

Performance of a Discrete Wavelet Transform for Compressing Plasma Count Data and its Application to the Fast Plasma Investigation on NASA's Magnetospheric Multiscale Mission

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Plasma measurements in space are becoming increasingly faster, higher resolution, and distributed over multiple instruments. As raw data generation rates can exceed available data transfer bandwidth, data compression is becoming a critical design component. Data compression has been a staple of imaging instruments for years, but only recently have plasma measurement designers become interested in high performance data compression. Missions will often use a simple lossless compression technique yielding compression ratios of $\sim 2:1$, however future missions may require compression ratios upwards of $10:1$. This study aims to explore how a Discrete Wavelet Transform combined with a Bit Plane Encoder (DWT/BPE), implemented via a CCSDS standard, can be used effectively to compress count information common to plasma measurements to high compression ratios while maintaining little or no compression error. The compression ASIC used for the Fast Plasma Investigation (FPI) on board the Magnetospheric Multiscale mission (MMS) is used for this study. Plasma count data from multiple sources is examined: resampled data from previous missions, randomly generated data from distribution functions, and simulations of expected regimes. These are run through the compression routines with various parameters to yield the greatest possible compression ratio while maintaining little or no error, the latter indicates that fully lossless compression is obtained. Finally, recommendations are made for future missions as to what can be achieved when compressing plasma count data and how best to do so.