Intensification of the hydrological cycle expected in West Africa over the 21st century

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INTRODUCTION

•It is now established that global warming will result from enhanced anthropogenic greenhouse gases (1). Such a warming is expected to affect precipitation and its variability, especially drought and flood episodes, in both the tropics and the subtropics (2). Over West Africa, previous studies (1,3) have shown that the warming is expected to occur at a faster rate than the global average (+ 0.5 vs. + 0.3 °C per decade). Future changes in precipitation extremes are expected in some sub-regions, such as an increase in the maximum length of dry spells over West Sahel (4,5) and an intensification of extreme rainfall over the Guinea Coast (5).

• Thus, even though previous studies have reported important changes in the future regional precipitation, very little is known about the processes involved and the role of the future warming. To better understand the future impact of the warming on the hydrological cycle in the different sub-regions of West Africa, this study uses the state-of-the-art, high resolution projections of the recent CORDEX-AFRICA experiments to investigate, over the twenty-first century, the future changes in different aspects of the hydrological cycle and their relationship with regional temperatures

DATA & METHOD

- 18 high-resolution regional climate projections taken from the most up-to-date ensemble
  produced in the recent years for Africa: CORDEX-AFRICA

- We consider the three following sub-regions: West Sahel (10°N-20°N 18°W-10°W), Central Sahel (10°N-20°N 10°W-10°E), and Guinea Coast (5°N-10°N 10°W-10°E), shown as black boxes in the Figures

- Using the threshold of 1 mm/day, we define
  a dry day: daily precipitation amount is below 1 mm/day
  a wet day daily: precipitation amount is above 1 mm/day

- We compute the annual hydroclimatic intensity index (HY-INT) following Eq. (3):$HY-INT=\frac{DSL_n}{INT_n}$
  Where $DSL_n$and $INT_n$are the normalized

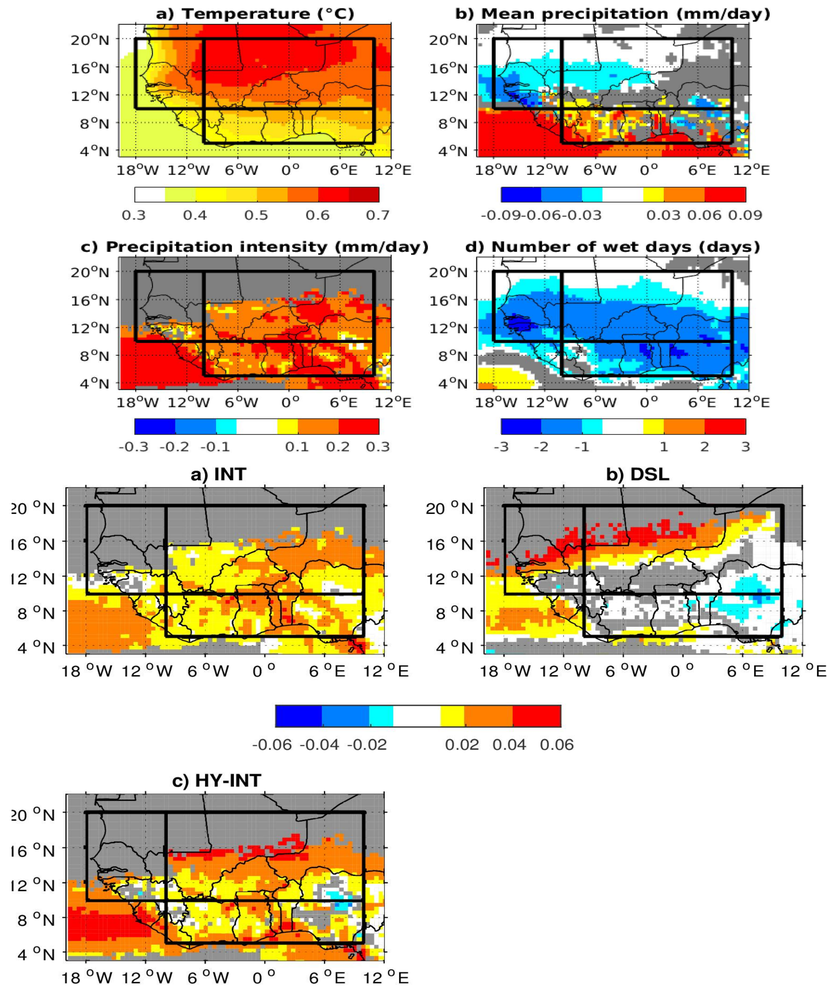
- $DSL=\frac{NDD}{NDS}$
  where NDD is the annual number of dry days excluding isolated dry days (single dry day preceded and followed by a
  wet day), and NDS is the total number of dry spells during that year

RESULTS

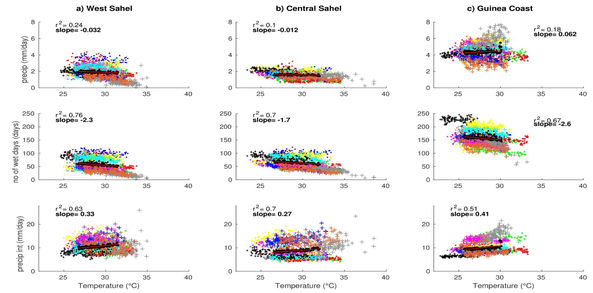
- According to the result temperature is expected to increase on average by +0.5°C per decade over the entire West Africa.

We also find that

- mean precipitation is expected to decrease with temperature over the Sahel and increase with temperature over the Guinea Coast.
- the hydrological cycle is expected to increase with temperature over the entire West Africa, on average by + 11 % per °C over the Sahel and + 3% per °C over the Guinea Coast.
- the Sahel takes longer to reach saturation (DSL increases on average by + 7.5 % per °C) and releases more water when it condensates (INT increases on average by + 3.1 % per °C).
- the Guinea Coast however, does not take longer to reach saturation (DSL decreases on average by – 1 % per °C), but does release more water when it condensates (INT increases by + 4.1 % per °C but DSL decreases by – 1 % per °C).



Multimodel mean trend maps (2006-2100)



Annual means of precipation, no. of wet days and precipitation intensity against annual meantemperature

CONCLUSION

We conclude that

1) West African surface temperatures are expected to increase at a faster rate than the global averaged warming (+ 0.5 °C vs. 0.3 °C per decade)

2) precipitation is expected to intensify but rarefy over the entire region

3) dry spells are expected to become longer (especially over the northern and the western part of the Sahel)

4) wet spells are expected to become shorter over the Guinea Coast.

Hence the hydrological cycle is expected to intensify over West Africa, and especially over the Sahel, as a result of local warming.

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