Lab 1
GPGN 411
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Modeling Gravity Gradients in Space Domain

Objective

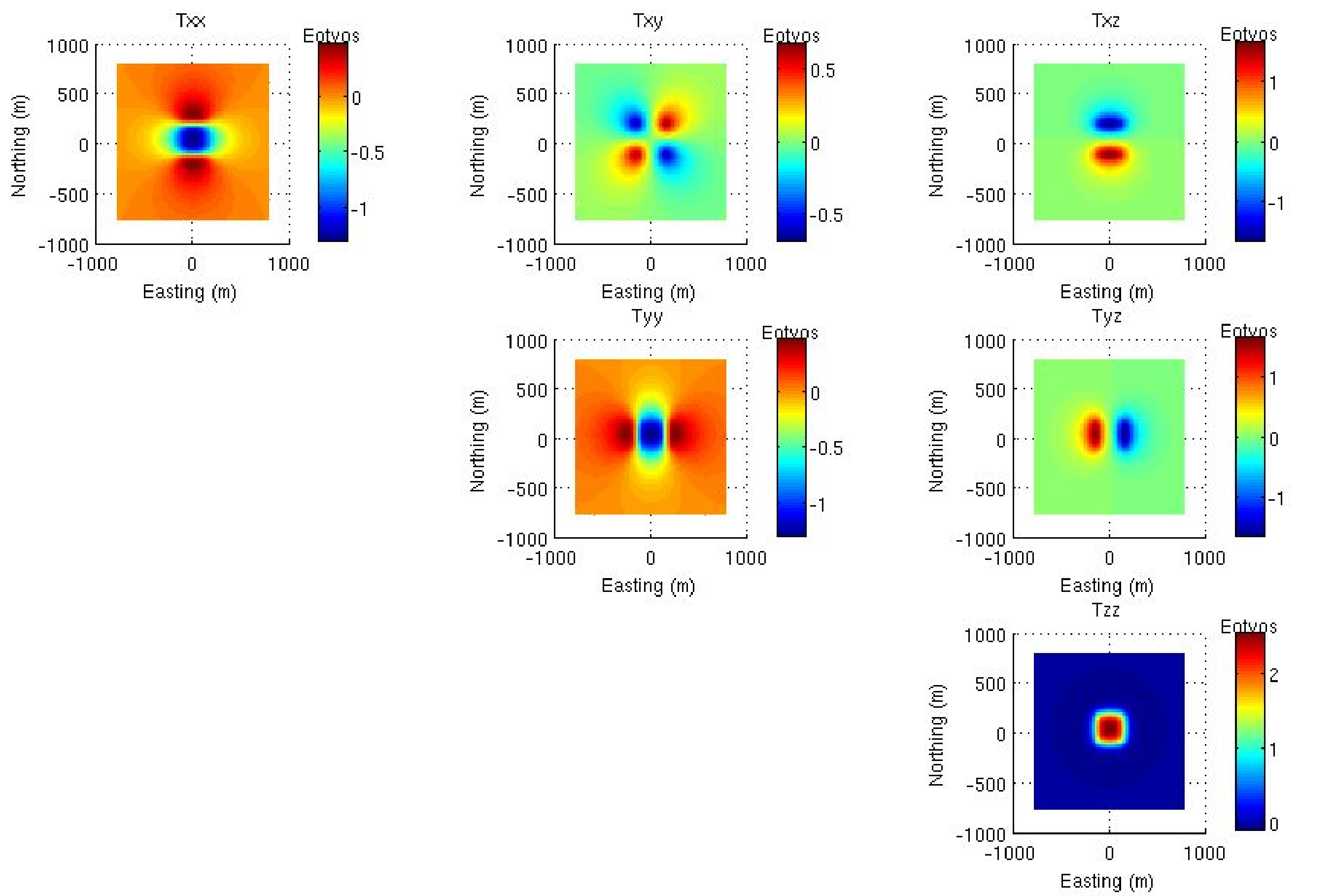
The objective of this lab, *Modeling Gravity Gradients in Space Domain*, was to introduce the tensor field and how to calculate its components. This includes calculating the response analytically from known equations as well as implementing a numerical method in a computer language to evaluate the field components for a given body and survey geometry.

Gradient Tensor

The gradient tensor in figure 1 was calculated in the C programming language and exported to CSV(Comma Separated Value) files from the application file, *lab01.c*. There are three unique types of data files produced by this application. The first is the list of observation points used in the survey in the files *x_obs.csv* and *y_obs.csv*. Each of these files represent orthogonal locations along the X axis and Y axis which together form an observation grid. The second type of file is a surface plot of the survey values for each tensor component. For instance *T_xx_m.csv* contains the values for the XX component of the gravity gradient tensor and is in matrix form, indicated by the subscript and letter m. The third data format is the format requested in the lab handout, point-value form. This format has a coordinate pair in X-Y and a gravity gradient value on each line. It is also indicated by the tensor component in the file name, for instance *T_yz_p.csv*, but uses a subscript and letter p to indicate the alternative format.

The next step in this process is running the file *Plotter.m* from the same directory in MatLab. This script reads in the csv gravity gradient tensor component files and plots them each as a subplot of one larger plot. This script produced the plot in figure 1 seen on the next page.

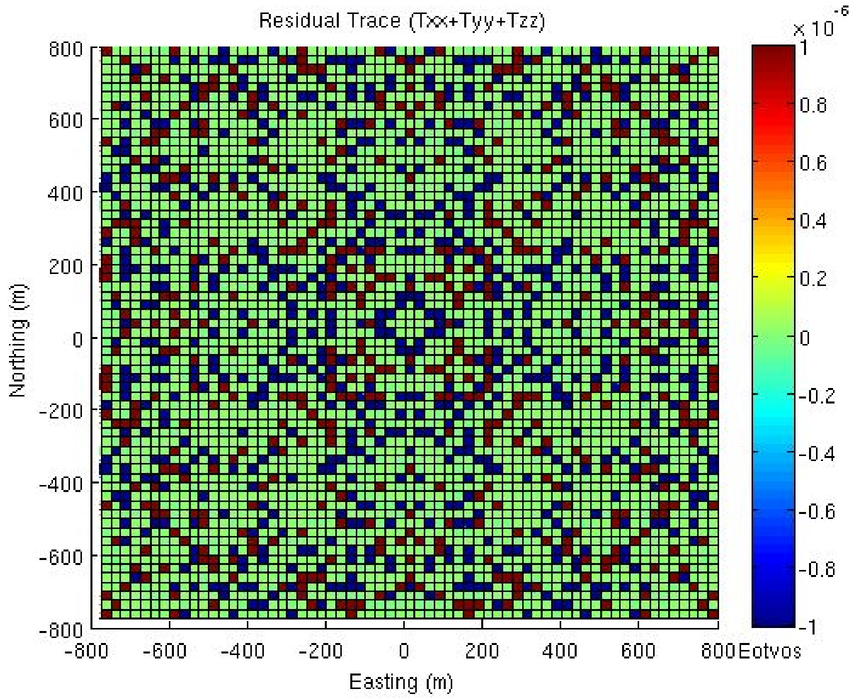
Figure 1: Gravity Gradient Response by Tensor Component



Numerical Verification

Numerical verification was performed by analyzing the laplacian of the gravitational response. Since we know the laplacian of the gravitational response must be equal to zero, we can sum the trace of the gravity gradient tensor at each observation point on our grid. This is done in the matlab script *trace.m* by superimposing T_{XX} , T_{YY} , and T_{ZZ}. The result of this process are plotted in figure 2.

Figure 2: Tensor Trace at each Observation Point



This plot shows that the error in the calculation of each observation is on the order of 10^6 time smaller than the gravity gradient response at that same location. This error is acceptable for the purpose of this lab.

Discussion

The most interesting observation I made in this lab was the gravity gradient tensor response of the cube is qualitatively similar to the gravity gradient tensor response of a point source. I also observed that by superposition and a multiple prism geometry almost any shape can be created and gravity gradient response calculated. I understand superposition and the fundamentals of calculating a gravity gradient tensor from its characteristic functions much better than I did before this lab.