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Control of the South Atlantic Convergence Zone by extratropical thermal forcing

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Paleoclimatic data suggest that the extratropics have the capability to trigger global teleconnection patterns that drive changes in the distant tropical regions mediated through both atmospheric and ocean processes. In particular, abrupt events associated with changes in the strength of the Atlantic Meridional Overturning Circulation evidence a synchronous behaviour between the high latitude North Atlantic Ocean temperatures and tropical changes. The Intertropical Convergence Zone (ITCZ) has been the most studied feature in this sense and the general picture emerging from these studies is that the ITCZ tends to shift toward the warmer hemisphere. However, there is evidence supporting the idea that other features of the tropical climate might be affected by such an extratropical influence.

In this study the response of the South Atlantic Convergence Zone (SACZ) to an extratropical thermal forcing is investigated in a hierarchy of model simulations. For each model hierarchy, three sets of experiments are performed, varying the extratropical forcing. In the first the forcing consists of warming of the Northern Hemisphere (NH) and cooling of the Southern Hemisphere (SH), with zero global average. In the second and third experiments, the former forcing is divided into its northern and southern components to asses their relative roles in affecting the SACZ. In all the cases realistic surface boundary conditions are implemented.

We find that during its peak in austral summer the SACZ can be affected by an extratropical thermal forcing with a behaviour that does not replicate the ITCZ response of shifting toward the warmer hemisphere. In fact, we find that when the NH extratropics warm and the SH extratropics cool, the SACZ experiences a significant weakening associated, mostly, to the NH component of the forcing. Our results indicate that 75% of the SACZ signal in response to the forcing is linked to the development of a secondary tropical convergence zone in the Atlantic Ocean around 20°N-30ºN, which depends on the tropical sea surface temperatures response. The remaining 25% of the signal can be explained through the development of a Walker-type of circulation between western tropical Africa and the SACZ, being this mechanism associated with the African land surface temperature reaction to the remote forcing.

Our results are in agreement with paleoclimatic studies and, therefore, the proposed physical mechanisms linking the NH extratropics with the SACZ might be plausible.