PI: Yuri Shprits/University of California Los Angelos
Title: Quantifying Losses and Sources of Relativistic Electrons Using Kalman Filtering

Abstract: In this study we propose to create tools and develop methods which will enable critically need science advances (A. 21_1.2.1 LWS TR&T announcement) in the radiation belt research and may be applied in other fields. The created tools will optimally assimilate and portray data from different sources for LWS research and forecasting objectives (A. 21_1.2.1 LWS TR&T announcement). The developed software will be capable of globally reconstructing equatorial radiation belt fluxes with high time resolution for future use in analyzing results from the future LWS RBSP mission. We will use satellite data from CRRES, HEO, SAMPEX, Polar, LANL and GPS combined by means of Kalman filtering with a radial diffusion model. The results will provide an insight into the physics of the acceleration and loss mechanisms in the outer radiation zone (a key Objective 5.14 of the NASA Strategic Plan, Understanding the fundamental physical processes of space plasma physics) and can be also used to develop new empirical models (A. 21_1.2.1 LWS TR&T announcement) of the radiation belts. Our estimation of the accurate initial conditions may be used for advancing radiation belt nowcasting (NASA report TM-2002-211613 Section 3.2.2 of the LWS mission Definition Team). Using these tools we will be able to estimate the errors of the various detectors on the various satellites which will be used for the parameter estimation of the model. We will apply extended sequential Kalman filtering techniques to find unknown parameters of the system and thus compensate for missing or misrepresented physics in the model. The data from different satellites will sequentially change the parameters of the system and drive them to their true values. This study will deliver tools and methods for understanding and quantifying the high energy electron radiation belt fluxes. The methodology developed in this study can be also used for advancing other areas of LWS research, where sparse and low resolution data can be combined with physics based model to globally reconstruct observations and to find the unknown physical parameters of the system. The proposed research is central for the LWS objectives as suggested in the NASA report TM-2002-211613 Section 3.1 of the LWS mission Definition Team: Data assimilation models combine measurements, empirical models, and mathematical optimization methods and first principles models to provide the most realistic possible picture of the present condition or updates and corrections to the propagation of conditions forward in time. In this way these models improve nowcasting and forecasting.