ATMS Remapping Products and Their Potential Applications

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Abstract: Remapping method provides not only an optimal combination of measurements within a specified region, but also a quantitative measure of the tradeoff between resolution and noise. In this work, the Backus-Gilbert method and AAPP MTF matching method were investigated for ATMS SDR remapping processing based on a sub-pixel microwave antenna temperature simulation technique. Results show that for ATMS remapping process, the BG algorithm is superior over AAPP in terms of processing time and data quality of remapping products. The BG algorithm can not only be used to generate remapping datasets in different resolution to satisfy the different requirements from user community, in addition, it can also be used to eliminate the resolution degradation at the edge of the scan, as well as the beam center pointing misalignment between different frequency bands.

BG REMAPPING ALGORITHM

The B-G algorithm finds a set of optimal coefficients, for constructing a new observation with an expected FOV size as a linear combination of adjacent original observed antenna brightness temperatures

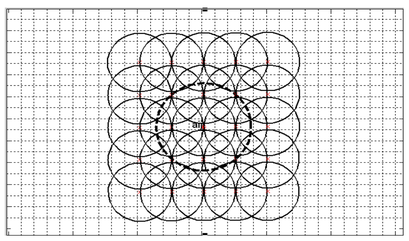
$$T^a(\hat{\rho}_0) = \sum_{i=1}^{n}\sum_{j=1}^{n} a_{ij} T^a(\hat{\rho}_{ij})$$

The B-G algorithm aims at finding a set of coefficients, so that the rebuilt antenna gain pattern is close to the expected gain function. It also ensures that the instrument noise is not significantly increased, which is especially important for resolution enhancement processing

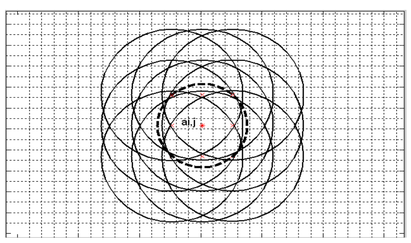
$$Q = Q_0 \cos\gamma + (\Delta T_{rms})^2 w \sin\gamma$$

$$Q_0 = \int \left[\sum_{i=1}^{n}\sum_{j=1}^{n} a_{ij} G_{ij}(\hat{\rho}) - F(\hat{\rho}_0, \hat{\rho}) \right]^2 dA$$

Resolution Downgrade



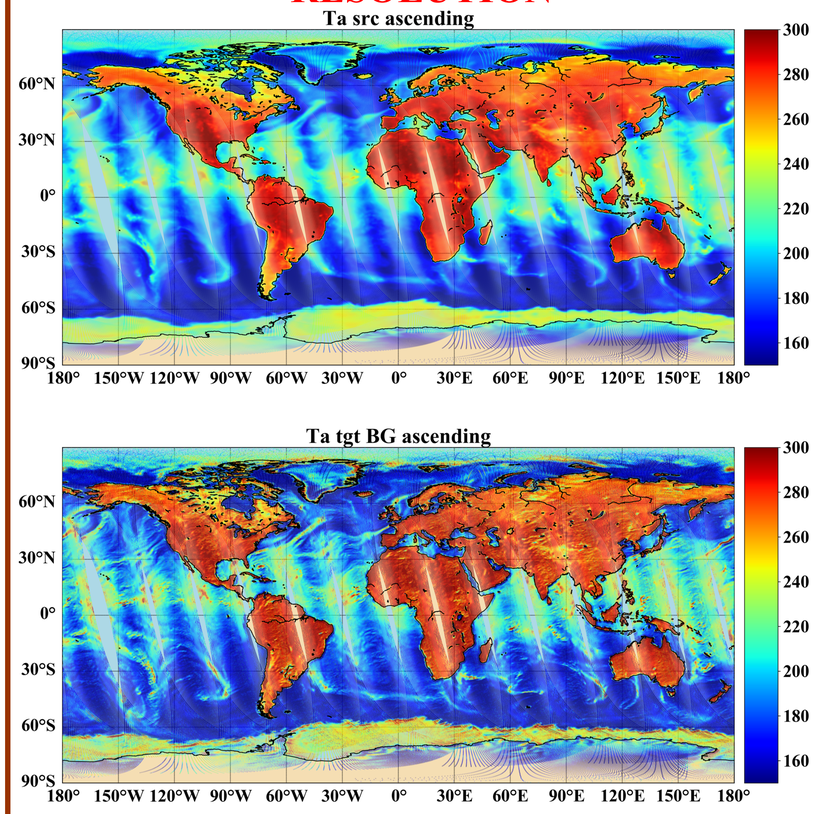
Resolution Enhancement



ATMS REMAPPING DATA EXAMPLES

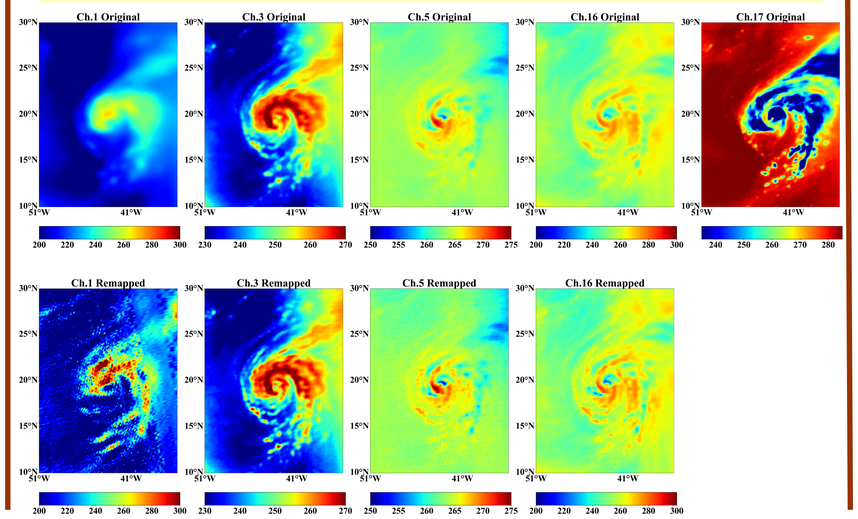
Currently the BG algorithm can be used to process ATMS TDR/SDR products and generate remapping data sets at 5.2, 3.3, 2.2 and 1.1 deg beam width resolution. The remapping products can be delivered as data sets, software package, or simply the remapping coefficients. The remapping coefficients can be generated offline according to different user requirements, and only need to be adjusted for different satellite.

REMAPPING SDR PRODUCTS AT 1.1^{O} BW RESOLUTION



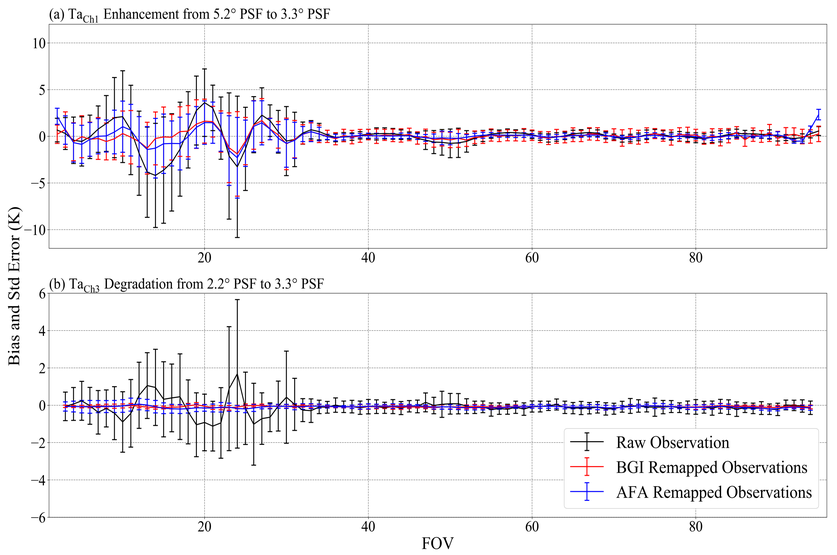
HURRICANE OBSERVATION FROM REMAPPING PRODUCTS

ATMS observations at different resolution for Hurricane Lorenzo on 9/27/2019 were remapped to a consistent 1.1^{o} BW resolution. Compare with the original observations, the Hurricane structure became clearer and consistent from low to high frequencies.



DATA QUALITY EVALUATION RESULTS FOR REMAPPING PRODUCTS

Based on the simulated "Truth", the bias and standard deviation of error for both original and remapped observations at different FOV positions are calculated to investigate the performance of the algorithms. The most significant reduction in the bias and standard error occurs at FOVs that contain coastlines. For the hurricane center over the ocean observed around nadir, the bias and standard error reduce after remapping. From FOVs 60–70, where no sharp change in Ta appears, the resolution enhancement amplifies the standard error, and the resolution degradation alleviates the standard error, illustrating the noise change caused by the remapping process. The bias at the scan end of channel 1 caused by the AFA is clearly seen, compared to the observations at other FOVs over the ocean.



Conclusion

Remapping algorithm can explore the unique feature of oversampling design in ATMS instrument. In this work, the remapping algorithm based on B-G method and AAPP MTF matching method were investigated by using simulated "original" and "ground truth" brightness temperature. Results show that for ATMS observations, BG algorithm take less CPU time for the remapping processing and generate datasets with higher quality. In addition to generate products with consistent resolution across different channels, the BG remapping algorithm can also be used to eliminate resolution degradation at the edge of the scan as well as the beam misalignment problem between different channels.

References

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