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Interannual Variation of Surface Wind over the Southern Ocean -Correlation Feature with DPOI and KDOI-

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1.Introduction

It is well known that most of the surface in the southern hemisphere is covered by ocean and especially its high latitudes are governed by the strongest surface winds of the entire ocean. Previous studies have pointed out that there are some meteorological patterns over the southern ocean such as Southern Annular Mode (SAM; Thompson and Wallace,2000), Antarctic Oscillation (AAO; Gong and Wang, 1999) and Antarctic Circumpolar Wave (ACW; White and Peterson,1996), and then that they are related to the strength of the westerly winds and affect large change of ecological environment in the Antarctic/ Southern Ocean during recent decades (Aoki, 2002; Marshall, 2003; Naganobu et al., 2014, IPCC, 2001, 2007, 2013).

The Antarctic krill (Euphausia super- ba) is a key species in the Antarctic Ocean, so understanding of its relationships with climate and oceanic condition is considered to be a fundamental issue. Naganobu et al.(1999) and Kondo(2008) found significant correlations between the krill recruitment and DPOI (Drake Passage Oscillation Index) which is a climate indice defined by the sea-level pressure differences between Rio Gallegos at the southern edge of the South America and Esperanza at the northern edge of the Antarctic Peninsula. The strength of the westerlies affects krill recruitment, so the strong (weak) westerlies resulted in high (low) krill recruitment. Further, it was also suggested that the westerly wind changes around the Drake Passage have high correlations with those in wide area including south of the Indian Ocean, so the DPOI is a good index as an environmental condition in the Southern Ocean (Yoda, 2011).

In this study, we focus on spatial features in wind variations over the southern ocean that the DPOI has high correlations with, and then derive a similar indice to DPOI in the Prydz Bay area, Kerguelen Davis Oscillation Index (KDOI) which is defined by the sea level pressure difference between Kerguelen Island and Davis. Correlations analyses are made between time series of these indices and surface winds data set.

2.Data

Number of marine meteorological observations over the southern hemisphere decreases as going to the past, so it is difficult to use data sets by numerical model and reanalysis data having long-term time coverage with persistent reliability. Instead, we also use the data set of surface winds which have been constructed by satellite scatterometer data. In this study, time series of monthly data are used.

3.Results

First, we notice time variations of DPOI and KDOI. Their spectra reveal significant peaks at the periods of 6-month and 12-months, and another peak at the periods of 32 months and 24months for DPOI and KDOI, respectively (Fig1.). In addition, the DPOI has also high energy level in the periods longer than 100 months, suggesting dominance of long-term variations.

Second, to investigate the relationship of DPOI and KDOI with surface winds from the NCEP/NCAR reanalysis data set over the southern ocean, we derive spatial correlations of the index with the zonal components. Results reveal that in interannual timescales by 12-month running mean, the DPOI has high correlations in the Drake Passage and south of Australia (Fig.2), and the KDOI in Prydz Bay and north of the Weddell and Ross seas (Fig.3). On the other hand, correlation distributions for long-term time scales by 36-month running mean show negative values in west of the Drake Passage and Ross sea for DPOI, and positive values in the same areas for KDOI. In addition, in areas of the Ross ice shelf and Ronne ice shelf, the DPOI and KDOI have positive and negative, respectively, correlations (Fig4., Fig5.). Further, both in time scales, no correlations are found west of the Drake Passage both for DPOI and KDOI.

These suggest that the surface wind variations over the southern ocean have different spatial features in interannual time scales, and thus these details will be examined.

Keywords: Circumpolar westerlies, DPOI, KDOI, AAOI

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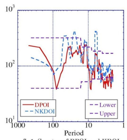

fig1. Spectra of DPOI and KDOI.

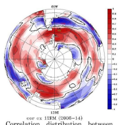

fig2. Correlation distribution between DPOI and the zonal wind (12-month running mean).

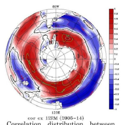

fig3. Correlation distribution between KDOI and the zonal wind (12-month running mean).

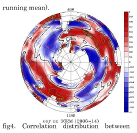

fig4. Correlation distribution between DPOI and the zonal wind (36-month running mean).

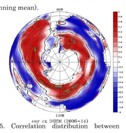

fig5. Correlation distribution between KDOI and the zonal wind (36-month running mean).