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Response of Carbon-14 in atmosphere and ocean to changes of the Atlantic meridional overturning circulation

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Reconstructions of past atmospheric radiocarbon concentrations show large natural variations over the last 20 kyr, mostly due to modulations of the galactic cosmic ray flux and changes in the Earth's carbon cycle. At the onset of the Younger Dryas cold event (ca. 12,700 years BP), atmospheric radiocarbon abruptly increased by 40 to 80 permil within a century. Previous observational and modelling studies have investigated potential mechanisms for this rapid increase, such as, e.g., a reduction in strength or a complete shutdown of the Atlantic meridional overturning circulation (MOC) due to freshwater inputs into the North Atlantic from melting land-ice. We investigate the response of atmospheric radiocarbon concentrations and sea surface reservoir age in various regions of the Atlantic ocean to a shutdown and subsequent recovery of the MOC using the cost-efficient, three-dimensional Bern3D ocean model. Sensitivity studies show a maximum change in atmospheric radiocarbon of 40 permil, strongly depending on amplitude, duration and region of freshwater input. Modeled variations in reservoir age are as high as 350 years, with maximum changes in regions where freshwater perturbations impact the strength of upwelling and vertical mixing. These results imply an age bias of the same order when dating marine records, as sea surface reservoir age is usually assumed to be constant.