Impacts of AMOC Changes on Ocean Biogeochemistry and Atmospheric Greenhouse Gases Inferred From Paleoclimate Data and Modeling

AMOC variability during the last glacial period was associated with changes in ocean nutrient cycling and productivity. Model simulations suggest that reduced formation of North Atlantic Deep Water diminishes upwelling of nutrients into the photic zone in the Indian and Pacific oceans reducing productivity there. Decreased productivity leads to reduced remineralization of organic matter in the subsurface, which causes less oxygen consuption and increasing concentrations of dissolved oxygen. Both reduced nitrification due to lower productivity and reduced denitrification due to increasing oxygen concentrations decrease nitrous oxide production in the upper ocean, which decreases atmospheric nitrous oxide concentrations on centennial time scales. The carbon inventory of the global ocean decreases on a longer (millennial) time scale due to changes in the efficiency of the biological pump, which involves the deep ocean. This leads to outgassing of $CO_2$ and slowly increasing atmospheric $CO_2$ concentrations. Available proxy data from ocean sediments and ice cores support the model simulations. However, new high resolution measurements of atmospheric $CO_2$ from ice cores show rapid changes, the origin of which remains to be determined.