Compressed Image Artifact Removal: Improving Instrument Data Quality After Lossy Compression

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Background

Satellite instruments are collecting more data then ever before, outpacing advances in the telemetry infrastructure that enable their transmission.

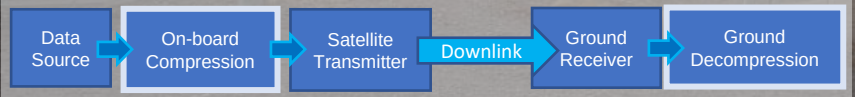
A common trade-off in missions is **choosing to trade data quality for increased downlink volume**. Two methods of doing this are decreasing temporal / spatial / spectral resolution, and lossy compression.

Lossy compression is dangerous, but **image quality is extensively studied in computer vision / AI.** Specifically, around the following tasks:

- Denoising
- Flagging Image Quality
- Inpainting and object removal

Using **supervised learning** and a set of before/after training examples of the compression effect, models can be trained to remove the compression artifacts and noise in general.

Often, a training dataset is available through **dual downlink of paired high-quality and lossy-quality data**. In practice, one must wait for the mission to collect enough data.

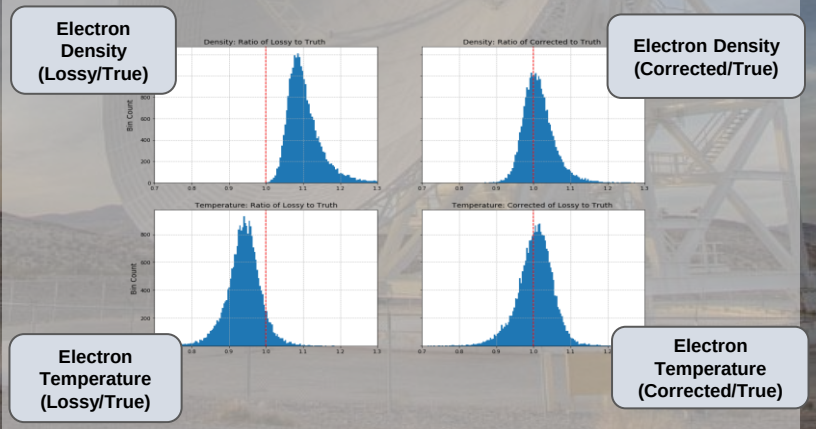


Instrument Case Study (MMS/FPI)

Particle instrument that during beginning of mission had lossy quality issues. Later-on it operated for period with no issues: this **allowed us to created side-by-side training dataset of compressing effect**.

Designed, trained and tested neural network to correct compression noise. Before/after results below.

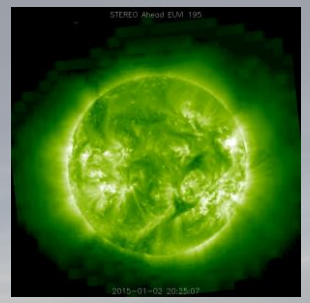
We used a **multi-layer perceptron neural network operating on patches** (tiles) of the image. To support the scientific community, we provided an interpretation of the reconstruction using basis functions theory.



Next Steps

We plan to start **designing other improvement pipelines**, starting with STEREO's operational space weather imagers EUVI and COR2.

Though at lower time resolution, versions of these images without quality issues are available to create a training set.



Lossy compression introduces artifacts in outer areas of solar image

This task, aiming to repair imagery rather particle data, has many more dimensions and different types of compression noise.

Having high-quality, high-resolution solar imagery will boost the national space weather forecasting capability, leading the path for other applications.

Support for research and engineering done for this work came from the MMS and STEREO missions. For full text open-access publication on the MMS/FPI instrument compression artifact removal, see: https://doi.org/10.1029/2019JA027181