Laboratory Modeling of High-Altitude Discharges

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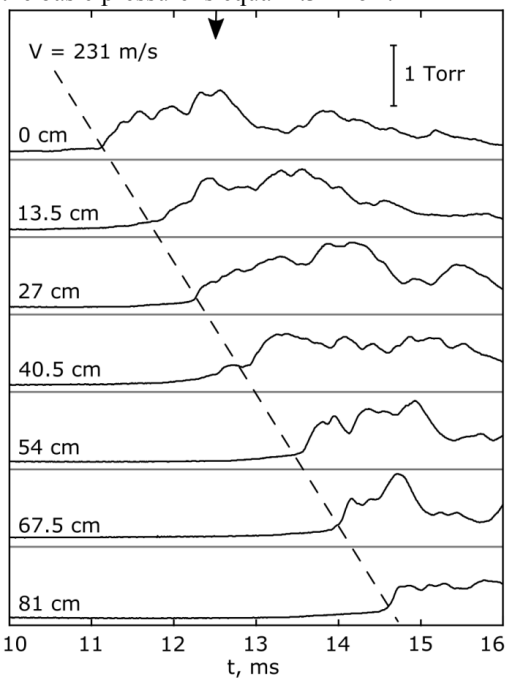
1. Introduction

Sprites and jets are very interesting geophysical phenomena in the Earth's atmosphere, but their laboratory modeling is difficult. Vertical size of discharges are 30-40 km, it means that pressure at the top and at the bottom of discharges differs by about 2 orders. Creation of such high pressure difference in a laboratory is a difficult technical problem.

2. Results

The vacuum chamber 1.9 m long and 1.6 m in diameter was taken for laboratory modeling. We create pressure difference between electrodes in the impulse regime (air valve is opened for 30 ms). Distribution of the pressure along the vacuum chamber in different points between electrodes after air injection is shown in the Fig. 1 (left). After 12.5 ms the pressure near left electrode is the highest and near the right electrode it is still without perturbation. This is a time delay between air injection and voltage supply to the electrodes in all our experiments.

Photos of discharges in the absence and presence of air injection are shown in the first line of Fig. 1 (right). All other parameters are the same in both experiments: the background pressure is equal to 0.35 Torr, the discharge gap is equal to 81 cm, the voltage is equal to 6 kV. The negative electrode is seen as a peak on the left, the positive electrode is a disk on the right. Diffuse discharge forms in the whole volume between electrodes without air injection. During the injection of the air the pressure difference between electrodes reaches 8 times. Streamer discharge forms in the left part of discharge. The maximum current is about 700 A in both experiments, the duration of discharge is no more than 20 µs. During increasing of the pressure diffuse part of discharge becomes smaller and we have practically streamer discharge in the whole volume than the basic pressure is equal 1.31 Torr.



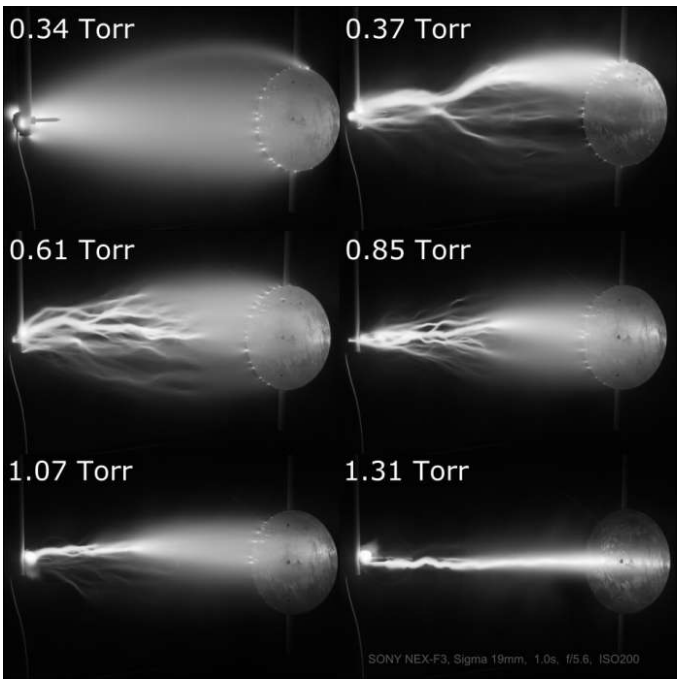


Figure 1. Distrubution of the pressure along the axis of the vacuum chamber during the impulse air injection (left). Discharges in the vacuum chamber with different basic pressure with impulse injection of air (except picture p=0,34 Torr) (right).