The distribution of glacial meltwater in the Amundsen Sea, Antarctica, revealed by excess helium and neon

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Noble gases dissolved in seawater can be useful tracers of freshwater added by the glacier melting since the air bubbles trapped in glacial ice dissolve in seawater, resulting in supersaturation. To investigate the distributions of glacier meltwater (GMW) in the Amundsen Sea, Antarctica, we measured the two noble gases, helium (He) and neon (Ne), in the water column of the Amundsen Sea in 2011 and 2012. The study area is Amundsen Sea continental shelf, the most rapidly melting parts of the West Antarctic Ice Sheet. The measured saturation anomalies of He and Ne (ΔHe and ΔNe) ($\Delta C = (C/C_{eq} - 1)\times 100\%$, where He_{eq} and Ne_{eq} are at equilibrium with the atmosphere) were in the range of 3 - 35% and 2 - 12% (n>80), respectively, near the Dotson - and Getz Ice Shelves (DIS and GIS). The calculated GMW fraction in seawater, based on the excess ΔHe in DIS, GIS and Dotson trough (DT) regions, were 0.4 - 2.0%, 0.4 - 0.8%, and 0.4 - 1.2%, respectively. Along the DT, the largest GMW fractions (up to 1.2%) were observed in 450 - 500 m depth where the warm CDW melts the base of the ice shelves along DT in 2011. This large extent of GMW were even appeared nearly 300 km away from the ice shelves derived from the returning flow to Amundsen Sea Polynya (ASP), suggesting that GMW can be transported more than several hundred kilometers offshore. Near the ice shelves, the GMW fraction was substantially higher in DIS than those in GIS and the largest (up to 2.0%) of GMW were observed in the western part of DIS. In 2012, the GMW fractions were significantly decreased up to 30-40% in DIS and GIS, respectively, indicating distinct temporal variability in glacial melting compared to 2011. Our results imply that ΔHe and Δ Ne are sensitive GMW tracers with high spatio-temporal resolutions.