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Computation of ion production rate profiles induced by cosmic rays during Bastille day 14 July 2000 ground level enhancement GLE 59

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The galactic cosmic rays are the main source of ionization in the Earth stratosphere and troposphere. They play an important role in various processes related to atmospheric physics and chemistry. Sporadically solar energetic particles enhance the ion production rate, specifically over polar caps. At recent was observed an apparent effect on minor constituents and aerosols over polar region during major solar proton events, specifically during the greatest GLE event (of 23-rd solar cycle) on 20 January 2005. Solar cycle 23 provided several strong ground level enhancements. The studied Bastille day event on 14 July 2000 is the first major event positioned exactly at the maximum of solar cycle 23. The previous four events (GLE 55 –58) in the rise phase of solar cycle 23 were observed with intensities ranging ˜ 3 –11%, i.e. they were still relatively weak.
In the work presented here we apply a full Monte Carlo 3-D model for cosmic ray induced ionization in order to compute the ion production during the Bastille day event. The model is based on atmospheric cascade simulation with CORSIKA code using FLUKA and QGSJET II hadron generators. The ion production rate profiles during the event are considered as a superposition of cosmic rays with galactic and solar origin. The time evolution of ion production rate is computed considering the variation of solar proton spectra throughout the event, apparent source position and anisotropy. The ion production rate is computed as a function of the altitude above the sea level at several geomagnetic cut-off rigidities, namely 1 GV, 2 GV and 3 GV. The total ionization effect is also estimated.
The present study is part of a larger research project on impact of galactic and solar cosmic rays on the atmosphere during 23-th solar cycle. During the solar cycle 23, sixteen GLE events were observed. The greatest of them are: the considered here Bastille day event on 14 July 2000 (GLE 59), the Easter events on 15 and 18 April 2011 (GLEs 60 and 61), the Halloween events on October-November 2003 (GLEs 65, 66 and 67), the GLE 69 on 20 January 2005 and the GLE 70 on 13 December 2006. The comparative study of the effects of these GLE events is of great importance for space physics as well as for space weather and space climate.

Collaboration

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