Cosmonaut Sea Meso-scale Oceanic Structure Survey (CoSMOSS)

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The Weddell Gyre is a major oceanographic feature of the Southern Ocean, which plays an influential role in global ocean circulation as well as gas exchange with the atmosphere. The Weddell Basin and adjacent continental shelf is the region of the majority of the deep and bottom water formation around Antarctica. The deep and bottom water mass in the Weddell Sea experiences significant long-term warming with notable decadal variations, which makes this region as a huge heat reservoir in the global climate system (Farhbach et al., 2011; Purkey and Johnson, 2010). The understanding of the Weddell Sea oceanic system has hence global implications.

One of the pressing issues in the oceanography of this region is the fact that the eastern boundary of the Weddel Gyre remains poorly resolved with no well-defined boundary current marking its eastern periphery (Vernet et al., 2019). The boundary can be either prescribed to the west or east of the Cosmonaut Sea (30-50˚E), depending on the context of the study. Exchange with the Antarctic Circumpolar Current to the north can be substantial in heat intake into the gyre. Contributions from the east are also important. The westward drift of Antarctic Bottom Water from the polynya off Cape Darnley (Ohshima et al., 2013) contributes to the property transformation of the Antarctic Bottom Water and its multi-decadal freshening is observed (Aoki et al.,2020).

The oceanic condition in the Cosmonaut Sea affects sea ice and continental ice. The eastward-flowing southern edge of the Antarctic Circumpolar Current is considered essential in the occurrence of Cosmonaut Polynya (Comiso and Gordon, 1996). The warm water coming from the eastern boundary intrudes into Lutzow-Holm Bay and affects the continental ice and freshwater discharge (Hirano et al., 2020). Stability of land fast ice in this region changes on the decadal time scale, which suggests an oceanic connection (Aoki, 2017).

Recently, satellite altimetry has revealed a complicated structure of the surface current system in this region. The contour of the surface dynamic height does not simply align the south-eastward migrating Antarctic Circumpolar Current but a large embayment of a higher height is detected (Figure 1; Mizobata et al., 2020). However, direct and detailed observations are still limited. Umitaka maru visited twice in the 2000s and Mirai did S4 transect in 2013 (Aoki et al., 2020) but high-resolution hydrography has not been conducted nearly or more than a decade. Mid-depth floats are also sparse in this region (Yamazaki et al., 2020).

To fill the gap of the current state of understanding, we propose a coordinated hydrographic campaign - Cosmonaut Sea Meso-scale Oceanic Structure Survey (CoSMOSS)- for the region in the Cosmonaut Sea (Figure 1). A high-resolution hydrographic array with top-to-bottom observational capacity (by Hakuho maru etc.) in the deep basin will help revealing the complicated structure of the complicated sub-gyral structure. At the same time, observation in the ice-covered shelf with an ice-breaking capacity (by Shirase) is valuable in estimating the effect of heat transfer

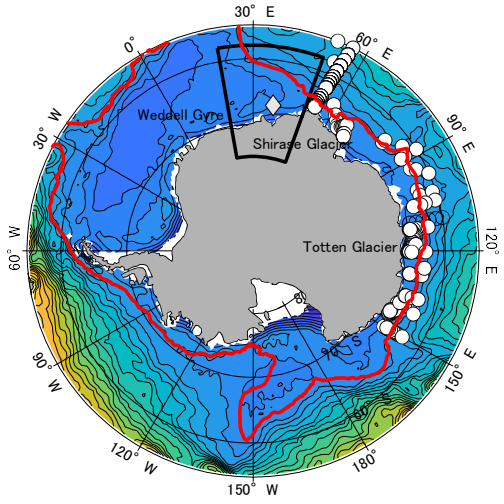

Figure 1. Temporal mean dynamic height of the Southern Ocean (Mizotabata et al. 2020). The bold line denotes the southern boundary of ACC constructed by Shimada et al. (2013). Diamond denotes the location of the bottom temperature time series and dots denote stations of recent high-resolution Japanese hydrographies.

onto the shelf with the aid by bio-logging (Kokubun et al., submitted). The coordinating campaign will contribute to filling the last missing piece of the general circulation in the Southern Ocean.

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