# Characterizing Objective Analysis Errors for Dual Polarization Weather Radar


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## OBJECTIVES

Radar data objective analysis is the process of interpolating spherical radar data onto a Cartesian grid. During this process, the data points on the Cartesian grid are estimated from the radar data through different interpolation schemes. This study aims to characterize the error associated with multiple interpolation schemes.

## METHODS

To judge error, synthetic analysis fields were created. Each analysis field, given by mathematical function, simulated different storm types. Fields were sampled on polar and Cartesian grid, with varying sampling parameters. The sampled polar data was then interpolated onto a Cartesian grid using 4 different interpolation schemes- nearest neighbor, linear, Cressman (Cressman, 1958), and a modified Barnes algorithm as used by Trapp & Doswell (2000). The interpolated data is then compared to the original analysis field to quantify error. The error analysis measures used in this study are: mean squared error (MSE) and structural similarity index (SSIM).

## CONCLUSIONS AND FUTURE WORK

The MSE and SSIM fields show that the Barnes and Cressman schemes perform the best at dampening the effects of noise on the interpolation. While more sensitive to noise, the linear interpolation scheme does a better job of preserving storm boundaries. On the “checkerboard field”, the Cressman scheme underestimated the intensity at the center of each cell. Overall, the Cressman interpolation scheme showed the best performance in the presence of noise, while in a noiseless environment linear interpolation preserved the data with the highest fidelity. The information found in this study could be used to create an adaptive storm based interpolation algorithm. In future work, we plan to explore frequency based methods for interpolation. This would allow for a frequency adaptive interpolation approach that maintains the dominate storm spectral characteristics.


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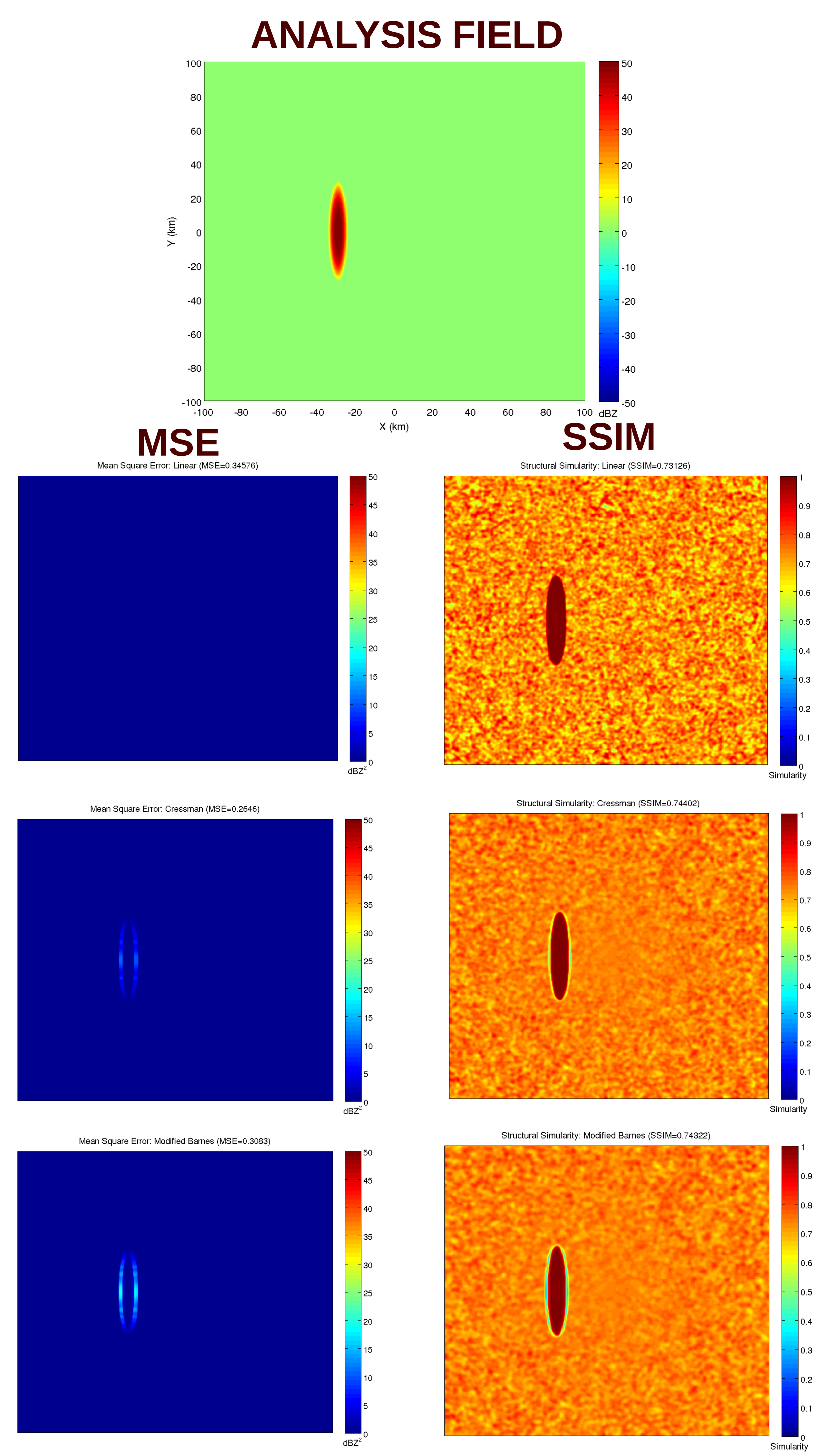


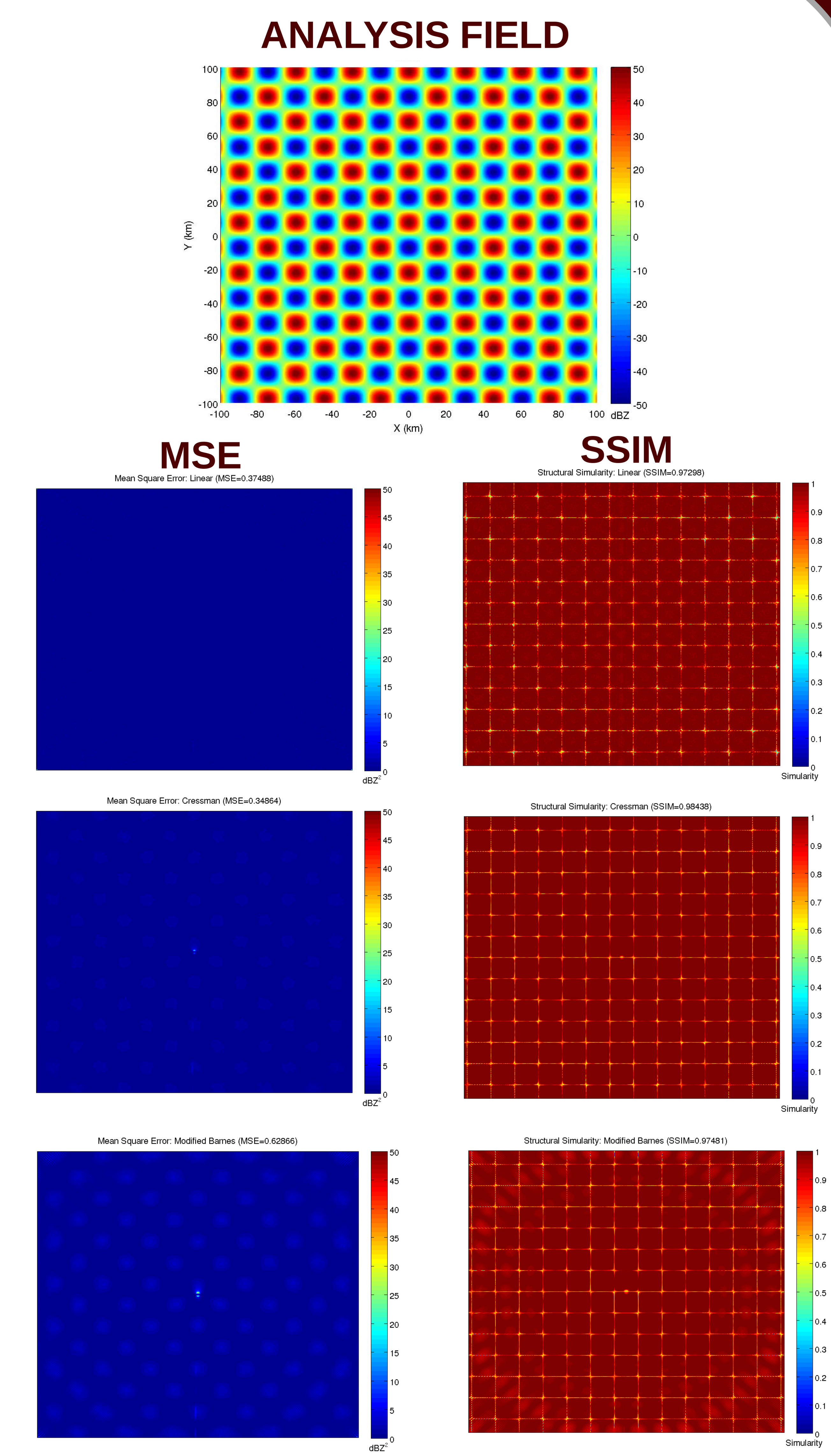


The first analysis field depicts a simulated storm cell or linear system centered about 20-40km west of the radar. The second analysis field depicts a “checkerboard” domain with concentric cells of negative and positive data. The analysis fields were sampled onto a polar grid and interpolated onto Cartesian grid with each different scheme. Input data had additive Gaussian noise with a mean of 0 and variance of 50.

SSIM measures the structural similarity of the reconstruction, while MSE gives a more traditional error metric.

| Interpolation Scheme | Cell MSE | Cell SSIM | Field MSE | Field SSIM |
|---|---|---|---|---|
| **Nearest Neighbor** | 0.46666 | 0.71722 | 1.67690 | 0.87366 |
| **Linear** | 0.34576 | 0.73126 | 0.37468 | 0.97298 |
| **Cressman** | 0.26460 | 0.74402 | 0.34864 | 0.98438 |
| **Modified Barnes** | 0.30830 | 0.74322 | 0.62866 | 0.97481 |

Highest Performing Interpolation Highlighted