Solar flare activity as a new, unknown source of ^{3}He in the atmosphere

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Measurements of helium in the atmosphere suggest a supply of crustal ^{4}He from fossil fuel emissions since the onset of industrial activity [1,2]. However, corresponding ^{3}He/^{4}He ratio of air appears near-constant [3,4], which calls for an unknown source of ^{3}He to compensate contribution of anthropogenic ^{4}He. Here we report ^{3}He/^{4}He variations measured in atmospheric air during a solar flare event. Samples were collected in Ny-Ålesund, Svalbard islands near the North Pole. On September 6th, 2017, a massive solar explosion, or solar flare, occurred. The solar wind was expected to reach the Earth on September 8th [5]. Therefore, the dates of air sample collection were set for eight days about one week apart, from August 30th to October 18th, 2017. The ^{3}He/^{4}He ratios were measured in the samples and calibrated against the standard atmosphere collected in Kashiwa City, Chiba Prefecture, Japan [6]. The ^{3}He/^{4}He ratios varied from -6.1‰ to +7.9‰ compared the air standard. The ^{3}He/^{4}He ratios of 12 samples agreed with the atmospheric values of Kashiwa within uncertainties. A total of five samples showed an excess of ^{3}He compared the atmospheric ratio. These samples were collected on September 13th, 20th, and 27th, immediately after the solar flare event of September 6th. If the solar wind, enhanced by solar flares, was fed into the atmosphere by the auroral precipitation mechanism [7], it would increase the polar atmospheric helium isotope ratio. The helium would then be diluted by diffusion and the excess ^{3}He would rapidly disappear. We therefore propose that the unknown source of ^{3}He capable to compensate for anthropogenic addition of ^{4}He is the injection of solar wind-derived ^{3}He into the atmosphere.

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