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Study of Intensity and Thickness of Surface Heat Inversion for Baghdad

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Abstract. this work presents the intensity and thickness surface heat inversions for Baghdad city. This inversion plays an important role in the study of concentrations of pollutants as well as its effect on spraying insecticides, which starts from a height of 2 m using the daily radiosonde data (midnight) of the period from (2013-2014) obtained from the Iraq Meteorological Organization and Seismology (IMOS). The intensity of the heat inversion was studied on a seasonal basis. It was clear from the study that surface heat inversion shows the highest intensity in the summer and the lowest intensity in both winter, spring and autumn. It was through this research calculated the thickness of the surface heat inversion the results were the largest thickness in the summer months.

Keywords. Heat inversion; Intensity; Thickness; Baghdad

1. Introduction

Temperature inversion is the increase of air temperature with height in the troposphere. Perfectly cold air comes down while the warm air rises, lead to the air around us to move and mix. This method is called Convection, it decreases the temperature with elevation. Heat inversion is one of the most important meteorological phenomena, air temperature increases with elevation instead of decreasing, atmospheric lapse rate is reversed [1]. The ground missing heat at night and the low-level air cools this lead to air temperature increasing with elevation and the temperature profile is said to be inverted. When it comes to near to the ground it is cause surface heat inversion [2]. These thermal inversion can occur on the surface are associated with stable stratification conditions or "the most stable" [3].

Parameters like the strength and thickness (or depth) are physical characteristics of temperature inversion. Inversion intensity is well-defined as the temperature difference between the surface and the top of the inversion, and the thickness of inversion is defined as the height difference between the surface and the top of the heat inversion [4]. The known approach in definition of the inversion parameters is field measurements by radiosonde [5].

Intensity of surface thermal inversions will be affected in an unknown way. A variation in the intensity of these low-level inversions would likely have a big impact on air quality [6]. Several studies have been carried out that confirm the surface heat inversion for example H. Kachar, M. Mobasheri, A. Abkar, and M. R. Zadegan the use of Radiosonde data, Kermanshah weather station was selected as the study area. 90 inversion days was selected from 2007 to 2008 where the sky was clear and the Radiosonde data were available was calculated strength and depth of temperature inversion for these days [7].

The aim of study to determine the properties of surface heat inversion, intensity and thickness variation on a seasonally basis in Baghdad for the period (2013-2014).



2. Sit and data

Weather station is located at the International Baghdad Airport (ABI) with geographical coordinates (latitude 33.14° N and longitude 43.34° E) as shown Figure 2.2. The elevation of the station is at 33 m above mean sea level. The station is located in a area about 16 km west the Baghdad.

The purpose to execute this study, it obtained radiosonde data, included air temperature and elevation of the Baghdad station belonged to Iraqi Meteorological Organization and Seismology (IMOS) for a period of one year (2013-2014).

3. Methodology

To know the surface heat inversion thickness and intensity are among the characteristics of thermal inversion, there are several different stages to conduct this study as follows:

- Collecting radiosonde data for both height and temperature
- Schedule this data using Excel
- The air temperature profile was drawn using the MATLAB program, for the data identified for the purpose of this study
- Determine the days when the surface heat inversion occurs to the work required for the study
- Then, the intensity ΔT and thickness ΔZ of the surface thermal inversion were calculate chosen to do the study, one of the air temperature distribution profiles with the elevation during the days of a surface heat inversion in order to Understanding and elucidation what occur during the thermal inversion as in Figure 1 (A and B).

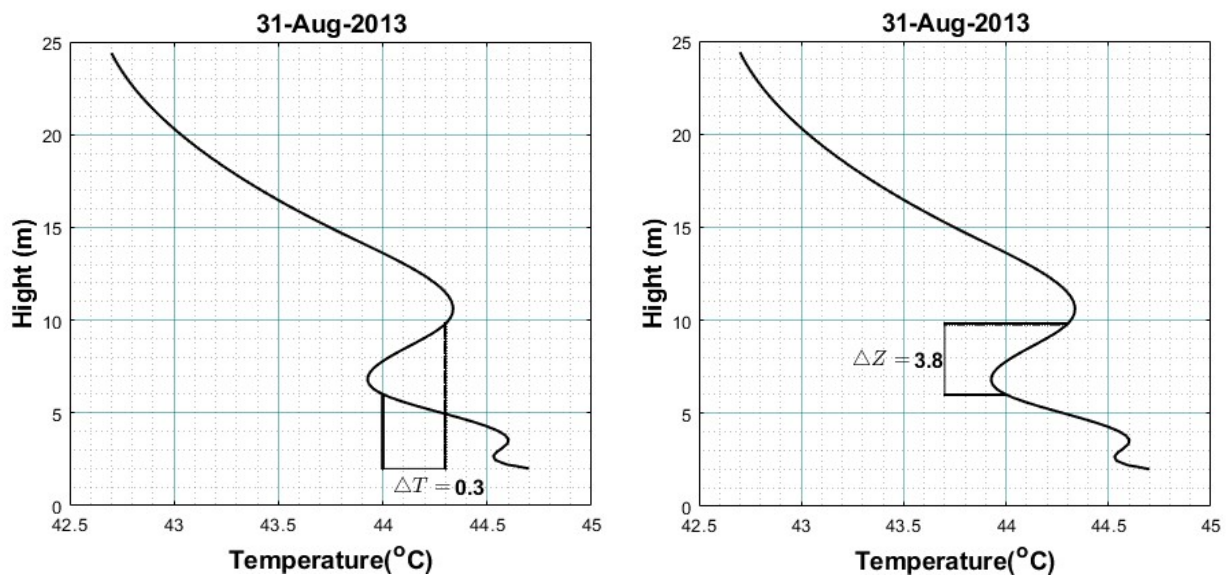


Figure 1. air temperature profile a, intensity of the heat inversion b, thickness of the heat inversion of Baghdad for 31 August 2013.

A schematic illustration of the typical intensity and thickness of the heat inversion is shown in figure 1 A. and B.

4. Results and Discussion

4.1. Inversion intensity (I_{in})

The (I_{in}) is one of the most important of surface thermal inversion characteristics, so the focus was on the inversion intensity which is calculated as the intensity of the air temperature within the inversion layer.

In general, result of I_{in} are displayed in Fig. 2-5 and which may follow the general expression give as:

$$(1) \quad I_{in} = a + b \cdot t + c \cdot t^2$$

If $c=0$, then liner equation, become: $I_{in} = a + b \cdot t$

Where I_{in} is intensity of the inversion, a, b, c are empirical constants derived from data of intensity and dates, t is the figure date. The values of them are derived for each season and reporter in from table 1.

Fig.2 represents the seasonal variation of the surface heat inversion intensity at winter. The result reveals highest I_{in} for winter was 0.7°C .

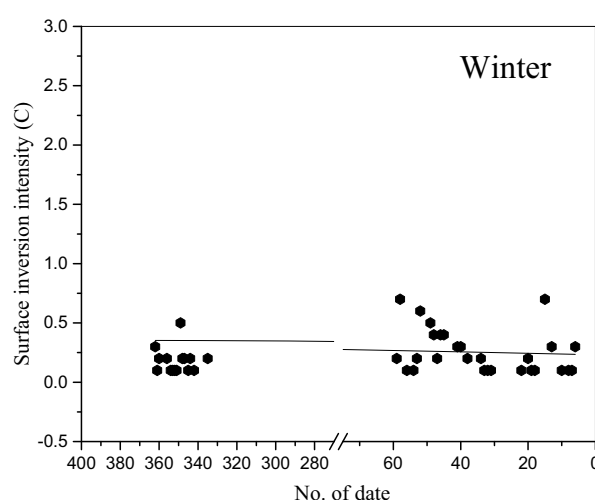


Figure 2. Seasonal variation of I_{in} during winter.

The results of inversion intensity in winter approximately appear a constant during this season.

Table 1. The values for the constants of Eq. (3)

Season	h	i	j
Winter	0.23	6.6	-9.1
Spring	-0.13	0.0	-2.3
Summer	5.20	-0.0	1.3
Autumn	0.87	-0.0	

Fig. 3 shows the non-linear of the surface heat inversion intensity in the spring which increases with days and the highest intensity of the inversion was 0.8°C .

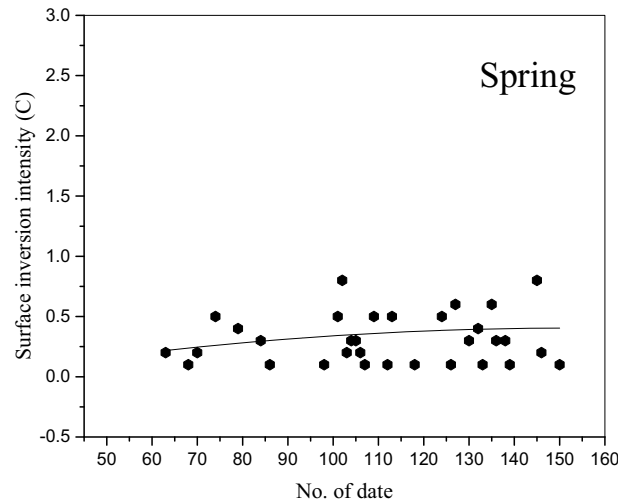


Figure 3. Seasonal variation of I_{in} during spring.

The trend of the intensity increases with the days at this season.

Fig.4 shows the variation in the surface heat I_{in} ($^{\circ}\text{C}$) during the summer, and the highest I_{in} was 2.6°C .

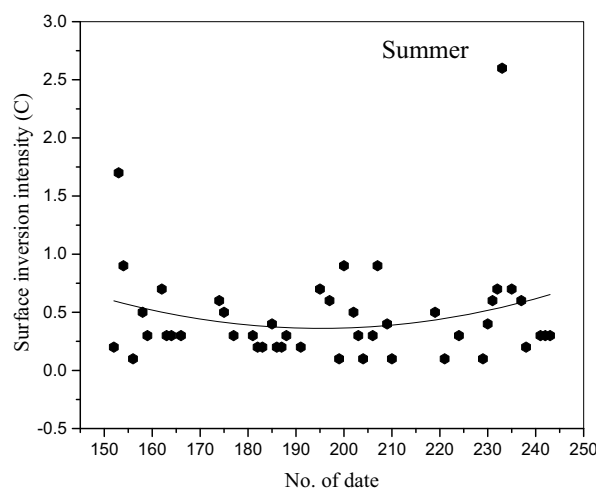


Figure 4. Seasonal variation of I_{in} during summer.

The results I_{in} in summer shows non-linear behavior.

Fig.5 represents variations of the surface heat I_{in} at the autumn. The results showed the highest of I_{in} was 0.9°C . The results of inversion intensity in autumn shows invers behavior during autumn.

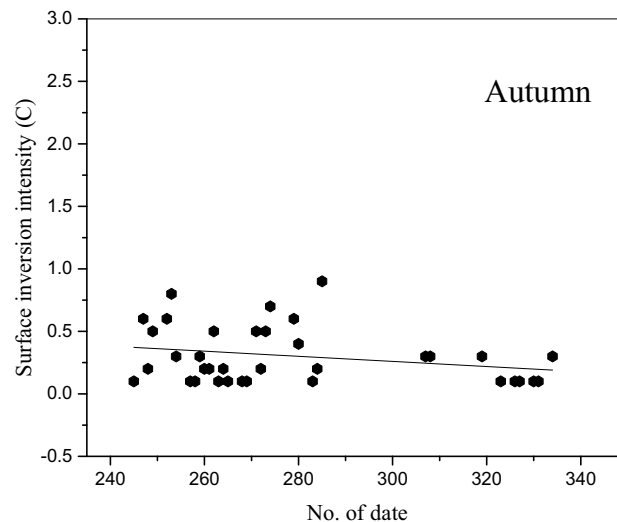


Figure 5. Seasonal Variation of I_{in} during autumn.

To discuss the seasonal variation of the heat inversion intensity we start with Figure 4, which represents of the surface heat I_{in} in summer. Highest of the inversion intensity during this season in the Baghdad station.

This is normal for high temperatures during this season in the whole country from south to north autumn shows values close to those of summer. While the values less of the intensity of the inversion during the winter and spring. This is due to lower temperatures in these two seasons compared to the summer [9].

4.2. Heat inversion thickness (TH_{in})

The seasonal variation of the surface inversion layer thickness is characterized by heterogeneity between seasons, therefore, the thickness of the inversion was studied to see which of the seasons were thicker.

Figures 6 to 9 represent the results of the thickness of the surface thermal inversion, which follows the mathematical expression as follows:

$$(2) \quad TH_{in} = a + b \cdot t + c \cdot t^2$$

The table 2 shows the values of constants these constants computed for each season.

Figure 6 shows the seasonal variation of the surface inversion layer thickness in winter has highest thickness value 34.2 m, and lowest value 3 m. The average value is 18 m during this season.

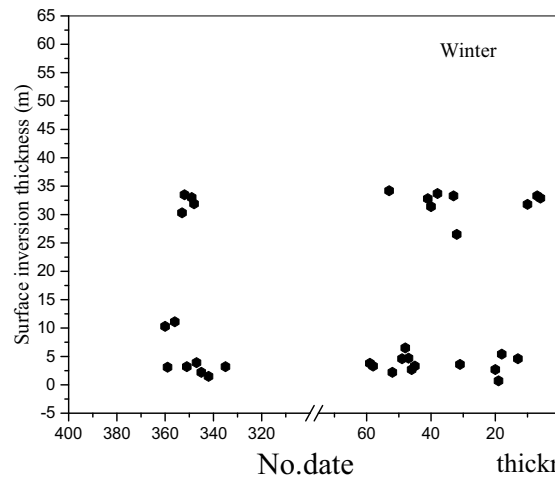


Figure 6. Seasonal variation of TH_{in} during winter.

The behavior results thickness of the inversion layer during the winter is scatter, the reason may be the impact of ground conditions on the air layer in contact with the surface of the earth, since the soil coefficients a little heat capacity that reflected on the loss of heat and heat gain quickly.

The meaning of the land is dry because of the lack of rain (drought) or the impact of the surface of the station locally.

Table 2. the values for the constants of Eq. (4)

Season	D	e
Winter	10	10
Spring	17.4	0.03
Summer	51.1	-0.17
Autumn	11.9	-0.01

Fig.7 represents the seasonal variation of the thickness during the spring. It was have highest value of the inversion thickness through spring is 34.2 m. Here the behavior results thickness of the heat inversion is linear.

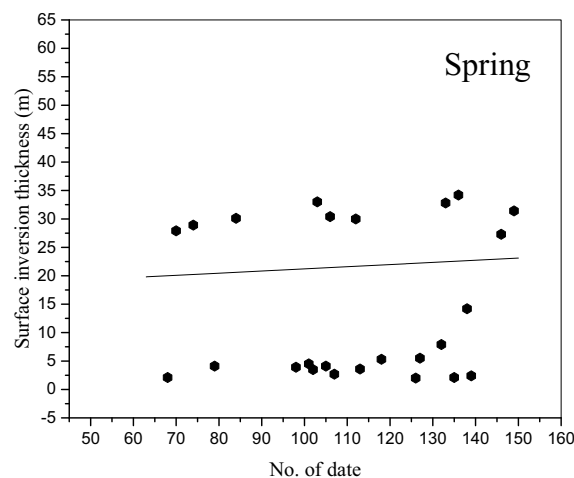


Figure 7. Seasonal variation of TH_{in} during spring.

As for the Figure 8 is the seasonal change in the inversion thickness during the summer. The results during this season are different because they recorded the highest thickness compared to other seasons, the highest thickness is 51.2 m.

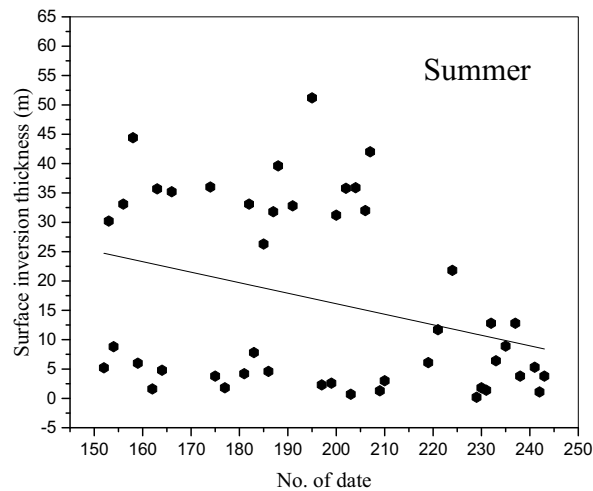


Figure 8. Seasonal variation of TH_{in} during summer.

The behavior of the values of the results during the summer is invers because there are negative values.

Fig.9 shows the seasonal changes of the surface thermal inversion thickness during autumn, it was found that the highest thickness of the inversion in autumn reaches 32 m. The behavior of the surface heat inversion thickness is invers (non-linear).

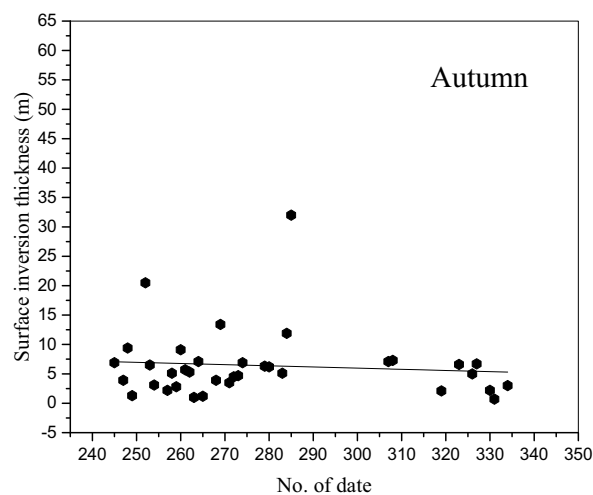


Figure 9. Seasonal variation of TH_{in} during autumn.

The results from the figure 6_9 shows the height surface inversion layer thickness was in summer (51.2 m) over Baghdad. The thicknesses reduced in autumn, spring and winter. The height altitudes was 32.34.2, 34.2 m, respectively, over these seasons due to the increase in the amount of clouds in these seasons.

5. Conclusion

We find in Baghdad station used for this study:

- Increase the intensity of surface thermal inversion in the summer and autumn, due to high temperatures during the two seasons for the other, especially in the summer, where the highest of I_{in} .
- Surface heat inversion thickness does not exceed 50 m, under 60 m.
- Summer recorded the largest thickness of surface heat inversion compared to other seasons due to the difference in wind speed and the amount of little clouds in summer, while in winter the amount of clouds is large.

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