CryoSat-2/SIRAL 観測で明らかになった冬期北極海におけるボーフォート循環の変動

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Wintertime variability of the Beaufort Gyre in the Arctic Ocean derived from CryoSat-2/SIRAL observations

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The variability of the Beaufort Gyre (BG) and its various impacts were previously documented. McPhee (2013) demonstrated that the geostrophic currents on the periphery of the BG between 2003 and 2011 were intensified relative to the climatological value. Proshutinsky *et al*. (2002) proposed a hypothesis that the BG accumulated freshwater mechanically because of Ekman convergence and the associated downwelling, and Proshutinsky *et al*. (2009) used long-term in situ measurements to provide observational evidence for that hypothesis. Morison *et al*. (2012) investigated in situ measurements and satellite data and concluded that the spatial and temporal variability of freshwater in the Arctic Ocean was caused by changes in the pathways of river runoff that are modulated by the Arctic Oscillation rather than the strength of the wind-driven BG circulation (i.e., deepening/shallowing of isohaline surface). In either case, determining the spatial and temporal variability of the BG and surrounding oceanic circulation patterns is crucial for understanding the freshwater content in the Arctic Ocean.

We processed the sea surface height measured by the SAR (Synthetic Aperture Radar) / Interferometric Radar Altimeter on board the CryoSat-2 (CS-2) and successfully estimated the monthly dynamic ocean topography (DOT) of the Arctic Ocean. The CS-2 monthly DOT showed the interannual and monthly variability of the BG during winter between 2010/2011 and 2014/2015. The northward flow at the western edge of the BG was primarily estimated over the Chukchi Borderland (CBL). However, the BG extended across the CBL, and the northward flow was estimated over the Mendeleev Ridge in the winter of 2012/2013. Our analyses revealed a significantly variable BG in response to changes in the sea surface stress field. Our analysis indicated that 1) sea ice motion acts as a driving force for the BG when sea ice motion was intensified during winter and 2) sea ice motion can also acts as an inhibiting force for the BG when sea ice motion is weakened during winter. In addition, the relationship between the DOT, steric height and ocean bottom pressure implied that the DOT during winter responded to varying wind stresses through baroclinic and barotropic adjustments. According to a tracer experiment, we inferred that in the winter of 2012/2013, the Pacific-origin water carried into the BG through the Barrow Canyon was transported to the northern shelf and shelf break of the Chukchi Sea rather than the CBL, which is where the Pacific-origin water had been transported in the other years of the target period.

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