Lab 4
Radially Averaged Power Spectra and Source Depth

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Calculating Depth

To calculate the depth of an anomaly we will assume that the depth, h, can be found using the formula

$$\begin{aligned} P(\omega_r) &\propto e^{-2h\omega_r} \\ ln(P(\omega_r)) &\propto -2h\omega_r \end{aligned}$$

where $P(\omega_r)$ is the radially averaged power spectrum, h is the depth of the anomaly, and ω_r is the radial wave number. The following are the calculations of the corresponding anomalies contained in my magnetic data from lab 2 and the two provided data files *set2.dat* and *set3.dat*.

This means that by taking the first derivative of the above quantity

$$\frac{d}{d\omega_r} ln(P(\omega_r)) \propto -2h$$

and solving for h

$$-\frac{1}{2}\frac{d}{d\omega_r} ln(P(\omega_r)) \propto h$$

we can deduce that negative one half of slope of the radially averaged power spectrum is the equivalent source depth.

Using the formula from above we can estimate the depth of each of the anomalies in question.

$$
\begin{aligned}
B_z\text{:} \quad & \tfrac{15.97-2.62}{0.02995-0.1299} &=& \quad 66.78 \text{ meters} \\
\textit{Set 2, } 1^{st} \textit{ anomaly}\text{:} \quad & \tfrac{21.11-8.915}{0.00995-0.06995} &=& \quad 101.625 \text{ meters} \\
\textit{Set 2, } 2^{nd} \textit{ anomaly}\text{:} \quad & \tfrac{8.915-5.264}{0.06995-0.1299} &=& \quad 30.45 \text{ meters} \\
\textit{Set 3, } 1^{st} \textit{ anomaly}\text{:} \quad & \tfrac{21.22-14.35}{0.00995-0.0495} &=& \quad 86.85 \text{ meters} \\
\textit{Set 3, } 2^{nd} \textit{ anomaly}\text{:} \quad & \tfrac{14.35-12.6}{0.04995-0.15} &=& \quad 8.74 \text{ meters}
\end{aligned}
$$

Discussion

- Smoothing is necessary because as we see in the linearly interpolated grey lines on each of the three figures, they are barely able to be interpreted. The red lines on the other hand are formed by trapezoidal integration of the data and represent localities of the data instead of the entire data set. The result is a smoothed line that is able to interpreted for depth information.
- The major differences in the two data sets are the depths of the anomalies. The elongate anomaly in set appears deeper in Set 2 and the two round anomalies appear more to be shallower. In contrast, the elongate anomaly appear shallower in set 3 than the deeper round anomalies.
- All of the following plots contain the raw data, linearly interpolated data, and smoothed data.
- The depth were interpreted from the red dots present in each of the following figures
- The trapezoidal sums are centered at the average data radial frequency, ω_r, on intervals of 200 data points.

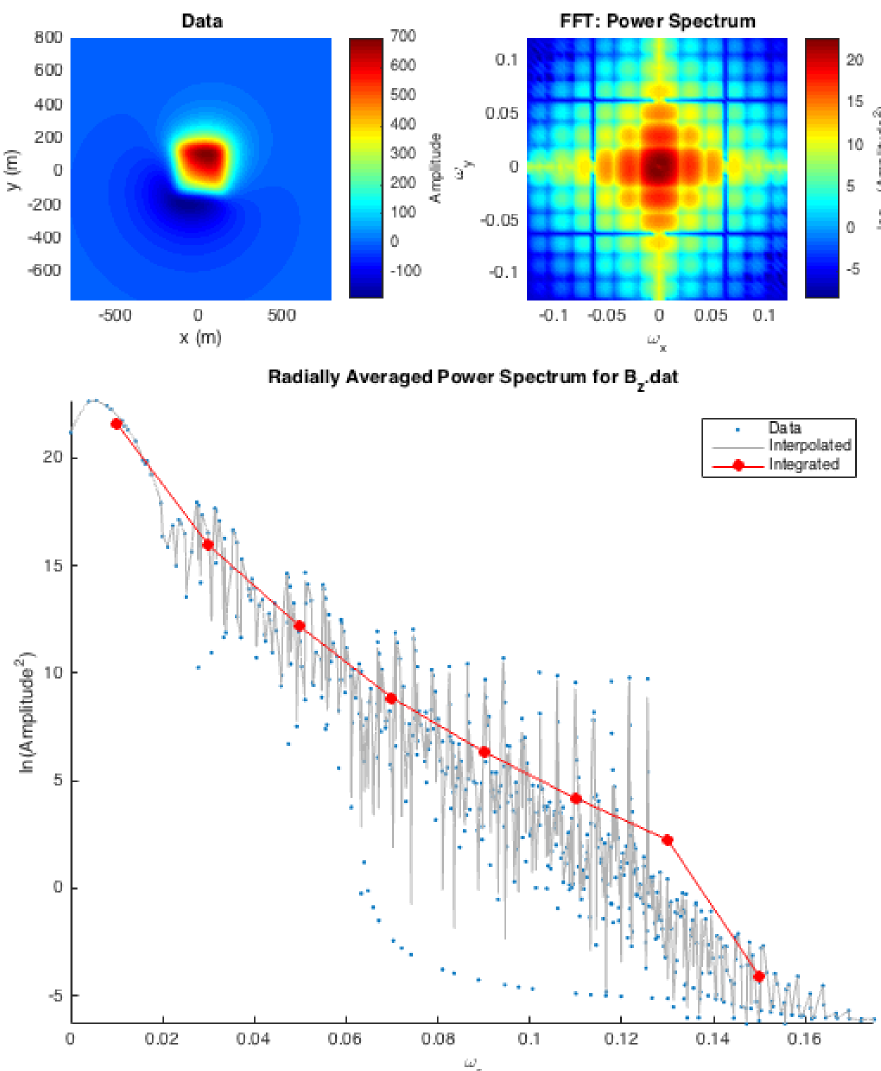

Figure 1: Power Spectrum of Magnetic B_z Data from Lab 2

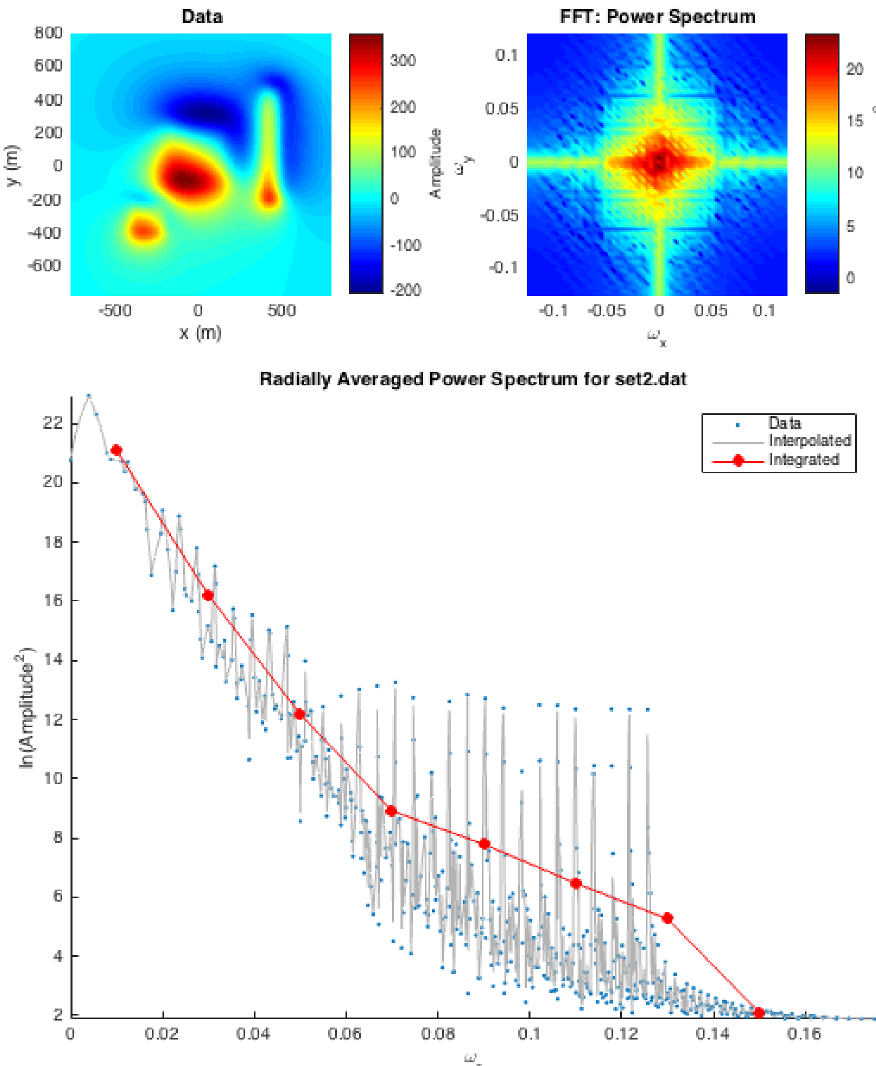

Figure 2: Power Spectrum of Set 2 Data

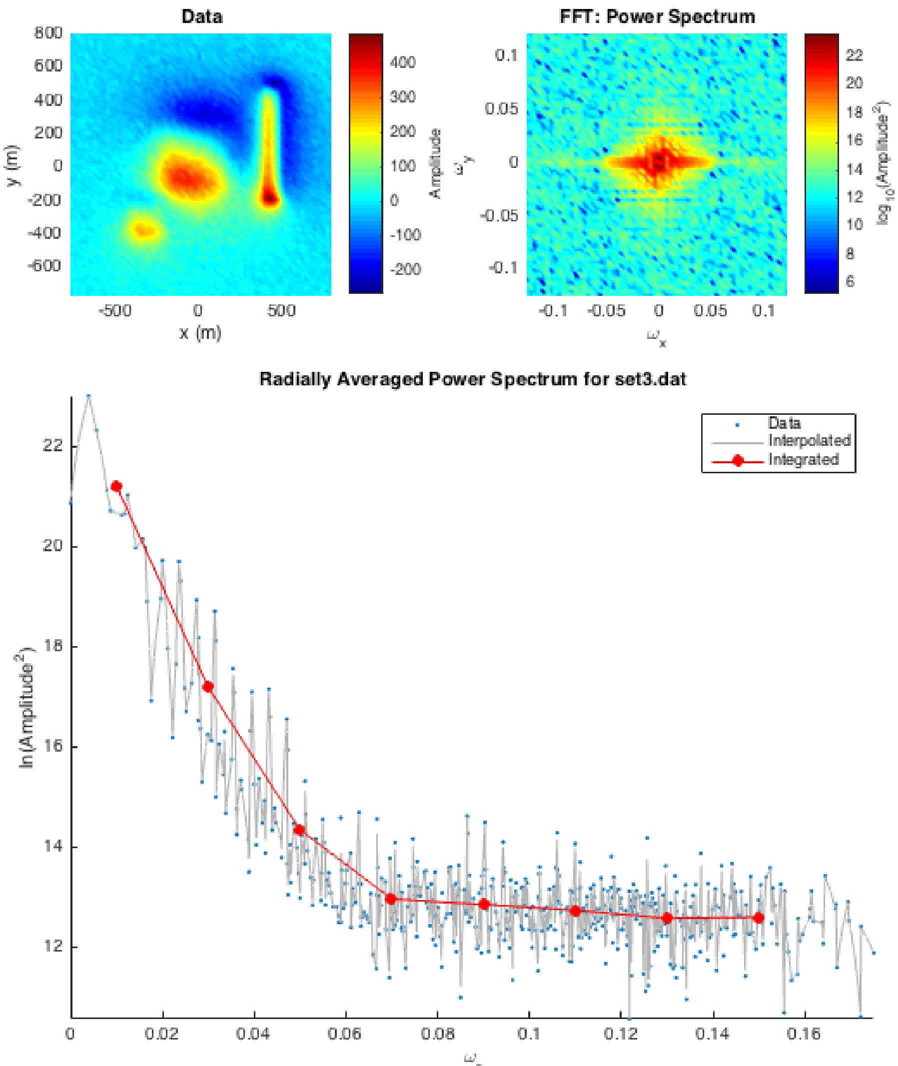

Figure 3: Power Spectrum of Set 3 Data