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Kinetic features observed in electron distributions and their consequences in solar wind modelling

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More than 120 000 of velocity distributions measured by Helios, Cluster and Ulysses in the ecliptic have been analyzed within an extended range of heliocentric distances from 0.3 to over 4 AU. The velocity distribution of electrons reveal a dual structure with a thermal (Maxwellian) core and a suprathermal (Kappa) halo. A detailed observational analysis of these two components provides estimations of their temperatures and temperature anisotropies. The core temperature is found to decrease with the radial distance, while the halo temperature slightly increases. For low values of the power-index kappa, these two components manifest a clear tendency to deviate from isotropy in the same direction, that seems to confirm the existence of mechanisms with similar effects on both components, e.g., the solar wind expansion, or the particle heating by the fluctuations.

We took into account Kappa-distributed populations of electrons to develop a kinetic solar wind model. Low values of the parameter kappa are associated to an enhanced population of suprathermal electrons leading to higher velocities at large radial distances. Boundary conditions are based on observational input of photospheric magnetograms. The initial magnetic field is then reconstructed using a potential field source surface (PFSS) scheme to provide the magnetic field from the photosphere up to the PFSS at low radial distances in the corona. The magnetic field reconstruction allows us to associate specific structures observed in the photosphere (like coronal holes and sunspots) to specific solar wind sources. Conditions of densities, velocity and temperatures at the exobase level are then associated to the magnetic field characteristics on the basis of previous observations. They are used as boundary conditions at the exobase to obtain an extended radial profile of the velocity distribution functions of the particles from the corona higher up in the heliosphere. The results arecompared with solar wind observations from OMNI at 1AU to obtain the best prediction of solar wind characteristics.