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ATMOSPHERIC ELEMENTS AND ITS EFFECTS ON CO CONCENTRATION COLUMNS OVER SOUTH-IRAQ (BASRA CITY)

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ABSTRACT

In this research we used the data of carbon monoxide column concentration , atmospheric elements , temperature at 2m (T), dew-point 2m (T_d), wind speed 10m (U),total cloud cover (TCC) and relative humidity (RH%)(calculated from T and T_d) , and other elements included boundary layer height (in meter)(BLH) , sensible heat flux (SSLHF) in units (J.s/m^2), from (ECMWF) over Basra province and at grid point 30.375˚ latitude and 47.25˚ longitude. We concentrated on the relationship between these atmospheric elements and the CO column concentration by used hourly data recorded every 3 hour at 00,03,06,09,12,15,18,21 ,in four months (Jan, April, July, Oct.) from 2012. Hourly analysis of Maximum and minimum data contour line CO is plotted graphically over Iraq map by satellite image, maximum values of CO is at July month $1.16*10^{-3}$ kg/m^2 , while lowest minimum data recorded at January $6.95*10^{-5}$ kg/m^2 . The statically simple linear regression and multiple linear regression is reported , in simple linear regression the effect of these element on CO is don't clear specifically at months Jan and Oct. , while in the April and July the correlation is significant specifically at the element Td , RH% , SSLHF at April and T , U , TCC, BLH SSLHF at July. Where the simple correlation coefficient have values 0.512, 0.468, 0.507, 0.482 and 0.44 respectively. Multiple linear regression used several tests method such as normality, constant variance test and power of performed to examine the correlation between dependent variable and independent variable (atmospheric elements) , all of these methods is based on the probity values P , Overall correlation in multiple linear regressions between dependent variable (CO concentration column) and independent variable became better because we take completed effected integrated, thus R became 0.55, 0.688, 0.789 and 0.756 for months Jan, April ,July and Oct. respectively

Keywords: Atmospheric elements, CO concentration column, multiple leaner regressions, normality and Constant of variance test.

1. INTRODUCTION

CO is a particularly useful indicator of urban air pollution. It shares many combustion sources with particulate matter and with other urban primary pollutants. For example it is well correlated with (NMHC) from combustion sources [1][2]. It tends to show greater spatial homogeneity [3] than many shorter-lived pollutants whose concentration is strongly affected

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by local sources. In fact, compared to most urban air pollutants, carbon monoxide has a long atmospheric lifetime, from 1.1 to 2.4 months in the tropical boundary layer, and from 2.2 to 3 months in the mid-latitude lower troposphere [4]. The long lifetime has several implications. The gas has often been utilized as a tracer of long distance and intercontinental pollution transport. This makes CO relevant to people concerned with ambient air quality management as well as officials responsible for protecting public health and safety. Ambient air quality standards are the foundation of air quality management programs in many countries worldwide. Such standards typically specify maximum permissible concentrations in ambient air for certain pollutants. To achieve ambient standards in the United States, the U.S. Environmental Protection Agency (EPA) implemented progressively tighter tailpipe emission standards for motor vehicles. As a result, these standards have substantially reduced ambient CO concentrations in most metropolitan areas of the U.S. and have had other collateral benefits. For example, the nation had 11,667 fewer deaths from accidental CO poisoning between 1968 and 1998, according to a study by the Centers for Disease Control and Prevention (CDCP) [5]. Still, an average of 480 U.S. residents died each year during 2001–2002 from nonfire-related unintentional CO poisoning. In addition, an estimated 15,200 persons, that is, people with confirmed or possible nonfire-related CO exposure or poisoning, were treated annually in U.S. hospital emergency rooms [6].EPA established the National Ambient Air Quality Standards (NAAQS) and set deadlines for their allowable ambient concentrations and averaging time for certain 'criteria ' air pollutants including CO, its primary and secondary NAAQS for CO , The primary standards specify a level of air quality sufficient to protect public health and secondary standards are intended to protect public welfare , the standards include adequate margin of safety to reflect scientific uncertainties related to measurement of the effects of air pollutant exposure in the population [7]. The NAAQS for CO are designed to keep COHb levels below 2% in the blood of 99.9% of nonsmoking healthy adults and people who belong to probable high-risk groups .the high-risk groups include the elderly , pregnant women , fetuses , young infants, and those suffering from anemia or certain other blood, cardiovascular , or respiratory diseases ,and people with coronary artery disease [8]. Godish argues that a significant number of people still be at risk from CO exposure ,even if ambient CO concentrations do not exceed the 8-hour NAAQS for CO [9].

The world health organization (WHO) put guideline for CO exposures its relevant to the discussion above, its taken average times to exposure with maximum concentrations, as [8-hour for 10 mg/m^3 (9 ppm), 1-hour for 30mg/m^3,30min for 60 mg/m^3 and 15min for 100mg/m^3(90ppm)] [10] .Unlike the NAAQS, the guidelines specify maximum concentrations for two shorter time spans (30min and 15min)[11] . WHO's guidelines are intended to prevent blood levels of COHb from exceeding 2.5–3% in nonsmoking populations even when a person engages in relatively heavy work. Romieu 1999, reported that average COHb levels are about 1.2–1.5% in the general population and from 3% to 4% in the blood of cigarette smokers [12].

In Iraq many electric generated after 2003 is install in residential cities its effected on the standard local value of CO, in this research we concentrated on the concentration columns of CO and selected Basra as case study. This study also consider the atmospheric elements temperature, dew point temperature, wind speed , relative humidity , total cloud cover, and other physical elements such as boundary layer height and sensible heat flux . These elements is tested as effected on CO concentration.

2. LOCATION AND DATA USED

The data used in this study covered south of Iraq from a grid of thirty -four points extends from (29.25°-37.125°) N latitudes and (39.375- 47.25°) E longitudes with a uniform grid interval of 1.125 degrees longitude and 1.125 degrees latitude for the first day of January 2012 to 31 December 2012 and for the time (3, 6, 9, 12, 15, 18, 21, 00) UTC. The data file (NC extension) consists of atmospheric elements (temperature at 2m, dew-point 2m , wind speed 10m,total cloud cover) and other elements resulted from above included boundary layer height (m) , sensible heat flux ($J.s/m^2$), and relative humidity (%), data file also contain CO concentration in (kg/m^2) at the same time and location. The data taken from ECMWF (European Centre For Medium-Range Weather Forecasts) ECMWF values are not really observed,

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of course, but from a numerical model [13]. Site study that represented as grid points distributed on Iraqi provinces some of these that has large area taken more than 8 grid point such as Anbar but other taken one such as Dhi Qa and Basra other don't appeared such as Baghdad province , this return to distance grid by ECMWF. This paper concentrated on the south area of Iraq and specially on the Basra city its contain one grid point according to this data (30.375° north and 47.25° east) . Basra city is located south of Baghdad city (capital of Iraq) about 549km, at latitude 30.310 north and longitude 47.470East, and 2m above sea level ,figure 1, 55 kilometers from the Persian Gulf. Its economy is largely dependent on the oil industry. Iraq has the world's 4th largest oil reserves estimated to be more 115 billion barrels (18.3×10^{9} m^{3}). Some of Iraq's largest oil fields are located in this province, and most of Iraq's oil exports leave from Al Basra Oil Terminal [14]. The south oil company has its head office in this city. This make activity in Basra is centered on the petrochemical industry and other, Basra is considering as economic capital of Iraq.

3. METHODOLOGY

After open file data that contains grid point over area of Iraq, including location study grid point we obtains hourly Atmospheric parameter such as temperature at 2m , dew-point 2m (measured in k and converted to centigrade), horizontal wind speed at 10m(m/s),total cloud cover (have values from 0-1) , in addition to CO concentration in (kg/m^2) data file contains boundary layer height over this point grid in meter units and sensible heat flux in ($J.s/m^2$) , on the other hand relative humidity can be obtain from formula [15] :

$$\text{Relative humidity} = 100\left(\frac{112 - 0.1\text{T} + \text{T}_d}{112 + 0.9\text{T}}\right)^8 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(1)$$

Where T_d , T : is dew-point and temperature at 2m.

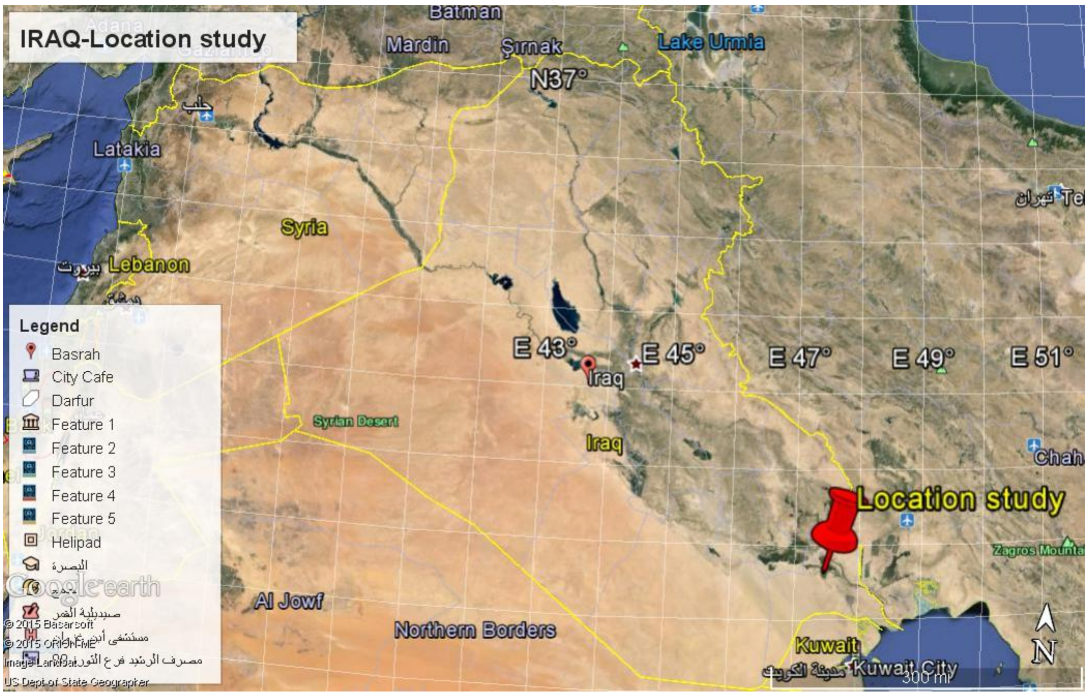

Figure 1: location study (30.375N-47.25E) over Iraq map.

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Descriptive statistics was used to explain the mean values of the hourly data for four months that represent the seasons in Iraq and in Basra province for CO air quality column and atmospheric variability. Personal correlation statistics was used to examine the influence of change in these variability on the CO concentration according to formula [16] :

$$r = \frac{\sum_{i=1}^{n}(x-\bar{x})(y-\bar{y})}{\sqrt{\sum_{i=1}^{n}(x-\bar{x})^2}\sqrt{\sum_{i=1}^{n}(y-\bar{y})^2}} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (2)$$

Where: r correlation coefficient

x = independent variable

y = dependent variable

$\bar{x}$ = mean of x

$\bar{y}$= mean of y

This relationship were examined also by the multiple linear regression analysis, CO concentration consider as dependent variable and the other metrological variability represent the independent variable. This enables us to identify the degree and nature of relationship which exists between them, the multiple regression techniques has the form [17]:

$$y = b_1 + b_2 x_2 + \dots\dots + b_k x_k + e \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (3)$$

Where y is dependent variable, $x_2, x_3 \dots\dots x_k$ (meteorological variables) are independent variables, $b_1, b_2, \dots\dots\dots, b_k$ are linear regression parameters, e is an estimated error term, which is obtained from independent random sampling from the normal distribution with mean zero and constant variance. The task of regression modeling is to estimate the $b_1, b_2, \dots\dots\dots, b_k$ which have been done using least square technique.

4. RESULTS AND DISCUSSION

Data used in this study is taken from (ECMWF) at the period 2012 and at four months represent weather condition of Iraq , data is record CO concentration column and atmospheric elements every three hours . the aim of this research is to evaluated the concentration column of CO at south area of Iraq that consider as one of the most production oil reserves at the third world's. we selected CO concentration column because it's one of the most important trace gases emitted from anthropogenic pollution and biomass burning , additionally , CO was recognized as an important indirect greenhouse gas that could have an effect on global climate with a relatively long life time , on the other hand , meteorological elements for the site of the CO concentration column that taken is arise , this elements includes temperature , wind speed , dew point, total cloud cover all this can be consider as stability in the atmospheric layers near the ground , where NO direct measure of stability were made at either site , this elements data also contain surface sensible heat flux and boundary layer height . These related to the stability index also, all of these will analysis to known the effect of these elements on the CO column concentration and test the coefficient between these elements at the period time. Overall from analysis of hourly values data we see that all the high concentration is concentrated at the 00 at Jan and Oct. months , where atmosphere is cold and moderate and cloud cover is high , but the case is change in the months

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April and July where there is high sunlight ,notes figures 2 ,3 table 1. From these conclude results, we see temperature is increases in these months April, July where its reached to hourly recorded about 40.5-50.9C˚ in this condition wind speed also increases, table 1. This increases in the temperature causes increases in the BLH where its reached as average as 1306.1±1502 meter and 1700±2037.91meter respectively, while its maximum value is 4859.3 and 6070meter for these months. if we backward to the CO column and table 1, we see that its stay represent maximum values at these period these may be due to the chemical reaction in the atmosphere where at this period (July) month there is don't found any cloud cover this may be due to the high solar radiation at this period and chemical reaction with other elements, figure 3 and table 1.

On the other hand lowest hourly concentration values of CO concentration column is almost concentrated on the early morning of daytime , figure 4 , this figure consider as the satellite image of the lowest values of the CO column at the four months and at the hours of the study , we notes that the isocline of CO column concentration is change every three hours , as consider of grid point of study latitude 30.3degree and longitude 47.25˚ degree , that may be happened from the regional change of CO concentration with time . The lowest concentration of this data is at the hours of January about $6.954*10^{-5}$ kg/m^3 at 2/1/2012 hour 06 , see figure 4 at this period other atmospheric elements is present at daily values of elements figure 3 , temperature is moderate 10-20 C˚, where T_d and RH% is highest values .

Daily simple linear correlation coefficient is reported at this study to test the range of correlation and effect of these elements on the CO concentration column, in the January months we don't see any clear relationship between these element and CO concentration, see figure 3 and table 2 , that state simple linear regression of atmosphere elements at last graph . at April month the relation is better from the January , there is correlation but regarded less value considered to the elements Td , RH% , SSLTF that can't see in the figure 3 , this correlation is consider also on the July month but its return o the the previous case at the October month table 2 , also we see overall that there is increases in CO column at April and July with increases in the most atmospheric elements of other factors .Overall , all these element effected by the each one on the CO column but the case in interaction ad we can used all the atmosphere element assemblage to calculate its effect on the CO column concentration , these case can done through the multiple linear regression table 3.

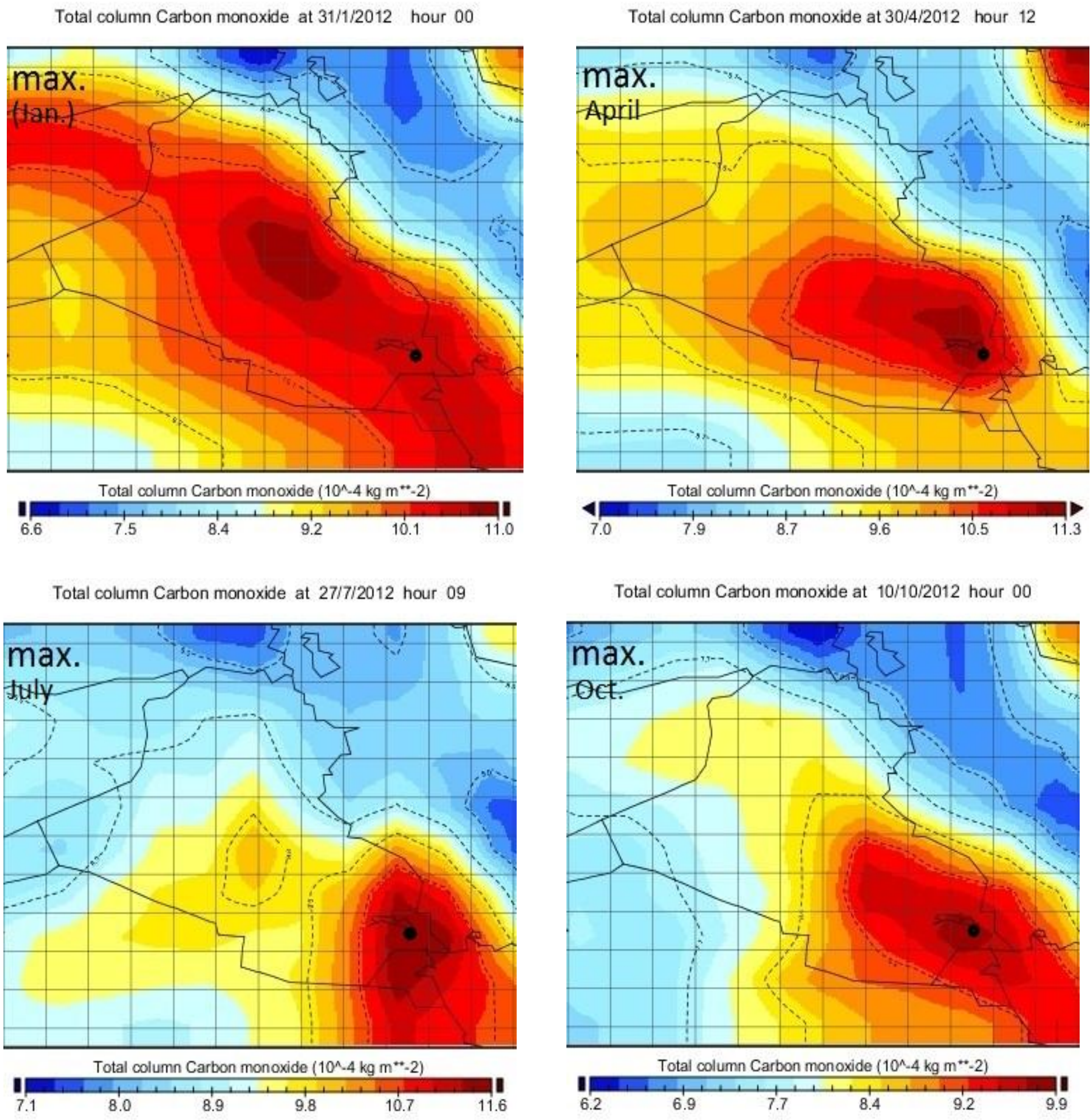

Figure 2: hourly change of CO column concentration in kg/m2 that represent the highest values at the four months of Iraq weather (Jan. , Apr. , July, Oct.)

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Table 1: Maximum and minimum hourly values for CO concentration column and Atmospheric variability at months (Jan., Apr., July, Oct.)

Months		CO (mg/m^2)	T C^0	T_d C^0	U (m/s)	RH%	TCC	Blh meter	SSF. J.S/m^2
Jan.	Avr.	0.00098± 6.95E-05	12.2±5.07	1.222531 5.347862	2.603014 1.420892	51.61± 20.1	0.182±0.33	407.44±574.24	-1716529± 1341990
	Max.	0.00122	23.59323	13.27843	7.733016	99.75	1.00000727	2540.6	666162
	Min.	6.95446E-05	-0.3932	-13.7919	0.070358	15.99	5.55112E-17	10.381..	-5E+06
Apr.	Avr.	0.001036± 5.042E-05	27.33±5.852	4.333±5.76	2.808±1.65	27.39± 17.19	0.243±0.339	1306.1±1502	1923205± 1095095
	Max.	0.0011348	40.512	17.093	8.0164	97.21	1	4859.3	302022
	Min.	0.000891	15.46	-6.261	0.0353	5.738	0	11.743	342.219
Jul.	Avr.	9.95E-04± 6.04E-05	4.00E+01± 6.07	4.28±3.533	3.27E+00± 2.220883	13.84± 9.922	3.80E-02± 0.125	1.70E+03± 2037.913	1.59E+06± 1924555
	Max.	1.16E-03	5.09E+01	2.06E+01	8.89E+00	56.07	1	6.07E+03	2.94E+06
	Min.	8.91E-04	2.91E+01	-3.56	3.05E-02	4.051	00	1.20E+01	-6.35E+06
Oct.	Avr.	8.77E-04± 4.21E-05	30±5.62	7.42E±5.78	2.39±1.359	7.58E+01 ± 24.4873	2.76E-01± 0.381	9.26E+02± 1323.8	1.35E+06± 764485.3
	Max.	9.94E-04	4.18E+01	2.44E+01	5.82E+00	1.41E+02	1	4.56E+03	2.20E+06
	Min.	7.51E-04	1.70E+01	-1.33E+00	3.61E-02	2.45E+01	0	1.22E+01	-2.33E-10

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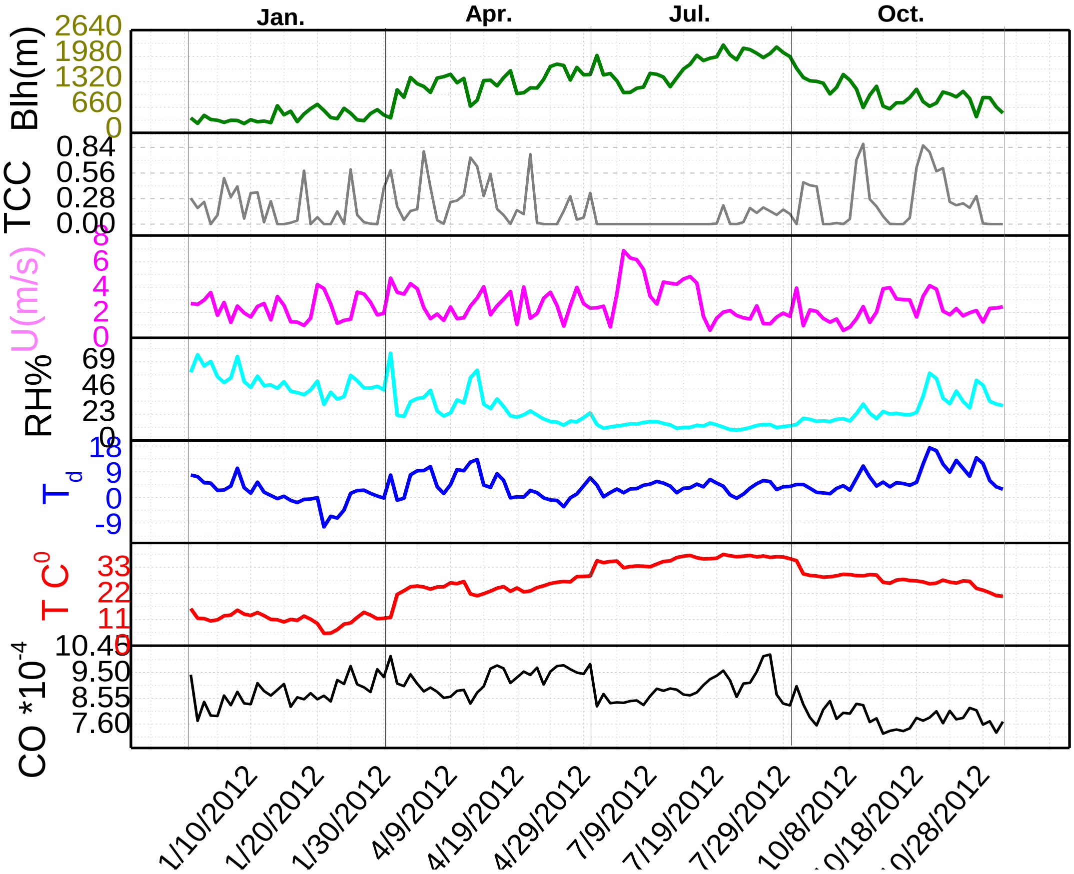

Figure 3: Daily time sires for CO concentration column and atmospheric variability at months (Jan., Apr., July, and Oct.) from 2012

Table 2: Daily simple linear regression (R) between CO concentration column and different atmospheric Elements (T, T_d, U, RH%, TCC, SSHF, BLH….) at four Months from 2012.

	Jan	April	July	October
T	0.0593	0.368	0.512	0.383
T_d	0.00654	0.437	0.399	0.123
U	0.136	0.0681	0.468	0.493
RH%	0.0354	0.517	0.00747	0.00724
TCC	0.321	0.300	0.507	0.352
BLH	0.230	0.423	0.482	0.320
SSLHF	0.00586	0.568	0.440	0.407

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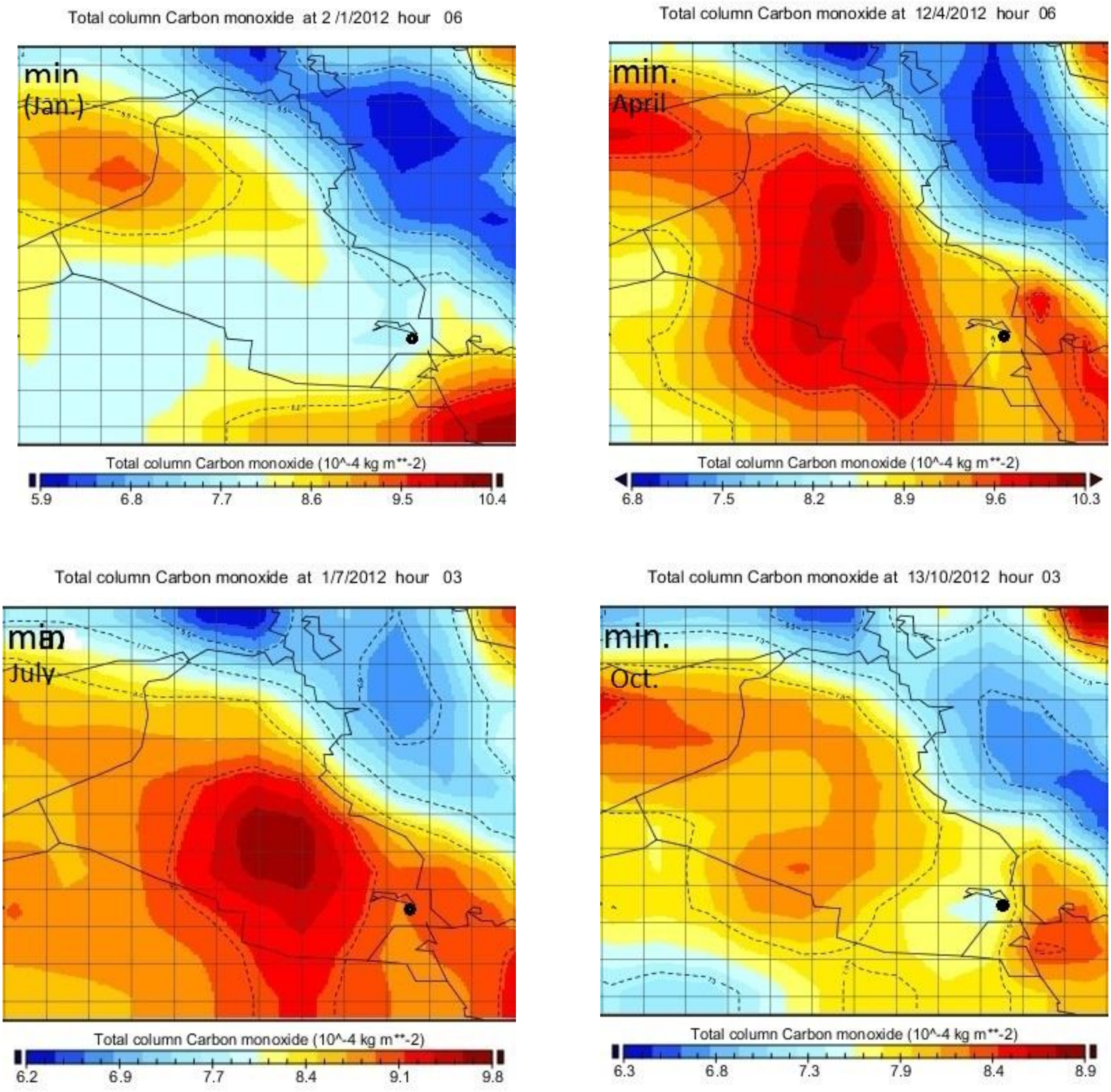

Figure 4: CO column concentration in kg/m2 that represent the minimum values at the four months of Iraq weather (Jan. , Apr. , July, Oct.)

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Multiple linear regressions used in this work to test these atmospheric elements data for its suitability for regression with CO column concentration by assumed, these atmospheric elements is normally distributed about the regression and the variance of the CO variable is constant regardless of value of the independent variable (atmospheric elements), the residuals are independent of each other. All of these assumptions depend on the tests such as *normality test*, *constant variance test*, *Durbin Watson test*.

Normality test uses shapiro-wilk test to test for a normally distributed atmospheric elements. its depend on the P value (probability) where P value determines the probability of being incorrect in concluding that the data is not normally distributed , if the P computed by the test is greater than the P set here (This value according to this model research is equal to 0.05), the test passes . The values of normality test is 0.303, 0.599, 0.756 and 0.476 for months Jan., April, July and Oct. respectively, table 3. Probability P value to pass according to shapiro-wilk test(normality) is the highest at July and lowest for Jan, table 3.

On other hand, Constant of variance is applied on this data, this test is achieved by the calculate the spearman rank correlation between the absolute values of the residuals of (atmospheric elements) and the observed value of the dependent variable. When this correlation is significant, the constant variance assumption may be disturbed, and you should consider trying a different model. The p values of this test are about 0.751, 0.77, 0.989 and 0.547 for months Jan., April, July and Oct. respectively, table 3 .Because the parametric statistical methods are relatively robust in terms of detecting violations of assumptions, the suggested value in sigmaplot model is 0.05, larger values of P (for example 0.1) require less evidence to conclude that the residuals are not normally distributed or constant variance assumption is violated.

Table 3: Daily multiple linear regression (R) between CO concentration column and atmospheric Elements (T, T_d, U, RH%, TCC, SSHF, BLH….) at four Months from 2012.

Months	*Correlation Coefficients for Multiple linear regression*	*CO can be predicted from independent variable P<0.05*	*Normality test is Passed if P equal to...*	*Constant variance test passed if P equal to …*	*Power of performing passed if P in the range …*
Jan	0.556	TCC	0.303	0.751	0.05-0.912
April	0.688	NONE	0.599	0.774	0.05-0.992
July	0.789	U ,TCC,SSHF	0.756	0.989	0.05-1.0
Oct.	0.756	U	0.476	0.547	0.05-0.999

In the power of performed test, the power of a regression is the power to detect the observed relationship in the data. The alpha (α) is the acceptable probability of incorrectly concluding there is a relationship. The suggested value is $\alpha = 0.05$, this mean that a one in twenty chance of error is acceptable , or that you are willing to conclude there is a significant relationship when P<0.05. Smaller values of α in stricter requirements before concluding there is a significant relationship, but a greater possibility of concluding there is no relationship when one exits. Larger values of α make it easir to conclude that here is a relationship; according to this information July (P in range 0.05-1) has large correlation of data used table 3.

According to these tests CO Column concentration can be predicted from these atmospheric elements (independent variable where P<0.05), the most appropriate of variable is TCC and U (m/s) for data at Jan and Oct. months. In July these independent variable increases to three (U, TCC and SSHF). None of these independent variables have values less than 0.05 in April month, thus we don’t have any atmospheric variable can used to predicted CO column concentration, table 3.

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Overall correlation in multiple linear regressions between dependent variable (CO concentration column) and independent variable (T, T_d, U, RH%, TCC, SSHF, BLH….) became better because we take completed effected integrated, thus R became 0.55, 0.688, 0.789 and 0.756 respectively, table 3.

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