

Measurement of Atmospheric Electric Field in Fair Weather by means of Corona Discharge Instrument

Fair-Weather Electrical Properties of the Atmosphere

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Corona discharge occurs at the tip of needle-shaped metal standing on a plane metal plate under an ambient electric field parallel to the plate, because the intensified ambient electric field at the tip causes atmosphere to be plasma. During the corona discharge, flows of small ions in the atmosphere emitted from and moving into the plasma also occur. This causes a corona discharge current inside the needle-shaped metal to compensate an imbalance of electric charge inside the plasma. The relation between the ambient atmospheric electric field E [V/m] and the corona discharge current I [A] is expressed by $I = a (E^2 - M^2)$, where M and a are a threshold of the corona discharge and the constant values depending of the surrounding conductive and morphological conditions, of which the values depend on the polarity of the ambient electric field E . Because of this threshold, the corona discharge current measurement often used under the condition of intensive atmospheric electric field such as the period of thunderstorm.

On the other hand, a weak leak current can be measured before the corona discharge according to laboratory experiments. Since the weak leak current is proportional to the ambient electric field, we apply the measurement of the weak leak current to observe the atmospheric electric field in fair weather. In the experiment, we used the probe equipped with the edge of 8-meter pole standing on the roof of four-story building. From a long-term observation, the measured current is proportional to the atmospheric electric field in fair weather while a square of the measured current is proportional to the atmospheric electric field which agrees with the relation $I = a (E^2 - M^2)$. Therefore, we conclude that this instrument of corona discharge is applicable to the measurement of the atmospheric electric field in fair weather. The mechanism of such a proportional relation is still under discussion. However, an air-earth current along the intensified electric flux is related to the measured current, because the air-earth current is proportional to the atmospheric electric field under a constant condition of atmospheric conductivity.