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Makoto Okazaki, Masachika Masujima, Hiroto Murase  
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# Oceanographic conditions in the survey area of JARPNII coastal component off Kushiro in September from 2000 to 2013 using FRA-ROMS data

MAKOTO OKAZAKI<sup>1</sup>, MASACHIKA MASUJIMA<sup>1</sup>, HIROTO MURASE<sup>2</sup> AND KENJI MORINAGA<sup>2</sup>

<sup>1</sup> National Research Institute of Fisheries Science, Fisheries Research Agency (FRA), 2-12-4 Fukuura, Kanazawa, Yokohama, Kanagawa 236-8648, Japan

<sup>2</sup> National Research Institute of Far Seas Fisheries, Fisheries Research Agency (FRA), 2-12-4 Fukuura, Kanazawa, Yokohama, Kanagawa 236-8648, Japan

## ABSTRACT

Oceanographic conditions in the survey area of JARPNII coastal component off Kushiro were study by using FRA-ROMS data. FRA-ROMS is an ocean forecast system developed by Fisheries Research Agency (FRA) based on Regional Ocean Modeling System (ROMS). Spatial distributions of four water types (Oyashio, cold, warm and Kuroshio) around Kushiro in September from 2000 to 2013 was qualitatively investigated using the data. Oyashio was dominant water type in subsurface in the survey area. Mean water temperate at 10 m deep in the survey in September was generally decreased from 2000 to 2004 then increased to 2006. It decreased again to 2009. It was relatively stable from 2009 to 2013. Spatial distribution of water temperate at 10 m deep was highly variable from year to year.

## INTRODUCTION

The second phase of the Japanese Whale Research Program under Special Permit in the North Pacific (JARPNII) has been conducted since 2000. The survey in the first two years (2000 and 2001) was conducted as a feasibility study and then it has been conducted as a full scale research since 2003. Coastal component off Kushiro has been conducted since 2002. Main target species is common minke whale (*Balaenoptera acutorostrata*). Maximum range of the sampling survey is set as 50 n.miles from Kushiro but sampling is typically conducted within 30 n.miles (Fig. 1). Sighting surveys were also conducted around the sampling survey area. The surveys were conducted mainly in September.

Waters off Kushiro serve as a fishing ground for commercially important species such as Japanese sardine (*Sardinops melanostictus*), Japanese anchovy (*Engraulis japonicus*), Pacific saury (*Cololabis saira*), chub mackerel (*Scomber japonicus*), walleye Pollock (*Theragra chalcogramma*) and Japanese common squid (*Todarodes pacificus*). These species are also consumed by common minke whales as prey (Konishi *et al.*, 2009; Tamura and Fujise, 2002; Tamura *et al.*, 1998; Tamura *et al.*, 2016: SC/F16/JR17). It is expected that oceanographic conditions affect availability of prey for common minke whales.

In this paper, it is investigated that whether oceanographic conditions off Kushiro in September were changed from 2000 to 2013 by using FRA-ROMS data. FRA-ROMS is an ocean forecast system developed by Fisheries Research Agency (FRA) based on Regional Ocean Modeling System (ROMS).

## MATERIALS AND METHODS

Monthly mean water temperature at 100 and 200 m deep off Kushiro in September from 2000 to 2013 were prepared using data extracted from FRA-ROMS. Four water types were classified based on following criteria:

Oyashio water: Area where water temperature at 100 m deep is lower than 5°C

Cold water: Area where water temperature at 100 m deep is higher than 5°C and lower than 10°C

Warm water: Area where water temperature at 100 m deep is higher than 10°C and water temperature at 200 m deep is lower than 14°C

Kuroshio water: Area where water temperature at 200 m deep is higher than 14°C

The criteria is conventionally used by FRA for the purpose of oceanographic and fisheries forecast. Maps of the water types were prepared. Changes in spatial distributions of the water types were investigated qualitatively by these maps

Monthly mean water temperature at 10 m deep off Kushiro in September from 2000 to 2013 were also prepared using data extracted from FRA-ROMS with an expectation that local distribution of small pelagic fish are more related to water temperature at shallow depth. Mean temperatures at 10 m deep in the three types of survey areas (30 and 50 n.miles from Kushiro, and sighting survey area) were calculated.

## RESULTS AND DISCUSSION

Maps of water types in September from 2000 to 2013 are shown in Fig. 2. Oyashio was dominant in Kushiro in that period although year to year variations and spatial heterogeneity of distribution of water types were observed. Maps of water temperature at 10 m deep in September from 2000 to 2013 are shown in Fig. 3. Spatial distribution of water temperature at 10 m deep was highly variable from year to year. Trends of mean temperatures at 10 m deep in the three types of survey areas (30 and 50 n.miles from Kushiro, and sighting survey area) are shown in Fig. 4. Temperatures are slightly different among the areas but the trends are similar. It was generally decreased from 2000 to 2004 then increased to 2006. It decreased again to 2009. It was relatively stable from 2009 to 2013.

Overall, the results of this study implied that Oyashio was dominant water type in subsurface around Kushiro in September from 2000 to 2013 while temperature at 10 m deep was highly variable in the period.

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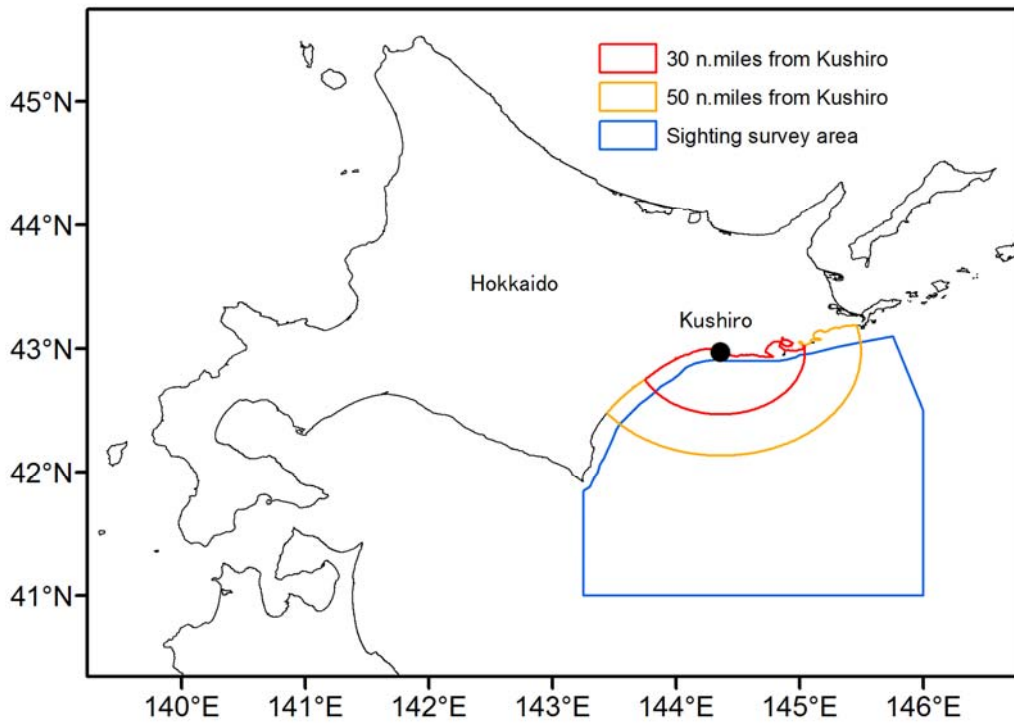


Fig. 1. Survey areas of JARPNII coastal component off Kushiro. Red area: 30 n.miles from Kushiro port (typical range of sampling survey); orange area: 50 n.miles from Kushiro port (maximum range of sampling survey); blue area: sighting survey area.

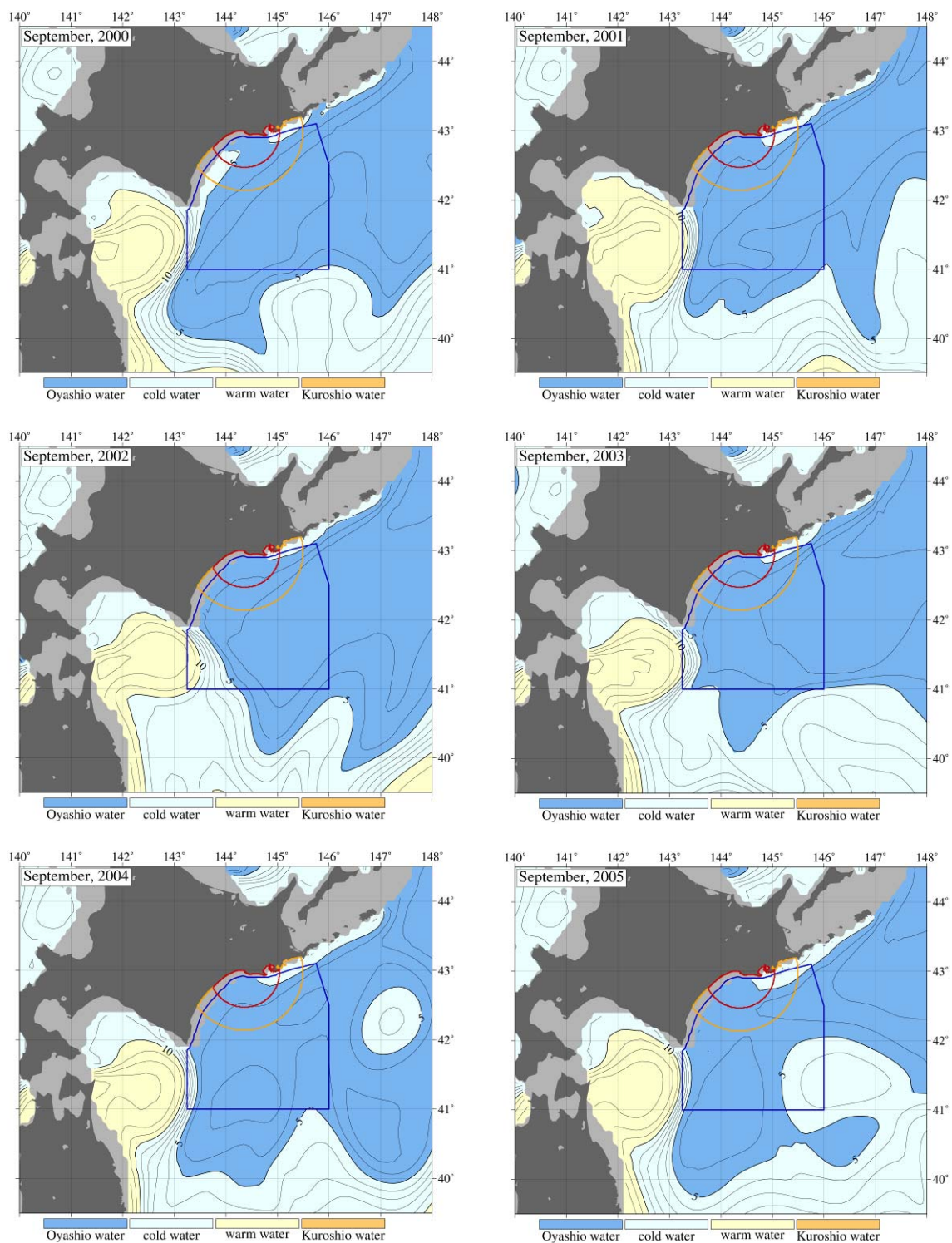


Fig. 2. Water temperature at 100 m deep in the survey areas of JARPNII coastal component off Koshiro in September from 2000 to 2005. Four water types (Oyashio, cold and warm) are shown in the maps. Red area: 30 n.miles from Koshiro port (typical range of sampling survey); orange area: 50 n.miles from Koshiro port (maximum range of sampling survey); blue area: sighting survey area.



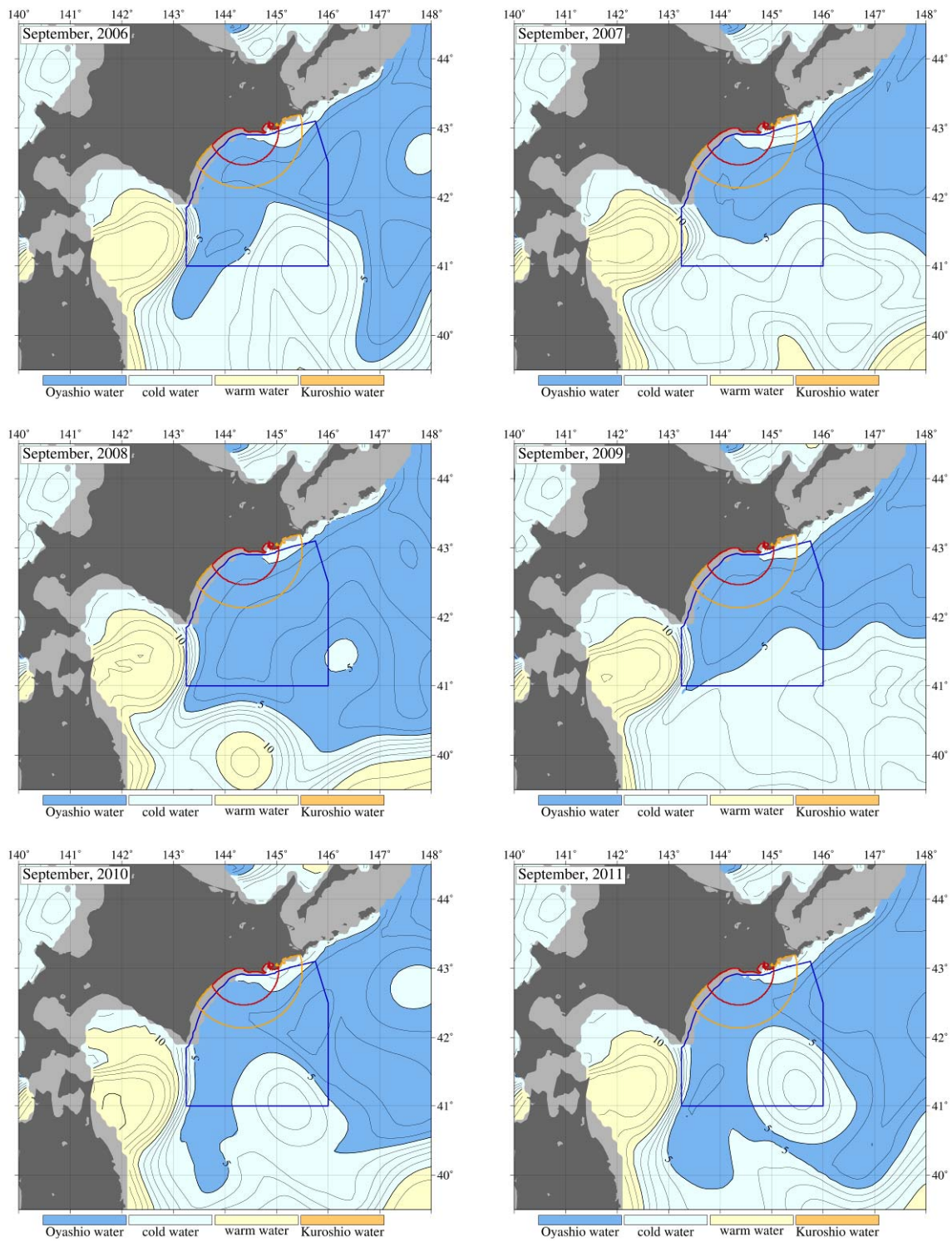


Fig. 2. (Continued)

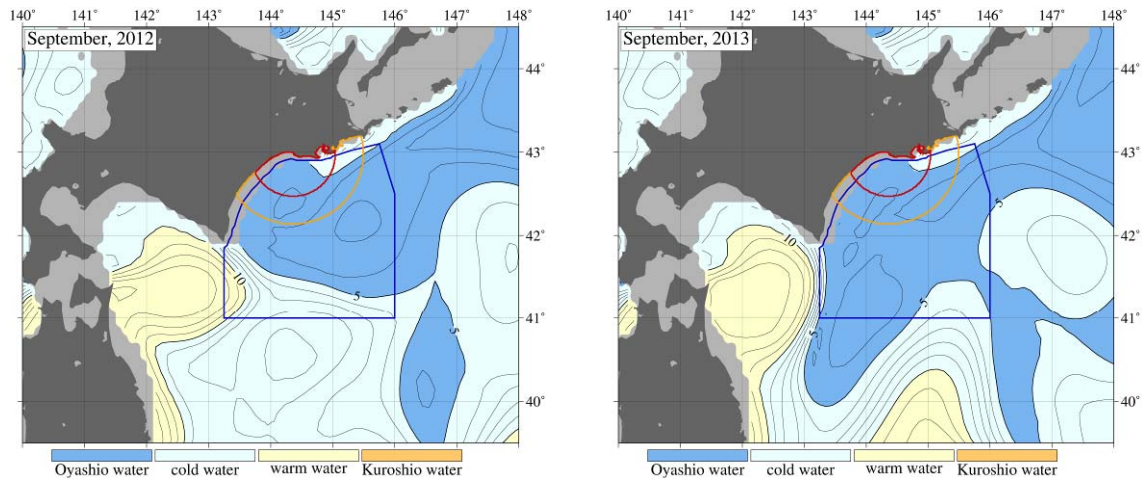


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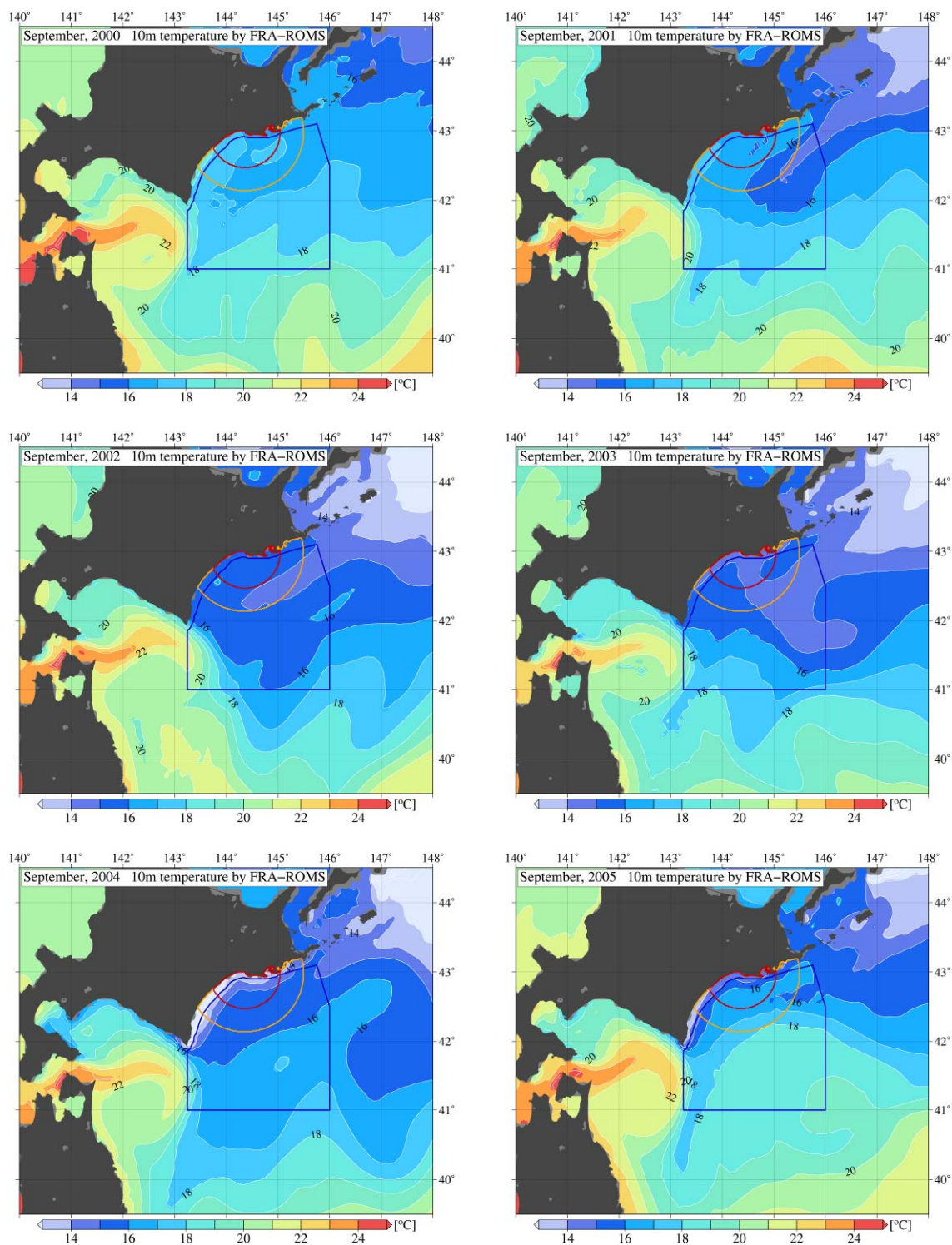


Fig. 3. Water temperature at 10 m deep in the survey areas of JARPNII coastal component off Kushiro in September from 2000 to 2013. Four water types (Oyashio, cold and warm) are shown in the maps. Red area: 30 n.miles from Kushiro port (typical range of sampling survey); orange area: 50 n.miles from Kushiro port (maximum range of sampling survey); blue area: sighting survey area.



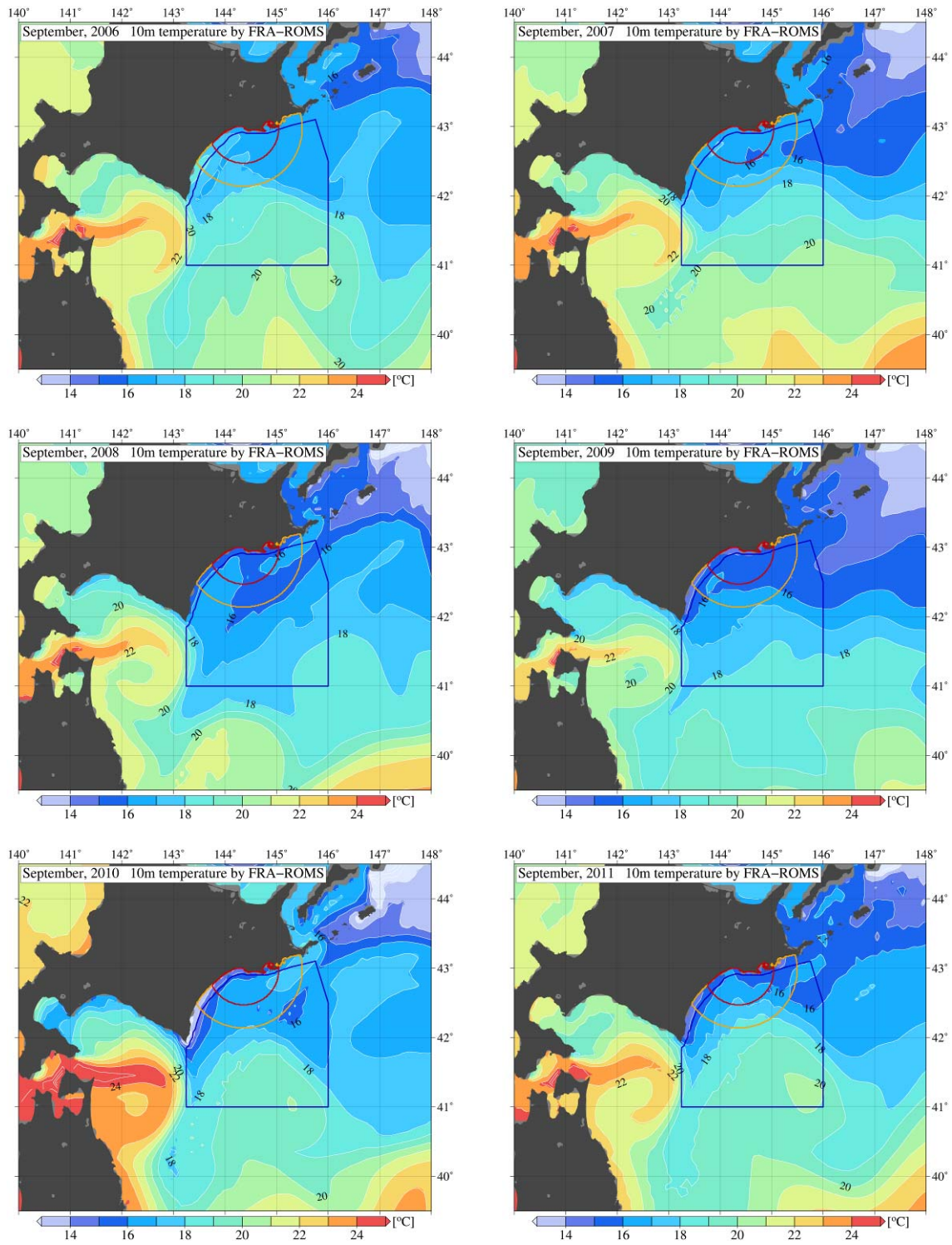


Fig. 3. (Continued).

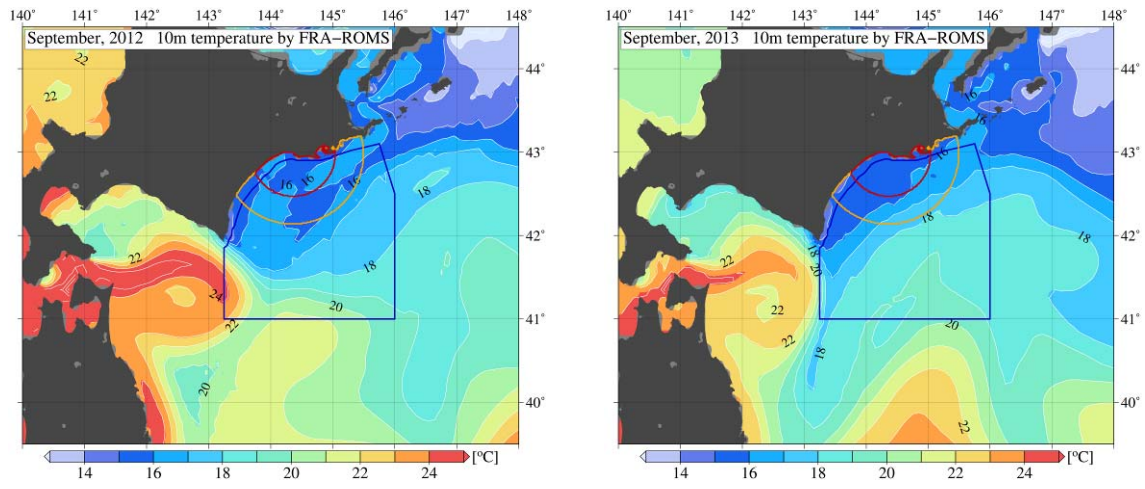


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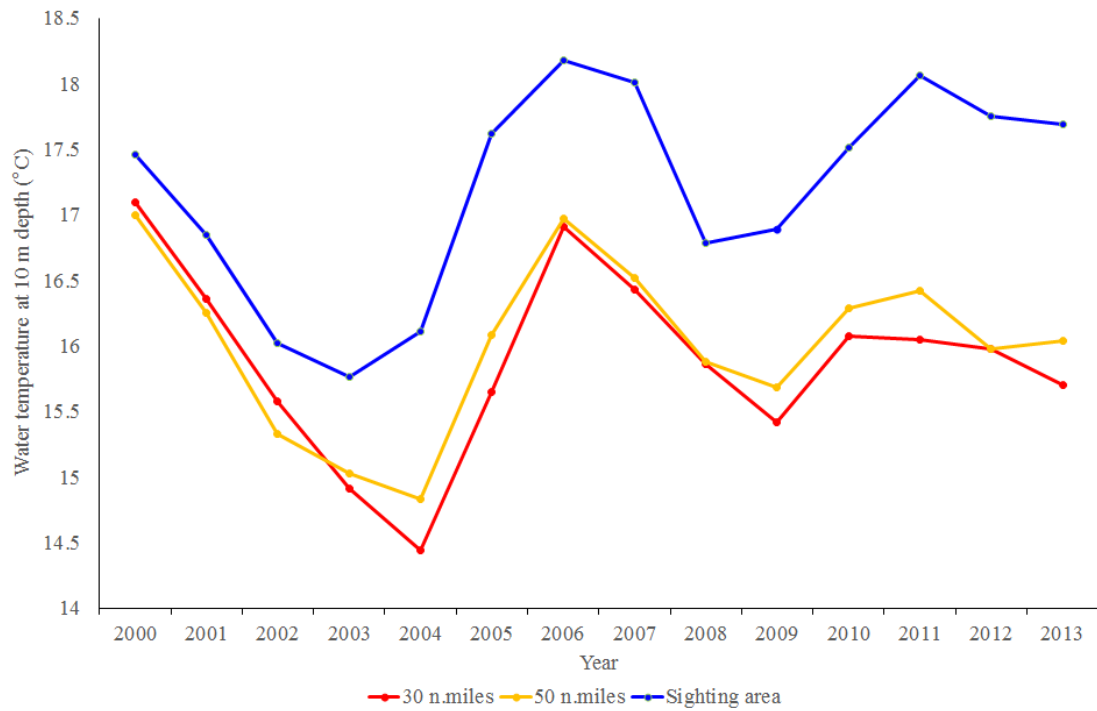


Fig. 4. Trends of mean water temperature at 10 m deep in the survey areas of JARPNI coastal component off Kushiro in September from 2000 to 2013. Red: 30 n.miles from Kushiro port (typical range of sampling survey); orange: 50 n.miles from Kushiro port (maximum range of sampling survey); blue: sighting survey area.