

Remarks on the paper

Atmospheric electric field anomalies associated with solar flare/coronal mass ejection events and solar energetic charged particle “Ground Level Events”

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Possible relationships between solar events and atmospheric quantities have been frequently reported but not always unambiguously established. Research in this direction is therefore highly wanted. The presented paper is meant as a step towards this aim, but can hardly be regarded as a successful one. The main problem is on one hand that the authors consider only three events, on the other hand that the presented results have only one feature in common: namely that the vertical electric field E_z starts to increase already hours before the onset of the charged particle event and before the associated flare.

Therefore none of the presented examples provides a convincing relationship between the vertical electric field E_z and the regarded solar event.

Moreover, Fig. 1 shows that in all four stations measuring E_z its temporal behaviour is different: a short strong fluctuation at Apatity, an increase over several hours at Vostok, fluctuations at Voeikovo, and a very small and short-lived increase at Nagycenk. Can this be all related to the same solar event?

Fig. 2 shows an almost regular fluctuation with a time period of about 1.5 hours which again starts before the solar event. The authors did not mention/explain this regular fluctuation.

In Fig. 3 an association (not a causal relationship!) between the strong E_z increase and the solar event seems to be the clearest, except for the fact that the E_z increase starts again hours before the GLE.

The authors claim in their abstract: “*All three events seem to be associated with relativistic solar protons (i.e. protons with energies >450 MeV) of the Ground Level Event (GLE) type.*” and in their conclusions: “*We suppose that the E_z disturbances observed are caused by solar energetic (with energies exceeding a few MeV) charged particles (electrons and protons) associated with the CME formation.*”, but they fail to present a convincing explanation why the change in E_z starts hours earlier than the GLE onset. They briefly mention different possible reasons for this behaviour, but could not give any firm experimentally-supported explanation (which is admittedly difficult).

It is further not clear why the authors prefer to state a relationship between the observed E_z change and the GLE and not with the associated flare. The x-rays could in principle change the atmospheric conductivity as well as the charged particles.

The authors state at the beginning of their section 2: “*Only five GLEs have been detected in 2001. Unfortunately, fair weather conditions occurred only for three of them.*” The authors did not specify how they define “fair weather conditions”. How do they know that “fair weather conditions” prevailed during the remaining three events?

It is well acknowledged that the authors try to verify many of their possible explanations for the E_z and the solar event behaviour on other work (about 50 references!), but this cannot take the place of firm experimental support for an explanation of the “*pre-SF/CME atmospheric E_z disturbances*”.