

Strong ice-ocean interaction at Shirase Glacier Tongue, East Antarctica

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Shirase Glacier Tongue (SGT) is a thick floating slab of ice that forms where the glacier flows down onto the ocean surface at the southern closed-section of Lützow-Holm Bay (LH Bay) off Enderby Land, East Antarctica. Compared with other major ice shelves/tongues around Antarctica, SGT is smaller in area but its basal melt rate was estimated to be relatively high at a rate of $\sim 7 \pm 2$ m per year (Rignot et al., 2013) based on presence of warm deep water. Although comprehensive hydrographic observations in LH Bay is indispensable for understanding the SGT-ocean interaction, they are extremely limited since the bay is usually covered with heavy fast ice even in summer. To explore in detail the SGT-ocean interaction, summer comprehensive hydrographic observations in LH Bay were conducted during JARE58th in 2017 under the project called ROBOTICA.

LH Bay has a deep glacial trough in its center, connecting the regions from shelf break to SGT. Cold, fresh, and oxygen-rich Winter Water (WW: remnant of winter mixed layer) is overlying warm, saline, and oxygen-poor modified Circumpolar Deep Water (mCDW) along the deep trough from the shelf break to the ice front. This indicates mCDW inflow beneath the SGT, and the inflowing mCDW temperature exceeds the in-situ freezing point by more than 2.7°C. At surface/sub-surface layers, water properties become warmer and lower oxygen content toward the ice front. On $\delta^{18}\text{O}$ -salinity space, this anomalous warm and oxygen poor layer at the ice front is distributed along the line connecting mCDW with glacial end-members, with glacial melt water fraction estimated to be 0.5-1.7%. In addition, the anomalous layer contains relatively high mCDW fraction even at surface/sub-surface layers, indicating the glacial melt water outflow beneath the SGT as a mixture with mCDW.

The above observational results suggest a 3-dimensional circulation, associated with SGT-ocean interaction (i.e., basal melting of SGT by mCDW; Figure 1), that comprises: (1) warm mCDW flows southward at the deep layer of glacial trough leading into the region beneath SGT, (2) mCDW meets to melt the base of SGT, then a mixture of glacial melt water and mCDW is transported upward as a buoyant melt plume, and (3) the mixture exports northward at surface and sub-surface layers. As is the case with Totten Ice Shelf, the SGT is also characterized as a warm ice cavity atypical in East Antarctica, which resulted from an absence of coastal polynya (i.e., cold Dense Shelf Water) as well as a presence of deep trough serving as a pathway of mCDW toward the SGT in LH Bay.

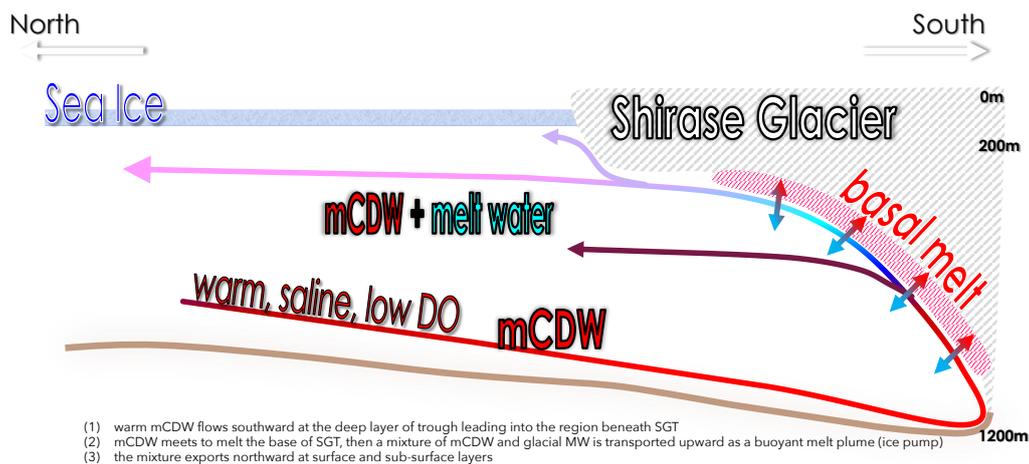


Figure 1. Schematic illustrating a 3-dimensional circulation associated with SGT-ocean interaction.

References

Rignot, E., S. Jacobs, J. Mouginot, & B. Scheuchl (2013), Ice-shelf melting around Antarctica, *Science*, 341(6143), 266-270, doi:10.1126/science.1235798.