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DETERMINED ABU-KHOV LENGTH OVER BAGHDAD CITY

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Abstract: atmospheric stability is very important parameter because is ruled the dissipation of air, in this study modern device depend on sound wave used to measure atmospheric stability by Monin-Abukhov length (L) and scaling parameter z/L over Baghdad city at summer season months. This parameter $z\text{-}z_d/L$ need to estimated topographic surface by morphometric analysis to obtain zero plane displacement (z_d=10.4m) and roughness length (zo=1.4m) from domain wind direction (from North to South at this study). At this study 2640 run done ,79% unstable , 12.6% neutral, and 8.3% stable, there is also subdivision for these results in cases unstable and stable condition to very and slightly . Classification is also done at daytime and nighttime, where the rates for unstable at daytime and nighttime is high and nearly have small difference, but in neutral and stable there is clear difference. Similarity function and scaling parameter from monin-Abu khov theory is calculated to test the turbulent and also can be comported with previous studies such as Businger and other.

Keywords: *Obu-khov similarity, scaling parameter z/L, stability, similarity function*

تحديد طول ابوكوف فوق مدينة بغداد

الخلاصة: الاستقرارية الجوية عامل مهم جدا لانها يسيطر على تبدد وانتشار الهواء .في هذه الدراسة تم استخدام جهاز حديث يعتمد في فوق مدينة بغداد (الجامعة z/L القياس لاستقرارية على الموجات الصوتية بواسطة طول مونين ابو كوف ومعامل الاستقرارية القياسي يحتاج الى تخمين طبوغرافية السطح من خلال التحليل الهندسي للحصول $Z\text{-}Z_d/L$ المستنصرية) عند اشهر الصيف .معامل الاستقرارية من الاتجاهات السائدة (من الشمال الى الجنوب خلال (Z_0=1.4m) وطول الخشونة السطح) (Z_d=10.4m على ارتفاع الازاحة الصفرية هذه الدراسة) . خلال الدراسة التي استمرت 3 اشهر تم عمل 2640 رصدة حيث كانت النتائج هي 79% ظروف غير مستقرة و 12.6% ظروف متعادلة و 8.3% ظروف مستقرة، وهذه الحالات لها تقسمات ثانوية حسب الدراسة وخاصة للحالات الغير مستقرة و المستقرة وهي التصنيف للنتائج كان ايضا خلال الليل والنهار ، ففي الحالة الغير مستقرة كانت نسب عالية ومتقاربة خلال الليل (قليل) و(بشكل كبير). والنهار ، وهذه غير موجودة بالظروف المستقرة و المتعادلة حيث يوجد اختلاف . الدوال التشابهية ومعاملات القياسية ايضا تم حسابها لاختبار الاضطراب ومقارنة النتائج مع الدراسات السابقة التي اجراها بوسنكر واخرون

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1. Introduction

Monin and Obu-khov similarity (MOS) theory (Monin and Obu-khov 1954) is extensively used to estimate the stability scaling $\zeta = z/L$, where z is the height above the ground and L is the Obu-khov length, this parameter is used in weather forecasting in addition to for climate modelling and air quality [1].

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A similarity theory uses dimensional analysis as the basis for interactive relationships between different quantities in non-dimensional form, so as to interpretation underlying scaling laws. This method includes the choice of appropriate scaling variables and the assembly of these into non-dimensional sets. One of the major goals of any similarity theory applied to the atmosphere is the correct scaling of characteristic structures of the ABL (the wind profile, turbulence variances) through the optimal of appropriate length, velocity and temperature scales (called similarity scaling) [2].

This evidence can be useful in solving a variety of technological and geophysical problems, such as heat and moisture exchange, the dynamical interface of the underlying surface with the atmosphere, the resulting transformation of air masses, the microclimatology of agricultural crops, the propagation of mixing in the atmosphere, the scattering of sound and radio waves by atmospheric in homogeneities, the shining of stars, etc [3]. Several theories will be described such as Rossby-number similarity, mixed- layer similarity, Monin-Obukhov (surface-layer) similarity, to definite profile relations (in particular, the wind) and associated drag, heat and mass transfer relations Surface layer similarity theory need to applied thermally stratified surface layer, this method consider very useful to interpretation turbulence in bounded air layer specifically in the surface layer. Where it’s given many forms and equations to parameterized air mass heat and other parameters such as energy transported through air near surface [4].

2. Site

Baghdad is the largest and most heavily populated city in Iraq with an area of about 900 Km^2, whereas the total area of Baghdad Governorate reaches 5159 Km^2 [5]. The estimated population is in the order of 6 million [6]. Baghdad lies in the middle east of Iraq within the Mesopotamian Plain. The Tigris River passes through the city dividing it into two parts; Karkh and Rasafa.[7]. Baghdad maps, specifically those prepared by Baghdad Environment Directorate, According to these statistics the percentages of the urbanized, agricultural, and industrial areas from the total area are 72.69%, 25%, and 2.31% respectively [8]. In this study the location of AL-Mustansiriya University,(atmospheric sciences building) with 33.22’03.36’’N, 44.24’13.15’’E. and at an elevation of 31.7m above mean see level was chosen.

This location is sited on the east part of Baghdad to followed Al-Wazirya Municipality its consists mainly from various roughness elements, such as low houses with 3m height to tall buildings with 30m such as government offices. The site level around the experiment site tree cover is considered and approximately and 80% covered by buildings. We divided the studied area to eight direction sectors of 450 as stated in figure 1. This figure also show domain wind speed and direction, most this directions is limited from North to South.

3. Tools and Data

Ultrasonic type UMG61914-1189-PK-021 Gill Wind Master used in this study, it is a accuracy anemometer submission three-axis wind measurement data. This tool will display wind speeds in range 0-50m/s and provides sonic temperature, speed of sound and U, V & W path outputs at 1Hz (20Hz unrestricted if wished). This anemometer involve of Aluminum /carbon fiber and is perfect for appreciative turbulent flows, surface energy Balance and scalar fluxes figure 2a. This 3D sonic anemometer is perfectly suited to the quantity of air turbulence around bridges, buildings, wind turbine sites, building ventilation controller systems, meteorological and flux amount sites [9]. Ultrasonic anemometer measures the times taken for an ultrasonic pulse of sound to transportable from an upper transducer to the reverse lower transducer, and matches it with period for a pulse to travel from lower to upper transducer. Figure 2 shows, the air velocity lengthways the Axis between each couples of transducers can then be considered from the times of flight on each axis.

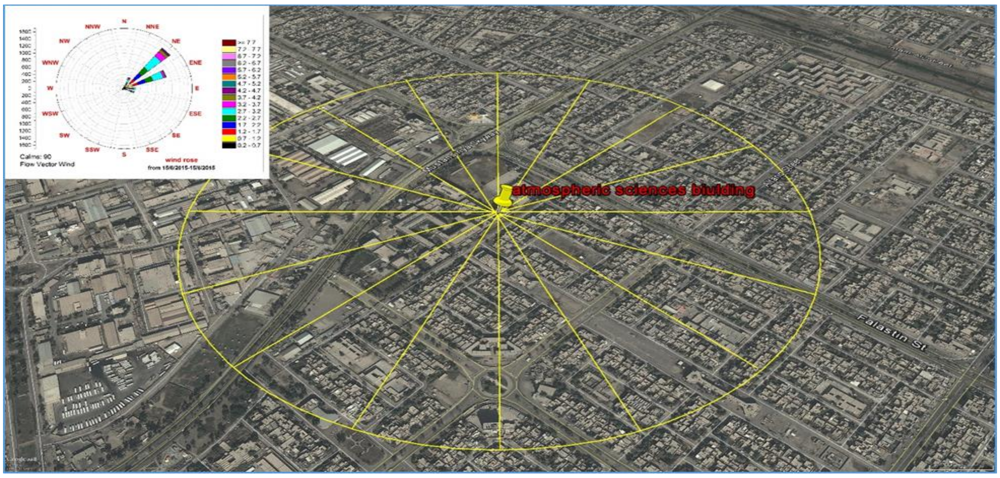

Figure (1): location study in Baghdad city divided to 16 direction sectors of 22.5^0

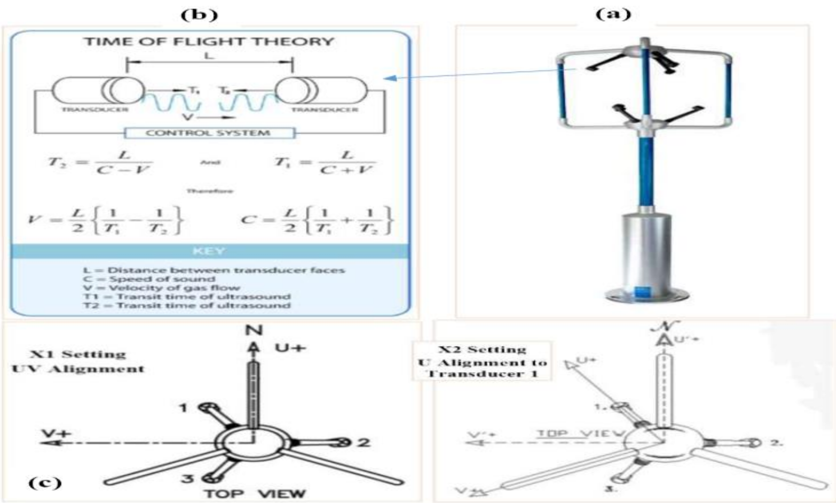

Figure (2): Time of Flight details, U, V and W Axis Definition for ultrasonic anemometer

It can be seen from Figure 2 that the speed of sound in air can be calculated from the times of flight. Thus the sonic Temperature can be derived from the principle $\mathbf{T_{S1} = C_1 / 403}$.

Where:

T_{S1} = Sonic temperature

C_1 = Speed of sound

The procedure does not description the effect of Humidity Crosswind, thus adjustment applied to results in some circumstances. +U axes is defined as concerning the path in line with the north spar as indicated in the figure 2. +V is well-defined as towards the direction of 90 anti-clockwise from N (Orientation spar which is normally aligned to North), +W is definite as vertically up the mounting shaft. Annotation, when the unit is organized for the X_2 location the UV definition rotates 30 degrees anti-clockwise such that U is now in line with transducer axis figure 3c[9] .

This device used in this research to calculate Abu-khov length it's installed at 2.5m height above roof surface building. The processes consider taken data of u,v,w component and sonic temperature (assumed equal to air temperature) each one second, that used to extracted covariance and turbulent values and also scaling parameter, these used to calculated directly flux and Abu-khov values, as shown in flow chart figure 3.

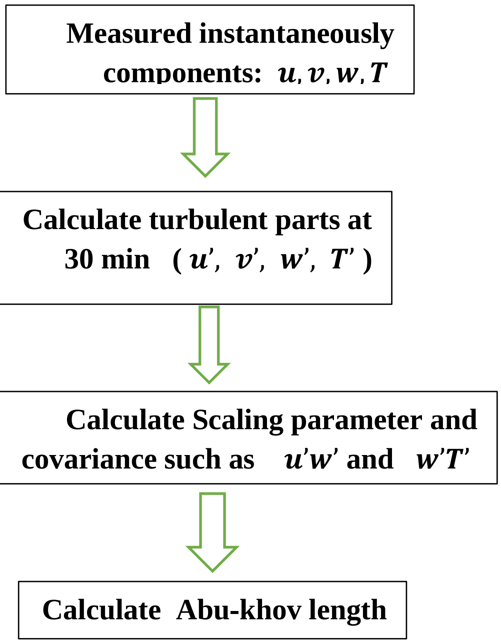

Figure (3): show flow chart for process calculated Abu-khov length

In figure 3 u', v', w' is turbulent parts for wind speed obtain from equations [10]:

$$U' = u - u$$
$$v' = v - v$$
$$w' = w - w$$

u, v, w Instantaneous value, and $\bar{u}, \bar{v}, \bar{w}$ average mean

In other hand $u'w', w'T'$… etc. covariance values, represent flux

4. Roughness in Urban Area

Approaches to regulate roughness parameters can be separated into those that need observations of wind (anemometric or micrometeorological), and those that are established on the morphology and spatial organization of surface roughness components (referred to as morphometric investigation). All these require a value of z_d which can be gotten by morphometric method as: [11].

$$z_d = z_H \left(\frac{\sum A_{rb} + \sum(1-p)A_{rt}}{A_T}\right)^{0.6} \quad (1)$$

Where A_{rb} the area of buildings is, A_{rt} is the area of trees, A_T is the total area, and p is the porosity of trees. This way takes into description both the height and area of the roughness elements, this balance is used to regulate a value of z_d by wind direction, for each season, for each site. The porosity coefficient is set to 0.6 in winter, 0.4 in the fall and spring, and 0.2 in summer. Morphometric analysis to assessing z_0 used by Bottema (1995) that presented a method adopted in urban areas, which was also engaged by Grimmond et al. (1998) [12]. This technique is used to associate z_0 values to those that will be obtained from comments (i.e., the two previous methods) for all wind directions. This formula can obtain as [13]:

$$z_0 = (\overline{z_H} - z_d)\left(\frac{-0.4}{0.5\left(\frac{\sum C_{Db} L_b z_{Hb} + \sum C_{Dt} L_t z_{Ht}}{A_T}\right)}\right) \quad (2)$$

Where z_{Hb} and z_{Ht} are the heights of buildings and trees, $\overline{z_H}$ is the average height for A_T and the total area. L_b and L_t are the range of buildings and trees perpendicular to the wind direction and C_{Db} and C_{Dt} are the drag coefficients for buildings and trees, and these are allocated a value of 0.8 for C_{Db} and 0.48 for $C_{Dt} = (C_{Db} - p)$ where p is a coefficient to allow for the porosity of trees. Subsequently the observational data analyzed in this study was collected during the spring season, the porosity coefficient is set to 0.4.

5. Similarity Theory in Surface Layer

The surface layer similarity theory can be characterized by Turbulence in the thermally stratified surface layer. The scheme was conveyed last decades by researchers Monin and Obukhov in fifteen decay from eighteenth century [14]. They used this theory in parametrized energy and mass transported near earth surface, this done from many applications and experimental examination to configure this active structure of this methodology, direct and clear to estimated turbulence surface layer [4]. Monin and Obukhov theory say, there is similar in behavior of some parameter scales than processed in surface layer, where its consider constant specifically kinematic values of turbulent fluxes with height, that given as:

$$H = \overline{w'\theta'}\,, \frac{\tau_0}{\rho} = \overline{w'u'}\;\; u_*^2 = \frac{\tau_0}{\rho}\;\;, T_* = -\frac{H_0}{u_*}\;\;,\;\; L = \frac{u_*^2}{\beta k\, T_*} \qquad (3)$$

Where

$u_*,\ T_*,\ L$ Velocity, temperature, height scales

$\beta = g/T_o$ Buoyancy parameter

L is called the Monin-Obukhov length, it's take the sign negative in unstable and convection condition and positive in stable stratification condition. Annotation, Hov (effective potential temperature flux) will substituted by Ho (potential temperature flux) if the environment is moist, where the values of T_* and L will change if moisture included in definition of these scaling parameter [15].

The height of Monin-Obukhov can be configure from the equality of shear construction term in turbulent kinetic energy and the buoyant production term. The parameter control stability, thus when boundary layer in stable condition, Monin-Obukhov length become L > 0 and Ho greater than 0, and T_* greater than 0. In the unstable boundary layer Ho greater than 0, T_* smaller than 0 and L less than 0. In stable condition the turbulent energy creating from mechanical turbulent where it's produced by shear for z < -L closer to the surface, while in unstable condition buoyant produced by the heat flux when z > -L. The similarity theory forecasts that any turbulent features of the flow, non-dimensionalized with surface layer scales, will be a general function of the stability, stability parameter will be as ζ = z/L, thus: [16]

$$\frac{\overline{w'^2}}{u_*^2} = \Psi_w\left(\frac{z}{L}\right), \frac{\overline{\Theta'^2}}{T_*^2} = \Psi_\Theta\left(\frac{z}{L}\right), \frac{L}{u_*}\frac{dU}{dz} = \Psi_m\left(\frac{z}{L}\right), \frac{L}{T_*}\frac{d\Theta}{dz} = \Psi_h\left(\frac{z}{L}\right) \qquad (4)$$

Where U, and Θ, are the average wind velocity, potential temperature respectively. Frequently, the non-dimensional gradients Φ are taken as function of ζ = z/L and exchanged by new similarity tasks, well-defined experimentally as: $\Phi_m = \zeta\,\Psi_m$, $\Phi_h = \zeta\,\Psi_h$. may be real some time Accordingly:

$$\frac{z}{u_*}\frac{dU}{dz} = \Phi_\mathrm{m}\left(\frac{z}{L}\right) \quad , \quad \frac{z}{T_*}\frac{dU}{dz} = \Phi_\mathrm{h}\left(\frac{z}{L}\right) \qquad (5)$$

Φ_m , Φ_h Consider as non-dimensional similarity functions for wind and heat respectively. Monin and Obukhov pointed out to these obstructive forms of the similarity functions, it may take different values according to stability stratification systems that is may be neutral, very stable, and very unstable conditions [17-18-19] .

6. Derivation Monin-Obukhov Length

Similarity theory describing the mean wind profile in the atmospheric surface layer as a function of dimensionless numbers. It is derived from the Turbulent Kinetic Energy (TKE) equation as:

$$\frac{\partial \bar{\mathrm{e}}}{\partial \mathrm{t}} = \frac{\mathrm{g}}{\theta}\,\overline{(\mathrm{w'\theta'})} - \overline{\mathrm{u'w'}}\frac{\partial \bar{\mathrm{u}}}{\partial \mathrm{z}} - \frac{\partial\left(\overline{\overline{\mathrm{w'e}}}\right)}{\partial \mathrm{z}} - \frac{1}{\rho}\frac{\partial(\overline{\mathrm{w'p'}})}{\partial \mathrm{z}} - \varepsilon \qquad (6)$$

$(\frac{\partial \bar{e}}{\partial t})$ Represent local storage of TKE,($\frac{g}{\theta}\,\overline{(w'\theta')}$) is the buoyant production or consumption term, $(-\,\overline{u'w'}\,\frac{\partial \bar{u}}{\partial z})$ is a Mechanical or shear production term, $(-\,\frac{\partial(\overline{w'e})}{\partial z})$ Represents the turbulent transport of TKE, $(-\,\frac{1}{\rho}\,\frac{\partial(\overline{w'p'})}{\partial z})$ is a pressure correlation term, (ε) represents the viscous dissipation of TKE. This form of equation consider as a special from of the TKE budget equation because it choose a coordinate system aligned with the mean wind , assume horizontal homogeneity , and neglect subsidence [20]. Multiply the whole equation by $(\frac{-k\,z}{u_*^2})$, assume all turbulent fluxes equal their respective surface values: and focus only on just terms buoyancy, shear stress, and dissipation term, equation 6 become as :

$$= \frac{k\,z\,g}{\theta\,u_*^3}\,\overline{(w'\theta')} - \frac{\overline{(u'w')}\,kz}{u_*^3}\frac{\partial \bar{u}}{\partial z} - \frac{\varepsilon\,k\,z}{u_*^3} \qquad (7)$$

Each of these terms is now dimensionless. The last term, a dimensionless dissipation Rate, will not be pursued further here. Team buoyant production is usually assigned the symbol, and is further defined as; z/L, where L is the *Obukhov length.* Thus:

$$\zeta = \frac{z}{L} = \frac{-k\,z\,g}{\bar{\theta}_v\,u_*^3}\,\overline{(w'\theta_v{}')} \qquad (8)$$

$$L = \frac{-\bar{\theta}_v\,u_*^3}{k\,g\,\overline{(w'\theta_v{}')}} \qquad (9)$$

One physical interpretation of the Obukhov length is that it is proportional to the height above the surface at which buoyant factors first dominate over mechanical (shear) production of turbulence. For convective situations, buoyant and shear production terms are approximately equal at z = -0.5 L. It is sometimes ζ called a stability parameter, although its magnitude is not directly related to static nor dynamic stability. Only its sign relates to static stability: negative implies unstable, positive implies statically stable. A better description of ζ is "a surface-layer scaling parameter"[21]. This scaling parameter classified according to stability to five classes, see table 1 [22].

Table 1: classified of scaling parameter to five classes according to z-zd/L values.

Stability class	$\frac{z}{L}$
Very stable (VS)	$\frac{z}{L} > 0.2$
Stable (S)	$0.04 < \frac{z}{L} < 0.2$
Near neutral (NN)	$-0.04 < \frac{z}{L} < 0.04$
Unstable (U)	$-0.2 > \frac{z}{L} > -0.04$
Very unstable (VU)	$\frac{z}{L} < -0.2$

7. Results and Discussion

7.1 morphometric Analysis for Location Study

To test turbulent in location study (urban area), needed to know the height where wind speed profile begin to increases, thus can done from study displacement distance z_d by equation 1, this equation depend on the morphometric analysis for topographic area. Because most of the domain wind is concentrated in the directions from north to south through the period of study see figure 4 (included wind rose), thus equation 1 and also equation 2 (used to calculate roughness length z_0 morphometrically) is applied on area from north to south around area of study; it's divided to eight sectors. Every sector have 22.5 degree, See figure 4 that state the calculated displacement distance for every sector. Figure 4, also show roughness length that calculated by the equation 2. Satellite images were taken from the study site using Google Earth, a circle area with a radius of 800 m, from center area that represent study site is taken. Total area and circumference of this circle is (1,138,108) m^2 and (3,782) m, respectively, this circle area is divided into 8 sections, see figure1, (which also show the prevailing winds during the period of Study) the area of each section 142263 m^2. After that land cover buildings and trees were estimated as percent numbers to put in equations 1 and 2, and given estimated value of roughness length. The largest values for roughness and displacement length is concentrated in direction sector ESE and S ,see figure 4,that state also photos for each sector, where largest high building is found. This method consider, one of the very accurate method because it's depend on the geometrical and plans for the building in place.

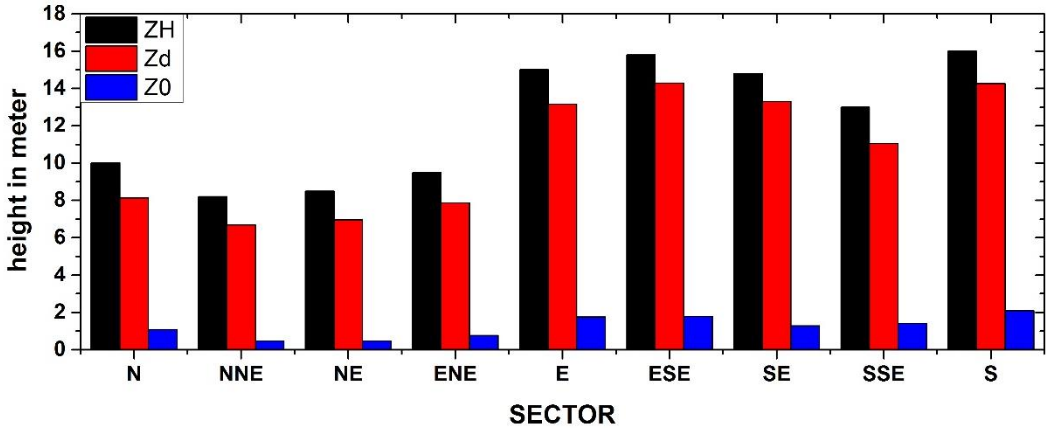

Figure 4: morphometrically analysis values for Z_h, Z_d, Z_0 for area study from North to South

7.2 Diurnal variation for Monin-Abukhov length

Monin Abu khov length calculated by equation 9, this need to calculate friction velocity u_* and average kinematics heat flux $\overline{w'T'}$, these parameter can be estimated by ultrasonic anemometer, this devices recorded these parameter every one second, each observed consist of 30min time. In this study The period of observation continuous to about 55 day, through months June, July, August, the a summed observation is 2640 run. Figure 5 show time series at month's study, most $z\text{-}z_d/L$ values concentrated on the positive and negative near zero values. But there is abnormal values result from free convection in the negative part mostly at daytime, and forced convection at high wind speed and at nighttime. From classified Scaling parameter z-z_d/L value according to table 1, most of frequency of stable stability is concentrated at nighttime, see figure 6.

Rate of Stability condition by high response is classified according general overview for scaling parameter z/L= ζ, that depend on similarity theory and Monin-Obukhov in derivation of ζ and according to conditions of stability, where number of observed is (1996, 317, 209) for unstable, neutral and stable respectively.

It has (79.1%, 12.6% and8.3%) respectively for unstable, neutral and stable conditions, and this consider general classified. Stability also classified according to table 1, that contain sub classified for parameter (z-$z_{\mathbf{d}}$)/L) , See figure 6, this figure classified all data used its contain, very high values for stability have range from very unstable and extremely stable range, this consider abnormal observed data, and have Very small frequency.

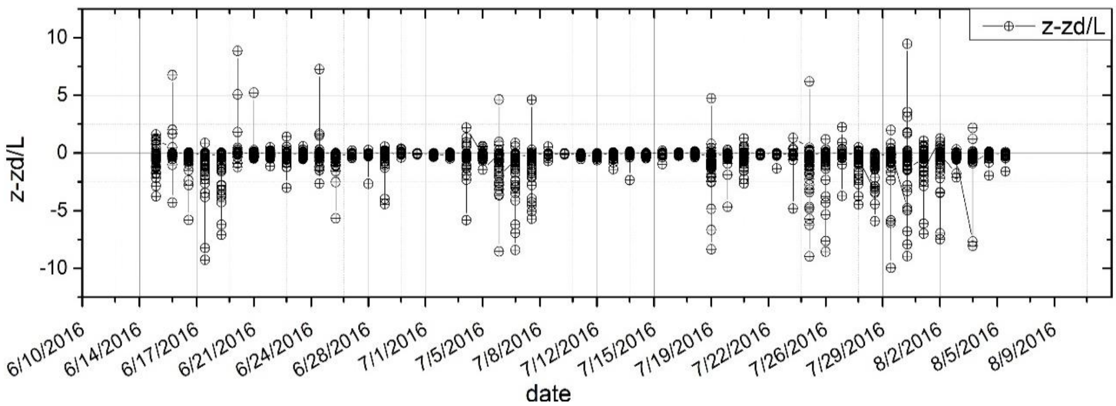

Figure 5: time series for stability parameter z-z_d/L at area study from North to South

Thus data used for ((z-z_d)/L) concentrated in values from -10 (unstable condition) to 10 (stable condition), this configure about 97.5% (2460 observed) about from total data (2523 Observed). Figure 6 shows the frequency percent for stability ranges calculated during the study using the ultrasound device.

In this figure there are two stable conditions, a slightly stable condition of 3.7% and a very stable condition of 4.1% depend on classified Table 1, the unstable condition is also divided into two cases, a slightly unstable condition with a 42.8% percentage and a very unstable condition with a percentage of 34.3%. In the neutral case, there are no subdivisions and the number of observations has 370 with a range of values of stability ((-0.036) -0.036) see table 1.

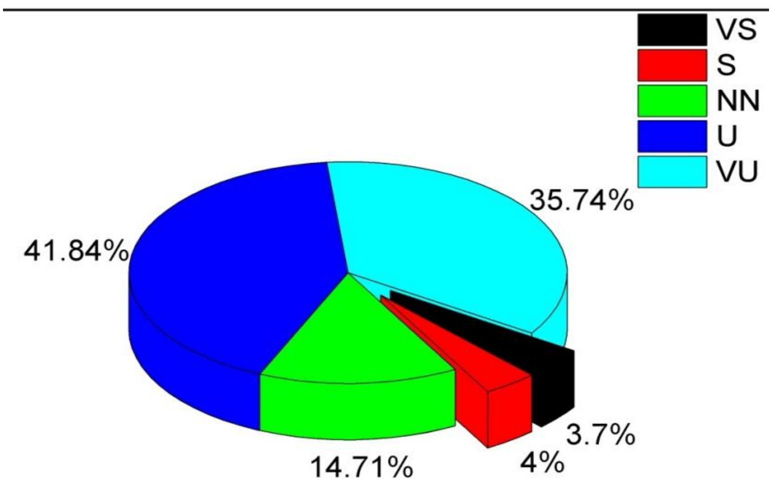

Figure 6: sub classified of atmospheric condition according to scaling parameter $z\text{-}z_d/L$

Stability parameter also classified at daytime and nighttime period hour because period study is at summer season thus daytime period hours started from 5:30AM to 19:30PM, while nighttime period hours started from 19:30PM to 5:30AM. The effect of urban heat island on the stability over Baghdad city is clear through this study, where unstable conditions is founded over nighttime and at relatively high frequency, see figure 7.

For example unstable (U) and very unstable (VU) configure about 77% in nighttime this is return to large heat storage in urban area, and slow cooling surface at night, this rate increases to 90.5% at daytime period, where surface absorbed directly heat from sun. The rates of unstable condition in figure 7 refer to active turbulent from convection, this case extended to nighttime that may be in stable condition in normal case.

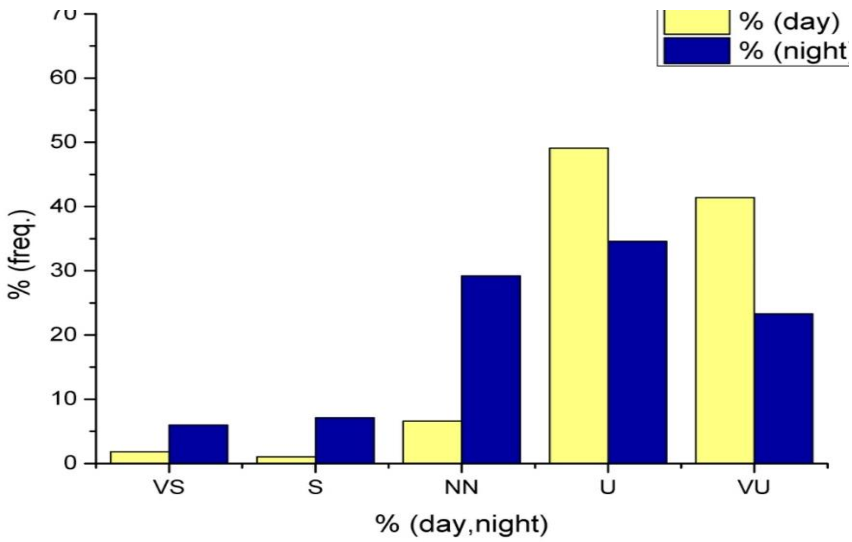

Figure 7: Stability Condition Classes According to $z\text{-}z_d/L$ in daytime and nighttime periods

7.3 Estimation of M-O Similarity Functions

Turbulent recored data by sonic device also tested by monin-abu khov similarty functions, where list of equations in text used, such as equations 3,4,5. For example scaling parameter such as u_* and T_* calculated by equation 3, ploted with scaling stability parameter (z-z_d/L), see figure 8, where 8(a) show behavour of T_* with z-z_d/L it clear there inverse relation of -(z-z_d/L) with negative values of T_* in unstable condition. In this case data scatter large in range about -0.6C°, this scatter is decreases in near zero for T_* and z-z_d/L, where stability is changed from unstable to neutral condition. After neutral condition towerds stable conditions scatter T_* values increases, overall postive T_* increases slight with z-z_d/L, but its limited to small range +0.1 C°, see figure 8a. The scalling positive values for T_* represent stable condition (turbulent weake and sprodic) and there is proportional relasionship between z-z_d/L and T_*. Figure 8(b) show the varation of the u_* scalling parameter with stability parameter z-z_d/L , notes that large values for u_* concentrated in near neutral case (accoreding to table 1, z/L in range grater than -0.04 and less than 0.04), this case consider taransient between unstable case (negative values for z-z_d/L) where convection and vertical movement is active and stable condition where turbulent from mechanical shear is active (positive values for z/L), overall in recent figure there is also activity in turbulent of u_* at large values of – (z-z_d/L) because local thermal convection. T_* and u_* also used to estimated the heat stability correction function Ψ_h that calculated from equation 4, intensity of turulence in vertical direction Ψ_w also calculated, see figure 9(b,c) nondirectional heat parameter Φ_h also Calculated and plotted with stability parameter z-z_d/L, see figure 9a. In this figure most Φ_h values constructed at unstable condition according to table 1 have range nearly limited from 150 to -150.

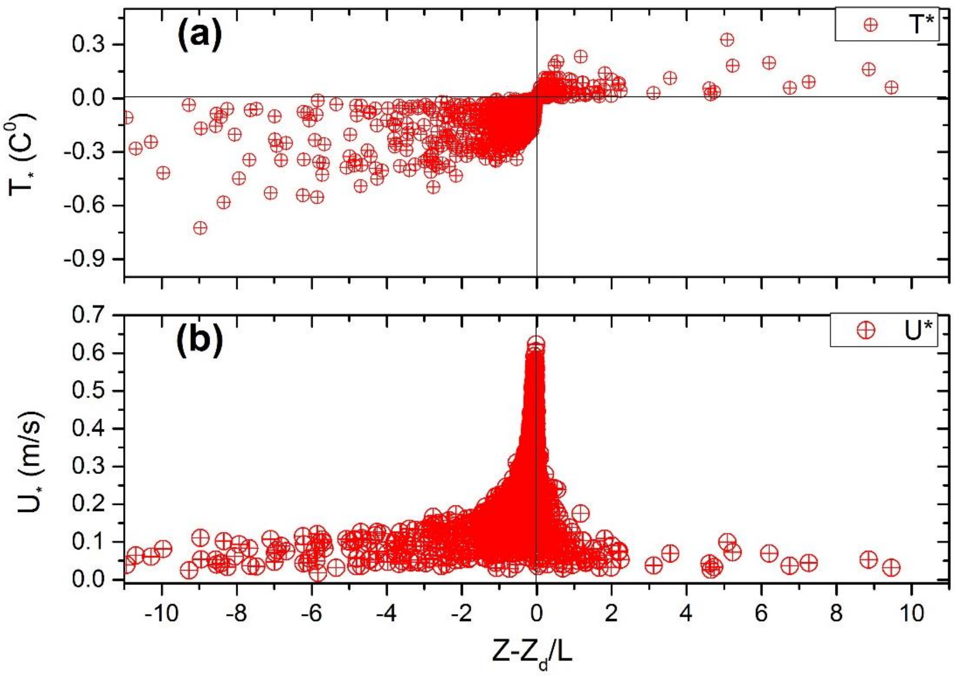

Figure 8: scaling parameter such as (a) T_* and (b) plotted with scaling parameter Z-Z_d/L

This case change in neutral case where it's extended to large values in positive and negative greater than 350. overall there is empirical equation between Φ_h and z/L, review references Businger 1970.The trends of Ψ_h and Φ_h is similar but Ψ_h is difference , where its values is small relative to Ψ_h and all values is nearly positive, where there is vertical movement specifically at nearly neutral and slightly unstable, see figure 9(c). The non-directional turbulent intensity by u_*/u and $\boldsymbol{\sigma_w/u_*}$ also calculated at this study to examine the turbulent in horizontal and vertical direction, where there is positively trends for the two parameter, in 10(a) there is increases in the u_*/u with near neutral and slightly unstable, but in the stable part u_*/u decrease to small values. In the figure 10(b) the σ_w/u_* is decreases towards the near neutral and slightly unstable and transported to increases in stable part, this refer to increases intensity at unstable and in small rate in stable condition, but in neutral case the horizontal turbulent velocity is active and domain.

8. Conclusions

In this research turbulent very important matter its ruled the diffusion of any atmospheric parameter, similarity theory can be consider to interoperated turbulent in surface layer and calculate turbulent parameter such as u', w', T' this done by the
ultrasonic anemometer, this devise installed at atmospheric building. Overall all active measured of turbulent quantity started after displacement level, thus displacement distance z_d is estimated for only 8 sector by morphometric analysis about (10.6m) because domain wind Direction. This height is subtracted from height of scaling stability parameter $z-z_d$ (z=23m choose in this study).

Important result from this research is turbulent by scaling Stability parameter is very large frequency by negative values of $z-z_d/L$. This refer to urban heat island and large heat storage at daytime where most the record of data is at summer season.

Similarity theory also tested by similarity functions, similarity function resulted From applied analysis dimensional and Buckingham theorem, all similarity function is function of Obu-khov length similarity function for momentum and heat and also correction function say there is strong relationship between this parameter and scaling stability parameter z-zd/L, in study is an attempt to test behavior of these function in urban city, for example in Ψ_h and Φ_h there is increases of these values from unstable ($z-z_d/L$ orefere to decrease with stability from unstable to stable by neutral condition.

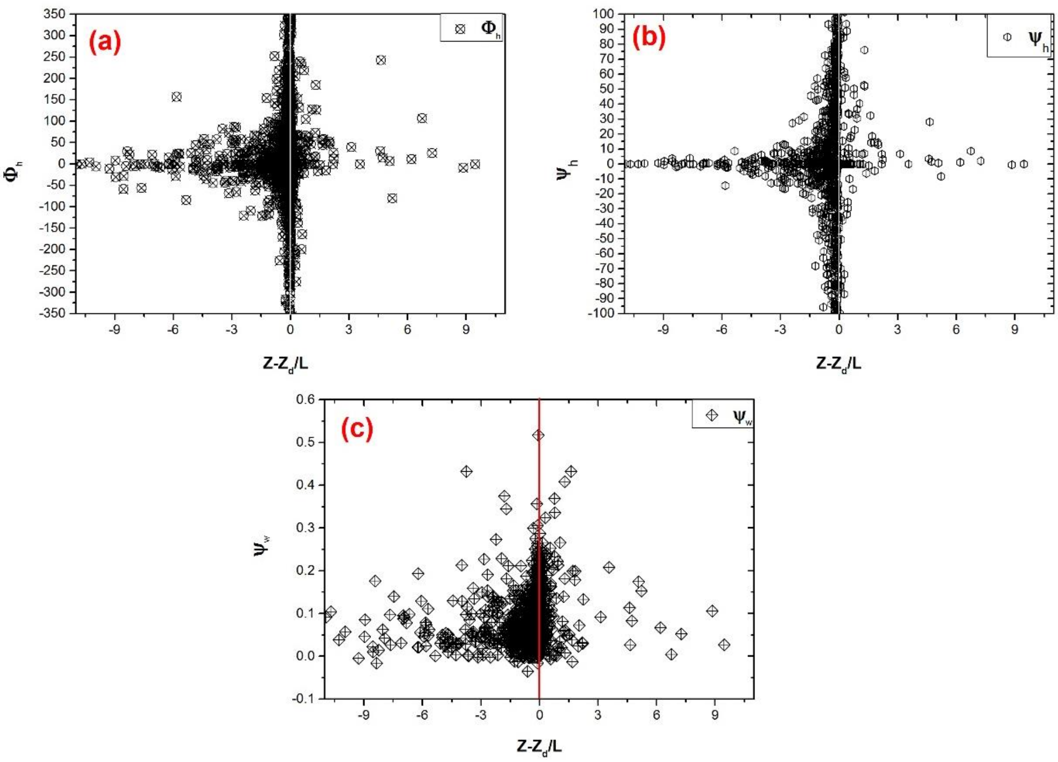

Figure 9: show (a) non-dimensional heat parameter, (b) similarity correction in heat (c) Intensity of turbulence in the vertical direction plotted with stability scaling parameter Z-Z_d/L

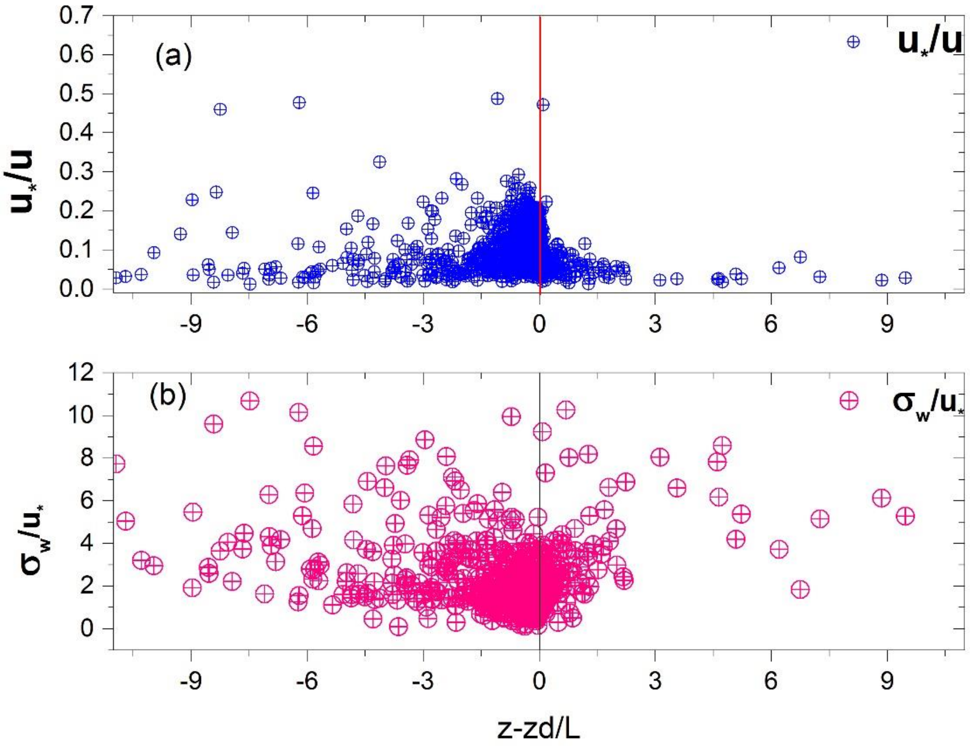

Figure 10: turbulent intensity parameter such as (a) U*/U, (b) σ_w/U_* with scaling stability parameter Z-Z_d/L

Where the values of u_*/u is constant at stable condition, this case concede with $\boldsymbol{\sigma_w/u_*}$**,** where intensity is decreases towards neutral condition, see figure 10. This real opposite with figure 8a where u_* is increases at the neutral condition and decreases at neutral for the scalar parameter T_*. Overall there is opposite relation between to forces for convection, forced convection resulted from mechanical forces horizontal transported: advection (wind field) from inhomogeneity's of ground surface most of T_* and u_* values concentrated in range +1 >z/ L > -1, in contrast free convection is caused by density difference and occurs for $\frac{z}{L} < -1$ in this case domain scaling parameter is w_* in free convection gradient is neglect.

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