Icarus 220 (2012) 889–895

Contents lists available at SciVerse ScienceDirect

Icarus

journal homepage: www.elsevier.com/locate/icarus

Influence of solar flare X-rays on the habitability on the Mars

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ARTICLE INFO

Article history:
Received 13 October 2011
Revised 5 June 2012
Accepted 5 June 2012
Available online 23 June 2012

Keywords:
Astrobiology
Mars
Mars, Atmosphere
Solar radiation
Search for Extraterrestrial Life

ABSTRACT

We probe the lethality of X-rays from solar flares to organisms on Mars based on the observations of 10 solar flares. We, firstly, estimate the doses produced by the strong flares observed by the RHESSI and GOES missions during the descending phase of sunspot cycle 23. Next, in order to realize the dependence of dose on flux and steepness of spectra, we model the incident spectra over a wide range of spectral index to estimate dose values and compare them with the observed doses. We calculate the distribution of surficial spectra visible to organisms on the martian surface by employing attenuation of X-rays due to CO_2 column densities distribution over the South Pole. The surficial flux distribution after folding with the opacity of water enables us to estimate the dose distribution over the South Pole. The dose measured from the surficial spectrum produced by the observed 10 flares corresponding to the latitudes 50–60°, 60–70°, 70–80° and 80–90°S varies in the range of 6.39×10^{-9}–1.80×10^{-6}; 4.89×10^{-10}–5.21×10^{-8}; 5.10×10^{-11}–5.20×10^{-9} and 4.42×10^{-10}–4.89×10^{-12} gray (1 gray = 10^4 erg/g) respectively. Comparing the measured as well as the modeled doses with those proposed to be lethal for various organisms by Smith and Scalo (Smith, D.S., Scalo, J. [2007]. Planet. Space Sci. 55, 517–527); we report that the habitability of life on the South Pole remains unaffected even by the strongest solar flare occurred during descending phase of solar cycle 23. Further, the monthly integrated energy released by the solar flares in the most productive month *viz.* October 2003 and January 2005 from the GOES soft X-ray observations is estimated to be 8.43 and 3.32×10^{32} ergs respectively, which is almost equal in order to the typical energy released by a single strong X-class flare. Therefore, we propose the life near the South Pole region on the Mars remain uninfluenced by X-ray emission even during monster phenomena of energy release on the Sun and/or Star.

1. Introduction

The thin atmosphere of the Mars is transparent to all high energy radiation such as UV, X- and gamma-rays, and high energy particles, which may be lethal on the martian surface. Thus habitability for all types of life from human to microbial is a central problem for Mars exploration, suggests improving our current knowledge of surficial radiation doses from all possible sources.

Solar flare X-ray emission is several orders of magnitude higher than the pre-flare coronal X-ray background (Jain et al., 2005, 2008), and therefore large dose rates are possible. Smith and Scalo (2007) have studied the potentially high doses of ionizing radiation during strong solar X-ray flares over putative organisms on the martian surface. They employed the power-law behavior of flare spectra to estimate the surficial spectra and biological doses from indirect genome damage over the X-ray opacity of water. They found that the resulting doses depend sensitively on the slope of the power law for the energy spectrum of the flares, which varies greatly and unsystematically for solar flares. In addition they consider flare energies much greater than observed for the Sun, up to 10^{38} ergs, based on observations of active solar mass stars. From their modeling studies, Smith and Scalo (2007) conclude that lethal flare events would occur on Mars with a recurrence interval of decades for humans, to millions years for radiation resistance microorganisms. However their results are model dependent with strong sensitivity to the total flare energy and the spectral index. Further, the total energy emitted in the form of X-rays from the stellar sources may not be of much concern while estimation of lethality on Mars. For example, the nearest star from the Solar System after the Sun, Alpha centaury is $\sim 2.75 \times 10^5$ times away from Mars relative to the Sun suggesting 10^{10} times reduction in the flux and hence equivalent less energy over the martian atmosphere. Thus, it is of interest to consider the actual flare history of the Sun over recent time to compare recorded flares to the modeling results of Smith and Scalo (2007).

In this paper we investigate the behavior of the surficial X-ray spectrum and dose values from both the observed and modeled

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0019-1035/$ - see front matter © 2012 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.icarus.2012.06.011