Modeling warm water intrusion into Lützow-Holm Bay, East Antarctica

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Recent satellite observations suggest that more than half of mass loss from the Antarctic Ice Sheet can be explained by the basal melting of Antarctic ice shelves. Many studies have focused on active basal melt at ice shelves in the Amundsen-Bellingshausen Sea and the Totten Ice shelf, East Antarctica. These ice shelves' bases are exposed to Circumpolar Deep Water, the warmest water mass below the subsurface layer over the Southern Ocean. The warm water mass on the Antarctic coastal margins is a key component for understanding intense basal melting. There is a common oceanographic feature in the two regions: Antarctic Circumpolar Current is very close to the coastal regions, and thus Circumpolar Deep Water can affect regional coastal water masses. The Shirase Glacier Tongue in Lützow-Holm Bay, East Antarctica, is located in the south-eastern part of the Weddell Gyre in the Atlantic sector, where the southward-directed flows advect the relatively warm water toward the coastal region. A recent in-situ oceanographic observational study showed that Circumpolar Deep Water intrudes into Lützow-Holm Bay from the shelf break and similarity of the strong ice-ocean interaction at ice shelves in the Amundsen-Bellingshausen Sea and the Totten Ice Shelf. Here, we conduct a high-resolution numerical simulation with an ocean-sea ice-ice shelf model to understand ocean structure in the Lützow-Holm Bay and the seasonal variation in strong basal melting at the Shirase Glacier Tongue. The model results demonstrate that the basal melt rate reaches a maximum in summer, which is consistent with seasonal change in the strength of Circumpolar Deep Water intrusion. Furthermore, experiments with and without fast ice in the bay show that fast ice plays a role as a surface thermal insulator in the bay and that the existence of fast ice can enhance the basal melting at the Shirase Glacier Tongue.

Keywords: ice-ocean interaction, Circumpolar Deep Water, Lützow-Holm Bay