Data from ship-based hydrographic surveys and from autonomous floats revealed substantial warming in the Southern Hemisphere Ocean since 1930s. An important feature of this warming is that the sea surface temperature (SST) changed very little since 1970s. Recent examinations of long-term global SST data and polar surface air temperature have revealed multi-decadal inter-hemispheric seesaw or bipolar seesaw pattern, which is well correlated with the Atlantic Multi-decadal Oscillations (AMO). During the recent decades after around 1980, the SST in the Southern Ocean (SO) has been undergoing a cooling phase. It is hypothesized in some studies that the multi-decadal oscillations of the Atlantic Meridional Overturning Circulation (AMOC) could be the cause of the AMO, and hence could be responsible for the multi-decadal SST variability in the SO.

We investigate whether the multi-decadal SO SST variability is caused by the oscillations of the AMOC or is induced by atmospheric forcing, through analysing results from coupled climate models, the observed changes in surface heat fluxes and in the SO ocean heat content, and the multi-decadal relationships between the SO SST and long-term SAM index and Inter-decadal Pacific Oscillation index. We found that the AMOC has very minor effects on the SO SST, and the SAM is mainly responsible for the broad SST changes in the SO. Our further analysis suggests that the AMO and the multi-decadal variability in the SAM have the same origin, with both being caused by external forcing.