

PHYS 895 Intro to Scientific Computing - Homework 5

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November 21, 2017

Contents

1	README	2
2	UNH Weather Data	2
2.1	Daily - $Fmin = 1440$	2
2.1.1	Temperature	2
2.1.2	Wind Speed	3
2.2	Weekly - $Fmin = 10080$	3
2.2.1	Temperature	3
2.2.2	Wind Speed	4
2.3	Monthly - $Fmin = 40320$	4
2.3.1	Temperature	4
2.3.2	Wind Speed	5
2.4	Seasonally - $Fmin = 120960$	5
2.4.1	Temperature	5
2.4.2	Wind Speed	6
3	Student Voice Comparisons	6
3.1	Results, $fmin = 128hz$	7
3.2	Results, $fmin = 1080Hz$	10

1 README

There are 3 main files that run and analyze given data. The FORTRAN file, *hw5.f* takes in three arguments (text data one column file, number of points, and minimum frequency segment to use). With these arguments Welch's method of creating a PSD is implemented in the subroutine *betterpwd1*. The output of the power of functions and period, are written to two files., called "tmp.[DATA INPUT FILE].spectrum" and "tmp.[DATA INPUT FILE].spectrum.p" for the function and period power, respectively. From here, *hw5gnuplot.p* takes over and reads in both of these files to generate a multiplot PDF of the data. This is then saved to the designated file name from the main program controller, *run_prog.pl*. The main file *run_prog.pl* takes in 4 arguments, the 3 mentioned for the FORTRAN file, and one extra argument for the output data pdf. For example, to run the raw temperature data based off of minimum frequency of 1 month (43200):

```
$ perl run_prog.pl raw_temp.txt 7646541 43200 temperature_month.pdf
```

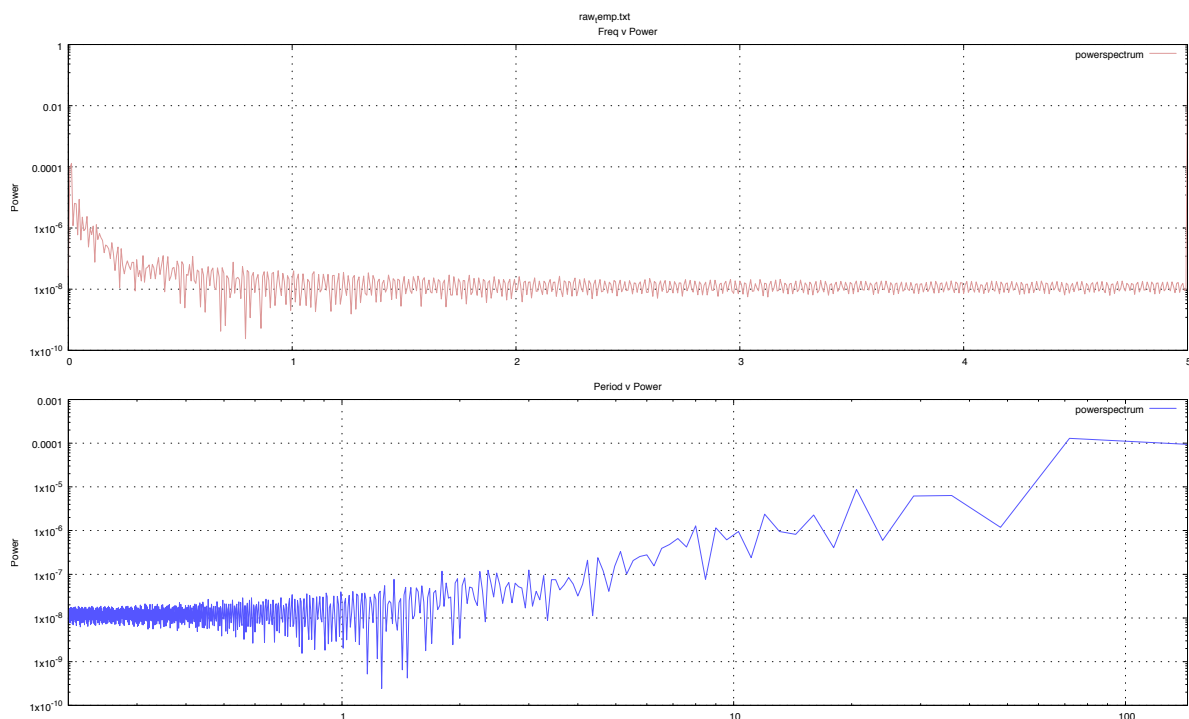
2 UNH Weather Data

Running the Welch's method on our weather temperature and wind speed data, we look for certain characteristics. As we adjust the minimum frequency and windowing of Welch's method we can see different peaks of the periods we would expect, like yearly and daily. As a note, each data point is 1 minute of averaged data and the total samples in both the temperature and the wind speed file is 7646541 data points. In each subsection, we have used the *fmin* of a given time, daily, weekly, monthly, or seasonally to see how the data changes and what periods arrive. However, this is the segment length for Welch's method, and as a note, is not measured in *Hz*. We used a 'HAMMING' window, as this gave us the best results compared with 'RECTANGLE' and 'NUTALL' windows. Additionally, for the period vs. power plot, we use a logscale on the x-axis in order to get a better sense of the shape of periodogram.

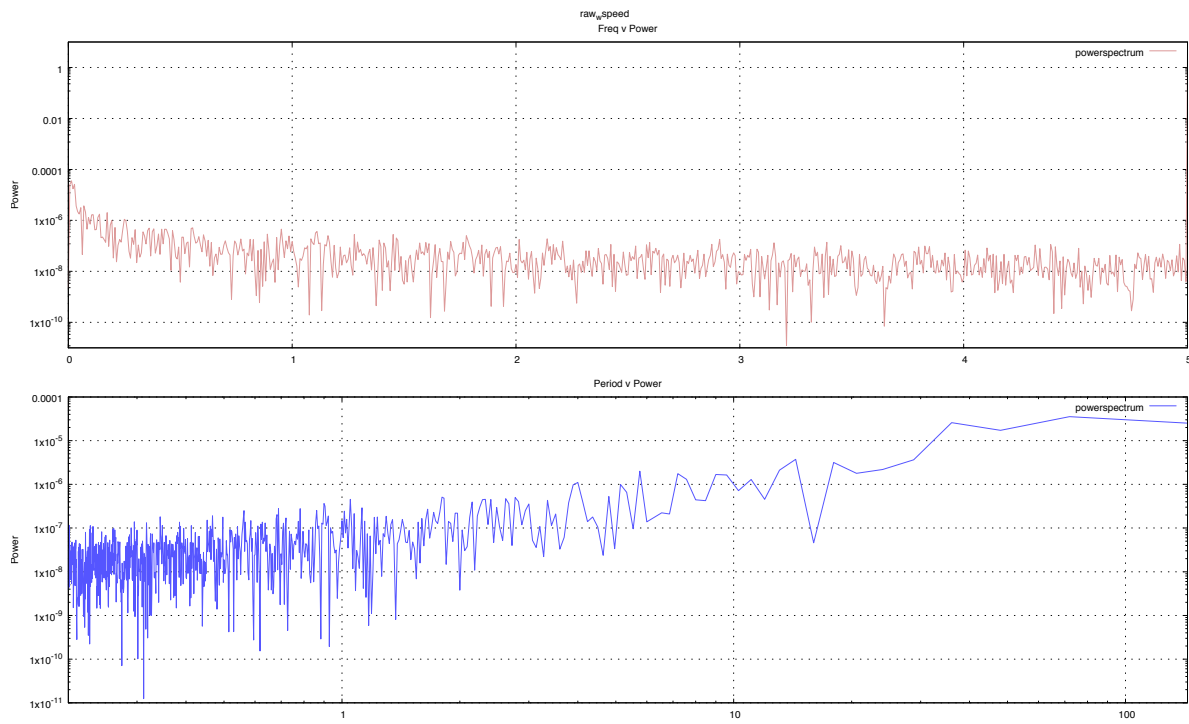
2.1 Daily - $F_{min} = 1440$

2.1.1 Temperature

Hard to see any periodicity arise in either temperature or windspeed at this *fmin*.



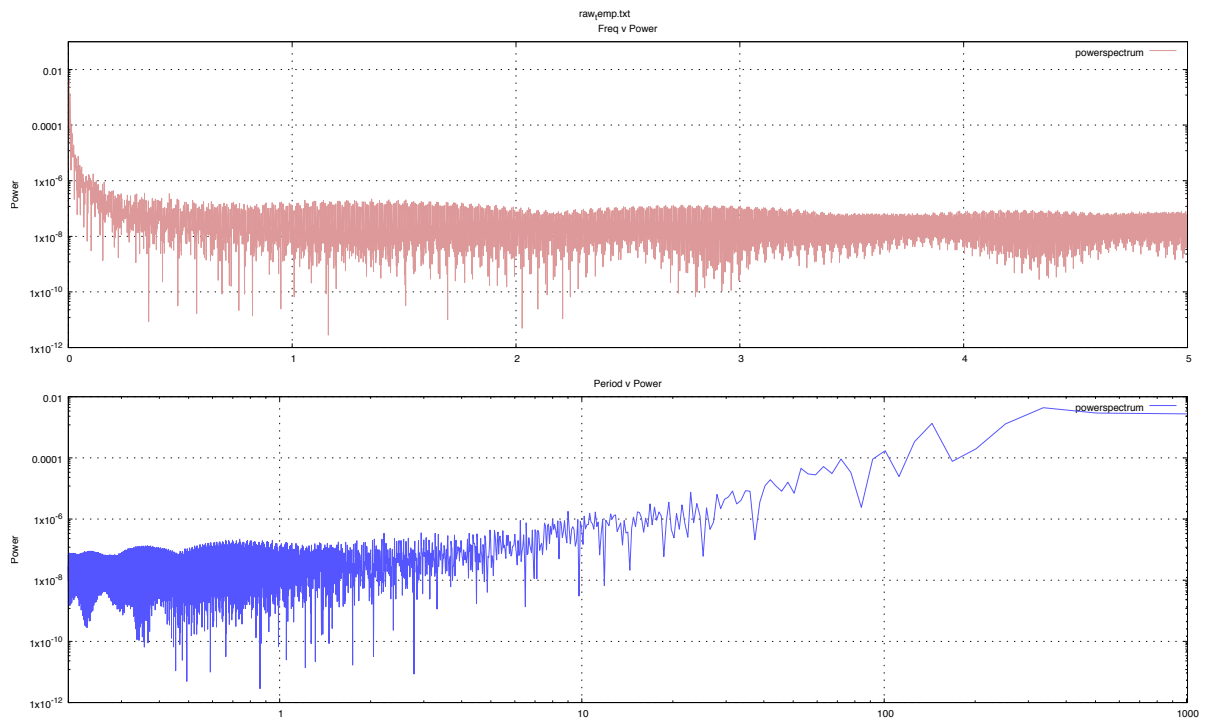
2.1.2 Wind Speed



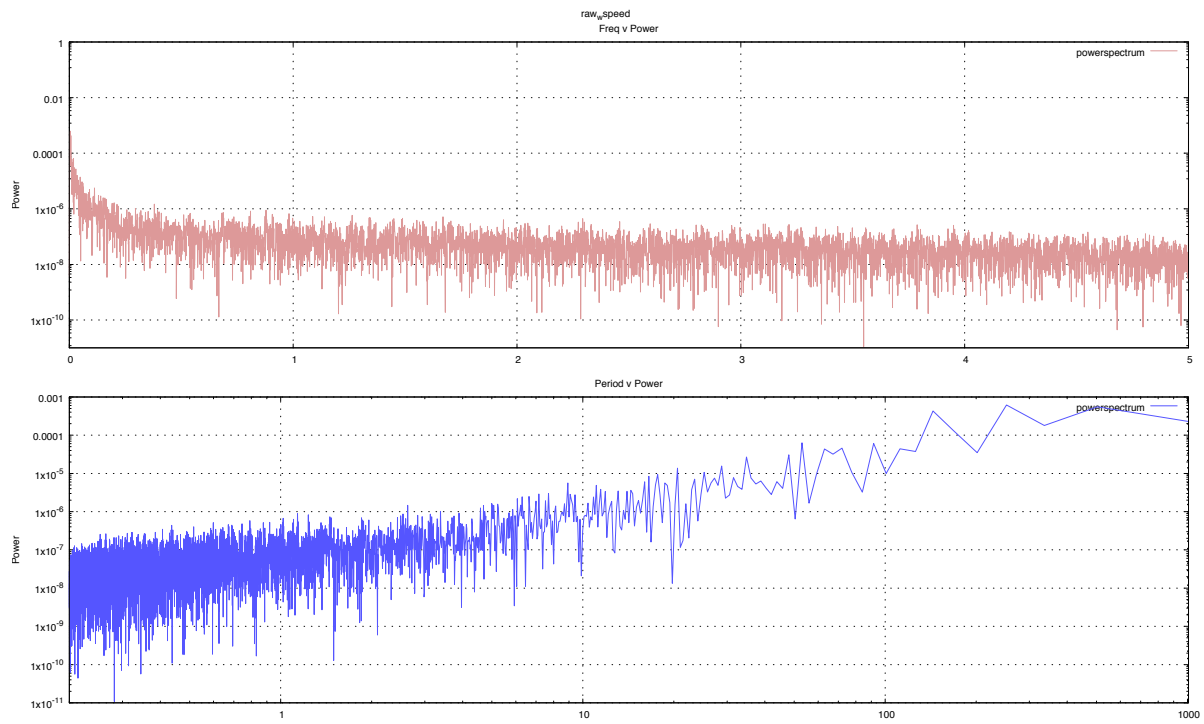
2.2 Weekly - $F_{min} = 10080$

We see that temperature has a couple cycles, however, wind speed does not.

2.2.1 Temperature



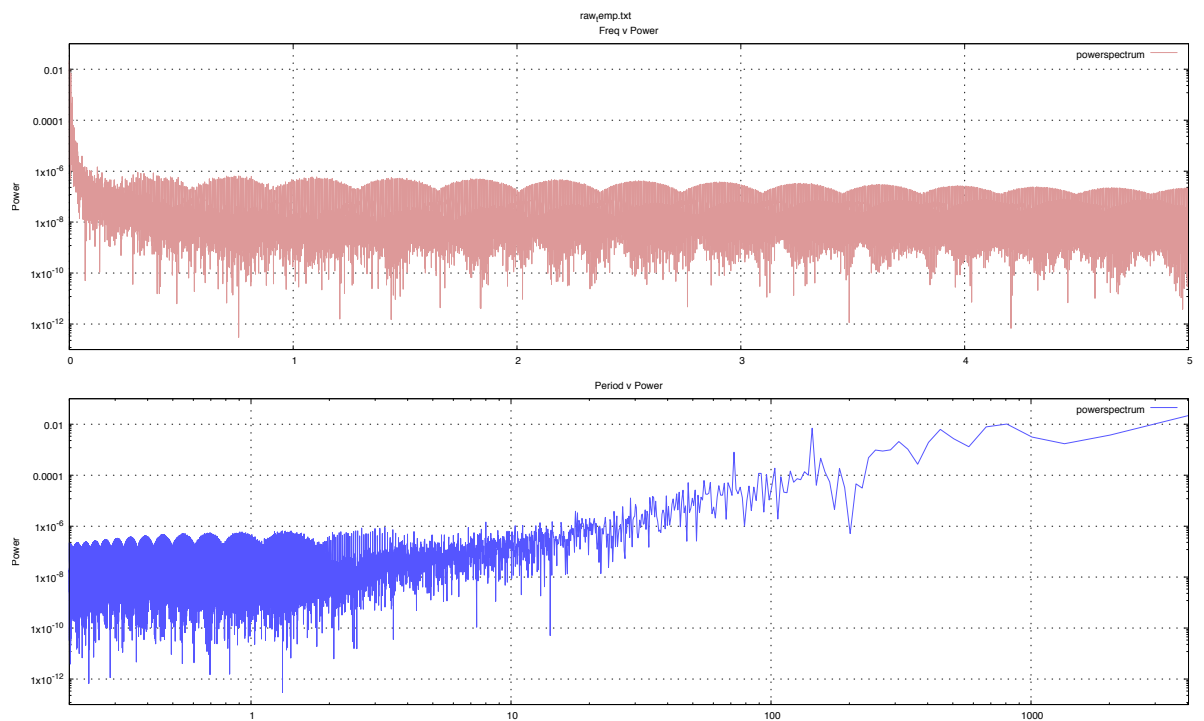
2.2.2 Wind Speed



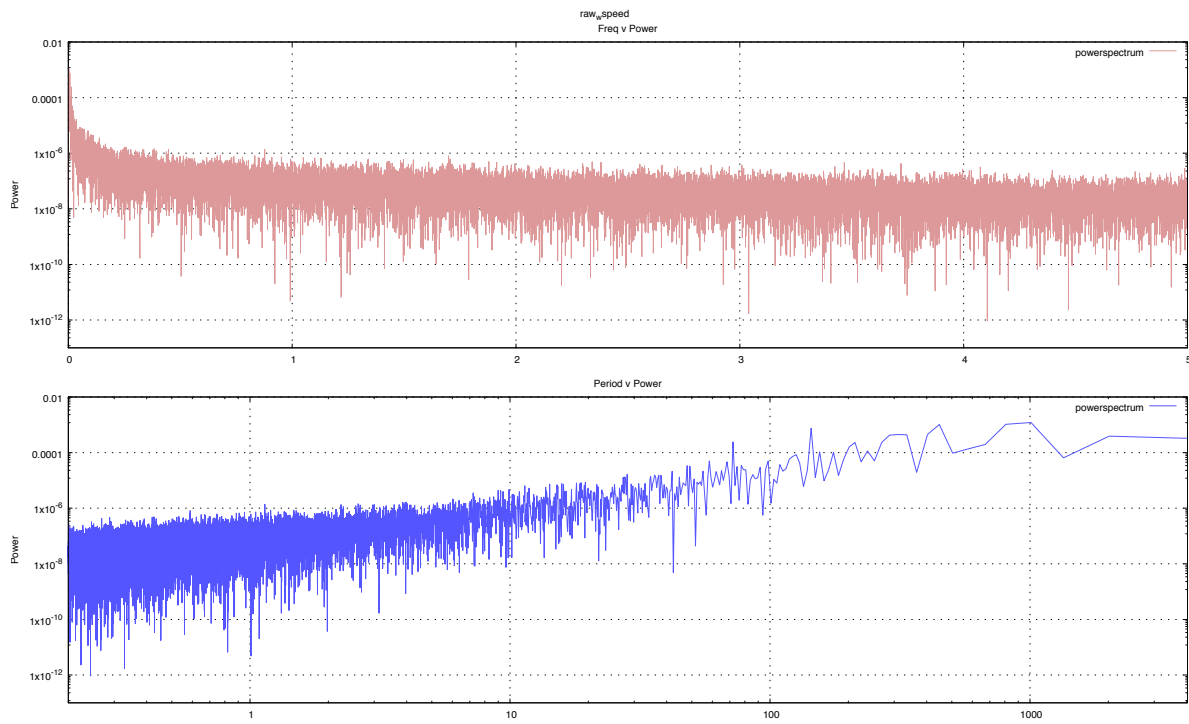
2.3 Monthly - $F_{min} = 40320$

With a monthly freqmin, we see there are a lot more cycles appearing, however the wind speed still has no cycle.

2.3.1 Temperature



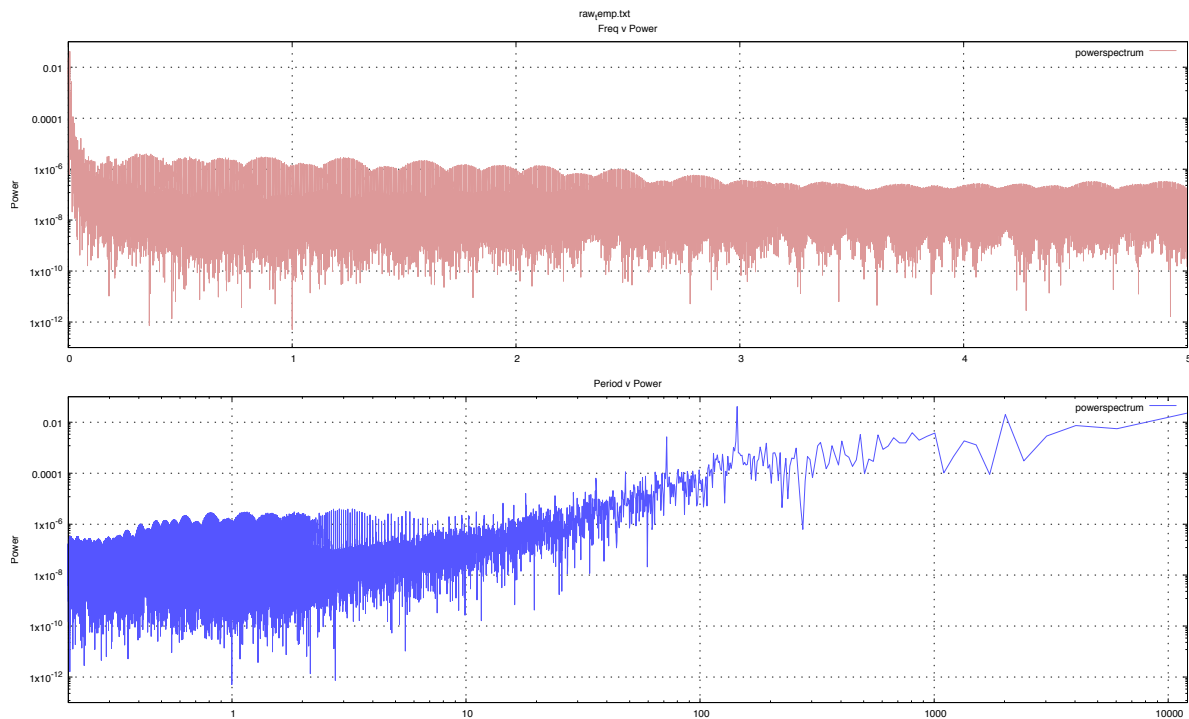
2.3.2 Wind Speed



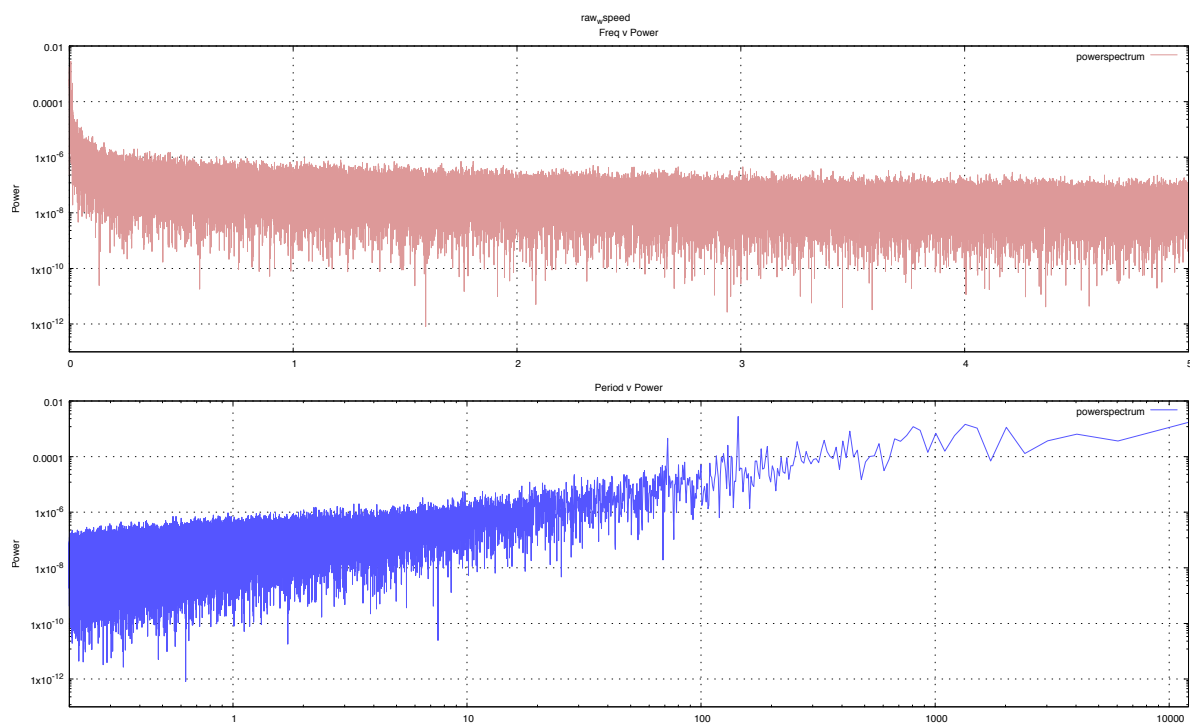
2.4 Seasonally - $F_{min} = 120960$

Here with the seasonal frequency (month * 3), there is a lot more cycles, however, no cycles with the wind speed.

2.4.1 Temperature



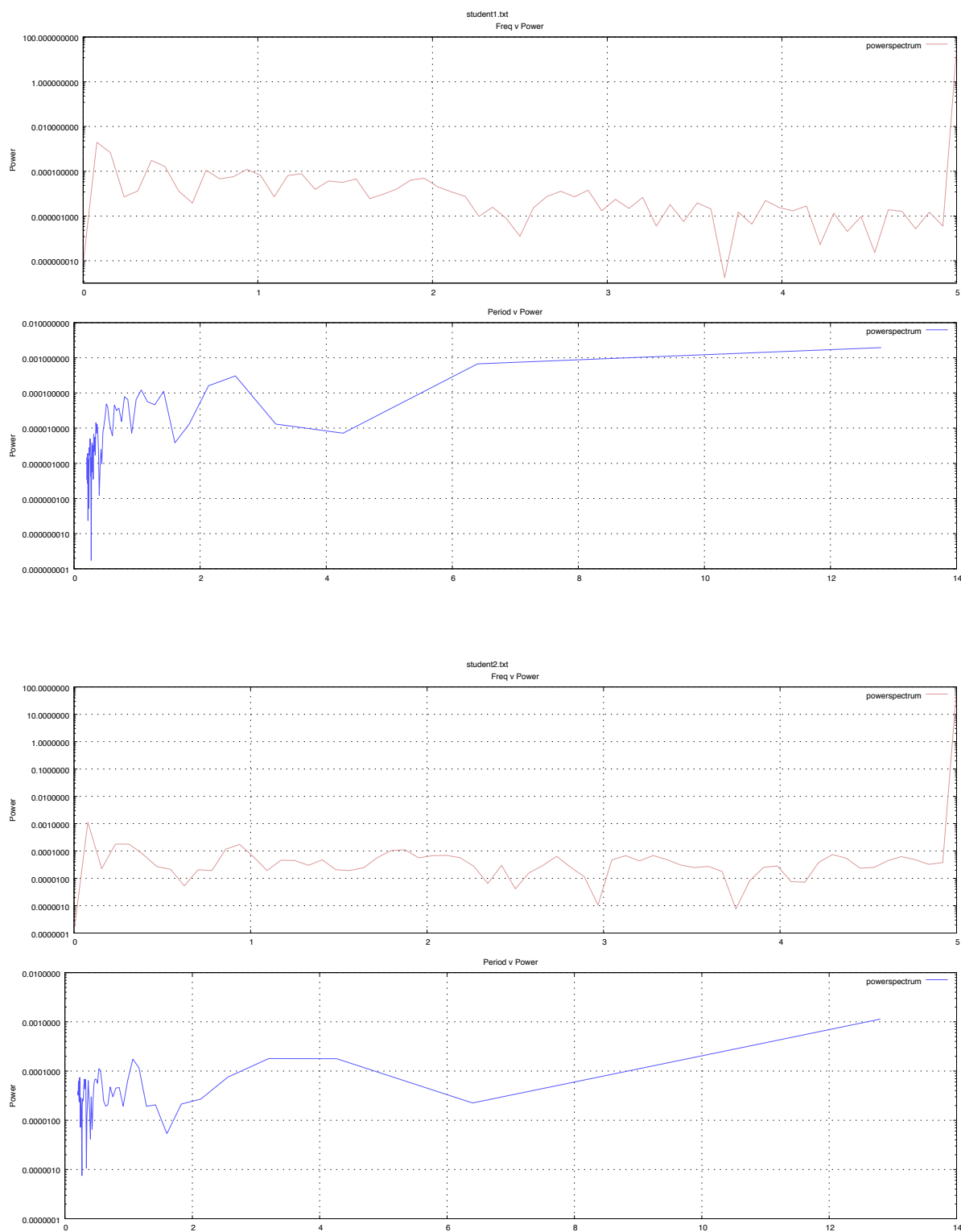
2.4.2 Wind Speed

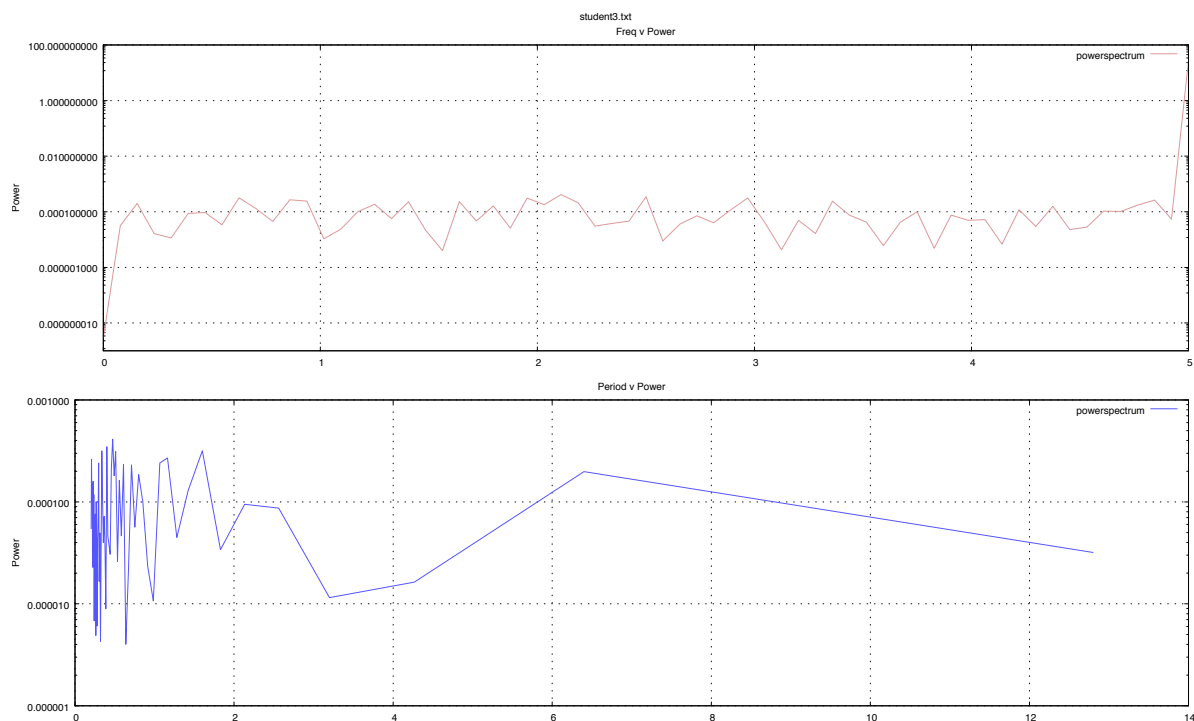


3 Student Voice Comparisons

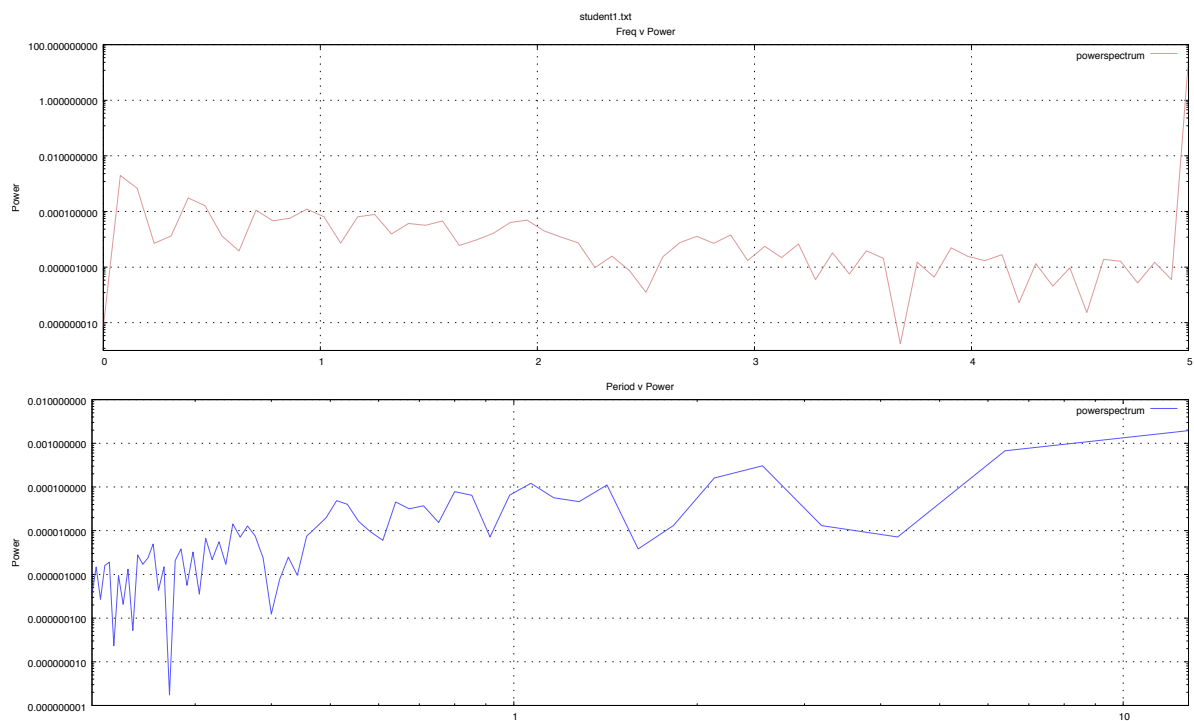
Here we present results of Welch's method on 3 different students say "Hi" with a long drawn out "i" sound. The sampling rate for all recordings was 44 kHz. We used a minimum frequency of 128 hz, or 128 samples initially.

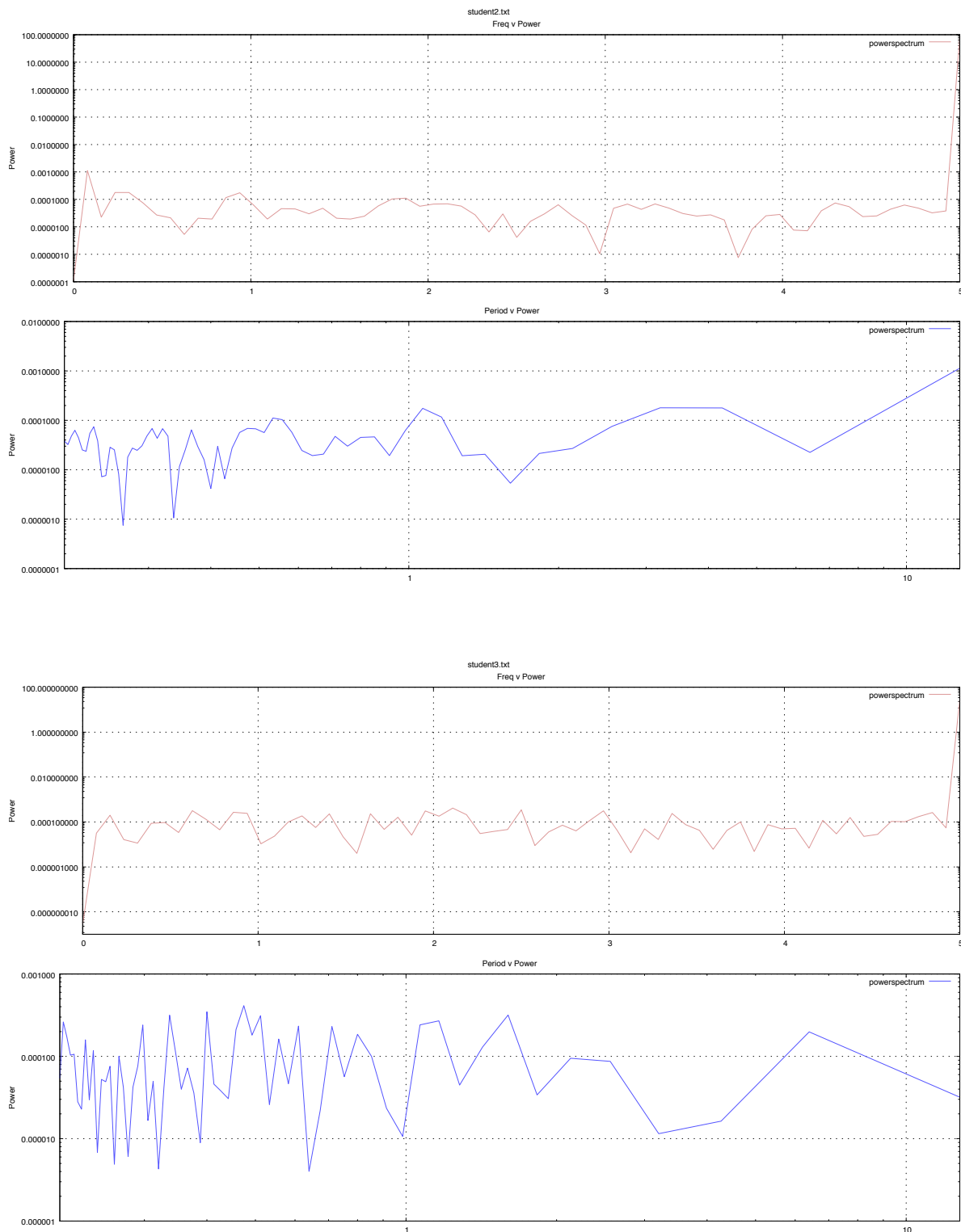
3.1 Results, $f_{min} = 128\text{hz}$





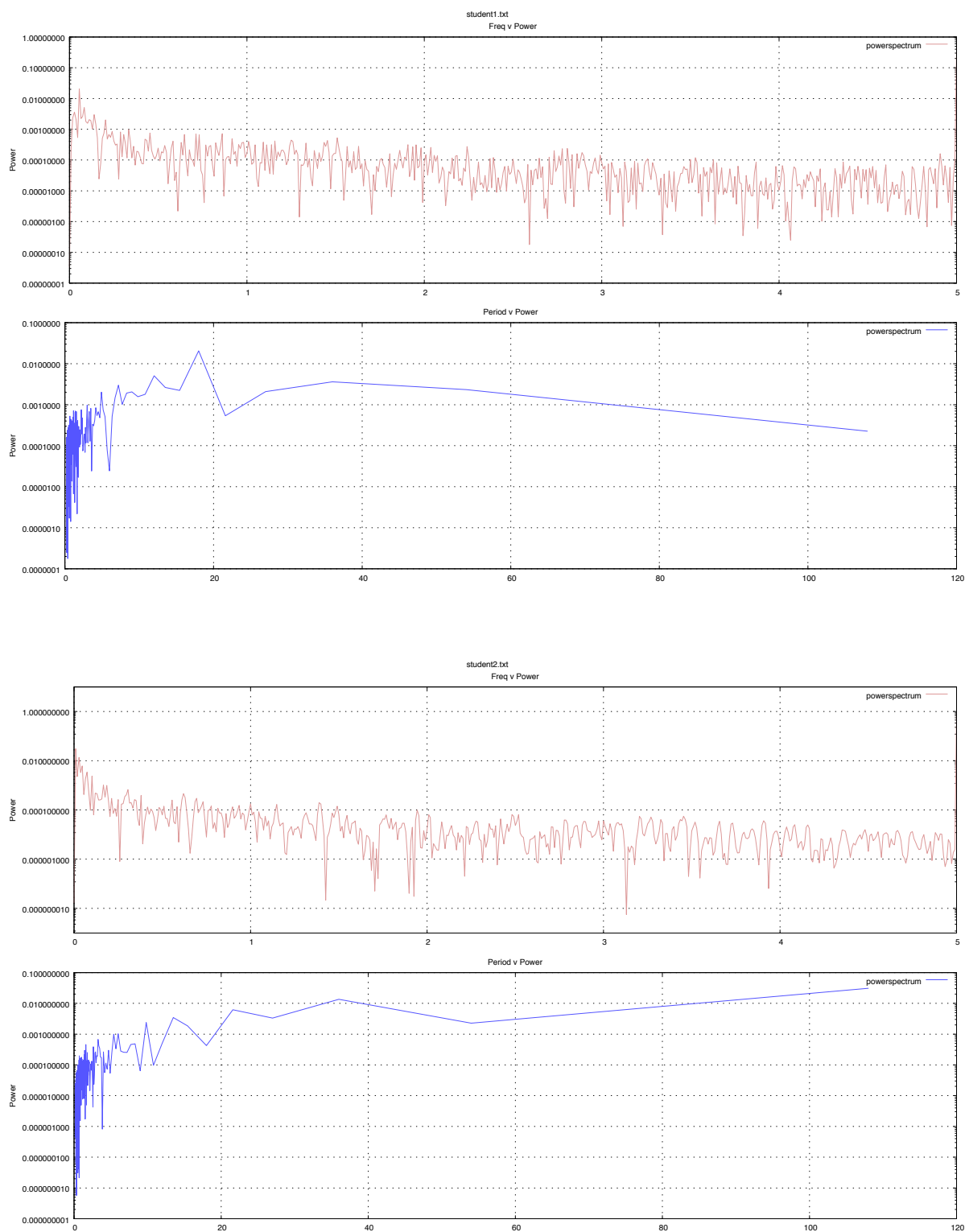
We see here that the results are not very similar, however there is quite a bunch up at the beginning of each of the period v power plots. Let us use a logarithmic x axis to fix this.

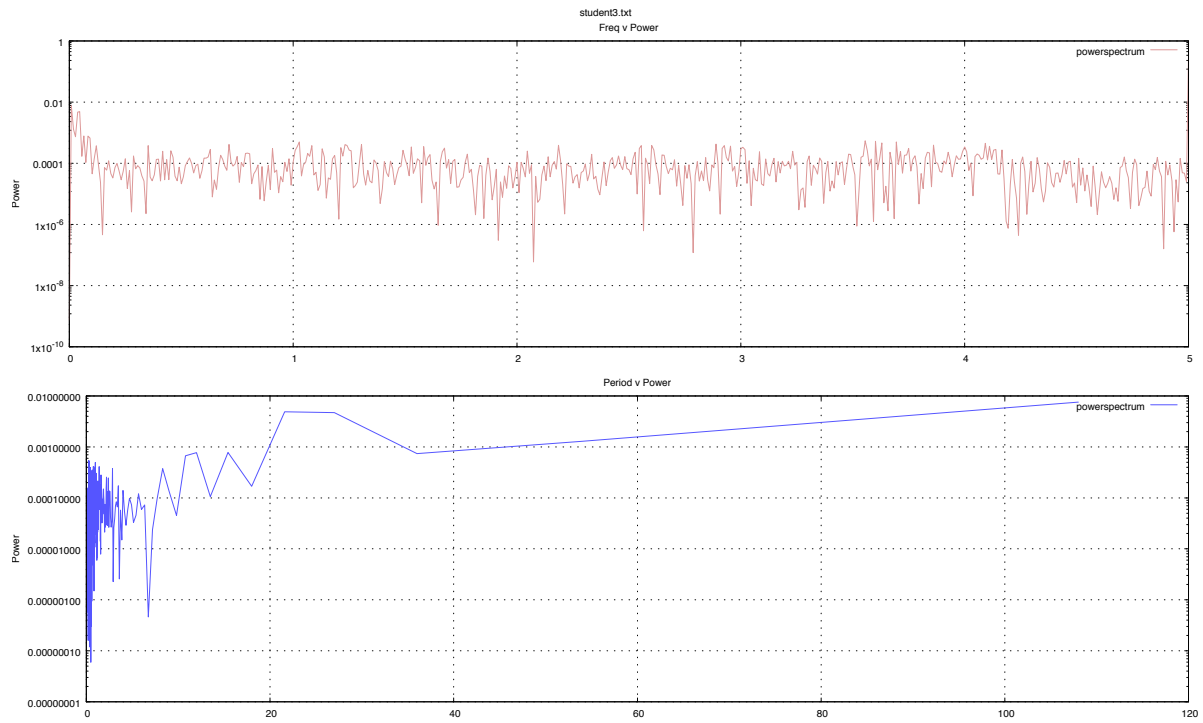




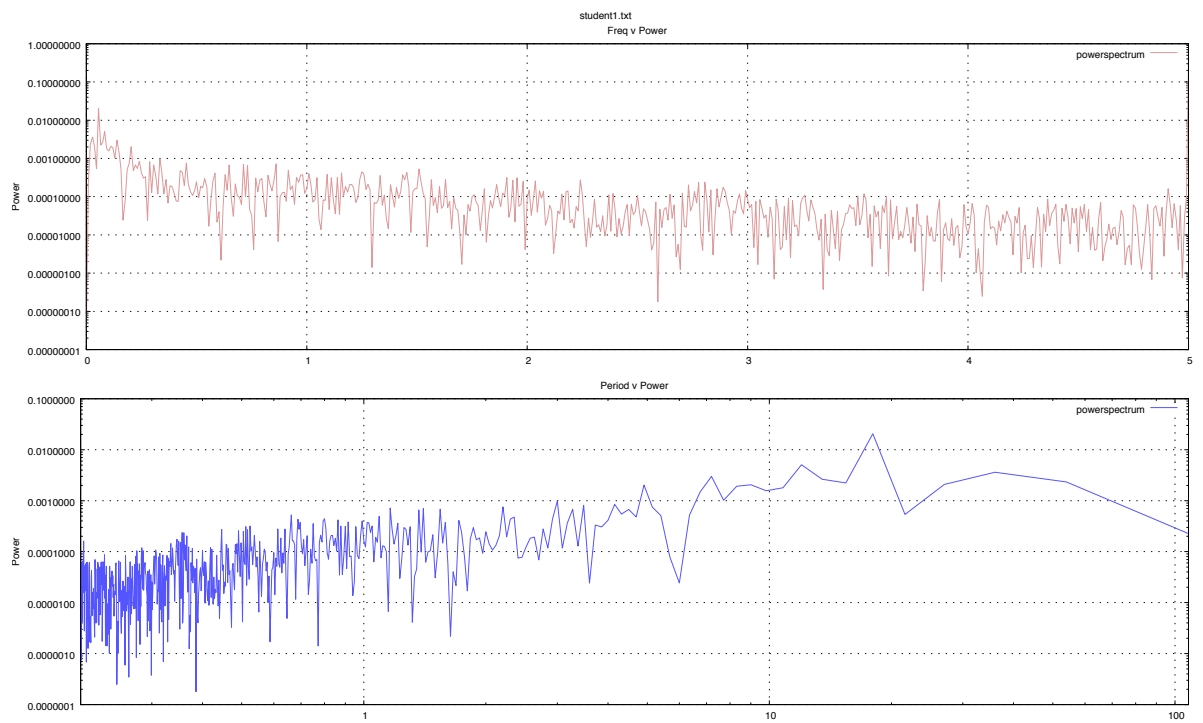
With a clearer picture of the results, we can tell that the graphs have a similar form, hinting towards the same sound being uttered, however the exact shape and the power of different frequencies are quite different. This implies that we are dealing with 3 different students, aka, it would be very difficult to fake someone else's spectrum. Below, we show the same analysis, but a larger minimum frequency of 1080 Hz.

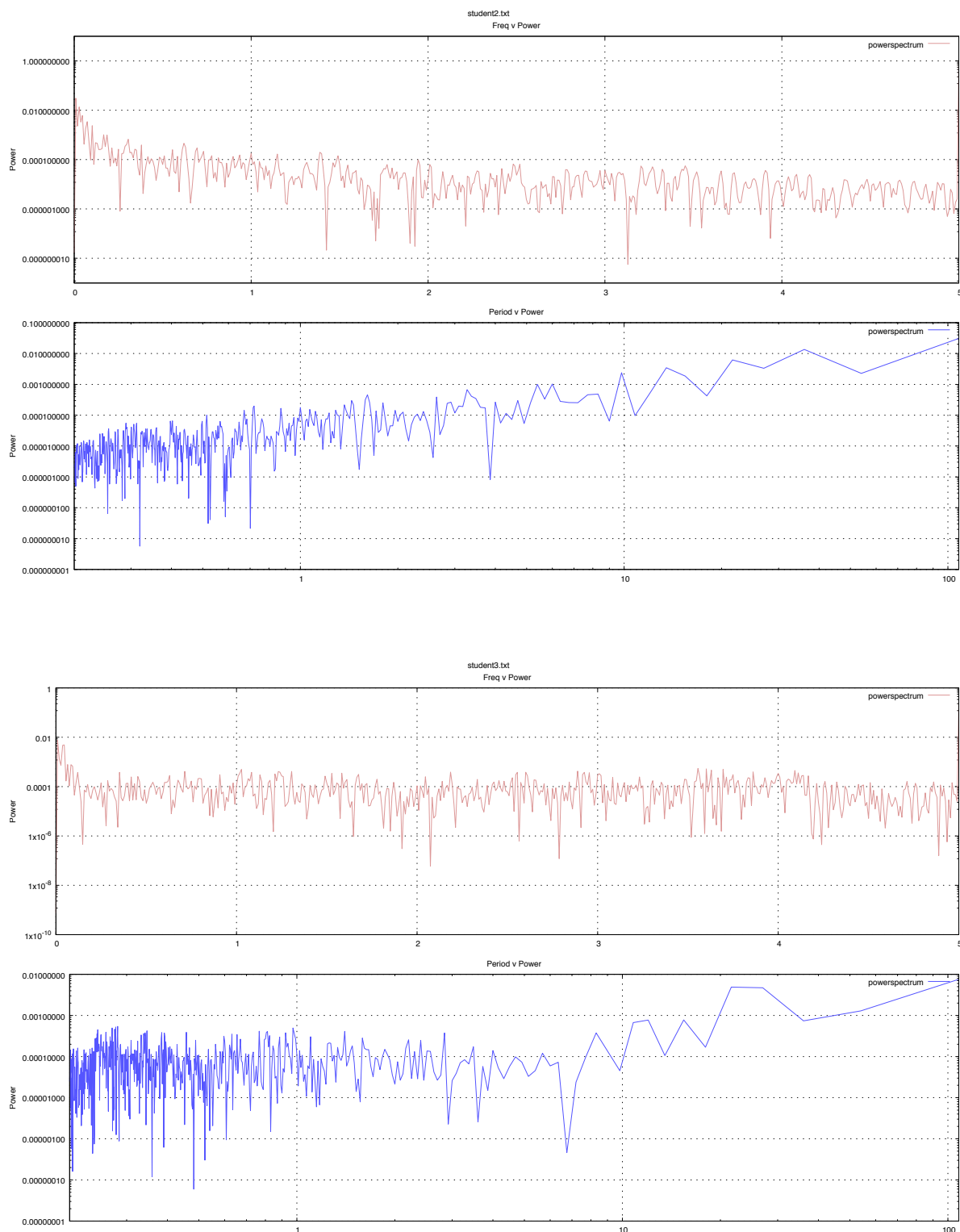
3.2 Results, $f_{min} = 1080Hz$





Again we look at a log scale for the period.





We see the same results as before, but with more information. There are clear spikes in both the frequency and the period relating to power still, but they are still quite different for each student, continuing to make it incredibly hard to replicate someone's spectrum.