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THE PARTICULAR RAINY SEASON OF THE YEAR 2019 ALONG THE IVORIAN COASTLINE

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ABSTRACT

The rainy season of the bordering countries of the Gulf of Guinea (GG) is modulated by the African monsoon flow with a major rainy season observed from May to July while a minor one occurred from September to November. The climate change and the global warming are supposed to induce strong changes in the natural events and particularly the time and spatial variability, and intensity of the rainfall amount. A study focusing on rainfall variability for the year 2019 with in situ data from the national airport of Cote d'Ivoire and Atmospheric reanalysis (ERA5) data has shown that, for this particular year the minor rainy season has been very important with higher rainfall amount observed during this period. The Agriculture is among the most important economy sectors. And we think that this important minor rainy season should have an important effect on agricultural output as harvesting and planting of fast growing varieties such as rice, maize and so on.

Keywords : *Gulf of Guinea, rainfall, abrupt change.*

RÉSUMÉ

La particulière saison des pluies de l'année 2019 le long de la côte Ivoirienne

La saison des pluies des pays côtiers du Golfe de Guinée (GG) est modulée par la mousson ouest Africaine avec une grande saison des pluies observée entre mai et juillet tandis qu'une petite saison se développe entre septembre et

novembre. Le changement climatique et le réchauffement global de la planète entrainent de grands changements dans la variabilité des intensités et des occurrences des phénomènes naturels ainsi que la variabilité des intensités et des saisons de pluies. Cette étude portant sur la variabilité des précipitations pendant l'année 2019 à partir des données d'observations de l'aéroport d'Abidjan ainsi que des réanalyses atmosphériques (ERA5) a révélé un changement important le long de la côte Ivoirienne. La petite saison des pluies a été très particulière. L'on a enregistré une très grande quantité de pluie pendant la petite saison des pluies. A la station d'Abidjan, la petite saison des pluies a été plus importante que la grande saison des pluies. L'agriculture faisant partie des secteurs clés de l'économie Africaine et particulièrement Ivoirienne, nous pensons qu'une telle importante petite saison des pluies pourrait être bénéfique pour les cultures à rendement rapide tels que le maïs et le riz.

Mots-clés : *Golfe de Guinée, précipitation, changement brusque.*

I - INTRODUCTION

The West Africa and particularly the Gulf of Guinea ***(Figure 1)*** is one of the most vulnerable regions to global warming due to low adaptive capacity [1]. The economy of this region strongly dependent of agriculture is still dependent of the rainy season variability. The rainfall variability in the Gulf of Guinea (GG) and particularly in Cote d'Ivoire depends on the West Africa Monsoon [2]. This variability is characterized by two rainy seasons, the maximum one from May to July with the maximum precipitation amount observed in June. A minor rainy season is observed from September to October [3]. An abrupt change in the African Monsoon and associated rainfall intensity would have an important socioeconomic impacts and particularly on food security in many West African countries [4].

Figure 1 : *Map of West Africa. Cote d'Ivoire is represented in the Gulf of Guinea with big blue dot showing the main city Abidjan* [5]

The increases in rainfall amounts and intensity over the West African Monsoon (WAM) region are observed in the recent decades [6]. For example, an increase in Sahel precipitations has been associated with a summer intensification and northward shift of the WAM system [7]. While future projection of the WAM exhibits warming over the entire domain, decreasing precipitation over the southern Sahel, and increase over the western Sahara [8]. [9] have observed some changes in August precipitations. Model simulations show an inverse tendency of rainfall amounts over the Sahel [10]. The Japanese Meteorological Institute model simulates a frequent dry Sahel/west Guinean coast pattern. [11] concluded that Sahelian droughts will become more frequent. It is evident that changes in rainfall amounts are occurring. Most of the results concern the Sahel. But what going on along the Ivorian coast? Combining atmospheric reanalysis precipitation and rainfall data recorded at the Abidjan Airport, this study focuses on the rainfall variability during the year 2019. The outline of this paper is presented as follow. The data are presented in the second section. Section 3 and 4 present and discuss respectively the main results of this work. We conclude this work in section 5.

II - MATERIAL AND METHODS

II-1. Material

The data used in this work are monthly precipitation data provided by the Abidjan Airport (4.02°W,5.33°N) and the European Reanalysis ERA5. The Abidjan Airport monthly data are used to determine the rainfall variability during the year 2019 while the ERA5 monthly precipitation data covering the 1980-2020 period have been used in this study to show the monthly climatology of the rainfall amount at the nearest grid points of Abidjan Airport and also to compare 2019 in situ data at Abidjan Airport. The ERA5 data have a spatial resolution of 25Km between two consecutive grid points and have been widely used for climate studies over the West Africa and in the GG. The coordinates of the grid point (4°W,5.25°N) close to Abidjan Airport have been used to build time series data from ERA5.

II-2. Methods

The ERA5 data are downloaded into Netcdf format. We use the software cdo (climate data operator) to select data around the grid point (4°W ; 5.25°N), and these data have been averaged to build the time series. For the respective months of the calendar during the period 1980-2020, the data have been averaged to get the climatology.

III - RESULTS

The rainfall variability in the GG is characterized by a seasonal variability modulated by the West African Monsoon [2]. The ***Figure 2*** shows the bar diagram of the monthly climatology rainfall in the box delimiting the grid points close to the Abidjan Airport, the monthly precipitation at the Abidjan Airport in 2019 and the reanalysis monthly precipitation in 2019 at the nearest grid point of the Airport. Maximum rainfall amounts are observed in June and October characterizing respectively the pick of the major rainy season and the minor rainy season [2, 3]. We observe two weak values in December-January and in August during the driest season. The rainfall amount increases from March to reach an absolute maximum in June during the major rainy season. During the minor rainy season, the rainfall amount increases from September at the end of the major coastal upwelling to reach a second relative maximum value characterizing the minor rainy season. Contrary to the monthly climatology distribution over the 1980 - 2020, the distribution of the monthly mean rainfall amount from the Airport shows two maximum rainfall amount respectively in April-May and October with the highest amount observed in

October. The highest amount of the rainfall associated to the major season is not observed during the same periods. A major change is observed concerning the rainy season. The minor rainy season is observed from March to Jun with the highest amount of rainfall observed in April-May. While the minor rainy season usually observed becomes now the major rainy season with the highest amount of rainfall observed in October. Concerning the dry season, no change is observed during the year 2019. The rainfall amounts are weaker in January and August during the driest season. The monthly precipitation from the atmospheric reanalysis shows similar pattern to in situ data from the Airport. The ERA5 data shows a major change in the rainfall amount of the minor rainy season compared to the climatology. The minor rainy season has been very important with rainfall amount higher in September and October with values greater than those of June. The minor rainy season has not been shifted as observed with the Airport rainfall data but this has recorded a high amount of rainfall greater than 200mm/day during September and October. Note that, for the monthly climatology the rainfall amount is less than 150mm/day during the different months of the minor rainy season. This shows an important increase of the rainfall amount during the minor rainy season of the year 2019.

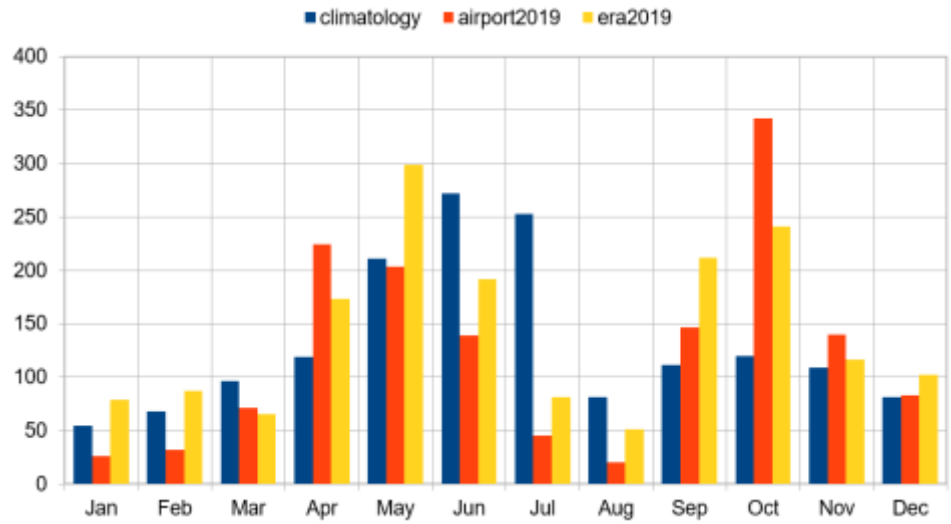

Figure 2 : *Bar diagram of rainfall amount monthly climatology at the nearest grid points of Abidjan*

Airport (blue color), rainfall amount monthly mean recorded at Abidjan Airport (red color) and, of rainfall amount monthly mean from the ERA5 data selected at the nearest grid points of Abidjan Airport (yellow color). The rainfall data from ERA5 have been selected at the grid points (4°W, 5.25°N) to build the time series and the data of the respective months over the 1980-2020 periods have been averaged to get the monthly climatology. Units are mm/day.

IV - DISCUSSION

Changes in the rainfall variability have been observed during these recent years in the Sahel and also in some West African countries [4, 6 - 9]. These changes result from some recent variability of the West Africa Monsoon linked to global ocean circulation [4] or to tropical sea surface temperature variability. In Nigeria, strong break in rainfall amount is being observed in August [9]. Along the northern coast of GG and particularly along the Ivorian coastline where strong seasonal sea surface temperature variability is observed, the rainy season is characterized by two rainy seasons with the major ones from March to July and the minor one from September to November just after the major cold season [2, 3]. In this study, the highest rainfall amount is observed in September-October contrary to the rainfall climatology of this region [2, 3]. This result evidences a strong and abrupt change of the rainy season during this year. The Agriculture is among the most important economy sectors. And we think that this important minor rainy season should have an important effect on agricultural output as harvesting and planting of fast growing varieties such as rice, maize and so on. The farmers should think about adapting their agricultural varieties to such change in rainy season.

V - CONCLUSION

This study focuses on the variability of the rainfall amount along the Ivorian coastline in 2019. Monthly data provided by the Abidjan Airport and the CRU gridded monthly data have been used to conduct this work. This work shows and abrupt change of the rainy season with weakest rainfall amount observed during the major rainy season while the period September-October known as the minor rainy season recorded the highest rainfall amount. This strong change of the rainy season concerns only the rainfall intensity. No particular change has been observed about the dry season. Our results suggest that farmers should think about adapting their cultural methods in the future.

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