Projected Hydrological Changes for Agricultural Risk Assessment over Southern Africa in a Warmer World

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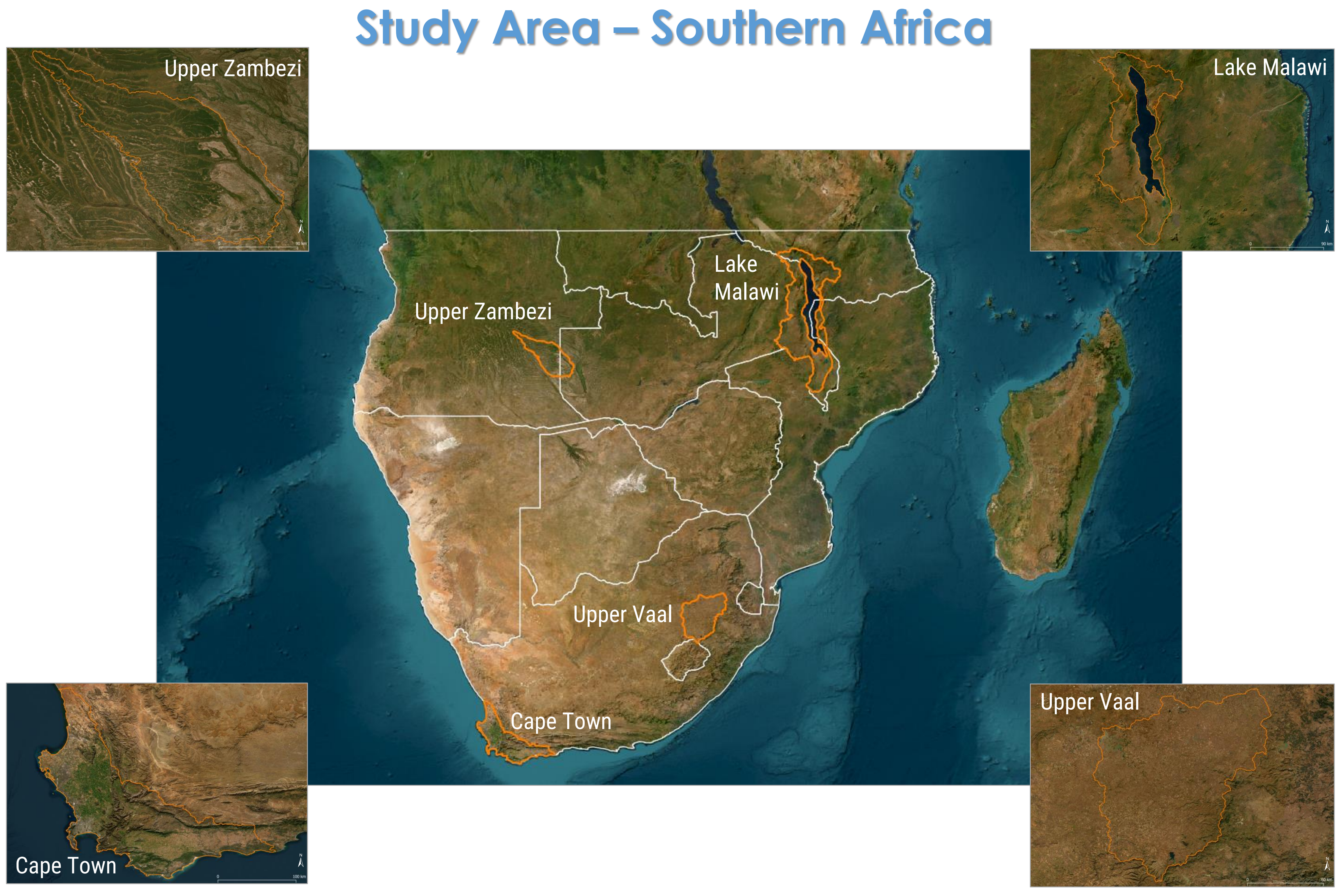
Introduction

Motivation

- Southern Africa was identified as a climate change hotspot by the IPCC SR1.5.
- The region is warm, dry and water-stressed and is projected to become drastically warmer, and likely also drier under low mitigation scenarios.
- Such a change in the regional climate system will likely lead to changes in water availability and limited adaptation options, with potentially unprecedented impacts on agriculture and food security.

Study Area – Southern Africa



Objectives

Overall objective: To project hydrological changes in southern Africa and assess their potential impact on risks to food security.

Specific objectives:

- Calculation of hydrology-related climate impact indicators based on regional climate model projections of CORDEX-CORE under low mitigation.
- Analysis of annual and seasonal changes in hydrology-related climate impact indicators, in order to detect changes in planting date, length of the growing season and burning season.

Projected Annual Changes

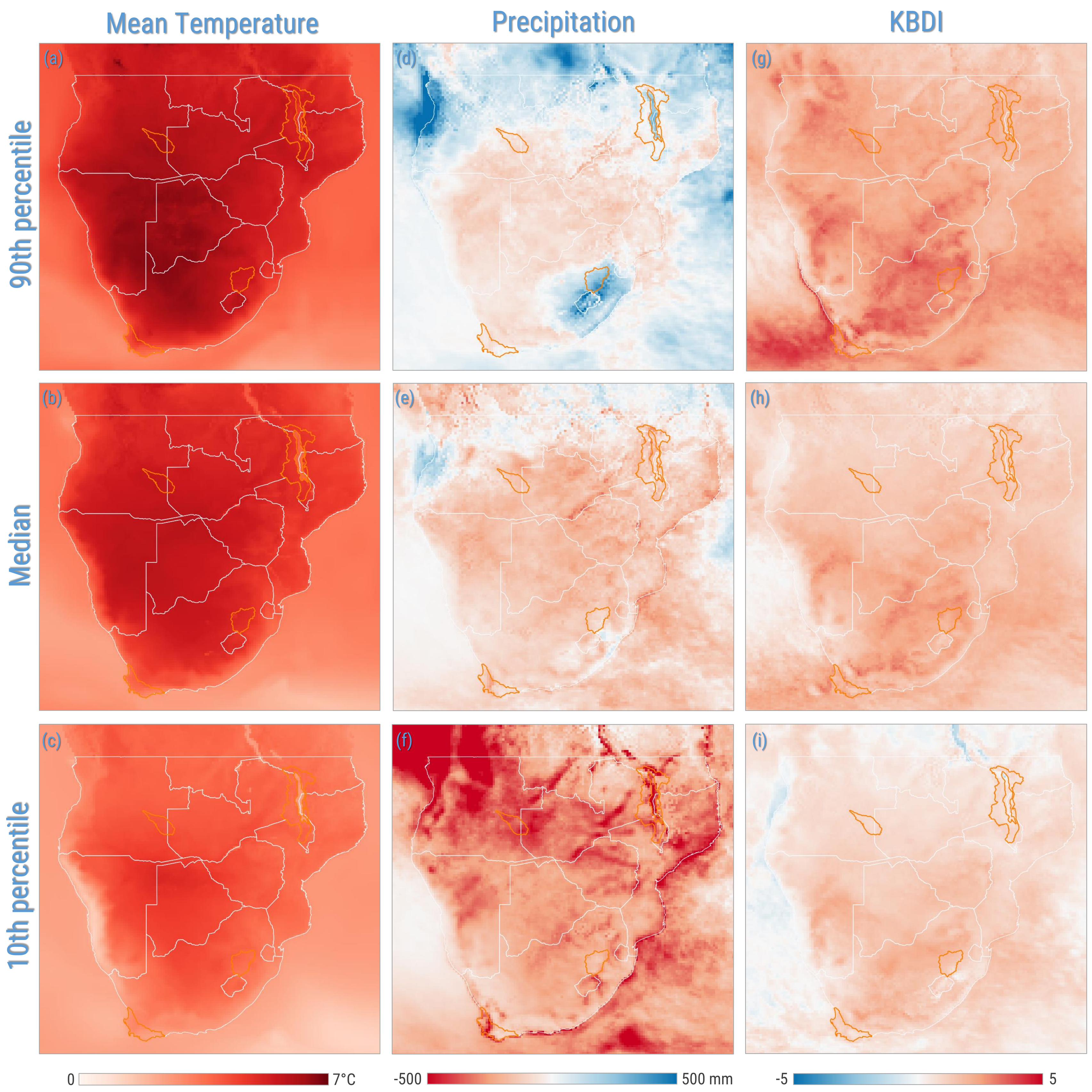


Fig. 1: Projected changes in annual-average surface-temperature (°C) (a - c), precipitation (mm) (d - f) and Keetch-Byram drought index (dimensionless, 1-10) (g - i) over southern Africa, for the time period 2080-2099 relative to 1971-1990. The 90th percentile, median and 10th percentile are shown for a multi-model ensemble of 9 regional climate CORDEX-CORE simulations under the low mitigation scenario RCP8.5, with horizontal resolution of 0.22° (3 RCMs: GERICS-REMO2015_v1, CLMcom-KIT-CCLM5-0-15_v1, ICTP-RegCM4-7_v0, driven by 3 GCM projections: MPI-M-MPI-ESM-LR/MR, MOHC-HadGEM2-ES, NCC-NorESM1-M).

Projected Seasonal Changes

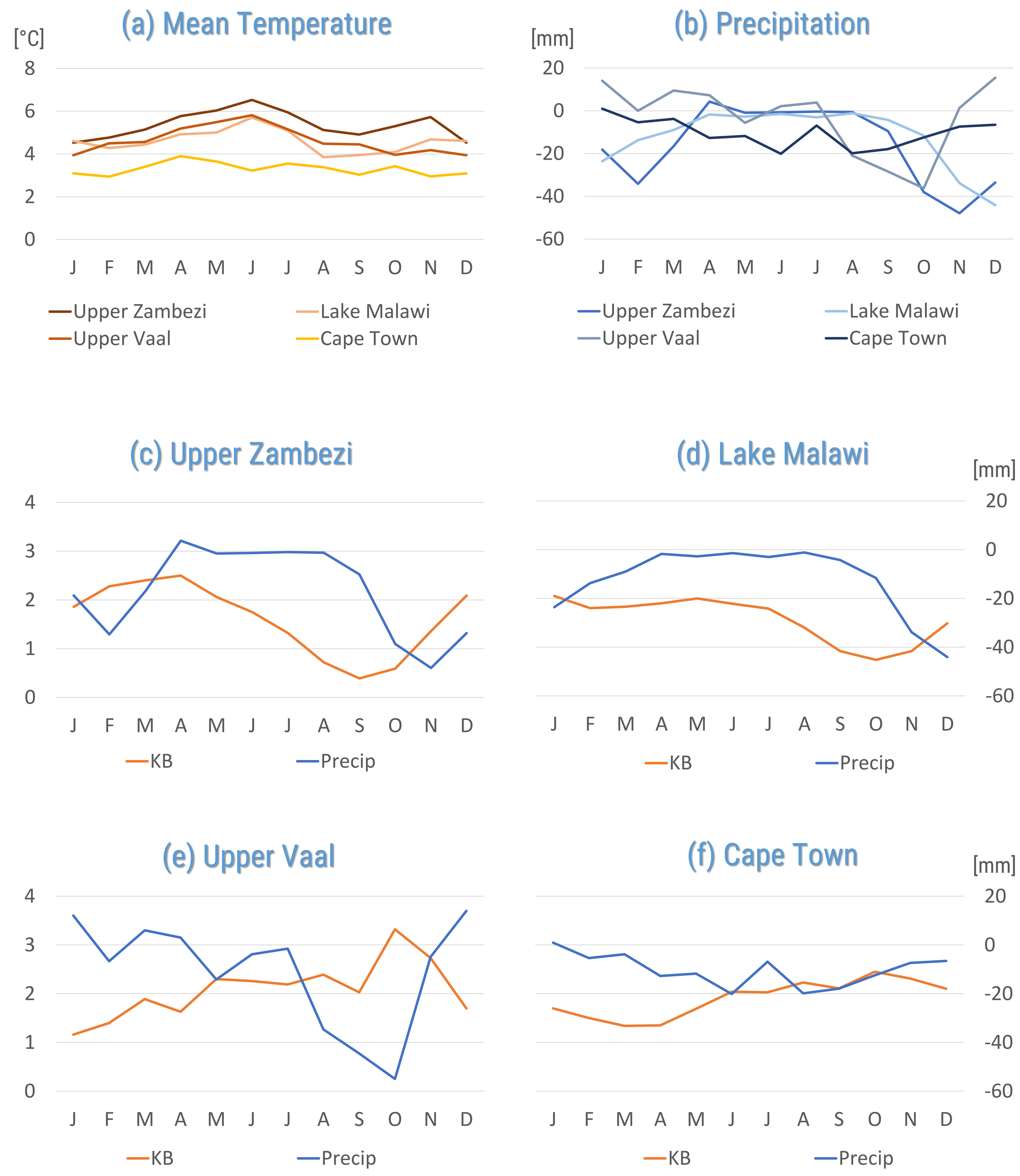


Fig. 2: Projected changes in the seasonal cycle of mean temperature (a), precipitation (b) and the Keetch–Byram drought index for Upper Zambezi, Lake Malawi, Upper Vaal and Cape Town (c-f) for the time period 2080-2099 relative to 1971-1990. The median is shown for the ensemble of 9 regional climate CORDEX-CORE simulations under the low mitigation scenario RCP8.5 (3 RCMs: GERICS-REMO2015_v1, CLMcom-KIT-CCLM5-0-15_v1, ICTP-RegCM4-7_v0, driven by 3 GCM projections: MPI-M-MPI-ESM-LR/MR, MOHC-HadGEM2-ES, NCC-NorESM1-M).

Conclusions

Projected annual and seasonal changes (2081-2100 vs 1971-1990)

Near-surface mean temperature

- Projected increases of mean temperature range between 3.4 - 6.6 °C (90th percentile), 2.6 - 5.9 °C (median) and 1.3-5.1 °C (10th percentile) over southern Africa (figures 1(a)-(c)).

Precipitation

- Most CORDEX-CORE downscalings are indicative of general precipitation decreases over southern Africa (figures 1(d)-(f)).
- Over the Lesotho Drakensberg and the northern part of the domain the precipitation futures are uncertain.

Keetch-Byram drought index (KBDI)

- Soil drying, as approximated by KBDI, is projected over southern Africa as a consequence of strong regional warming and related increases in evapotranspiration (figures 1(g)-(i)).
- Even in the presence of rainfall increases the projected reduction in soil-moisture availability is a robust signal across the CORDEX-CORE ensemble.

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Upper Zambezi: Substantial reductions in precipitation and strong increases in temperature are projected for the summer half-year of October to March, resulting in soil-moisture decreases with potential risks for groundwater recharge and rural agriculture.

Lake Malawi basin: Mid-summer precipitation is projected to decrease in Malawi with associated reductions in soil-moisture. Such changes may impact directly on the maize crop and via implications for lake levels also affect fisheries and water allocations to the irrigation and hydropower sectors.

Upper Vaal: The projections are indicative of substantial precipitation reductions in spring, resulting in a decreased soil-moisture availability and a shorter growing season, with corresponding delays in the planting date of maize crop.

Cape Town: Projected temperature increases combined with general precipitation decreases across the winter-rainfall region lead to projected reductions in soil-moisture availability, with potential impacts on all key crops including vineyards, wheat and non-citric fruits. The projected decrease in soil-moisture availability during summer will result in a longer and more intense burning season.

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