ANTARCTIC O₃ DEPLETION AND ITS CORRELATION WITH RELATIVE SUN-SPO T NUMBER

1. A critical study have been performed to study the correlation between Antarctic O₃ concentration and relative sun-spot number. From correlation coefficient between monthly mean value of O₃ concentration of Antarctic Survey station and that of relative sun-spot number, it is inferred that chemical processes in association with special atmospheric conditions prevailing over Antarctica are responsible for dramatic decrease of O₃ concentration at Antarctica during spring time.

Fig. 1. Variation of Antarctic O₃ concentration and relative sun-spot number during the period 1964-85
Fig. 2. Variation of Antarctic $O_3$ concentration with relative sun-spot number

2. $O_3$ is a minor constituent of the atmosphere. It plays an important role to control the chemical kinetics of the atmosphere. Dramatic decrease of Antarctic $O_3$ concentration during spring time is presented in our previous paper (Ghosh and Midya, 1994) and is now well established phenomenon. The paper presents the correlation between Antarctic $O_3$ concentration and relative sun-spot number. It is concluded that correlation coefficient between Antarctic $O_3$ concentration and relative sun-spot number is insignificant during spring time and chemical processes are responsible for dramatic decrease of $O_3$ concentration over Antarctica.

Monthly mean relative sun-spot number for the period 1964-85 and Solar UV for the period 1966-85 are taken from Solar Geophysical Data Book, NOAA, published by De-
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TABLE 1

<table>
<thead>
<tr>
<th>Correlation coefficient between</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monthly mean [O₃] and monthly mean relative sun-spot number</td>
<td>0.06</td>
<td>0.13</td>
<td>*</td>
<td>*</td>
<td>0.10</td>
<td>0.26</td>
<td>0.31</td>
<td>0.20</td>
<td>*</td>
<td>0.04</td>
<td>-0.04</td>
<td>0.19</td>
</tr>
<tr>
<td>Monthly mean [O₃] and yearly mean [O₃] during 1964-85</td>
<td>0.26</td>
<td>-0.05</td>
<td>*</td>
<td>*</td>
<td>0.77</td>
<td>0.38</td>
<td>0.43</td>
<td>0.82</td>
<td>*</td>
<td>0.90</td>
<td>0.47</td>
<td>0.69</td>
</tr>
<tr>
<td>Monthly mean and yearly mean relative sun-spot number during 1964-85</td>
<td>0.95</td>
<td>0.93</td>
<td>0.92</td>
<td>0.93</td>
<td>0.96</td>
<td>0.97</td>
<td>0.96</td>
<td>0.95</td>
<td>0.94</td>
<td>0.96</td>
<td>0.95</td>
<td></td>
</tr>
<tr>
<td>Monthly mean relative sun-spot number and monthly mean UV</td>
<td>0.75</td>
<td>0.80</td>
<td>0.90</td>
<td>0.77</td>
<td>0.79</td>
<td>0.81</td>
<td>0.76</td>
<td>0.84</td>
<td>0.89</td>
<td>0.67</td>
<td>0.80</td>
<td>0.79</td>
</tr>
</tbody>
</table>

"*" signifies that correlation coefficients are not calculated due to insufficient data.

The nature of variation of O₃ concentration of two Antarctic Survey Stations with relative sun-spot number is shown in Fig. 1. Relative sun-spot number clearly follows the 11 years solar cycle. O₃ concentration follows decreasing trend with relative sun-spot number up to the year 1974-75. Afterwards relative sun-spot number begins to increase but we see that O₃ concentration continues its decreasing trend.

3. For analysis of data, O₃ concentration of McMurdo is used (Komhyr et al. 1986). In case of relative sun-spot number we see that correlation coefficient between monthly mean and yearly mean of relative sun-spot number is nearly same for all the months and it is very high Table 1. In case of correlation coefficient between monthly mean values of relative sun-spot number and that of UV radiation we have also obtained very high correlation coefficient for each month (Table 1). The correlation coefficient between monthly mean values of Antarctic O₃ concentration and that of relative sun-spot number is calculated for different months Table 1. It is observed that the correlation coefficient between two parameters during Antarctic Spring is not significant. It implies that relative sun-spot number does not play any important role to control the O₃ concentration during Antarctic Spring. It is also clear from the scatter diagram (Fig. 2) that variation of Antarctic O₃ concentration with relative sun-spot number is almost a straight line which is parallel to relative sun-spot number axis. This implies that O₃ concentration is independent of relative sun-spot number.

A scattered diagram between solar UV radiation and O₃ concentration of Antarctic Survey Station is drawn (Fig.3). A straight line is obtained with positive slope. From regression analysis we obtained an empirical equation as given in Fig. 3. From positive slope, it is clear that O₃ concentration increases with increase of solar UV radiation. It confirms that solar UV is not responsible for O₃ hole at Antarctica.

In another communication (Midya et al. 1998) we have shown that correlation coefficient between Antarctic O₃ concentration and solar flare index is not significant. Solar flare index is the actual energy output of any flare event. In this connection it may be mentioned that we have obtained satisfactory result in finding the effect of solar flare index on different airglow emission lines (Midya et al. 1993a, Midya et al., 1993b). Here we also see that relative sun-spot number has not any significant role in the special depletion of O₃ at Antarctica during spring time. Different processes such as active chlorine formation from chlorofluorocarbons, chlorine-bromine reactions, PSC cloud formation at temperature lower than -80°C during Antarctic spring (Ghosh and Midya, 1994) are responsible for depletion of ozone at Antarctica during spring time.

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References


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