



Links between the Southern Annular Mode and the Atlantic Meridional Overturning in a climate model

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The links between the atmospheric Southern Annular Mode (SAM), the Southern Ocean and the Atlantic Meridional Overturning Circulation (AMOC) at interannual to multidecadal timescales are investigated in a 500-years control integration of the IPSL-CM4 climate model. The Antarctic Circumpolar Current is well correlated with the SAM at the yearly timescale, reflecting that an intensification of the Westerlies south of 45°S leads to its intensification. At the same time, the global Meridional Overturning Circulation is modified locally, primarily reflecting a forced barotropic response.

In the model, a positive SAM phase is found to precede an AMOC acceleration by about 8 years. This is due to an atmospheric teleconnection between the SAM and the northern North Atlantic, which results from a hemispherically symmetric influence of El Niño Southern Oscillation (ENSO). A SLP low centered near the tip of Greenland and a positive SAM phase are indeed found during La Niña conditions, leading to anomalous salinity advection toward the main area of deep convection in the model. This leads to a progressive erosion of the vertical stratification, which enhances the deep convection and then accelerates the AMOC. The observations also suggest interhemispheric links related to ENSO, albeit less pronounced in the northern North Atlantic, and even though no significant correlations are found between the SAM and the North Atlantic SLP in the reanalysis.

A more direct but slower oceanic link between the SAM and the AMOC is found at multidecadal time scale. Salinity anomalies generated by the SAM both in the Pacific and in the Indian basins enter the South Atlantic and propagate northward. They eventually reach the northern North Atlantic about 70 years after a positive SAM, where they similarly affect the vertical stratification and thus the AMOC. A deceleration of the AMOC is found 20 years later. This phase reversal is due to the same mechanism as negative salinity anomalies coming from the Indian and Pacific basin enter in the Atlantic basin about 20 years after a positive SAM phase. This freshening is generated earlier by SAM-driven anomalous advection in the Pacific and the Indian basins, and is then advected into the Atlantic basin.