Tropospheric and Stratospheric Conductivity Measurements in Brazil

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Conductivity measurements were carried out during a balloon flight launched from Cachoeira Paulista, Brazil (22°44′ S, 44°56′ W) on Jan 26, 1994. For the first time negative and positive conductivity profiles with altitude were obtained in Brazil. Along its trajectory the balloon passed over three thunderstorms, as identified by video on-board images. The data give an unique opportunity to study the stratospheric conductivity variations.

INTRODUCTION

Conductivity measurements in the troposphere and stratosphere have been reported by several authors (e.g. Bering et al., 1980; Holzworth and Chiu, 1982; Holzworth et al., 1986; Byrne et al., 1988; Pinto et al., 1988; Hu et al., 1989). The measurements show that in the troposphere the conductivity increases almost exponentially with the altitude and in the stratosphere it is influenced locally by thunderstorms.

On January 26, 1994, a stratospheric balloon was launched from Cachoeira Paulista, Brazil (22°44′ S, 44°56′ W) carrying a double probe electric field detector to measure the conductivity in the troposphere and stratosphere. The payload also carried a video camcorder model Panasonic PV-704, looking downward. Negative and positive conductivity were measured each 10 minutes during about 3 hours in daytime. In the stratosphere, the positive conductivity was found to be contaminated by photoelectric emission, and the data were not considered in this paper.

In this paper the first conductivity profiles for negative and positive conductivities obtained in Brazil are presented. The negative conductivity measurements obtained in the stratosphere are also presented and discussed in terms of thunderstorm related variations. As far we know, this is the first conductivity data in the stratosphere supported by video images.

RESULTS

Figure 1 shows the negative and positive profiles obtained on Jan 26, 1994. Because the high impedance of the atmosphere, the double probe technique is useful only for altitudes above 10 km (Byrne et al., 1988). In order to avoid such a problem, only data above 16 km were considered. Differently of the negative conductivity, the positive conductivity in 26 km already shows the influence of photoelectric emissions, which causes an increase in the measured value. A same behavior was found by Chakrabarty et al. (1994). So, the positive conductivity value in this altitude was not considered in the calculation of the best fit, represented in the figure by a straight line. The linear fits give conductivity scale heights of 5.2 km for negative and 5.8 km for positive conductivity. Figure 2 shows the negative conductivity measurements in the stratosphere obtained on Jan 26, 1994. Due to the small variations of the balloon altitude along the flight, the data are normalized to 25.8 km of altitude using the scale height of 5.2 km. The periods when the balloon was just over the thunderstorms are indicated by ash bars. During these periods, the electric field recovery curves not follow an exponentially curve, and in consequence, no data were available. Also during these periods the electric field remains saturated above the 4 V/m threshold. This behavior may be associated with the high radiation albedo in the top of the thunderstorms (Kreith, 1975; Rao et al., 1990).

DISCUSSION

The negative and positive conductivity values obtained during the ascension of the balloon launched on Jan 26, 1994, in Brazil, showed almost the same value. No evidence was found that the positive conductivity tends to be 10 to 15% higher than the negative conductivity, as it has been claimed by Gringel et al. (1986) and Hu et al. (1994). In consequence, almost the same scale heights were obtained. The values of scale height, 5.2 km for negative and 5.8 km for positive conductivity, are in general agreement with other measurements made in different parts of the world (see, for example, Holzworth, 1991).

The average value of the conductivity in the stratosphere, shown in figure 2, is in reasonable agreement with the average value obtained by Pinto et al. (1988) in the same region during nighttime. The variation of the conductivity in figure 2 shows a systematic decrease when the balloon approaches to a thunderstorm. The conductivity drops by a factor of about 2 in the vicinity of the first thunderstorm, and by a factor of about 1.5 in the vicinity of the second thunderstorm. The same tendency seems to occur in the vicinity of the third thunderstorm. The on-board video images show that in all cases the balloon passed just over the storm. The same behavior in the conductivity was seen by Pinto et al. (1988), although no images were available at that time. We suggest that the systematic decrease of the stratospheric conductivity may be explained by injection in the stratosphere of air parcels containing low concentration of small ions from the top of the thunderstorms, reducing the total concentration of small ions. Such parcels can be found in the interior of the thunderstorms (Makino and Ogawa, 1985).

CONCLUSIONS

The main conclusions of this paper are:
- the first negative and positive conductivity profiles in the troposphere and stratosphere in Brazil were obtained. The scale heights are in reasonable agreement with measurements in other parts of the world.
- the negative conductivity in the stratosphere shows a decrease just over a thunderstorm.

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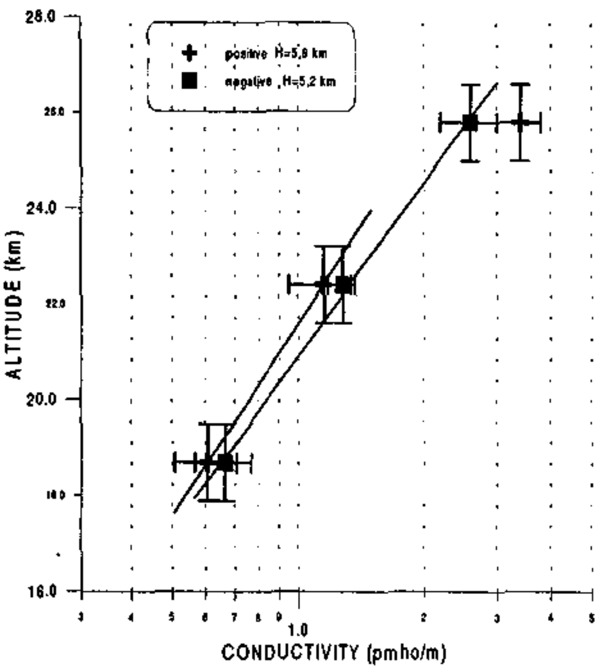

Figure 1 - Vertical profile of negative and positive conductivity obtained on Jan. 26, 1994.

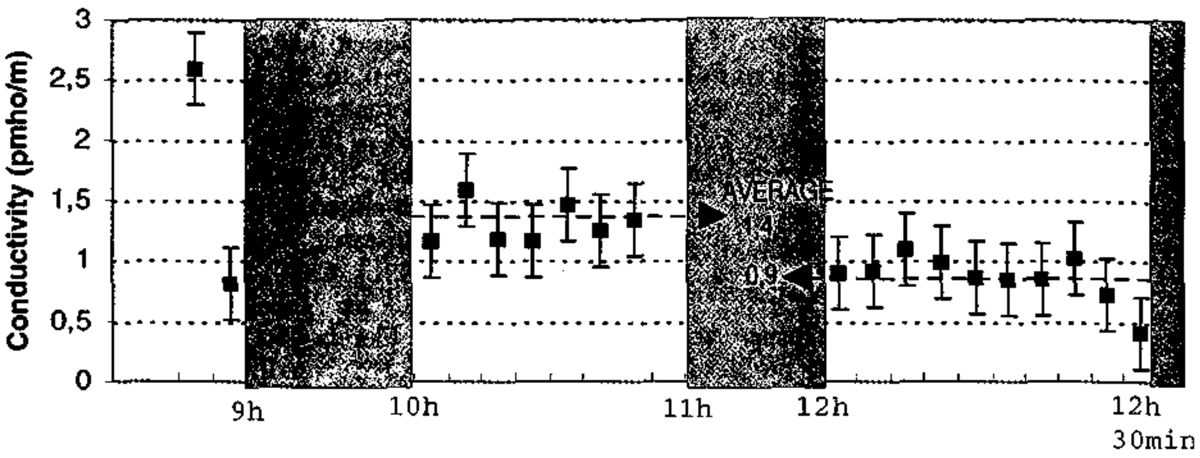

Figure 2 - Negative conductivity measurements obtained on Jan. 26, 1994.