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Solar wind evolution since 1990 and H ENA ionization rates and survival probabilities in the heliosphere

J.M. Sokol (1), M.A. Kubiak (1), M. Bzowski (1), M. Tokumaru (2), K. Fujiki (2), D.J. McComas (3), and P. Bochsler (4)

(1) Space Research Centre PAS, Warsaw, Poland (jsokol@cbk.waw.pl), (2) Solar-Terrestrial Environment Laboratory, Nagoya University, Nagoya, Japan, (3) Southwest Research Institute and University of Texas, San Antonio TX, (4) Space Science Center & Department of Physics, University of New Hampshire, Durham NH

We derive the solar wind speed and density evolution in heliolatitude and time from 1990 to the end of 2011 based on remote-sensing and in-situ data sources in and out of the ecliptic plane and use it to calculate survival probabilities of heliospheric Energetic Neutral H Atoms (H ENA) in the energy range observed by the Interstellar Boundary Explorer (IBEX). We determine the heliolatitude structure of the solar wind speed using remote-sensing radio observations of interplanetary scintillations processed using the Computer Assisted Tomography algorithm and obtain yearly profiles on a 10-degree heliolatitude grid, which agree well with the in-situ measurements by Ulysses. Since the in-situ information on the solar wind density structure out of ecliptic is only available from the Ulysses data, we derive correlation formulae between solar wind speed and density profiles from Ulysses fast latitude scans and calculate the 3D structure of solar wind density. For the ecliptic heliolatitude band we use in-situ measurements from the OMNI-2 collection. Having obtained evolution of solar wind speed and density in time and heliolatitude, to calculate the ionization rate of H ENA we need the photoionization rate of H, which we obtain from TIMED SEE and SOHO CELIAS/SEM measurements supplemented with proxies. With the history of evolution of the solar factors responsible for the ionization of H ENA derived, we calculate the survival probabilities of H ENA observed by IBEX. To that end, we employ an atom-tracing approach. We track the atom trajectories from IBEX backwards in time up to the termination shock, solving the equation of motion and simultaneously calculating the survival probability against ionization. The equation of motion includes the forces of solar gravity and radiation pressure, which is a function of the total solar flux in the Lyman-alpha line and of radial velocity of the atom relative to the Sun due to the Doppler effect. To model the radiation pressure, we use a composite time series of the solar Lyman-alpha flux compiled by the Laboratory for Atmospheric and Space Physics (LASP), University of Colorado, and a model of the solar Lyman-alpha line evolution in time based on solar Lyman-alpha observations from SOHO SUMER. The survival probabilities are presented as a function of ENA energy, time, and heliolatitude.