Quantitative Image Restoration

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Background. One of the NOAA’s mission support goal is to “Provide a Continuous Stream of Satellite Data and Information with the Quality and Accuracy to Meet Users Requirements for Spatial and Temporal Sampling and Timeliness of Delivery”.

The intrinsic risks of damaged to sensors associated to launching and operating satellites in the hostile environment of space continuously threaten NOAA's critical priority of maintaining a continuous stream of accurate and high quality satellite data and information. Such risks are not specific to GOES-R, but given the essential role GOES-R will play for NOAA, it is critical that techniques be in place and ready to mitigate any potential risk from temporary or permanent non-functional detectors. Even when the detectors are partially function, artifacts such as stripes can present severe problems. The real possibility of such problems is clear as seen in SEVERI striping abnormalities on the MSG, or the large number of damaged detectors in band 6 of Aqua (MODIS). Fortunately there are powerful statistically sound methods of estimating the missing data. While none would suggest such estimations can completely replace the missing data, they can mitigate the risk by using all available data to provide the a high quality estimation of the missing data. This threat can be mitigated through development of the statistically sound and high performance quantitative image restoration algorithm we have propose.

Scope of Proposed Work. The estimator we propose, will use values in a spectral/spatial neighborhood of the pixel to be estimated, and propose a value based on training data from the uncorrupted pixels. Due to the non-parametric nature of the estimator, we avoid the blurring inherent spatial interpolation, which have implicit smoothness priors. Our preliminary work shows this approach not only reduces the RMSE but restores the correct gradient information as well. We have shown that using all of the neighboring channels we are able to quantitatively estimate the value at dead or noisy detectors in the MODIS band 6 case. We also have performed an initial evaluation using MODIS Terra (undamaged) data, to estimate the potential benefit to the Aqua snow product. We have demonstrated that NASA’s snow product applied to our restored band 6 better matches the true band 6 snow product than the currently used band 7 proxy. In particular, the restored Band 6 data is much more reliable under certain conditions where the Band 7 algorithm tends to run into problems, including the very important border areas between snowy regions and snow-free regions, and areas where tree cover makes determinations of snow on the ground difficult.

The technique is not specific to MODIS and provides a general basis for risk reduction due to detector damage. We will adapt our current band 6 MODIS restoration algorithm to work with visible as well as near infra-red and infra-red bands of the ABI simulated data. We are planning to investigate improvements by integrating spatial interpolation within the damaged channel with cross band interpolation and by fusing information from full disk and CONUS high resolution for restoration. Furthermore, we will evaluate against MSG data and ABI simulated data to determine the statistical confidence of restoration and develop an integrated software library implementation for producing restored bands and the confidence of restoration at each pixel. Our collaborator Walter Wolf (NOAA/STAR) will provide GOES-R simulated and/or proxy datasets as well as an independent verification of the differences between the original data and restored data. He will also run a suite of GOES-R products and create difference plots for the original runs and the runs with the restored data.