Warm European summers initiated by freshwater in the North Atlantic

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Recent decades have been characterised by record Arctic sea ice losses and an increasing occurrence of weather extremes in the North Atlantic region. While earlier studies have identified statistical linkages between the two, the dynamical connections remain elusive. Here, we show that freshwater plays a crucial role. Combining ocean and atmospheric data, we show that individual strong freshwater events trigger intense cold anomalies in winter, resulting in sharp temperature gradients, amplified baroclinic instability, shifts in the jet stream maxima and extreme heat anomalies over large parts of Europe in the following summer. The stronger the freshwater events are, the more vigorous is the atmospheric response in winter, the more pronounced are the subsequent shifts in the North Atlantic Current and the jet stream and the larger are the heat anomalies over Europe. The strength of the freshwater event still controls the ocean and atmospheric evolution, including the European summer temperatures, two years after the initial event with the correlations exceeding 0.9. Considering these high sensitivities and the expected, increased Arctic freshwater discharges in future, we conclude that Europe is facing hot summers.