Long-term observations of the trapped high-energy proton population (L<4) by the NOAA polar orbiting environmental satellites (POES)

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The Space Environment Monitor (SEM) onboard the NOAA POES satellites has been measuring the near-Earth charged particle environment since 1978, providing an extensive database that can be used for studying the long-term behavior of this population of trapped particles. POES stands for Polar Orbiting Environmental Satellite series. These satellites orbit at ˜840 km altitude and at an inclination of 98o. The SEM-1 instrument was flown on the POES NOAA-12, -13, and -14 satellites (from 1978). Its replacement, SEM-2, has flown on the POES NOAA-15, -16, and -17 satellites (from 1998). Here we are interested in studying the statistical variations of the long-term behavior of the high-energy trapped proton environment. Among the detectors in SEM (details to be given in the final manuscript), the four SEM-2 omni-directional proton detectors for energies >16 MeV, >36 MeV, >70 MeV, and >140 MeV provide the data most relevant to this study.

For this study, the SEM-2 omni-directional detector data from each satellite (NOAA-15, -16, and -17) were accumulated over 8-second intervals and arranged/collected on a 1o latitude by 2o longitude grid. The data set covers the period between June 1, 1998 and June 30, 2005. This amounts to about 15 years of satellite data. The spatial grid covers latitude center values from 65.5o north to 72.5o south and longitude center values from 1o east to 359 o east. Typically there are 1700 to 2100 individual data entries per detector within each longitude-latitude bin. For each spatial bin, we also computed geomagnetic field parameters (e.g., McIlwain's L value, local field strength, field strength at the equator along the field line, etc) at the center of the bin for other uses. For this purpose, we used the International Geomagnetic Reference Field (IGRF) Model, Epoch 2003. Each data sample within the spatial bin also contains the information on geomagnetic activity and an index for solar energetic particle (SEP) events at the time the data were taken. The final data set thus obtained forms an extensive source of information useful for studying the long-term near-Earth trapped proton environment.

In the final manuscript, we will describe in full the details of the steps that led to the creation of the data set. Descriptions of several interesting findings from the analysis of the data will also be provided. One example is that there were clear indications of the creation and decay of an "outer belt" of energetic protons following the 2004 July and November SEP events. We have also developed a statistical model using the data set. This model was used to deduce the state of high-energy proton environment along an L shell. The latter has been used to predict potential statistical variations in the radiation environment for low altitude spacecraft.