

QC TX Network

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Introduction

The purpose of this report is to review the metadata of the TX network. The reason for this study is that regional moment tensor inversion requires confidence in the metadata in order to use the results. I previously noted problems when using some of the TX stations to study the Mexico earthquake of 2017/08/26. I rejected some stations because the Love wave did not appear on the transverse component and because the Rayleigh wave was not retrograde elliptical.

The method is study used in this evaluation is to get recordings from the IRIS DMC for some large earthquakes, preferably teleseismic. The advantage of using distance teleseisms is that one can justify the assumption that wave amplitudes should be the same at low frequencies across the network. A proper test would use earthquakes with different back azimuths from the network, but this was a problem for the 2017 and early 2018 time period. Earthquake do not occur uniformly in space.

The procedure used had the following steps:

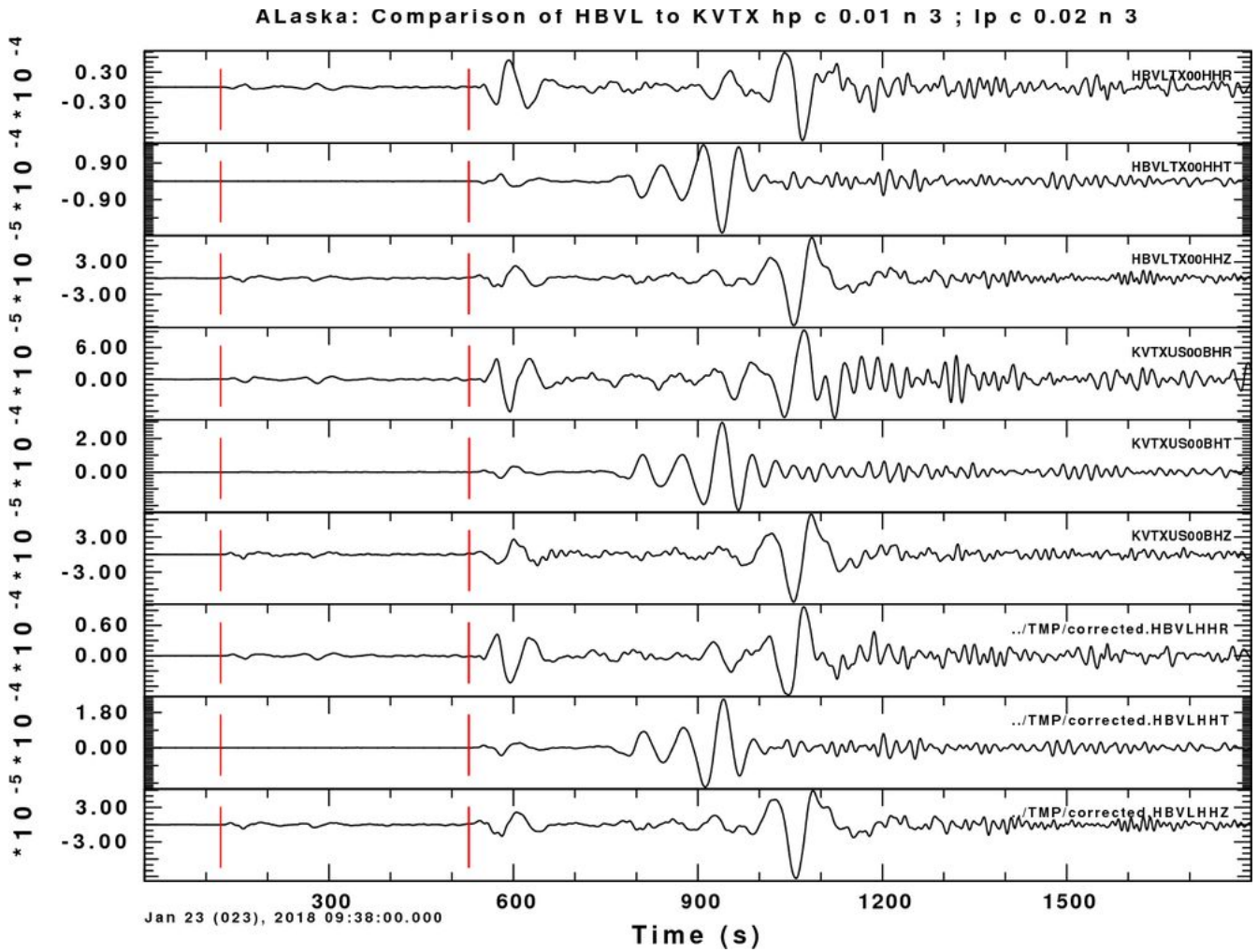
- Download waveforms from the IRIS DMC
- Remove the instrument response. Rather than using the pole-zero file, I used the RESP file with the program **evalresp**. This includes the FIR filters, and as we will see, a problem was identified in some of the RESP files.
- Rotate the waveforms for a station to form Z, R and T components.
- Low pass filter the waveforms to identify a pulse-like feature that can be followed across the network. This report uses P, S or the surface-waves according to the data set.
- Compare the filtered Z, R and T at adjacent stations, or preferably, to a US network station.
- If this is a discordancy, suggest and test a solution.

Data from the following earthquakes were used in this evaluation:

Event	Date	Time	Latitude	Longitude	Depth	Magnitude
Alaska	2018/01/23	09:31	56.046	-149.073	25	7.9
Honduras	2018/01/10	02:51	17.474	-83.519	10	7.5
Montana	2017/07/06	06:30	46.881	-112.575	10	5.8
Gulf of Cal.	2018/01/19	16:17	26.680	-111.107	10	6.3

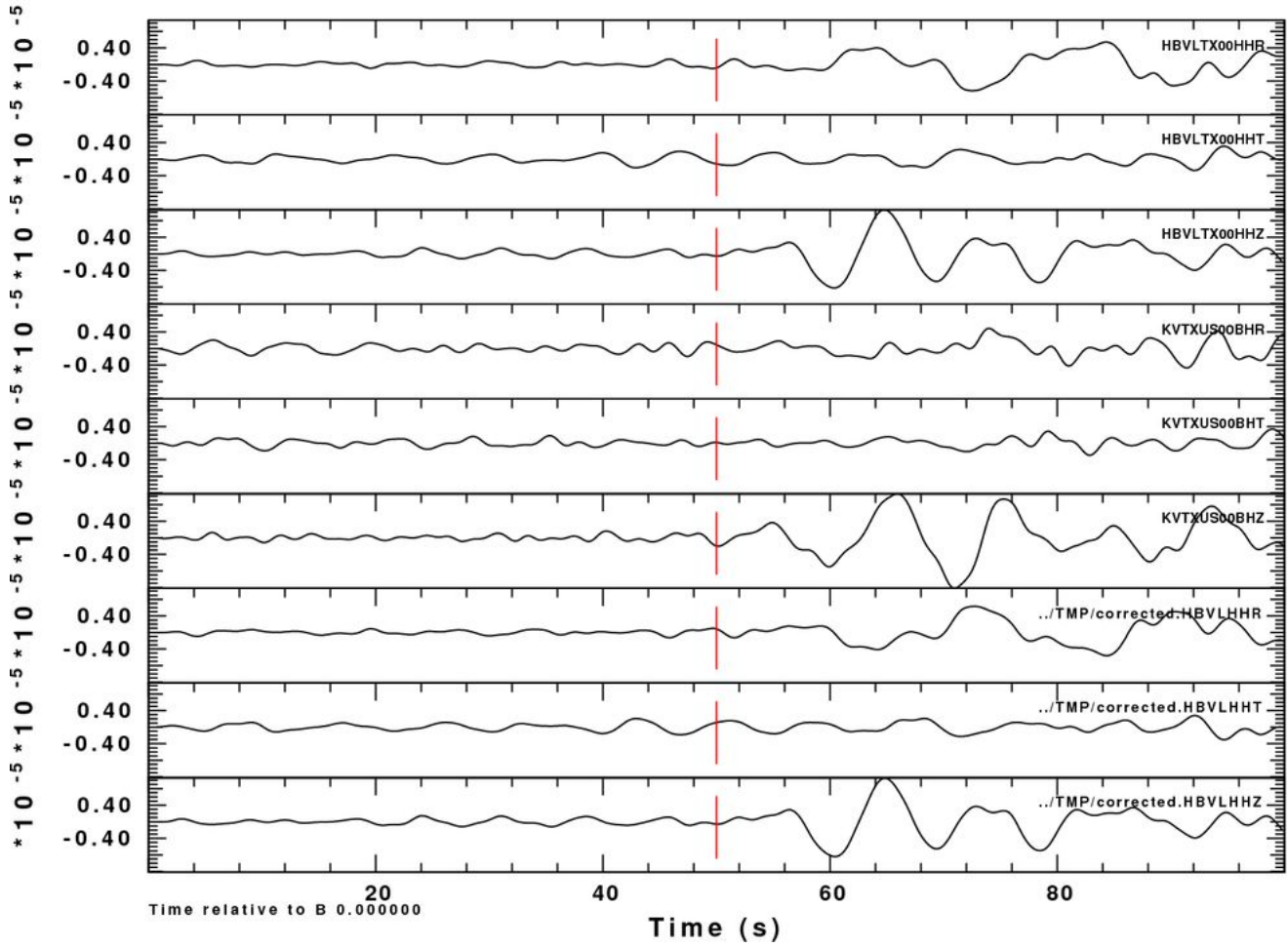
The following pages will present the comparison of filtered waveforms. The layout is that the first three traces are the inferred R, T and Z for the station using the current metadata. The second group of three shows the traces for the reference station. The bottom group of three traces shows the result for the station with the corrected orientations. The figure title gives the gsac command used to bandpass filter the waveforms and also indicates the feature that identifies misorientation. The figure caption gives more detail.

HBVL

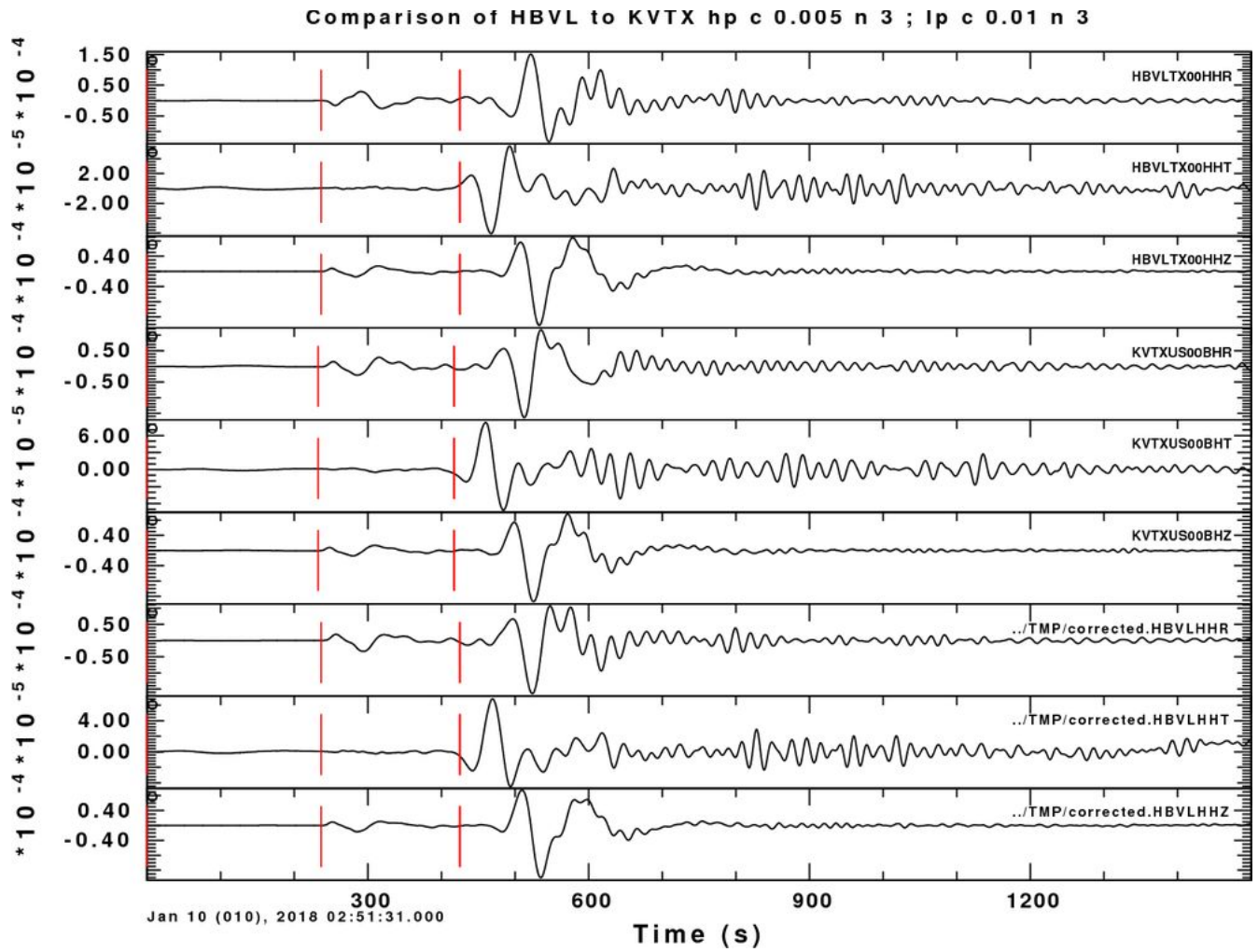


The S on the R component is reversed in the original waveforms. The T is also reversed.

G. California P: Comparison of HBVL to KVTX hp c 0.05 n 3 ; lp c 0.25 n 3 ; ylim all

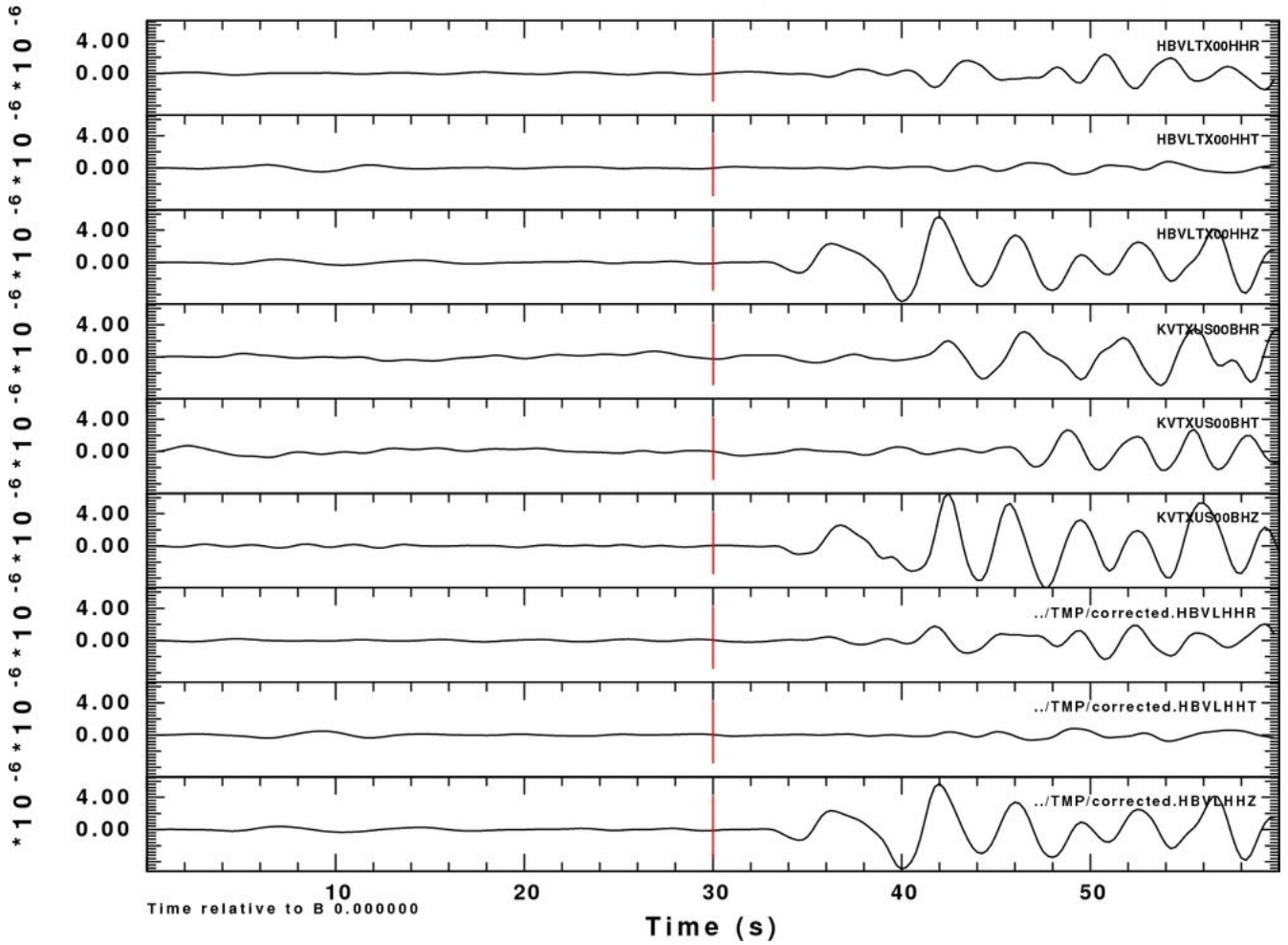


This was better if I had not use the “ylim all”

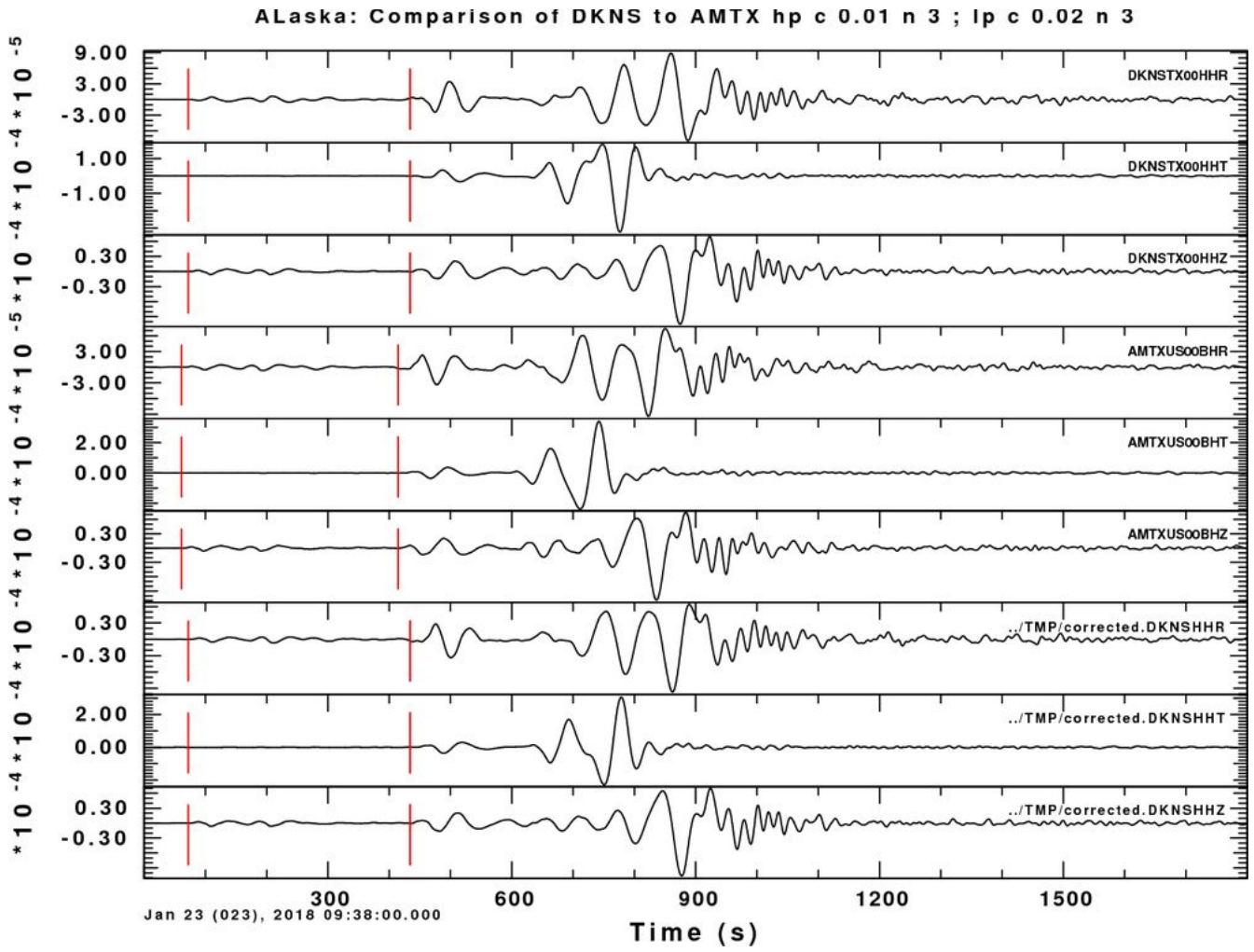


Note again that the R is reversed – a positive P on the Z must have a positive P on the R. The T is also reversed.

Montana P: Comparison of HBVL to KVTX hp c 0.05 n 3 ; lp c 0.25 n 3 ; ylim all

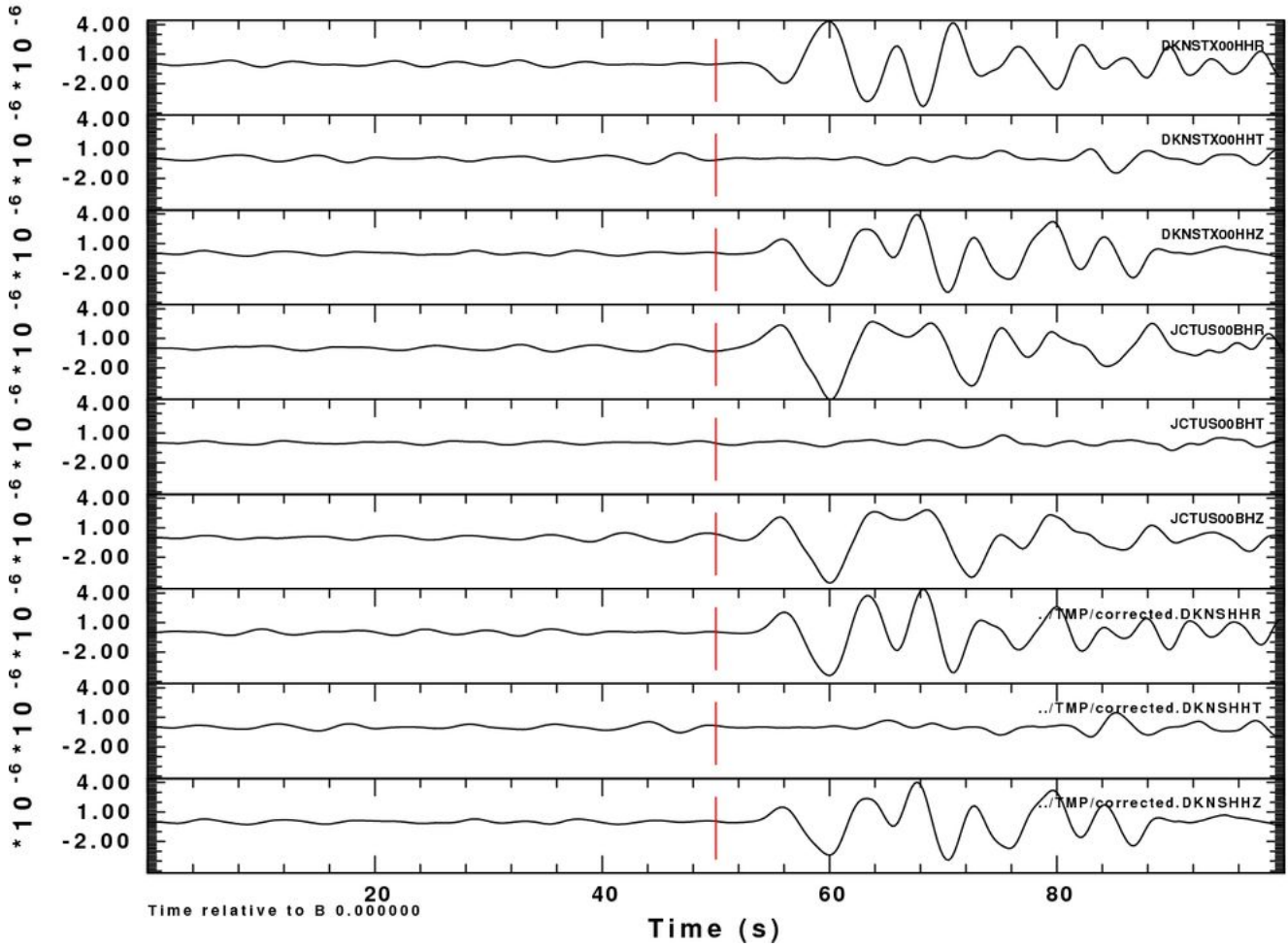


DKNS

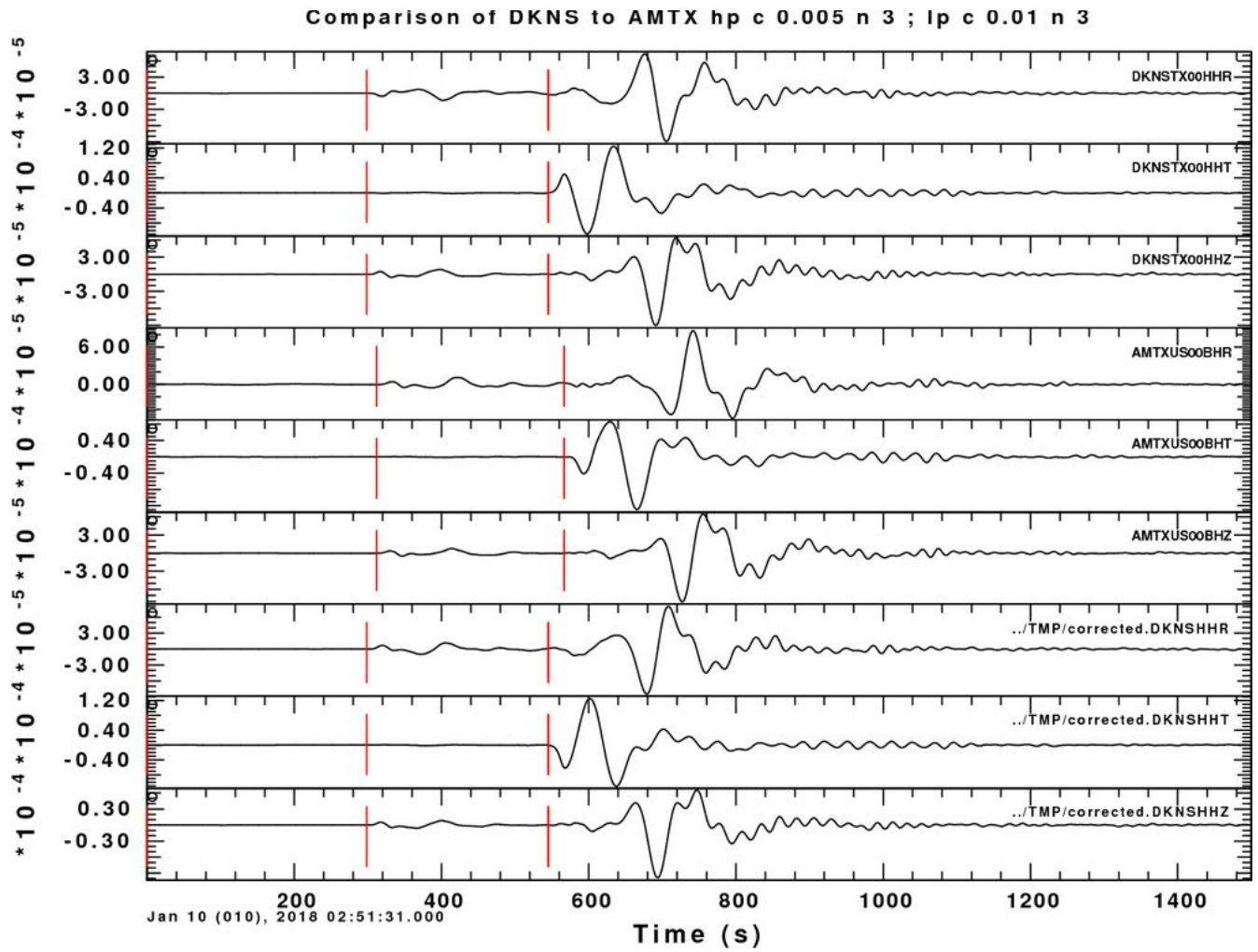


The original R and T are reversed.

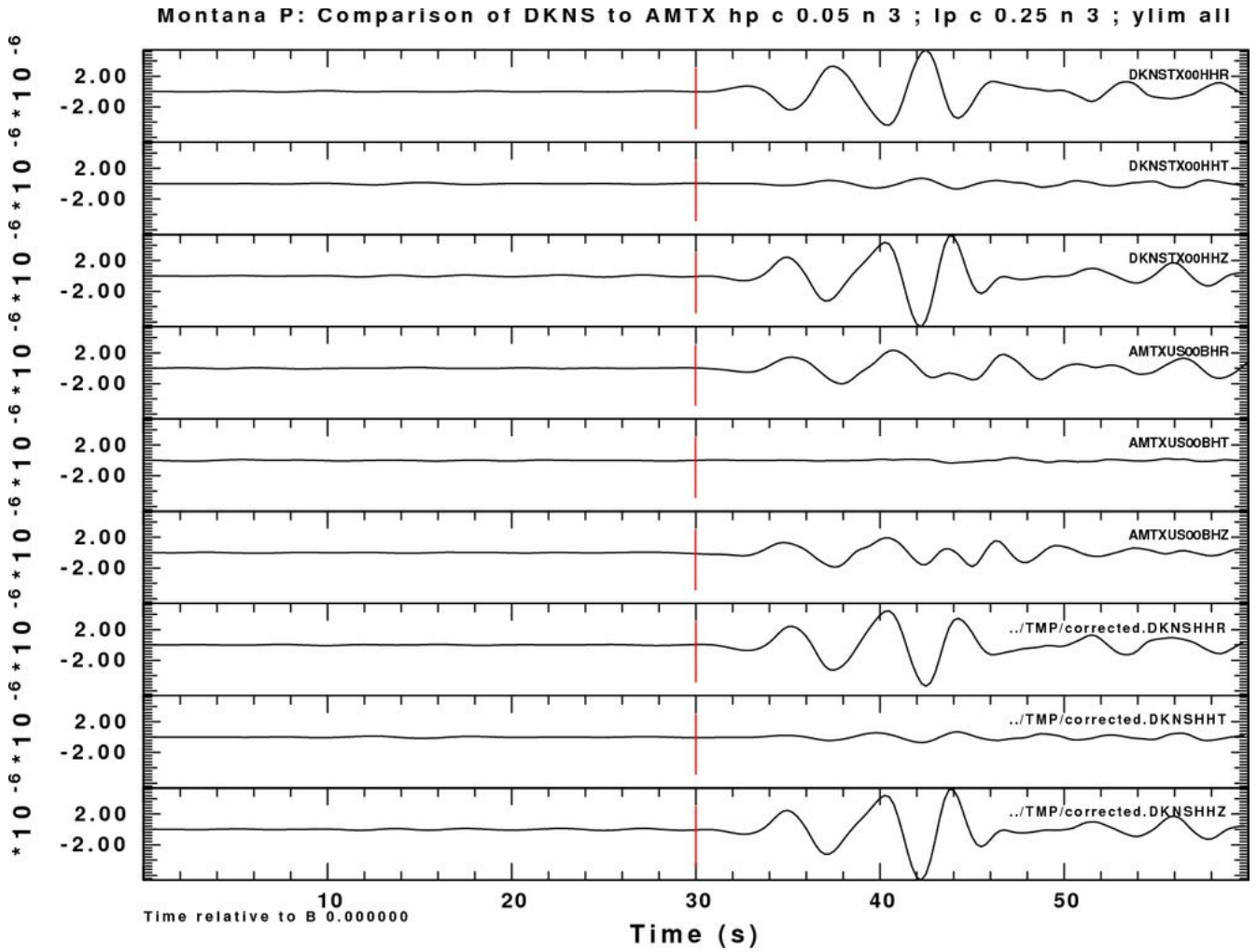
G. California P: Comparison of DKNS to JCT hp c 0.05 n 3 ; lp c 0.25 n 3 ; ylim all



Focus on the P. The R is reversed in the original.

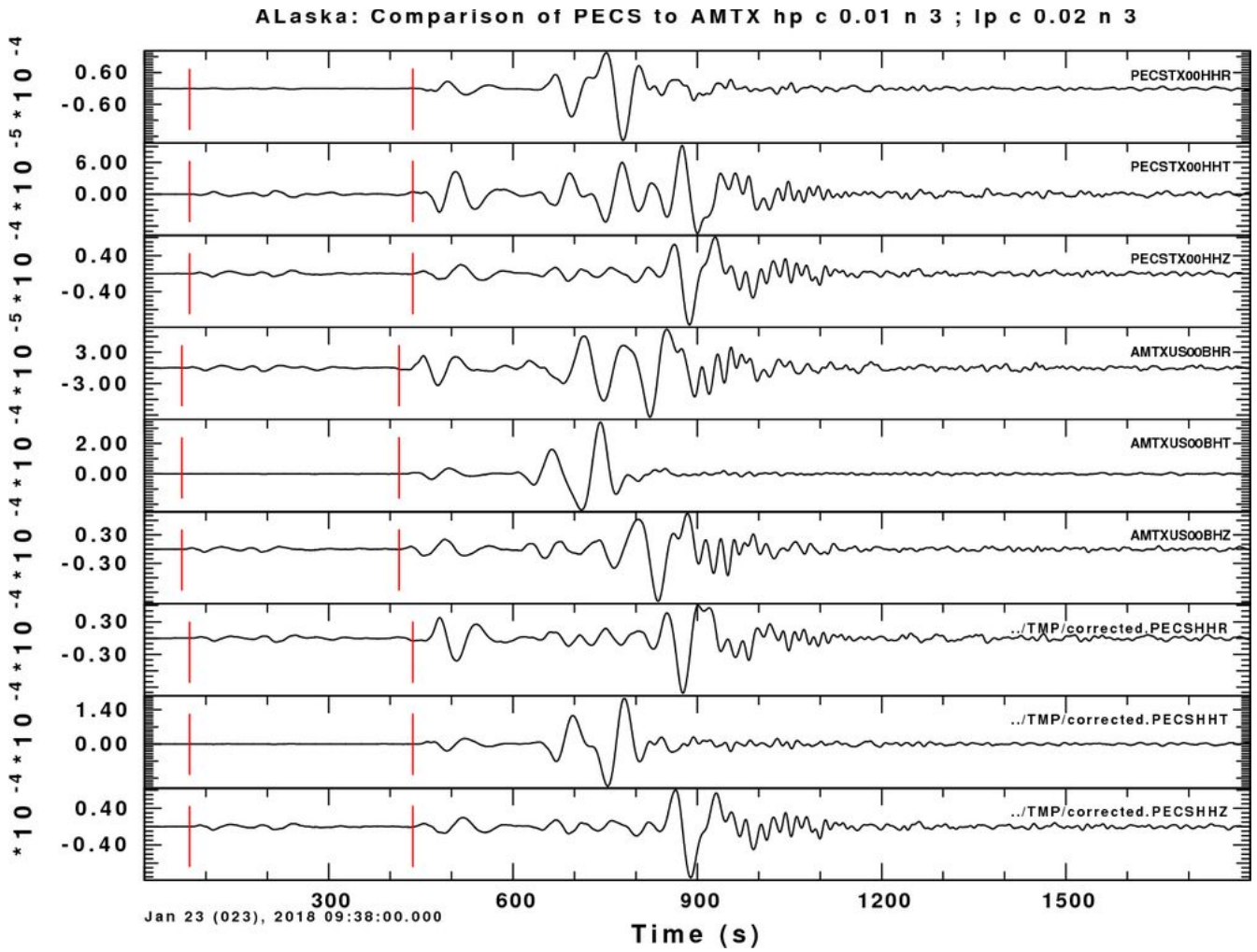


Focus on the P. The original Z and R are in opposite directions for the Honduras event.



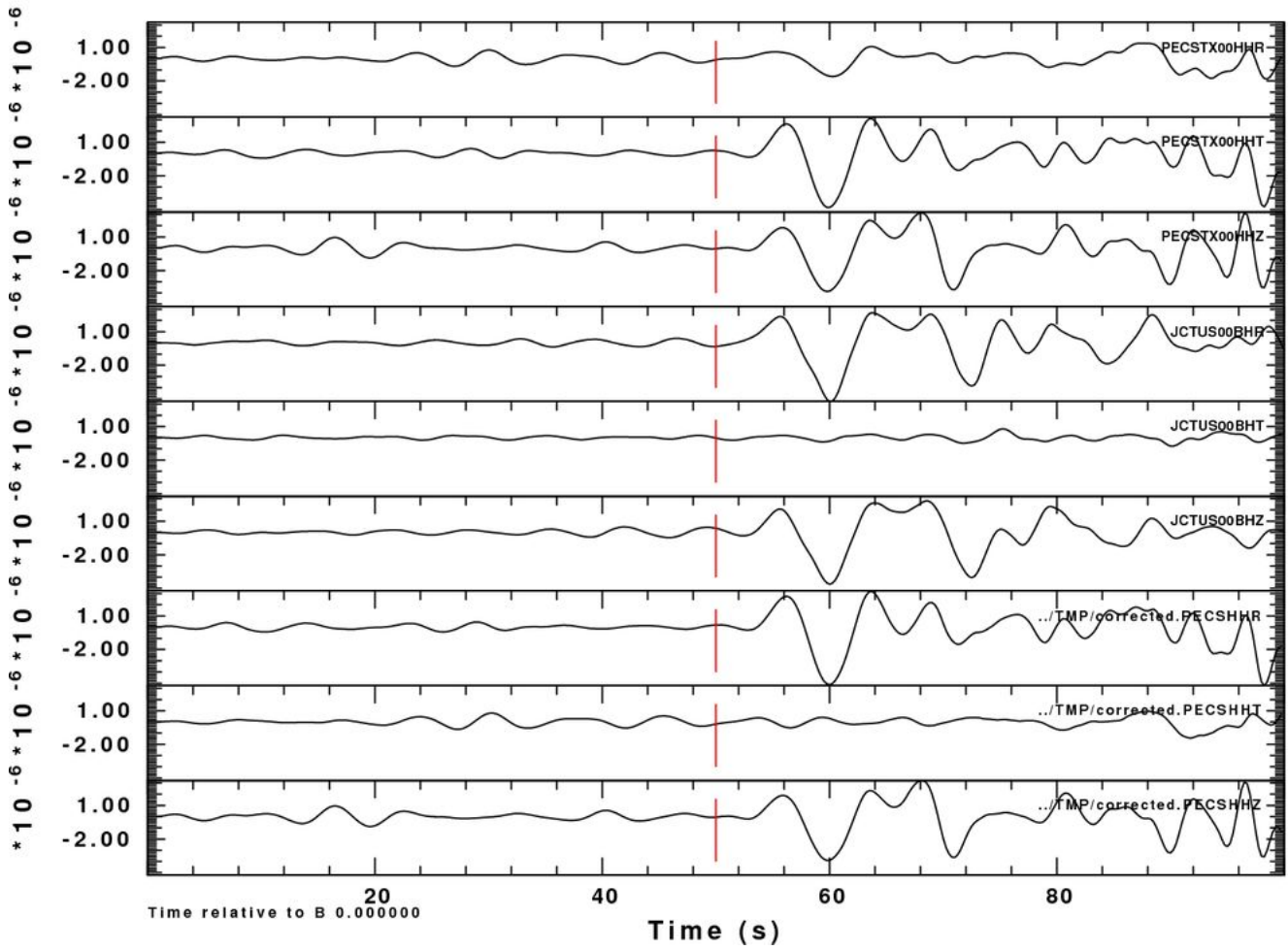
The original had bad P-wave particle motion.

PECS

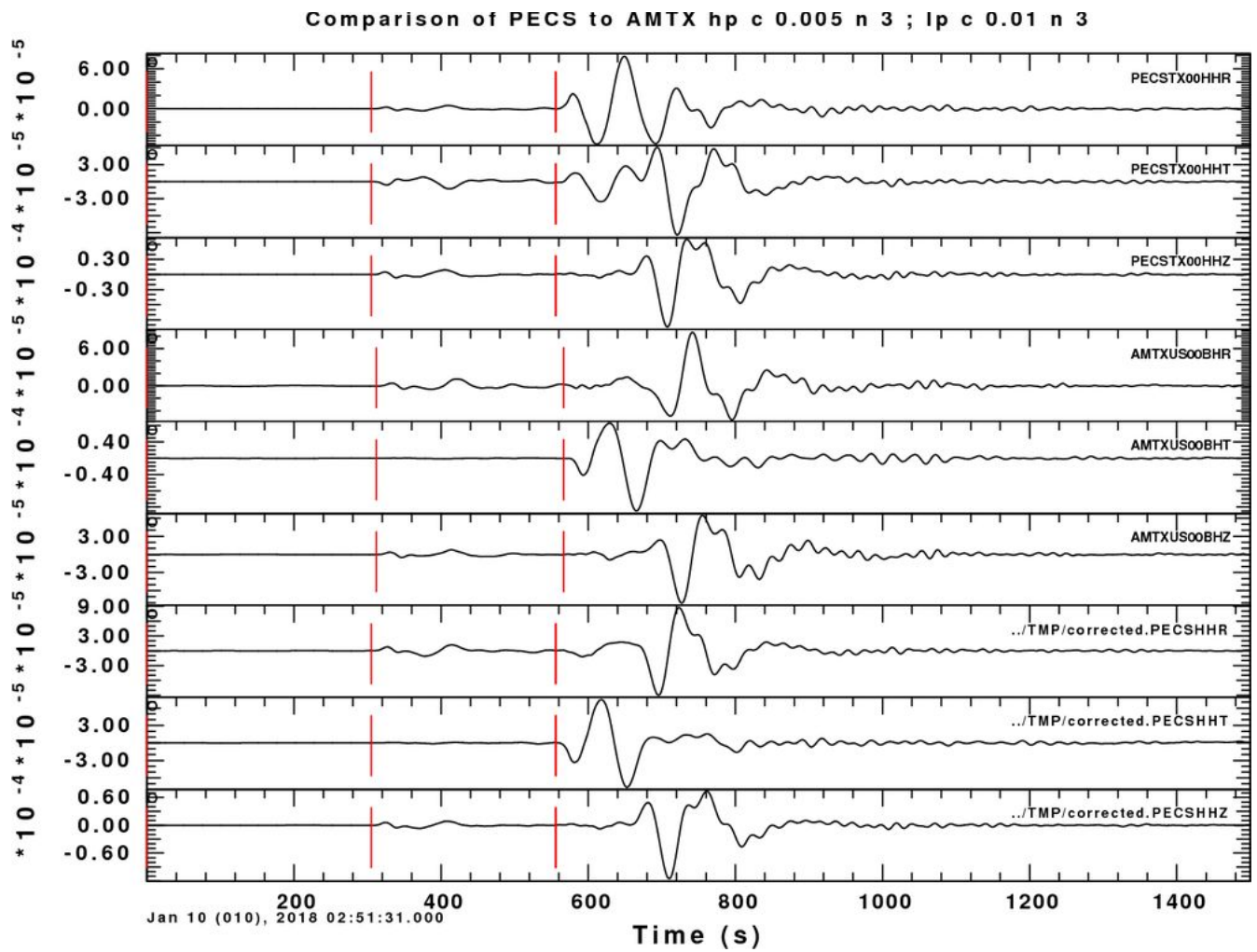


Look at S arrival on the T and R components

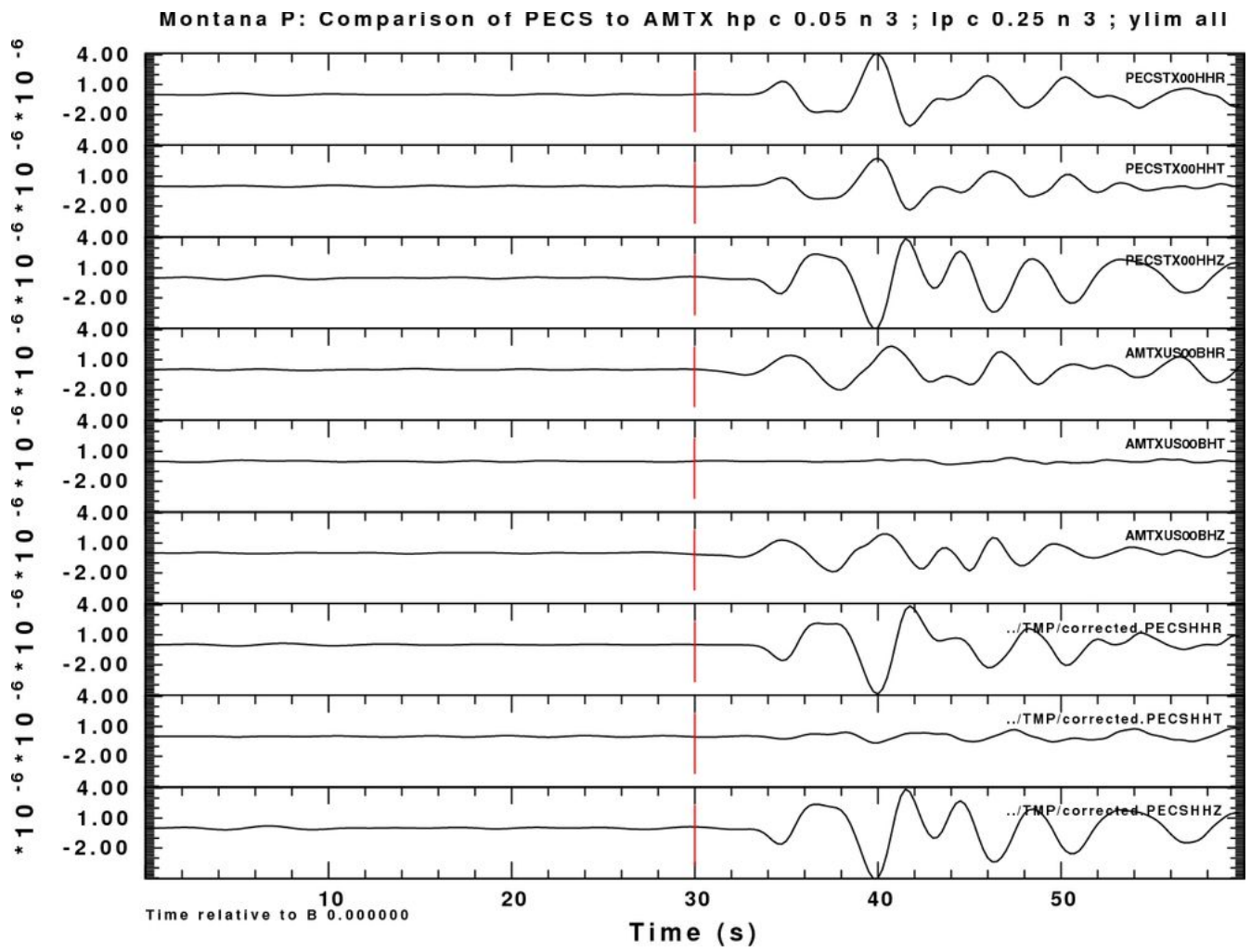
G. California P: Comparison of PECS to JCT hp c 0.05 n 3 ; lp c 0.25 n 3 ; ylim all



The original has large P on the T component.

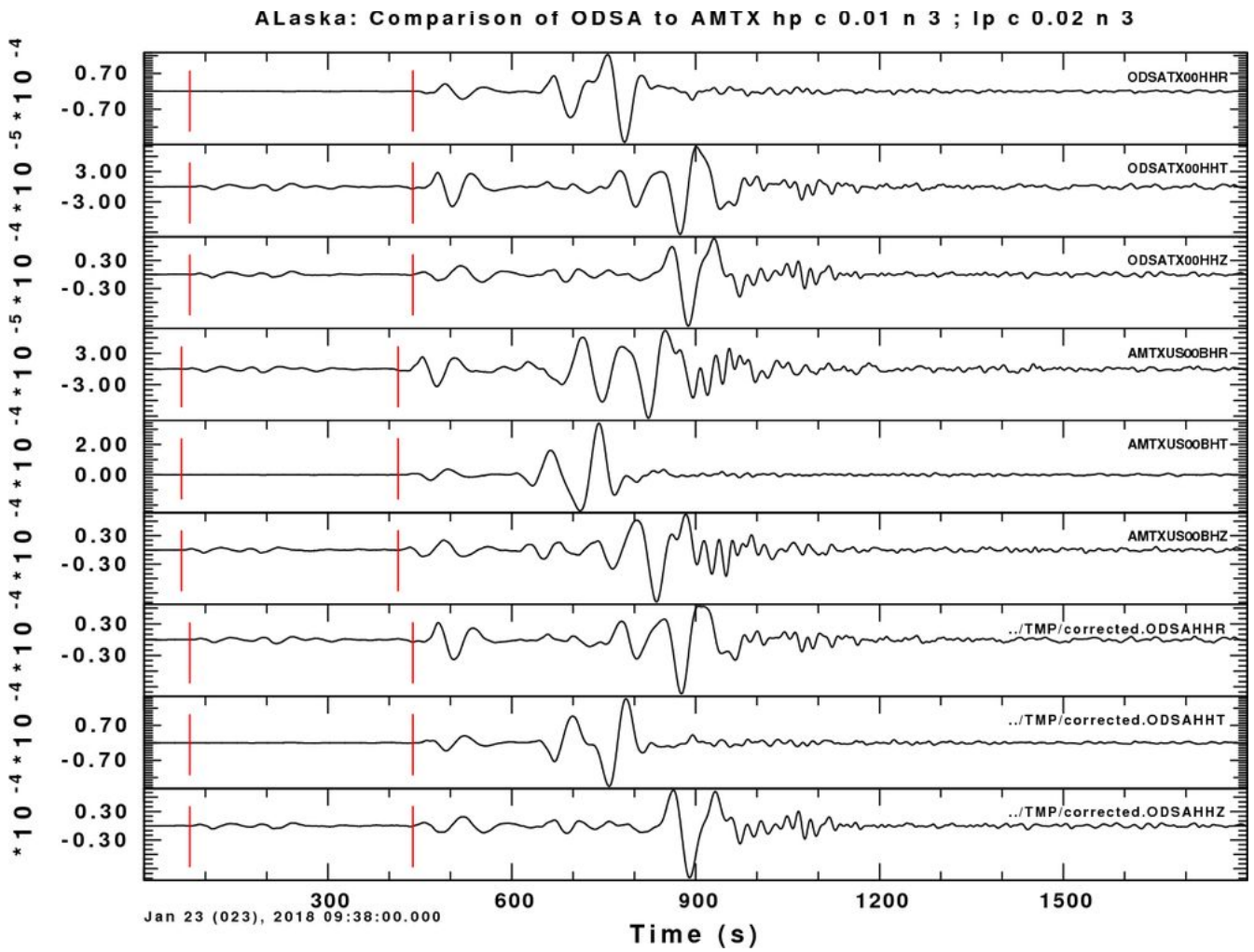


Compare the original S and Rayleigh to what was observed at AMTX. Note how AMTX agrees with the corrected PECS for the Honduras event.



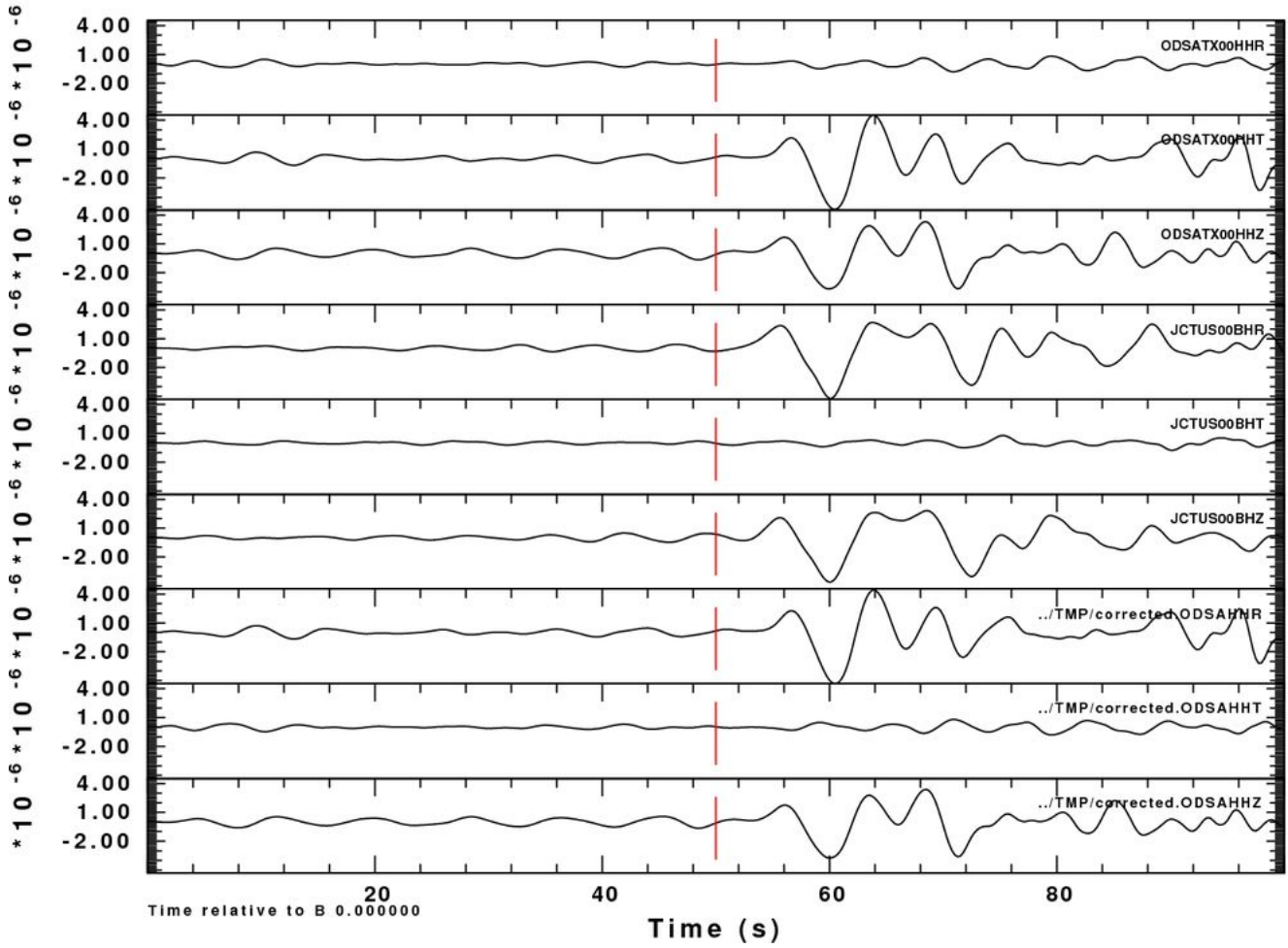
Compare the P motions.

ODSA

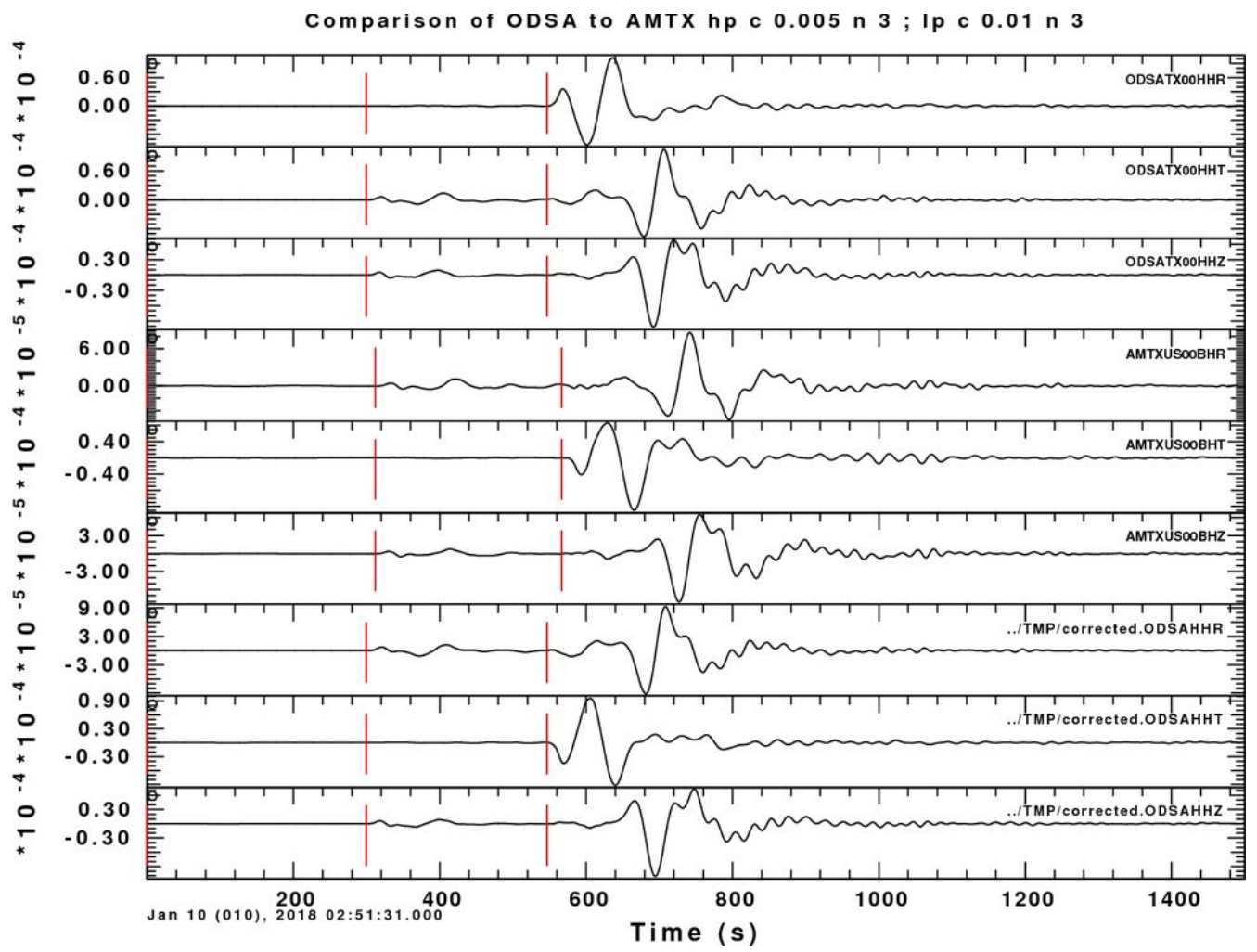


Alaska – Look at S pulse

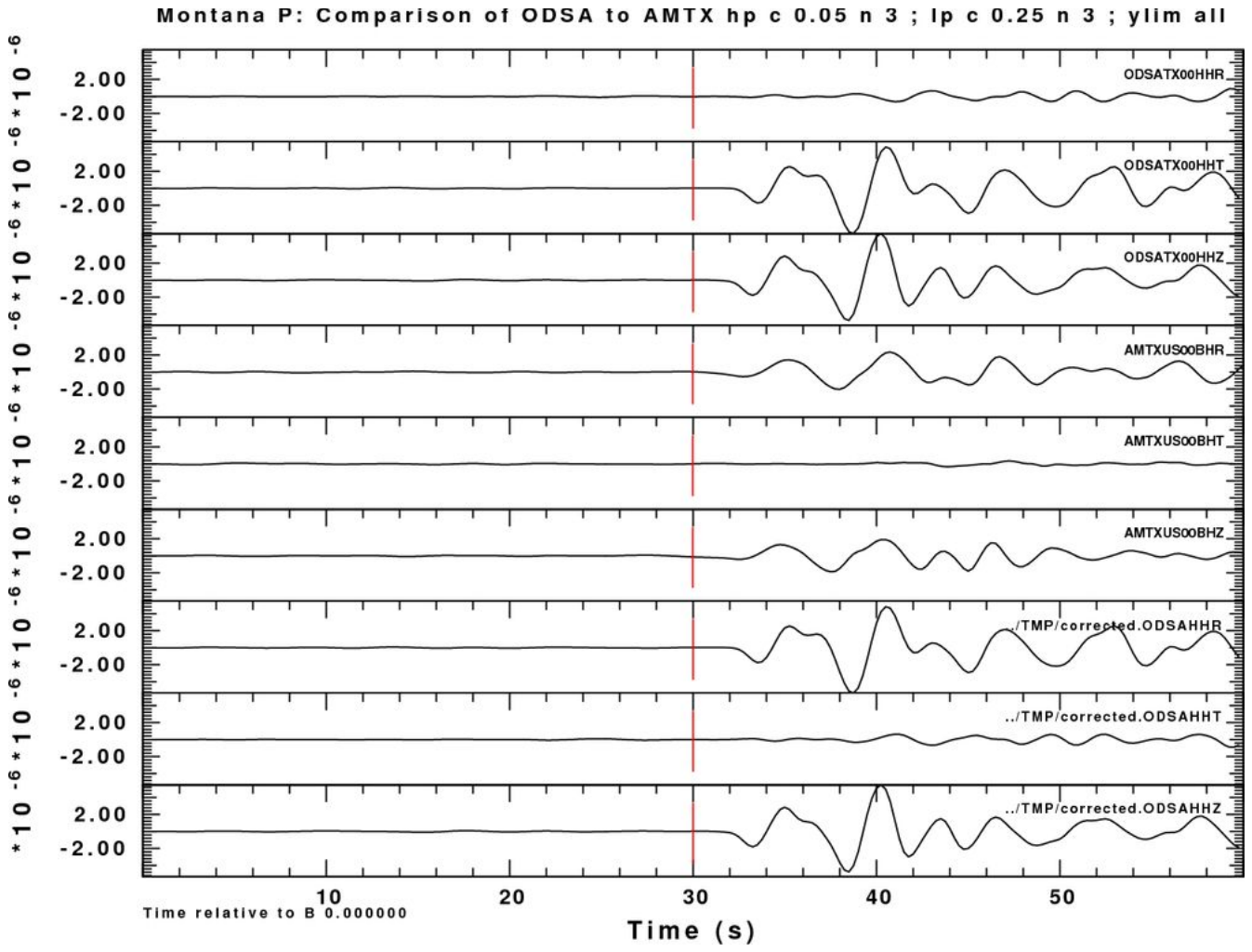
G. California P: Comparison of ODSA to JCT hp c 0.05 n 3 ; lp c 0.25 n 3 ; ylim all



Gulf of California – P on the T

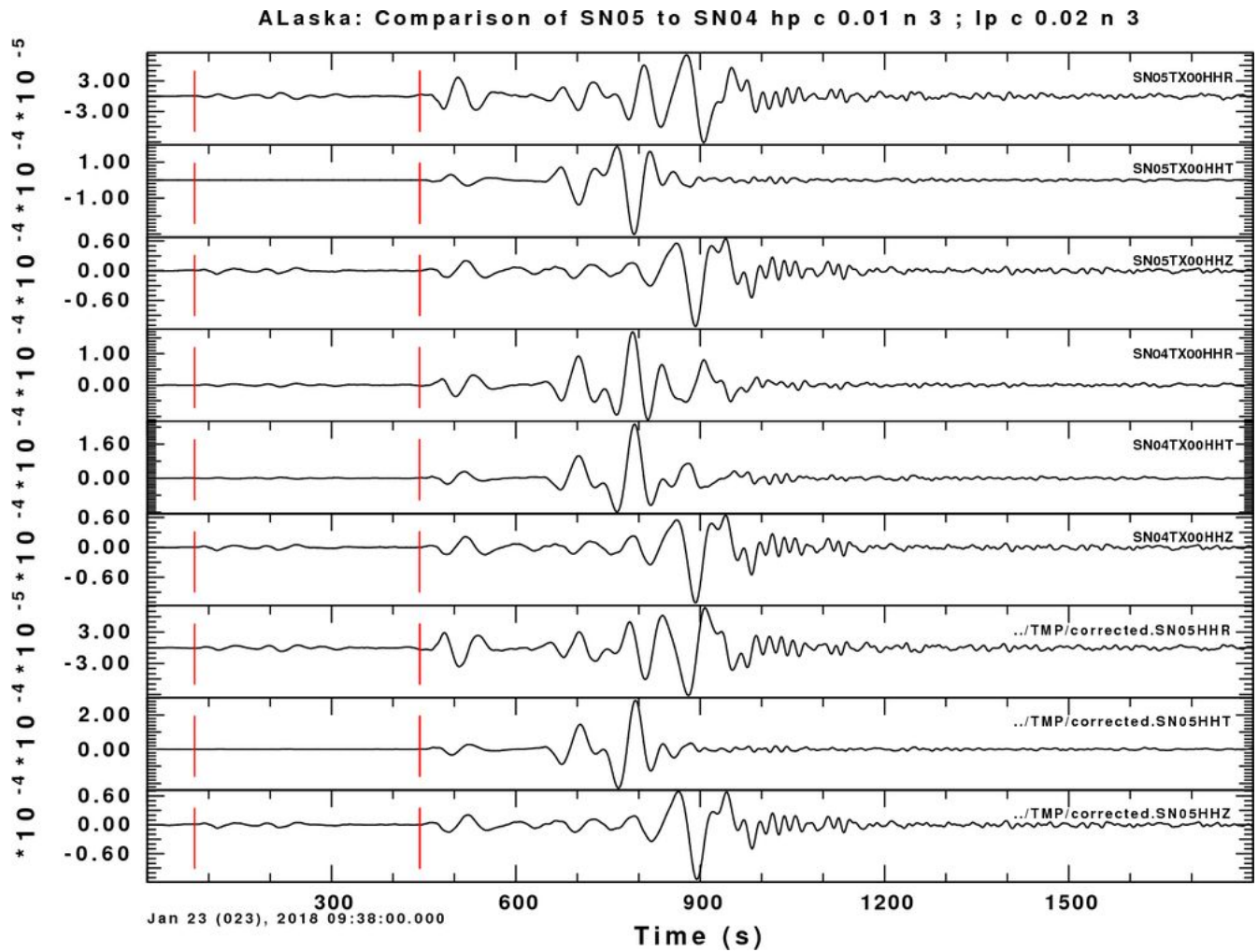


Honduras – Love on the R and Rayleigh on the T

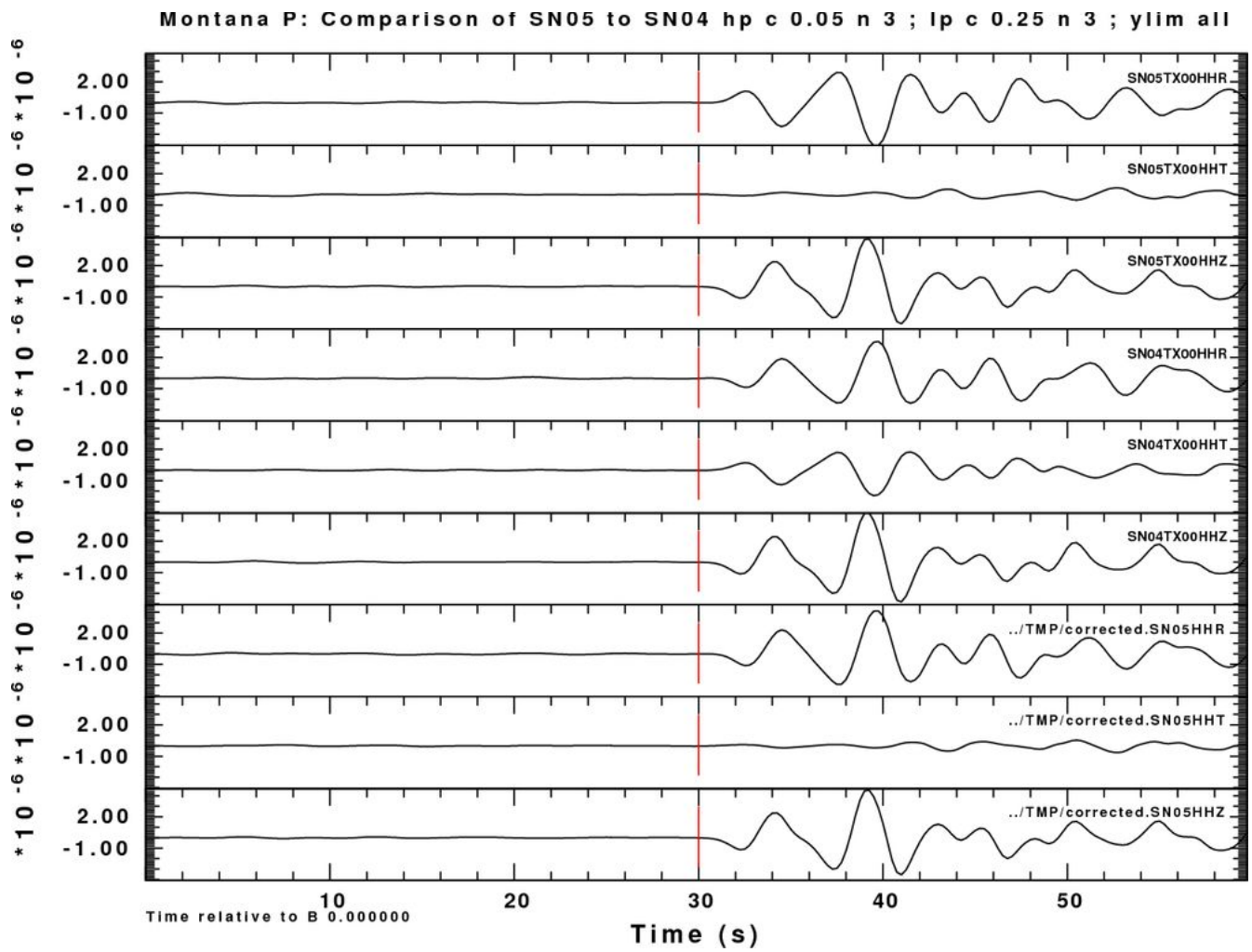


Montana – P on the T

SN05



Alaska – S on the R



Montana – P on the R is incorrect.

Summary

This exercise identified component orientation problems at the TX stations DKNS, ODSA, PECS, HBVL and SN05. In addition problems in the RESP file at the SN0? And SN1? stations were found.

Component orientation is given in terms of two angles which define a vector in space. An increase in digital counts corresponds to a ground motion in that direction. There are two conventions, though. Sac uses CMPINC and CMPAZ, where CMPINC is an angle measured with respect to the upward vertical and the CMPAZ is the azimuth measured from north. SEED has DIP and AZ, where DIP is measured downward from the horizontal plane and Az is the azimuth measured from north. So $\text{sach.cmpinc} = \text{dip} + 90.0$. Thus a typical vertical will have $\text{CMPINC}=0$ and $\text{CMPAZ}=0$ (azimuth makes no difference here, but one almost always sees 0) in the Sac header and $\text{AZ}=0$ and $\text{DIP}=-90$ for the SEED.

In the summary table here, I will show that Sac values from the current metadata, the suggested fix for the Sac values and the suggested fix for the SEED values:

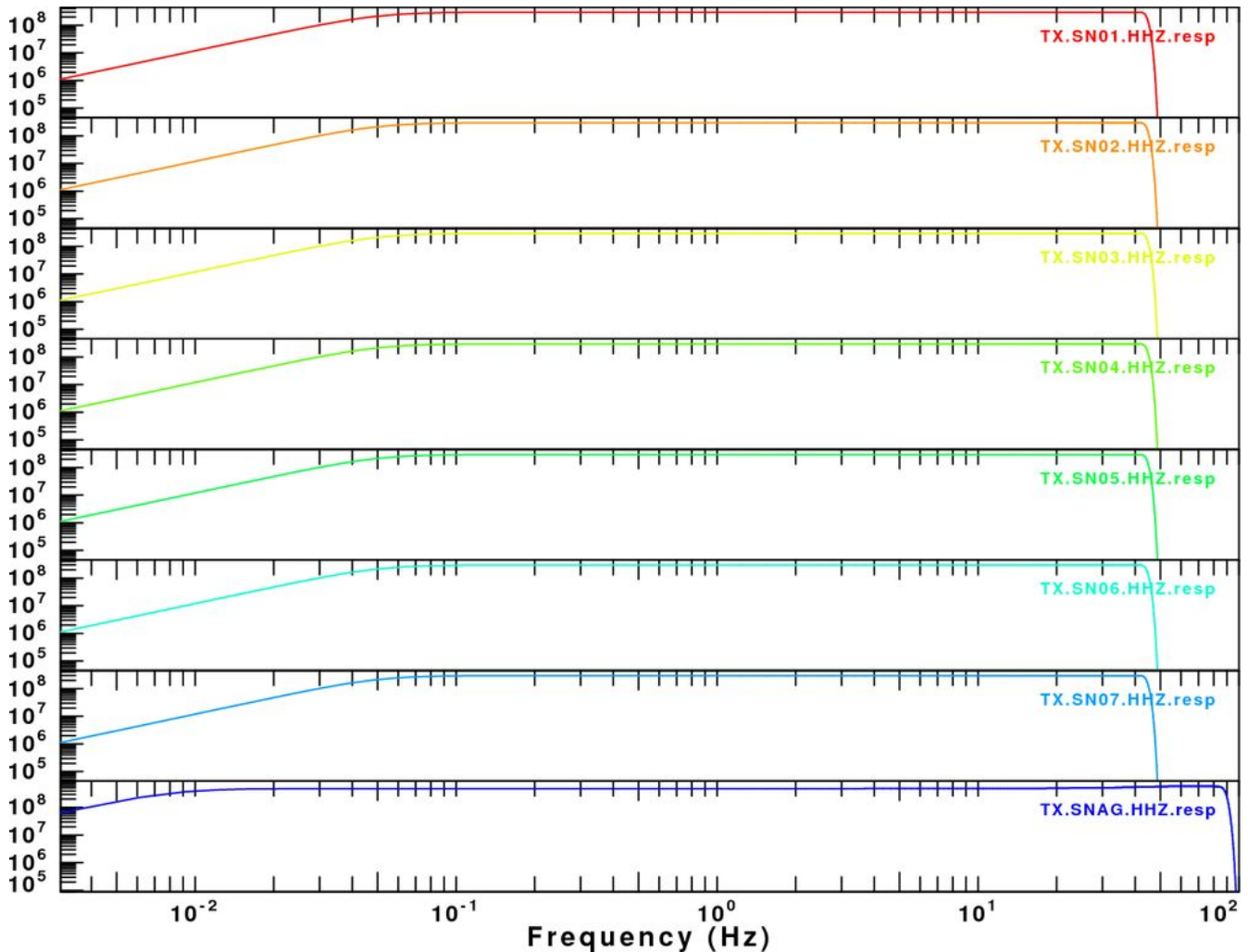
Component orientations

Station	Component	Original Sac values		Corrected Sac values		Corrected SEED values	
		CMPINC	CMPAZ	CMPINC	CMPAZ	DIP	AZ
HBVL	HH1	90	238	90	58	0	58
	HH2	90	328	90	148	0	148
	HHZ	0	238	0	0	-90	0
DKNS	HH1	90	206	90	26	0	26
	HH2	90	296	90	116	0	116
	HHZ	0	206	0	0	-90	0
PECS*	HH1	90	89	90	90	0	90
	HH2	90	0	90	180	0	180
	HHZ	0	89	0	0	-90	0
ODSA	HH1	90	130	90	40	0	40
	HH2	90	220	90	130	0	130
	HHZ	0	130	0	0	-90	0
SN05	HH1	90	0	90	180	0	180
	HH2	90	90	90	270	0	270
	HHZ	0	0	0	0	-90	0

*The 89 may be correct and thus the others should be 89 and 179 for HH1 and HH2, respectively.

RESP files

I noted a problem with the RESP files for stations SN01, SN02, SN03, SN04, SN05, SN06 and SN07 when studying the Alaska earthquake. These stations, as well as SNAG, acquire data at 200 samples per second. This means that the FIR filters should act near the Nyquist frequency of 100 Hz. Because I had very noisy deconvolved traces with spikes and higher than expected ground amplitudes, I plotted the output of **evalresp** using **gsac**. The plots for the HHZ components are shown in the next figure.



Plot of the velocity sensitivity from the RESP files for the given stations.

You will see that SNAG does what it should while the SN0X stations have a cutoff at 50 Hz, which is appropriate for 100 Hz data streams.

Conclusion: The metadata uses the FIR filters for 100 Hz data streams and not the actual 200 Hz

streak. Put in the correct FIR filters.