БЪЛГАРСКА АКАДЕМИЯ НА НАУКИТЕ
ЦЕНТРАЛНА ЛАБОРАТОРИЯ ПО СЛЪНЧЕВО-ЗЕМНИ ВЪЗДЕЙСТВИЯ-БАН
СЪЮЗ НА УЧЕНИТЕ В БЪЛГАРИЯ - КЛОН СТАРА ЗАГОРА
ИНСТИТУТ ПО АСТРОНОМИЯ-БАН
ГЕОФИЗИЧЕН ИНСТИТУТ-БАН
СЪЮЗ ПО ЕЛЕКТРОНИКА, ЕЛЕКТРОТЕХНИКА И СЪОБЩЕНИЯ

СБОРНИК ДОКЛАДИ
НА
ТРЕТАТА НАЦИОНАЛНА КОНФЕРЕНЦИЯ

ПО

ОСНОВНИ ПРОБЛЕМИ НА СЛЪНЧЕВО-ЗЕМНИТЕ ВЪЗДЕЙСТВИЯ

С О Ф И Я

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ПРОГРАМА

<u>27.06.96</u>

$10^{00} \div 10^{15}$	Откриване
$10^{15} \div 11^{30}$	Научна Сесия I - А (Доклади I.1÷I.8) Председател: акад. Д. Мишев
$11^{30} \div 13^{00}$	Научна Сесия I - Б (Доклади I.9÷I.16) Председател: проф. дфн. И. Кутиев
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$15^{30} \div 16^{00}$	Кафе
$16^{00} \div 17^{30}$	Научна Сесия III (Доклади III.1÷III.11) Председател: ст.н.с. д-р Цветан Дачев

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$9^{00} \div 10^{30}$	Научна Сесия IV (Доклади IV.1÷IV.7) Председател: ст.н.с. дфн. Вл. Дерменджиев
$10^{30} \div 11^{00}$	Кафе
$11^{00} \div 13^{00}$	Научна Сесия V (Доклади V.1÷V.7) Председател: ст.н.с. дмн. Ирина Стоилова
13^{10}	Завършване

I. 8. ON THE VARIATIONS OF DAYTIME H^+/O^+ AND He^+/O^+ DENSITY RATIOS DURING LOW SOLAR ACTIVITY

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1. Introduction

The knowledge of ion composition (individual ion densities normalized to the total ion density) is important for understanding various ionospheric processes like plasma instabilities, plasma transport, etc. The models of ion composition may help this research. At present, the results of composition modelling are still not satisfactory. For instance, the most advanced empirical model, the International Reference Ionosphere (IRI) model, gives a constant H^+/He^+ density ratio (Bilitza *et al.*, 1993), which is not confirmed by measurements.

The aim of this report is to present an analysis of the altitudinal, latitudinal, and seasonal variations of H^+/O^+ and He^+/O^+ density ratios by using satellite measurements. It will help a further development of a better composition model (Stankov, 1995) which may be directly used in IRI.

2. Data base

For the purpose of this study, a Bennett ion mass spectrometer (BIMS) measurements of O^+, H^+ and He^+ densities were used. The measurements were carried out during the *Atmosphere Explorer* (AE-C) satellite mission (Dec 1973 - Feb 1975), i.e. are valid for low solar activity (F10.7 ~ 90). To analyze the latitudinal and seasonal variations, data from all longitudes have been sorted into 6 magnetic latitude ranges (0-10°, 10-20°, ... , 50-60° N), and 3 seasons - winter (days 311-36), equinox (days 37-127, 219-310), summer (days 128-218). Noon conditions, 9:00-15:00 LT, are only considered.

3. Analysis

The *altitudinal variation* of H^+/O^+ ratio above hmF2 is determined by the opposite gradients (in altitude direction) of O^+ and H^+ density. In result, the H^+/O^+ ratio increases quickly with altitude until reaching the value of 1 at the O^+-H^+ transition height. Above this level, the growth is slower due to small gradients of H^+ density. The altitude behaviour of He^+/O^+ is similar to that of H^+/O^+ density ratio. However, the He^+/O^+ ratio increases much slower. Below ~ 400 km. the He^+/O^+ profile is not determined because of small He^+ density values (due to He^+ loss reactions with N_2 and O_2).

Concerning the *latitudinal dependence* of H^+/O^+ and He^+/O^+ density ratios, there exists a trend for both ratios to increase in equatorward direction, being more pronounced for the H^+/O^+ ratio. The growth is observed at all heights. For altitudes below 500-600 km the O^+, H^+ and He^+ density distribution reflects the photochemical-equilibrium conditions which lead to relatively small differences with varying latitude. At higher altitudes the differences are much greater - in the equinox case the equatorial value of H^+/O^+ at 1100 km altitude is almost 10 times bigger than the ratio representing 50-60° range. It is explained with the strong latitudinal dependence of the plasmaspheric H^+ density profile. The described variations are manifested also by the H^+/He^+ ratio (**Fig.1**). The He^+ data are sparse and greatly scattered, causing significant variations in the upper H^+/He^+ profiles.

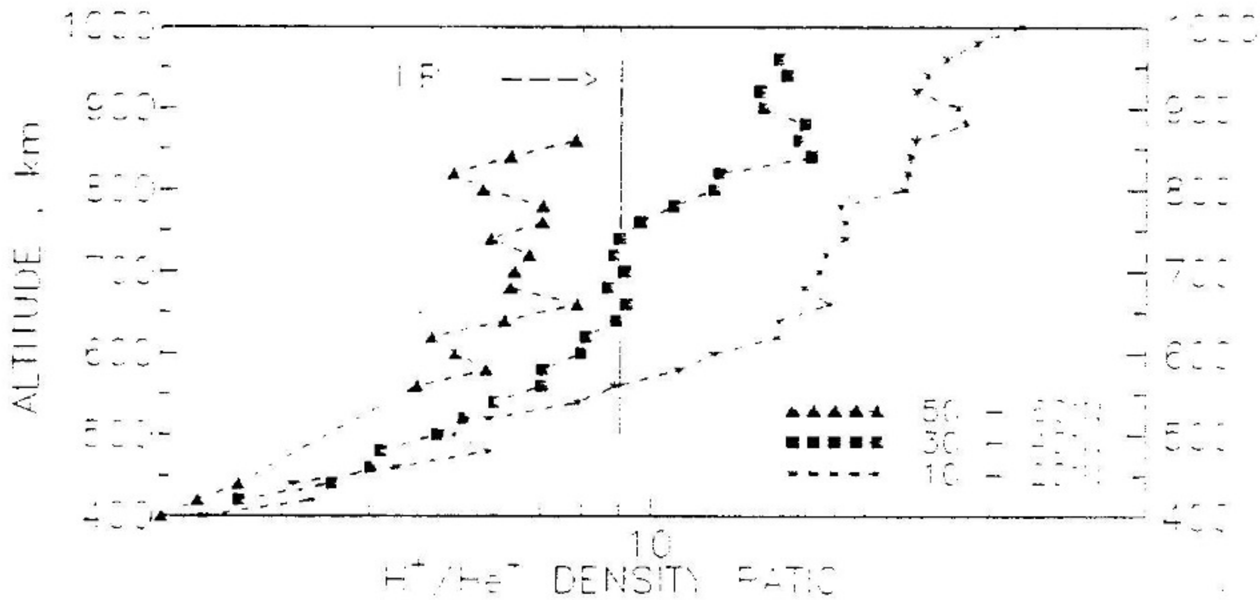

Fig.1 *The altitudinal and latitudinal dependence of H^+/He^+ ratio during equinox*

The *seasonal dependence* preserves the above described altitudinal and latitudinal behaviour of H^+/O^+ and He^+/O^+ ratios. The available BIMS data show a trend for both ratios to increase from summer to winter. It is a consequence of the seasonal anomaly, higher light ion densities in winter, and steeper O^+ density profile during summer.

6. Discussion

The data analysis suggests that, although altitude and latitude dependencies are well described, more data should be used (e.g. MIMS - Magn. Ion Mass Spectrometer) for reliable modelling of the seasonal and He^+/O^+ density ratio variations. There are also gaps in the measurements (concerning altitude and latitude) due to orbit parameters. From this aspect, a theoretical model might be successfully applied in the compostion modelling (Stankov, 1995).

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