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Saltwater transport through the Indian-Atlantic ocean gateway: Does it modulate the Atlantic MOC?

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The Indian-Atlantic (I-A) ocean gateway at the southern tip of Africa is a prime pathway of the ocean THC return flow to the Atlantic that compensates for the export of deep waters from the Atlantic to the rest of the world ocean. The I-A gateway climatology is substantially controlled by the Agulhas Retroflection that recirculates tropical warm and saline Agulhas Current water through the area. Numerical models highlight the possibility that the leakage of some of this water into the South Atlantic acts as a rheostat for Atlantic MOC variability: internal wave propagation and northward salt water advection modulate convective activity in the subpolar North Atlantic, thereby controlling the rate of the basin-scale overturning. Primary control on the I-A gateway circulation and the salt leakage is exerted by wind forcing of the South Indian Ocean subtropical gyre circulation and the southern westerlies that interact with the inertia of the incoming saltwater flow of the Agulhas Current and determine the mode of the saltwater circulation through the gateway: western vs eastern position of the Agulhas Retroflection and large vs. small leakage. Several scenarios have been simulated with numerical models, but not all models yield the same response of the leakage to changing boundary conditions and none of them has been tested against observations.

Owning to the insufficient monitoring of the I-A gateway circulation and associated saltwater leakage the sensitivity of the leakage and of the Atlantic MOC to the leakage cannot be tested with modern observations. Palaeo-reconstructions that quantify the parameters relevant to the gateway circulation to date are the best way of testing the different scenarios. The EU funded GATEWAYS project produces such palaeo-data profiles and provides insight into surface ocean variability in the region under the climatic boundary conditions of the Late Pleistocene. Data profiles providing multi-decadal to centennial resolution are punctuated by episodic salinity maxima in the gateway that are indicative of short-lived Agulhas Leakage maxima. The data notably highlight the sensitivity of the I-A gateway circulation to Antarctic climate variability. Far-field correlation of several of these events with millennial scale events in the North Atlantic hint at a direct connection between Agulhas Leakage and MOC perturbation. Not all leakage events can be traced upstream in the Agulhas Current but seem confined to the immediate gateway region, hence indicating a prominent role of the I-A gateway dynamics in driving the rate of salt water leakage to the South Atlantic.