IS THERE ANY "AFTER EFFECT" IN DENSITY VARIATIONS OF THE NEUTRAL ATMOSPHERE ?

by

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ABSTRACT It is demonstrated that simultaneously with variations of ionospheric absorption there are unmodeled increases of neutral density 6-7 days after geomagnetic storms i.e. we observe an "after effect" in the neutral atmosphere as well.

INTRODUCTION

It is well known that the ionospheric absorption -- determined at mid-latitudes at different radio frequencies, l.f. band in particular -- can be higher during geomagnetic storms than under quiet conditions. Sometimes ionospheric absorption remains at a high level well after the end of the geomagnetic storm. This is the so called "ionospheric absorption after effect".

According to Lauter and Knuth (1967) this after effect originates from the enhanced ionization in the lower ionosphere produced by electrons with energies larger than 40 keV, precipitating from the outer radiation belt of the magnetosphere. On the other hand, according to Belrose (1964) the delay of the after effect with respect to the corresponding geomagnetic disturbance suggests that this effect may be related to changes in the chemical composition of the atmosphere. The changes occur during the main phase of geomagnetic storms in the auroral zone and are transferred later towards the Equator.

Our aim was to investigate whether there are any changes in the neutral density parallel to the lower ionospheric after effect?

DATA AND ANALYSIS

As 1965-72 is the time interval of our data file (Illés-Almár 1979) (drag measurements of 59 satellites) those geomagnetic disturbances were selected which occure in this period with single peak and $A_p > 80$. Altogether 14 such geomagnetic storms have been found.

Density changes in the neutral atmosphere were investigated up to 20 days after each geomagnetic storm event with the so called method of superposed epochs.

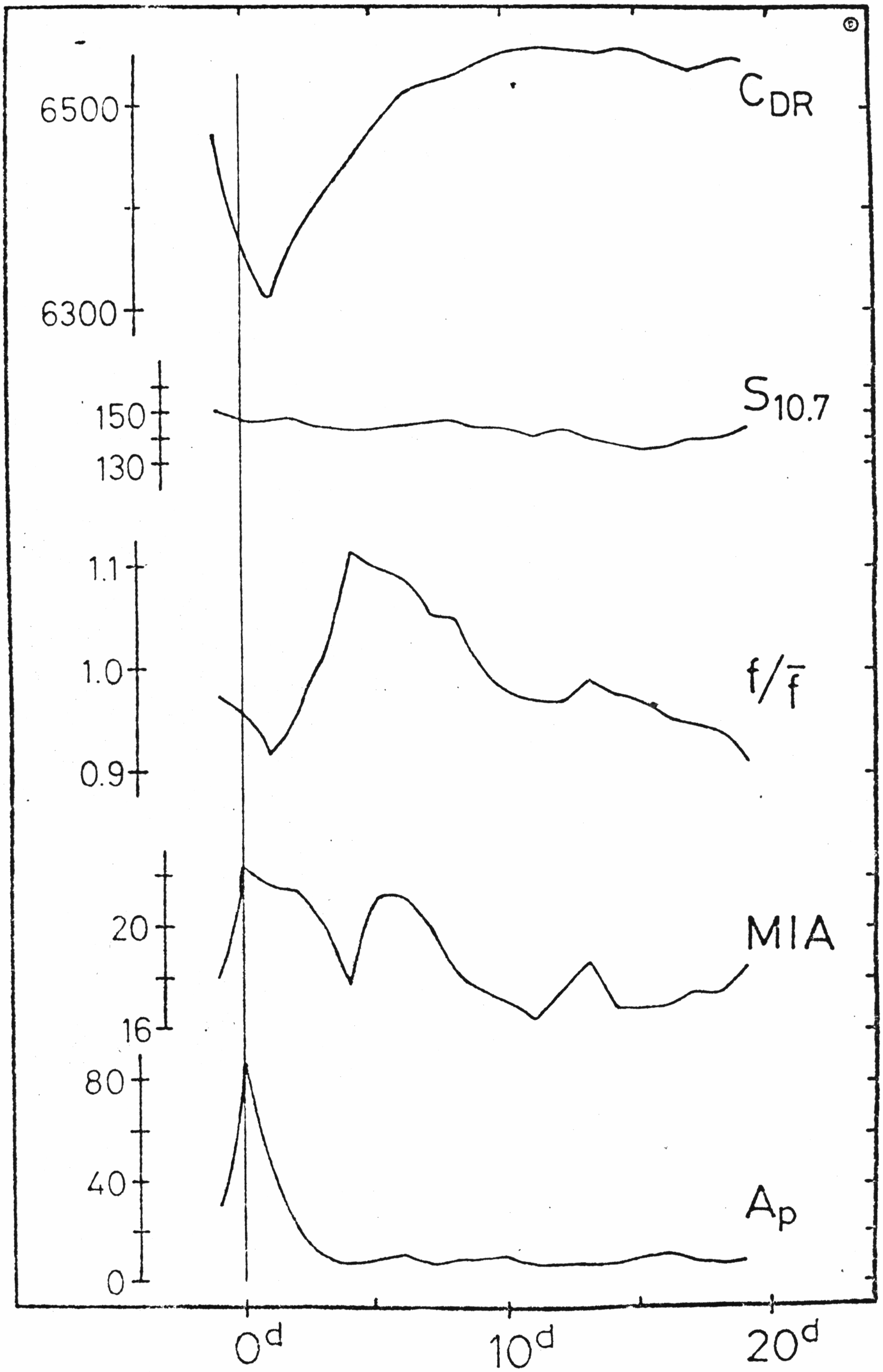
At first a mean normalized f curve ($f/\bar{f}$) was constructed from that of the individual satellites (where each f value is the ratio of observed and corresponding CIRA 72 model density values). The method of superposed epochs was then applied as a second step, defining the peak day of each geomagnetic storm as zero point.

The figure gives the result of the method of superposed epochs for different solar and geophysical parameters as well. The x axis represents the number of days after the peaks of geomagnetic storms.

The lowermost curve is the superposed A_p curve for the 14 geomagnetic events.

The next curve gives the superposed mean ionospheric absorption (MIA) parameter measured at Kühlungsborn station, GDR, on 245 kHz frequency at night. Night time measurements of MIA are not affected by the enhanced EUV ionization. The MIA maximum at zero day corresponds to the A_p peak and is the response of the lower ionosphere to geomagnetic storms. The later maxima belong to the well known ionospheric after effect as main phase and second phase of it.

The third curve shows the superposed normalized $f/\bar{f}$ values of the neutral density variations. It should scatter around 1.0 if the model is correct. The existence of a definite maximum around the 6th day suggests, however, that there is an "after effect" in the neutral atmosphere as well. This maximum is not


6500
6300
150
130
1.1
1.0
0.9
20
16
80
40
0
C_{DR}
$S_{10.7}$
$f/\bar{f}$
MIA
A_p
0^d
10^d
20^d

predicted by the model.

$S_{10.7}$ is the solar activity parameter used in models. This superposed curve demonstrates only that there is no relation between f values and the solar activity index $S_{10.7}$.

The uppermost curve is the galactic cosmic radiation count rate measured at Deep River station, USA (C_{DR}) showing the well known Forbush decreases at times of geomagnetic storms. This C_{DR} index was suggested earlier by Illés-Almár as a new additional index for upper atmospheric studies (E. Illés-Almár 1979, E. Illés 1981, E. Illés-Almár in print). Neither this curve is giving any explanation to the after effect.

CONCLUSION

The analysis of this neutral density after-effect is not finished yet. Nevertheless we would like to draw the attention to the importance of it -- especially in connection with the construction of the new CIRA model. Our results indicate the presence of a retarded magnetospheric heating for the neutral atmosphere after geomagnetic storms. This kind of heating is not included in any model yet. Enhanced precipitation of particles coming from radiation belts, however, may cause extra heating for the neutral component of the atmosphere even outside geomagnetic storms.

We would like to emphasize that the existence of the lower ionospheric after effect is considered only as an indicator of the existence of any precipitation. The lack of the lower ionospheric after effect in some cases does not necessarily mean the lack of precipitation in higher atmospheric levels and -- on the other hand -- its appearance does not demand a precipitation in higher levels. The two phenomena do not go necessarily together in all cases.

The fine structure of the effect and the physical explanation will be further investigated.

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Section D

DETERMINATION OF ARTIFICIAL SATELLITE ORBITS FOR GEODYNAMIC STUDIES

Секция Д

ОПРЕДЕЛЕНИЕ ОРБИТ ИСЗ ДЛЯ ГЕОДИНАМИЧЕСКИХ ИССЛЕДОВАНИЙ