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Quantitative Assessment of CRAND Contribution to the Relativistic Electrons in the Inner Belt and Slot Region

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The Galaxy is filled with cosmic-ray particles, mostly protons with kinetic energies greater than hundreds of MeV. Around Earth, trapped energetic protons, electrons and other particles circulate at altitudes from about 500 to 40,000 kilometers in the Van Allen radiation belts. Soon after these radiation belts were discovered six decades ago, it was recognized that the main source of inner-belt protons (with kinetic energies at and greater than tens to hundreds of MeV) is cosmic-ray albedo neutron decay (CRAND). In this process, cosmic rays that reach the upper atmosphere interact with neutral atoms to produce albedo neutrons, which, being prone to β-decay, are a possible source of geomagnetically trapped protons and electrons. These protons would retain most of the kinetic energy of the neutrons, while the electrons would have lower energies, mostly less than one MeV. The viability of CRAND as an electron source has, however, been uncertain, because measurements have shown that the electron intensity in the inner Van Allen belt can vary greatly, while the neutron-decay rate should be almost constant. Here we show direct measurements of relativistic electrons near the inner edge of the inner radiation belt, where only quasi-trapped population exist, made by Colorado Student Space Weather Experiment (CSSWE)/Relativistic Electron and Proton Telescope integrated little experiment (REPTile). We demonstrate that the main source of these electrons is indeed CRAND, and that this process also contributes to electrons elsewhere [1].

Following the direct identification and measurements of CRAND produced electrons near the inner edge of the inner belt, we extend the study addressing more in-depth questions: (1) What is the relative CRAND contribution to the inner belt and slot region comparing with electrons injected from further out? (2) How does this relative contribution depend on the geomagnetic activity and energy of the electrons? (3) What is the solar cycle dependence of CRAND electrons? In order to answer these questions, extended data of relativistic electrons in the inner belt and slot region are needed for a much longer time period and also finer energy resolution is required. Thus we will analyze and model data from other low Earth orbit measurements, such as from SAMPEX/PET, DEMETER/IDP, and PROBA-V/EPT, in addition to data from CSSWE/REPTile. Results centered around the above questions will be presented and discussed.

[1] Li, Xinlin, Richard Selesnick, Quintin Schiller, Kun Zhang, Hong Zhao, Daniel Baker, and Michael Temerin (2017), Measurement of electrons from albedo neutron decay and neutron density in near-Earth space, *Nature* 552, 382-385, doi:10.1038/nature24642.