RECENT MEASUREMENTS OF ELECTRIC CONDUCTIVITY AND ION PRODUCTION RATE
IN THE LOWER STRATOSPHERE

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Abstract. Balloon measurements of the electric conductivity and ion production rate were made during the Atmospheric Electrical Measurements Workshop at the University of Wyoming in the summer of 1978. The reasonable agreement was obtained from the comparison flights of electric conductivity. The small difference in the comparative measurements of ion production rate was found at the stratospheric heights. The measurements of ion production rate during the period of different sunspot numbers show the dependence of solar activity at the stratospheric heights.

1. Introduction

Among many parameters of Atmospheric Electricity, the electric conductivity and ion production rate are the most fundamental parameters to understand the electrical state of the atmosphere from ground to the stratosphere. Many measurements of these parameters to the stratospheric heights have been made in recent years (e.g. Hake et al., 1973, Morita and Ishikawa, 1976, Rosen and Hofmann, 1980 and others). To understand the complex dependence of the electrical state of the atmosphere on the height, systematic measurements of these parameters have to be carried out at different geomagnetic latitudes and solar conditions. For this reason several balloon measurements of the electrical parameters have been made over Sanriku (Japan), Laramie and Hilo (USA) as a part of Japan-USA cooperative sounding program in recent years (Morita and Ishikawa, 1976 and Morita et al., 1979). More recently, Atmospheric Electrical Measurements Workshop was held at the University of Wyoming in the summer of 1978. The results of workshop are presented by Rosen et al. (1978 and 1979) and will be presented more completely by Rosen et al. (1980). This letter presents briefly some of the results of electric conductivity and ion production rate obtained from the workshop.

2. Measurements

The Atmospheric Electrical Measurements Workshop was made to intercompare several instruments measuring the electrical parameters by the effort of Atmospheric Physics group of the University of Wyoming. The simultaneous measurements of electric conductivity were made on two balloon flights during the workshop. On the first flight the electric conductivity was measured by three universities of Wyoming (Rosen and Hofmann), Tübingen (Gringel) and Nagoya (Morita). The measurement of ion production rate of University of Nagoya (Morita) was also made on this flight (W-183). On the second flight (W-186) two conductivity instruments of Gringel and Morita were compared. The balloon flights were conducted on July 30 (W-183) and on August 4 (W-186), 1978. The positive polar conductivity was measured by balloon-borne small Gerdien type condensers. The condensers used in the present measurements are believed to be suitable at higher altitudes where high mobility ions predominated. On July 30 another conductivity profile was measured by University of Kyoto (Ogawa) using the relaxation method.

Fig.1. A comparison of positive polar conductivity profiles over Laramie, Wyoming on July 30, 1978.

The vertical profiles of ion production rate were measured simultaneously by the University of Wyoming (Hofmann and Rosen) and Nagoya (Morita). The balloon flight was conducted on August 4, 1978 (W-188). The ionization chamber used by University of Nagoya consisted of a sealed aluminium sphere containing clean, dry aged air at ground pressure. The energy absorbed by the wall was 13.5 MeV for proton and 0.77 MeV for electron. The chamber was originally designed and constructed by Ikebe et al. (1970). The University of Wyoming used a large, non-sealed, very thin walled ionization chamber (Hofmann and Rosen, 1979). The chamber was open to the outside atmosphere and inside air was at ambient pressure. The chamber is believed to be more sensitive to the soft component of the cosmic rays and to be negligible the secondary radiation by the wall.

3. Results and Discussions

Fig.1 shows the profiles of positive polar conductivity measured simultaneously during the flight W-183. Open and closed circles in Fig.1 give the measurements of Gringel, and Rosen and Hofmann, while the continuous line shows the results of Morita. Gringel and Morita used the Gerdien condensers of nearly the same geometry and very similar design. On the other hand, the condenser used by Rosen and Hofmann was considerably different geometry and design from the others. Thus the results of Gringel and Morita would be expected to be consistent as is found in Fig.1. However, the results of Rosen and Hofmann seem also agree reasonably with the others. The agreement was also observed in the second set of simultaneous conductivity measurements between Gringel and Morita. The conductivity profile

Fig.2. A comparison of STP ion production rate profiles for W-183, 188 and 220.

measured by Ogawa seems to be different and lower absolute values. The disagreement may be attributed to the difference of the method of conductivity measurements.

Fig.2 shows the results of ion production rate measurements of Nagoya University. The profiles are shown by normalizing the ionization rates to standard temperature and pressure (STP). The agreement of the two profiles of W-183 and 188 is reasonably good. To see the influence of solar activity on ion production rate in the stratosphere, another profile is compared in Fig.2. The profile was obtained on Dec. 19, 1979 (W-220) over Laramie, Wyoming. Above 15 km the difference between the profiles of W-183, 188 and 220 is quite evident. Solar Geophysical Data give the Zürich smoothed sunspot number for Solar Cycle 21 beginning June 1976 in Fig.3. The period of ion production rate measurements is shown by arrows in Fig.3. The variation of observed sunspot value suggests the maximum occurred in

Fig.3. Solar sunspot number versus time during ion production rate measurements.

the interval December 1979-January 1980 and the period coincides with that of the measurements of W-220. Thus the present measurements of ion produc-

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tion rate are in agreement with the inverse correlation of solar activity and galactic cosmic radiation flux. During the flight W-220 the present ionization chamber was also compared with the chamber developed by the University of Wyoming. The results of comparison flights suggest that the agreement is quite good in the altitudes between 5 and 15 km and small difference is evident at higher altitudes. No definitive conclusions can be reached regarding the disagreement at the stratospheric heights at present time. The question will be resolved by further comparison measurements.

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