Equatorial pitch angle distributions in Earth's radiation belts: an empirical model from Van Allen Probes data

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Earth's radiation belts comprise complex and dynamic systems, depending substantially on solar activity. The pitch angle distributions (PADs) play an important role for radiation belts modelling, as they yield information on the particle transport, source and loss processes. Yet, many missions flying in the radiation belts provide omni-directional or uni-directional electron flux measurements and do not resolve pitch angles. We propose an empirical model of the equatorial PADs and a method to retrieve PADs from omni-directional flux measurements at different energies and locations along the inclined orbits. We use the entire dataset of MagEIS and REPT instruments aboard the Van Allen Probes (RBSP) mission to analyze the equatorial pitch angle distributions in the energy range from 30 keV to 6.2 MeV. The fitting method resolves all main types of PADs, including butterfly and cap distributions, and the resulting coefficients are directly related to the PAD shapes. The developed model can be used to obtain pitch angle resolved fluxes for GPS, Arase and other missions. The proposed algorithm is applied to the GPS electron flux data set to obtain the pitch-angle resolved fluxes, which are compared to the RBSP data at a number of GPS-RBSP conjunctions. The proposed model also allows one to reconstruct the pitch-angle resolved data using LEO measurements. The dynamics of the fitting coefficients based on solar activity is discussed with respect to AE, Kp, Dst indices and solar wind parameters: velocity, density and dynamic pressure.