Geophysical Research Abstracts
Vol. 15, EGU2013-11611, 2013
EGU General Assembly 2013

The dependence of peak electron density on solar irradiance in the ionosphere of Mars

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The dominant ionospheric layer at Mars is produced primarily by extreme ultraviolet solar photons that ionize atmospheric CO_2. Previous investigations of the Mars ionosphere have concluded that increased solar ionizing flux leads to increased peak electron densities. These investigations have used the $F_{10.7}$ or $E_{10.7}$ solar indices as a proxy for the solar ionizing flux at Mars. Many have represented this relationship using $N_0 \propto F^k$, where N_0 is the subsolar peak electron density, F is either $F_{10.7}$ or $E_{10.7}$, and k is an exponent. These exponents have varied greatly and most are less than $k = 0.40$. Here we explore different proxies for the ionizing solar flux at Mars using Mars Global Surveyor radio occultation data and solar spectra measurements from the TIMED-SEE instrument. We have integrated TIMED-SEE spectra up to 90 nm, the ionization threshold of CO_2, and used this as a proxy for the solar ionizing flux. We have used energy flux spectra, photon flux spectra, and the total number of ionizations to derive exponents of 0.47 ± 0.02, 0.54 ± 0.03, and 0.52 ± 0.02 respectively. Our derived exponents are larger than those found by previous investigations that used $F_{10.7}$ or $E_{10.7}$. The exponents are also close to the theoretical prediction of simplistic Chapman theory, which predicts $k = 0.50$. The significant difference in the derived exponents using our proxy compared to $F_{10.7}$ or $E_{10.7}$ may imply that these indices are not an accurate description of the ionizing flux at Mars. Although our proxy has many uncertainties associated with it, it is based more on the physical conditions at Mars than $F_{10.7}$ or $E_{10.7}$ and may be a better representation of the ionizing flux at Mars.