# THE EFFECT OF NON- STANDARD ATMOSPHERIC BEHAVIIORS IN BAGHDAD CITY ON MEASURING DISTANCES BY USING ELECTRONIC DISTANCE MEASUREMENT INSTRUMENTS (E.D.M.I.)+

# تأثير الأحوال الجوية (غير القياسية ) في مدينة بغداد على أنحراف الأشعة عند قياس المسافات باستخدام أجهزة قياس المسافات الالكترونية

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**Abstract:-**

**This paper studies the ability to avoid and correct the measured distance due to the effect of non-standard atmospheric behaviors such as; change in temperature, change in air pressure, humidity and difference in elevation on measuring distances by using electronic distance measurement instruments such as total station. Then by using meteorological data sheets of Baghdad city (2007), we can derive a model and design it by a computer program and another program (Mat lab 6.5) to calculate the amount of correction on measured distances under these circumstances.**
**The research concludes that the change in the length of measured distance is neglected when measuring short distances but that change increases when the change in temperature, humidity, air pressure and the height above sea level are increased more than the circumstances at which the instrument was made (standard condition ) ,as shown in the instrument guide (user manual** ).

**المستخلص:**

يهدف هذا البحث الى امكانية تلافي وتصحيح الاخطاء بسبب تأثير الظروف الجوية غير القياسية مثل ( التغير في درجات الحرارة و التغير في الضغط الجوي والرطوبة واختلاف مناسيب الارض )في مدينة بغداد على قياس المسافات باستخدام أجهزة المساحة الالكترونية لقياس المسافات مثل اجهزة(المحطات الكاملة)؛ ومن خلال استخدام البيانات الخاصة بدائرة الانواء الجوية لسنة ٢٠٠٧ ( لمدينة بغداد) واعداد نموذج حسابي متكامل و تصميم برنامج وبمساعدة برنامج اخر ( حساب وتصحيح المصفوفات) ويقوم بتنظيم المعلومات وحساب مقدار التصحيح للمسافات المقاسة تحت تاثير هذه الظروف.
وتوصل الباحث الى الاستنتاج التالي أن هناك تغييرا طفيفا في طول المسافات المقاسةلحد معين ولكن هذا التغير يزداد في حالة( تغيير كبير في درجات الحرارة والرطوبة والضغط الجوي وارتفاع مناسيب منطقة العمل عن مستوى سطح البحر) عن الظروف التي صنع الجهاز خلالها ( الظروف القياسية) الموجودة في دليل الجهاز.

+Received on 7/7/2008 ,Accepted on 17/6/2009 .
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## Introduction:-

The principle of surveying instrument depends on the rays of light, the light rays refracted when they pass from one medium to another with different refractive index.

In the atmosphere, the value of refractive index varies with time, temperature, atmospheric pressure, humidity and geographical position. The light propagation within the atmosphere is separated into two classes of standard and non-standard.

In low altitudes of the standard atmosphere the refractive index decreases nearly linearly with increasing height due to reducing the temperature and atmospheric pressure. This effect causes bending the light rays downward and producing an error in the range and elevation angle as measured by the electronic distance measurement instrument such as Total Station [1].

In these instruments the correction constant (ppm) might be calculated and inserted to the instrument by the keyboard using the atmospheric correction chart or graphs.

The non- standard atmosphere means any condition of atmosphere different from that assumed in a standard atmosphere because of the vagaries of weather. The abnormal refraction may lead to multipath light propagation, and the received light represents the sum of the multipath rays of different phase (due to path length difference) and different amplitude. The telescope reading may be oscillate when looking from the eyepiece of the surveying instruments (error).the abnormal refraction usually results from the passage of warm dry air over a cool surface of water, or from evaporation of water from the ground surface producing concentration of moisture and a decreasing in temperature near the surface (atmosphere inversion ). The temperature and moisture variation may extend from the ground surface to a height of a few hundred meters. When these condition exist, the rays curvature may be equal to, or even greater than, the earth curvature. Some of the rays may trap and tends to follow the ground surface.

The present work starts with modeling of abnormal atmospheric conditions using data meteorological sheets of Baghdad city for the year (2007). And a computer program was developed to model with help of program named (mat lab 6.5) to calculate the light ray tracing for each condition. The maximum launching angle for ducting and the maximum trapped wavelength was calculated as the general duct characteristics from the abnormal model. This method was previously employed in the field of tracking corrections [2] & [3]. We hope through the present work to use the atmosphere conditions in the field of surveying as not previously studied in the best of our knowledge. Under the duct condition, the effects of the height of instrument position and the telescope inclination angle were investigated in order to reducing of the ray trapping. The result obtained on abnormal condition indicated that the best measuring result can be obtain when increase the instrument height, introducing the inclination angle, or both. The error effect also can be reducing with the suitable chose of the instrument position.

For the practical work epitomized by selecting control station on the top of technical college/ Baghdad and measuring some distances as pointed on the study area map.

## Theory & analysis:-

### 1- Atmospheric refractive index:-

The refractive index of the air (n) varies with change in temperature, pressure, humidity. For more numerical convenience, the refractive (N) is defined as [4]:

$$N = (n-1)*10 \qquad \text{N units……..... (1)}$$

$$N(h) = 77.6\left(\frac{p(h)}{T(h)}\right) + 3.75*10^{5}\left(\frac{e(h)}{T(h)^{2}}\right) \qquad \text{M units……... (2)}$$

Where p is the barometric pressure (mbr)
h is the height (m)
T is absolute temperature (k)
e is the water vapor pressure (mbr)
Given by:

$$e = 0.161*10^{-2}*P*S \qquad \text{(mbar)………… (3)}$$

Where S is the mixing ratio (gram/k gram)

Using equations (2) and (3) one obtains:

$$N(h) = \left(\frac{77.6}{T(h)}\right) p(h) + \left(\frac{61.8\, p(h)*s(h)}{T(h)^{2}}\right) \qquad \text{…………(4)}$$

For the direct application the modified refractivity M be used instead of N, such that:-

$$M(h) = N(h) + 10\left(\frac{h}{r}\right) \qquad \text{M unit.................. (5)}$$

Where r is the earth's radius in meter (6367261m).

The radio sound data (P, T and S) were used for modeling

**2 -The standard and non-standard atmospheres.**

**2-a- <u>Standard atmosphere</u>:-**

In the first kilometer above the ground surface all types of standard atmosphere models (linear, modified effective earth radius and exponential) assumed that N decays linearly with height.

Figure (1) show the curve of (M) model for the standard atmosphere of Baghdad city as well as the best fitted lone. The following equation extracted from the curve fitting method.

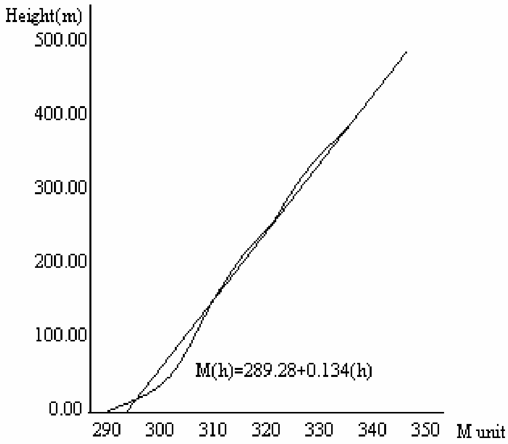
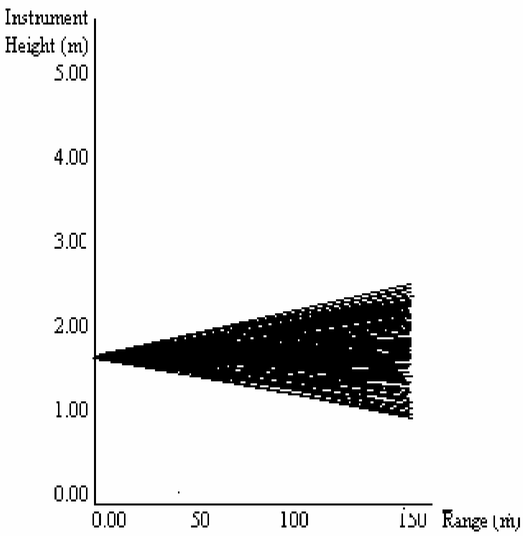


Fig.1 The model of the normal atmosphere of baghdad city (2007)

$$M(h) = 289.2823+0.13403(h) \qquad \text{M unit} \ldots\ldots\ldots\ldots (6)$$

Equation (6) was used in computer program to calculate the ray tracing as in figure (2).



(a) Short Range
Fig.2 The ray behavior under normal atmospher

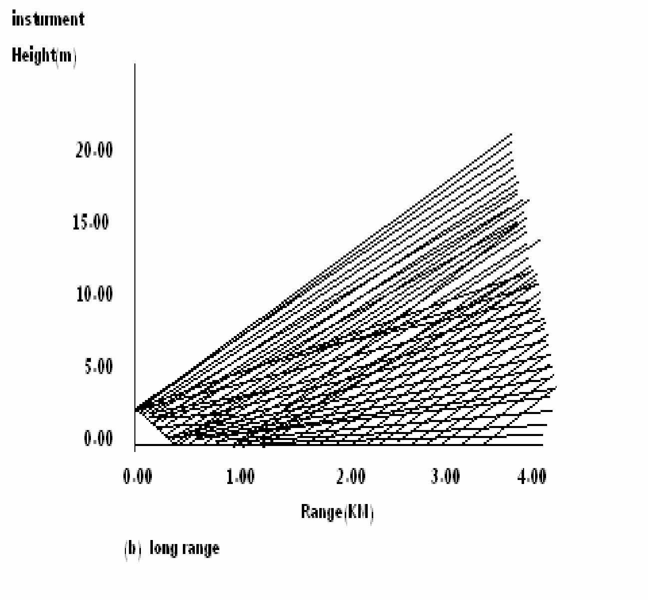



Figure (2) the ray's behavior under normal atmosphere

**2-b- <u>Non-standard atmosphere</u>:-**

In non-standard atmosphere, the (M) value is useful in identifying the trapping gradients, the trapping occurs for all negative (M) gradients.

**2-c- <u>Duct characteristic</u>:-**

Rays propagates within the duct are trapped when they are launched at angle less than critical value:

$$\acute{\alpha}c = (2\ M*10^{-6})^{-5} \quad \text{rad} \ldots\ldots\ldots\ldots\ldots\ldots\ (7)$$

Using the suitable parameters (h, n, Δ M and Δ h) to obtain the modified.
Refractive index profiles that met the data curve of the radiosonde table as shown in figure (3). The ray tracing program and the modified refractive index profile are used to describe the ray tracing as in figure (4).

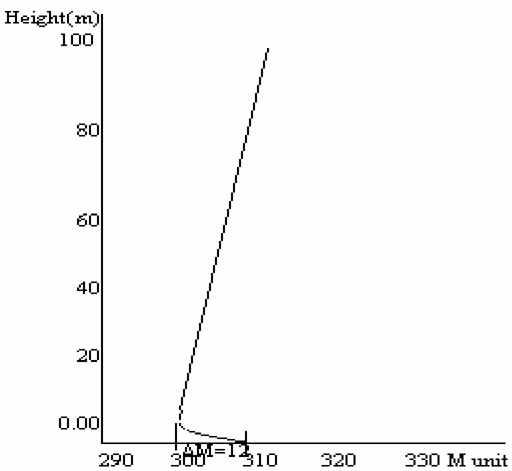



FIG.3 The M model of ground base duct

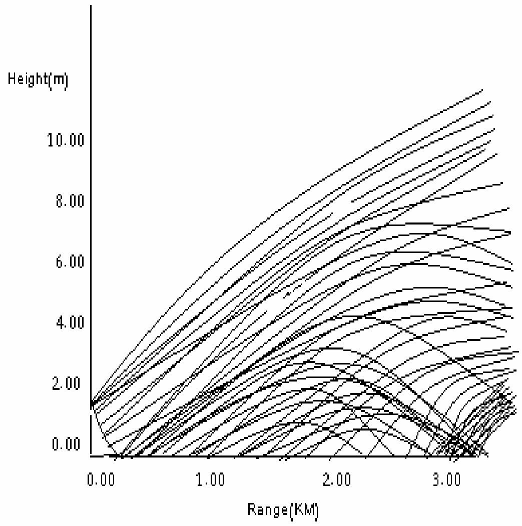



Figure 4 The rays behavior within the ground –base duct

**2-d-** **<u>Modeling of the duct</u>:-**

To model the abnormal modified refractivity M the following expressions will be used.

$$N(h) = N_o + kh + \left(\frac{\Delta N}{\pi}\right)\tan^{-1}\left(\frac{2.63(h - h_o)}{\Delta h}\right) \quad \text{N unit} \quad \text{----------(8)}$$

$$M(h) = N_o + kh + \left(\frac{\Delta N}{\pi}\right)\tan^{-1}\left(\frac{2.63(h - h_o)}{\Delta h}\right) + \left(\frac{h}{r}\right)*10^{6} \quad \text{----------(9)}$$

To avoid the ray trapping, the tilt angle must be greater than (άc= 0.28069 deg) for (ΔM=12) and the position of the instrument axis must be in the center of the duct [5].

To reduce the duct effect a tilt angle of (0.3 deg) was introduced as shown in figure (5, 6, and 7) in which the effect of trapping is reduced.

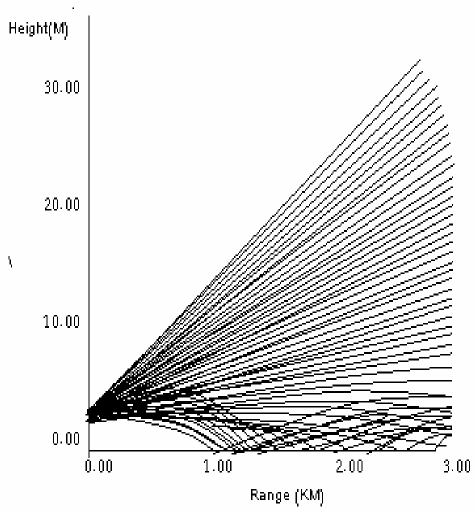


Figure (5) the rays behavior within the ground–base and insturment tilt 0.3 deg

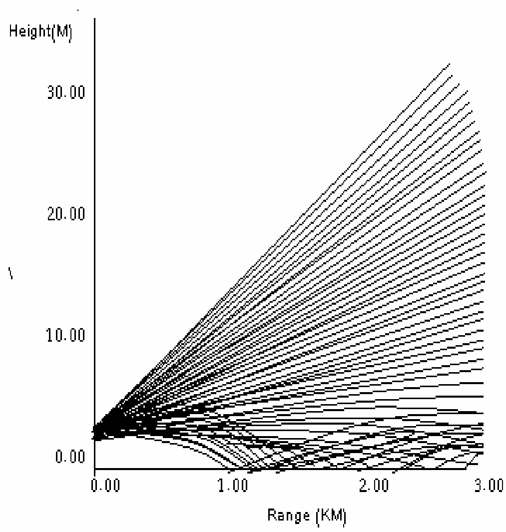
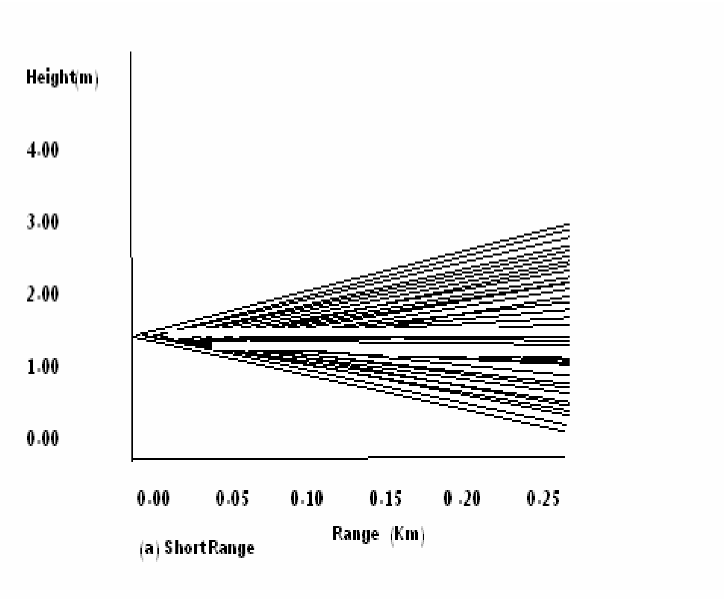


Figure 6 The rays behavior within the ground–base duct, insturment height 1.5m and tilt angle 0.3 deg.



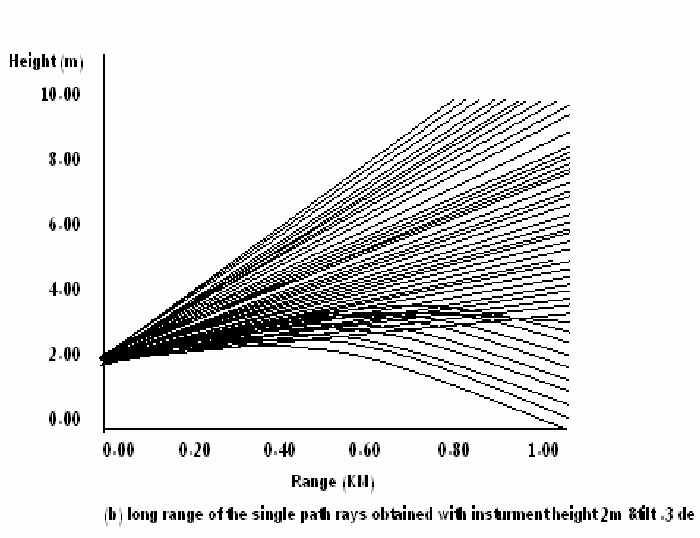




Figure (7).The range of single path rays.

## <u>Results and conclusion</u>:-

Figure (2a) represents the ray propagation as affected by standard atmosphere in which the surveying instrument receives only single path of ray (direct path) .with increasing range, the effect of the ground reflection is illustrated in figure (2b). The ray's behavior under the influence of the ground base duct is shown in figure (4).

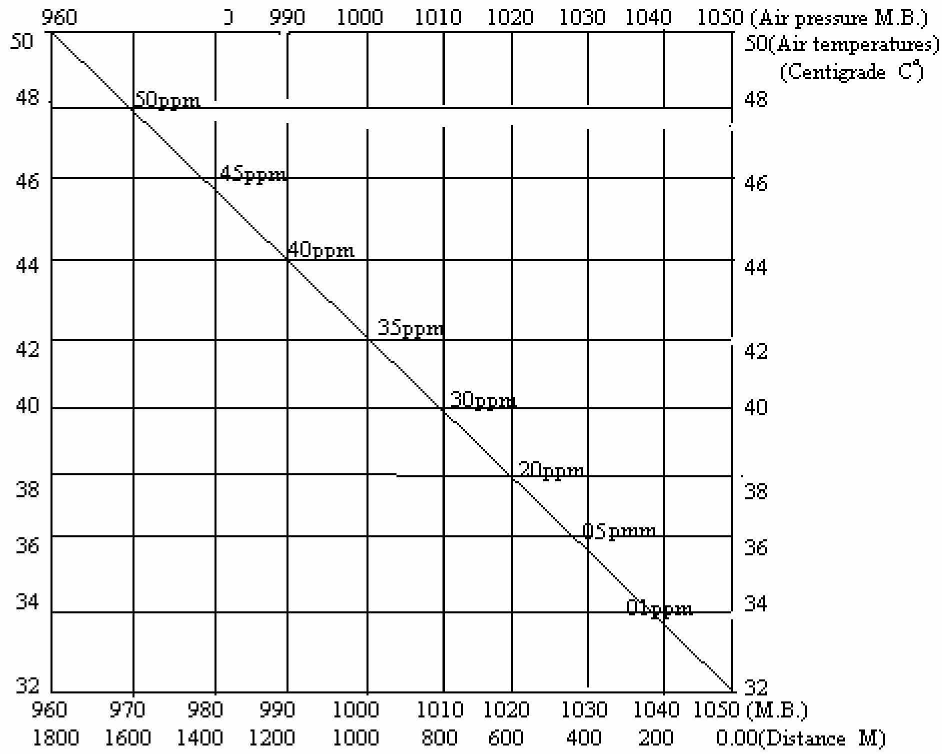
Above (0.3km) range the trapping effect is clear. In figure (5) the rays behavior is improved by a nearly (230%) such that the trapping effect is excluded up to 0.5km range. This was achieved using the tilt angle of (0.3 degree). The effect of the instrument height is shown in figures (5, 6). About 15% improvement in range is observed when the height is increased from (1.5m to 2m.) From the previous results, the following conclusions can be extracted:

1- Introducing the tilt angle( higher than a critical value ) in consideration causes significant increase in the range of the single path propagation
2- Increasing the height of the observations improves range of the single path ray.
3- The parallax effect can be reduced by the observation by choosing a suitable position of the instrument such that minimum number of rays is intercepted.

A precise correction can be inserted using a suitable computer program supplied to the instrument taking in consideration the temperature, pressure and humidity factors.

This is in progress as a future work. As shown in figure(8).which the data were used in the appendix (A).and figure (9) shows the study area.

FIG. 8-Atmospheric correction in ppm with C°, M.B. ,H(meters) at 65 relative humidity study aera, Alzafaranyas between 31m -32m above mean sea level.




note;- the insturment was set up on the top of technical college building as shown in the figure (9)

Appendix A

المعدلات الشهرية لدرجات الحرارة (بالمقياس المئوي) والرطوبة النسبية لمدينة بغداد 2007

## MONTHLY AVERAGE TEMPERATURES ( CENTIGRADE ) AND RELATIVE HUMIDITY FOR BAGHDAD CITY FOR THE YEAR 2007

Table (1/6) — جدول (1/6)

| Month | المعدل اليومي واعلى واوطأ رطوبة نسبية % / Monthly average , highest & lowest humidity ( % ) | | | | | | المعدل الشهري لدرجات الحرارة الاعتيادية والعظمى والصغرى / Monthly average normal , maximum & minimum temperatures (c) | | | | | | الشهر |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | التاريخ | اوطأ رطوبة | التاريخ | اعلى رطوبة | المعدل الشهري / Monthly average | | الصغرى / Minimum | | العظمى / Maximum | | المعدل الشهري / Monthly average | | |
| | Date | Lowest Humidity | Date | Highest Humidity | المعدل العام / general Ave. | 2007 | المعدل العام / General Ave. | 2007 | المعدل العام / General Ave. | 2007 | المعدل العام / General Ave. | 2007 | |
| January | 28 | 20 | 19-12 | 98 | 72 | 67 | 3.7 | 3.0 | 15.5 | 14.0 | 9.2 | 8.1 | كانون الثاني |
| February | 22 | 22 | 17 | 100 | 61 | 61 | 5.2 | 7.2 | 18.3 | 19.1 | 11.7 | 13.2 | شباط |
| March | 10 | 10 | 18 | 97 | 52 | 43 | 9.2 | 10.4 | 22.9 | 24.1 | 16.0 | 17.2 | اذار |
| April | 18,6 | 12 | 11 | 91 | 42 | 41 | 14.9 | 15.3 | 29.8 | 28.4 | 22.5 | 21.8 | نيسان |
| May | 23,24 | 7 | 16 | 88 | 31 | 31 | 19.7 | 23.7 | 36.3 | 39.1 | 28.4 | 31.5 | ايار |
| June | 30,5 | 6 | 11 | 61 | 24 | 23 | 22.8 | 25.6 | 41.2 | 42.8 | 32.3 | 34.5 | حزيران |
| July | 14 | 4 | 16 | 50 | 24 | 22 | 25.1 | 27.5 | 43.8 | 44.5 | 34.7 | 36.2 | تموز |
| August | 27,25 | 5 | 10 | 65 | 26 | 24 | 23.9 | 27.0 | 43.4 | 44.8 | 33.8 | 35.7 | اب |
| September | 22 | 4 | 13 | 59 | 30 | 26 | 20.1 | 23.0 | 40.1 | 42.0 | 30.2 | 32.1 | ايلول |
| October | 2 | 8 | 31 | 64 | 40 | 33 | 15.4 | 18.3 | 33.1 | 40.0 | 24.1 | 26.2 | تشرين الأول |
| November | 13 | 9 | 22 | 83 | 57 | 45 | 9.2 | 9.0 | 23.8 | 25.0 | 16.1 | 16.7 | تشرين الثاني |
| December | 27,5 | 18 | 11 | 93 | 72 | 52 | 5.2 | 4.5 | 17.0 | 18.5 | 10.8 | 10.6 | كانون الأول |

Note : The period of [illegible]

ملاحظات :عدد سنوات المعدل العام (30)سنة

Source : Funding seismographic & meteorological commission .

المصدر : الهيئة العامة للأنواء الجوية والرصد الزلزالي .

## الضغط الجوي على مستوى سطح البحر خلال سنة 2007 ( مليبار )

## MEAN SEA LEVEL PRESSURE IN 2007 (M.B.)

Table (1/12) — جدول (1/12)

| Month | Mosul الموصل | | Baghdad بغداد | | Rutba الرطبة | | Basrah البصرة | | الشهر |
|---|---|---|---|---|---|---|---|---|---|
| | 2007 | المعدل العام general | 2007 | المعدل العام general | 2007 | المعدل العام general | 2007 | المعدل العام general | |
| January | 123.6 | 1021.3 | 1023.6 | 1020.3 | - | - | - | 1019.7 | كانون الثاني |
| February | 1016.9 | 1019.0 | 1016.8 | 1018.2 | - | - | - | 1017.6 | شباط |
| March | 1014.4 | 1016.0 | 1014.4 | 1015.2 | - | - | - | 1014.4 | اذار |
| April | 1012.7 | 1012.9 | 1014.7 | 1012.0 | - | - | 1010.6 | 1011.0 | نيسان |
| May | 1008.7 | 1009.4 | 1007.7 | 1008.0 | - | - | 1006.2 | 1007.0 | أيار |
| June | 1000.5 | 1003.7 | 1006.2 | 1003.8 | - | - | 998.4 | 1001.1 | حزيران |
| July | 998.2 | 1000.0 | 999.4 | 999.9 | - | - | 997.4 | 997.3 | تموز |
| August | 1000.3 | 1001.7 | 997.8 | 1001.6 | - | - | 998.6 | 999.3 | آب |
| September | 1005.7 | 1008.5 | 1006.0 | 1007.6 | - | - | 1003.2 | 1005.4 | أيلول |
| October | 1014.4 | 1014.7 | 1014.4 | 1013.8 | - | - | 1012.5 | 1012.3 | تشرين الأول |
| November | 1018.2 | 1019.3 | 1018.2 | 1018.5 | - | - | 1016.7 | 1017.3 | تشرين الثاني |
| December | 1020.5 | 1021.1 | 1020.7 | 1020.7 | - | - | 1019.6 | 1019.7 | كانون الأول |

Note : The period of normal is ( 30 ) years

ملاحظات : عدد سنوات المعدل لعام ( 30 ) سنة

Source : Funding seismographic & meteorological commission .

المصدر : الهيئة العامة للأنواء الجوية والرصد الزلزالي .

## الظواهر الجوية لسنة 2007

## WEATHER PHENOMENA IN 2007

Table (1/13) جدول (1/13)

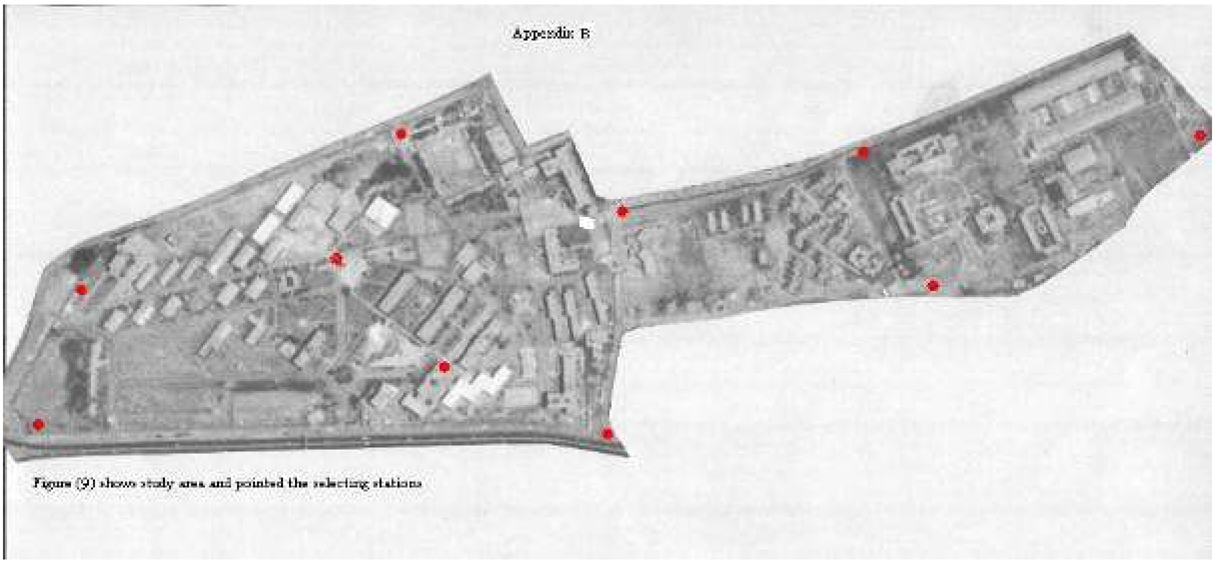
| Weather phenomena | Station المحطة | | | | الظواهر الجوية |
|---|---|---|---|---|---|
| | البصرة Basrah | الرطبة Rutba | بغداد Bagdad | الموصل Mosul | |
| Number of days* | | | | | عدد الايام * |
| Cloudy | - | - | 16 | 31 | غائم |
| Partlaly Clouded | - | - | 142 | 153 | غائم جزئي |
| Clear | - | - | 202 | 180 | صافي |
| Dust and Sandstorms | - | - | 4 | 3 | عواصف ترابية ورملية |
| Thunder Storms | - | - | 8 | 19 | عواصف رعدية |
| Hail | - | - | 0 | 0 | البرد |
| Snow | - | - | 0 | 0 | الثلج |
| Rain | 32 | - | 32 | 94 | المطر |

* Total number of days exeeeds the number of days in the year because more than one phenomena may occur in the same days .

مجموع عدد الأيام يزيد عن عدد ايام السنة بسبب وجود تداخل في الحالات المذكورة .

Source : Funding seismographic & meteorological commission

المصدر : الهيئة العامة للأنواء الجوية والرصد الزلزالي .

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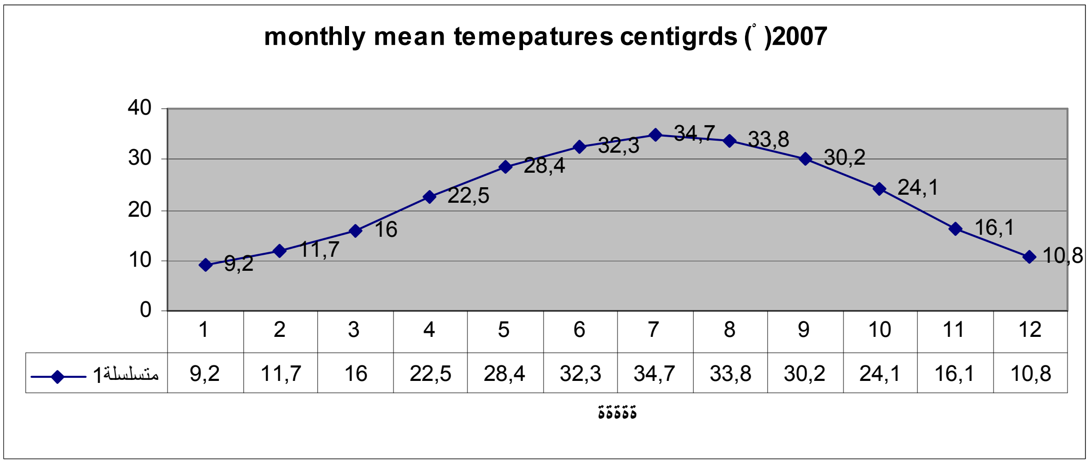
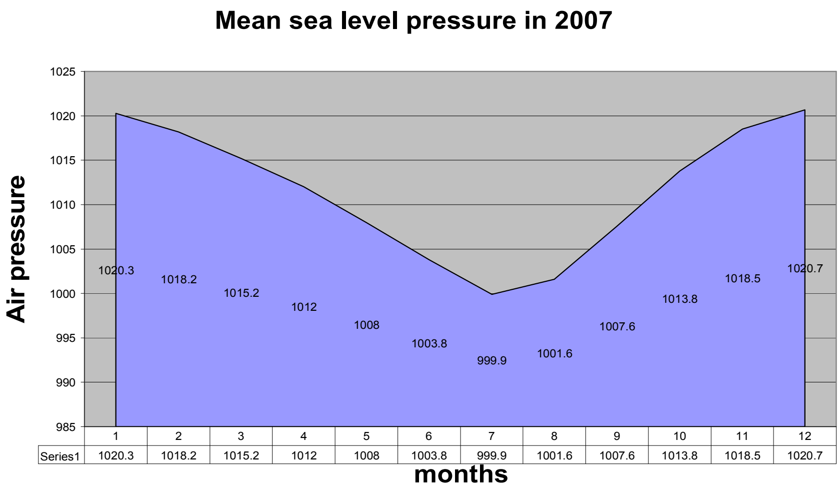
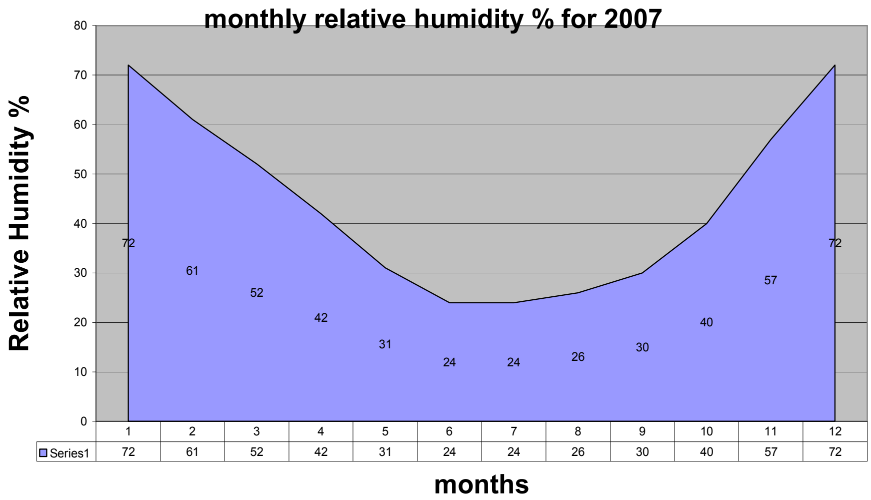
Appendix C





Mean sea level pressure in 2007
Air pressure
1025
1020
1015
1010
1005
1000
995
990
985
1020.3
1018.2
1015.2
1012
1008
1003.8
999.9
1001.6
1007.6
1013.8
1018.5
1020.7
1 2 3 4 5 6 7 8 9 10 11 12
Series1 1020.3 1018.2 1015.2 1012 1008 1003.8 999.9 1001.6 1007.6 1013.8 1018.5 1020.7
months

monthly relative humidity % for 2007
Relative Humidity %
80
70
60
50
40
30
20
10
0
72
61
52
42
31
24
24
26
30
40
57
72
1 2 3 4 5 6 7 8 9 10 11 12
Series1 72 61 52 42 31 24 24 26 30 40 57 72
months