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Simulating SST Teleconnections to Africa: What is the State of the Art?

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It is well-known that variations in sea surface temperatures (SSTs) are partly responsible for large interannual anomalies of seasonal mean rainfall over many areas of Africa. Knowledge of these teleconnections is increasingly used to provide probabilistic predictions of such rainfall anomalies, with the objective of helping vulnerable African communities and assisting national resource management. This study provides an overview of the state-of-the-art of modelling SST teleconnections to Africa, and begins to investigate the sources of error. Data is obtained from the Coupled Model Intercomparison Project, CMIP3 and CMIP5, using the '20C3M' and 'historical' coupled model experiments.

A systematic approach is adopted, with the scope narrowed to 6 large-scale regions of Sub-Saharan Africa within which seasonal rainfall anomalies are reasonably coherent, along with 6 SST modes known to affect theses regions. No significant non-stationarity of the strength of these 6x6 teleconnections is found in observations. The capability of models to represent each teleconnection is then assessed (whereby half the teleconnections have observed SST-rainfall correlations that differ significantly from zero).

A few of these teleconnections are found to be relatively easy to model, including that from the Mediterranean to the Sahel in July-September. A few more pose substantial challenges to models, such as the link between the Equatorial East Atlantic and July-September rainfall in the Guinea Coast region, and the link between the Central Indian Ocean and the Sahel (also July-September). Many other teleconnections exhibit a wide variety of model skill. Furthermore, some models perform consistently better than others, with the best able to at least adequately simulate 80-85% of the 36 teleconnections. No improvement is found between CMIP3 and CMIP5.

Analysis of atmosphere-only simulations suggests that the coupled model teleconnection errors may arise primarily from errors in their SST climatology and variability, although errors in the atmospheric component of teleconnections also play a role. Last, no straightforward relationship is found between the quality of a model's teleconnection to Africa and its SST or rainfall biases or its resolution. Perhaps not surprisingly, the causes of these errors are complex, and will require considerable further investigation.