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「論文博士用」

学 位 論 文 の 要 旨

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学位論文題目	Evaluation of ocean heat advection role on sea surface temperature anomaly in ocean reanalysis models and Coupled Model Intercomparison Project phase 5 (CMIP5) models in western Indian Ocean.

学位論文要旨

Recently, the state-of-the-art coupled global circulation models in coupled model intercomparison project phase five (CMIP5) are still modulated by a systematic bias in simulating sea surface temperature (SST) in the western Indian Ocean (WIO). It was shown that positive-Indian Ocean dipole (IOD)-like bias presents during boreal autumn. Previous studies have shown that weak southwest summer monsoon creates warm SST bias in WIO. In boreal autumn, Bjerknes feedback helps to amplify the warm SST biases into an IOD-like bias pattern, with easterly wind bias and an unrealistic mean thermocline slope tilting upward toward the eastern Indian Ocean (EIO). This is accompanied by greater precipitation bias in WIO and less precipitation bias in EIO. However, the process to initiate warm SST bias under weak southwest monsoon remains unclear. The role of ocean advection to the SST bias has not been fully discussed yet. Therefore, the main objective of this study is to investigate the ocean advection role in forming SST bias under weak southwest summer monsoon bias in CMIP5 models. We studied the role by analyzing how the advection process in ocean reanalysis models initiate the SST anomaly under weak and strong southwest monsoon.

In this study, we analyzed four ocean reanalysis models namely: GECCO2, SODA3, ORAS4, and GODAS. Heat budget analysis showed that there is a strong relationship between mixed layer temperature anomaly (as a proxy of SST) in WIO and the advection process. The results showed zonal advection is the important process to initiate SST anomaly in western equatorial Indian Ocean (WEIO), while vertical advection initiates the SST anomaly in the western Arabian Sea (WAS) and the southwestern Indian Ocean (SWIO).

More detailed investigation on CMIP5 models shows that about half of models pronounce warm SST bias, while the other half of models pronounce cool SST bias. The models with warmer SST biases exhibit a pattern that is similar to the IOD, with stronger equatorial easterly wind biases during fall and a deeper thermocline in the western equatorial Indian Ocean. In the models with cooler SST biases, negative SST biases are observed over the entire tropical Indian Ocean throughout the year and the wind biases over the equatorial Indian Ocean are southeasterly during summer and fall. The new findings of this study reveal the role of ocean current in forming the early summer development of SST biases over the WEIO. Heat budget analysis showed the formation of SST biases is related to surface current biases induced by the weaker biases of southwesterly monsoon winds and SST biases over the southwestern equatorial Indian Ocean, which is advected by the East African Coastal Currents.

This study is highly significant for further understanding the evolution of systematic bias of SST over WIO. This study suggested realistic simulation of western boundary current in CMIP models is important to reduce the SST bias. It was documented that the CMIP5 models show a future IOD-like climate change. The peak of the SST warming over the WEIO occurs off the equator, somewhat similar to the biases in the historical simulations among the CMIP5 models. Examination of the process causing the future SST changes over the western Indian Ocean will be performed in future work.

注）和文 2,000 字以内又は英文 800 語以内　　続紙　有□　無■