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Bidecadal North Atlantic ocean circulation variability controlled by timing of volcanic eruptions

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Understanding the mechanisms driving Atlantic Meridional Overturning Circulation (AMOC) decadal variability is critical for climate predictability in the Northern Hemisphere. North Atlantic paleoclimate proxy records exhibit bidecadal ocean climate variability but the climate impacts of this variability remains poorly understood. Here we show that the subset of CMIP5 historical simulations that produce such bidecadal variability exhibit a robust maximum in AMOC strength 15 years after the 1963 Agung eruption, followed by a second maximum in the 1990s, both due to triggering of a bidecadal cycle. The mechanisms at play involve salinity advection from lower latitudes and explain the timing of Great Salinity Anomalies in the North Atlantic in the 1970s and 1990s, which preceded the AMOC maxima. Ensemble simulations as well as Greenland and Iceland paleoclimate records support the triggering of bidecadal cycles following five Agung-like volcanic eruptions during the last millennium. Over the last decades, climate simulations and a conceptual model reveal interference patterns associated with the timing of subsequent volcanic eruptions. Destructive interference caused by the Pinatubo 1991 eruption may have led to a stable AMOC in the 2000s. It is shown that the response to volcanoes account for about 60% of AMOC decadal variability during the 1975-2005 period. Our results imply a long-lasting impact of volcanic eruptions on AMOC, North Atlantic circulation and climate, and a potentially significant multi-decadal predictability following the next large volcanic eruption.