# The current and future water balance of West-Africa with focus on Northern Ghana and Burkina Faso

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# BRAVE2

"Building understanding of climate variability into planning of groundwater supplies from low storage aquifers in Africa – second phase".

Funded under the NERC/DFID/ESRG Unlocking the Potential of Groundwater for the Poor (UPGro) Program.

Investigators from the University of Reading, the British Geological Survey, and a large number of water resources research, governance, and (international) aid agency partners in Ghana and Burkina Faso.

# Details of the Research

Modelling the water balance with land-surface models, in the context of recharge prediction of Sub-Saharan shallow aquifers. Emphasis is on the extremes and how these may change in the future, in relation to management of surface and groundwater resources in Sub-Saharan Africa (SSA).

We are using data derived from the Met Office Unified Model (GA3) ensemble of high resolution free-running atmosphere-only model runs (UPSCALE) with the JULES surface scheme to study the SSA water balance.

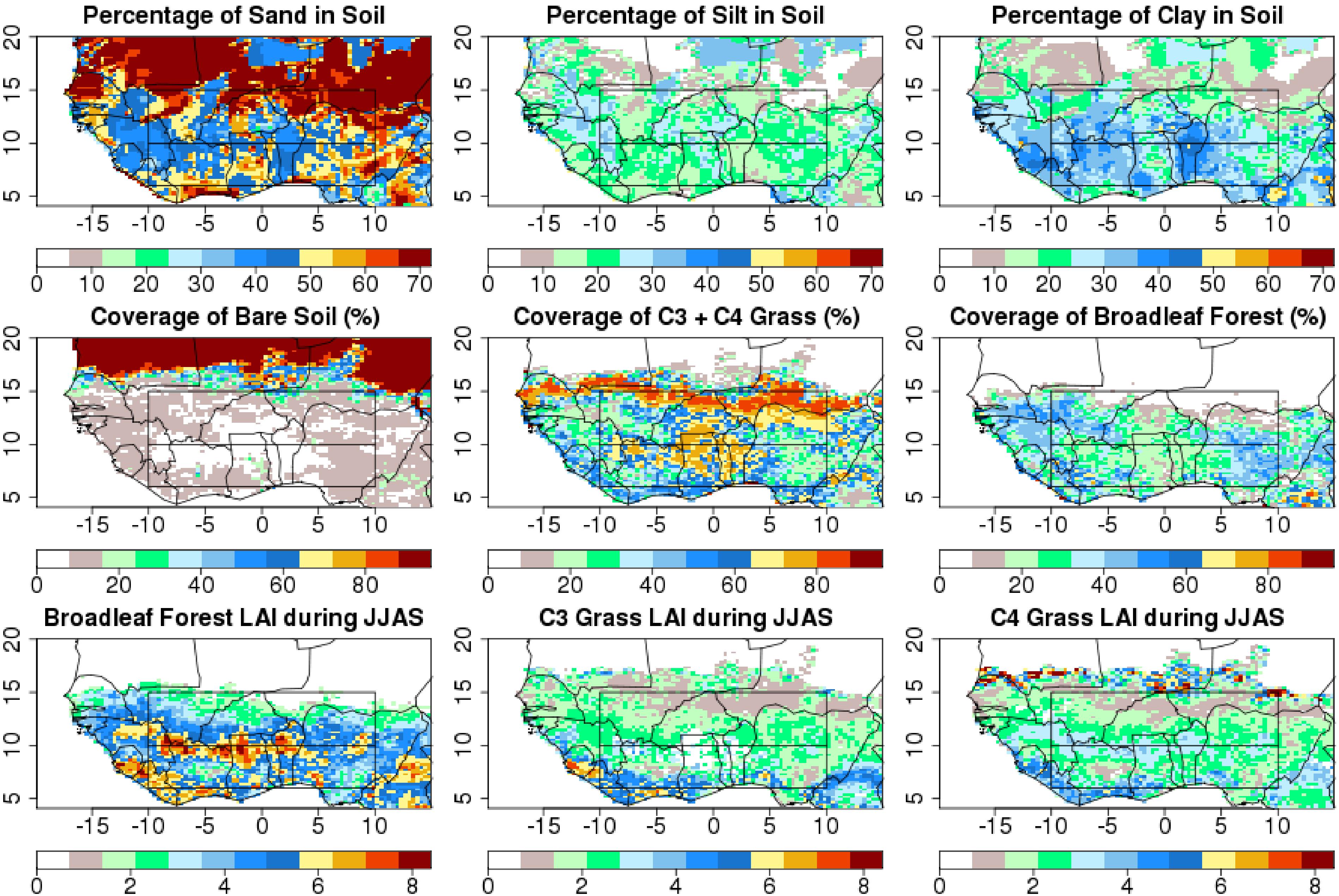
Simulations forced with OSTIA SSTs for present climate and OSTIA + SST change between 2000-2100 for future climate.

# The Water Balance

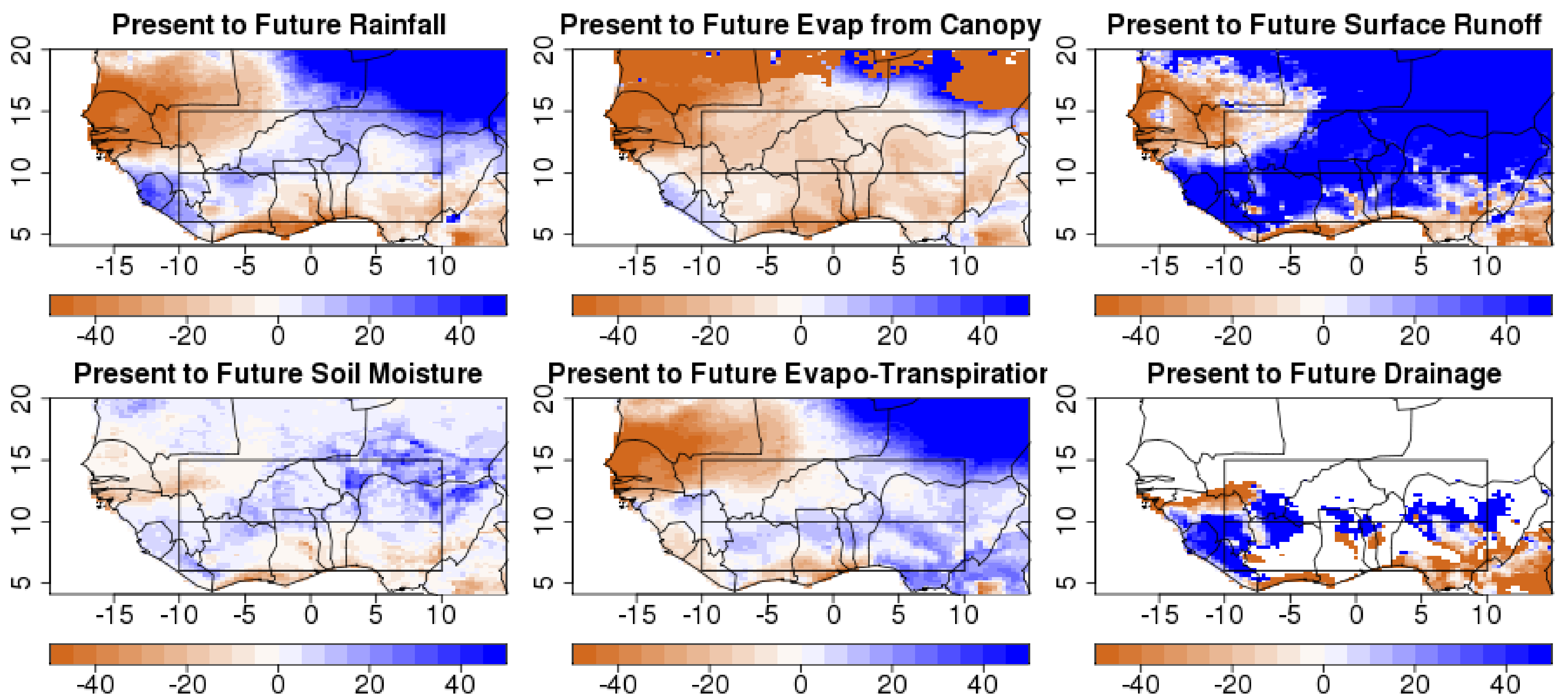
Rainfall is either intercepted by the canopy and re-evaporates, or runs off the surface, or goes into the soil. The soil moisture is then taken up by plants (or evaporates from the surface) or drains into aquifers.

The water balance then depends on the amount of rainfall and fraction from convective storms, which will change in the future, and on the type of soil and vegetation, how fast water can infiltrate the soil and how much is taken by plants.

We are comparing the model present (5 x 27 years) and future (3 x 27 years) climate, the 5 wettest and 5 driest years in each case, and areas with grass or trees.

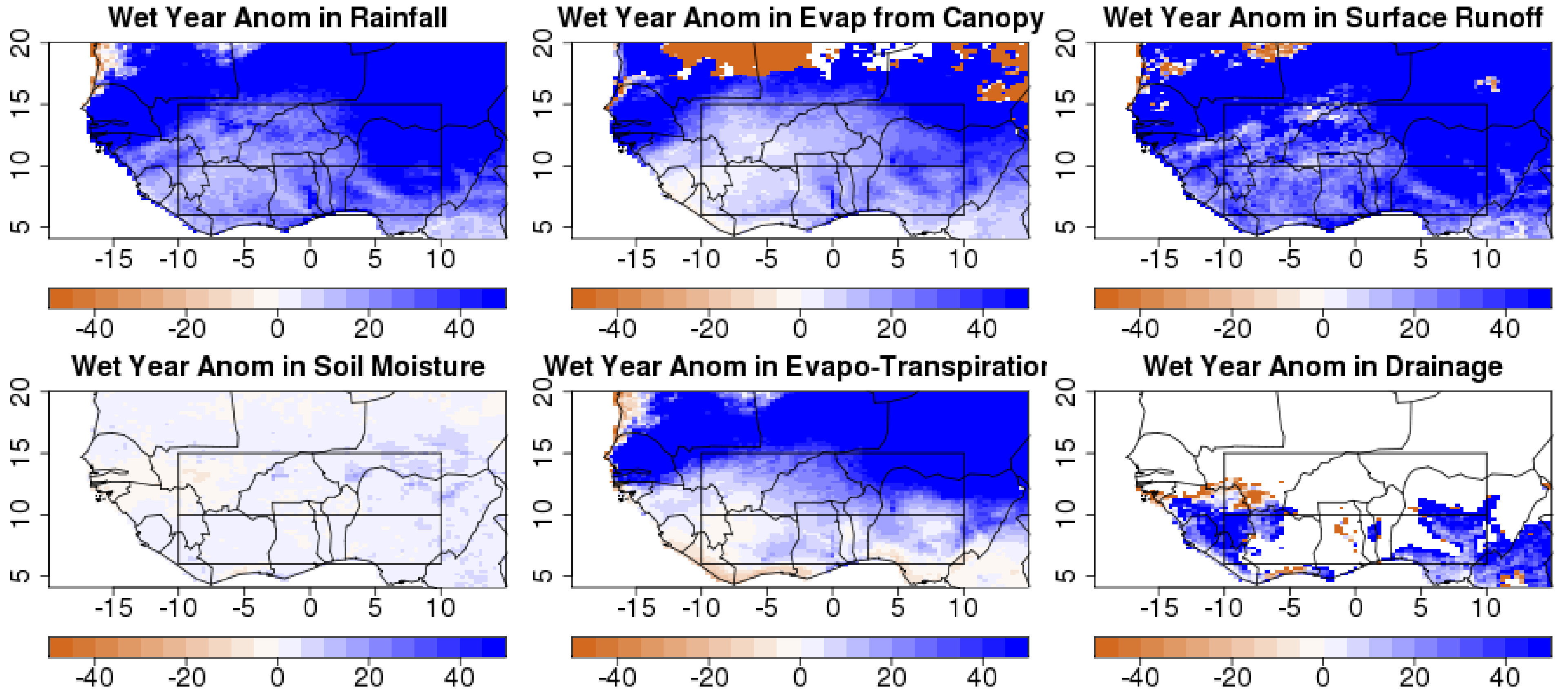



The coverage of soil and vegetation types in West Africa



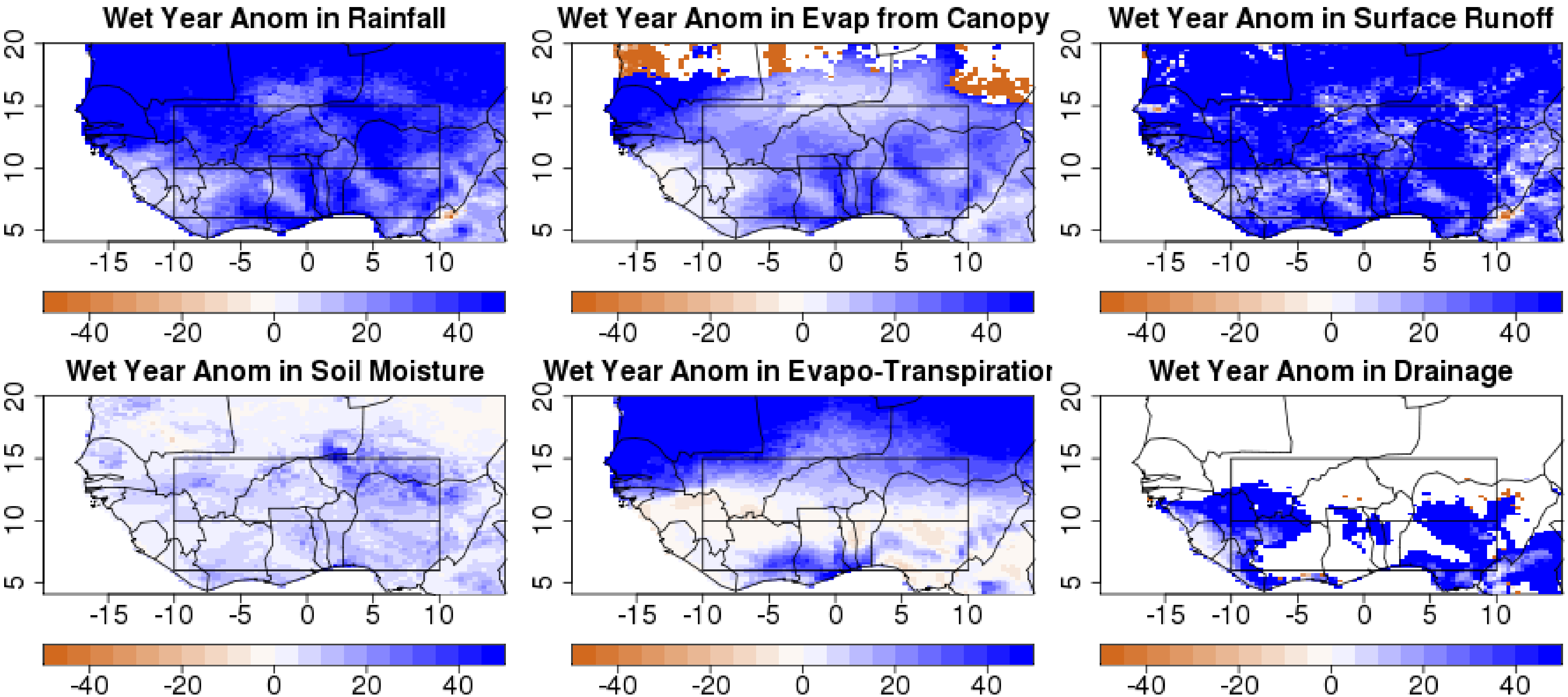

Percentage changes in the climatology going from model present to future climate (during JJAS)

Rainfall increases inland but is reduced near the coasts, evaporation from the canopy is reduced suggesting that a larger fraction of the rain is from convective storms

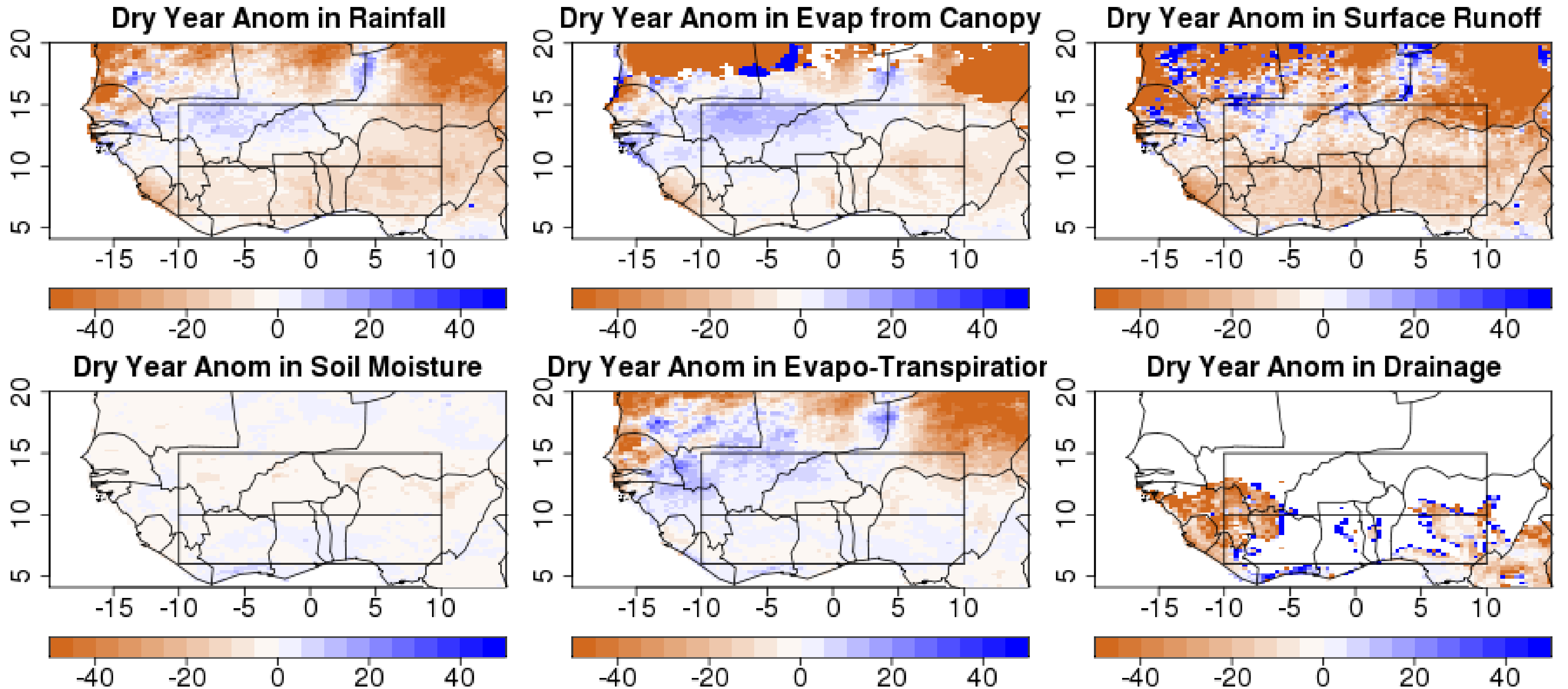



Percentage mean anomalies for the 5 wettest years in the model present climate (during JJAS)

Large percentage increases in rainfall, runoff and drainage, but smaller increases in soil moisture and evaporation

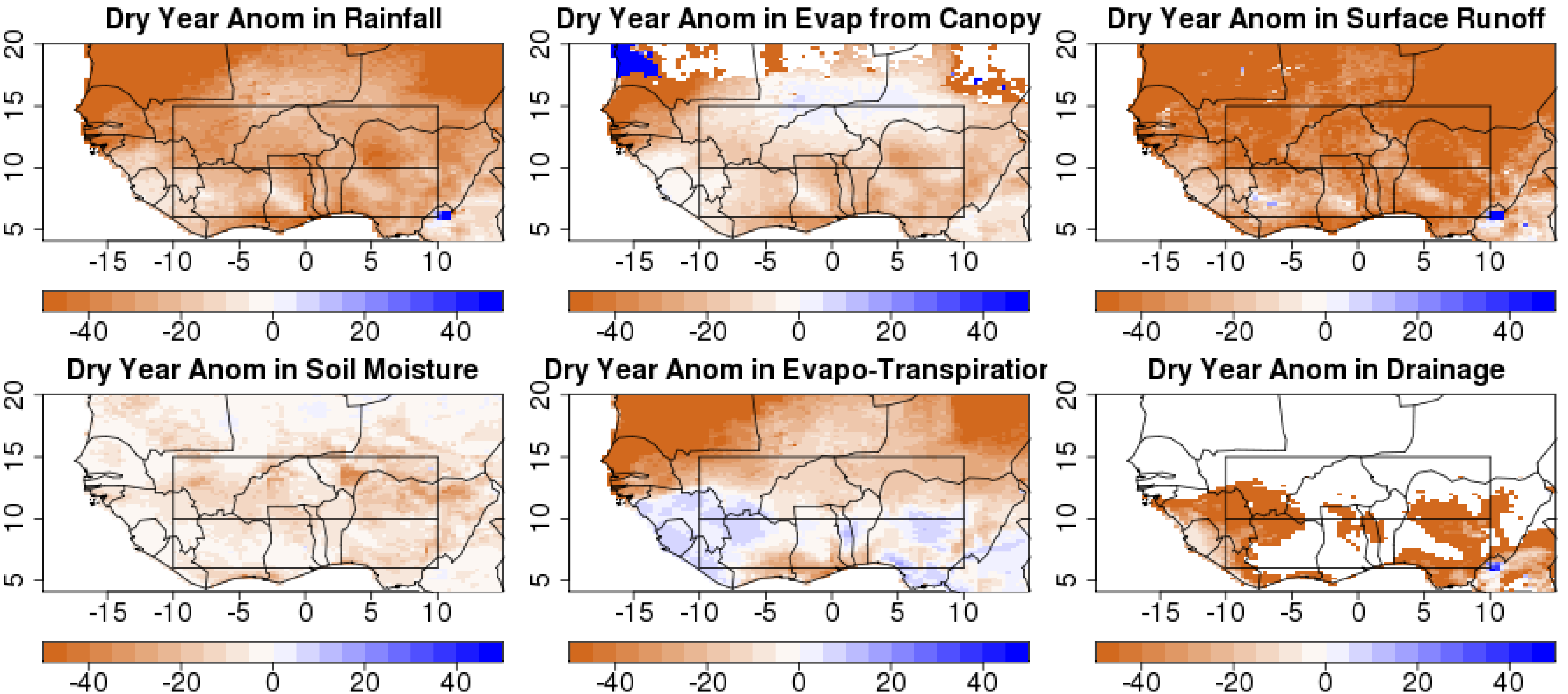



Percentage mean anomalies for the 5 wettest years in the model future climate (during JJAS)

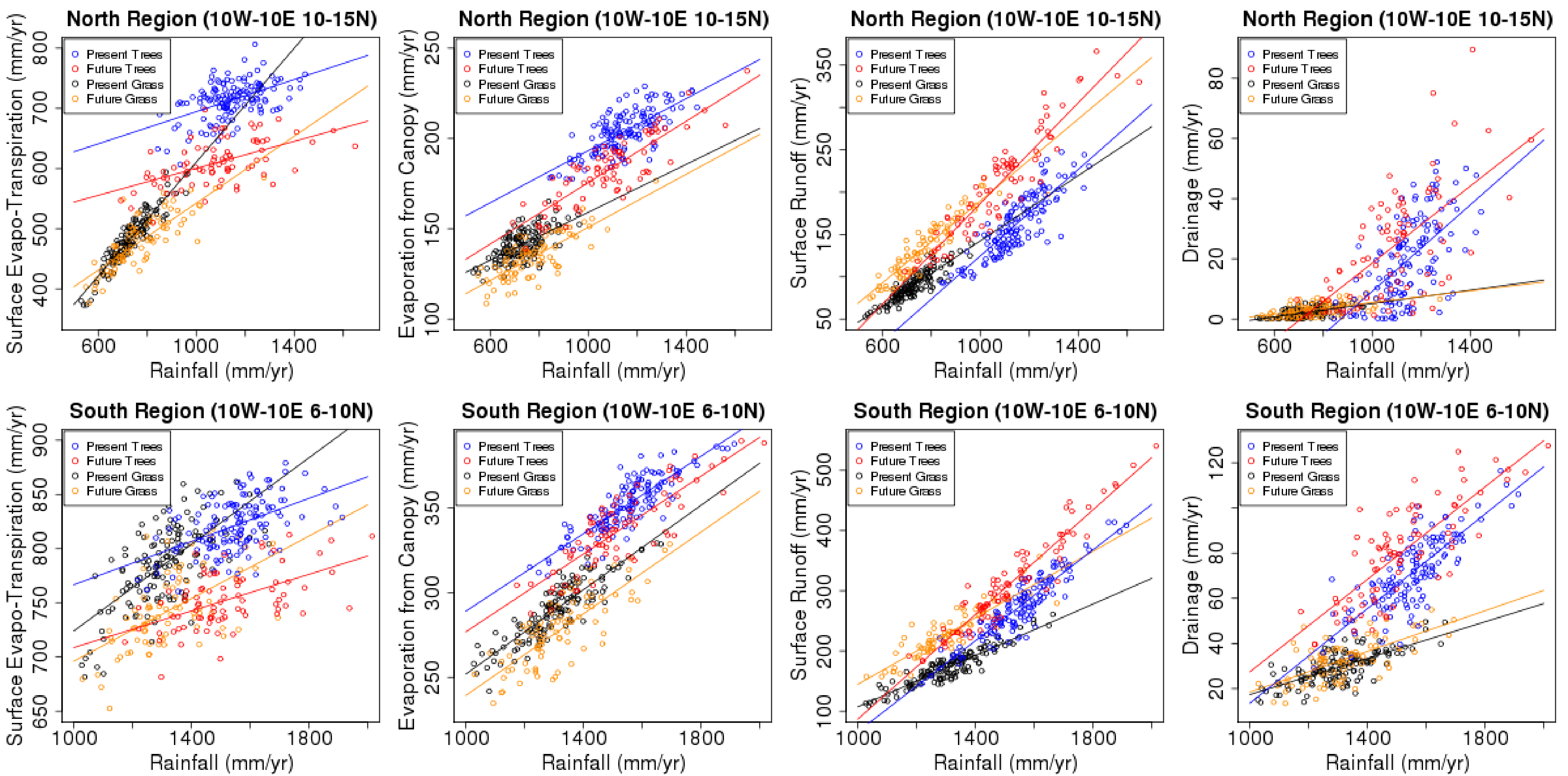



Percentage mean anomalies for the 5 driest years in the model present climate (during JJAS)

Here the pattern is more complex with reduced rainfall in the South but some increases in the North

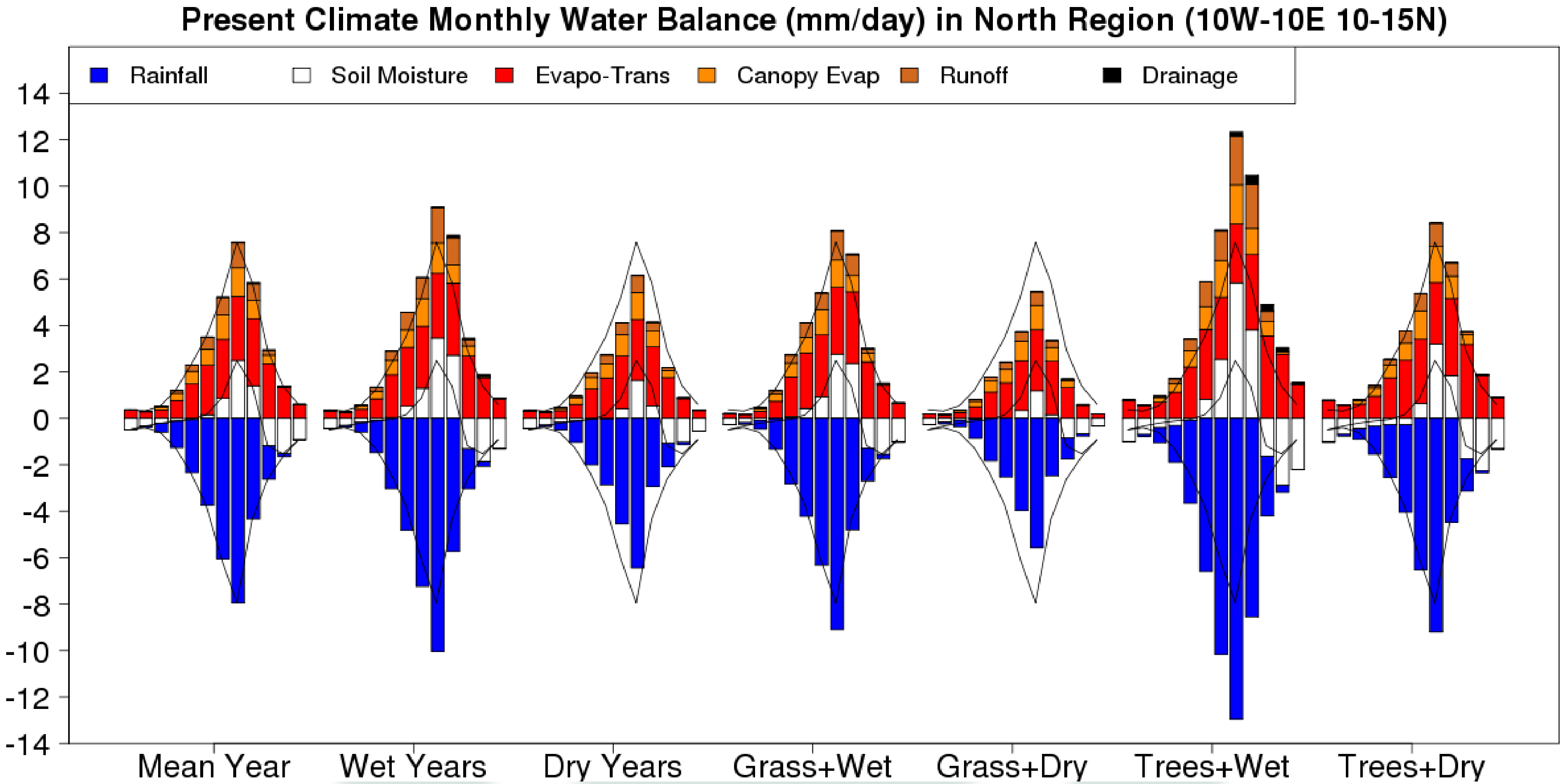



Percentage mean anomalies for the 5 driest years in the model future climate (during JJAS)



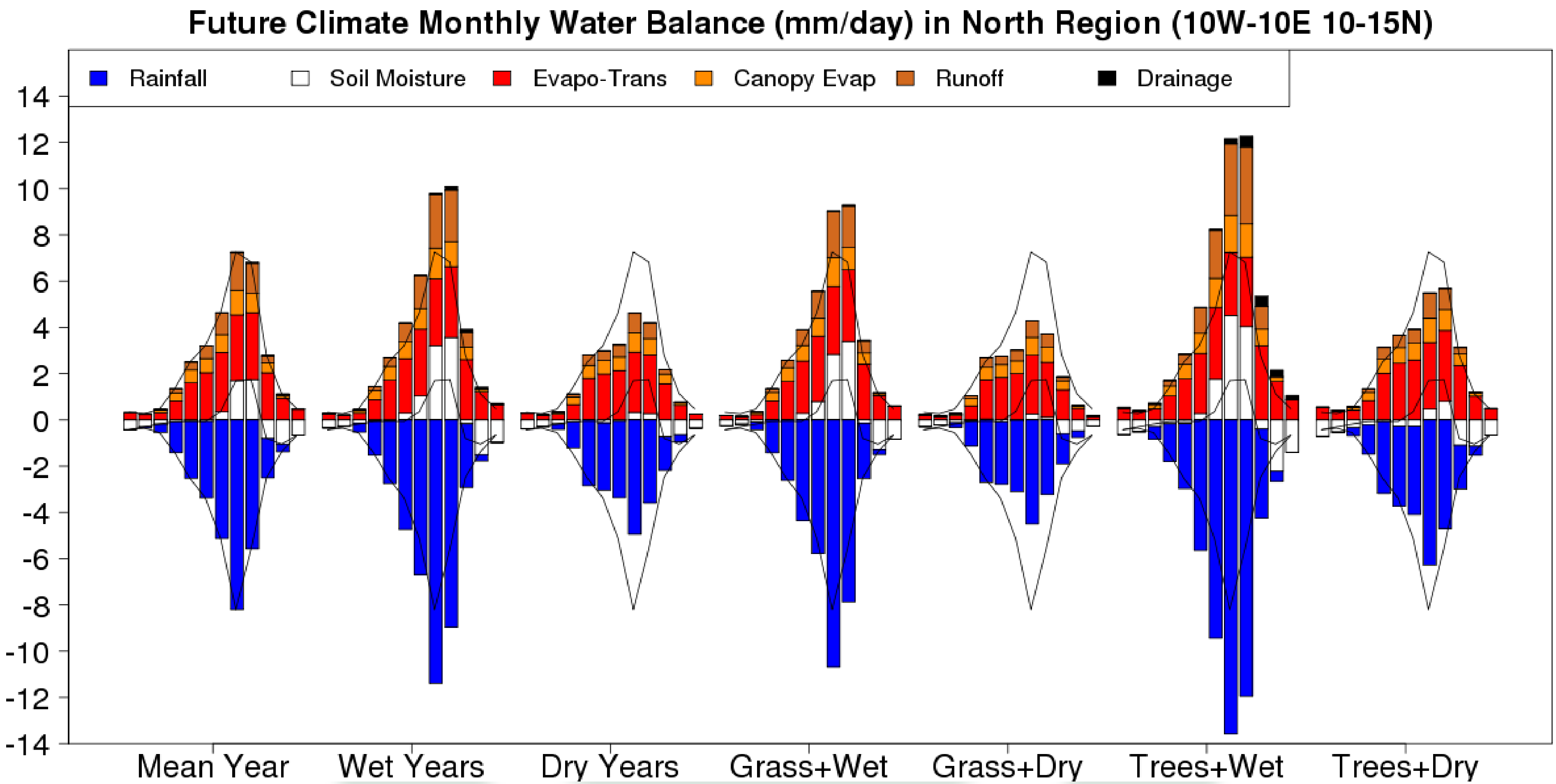

Annual values vs rainfall in the North and South regions, for areas with grass or trees, model present or future climate

Future climate – less evaporation but more surface runoff
Trees – more evaporation at low rainfall and more drainage



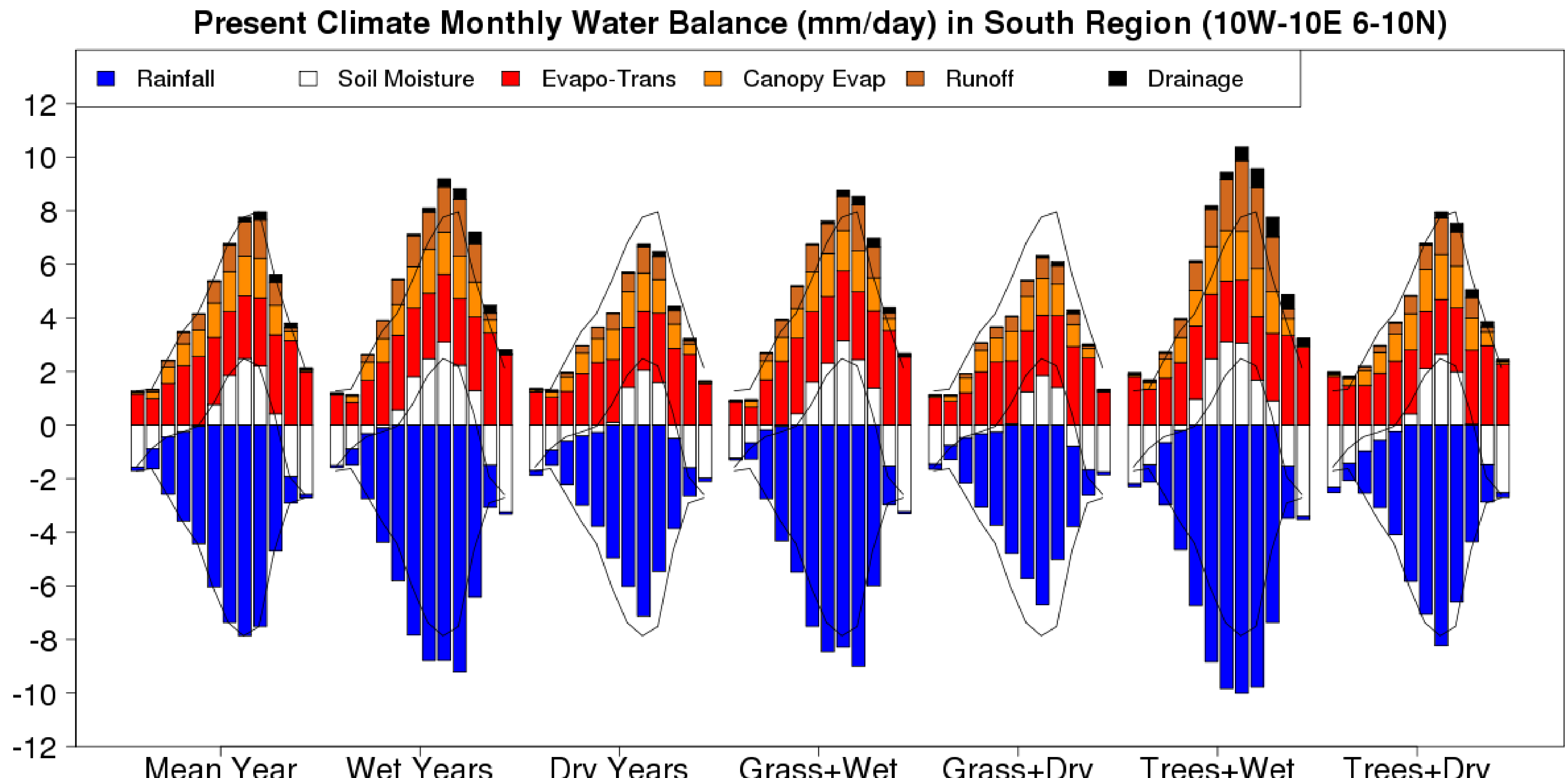

January to December water balance in the North region for model present climate

Trees receive more rainfall, have a greater soil moisture cycle and more surface runoff and drainage than grass



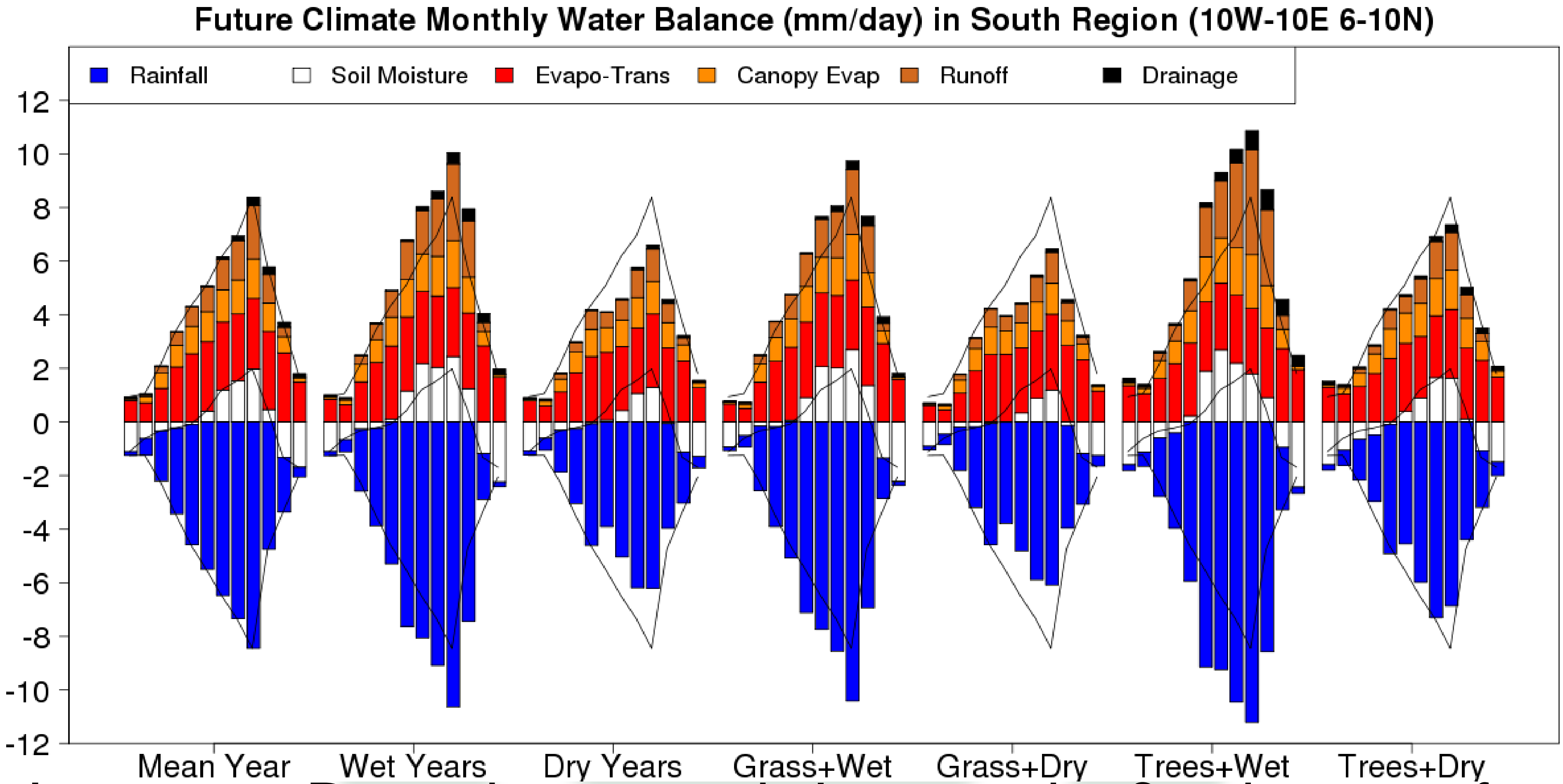

January to December water balance in the North region for model future climate

Larger difference between the wettest and driest years, and rainfall occurs slightly later in year than in present climate




January to December water balance in the South region for model present climate

Trees receive more rainfall and have greater runoff and drainage than grass




January to December water balance in the South region for model future climate

Have a smaller soil moisture cycle, and rain occurs slightly later in the year than in the present climate model runs

# Conclusions

In the model future climate runs rainfall is increased inland, falls slightly later in the year, and the difference between the wettest and driest years is larger. Reduced surface evapo-transpiration and evaporation from the canopy, but greater surface runoff and drainage, for given annual rainfall suggests that a greater fraction of the rain is from convective storms.

Areas with trees receive more rainfall, mostly due to large-scale circulation but also from evaporation feedback. Trees have greater evapo-transpiration at low annual rainfall, because their deeper roots are able to access more water from the soil, and more evaporation from the canopy due to their high leaf area index.