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Systematic characterization of structural, dynamical and electrical properties of dust devils and implications for dust lifting processes

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Dust devils are convective vortices able to lift sand and dust grains from the soil surface, even in conditions of low wind speed environment. They have been observed not only on Earth but also on other planets of the solar system; in particular, they are largely studied on Mars. Indeed, the contribution of the dust devils to the Martian climate is a highly debated question. In order to investigate this topic, it is important to understand the nature of the dust lifting mechanism by the vortex and characterize the induced electric field.
As part of the development process of DREAMS, the meteorological station on board the Schiapparelli lander of the ExoMars 2016 mission, and of the Dust complex package of the ExoMars 2020 mission, we performed various field campaigns in the Sahara desert (Tafilalt region, Morocco). We deployed a fully equipped meteorological station and, during the 2014 summer, we observed three months of dust devils activity, collecting almost six hundreds events. For each dust devil, we monitored the horizontal wind speed and direction, the vertical wind speed, the pressure drop due to the vortex core, the temperature, the induced electric field and the concentration of dust lifted. This data set is unique in literature and represents up to now the most comprehensive one available for the dusty convective vortices.
Here we will present the analysis of the Moroccan data with particular emphasis on the study of the atmospheric electric field variations due to the passage of the vortices.
The distribution of the vortex parameters (wind speed and direction, pressure, E-field and dust lifted) are showed and compared, when possible, to the ones observed by the Martian surveys. The connection between the E-field and the other parameters will be presented.
In the terrestrial environment, the development of the convective vortices is restricted by the presence of the vegetation and of the urban areas, hence dust devils can impact the climate only on local scale. Instead, on Mars the presence of the dust devils has been confirmed at almost every latitude and altitude and it has been indicated as the possible main source of suspended dust outside the storm seasons. Hence, the study of the dust devils becomes of great importance in order to understand the atmospheric dust loading and the global climate of the planet. In addition, the dust lifting phenomena are probably one of the main source of atmospheric electrification on Mars and the measurement and study of the Martian boundary layer electric field is one of the main objectives of the future Martian space missions, such as ExoMars 2020. Indeed, this mission will accommodate "Dust Complex", a suite of sensors that will monitor lifted dust and atmospheric electric field on the surface of Mars.
For these reasons, the present work represents a useful tool for the understanding of the dust lifting phenomena and their electrification both on Earth and on Mars.