Geophysical Research Abstracts
Vol. 21, EGU2019-4109, 2019
EGU General Assembly 2019

Quantifying the contribution of the Atlantic sector of the Sourthern Ocean to the lower limb of the global circulation

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The Weddell Sea is a key region in the global climate system as it fuels the global overturning circulation by producing the world's densest water mass, the Antarctic Bottom Water (AABW), which ultimately ventilates and sets the characteristics of the world's deep oceans. AABW is formed by the production of very saline and dense waters on the continental shelves, as well as by entrainment and mixing with overlying old Circumpolar Deep Water. While the relative importance of the process by which AABW is formed is still imperfectly determined, it is key to our understanding of the overturning circulation, and of the observed variability and trends of AABW characteristics. In this study, we use a new set of observations of water stable isotopes on the southern Weddell Sea continental shelf, along with hydrographic transects at the northern edge of the Weddell Sea to disentangle the rate of production of dense shelf water which ultimately fuel the bottom water exported in the gyre. We also able to quantify the net volume of dense water produced by entrainment in the Weddell Gyre. In addition, we highlight the formation process of dense shelf water outflowing from the southern Weddell Sea continental shelf, by pinpointing the role of ocean/ice-shelf interactions in altering the characteristics of dense shelf water. Indeed, the region hosts the largest Antarctic ice-shelf, Filchner-Ronne Ice Shelf (FRIS) where ocean-ice interactions in the cavities are pivotal for our understanding of future climate change, and impact the overturning circulation. We identify the main locations where water containing glacial meltwater flows out from the cavity, quantify the rate of melt and freeze in the cavity, and pinpoint the source waters that originally entered the cavity. In summary, we provide a detailed decomposition of the life history of AABW before it is exported at the northern edge of the Weddell Gyre.