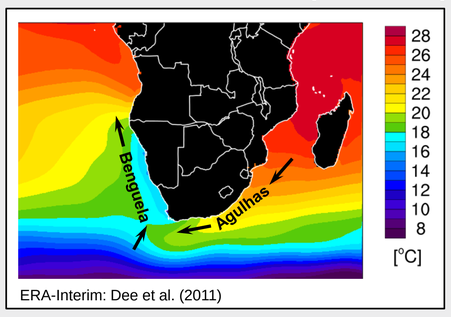
Sensitivity of the hydrological cycle to corrections of the sea surface temperature biases over southern Africa in a regional climate model

Torsten Weber, Andreas Haensler, and Daniela Jacob

Introduction

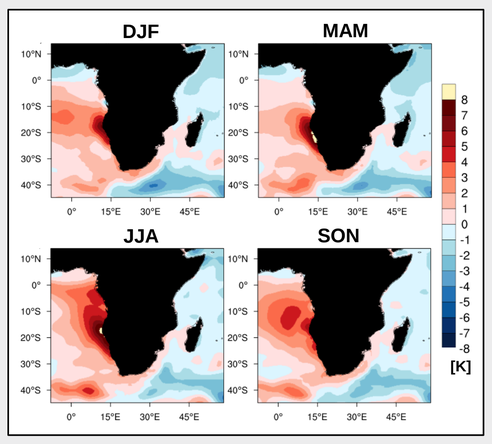
Mean SST ERA-Interim (1993-1997)



ERA-Interim: Dee et al. (2011)

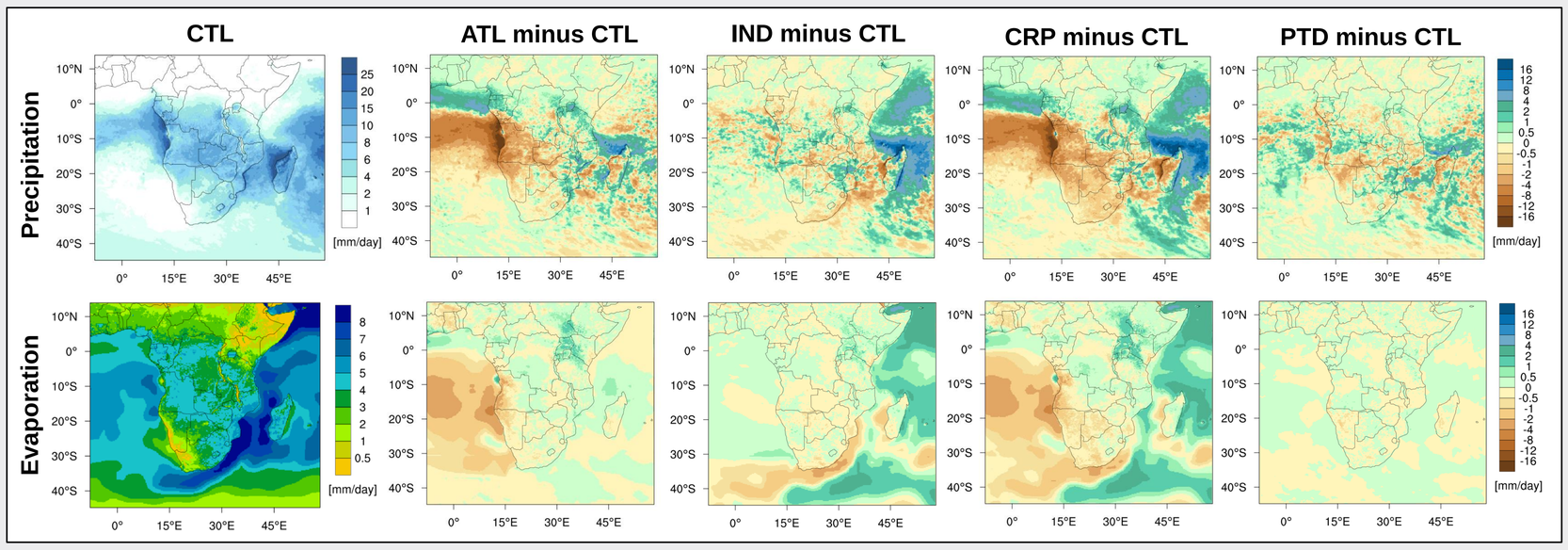
High resolution climate change projections and subsequent detailed analysis of the hydrological cycle are of particular importance for southern Africa since possible changes of the climate will affect the water availability in this region. Regional climate models (RCMs) are used to downscale climate change projections generated with general circulation models (GCMs) to obtain high resolution climate information. These GCMs are usually coupled with an ocean model providing ocean parameters such as sea surface temperature (SST) needed by GCMs.

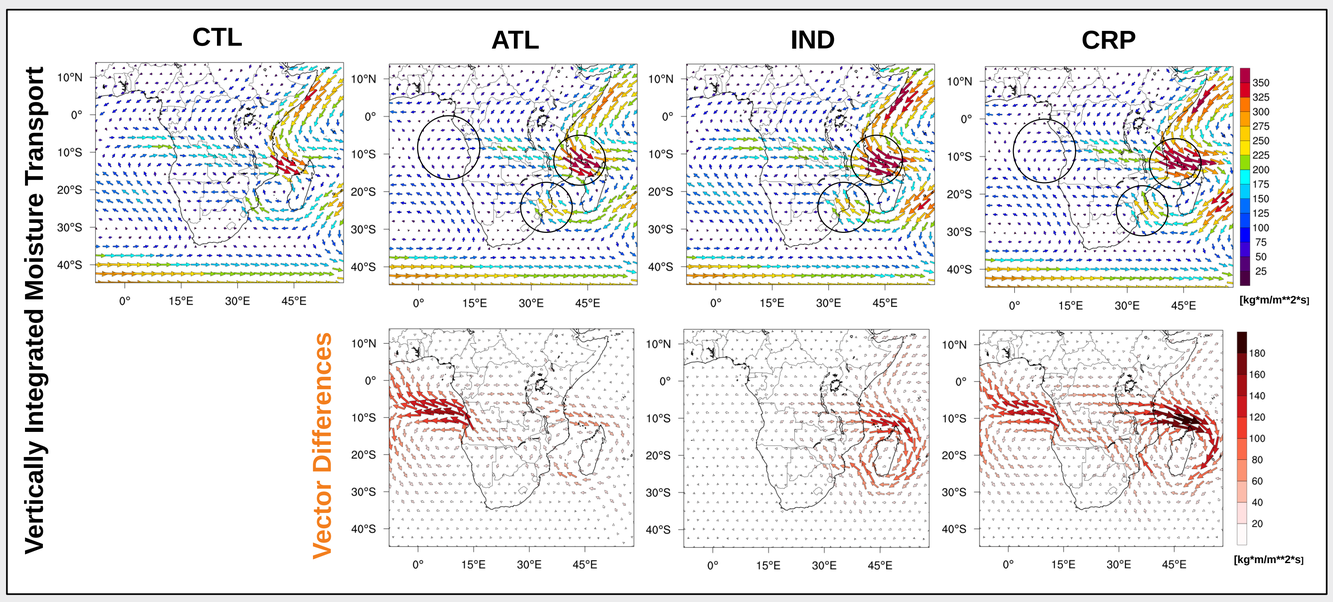
Mean difference
MPI-ESM-LR HIST minus ERA-Interim
(1993-1997)



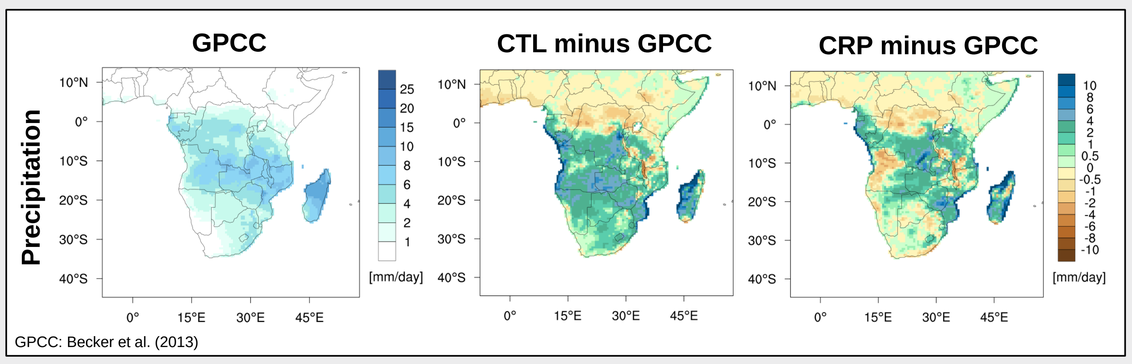
Here, the cold up-welling Benguela current flows northward along the west coast of southern Africa in the Atlantic Ocean whereas the Agulhas current flows southward along the east coast in the Indian Ocean. However, global ocean models often have deficiencies in resolving regional to local scale ocean currents, as it is the case in the oceans offshore the southern African region. Consequently, the moisture transport from the Atlantic and Indian Ocean affected by their SSTs is also biased.

Results for Southern Hemispheric Summer (DJF) from 1993-1997



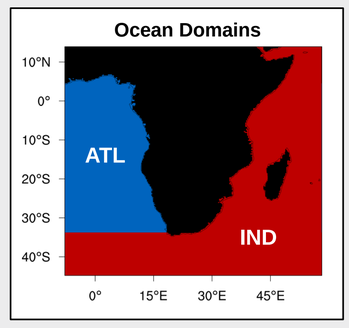


Validation



GPCC: Becker et al. (2013)

Method



To analyze the impact of the deficiencies in the SST representation on the regional hydrological cycle, we perform several simulations with the regional climate model REMO (Jacob, 2001) forced with MPI-ESM-LR HIST at a spatial resolution of 25 x 25 km². Five sensitivity experiments, each covering five years (1993-1997), were carried out with:

- **CTL:** SST as given by MPI-ESM-LR HIST
- **ATL:** SST of Atlantic Ocean and Benguela current replaced by ERA-Interim
- **IND:** SST of Indian Ocean including Agulhas current replaced by ERA-Interim
- **CRP:** SST as given by ERA-Interim
- **PTD:** As CTL, but with perturbed atmospheric conditions to assess the internal model variability of REMO

Conclusion

The results show a distinct impact of the SST biases on the hydrological cycle in southern Africa with the Atlantic SST as the major force of the hydrological cycle. Corrections of the SST lead to less precipitation and evaporation as well as to a reduction of moisture transport onshore from the Atlantic Ocean. These changes are higher than the internal model variability. Based on these findings the SST bias should be taken into account for regional climate change projections.

References

Jacob D. (2001): The role of water vapour in the atmosphere. A short overview from a climate modeller's point of view. Phys. Chem. Earth A 26 (6–8):523–527.

Becker et al. (2013): A description of the global land-surface precipitation data products of the Global Precipitation Climatology Centre with sample applications including centennial (trend) analysis from 1901–present. – Earth System Science Data 5: 71–99. DOI:10.5194/essd-5-71-2013.

Dee et al. (2011): The ERAInterim reanalysis: configuration and performance of the data assimilation system. – Quarterly Journal of the Royal Meteorological Society 137: 553–597. DOI: 10.1002/qj.828.

Climate Service Center Germany (GERICS) • Helmholtz-Zentrum Geesthacht • Fischertwiete 1 • 20095 Hamburg • Germany • Phone +49 (0)40-226 338-436 • Fax +49 (0)40-226 338-163
Contact: Dr. Torsten Weber • Email: torsten.weber@hzg.de