In [2]:

```
import numpy as np
import matplotlib.pyplot as plt
from matplotlib.mlab import csd
from obspy import read
from obspy.signal.invsim import corn_freq_2_paz
import scipy
import warnings
import math
import os
import time
warnings.filterwarnings("ignore")
```

In [3]:

```
paz={
    'poles': [-0.03702 +0.03702j,
              -0.03702 -0.03702j,
              -222.14+222.14j,
              -222.14-222.14j],
    'zeros': [0j, 0j],
    'gain': 60231900.0,
    'sensitivity': 2000.0}
paz_1hz = corn_freq_2_paz(1.0, damp=0.707)  # 1Hz instrument
paz_1hz['sensitivity'] = 1.0
```

In [6]:

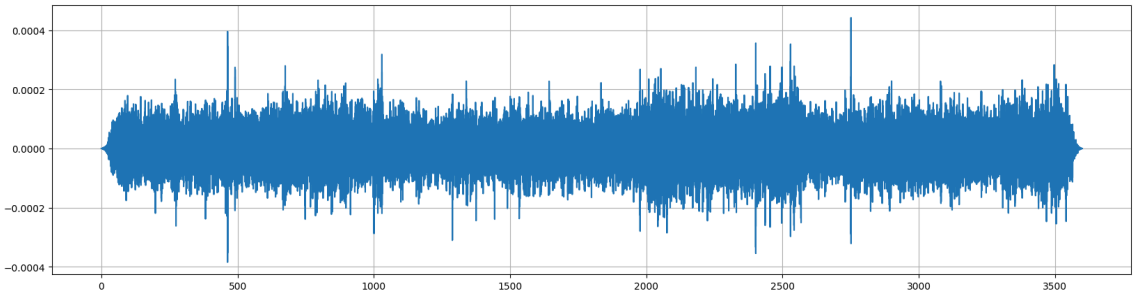
```
dirname='C:\\Users\\adich\\Documents\\Noise\\SAC 3D'
ext=('.SAC')
tr=[]
for files in os.listdir(dirname):
    if files.endswith(ext):
        st=read(files)
#         st.decimate(4, strict_length=False, no_filter=True)
        st.simulate(paz_remove=paz, paz_simulate=paz_1hz)
        tr.append(st)
    else:
        continue
```

In [3]:

```
def data_prep(st):
    u=st.data
    t=st.times()
    t_r=np.max(t)
    time=t[np.where(t>=0.9*t_r)[0][0]]
    del_t=t[1]-t[0]
    index_1=int(np.where(t<=t_r/3)[0][0])
    index_2=int(np.where(t>=2*t_r/3)[0][0])
    alpha_u=(9/(2*(t_r**2)))*(np.sum(u[index_2:]*(del_t*np.ones(len(u[:
    t_lp=alpha_u*(time-(t_r/2))
    u_mean=np.mean(st.data)
    return u-((u_mean+t_lp)*np.ones(len(u)))
```

In [8]:

```
fig=plt.figure(figsize=(20,5))
plt.plot(tr[1][0].times(),tr[1][0].data)
# plt.plot(tr[0][0].times(),data_prep(tr[0][0]))
plt.grid()
```



In [13]:

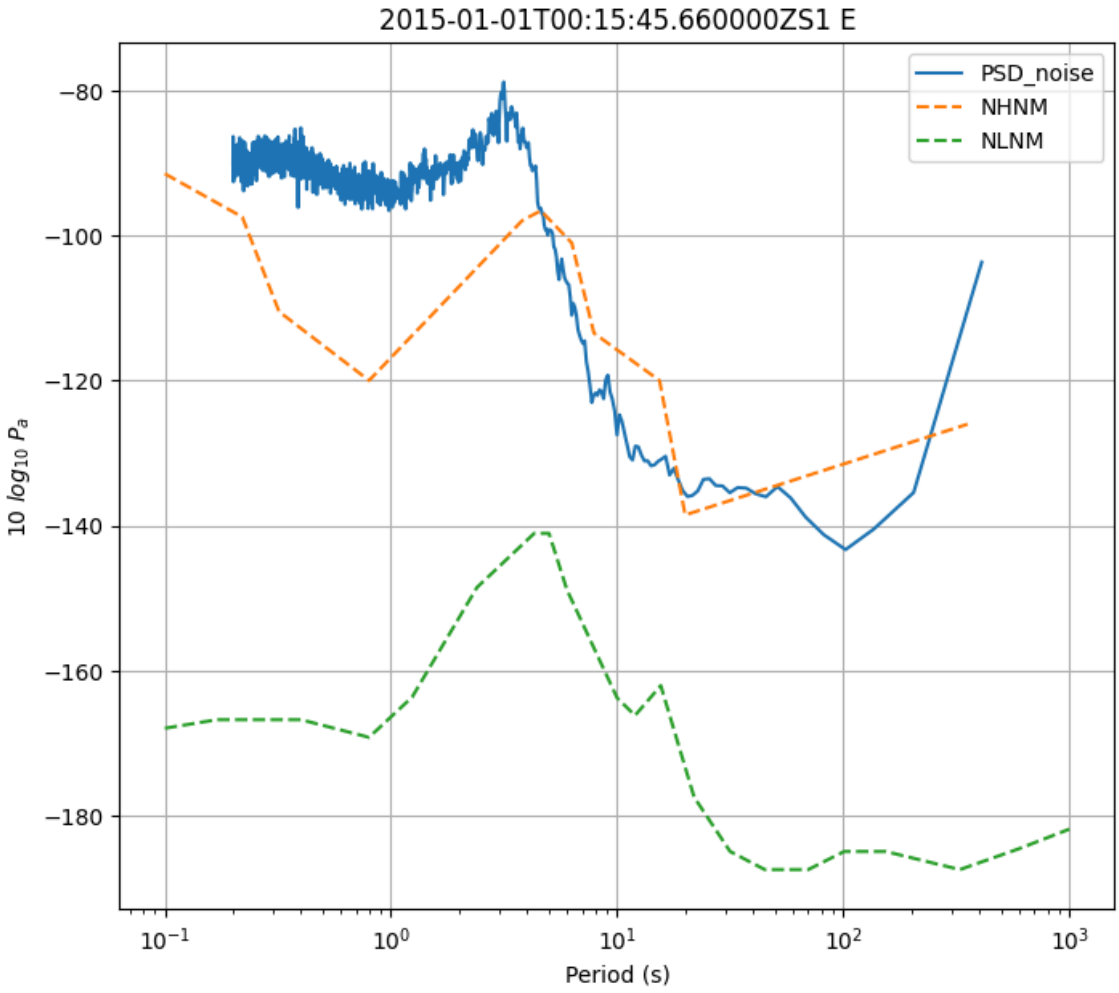
```
def plotPSD(st,window_length= 3600,nSegments= 15,percentOverlap= 50.0):
    nSegWindow = int((nSegments - 1)*(1.0-float((percentOverlap)/100.0)
    n_points = st.stats.npts
    sampling_frequency = st.stats.sampling_rate
    delta = float(st.stats.delta)
    this_n_samp = int((window_length/delta + 1)/nSegWindow)
    nfft = 2**int(math.log(this_n_samp, 2))
    windlap=percentOverlap/100
    x=data_prep(st)
    power,freq=csd(x,x,NFFT=nfft,noverlap=int(nfft * windlap), Fs=1. /
    fig=plt.figure(figsize=(8,7))
    plt.plot(1/freq[1:],10*np.log10(power[1:]),label='PSD_noise')
    nhnm()
    nlnm()
    plt.xscale('log')
    plt.title(str(st.stats.starttime)+str(st.stats.channel))
    plt.ylabel('10 $log_{10}$ $P_{a}$')
    plt.xlabel('Period (s)')
    plt.grid()
    plt.legend()
    plt.show()
```

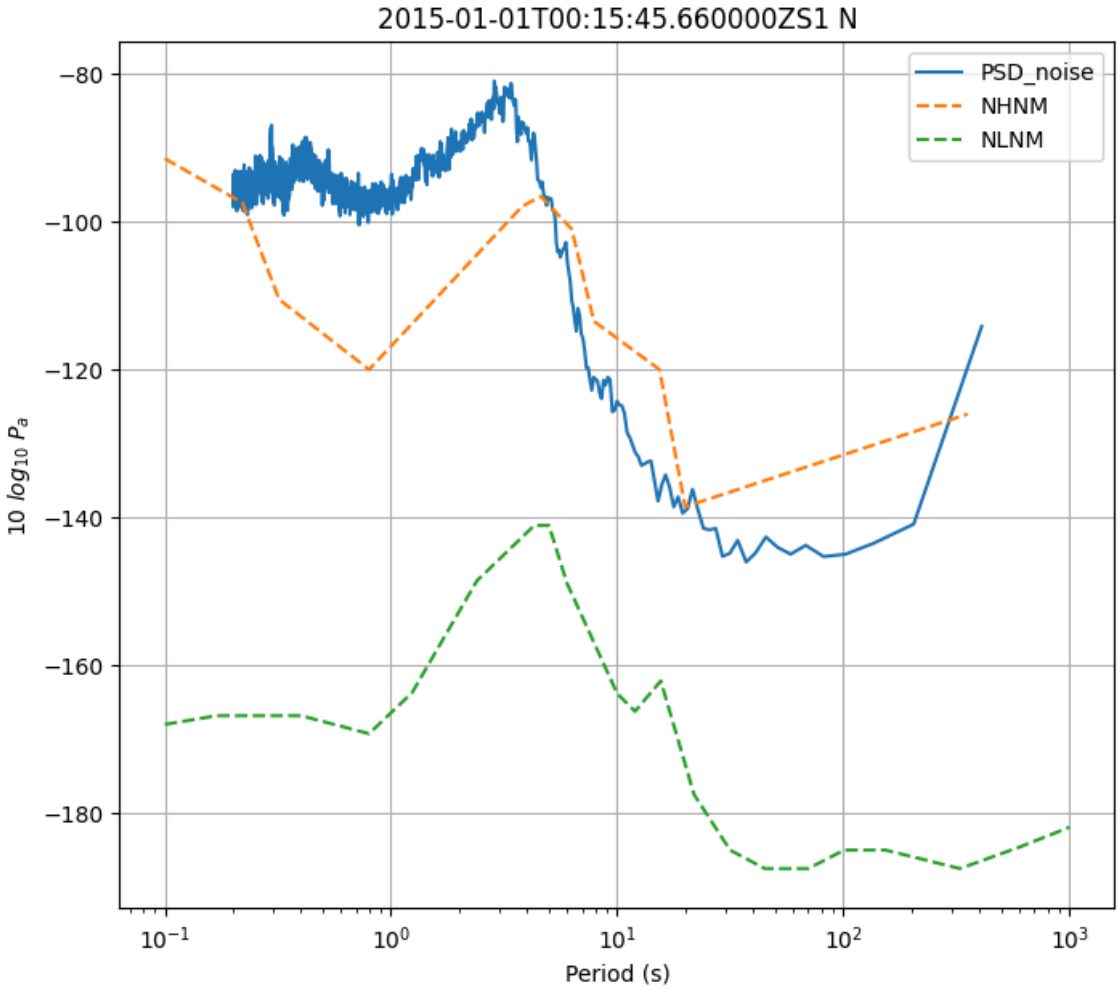
In [14]:

```
def nlnm():
    period=np.array([0.1,0.17,0.4,0.8,1.24,2.4,4.3,5.0,6.0,10.0,12.0,15
    P_a=np.array([1.6*10**(-17),2.1*10**(-17),2.1*10**(-17),1.2*10**(-1
    plt.plot(period,10*np.log10(P_a),label='NLNM',linestyle='--')
def nhnm():
    period=np.array([0.10,0.22,0.32,0.80,3.80,4.60,6.30,7.90,15.40,20.0
    P_a=np.array([7.1*10**(-10),1.8*10**(-10),8.9*10**(-12),1.0*10**(-1
    plt.plot(period,10*np.log10(P_a),label='NHNM',linestyle='--')
```

In [34]:

```
for i in range(len(tr)):
    plotPSD(tr[i][0])
```

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PSD_noise
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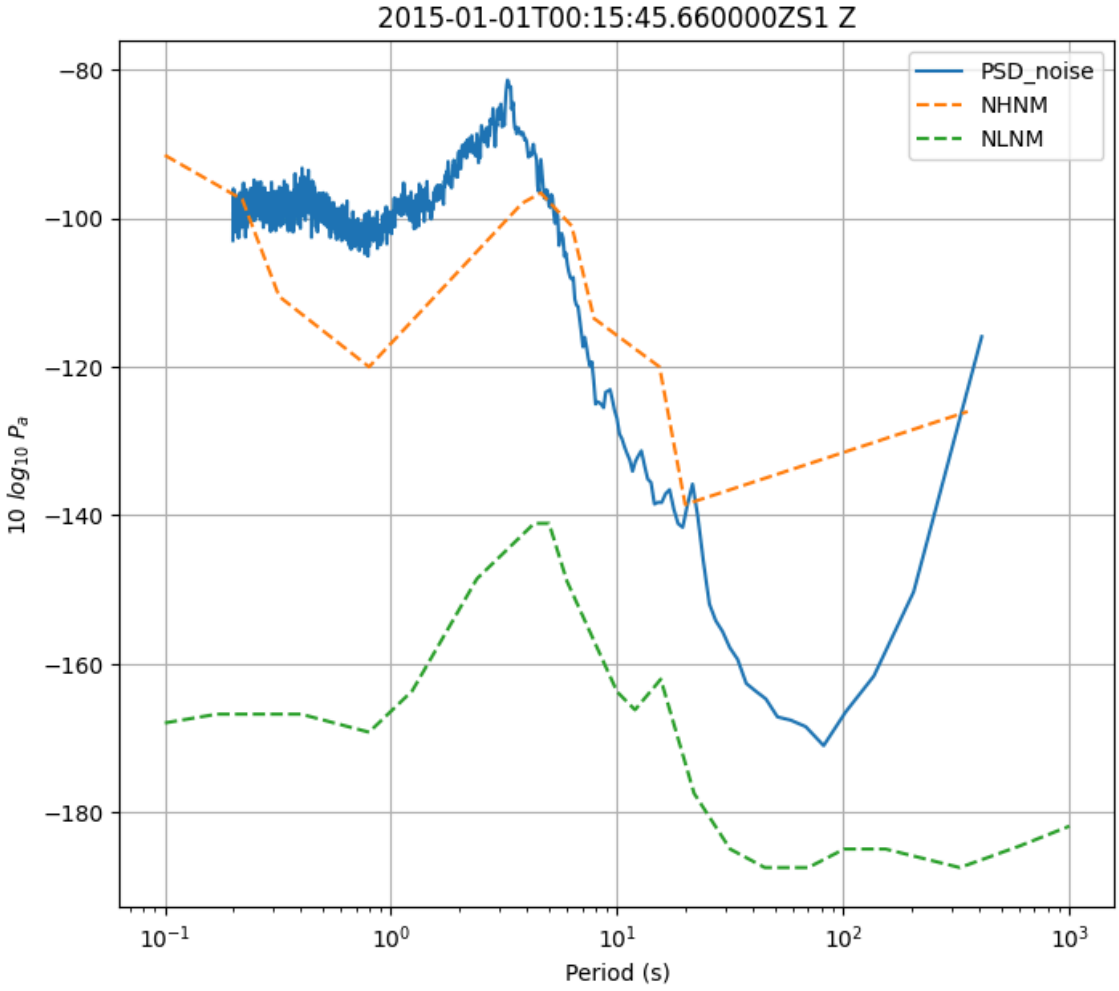
Period (s)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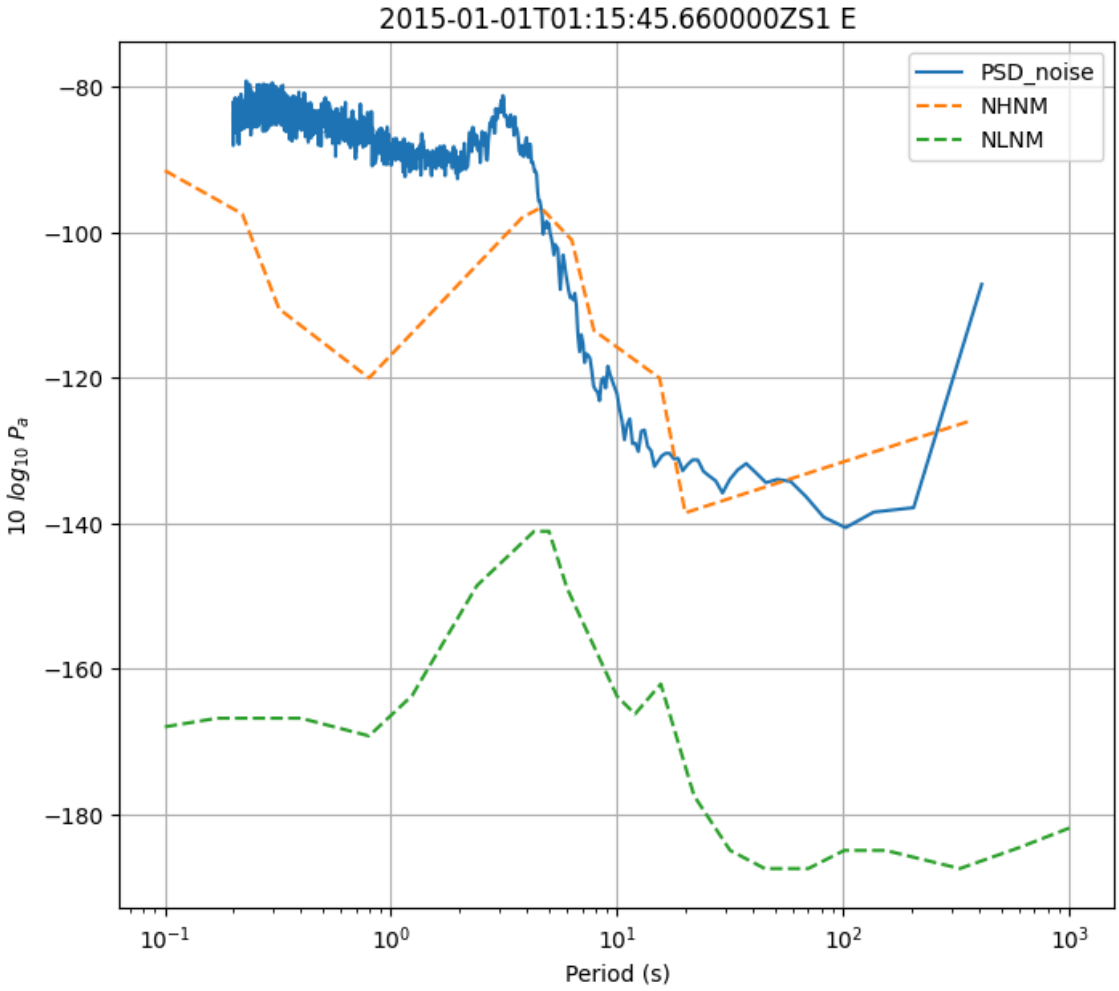
Period (s)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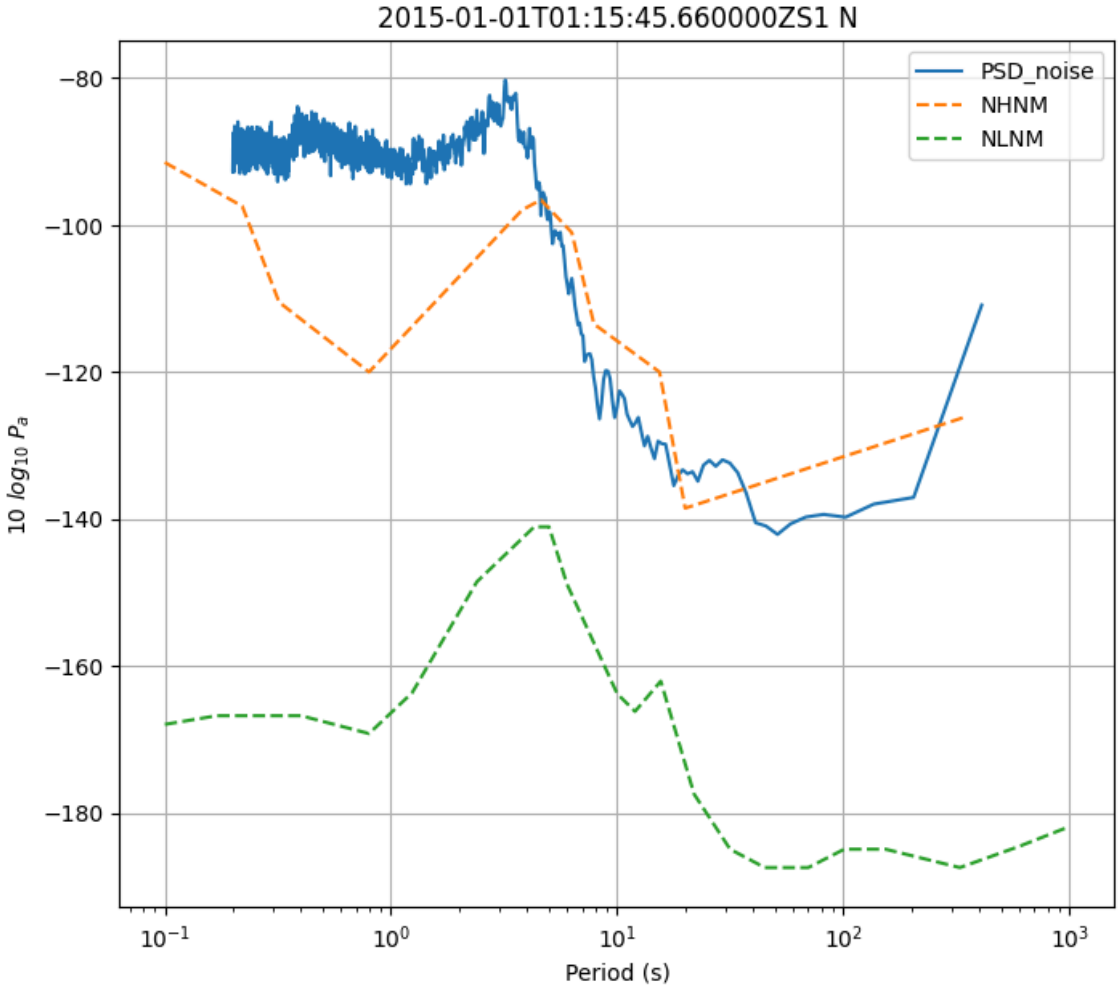
Period (s)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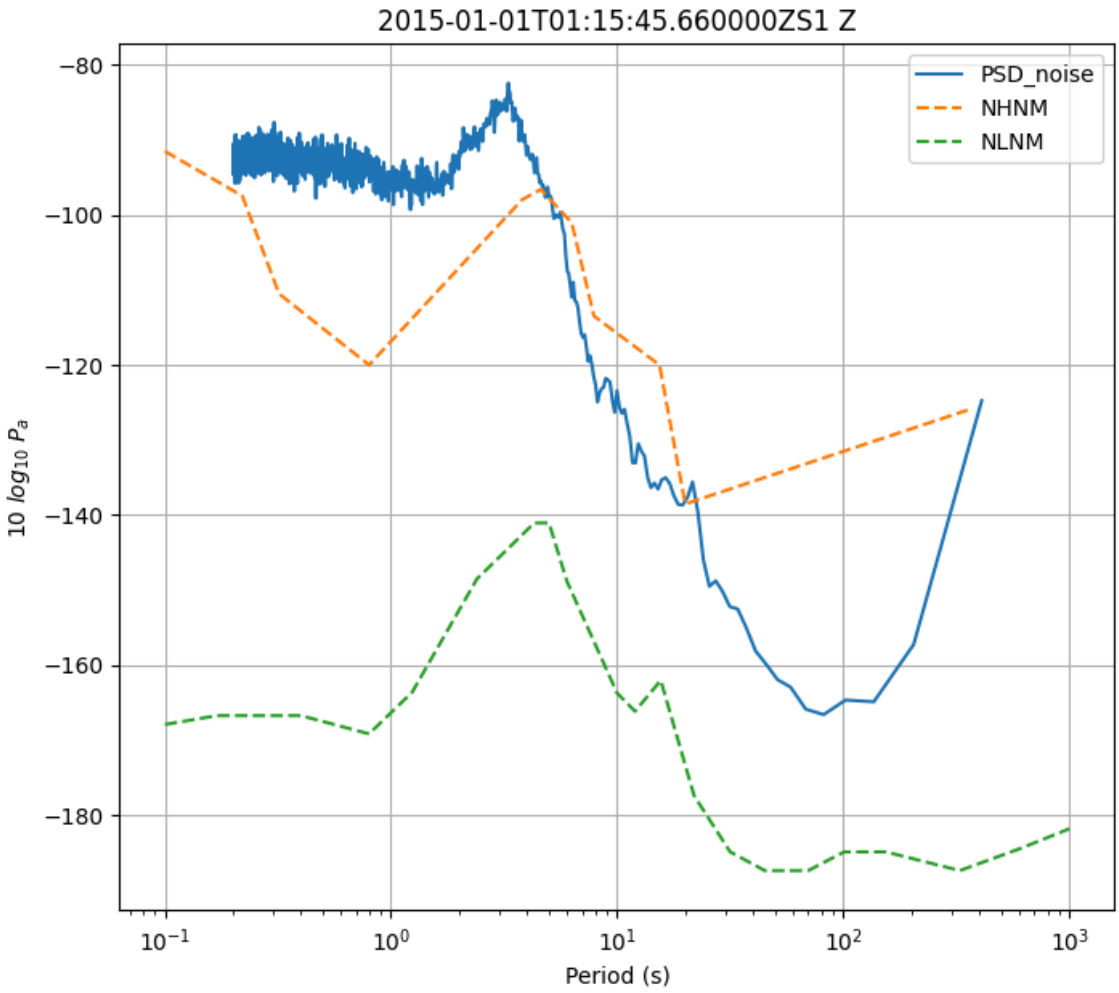
Period (s)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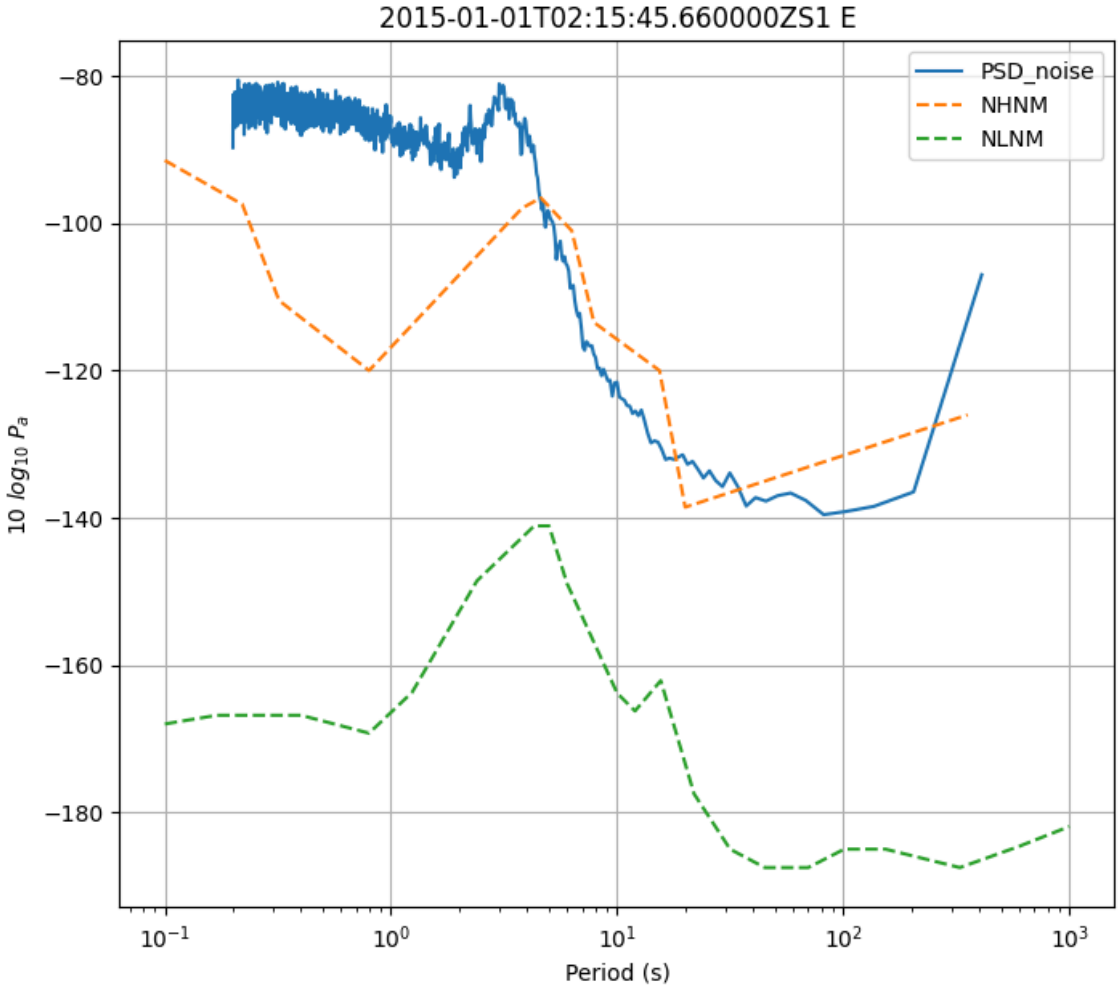
Period (s)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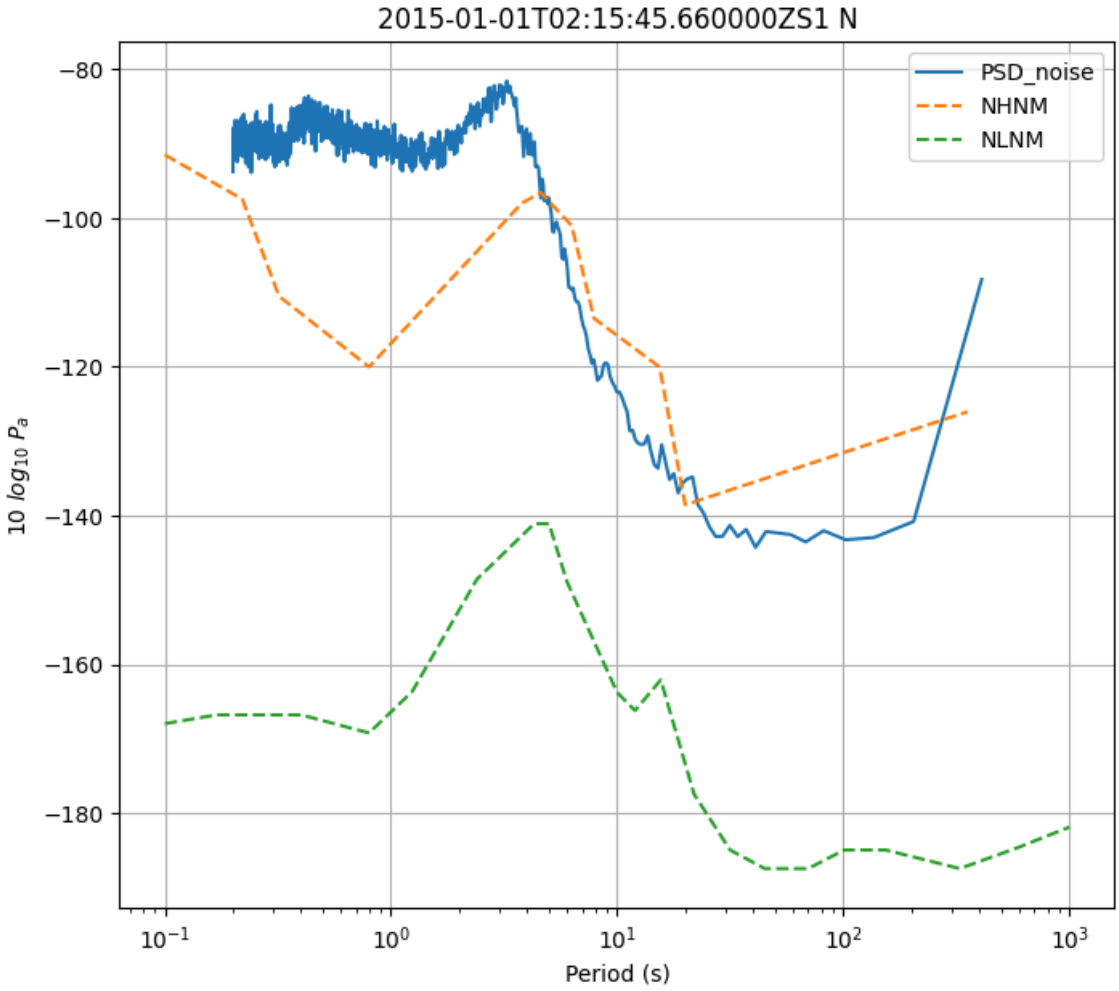
Period (s)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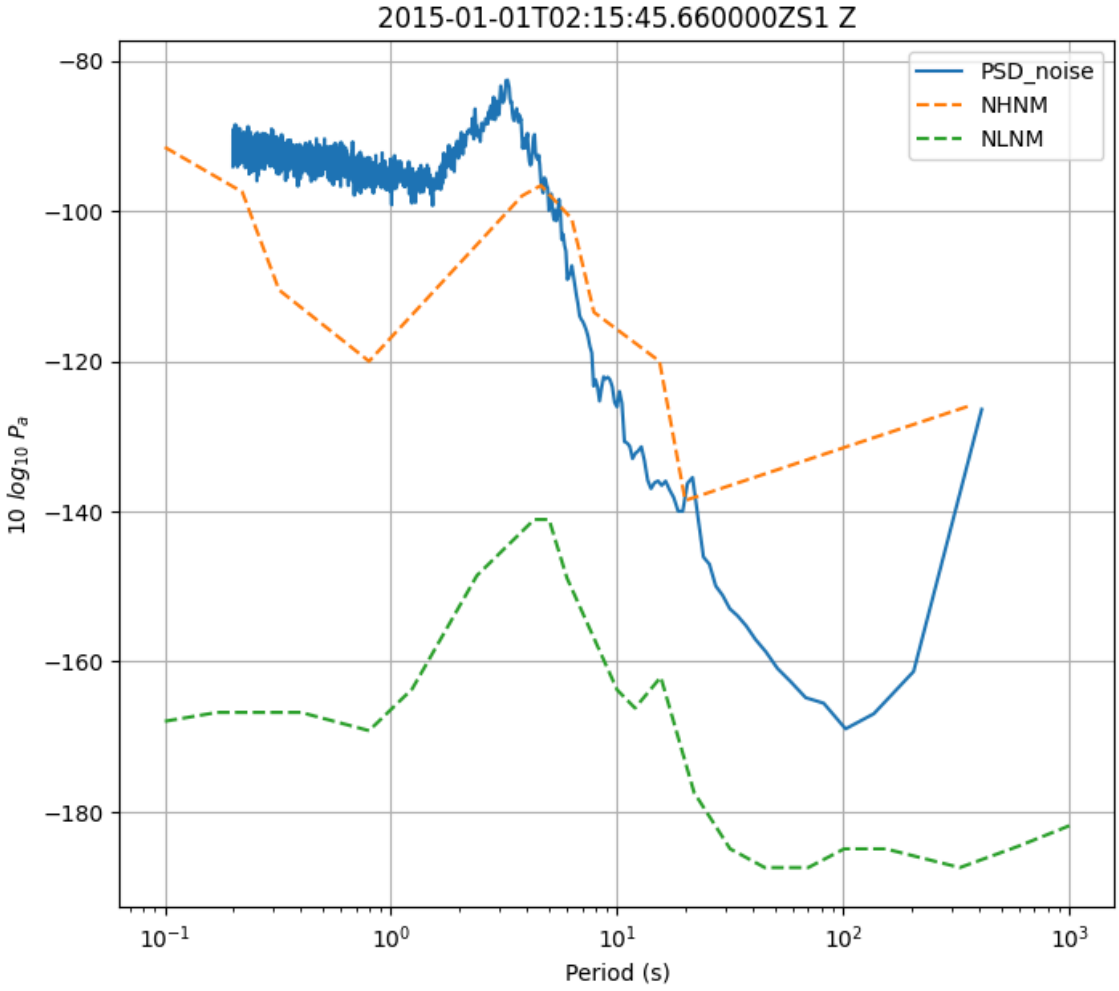
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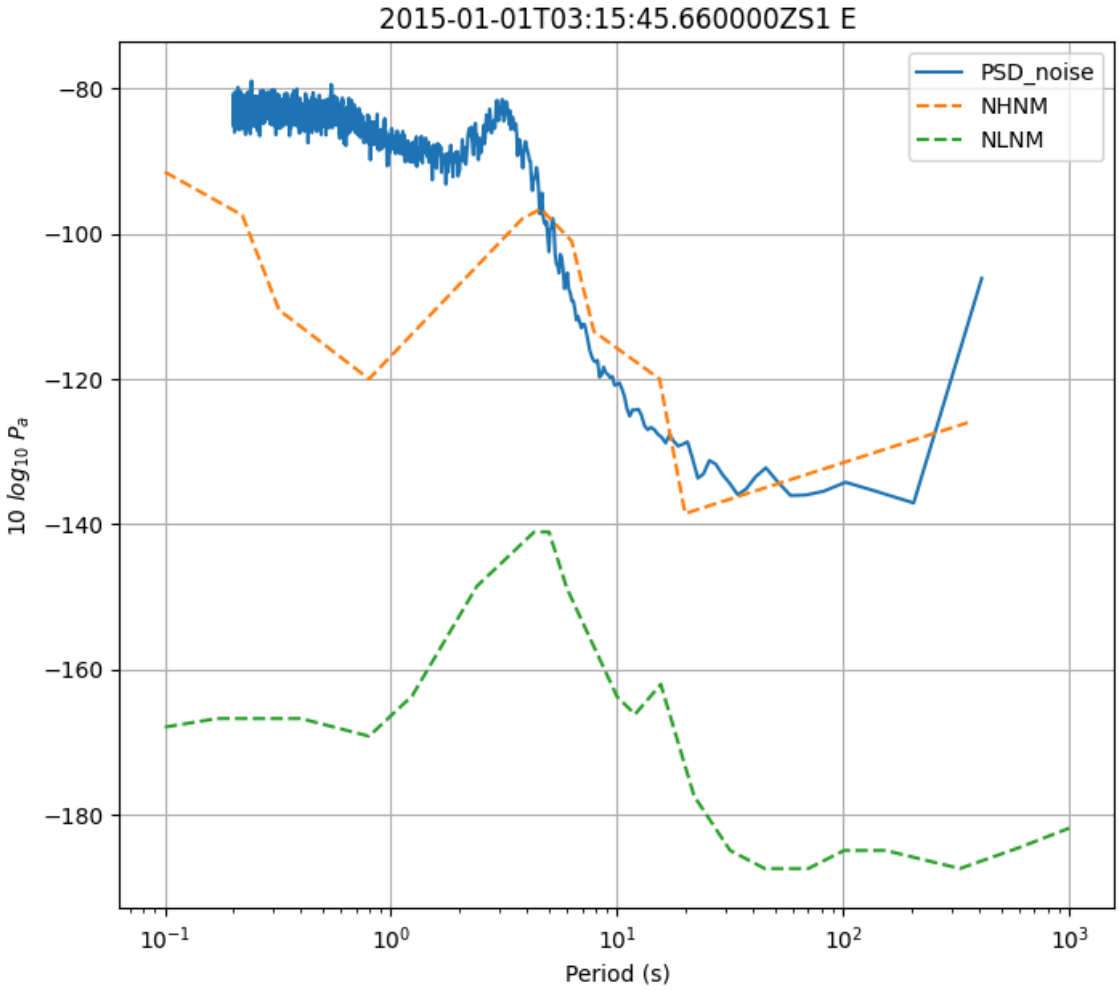
Period (s)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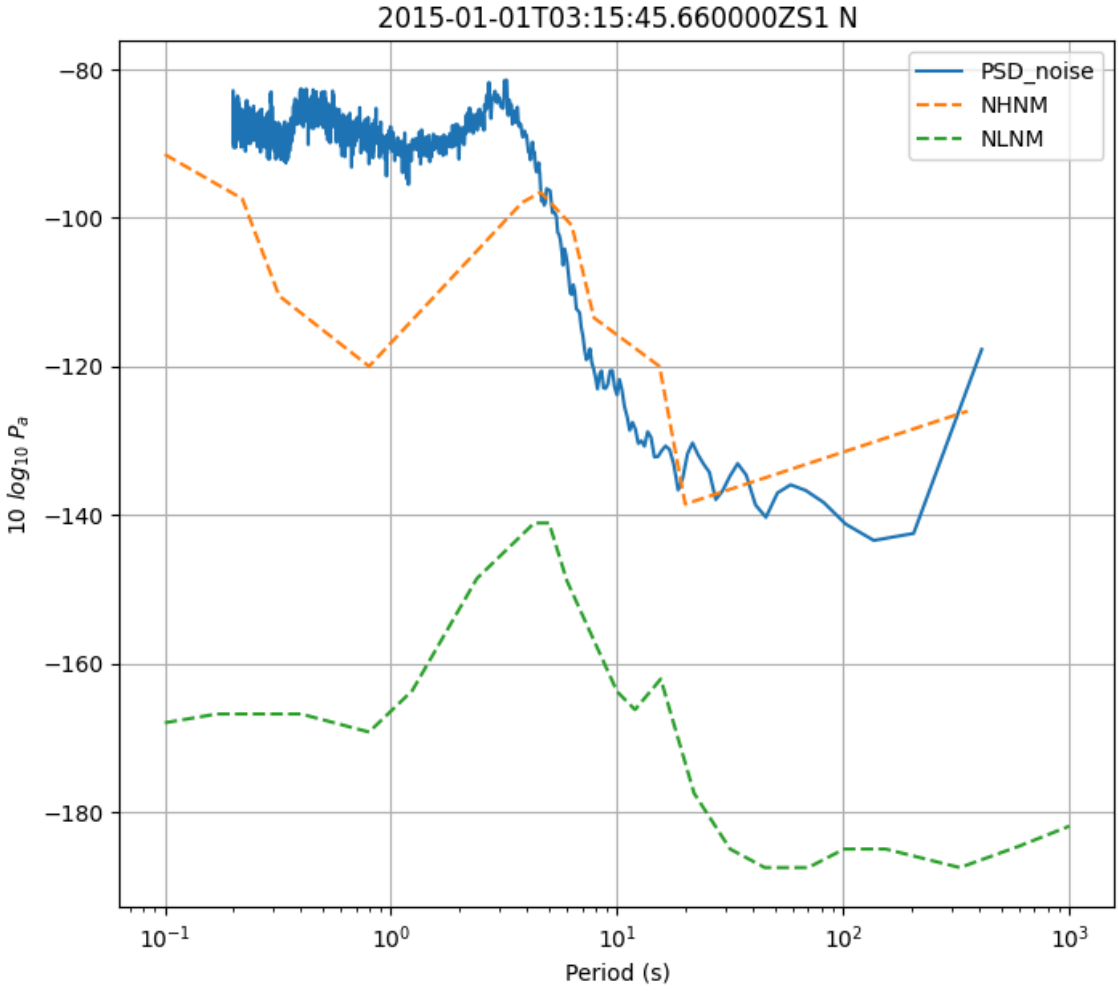
Period (s)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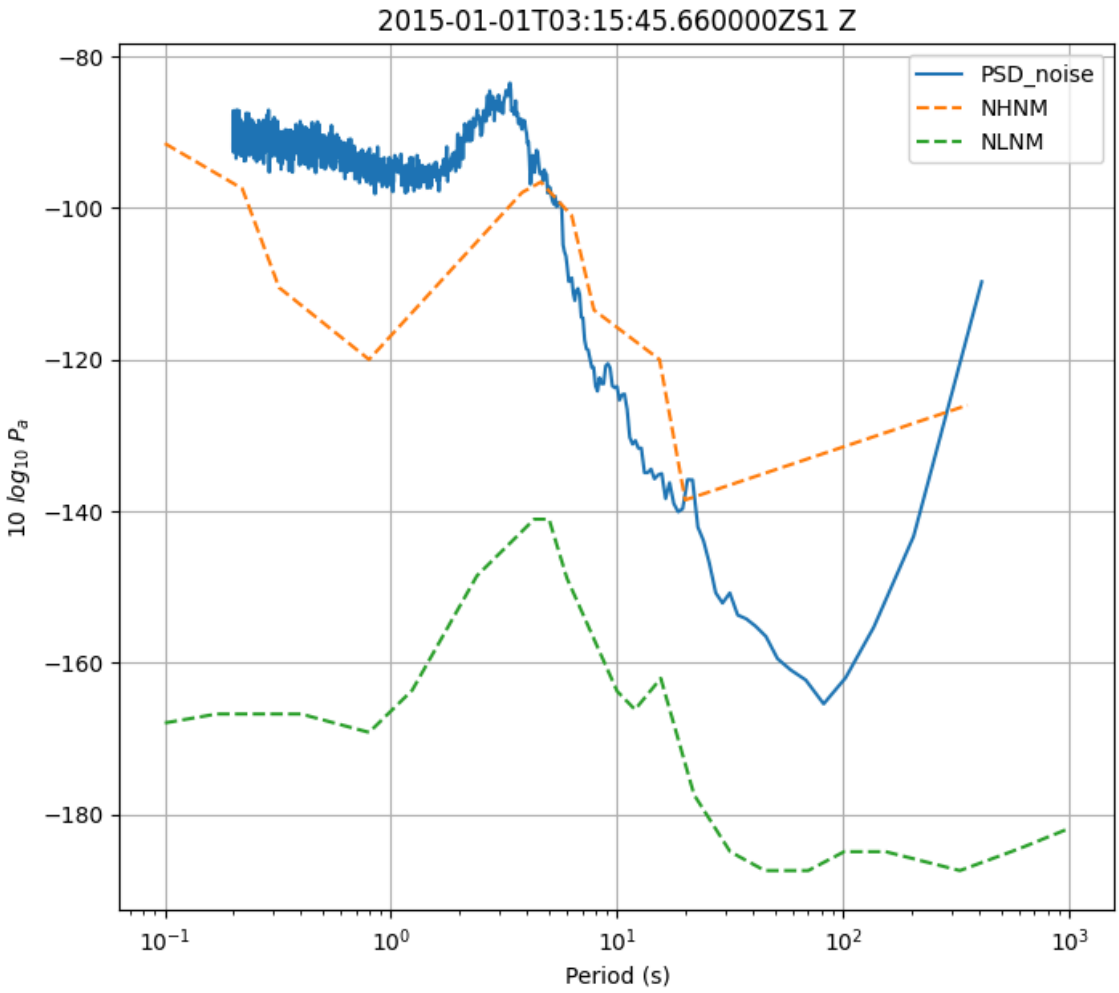
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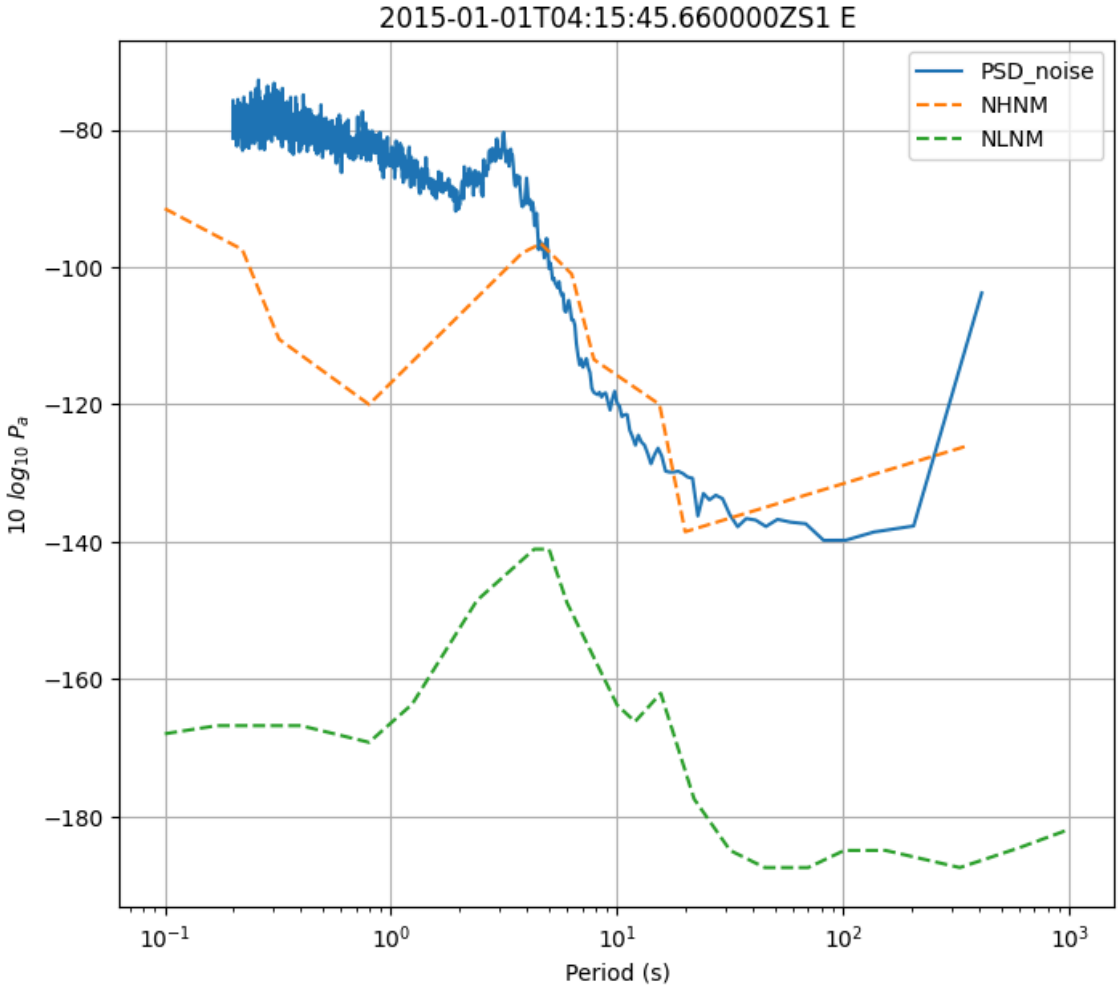
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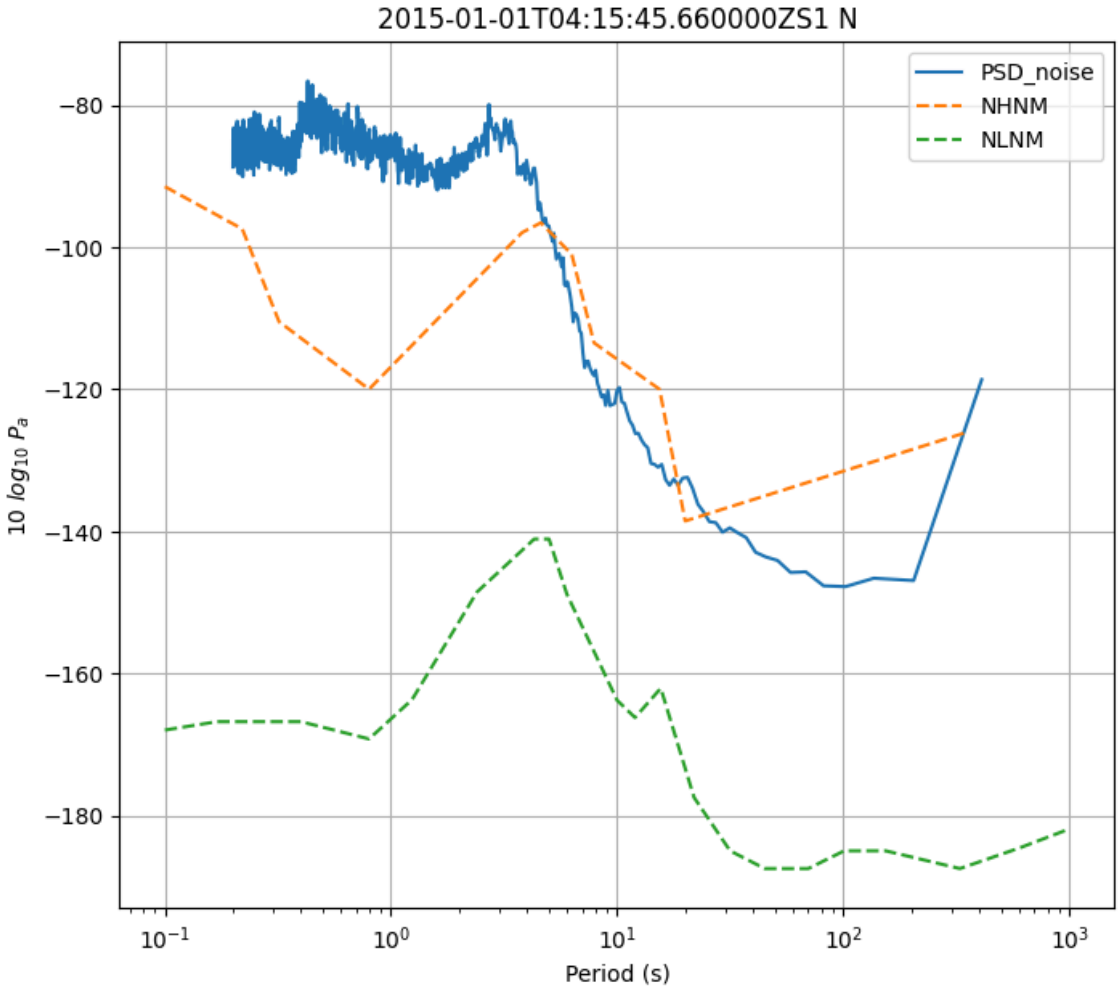
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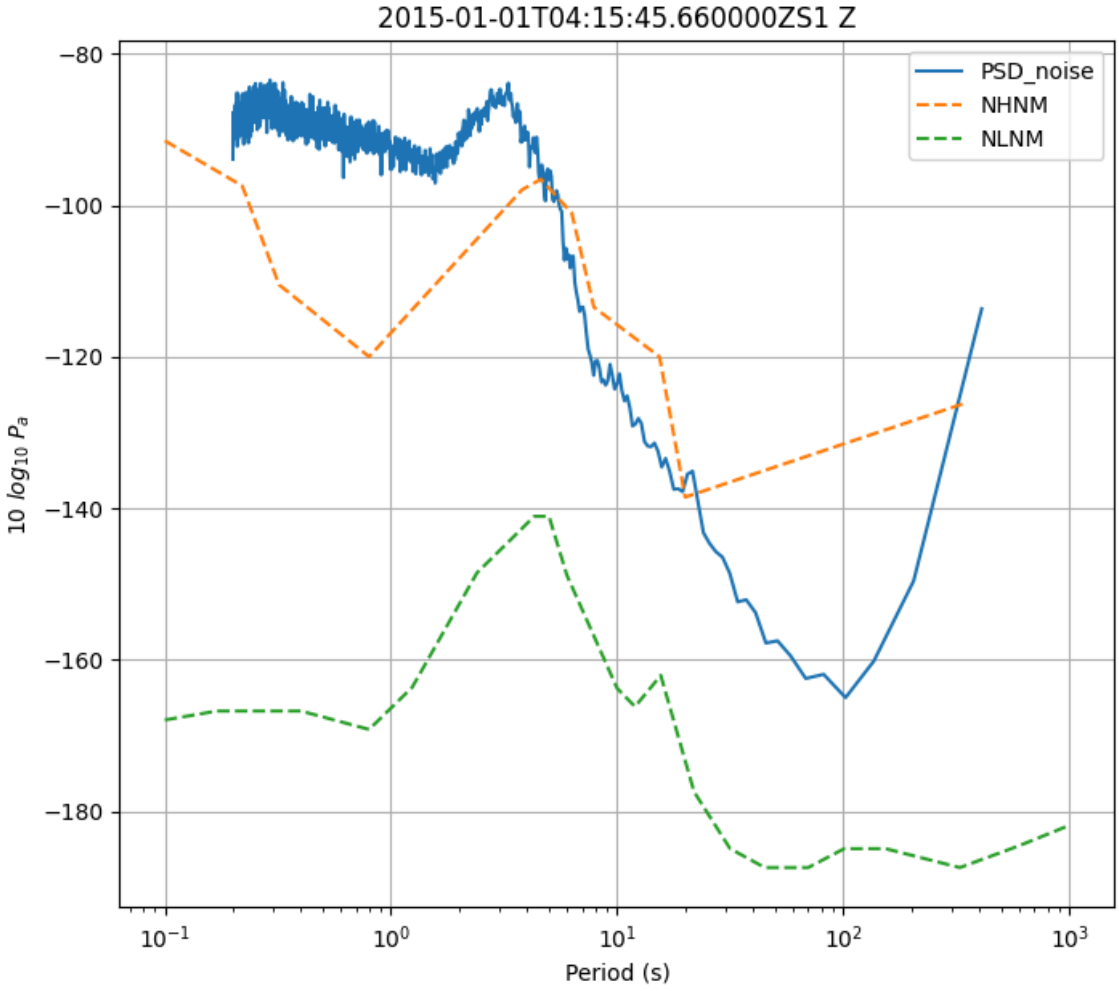
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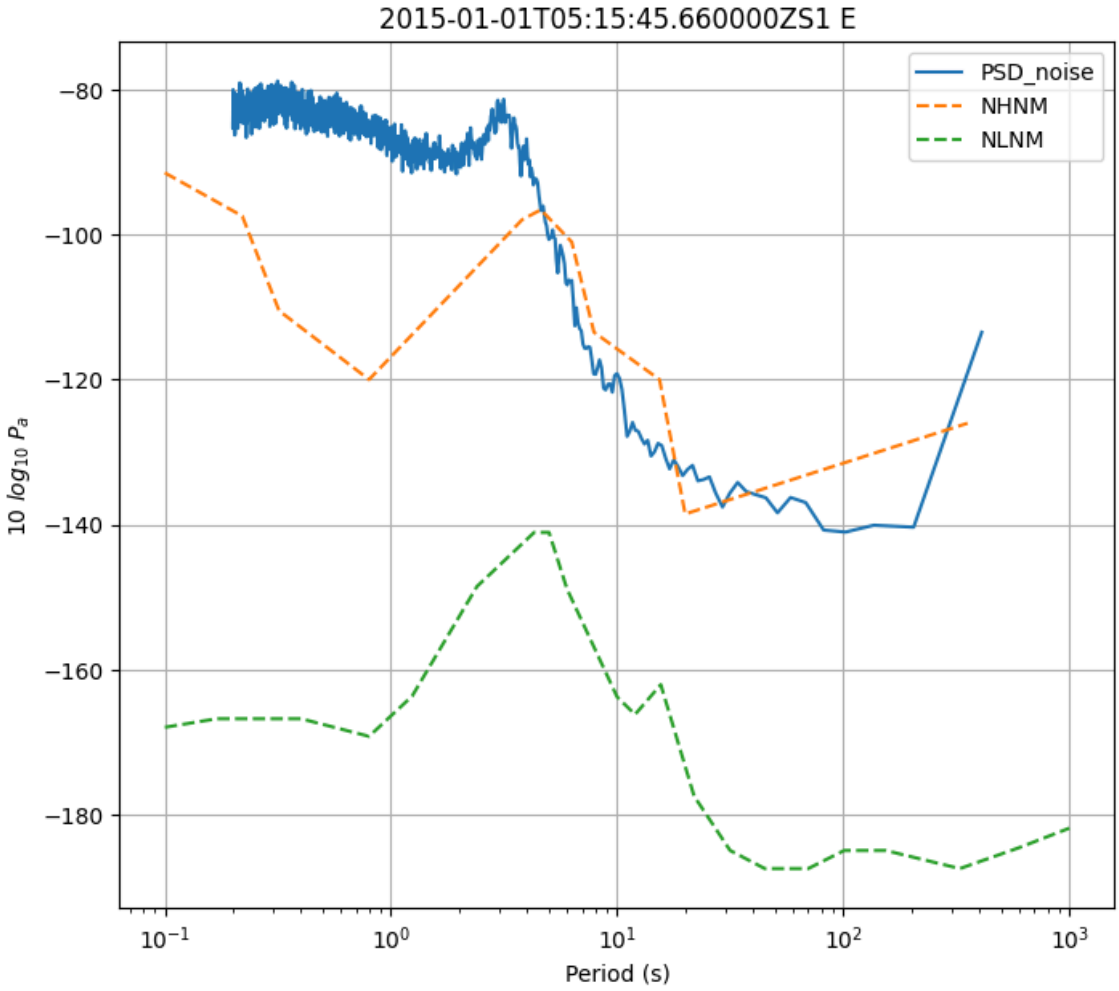
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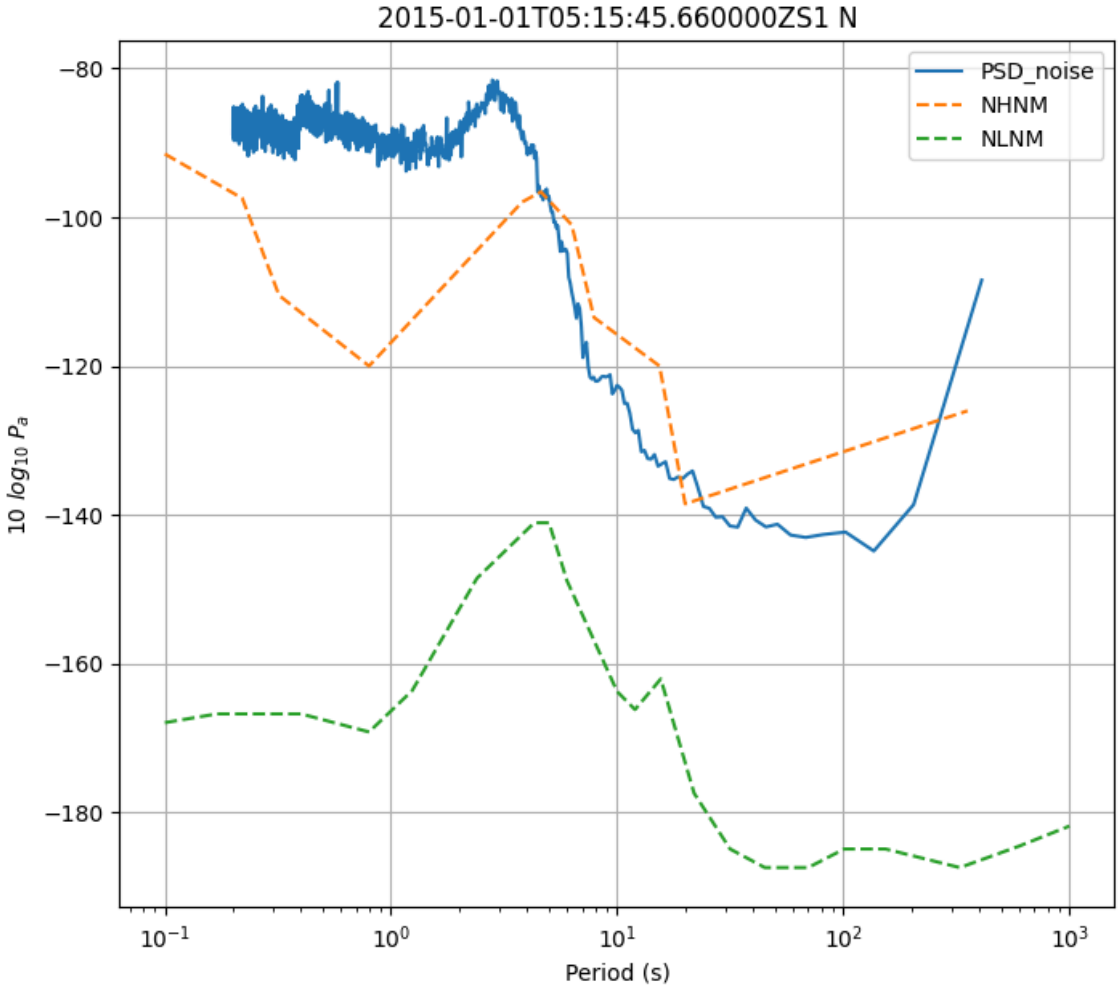
Period (s)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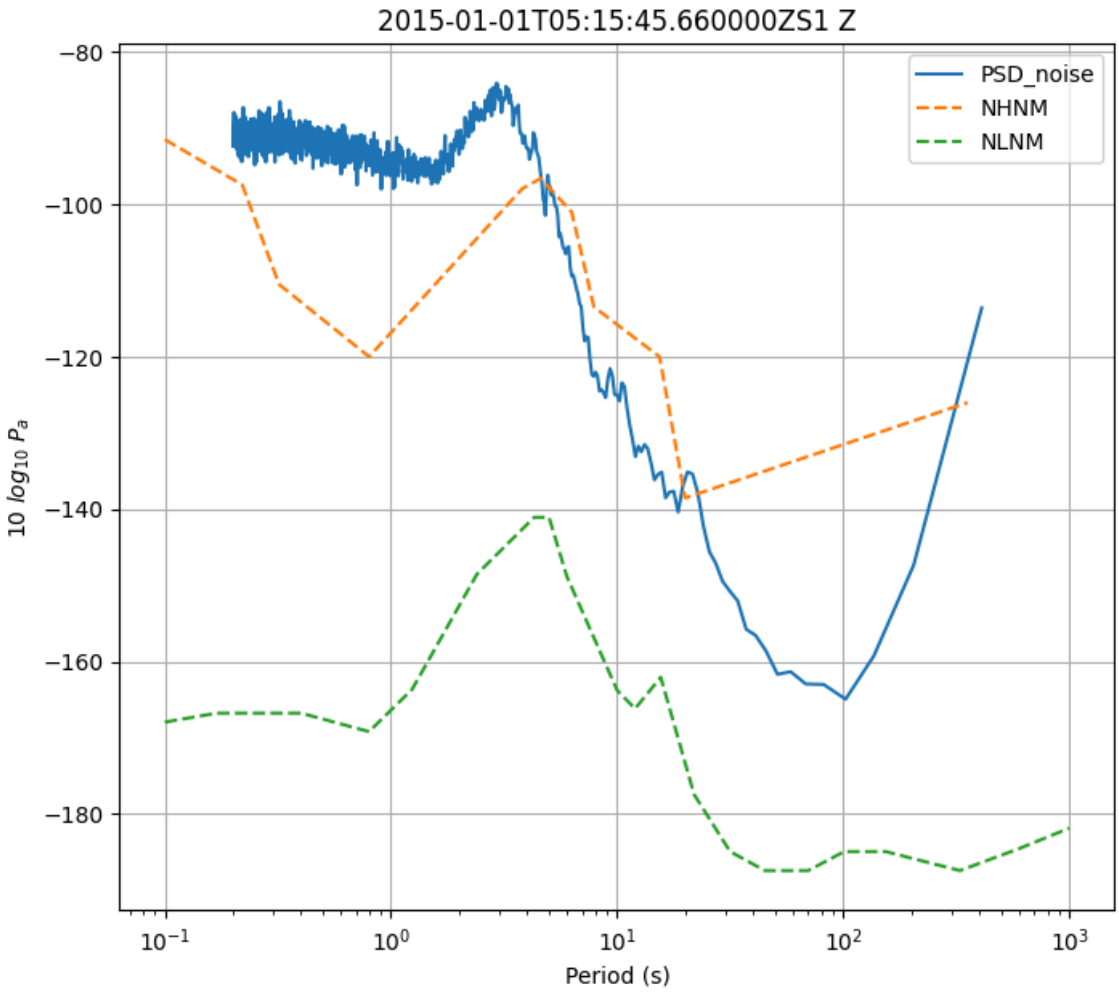
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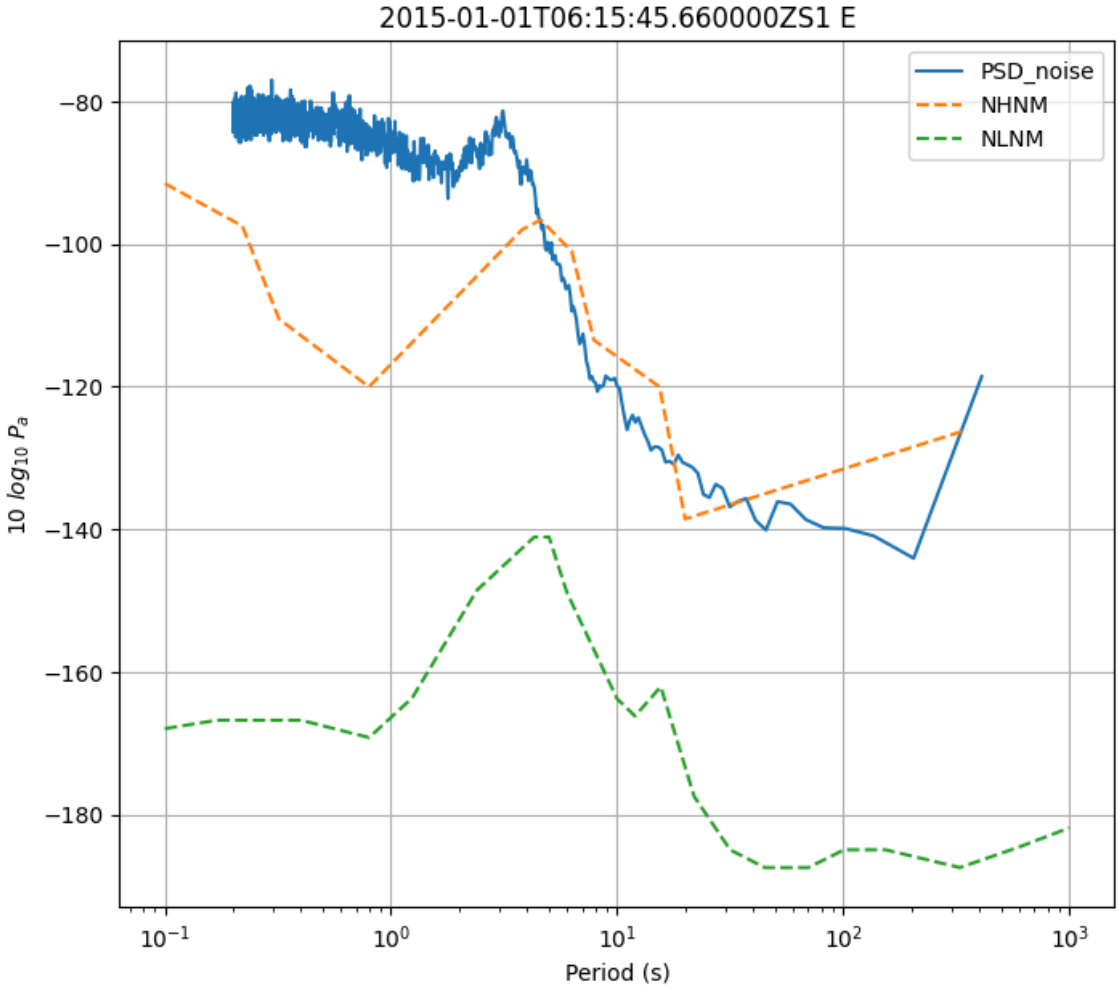
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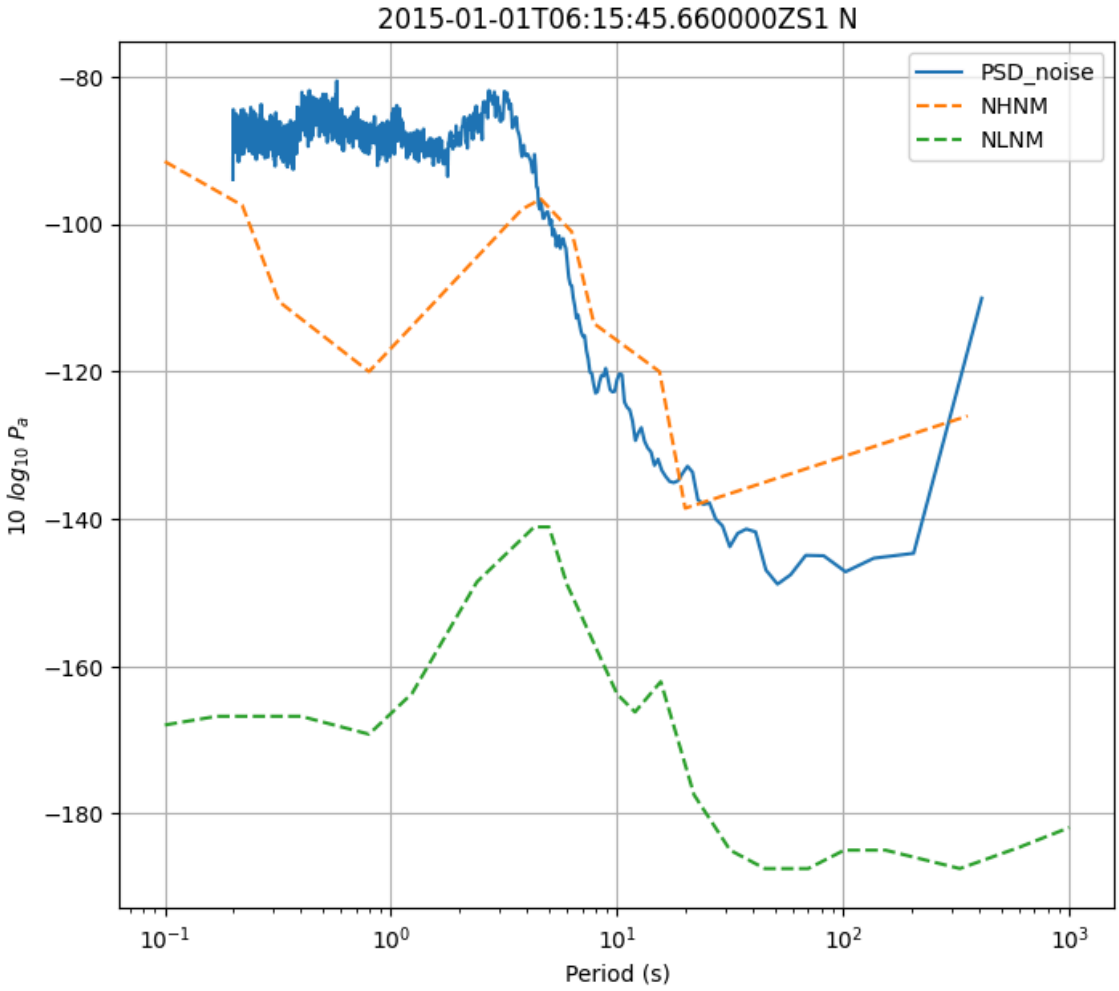
Period (s)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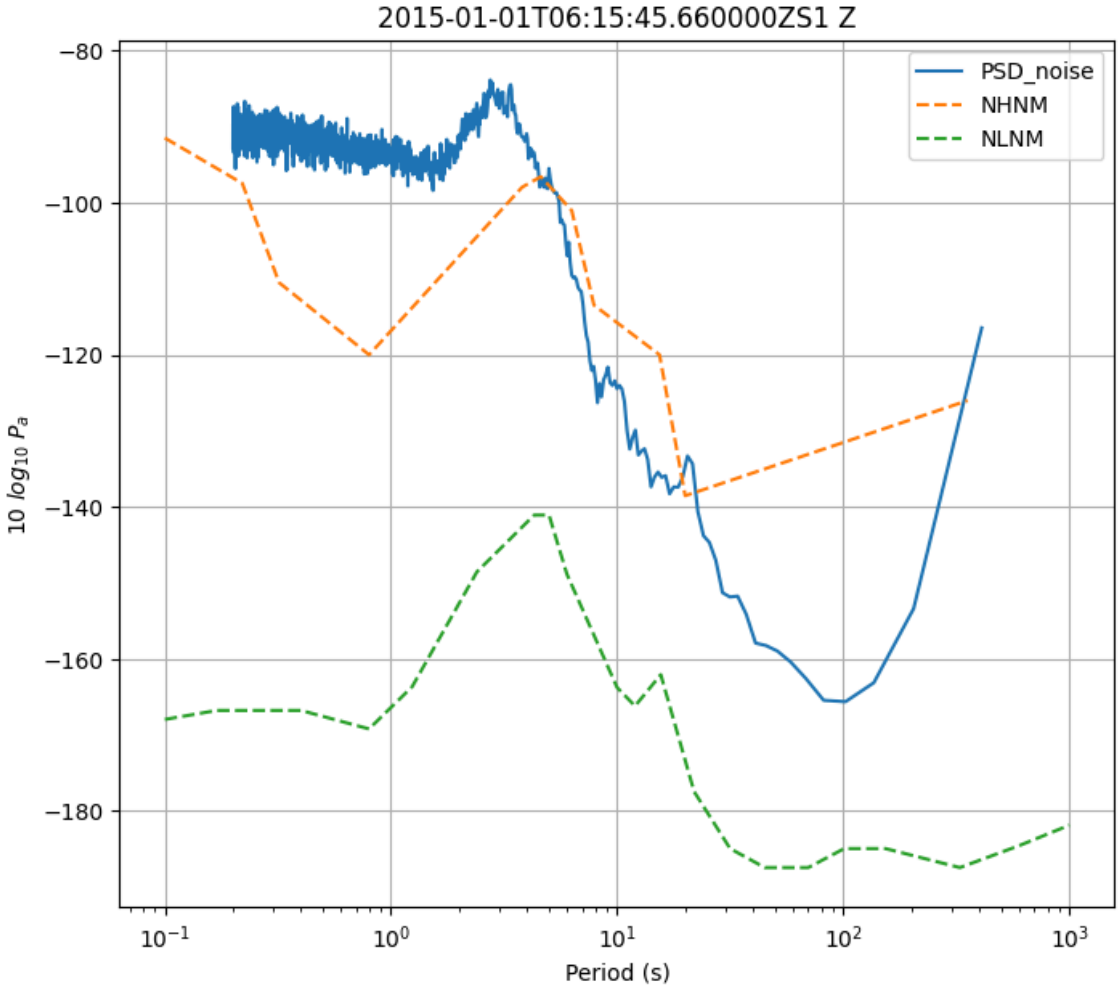
Period (s)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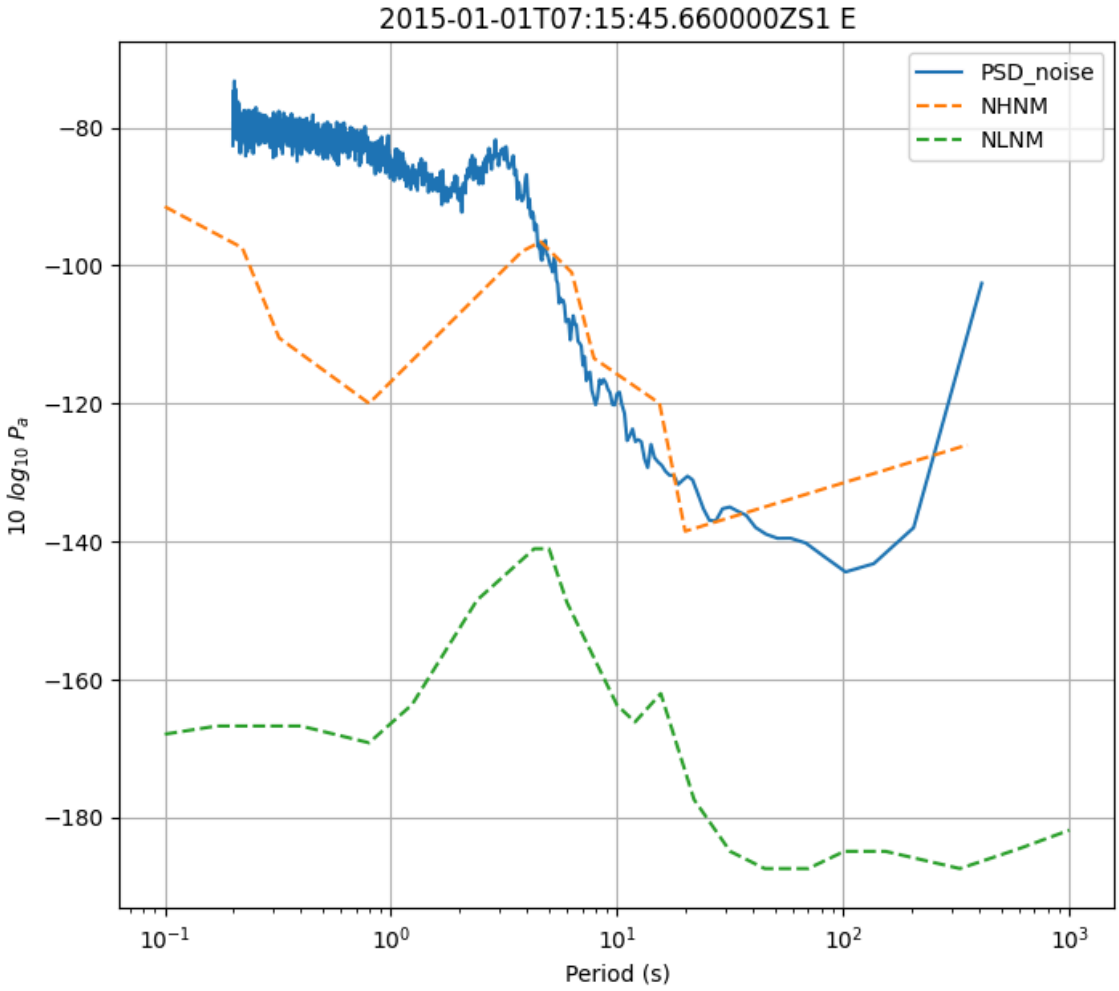
Period (s)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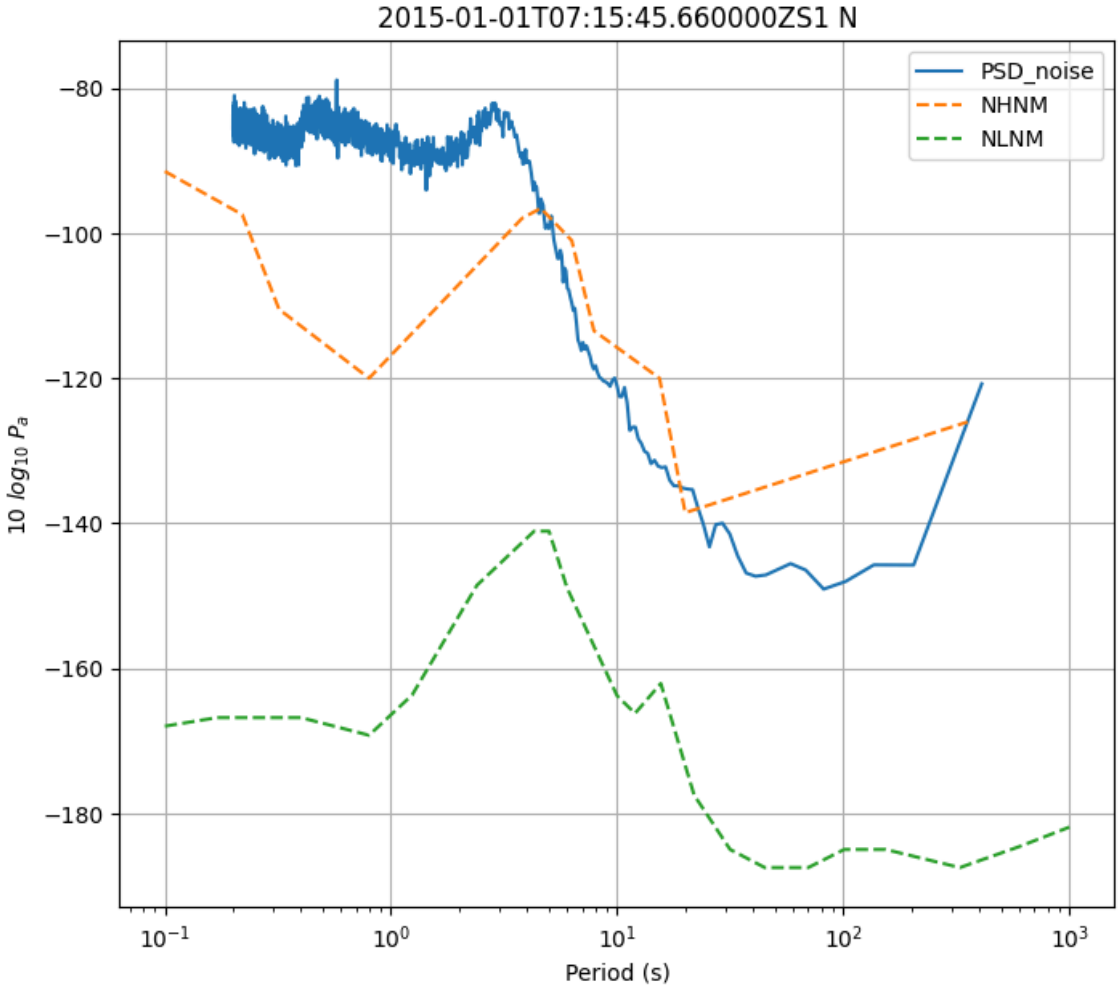
Period (s)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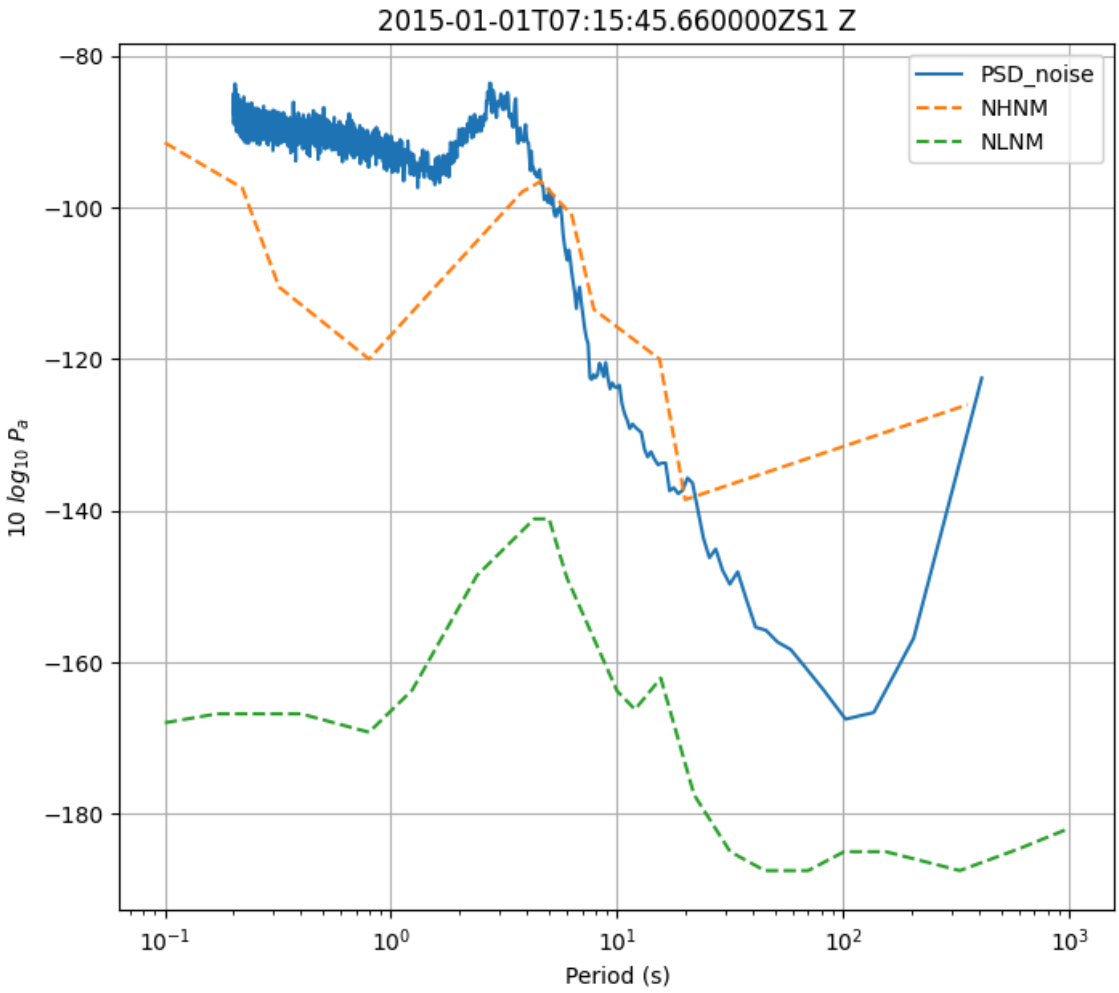
Period (s)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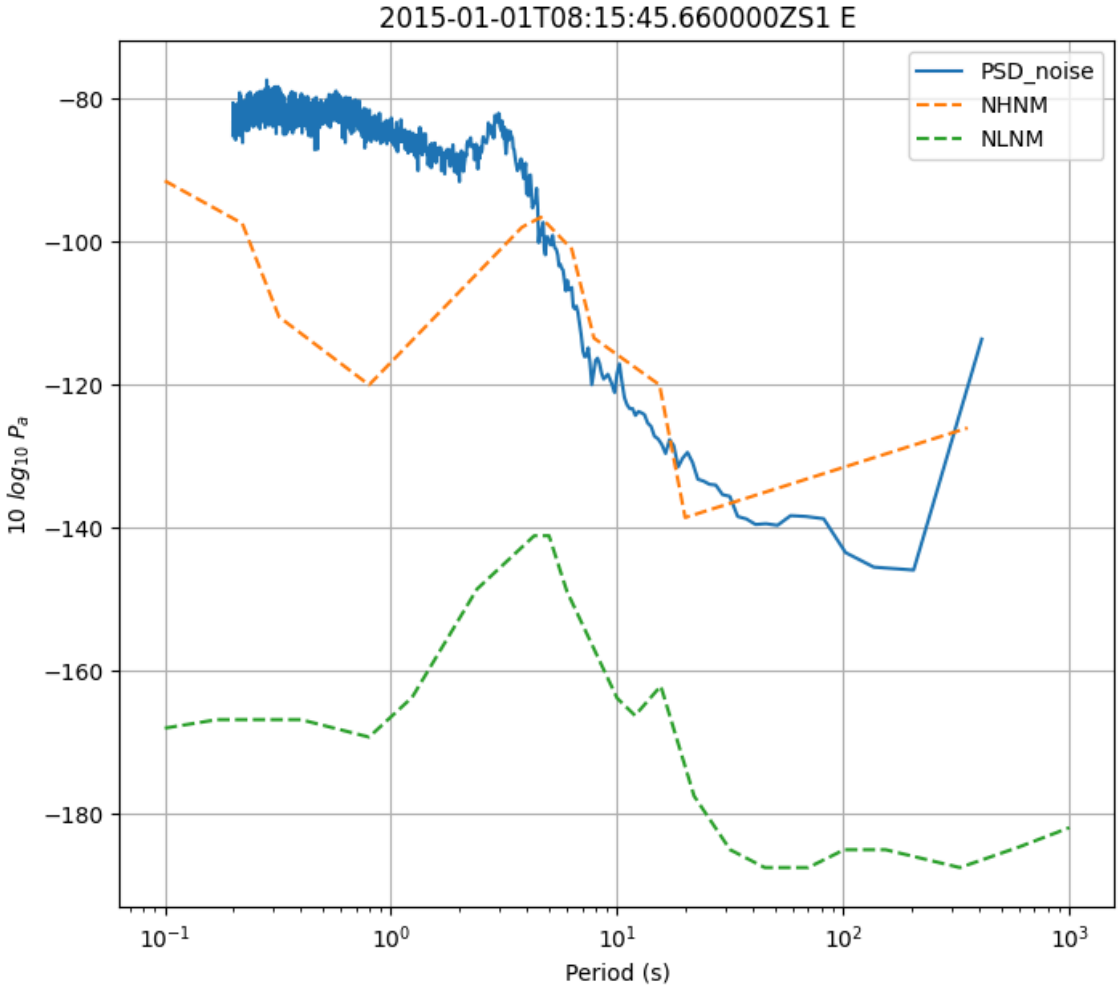
Period (s)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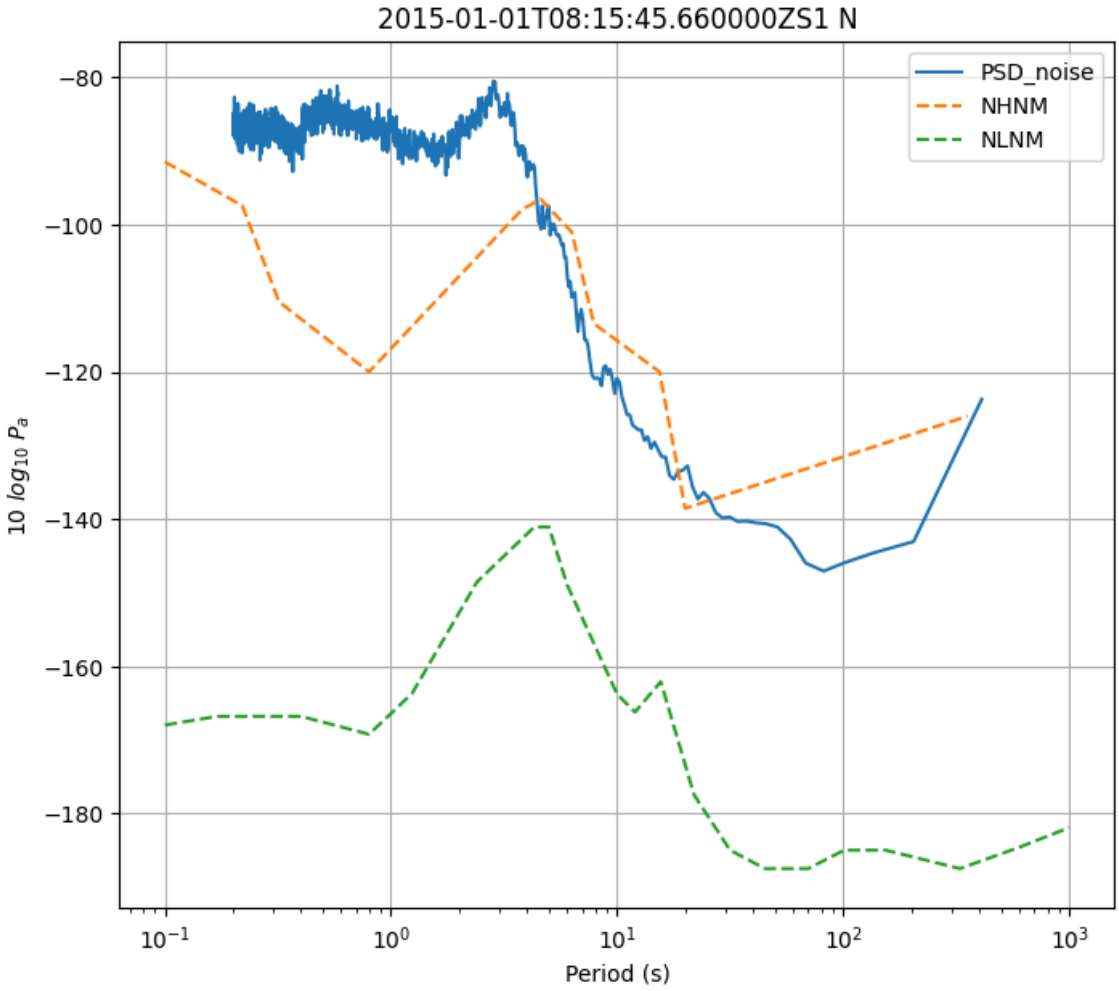
Period (s)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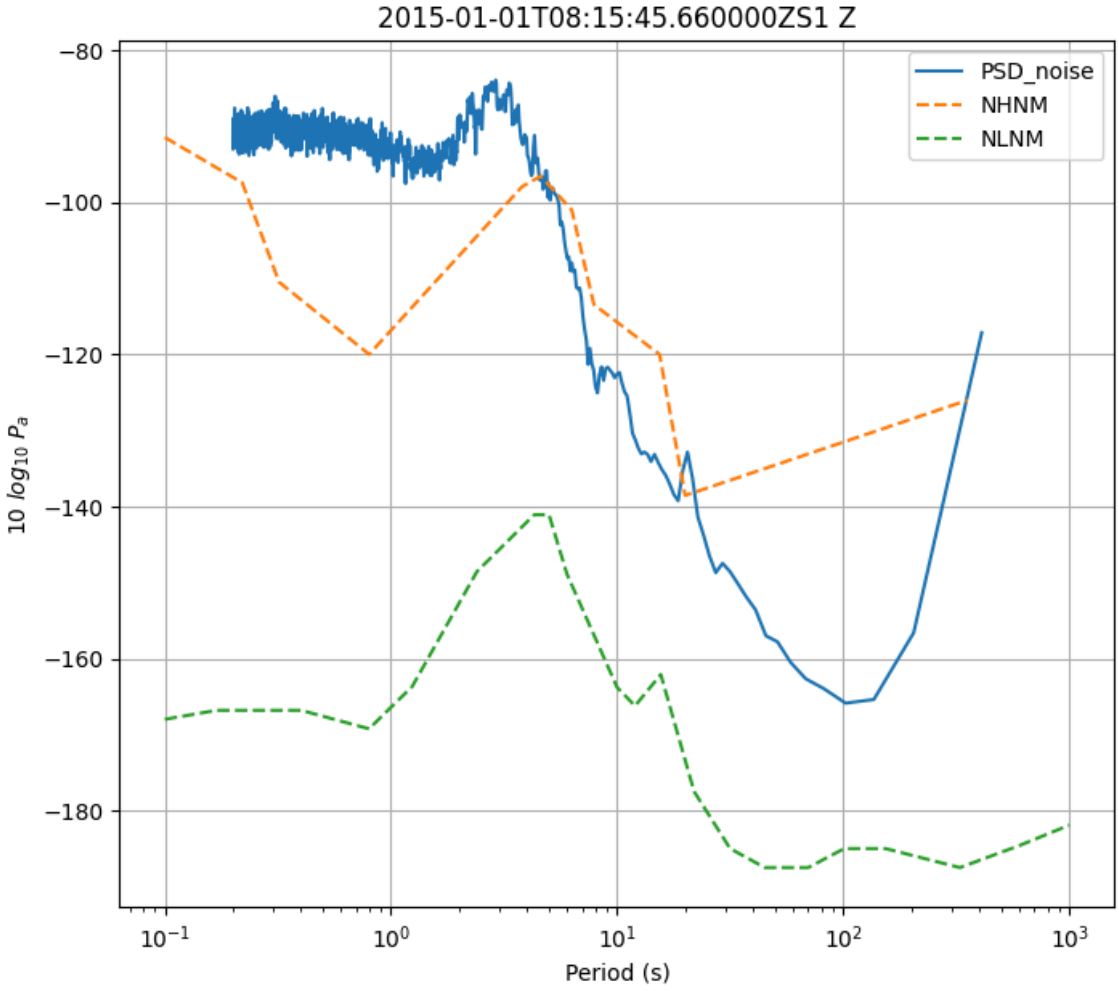
Period (s)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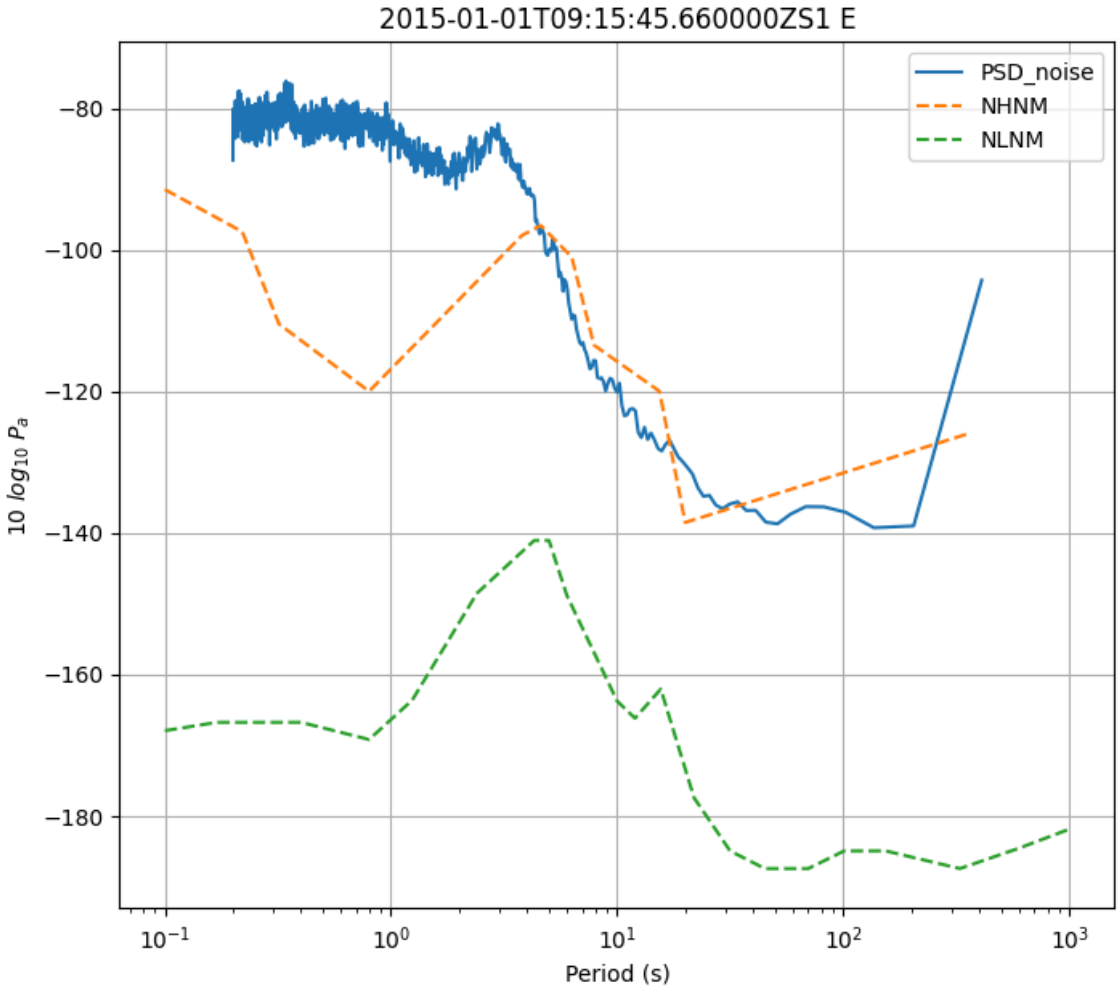
Period (s)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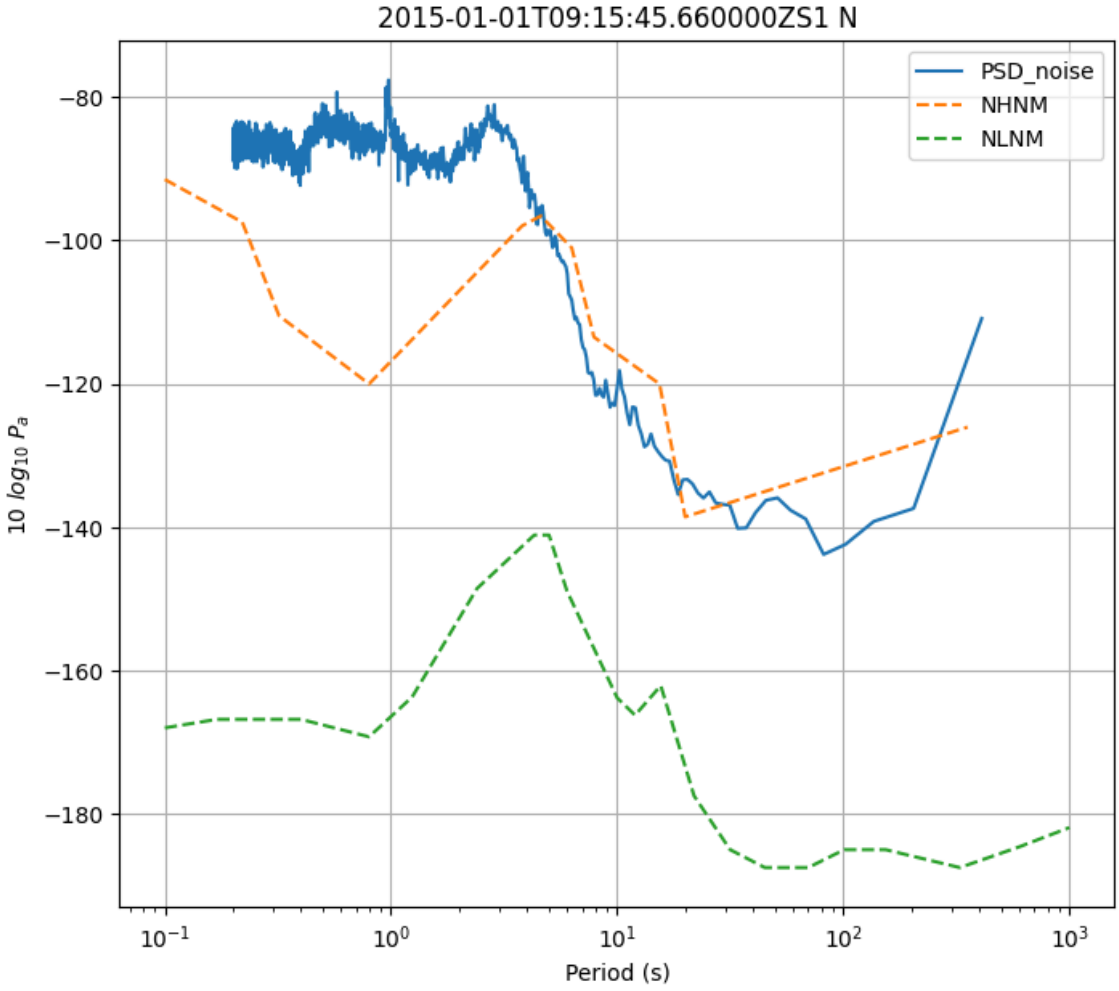
Period (s)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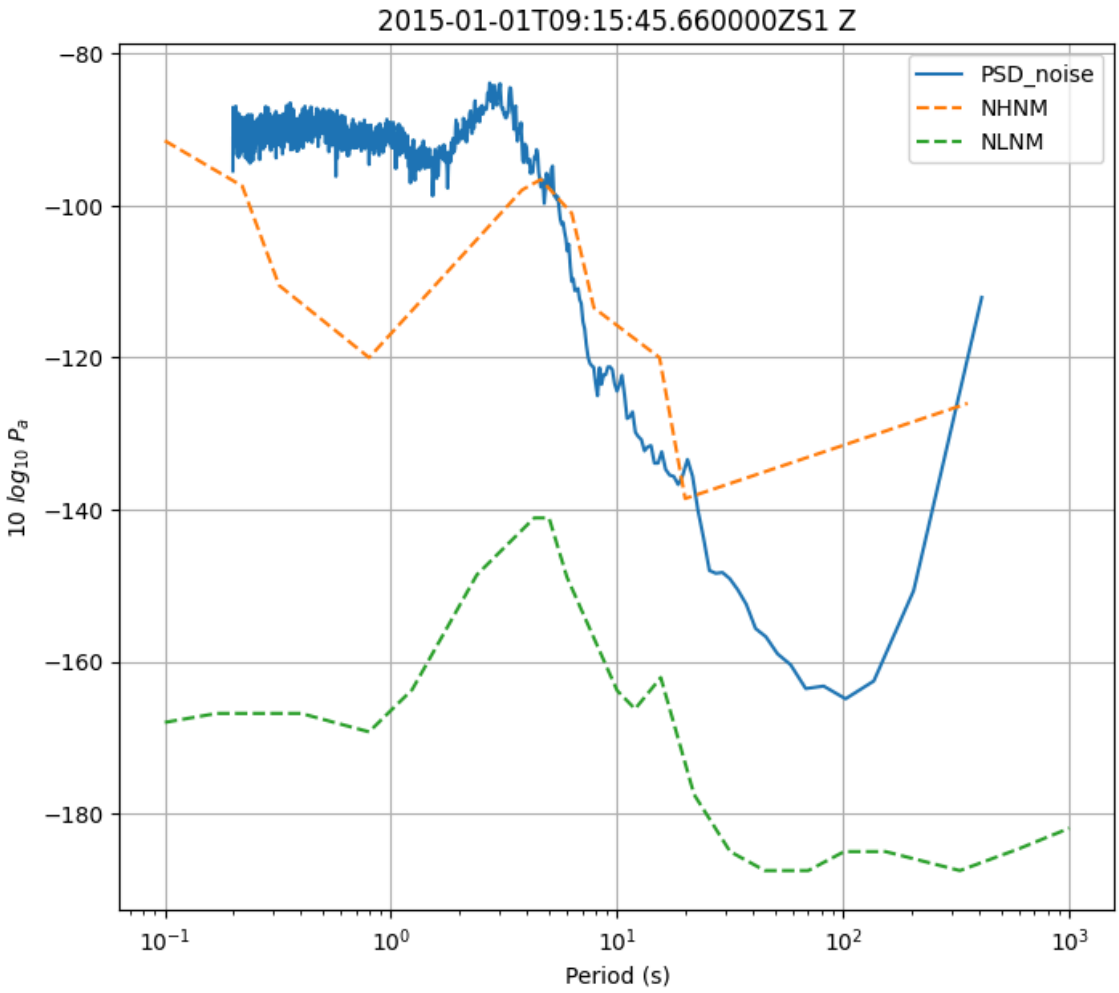
Period (s)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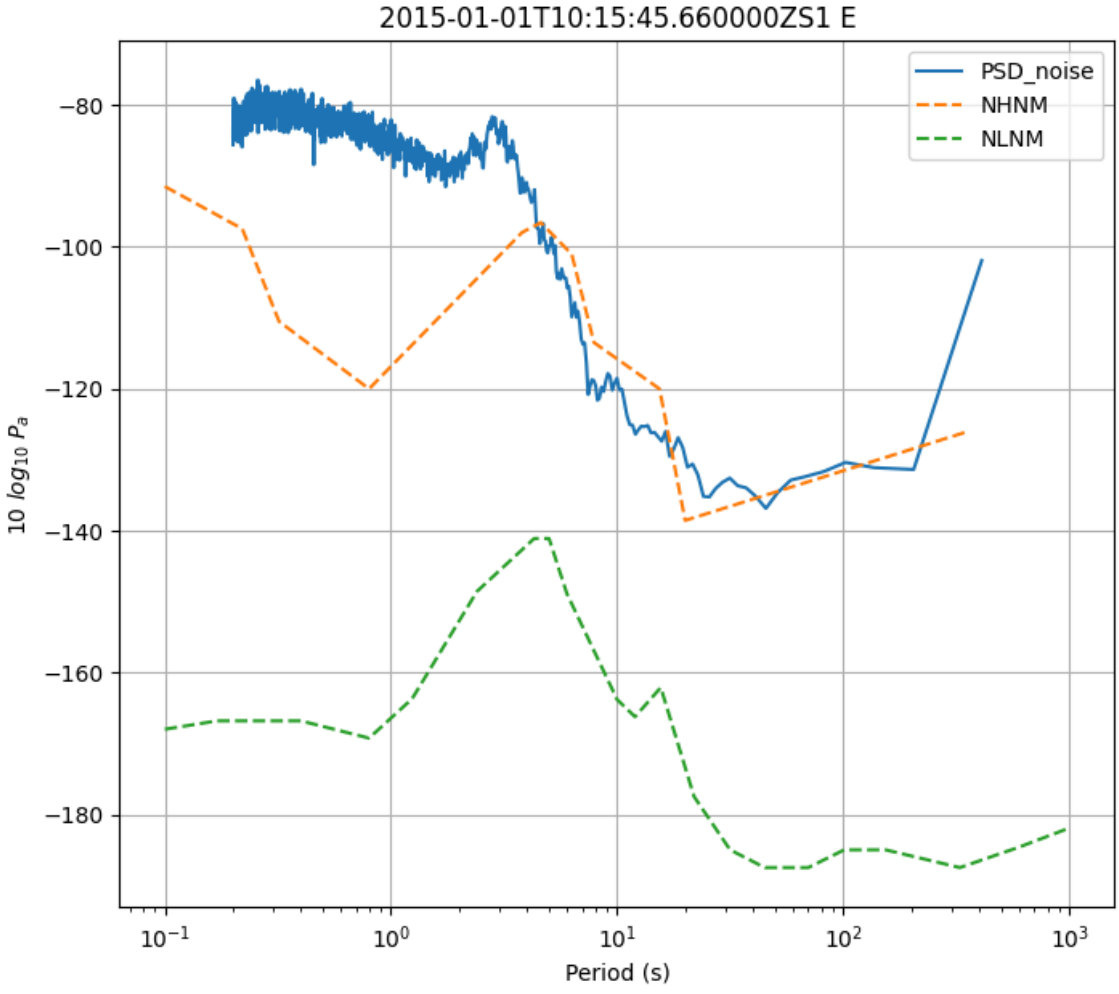
Period (s)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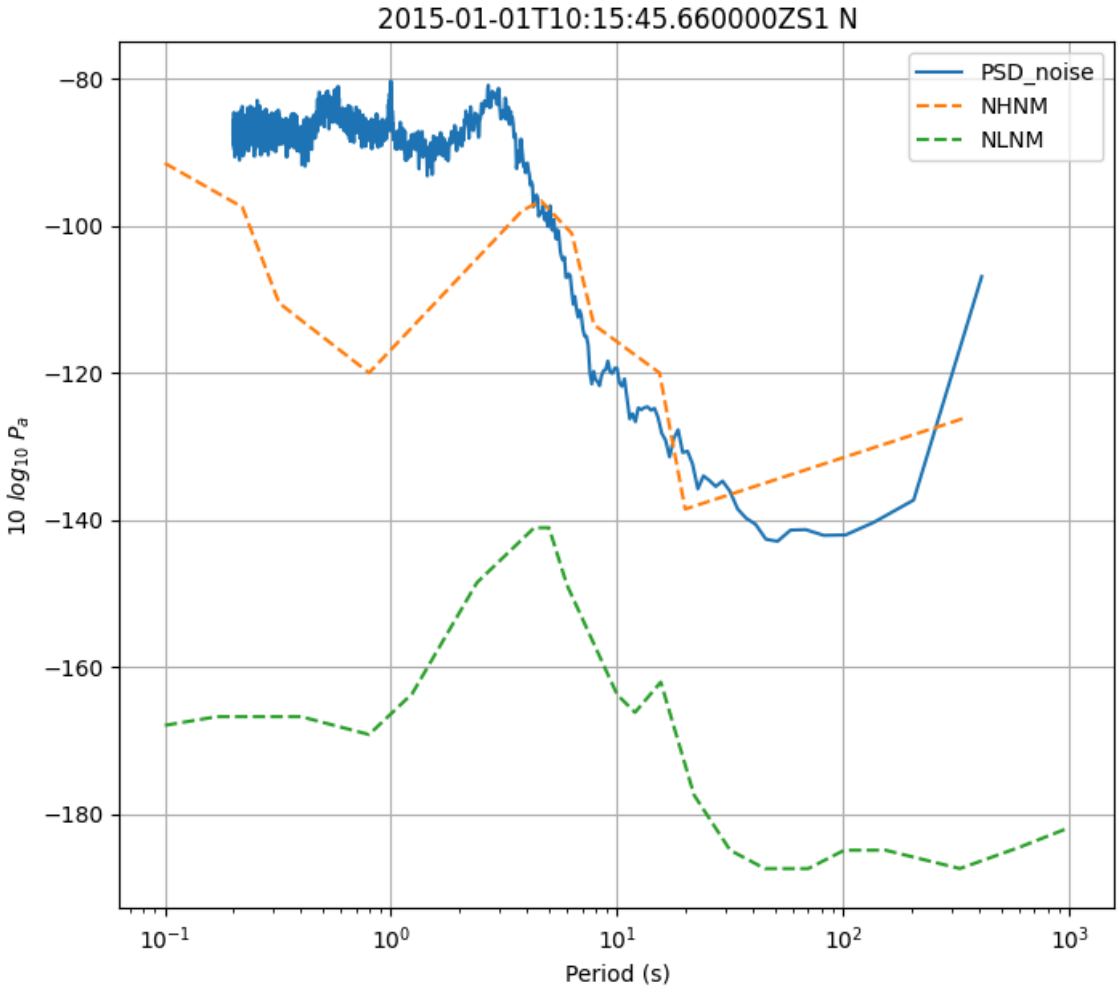
Period (s)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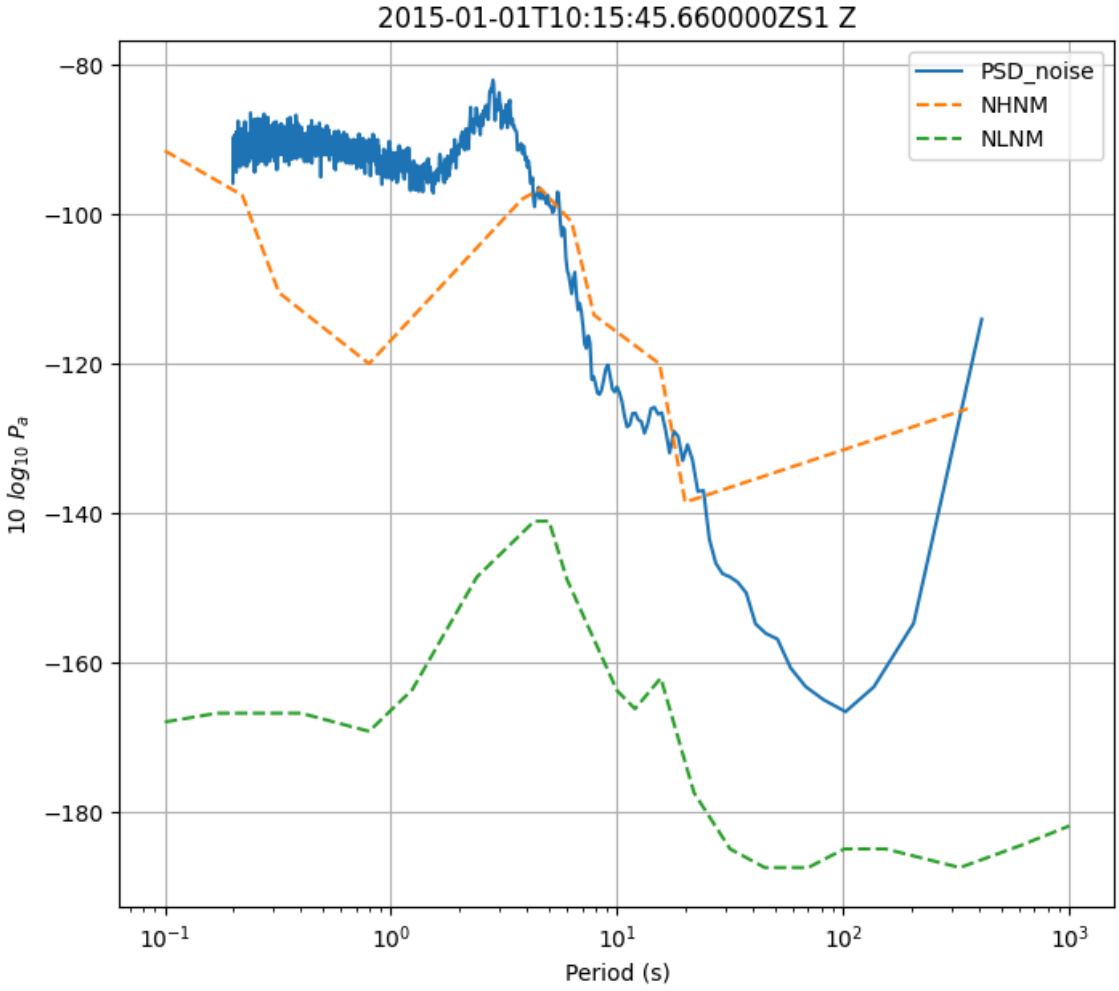
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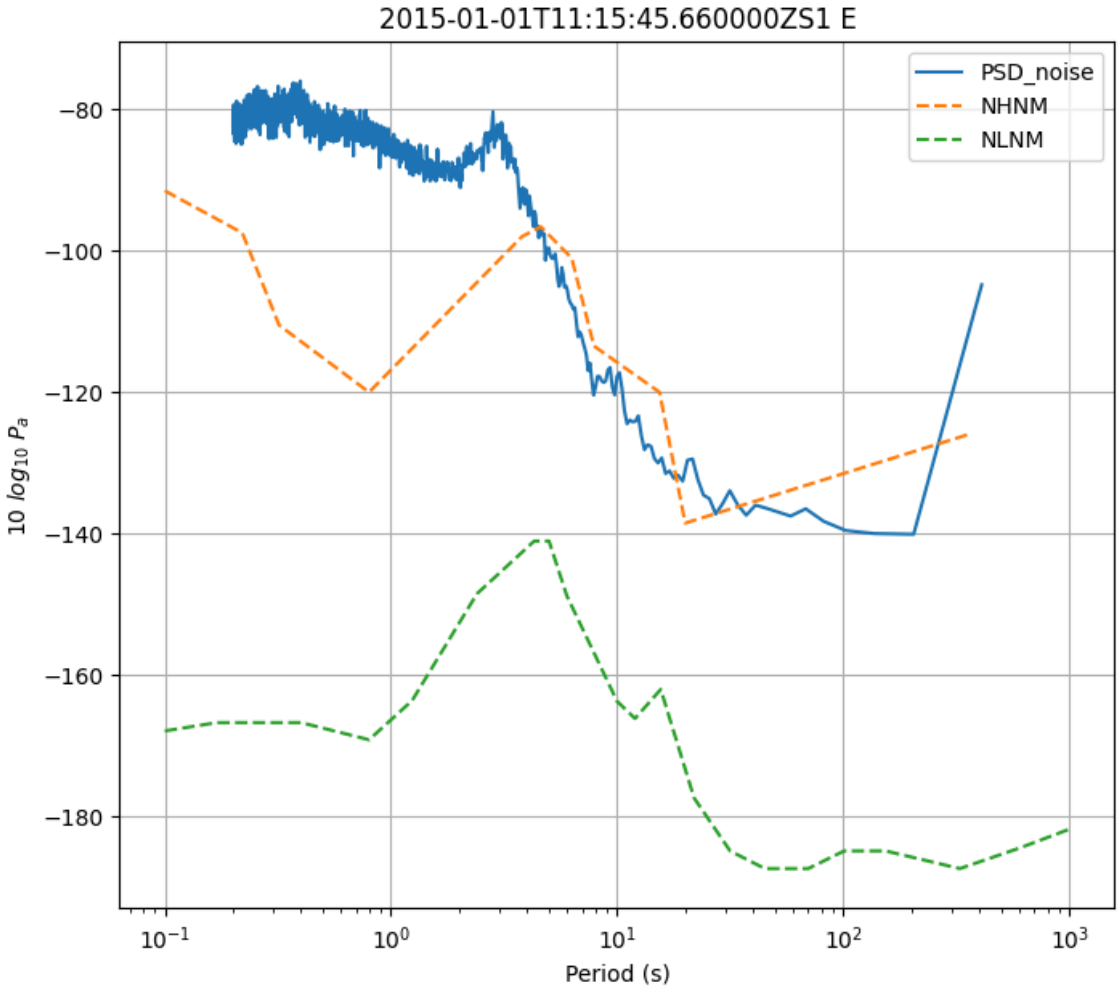
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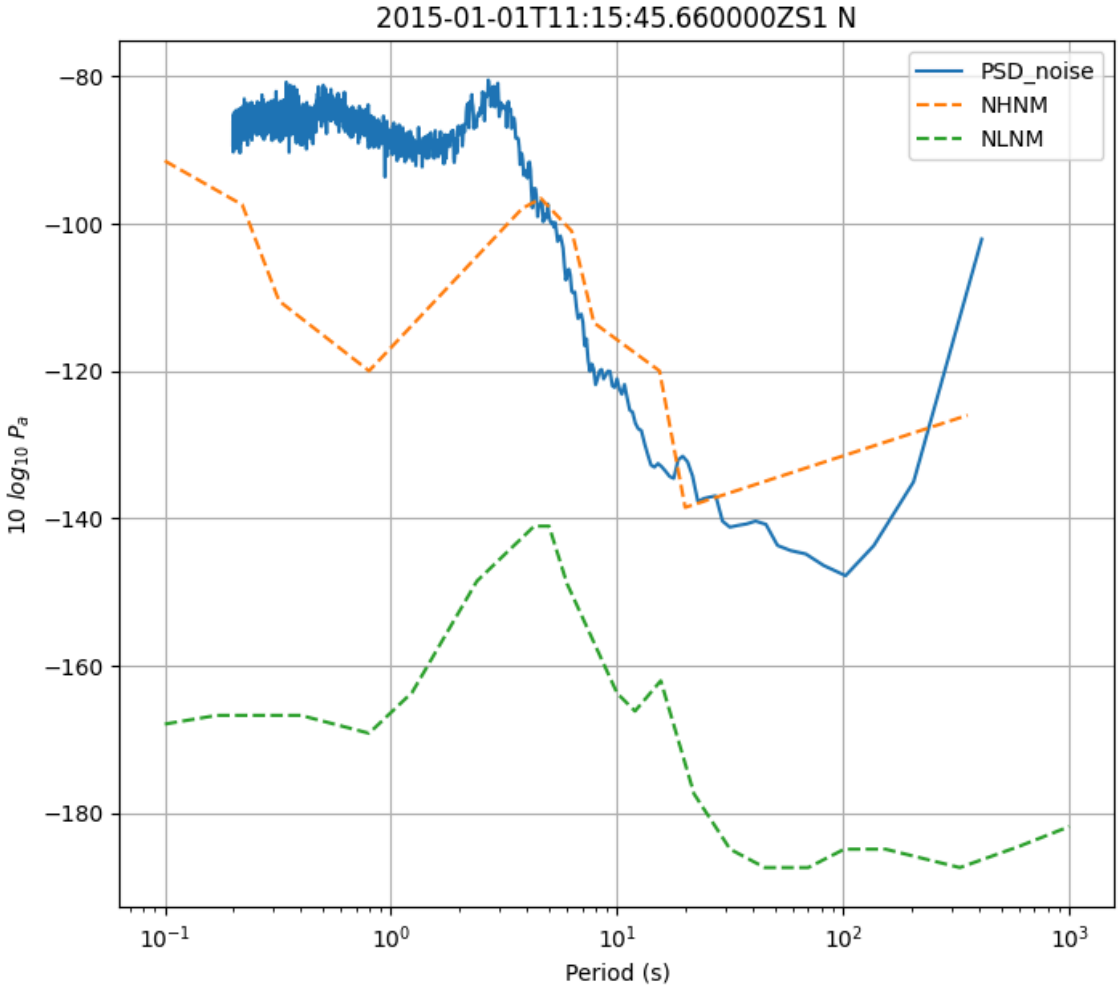
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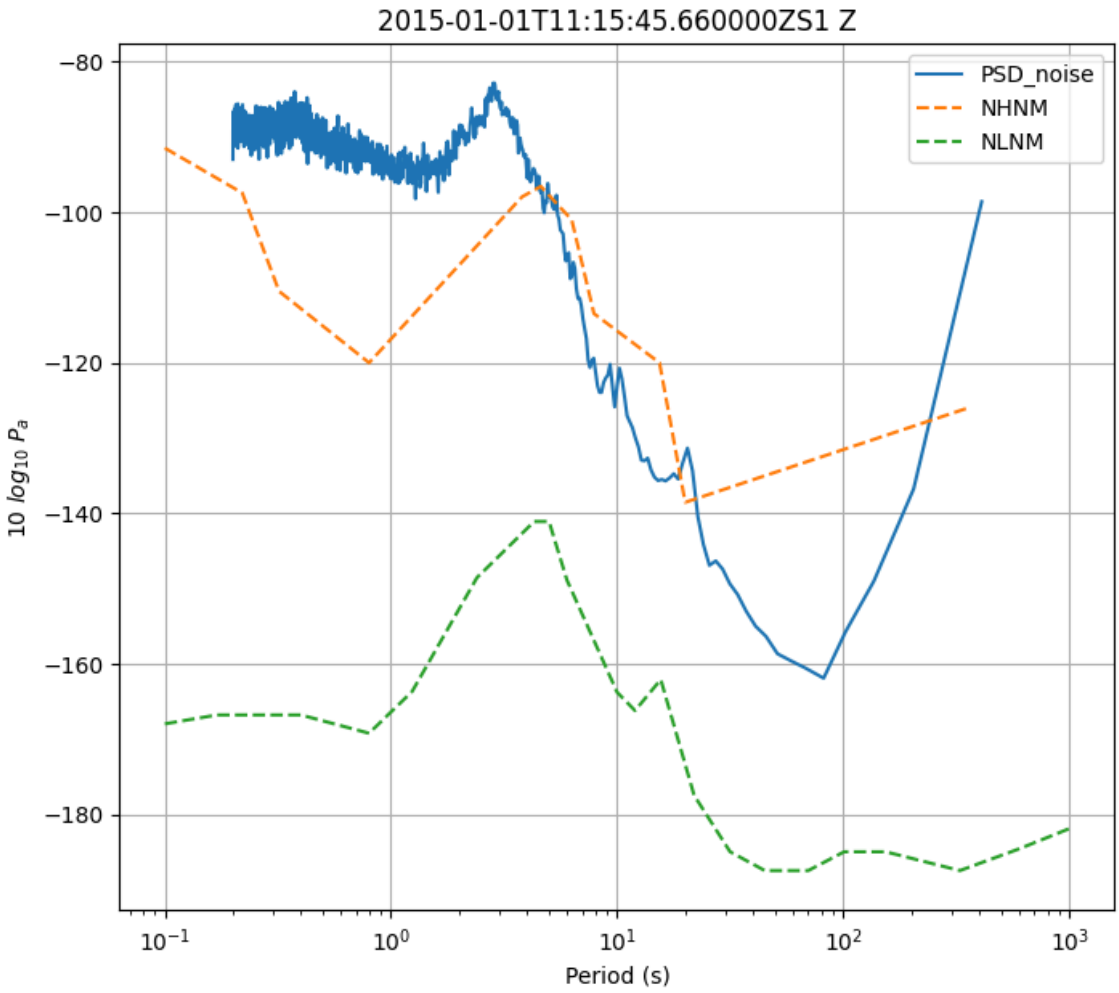
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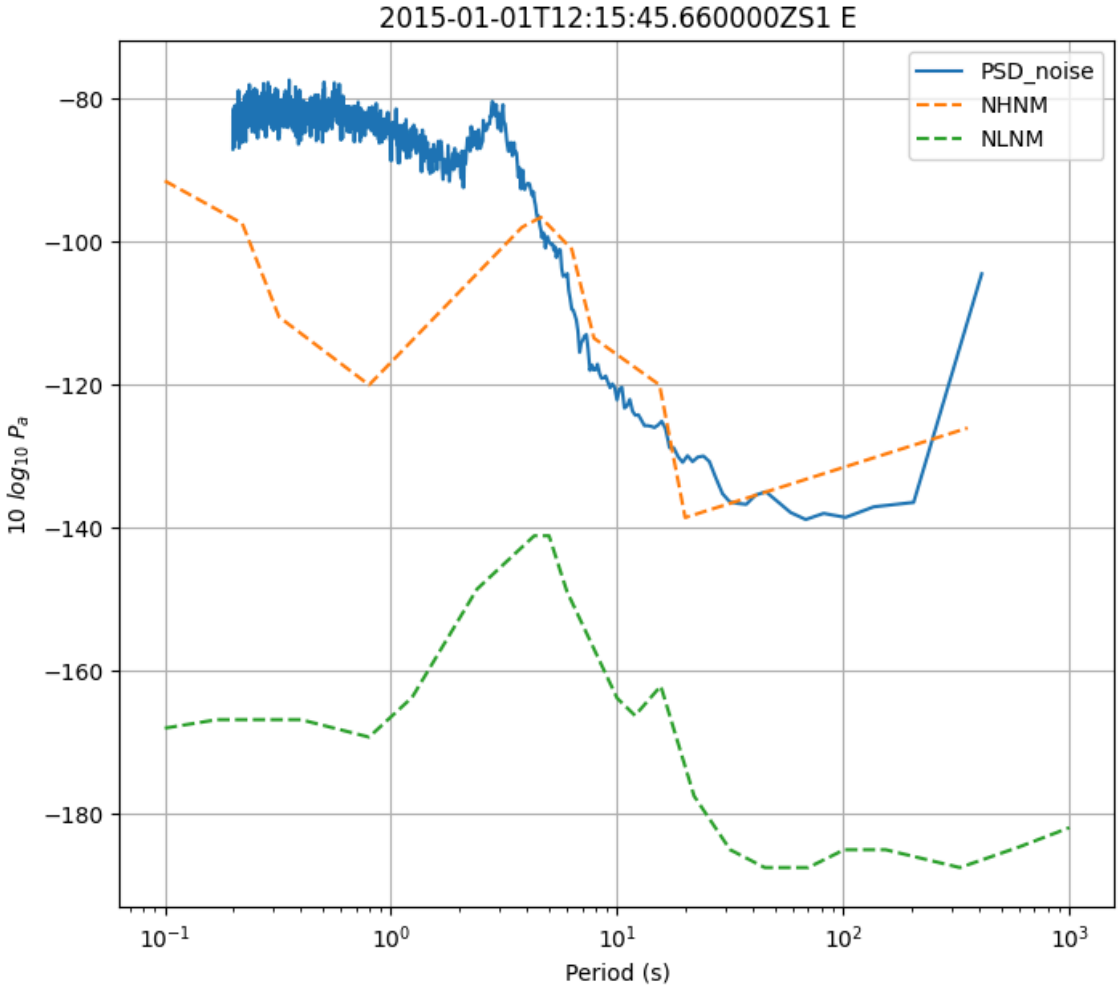
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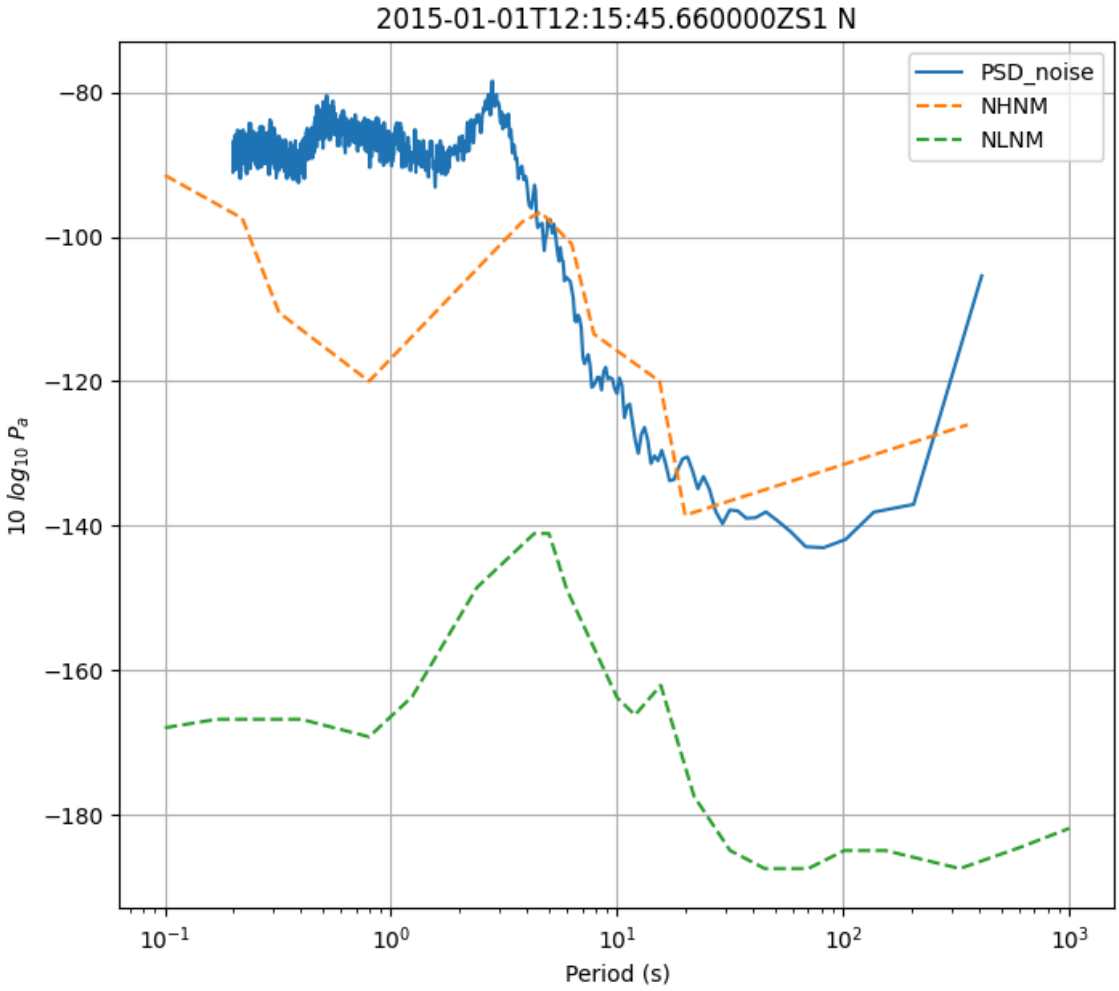
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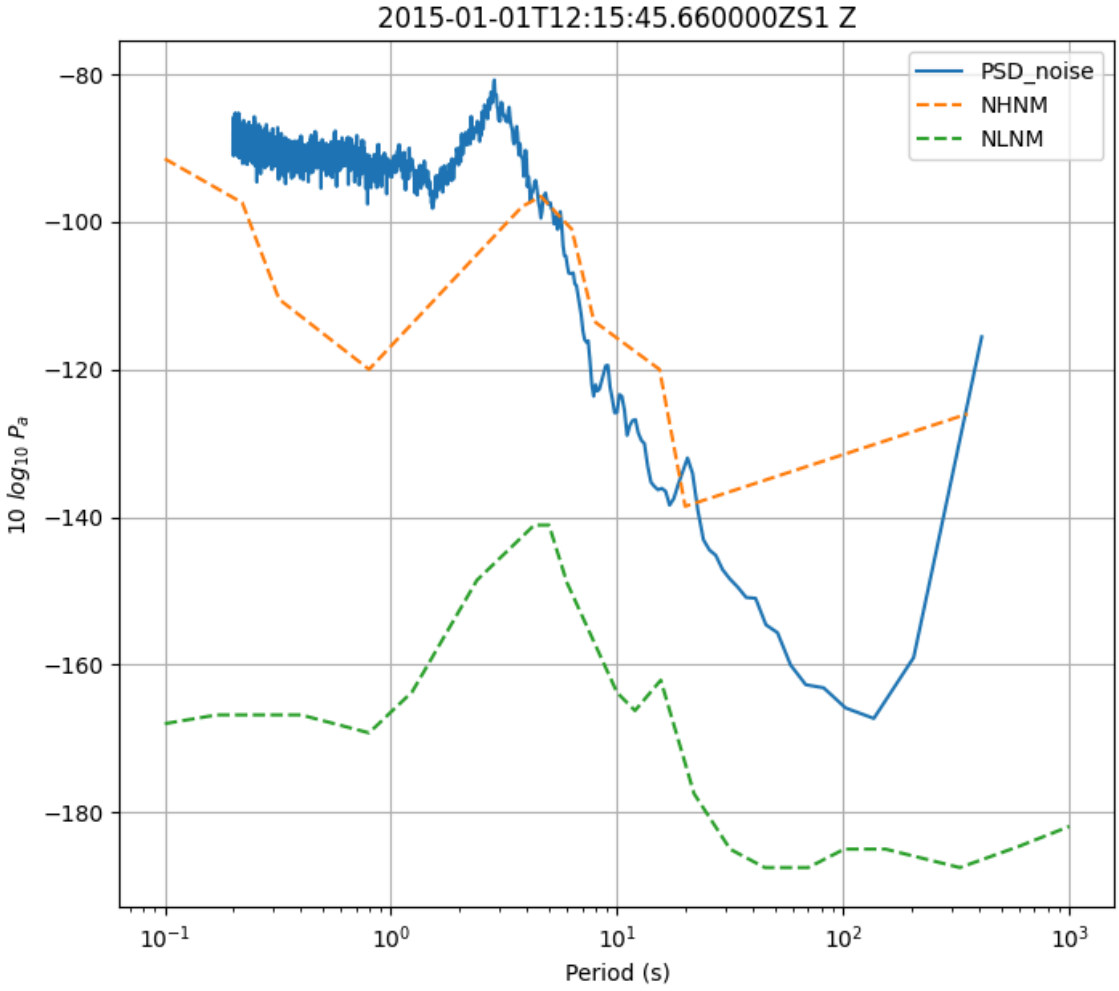
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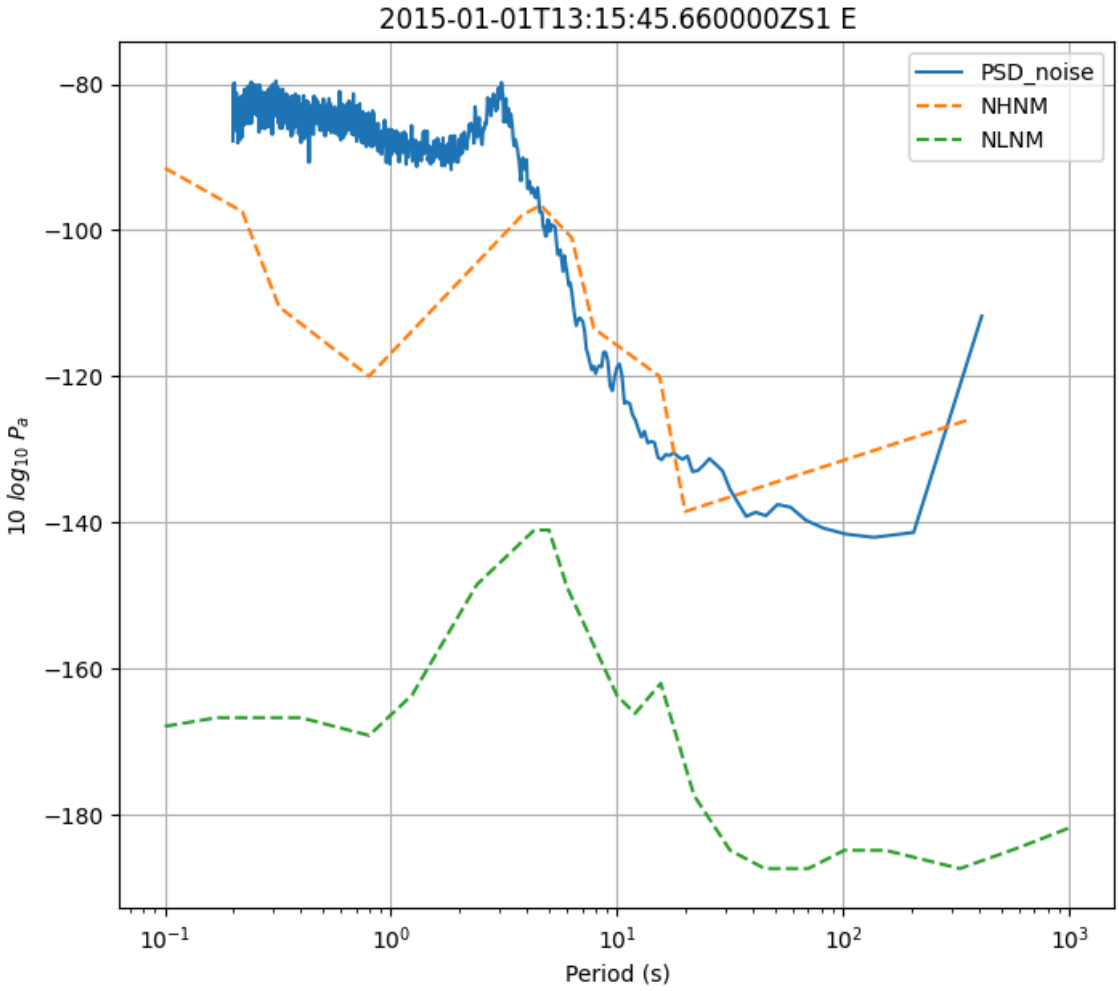
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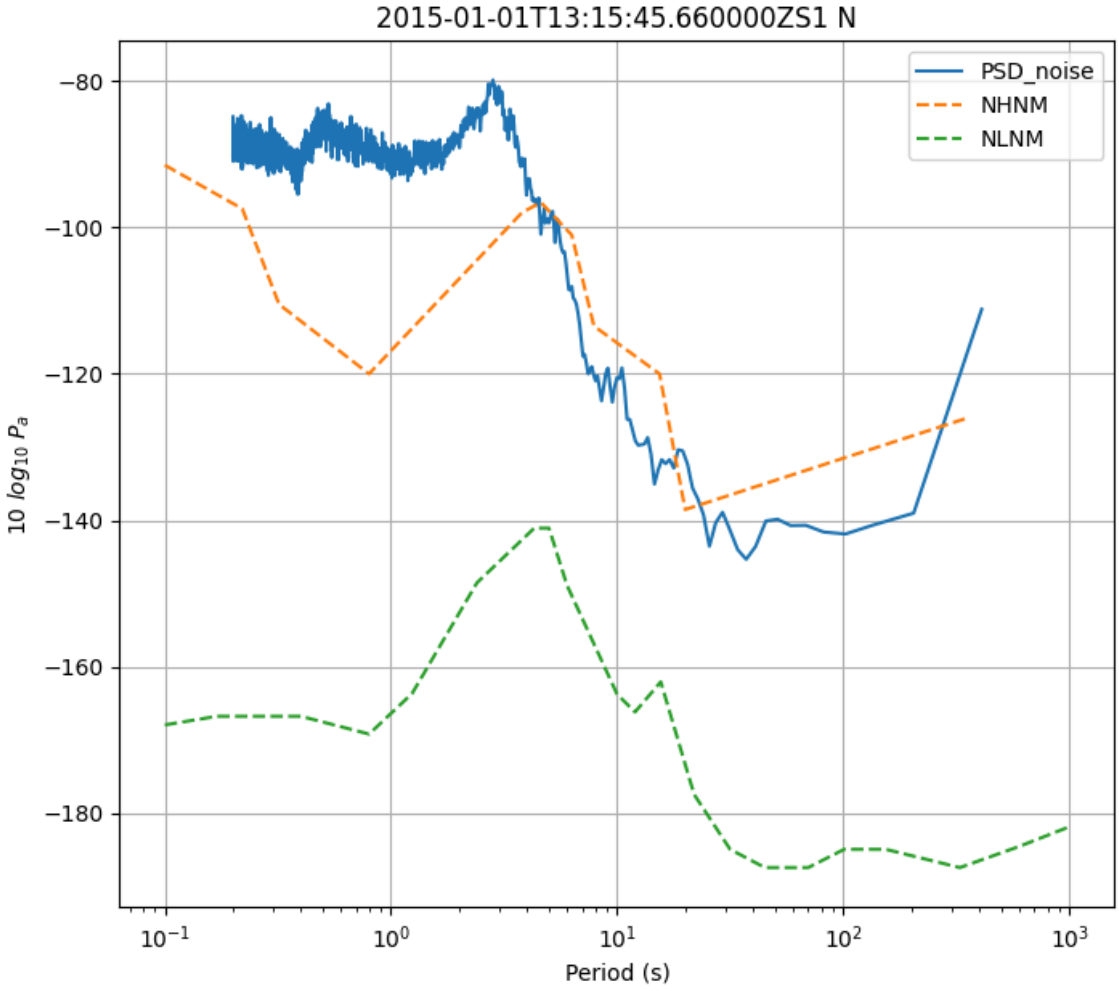
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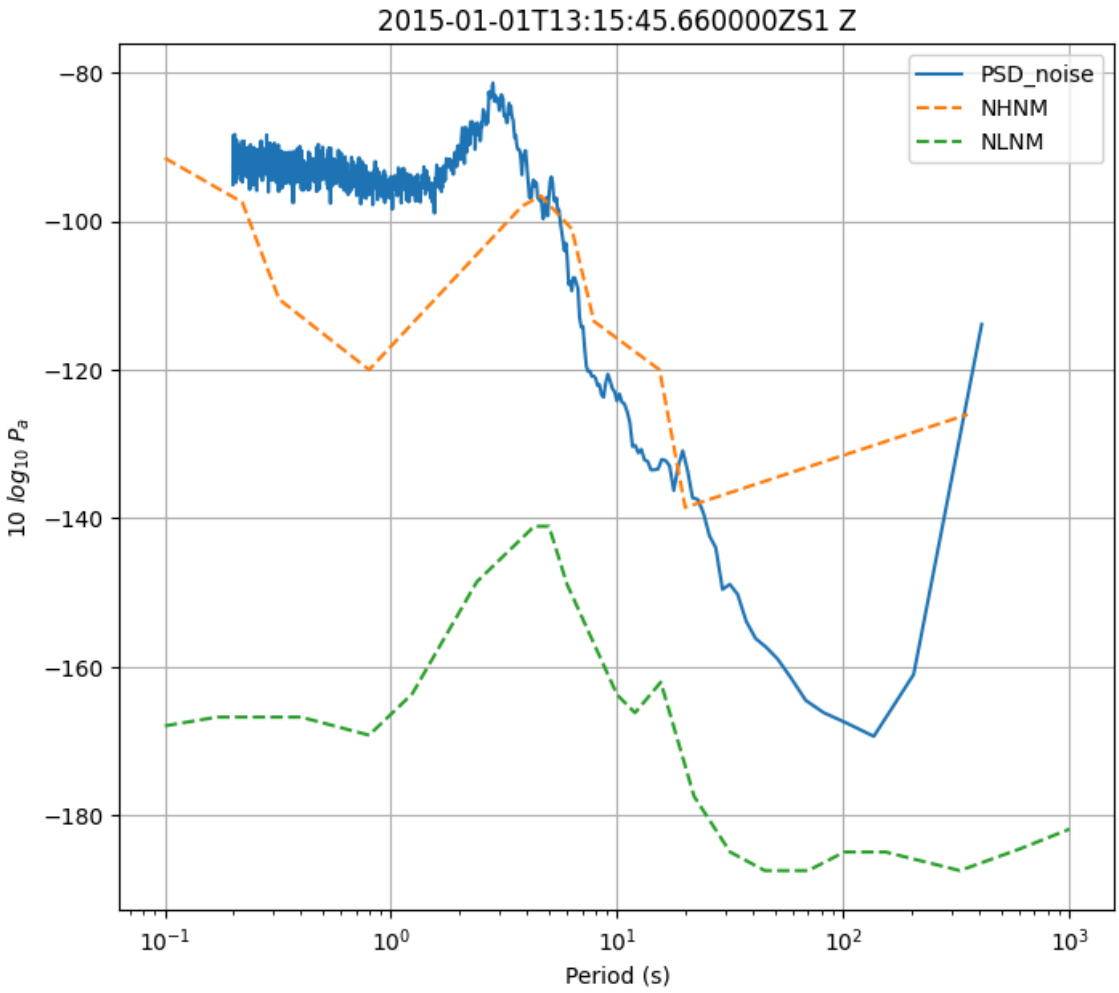
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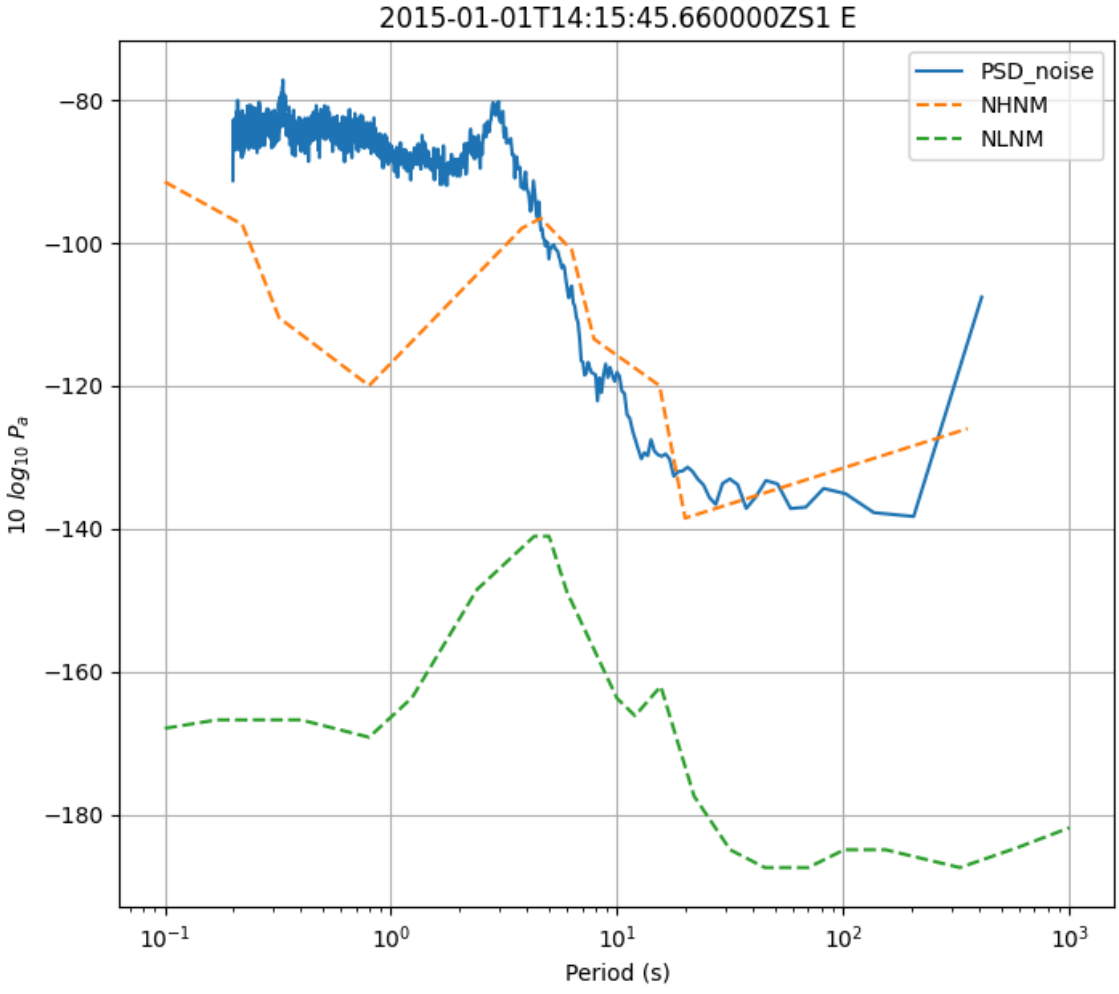
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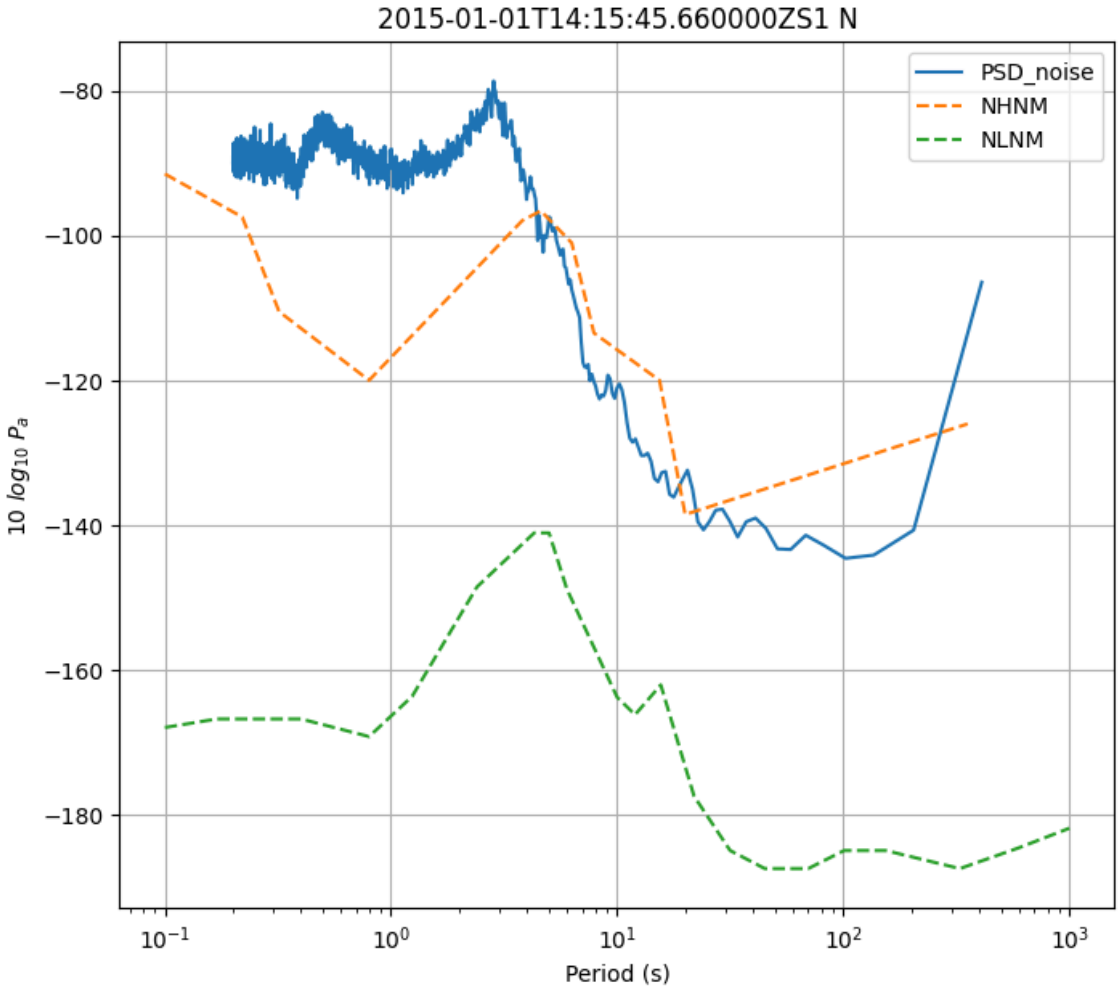
Period (s)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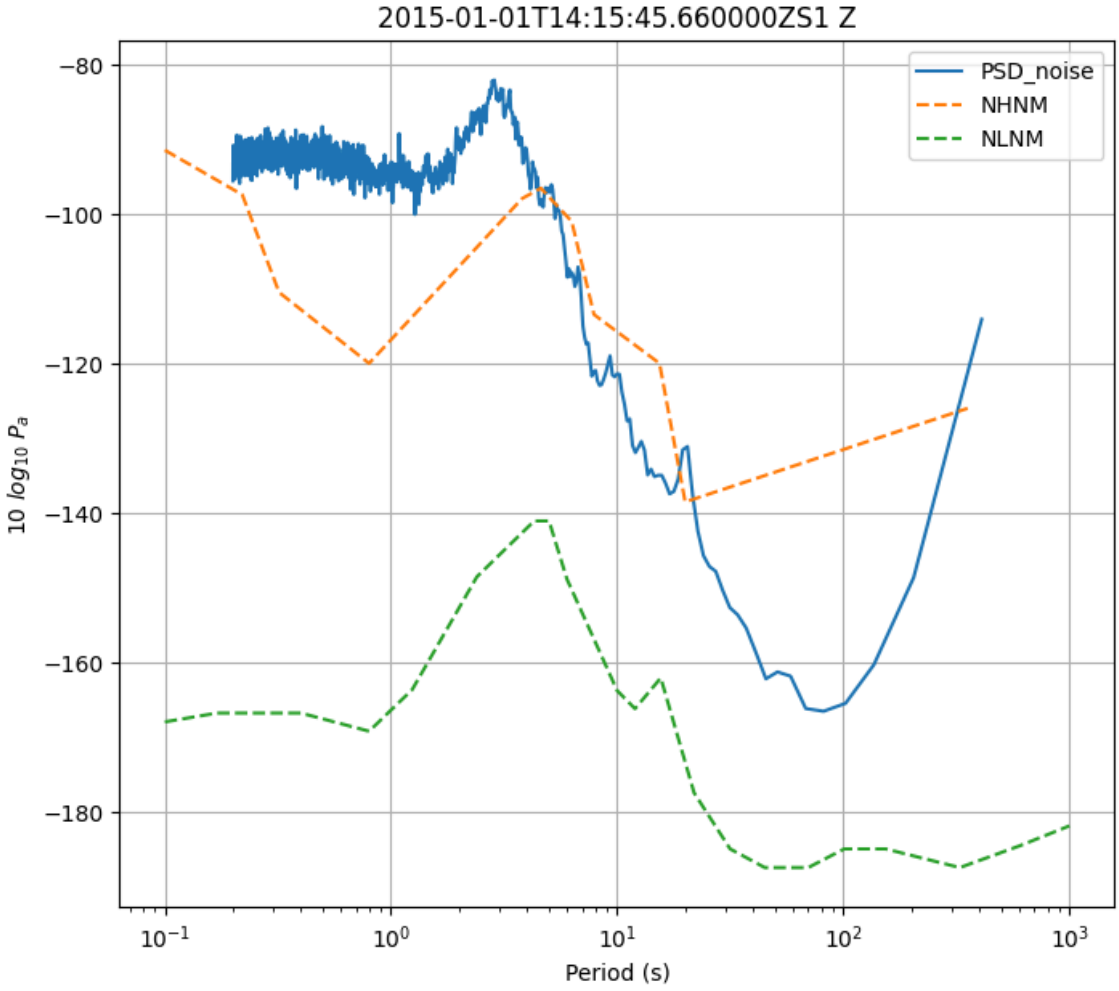
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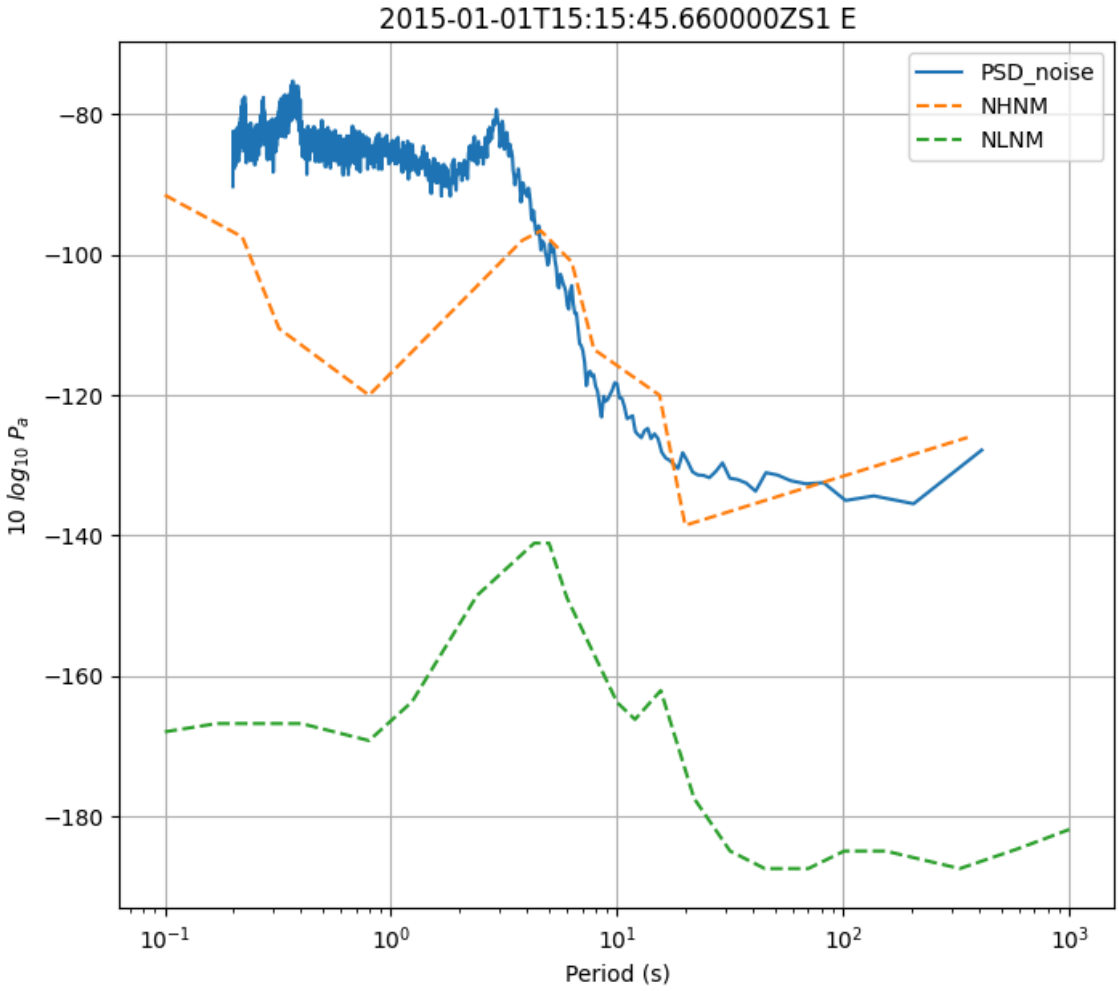
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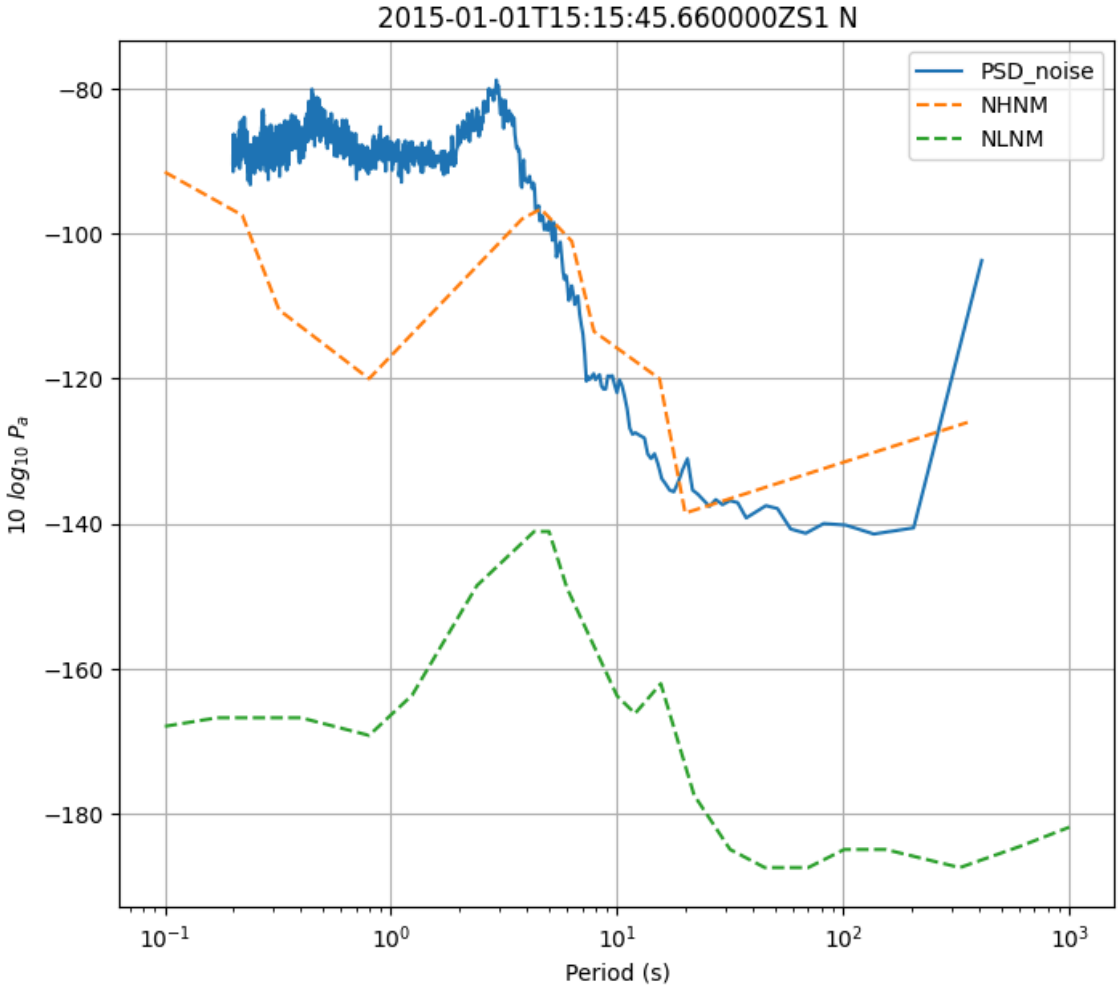
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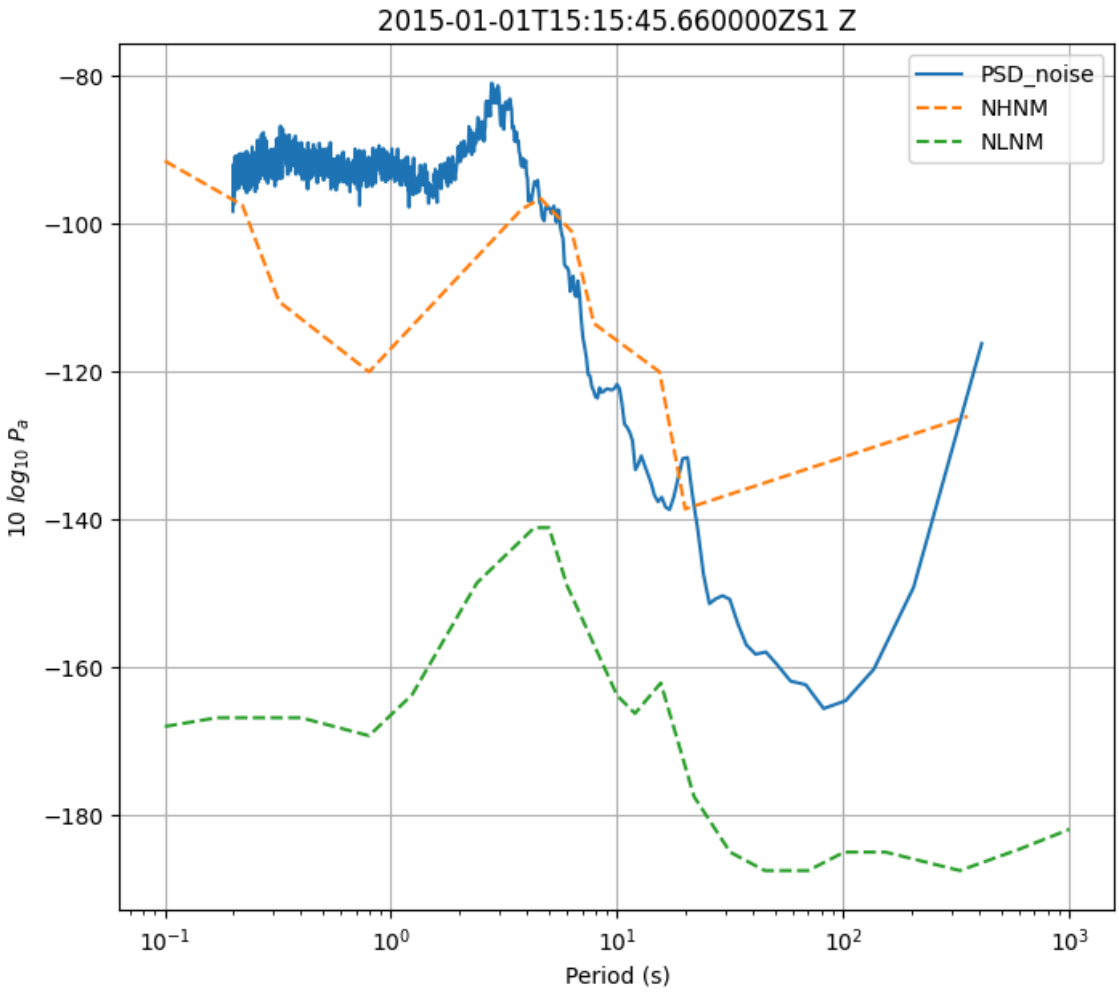
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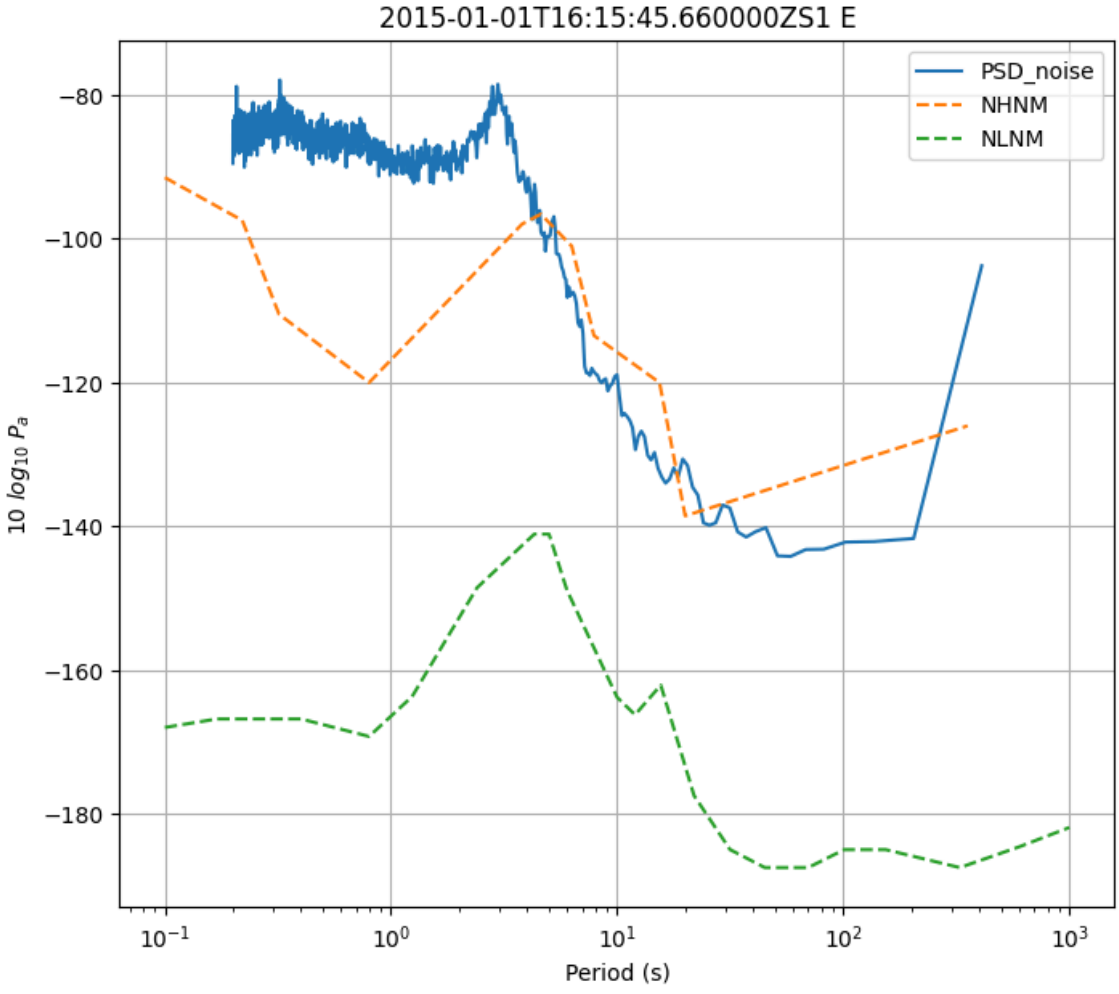
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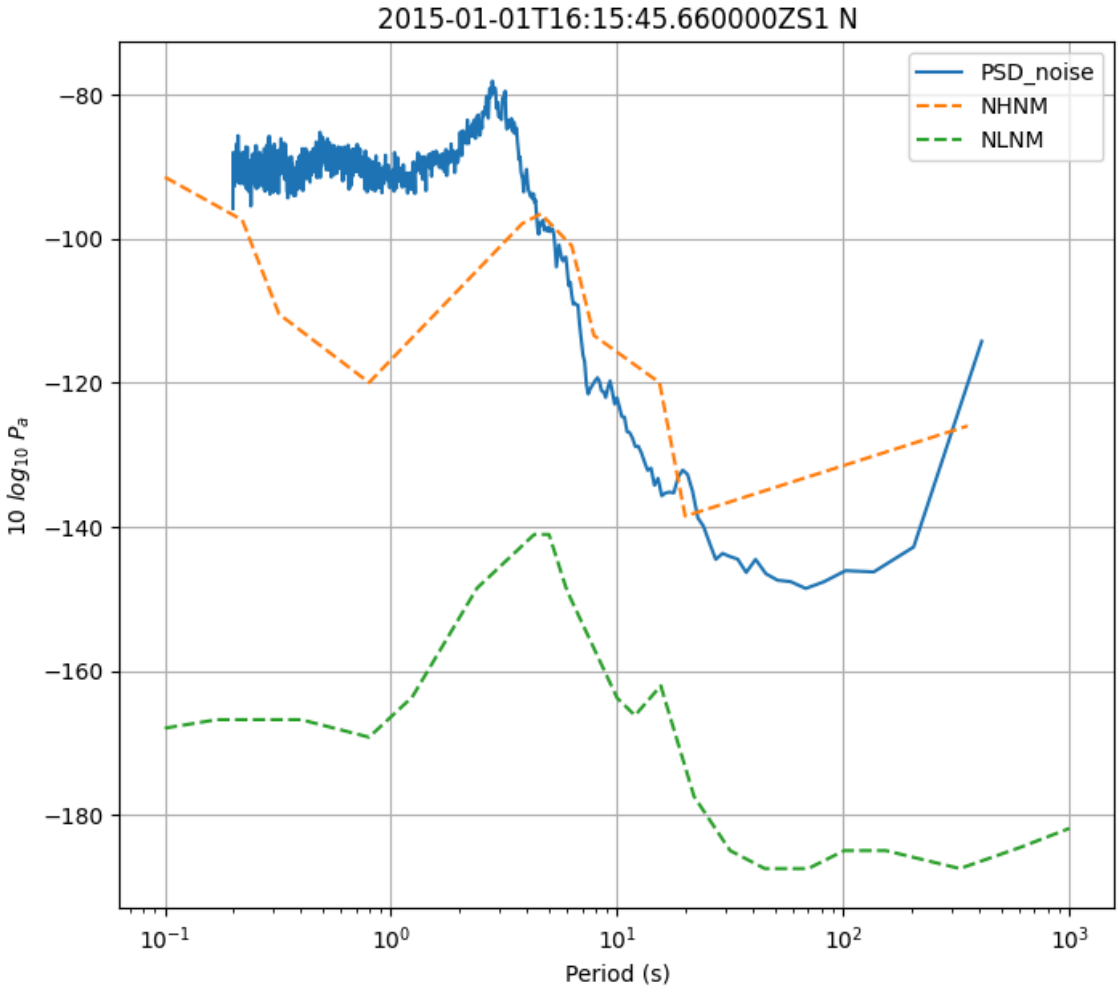
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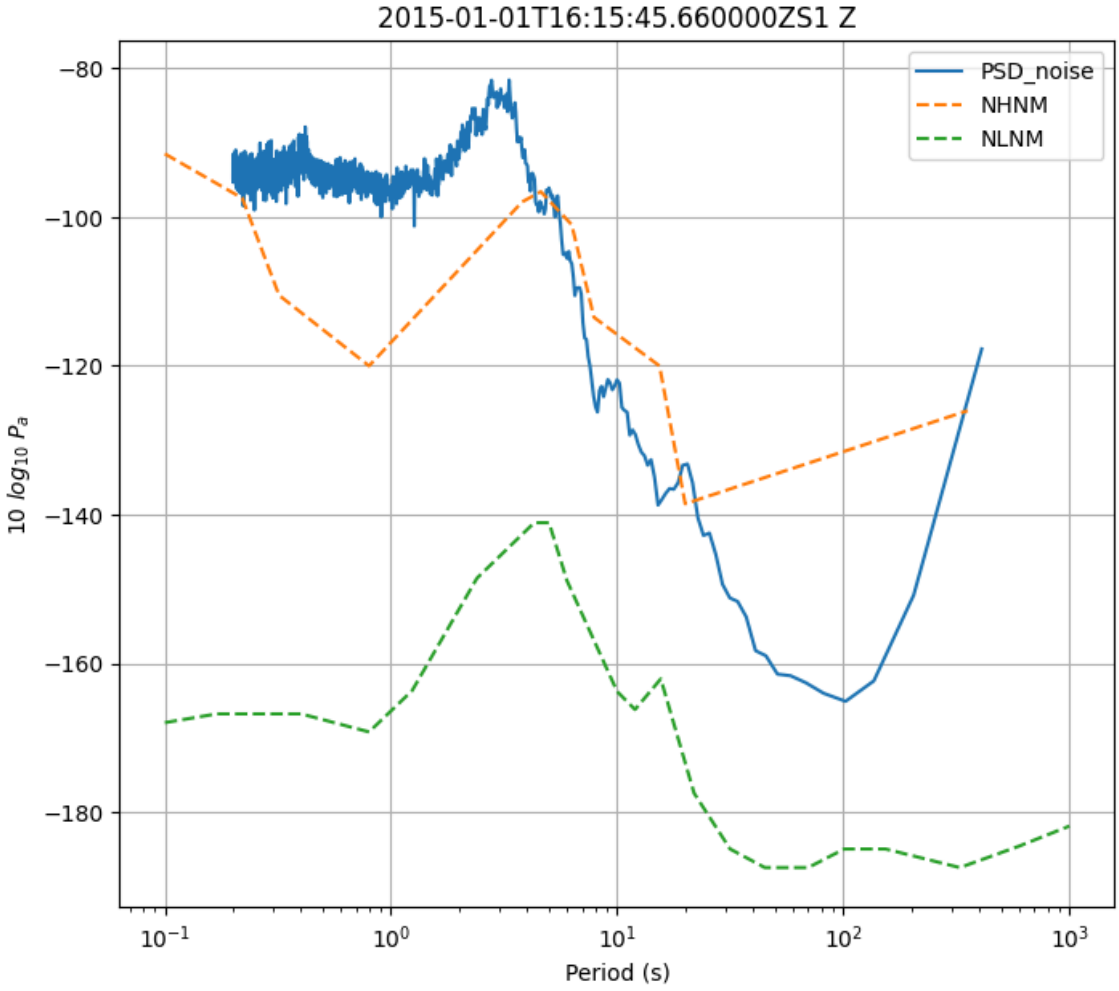
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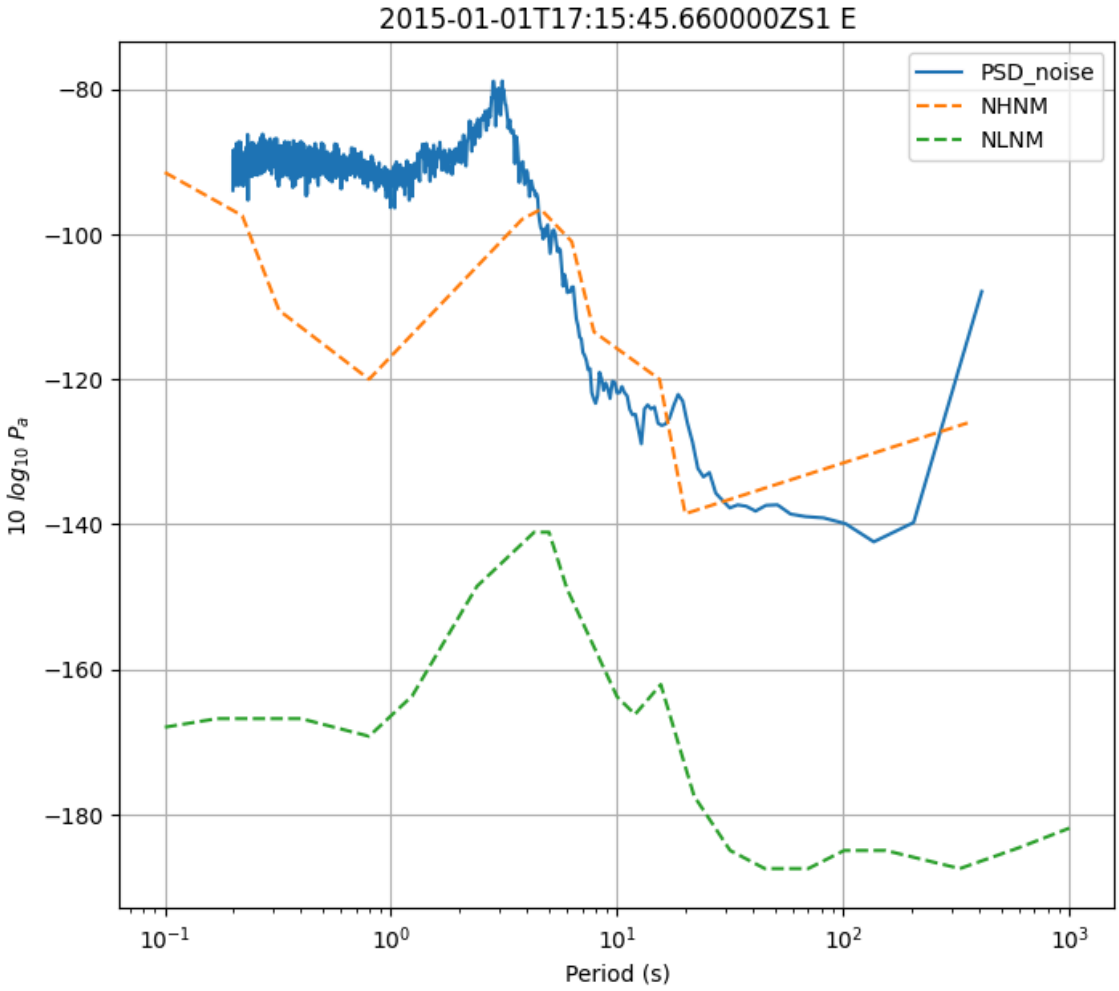
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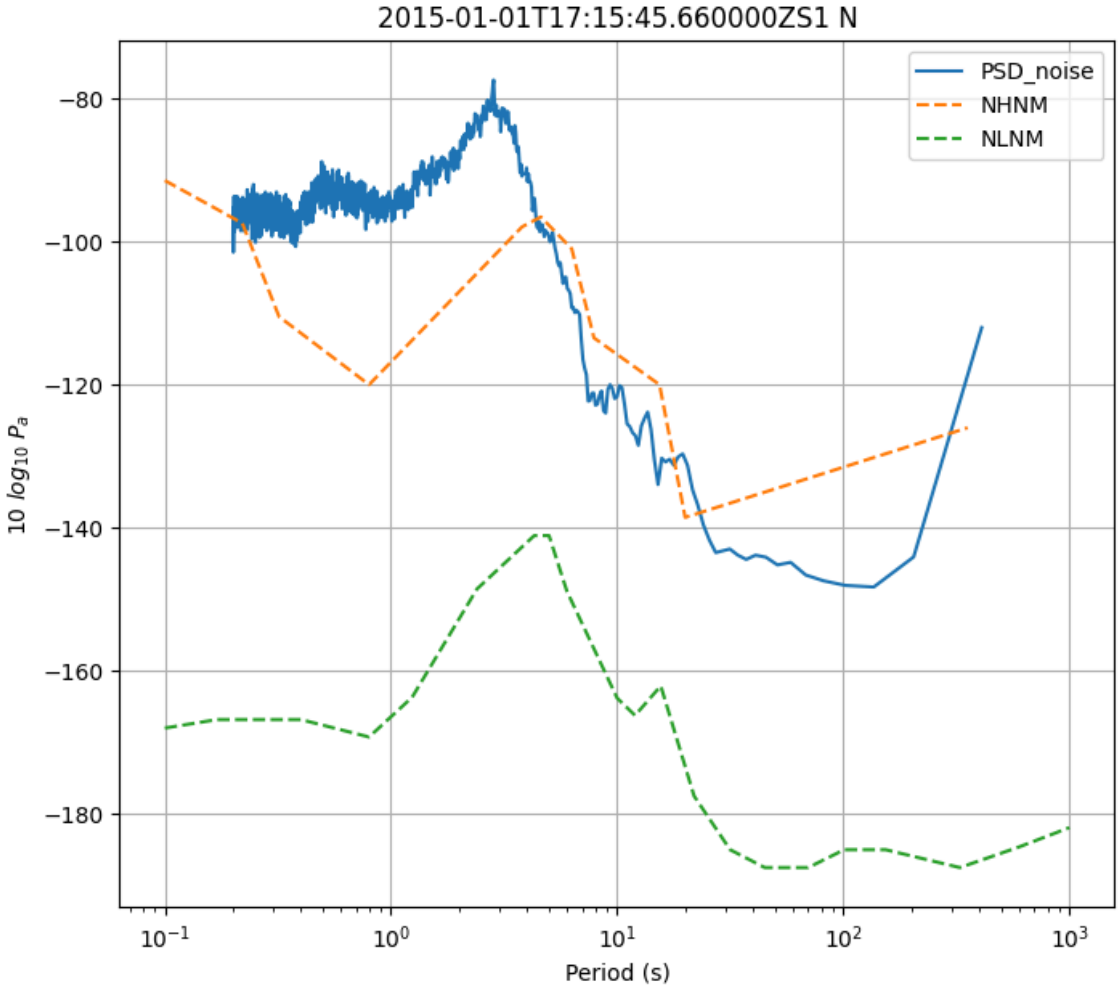
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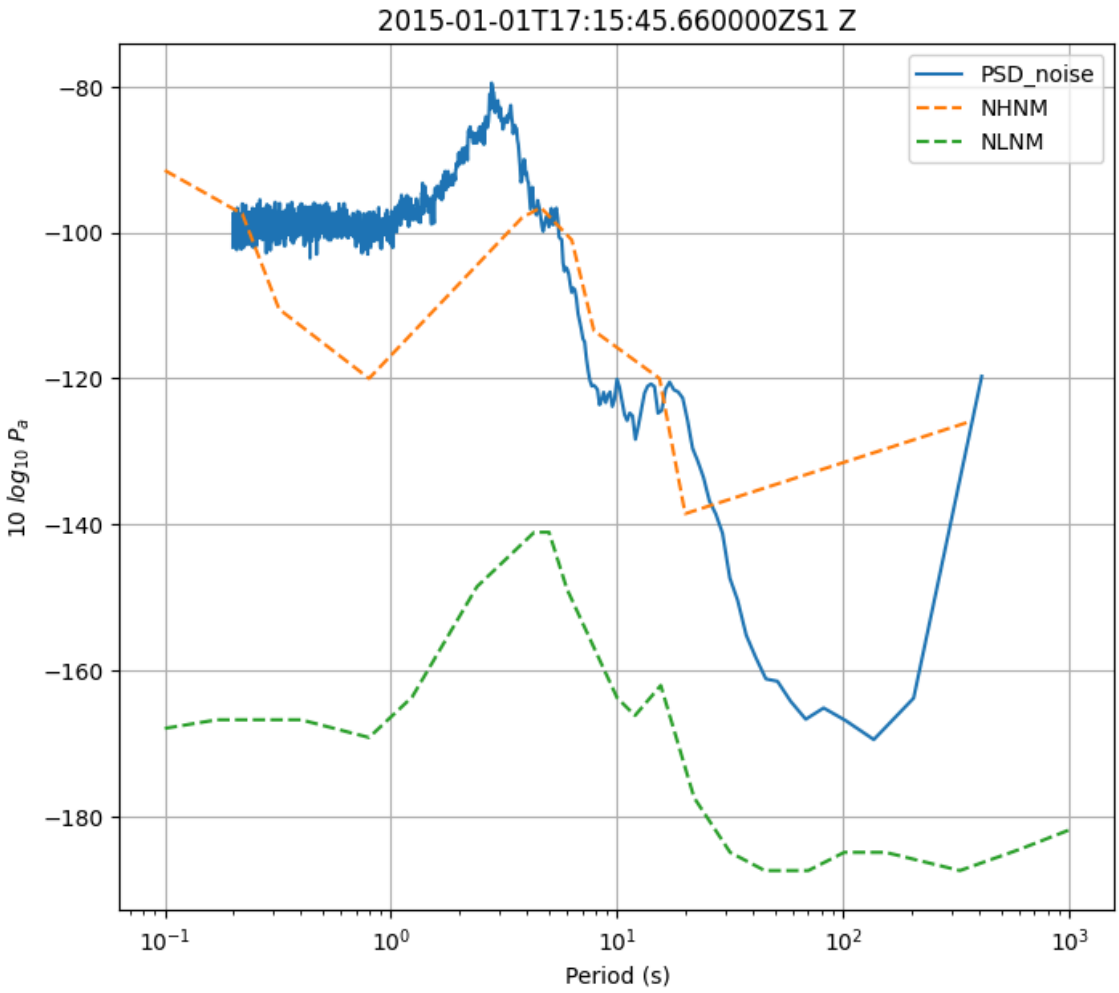
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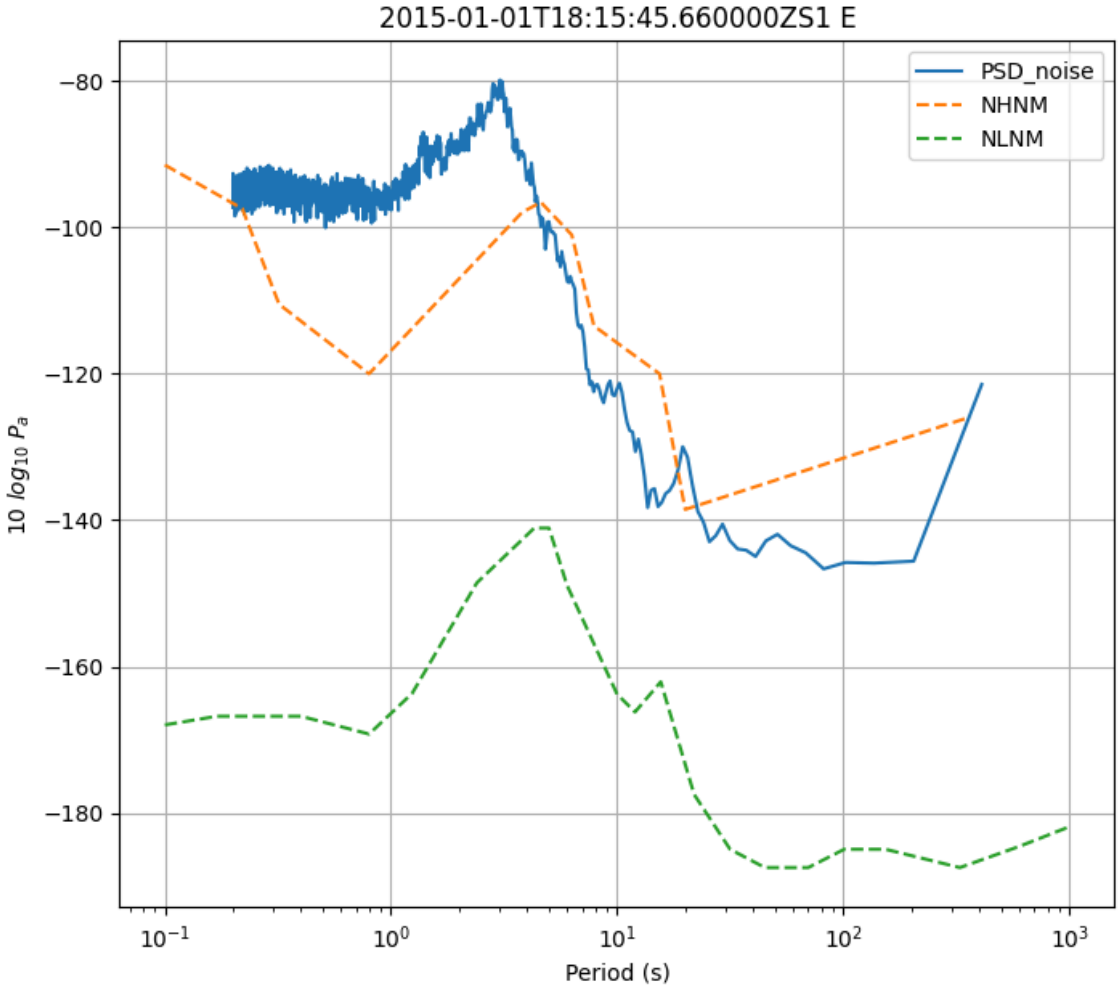
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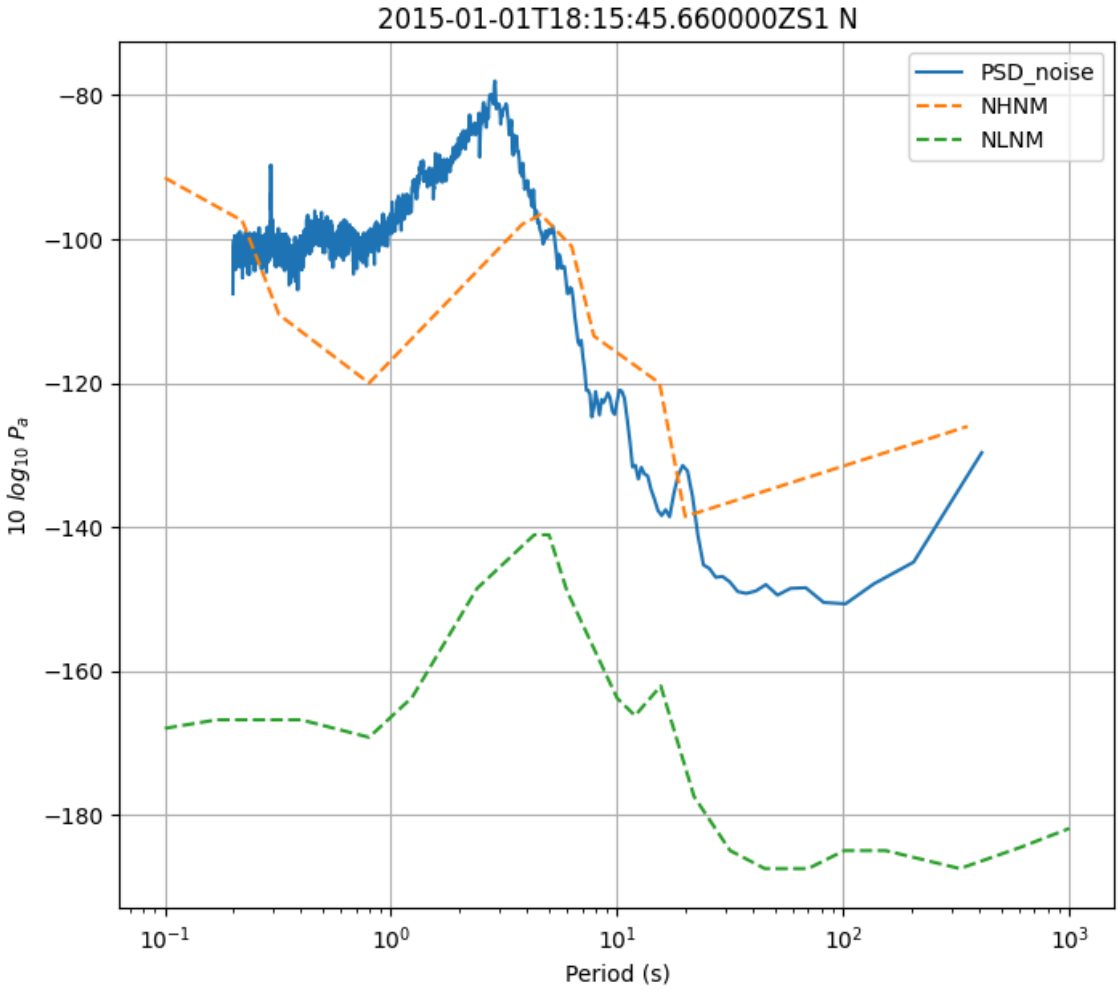
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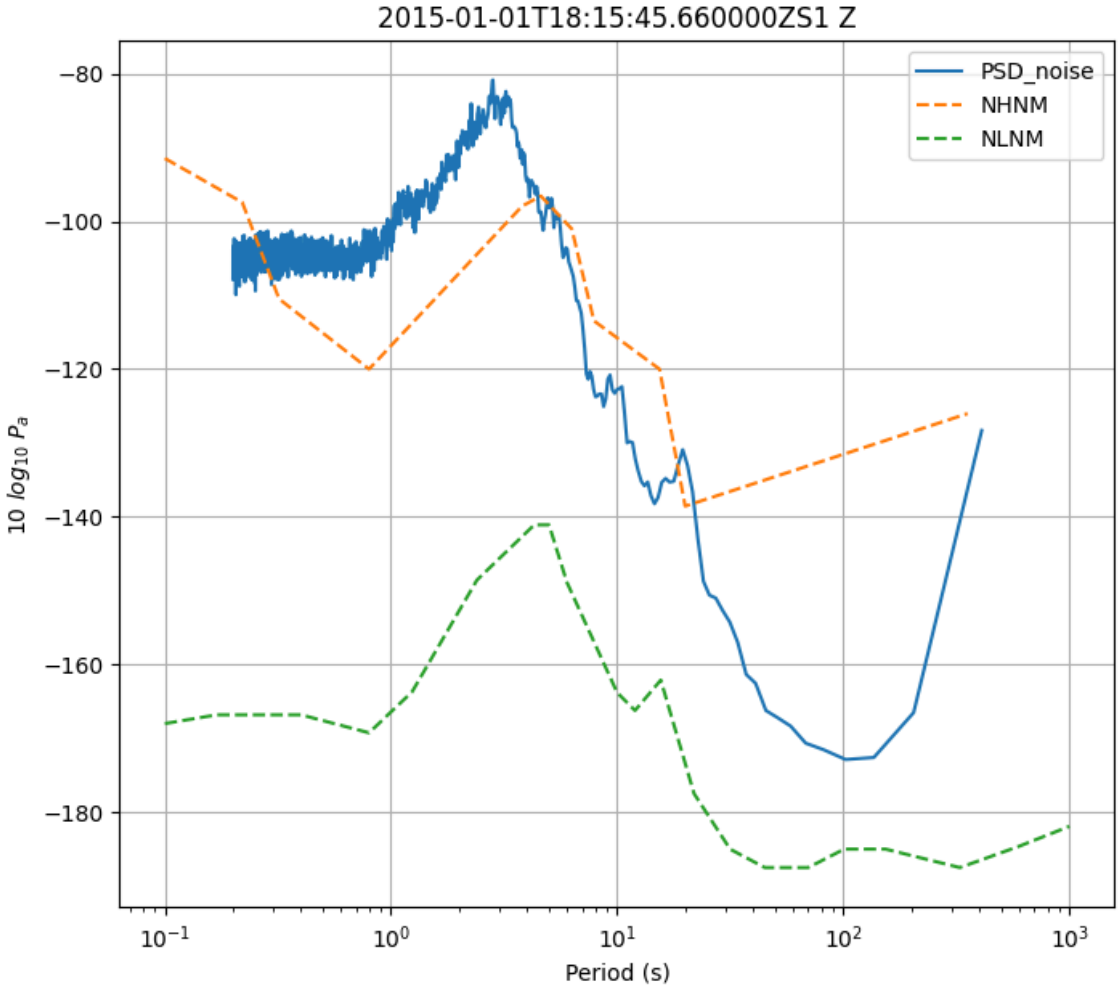
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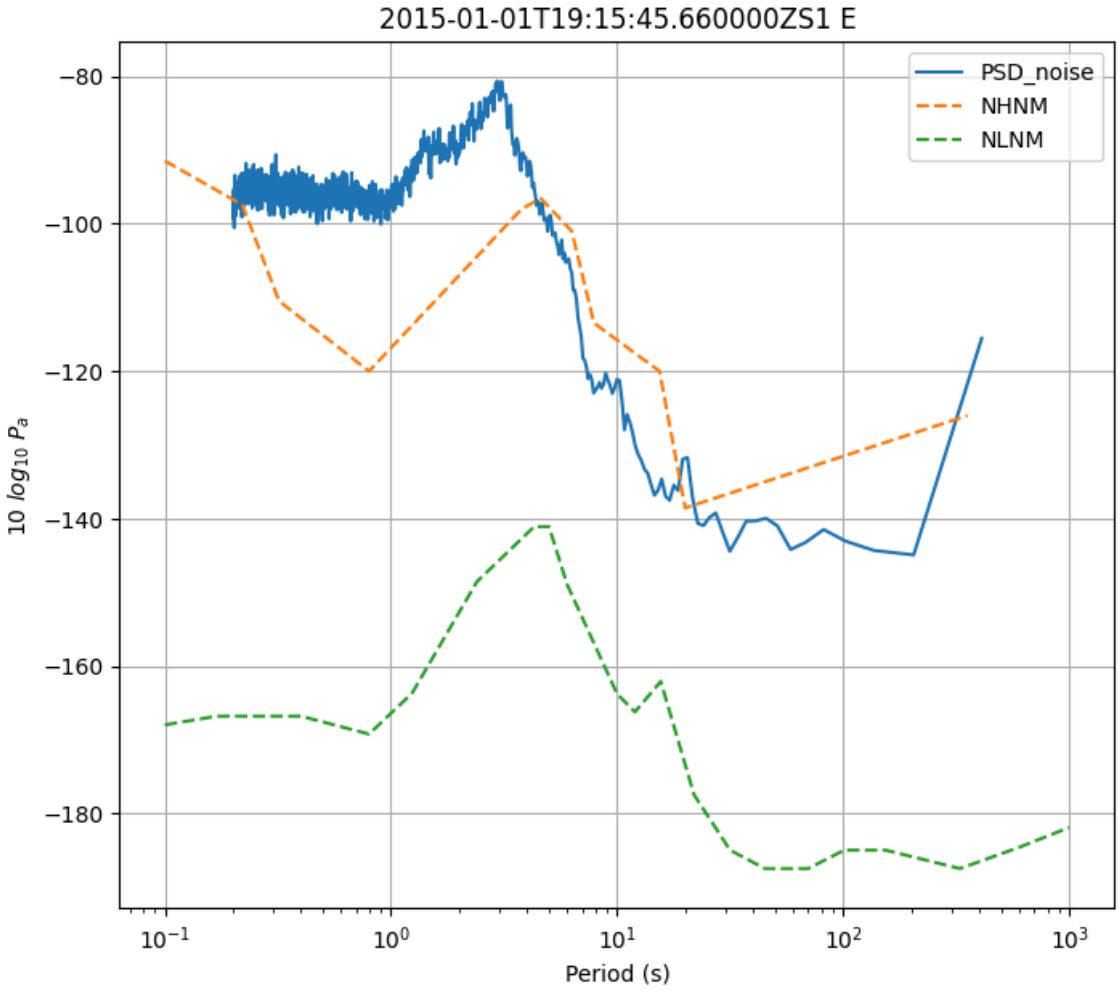
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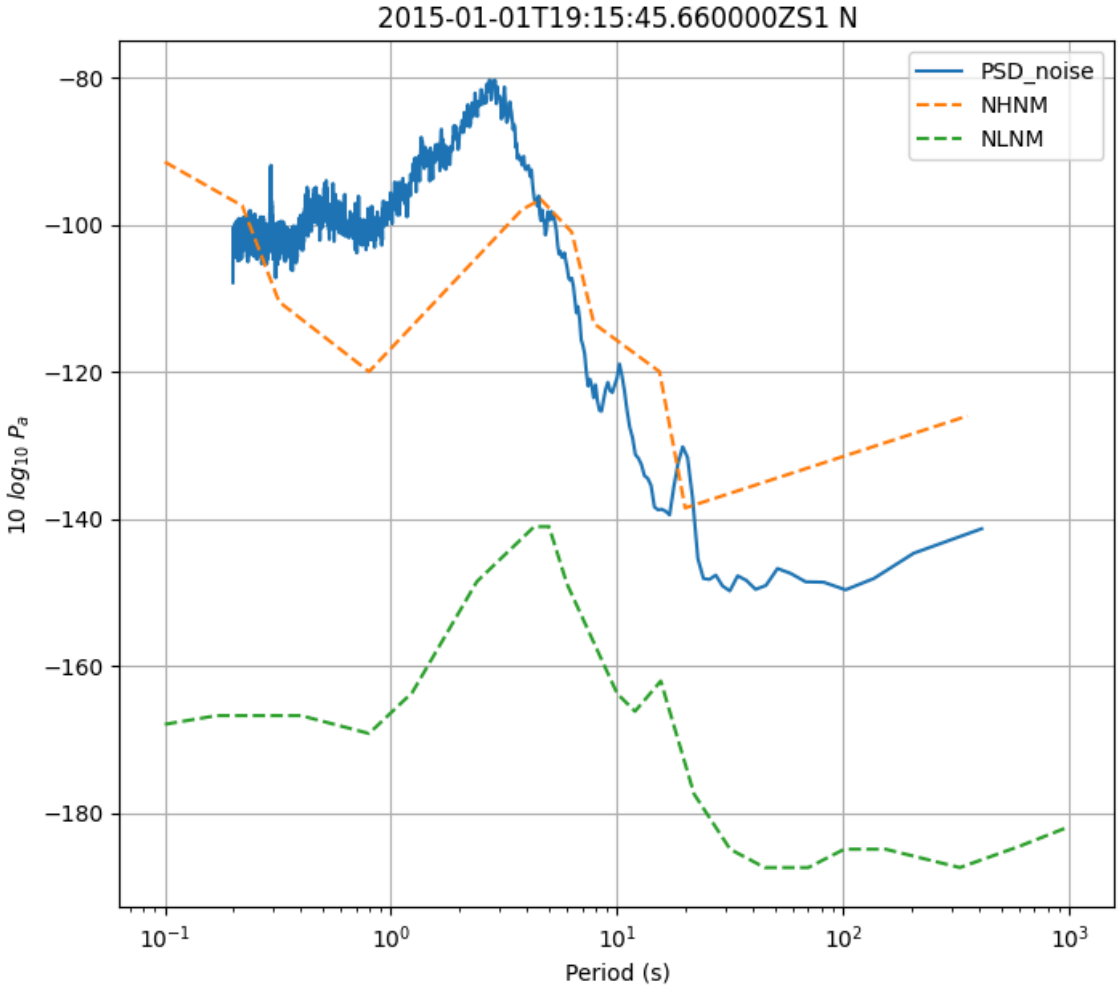
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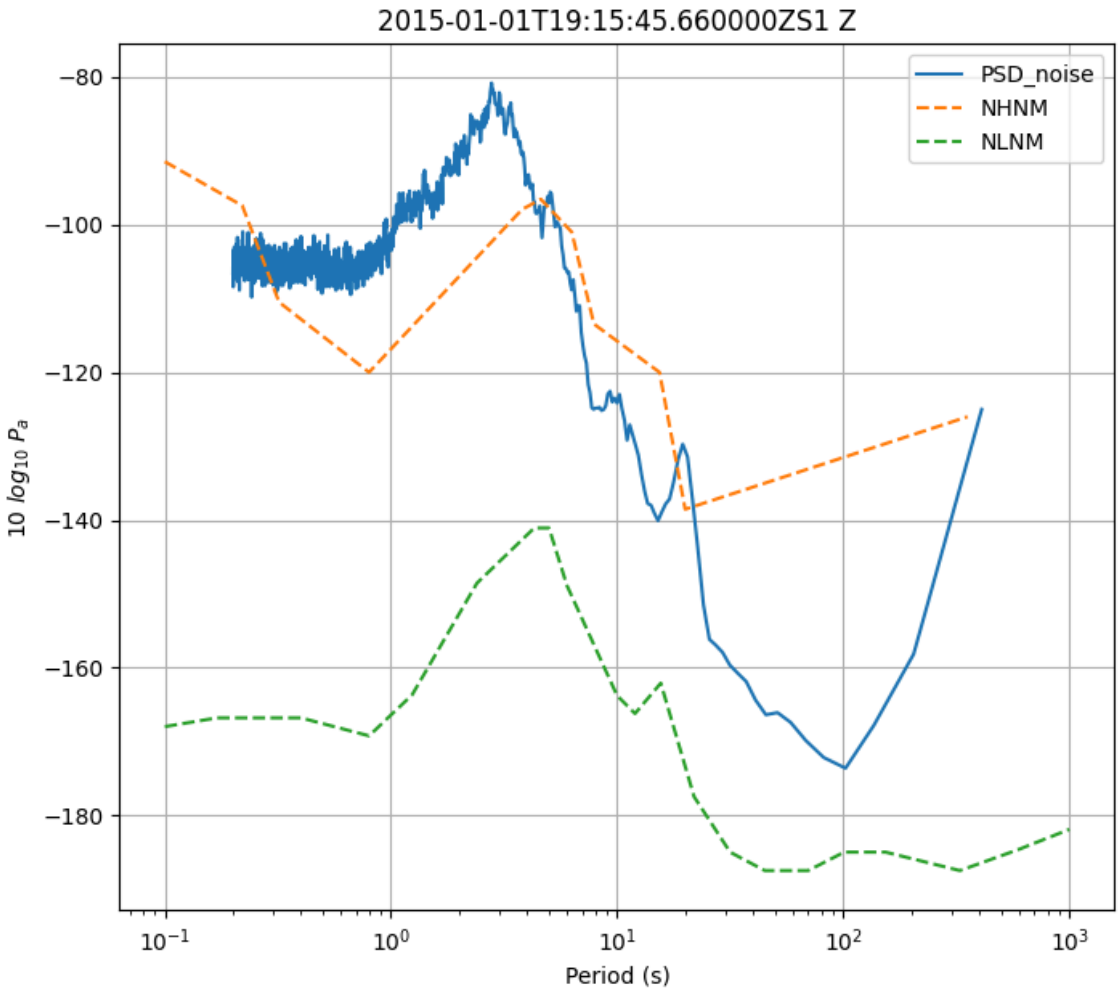
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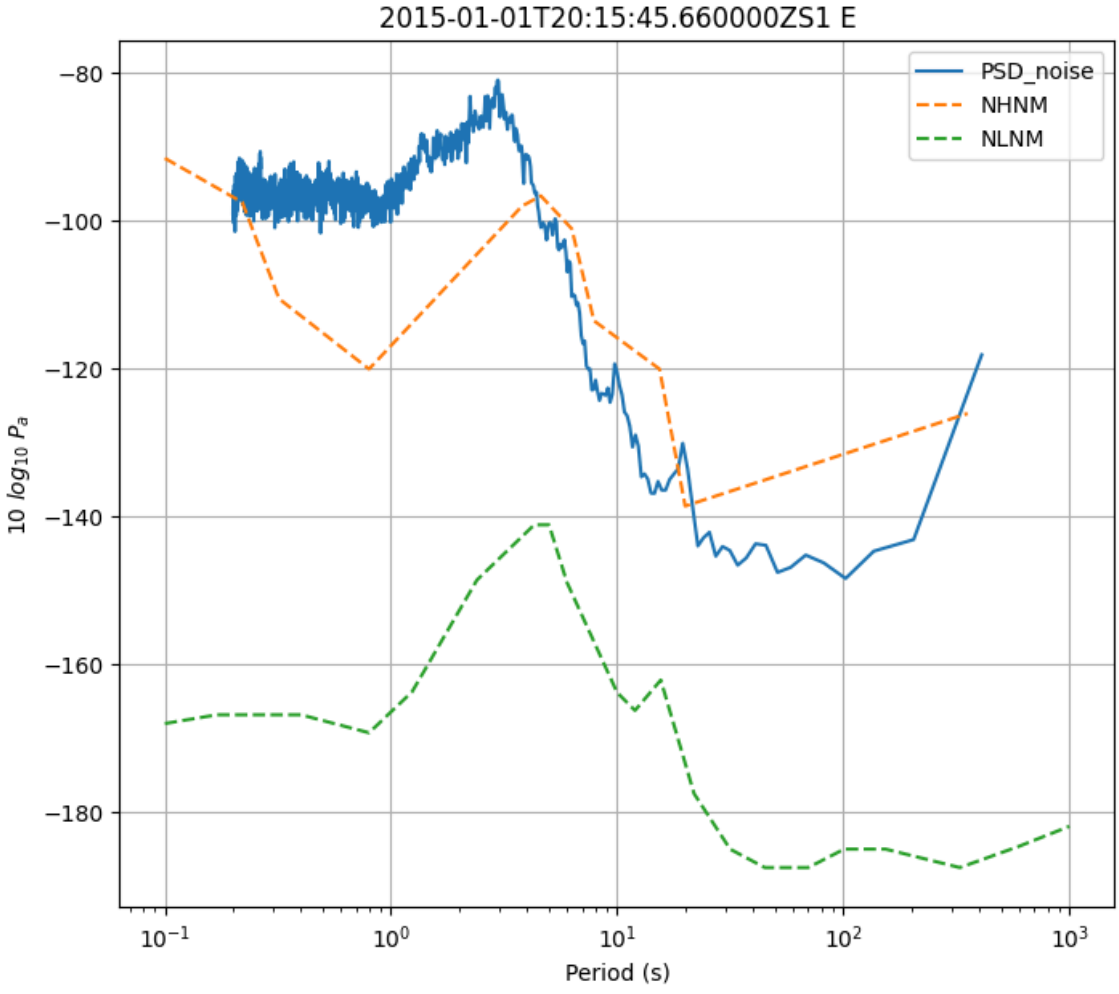
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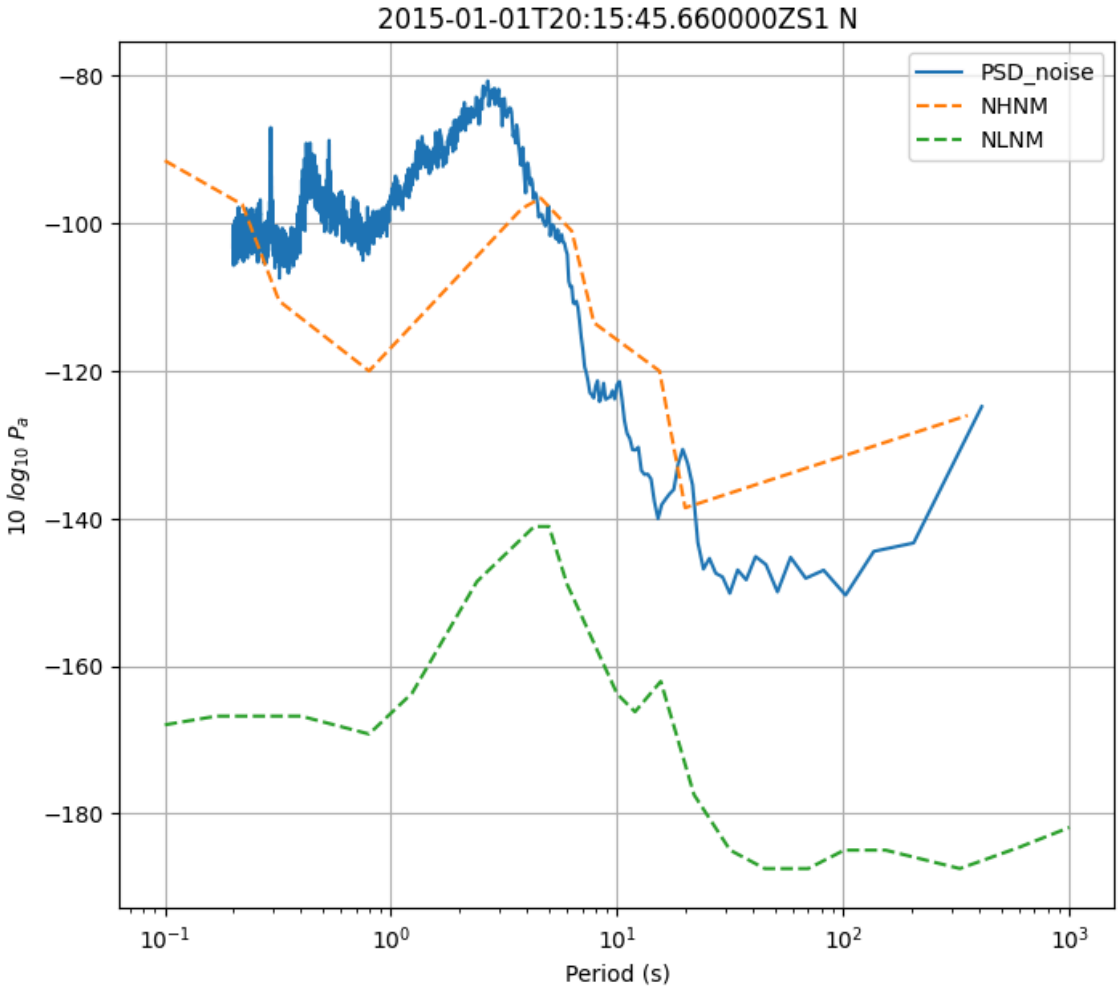
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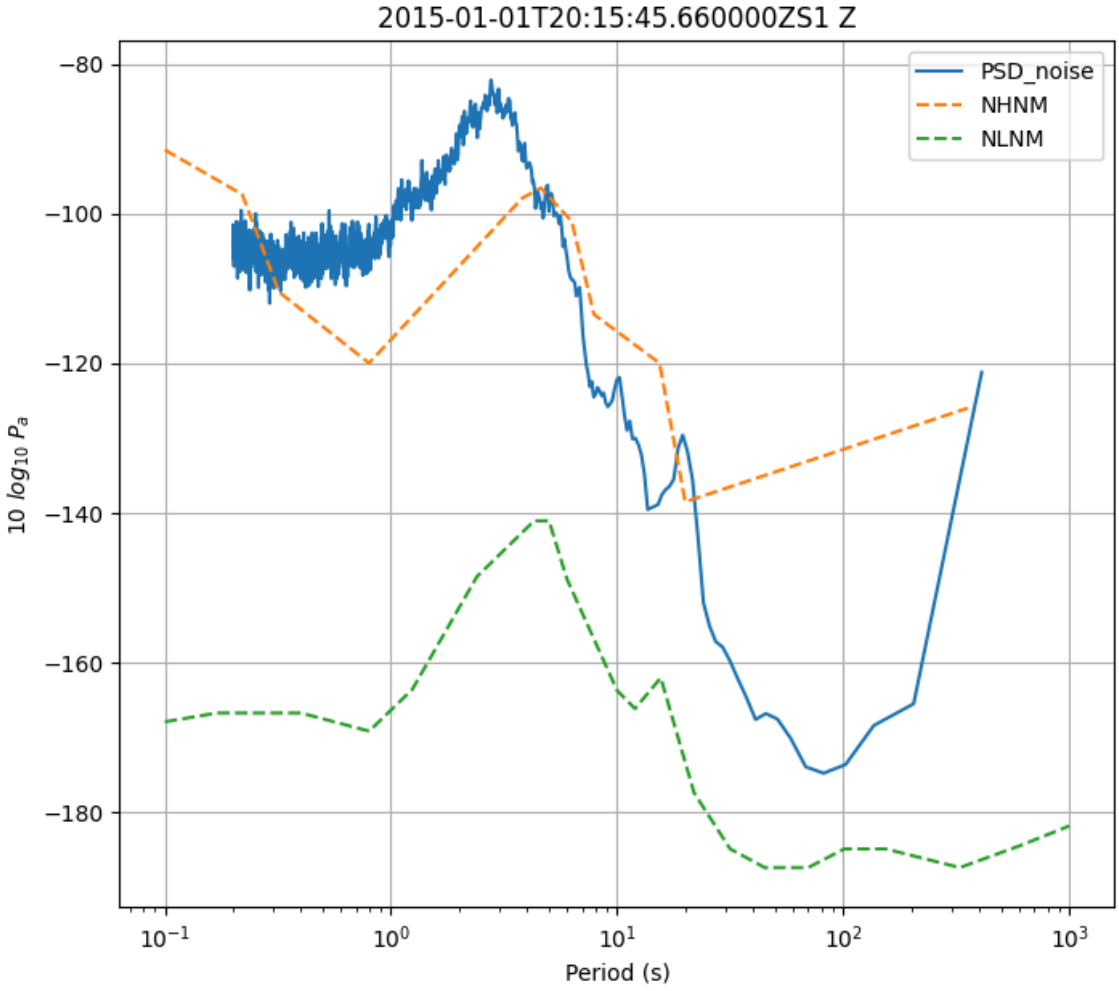
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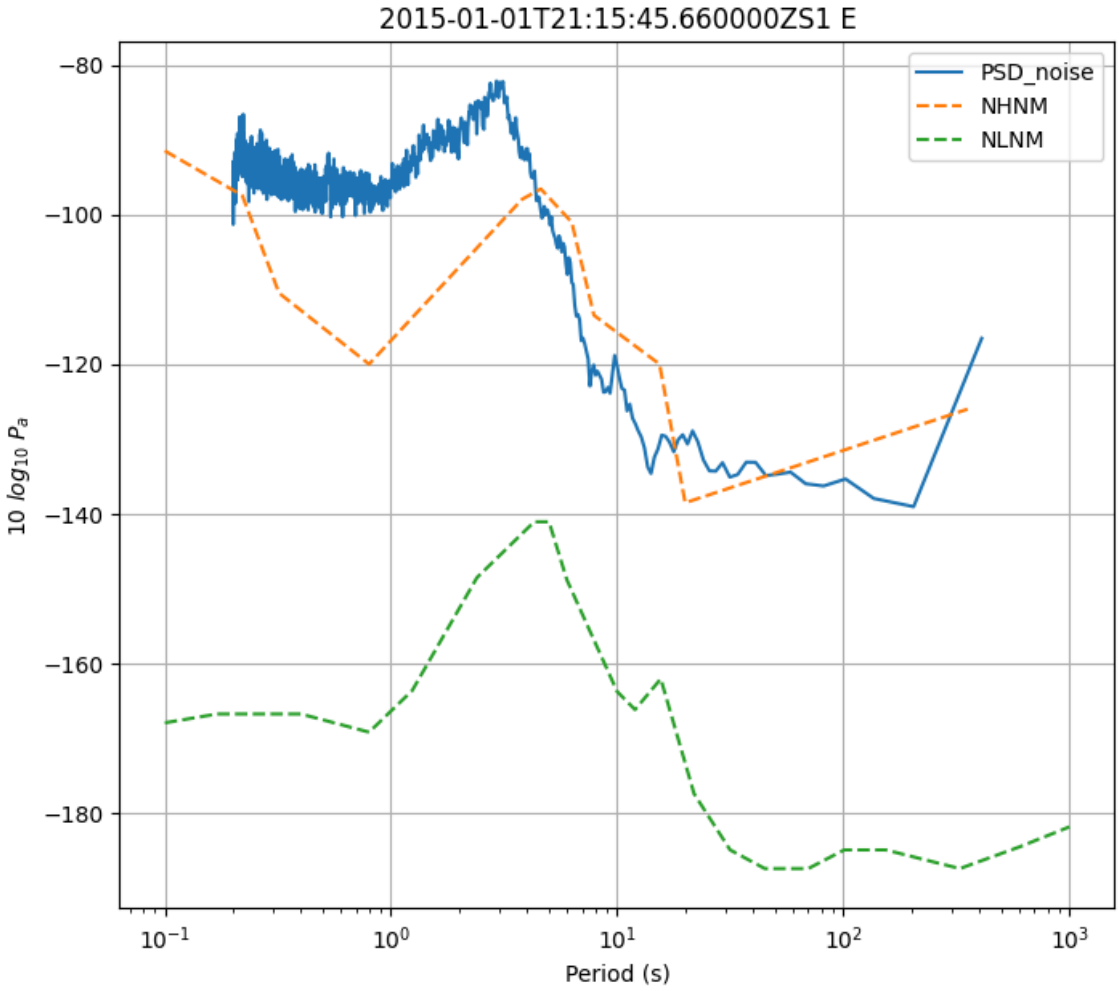
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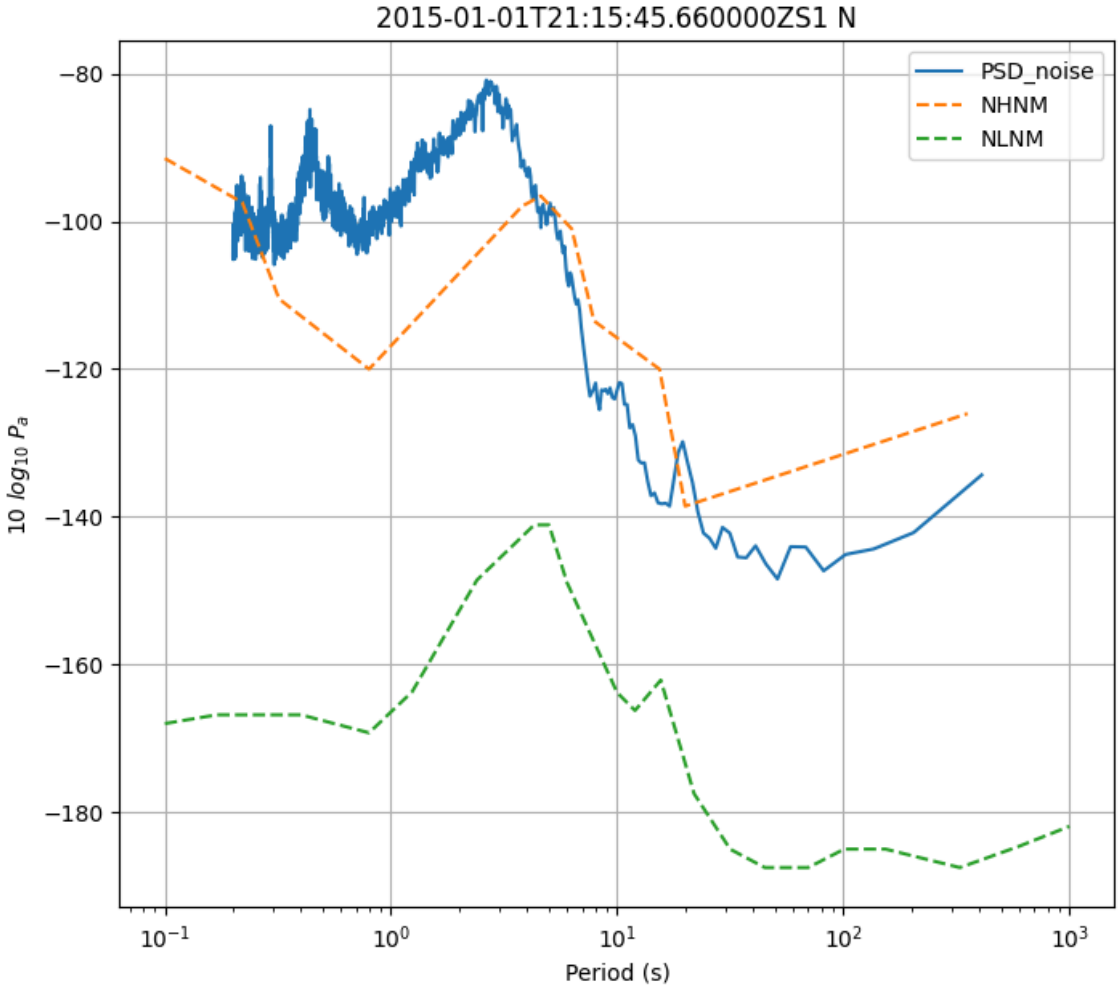
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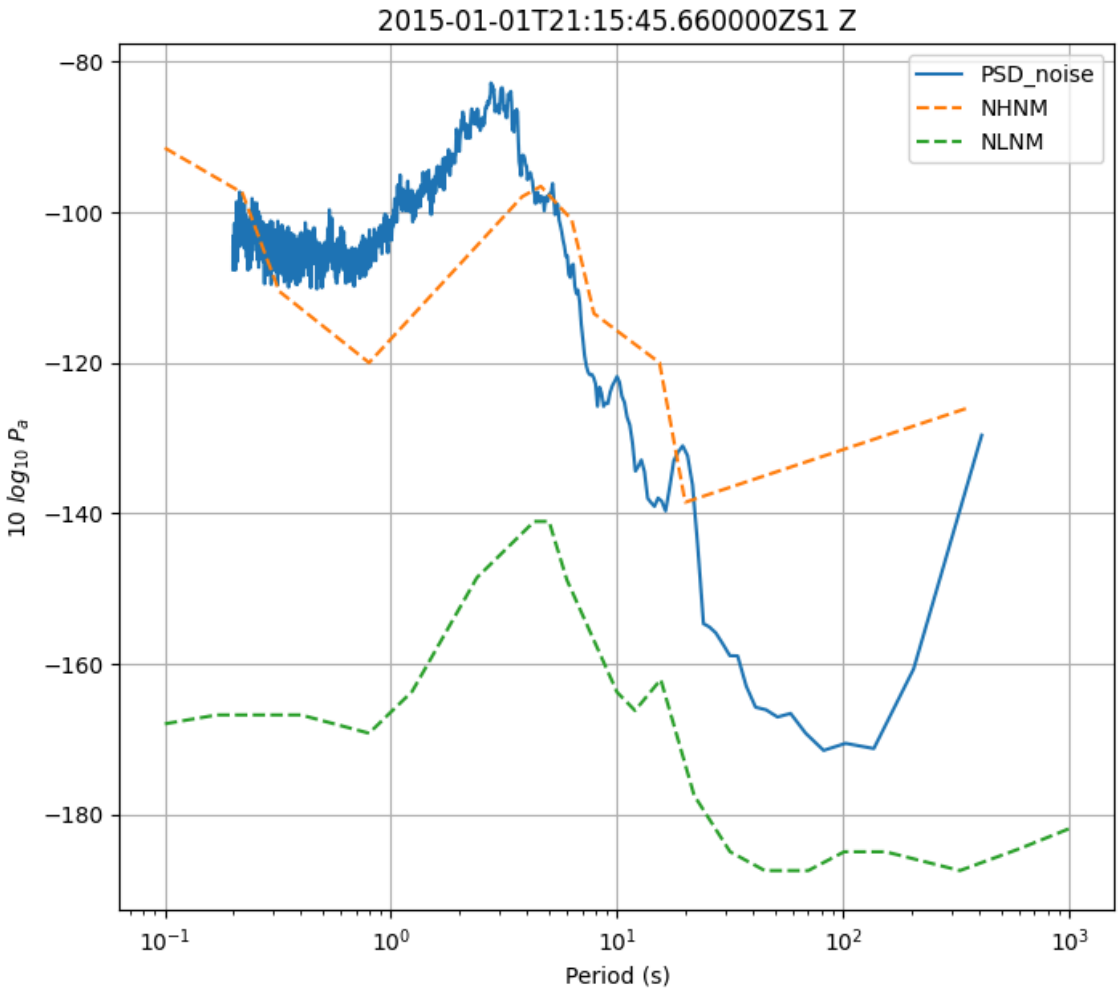
102
103
Period (s)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NLNM
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10 log10 Pa
10−1
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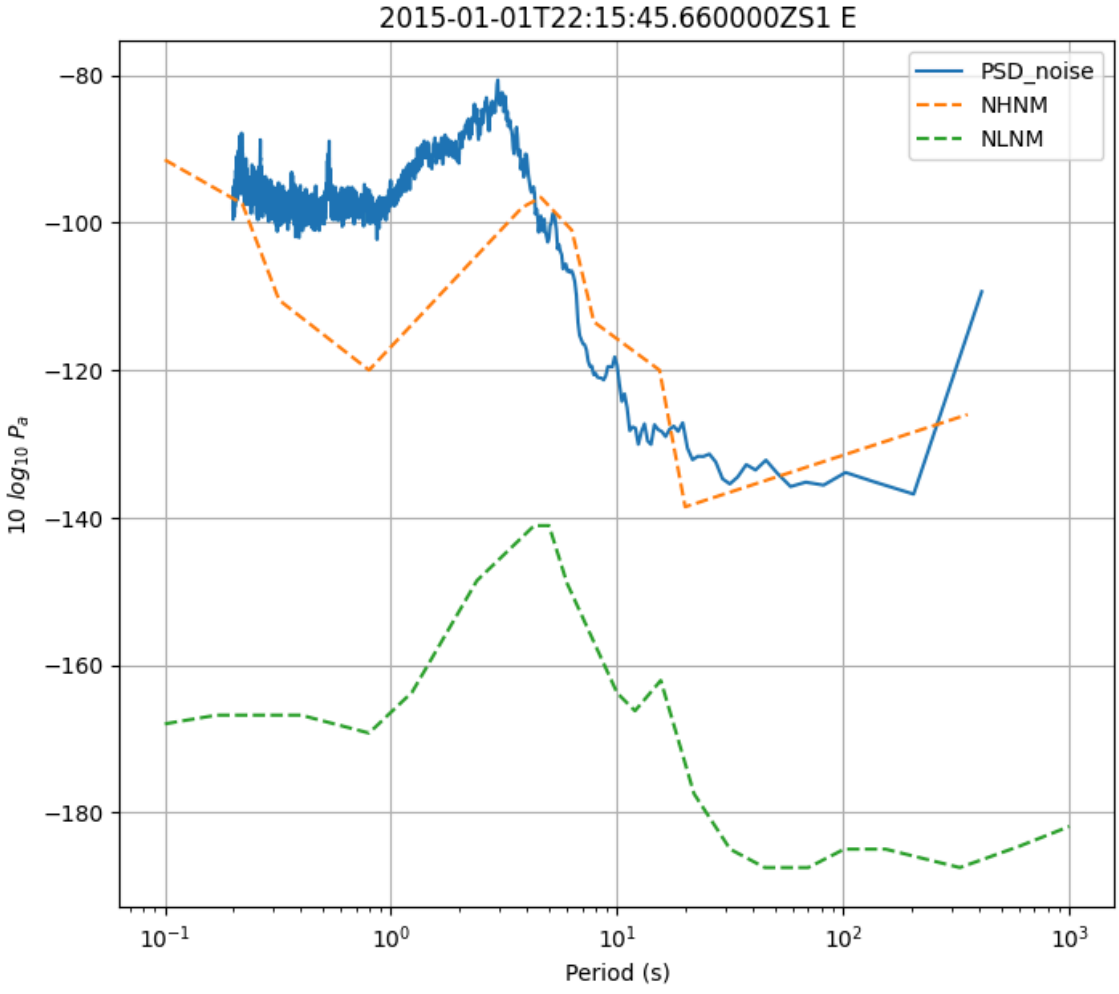
103
Period (s)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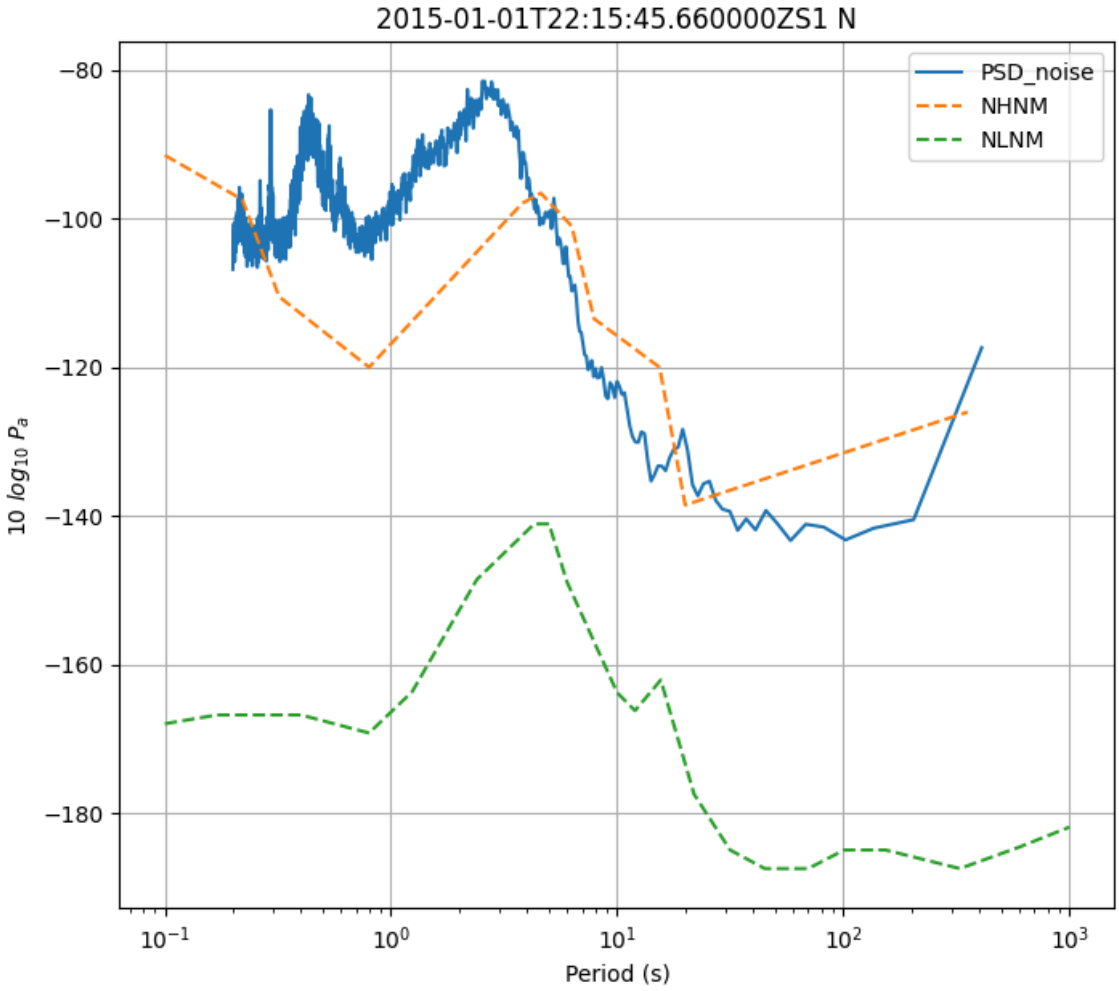
Period (s)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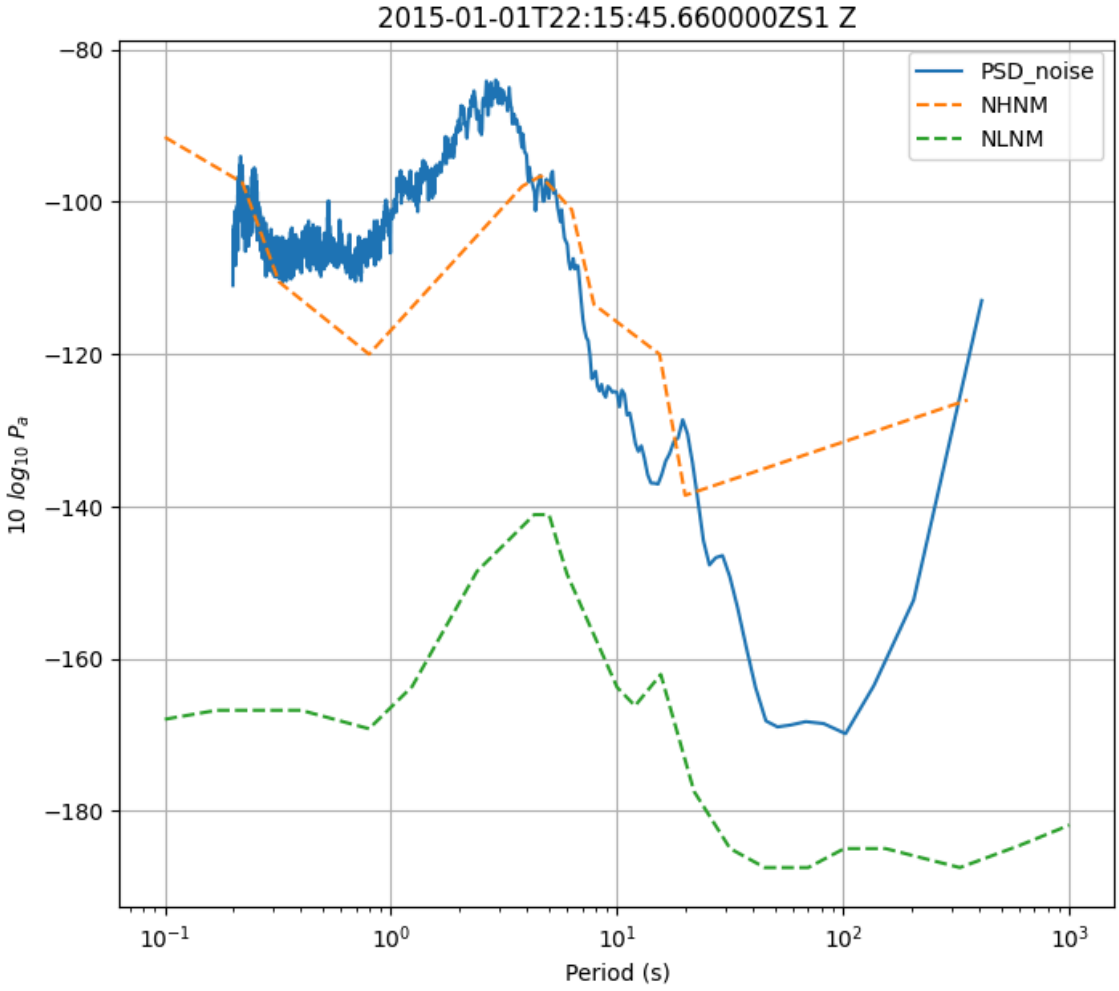
Period (s)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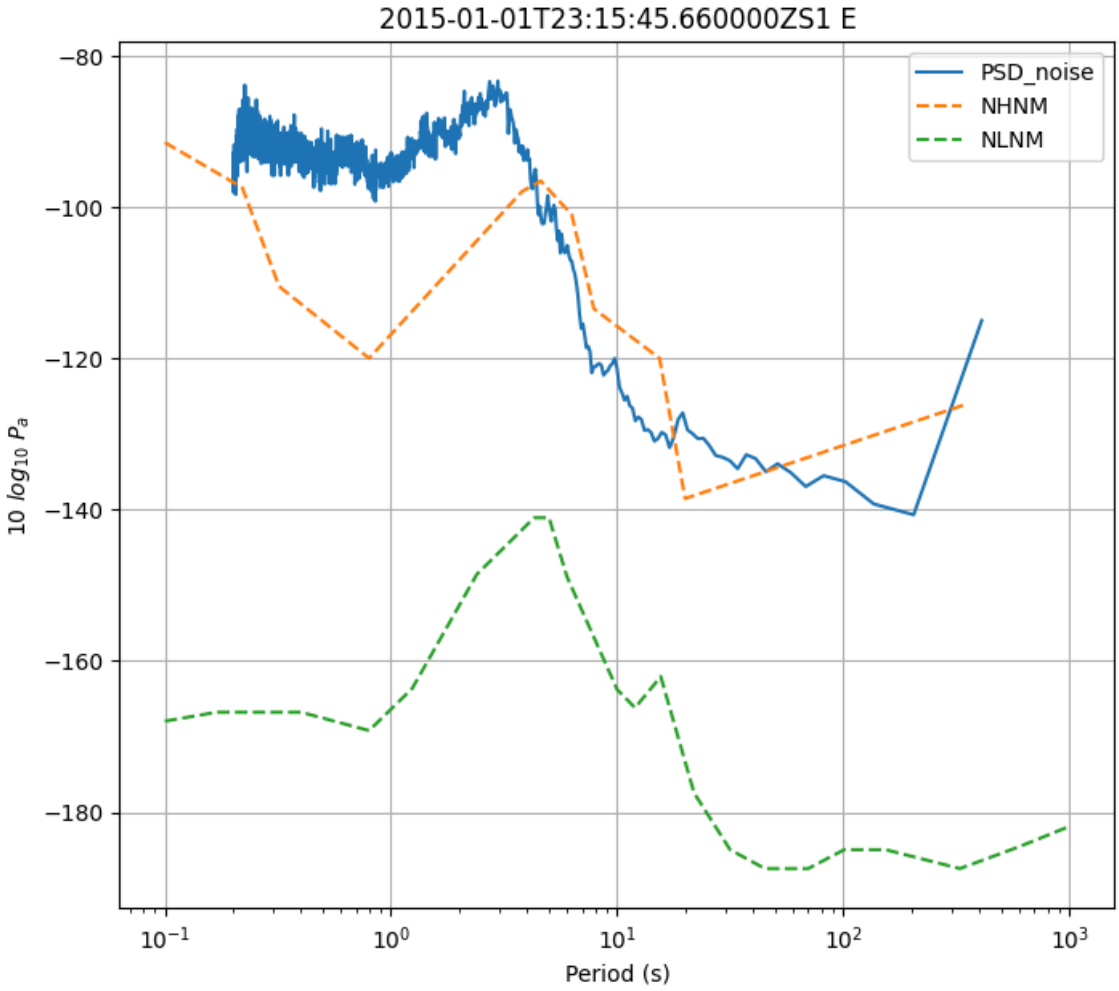
Period (s)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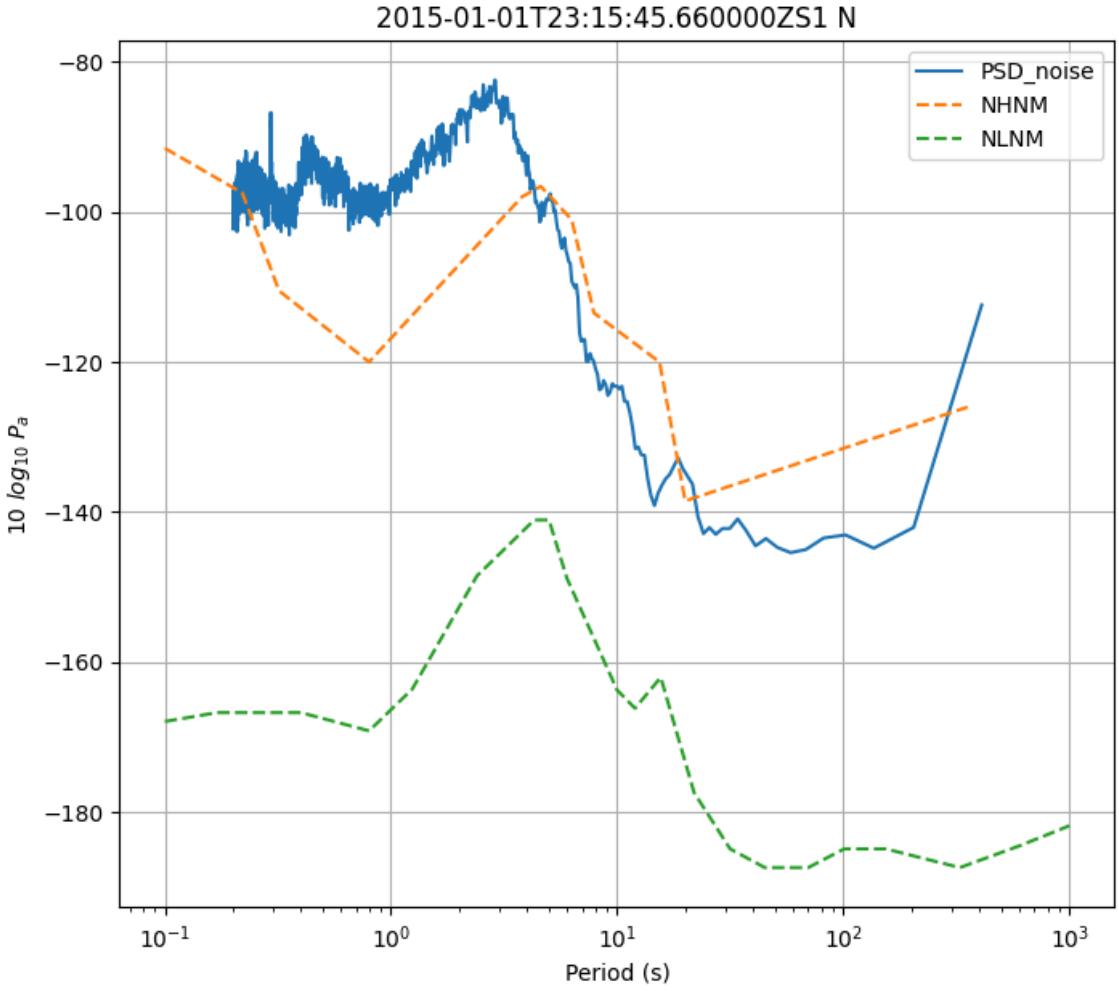
Period (s)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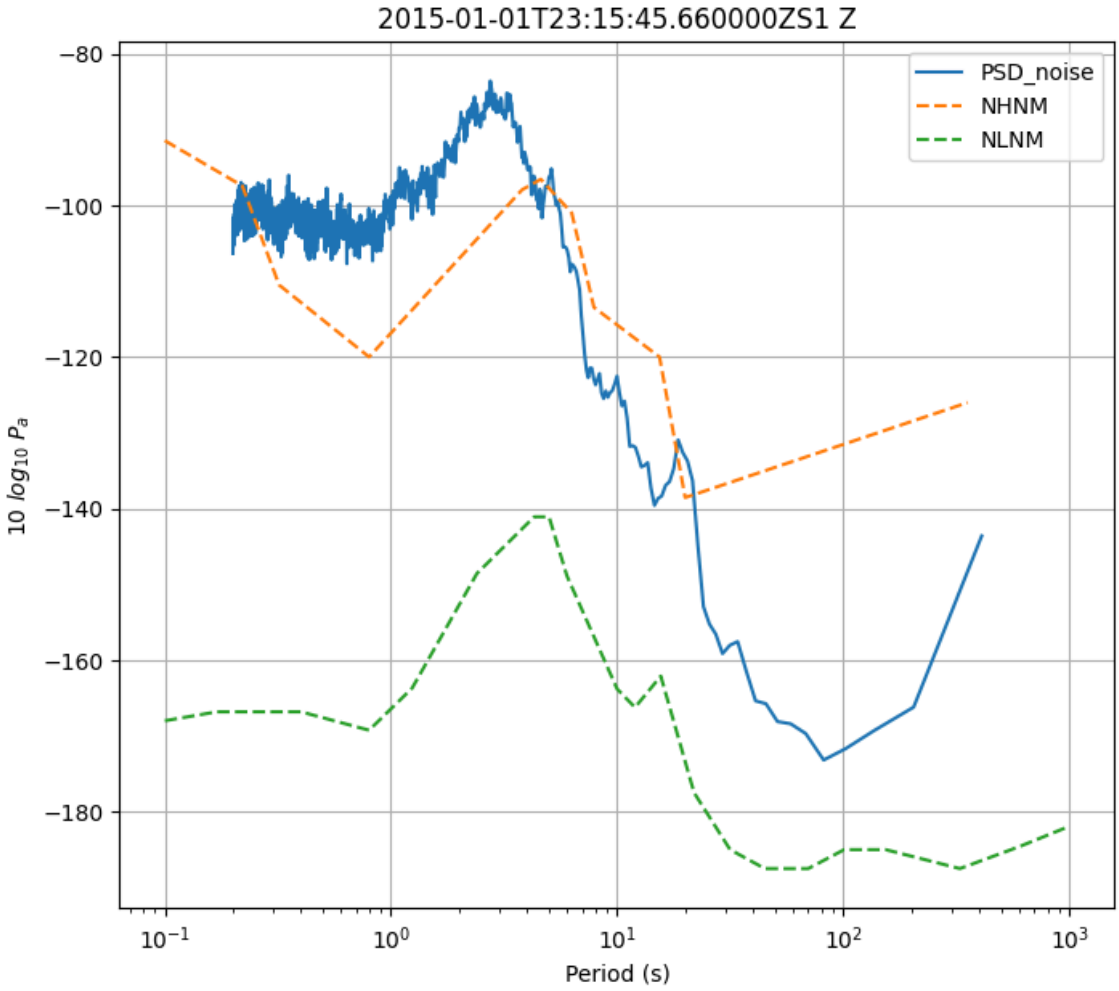
Period (s)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Period (s)