Dichotomy between freshwater and heat flux effects on oceanic conveyor belt stability and global climate

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The Atlantic meridional overturning circulation (AMOC, or oceanic conveyor belt) is an important global scale oceanic circulation and major changes in AMOC may be responsible for past abrupt climate change events, such as those recorded in Greenland ice core record. Here, by using two versions of a coupled climate model, we show that the AMOC's stability depends not only on the background climate, but also on the type of primary external forcing: freshwater or greenhouse gases (GHGs). When freshwater forcing is dominant, AMOC hysteresis such as a sudden collapse or reactivation of AMOC become possible only under simulated glacial conditions. Whereas, under present day/future conditions, either freshwater or GHGs forcing could induce a collapsed AMOC but only GHG forcing produced a bi-stable equilibrium state equatable with abrupt climate change. Our results further demonstrate that the Bering Strait status (open vs. closed) may facilitate or prohibit the existence of AMOC hysteresis irrespective to the background climate conditions, but respective to primary forcing (freshwater vs. GHGs). In addition, the collapse of the AMOC induces a cooler and less cloudy Northern Hemisphere with reduced hydrological cycle intensity, but a slightly warmer and more cloudy Southern Hemisphere with enhanced hydrological cycle.