The controversy of the variation of the helium isotopes ratio in air with latitude

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The helium isotopic ratio of the atmosphere, $R_a={}^3He/{}^4He=1.39*10^{-6}$, is commonly considered constant on a global scale [1]. However, mining and burning of fossil fuels might change this ratio on a short timescale by release of crustal ^4He [4]. These anthropogenic activities, prevelant in the northern hemisphere, have been suggested to increase R_a from north to south by $(0.16 \pm 0.08) \times 10^{-5}$ R_{HESJ} ($^3He/^4He$ ratio of the Helium Standard of Japan) per degree of latitude [6]. However, because interest in this variation is relatively new, the data does not currently cover a wide range of latitudes. A larger data set is needed to verify this variation, which is very small (permil level), and so, potentially highly influenced by experimental/ analytical processes or/and lack of data.

In the CRPG noble gases laboratory, we analyzed normalized R_a of ten air samples collected at different latitudes around the world. We used a multi-aliquots method, a newly design air-line and a static Thermo Helix Split Flight Tube (SFT) multi-collector noble gas mass spectrometer [2]. We detect likely oscillatory variation of the mean value of R_a with latitude (including previous data [3] [5] [6], 2σ) by using Student's t-test (95%). This variation is consistent with the tropospheric circulation. We found lower R_a values around 60ºN/S and at the equator, related to preferential loss of ^3He from high evaporation rate, and in contrast, higher R_a values around 30ºN/S corresponding to a high pressure areas. However, the change of the R_a seems not obvious if we consider that all uncertainties are mostly overlapped.

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