ABSTRACT

As a fundamental of the navigation simulation to understand the passage possibility through the Northern Sea Route (NSR), the navigation simulation is performed during the sea ice decrease period (2007 to 2011) with the sea ice concentration reanalysis. Under even the strictest sea ice condition, the continuous passage period through the NSR is from the last of August to the beginning of September in each year during 2009 to 2011. The NSR passage period in each year is irregular. The simulation in this study can evaluate whether ships can pass through the NSR and escort ships are needed.

KEY WORDS: Northern sea route; sea ice concentration; navigation simulation; Arctic Ocean; great circle sailing; reanalysis data; ERA Interim

INTRODUCTION

The sea ice area in the Arctic Ocean has recently tended to decrease. It was reported that the sea ice area in the Arctic Ocean in September 2012 was the minimum ever recorded (Fig.1). We expect that the ship passage period through the northern sea route (NSR) will be further extended. Therefore worldwide ship transport companies are interested in the NSR because the NSR utilization brings about the advantages that the NSR can save passage time and fuel consumption more than the typical route between East Asia and Europe via the Suez Canal. Some of ship transport companies in the East Asia have utilized the NSR practically.

Seeing some of the past navigation simulation researches on the NSR, Kishi et al., (2000) have performed the realistic navigation simulation on the NSR by the ship speed estimated from sea ice climatology data. Toriumi (2010) has performed the navigation simulation on the NSR using Lloyd’s ship movement data which is ship departure/arrival time data and showed to some extend the saving effect of fuel consumption by utilizing the NSR. However, these researches might be rough navigation simulation because they use climatology and indirect data which are not under way.

The observation of the passage situation on the NSR is needed to understand more accurate passage situation. However, it is difficult to analyze the observation on the NSR navigation data because there are few reports that ships have succeeded passing through the NSR. Therefore it is necessary to perform more realistic navigation simulation than the past simulation.

Currently we can use easily some reanalysis data which are distributed from some meteorological institutes. ECMWF (European Centre for Medium-Range Weather Forecasts) which is one of the most representative meteorological institutes distributes the sea ice concentration reanalysis data. The navigation simulation on the NSR with the sea ice concentration reanalysis data is expected to show more accurate passage situation on the NSR than the past simulation.

In this study, the navigation simulation on the NSR during the sea ice decrease period is performed with the sea ice concentration reanalysis data. The possibility that ships can pass through the NSR is examined quantitatively focusing on the sea ice condition on the NSR.

![Fig 1. Time-series representations of minimum sea ice extents in the Arctic Ocean (including the Sea of Okhotsk and the Bering Sea). The solid blue line indicates the minimum extent in the Arctic Ocean. The dashed line indicates the linear trend of each value. The figure is cited from the Japan Meteorological Agency. (http://www.data.kishou.go.jp/kaiyou/english/scaice_global/series_glb al_e.html).](http://www.data.kishou.go.jp/kaiyou/english/scaice_global/series_global_e.html)