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Intra-seasonal variability of the Beaufort Gyre and its impact on the fate of Arctic Sea ice in the Pacific Sector of the Arctic Ocean

Kohei Mizobata (1) and Noriaki Kimura (2)

(1) Tokyo University of Marine Science and Technology, Japan (mizobata@kaiyodai.ac.jp), (2) National Institute of Polar Science, Japan (kimura@1.k.u-tokyo.ac.jp)

Decades of satellite observation have revealed drastic reduction of sea ice over the Chukchi Borderland (hereafter CBL) area in the Arctic Ocean. One of the triggers for this reduction is the Pacific Summer Water (hereafter PSW), which enters in the Arctic Basin via the Chukchi Sea. After intruding the Arctic Ocean, the PSW is transported by the clockwise Beaufort Gyre (hereafter, BG) and is delivered to CBL region during wintertime. It is thought that the increase in ocean heat content due to PSW will delay sea ice formation. However, there is an inter-annual variability of sea ice distribution in the Pacific sector of the Arctic Ocean, indicating the temporal and spatial variability of the PSW.

To understand where and when the PSW arrives in the Pacific sector of the Arctic Ocean, we need to elucidate the distribution and strength of the BG during wintertime. Hydrographic observations by the drifting/ice-mounted buoy and mooring are quite helpful to obtain in-situ measurements, however, it is hard to elucidate changing spatial and temporal distribution patterns of BG and PSW. In this study, we investigated monthly DOT field derived from the measurements of the Synthetic Aperture Interferometric Radar Altimeter (SIRAL), which is mounted on the Cryosphere Satellite-2 (CryoSat-2). Moreover, we employed 1) the ice concentration and ice velocity datasets derived from the data observed by the satellite microwave sensors, the Advanced Microwave Scanning Radiometer for EOS (AMSR-E, mounted on the earth observing satellite AQUA) and AMSR2 (mounted on the satellite, Global Change Observation Mission 1st – Water (GCOM-W1)), 2) the NCEP-DOE Reanalysis 2 sea level pressure, to examine sea surface stress field and 3) CryoSat-2 sea ice thickness distributed by the AWI.

DOTs derived from the Cryosat-2/SIRAL measurements show both inter-annual and intra-seasonal variability of the Beaufort Gyre during wintertime. Actually, the Beaufort Gyre responds to changing sea ice motion modulated by wind forcing. For example, intensification of the Beaufort Gyre and sea ice motion occurred from December 2012 to January 2013, simultaneously. In that case, the role of sea ice motion for the Beaufort Gyre is a driving force. However, the comparison of DOTs and sea surface stress field suggests us that sea ice motion also plays a role of the deterrent force to the Beaufort Gyre. From January to February in 2013, sea ice motion weakened due to weakened wind forcing, and then the spatial distribution of the Beaufort Gyre was modulated and the Beaufort Gyre weakened. Thus, the Beaufort Gyre in the wintertime is quite variable, and those results suggest that intra-seasonal variability of the pathway of the PSW driven by the Beaufort Gyre, and the impact of the PSW on the process of sea ice loss.

We will present results from the comparison of satellite-derived DOT and sea ice thickness, and will discuss the contribution of variable BG during wintertime to the suppression of sea ice formation in the Arctic Ocean.