Chemoautotrophic carbon fixation has been proposed as an alternative to heterotrophy to support the microbial loop in the deep sea and in polar regions during winter when photoautotrophic production is light-limited. Rate data that could be used to test this hypothesis are extremely limited, despite the reported abundance of potentially chemoautotrophic ammonia oxidizing Archaea (AOA) in these habitats. We found significant rates of ammonia oxidation (AO; 0.52-140 nM d^{-1}) in samples from continental shelf waters west of the Antarctic Peninsula. These rates are higher than those previously measured in polar waters and suggest a significant contribution by polar regions to oceanic nitrification. We observed higher AO rates in early spring samples from near-surface (0-100 m) waters compared to rates from similar depths during summer. AO rates in samples from deeper water (>150 m) did not change between seasons, despite 10 to 100-fold greater abundances of Thaumarchaeota genes and transcripts in summer samples. We found no consistent relationship between AO rates and archaeal ammonia monooxygenase (*amoA*) gene or transcript abundance; or with the ratio of *amoA* transcripts per gene, which has been used as a proxy for activity. Experiments with organic nitrogen compounds identified urea as a potential contributor to AOA productivity. On an annual basis, chemoautotrophic carbon fixation supported by AO was ~3% of phytoplankton primary production and could support most of the bacterioplankton production measured in winter.