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MEASUREMENT OF THE PLASMA PARAMETERS IN THE IONOSPHERE BY NIGHT WITH RETARDING POTENTIAL ANALYZERS ON BOARD OF THE GEOPHYSICAL ROCKET VERTICAL–10

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Two retarding potential analyzers looking in and opposite to the flight direction were attached to the container of the geophysical rocket Vertical–10, which was launched December 21, 1981, 21. 35 Moscow time. The plasma parameters have been determined by curve fitting. The profile of the ion temperature shows fluctuations above 600 km hinting at some height dependent source of energy. Such irregular behaviour of the ion temperature was already found previously during the flight of Vertical–6 in 1977.

Keywords: plasma parameters in the ionosphere; retarding potential analyzer; rocket measurements

The measurements with plane-gridded retarding potential analyzers carried out previously by day on board of the geophysical rockets Vertical–6 and Vertical–9 were repeated on Vertical–10 by night. Vertical–10 was launched December 21, 1981 21. 35 Moscow time from the midlatitude area of the European part of the USSR.

The sensing part of the equipment consisted of two planegridded ion traps. The ion traps were prepared in the Institute for Space Research, Academy of Sciences of the USSR, Moscow. During ascent the ion flux was analyzed by the upwards looking ion trap, while in course of the descent the downwards looking analyzer worked. Thus, during both the ascent and the descent there was an ion trap on the container looking into the flight direction.

The electronic units were constructed using the experiences obtained during previous experiments. The evaluation of the data has shown that at low altitudes the sensitivity of the amplifier (positive ion current) is not high enough for a reliable determination of the positive ion composition (concentration of molecular ions). Therefore, the sensitivity of the amplifier has been increased. In the previous experiments the amplifier had three different ranges of measurement with automatic change of the ranges. The first range extended from $5 \cdot 10^{-11}$ to $3 \cdot 10^{-9}$ A, the second range from $1 \cdot 10^{-9}$ to $6 \cdot 10^{-8}$ A and the third range from $2 \cdot 10^{-8}$ to $1 \cdot 10^{-6}$ A.

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The instrument on Vertical–10 had the following ranges of measurement: $2.8 \cdot 10^{-13} - 9.1 \cdot 10^{-11}$ A, $9.1 \cdot 10^{-11} - 2.6 \cdot 10^{-9}$ A and $2.6 \cdot 10^{-9} - 9.6 \cdot 10^{-8}$ A in order of decreasing sensitivity. As it can be seen, the sensitivity of the amplifier was now an order of magnitude higher, than in case of the previous equipments.

Further in case of the previous instruments in altitudes, where only light, aton ions (He^+, H^+) collected at small retarding potentials are present, the number oi measurements per sweep was small. Thus, in this case the characteristic curve was not sufficiently determined and the ion composition could not reliably enough be found by means of curve fitting. Therefore, the range of the retarding potential and the period of the saw-tooth voltage were diminished. In the preceding equipments the retarding potential (amplitude of the saw-tooth voltage) changed from +18 V to −2 V (compared to the potential of the body) its period being 3 s. In case of the instrument flown on Vertical–10 the saw-tooth voltage changed from +16 V to −2 V in 2.5 s. Thus, the number of measurements determining the current-voltage curve increased both in low and high altitudes. The electronic units were constructed in the Central Institute for Physics, Budapest.

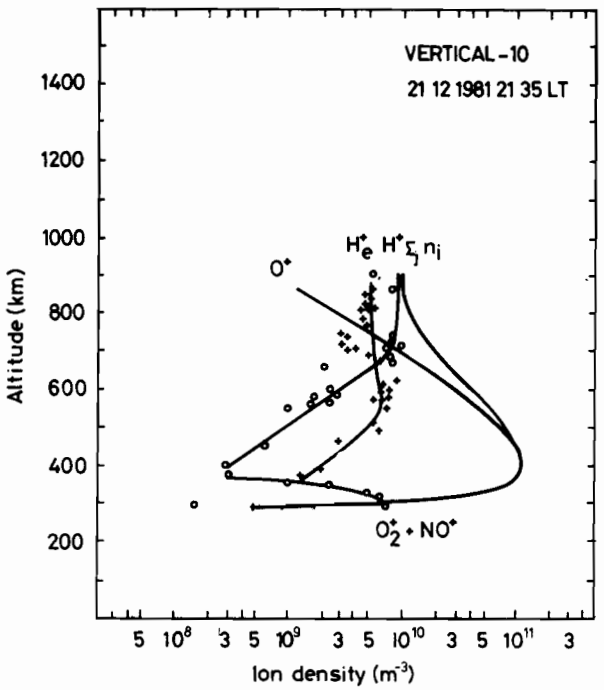

Fig. 1. Height variations of the total positive ion density and the concentrations of the ions $O_2^+ + NO^+$, O^+, He^+, H^+ during descent

The characteristic curves were evaluated by curve fitting (Knudsen 1966, Moss and Hyman 1968, Hanson et al. 1970, Bencze et al. 1984). The unknowns determined during the processing of the data were the total ion density, the ion composition, the ion temperature and the potential of the container. The curve fitting has been carried out so that the types of ions, the concentration of which had to be determined, were different in different height regions. The data processing has been done in the Geodetic and Geophysical Research Institute, Hungarian Academy of Sciences, Sopron.

As regards the geophysical conditions at the time of the flight the relative sunspot number was 72, the daily solar flux at 2800 MHz was 142.2, the three-hourly planetary geomagnetic index $Kp = 2^-$. Thus, the rocket was launched in rather quiet geophysical conditions.

In Fig. 1 the total positive ion density profile measured during the descent is shown. Because of night and quiet geomagnetic conditions the concentration of ions is small. In Fig. 1 the height variations of the ions $O_2^+ + NO^+$, O^+, He^+ and H^+ are also plotted.

In Fig. 2 the height variation of the ion temperature during descent is shown. The ion temperature is low because of night and quiet geomagnetic conditions, as in case of the positive ion density. The profile indicated fluctuations of the ion temperature above

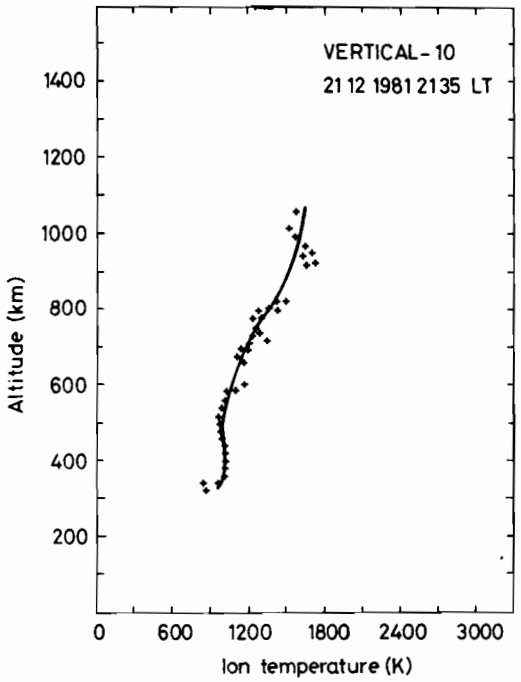

Fig. 2. The ion temperature profile determined for the descending part of the orbit

600 km. The reliable determination of the ion temperature profile is aggravated by the significant variation of conditions during a single sweep of the retarding potential, too. This makes impossible to evaluate the characteristic curves and thus, some data determining the profile are missing.

Previous measurements may prove that these strange variations are not error due to the equipment or to the evaluation of the data. Namely, similar temperature fluctuations have been found during the flight of Vertical–6, in October, 1977 (Apáthy et al. 1981). It is assumed that this behaviour of the ion temperature might be due to charge exchange and to the counterstreaming of ions in this region.

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