Comparison – HEM Responses From MultiLoop III and R. Smith's M.Sc. Thesis For a Variable Resistance Thin Sheet

In this study, a helicopter electromagnetic (HEM) response of an infinite thin sheet with a variable resistance is calculated with MultiLoop III. Results are compared with a those computed using a computer program written by Richard Smith and published in a University of Toronto Master's thesis in 1984.

Smith's method uses a Fourier transform to handle the variable resistance of the sheet in wave number domain, and computes the spatial response with an FFT to space domain. The comparison is computed for vertical magnetic dipoles 40 meters above the ground, with a 9 meter separation operating at 300 Hz, and is plotted in PPM.

The Fourier model results have been scanned and are illustrated in Figure 1. The top panel shows the model while the bottom panel shows the computed profiles. The model consists of a square sheet gridded for the Fourier method at 4 meters, for a total 128 by 128 points. The background surface resistance was 0.01 ohms. A small patch of anomalous resistance is located in the centre of the sheet, which was inferred from the figure to be about 70 meters in extent. Four conductivity contracts were computed, 100:10 S, 100:31 S, 100:920 S and 100:9100 S.

For the MultiLoop III computations, a pseudo-infinite thin sheet was used. The sheet consisted of 1801 points and had a diameter of 1440 meters. The resistance of the sheet was set to 0.01 ohms outside the anomalous area. The resistance anomaly was represented with a radially symmetric function in the Resistance dialogue. An example of the resistance function used for the 100:10 S computation is:

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IF (X*X + Y*Y < 70*70, 1.0/(10+90*SQRT(X*X+Y*
Y)/70),0.01)
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Results for the 4 models generated by MultiLoop III are illustrated in Figures 2, 3, 4 and 5. Results from the two methods are qualitatively the same: Figures 6,7 show a graphical overlay of the Fourier and Figure 2 responses. The Fourier results are more "rounded" than the MutliLoop III results, and the agreement is pretty good considering the coarse discretization of the FFT. Some of the factors contributing to the differences are: 1. The exact nature of the resistance function used in the Fourier method is not known and is estimated from the contour plot; 2. The Fourier method was limited to 128 wave numbers, and so could have been limited in representing field variations; 3: The Fourier method repeated the anomalous zones as the FFT assumes a periodic resistance function.

The comments and assistance provided by Richard Smith are gratefully acknowledged.
Files used in this comparison are in demo folder under:
/MLPIII Comparison/RSmithMSc-VariableResitance

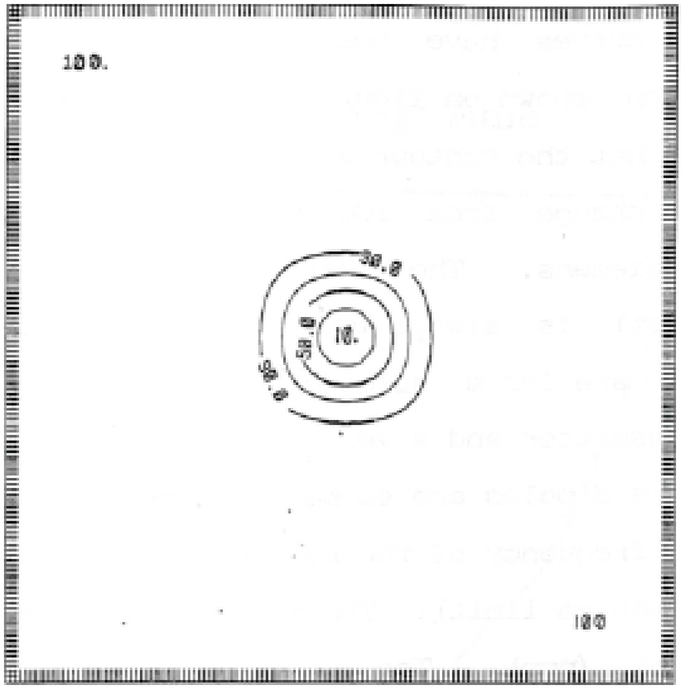

FIGURE 3.9 Contours of the conductivity structure considered (plotted in Seimens). The full grid of discretisation is shown (from -256m to 252m in the x and y directions - the node spacing is 4 metres) The surrounding conductivity thickness product is 100 Siemens, but in the centre this decreases to 10 Siemens.

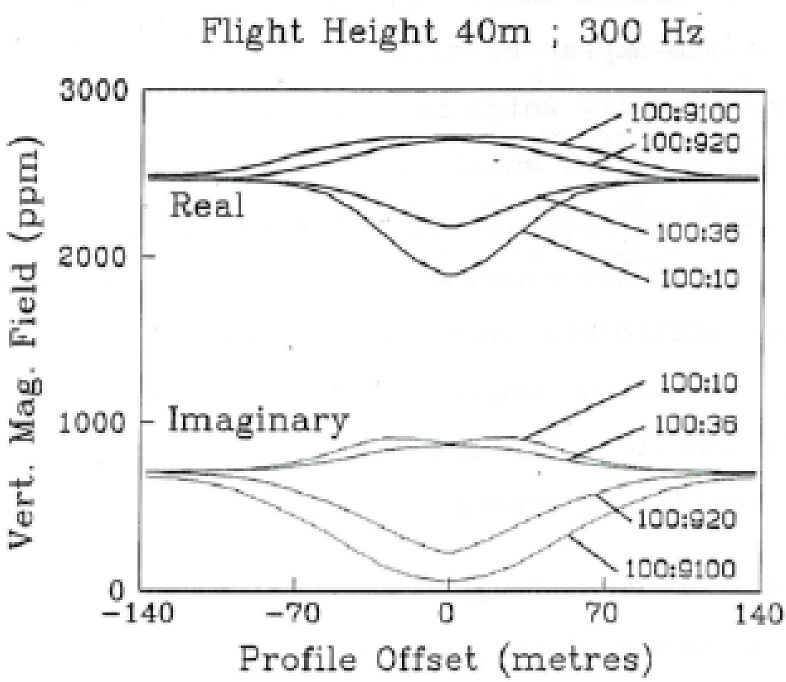

FIGURE 3.10 The vertical magnetic field in ppm of the exciting field at the receiver as a function of offset of the transmitter/receiver pair from the centre of the conductivity structures shown in figure 3.9

Figure 1: Conductance model (top) and profiles computed from the Fourier solution.

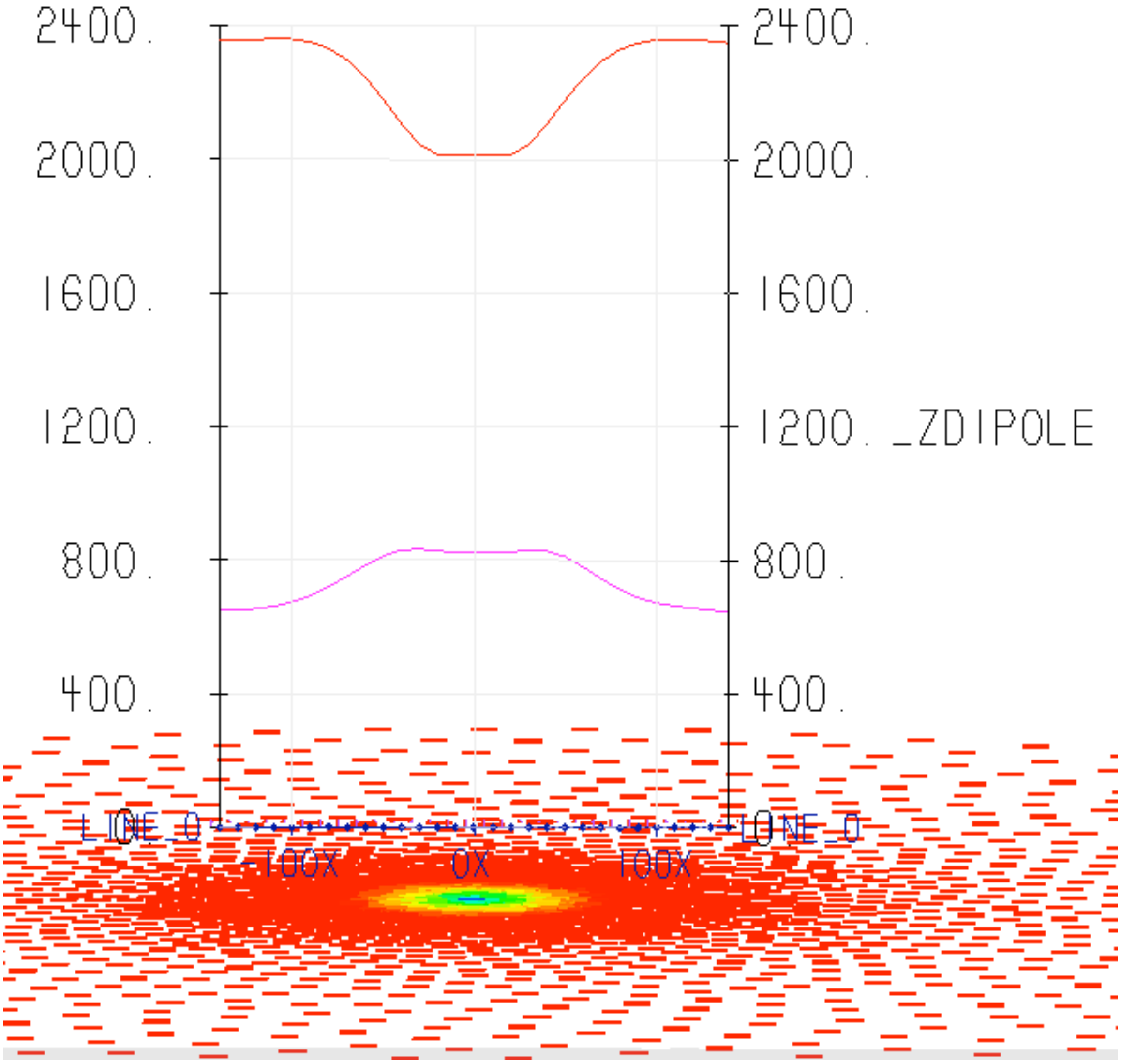

Figure 2: The response computed by MultiLoop III for the 100:10 S model.

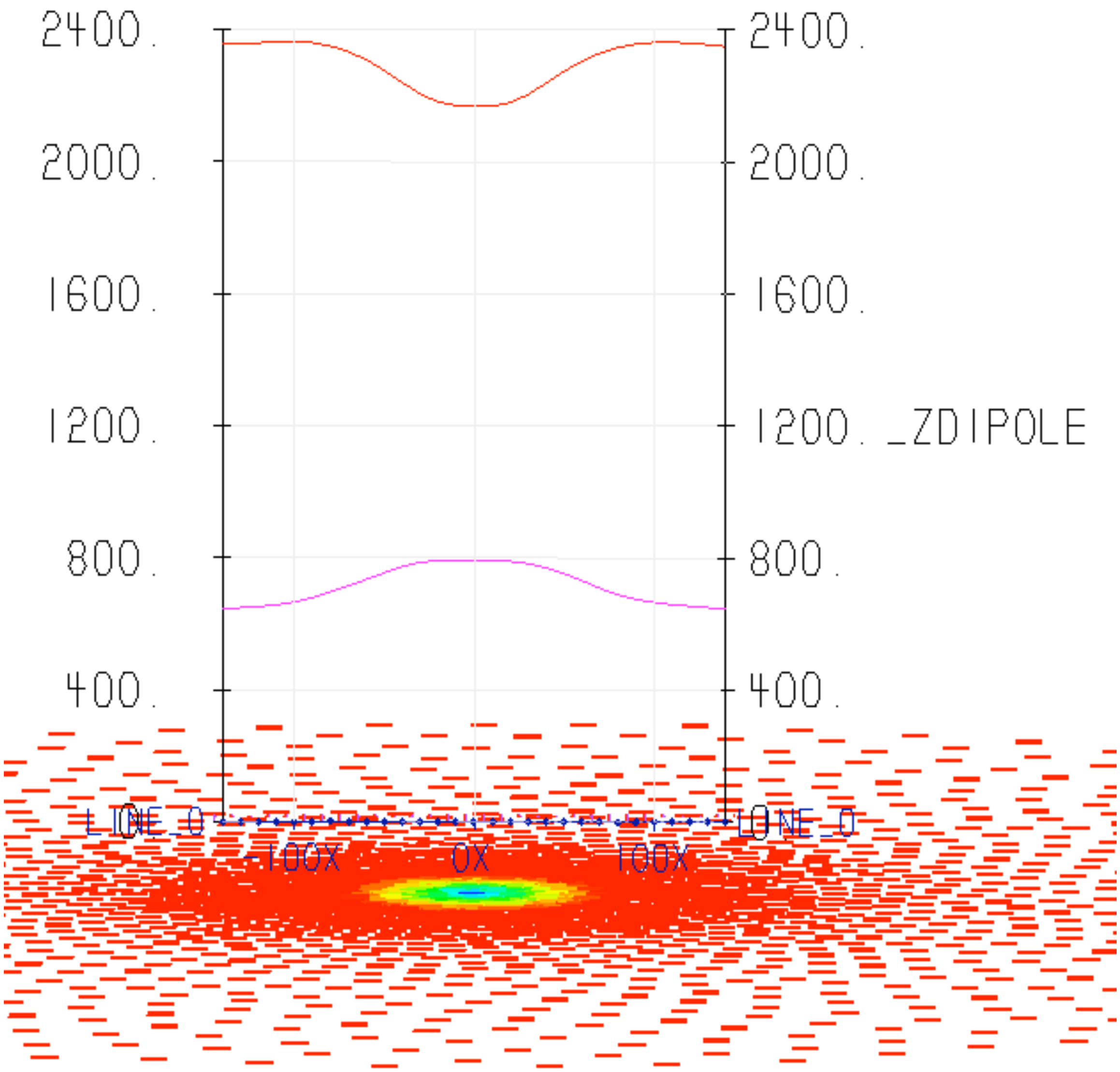

Figure 3: The response computed by MultiLoop III for the 100:31 S model.

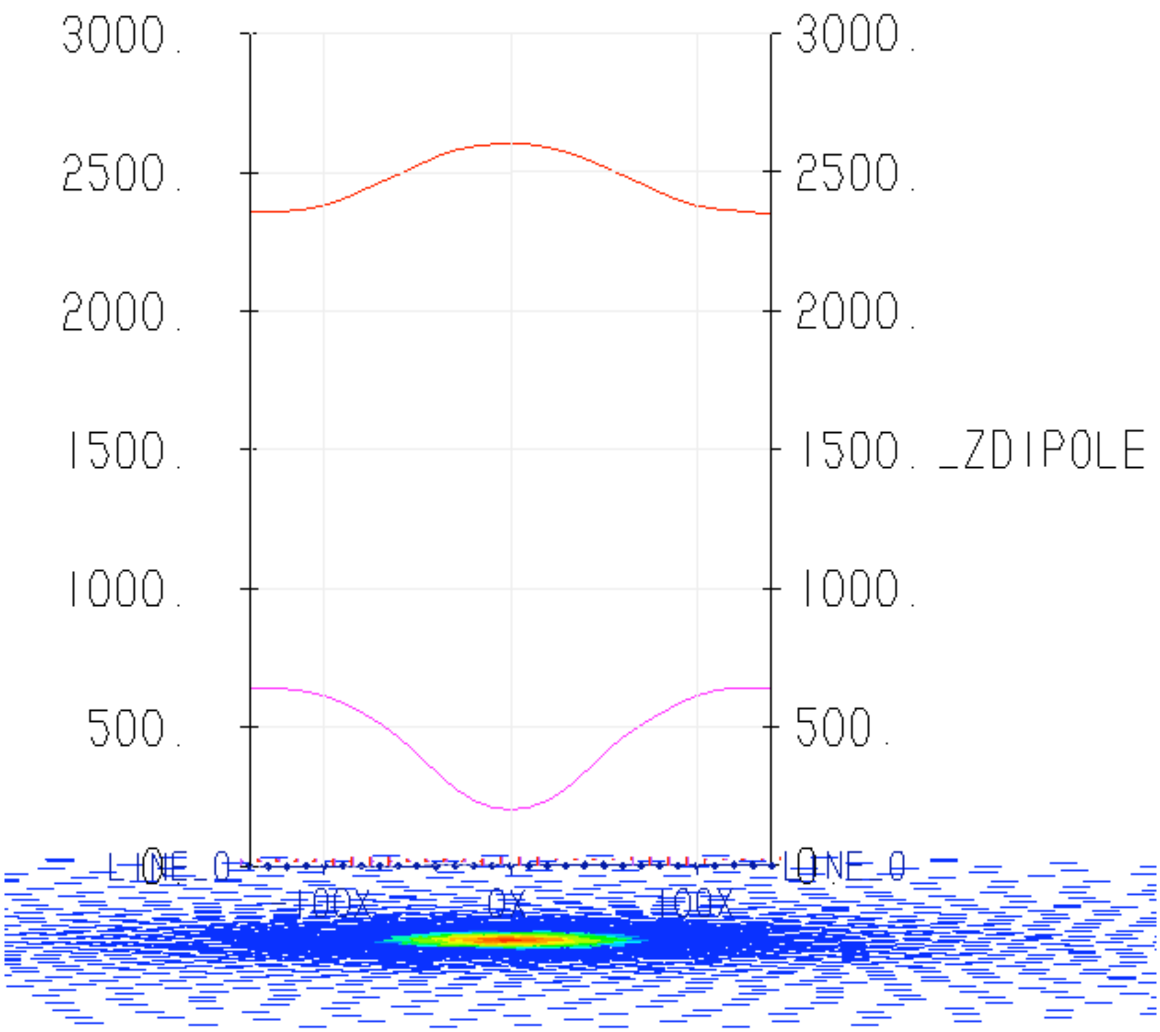

Figure 4: The response computed by MultiLoop III for the 100:920 S model.

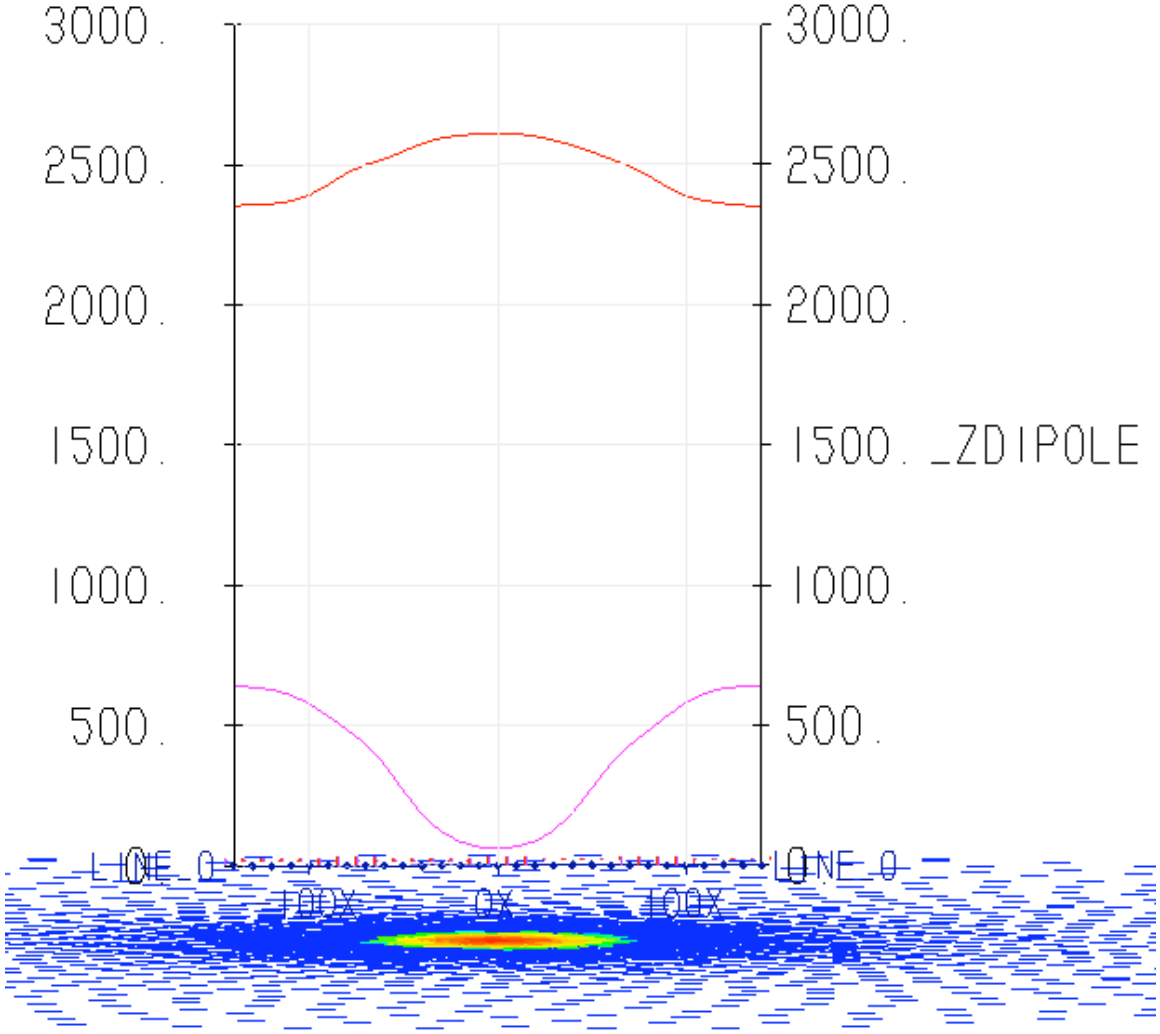

Figure 5: The response computed by MultiLoop III for the 100:9100 S model.

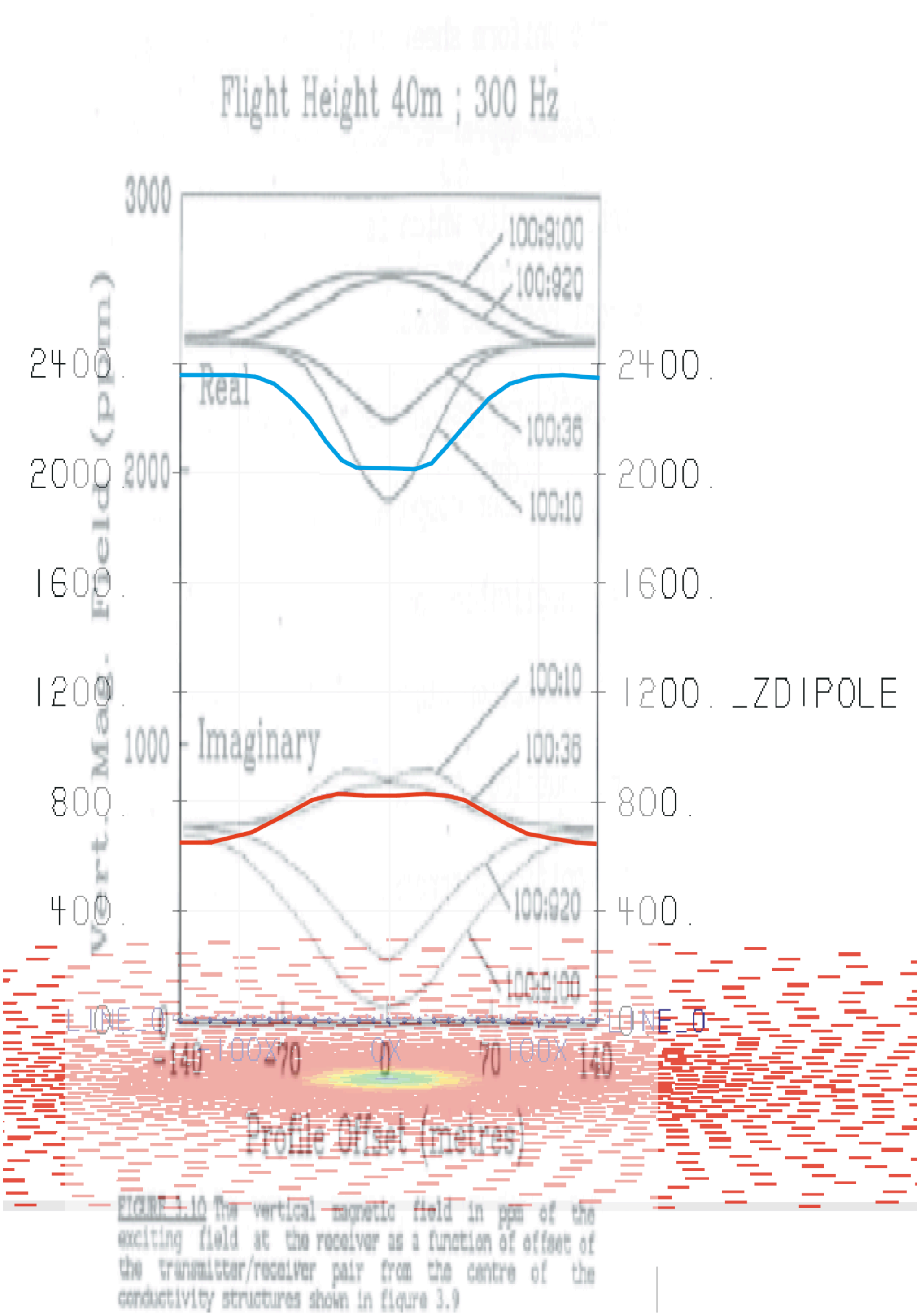

Figure 6: The response computed by MultiLoop III for the 100:10 S model overlain on the Fourier responses

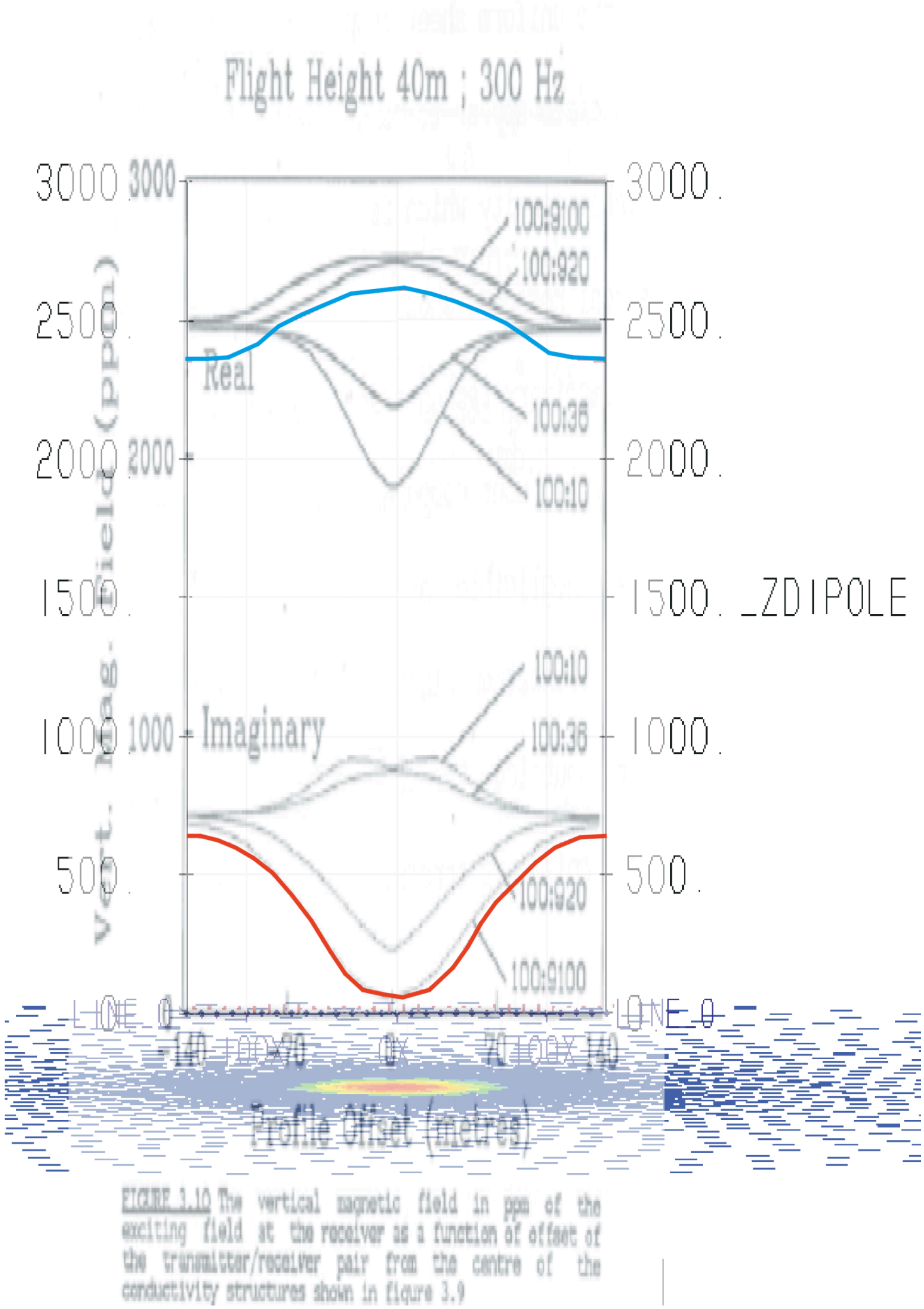

Figure 7: The response computed by MultiLoop III for the 100:9100 S model overlain on the Fourier responses