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For the Rinaldi Receiving Station recording of the 1994 Northridge mainshock, I happened to notice that the low-cut filter corner in the PEER NGA flatfile is 0.3 Hz, which struck me as being too high. I confirmed this with Walt via telephone conversations last week. He is not sure where he obtained the data or what processing was done on the record. On looking into the issue, I discovered that the data in the flatfile corresponds to the "old" data (with a duration of about 16 sec). Trifunac et al. (1998) redigitized the data. Their version of the data differs in several ways from the "old" version: they included more of the record, they captured peaks not properly digitized in the "old" version, and they corrected for more stalls on the record. As a matter of interest, it should be noted that no internal time code marks are available for this record, and thus the peak velocities and peak displacements, as well as the spectral amplitudes, are dependent on the assumption that 1 cm = 1 sec.

The unprocessed "new" data can be obtained from ftp://cwis.usc.edu/pub/todorovs/North_aft_M5/DWP/MAIN/V1/. The file name for Rinaldi is V1X0006.DWP.

To see how the "new" data might differ from that used in the NGA flatfile, I include here a series of plots comparing waveforms and response spectra. I processed the new data using both causal and acausal filters, each with different rolloffs. The processed data available from USC has filtered the 228 degree trace with a transition from 0.09 to 0.11 Hz and the 318 degree component with a transition between 0.15 and 0.20 Hz. In the Trifunac et al. (1998) papera transition from 0.07 to 0.09 Hz is used for both components. In this note I used Butterworth filters with corners of 0.01, 0.02, 0.10, and 0.20 Hz. I did no baseline corrections before filtering. I only show plots of the waveforms for the recorded section of time. Because I have not included the padded portions, the displacements sometimes do not return to around zero at the end of the recorded time, although plots of the complete time series that was filtered do show that the displacements return to zero (in other words, the filtering was done correctly and no "wrap-around" pollution exists--- see Boore, 2005, for a discussion).

Please note that waveforms plots were made using a "quick-and-dirty" plotting program and as a result, the traces appear to have dropouts. But they should be adequate for purposes of comparisons, and the peak motions along the ordinate axes are accurate.

Here are some observations:

1. at short periods, there are systematic differences between NGA and "new" for the 318 degree component, although the short-period response is essentially identical for all acausal filters. The NGA spectra are given at 0.01 and 0.02 sec, but the similar values at both periods is not consistent with the "new" results, and furthermore the abrupt leveling off of the NGA spectrum for periods shorter

than about 0.02 sec looks strange (the spectrum for the 228 degree component also levels off at about 0.02 sec, but more gradually). The spectra for the 228 degree component are similar for NGA and “new” (as long as acausal filtering is used).

2. at long periods, there are differences between NGA and “new” for periods longer than about 2 to 3 sec (depending on component), but here the “new” results vary with the filter corner (as expected). For the 228 degree component, the NGA results are greater than the “new” results for periods between about 2 to 5 sec and are tending to lower values for greater periods. For the 318 degree component, the NGA values are lower than the “new” values for periods greater than about 6 sec (except for the “new” results using a filter corner of 0.2 Hz).

Bottom line: I recommend replacing the NGA values for the Rinaldi Receiving Station recording of the 1994 Northridge mainshock with the USC digitized data, corrected for stalls. The processing of the corrected data should use acausal, not causal filters (note the sensitivity of the short period response on the 228 degree component to long-period cutoffs for the causal filter, as well as the greater sensitivity of the peak velocity to filter corner for causal filters).

Figures follow, with minimal description.

References

Boore, D. M. (2005). On pads and filters: Processing strong-motion data, *Bull. Seism. Soc. Am.* **95**, (in press).

Trifunac, M.D., M.I. Todorovska, and V.W. Lee (1998). The Rinaldi strong motion accelerogram of the Northridge, California earthquake of 17 January 1994, *Earthquake Spectra* **14**, 225--239.
Dave’s reading notes: Add intervals to correct for many stalls. The resulting a,v,d, and rs differ from the ``old'' both because of the added stalls and because some peaks in the old digitizing were underestimated. Overall, however, the results do not differ by much. This may be because the stalls are apparently of short duration (the longest being 0.1 sec, but this being well after the strong shaking) and because no stall occurred during the strongest pulse. A complication in the analysis is that the 1/2 sec time marks are missing on the top and bottom of the trace--- so time has to be obtained by assuming 1 cm = 1 sec.

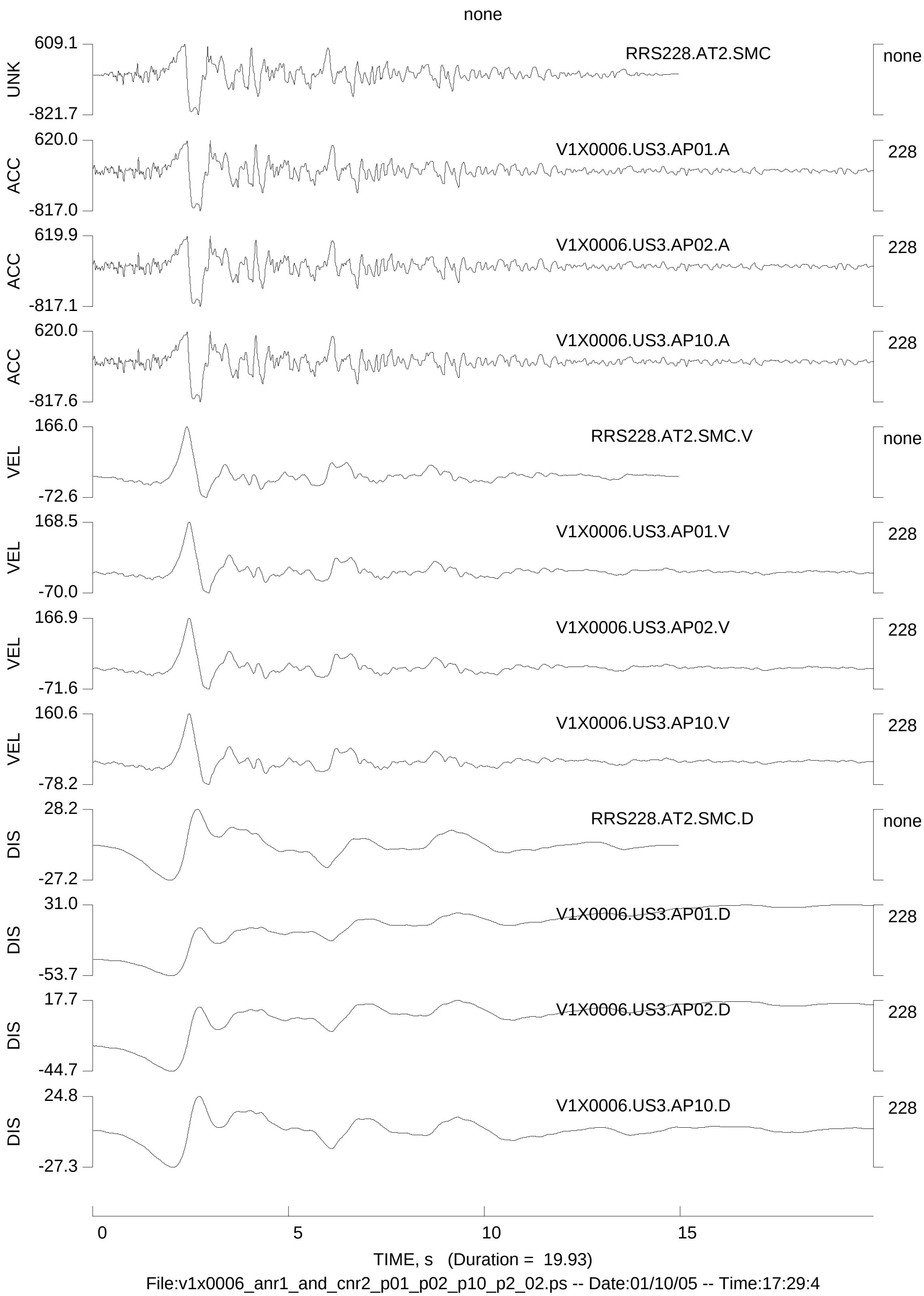

Figure 1. NGA time series ("RRS" file name), and acausally filtered, 228 degree component using filter corners of 0.01, 0.02, 0.1, and 0.2 Hz.

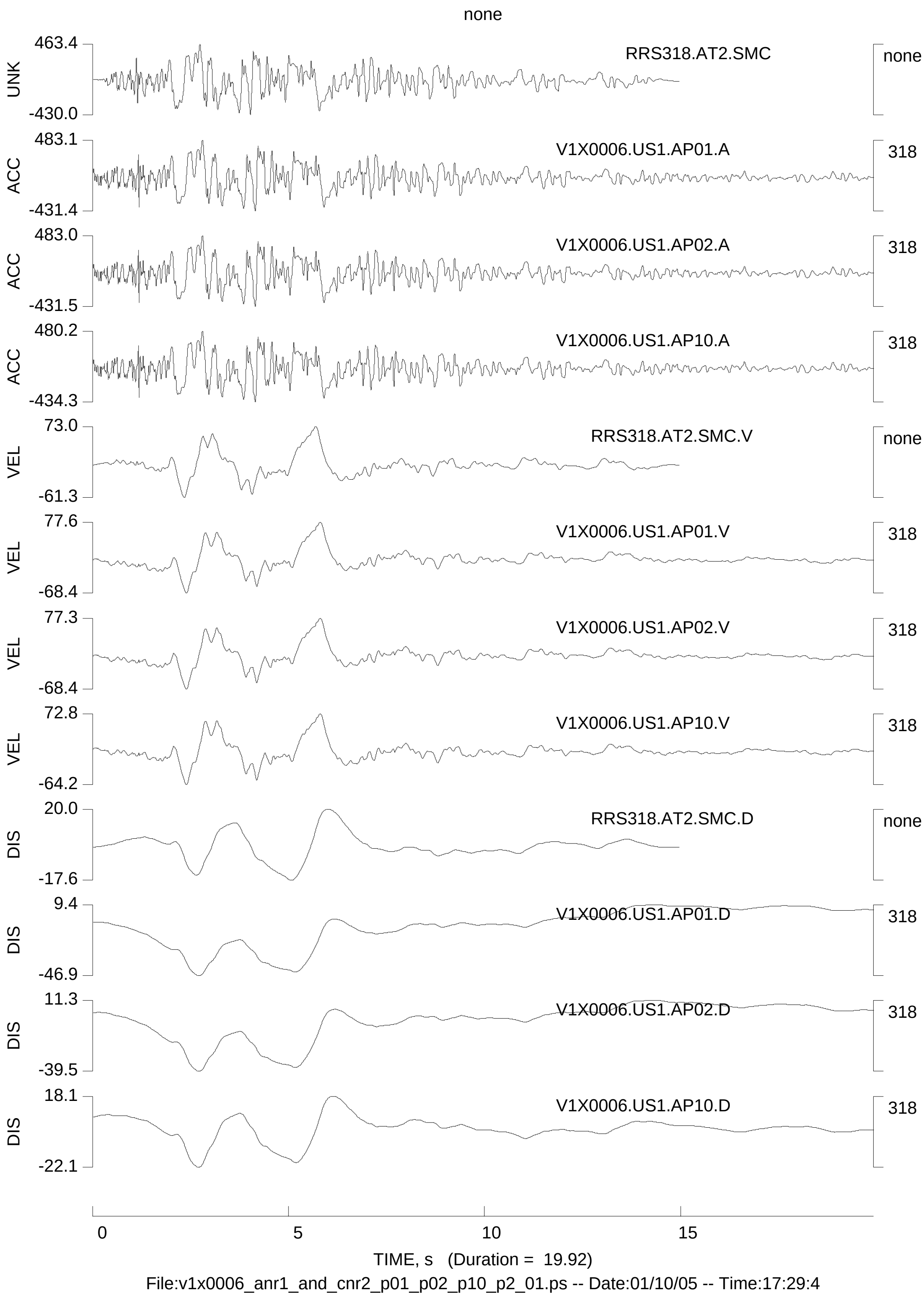

Figure 2. NGA time series ("RRS" file name), and acausally filtered, 318 degree component using filter corners of 0.01, 0.02, 0.1, and 0.2 Hz.

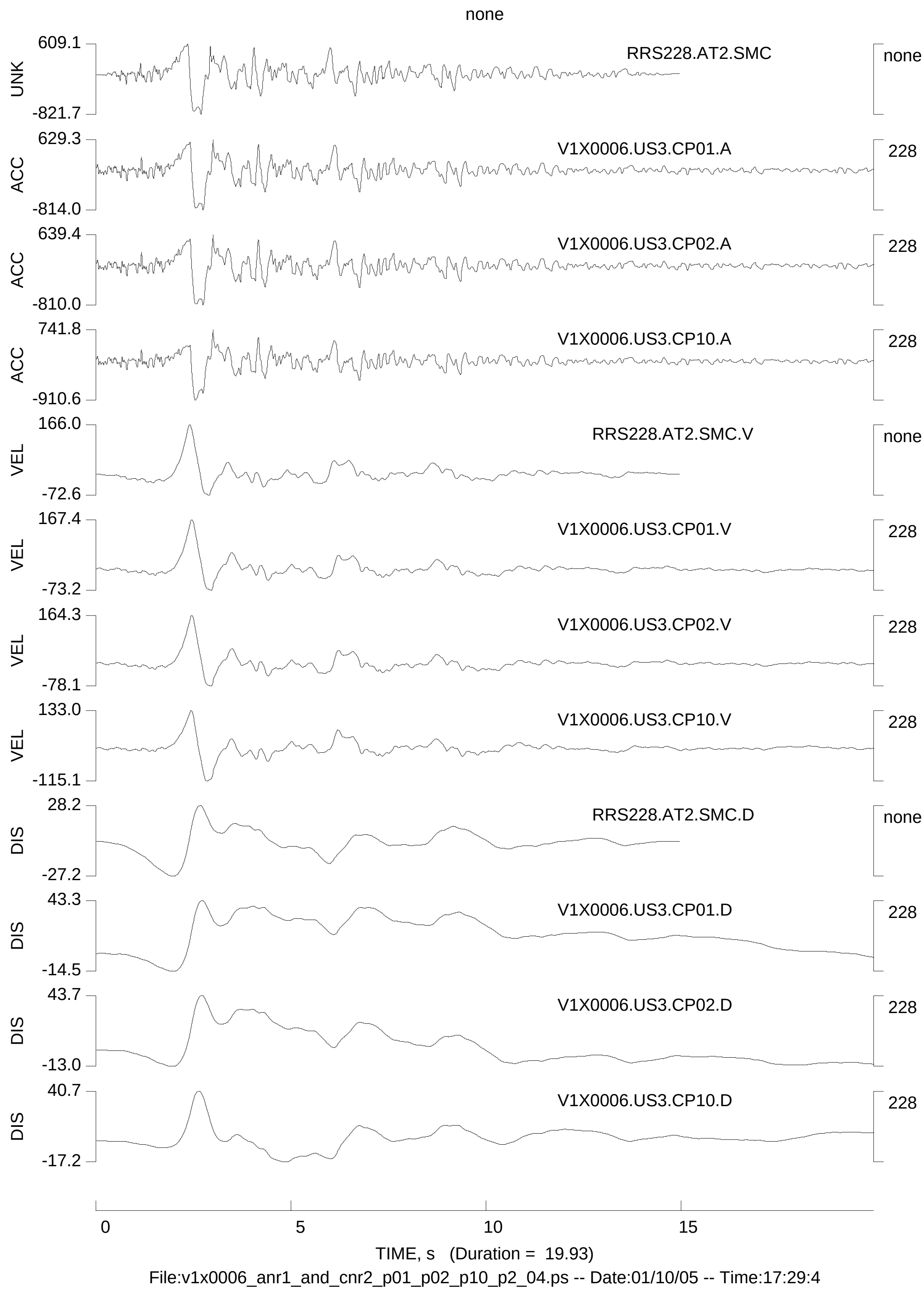

Figure 3. NGA time series ("RRS" file name), and causally filtered, 228 degree component using filter corners of 0.01, 0.02, 0.1, and 0.2 Hz.

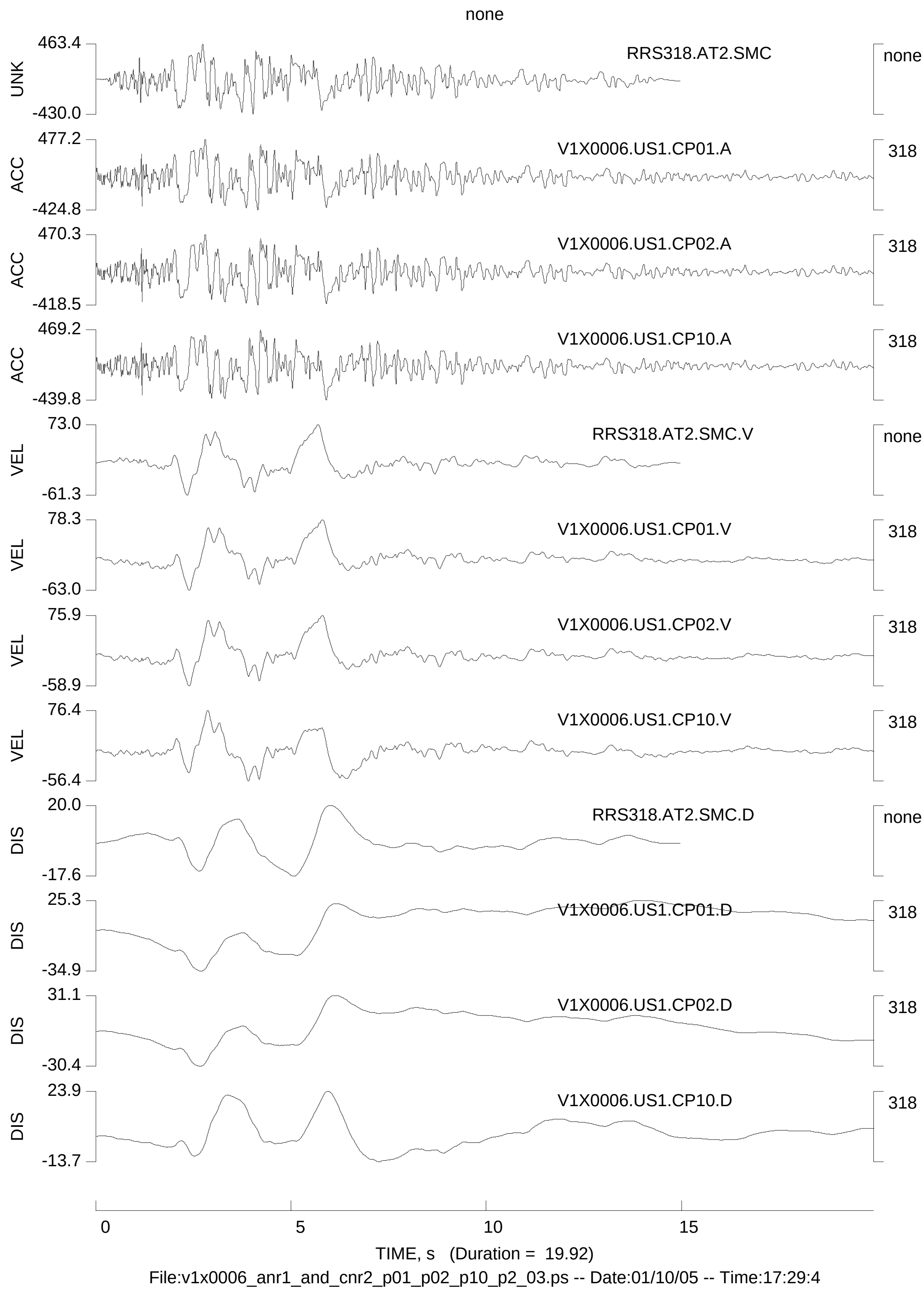

Figure 4. NGA time series (“RRS” file name), and causally filtered, 318 degree component using filter corners of 0.01, 0.02, 0.1, and 0.2 Hz.

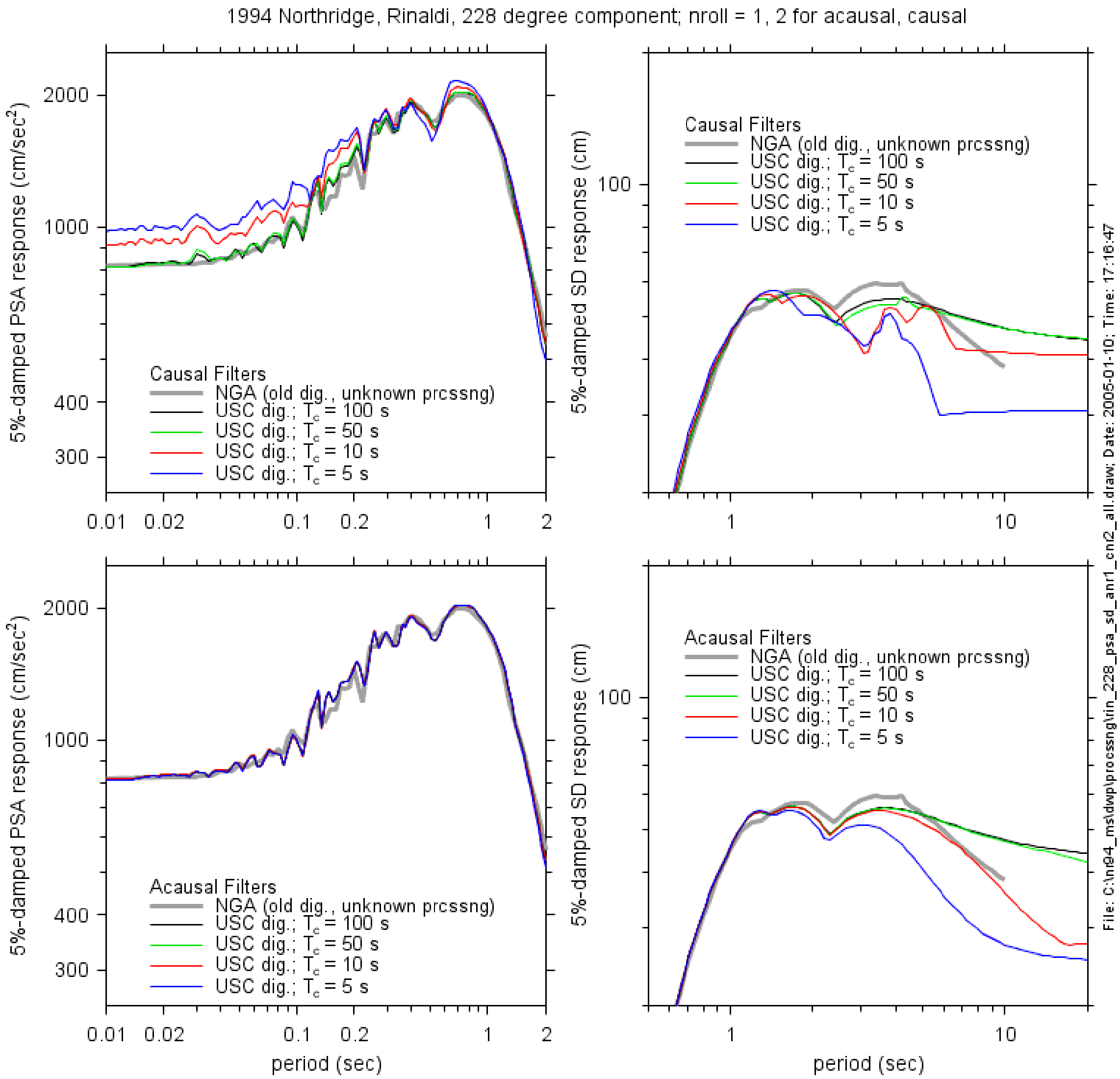

Figure 5. PSA and SD response, acausal and causal filters, as well as NGA spectra, for 228 degree component. Lowest order time-domain filters were used.

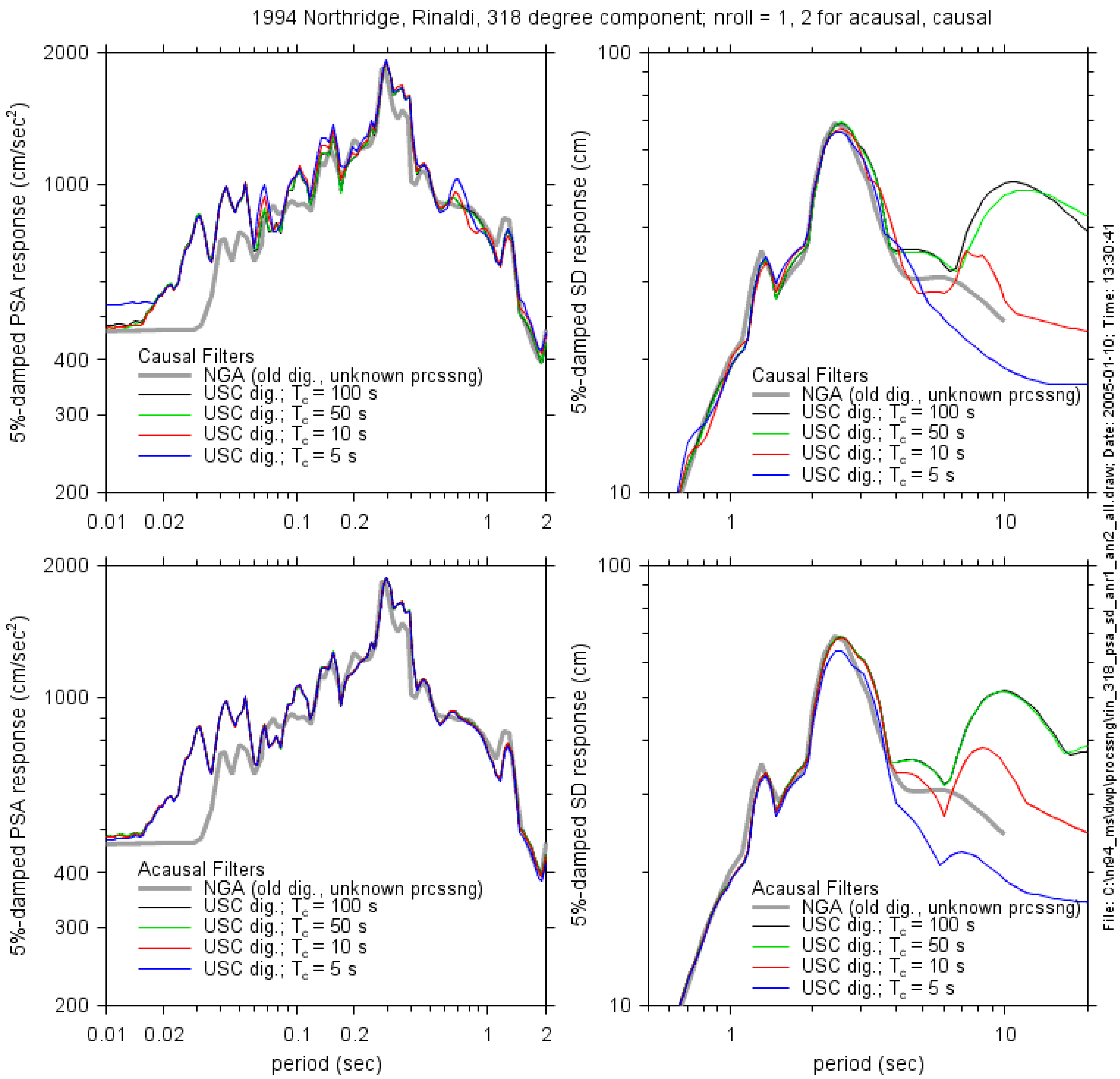

Figure 6. PSA and SD response, acausal and causal filters, as well as NGA spectra, for 318 degree component. Lowest order time-domain filters were used.

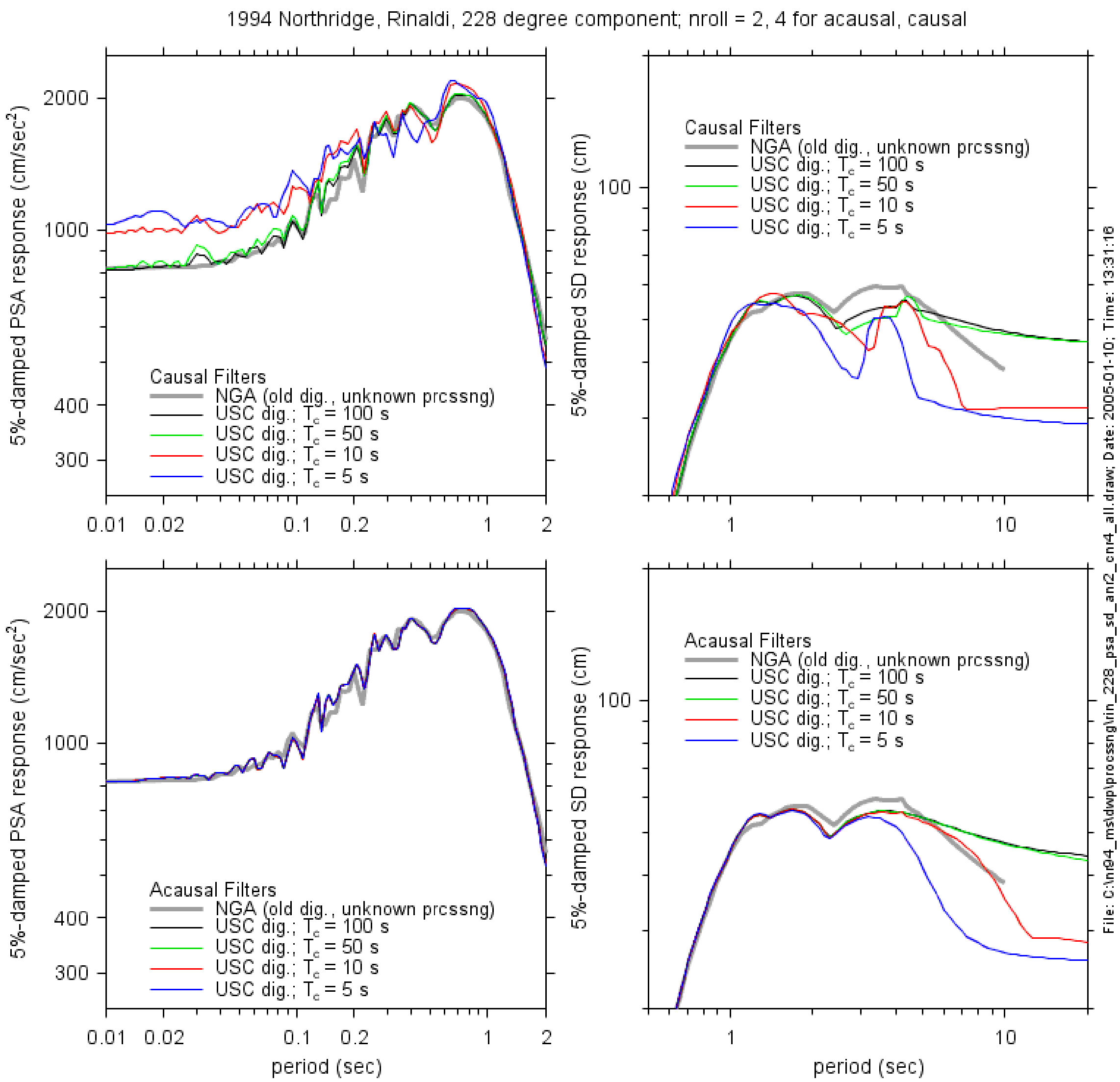

Figure 7. PSA and SD response, acausal and causal filters, as well as NGA spectra, for 228 degree component. Order of filters twice that used in previous two figures.

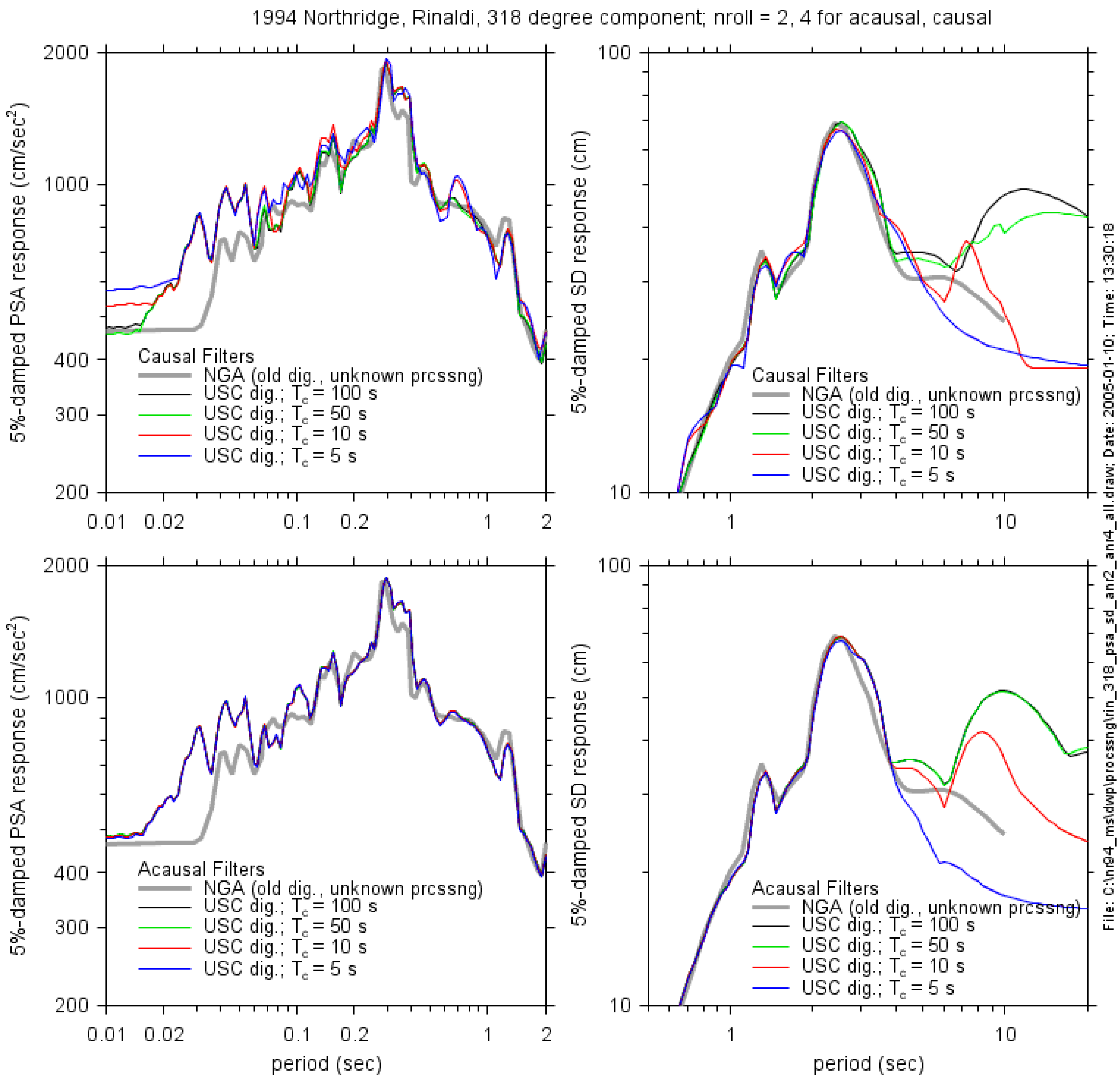

Figure 8. PSA and SD response, acausal and causal filters, as well as NGA spectra, for 318 degree component. Order of filters twice that used in Figures 5 and 6.