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Modeling and Forecasting Selected Meteorological Parameters for the Environmental Awareness in Sub-Sahel West Africa Stations

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Abstract

The monthly air temperature, rainfall, air pressure, and wind speed direction for the environmental time series recorded between January 1, 1980 and December 31, 2020 in six African stations from different climatic zones were modeled and forecasted. In the forecasting, Augmented Dickey Fuller test, ARIMA models, Auto correlation Function (ACF) and Partial Autocorrelation Function (PACF) were used. Result showed that in most of the fitted models, the Moving Average terms both seasonal and non- seasonal were also significant ($p < 0.05$) indicating that the previous day value of the stochastic term also had a significant effect on the present value of meteorological parameters in the environment. It was observed that in all the fitted models except for wind direction in Conakry and rainfall in Abidjan have all their Autoregressive term of order 1 significant ($p < 0.05$) which implies that previous day value of these meteorological parameter had a significant effect on the present day value of the parameters. Therefore, the forecast model indicates that maximum temperature are expected in February, March, April, and June while minimum temperatures in January, August, December. Although, the selected models cannot forecast the precise air temperature, this can also provide information that can be of help to create tactics for appropriate preparation of farming which can be used as tools for effective environmental preparation and policymaking.

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Keywords: Meteorological Parameters, ARIMA models, ACF, PACF, Forecast

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1. Introduction

The forecasting of future weather sequence variables for environmental awareness is based on the spell of historical categorization, which is known as an essential metric for atmospheric parameter forecasting and modeling [1-9]. Furthermore, agricultural products are subject to meteorological, ecological, and environmental variation [8, 10-14], wherein planetary and chronological qualities have a very important link over the environment by applying time series modeling i.e ARIMA model [5, 15-18]. International heating impacts, according to [19-22], contribute to the development of the atmospheric structure; nevertheless, this effect is on the upcoming alterations in the cli-

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matic growth of the environment, where the occurrence and size of diverse happenings affect the growth of any region [6, 23]. According to the international heating effect, an increase in temperature and a decrease in rainfall lead to famine in any environment; nevertheless, this contributes to multiple pressures on food as a result of reduced rainfall and an increase in environmental temperature [17].

The impact of weather quantity forecasting on environmental consciousness is critical for agricultural products employing statistical models for forecasting [4, 6, 24, 25]. Statistical time series offered historical information on the modeling of the atmospheric awareness of the atmospheric parameter, according to several studies [6]. Various writers have noticed that data series patterns play a role in forecasting based on the environment, which has an impact on the climatological influence of environmental degradation and development [4, 25]. The autoregressive integrated moving average (ARIMA) time series modeling has been found to be a good method for forecasting and predicting some atmospheric characteristics that is widely accepted [7, 24]. Furthermore, ARIMA models have been shown to be one of the most widely utilized models for a variety of applications, including science, technology, economy, market, commerce, and industry[4, 6, 7]. ARIMA models, in particular, have been found to be effective in forecasting various weather conditions [26]. [20] revealed linear ARIMA model and quadratic model as the overall best performing model for the prediction of the monthly and annual temperature in Libya. Following [27], the use of the ARIMA model for 50-years (1955 - 2005) in Shiraz, south of Iran was found to be a good model in the future forecasting of temperature. Moreover, [27, 28] use another model Kwon as a seasonal autoregressive integrated moving average (SERIMA) to forecast the mean monthly average of the maximum temperature experienced in the India sub-region. According to the above researchers, their results revealed that maximum temperature forecast was a good parameter for guiding agricultural producers. In another vein, [29] used different ARIMA models and linear trends models to forecast the temperature and precipitation in the Afyonkarahisar area in Turkey and found that there would be an increase in temperature till the year 2025. According to pieces of literatures, [30] using statistical properties studied the historical effect of temperature in Canada for the period 1913-2013 whereby determine a seasonal ARIMA model to forecast forthcoming temperature records. In their research [31] implemented the use of the SERIMA model as proposed by different researchers on the frequency analysis and forecasting monthly rainfall in Umuahia. [7, 32, 33] predicted once-a-month rainwater across several areas within Ghana using different models such as SERIMA and ARIMA models. Weekly and monthly rainfall using time series with the help of SERIMA models over selected weather stations in Malaysia were erected by [34] and in India according to [34, 35]. Various authors, including ([25, 36-40]), worked on atmospheric and meteorological modeling using various statistical models. The stated ARIMA versions take a good quality post-sample predicting performing for yearly and monthly agrometeorological time series [6]. However, for this study trend parameters shall be fitted for the polynomial function, and the period constraint will be projected along with Fourier sequences for the environmental awareness. Furthermore, the major purpose of this research was to examine statistical modelling of the monthly atmospheric parameters' perception utilizing time series for the environmental awareness from six distinct stations in Sub-Sahel African cities over four decades.

2. Methodology

2.1. Study Area

This study was conducted for locations in the West African sub-region as shown in Figure 1. The selected locations for this research were: Daka (17.366 ^oW, 14.765 ^oN), Conakry (13.578 ^oW, 09.641 ^oN), Abijan (04.008 ^oW, 05.360 ^oN), Bamako (08.003 ^oW, 12.639 ^oN), Niamey (12.125 ^oW, 13.512 ^oN), Abuja (07.399 ^oW, 09.077 ^oN). This study used the data from 1980 to 2020 for all the stations considered.

2.2. Data Collection and Analysis

The data for this study was collected from the archive of the Modern-Era Retrospective analysis for Research and Applications, Version 2 (MERRA-2) Web services. The data were accessed on 5th of August, 2021 and the method of data collection followed what was done by [41] as reported by [24, 42, 43].

2.3. Statistical Analysis Modeling

The stationarity of each of these meteorological parameters in each station was tested using the Augmented Dickey Fuller test and p-value less than 0.05 indicates stationarity. The tentative ARIMA models were identified based on Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) plots and the estimation of parameters of the ARIMA were facilitated using the Statistical Package for Social Sciences (SPSS version 20.0). After the estimation of the model parameters, model diagnostic checking principally aimed at checking the fitness of the models was determined based on Ljung-Box test with p-value greater than 0.05 indicating a good fit and hence one year forecast of these meteorological parameters were provided for the different locations.

3. Results and Discussion

3.1. The variation of the meteorological parameters over the environment

The results of the monthly variation of air temperature, relative humidity, pressure, wind speed, wind direction and rainfall for the African stations considered as related to temperature are shown in Figures 2, 3, 4, 5, 6, and 7. Abidjan Figure (Aa, Ba, Ca, Da, Ea.) revealed that air temperature had a significant effect on the other parameters considered, as shown in Figure 2(Aa), the temperature got to it minimum $T = 24.4\ oC$ in August, while relative humidity got to it minimum $RH = 71.9\%$ in January and maximum temperature $T = 27.9\ ^oC$ was recorded in February while the maximum relative humidity

Table 1. The division of the studied African stations into the hinterland and coastal regions.

Station	Division	Country	Longitude (^oW)	Latitude (^oN)	Period of Data
Dakar	Coastal Region	Senegal	17.366	14.765	1980 - 2020
Conakry	Coastal Region	Guinea	13.578	09.641	1980 - 2020
Abidjan	Coastal Region	Cote d'Ivoire	04.008	05.360	1980 - 2020
Bamako	Hinterland Region	Mali	08.003	12.639	1980 - 2020
Niamey	Hinterland Region	Niger	12.125	13.512	1980 - 2020
Abuja	Hinterland Region	Nigeria	07.399	09.077	1980 - 2020

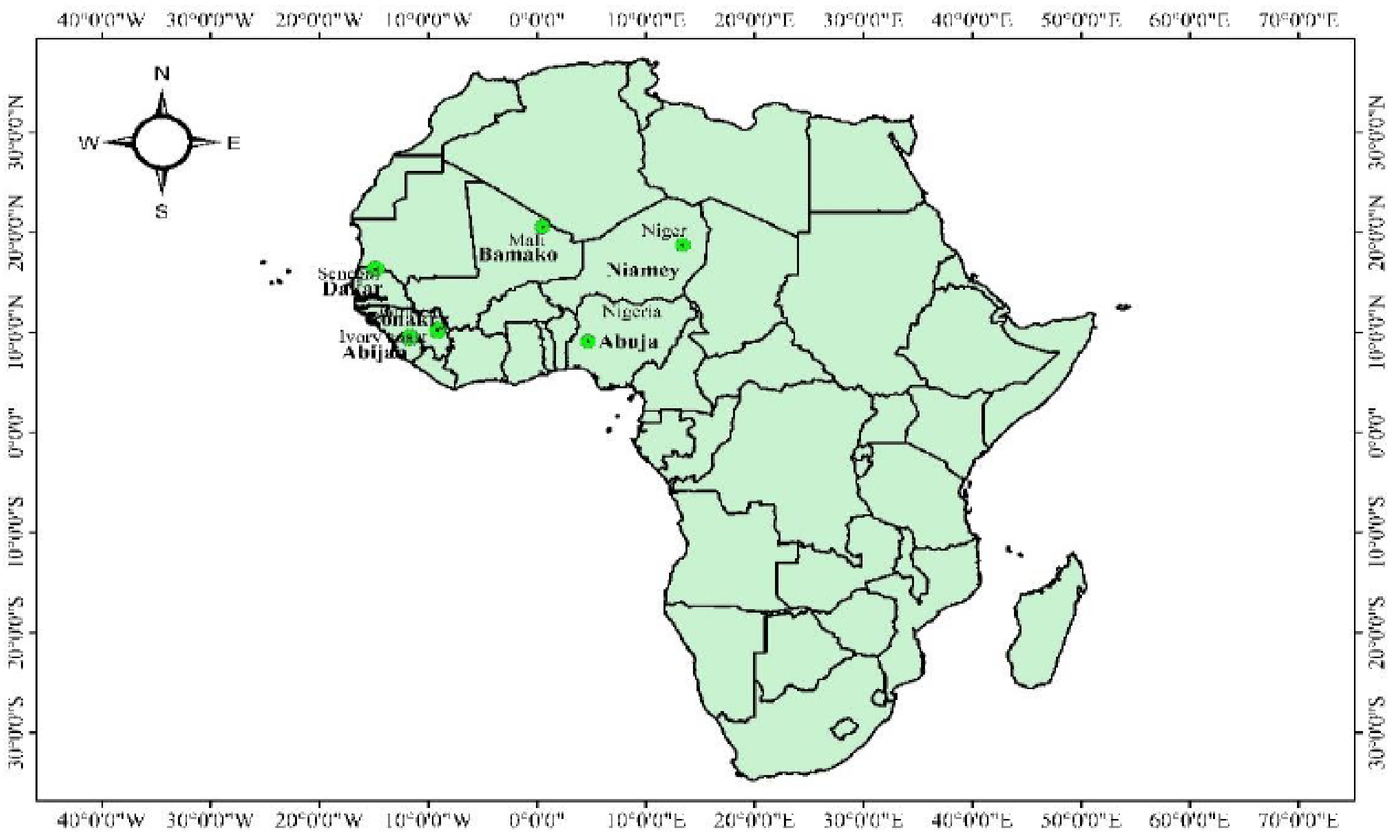

Figure 1. Map of Africa showing the stations for the research.

RH = 85.2% was recorded in June. Figure 2(Ba) shows the correlation between temperature and pressure. The results revealed that the maximum temperature $T = 27.9\ ^oC$ was recorded in February while the maximum air pressure $P = 1009.9\ hPa$ has been recorded in July. However, the minimum temperature was recorded in August $T = 24.4\ ^oC$ and the minimum air pressure was recorded in February $P = 1006.0\ hPa$. However, the maximum and minimum temperature of the station does not change for the plot across all other parameters. Figure 1(Ca) showed that wind speed had a minimum value in January ($WS = 2.2\ m/s$), while the maximum value was recorded in July ($WS = 3.9\ m/s$). This correlation shows that, when the temperature is low, there is an increase in the wind speed of the station. Figure 2(Da) shows that the wind direction got to its minimum in November ($WD = 189.1^o$), this indicates that the direction towards which the wind is moving was low in November, maximum in September ($WD = 209.0^o$). Maximum rainfall was recorded in May ($RF = 253.8\ mm$) while the minimum rainfall was recorded in August ($RF = 84.0\ mm$). The result demonstrates that temperature has a significant influence on the other parameters, as the higher the temperature, the greater the variation in the other parameters. This applies to all of the stations in this investigation.

Figure 3 (Ab, Bb, Cb, Db, Eb) shows the correlation between temperature and other parameters. The result Ab shows that maximum temperature $T = 27.7\ ^oC$ was observed in March, while minimum temperature $T = 23.8\ ^oC$ was observed in August. This shows that August is more humid than other months. However, Maximum relative humidity $RH = 85.8\%$ was observed in August while minimum relative humidity $RH = 43.6\%$ was observed in February. The correlation between the two parameters shows that when the temperature is at maximum, relative humidity at minimum, vice vasa. Figure 3(Bb) shows the relationship between temperature and air pressure, this revealed

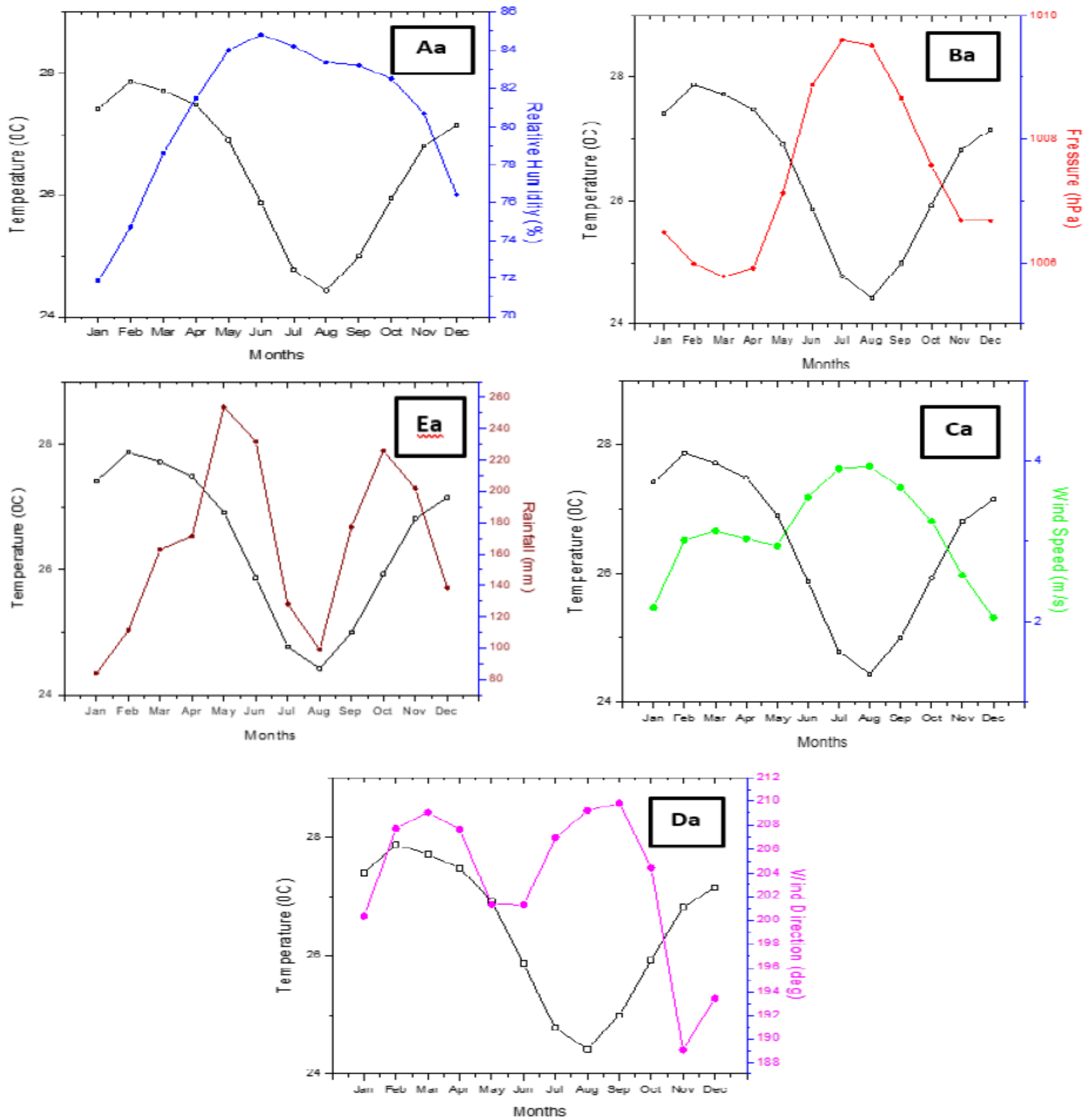

Figure 2. The Environmental Variation of Atmospheric Parameters for Abidjan.

Table 2. Summary result for Augmented Dickey Fuller (ADF) Test for stationarity of the meteorological parameters.

Station	Pressure	Rainfall	RH	Temp	WD	WS
Dakar	0.0054*	0.0013*	0.0009*	0.0020*	0.0006*	0.0001*
Conakry	0.0011*	0.0036*	0.0023*	0.0000**	0.0000*	0.0104*
Abidjan	0.002*	0.0023*	0.0015*	0.0048*	0.0227*	0.0082*
Bamako	0.0104*	0.0044*	0.0000**	0.0000**	0.0159*	0.0001*
Niamey	0.0003*	0.0051*	0.003*	0.0000*	0.0000*	0.0001*
Abuja	0.0007*	0.0010*	0.0088*	0.0213	0.0001*	0.0001*

RH- Relative humidity, WD- Wind direction, WS- Wind speed, values reported are the p-values, **stationary after first differencing, *stationary at level

that as the temperature increases air pressure decreases. However, air pressure (P = 961.4 hPa) got to its minimum in March and maximum (P = 964.7 hPa), this shows that air pressure is more pronounced in March at Abuja than in other months. The correlation of wind speed and temperature as shown in Figure 3(Cb), revealed that wind speed was at minimum level in Oc-

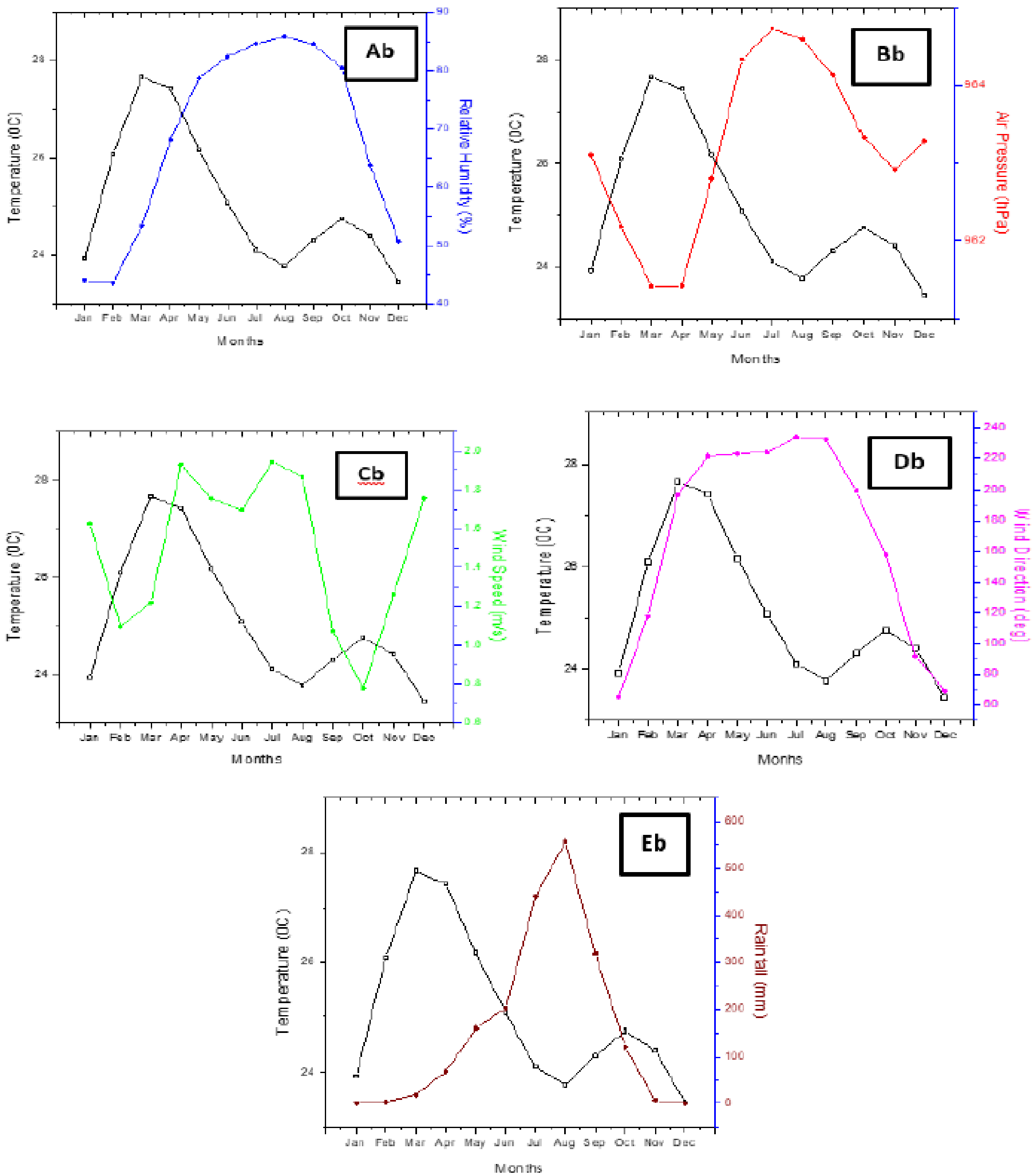

Figure 3. The Environmental Variation of Atmospheric Parameters for Abuja.

tober and maximum in April as shown. More so, for wind direction, the maximum value was recorded in August and the minimum in January. This show that the wind direction is high in August than in other months as revealed by Figure 3(Db). For Figure 3(Eb), the rainfall got to its maximum ($RF = 556.5\ mm$) in August with a sharp increase, whereas there was no record of rainfall or zero rainfall in January, November, and December. This was also reported by [31]. These months signify the winter period of the station, where no record of rainfall was observed. The results of Abuja revealed that temperature follows a sinusoidal pattern with a minimum in August and a maximum in March. This shows the transition between the winter to the rainy season of the station.

The results of the station Bamako as presented in Figures Ac, Bc, Cc, Dc, Ec and Fc, revealed that temperature has a minimum and maximum values as $T = 32.5\ ^oC$ and $T = 23.4\ ^oC$

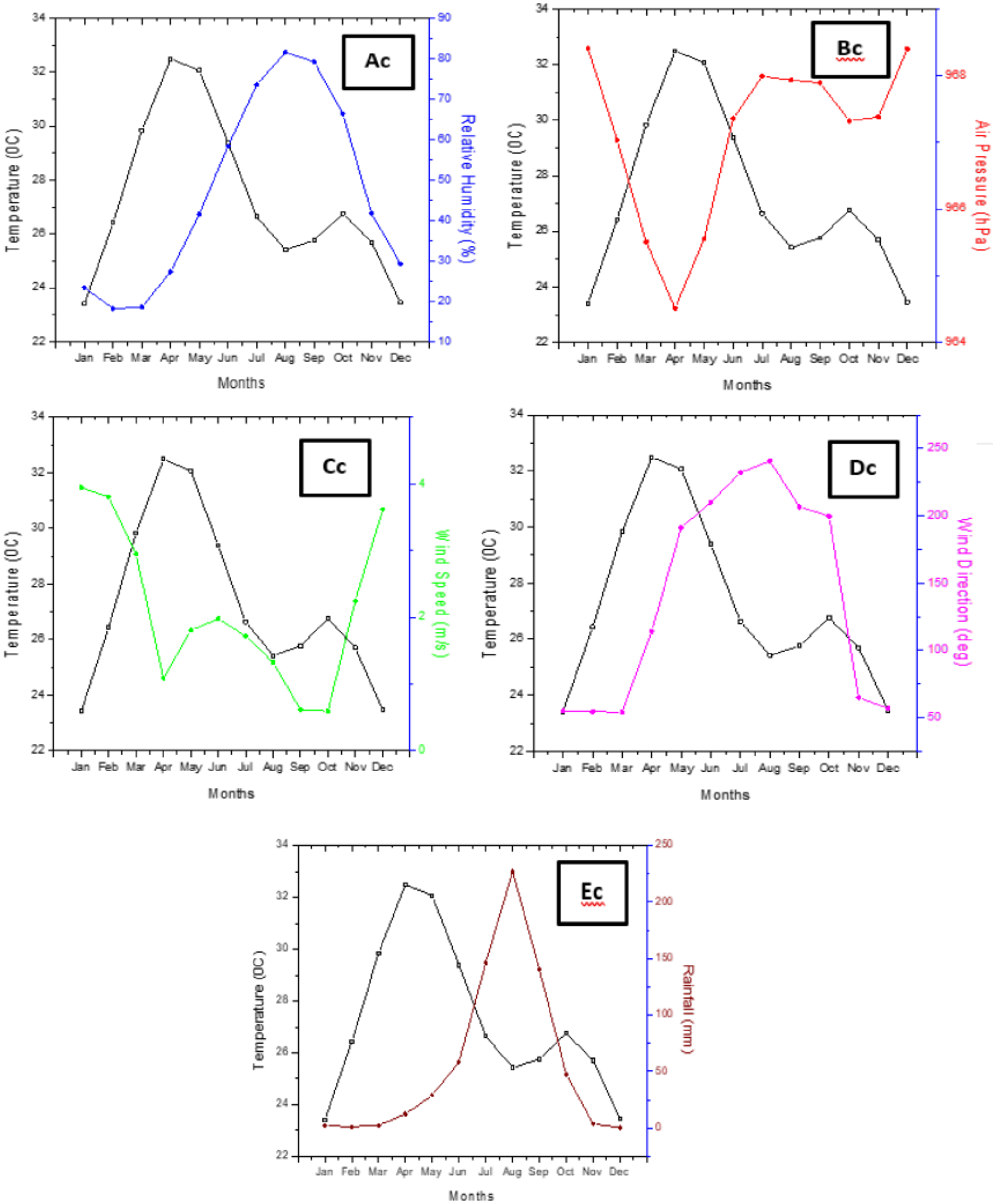

Figure 4. The Environmental Variation of Atmospheric Parameters for Bamako.

in January and April respectively. This signifies the winter and the summer month for the station. The result also shows that relative humidity has minimum and maximum values as $RH = 18.3$ % in February and $RH = 81.5$ % in August, this shows that the water content in the atmosphere is low in February and high in August. Thereby, August is classified to be the rainy season for the station. The air pressure was observed to be in the range (965.5 - 968.4) hPa, this shows that the air pressure was observed to be significant in the station. Wind speed was observed to be in the range (0.6 and 3.9) m/s, this shows that

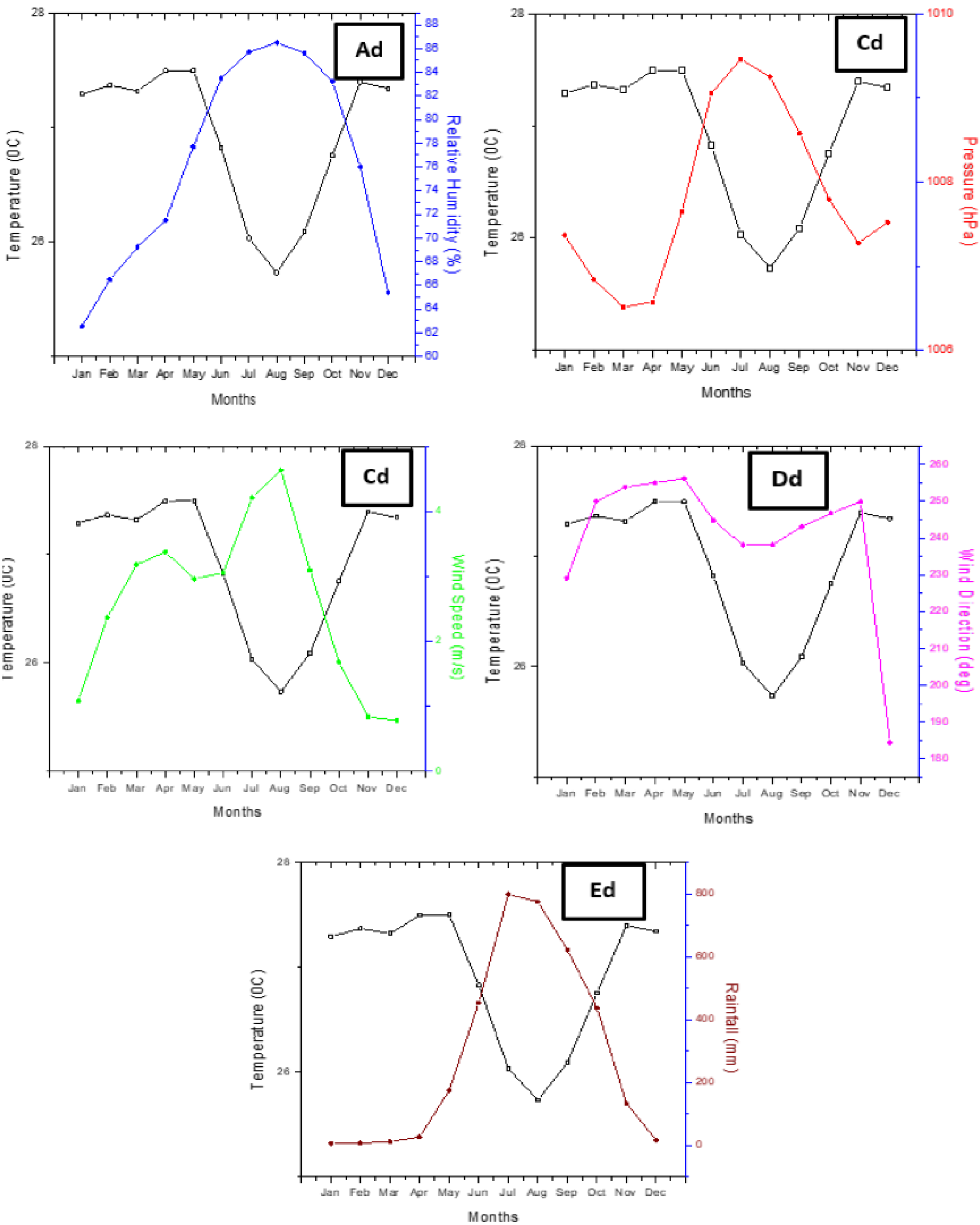

Figure 5. The Environmental Variation of Atmospheric Parameters for Conakry.

the wind speed for the station is low to power any wind turbine machine in the station. The direction of the wind shows that the wind moves with the value (54.0 - 240.8) ^{o}. Rainfall is at maximum of 227 *mm* in August and a minimum of 0.6 *mm* in December. This shows that the rate of rainfall in August is as high as the other months. August is observed to be the peak of rainfall in the station, and it signifies the summer month.

The station Conakry shows that temperature ranges between

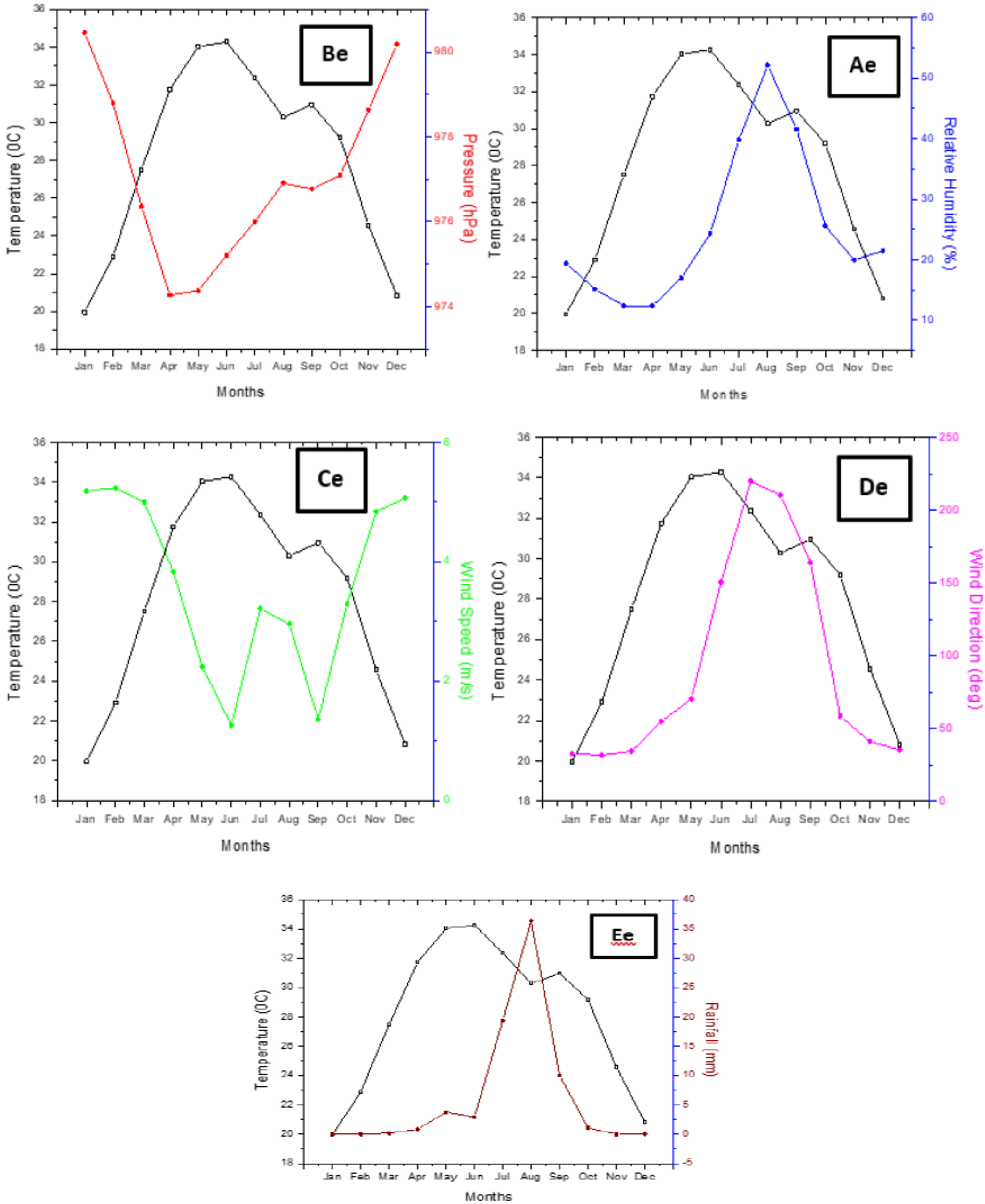

Figure 6. The Environmental Variation of Atmospheric Parameters for Dakar.

$T = (25.7 - 27.4)\ ^{o}C$, the relative humidity is at its minimum 62.6 % in January and maximum in August 86.5 %, this shows that the water content in the atmosphere is more in August and low in January. The air pressure of the station showed that June 1009.5 *hPa* had the maximum value as compared to the other months, whereby, March had the minimum 1006.5 *hPa*. The wind speed and wind direction revealed that December had the minimum values with May and August as the highest. The rainfall of 798.0 *mm* in July was the highest and 6.6 *mm* was the lowest in the station.

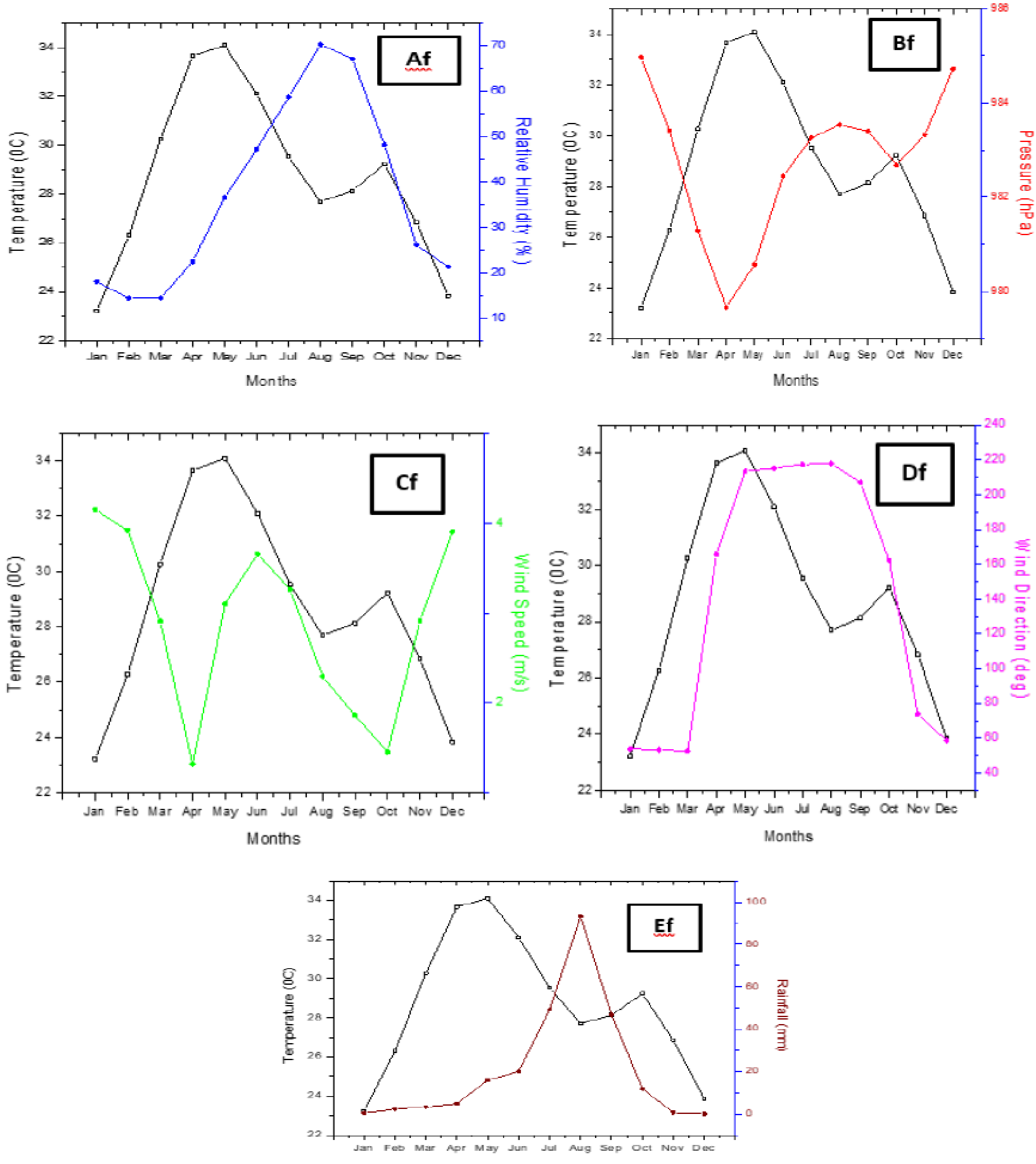

Figure 7. The Environmental Variation of Atmospheric Parameters for Niamey.

Figure 6(Ae, Be, Ce, De, Ee.) revealed that air temperature has a significant effect on other parameters considered, as shown in Figure 6(Ae), the temperature got to it minimum $T = 20.0\ ^{o}C$ in January, while relative humidity got to it minimum $RH = 12.4\%$ value in April and maximum temperature $T = 34.3\ ^{o}C$ was recorded in June while maximum relative humidity $RH = 41.6\%$ was recorded in September. Figure 6(Be) shows the correlation between temperature and pressure. The results revealed maximum air pressure $P = 980.5\ hPa$ was recorded in January and minimum air pressure was recorded in April $P = 974.2\ hPa$. However, the maximum and minimum temperature of the station does not change for the plot across all other parameters. Figure 6(Ca) shows that wind speed has a minimum value in June ($WS = 12.2\ m/s$), while the maximum value was recorded in February ($WS = 5.2\ m/s$). This correlation shows that, when the temperature, there is an increase in

Table 3. Summary result for ARIMA models for the different meteorological parameters in the various stations.

Stations		Models	Constant	AR1	AR2	MA1	MMA2	MA3	SAR1	SMA1	Ljung Box test p-value
Dakar	Temp	$ARIMA(1,0,1)(1,0,1)_{12}$	28.091	0.677		0.406	-	-	1.000	0.903	0.288
			(0.000)**	(0.000)**		(0.000)**			(0.000)**	(0.000)**	
	RH	$ARIMA(1,0,0)(1,0,1)_{12}$	25.893	0.622	-	-	-		0.998	0.874	0.507
			(0.000)**	(0.000)**					(0.000)**	(0.000)**	
	P	$ARIMA(1,0,1)(1,0,1)_{12}$	977.164	0.274	-	-	-	-	0.999	0.921	0.195
			(0.000)**	(0.000)**					(0.000)**	(0.000)**	
	WS	$ARIMA(1,0,1)(1,0,1)_{12}$	3.610	1.115	-	-	-	-	0.999	0.920	0.492
			(0.000)**	(0.011)*					(0.000)**	(0.000)**	
	WD	$ARIMA(0,0,0)(1,0,1)_{12}$	92.466		-	-	-	-	0.999	0.898	0.127
			(0.000)**		-	-	-	-	(0.000)**	(0.000)**	
	RF	$ARIMA(1,0,0)(1,0,1)_{12}$	6.140	0.238					0.992	0.857	0.908
			(0.103)	(0.000)**					(0.000)**	(0.000)**	
Conakry	Temp	$ARIMA(1,1,1)(1,0,1)_{12}$	0.001	0.599		0.9999	-	-	0.9999	0.935	0.691
			(0.000)**	(0.000)**		(0.000)**			(0.000)**	(0.000)**	
	RH	$ARIMA(1,0,1)(1,0,1)_{12}$	1007.848	0.838		0.563	-	-	0.999	0.926	0.227
			(0.000)**	(0.000)**		(0.000)**			(0.000)**	(0.000)**	
	P	$ARIMA(1,0,1)(1,0,1)_{12}$	-0.005	0.365		0.053	-	-	-0.439	0.990	0.634
			(0.651)**	(0.008)**		(0.718)**			(0.000)**	(0.004)**	
	WS	$ARIMA(1,0,1)(1,0,1)_{12}$	2.533	0.204		-	-	-	0.998	0.845	0.053
			(0.000)**	(0.000)**					(0.000)**	(0.000)**	
	WD	$ARIMA(1,0,1)(1,2,1)_{12}$	-0.017	-0.229		-0.068	-	-	-0.477	0.990	0.634
			(0.784)	(0.432)		(0.818)			(0.000)**	(0.000)**	
	RF	$ARIMA(1,0,0)(1,0,1)_{12}$	289.068	0.119		-	-	-	0.999	0.960	0.430
			(0.000)**	(0.009)**					(0.000)**	(0.001)**	
Abidjan	Temp	$ARIMA(1,0,1)(1,0,1)_{12}$	26.442	0.620	-	0.023	-	-	0.999	0.895	0.432
			(0.000)**	(0.000)**		(0.765)			(0.000)**	(0.000)**	
	RH	$ARIMA(1,0,1)(1,0,1)_{12}$	1007.461	0.802	-	0.515	-	-	0.999	0.920	0.065
			(0.000)**	(0.000)**		(0.000)**			(0.000)**	(0.000)**	
	P	$ARIMA(1,0,1)(1,0,1)_{12}$	80.66	0.516	-	0.044	-	-	0.995	0.883	0.265
			(0.000)**	(0.000)**		(0.643)			(0.000)**	(0.000)**	
	WS	$ARIMA(1,0,1)(1,0,1)_{12}$	3.060	0.390	-	0.100	-	-	0.997	0.885	0.750
			(0.000)**	(0.006)**		(0.508)			(0.000)**	(0.000)**	
	WD	$ARIMA(1,0,1)(1,0,1)_{12}$	203.989	0.978	-	0.918	-	-	0.999	0.967	0.145
			(0.000)**	(0.000)**		(0.508)			(0.000)**	(0.000)**	
	RF	$ARIMA(1,0,0)(1,0,1)_{12}$	154.539	0.264	-	0.033	-	-	0.982	0.832	0.145
			(0.000)**	(0.1620)		(0.867)			(0.000)**	(0.000)**	
Bamako	Temp	$ARIMA(1,1,1)(1,1,1)_{12}$	-0.000286	0.2910	-	0.924	-	-	0.023	0.998	0.143
			(0.467)	(0.000)**		(0.000)**			(0.662)	(0.158)	
	RH	$ARIMA(1,1,1)(1,1,1)_{12}$	0.004	0.5290	-	0.955	-	-	0.139	0.996	0.894
			(0.467)	(0.000)**		(0.000)**			(0.008)**	(0.000)**	
	P	$ARIMA(1,0,1)(1,0,1)_{12}$	967.146	0.7430	-	0.440	-	-	0.999	0.939	0.245
			(0.000)**	(0.000)**		(0.000)**			(0.008)**	(0.000)**	
	WS	$ARIMA(2,0,3)(1,0,1)_{12}$	2.129	1.711	-0.951	1.548	-0.711	-0.084	0.999	0.917	0.052
			(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.087)	(0.008)**	(0.000)**	
	WD	$ARIMA(1,0,0)(1,0,1)_{12}$	141.407	0.104	-	-	-	-	0.995	0.766	0.131
			(0.000)**	(0.022)**					(0.000)**	(0.000)**	
	RF	$ARIMA(1,0,0)(1,0,1)_{12}$	56.648	0.148	-	-	-	-	0.999	0.969	0.131
			(0.012)**	(0.001)**					(0.000)**	(0.000)**	
Niamey	Temp	$ARIMA(1,0,1)(1,0,1)_{12}$	28.674	0.555		0.254	-	-	0.999	0.903	0.511
			(0.000)**	(0.000)**		(0.048)*			(0.000)**	(0.000)**	
	RH	NSM									
	P	$ARIMA(1,0,1)(1,0,1)_{12}$	982.790	0.627		0.353	-	-	0.999	0.964	0.905
			(0.000)**	(0.000)**		(0.004)**			(0.000)**	(0.000)**	
	WS	$ARIMA(0,0,0)(1,0,1)_{12}$	-	-		-	-	-	0.999	0.9160	0.561
									(0.000)**	(0.000)**	
	WD	$ARIMA(0,0,0)(1,0,1)_{12}$	141.247	0.034		-	-	-	0.999	0.983	0.300
			(0.000)**	(0.460)**					(0.000)**	(0.000)**	
	RF	$ARIMA(1,0,0)(1,0,1)_{12}$	25.059	0.201		-	-	-	0.9930	0.813	0.568
			(0.019)*	(0.000)**					(0.000)**	(0.000)**	
Abuja	Temp	$ARIMA(1,1,1)(1,0,1)_{12}$	25.090	0.810		0.217	-	-	0.997	0.869	0.187
			(0.000)**	(0.000)**		(0.001)**			(0.000)**	(0.000)**	
	RH	$ARIMA(1,0,1)(1,0,1)_{12}$	68.759	0.710		0.182	-	-	0.998	0.885	0.360
			(0.000)**	(0.016)*		(0.000)**			(0.000)**	(0.000)**	
	P	$ARIMA(1,0,1)(1,0,1)_{12}$	963.248	0.770		0.485	-	-	0.998	0.900	0.387
			(0.000)**	(0.000)**		(0.000)**			(0.000)**	(0.000)**	
	WS	$ARIMA(1,0,1)(1,0,1)_{12}$	1.498	0.461		0.283	-	-	0.999	0.972	0.750
			(0.000)**	(0.022)*		(0.192)			(0.000)**	(0.000)**	
	WD	$ARIMA(1,0,0)(1,2,1)_{12}$	169.613	-0.022		-0.178	-	-	0.999	0.931	0.142
			(0.000)**	(0.000)*		(0.000)**			(0.000)**	(0.000)**	
	RF	$ARIMA(1,0,0)(1,0,1)_{12}$	158.924	-		-	-	-	0.999	0.909	0.182
			(0.000)**						(0.000)**	(0.000)**	

*Significant at 5% ($p < 0.05$), **Significant at 1% ($p < 0.01$), NSM- No Suitable Model

the wind speed of the station. Figure 6(Da) shows that the wind direction got to its minimum in February ($WD = 31.8^o$), this indicates that the direction towards which the wind is moving was low in February. However, it got to its maximum in July

Table 4. Summary of forecast of meteorological parameters in 2021.

	Months	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
Temperature	Dakar	20.33	23.64	28.21	31.95	34.21	34.60	32.57	29.92	30.80	29.36	24.78	20.82
	Conakry	28.23	28.13	27.96	27.99	27.91	27.23	26.45	26.12	26.46	27.11	27.73	27.68
	Abidjan	27.31	27.86	27.71	27.51	27.06	26.01	24.94	24.63	25.30	26.16	26.92	27.16
	Bamako	23.91	26.46	29.74	32.27	31.88	29.18	26.45	25.23	25.57	26.54	25.48	23.31
	Niamey	23.42	26.54	30.50	33.79	34.23	32.11	29.52	27.62	28.07	29.18	26.96	23.93
	Abuja	25.41	27.67	29.11	28.54	26.92	25.64	24.62	24.15	24.60	25.13	25.31	24.40
Relative Humidity	Dakar	19.33	15.11	12.45	11.72	16.38	26.09	40.40	55.84	45.09	28.65	20.63	22.02
	Conakry	63.49	65.15	67.34	70.61	77.84	81.63	85.64	86.36	84.90	81.98	74.65	67.44
	Abidjan	75.69	77.61	80.70	82.84	84.22	85.06	84.80	83.46	83.65	83.51	82.04	77.92
	Bamako	28.73	22.87	23.32	34.08	46.91	64.15	78.73	86.56	84.18	71.25	46.92	35.20
	Niamey	-	-	-	-	-	-	-	-	-	-	-	-
	Abuja	41.16	40.71	51.24	64.31	76.49	81.21	83.92	85.26	83.98	79.43	61.78	46.55
Pressure	Dakar	980.41	978.62	976.49	974.67	974.69	975.38	976.17	977.12	977.06	977.17	978.65	980.39
	Conakry	1007.48	1006.82	1006.68	1006.75	1007.79	1009.06	1009.37	1009.15	1008.56	1007.75	1007.29	1007.61
	Abidjan	1006.70	1006.01	1005.97	1006.12	1007.28	1008.89	1009.50	1009.38	1008.56	1007.47	1006.65	1006.77
	Bamako	968.63	967.15	965.69	964.76	965.75	967.45	968.06	967.94	967.99	967.37	967.43	968.52
	Niamey	985.04	983.42	981.33	979.79	980.66	982.48	983.30	983.55	983.46	982.72	983.30	984.76
	Abuja	963.25	962.08	961.55	961.69	963.03	964.43	964.75	964.60	964.28	963.37	962.84	963.32
Wind Speed	Dakar	4.98	5.15	4.89	4.04	2.29	1.40	3.42	3.00	1.53	3.01	4.70	5.06
	Conakry	1.12	2.27	3.29	3.45	3.13	3.11	4.36	4.60	2.93	1.61	0.69	0.87
	Abidjan	2.13	2.98	3.17	2.96	2.89	3.50	3.80	3.87	3.59	3.07	2.36	1.86
	Bamako	3.75	3.61	2.68	1.02	1.79	2.01	1.64	1.47	0.66	0.71	2.27	3.61
	Niamey	4.13	3.83	2.85	1.38	3.12	3.61	3.15	2.22	1.68	1.41	2.84	3.91
	Abuja	1.56	1.11	1.24	1.90	1.73	1.68	1.91	1.84	1.09	0.82	1.28	1.75
Wind Direction	Dakar	34.25	33.26	35.77	52.80	66.87	166.12	217.38	209.63	178.39	67.88	43.54	37.41
	Conakry	172.18	245.84	250.73	253.05	260.33	243.58	242.35	230.74	249.20	228.12	224.98	288.50
	Abidjan	207.00	213.61	214.48	212.81	206.76	206.54	211.48	213.79	214.00	208.84	194.38	198.62
	Bamako	60.00	57.05	51.42	82.24	191.22	210.36	227.14	242.40	165.71	130.56	67.29	63.67
	Niamey	54.18	53.37	53.18	165.19	213.17	214.98	217.19	217.75	206.62	162.16	73.92	59.08
	Abuja	66.78	122.09	193.64	217.06	220.62	222.25	231.96	230.92	192.51	153.75	92.82	71.67
Rainfall	Dakar	0.26	0.34	0.47	0.78	3.02	5.61	19.43	49.03	12.15	1.95	0.35	0.38
	Conakry	10.30	9.09	14.28	29.71	181.35	466.29	799.55	766.82	608.51	426.43	135.00	19.42
	Abidjan	71.46	111.98	149.54	147.04	200.59	225.24	127.42	98.04	189.13	247.20	201.00	123.49
	Bamako	2.83	1.75	3.04	12.42	29.57	58.56	145.64	227.11	135.31	47.73	4.33	1.32
	Niamey	0.75	5.04	3.41	4.09	15.44	23.05	48.94	142.67	57.58	22.88	0.96	0.92
	Abuja	2.26	7.53	17.90	71.01	157.21	207.67	407.30	503.16	295.58	129.21	8.07	2.16

($WD = 219.9^o$). Maximum rainfall was recorded in August ($RF = 36.4$ mm) while zero rainfall was recorded in February ($RF = 0.0$ mm). The maximum rainfall indicates that there is a low temperature during the period, this signifies increases in rainfall rate due to the low temperature for the station. The result shows that temperature has a significant effect on other parameters because of the more the temperature the higher the variation of other parameters.

Figure 7 (Af, Bf, Cf, Df, Ef) shows the correlation between temperature and other parameters. The result Af shows that maximum temperature $T = 34.1$ ^oC was observed in April, while minimum temperature $T = 23.2$ ^oC was observed in January. Maximum relative humidity $RH = 70.3\%$ was observed in August while minimum relative humidity $RH = 18.0\%$ was observed in January. The correlation between the two parameters shows that when the temperature is at maximum, relative humidity at minimum, vice vasa. Figure 7(Bf) shows the relationship between temperature and air pressure, this revealed that as the temperature increases air pressure increases. However, air pressure ($P = 979.7$ hPa) got to its minimum in February and maximum ($P = 984.9$ hPa), this shows that air pressure is more pronounced in January at Niamey than in other months. As shown in Figure 7(Cf), the correlation of wind speed and temperature, revealed that wind speed was at minimum in April and maximum in January. More so, for wind direction, the maximum value recorded was in August and the minimum in March. This show that the wind direction was high in August than in other months as revealed by Figure 7(Df). For Figure 3(Ef), the rainfall got to its maximum ($RF = 93.1$ mm) in August with a sharp increase, whereas there was no record of rainfall or zero rainfall in December. The results of Niamey revealed that temperature follows a sinusoidal pattern with the minimum in January and a maximum in April. This shows the transition between the dry to rainy seasons of the station.

3.2. Statistical Analysis

Table 2 shows summary result of the stationarity of the series using Augmented Dickey Fuller test for each of the meteorological parameter in the different locations. The result reveals that in all stations, all the parameters were stationary at level with exception of temperature in Conakry, RH and temperature in Bamako which were only stationary after first differencing meaning that they are integrated of order 1.

The estimates of the different Autoregressive Integrated Moving Average (ARIMA) models fitted to these meteorological parameters are as shown in Table 3. The Ljung Box test was applied to diagnose the different ARIMA model fitted and the p-values obtained for all models were greater than 0.05 ($p > 0.05$) which indicates that these models were of good fit. In all the fitted models except for wind direction in Conakry and rainfall in

Abidjan have all their Autoregressive term of order 1 significant ($p < 0.05$) which implies that previous day value of these meteorological parameter has a significant effect on the present day value of the parameters. This indicates as the previous day value of these parameters increases significantly, there is a corresponding significant increase in the present day value of the meteorological parameters. Result also shows that in most of the fitted models, the Moving Average terms both seasonal and non- seasonal were also significant ($p < 0.05$) indicating that the previous day value of the stochastic term also has a significant effect on the present value of meteorological parameters in the study area. Since the different ARIMA models were found to be of good fit, these models were used in forecasting the future values of the meteorological parameters in each of the selected locations and the summary result of the forecast are presented in Table 4.

The forecast indicates the maximum temperature are expected in June in Daka while in Conakry, Abidjan, Bamako, Niamey and Abuja, maximum temperature are expected in January, February, April, May and March respectively. Also, minimum temperatures were predicted in Daka, Conakry, Abidjan, Bamako, Niamey and Abuja in the months of January, August, December, January and August respectively. In Daka, Conakry, Bamako and Abuja, maximum relative humidity was predicted in August while in Abidjan maximum relative humidity was predicted in June. For other these meteorological parameters, the predicted values for 2021 were presented in Table 4.

4. Conclusion

The environment and statistical analysis of the meteorological parameters shows that the monthly mean variations of air temperature and other parameters considered for African stations exhibit similarity behaviour and dynamics, however, some statistical parameters fluctuate significantly between the stations studied. Air temperature, rainfall, air pressure, wind speed and direction modelling and its predicting posture a stimulating mission aimed at treatment slightly on monthly time series over the environment. In this study, it was observed that ARIMA model for the environmental study can proficiently get the reason of the increase in the meteorological parameter study by producing the minimum prediction of the root mean squared error which could be better forecast in the long time seasonal time series of the high frequency. For this research, the best model for prediction depends on the stations. The results revealed different time series (ARIMA 101, ARIMA 111, ARIMA 110, ARIMA 011) which are appropriate for the West African continental data sets. However, investigative inspection settles the competence of the models. Therefore, the forecast model indicates that maximum temperature are expected in June while minimum temperatures in January, August, December. Although, the selected models cannot forecast the precise air temperature, this can also provide information that can be of help to create tactics for appropriate preparation of farming which can be used as tools for effective environmental preparation and policymaking.

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