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Arctic Ocean freshwater as a trigger for abrupt climate change

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The cause of the Younger Dryas cooling remains unresolved despite decades of debate. Current arguments focus on either freshwater from Glacial Lake Agassiz drainage through the St Lawrence or the MacKenzie river systems. High resolution ocean modeling suggests that freshwater delivered to the North Atlantic from the Arctic Ocean through Fram Strait would have had more of an impact on Atlantic Meridional Overturning Circulation (AMOC) than freshwater from the St Lawrence. This has been interpreted as an argument for a MacKenzie River /Lake Agassiz freshwater source. However, it is important to note that although the modeling identifies Fram Strait as the optimum location for delivery of freshwater to disrupt the AMOC, this does not mean the freshwater source came from Lake Agassiz. Another potential source of freshwater is the Arctic Ocean ice cover itself. During the LGM, ice cover was extremely thick—many tens of meters in the Canada Basin (at least), resulting in a hiatus in sediment deposition there. Extreme ice thickness was related to a stagnant circulation, very low temperatures and continuous accumulation of snow on top of a base of sea-ice. This resulted in a large accumulation of freshwater in the Arctic Basin. As sea-level rose and a more modern circulation regime became established in the Arctic, this freshwater was released from the Arctic Ocean through Fram Strait, leading to extensive sea-ice formation in the North Atlantic (Greenland Sea) and a major reduction in the AMOC. Here we present new model results and a review of the paleoceanographic evidence to support this hypothesis. The bottom line is that the Arctic Ocean was likely a major player in causing abrupt climate change in the past, via its influence on the AMOC. Although we focus here on the Younger Dryas, the Arctic Ocean has been repeatedly isolated from the world ocean during glacial periods of the past. When these periods of isolation ended, it is probable that there were significant effects on paleoclimate, paleoceanography and the carbon cycle as the Arctic Ocean became reconnected to the larger oceanic circulation.