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ON OZONE CORRELATION WITH METEOFIELDS IN THE NORTHERN HEMISPHERE

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ABSTRACT

The correlation coefficients of temperature and geopotential heights at various levels with total ozone and its vertical distribution have been analyzed, using the ground based and ozone sounding data.

Two independent groups of factors affect total ozone. The first group - the geopotential values of the troposphere - stratosphere border (100-500 mb) manifest themselves most of all in the middle latitudes. Pertaining to this group is the total ozone correlation with the tropopause height and temperature at 500 mb. The correlation coefficients are negative (-0.55..-0.65) and little depend on the season. Related to this factor is a high (up to 0.8) correlation of ozone partial pressure with the temperature in the lower stratosphere.

The second group is the geopotential and temperature values at the 10-30 mb levels. The highest correlation coefficients (up to 0.6) are observed in winter in the subpolar latitudes. In summer they are substantially lower - about 0.1.

1. INTRODUCTION

Total ozone relation to the meteorological processes was discovered during the first years of ozone observations and has been investigated well enough by the present time. Total ozone is inversely correlated with the pressure pattern in the upper troposphere and lower stratosphere (e.g., Craig, 1965; Dutsch, 1969). Besides, total ozone variations are related to the processes occurring in stratospheric layers 15-35 km (e.g., Dobson,1973). A quantitative estimation of various atmospheric processes' contribution to total ozone variability seems important.

One of the possible solutions is the estimation of ozone values correlation with the temperature and geopotential height.

2. DATA SETS

For the correlation analysis the total ozone daily mean values obtained at 100 Northern Hemisphere ground based ozonometric stations (Dobson and filter) for the period of 1973-1985 as well as ozone sounding data were used. The data are published by AES, Canada, and WMO. The daily data on temperature and geopotential height on 850, 700, 500, 300, 200, 100, 30 and 10 mb levels were used. Before the correlation's computation the initial data series were deseasonalized. Correlation coefficients were computed for four seasons.

3. TOTAL OZONE CORRELATION WITH THE TEMPERATURE AND GEOPOTENTIAL HEIGHT

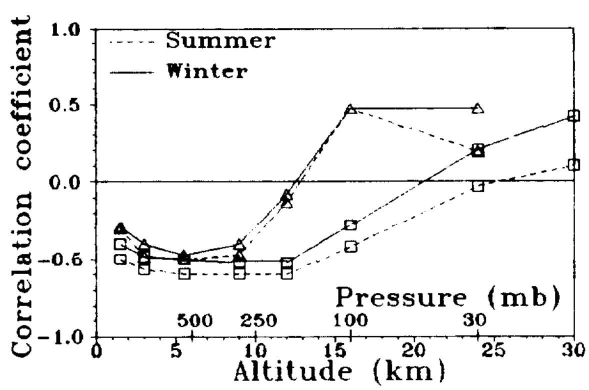

Fig. 1. Correlation coefficients between total ozone and temperature (▲) and between total ozone and geopotential high (□) for Central Europe.

Figure 1 shows the altitudinal course of the correlation coefficient between total ozone and geopotential height, and between total ozone and temperature for

Central Europe. The largest in absolute value correlation is observed between total ozone and geopotential at 300 mb and between total ozone and temperature at 500 mb and 100 mb. In the polar and tropical latitudes the correlation coefficients altitudinal course remains the same, but the maximum correlation's altitude is somewhat changed.

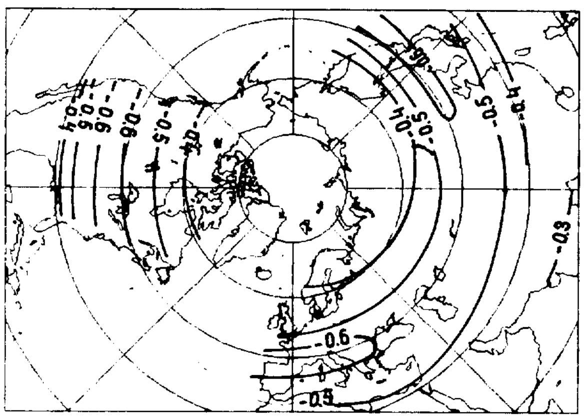

Fig. 2. Correlation coefficient of total ozone and 300 mb geopotential high for Winter.

Figure 2 shows the map of the correlation coefficients between total ozone and the 300 mb geopotential for winter. The maximum correlation (more than 0.6) is observed in the 40°-50°N zone, i.e., between the major jet streams in the region where both Arctic and Antarctic air masses can penetrate. Relatively high correlation of total ozone with temperature and geopotential in the troposphere is accounted for the troposphere - stratosphere border effect.

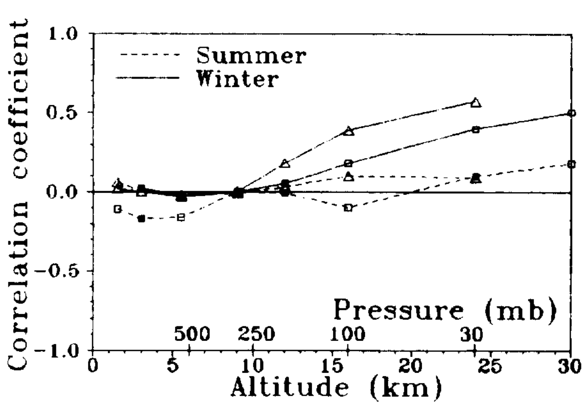

Fig. 3. Partial correlation coefficients (relative to ozone - 300 mb geopotential correlation) between total ozone and temperatute (▲) and between total ozone and geopotential (□) for Central Europe.

The temperature at 100mb, 500mb; and 200mb and 300mb geopotential heights are closely related to each other. These factors make up the first group of factors affecting to total ozone.

For the examination of other factors affecting total ozone the partial correlation (relative to ozone - 300 mb geopotential correlation) between ozone

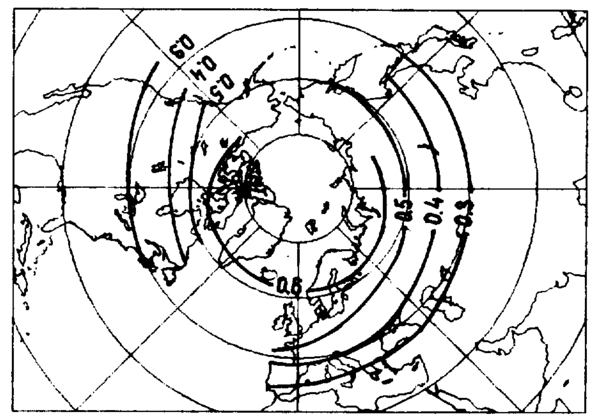

Fig.4. The partial correlation coefficient (relative to ozone - 300 mb geopotential correlation) of total ozone and 10 mb geopotential for Winter.

and meteoparameters has been considered (Figure 3). The partial correlations' consideration makes the correlation between total ozone and meteoparameters in the troposphere and lower stratosphere insignificant. Partial correlation with meteoparameters at 30-10 mb levels remains high, and this suggests their independent origin. Maximum (up to 0.6) particular correlation is observed in winter between total ozone and the 10 mb geopotential. The map of their values is shown in Figure 4.

A monotonic growth of correlation coefficients towards the polar latitudes is observed. This correlation is probable to be accounted for the circumpolar vortex effect on total ozone. Its intensity variation and movement relative to the average long-term position cause geopotential and total ozone variations. Particularly variable in this respect is the circumpolar vortex, and the correlation coefficients are maximum in winter. The temperature variations at 30 mb are related to the geopotential variations at 10 mb (the correlation coefficient reaching 0.85 in winter) and the relation of total ozone to the temperature at 30 mb is probable to have the same reason. These factors make up the second group.

The value of the multiple correlation

between total ozone and geopotential at 300 and 10 mb goes up to 0.7-0.8. It means that these two parameters "account for" more then 50% of the observed total ozone variance. About 15%-25% of variance are accounted for the instrument error of total ozone measurements. Using the 200 mb geopotential and the temperature at 30 mb as predictors lead sometimes to an insignificant improvement.

The factors of the first group well manifest themselves in short time intervals of several days. The second group is characteristic of processes of longer duration.

5. CORRELATION WITH OZONE CONCENTRATION AT DIFFERENT LEVELS

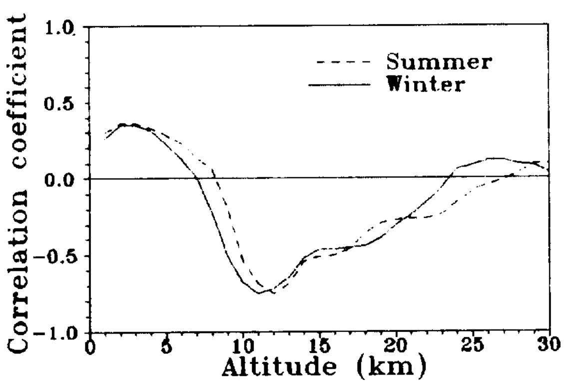

Fig. 5. Correlation coefficient between the temperature at the 6 km level (500mb) and ozone concentration at different altitudes for Hohenpeissenberg.

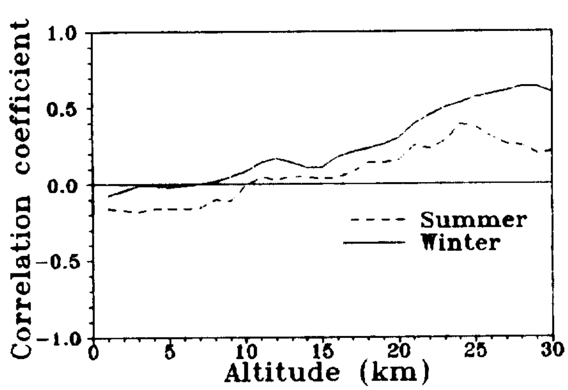

Fig. 6. Correlation coefficient between the temperature at the 24 km level (30mb) and ozone concentration at different altitudes for Hohenpeissenberg.

The ozonesonde measurements enable to determine the altitudes in the ozone profile with which the mentioned correlation is associated. For this purpose the Hohenpeissenberg station (48°N, 11°E) data were used. The ozone concentration and the temperature in 1 km layers were computed from the observations results, and then for the temperature at each level the correlation coefficients with ozone concentration at all the levels from 1 to 30 km were computed. The largest ones in absolute value are observed between the temperature at 6 km (500 mb) and ozone concentration in the lower stratosphere (Figure 5). This relation accounts for the influence of the first group of factors upon total ozone.

In Figure 6 correlation between the temperature at 24 km (30 mb) and the ozone partial pressure is shown. As the figures show the first factor is associated with the ozone concentrations near the tropopouse, the second - in the middle stratosphere.

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