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Low-frequency oscillations of the Atlantic Ocean meridional overturning circulation in a coupled climate model

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Abstract. Using a 3-dimensional climate model of intermediate complexity we show that the overturning circulation of the Atlantic Ocean can vary at multicentennial-to-millennial timescales for modern boundary conditions. A continuous freshwater perturbation in the Labrador Sea pushes the overturning circulation of the Atlantic Ocean into a bi-stable regime, characterized by phases of active and inactive deep-water formation in the Labrador Sea. In contrast, deep-water formation in the Nordic Seas is active during all phases of the oscillations. The actual timing of the transitions between the two circulation states occurs randomly. The oscillations constitute a 3-dimensional phenomenon and have to be distinguished from low-frequency oscillations seen previously in 2-dimensional models of the ocean. A conceptual model provides further insight into the essential dynamics underlying the oscillations of the large-scale ocean circulation. The model experiments indicate that the coupled climate system can exhibit unforced climate variability at multicentennial-to-millennial timescales that may be of relevance for Holocene climate variations.

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