AN OCEAN MONITORING PROGRAM AROUND JAPAN: A SENSOR FOR CLIMATE/ENVIRONMENT VARIATION OF THE WESTERN NORTH PACIFIC

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1. INTRODUCTION

The western North Pacific region in the vicinity of Japan Islands is the formation region of two large-scale water masses, North Pacific Intermediate Water (NPIW) and North Pacific Subtropical Mode Water (NPSTMW). These water masses play a key roll in the North Pacific shallow overturn system, and hence have strong relation to multidecadal-scale variation of oceanic environment observed in this basin such as PDO and recent global warming. Japan Islands also face several marginal seas such as East China Sea and Japan Sea: Each of them has own long-term variation patterns independent to open western North Pacific, under the influence of large river systems and/or other coastal processes.

These oceanic regions are also known as one of the most productive area in the world oceans, having definite importance in biogeochemical cycles and oceanic ecosystems including fisheries. Ecosystems and biogeochemical cycles in these regions also show significant long-term variability, reflecting above-mentioned oceanic fluctuations. Furthermore, now they are believed to be subject of ongoing changes caused by the global warming. To monitor these existing variations and predict future changes in the around-Japan oceanic regions, and to estimate their influence to biogeochemical and /or ecological processes including fisheries, Fisheries Research Agency had started a new set of hydrographic monitoring lines covering these oceanic regions from 2002.

The monitoring network consists of four repeat observation lines, each of them corresponds to major oceanic domain around Japan (Figure 1).

Shipboard surveys are operated basically seasonally on each line, and hydrographic, biogeochemical and lower-trophic biological properties from surface down to ~3000m are observed. A part of these monitoring lines have precedently established in 1988 and already have ~20 years time length. Moreover, retrospective studies using the pre-existing public dataset enable us to analyze more longer-term changes in these oceanic regions.

So far, we have detected several long-term variations in these regions such as the followings:

2. OBSERVED LONG-TERM VARIATION IN THE AROUND-JAPAN OCEANS

2.1. enhancement of surface stratification in subarctic Western North Pacific regions

Time-series analysis of historical hydrographic data in the Oyashio domain collected from 1968 to present show significant multi-decadal decrease of oxygen content and simultaneous increase of nutrient content on isopycnal surfaces below winter mixed layer [1]. Now similar signals are also found in the wide area of the North Pacific [2-5], including Kuroshio domain and Japan Sea [6]. By data-analysis and model studies, it is concluded that these signals arise as the result of the multi-decadal decrease of winter vertical mixing in the subarctic North Pacific [7-9], which are caused by the decrease of winter surface salinity [1, 10] and corresponding enhancement of the surface stratification.

2.2. multidecadal-scale reduction of winter surface nutrient concentrations and consequent reduction of spring phytoplankton in the Oyashio domain

Simultaneously with the subsurface increase of nutrient content, multi-decadal decrease of winter surface nutrient is found in the Oyashio domain [11,12]. This reduction of nutrient consequently arises multi-decadal decrease of net community production and surface chla abundance in the spring Oyashio domain [11,13,14]. Such multidecadal reductions of surface nutrient utility [15] and phytoplankton abundance [16] are also found in the wide area of subarctic North Pacific. However, its influence to the higher level ecosystems such as zooplankton abundance are so far varied with regions and species [12,14].

2.3. High possibility for the advanced establishment of spring phytoplankton bloom after 1990s.

In parallel with the overall size-reduction trends, phenological variations are also suggested in recent spring Oyashio communities. Signal for the advanced initiation of seasonal mixed-layer shoaling was recently detected in the spring Oyashio region. Since spring bloom is developed soon after the mixed-layer shoaling in this region, this finding indirectly means early development of Oyashio spring bloom in recent years. The stage-independent time series analysis of *Neocalanus* species in Oyashio region shows that C2 abundance has been increased from 1960s to 2000s for all species, while C5 abundance time series showed negative trend in the half of investigated species. This

result suggests that the hood availability of the early-spring season has been improved despite of overall size-reduction of spring phytoplankton communities, because of the multi-decadal advance of the spring bloom establishment. Such combined effect of size/phenology variation makes zooplankton response highly diverse depending on the species and regions.

2.4. Surface stratification of East China Sea before 1990s due to the enhanced load of Yangtze River.

Hydrographic time series in the northern East China Sea shows a decreasing trend of summer surface salinity, concurrent with the increasing trend of nitrate concentration from 1950 to 2002. This trend is considered to be caused by the increasing trend of summer Yangtze River discharge [17]. Also, change in the wind fields and surface circulations caused more shorter-term variations.

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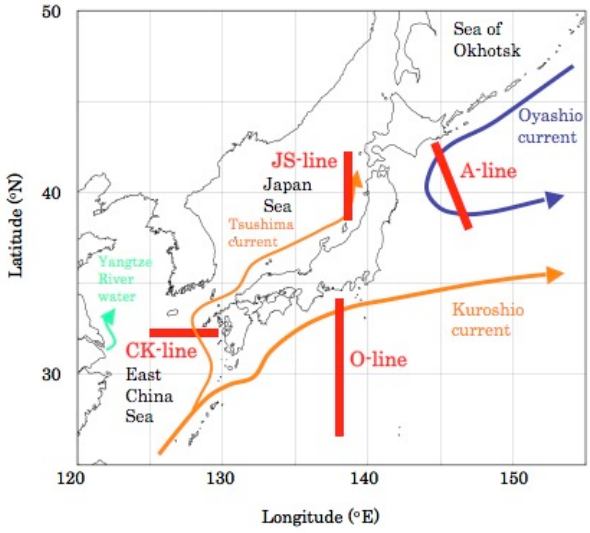

Figure 1. Map of FRA monitoring cruise line