MODELLING OF ATMOSPHERIC IONIZATION DUE TO ENERGETIC PARTICLES WITH VARIOUS POPULATION

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An extension of the widely used cosmic ray ionization model CRAC (Cosmic Ray Atmospheric Cascade) [1], namely CRAC:EPII (Cosmic Ray Atmospheric Cascade: Electron Precipitation Induced Ionization) [2] and CRAC:HEPII (Cosmic Ray Atmospheric Cascade: High Energy Proton Induced Ionization) is presented. The model upgrade allows one to compute the atmospheric ionization due to various populations of particles, namely precipitating electrons and precipitating and/or high energy protons, galactic cosmic rays, solar energetic particles. The models are full target, namely they are based on a full Monte Carlo simulation of particle propagation and interaction in the atmosphere. Therefore, the model within his extension considers explicitly all the physical process involved in atmospheric ionization. The Monte Carlo simulations are performed with the PLANETOCOSMICS code with NRLMSISE 00 atmospheric model employed. The model is based on a well-known formalism of precomputed yield functions. A practical receipt for computation of electron impact ionization, using various model spectra and angular distributions is shown. A quantitative comparison with parameterization driven model of atmospheric ionization induced by precipitating electrons is carried out and good agreement is achieved [3]. Several example applications are shown. An updated ionization yield function by primary cosmic ray protons in the upper/middle atmosphere is also presented and several practical applications are demonstrated, namely the computation of enhancement of atmospheric ionization during strong solar particle events.

[1] I. Usoskin and G. Kovaltsov, Journal of Geophysical Research 111 (2006) D21206.
[2] A. Artamonov et al., Journal of Geophysical Research 121 (2016) 1736.
[3] A. Artamonov et al., Journal of Atmospheric and Solar-Terrestrial Physics 149 (2016) 161.