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The wind driven spin-up of the Beaufort Gyre from satellite radar altimetry

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The Arctic Ocean's freshwater budget comprises contributions from river runoff, precipitation, evaporation, sea-ice and exchanges with the North Pacific and Atlantic. The consequent storage of >70,000 km3 of freshwater reduces the salinity of upper-layer seawater, which is separated from underlying warm, saline water by a strong halocline. Spatially and temporally limited observations show that the Arctic Ocean's freshwater content increased over the last few decades, predominantly in the west, and that freshwater entering the North Atlantic decreased by a similar amount. Models suggest that wind-driven convergence drives freshwater accumulation, but there are no continuous observations of changes in sea surface height (SSH) or halocline depth associated with this mechanism. Here we show the wind-driven spin-up of the Beaufort Gyre from continuous satellite measurements of SSH between 1995-2010. We observe a positive SSH trend and show that the trend in the wind field has a corresponding spatial pattern, indicating that wind-driven convergence controls freshwater variability. We calculate a freshwater increase of 8000$\pm$2000 km3 over the Western Arctic, in keeping with hydrographic observations. A reversal in the wind field could spin-down the Beaufort Gyre, releasing this freshwater to the Arctic Ocean and/or the North Atlantic, potentially affecting the wider global ocean circulation.