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Evolution of the electron heat flux in the expanding solar wind: Helios observations

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Electron velocity distribution functions (eVDFs) observed in the solar wind exhibit significant deviations from Maxwellian properties. In particular, a considerable skewness, the so-called strahl population, is typically present along the local magnetic field at supra-thermal energies. Supra-thermal electrons, building up the non-thermal strahl tail of the eVDF, carry a substantial part of the heat flux in the solar wind. Understanding the fundamental heat transport and dissipation in the expanding solar wind plasmas therefore requires a detail analysis of eVDF properties and kinetic treatment of observed phenomena. Here we present a large survey of electron heat flux properties as observed between 0.3 and 1 AU by the Helios I&II spacecraft. The study is based on a full analytical modeling of measured 2D eVDFs and consequent analysis of derived eVDF moments. Particularly we examine electron heat flux properties and their evolution along the solar wind expansion with respect to local electron temperature and temperature gradient. In addition we compare our findings with theoretical approaches of the heat transport in plasma environments.