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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Influence of a Carrington-like event on the atmospheric chemistry, temperature and dynamics" *by* M. Calisto et al.

Anonymous Referee #2

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General comments: This paper is well-motivated and generally well-written regarding the influence of a Carrington-like event on the atmosphere. The authors use a global circulations model in their study and scale-up the August 1972 SPE for altitude and time dependent ionization rates, which are used as input for their model. They find very significant responses in the atmospheric constituents and temperature from such an event. I recommend that the paper be published subject to the authors considering these three specific comments and three suggested technical corrections.

Specific comments: 1) p. 14753 (lines 25-27) and p. 14754 (lines 1-2): "This procedure suggests that there is hardly any penetration of the signal into the troposphere, which

means that the event is unlikely to produce a nitrate spike in the ice core records. If correct, this depris us of using ice core nitrate as a potent indicator of such events (Wolff et al., 2012)." Comment: I agree that it does seem unlikely that such an event would produce a nitrate spike in the ice core records. However, there has been discussion in the literature indicating that an increase of odd nitrogen in the stratosphere could be transported to the ground via either stratosphere/troposphere exchange or denitrification through polar stratospheric clouds (e.g., F. M. Vitt et al., J. Atmos. Solar-Terr. Phys., 62, 669-683, 2000). Perhaps the discussion in the paper should be modified slightly, given that direct production of odd nitrogen in the troposphere is not the only way to communicate a signal of nitrate to the ground.

2) p. 14753, lines 20-21 and Figure 1: "The ionization rates taken from Rodger et al. (2008)..." Comment: It wasn't clear how much the August 1972 ionization rates were increased to provide ion rates for the Carrington event. The discussion in this paper and the Rodger et al. (2008) study imply that it depends on the proton energy. It would be nice to have a couple of values indicated in the manuscript regarding this scaling. Something like "The proton flux at 30 MeV for the August 1972 period was scaled by X to derive the Carrington event proton flux at that energy." would be helpful. For example, Thomas et al. (2007) increased their computed October 1989 ionization rates by a factor of 6.5 to derive their Carrington event values.

3) Figure 1: Ionization rates Comment: The ionization rates presented in Figure 1 appear to be somewhat similar values as those presented in Figure 4 of D. W. Rusch et al. (Planet. Space Sci., 29, 767-774, 1981) for the August 1972 event. Rusch et al. (1981) show a peak ionization rate of >40,000 cmˆ-3 sˆ-1 whereas this paper appears to have a peak rate of >25,000 cmˆ-3 sˆ-1 (if I am reading the contours correctly). It does appear that the peak ionization rate is slightly higher in altitude in this work than in the Rusch et al. (1981) paper. Some mention of this previous study would be of use here.

Suggested technical corrections:

ACPD

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1) p. 14751, line 23: Change “as reference event” to “as a reference event”

2) p. 14752, lines 2-5: Remove sentence “The energy deposition and ionization rates (IR) due to primary protons and secondary electrons with respect to altitude were then calculated using a method utilizing energy-range relationships for protons (Verronen et al., 2005).” Comment: It seems like this sentence is mostly a restatement of the previous sentence in the paper: “In order to model the Carrington Event, we adopted the altitude dependent ionization rates (IR) from Rodger et al. (2008), which were calculated using a method utilizing energy-range relationships for protons (Verronen et al., 2005).”

3) p. 14754, line 1: Change “depris” to “deprives”

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 14747, 2012.