In [827]:
```
import numpy as np
from matplotlib import pyplot as plt
import numpy.lib.recfunctions as nlr
%matplotlib inline
```

In [828]:
```
Data = np.genfromtxt('recs2009_public.csv',delimiter=',',\
                     dtype=[('WALLTYPE', '<i8'),('HDD65', '<i8'),('DIP
                     ('PELHEAT','i8'),('PGASHEAT','i8'),('TOTHSQFT','<
                     skip_header=1,usecols=(24,6,315,430,609,699,705,8
```

In [829]:
```
Data.dtype.fields
```

Out[829]:
```
mappingproxy({'PELHEAT': (dtype('int64'), 40), 'HDD65': (dtype('int6
4'), 8), 'DIPSTICK': (dtype('int64'), 16), 'FUELHEAT': (dtype('int6
4'), 24), 'WALLTYPE': (dtype('int64'), 0), 'TOTHSQFT': (dtype('int6
4'), 56), 'PGASHEAT': (dtype('int64'), 48), 'WINDOWS': (dtype('int6
4'), 32), 'TOTALBTUSPH': (dtype('float64'), 64)})
```

In [830]:
```
Data.shape
```

Out[830]:
```
(12083,)
```

In [831]:
```
area = np.where(Data['TOTHSQFT']>0)
Data = Data[area]
wall = np.where(Data['WALLTYPE']<8)
Data = Data[wall]
#dipstick = np.where(Data['DIPSTICK']==0)
#Data = Data[dipstick]
fuel = np.where(Data['FUELHEAT']!=-2)
Data = Data[fuel]
#elepay = np.where(Data['PELHEAT']!=-2)
#Data = Data[elepay]
#gaspay = np.where(Data['PGASHEAT']!=-2)
#Data = Data[gaspay]
energy = Data['TOTALBTUSPH']/Data['TOTHSQFT']
Data_1 = nlr.drop_fields(Data,('TOTHSQFT','TOTALBTUSPH'))
Data_2 = nlr.append_fields(Data_1,'energy',data=energy)
```

In [832]:
```
Data_2.shape
```

Out[832]:
```
(11588,)
```

```
In [833]: Data_2
```

```
Out[833]: masked_array(data = [(1, 4742, -2, 5, 41, 1, -2, 2.7470944921677614)
           (2, 2662, -2, 1, 41, -2, 1, 14.110380116959064)
           (1, 6233, -2, 1, 20, -2, 2, 76.22727272727273) ...,
           (3, 7935, 0, 1, 42, -2, 1, 16.892131069122218)
           (1, 5834, 0, 1, 41, -2, 1, 57.66319444444444)
           (2, 2806, -2, 1, 30, 1, 1, 4.81504424778761)],
                       mask = [(False, False, False, False, False, False, Fals
          e, False)
           (False, False, False, False, False, False, False, False)
           (False, False, False, False, False, False, False, False) ...,
           (False, False, False, False, False, False, False, False)
           (False, False, False, False, False, False, False, False)
           (False, False, False, False, False, False, False, False)],
                 fill_value = (999999, 999999, 999999, 999999, 999999, 999999,
          999999, 1e+20),
                      dtype = [('WALLTYPE', '<i8'), ('HDD65', '<i8'), ('DIPSTI
          CK', '<i8'), ('FUELHEAT', '<i8'), ('WINDOWS', '<i8'), ('PELHEAT',
          '<i8'), ('PGASHEAT', '<i8'), ('energy', '<f8')])
```

```
In [834]: N = len(Data_2)
          DM_material = np.zeros((N,7))
          for i in range(N):
              DM_material[i][Data_2['WALLTYPE'][i]-1] = 1
          DM_material
```

```
Out[834]: array([[ 1.,  0.,  0., ...,  0.,  0.,  0.],
                 [ 0.,  1.,  0., ...,  0.,  0.,  0.],
                 [ 1.,  0.,  0., ...,  0.,  0.,  0.],
                 ...,
                 [ 0.,  0.,  1., ...,  0.,  0.,  0.],
                 [ 1.,  0.,  0., ...,  0.,  0.,  0.],
                 [ 0.,  1.,  0., ...,  0.,  0.,  0.]])
```

```
In [835]: DM_fuel = np.zeros((N,9))
          for i in range(N):
              if Data_2['FUELHEAT'][i] == 21:
                  DM_fuel[i][8] = 1
              elif Data_2['FUELHEAT'][i] == 8 or Data_2['FUELHEAT'][i] == 7 or D
                  DM_fuel[i][Data_2['FUELHEAT'][i]-2] = 1
              else:
                  DM_fuel[i][Data_2['FUELHEAT'][i]-1] = 1
          DM_fuel
```

```
Out[835]: array([[ 0.,  0.,  0., ...,  0.,  0.,  0.],
                 [ 1.,  0.,  0., ...,  0.,  0.,  0.],
                 [ 1.,  0.,  0., ...,  0.,  0.,  0.],
                 ...,
                 [ 1.,  0.,  0., ...,  0.,  0.,  0.],
                 [ 1.,  0.,  0., ...,  0.,  0.,  0.],
                 [ 1.,  0.,  0., ...,  0.,  0.,  0.]])
```

```
In [836]: DM_gaspay = np.zeros((N,4))
          for i in range(N):
              if Data_2['PGASHEAT'][i] == -2:
                  DM_gaspay[i][3] = 1
              else:
                  DM_gaspay[i][Data_2['PGASHEAT'][i]-1] = 1
          DM_gaspay
```

```
Out[836]: array([[ 0.,  0.,  0.,  1.],
                 [ 1.,  0.,  0.,  0.],
                 [ 0.,  1.,  0.,  0.],
                 ...,
                 [ 1.,  0.,  0.,  0.],
                 [ 1.,  0.,  0.,  0.],
                 [ 1.,  0.,  0.,  0.]])
```

```
In [837]: DM_elepay = np.zeros((N,4))
          for i in range(N):
              if Data_2['PELHEAT'][i] == -2:
                  DM_elepay[i][3] = 1
              else:
                  DM_elepay[i][Data_2['PELHEAT'][i]-1] = 1
          DM_elepay
```

```
Out[837]: array([[ 1.,  0.,  0.,  0.],
                 [ 0.,  0.,  0.,  1.],
                 [ 0.,  0.,  0.,  1.],
                 ...,
                 [ 0.,  0.,  0.,  1.],
                 [ 0.,  0.,  0.,  1.],
                 [ 1.,  0.,  0.,  0.]])
```

In [838]:

```
DM_dipstick = np.zeros((N,3))
for i in range(N):
    if Data_2['DIPSTICK'][i] == -2:
        DM_dipstick[i][2] = 1
    else:
        DM_dipstick[i][Data_2['DIPSTICK'][i]] = 1
DM_dipstick
```

Out[838]:

```
array([[ 0.,  0.,  1.],
       [ 0.,  0.,  1.],
       [ 0.,  0.,  1.],
       ...,
       [ 1.,  0.,  0.],
       [ 1.,  0.,  0.],
       [ 0.,  0.,  1.]])
```

In [839]:

```
DM_windows = np.zeros((N,8))
for i in range(N):
    if Data_2['WINDOWS'][i] == 0:
        DM_windows[i][0] = 1
    elif Data_2['WINDOWS'][i] == 10:
        DM_windows[i][1] = 1
    elif Data_2['WINDOWS'][i] == 20:
        DM_windows[i][2] = 1
    elif Data_2['WINDOWS'][i] == 30:
        DM_windows[i][3] = 1
    elif Data_2['WINDOWS'][i] == 41:
        DM_windows[i][4] = 1
    elif Data_2['WINDOWS'][i] == 42:
        DM_windows[i][5] = 1
    elif Data_2['WINDOWS'][i] == 50:
        DM_windows[i][6] = 1
    else:
        DM_windows[i][7] = 1
DM_windows
```

Out[839]:

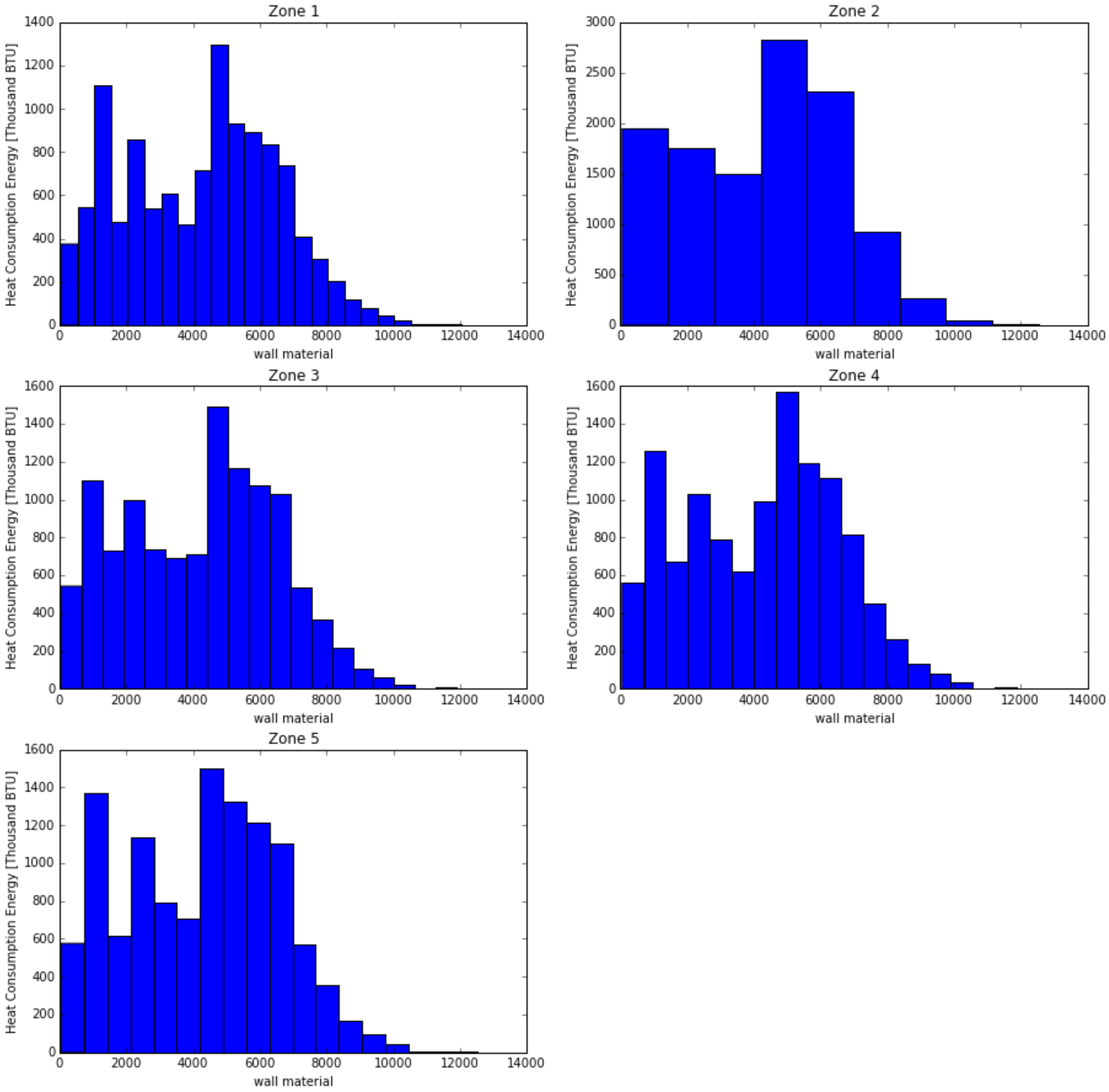
```
array([[ 0.,  0.,  0., ...,  0.,  0.,  0.],
       [ 0.,  0.,  0., ...,  0.,  0.,  0.],
       [ 0.,  0.,  1., ...,  0.,  0.,  0.],
       ...,
       [ 0.,  0.,  0., ...,  1.,  0.,  0.],
       [ 0.,  0.,  0., ...,  0.,  0.,  0.],
       [ 0.,  0.,  0., ...,  0.,  0.,  0.]])
```

In [840]:

```
print('The minimum heating degree days is '+str(min(Data['HDD65'])))
print('The maximum heating degree days is '+str(max(Data['HDD65'])))
```

```
The minimum heating degree days is 53
The maximum heating degree days is 12525
```

```
In [841]: fig1= plt.figure(figsize=(15,15))

          plt.subplot(321)
          plt.hist(Data['HDD65'],bins=25)
          plt.title('Zone 1')
          plt.xlabel('wall material')
          plt.ylabel('Heat Consumption Energy [Thousand BTU]')

          plt.subplot(322)
          plt.hist(Data['HDD65'],bins=9)
          plt.title('Zone 2')
          plt.xlabel('wall material')
          plt.ylabel('Heat Consumption Energy [Thousand BTU]')

          plt.subplot(323)
          plt.hist(Data['HDD65'],bins=20)
          plt.title('Zone 3')
          plt.xlabel('wall material')
          plt.ylabel('Heat Consumption Energy [Thousand BTU]')

          plt.subplot(324)
          plt.hist(Data['HDD65'],bins=19)
          plt.title('Zone 4')
          plt.xlabel('wall material')
          plt.ylabel('Heat Consumption Energy [Thousand BTU]')

          plt.subplot(325)
          plt.hist(Data['HDD65'],bins=18)
          plt.title('Zone 5')
          plt.xlabel('wall material')
          plt.ylabel('Heat Consumption Energy [Thousand BTU]')

Out[841]: <matplotlib.text.Text at 0x10fcd0b38>
```


Zone 1
Heat Consumption Energy [Thousand BTU]
0
200
400
600
800
1000
1200
1400
wall material
0
2000
4000
6000
8000
10000
12000
14000
Zone 2
Heat Consumption Energy [Thousand BTU]
0
500
1000
1500
2000
2500
3000
wall material
0
2000
4000
6000
8000
10000
12000
14000
Zone 3
Heat Consumption Energy [Thousand BTU]
0
200
400
600
800
1000
1200
1400
1600
wall material
0
2000
4000
6000
8000
10000
12000
14000
Zone 4
Heat Consumption Energy [Thousand BTU]
0
200
400
600
800
1000
1200
1400
1600
wall material
0
2000
4000
6000
8000
10000
12000
14000
Zone 5
Heat Consumption Energy [Thousand BTU]
0
200
400
600
800
1000
1200
1400
1600
wall material
0
2000
4000
6000
8000
10000
12000
14000

In [842]:

```
def Tc(hdd, T_bound):

    Tc_matrix = np.zeros((len(hdd), len(T_bound)+1))

    for (i,t) in enumerate(hdd):
        # first chunk
        if t <= T_bound[0]:
            Tc_matrix[i,0] = t
            continue
        else:
            Tc_matrix[i,0] = T_bound[0]

        # chunks in the middle
        n = 1
        while(n < len(T_bound)-1 and t > T_bound[n]):
            Tc_matrix[i,n] = T_bound[n+1] - T_bound[n]
            n += 1
        if(n < len(T_bound) and t <= T_bound[n]):
            Tc_matrix[i,n] = t - T_bound[n-1]
            continue

        # last chunk
        if(t > T_bound[-1]):
            if(len(T_bound)>1):
                Tc_matrix[i,-2] = T_bound[-1] - T_bound[-2]
            Tc_matrix[i,-1] = t - T_bound[-1]

    return Tc_matrix
```

In [1280]:

```
# get T_bound
num_chunk = 25

H_bound = np.linspace(min(Data['HDD65']),max(Data['HDD65']),num_chunk
H_bound
```

Out[1280]:

```
array([   551.88,   1050.76,   1549.64,   2048.52,   2547.4 ,   304
6.28,
         3545.16,   4044.04,   4542.92,   5041.8 ,   5540.68,   603
9.56,
         6538.44,   7037.32,   7536.2 ,   8035.08,   8533.96,   903
2.84,
         9531.72,  10030.6 ,  10529.48,  11028.36,  11527.24,  1202
6.12])
```

In [1281]:

```
DM_hdd = Tc(Data_2['HDD65'],H_bound)
DM_hdd.shape
```

Out[1281]:

```
(11588, 25)
```

```
In [1282]: energy = Data_2['energy']
           energy.shape
```

```
Out[1282]: (11588,)
```

```
In [1297]: X = np.hstack((DM_material,DM_fuel,DM_hdd,DM_dipstick))
           X
```

```
Out[1297]: array([[ 1.,  0.,  0., ...,  0.,  0.,  1.],
                  [ 0.,  1.,  0., ...,  0.,  0.,  1.],
                  [ 1.,  0.,  0., ...,  0.,  0.,  1.],
                  ...,
                  [ 0.,  0.,  1., ...,  1.,  0.,  0.],
                  [ 1.,  0.,  0., ...,  1.,  0.,  0.],
                  [ 0.,  1.,  0., ...,  0.,  0.,  1.]])
```

```
In [1284]: #from scipy import linalg
           np.linalg.inv(np.dot(X.T,X))
```

```
Out[1284]: array([[  3.65439989e+11,   4.53178074e+11,   4.22831089e+11, ...,
                    -1.71366022e+11,  -2.08942127e+11,  -2.68216544e+11],
                  [  3.65439989e+11,   4.53178074e+11,   4.22831089e+11, ...,
                    -1.71366022e+11,  -2.08942127e+11,  -2.68216544e+11],
                  [  3.65439989e+11,   4.53178074e+11,   4.22831089e+11, ...,
                    -1.71366022e+11,  -2.08942127e+11,  -2.68216544e+11],
                  ...,
                  [ -4.22661012e+11,  -4.22661012e+11,  -4.22661012e+11, ...,
                     1.06619309e+12,   1.06619309e+12,   1.06619309e+12],
                  [ -4.22661012e+11,  -4.22661012e+11,  -4.22661012e+11, ...,
                     1.06619309e+12,   1.06619309e+12,   1.06619309e+12],
                  [ -4.22661012e+11,  -4.22661012e+11,  -4.22661012e+11, ...,
                     1.06619309e+12,   1.06619309e+12,   1.06619309e+12]])
```

```
In [1285]: beta_hat = (linalg.inv(np.dot(X.T,X)).dot(X.T)).dot(energy)
           beta_hat
```

```
Out[1285]: masked_array(data = [  2.24368541e+01  -2.69367116e+01   2.56770540
           e+01  -8.06490119e+01
             -1.91003027e+01  -1.16185326e+01  -3.81134017e+01   1.11357103e+02
              6.73552354e+01  -8.85036832e+01   3.14595129e+01  -1.69511331e+01
              1.18606210e+02  -3.56294592e+01  -1.61372408e+01  -2.39179913e+01
              2.75064133e-03  -4.76590846e-03   3.01742717e-03   3.34831433e-03
              1.93226065e-03   7.13457114e-03   3.62479953e-03   4.78596277e-03
              9.67218344e-03  -2.79343541e-03   7.07080640e-03  -5.64363362e-04
              3.25410436e-03   1.54981943e-03  -1.33057460e-02  -6.94462247e-03
              3.35816758e-03   2.35512835e-02  -2.68173339e-03   8.72310828e-04
              3.03335120e-02   2.10511301e-02  -7.12351835e-02   1.68385742e-03
              2.22912061e-02   1.93989442e+01   1.30795586e+01   8.32539835e+0
           0],
                        mask = False,
                  fill_value = 1e+20)
```

In [1286]:

```
predicted = np.dot(X, beta_hat)
Y = energy
print(Y)
print(predicted)
SSres = (Y-predicted).T.dot(Y-predicted)
SSres
ave_y = np.mean(Y)
SStot = (Y-ave_y).T.dot(Y-ave_y)
R2 = 1-SSres/SStot
R2
```

```
[2.7470944921677614 14.110380116959064 76.22727272727273 ...,
 16.892131069122218 57.66319444444444 4.81504424778761]
[  29.1156319    96.84352641  160.46180423 ...,  167.13517161  171.0
218867
   97.87090465]
```

Out[1286]:

```
-5.8158963042823153
```

In [1287]:

```
P = len(X[0])
MSE = SSres/(N-P)
MSE
```

Out[1287]:

```
8240.2342158329811
```

In [1288]:

```
a = linalg.inv((X.T).dot(X))
a_diagonal = a.diagonal()
a_diagonal
```

Out[1288]:

```
array([  4.79430149e+11,   3.73764896e+11,   4.13389366e+11,
         4.29899562e+11,   4.86034227e+11,   3.73764896e+11,
         3.60556739e+11,   8.50555235e+11,   7.60058536e+11,
         9.10886368e+11,   8.05306885e+11,   9.81272689e+11,
         7.44975753e+11,   8.20389669e+11,   8.45527641e+11,
         7.29892970e+11,   7.54444084e-08,   2.49842647e-08,
         2.73780685e-08,   3.09843856e-08,   3.16040381e-08,
         2.50602029e-08,   3.08083309e-08,   3.17523556e-08,
         2.57425428e-08,   1.92277620e-08,   1.83902363e-08,
         2.03491795e-08,   2.07169589e-08,   2.78091170e-08,
         4.10014460e-08,   6.18905655e-08,   1.00136177e-07,
         1.77870659e-07,   2.59695664e-07,   4.01145655e-07,
         1.30004434e-06,   3.91049611e-06,   5.09408883e-06,
         7.87349185e-06,   8.24266761e-06,   1.06619309e+12,
         1.06619309e+12,   1.06619309e+12])
```

```
In [1289]: S_beta_k_sqaure =  MSE*a_diagonal
           S_beta_k = np.sqrt(S_beta_k_sqaure)
           S_beta_k
```

```
Out[1289]: array([  6.28539316e+07,   5.54969394e+07,   5.83645886e+07,
                    5.95186784e+07,   6.32853527e+07,   5.54969394e+07,
                    5.45075406e+07,   8.37184230e+07,   7.91394993e+07,
                    8.66366955e+07,   8.14611401e+07,   8.99217259e+07,
                    7.83503330e+07,   8.22204538e+07,   8.34706283e+07,
                    7.75531368e+07,   2.49335035e-02,   1.43483864e-02,
                    1.50200432e-02,   1.59786919e-02,   1.61376788e-02,
                    1.43701754e-02,   1.59332314e-02,   1.61755015e-02,
                    1.45644973e-02,   1.25873453e-02,   1.23101525e-02,
                    1.29492087e-02,   1.30657030e-02,   1.51378214e-02,
                    1.83810097e-02,   2.25830192e-02,   2.87253468e-02,
                    3.82844079e-02,   4.62596270e-02,   5.74937749e-02,
                    1.03502028e-01,   1.79508785e-01,   2.04881637e-01,
                    2.54714383e-01,   2.60617558e-01,   9.37319626e+07,
                    9.37319626e+07,   9.37319626e+07])
```

Create a 95% confidence level.

```
In [1290]: from scipy.stats import t
           t_1 = t.isf(0.025,N-P)
           t_1
```

```
Out[1290]: 1.9601695039223017
```

```
In [1291]: low_CI = beta_hat-t_1*S_beta_k
           high_CI = beta_hat+t_1*S_beta_k
           CI = np.vstack((low_CI, high_CI)).T
           CI
```

```
Out[1291]: masked_array(data =
            [[ -1.23204338e+08   1.23204382e+08]
            [ -1.08783435e+08   1.08783381e+08]
            [ -1.14404461e+08   1.14404512e+08]
            [ -1.16666779e+08   1.16666618e+08]
            [ -1.24050038e+08   1.24049999e+08]
            [ -1.08783420e+08   1.08783397e+08]
            [ -1.06844057e+08   1.06843981e+08]
            [ -1.64102188e+08   1.64102411e+08]
            [ -1.55126766e+08   1.55126901e+08]
            [ -1.69822697e+08   1.69822520e+08]
            [ -1.59677611e+08   1.59677674e+08]
            [ -1.76261842e+08   1.76261808e+08]
            [ -1.53579815e+08   1.53580052e+08]
            [ -1.61166062e+08   1.61165990e+08]
            [ -1.63616596e+08   1.63616564e+08]
            [ -1.52017318e+08   1.52017270e+08]
            [ -4.61232518e-02   5.16245345e-02]
            [ -3.28911780e-02   2.33593610e-02]
            [ -2.64244034e-02   3.24592577e-02]
            [ -2.79726302e-02   3.46692589e-02]
            [ -2.97003251e-02   3.35648464e-02]
            [ -2.10334085e-02   3.53025508e-02]
            [ -2.76070347e-02   3.48566338e-02]
            [ -2.69207619e-02   3.64926874e-02]
            [ -1.88767001e-02   3.82210669e-02]
            [ -2.74667659e-02   2.18798950e-02]
            [ -1.70591791e-02   3.12007919e-02]
            [ -2.59470073e-02   2.48182805e-02]
            [ -2.23568881e-02   2.88650968e-02]
            [ -2.81228765e-02   3.12225153e-02]
            [ -4.93356407e-02   2.27241487e-02]
            [ -5.12111680e-02   3.73219230e-02]
            [ -5.29483813e-02   5.96647164e-02]
            [ -5.14926454e-02   9.85952124e-02]
            [ -9.33584435e-02   8.79949768e-02]
            [ -1.11825233e-01   1.13569855e-01]
            [ -1.72548008e-01   2.33215032e-01]
            [ -3.30816515e-01   3.72918776e-01]
            [ -4.72837920e-01   3.30367553e-01]
            [ -4.97599509e-01   5.00967223e-01]
            [ -4.88563384e-01   5.33145796e-01]
            [ -1.83730515e+08   1.83730554e+08]
            [ -1.83730522e+08   1.83730548e+08]
            [ -1.83730526e+08   1.83730543e+08]],
                         mask =
            False,
                   fill_value = 1e+20)
```

```
In [1292]: diff = np.diff(CI)
            diff
```

```
Out[1292]: masked_array(data =
             [[  2.46408720e+08]
             [  2.17566816e+08]
             [  2.28808973e+08]
             [  2.33333397e+08]
             [  2.48100037e+08]
             [  2.17566816e+08]
             [  2.13688038e+08]
             [  3.28204599e+08]
             [  3.10253666e+08]
             [  3.39645217e+08]
             [  3.19355285e+08]
             [  3.52523650e+08]
             [  3.07159867e+08]
             [  3.22332052e+08]
             [  3.27233160e+08]
             [  3.04034587e+08]
             [  9.77477863e-02]
             [  5.62505390e-02]
             [  5.88836611e-02]
             [  6.26418891e-02]
             [  6.32651716e-02]
             [  5.63359592e-02]
             [  6.24636685e-02]
             [  6.34134493e-02]
             [  5.70977670e-02]
             [  4.93466609e-02]
             [  4.82599711e-02]
             [  5.07652878e-02]
             [  5.12219850e-02]
             [  5.93453918e-02]
             [  7.20597894e-02]
             [  8.85330910e-02]
             [  1.12613098e-01]
             [  1.50087858e-01]
             [  1.81353420e-01]
             [  2.25395089e-01]
             [  4.05763039e-01]
             [  7.03735291e-01]
             [  8.03205473e-01]
             [  9.98566732e-01]
             [  1.02170918e+00]
             [  3.67461069e+08]
             [  3.67461069e+08]
             [  3.67461069e+08]],
                         mask =
             False,
                   fill_value = 1e+20)
```

```
In [1293]: np.where(diff<50)
```

```
Out[1293]: (array([16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30,
           31, 32,
                   33, 34, 35, 36, 37, 38, 39, 40]),
            array([0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
           0, 0, 0,
                   0, 0]))
```

```
In [1294]: T = beta_hat/S_beta_k
           T
```

```
Out[1294]: masked_array(data = [3.569681880001958e-07 -4.853729210691395e-07
           4.399423462518954e-07
            -1.355020205942398e-06 -3.018123763701536e-07 -2.0935447524818683
           e-07
            -6.992317270315613e-07 1.330138564305017e-06 8.510950406215326e-07
            -1.021549618037400e-06 3.861904324136985e-07 -1.8850987219770021e-
           07
            1.513793316145047e-06 -4.333405815318026e-07 -1.9332837381686245e-0
           7
            -3.084077867849809e-07 0.11031908648219983 -0.33215640566009286
            0.20089337508912283 0.2095487134160817 0.11973597155814207
            0.49648462401887317 0.22749933400119168 0.29587724275465443
            0.6640931866221754 -0.22192411025082437 0.5743882044374322
            -0.043582845653453404 0.2490569678693018 0.10238061251036644
            -0.7238854785132276 -0.30751523592140967 0.11690607600284786
            0.6151664544453885 -0.05797135777877348 0.01517226567143384
            0.29307166703731846 0.11727075153830062 -0.347689449439907
            0.0066107669118400875 0.08553224969138296 2.069618910831305e-07
            1.3954213963552686e-07 8.882133819412858e-08],
                        mask = [False False False False False False False False
           False False False False
            False False False False False False False False False False False F
           alse
            False False False False False False False False False False False F
           alse
            False False False False False False False False],
                  fill_value = 1e+20)
```

```
In [1295]: alpha = 0.01
           t_2 = t.isf(0.005,N-P)
           t_2
```

```
Out[1295]: 2.5762552662136433
```

```
In [1296]: for i in range(len(T)):
               if -t_2 < T[i] < t_2:
                   print((i,T[i]))
```

```
(0, 3.5696818800019581e-07)
(1, -4.8537292106913945e-07)
(2, 4.3994234625189542e-07)
(3, -1.3550202059423983e-06)
(4, -3.0181237637015357e-07)
(5, -2.0935447524818683e-07)
(6, -6.9923172703156131e-07)
(7, 1.3301385643050171e-06)
(8, 8.5109504062153255e-07)
(9, -1.0215496180374008e-06)
(10, 3.8619043241369849e-07)
(11, -1.8850987219770021e-07)
(12, 1.5137933161450471e-06)
(13, -4.3334058153180263e-07)
(14, -1.9332837381686245e-07)
(15, -3.0840778678498091e-07)
(16, 0.11031908648219983)
(17, -0.33215640566009286)
(18, 0.20089337508912283)
(19, 0.20954871341608169)
(20, 0.11973597155814207)
(21, 0.49648462401887317)
(22, 0.22749933400119168)
(23, 0.29587724275465443)
(24, 0.66409318662217542)
(25, -0.22192411025082437)
(26, 0.57438820443743221)
(27, -0.043582845653453404)
(28, 0.24905696786930179)
(29, 0.10238061251036644)
(30, -0.7238854785132276)
(31, -0.30751523592140967)
(32, 0.11690607600284786)
(33, 0.61516645444538853)
(34, -0.057971357778773477)
(35, 0.01517226567143384)
(36, 0.29307166703731846)
(37, 0.11727075153830062)
(38, -0.34768944943990698)
(39, 0.0066107669118400875)
(40, 0.085532249691382956)
(41, 2.0696189108313051e-07)
(42, 1.3954213963552686e-07)
(43, 8.8821338194128576e-08)
```

```
In [ ]:
```

In [ ]: