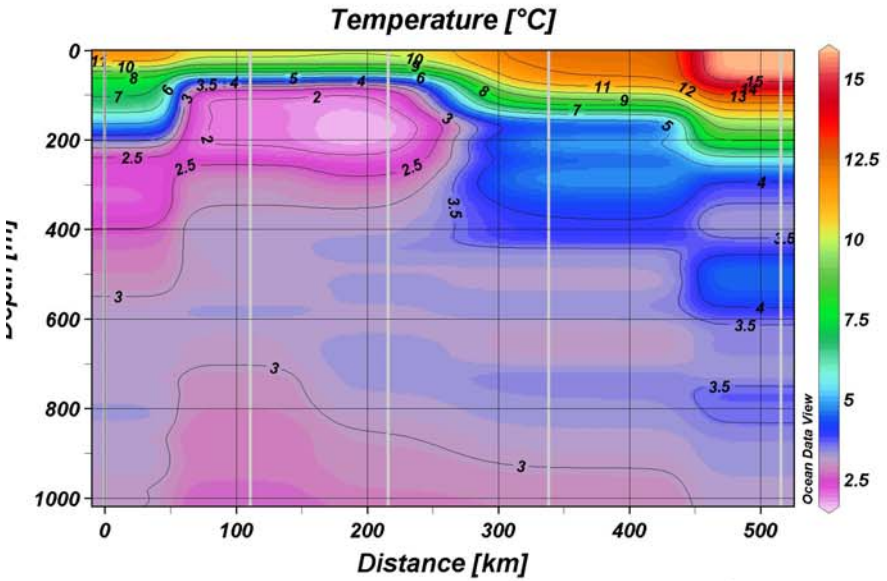
in anticyclonic eddy (St 58, 59, 64),

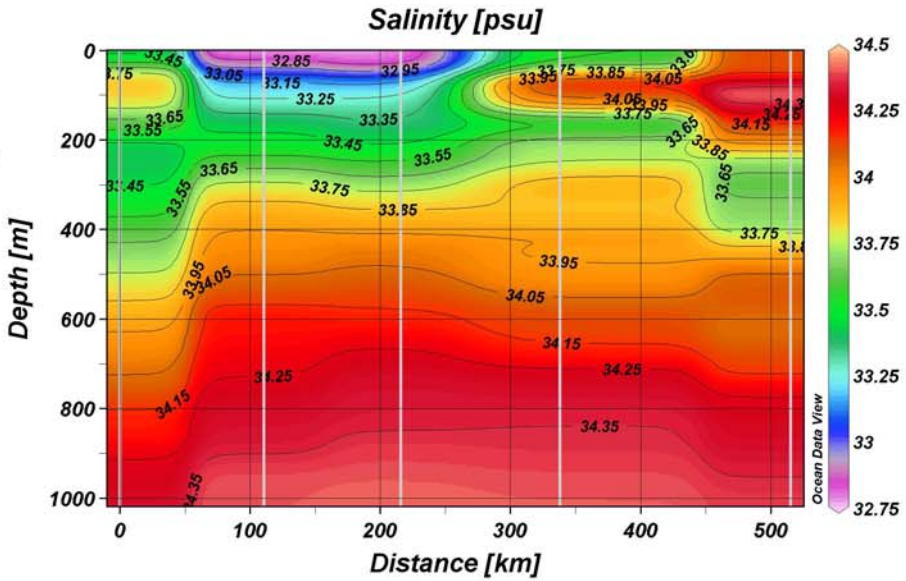
in Oyashio waters (St 57)

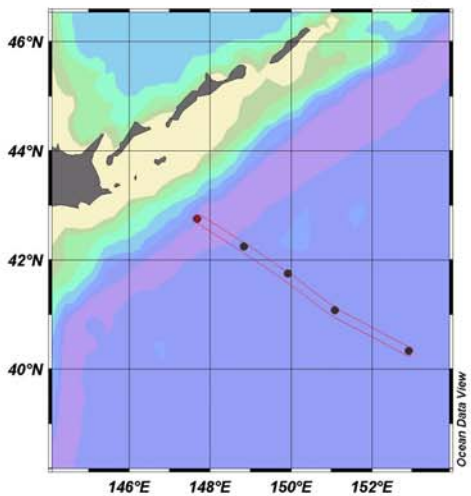
and in second branch of the Oyashio (St 63)

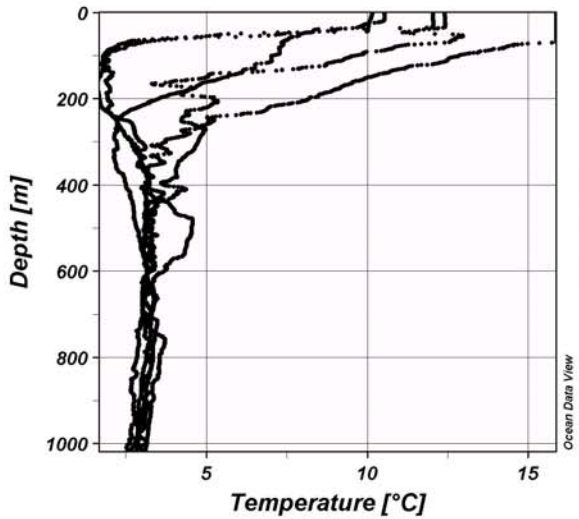


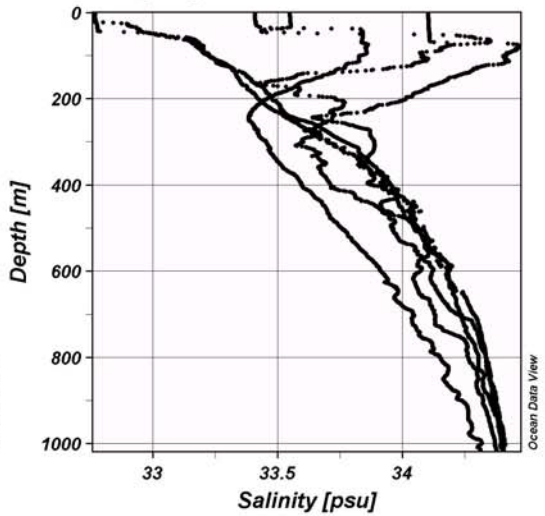
T and S on the Section (from center of anticyclonic eddy)

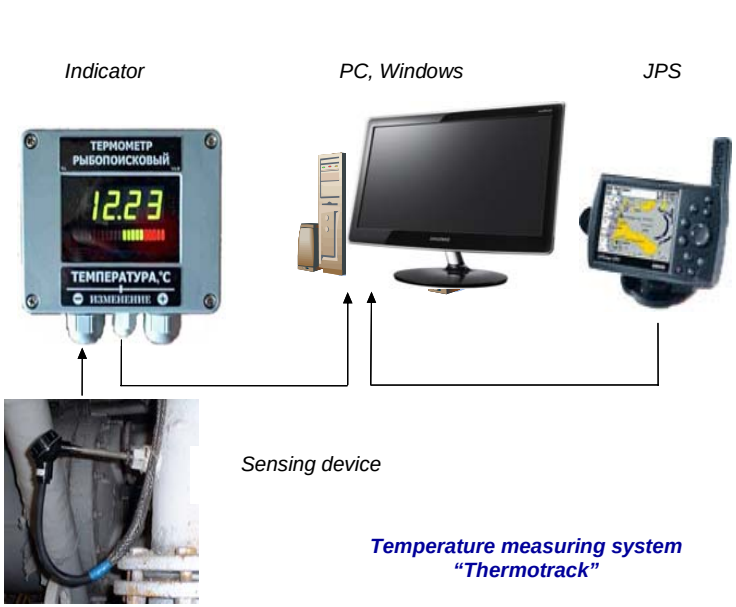






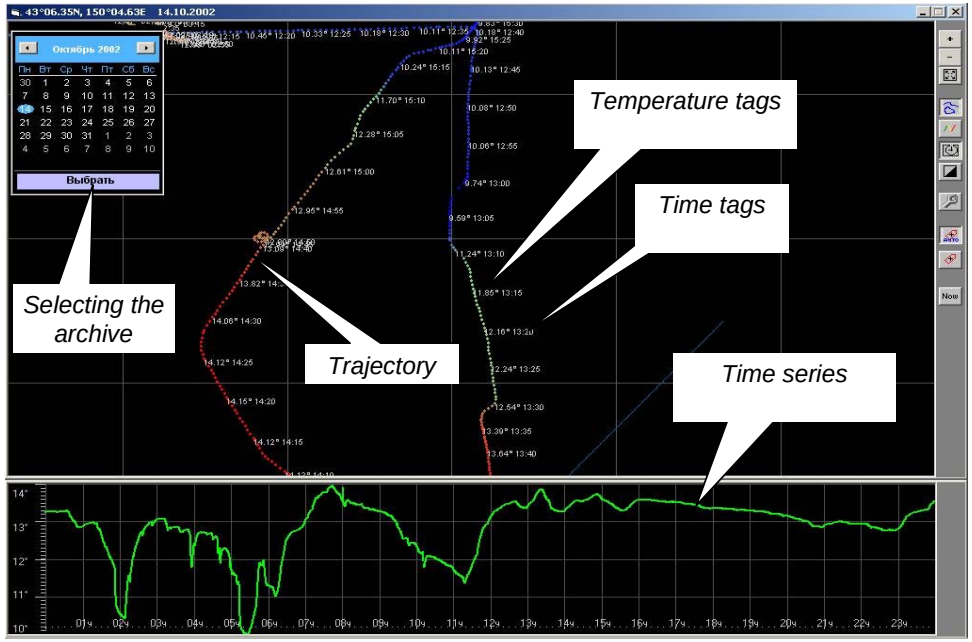






Temperature measuring system "Thermotrack"

Filatov *et al*, 2011

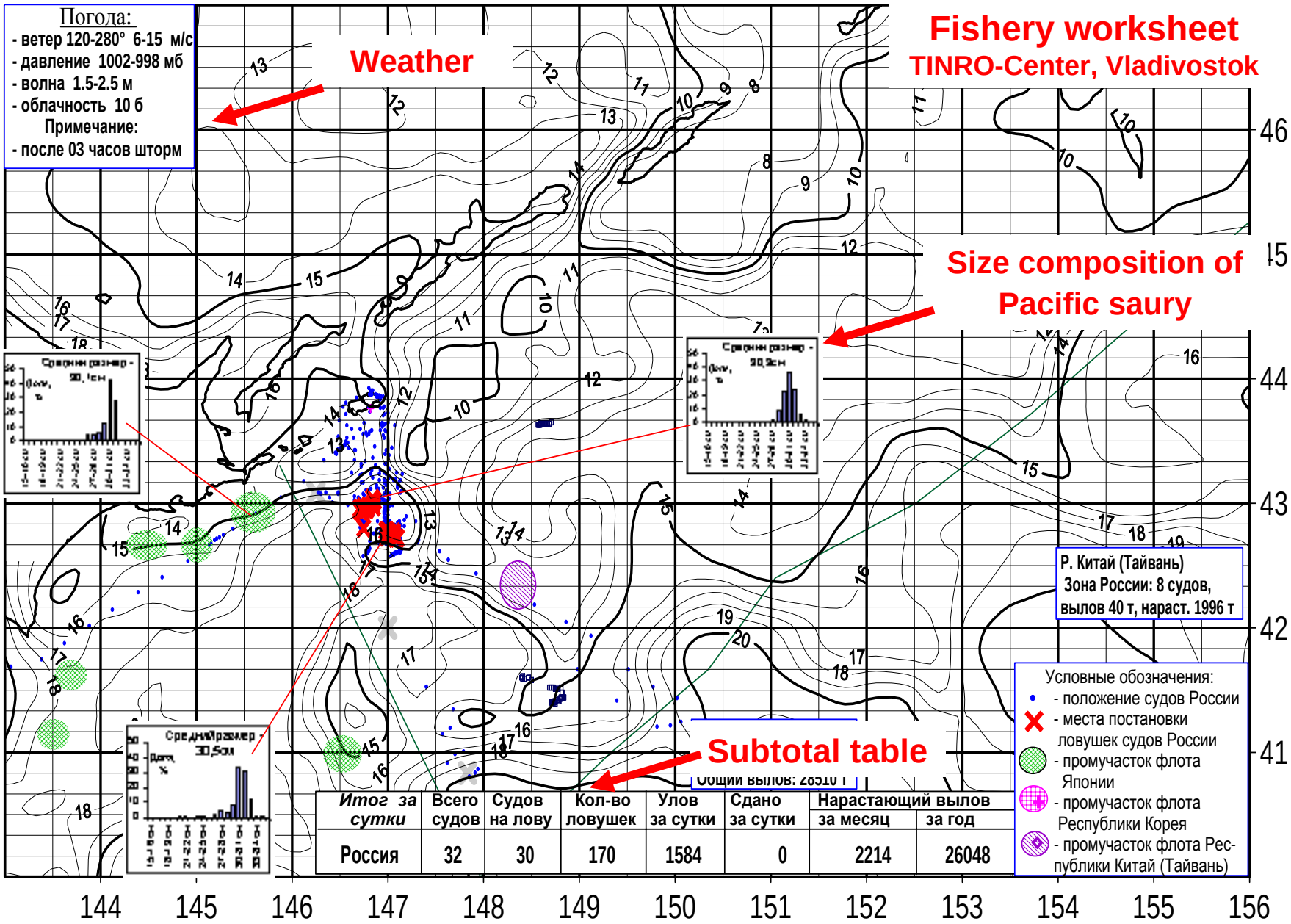


Visualization temperature measurements by "Thermotrack" on the monitor PC as map (track-time) and diagram

Data obtained *in situ* by temperature measuring system "Thermotrack"

Sea surface temperatures are monitored with accurate, calibrated temperature sensors on fishing vessels.
Usage of SST data obtained in situ allowed us to improve the SST fields derived from satellite data directly in the fishing area and to reveal local ocean conditions (areas of the fronts, the individual eddies, etc.).

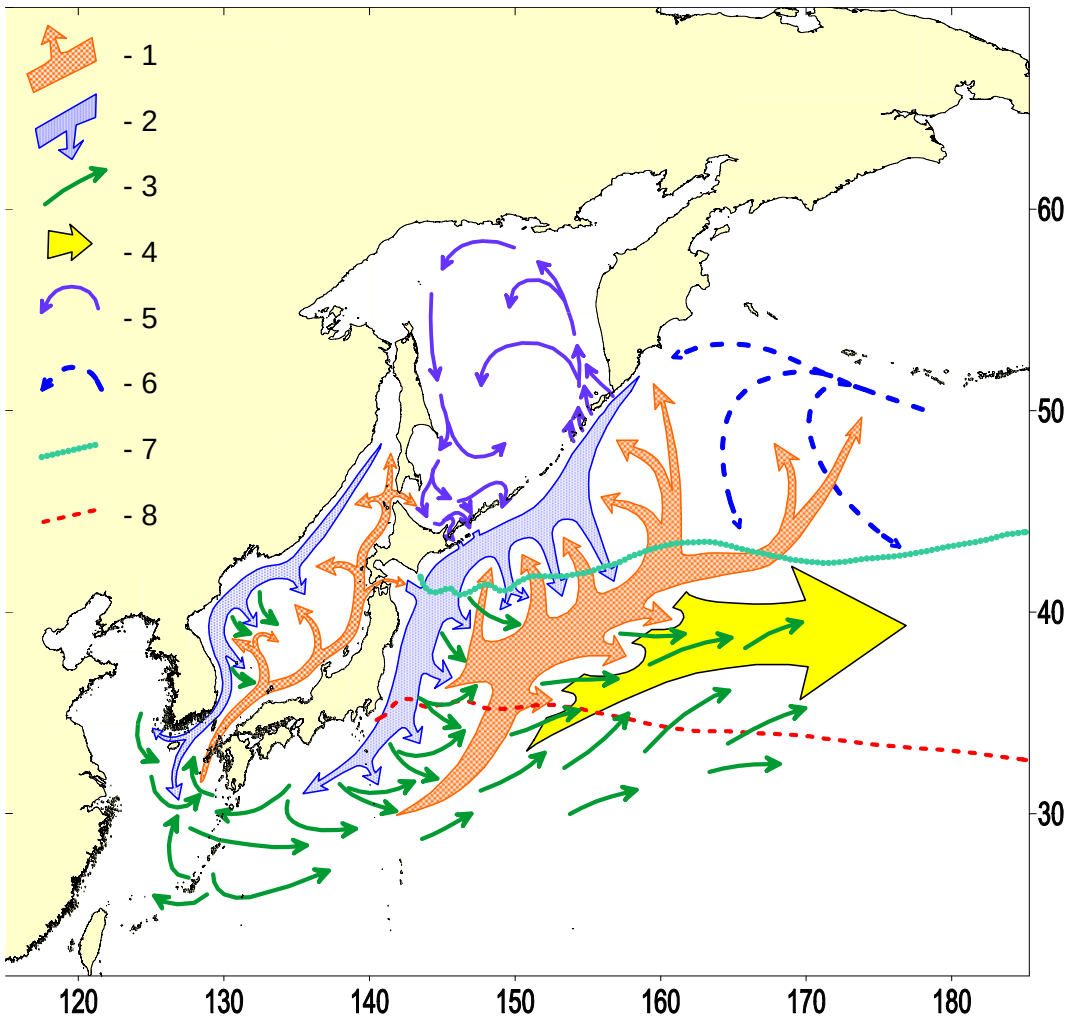
Operational fisheries oceanography: example of Fishery worksheet



Итог за сутки	Всего судов	Судов на лову	Кол-во ловушек	Улов за сутки	Сдано за сутки	Нарастающий вылов	
						за месяц	за год
Россия	32	30	170	1584	0	2214	26048

General scheme of saury migrations in the North-West Pacific:

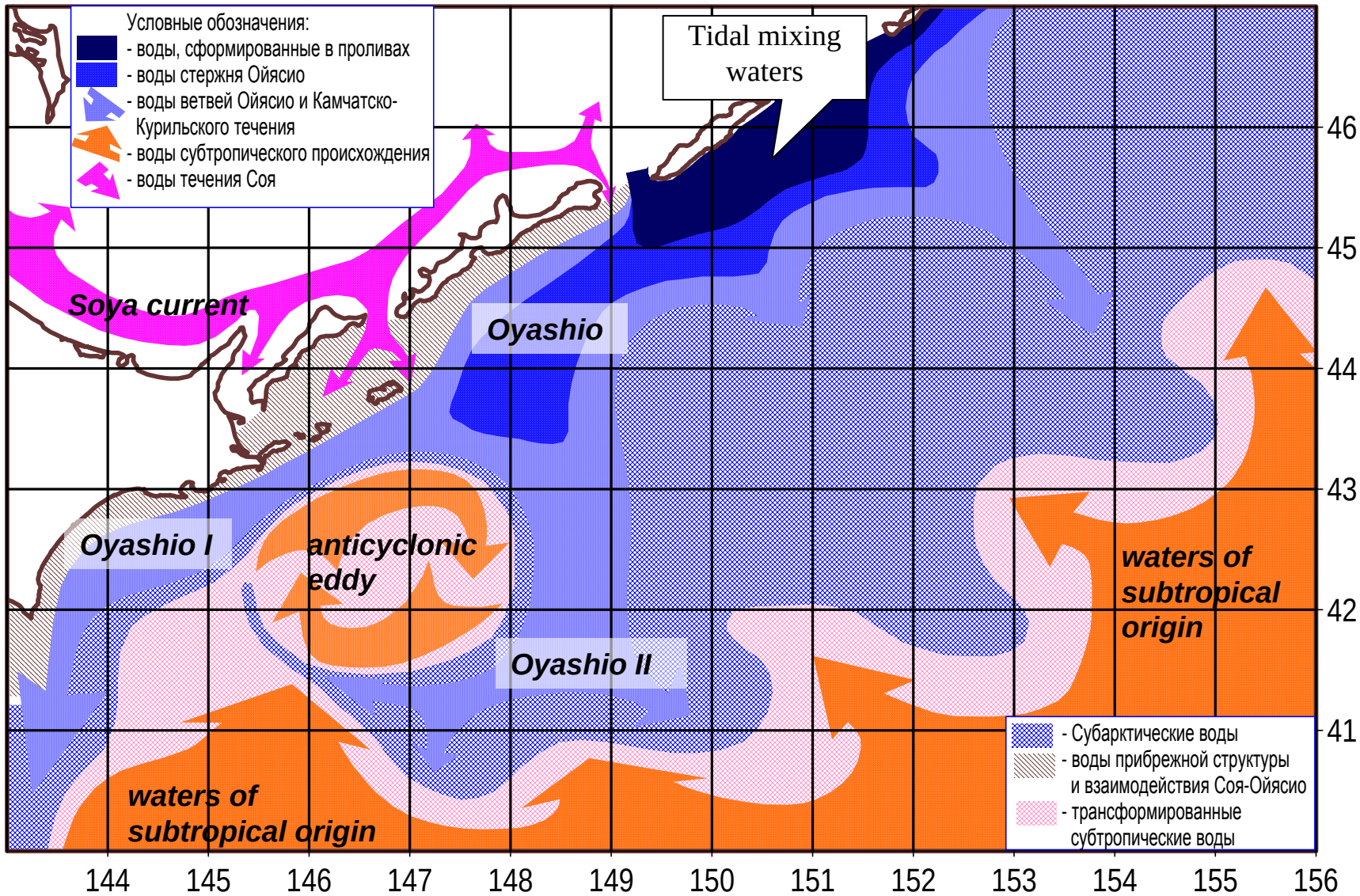
1 – spring-summer migrations; 2 – autumn migrations; 3 – transport of eggs and larvae; 4 – transport of juveniles (for winter spawning);
5 – unstable migrations in the Okhotsk Sea; 6 – migrations from «north ocean water»; 7 – North Subarctic Front; 8 – Kuroshio Front



There are some physiological aspects: Saury avoids areas with a high concentration of phytoplankton. We think that high abundance of phytoplankton obscures its vision. Saury feeds large zooplankton.
For successful fishing saury must be hungry, because a well-fed saury does not react to light.

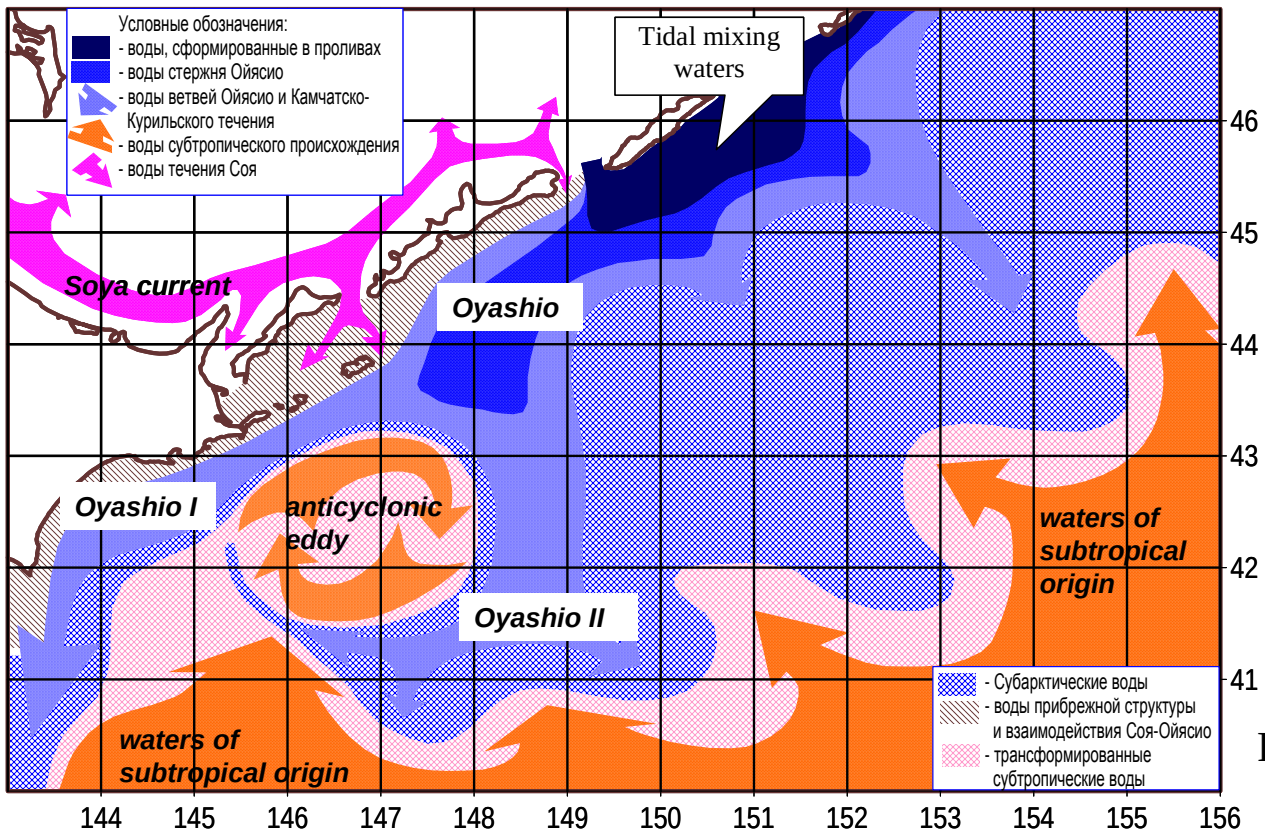
Filatov et al., 2011

Key oceanographic structures in the Kuril region



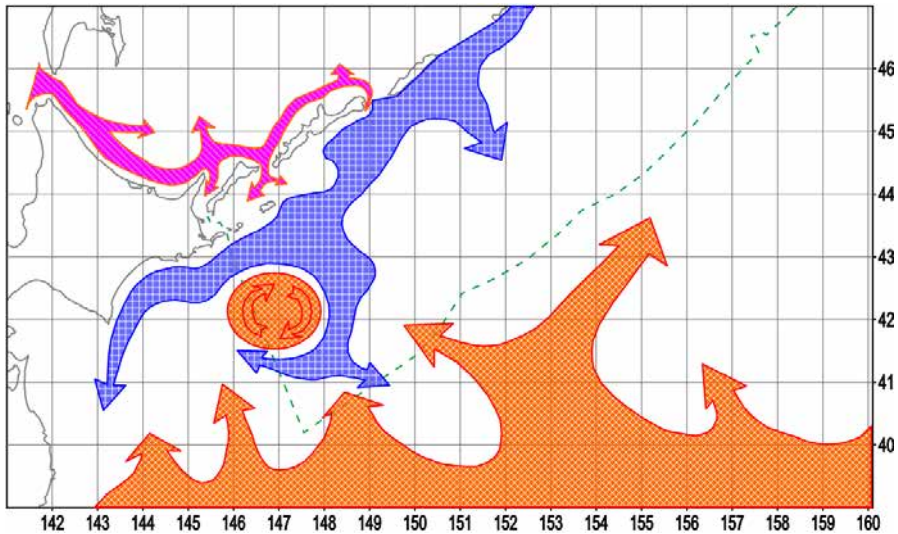
Filatov *et al*, 2011

The role of mesoscale structures in the fishing grounds formation is shown on the basis of experience of saury fishing scientific support implemented by TINRO-Center in the Northwestern Pacific. The region is characterized by strong mesoscale variability associated with the Oyashio current branches, anticyclonic and cyclonic eddies, processes of frontogenesis and frontolysis. The presence of warm anticyclonic eddy is the main feature of the hydrological situation, affecting the first stage of the fishery, which is carried out in the area of the first branch Oyashio and in waters adjacent to the Kuril Islands.



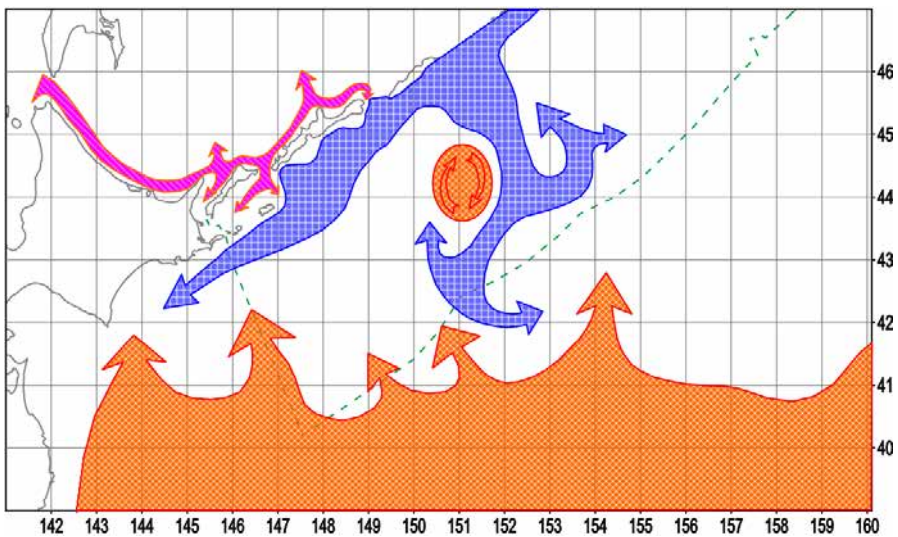
Filatov *et al*, 2011

Three types of oceanographic situations

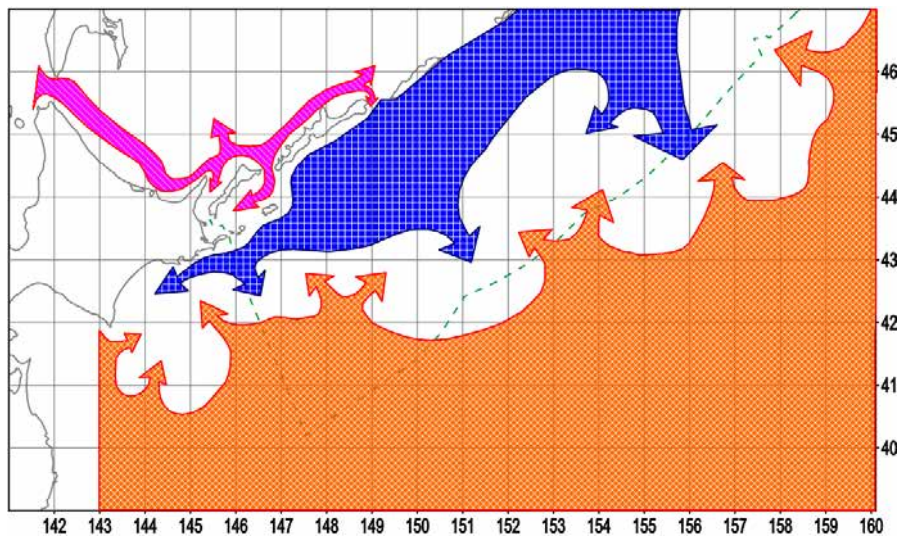


Azn eddy near islands

Filatov, 2015

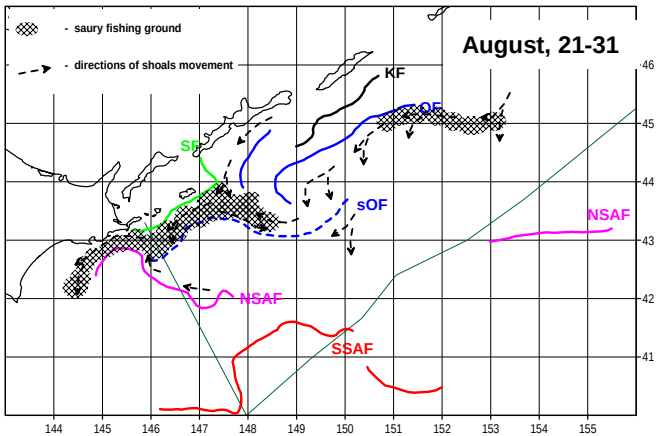


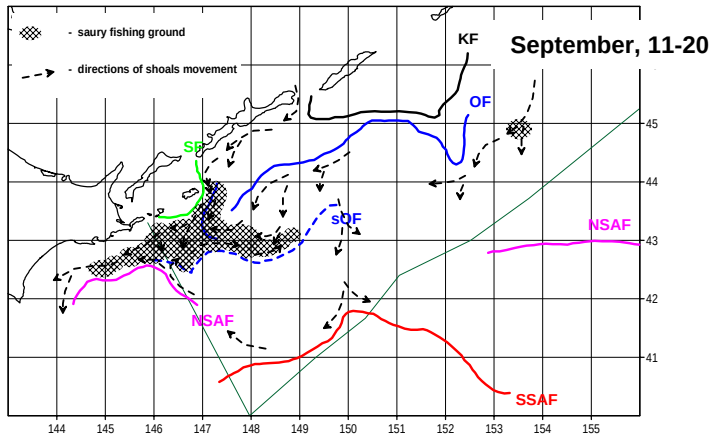
Azn eddy far from islands

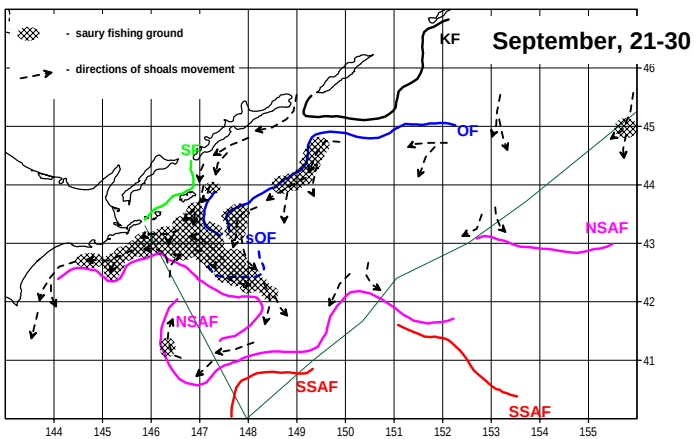


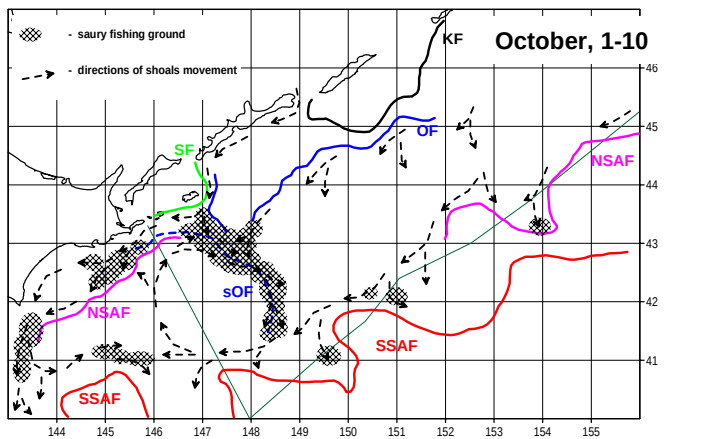
Azn eddy is absent

Position of fronts, saury fishing ground and main directions of shoals movement







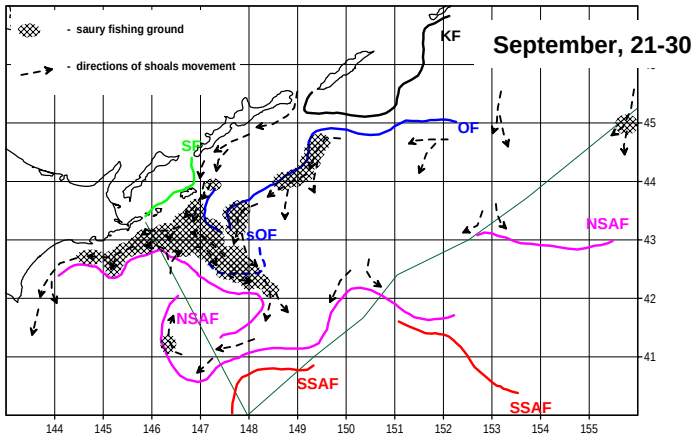


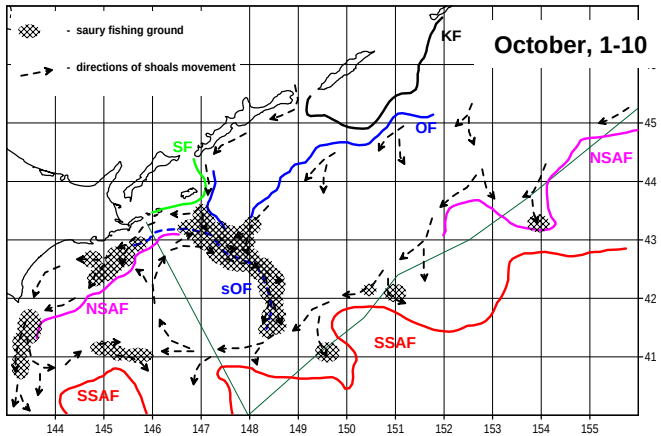
August, 21-30 – October, 1-10 2005

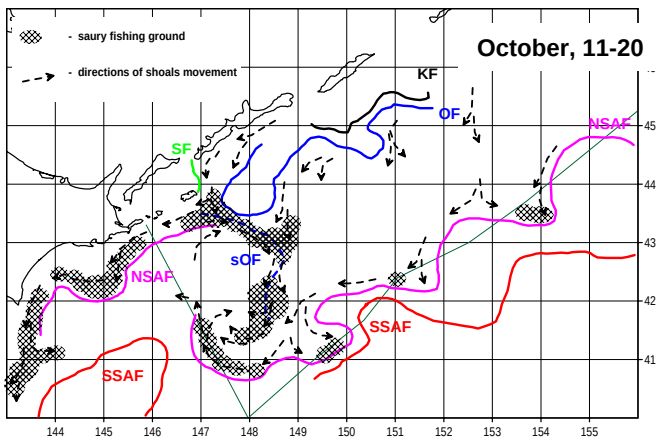
Oceanographic fronts:

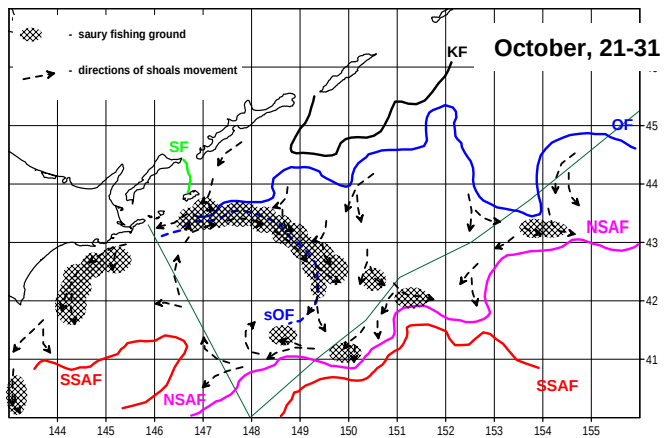
KF – Kuril Front, OF – Oyashio Front, sOF – secondary Oyashio Front, SF – Soya Front, NSAF – North Subarctic Front, SSAF - South Subarctic Front

Position of fronts, saury fishing ground and main directions of shoals movement







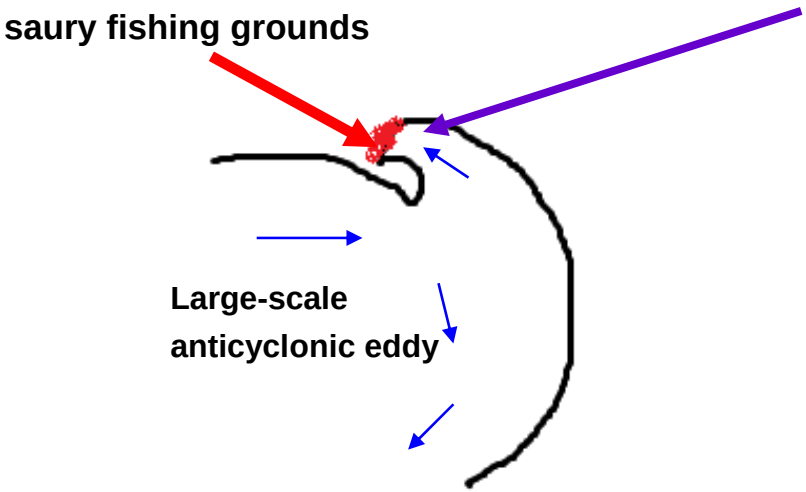


September, 21-30 – October, 21-31 2005

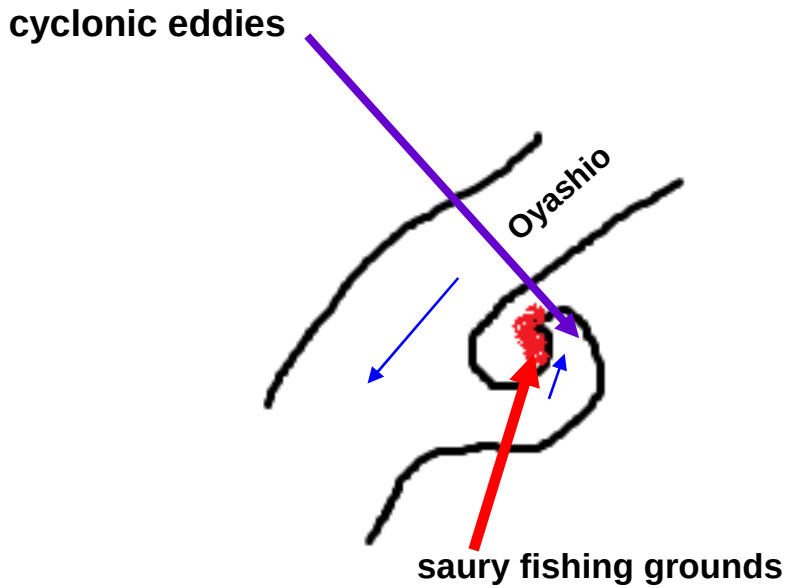
Oceanographic fronts:

KF – Kuril Front, OF – Oyashio Front, sOF – secondary Oyashio Front, SF – Soya Front, NSAF – North Subarctic Front, SSAF - South Subarctic Front

Submesoscale inhomogeneities



Cyclonic submesoscale eddy on the anticyclonic eddy boundary



Cyclonic eddy to the left of Oyashio current

The average duration of sustainable fishery is ~1 week for cyclonic eddies (~18 km), and 1-2 days for submesoscale eddies.

Summary

1. Important factor determining of the large-scale saury distribution and the concentration of fisheries activity is the presence and the position of the large anticyclonic eddy (diameter ~160-190 km) off east Hokkaido Island in summer and autumn. This eddy affects the saury fishery during several months.

2. In some cases it is possible to trace the inflow of cold water with very different biological characteristics in the center of this eddy leading to the formation of local fronts inside it, where saury fishery has been successful during 1 week.

3. The average duration of sustainable fishery is ~1 week for cyclonic eddies (~18 km), and 1-2 days for submesoscale eddies.

4. Operational detection of high-gradient frontal zones is based on SST and altimetry data. Usage of SST data obtained in situ by research and fishing vessels allowed us to improve the SST fields in the fishing area and to identify the local and submesoscale inhomogeneities promising for fishery (areas of the fronts, individual eddies, etc.) and to trace their evolution.

Thank you for attention!