Geophysical Research Abstracts
Vol. 18, EGU2016-1482-3, 2016
EGU General Assembly 2016

Atmospheric Electricity Effects of Eastern Mediterranean Dust Storms

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Abstract. We present atmospheric electrical measurements conducted at the Wise Observatory (WO) in Mizpe-Ramon (30035'N, 34045'E) and Mt. Hermon (30024'N, 35051'E), Israel, during two massive and unique dust storms that occurred over the Eastern Mediterranean region on February 10-11 and September 08-12, 2015. The first event transported Saharan dust from Egypt and the Sinai Peninsula in advance of a warm front of a Cyprus low pressure system. In the second event, dust particles were transported from the Syrian desert, which dominates the north-east border with Iraq, through flow associated with a shallow Persian trough system. In both events the concentrations of PM10 particles measured by the air-quality monitoring network of the Israeli Ministry of the Environment in Beer-Sheba reached values > 2200 μg m-3. Aerosol Optical Thickness (AOT) obtained from the AERONET station in Sde-Boker reached values up to 4.0. The gradual intensification of the first event reached peak values on the February 11th > 1200 μg m-3 and an AOT $\sim$ 1.8, while the second dust storm commenced on September 8th with a sharp increase reaching peak values of 2225 μg m-3 and AOT of 4.0.

Measurements of the fair weather vertical electric field (Ez) and of the vertical current density (Jz) were conducted continuously with a 1 minute temporal resolution. During the February event, very large fluctuations in the electrical parameters were measured at the WO. The Ez values changed between +1000 and +8000 V m-1 while the Jz fluctuated between -10 and +20 pA m-2 (this is an order of magnitude larger compared to the fair weather current density of $\sim$2 pA m-2. In contrast, during the September event, Ez values registered at WO were between -430 and +10 V m-1 while the Jz fluctuated between -6 and +3 pA m2. For the September event the Hermon site showed Ez and Jz values fluctuating between -460 and +570 V m-1 and -14.5 and +18 pA m-2 respectively. The electric field and current variability, amplitude and the comparison between the two events are very different from the mean fair-weather values measured at both sites.

Dust storms with such intensities are often accompanied by large electrical charging, most likely due to triboelectric processes. The differences in the aerosol source region and meteorological conditions have a major influence on the amount of the electrical charge during such storms. One notable difference between the two events is the wind intensity: while during the February event the Ez and Jz fluctuations were well correlated with wind speeds in excess of 60 km h-1, the winds in the September event rarely exceeded 40 km h-1. Different estimates of the charge generation mechanisms will be discussed.