Rapid Early Holocene Sea-level Rise: Laurentide or Antarctic Ice?

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Maximum rates of glacio-eustatic sea-level rise (SLR) reached 50 mm/yr during the last deglaciation, >16 mm/yr during the last interglacial period, and 7-15 mm/yr during the early Holocene. These rapid rates, which were 3 to > 10 times the current rate of SLR, are ultimately caused by changes in orbital insolation and poorly understood ocean-climate-ice sheet interactions. Understanding the contribution of northern hemisphere and Antarctic ice sheet to past periods of rapid SLR yields clues about possible future rates for Greenland and Antarctic ice. We will discuss sea level change between 10 and 7 ka, which includes the largest climate anomaly of the Holocene interglacial - the 8.2 ka (thousand years ago) cooling event. The 8.2 ka event was a complex multi-century period of atmospheric cooling and reduced deep ocean circulation followed by an abrupt, large-scale warming ~ 7.9 ka when meridional overturning circulation (MOC) in the North Atlantic strengthened. The most likely trigger was abrupt discharge of 163,000 km^3 of freshwater from glacial lake Agassiz-Ojibway through Hudson Strait ~8.4-8.3 ka, which slowed MOC and contributed ~ 0.2 to 1.0 m of sea-level equivalent. Coral reef and coastal stratigraphic records indicate that early Holocene sea level rose a total of ~16 m between 9 and 7.0 ka, concentrated in several pulses about 8.9 ka, 8.0 ka and 7.6 ka when rates exceeded 7-15 mm/yr. Glacial lake water accounts for < 1 m sea-level equivalent, so most early Holocene SLR came from melting ice sheets. Evidence combined from sediment core tidal marsh record from Chesapeake Bay, North American glacial geology, and deep-sea foraminiferal oxygen isotopes suggest a pattern of early Holocene SLR characterized by alternating contributions from the remaining Laurentide Ice Sheet and unknown parts of the Antarctic Ice Sheet. Interhemispheric phasing of northern and southern hemisphere millennial climate variability is embodied in the “bipolar see-saw” hypothesis, which invokes changes in the strength of deep-ocean circulation as a mechanism. This hypothesis can be tested by correlating intervals of rapid SLR and with Antarctic and Laurentide ice-sheet history at multi-centennial timescales.