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Radial Evolution of Non-thermal Electron populations in the Low-latitude Solar Wind: Helios, Cluster and Ulysses observations

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We have performed a statistical study of a substantial amount of solar wind electron velocity distribution functions (eVDFs). In our data set we combine measurements acquired on-board three spacecraft (HELIOS, CLUSTER II and ULYSSES) in the low ecliptic latitudes covering the heliocentric distance from 0.3 up to 4 AU. In this study we focus on the non-thermal properties of the measured eVDFs in both the slow and the fast solar wind regimes. All three eVDF components typically observed in the solar wind, i.e. the core, the halo and the strahl, are modeled analytically. We study the radial evolution of the basic eVDF moments, i.e. density, temperature and heatflux, of the three electron components and also the non-Maxwellian character of the high energy eVDF tails as a function of the radial distance from the Sun. In addition, we provide results on break-point energy between thermal and nonthermal part of the eVDF and verify also the zero-current condition. We then summarize all mean electron properties in the radial evolution of the model eVDF.