Ice Shelf Melt Water Feedback to Melt Rate of Pine Island and Thwaites Glaciers

Kofan Lu
Japan Agency for Marine-Earth Science and Technology

Pine Island and Thwaites Glaciers contribute ~25% ice loss in the Antarctic, which brings melt water impacting not only the global sea level rise, but the stratification of the Amundsen Sea. Changes of stratification affects the Circumpolar Deep Water (CDW) heat transport and further the feedback to ice shelves melt. Decadal variations of ice shelf melt rate are found linked to synoptic wind decadal variation. This linkage is believed to be a consequence of melt feedback altered by CDW layer thickness. However, the feedback reacts variously from each ice shelves in the Amundsen Sea and the mechanisms are complex and poorly documented. A series of systematic model experiments using MITgcm are conducted and analyzed to understand the crucial process that affects melt water feedback specifically focusing on Pine Island and Thwaites Glaciers (PITW). Analytical melt rates of Pine Island and Thwaites Glaciers are imposed as constants into an Amundsen Sea model integrated from 1979 to 2019 with additional 25 years adjustment time. Melt feedback is evaluated as the differences of model-derived ice shelf melt rate among each model runs and compared to the possible factors such as the principal components of synoptic winds and CDW layer thickness EOFs. Melt feedback is found positive only in the vicinity of PITW due to the CDW heat transport trajectories. Furthermore, the correlations between CDW layer thickness and the melt feedback are moderately strong ($R>0.4$), especially in Pine Island Glacier ($R\sim0.80$), showing that CDW amplifies the melt feedback of PITW. Although the direct linkage between melt feedback and synoptic wind is insignificant, the moderate correlation ($R\sim0.40$) between the principal components of the synoptic winds and CDW layer thickness EOFs in the vicinity of PITW specifying the importance of the linkages between the ice shelf melting and the large-scale climate pattern caused by anthropogenic factors.