Noise and digital filtering of the bad blocks in the 138 channel data set

March 26, 1997

The problem started when I realized that some of the velocity data blocks were bad. Figure 1 is one of the bad blocks. This is the velocity trace from channel 1 (one of the 16 bad ones on the first anemometer board) for block number 3:

Some of the blocks appeared ok. figure 2 is a velocity trace over all 1024 data points for block number 10, channel 1. It looks like it is ok except for the large variance. But after calculating the power spectral density of the block the spectrum looked bad, *v.* figure 3. There should not be a peak in the frequency at 500-600 Hz. There was obviously a big noise problem.

I went through all the blocks and calculated the psd of each one and plotted them to see what blocks looked good. I found about 80 which gave decent psd plots. One of them is block 77, *v.* figure 4. There is still a little peak at 500-600 Hz but overall it rolls off correctly.

I took all the "good" blocks, *i.e.* all those that looked like block 77, and calculated the POD eigenfunctions. The POD, of course, is as effective at reconstructing the spectra for the bad blocks as it is for the good blocks but I will include the POD in the following plots for fun.

figure 5 is a spectrum calculated from one of the first 16 channels (*i.e.* one from the bad anemometer board) and the POD reconstructed spectra. Notice the spectra do not roll off. In this figure I have skipped 10 bad blocks in the same way that I did it for my Ph.D. dissertation (these 10 bad blocks have some BIG problems but they are due to timing problems between the anemometers and the A/D and are not the same as the 220 bad blocks I am referring to here).

After we found the spectra did not roll off, Bill and I decided to digitally filter the spectrum near the potential core because of the noise problem. I now know that it is only the first 16 anemometer channels which have the problem but then we just filtered all 138 channels to be consistent. After filtering, the spectra looked like the one in figure 6.

Now, to test the noise problem and to see if the 80 good blocks were really good, I recalculated the POD eigenfunctions today and then calculated the spectrum using only the 80 good blocks. The spectra should roll off without having to use the digital filter, and this is what happens more or less, *v.* figure 7.

Note that I have NOT filtered this data with the digital filter. This is directly out of the original velocity data using only the good 80 blocks. It looks pretty good considering I only used 80 blocks. The one concern I have is that the value of the spectrum is so large at the low frequencies. My worst fear is that the Bessel filters were not filtering and this is aliased information. Does this seem like it to you also? I am certain that I checked out the Bessel filters and they were working but I can't understand why the spectrum goes up so much there. Note that it has been like this all along. I have seen other peoples measurements and it does go up a little. I hope we are not all aliasing.

One note, could the pulsing that we see near the potential core, the "eruptions", be the result of aliased information that has increased energy in the low frequencies ONLY in the channels near the potential core? This would mean that the "eruption" is not an "eruption" at all but rather the effects of aliasing. Wait, I guess it can't because that pulsing has a frequency of about 100 Hz which is the Strouhal frequency for the ring instability. Whew! I am glad that wasn't the case because that would really put a dent in the whole theory. As you can tell, I am just rambling here but I never get to talk to anyone about this so bear with me!!

The big question then is, do I use all 300 blocks and digitally filter all 138 channels (everything I have done so far has used this method) or do I just use the 80 good blocks on the first 16 channels and all 300 on the other 122 channels and not filter?

Any suggestions? I think I am still safe with the stuff I have already but I would like to have this straightened out as soon as possible. I'm sure I could just sweep it under the table but that wouldn't be very responsible I think.

Thanks for reading this over, I would appreciate any suggestions.

Joe

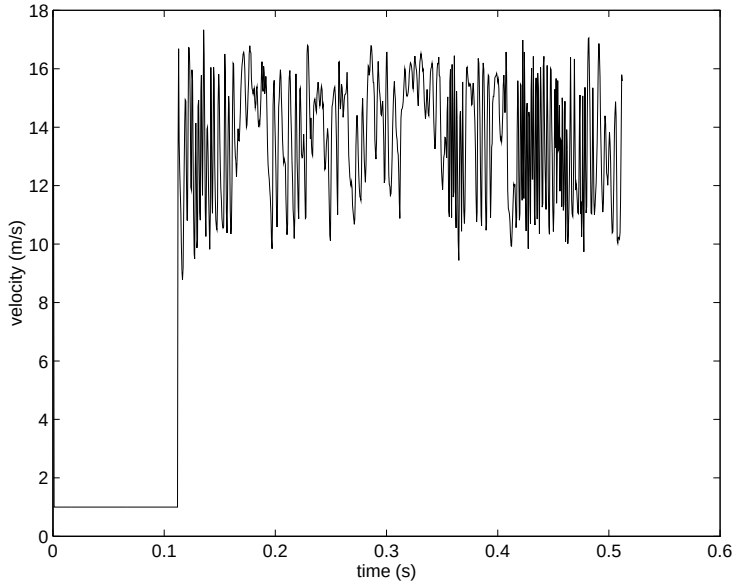

Figure 1: Block number 3. The velocity is obviously messed up

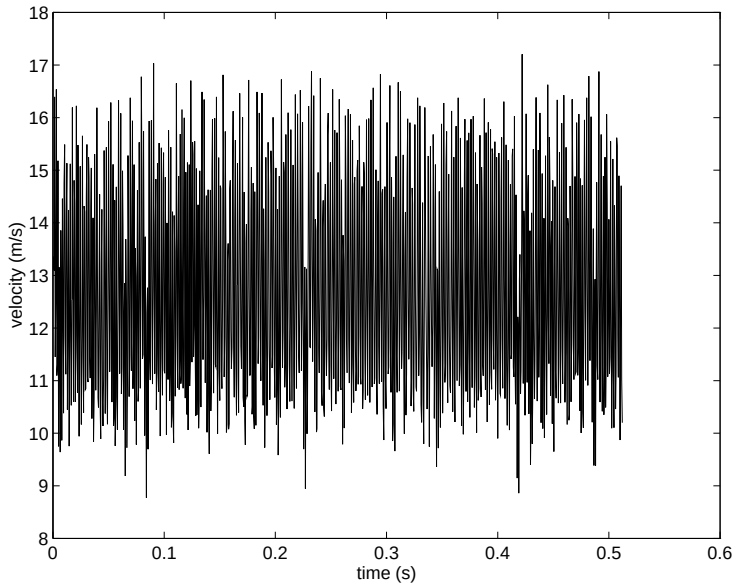

Figure 2: Block number 10, channel number 1. The velocity looks ok

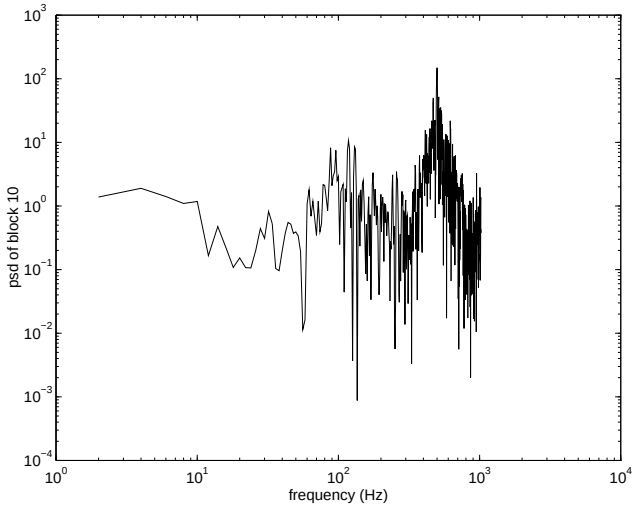

Figure 3: PSD of block number 10 for the first channel.

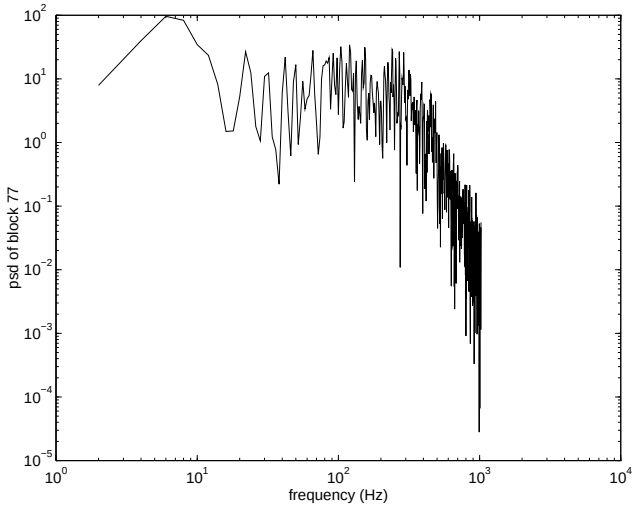

Figure 4: PSD of block number 77.

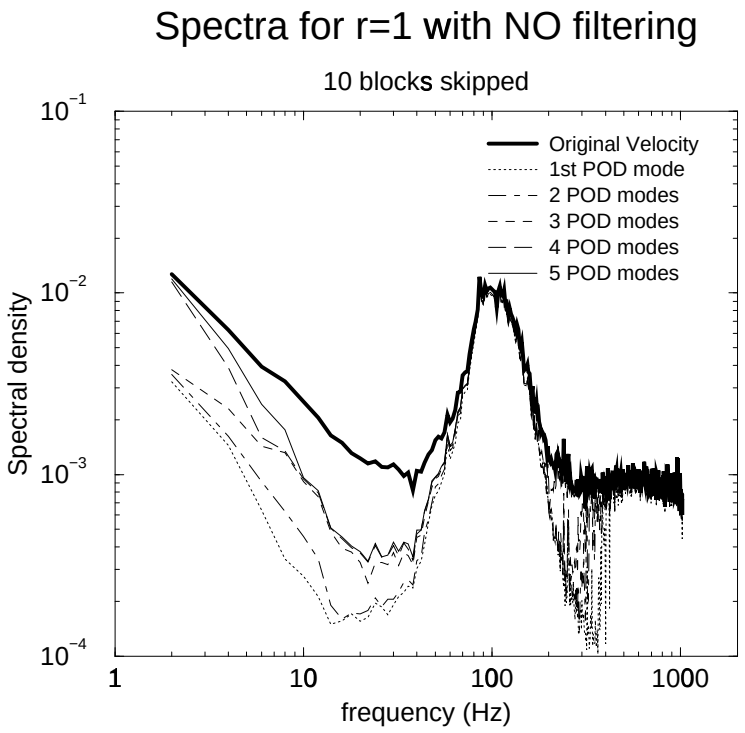

Figure 5: Spectrum from original velocity and reconstructed POD spectra

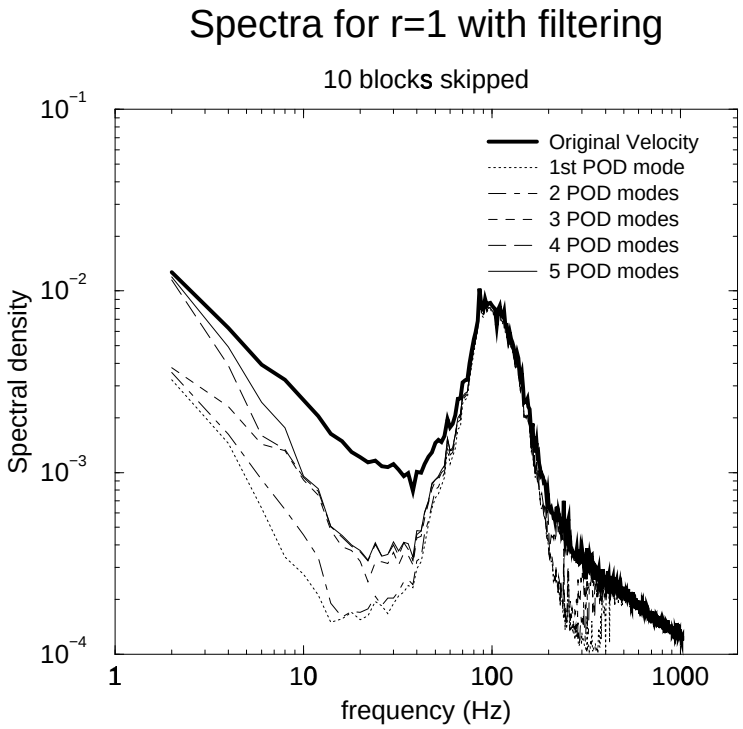

Figure 6: Spectrum from original velocity and reconstructed POD spectra

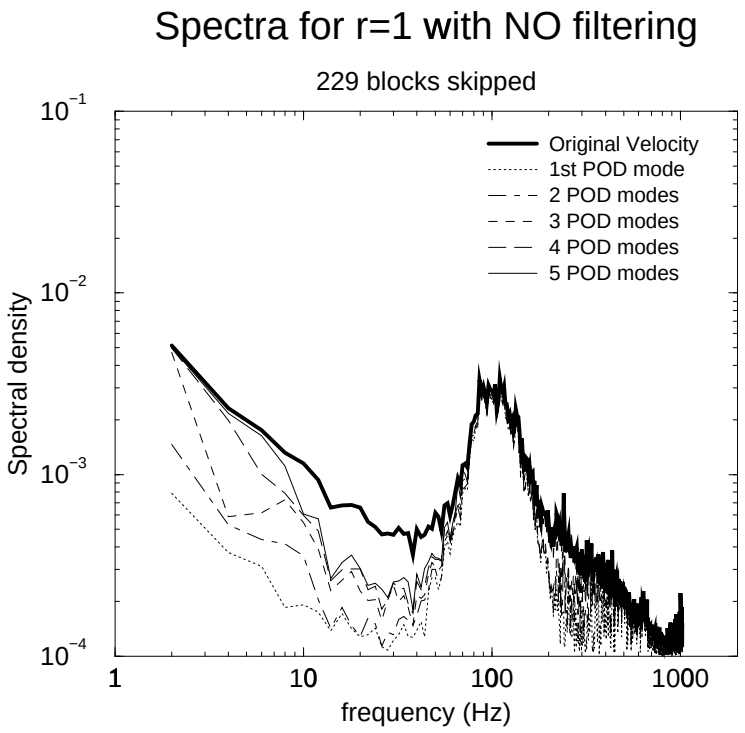

Figure 7: Spectrum from original velocity and reconstructed POD spectra