Comparison of the UTEM response over a dipping infinite half-sheet: MultiLoop III vs. scale model data

In this example, the response of a half plane scale model (dating from 1983) is compared with MultiLoop III modeling using an expanding mesh to represent a half-sheet of infinite extent. The scale model geometry is illustrated in table 1. A large sheet has been used to simulate a semi-infinite sheet that is dipping 30 degrees away from a 1000-meter square loop. The sheet is offset from the loop by 500 meters and is 100 meters deep. Lamontagne Geophysics Ltd produced the scale model data as part of a series of UTEM scale model experiments.

The original mesh used in MultiLoop III to represent the half-plane was scaled by a factor of 20 to ensure the mesh approximated the infinite size of the sheet well. However, it was observed that the anomaly crossovers near the top of the sheet were not faithfully reproduced. The mesh was then reduced in scale by a factor of two, decreasing the node separation in the mesh by contracting the mesh size. This resulted in a significant improvement in the match between the scale model and numerical data. A second contraction generated 4x denser sampling.

The high density grids produced excellent comparative results with the scale model data where the grid is near the surface. Increasing the density improved the decays and the properties of the profile near the crossover, and the 4x density mesh produced an excellent crossover match. However, the 4x density mesh was generating by contracting the original mesh, and so the resulting mesh did not effectively extend to infinity. As a result, the response computed from the 4x density grid where it is distant from the loop (at a scaled distance of about 1 kilometer) shows a slight reduction in anomaly amplitude.

In the figures that follow, Table 1 illustrates the scale model data and the data computed using the three mesh scales. Table 2 illustrates the decay at station 1500, and illustrates the effect of not using a mesh that is large enough to properly represent infinity. Table 3 illustrates the crossovers in detail, and shows the importance of dense node sampling when modeling the traverse lines that are close to the mesh.

In summary, this study shows that excellent matches to scale model data are obtained with MultiLoop III. When modeling structures that extend to infinity, care must be taken to select the appropriate mesh size. When modeling the response on a profile that passes near a mesh, the density of nodes in the vicinity of the profile can be important for accurately modeling the structure and migration of any cross overs.

Summary of Models Used

Model 1:

9 Channel UTEM system at 30 Hz, Base Frequency.
Loop: –500,0,0; 500,0,0; 500,1000,0; -500,1000,0
File: JmacnaeHalfPlanes/Dip30/HalfPlane1511Dip30Scale100.mlp
Strike: 90 Dip 30 Conductance 2.8 S. (r =0.357)
Calculated in MultiLoop III by scaling the distance down by a factor of 100, making r= 0.00357 ohms); Mesh has been scaled by a factor of 20.
Profile runs from X=100 to X=1500.

Model 2:

Identical to model 1, but the mesh has scaled from model 1 by a factor of 0.5, increasing the density of the nodes.
File: JmacnaeHalfPlanes/Dip30/HalfPlane1511Dip30Sca100-2.mlp

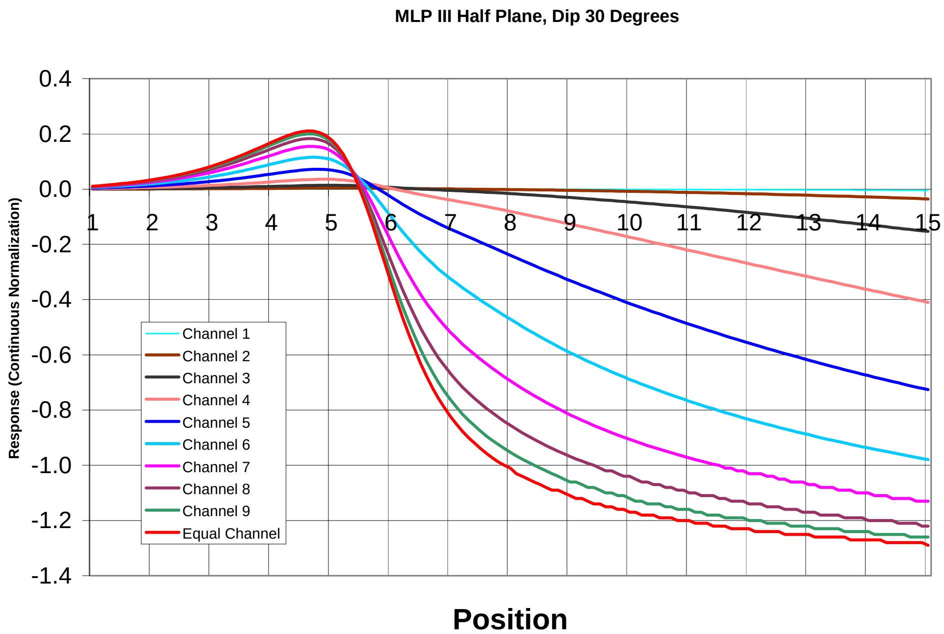
Model 3:

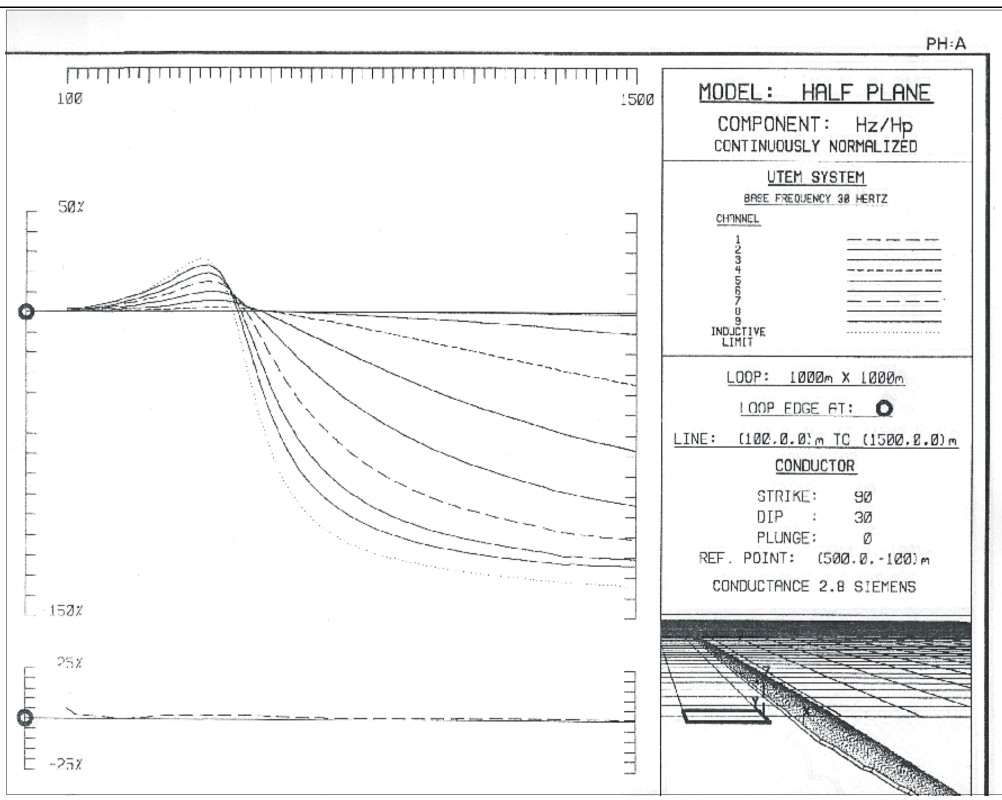
Identical to model 1, but the mesh has scaled from model 1 by a factor of 0.25, increasing the density of the nodes.
File: JmacnaeHalfPlanes/Dip30/HalfPlane1511Dip30Sca100-3.mlp

***Table 1:* Profile responses of the 30 degree dipping plate**

Comparison 1: Coarse mesh

MultiLoop III





Scale Model PH:A 2.8 S, Strike 90, Dip 30, 30 Hz. Base frequency, 1000 by 1000 m loop

Table 1, Continued

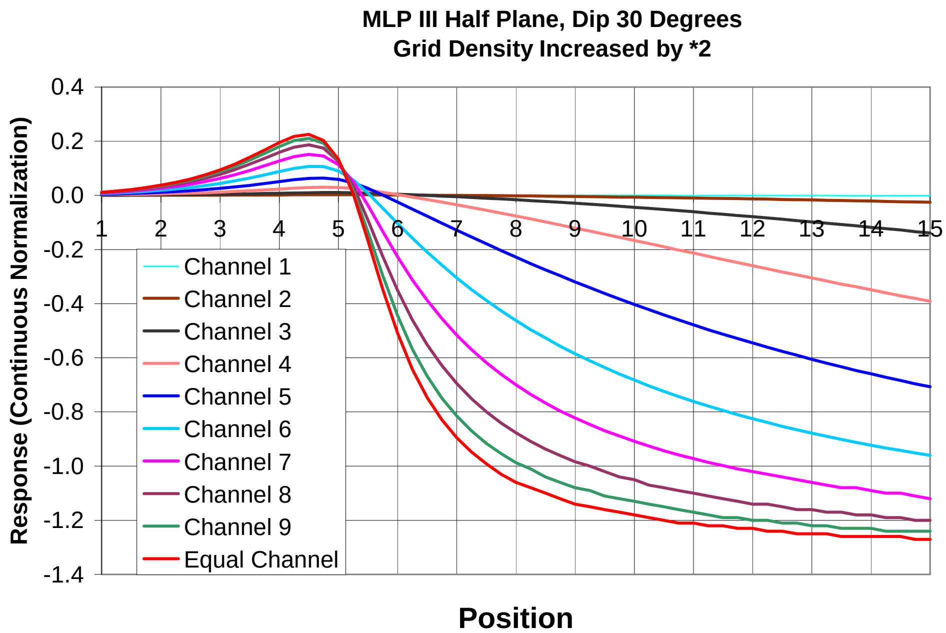
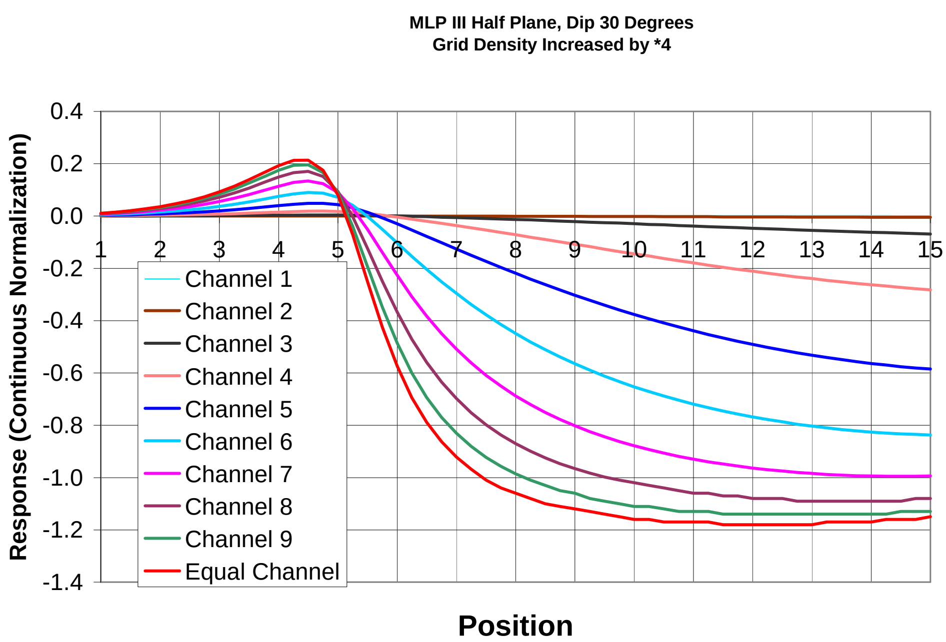
MultiLoop III – 2 times mesh density

MultiLoop III – 4 times mesh density


Table 2: **Decay at station 1500.**

The decays at station 1500 are plotted below. Increasing the density of the nodes improves the match between the scale model data and the numerical data from the initial grid and the 2* more densely sampled grid. However, the increased sampling density is obtained by shrinking the size of the mesh. When the mesh becomes too small to represent the currents flowing at the extremities of the mesh, the accuracy of the calculated response on the extremes of the profile diminishes. Table 2 illustrates this effect by comparing the decays at station 1500 for the different mesh sizes.

Table 2: MultiLoop III and Scale Model decay curves at station 1500 for the 30 degree dipping halfplane

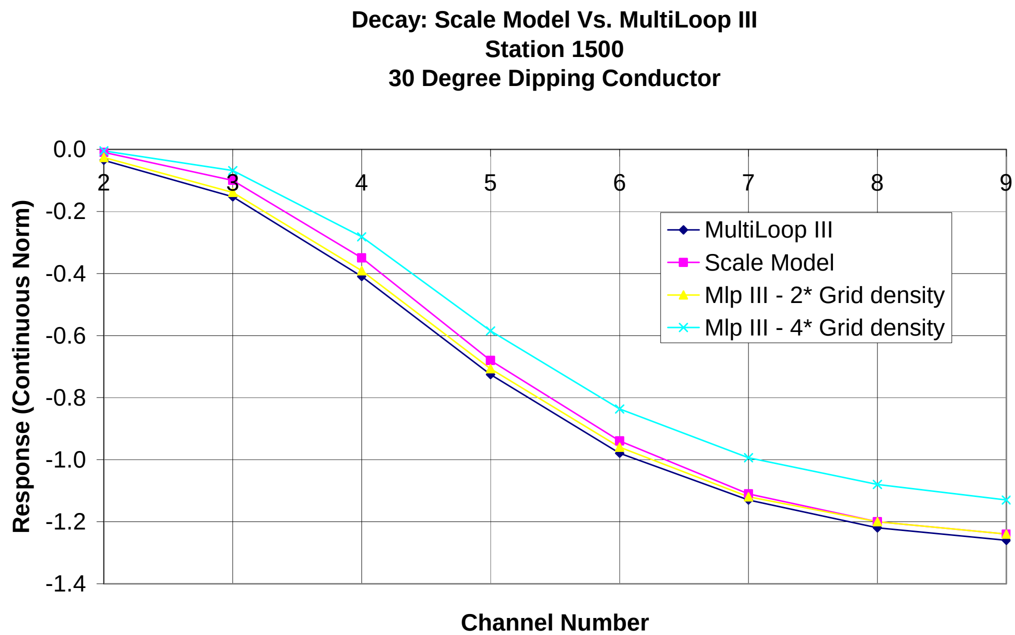
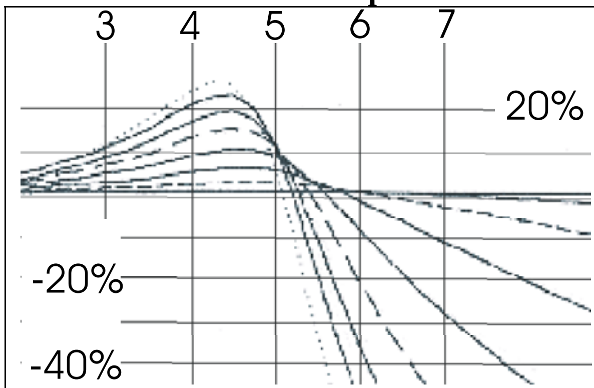
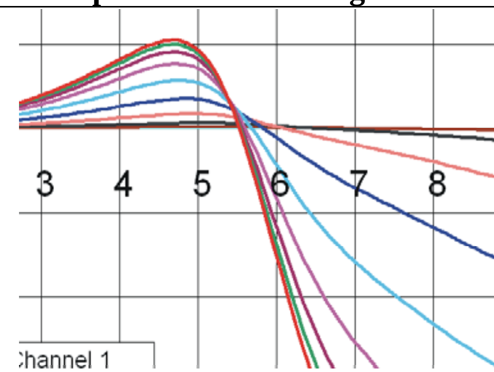
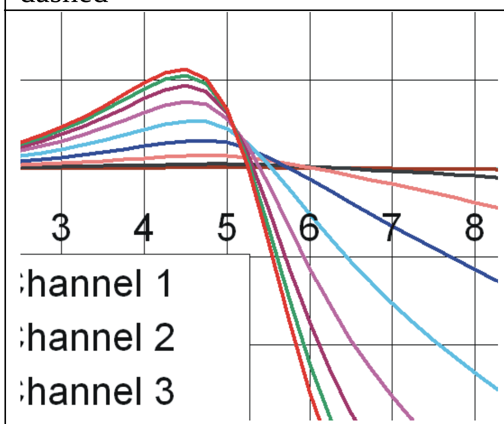
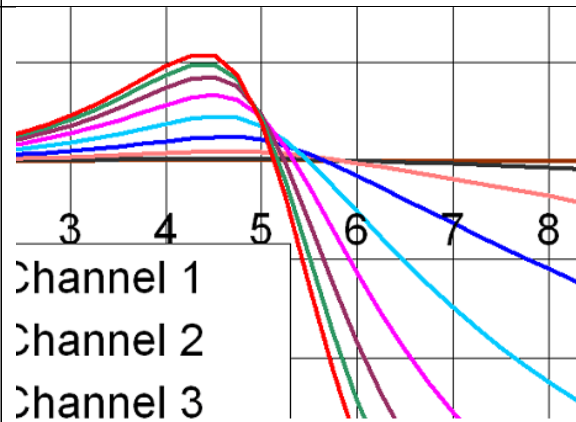


Table 3: **Detailed comparison of Cross-over responses for various grid densities.**

Table 3 (see below) compares the profiles of the crossovers computed using the 3 meshes with the crossover measured from scale modeling. Increasing the node density improves the location of the migrating crossovers and the magnitude of the response in the vicinity of the crossover. The match near the crossovers of the 4 times more densely sampled grid with the scale model data is excellent.

Table 3: **Detailed comparison of Cross-over responses for various grid densities.**

	
Scale Model: Horizontal grid lines represent 10%, vertical grid lines – inductive limit (dotted), channels 1 &2 solid, channel 3 - dashed	Low Density: Horizontal grid lines represent 20%.
	
Grid node density increased by 2 times	Grid density: 4 times;