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Flux of small interplanetary dust particles at Dome C (Antarctica):A fresh look with helium isotopes

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Cosmic dust including interplanetary dust particles (IDPs) and micrometeorites (MMs) range in size from ≤ 1 μm to ≅ 1 mm and represent the dominant source of extraterrestrial (ET) material entering Earth's atmosphere, with 5,200 tons/year [4]. However, dust accretion rates, volatile contents and histories of atmospheric heating are still debated [5]. In particular, the flux of ET particles smaller than 50 microns remains highly uncertain and strongly differs from that expected from numerical simulation by CABMOD-ZoDy [1]. Moreover, these IDPs bring to Earth $^{3}He_{ET}$ that is subsequently mixed in sediments and can provide a good proxy for geochemical reconstructions (e.g., sedimentation rates and detection of anomalous ET spike). Traditional particle counting techniques to determine ET material fluxes remain challenging and affected by large uncertainties [4]. Here, we measured the helium-3 and helium-4 concentrations in cosmic dust concentrated in ultra-clean snow from the Concordia station located at Dome C (Antarctica) [2]. After several steps of snow filtration down to 0.47 μm using a dedicated pressurized system, filters concentrating cosmic dust particles were observed under a microscope and the volume and mass of particles were estimated. The filters containing the recovered particles were then heated using an induction furnace and analyzed for their helium isotopic abundances using a Thermo Scientific SFT mass spectrometer. From these data, we attempt to better estimate the $^{3}He_{ET}$ annual flux and the mass of dust particles accreted to Earth. After compiling the available literature data, we observe that high helium and neon concentrations are correlated with the surface-to-volume ratios of particles, confirming that the implantation of solar wind ions in space [3] is likely the main source of light noble gases in IDPs and MMs.

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