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Simulating the 8.2 ka BP event: the role of Labrador Sea Water formation

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The 8.2 ka BP event is a ~300-year long pronounced cold period in the early Holocene, centered in the Greenland Ice Cores around 8200 yr BP. The proposed cause for the event is the drainage of the huge proglacial Laurentide lakes (Lake Agassiz and lake Ojibway), into the Hudson Strait, which could have resulted in a weakening of the thermohaline circulation (THC) and a subsequent decrease in heat transport to the North Atlantic region. In recent years, widely varying estimates of the involved freshwater pulse have been published, so that the specific conditions that led to the 8.2 ka BP event remain uncertain. It is important to resolve this issue, as it provides crucial information on the sensitivity of the THC to perturbations. To improve our understanding of the mechanism behind the 8.2 ka BP event, we tested if we could simulate the 8.2 ka BP event in experiments that were forced with recently published estimates on the volume and drainage duration of the Laurentide lakes. The experiments were performed with version 3 of the ECBilt-CLIO-VECODE climate model that simulates deep water formation in the Labrador Sea in contrast to version 2. Starting from an Early Holocene (8.5 ka BP) climate equilibrium state, we injected different realistic freshwater pulses varying in volume and duration into the Labrador Sea. The amount of freshwater was varied assuming that a huge amount of icebergs was released during the catastrophic drainage of the lakes. Additionally we tested the effect of a background baseline flow through the Agassiz outlet on Early Holocene climate and on the freshwater pulses. Our results imply that the amount of freshwater released is the decisive factor in the response of the ocean, while the duration only plays a minor role, at least when considering the short release durations (1yr, 2yr and 5 yr) of the applied freshwater pulses. In the experiments without a background baseline flow, the different scenarios do not

result in a weakening in North Atlantic overturning of more than ~100 years. On the other hand, the experiments with a background baseline flow (0.172 Sv) reproduce a more realistic Early Holocene (8.5 ka BP) climate, with an almost absent Labrador Sea Water formation. Moreover, by introducing the same freshwater pulse scenarios into these initial conditions we are able to produce a prolonged weakening in overturning for a period of ~300 years. The weakened overturning results in a cool and dry Greenland, a cool northern Europe and a dry North Africa, agreeing with observations from proxy records. These results show that we can reproduce the 8.2 ka BP event with realistic estimates of the Laurentide lake volume and drainage duration. The effect of the background baseline flow turns out to be very important in the experiment, leading to a greatly reduced Labrador Sea Water formation and a prolonged period of weakened overturning circulation in the North Atlantic in reaction to the freshwater pulses, both in agreement with proxy evidence.