Impact of GLE Events on the Earth's Atmosphere Electrical Properties and the Subsequent Effect on Dust Particles Transport

Athanasios Papaioannou [1], Sotirios A. Mallios [1*], Georgios Papangelis [1], George Hloupis [2]

[1] National Observatory of Athens, Institute for Astronomy, Astrophysics, Space Applications and Remote Sensing, Athens, Greece

[2] University of West Attica, Department of Surveying and GeoInformatics Engineering, Faculty of Engineering, Athens, Greece

The global electric circuit (GEC) represents the electric current pathway in Earth's atmosphere. The GEC is established by the conducting atmosphere, attributed to the presence of ions, created by ionization by galactic cosmic rays radiation, sandwiched between the conductive Earth and the conductive mesosphere–ionosphere, which form the planes of a global leaky capacitor, being kept at potential difference around 250 kV. Additionally, these electrical properties of the Earth's atmosphere can have a potential key role in the life-cycle of desert dust. The dust particles can be charged during their long range transport and along with the gravitational sedimentation can develop vertical electric fields within the dust layer, enhancing the preexisting field.

During a ground level enhancement (GLE) event recorded at Earth, the GEC experiences two major modifications. The first is the enhancement of the atmospheric electrical conductivity due to the increase of the ionization rate. The second is the enhancement of the electrical potential of the lower part of the ionosphere. These two modifications of the electrical properties of the atmosphere can further influence the dust particle transport.

A novel 1D numerical model has been developed to parameterize the charging process in the presence of a large-scale electric field. The model takes into account several atmospheric processes, such as: (i) the ionization due to the galactic cosmic rays radiation, (ii) the ion-ion recombination, and (iii) the ion attachment to dust particles, and is able to self-consistently calculate the time-dynamic evolution of the atmospheric conductivity, and atmospheric electric field, under the presence of a distribution of dust particles. Moreover, the model estimates the acquired electrical charge on the dust particles and calculates the electrical force that is applied on them. In this work, using as inputs to the model the modified ionization rate and the ionospheric potential during GLE59 (14-07-2000), its impact on the electrical properties of the earth's atmosphere and the subsequent effect on the dust particle transport are studied and quantified.

*Acknowledgement.*This research is supported by the project: "Modeling and Measuring Electrical Properties of Desert Dust Layers - Medimnos" (MIS 5049929) under the "[EDBM103] Researcher support with emphasis on new researchers" action of the operational programme "Development of Human Resources, Education and Lifelong Learning" co-funded by the European Social Fund (NSRF 2014-2020) which is co-financed by Greece and the European Union (European Regional Development Fund).