

Atmospheric helium isotopes and unknown source of helium-3

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Helium abundance measurements in the atmosphere suggest a supply of crustal ⁴He from natural gas extraction since the onset of the industrial era. However, the ³He/⁴He ratio of air appears near constant, which calls for an unknown source of ³He to compensate for the contribution of anthropogenic ⁴He. Here we report air ³He/⁴He variations measured during (1) a massive solar flare event and (2) after a large volcanic eruption. During the massive X9.3 solar flare of September 6th 2017 event, air ³He/⁴He variations were observed in Ny-Ålesund, Svalbard Islands near the North Pole. The solar wind was expected to reach the Earth on September 8th. Three air samples – which were collected after the solar flare event – showed an excess of ³He, up to 5.5±1.7‰ (d³He), compared to the terrestrial atmospheric isotopic value. If the solar wind, enhanced by solar flares, was embedded into the atmosphere by auroral precipitation, it would increase the polar atmospheric helium isotope ratio. In addition we found ³He/⁴He variations after the large eruption of Hunga Tonga-Hunga Ha'apai in the south Pacific Ocean on January 15th 2022. Immediately after the eruption, air ³He/⁴He increased significantly in Kochi city, southwest Japan. Supplied ³He excesses from these events (solar flare and volcanic eruption) may keep the atmospheric ³He/⁴He constant.