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Freshwater budget and nonlinearities in the Atlantic Ocean circulation

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Northward heat transport related to the North Atlantic Deep Water cell has a critical role in high-latitude climate and in particular in the temperate climate of northwest Europe. Paleoclimate reconstructions have shown that this overturning cell can change its operation mode (from 'ON' to 'OFF' state, or by changing the position of deep-water formation regions at high-latitudes) on decadal time scales, giving rise to significant climate impacts (e.g. Heinrich events during the last ice age). The stability properties of the Atlantic Meridional overturning circulation have been investigated through climate numerical models of different complexity. They generally confirm the existence of multiple operation modes which depend on outbursts of freshwater into the Atlantic ocean. However, the physical processes which effectively determine the state of the Atlantic Meridional overturning circulation is not yet fully understood.

We investigate the freshwater budget of the Atlantic basin using an intermediate complexity code, the Massachusetts Institute of Technology general circulation model in the configuration where ocean and sea-ice dynamics are coupled to simplified descriptions of atmosphere and land. We compare different stability indicators proposed in the literature and discuss how the salinity content affects the behaviour of the North Atlantic Ocean Circulation. In particular, we investigate nonlinear dependences of the operation modes on the averaged salinity content in the Atlantic ocean.