What is the potential for CO_2 outgassing from the buoyant upwelling of modified Circumpolar Deep Water in the Amundsen Sea Polynya?

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In some regions of the Antarctic continental shelf, biological productivity is supported by the buoyant upwelling of warm, micronutrient-rich modified Circumpolar Deep Water (mCDW) following additions of glacial meltwater in ice shelf cavities. This mCDW also carries high concentrations of dissolved inorganic carbon (CO_2), however, increasing the possibility of outgassing to the atmosphere. Similar to wind-driven upwelling regions, the air-sea exchange of CO_2 in these areas thus depends on the rate of upwelling versus the biological drawdown of CO_2 through net primary production. Respiration rates in the deep waters and within the cavity may also be important to this balance. The seas surrounding the Western Antarctic are currently a vital sink for atmospheric carbon, but increased upwelling of mCDW may diminish this region's ability to absorb atmospheric carbon in the long term, potentially reversing the region from a carbon sink to a new carbon source to the atmosphere. Understanding this nexus of physical and biological CO_2 modification is critical to predicting future air-sea interactions and climate scenarios.

To this end, seawater samples were collected during NBP10-05 (ASPIRE) and NBP 22-02 (ARTEMIS) and returned to Georgia for carbonate system analysis. Meltwater fractions were estimated from oxygen isotopes, conservative temperature, and absolute salinity. In-cavity respiration was estimated by comparing the observed CO_2 concentration of the outflow with dilution of canonical mCDW by glacial meltwater. No significant difference was detected (mean difference = -1.95 μmol/kg, standard deviation = 3.11 μmol/kg). This suggests that the residence time of upwelled mCDW in the ice shelf cavity is short enough that respiration does not significantly accumulate additional CO_2 between the inflow and outflow. However, even without

a significant respiration signal, the high concentration of CO_2 in mCDW may still cause outgassing to the atmosphere if upwelling continues to the surface. Using canonical alkalinity and measured CO_2 values, we calculated the pCO_2 and resulting air-sea CO_2 flux. These values were significantly higher than previous observations in the Amundsen Sea suggesting that along the face of the Dotson ice shelf upwelled mCDW may contribute to a potential reversal of the Amundsen Sea from a carbon sink to a carbon source to the atmosphere.