

Relationship between Southern Annular Mode and poleward ocean heat transport toward East Antarctic ice shelf

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The mass loss of ice shelf due to intrusion of warm Circumpolar Deep Water (CDW) has been pointed out. To understand East Antarctic ocean circulation carrying CDW, we newly developed the gap-free gridded Dynamic Ocean Topography (DOT) dataset using retrievals from the satellite radar altimeters. The DOT data confirms the existence of clockwise circulation in the East Antarctic embayment, which has been suggested by field observations. Our previous studies and the present results indicate that one of the transport processes of CDW, i.e., poleward ocean heat transport to ice shelves is the coupling of standing eddies in the basin and clockwise embayment circulations.

The temporal variability of clockwise embayment circulations is evident, implying temporal change of poleward ocean heat transport. Therefore, we investigated the causes of the temporal variability of those circulations. The singular value decomposition (SVD) analysis was performed on the cross-covariance matrix between DOT and ERA5 sea level pressure (SLP) from January 2011 to December 2020. The first SVD mode accounts for 52 % of the squared covariance fraction between two fields and correlation coefficient between those expansion coefficients is 0.77. The first SVD mode of SLP (SLP-1) shows the north-south contrast, i.e., the strength of the westerlies, while the SVD first mode of DOT (DOT-1) indicates similar north-south contrast with closed streamlines in the continental shelf. The spatial pattern of the SLP-1 is reminiscent of the Southern Annular Mode (SAM), and in fact there are positive correlations between SAM index and expansion coefficients of DOT-1 ($r=0.53$, $p<0.001$) and SLP-1 ($r=0.79$, $p<0.001$). Results suggests us that positive SAM situation leads to stronger westerlies with increased clockwise wind stress curl intensifying clockwise embayment circulations and following poleward oceanic heat transport toward East Antarctic ice shelf.

Keywords: East Antarctic ice shelf, Circumpolar Deep Water, Satellite altimeter, Ocean circulation, Southern Annular Mode