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Short term stratospheric ozone trend over Dumdum and its relation with Flare Index of northern hemisphere

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सार –इस शोध–पत्र में कोलकाता के डमडम स्टेशन पर 1979 से 1995 तक की अवधि के समतापमंडलीय ओज़ोन सांद्रण में फ्लेयर सूचकांक (क्यू.) के प्रभाव का विश्लेषण प्रस्तुत किया गया है। चूँकि डमडम उत्तरी गोलार्द्ध में स्थित है इसलिए हमने केवल उत्तरी गोलार्द्ध के फ्लेयर सूचकांक मानों का विवेचन किया है।

ABSTRACT. This paper presents an analysis of the effect of flare index (Q) on the stratospheric ozone concentration over Dumdum station, Kolkata for the period 1979-95. As Dumdum is situated in northern hemisphere we have considered the flare index values for the northern hemisphere only.

Key words – Ozone concentration, Flare index, Solar activities.

1. Introduction

A critical study has been performed to study the variation of ozone concentration with the flare index (Q) over Dumdum. Ozone is a minor constituent of the atmosphere. But it plays an important role in controlling the chemical kinetics of the atmosphere. The recent assessment (Bojkov, 1992) revealed that ozone is declining everywhere. Considering the importance of stratospheric ozone on the very existence of mankind extensive research work is being done to know the real mechanism of ozone depletion and its formation. That dramatic decrease of O_3 concentration occurs over Antarctica during spring time is a well accepted phenomenon now (Ghosh and Midya, 1994). In our previous work we have shown that the Antarctic ozone depletion is independent of solar UV radiation (Midya *et al.* 1996), solar flare index (Midya *et al*., 1997-98) and relative sunspot number (Midya *et al*. 1999). In all these studies we have established that solar activity is not the deciding factor for dramatic decrease of ozone concentration over Antarctica. This paper analyses the effect of flare index, another important solar parameter, on the stratospheric O_3 concentration over Dumdum station, Kolkata.

Flare index gives roughly the total energy emitted by the flares (Kleczek, 1952). It is expressed by the formula:

$$Q = i \times t \quad (1)$$

where 'Q' is the total energy emitted by the flare, '*i*' is the importance of coefficient of the flare and '*t*' is the duration of the flare in minutes.

Flare Index Data for the Northern hemisphere, used in this study, were calculated by T.Atac and A.Ozguc from Bogazici University Kandilli Observatory, Istanbul, Turkey.

2. Data

The trend line on the monthly mean ozone concentration data over the years under study has a negative slope (Fig. 1). This indicates stratospheric ozone concentration over Dumdum station is decreasing gradually during this period.

The regression trend line (Fig. 2) of ozone against flare index has a steep positive slope. It means an increase in the Flare index will lead to simultaneous increase in the ozone concentration. But from the destruction mechanism (Ghosh *et al*., 1994; Midya *et al*., 1996) of ozone by solar energy we could have expected a negative slope. As the overall ozone concentration over the station is decreasing (Fig. 1) we can say that the flare index *i.e*., the solar energy is not responsible for the decrease of the stratospheric ozone concentration over Dumdum.

$$O_3 + h\nu \text{ (UV energy)} = O + O_2 \quad (2)$$

$$O_3 + O = 2O_2 \quad (3)$$

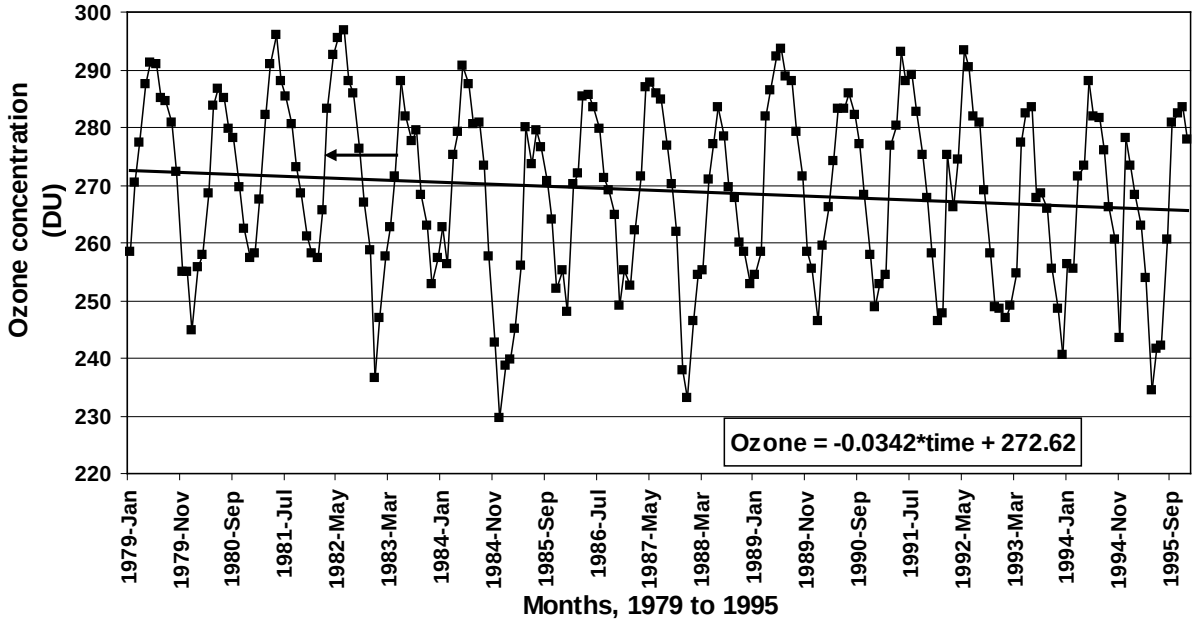

Fig. 1. A negative slope in the trend in the monthly mean stratospheric ozone concentration over Dumdum station during the time period 1979 to 1995

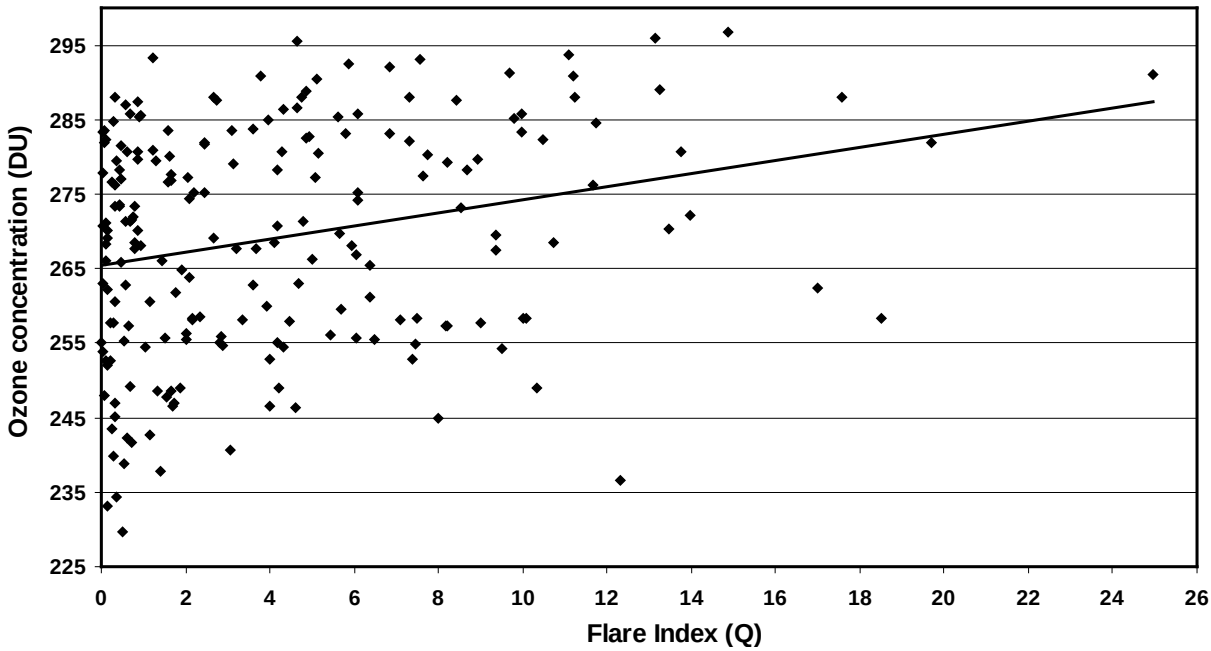

Fig. 2. Increasing trend of ozone with the flare index over Dumdum station during the time period 1979 to 1995

TABLE 1

Correlation coefficients between (i) the monthly mean stratospheric ozone concentration over Dumdum and the flare index, (ii) the monthly mean ozone concentration and the yearly mean ozone concentration and (iii) the monthly mean flare index and the yearly mean flare index : all are for the year 1979 to 1995

Correlation coefficients between	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
The monthly mean flare index and the monthly mean stratospheric O_3 concentration (DU)	0.13	0.34	0.59	0.38	0.45	0.53	0.45	0.59	0.64	0.35	0.28	-0.19
Monthly mean O_3 concentration (DU) and the yearly mean O_3 concentration (DU)	0.29	0.54	0.78	0.77	0.58	0.61	0.62	0.75	0.47	0.30	0.04	-0.07
Monthly mean flare index and the yearly mean flare index	0.88	0.86	0.82	0.69	0.76	0.88	0.75	0.89	0.95	0.77	0.70	0.82

TABLE 2

Difference in the coefficients of variation between the monthly mean stratospheric ozone concentration over Dumdum and the flare index for the year 1979 to 1995

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Difference in the coefficients of variation between the O_3 and the flare index	91	85	114	115	82	95	112	90	111	87	121	95

3. Results and discussion

Results of the statistical analysis among different monthly and yearly mean values of O_3 and flare index are given in Table 1. The correlation coefficients between the monthly mean ozone concentrations and the flare index show that none of the values are significant (~90%) enough to indicate that the flare index is the main agent, responsible for the decrease of the stratospheric ozone concentration over Dumdum. The only negative correlation coefficient, -0.19 for the month of December which could have indicated an inversely proportional relationship between the flare index and the stratospheric ozone concentration over Dumdum are again only a small value in absolute term.

Now considering the correlations between the monthly mean flare index and the yearly mean flare index if we see the months of January and the June we see that both the months have the same influence (r = 0.88) on deciding the yearly mean values of flare index. But the corresponding influence of the monthly mean ozone concentrations on the yearly mean values differ widely (r = 0.29 and 0.61 respectively). The same differences are visible in the correlation coefficients between the ozone concentrations and the flare index for these two months (r = 0.13 and 0.53 respectively).

Similar results are found from the difference in coefficients of variation between the flare index and the stratospheric ozone concentration over Dumdum (Table 2). Here we see that the difference is way apart from the <10% criterion.

So from all the above analysis we can conclude that the monthly mean stratospheric ozone concentration over Dumdum and the flare index are independent of each other. The decrease of ozone concentration with increase of flare index is quite expected. From our analysis it is clear that the trend of monthly mean ozone concentrations are not influenced by the flare index. The responsible ozone destructing agents here may be the green house pollutants like, CFCs, nitrogenous oxides, carbon monoxides, carbon dioxide, methane etc. (Midya *et al*. 2000).

4. Conclusion

The following conclusions are drawn from the analysis done here.

(*i*) The monthly mean values of stratospheric ozone concentration over Dumdum are decreasing over the years.

(*ii*) The flare index is not responsible for decline in stratospheric ozone concentration over Dumdum.

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