東シベリア海における夏季の海氷中期予測に対する総観規模大気擾乱の重要性

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Medium-range forecast skill of summertime sea ice conditions over the East Siberian Sea: Importance of synoptic-scale atmospheric fluctuations

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Accelerated retreat of Arctic Ocean summertime sea ice has focused attention on the potential use of the Northern Sea Route (NSR), for which sea ice thickness (SIT) information is crucial for safe maritime navigation. This study evaluated the medium-range forecast skill of summertime SIT, with special emphasis on the East Siberian Sea (ESS), based on the Towards an Operational Prediction system for the North Atlantic European coastal Zones ver. 4 (TOPAZ4) data assimilation system (Sakov et al. 2012). Intercomparison between all available observed (in situ and satellite) and operational model SIT data showed that TOPAZ4 reanalysis data reproduces the observed seasonal cycle (maximum in May and minimum in October) for the entire Arctic Ocean, with an average negative bias of ~30 cm.

Examination of vessel-tracking data and TOPAZ4 reanalysis data suggests the significant delay in vessel speed that occurred in July 2014 during passage of the ESS was caused by northwestward sea ice drift (~20 cm s^{-1}) as well as significant SIT (~150 cm). To explore the mechanism controlling the summertime (July) sea ice motions, we examined the speed and direction based on free-drift theory. The estimated values of the wind factor and the deviation angle are approximately within the range of typical surface wind parameters of 2 % for the wind factor and 30° for the deviation angle in the Arctic Ocean (Thorndike and Colony, 1982).

Forecast data of TOPAZ4 indicates northward sea ice drift occured in July 8, 2014 can be predicted skillfully with a lead-time of 5 days. The ECMWF medium-range forecast data show that the forecasts of the ensemble members spread after July 8 and the ensemble mean values are notably different from the analysis values. These results demonstrate the skill in the prediction of sea ice motion is attributable to that of the atmospheric wind condition. Therefore, TOPAZ4 data assimilation system could provide useful medium-range sea ice forecasts for summertime maritime navigation of the NSR. Since it was reported that additional radiosonde observations over the Arctic Ocean have had considerable impact on the prediction skill in synoptic-scale fluctuations (e.g., Inoue et al., 2015), it is expected that radiosonde observations in the Arctic Ocean could lead to further extension of the lead-time for predictions of summertime sea ice.

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