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Impact of freshwater release in the North Atlantic under different climate conditions in an OAGCM

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The response of climate to freshwater input in the North Atlantic (NA) has raised a lot of concern about the issue of climate stability since the discovery of abrupt coolings during the last glacial period. Such coolings have usually been related to a weakening of the Atlantic meridional overturning circulation (AMOC), probably associated with massive iceberg surges or meltwater pulses. Additionally, the recent increase in greenhouse gases in the atmosphere has also raised the possibility of a melting of the Greenland ice sheet, which may impact the future AMOC, and thereby the climate. In this study, the extent to which the mean climate influences the freshwater release linked to ice sheet melting in the NA and the associated climatic response is explored. For this purpose the simulations of several climatic states (last interglacial, Last Glacial Maximum, mid-Holocene, preindustrial, and future ($2\times CO2$) are considered, and the climatic response to a freshwater input computed interactively according to a surface heat flux budget over the ice sheets is analyzed. It is shown that the AMOC response is not linear with the freshwater input and depends on the mean climate state. The climatic responses to these different AMOC changes share qualitative similarities for the general picture, notably a cooling in the Northern Hemisphere and a southward shift of the intertropical convergence zone (ITCZ) in the Atlantic and across the Panama Isthmus. The cooling in the Northern Hemisphere is related to the sea ice cover response, which strongly depends on the responses of the atmospheric circulation, the local oceanic heat transport, and the density threshold of the oceanic convection sites. These feedbacks and the magnitude of temperature and precipitation changes outside the North Atlantic depend on the mean climate.