Quantitative investigation of October 2013 repeating radial wave event in Earth’s magnetosphere

Aims & Objectives
- On listening to the 2013 data for the GOES-13 spacecraft, we found an interesting repeating sound in the Poloidal/Radial component of the Earth’s magnetic field.
- The sound repeated four times and appeared to reduce in pitch (frequency) on each repetition.
- We decided to complete a quantitative in-depth analysis into this set of sounds, including comparing to available NASA solar data.

Spectral Analysis
- We analysed the first three measured harmonics of each sound, including measuring the peak frequencies, maximum power and the 3dB (1/2 Power) Bandwidth.
- By looking at the difference between each harmonic we were able to suggest the possible fundamental frequency of each event.

Event time analysis
- We also analysed the timing of the four event using the timestamp on the audio file.
- The four sounds were found to be space approximately a day apart.
- The fact that the sounds were spaced a day apart leads us to believe that the oscillation in the magnetic field was recorded when the spacecraft was in the same position on its orbit.
- Through calculation of the spacecraft local time it was discovered that the events were all recorded when the spacecraft was between the Earth and the sun as shown below.

Comparison to NASA sun activity data
- Comparison of flow speed with frequency to showed a potentially proportional relationship.
- It appears that some kind of solar event occurred which resulted in a sharp increase in flow speed that eased of over time, and the resultant oscillation in Earth’s magnetic field may have subsequently caused our set of sounds.
- As the flow speed decreased, this may have caused the decrease in the frequency of the oscillation in Earth’s magnetic field.

Event 1
Event 2
Event 3
Event 4

Figure 1: Wave event from GOES-13 POL Data

Figure 2: Spectral analysis of each event

Figure 3: Analysis of spectral data for each event

<table>
<thead>
<tr>
<th>Event</th>
<th>Audio Time</th>
<th>1st measured harmonic</th>
<th>2nd measured harmonic</th>
<th>First measured harmonic</th>
<th>Fundamental frequency</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>(s)</td>
<td>F_peak (Hz)</td>
<td>F_peak (Hz)</td>
<td>F_peak (Hz)</td>
<td>F_peak (Hz)</td>
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<tr>
<td></td>
<td></td>
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<td>3dB Bandwidth (Hz)</td>
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<tr>
<td>1</td>
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<td>136</td>
<td>1017</td>
<td>101</td>
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<td>2</td>
<td>264</td>
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<td>159</td>
<td>1103</td>
<td>264</td>
</tr>
<tr>
<td>3</td>
<td>265</td>
<td>662</td>
<td>104</td>
<td>883</td>
<td>263</td>
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<tr>
<td>4</td>
<td>266</td>
<td>541</td>
<td>90</td>
<td>820</td>
<td>101</td>
</tr>
</tbody>
</table>

Figure 4: Table showing analysis of event time

Figure 5: Diagram showing approximate position of spacecraft during events

Figure 6: Graphs of NASA data for Flow pressure/speed and proton density for this time period

Figure 7: Graphs showing potential proportional relationship between our data and NASA’s data