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Implications of Projected Temperature Over West Africa for the 21st Century Based on the Representative Concentration Pathways 4.5 And 8 .5 Wm −2

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Abstract: Projected changes in air surface temperature for the 21st century using Representative Concentration Pathways (RCPs) 4.5 and 8.5 Wm $^{-2}$ were analysed over selected domain of West Africa. Fourteen general circulation model historical temperature simulations evaluated using Taylor diagram, Normalised Mean Absolute Error, Normalised Root Mean Square Error were used for the projection. The analyses are done to address the challenges of climate change impact assessment over this highly vulnerable region of interest. The skilful models for temperature simulation over Guinean Savannah (GS), Western Sahel (WS), Lower Sahel (LS), and Eastern Sahel (ES) are selected for the projection analysis. ES and WS are expected to be significantly hotter throughout the 21st century with reference to 1985-2004 simulations. While there would be a delayed onset at the LS and GS region. The significant increase in temperature at ES and WS may result in destruction of infrastructure and properties, reduction in crop production, flooding and its associated consequences such as devastation of farms and loss of government revenues, if no adaptation and mitigation strategy is put in place.

Keywords: Temperature: Infrastructure: Destruction: Simulation: Concentration Pathways.

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1.0 Introduction of the Study

Climate is globally changing and West Africa is not left out. IPCC (Intergovernmental Panel on Climate Change) identified West Africa as one of the exposed regions to climate change. Changes in the climate of West Africa has been clearly associated with concentration of anthropogenic green-house gases and land use for future climate projection (Heger, 2007; Ayua et al., 2023). Rising temperature in global warming in West African and its associated climate change cannot be overemphasized. Its effect is felt in almost all aspect of human endeavour which include agriculture, energy, water supply, plants, animals and ecosystem, forest, recreation and so on (Pachauri & Reisinger, 2007; Gebeyehu et al., 2022). Warmer temperature leads to chain reactions while increasing temperature affect the oceans, ice and snows, pattern of the weather and animals and plants. This is because the hotter it gets the more severe the influences on the environment and people (EPA'S climate change indicator, 2016).

1.1 Study Area

The study domain in this paper is limited to the West Africa" frequently used to denote the western part of Africa. Lamb & Lélé (2010) considers "West Africa" as surrounded to the south and west by the Atlantic Ocean and the Sahel zone at 10° E and 20° N with 15 countries which include Liberia, Cape Verde, Niger, Gambia, Ivory Coast, Ghana, Guinea, Benin, Burkina Faso, Mali, Sierra Leone Nigeria, Senegal, Guinea-Bissau, Togo. Four homogeneous temperature regions identified based on principal component and cluster analyses constitute the sub-regions considered in this study (Adeniyi, 2014; Owhe-Ureghe et al., 2022; Hamadouche, 2023).

These regions are: Western Sahel (WS: 16W -1E, 19 - 25N); Eastern Sahel (ES: 6.7- 20E, 16 - 25N); Lower Sahel (16.4W - 16ºE, 12 -13.5N); Guinean Savannah (12W - 10E, 7 -10N).

Figure 1.1 Map of West Africa (source: Orion-meteorology map data, 2018).

This paper aims at evaluating 35 GCMs archived by CMIP5 in reproducing the twentieth-century temperature climatology over the four temperature regions of West Africa. This paper examined and presented the data, the methods used for assessment and validation, while the results of the validation were presented and discussed in the study. Finally, a conclusion was drawn. In the IPCC Report, RCPs (Representative Concentration Pathways) for climate change studies are well-defined by their complete radioactive forcing (Vuuren et al., 2011; Ukonu et al., 2022). The RCPs were designated to represent wide range of GHGs (Green House Gases) and all other influences of technological, socioeconomic and population growth. The Four different RCPs selected by IPCC are RCP 6 which denotes steadiness and by the end of 2100 will not exceed 6 Wm $^{-2}$ (Hijioka et al., 2008) RCP 8.5 signifies a rising radiative forcing by 2100 prominent to 8.5 Wm $^{-2}$ (Riahi et al., 2007; Rao & Riahi, 2006).Whereas RCP 4.5 at the end of 2100 characterises a balance without pathway overshoot to 4.5 Wm $^{-2}$ (Clarke et al., 2007) and RCP 2.6 is a low emission scenario with highest radiative forcing of ~ 3 Wm $^{-2}$ before the end of the century which will deteriorate after 2100 (Vuuren et al., 2011; Egan & Bamfo-Agyei, 2023). This work considers RCPs 8.5 and 4.5 which signify high and medium emission.

The climate of West Africa is governed by the collaboration of two air masses; whose impact differs all through the year in the ITCZ (Intertropical Convergence Zone) north south movement. Warm, dry air masses that originates from the excessive pressure system of the Sahara Desert from November to February results to harmattan and dusty winds over the region. Humid equatorial air masses from the Atlantic Ocean give rise to annual monsoon rains in the summers (Nicholson, 2013). Established on these differences, West Africa are classified into three climatic zones (Njeri et al., 2006, Fink et al. 2016) :(a) the humid tropical Guinea Cost situated alongside the Gulf of Guinea. (b)The Sudanian zone, with sub-humid climate located nearly between 9° N and 12.5° N. (c)the Sahelian zone, positioned approximately at 12.5° N latitude with a semi-arid climate.

It is obvious that rising temperature poses strong impacts on several sectors of the continent ranging from agriculture, water supply (through improved evaporation), security, energy, plants and animals, ecosystem, forest, recreation and biodiversity. Increasing temperature contribute immensely to global warming and climate change. This analysis is done to show what the temperature of West Africa would be till the end of the 21^{st} century and its associated problems on the people and environments. Therefore, adaptation and mitigation strategies should be taken to address the challenges and impact of climate change in West Africa especially regions and areas that are more vulnerable to rising temperature. This analysis will consider the projection of temperature on the four temperature regions (Guinean Savannah, Eastern Sahel, Lower Sahel and Western Sahel) of West Africa based on cultivating seasons, April-September (Monsoon or planting season) January-March (pre-monsoon or pre planting) and October-December (post monsoon or post planting season) with reference to crop production and food availability on both annual and percentile basis (25^{th}, 50th, and 75^{th}). The aim of this study is to determine the projected changes in Near–air Surface Temperature over West Africa using IPCC AR5 GCM models under RCPs 4.5 and 8.5 scenarios for the 21^{st} century. This paper presented the data, the methods used for the analyses of projections in section while the results of the 21st century projections was presented and discussed (Hamadouche, 2023). Finally, a conclusion was drawn based on the analysis.

2.0 Data and Methods

2.1 Data

The 35 CMIP5 (5th Coupled Model Inter comparison Project) models outputs of monthly Surface Air Temperature (SAT) over West Africa under RCP4.5 and RCP8.5 experiments used in this project work are accessible at: http://cmip pcmdi.llnl.gov/cmip5/. The horizontal resolution of the dataset is 1.125 to 2.8^0 and the time period in this research for the historical is 1985-2004 and 2016-2099 for the future projection.

2.2 Methods

2.2.1 Temperature projection assessment.

The presentation of models in projecting detailed features of any variable such as temperature is mostly authenticated by comparing the model data with the observed (historical) data with respect to the values of the area average (Dike et al. 2014) or the grid values (Mehran et al., 2014; Vintzileos & Ananth, 2010). In this work the authentication of time series, distribution and spatial patterns was done by computing the difference, percentage difference between the historical data(1985-2004)and the model data (2016-2035, 2046-2065, 2080-2099) at 20 years interval. The historical data were divided into seasons, the pre-planting season (January-February-March), JFM Planting season (April-May-June-July-August-September) AMJJAS and post-planting season (October-November-December) OND and compared with the future data of the selected models on percentiles and seasonal basis. However, the models are evaluated on area averages over the four temperature regions of West Africa using annual and (10^{th}, 50th and 90^{th}) percentiles.

2.2.1 Percentage difference: This is the difference between the future and the historical data divided by the future data multiplied by 100.

$$P.D = [((X_{FUTURE} - X_{HISTORICAL})/X_{HISTORICAL}) * 100] \quad (1)$$

P.D is the percentage difference, X_{FUTURE} is the averaged future data (2016-2035), and $X_{HISTORICAL}$ is the averaged historical data (1985-2004).

2.2.1.2 Percentile**:** Sample percentile, p-th percentile ($0 \leq p \leq 100$) of ordered statistics of the sample is the smallest value in the data such that p percent of the data is less than or equal to that value.
Ordinal rank is given by:

$$n = [\frac{p}{100} \text{ x } N] \quad (2)$$

Where N is the number of ordered values. The p-th percentile is the value that corresponds to the ordinal rank. Yearly percentiles are calculated from monthly averages of temperature for each year (Adeniyi, 2016; Vintzileos & Ananth, 2010).

The temperature projected changes are estimated on seasonal basis using growing (monsoon) season, AMJJAS (April-May-June-July-August-September) pre-growing (pre-monsoon) season, JFM (January-February-March) and the post- growing (post-monsoon) season OND (October-November-December).The projected temperature changes are evaluated by calculating the percentage difference of the averaged historical data (1985-2004) from the projected temperature data ranging from (2016–2035) early, middle (2046–2065) till the end (2080–2099) of the 21st century on interval of 20 years using RCPs 4.5 and 8.5 for each selected skilful model. The percentage consensus and ensemble mean change are also calculated for the different regions, percentiles and seasons for both RCPs 4.5 and 8.5 and for all the four temperature regions. The percentage temperature changes are also evaluated by calculating the percentage difference of the averaged historical data (1985-2004) from the projected temperature data ranging from (2016–2035) early, middle (2046–2065) till the end (2080–2099) of the 21st century on interval of 20 years as above.

3.0 Results and Discussion

The projection of RCP4.5 in Guinean Savannah Region on annual basis up to 2035 was 2.09^{o}c (0.7%) increase with 93% average consensus, while the growing season AMJJAS (April-May-June-July-August –September) was 1.67^{o}c (0.5%), JFM (January-February-March) the pre-planting season was 2.49^{o}c (0.8%) and the post planting season OND (October-November-December) increased to 1.6^{o}c (0.5%)respectively. For the mid- 21st century (2065) on annual basis the temperature increased to 3.77^{o}c (1.2%) with 100% average consensus, AMJJAS was 2.57^{o}c (0.2-0.9%), JFM 3.13^{o}c (0.2-1.1%) and OND was 2.14^{o}c (0.7%). At the end of the century (2099) on annual basis, temperature increased to 8.05^{o}c (0.1-1.5%), AMJJAS was 2.93^{0}c (1.0%), JFM temperature increase was 3.67^{0}c (0.2-1.6%) and OND to 2.93^{0}c (1.0%) respectively. There was an intensified increase on the RCP 8.5 which are: On Annual basis (2035) 3.5^{0}c (1.1%) increase was observed, AMJJAS was 1.96^{0}c (0.6%) JFM was 2.88^{0}c (1.1%) and OND was 2.69^{0}c (0.9%). Up to the mid-century (2065) the following changes was observed, Annual basis 4.55^{0}c (0.2-1.5%) with 100% average consensus, AMJJAS 3.56^{0}c (0.3-1.1%), JFM was 6.25^{0}c (0.3-2.1%) and OND 3.18^{0}c (0.1-1.2%) increase respectively. Towards the end of the century (2099) annual basis, the temperature amplified to 2.6^{o}c (0.9-2.7%), AMJJAS was 5.57^{o}c(0.7-1.8%), JFM was 2.6^{0}c (0.9-2.6%) and OND was 6.82^{0}c (0.4-2.3%) respectively.

Also the projection on RCP4.5 in LS region on annual basis till 2035 was 2.6^{0}c(0.9%) increase with 87% average consensus, AMJJAS was 2.2^{0}c (0.7%) JFM decreased to -0.8 (1.0%) and OND increased to 3.05^{0}c(0.8%). Up to 2065 on Annual basis it amplified to 2.8^{0}c(0.1-0.9%) with 100% average consensus, AMJJAS was 4.05^{0}c (0.2-1.3%), JFM 2.7^{0}c (1.3%) and OND 3.85^{0}c (1.0%) respectively. 2099 Annual basis the increase was 4.1^{0}c(0.1-1.4%), AMJJAS 3.95^{0}c (0.3-1.3%), JFM 3.3^{0}c (1.7%) and OND 4.95^{0}c(1.1%). For RCP 8.5 change, Annual basis 2035 was 3.1^{0}c(1.0%), AMJJAS was 2.45^{0}c (0.8%), JFM 3.55^{0}c, (0.6%) and

OND 1.9^{0}c (1.2%). 2065 Annual basis 5.1^{0}c (0.1-1.7%) increase with 100% average consensus, AMJJAS was 4.2^{0}c (0.5-1.4%), JFM 4.35^{0}c (1.4%) and OND 4.5^{0}c (0.2-1.5%). 2099 Annual basis increased to 7.8^{0}c(0.5-2.6%), AMJJAS 6.95^{0}c(0.9-2.3%), JFM 6.55^{0}c (2.1%) and OND 6.35^{0}c(0.9-2.2%) increase was also noticed.

However, on the projection of RCP4.5 in ES Region a temperature increase of 1.0^{0}c(1.0%) with 33% average consensus on Annual basis up to 2035, AMJJAS was 3.7^{0}c (1.2%) ,JFM 3.95^{0}c (1.4%) and OND 3.0^{0}c (1.0%) while 2065 Annual basis 2.85^{0}c (0.1%) increase with 27% average consensus was recorded, AMJJAS was 5.5^{0}c (1.9%), JFM 4.2^{0}c (1.5%) and OND 4.9^{0}c (1.7%).At the end of the century 2099 Annual basis 6.4^{0}c(2.2%), AMJJAS 4.9^{0}c (1.8%), JFM 4.89^{0}c(1.7%) and OND 10.35^{0}c (3.5%) increase was noticed. RCP 8.5% annual basis 2035 4.25^{0}c (1.5%), AMJJAS was 3.95^{0}c (1.3%), JFM 3.5^{0}c(1.2%) and OND 3.8^{0}c(1.3%).2065 Annual basis temperature increase was 5.1^{0}c (1.7%) with 100% average consensus, AMJJAS was 6.1^{0}c (0.3-2.1%), JFM 4.6^{0}c (1.6%) and OND 3.7^{0}c (1.3%).2099 Annual basis 8.35^{0}c(0.3%) AMJJAS 8.8^{0}c (1.2-3.0%) JFM 6.7^{0}c (2.3%) OND 6.05^{0}c(2.1%) was recorded.

Nevertheless, the projection of RCP4.5 in Western Sahel Region on Annual basis for 2035 was 2.6^{0}c(1.2%) increase with 73% average consensus, AMJJAS was 2.45^{0}c (0.8%), JFM 3.7^{0}c (1.6%) and OND 3.7^{0}c(1.3 %) while 2065 Annual basis 3.65^{0}c (1.3%) increase with 87% average consensus was recorded, AMJJAS was 3.97^{0}c (0.1-1.3%) JFM 4.6^{0}c (1.6%) and OND 3.4^{0}c (1.1%).Up to the end of the century 2099 annual basis 5.95^{0}c(2.1%), AMJJAS 5.22^{0}c (1.7%), JFM 5.2^{0}c(1.8%) and OND 3.5^{0}c (1.2%) increase was noticed. RCP 8.5% annual basis 2035 3.85^{0}c(1.3%), AMJJAS was 3.42^{0}c (1.1%), JFM 3.4^{0}c(1.3%) and OND 2.35^{0}c (0.8%).2065 Annual basis temperature increase was 4.55^{0}c (1.0-1.6%) with 93% average consensus, AMJJAS was 3.45^{0}c (1.8%), JFM 4.5^{0}c (0.2-1.6%) and OND 3.65^{0}c (0.2%).2099 Annual basis 7.25^{0}c(0.6-2.5%) AMJJAS 5.8^{0}c (1.8-2.4%) JFM 6.2^{0}c (0.7-2.1%) OND 7.5^{0}c (2.5%) temperature changes were noticed.

3.1 Results from the Plots

The difference between historical and future temperature projection on Eastern Sahel region of West Africa for both RCPS 4.5 and 8.5 changes and at different percentiles were calculated and recorded. For RCP4.5 the temperature increase on annual basis from 2016-2035 wabwencrement was 1.67^{0}c, 2065 was 2.57^{0}c and 2099 2.93^{0}c increase was noticed. Pre-planting season up to 2035 the increment was 2.49^{0}c, 2065 3.13^{0}c and 2099 was 3.67^{0}c respectively and for post planting season 2035 the increment was 1.6^{0}c, 2065 was 2.14^{0}c and 2099 was 2.93^{0}c. While for RCP8.5 the temperature intensified. On annual basis from 2016-2035 it increased up to 3.5^{0}c, from 2046-2065 it was 4.55^{0}c while 2080-2099 was 8. 050c. For planting season up to 2035 the increment was 1.96^{0}c, 2065 was 3.56^{0}c and 2099 was 5.57^{0}c respectively. Pre-planting season up to 2035 the increment was 2.88^{0}c, 2065 was 6.25^{0}c and 2099 was 2.6^{0}c and for post planting season 2035 the increment was 2.69^{0}c, 2065 was 3.18^{0}c and 2099 was 6.82^{0}c.

The temperature projected changes for West Africa for both RCPs 4.5 and 8.5 are in the same pattern with a greater increase to RCP 8.5 (Table 4.5; Dike et al., 2014). Though, the temperature changes expected in the different temperature regions are dissimilar (Table 4.5-4.12). The two RCPs 4.5 and 8.5 estimated rising temperature towards the end of the 21st century with an exaggerated increased on RCP8.5. ES getting hotter, WS and LS getting significantly hotter, and the LS and GS getting slightly hotter (Monerie et al., 2012). A significant increase up to 3.7^{0}c - 8.8^{0}c (1.2 to 3.0 %) in temperature was projected over ES from 2016 to 2099 for AMJJAS with bigger response to RCP8.5. And a very increasing rate of 1.0^{0}c -10.35^{0}c (1.0-3.5%) is expected up to the mid of the 21st century by the two RCPs especially RCP8.5 in OND which will make the region get hotter while for JFM a change of 3.95^{0}c to 6.7^{0}c (1.1-2.1%) was projected by the RCPs. These OND changes in the middle of the 21st century may not favor the planting season and will also have an adverse effect on crop production towards the end of the century in the region. However, in the Western Sahel an intensified increase of 2.45^{0}c - 5.8^{0}c (0.8-2.5%) was projected for the planting season towards the end of the century. This may not favor crop production in the area and moreover the post planting season will significantly get hot. This may cause flooding and its associated consequences. The Guinean savannah region will slightly get hot. This is due to the projection of 2.09^{o}c- 2.6^{0}c (0.7-1.2%) and AMJJAS 1.67^{o}c to 5.57^{o}c (0.5-1.2%) in the growing season which will favour and support crop production. The Lower Sahel also will experience a delayed onset in temperature increase and will slightly get hot 2.2^{0}c - 3.1^{0}c (0.7-1.1%) but with an amplification up to 7.8^{0}c(1.2-2.6%) just before the end of the century.

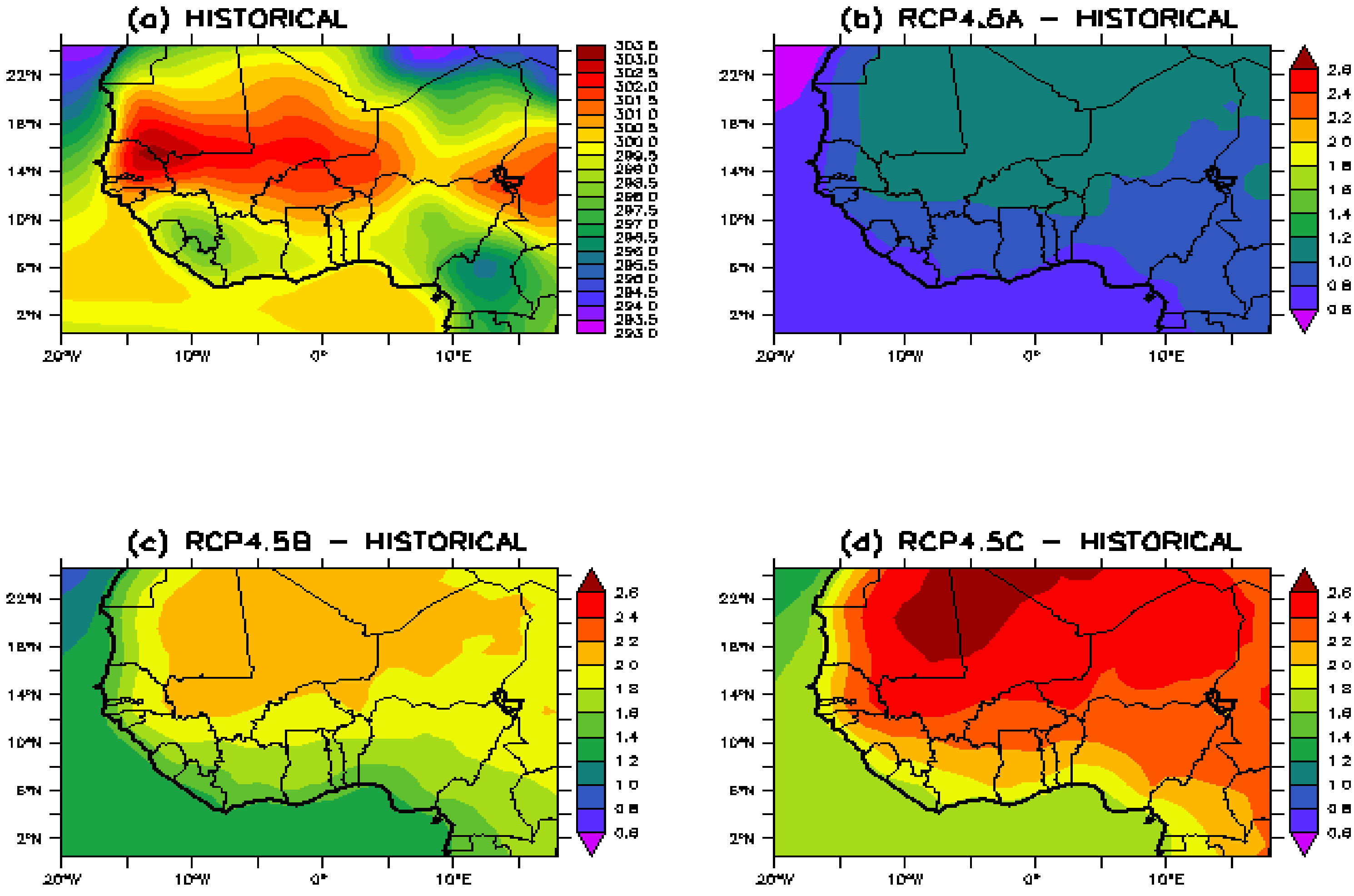


Fig 3.1 (a) Ensemble mean historical temperature climatology from 1985-2004 and

Difference between RCP 4.5 projected temperature and ensemble historical temperature climatology for (b) 2016-2035, (c) 2046-2065 and (d) 2080-2099. The figure above shows the temperature simulation (projection) of West Africa from 2016-2099 under RCP 4.5 scenario on annual basis. It is seen from the figure that temperature would increase from 0.8 to 2. 60c.up to 2035 it would rise to 1.8^{0}c, 2065 (2.0^{0}c) and 2099(2.6^{0}c) and prominent in Mali, Niger and Chad respectively.

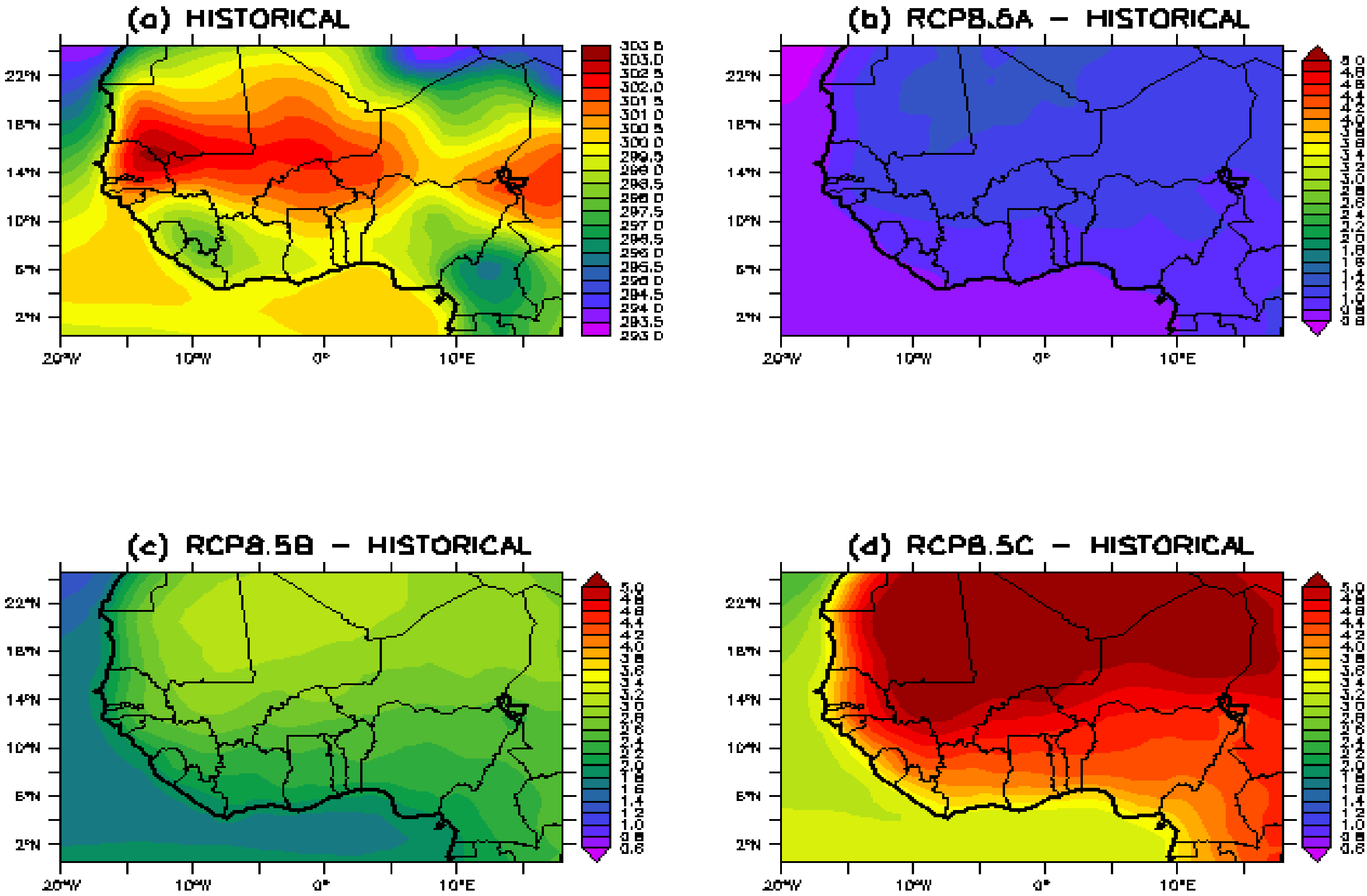


Table 3.1 Seasonal Future Projection of Temperature over Lower Sahel region of West Africa.

Fig 3.2 (a) Ensemble mean historical temperature climatology from 1985-2004 and Difference between RCP 8.5 projected temperature and ensemble historical temperature climatology for(b) 2016-2035, (c) 2046-2065 and (d) 2080-2099. The figure above shows the temperature simulation (projection) of West Africa from 2016-2099 under RCP 8.5 scenario on annual basis. It is seen from the figure that temperature would increase from 0.6 to 5. 00c. from 2016-2035 it would rise to 1.4^{0}c in Liberia, 2065 (3.4^{0}c) in Mali and 2099(5.0^{0}c) and prominent in almost all the countries especially Mali, Niger, Chad including Nigeria

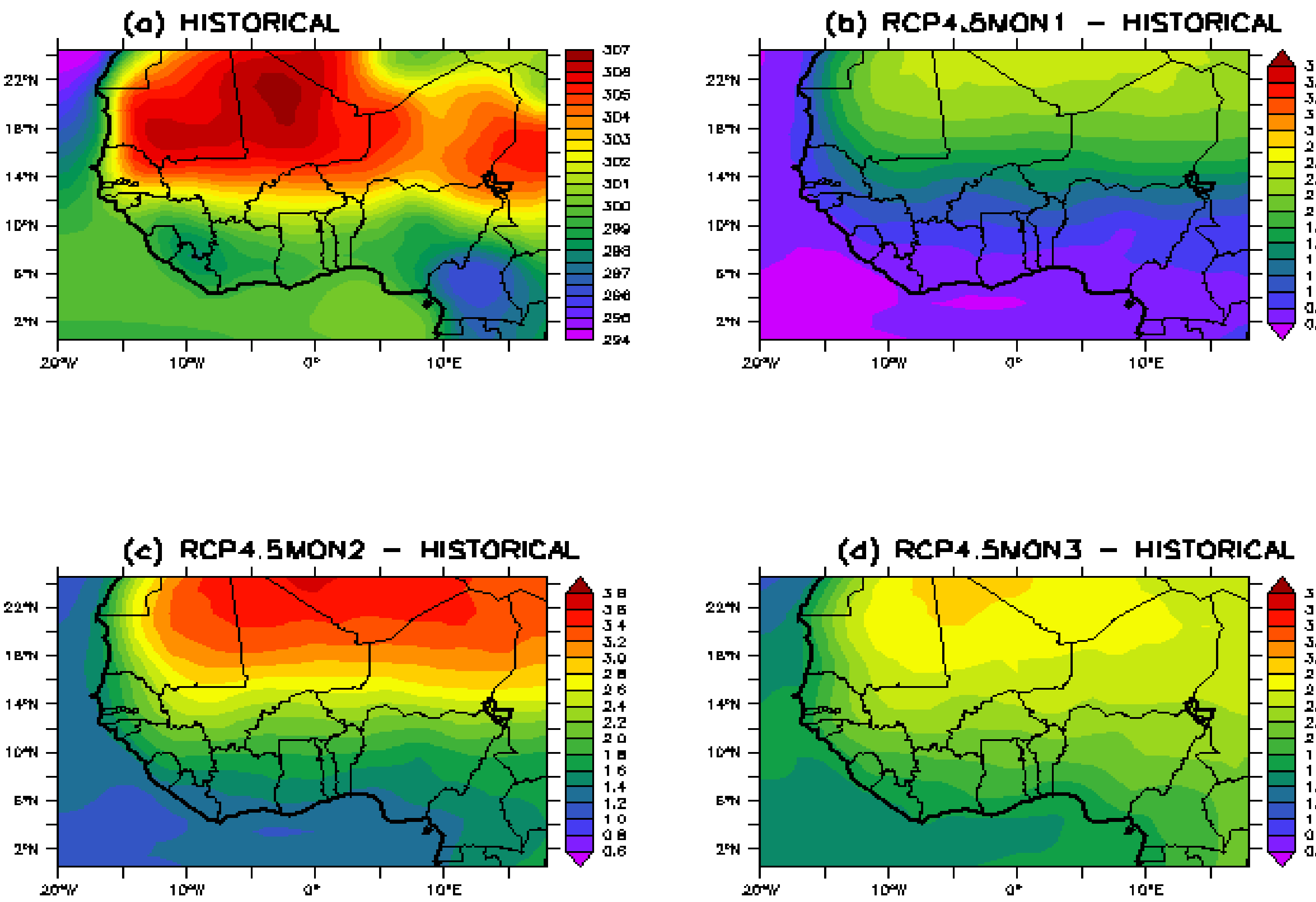
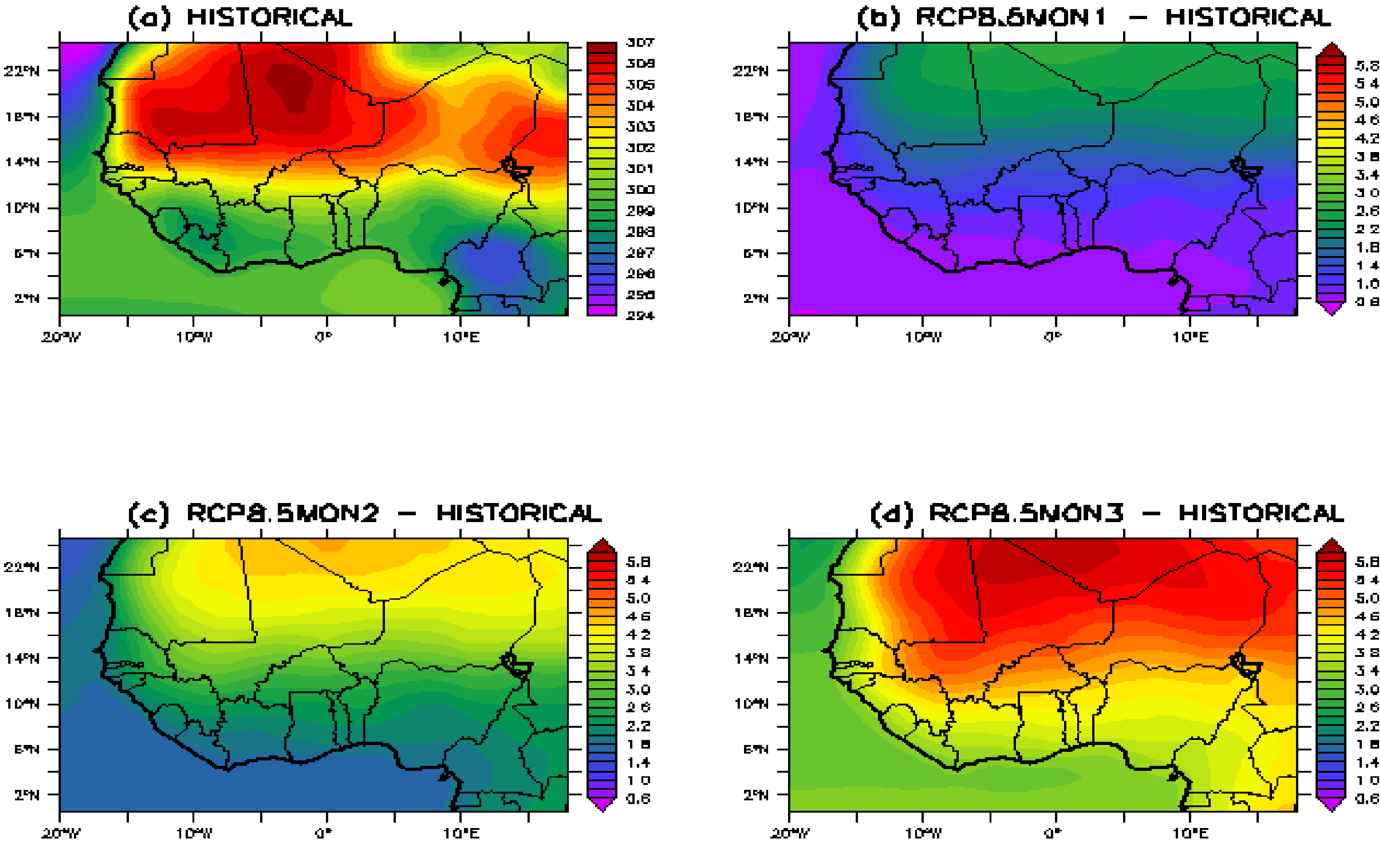


Fig3.3 (a) Ensemble mean historical temperature climatology from 1985-2004 and Difference between RCP 4.5 projected temperature and ensemble historical temperature climatology for(b) 2016-2035, (c) 2046-2065 and (d) 2080-2099. The figure above shows the temperature simulation (projection) of West Africa from 2016-2099 under RCP 4.5 scenario for planting (monsoon) season. It is clearly seen from the figure that temperature would increase from 0.6 to 3. 80c.From 2016-2035 it would rise to 2.6^{0}c,2065 (3.4^{0}c) and 2099(3.0^{0}c)

Fig 3.4(a) Ensemble mean historical temperature climatology from 1985-2004 and



Difference between RCP 8.5 projected temperature and ensemble historical temperature climatology for (b) 2016-203, (c) 2046-2065 and (d) 2080-2099 on planting season.

The figure above shows the temperature simulation (projection) of West Africa from 2016-2099 under RCP 8.5 scenario for planting (monsoon) season. It is clearly seen from the figure that temperature would increase from 0.6 to 5.8^{0}c.From 2016-2035 it would rise to 3.4^{0}c,2065 (4.2^{0}c) and 2099(5.8^{0}c)

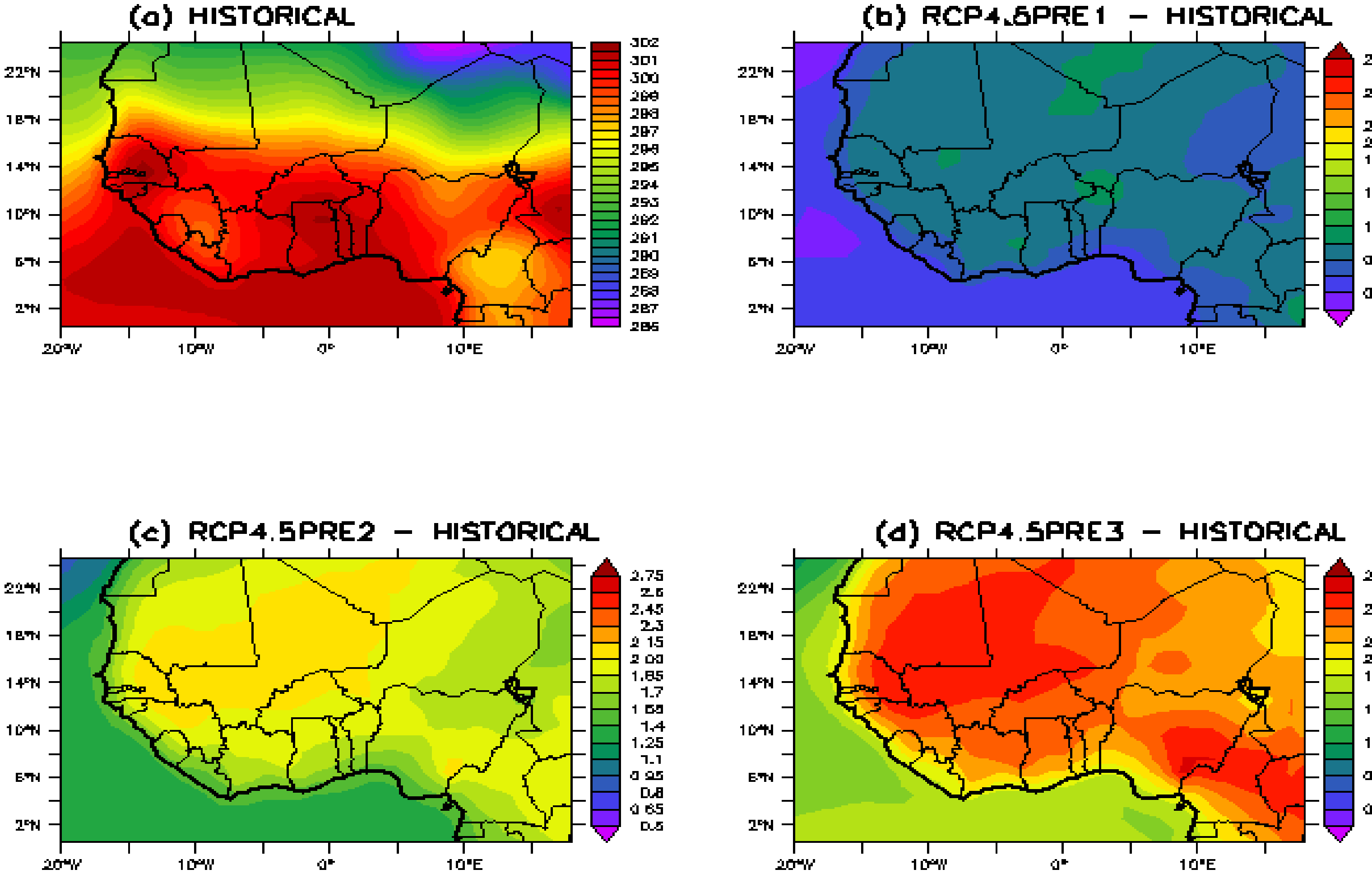


Fig3.5 (a) Ensemble mean historical temperature climatology from 1985-2004 and

Difference between RCP 4.5 projected temperature and ensemble historical temperature climatology on for (b) 2016-2035, (c) 2046-2065 and (d) 2080-2099 on pre-planting season

The figure above shows the temperature simulation (projection) of West Africa from 2016-2099 under RCP 4.5 scenario for pre planting (pre monsoon) season. It is clearly seen from the figure that temperature would increase from 0.5 to 2.75^{0}c.From 2016-2035 it would rise to 1.45^{0}c,2065 (2.05^{0}c) and 2099(2.75^{0}c).

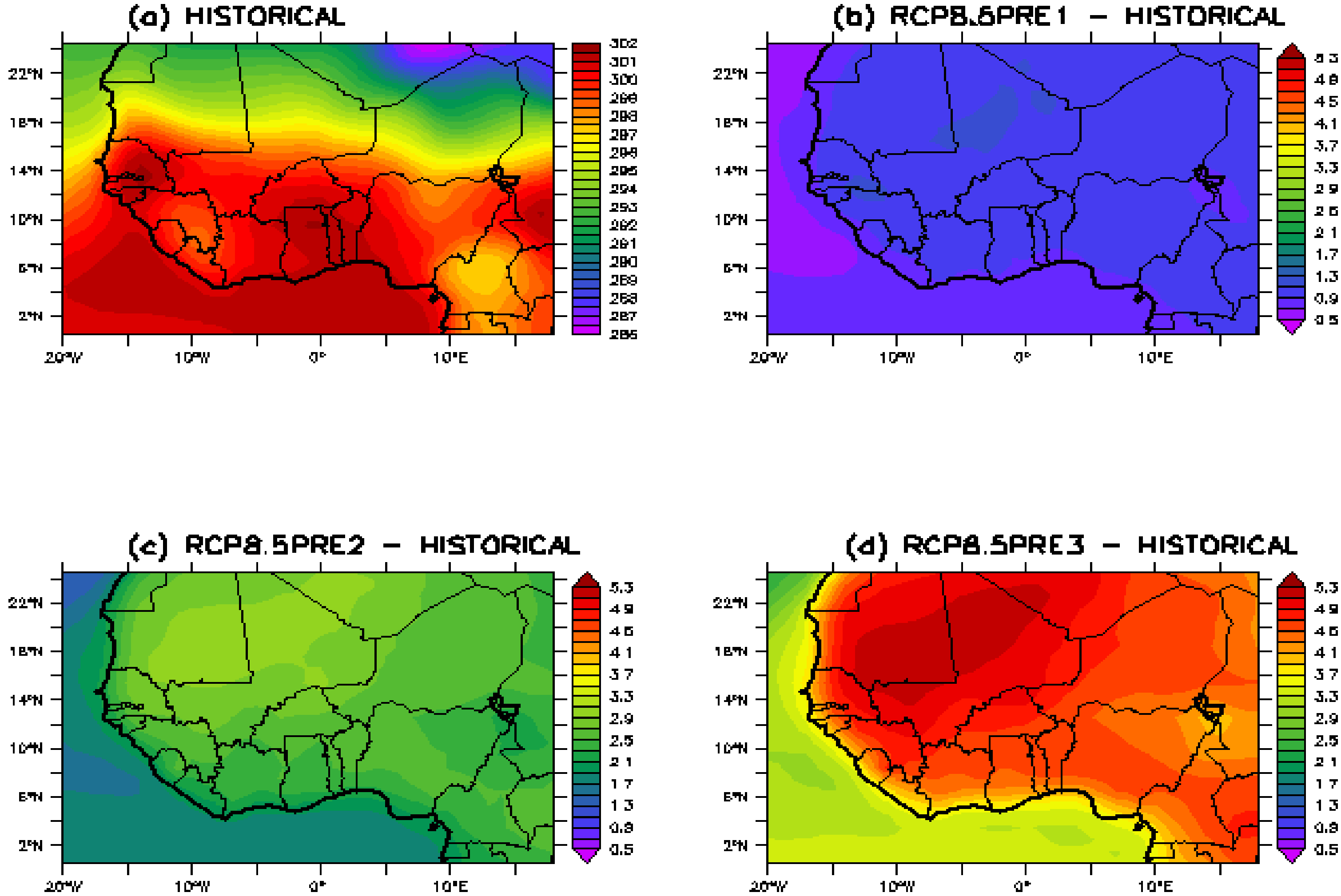


Fig 3.6 (a) Ensemble mean historical temperature climatology from 1985-2004 and

Difference between RCP 8.5 projected temperature and ensemble historical temperature climatology for (b) 2016-2035, (c) 2046-2065 and (d) 2080-2099 on pre-planting season. The figure above shows the temperature simulation (projection) of West Africa from 2016-2099 under RCP 8.5 scenario for pre planting (pre monsoon) season. It is clearly seen from the figure that temperature would increase from 0.5 to 5.3^{0}c From 2016-2035 it would rise to 1.3^{0}c, 2065 (3.7^{0}c) and 2099(5.3^{0}c).

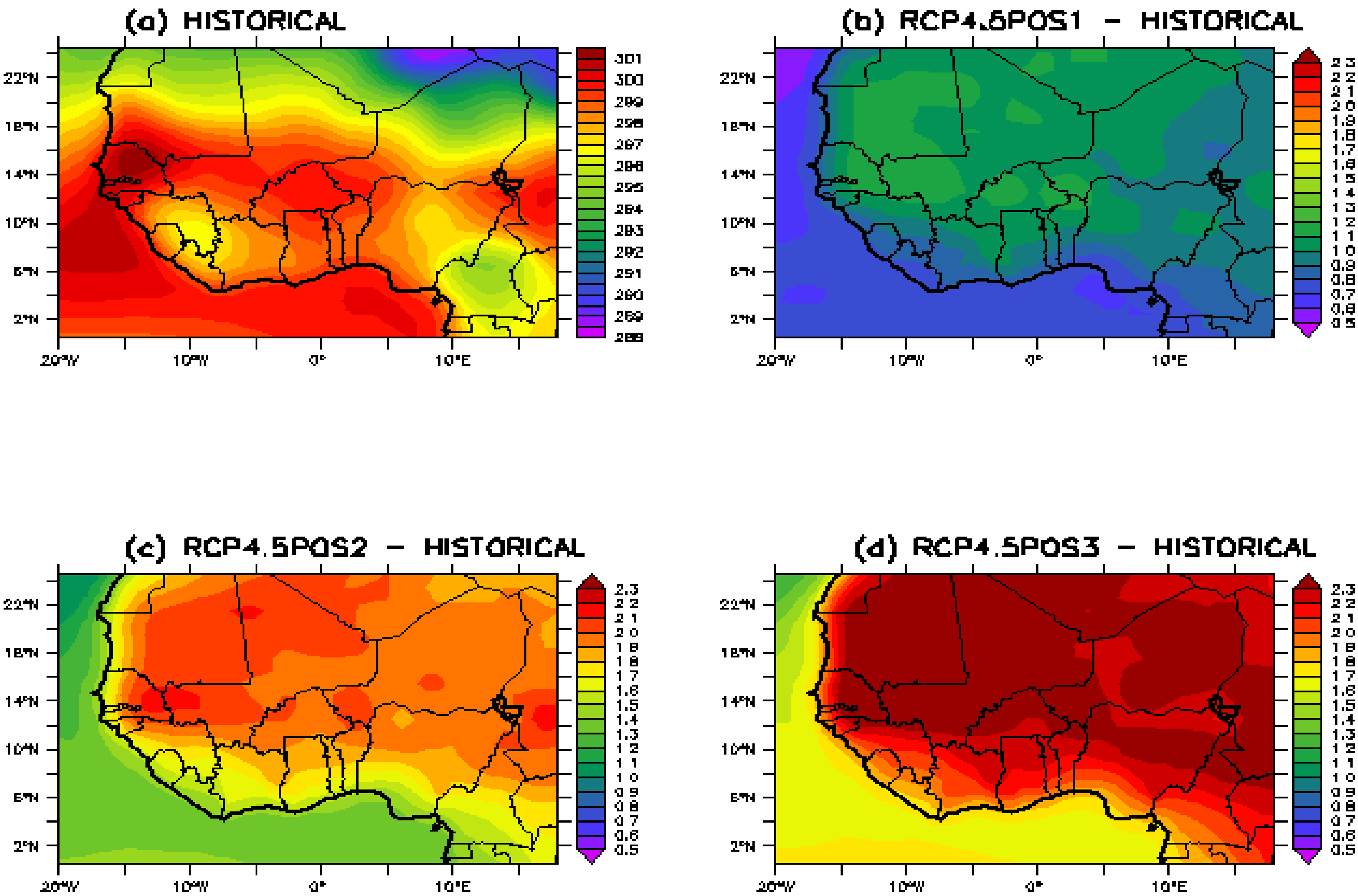
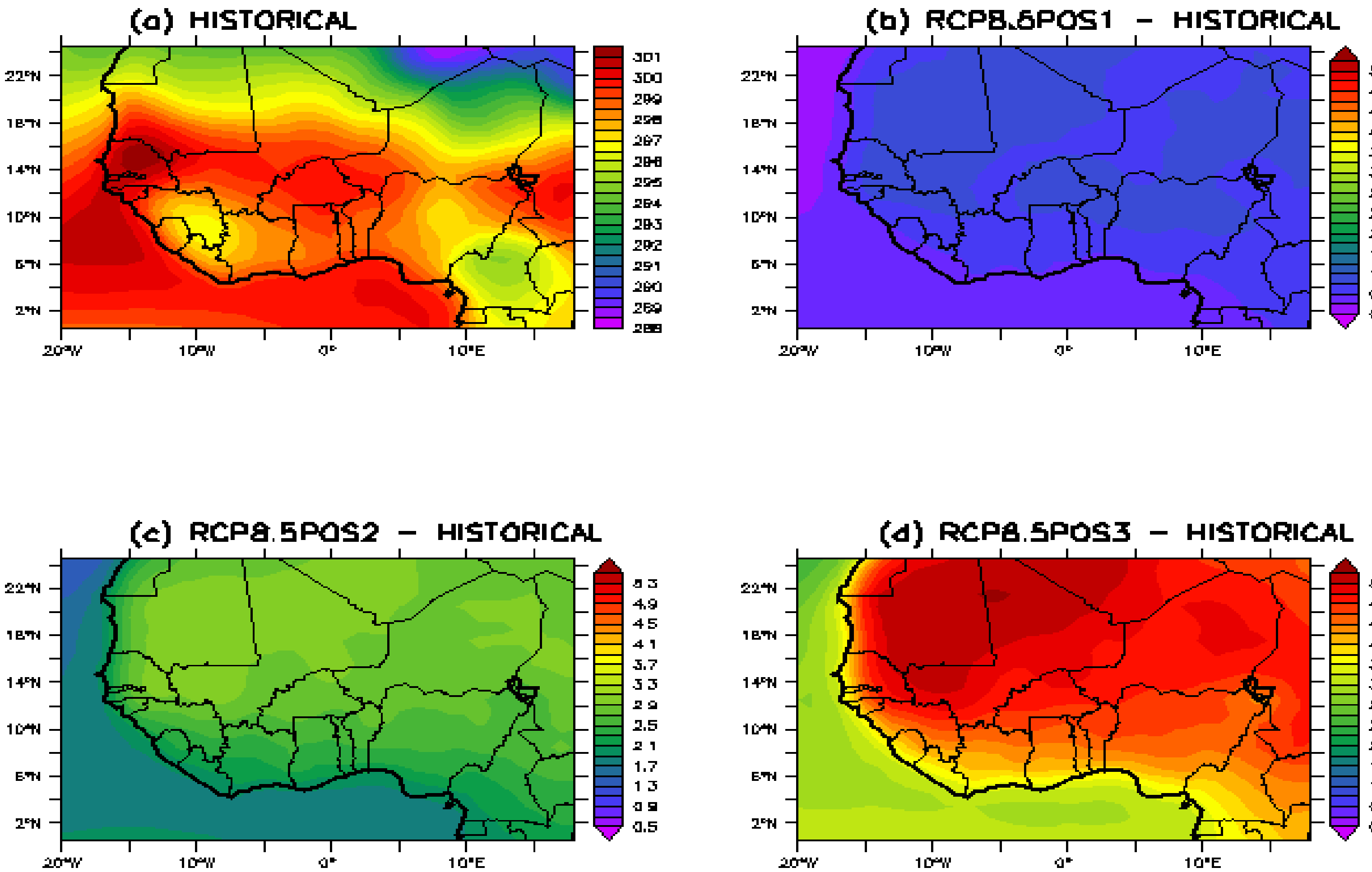


Figure 3.7(a) Ensemble mean historical temperature climatology from 1985-2004 and

Difference between RCP 4.5 projected temperature and ensemble historical temperature climatology for (b) 2016-2035, (c) 2046-2065 (d) 2080-2099 on post planting season. The figure above shows the temperature simulation (projection) of West Africa from 2016-2099 under RCP 4.5 scenario for post planting (post monsoon) season. It is clearly seen from the figure that temperature would increase from 0.5 to 2.3^0c.From 2016-2035 it would rise to 1.4^0c,2065 (2.1^0c) and 2099(2.3^0c). The table below shows the projection of RCP4.5 in Western Sahel Region on Annual basis for 2035 (1.2%) increase with 73% average consensus, AMJJAS was (0.8%), JFM (1.6%) and OND (1.3 %) while 2065 Annual basis (1.3%) increase with 87% average consensus was recorded, AMJJAS was (0.1-1.3%) JFM (1.6%) and OND (1.1%) the end of the century 2099 annual basis (2.1%), AMJJAS (1.7%), JFM (1.8%) and OND (1.2%) increase was noticed. RCP 8.5% annual basis 2035 (1.3%), AMJJAS was (1.1%), JFM (1.3%) and OND (0.8%).2065 Annual basis temperature increase was between (1.0-1.6%) with 93% average consensus, AMJJAS was (1.8%), JFM (0.2-



1.6%) and OND (0.2%).2099 Annual basis (0.6-2.5%) AMJJAS (1.8-2.4%) JFM (0.7-2.1%) OND (2.5%).

Fig3.8 (a) Ensemble mean historical temperature climatology from 1985-2004 and

Difference between RCP 8.5 projected temperature and ensemble historical temperature climatology for (b) 2016-2035, (c) 2046-2065 and (d) 2080-2099 on post planting season. The figure above shows the temperature simulation (projection) of West Africa from 2016-2099 under RCP 8.5 scenario for post planting (post monsoon) season. It is clearly seen from the figure that temperature would increase from 0.5 to 5. 30c From 2016-2035 it would rise to 1.3^{0}c, 2065 (3.7^{0}c) and 2099(5.3^{0}c).

5 Conclusion of the Study

For both RCPs 4.5 and 8.5 the pathway of the expected temperature changes is the same, but RCP 8.5 has more amplified changes. With reference to the historical data (1985–2004), from the mid (2065) to the late (2099) 21st century, ES region will become hotter during the planting season and on annual basis and most especially on the post planting season (OND). The increased temperature projection by both RCPs all through the pre-planting and planting season may distress the planting season and subsequently lead to failure of crop and scarcity of food. Insignificant reduction in Temperature is expected for the LS and GS for the planting season, a reduction is projected from 2035 to the end of the 21st century, and this shows that the region had experienced warming in latest decades as a response to amplified anthropogenic forcing. Cote d'Ivoire and Nigeria, with other Western Sahel countries are most liable to potential floods, increase of droughts which are due to high level of greenhouse gas. The rest of other West African countries will also experience this events but to a reduced magnitude. The LS displays almost the same inconsistency with the GS. Both scenarios project an increase for ES and WS and this increase at the ES would bring about flooding and its related consequences like death, destruction of farms, devastation of infrastructures, loss of government revenues and properties etc.

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