Project: **1110**

Project title: **Simulating Southern African precipitation during the last 65 years with a high-resolution atmospheric CCLM simulation**

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This high-resolution CCLM simulation for Southern Africa, covering the period 1951-2013, driven by the global coupled model FOCI, is part of a set of three CCLM simulation performed in the BMBF-funded CASISAC project. The joint project of Helmholtz-Zentrum Hereon, GEOMAR, University of Siegen, and Christian-Albrecht-University in Kiel has the goal to explore the current and future evolution of the Agulhas Current system around South Africa as a consequence of natural and anthropogenic drivers, and its impacts for the climate in Southern Africa. In our subproject at Helmholtz-Zentrum Hereon, we are studying the impact of the Agulhas Current System on the Southern African climate, especially precipitation.

After performing the simulations and being on maternity leave, we are analyzing the simulation focussing on two topics: the current and future precipitation trends in Southern Africa and the impact of the Agulhas Current System on them and extremes in precipitation, especially for coastal South Africa, changes in frequency and drivers.

Regarding precipitation changes and the impact of the Agulhas Current System, we analyzed the precipitation trend and the contribution of the Agulhas leakage, the part of the Agulhas Current that flows into the South Atlantic, to that trend, for both the historical and the future CCLM simulation (Fig. 1).

In the historical period, Agulhas leakage and precipitation along the southeast coast of South Africa are found to be positively correlated (Fig. 1a). A more intense Agulhas leakage imprints the SSTs patterns in the region, with warmer SSTs in in the retroflection region and colder SSTs in the southwest Indian Ocean. Warmer SSTs are linked with higher convective precipitation at the southeast coast of South Africa during summer. By contrast, the correlations of Agulhas leakage with precipitation in the winter rainfall zone around the Western Cape region are negative (Fig. 1a). This may be due to the modification of cyclonic activity by the SSTs in this season.
Concerning the long-term trends, the simulated precipitation displays a weak negative trend in most of southern Africa, with some precipitation intensification along the southeast coast (Fig. 1c). Around 1/10 of this trend can be statistically explained by Agulhas leakage (Fig. 1e). The areas with a positive precipitation trend are also the ones that are positively correlated to the leakage. In the Western Cape region (Fig. 1d) precipitation displays a long-term decline. Both trends reflect again the long-term impact of the intensifying leakage on precipitation at the southeast coast of South Africa.
Regarding changes in precipitation in the future scenario simulation, Agulhas leakage and precipitation in South Africa appear negatively correlated (Fig. 1b), contrary to the historical period. Thus, the simulation indicates both an intensification of leakage and a diminishing precipitation along the whole coast and the southern inland. Again, around 1/10 of the trend in precipitation is due to Agulhas leakage (Fig. 1f). The change in the dependency of Agulhas leakage strength and precipitation comparing the current and future periods requires further investigation. One explanation could be related to the southward shift of the Agulhas Current in the future scenario. According to this explanation, Agulhas leakage intensifies while the Agulhas Current weakens and is displaced poleward away from the coast. The precipitation at the southeast coast is stronger when the core of the Agulhas Current is located closer to the coast. This leads us to the conclusion that the future trend in simulated precipitation in the winter rainfall zone may be directly linked to the strength of the Agulhas leakage, whereas the trend in precipitation at the southeast coast may be more strongly linked to the position and intensity of whole Agulhas Current system. It should be, however, kept in mind that other remote influences, for instance that of ENSO can also modulate precipitation trends in this region.

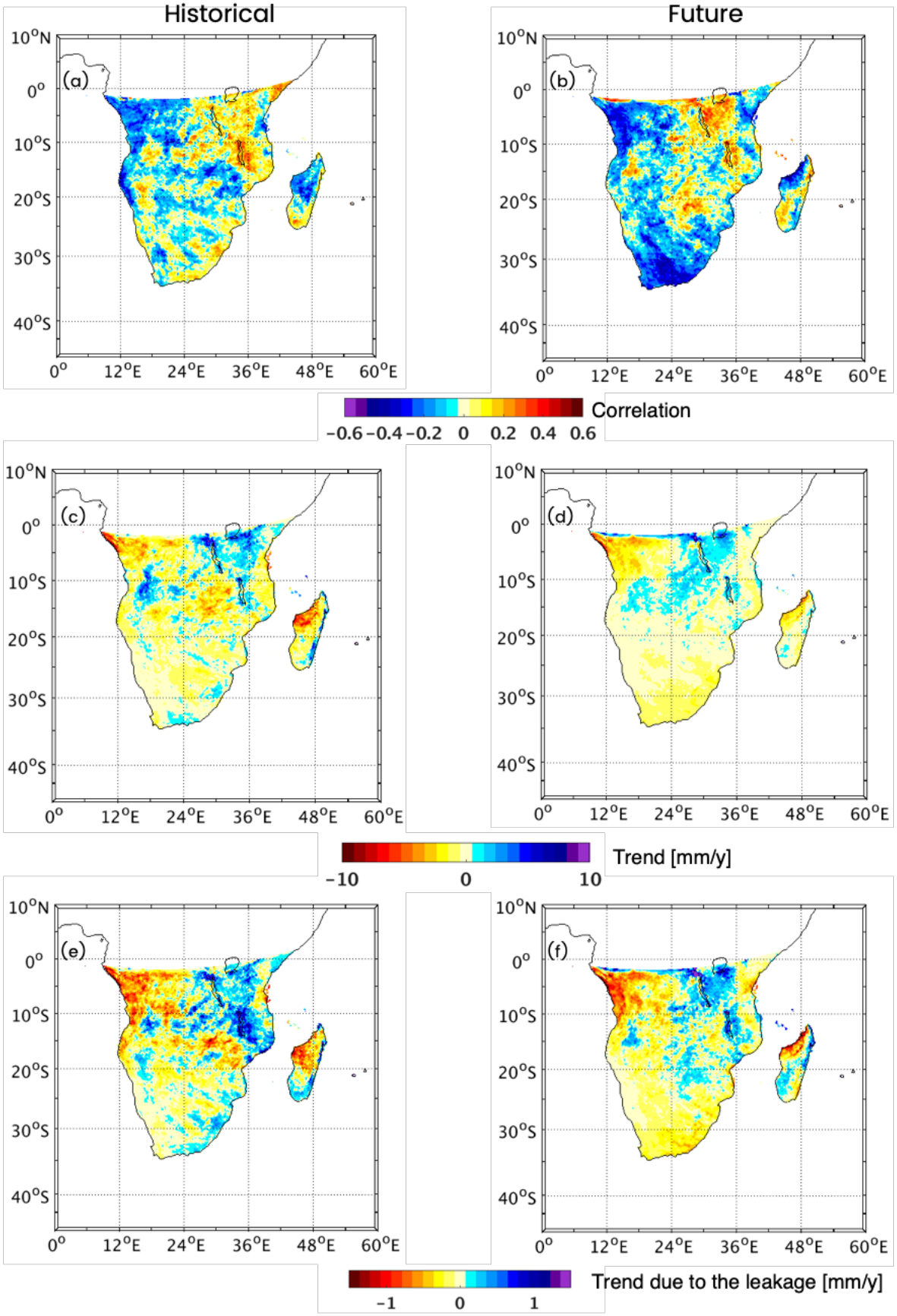

Figure 1: The correlation of (a,b) Agulhas leakage (FOCI simulation) and the precipitation (CCLM simulation), (c,d) the precipitation trend over the simulation period, and (e,f) the contribution of Agulhas Leakage to the precipitation trend, in the (left column) historical simulation covering the period 1951-2013 and (right column) the scenario simulation covering the period 2014-2099.