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Comparison of two-stream and kinetic methods of calculation of photoelectron effects

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Photoelectrons are an important source of ionization and ambient electron heating in ionosphere. Primary photoelectrons are produced via ionization of neutral atoms in thermosphere by solar EUV photons. Secondary photoelectrons are produced via ionization by primary photoelectrons. There are different ways of calculation of photoelectron effects. The most accurate way is to use the kinetic approach where photoelectrons are represented as particles, propagation of photoelectrons along field lines is calculated using either the dynamics equations or the laws of conservation of energy and magnetic moment, and each collision between a photoelectron and a neutral is treated individually. The benefit of this approach is that there are no limiting assumptions on the shape of the photoelectron velocity distribution function. The drawback is the high numerical cost. Another way is the two-stream approach of Nagy and Banks [e.g. Journal of Geophysical Review, 75, 6260, 1970]. In this approach, the photoelectrons are separated into a number of energy bins, for each bin there is a flux of photoelectrons propagating downward and a flux propagating upward, and continuity equations are solved for the fluxes in each bin. This approach has significantly less numerical cost than the kinetic one, but it is potentially less accurate because it assumes that the photoelectrons are isotropic. In this paper, both the kinetic and the two-stream methods are applied to calculate photoelectron effects along the same field line. The resulting rates of ionization and heating, as well as fluxes of photoelectrons with different energies are compared. The deviation of the angular distribution of photoelectrons predicted by the kinetic method from isotropic is discussed.

Keyword-1

photoelectrons

Keyword-2

kinetic algorithm

Keyword-3

two stream method

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