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Ion erosion from the EUV heated and extended nitrogen atmosphere of early Earth

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Abstract

During the first Gyr after the Earth's origin and the arrival of the Sun at the Zero-Age-Main-Sequence, the Sun's X-ray and EUV flux was much higher than at present. Recent studies indicate that EUV flux values 10 or 20 times higher than that of the present Sun can heat the nitrogen-rich thermosphere and expand the exobase of early Earth to altitudes well above the expected magnetopause distance. We investigate whether the early Earth could have had a nitrogen atmosphere which survived the period of high EUV radiation of the young Sun. We show that this may result in a magnetically non-protected upper atmosphere and thus in high nitrogen ion pick up escape rates. We studied the plasma induced nitrogen ion pick up escape by applying numerical test-particle stellar wind plasma - exosphere interaction model. Our results indicate that the ancient terrestrial atmosphere should have contained much more IR-coolers (e.g., CO_2, H_3^+, etc.) in the early Earth thermosphere than today in order to prevent the loss of the nitrogen inventory from early Earth.