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Cooling and Freshening of the Weddell Sea Outflow

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The Weddell Sea is the primary source of the coldest, densest water invading most of the world ocean, known as Antarctic Bottom Water. The formation process involves brine rejection during sea ice formation, which salinifies the relatively fresh waters on the Antarctic continental shelf. Mixing with meltwater from the floating Antarctic ice shelves is believed to contribute also. When it becomes sufficiently dense, the shelf waters can spill down the continental slope as a deep outflow plume, mixing as it descends with the warmer and saltier Warm Deep Water above. By the time the plume reaches the western Weddell Sea, it is a narrow ribbon of cold, dense water hugging the continental slope. Here we will show that this outflow is now colder and fresher than in any of the observations since 1989. This freshening is comparable in magnitude to that seen in bottom water off Adelie Land which implies that the freshening is circumpolar, contrary to some recent analyses. This is likely associated with freshening of source waters on the continental shelf of Antarctica caused by an accelerated hydrological cycle and/or additional melting of the Antarctic ice sheet. Such melting may in turn be caused by a strengthening of the circumpolar winds associated with the Southern Annular Mode, leading to a southward ocean transport of heat towards the Antarctic. The Weddell Sea freshening may have been exacerbated by the break-up of the Larsen Ice Shelf on the eastern Antarctic Peninsula in the late 1990s, leaving a large expanse of continental shelf able to host the formation of sea ice and hence form dense bottom water.