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STUDY ON THE VARIABLE CHARACTERISTICS OF ATMOSPHERIC OZONE IN HANOI AND HOCHIMINH CITIES

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ABSTRACT

Ozone present in the upper parts of the atmosphere, the stratosphere, has an important function in screening out part of the ultraviolet (UV) radiation coming to us from the sun. In that role, it is protecting life on the earth from the potentially injurious effect of the UV-B, the most damaging part of the UV spectrum. The situation is aggravated by the fact that human activities have been damaging the ozone in the stratosphere, where it is "good", and adding to its in the troposphere where it is "bad". In dealing with the above-mentioned problem, this work have been carried out in order to study the change and vary of total ozone (TLO) in Ha Noi and Ho Chi Minh cities. The study also tries to find out the causes of changing in TLO, suggest the appropriate measures for solving the problem and the technology to slow down and reverse the situation.

The authors have obtained the following results:

- The diurnal and annual progress curves of total ozone in Hanoi and Ho Chi Minh cities.
- The correlative and standard correlative function curves of total ozone, the structural and standard structural function curves of total ozone.
- The average variable coefficient of total ozone was 0,103 in Ha Noi and 0,064 in Ho Chi Minh cities.

Keywords: Standard deviation, Stratosphere ozone, Structural characteristics, TLO, Variable coefficient,

Introduction

Ozone is probably the most paradoxical item in the whole "Global Change" scene. At the level in the atmosphere where we live and breathe, the troposphere, ozone is rightly regarded as an atmospheric trace gas which can be extremely harmful to plant and animal life if exceeds its normally very low level. But the ozone present in the upper parts of the atmosphere and the stratosphere has an important function in screening out part of the ultraviolet (UV) radiation coming to us from the sun. In that role, it is protecting life on the earth from the potentially injurious effect of the UV-B, the most damaging part of the UV spectrum. The situation is aggravated by the fact that human activities have been damaging the ozone in the stratosphere, where it is "good", and adding to its in the troposphere where it is "bad".

In Vietnam, the observation of atmospheric ozone have been carried out in early of 1990s but it had got much concern from the Vietnamese government as improved two International conventions: The Vienna Convention on Protecting Atmospheric Ozone and Montreal Protocol on Eliminating Ozone Depleting Substance (in 1994). In June 10th 1995, the Prime Minister approved the National Program on Eliminating the Ozone Depleting Substances for Protecting Atmospheric Ozone.

In the last decade, dozens of researchers on the world have produced scores of report relating stratospheric ozone while in Vietnam the document as well as the data on ozone still limited. We only installed 3 stations for observing atmospheric ozone at Hanoi, Hochiminh City and Sapa in mid of 1990s. There were only a few researches on ozone.

In dealing with the above-mentioned problem, this work have been carried out in order to study the change and vary of atmospheric ozone in Hanoi and HoChiMinh city, Vietnam. The study also tries to find out the causes of changing in atmospheric ozone, suggest the appropriate measures for solving the problem and the

technology to slow down and reverse the situation, contributing to the National Program on Eliminating the Ozone Depleting Substances for Protecting Atmospheric Ozone.

Methodology

- Using theory on random function for studying and evaluating the variation of total atmospheric ozone (TLO).
- Establishing the database of atmospheric ozone for studied areas.
- Documenting.
- Analyzing the data of TLO related to the variation of ozone as well as referencing other researches in the South East Asian region.
- Describing and evaluating the variation of TLO in studied areas.
- Suggesting the appropriate measurements for ozone protection base on the results of the study on the variation of atmospheric ozone and the present condition of using ozone-depleting substances (ODS) in Vietnam.

The study used the TLO data from 1996 to 1997 of the two stations: Lang station in Hanoi and Tansonhoa station in Hochiminh city. The TLO was observed by Wide Band Ozone Spectrometer M-124 of Russia. The observation was carried out by two methods: Directly observed by sunlight and Indirectly observed by zenith light. There are 7 observations per day from 9am to 3pm.

The average of TLO on each day was calculated separately for each kind of observation.

$$\begin{aligned} (n_o)X_o &= N_o & (1) \\ (n_z)X_z &= N_z & (2) \end{aligned}$$

where:

- + X_o, X_z : are TLO observed directly by sunlight and indirectly by zenith light for each observation.
- + n_o, n_z : are number of observation directly by sunlight and indirectly by zenith light.
- + N_o, N_z : are diurnal average of TLO observed directly by sunlight and indirectly by zenith light for each observation.

In case the number of the observation directly by sunlight was less than 3, the diurnal average of TLO was calculated by:

$$X_{tb} = (n_o \cdot X_o + N_z \cdot X_z) / (n_o + n_z). \quad (3)$$

If the number of the observation directly by sunlight was more than 3, the diurnal average of TLO was the average of TLO observed directly by sunlight.

In addition, the study also used the data of TLO from 1978 to 1993 of Nimbus-7 Satellite for calculating the annual variation and fluctuation of TLO through year to year as well as the variation and fluctuation of ozone every season, comparing with the TLO observed by other stations in the South East Asian region.

Using theory of random function for calculating the variable characteristics and statistical characteristics of TLO in Hanoi and Hochiminh cities in Spring, Summer, Autumn and Winter with some main parameter as following:

* The average of TLO
$$\bar{X} = \frac{1}{N} \sum_{i=1}^N x_i \quad (4)$$

* Dispersion of TLO:
$$\sigma^2_x = \frac{1}{N-1} \sum_{i=1}^N (x_i - \bar{X})^2 \quad (5)$$

* Standard deviation of TLO:

$$\sigma_x = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (x_i - \bar{X})^2} \quad (6)$$

* Variable coefficient of TLO:

$$C_{vx} = \frac{\sigma_x}{\bar{X}} \quad (7)$$

* Correlative function:

$$R_x(K\tau_1) = \frac{1}{N-K} \sum_{i=1}^{N-K} (x_i - \bar{X})(x_{i+K} - \bar{X}) \quad (8)$$

* Standard correlative function:

$$r_x(K\tau_1) = \frac{R_x(K\tau_1)}{\sigma_x^2} \quad (9)$$

* Structural function of TLO:

$$B_x(K\tau_1) = \frac{1}{N-K} \sum_{i=1}^{N-K} (x_{i+K} - x_i)^2 \quad (10)$$

* Standard structural function of TLO:

$$D_x(K\tau_1) = \frac{B_x(K\tau_1)}{(\bar{X})^2} \quad (11)$$

Where:

x_i : is observed TLO in the day.

N: number of x_i .

$\tau = K\tau_1$.

Due to the interval between the observations is one hour so $\tau_1 = 1$ hour and $K = 1, 2, \dots, N-1 (<N)$.

The calculation was carried out for each form of observation and the result was the average of all forms. The result received automatically after analyzing the data on the computer.

Results and discussion

The result showed that the annual variation of TLO in studied area (Hanoi and Hochiminh cities) were quite appropriate with the distribution and variation laws of TLO in South East Asia, influenced of monsoon and tropical climate as well as atmospheric circulation in the region: TLO increase in Spring, reach to peak in Summer, slow down in Autumn and decrease to minimum level in Winter.

The result proved the relation between the appearance and movement of the Inter Tropical Conversion Zone (ITCZ) with the fluctuation of TLO: in summer, TLO decreasing rapidly in June and July in Hochiminh city and in August and September in Hanoi.

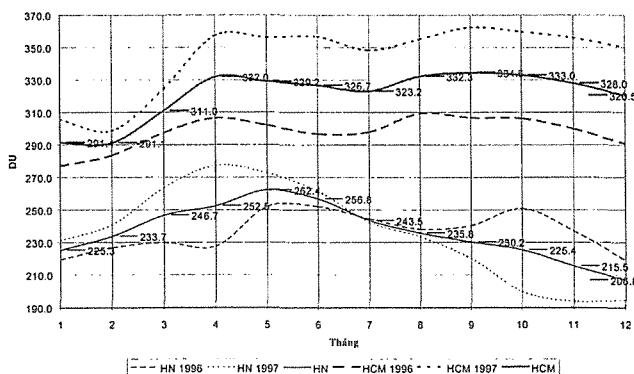


Fig.1. Annual progress curves of total ozone in Hanoi and HoChiMinh city

In addition, the study also found out some characteristics and differences in diurnal progress curves of total ozone between two studied areas. The TLO in Hanoi always lower than in Hochiminh city. In winter, the TLO in Hochiminh city decrease slightly while it decrease dramatically in Hanoi. The reason is the geographical position of Hochiminh city (near the equator) and the ITCZ still operating in this area.

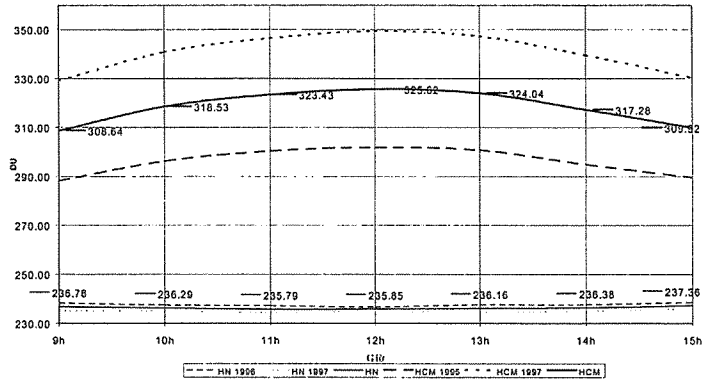


Fig.2. Diurnal progress curves of total ozone in Hanoi and HoChiMinh city

The standard deviation of TLO in Hanoi (23,4 DU) was higher than in Hochiminh city (20,5 DU) proves the high fluctuation and amplitude of TLO in Hanoi, in other word the atmospheric circulation in Hochiminh city was more stable than in Hanoi. This result caused the variable coefficient of TLO in Hanoi (0,103) was greater than in Hochiminh city (0,064).

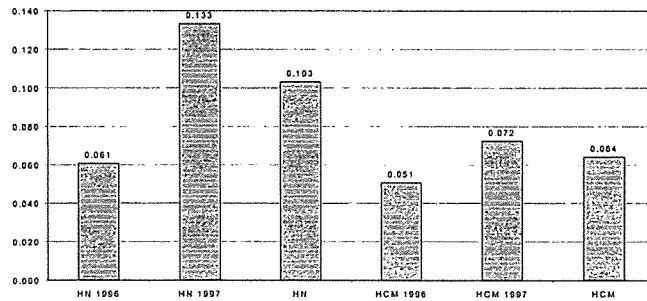


Fig.3. Variable coefficient of total ozone in Hanoi and HoChiMinh city

In general, the standard correlative function of TLO in both studied areas were small ($|r| < 0,214$ and $|r| < 0,045$ in Hochiminh city and Hanoi) proved the weak statistical relation of TLO in these areas.

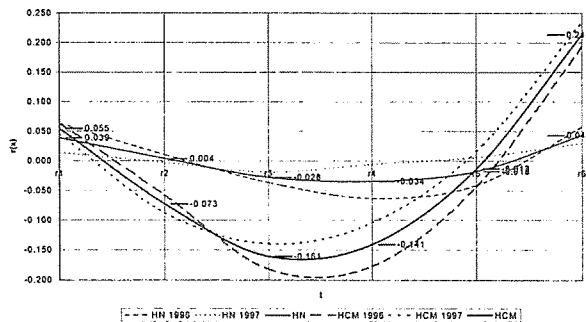


Fig.4. Standard correlative function curves of total ozone in Hanoi and HoChiMinh city

The variation of TLO was characterized by standard structural function showed that the variation characteristic of TLO in Hochiminh city greater than in Hanoi.

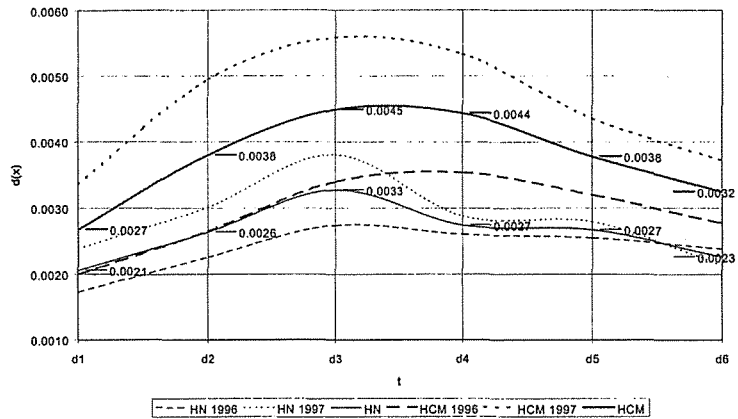


Fig.5. Standard structural function curves of total ozone in Hanoi and HoChiMinh city

The two most important that the study found out were the unusual decreased of TLO in Hanoi and the unusual increased of TLO in Hochiminh city. In autumn, especially in winter of 1997, TLO in Hanoi decreased to 215,3 DU and 196 DU, under standard of 220 DU. While in Hochiminh city the diurnal average of TLO in all day of 1997 was higher than in 1996, this proved that the TLO in the area had a tendency to increase.

We can see the situation was aggravated by the fact that we have been damaging the ozone in the stratosphere, where it is "good", and adding to its in the troposphere where it is "bad".

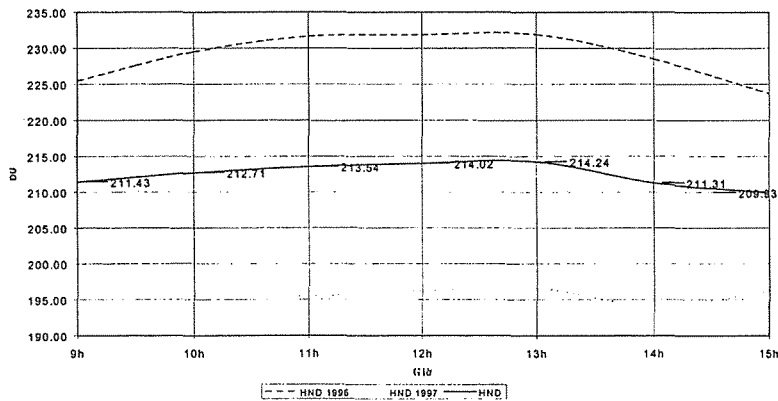


Fig.6. Diurnal progress curves of total ozone in winter of Hanoi

Conclusion

As the result of the study, we need to continue study on the TLO in Vietnam, especially the phenomenon of unusual decrease and increase of TLO in Hanoi and Hochiminh cities. However, this was the first time we discovered this phenomenon in Vietnam and it did not last long, the data used for calculating was only from 1996-1997, we should use more data of observation in the next year before concluding about the situation of stratospheric ozone layer in Vietnam: whether there's ozone hole in Hanoi or increasing troposphere ozone in Hochiminh city. At this time we should carry out the following activities:

- Continue observing the variation of TLO in Vietnam, tries to find out the causes of changing in TLO.
- Evaluating the statistical data of TLO from other ground stations in combination with the data of the meteorology stations, the characteristics of the climate in the region.
- Establishing some new observation stations in other area of Vietnam.
- Controlling NO₂ gas from the industrial zones and from transportation in order to avoid the increasing troposphere ozone.
- Implementing the National Program on Eliminating the Ozone Depleting Substances for Protecting Atmospheric Ozone, keep to The Vienna Convention and Montreal Protocol that Vietnam has approved as well as carry out effectively International cooperation on studying the atmospheric ozone.

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