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The thermohaline circulation in transient coupled ensemble lcimate simulations

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Idealised models have documented stable and unstable equilibrium states for the thermohaline circulation. Transient changes in this circulation might be driven by transient changes in the atmospheric forcing, but they also might be due to the internal variability of the coupled ocean-atmosphere system. In order to study the probability of changes in the thermohaline circulation that are associated with climate change, it was decided to produce a large ensemble of transient climate simulations. To this end the NCAR CCSM1.4 model was integrated 62 times for the period 1940-2080. During the historical part of the simulation, GHG concentrations, sulphate aerosols, solar radiation and vulcanic aerosols were prescribed according to observational estimates. From 2000 onwards, the solar constant was held constant and sulphate aerosols were kept fixed. Only the GHG concentrations varied according to a Business-as-Usual scenario. The ensemble members differ only in a small random perturbation in the initial temperature field of the atmosphere, enough to lead to entirely different atmospheric evolutions within the first couple of weeks of the integrations. The evolution of the thermohaline circulation in the 62 ensemble members is discussed, and the average change associated with the transient GHG forcing is separated from a part that is associated with the internal variability of the coupled ocean-atmosphere. In the latter we distinguish between THC variability that is associated with variations in the North Atlantic Oscillation and variability due to internal ocean dynamics.