Table of Contents

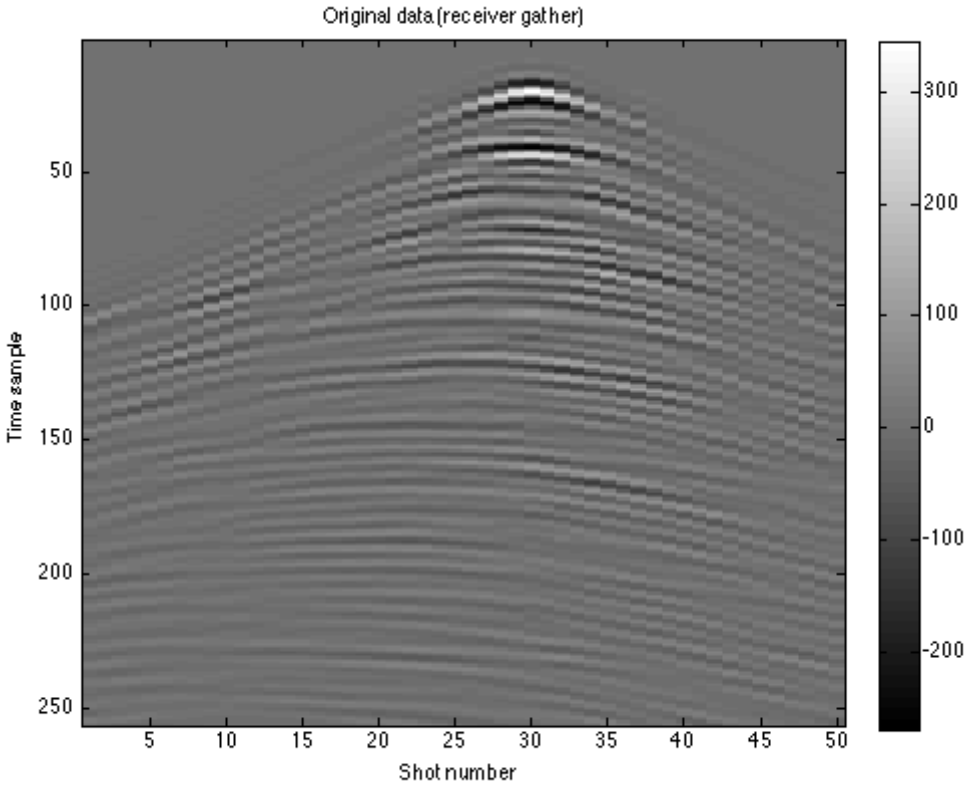

```
% random weights of simu shots

clear; close all;
cd ./simu_functions/
addpath(genpath(pwd))
cd ../../..
addpath(genpath(pwd))
cd ../../../../pqnl1;
addpath(genpath(pwd))

cd ../experiments/help_spgl1/modifying/task16bpdn/seismic/simushots
rmpath('/Volumes/Users/linamiao/Dropbox/PQN/pqnl1/minConF/')
```

original data

Number of time samples

```
nt = 1024;
% Number of sources
ns = 178;
% Number of receivers
nr = 178;

% Read data
D = ReadSuFast('GulfOfSuez178.su');
D = reshape(D,nt,nr,ns);

% Select small subset
D = D(1:256,30,1:50);

% Define new data sizes
[nt,nr,ns] = size(D);

% Vectorize D
D = D(:);

% Display
figure
imagesc(reshape(D,nt,ns)); colormap(gray); colorbar;
```

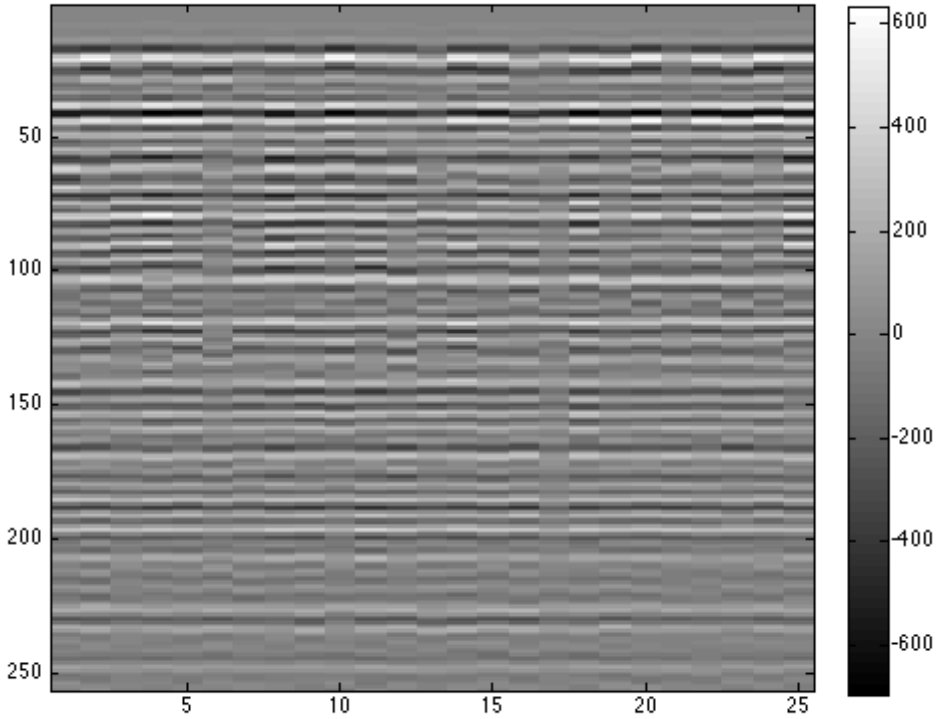
```
title('Original data (receiver gather)');
xlabel('Shot number'); ylabel('Time sample')
```



random weights of simu shots

```
p = .5;
nse = p*ns;
SS = rand(nse,ns);
Dt = opDirac(nt);
Dr = opDirac(nr);
RM = opKron(SS,Dr,Dt);

x_test = rand(size(RM,2),1);
y_test = rand(size(RM,1),1);
left = y_test'*(RM*x_test);
right = (RM'*y_test)'*x_test;
error = norm(left-right);
fprintf('In dottest error:%5.5e\n',error);


simD1 = RM*D;
figure;
imagesc(reshape(simD1,nt,nse)); colormap(gray); colorbar;
```

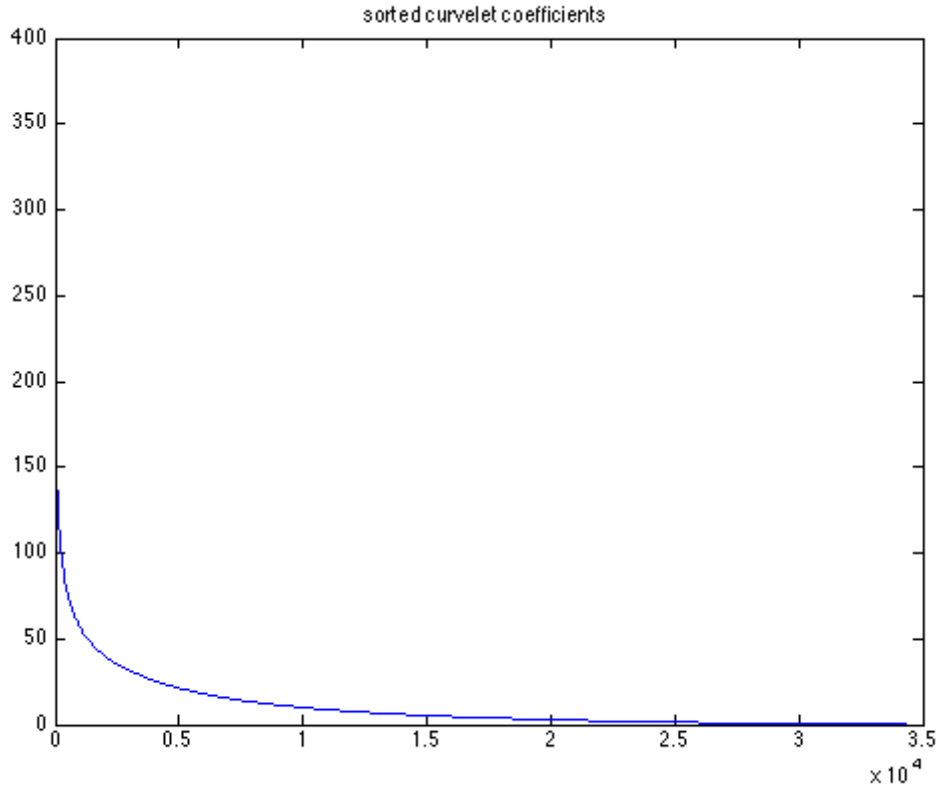
```
In dottest error:4.36557e-11
```



sparsifying transform

Use this to create a Curvelet SPOT operator:

```
C = opCurvelet(nt, ns);

% Transform the data into the Curvelet domain and plot the sorted coefficients
C_D = C*D;
sort_CD = sort(abs(C_D),'descend');
figure;plot(sort_CD);title('sorted curvelet coefficients')
```



reconstruct

```
A = RM*C';

% options = spgSetParms('optTol', 1e-4, 'iterations', 1000);%, 'fid', fid);
% xestspg = spgl1(A,simD1,0,1e-3,[],options);
% tau = norm(xestspg,1);
tau = 2.5572179e+05;

options = spgSetParms('optTol', 1e-4, 'iterations', 200);%, 'fid', fid);
xinit = zeros(size(A,2),1);

which spgl1
%keyboard;
xestspg = spgl1(A,simD1,tau,[],xinit,options);
%options.iterations = 100;
xestpqn = pqnl1_2(A,simD1,tau,[],xinit,options);
fspg = C'*xestspg;
snrspg = SNR(D,fspg);
fpqn = C'*xestpqn;
snrpqn = SNR(D,fpqn);


figure;
subplot(1,2,1);imagesc(reshape(fspg,nt,ns)); colormap(gray);
```

```
title(strcat(['p = .5, SNR=' num2str(snrspg) 'dB']))
subplot(1,2,2);imagesc(reshape(fspg-D,nt,ns)); colormap(gray);
title('difference')


figure;
subplot(1,2,1);imagesc(reshape(fpqn,nt,ns)); colormap(gray);
title(strcat(['p = .5, SNR=' num2str(snrpqn) 'dB']))
subplot(1,2,2);imagesc(reshape(fpqn-D,nt,ns)); colormap(gray);
title('difference')

% BPDN
[x_spg,r_spg,g_spg,info_spg] = spgl1(A, simD1, 0, 0, zeros(size(A,2),1), options);

[x_pqn1,r_pqn1,g_pqn1,info_pqn1] = pqnl1_2(A, simD1, 0, 0, zeros(size(A,2),1), opt

figure; subplot(2,1,1);plot(x_spg);subplot(2,1,2);plot(x_pqn1);
info_spg
info_pqn1

% show result
figure('Name','Solution paths')
plot(info_spg.xNorm1,info_spg.rNorm2,info_pqn1.xNorm1,info_pqn1.rNorm2);hold on
scatter(info_spg.xNorm1,info_spg.rNorm2);
scatter(info_pqn1.xNorm1,info_pqn1.rNorm2);hold off
legend('SPGL1','PQNl1')
axis tight
```

```
        /Tools/mat_toolbox/spgl1-slim/spgl1.m

         ================================================================================
         SPGL1_SLIM v. 46  (Tue, 14 Jun 2011) based on v.1017
         ================================================================================
         No. rows              :     6400      No. columns           :    34341
         Initial tau           : 2.56e+05      Two-norm of b         : 1.41e+04
         Optimality tol        : 1.00e-04      Target one-norm of x  : 2.56e+05
         Basis pursuit tol     : 1.00e-06      Maximum iterations    :      200

          Iter      Objective   Relative Gap      gNorm   stepG    nnzX    nnzG
             0  1.4084813e+04  2.4682857e+01   9.57e+03     0.0       0       0
             1  1.2846121e+04  2.6476916e+01   8.60e+03     0.0   33523       0
             2  4.9884426e+03  9.0858120e+00   4.42e+02     0.0   34272       0
             3  4.9008644e+03  9.1895090e+00   4.35e+02     0.0   34257       0
             4  2.2113177e+03  1.6911123e+01   1.68e+02     0.0   34334       0
             5  1.4785634e+03  3.7588609e+01   1.80e+02     0.0   34339       0
             6  2.6930985e+03  1.3922940e+02   1.85e+03    -0.3   34337       0
             7  1.6972935e+03  1.3509635e+02   8.19e+02     0.0   34336       0
             8  1.3568965e+03  2.4672795e+01   9.93e+01     0.0   34332       0
             9  1.3487532e+03  2.4795596e+01   9.87e+01     0.0   34334       0
            10  1.3464426e+03  1.5879849e+02   6.12e+02     0.0   27792       0
            11  9.0403473e+02  8.0011147e+01   1.29e+02    -0.3   28370       0
            12  8.8469504e+02  3.2616809e+01   5.68e+01     0.0   33924       0
            13  8.7828749e+02  3.3018693e+01   5.56e+01     0.0   33843       0
            14  8.6132268e+02  3.8114489e+01   6.42e+01     0.0   30240       0
```

15	8.5524914e+02	3.5524889e+01	5.45e+01	-0.3	30272	0
16	8.4927663e+02	4.2617056e+01	6.95e+01	0.0	30376	0
17	8.4326583e+02	3.1334890e+01	4.86e+01	0.0	29659	0
18	8.3837761e+02	3.2507098e+01	5.23e+01	0.0	29622	0
19	8.3213361e+02	3.1555905e+01	4.79e+01	0.0	29236	0
20	8.3174340e+02	9.3029774e+01	1.38e+02	0.0	29089	0
21	8.1721064e+02	3.1956506e+01	4.69e+01	-0.3	28955	0
22	8.1372733e+02	3.1289628e+01	4.73e+01	0.0	28950	0
23	8.0937530e+02	3.1463511e+01	4.69e+01	0.0	28623	0
24	7.5249619e+02	2.0948347e+02	2.44e+02	0.0	26622	0
25	7.2625401e+02	1.4221427e+02	1.50e+02	-0.3	27631	0
26	7.0975400e+02	3.2953713e+01	3.90e+01	0.0	31092	0
27	7.0801826e+02	3.2829885e+01	3.88e+01	0.0	28289	0
28	6.8712530e+02	3.7683906e+01	4.14e+01	0.0	26553	0
29	7.0559059e+02	2.4577654e+02	2.42e+02	-0.3	26807	0
30	6.6448274e+02	4.6534535e+01	4.67e+01	-0.3	28962	0
31	6.6234586e+02	3.4002568e+01	3.52e+01	0.0	28546	0
32	6.5893382e+02	3.3867693e+01	3.50e+01	0.0	27584	0
33	6.4344000e+02	2.7512637e+02	2.14e+02	0.0	23646	0
34	6.2496057e+02	2.4438338e+02	2.03e+02	-0.3	26525	0
35	5.4171859e+02	3.6324118e+01	2.52e+01	0.0	33427	0
36	5.3933220e+02	3.6245245e+01	2.52e+01	0.0	33712	0
37	5.2994853e+02	9.8196379e+01	6.27e+01	0.0	25115	0
38	5.3048441e+02	1.2727235e+02	7.02e+01	-0.3	25953	0
39	5.1955006e+02	4.1795808e+01	2.72e+01	0.0	32624	0
40	5.1849192e+02	3.6602256e+01	2.39e+01	0.0	27380	0
41	5.1539105e+02	3.6534331e+01	2.38e+01	0.0	25277	0
42	5.0704247e+02	1.3158049e+02	6.76e+01	-0.3	25272	0
43	5.0022797e+02	7.6506717e+01	4.35e+01	-0.3	27328	0
44	4.9720904e+02	3.7074157e+01	2.23e+01	0.0	26433	0
45	4.9636189e+02	3.7014306e+01	2.24e+01	0.0	25900	0
46	4.7198496e+02	5.2158568e+01	2.76e+01	0.0	23479	0
47	4.9086874e+02	1.8470689e+02	8.97e+01	-0.3	25331	0
48	4.6956034e+02	6.4054332e+01	3.22e+01	0.0	30208	0
49	4.6604305e+02	3.8001770e+01	2.04e+01	0.0	27329	0
50	4.6531052e+02	3.7972813e+01	2.03e+01	0.0	26045	0
51	4.3076184e+02	1.1861290e+02	4.92e+01	0.0	22390	0
52	4.2498162e+02	1.0810693e+02	4.07e+01	-0.3	25238	0
53	4.1805579e+02	3.8797795e+01	1.72e+01	0.0	30926	0
54	4.1722023e+02	3.9236697e+01	1.72e+01	0.0	26540	0
55	4.1575350e+02	3.9179310e+01	1.71e+01	0.0	24481	0
56	4.1309117e+02	1.8236525e+02	6.37e+01	-0.3	22402	0
57	4.0315403e+02	1.2479988e+02	4.40e+01	-0.3	25455	0
58	3.9608179e+02	4.0726395e+01	1.60e+01	0.0	26991	0
59	3.9552488e+02	4.0481713e+01	1.60e+01	0.0	25302	0
60	3.8782029e+02	4.1560206e+01	1.60e+01	0.0	22563	0
61	3.9379292e+02	1.3114722e+02	4.24e+01	-0.3	24040	0
62	3.8997328e+02	1.0381943e+02	3.51e+01	0.0	25711	0
63	3.8374344e+02	4.1292889e+01	1.54e+01	0.0	25201	0
64	3.8326915e+02	4.1166933e+01	1.53e+01	0.0	24496	0
65	3.7237284e+02	4.7843233e+01	1.70e+01	0.0	22042	0
66	3.7589158e+02	1.0076110e+02	2.97e+01	-0.3	23956	0
67	3.7096423e+02	5.9534101e+01	2.01e+01	0.0	25893	0
68	3.6901972e+02	4.2187774e+01	1.46e+01	0.0	24591	0

69	3.6854651e+02	4.2039063e+01	1.46e+01	0.0	23792	0
70	3.5205385e+02	5.7361098e+01	1.78e+01	0.0	21672	0
71	3.5432975e+02	1.2612543e+02	3.29e+01	-0.3	23807	0
72	3.5021317e+02	5.7506897e+01	1.75e+01	0.0	25446	0
73	3.4895281e+02	4.3464594e+01	1.35e+01	0.0	24178	0
74	3.4849097e+02	4.3335863e+01	1.35e+01	0.0	23268	0
75	3.3110695e+02	9.7179428e+01	2.44e+01	0.0	21318	0
76	3.3636000e+02	3.2274338e+02	7.30e+01	-0.3	23095	0
77	3.2998775e+02	1.5130939e+02	3.58e+01	0.0	26196	0
78	3.2814487e+02	4.4951469e+01	1.25e+01	0.0	24484	0
79	3.2774947e+02	4.4877681e+01	1.25e+01	0.0	23552	0
80	3.1236681e+02	1.2582036e+02	2.79e+01	0.0	21046	0
81	3.1137851e+02	1.3293588e+02	2.72e+01	-0.3	23692	0
82	3.0841537e+02	5.3005447e+01	1.28e+01	0.0	25761	0
83	3.0795946e+02	4.6550586e+01	1.15e+01	0.0	23458	0
84	3.0704823e+02	4.6579526e+01	1.15e+01	0.0	22047	0
85	3.0216399e+02	5.3737206e+02	9.77e+01	-0.3	20794	0
86	3.0567215e+02	5.8402849e+02	1.11e+02	-0.3	24146	0
87	2.8647371e+02	4.8960563e+01	1.04e+01	0.0	28769	0
88	2.8608174e+02	4.8528335e+01	1.04e+01	0.0	25390	0
89	2.8426211e+02	5.0133238e+01	1.07e+01	0.0	21997	0
90	2.8269375e+02	1.3277755e+02	2.27e+01	-0.3	22073	0
91	2.8079273e+02	5.8702924e+01	1.19e+01	-0.3	24065	0
92	2.8027155e+02	4.9143351e+01	1.01e+01	0.0	23045	0
93	2.7972228e+02	4.9085044e+01	1.01e+01	0.0	22244	0
94	2.7141083e+02	1.4858732e+02	2.36e+01	0.0	20705	0
95	2.7801082e+02	3.7524119e+02	6.02e+01	-0.3	22693	0
96	2.6932063e+02	6.9695000e+01	1.22e+01	0.0	23386	0
97	2.6887025e+02	5.0092345e+01	9.59e+00	0.0	22488	0
98	2.6846252e+02	5.0147328e+01	9.57e+00	0.0	21660	0
99	2.4725421e+02	1.2477314e+03	1.52e+02	0.0	19523	0
100	2.1852460e+02	9.7301238e+02	9.29e+01	-0.3	22656	0
101	2.0765941e+02	1.2848030e+02	1.27e+01	0.0	31571	0
102	2.0688656e+02	5.4855201e+01	6.49e+00	0.0	29689	0
103	2.0621453e+02	5.7106428e+01	6.80e+00	0.0	24893	0
104	2.0649074e+02	2.5854119e+02	2.24e+01	0.0	21341	0
105	2.0330272e+02	6.7333110e+01	7.53e+00	-0.3	24156	0
106	2.0286108e+02	5.5499404e+01	6.32e+00	0.0	23633	0
107	2.0243634e+02	5.8471542e+01	6.60e+00	0.0	22638	0
108	1.9732970e+02	3.1200600e+02	2.50e+01	0.0	20083	0
109	1.9425431e+02	1.5458074e+02	1.35e+01	-0.3	23061	0
110	1.9337691e+02	5.8350699e+01	6.02e+00	0.0	22703	0
111	1.9317399e+02	5.8087426e+01	6.03e+00	0.0	22130	0
112	1.9025157e+02	1.4577227e+02	1.23e+01	0.0	20171	0
113	1.9325131e+02	2.9270246e+02	2.29e+01	-0.3	22523	0
114	1.8855339e+02	6.3784376e+01	6.17e+00	0.0	25875	0
115	1.8824575e+02	5.9083228e+01	5.85e+00	0.0	23575	0
116	1.8798035e+02	5.9138288e+01	5.84e+00	0.0	22046	0
117	1.8431508e+02	6.6250564e+02	4.62e+01	0.0	19539	0
118	1.7135693e+02	2.6391599e+02	1.69e+01	-0.3	22275	0
119	1.6936073e+02	6.4965037e+01	5.17e+00	0.0	26206	0
120	1.6913051e+02	6.7076410e+01	5.37e+00	0.0	23787	0
121	1.6837120e+02	6.4902650e+01	5.16e+00	0.0	21736	0
122	1.6790426e+02	1.2022008e+02	8.35e+00	-0.3	21750	0

123	1.6907022e+02	2.9268807e+02	1.77e+01	-0.3	21761	0
124	1.6693333e+02	7.1606805e+01	5.52e+00	0.0	21950	0
125	1.6674803e+02	6.5074736e+01	5.10e+00	0.0	21518	0
126	1.6644530e+02	6.5098008e+01	5.09e+00	0.0	21036	0
127	1.6324490e+02	3.3039775e+02	1.88e+01	-0.3	20996	0
128	1.6169505e+02	2.2601137e+02	1.31e+01	-0.3	22057	0
129	1.6002575e+02	6.7522362e+01	4.82e+00	0.0	25425	0
130	1.5984653e+02	6.7028179e+01	4.85e+00	0.0	22905	0
131	1.5920282e+02	6.7529289e+01	4.84e+00	0.0	20851	0
132	1.5801384e+02	2.5728690e+02	1.41e+01	-0.3	20830	0
133	1.5684186e+02	9.8429240e+01	6.24e+00	-0.3	22606	0
134	1.5641107e+02	6.8307337e+01	4.72e+00	0.0	22008	0
135	1.5625228e+02	6.7987582e+01	4.72e+00	0.0	21444	0
136	1.5425454e+02	8.7294214e+01	5.50e+00	0.0	19896	0
137	1.5436056e+02	2.0440517e+02	1.10e+01	-0.3	20960	0
138	1.5387824e+02	1.4771340e+02	8.25e+00	0.0	21262	0
139	1.5348419e+02	6.8701359e+01	4.60e+00	0.0	20768	0
140	1.5335691e+02	6.9302919e+01	4.63e+00	0.0	20324	0
141	1.5189215e+02	8.0178203e+01	5.08e+00	0.0	19714	0
142	1.5180987e+02	3.5327238e+02	1.72e+01	-0.3	19937	0
143	1.5165938e+02	3.8608641e+02	1.89e+01	-0.3	21165	0
144	1.5088051e+02	7.0039354e+01	4.52e+00	0.0	20502	0
145	1.5076757e+02	7.0374834e+01	4.54e+00	0.0	20166	0
146	1.5001977e+02	7.2571412e+01	4.61e+00	0.0	19696	0
147	1.4929413e+02	7.0542049e+02	3.19e+01	-0.3	19709	0
148	1.4782346e+02	6.0353339e+02	2.74e+01	-0.3	22280	0
149	1.4594775e+02	7.1526440e+01	4.32e+00	0.0	22064	0
150	1.4582772e+02	7.1633124e+01	4.34e+00	0.0	21354	0
151	1.4433298e+02	1.0356254e+02	5.67e+00	0.0	19840	0
152	1.4532108e+02	3.7674630e+02	1.66e+01	-0.3	20902	0
153	1.4439547e+02	2.6284345e+02	1.23e+01	0.0	22220	0
154	1.4350311e+02	7.2197113e+01	4.24e+00	0.0	21345	0
155	1.4339653e+02	7.2308205e+01	4.25e+00	0.0	20832	0
156	1.4115707e+02	1.1216284e+02	5.83e+00	0.0	19515	0
157	1.4216247e+02	3.5472288e+02	1.49e+01	-0.3	20549	0
158	1.4139973e+02	2.5702491e+02	1.17e+01	0.0	22197	0
159	1.4034566e+02	7.3518252e+01	4.13e+00	0.0	21240	0
160	1.4024414e+02	7.3408443e+01	4.14e+00	0.0	20722	0
161	1.3841496e+02	1.0929834e+02	5.52e+00	0.0	19438	0
162	1.3842466e+02	1.6809888e+02	7.38e+00	-0.3	20518	0
163	1.3808347e+02	1.4743459e+02	6.95e+00	0.0	21035	0
164	1.3776293e+02	7.4321890e+01	4.03e+00	0.0	20298	0
165	1.3765378e+02	7.7105669e+01	4.15e+00	0.0	19862	0
166	1.3660726e+02	7.4446198e+01	4.00e+00	0.0	19379	0
167	1.3686551e+02	9.8407274e+02	3.75e+01	-0.3	19417	0
168	1.3556719e+02	7.4580847e+02	2.80e+01	-0.3	21590	0
169	1.3411824e+02	9.0402322e+01	4.43e+00	0.0	21525	0
170	1.3401340e+02	8.1318438e+01	4.12e+00	0.0	20789	0
171	1.3288944e+02	7.9845782e+01	4.02e+00	0.0	19543	0
172	1.3336278e+02	2.5091916e+02	9.99e+00	-0.3	20314	0
173	1.3334349e+02	2.6477594e+02	1.04e+01	0.0	21407	0
174	1.3213095e+02	8.1867169e+01	4.03e+00	0.0	21100	0
175	1.3203352e+02	7.7065143e+01	3.87e+00	0.0	20489	0
176	1.3136402e+02	8.2261064e+01	4.03e+00	0.0	19534	0

```
  177  1.3205330e+02  7.2444351e+02   2.54e+01    -0.3   19555       0
  178  1.2845002e+02  1.1650405e+02   5.05e+00    -0.3   22639       0
  179  1.2825863e+02  7.9183667e+01   3.74e+00     0.0   22006       0
  180  1.2804696e+02  8.0727978e+01   3.79e+00     0.0   21214       0
  181  1.2786485e+02  5.6031325e+02   1.94e+01     0.0   19155       0
  182  1.2334782e+02  1.8579228e+02   6.71e+00    -0.3   22060       0
  183  1.2258920e+02  8.0242362e+01   3.50e+00     0.0   22276       0
  184  1.2246636e+02  7.9994479e+01   3.51e+00     0.0   21681       0
  185  1.2127353e+02  1.2254433e+02   4.63e+00     0.0   19677       0
  186  1.2148062e+02  2.4680370e+02   8.34e+00    -0.3   21257       0
  187  1.2087434e+02  1.1144104e+02   4.29e+00     0.0   20920       0
  188  1.2070939e+02  8.0614715e+01   3.43e+00     0.0   20499       0
  189  1.2059617e+02  8.2590756e+01   3.48e+00     0.0   19895       0
  190  1.1674170e+02  5.1047750e+02   1.48e+01     0.0   18996       0
  191  1.1695764e+02  5.8321504e+02   1.67e+01    -0.3   21164       0
  192  1.1544129e+02  8.5853261e+01   3.30e+00     0.0   21463       0
  193  1.1533979e+02  8.4806755e+01   3.29e+00     0.0   20565       0
  194  1.1506012e+02  8.9366336e+01   3.40e+00     0.0   19602       0
  195  1.1498671e+02  1.2514779e+03   3.31e+01    -0.3   18923       0
  196  1.1103916e+02  4.5290076e+02   1.21e+01    -0.3   22017       0
  197  1.1044166e+02  8.8037217e+01   3.12e+00     0.0   21551       0
  198  1.1034511e+02  8.7370448e+01   3.11e+00     0.0   21050       0
  199  1.0995232e+02  4.3191168e+02   1.14e+01     0.0   19112       0
  200  1.0831722e+02  1.9957451e+02   5.57e+00    -0.3   22015       0

 ERROR EXIT -- Too many iterations

 Products with A     :     305        Total time   (secs) :   109.9
 Products with A'    :     201        Project time (secs) :     1.1
 Newton iterations   :       0        Mat-vec time (secs) :   107.0
 Line search its     :     250        Subspace iterations :       0


 ================================================================================
 PQNL1_SLIM v. 46  (Tue, 14 Jun 2011) based on v.1017
 ================================================================================
 No. rows              :     6400      No. columns           :    34341
 Initial tau           : 2.56e+05      Two-norm of b         : 1.41e+04
 Optimality tol        : 1.00e-04      Target one-norm of x  : 2.56e+05
 Basis pursuit tol     : 1.00e-06      Maximum iterations    :      200

  Iter      Objective   Relative Gap      gNorm   stepG    nnzX    nnzG
     0  1.4084813e+04  2.4682857e+01   9.57e+03     0.0       0       0
Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2        O
         1          1           4     3.12500e-02     1.29140e+04     2.635
         2          1          12     1.00000e+00     4.99852e+03     2.970
         3          1          20     1.00000e+00     4.90842e+03     2.949
         4          1          31     1.00000e+00     3.42510e+03     3.846
         5          1          54     1.00000e+00     2.49978e+03     4.396
         6          1          81     1.00000e+00     1.89649e+03     3.290
         7          1         101     1.00000e+00     1.75863e+03     3.097
         8          1         117     1.00000e+00     1.62467e+03     3.655
         9          1         147     1.00000e+00     1.41444e+03     3.761
```

10	1	173	1.00000e+00	1.15851e+03	3.656
11	1	209	1.00000e+00	1.01147e+03	2.495
12	1	227	1.00000e+00	9.66284e+02	1.697
13	1	258	1.00000e+00	9.22655e+02	1.930
14	1	275	1.00000e+00	8.79916e+02	1.798
15	1	312	1.00000e+00	8.21136e+02	1.290
16	1	351	1.00000e+00	7.87715e+02	1.352
17	1	401	1.00000e+00	7.54682e+02	1.703
18	1	442	1.00000e+00	7.16302e+02	1.931
19	1	477	1.00000e+00	6.61149e+02	1.555
20	1	521	1.00000e+00	6.22953e+02	1.010
21	1	560	1.00000e+00	6.04623e+02	1.213
22	1	599	1.00000e+00	5.90331e+02	1.360
23	1	631	1.00000e+00	5.62127e+02	1.305
24	1	683	1.00000e+00	5.24694e+02	9.267
25	1	719	1.00000e+00	4.96244e+02	6.667
26	1	773	1.00000e+00	4.74001e+02	7.738
27	1	808	1.00000e+00	4.60279e+02	8.006
28	1	839	1.00000e+00	4.46009e+02	7.182
29	1	883	1.00000e+00	4.20674e+02	7.800
30	1	944	1.00000e+00	3.96450e+02	7.789
31	1	995	1.00000e+00	3.77021e+02	6.026
32	1	1050	1.00000e+00	3.62083e+02	5.167
33	1	1108	1.00000e+00	3.50122e+02	7.199
34	1	1158	1.00000e+00	3.31610e+02	8.468
35	1	1206	1.00000e+00	3.11304e+02	5.716
36	1	1243	1.00000e+00	2.96220e+02	3.635
37	1	1293	1.00000e+00	2.86153e+02	5.741
38	1	1359	1.00000e+00	2.76289e+02	6.901
39	1	1412	1.00000e+00	2.60231e+02	5.539
40	1	1461	1.00000e+00	2.44060e+02	3.201
41	1	1520	1.00000e+00	2.35317e+02	4.122
42	1	1582	1.00000e+00	2.29016e+02	4.497
43	1	1634	1.00000e+00	2.21329e+02	4.203
44	1	1657	1.00000e+00	2.16279e+02	3.399
45	1	1728	1.00000e+00	2.08280e+02	3.920
46	1	1798	1.00000e+00	1.96481e+02	4.155
47	1	1867	1.00000e+00	1.87847e+02	3.307
48	1	1922	1.00000e+00	1.81848e+02	2.488
49	1	1994	1.00000e+00	1.75944e+02	2.840
50	1	2049	1.00000e+00	1.69824e+02	3.936
51	1	2113	1.00000e+00	1.62992e+02	3.810
52	1	2176	1.00000e+00	1.56092e+02	2.310
53	1	2217	1.00000e+00	1.52282e+02	2.040
54	1	2245	1.00000e+00	1.49936e+02	2.271
55	1	2325	1.00000e+00	1.43557e+02	2.716
56	1	2385	1.00000e+00	1.38270e+02	2.408
57	1	2451	1.00000e+00	1.32158e+02	1.388
58	1	2531	1.00000e+00	1.27056e+02	1.908
59	1	2571	1.00000e+00	1.24368e+02	1.909
60	1	2593	1.00000e+00	1.21180e+02	1.269
61	1	2652	1.00000e+00	1.16381e+02	1.585
62	1	2723	1.00000e+00	1.11444e+02	1.714
63	1	2774	1.00000e+00	1.07218e+02	1.933

64	1	2869	1.00000e+00	1.02641e+02	1.800
65	1	2933	1.00000e+00	9.83670e+01	1.833
66	1	2997	1.00000e+00	9.44310e+01	1.583
67	1	3080	1.00000e+00	9.06289e+01	1.322
68	1	3163	1.00000e+00	8.77142e+01	1.299
69	1	3201	1.00000e+00	8.58442e+01	1.384
70	1	3257	1.00000e+00	8.25602e+01	1.576
71	1	3271	1.00000e+00	8.14498e+01	9.116
72	1	3312	1.00000e+00	7.94283e+01	1.289
73	1	3388	1.00000e+00	7.70685e+01	1.210
74	1	3468	1.00000e+00	7.13734e+01	1.076
75	1	3539	1.00000e+00	6.75438e+01	1.805
76	1	3568	1.00000e+00	6.58681e+01	9.627
77	1	3616	1.00000e+00	6.38920e+01	7.666
78	1	3702	1.00000e+00	6.19549e+01	8.806
79	1	3749	1.00000e+00	5.92000e+01	9.424
80	1	3794	1.00000e+00	5.66149e+01	1.046
81	1	3861	1.00000e+00	5.40809e+01	9.353
82	1	3939	1.00000e+00	5.08947e+01	7.205
83	1	4010	1.00000e+00	4.86099e+01	6.021
84	1	4057	1.00000e+00	4.66844e+01	7.607
85	1	4108	1.00000e+00	4.54571e+01	9.720
86	1	4153	1.00000e+00	4.39031e+01	9.148
87	1	4199	1.00000e+00	4.16220e+01	6.515
88	1	4265	1.00000e+00	3.96233e+01	7.490
89	1	4330	1.00000e+00	3.85953e+01	7.963
90	1	4397	1.00000e+00	3.71195e+01	7.548
91	1	4497	1.00000e+00	3.51361e+01	6.260
92	1	4582	1.00000e+00	3.33077e+01	5.176
93	1	4656	1.00000e+00	3.19574e+01	6.083
94	1	4685	1.00000e+00	3.13572e+01	7.109
95	1	4743	1.00000e+00	3.00464e+01	7.996
96	1	4821	1.00000e+00	2.86129e+01	6.760
97	1	4878	1.00000e+00	2.71459e+01	4.270
98	1	4900	1.00000e+00	2.67560e+01	4.113
99	1	5007	1.00000e+00	2.57911e+01	4.185
100	1	5072	1.00000e+00	2.45814e+01	4.796
101	1	5179	1.00000e+00	2.29821e+01	4.631
102	1	5207	1.00000e+00	2.23072e+01	3.921
103	1	5263	1.00000e+00	2.12570e+01	3.891
104	1	5290	1.00000e+00	2.07367e+01	3.270
105	1	5363	1.00000e+00	1.95368e+01	2.836
106	1	5444	1.00000e+00	1.82065e+01	3.780
107	1	5504	1.00000e+00	1.72956e+01	2.650
108	1	5527	1.00000e+00	1.68990e+01	2.035
109	1	5629	1.00000e+00	1.58585e+01	2.363
110	1	5712	1.00000e+00	1.44437e+01	4.182
111	1	5786	1.00000e+00	1.33916e+01	2.100
112	1	5855	1.00000e+00	1.25702e+01	1.860
113	1	5865	1.00000e+00	1.22524e+01	2.404
114	1	5938	1.00000e+00	1.15416e+01	2.503
115	1	5991	1.00000e+00	1.08114e+01	4.090
116	1	6072	1.00000e+00	1.01084e+01	1.891
117	1	6150	1.00000e+00	9.47454e+00	1.534

118	1	6207	1.00000e+00	8.91940e+00	1.859
119	1	6262	1.00000e+00	8.35007e+00	3.199
120	1	6295	1.00000e+00	8.04296e+00	1.644
121	1	6322	1.00000e+00	7.72402e+00	1.364
122	1	6417	1.00000e+00	7.26656e+00	1.883
123	1	6496	1.00000e+00	6.89729e+00	1.316
124	1	6510	1.00000e+00	6.76099e+00	1.011
125	1	6558	1.00000e+00	6.44095e+00	1.255
126	1	6594	1.00000e+00	5.90286e+00	1.413
127	1	6670	1.00000e+00	5.31540e+00	2.224
128	1	6718	1.00000e+00	5.04863e+00	8.170
129	1	6771	1.00000e+00	4.87931e+00	7.788
130	1	6848	1.00000e+00	4.55267e+00	1.019
131	1	6893	1.00000e+00	4.11566e+00	1.124
132	1	6969	1.00000e+00	3.82615e+00	2.188
133	1	7013	1.00000e+00	3.53273e+00	7.199
134	1	7073	1.00000e+00	3.34540e+00	7.411
135	1	7116	1.00000e+00	3.18368e+00	9.069
136	1	7173	1.00000e+00	2.92094e+00	7.864
137	1	7243	1.00000e+00	2.81114e+00	1.636
138	1	7274	1.00000e+00	2.64206e+00	5.548
139	1	7283	1.00000e+00	2.61124e+00	5.481
140	1	7336	1.00000e+00	2.47842e+00	8.945
141	1	7383	1.00000e+00	2.35007e+00	1.033
142	1	7425	1.00000e+00	2.15357e+00	8.338
143	1	7482	1.00000e+00	2.06074e+00	9.987
144	1	7532	1.00000e+00	1.91157e+00	3.399
145	1	7581	1.00000e+00	1.85768e+00	4.234
146	1	7663	1.00000e+00	1.78832e+00	5.512
147	1	7722	1.00000e+00	1.68487e+00	6.205
148	1	7772	1.00000e+00	1.54935e+00	1.011
149	1	7796	1.00000e+00	1.42781e+00	2.779
150	1	7861	1.00000e+00	1.36452e+00	2.163
151	1	7920	1.00000e+00	1.29540e+00	2.703
152	1	7945	1.00000e+00	1.25844e+00	3.540
153	1	7984	1.00000e+00	1.20497e+00	4.065
154	1	8034	1.00000e+00	1.07280e+00	4.187
155	1	8078	1.00000e+00	1.05809e+00	6.659
156	1	8098	1.00000e+00	9.97365e-01	1.618
157	1	8142	1.00000e+00	9.72240e-01	1.420
158	1	8200	1.00000e+00	9.08976e-01	1.982
159	1	8247	1.00000e+00	8.58082e-01	3.435
160	1	8301	1.00000e+00	7.96622e-01	1.964
161	1	8368	1.00000e+00	7.39658e-01	1.381
162	1	8450	1.00000e+00	6.71326e-01	2.338
163	1	8508	1.00000e+00	6.35228e-01	3.211
164	1	8532	1.00000e+00	6.09099e-01	1.801
165	1	8570	1.00000e+00	5.68818e-01	1.358
166	1	8594	1.00000e+00	5.44578e-01	1.142
167	1	8663	1.00000e+00	4.81194e-01	1.852
168	1	8715	1.00000e+00	4.74307e-01	3.195
169	1	8738	1.00000e+00	4.43622e-01	1.180
170	1	8762	1.00000e+00	4.32254e-01	7.619
171	1	8821	1.00000e+00	4.09715e-01	1.151

```
      172          1       8866     1.00000e+00     3.90886e-01     1.338
      173          1       8919     1.00000e+00     3.39563e-01     1.596
      174          1       8958     5.00000e-01     3.26608e-01     1.728
      175          1       8990     1.00000e+00     3.05338e-01     7.144
      176          1       9018     1.00000e+00     2.92435e-01     6.387
      177          1       9077     1.00000e+00     2.81801e-01     7.422
      178          1       9117     1.00000e+00     2.61683e-01     9.359
      179          1       9165     1.00000e+00     2.38274e-01     7.331
      180          1       9194     1.00000e+00     2.24143e-01     7.012
      181          1       9251     1.00000e+00     2.10944e-01     7.065
      182          1       9325     1.00000e+00     2.04347e-01     1.570
      183          1       9341     1.00000e+00     1.88679e-01     4.807
      184          1       9387     1.00000e+00     1.81831e-01     3.594
      185          1       9438     1.00000e+00     1.70434e-01     4.779
      186          1       9456     1.00000e+00     1.61118e-01     3.725
      187          1       9500     1.00000e+00     1.48162e-01     8.254
      188          1       9546     1.00000e+00     1.35919e-01     4.198
      189          1       9594     1.00000e+00     1.31723e-01     3.462
      190          1       9638     1.00000e+00     1.18668e-01     3.758
      191          1       9687     1.00000e+00     1.16131e-01     6.890
      192          1       9722     1.00000e+00     1.09865e-01     2.680
      193          1       9786     1.00000e+00     1.04873e-01     2.044
      194          1       9868     1.00000e+00     9.71759e-02     2.384
      195          1       9926     1.00000e+00     8.73535e-02     3.858
      196          1       9989     1.00000e+00     8.04467e-02     3.409
      197          1      10027     1.00000e+00     7.66177e-02     1.809
      198          1      10071     1.00000e+00     7.32741e-02     1.661
      199          1      10137     1.00000e+00     6.95164e-02     2.060
      200          1      10175     1.00000e+00     6.49125e-02     3.975
  200  6.4912489e-02  2.7738629e+03   1.09e-02     0.0   30219       0
EXIT -- Optimal solution found

Products with A     :     208        Total time   (secs) :   506.4
Products with A'    :     208        Project time (secs) :   438.7
Newton iterations   :       0        Mat-vec time (secs) :    85.7


================================================================================
SPGL1_SLIM v. 46  (Tue, 14 Jun 2011) based on v.1017
================================================================================
No. rows              :     6400      No. columns           :    34341
Initial tau           : 0.00e+00      Two-norm of b         : 1.41e+04
Optimality tol        : 1.00e-04      Target objective      : 0.00e+00
Basis pursuit tol     : 1.00e-06      Maximum iterations    :      200

 Iter      Objective   Relative Gap  Rel Error      gNorm   stepG    nnzX
    0  1.4084813e+04  0.0000000e+00   1.00e+00  9.574e+03     0.0       0
    1  1.3937226e+04  1.9715609e+00   1.00e+00  9.142e+03    -0.3       1
    2  1.3589357e+04  4.7848122e+00   1.00e+00  1.517e+04    -0.3     722
    3  8.2256651e+03  2.4525451e+00   1.00e+00  5.678e+03     0.0    2819
    4  7.5794285e+03  5.6962752e-01   1.00e+00  2.345e+03     0.0    2731
    5  7.4996944e+03  3.8413148e-01   1.00e+00  2.141e+03     0.0    2495
    6  7.4351904e+03  3.9058329e-01   1.00e+00  2.167e+03     0.0    2232
    7  7.3860946e+03  8.1531517e-01   1.00e+00  2.733e+03     0.0    1948
```

8	7.3984316e+03	1.1670754e+00	1.00e+00	3.152e+03	-0.3	1805
9	7.3365178e+03	8.1307150e-01	1.00e+00	2.745e+03	0.0	1880
10	7.3223204e+03	2.3863254e-01	1.00e+00	1.982e+03	0.0	1780
11	7.3141553e+03	2.0702435e-01	1.00e+00	1.946e+03	0.0	1699
12	7.2681804e+03	2.6196508e-01	1.00e+00	2.021e+03	0.0	1415
13	7.2613664e+03	7.2908289e-01	1.00e+00	2.618e+03	-0.3	1419
14	7.2824411e+03	1.1913570e+00	1.00e+00	3.165e+03	0.0	1319
15	7.2505616e+03	9.6952667e-01	1.00e+00	2.925e+03	0.0	1427
16	7.2374623e+03	2.3384884e-01	1.00e+00	1.981e+03	0.0	1332
17	7.2347752e+03	1.5409967e-01	1.00e+00	1.883e+03	0.0	1288
18	7.2197541e+03	2.1371889e-01	1.00e+00	1.961e+03	0.0	1148
19	7.2123623e+03	5.0166110e-01	1.00e+00	2.303e+03	-0.3	1150
20	7.2054902e+03	2.3277042e-01	1.00e+00	1.981e+03	-0.3	1212
21	7.2023257e+03	2.1265550e-01	1.00e+00	1.955e+03	0.0	1135
22	7.1991043e+03	1.9186805e-01	1.00e+00	1.929e+03	0.0	1099
23	7.1940157e+03	6.9177170e-01	1.00e+00	2.552e+03	0.0	1022
24	7.2010302e+03	8.9397301e-01	1.00e+00	2.792e+03	-0.3	993
25	7.1881944e+03	4.5868165e-01	1.00e+00	2.261e+03	0.0	993
26	7.1855041e+03	1.5984018e-01	1.00e+00	1.889e+03	0.0	989
27	7.1842256e+03	1.2910440e-01	1.00e+00	1.851e+03	0.0	979
28	7.1674153e+03	2.9884574e-01	1.00e+00	2.036e+03	0.0	806
29	7.1685246e+03	5.4618323e-01	1.00e+00	2.375e+03	-0.3	833
30	7.1670236e+03	2.5278210e-01	1.00e+00	1.976e+03	0.0	856
31	7.1603548e+03	2.4093474e-01	1.00e+00	1.987e+03	0.0	874
32	7.1592026e+03	9.7363318e-02	1.00e+00	1.806e+03	0.0	816
33	7.1580309e+03	9.1120799e-02	1.00e+00	1.798e+03	0.0	792
34	7.1356434e+03	3.3876967e-01	1.00e+00	2.061e+03	0.0	559
35	7.1438797e+03	3.7352799e-01	1.00e+00	2.142e+03	-0.3	663
36	7.1328958e+03	5.3903023e-01	1.00e+00	2.331e+03	0.0	819
37	7.1285029e+03	9.9087390e-02	1.00e+00	1.798e+03	0.0	732
38	7.1275985e+03	7.2809648e-02	1.00e+00	1.767e+03	0.0	670
39	7.1270828e+03	6.2408099e-02	1.00e+00	1.754e+03	0.0	636
40	7.1256567e+03	1.5911749e-01	1.00e+00	1.868e+03	0.0	526
41	7.1214705e+03	1.0706195e-01	1.00e+00	1.812e+03	-0.3	566
42	7.1205656e+03	5.4551658e-02	1.00e+00	1.744e+03	0.0	553
43	7.1200517e+03	4.6021464e-02	1.00e+00	1.734e+03	0.0	536
44	7.1193034e+03	6.5112139e-02	1.00e+00	1.757e+03	0.0	523
45	7.1201928e+03	4.0372143e-01	1.00e+00	2.169e+03	0.0	514
46	7.1178361e+03	6.1444476e-02	1.00e+00	1.751e+03	-0.3	557
47	7.1173146e+03	8.2971108e-02	1.00e+00	1.779e+03	0.0	534
48	7.1168180e+03	5.1550203e-02	1.00e+00	1.740e+03	0.0	515
49	7.1160426e+03	7.9572003e-02	1.00e+00	1.774e+03	0.0	505
50	7.1165059e+03	2.3670563e-01	1.00e+00	1.965e+03	-0.3	495
51	7.1150256e+03	1.3991017e-01	1.00e+00	1.846e+03	-0.3	516
52	7.1143598e+03	1.1110514e-01	1.00e+00	1.813e+03	0.0	505
53	7.1141414e+03	4.8391847e-02	1.00e+00	1.736e+03	0.0	501
54	6.2663064e+03	9.5889712e+00	1.00e+00	2.586e+03	0.0	4116
55	4.8288468e+03	1.4553550e+00	1.00e+00	4.284e+02	0.0	34204
56	4.7338552e+03	1.7638172e+00	1.00e+00	4.201e+02	0.0	34040
57	4.5868118e+03	1.0391048e+00	1.00e+00	4.032e+02	0.0	17936
58	4.5957550e+03	4.4401159e+00	1.00e+00	8.096e+02	0.0	8708
59	4.6330434e+03	3.9066014e+00	1.00e+00	1.154e+03	0.0	18409
60	4.4085376e+03	1.4882575e+00	1.00e+00	3.840e+02	0.0	10599
61	4.3912808e+03	1.3729084e+00	1.00e+00	3.811e+02	0.0	9712

62	4.3561593e+03	1.2350453e+00	1.00e+00	3.749e+02	0.0	8030
63	4.2283605e+03	2.1202421e+00	1.00e+00	5.607e+02	0.0	4493
64	4.3186629e+03	7.5766599e+00	1.00e+00	1.548e+03	-0.3	4816
65	4.2193824e+03	4.0241026e+00	1.00e+00	8.635e+02	0.0	5924
66	4.1870441e+03	1.0808756e+00	1.00e+00	3.429e+02	0.0	5484
67	4.1820492e+03	1.0630376e+00	1.00e+00	3.419e+02	0.0	5077
68	4.1456886e+03	1.1524913e+00	1.00e+00	3.758e+02	0.0	3978
69	4.1450043e+03	1.4269721e+00	1.00e+00	4.048e+02	-0.3	4110
70	4.1407623e+03	2.8154181e+00	1.00e+00	6.426e+02	0.0	4163
71	4.1249439e+03	9.7554355e-01	1.00e+00	3.295e+02	0.0	4057
72	4.1212436e+03	9.6830509e-01	1.00e+00	3.288e+02	0.0	3953
73	4.1156066e+03	9.6425724e-01	1.00e+00	3.276e+02	0.0	3788
74	4.0395397e+03	7.1335355e+00	1.00e+00	1.407e+03	0.0	2307
75	4.0241204e+03	4.7377690e+00	1.00e+00	9.857e+02	-0.3	2575
76	3.9920879e+03	1.9540374e+00	1.00e+00	5.176e+02	0.0	3487
77	3.9858694e+03	7.2563404e-01	1.00e+00	3.140e+02	0.0	3272
78	3.9816722e+03	9.6264529e-01	1.00e+00	3.451e+02	0.0	3055
79	3.9733313e+03	1.4209945e+00	1.00e+00	3.934e+02	0.0	2604
80	3.9824778e+03	5.0294189e+00	1.00e+00	9.845e+02	-0.3	2534
81	3.9717162e+03	2.5170752e+00	1.00e+00	5.710e+02	0.0	2506
82	3.9650297e+03	9.2558861e-01	1.00e+00	3.234e+02	0.0	2565
83	3.9640291e+03	8.2794804e-01	1.00e+00	3.074e+02	0.0	2457
84	3.9569559e+03	6.8660409e-01	1.00e+00	2.831e+02	0.0	2304
85	3.9644307e+03	7.0706374e+00	1.00e+00	1.293e+03	-0.3	2305
86	3.9486390e+03	7.7129471e-01	1.00e+00	3.015e+02	-0.3	2462
87	3.9447332e+03	6.8653044e-01	1.00e+00	2.839e+02	0.0	2500
88	3.9426833e+03	7.0351912e-01	1.00e+00	2.857e+02	0.0	2332
89	3.9337729e+03	6.3714608e-01	1.00e+00	2.762e+02	0.0	2116
90	3.9311295e+03	1.9828560e+00	1.00e+00	4.811e+02	-0.3	2153
91	3.9343325e+03	1.9319151e+00	1.00e+00	4.758e+02	0.0	2179
92	3.9263772e+03	1.2296925e+00	1.00e+00	3.653e+02	0.0	2381
93	3.9247775e+03	6.3516714e-01	1.00e+00	2.740e+02	0.0	2221
94	3.9238999e+03	6.3178098e-01	1.00e+00	2.737e+02	0.0	2148
95	3.9107420e+03	6.8325453e-01	1.00e+00	2.850e+02	0.0	1938
96	3.9203170e+03	4.0755798e+00	1.00e+00	7.967e+02	-0.3	1981
97	3.9107382e+03	3.3500001e+00	1.00e+00	6.859e+02	-0.3	2169
98	3.9030225e+03	6.1110339e-01	1.00e+00	2.671e+02	0.0	2401
99	3.9021225e+03	6.0358974e-01	1.00e+00	2.668e+02	0.0	2184
100	3.9005281e+03	6.2670215e-01	1.00e+00	2.724e+02	0.0	2032
101	3.8906889e+03	2.0195585e+00	1.00e+00	4.876e+02	0.0	1766
102	3.8848373e+03	1.2510935e+00	1.00e+00	3.739e+02	-0.3	2015
103	3.8807659e+03	6.7617783e-01	1.00e+00	2.816e+02	0.0	2098
104	3.8796271e+03	6.1091021e-01	1.00e+00	2.724e+02	0.0	1951
105	3.8788049e+03	5.6786742e-01	1.00e+00	2.656e+02	0.0	1870
106	3.8739537e+03	9.1350066e-01	1.00e+00	3.162e+02	0.0	1735
107	3.8755250e+03	2.1006523e+00	1.00e+00	4.938e+02	-0.3	1787
108	3.8731490e+03	1.9657475e+00	1.00e+00	4.736e+02	0.0	1806
109	3.8706544e+03	5.3836942e-01	1.00e+00	2.593e+02	0.0	1793
110	3.8702411e+03	5.3184400e-01	1.00e+00	2.584e+02	0.0	1769
111	3.8674957e+03	5.2491501e-01	1.00e+00	2.582e+02	0.0	1714
112	3.8654796e+03	6.4477221e+00	1.00e+00	1.129e+03	-0.3	1469
113	3.8490178e+03	1.2477744e+00	1.00e+00	3.610e+02	-0.3	1729
114	3.8410411e+03	5.7417110e-01	1.00e+00	2.573e+02	0.0	2442
115	3.8391846e+03	4.9366475e-01	1.00e+00	2.466e+02	0.0	2080

116	3.8373912e+03	4.7987834e-01	1.00e+00	2.469e+02	0.0	1807
117	3.8364002e+03	8.3011915e-01	1.00e+00	3.015e+02	0.0	1624
118	3.8365824e+03	2.2033943e+00	1.00e+00	5.032e+02	-0.3	1630
119	3.7190995e+03	2.4778183e+00	1.00e+00	2.419e+02	0.0	34171
120	3.6082128e+03	1.8654112e+00	1.00e+00	2.300e+02	0.0	34235
121	3.3863571e+03	1.0479994e+01	1.00e+00	7.256e+02	0.0	31930
122	3.6184246e+03	1.8404754e+01	1.00e+00	1.763e+03	-0.3	25157
123	3.2184902e+03	3.1559486e+00	1.00e+00	2.509e+02	0.0	24231
124	3.1953946e+03	2.0542257e+00	1.00e+00	2.028e+02	0.0	23000
125	3.1622743e+03	1.9867526e+00	1.00e+00	1.997e+02	0.0	19670
126	3.0581925e+03	1.2347014e+01	1.00e+00	9.144e+02	0.0	5583
127	3.1821037e+03	2.9114458e+01	1.00e+00	1.851e+03	-0.3	6812
128	2.9878939e+03	1.4755231e+01	1.00e+00	9.445e+02	0.0	13600
129	2.9253013e+03	1.6591781e+00	1.00e+00	1.752e+02	0.0	11118
130	2.9199819e+03	1.6389660e+00	1.00e+00	1.758e+02	0.0	9760
131	2.8953823e+03	4.8362713e+00	1.00e+00	3.437e+02	0.0	5911
132	2.8834576e+03	1.7707633e+00	1.00e+00	1.684e+02	-0.3	6603
133	2.8780581e+03	1.7147206e+00	1.00e+00	1.735e+02	0.0	6542
134	2.8749384e+03	1.6756889e+00	1.00e+00	1.709e+02	0.0	6037
135	2.8690408e+03	2.2797521e+00	1.00e+00	2.051e+02	0.0	5569
136	2.8726265e+03	9.5089638e+00	1.00e+00	5.735e+02	-0.3	5192
137	2.8609944e+03	4.6974212e+00	1.00e+00	3.288e+02	-0.3	5528
138	2.8574951e+03	1.6163336e+00	1.00e+00	1.680e+02	0.0	5218
139	2.8560696e+03	1.6107960e+00	1.00e+00	1.680e+02	0.0	5117
140	2.8423615e+03	1.5848314e+00	1.00e+00	1.665e+02	0.0	4604
141	2.8417609e+03	1.0291048e+01	1.00e+00	6.129e+02	-0.3	4611
142	2.8315479e+03	2.8112640e+00	1.00e+00	2.289e+02	-0.3	5013
143	2.8289956e+03	1.4804401e+00	1.00e+00	1.609e+02	0.0	4931
144	2.8271159e+03	1.4956339e+00	1.00e+00	1.616e+02	0.0	4738
145	2.8202172e+03	3.3133909e+00	1.00e+00	2.518e+02	0.0	4331
146	2.8225276e+03	7.9258348e+00	1.00e+00	4.821e+02	-0.3	4390
147	2.8186613e+03	7.2473031e+00	1.00e+00	4.498e+02	0.0	4371
148	2.8146700e+03	1.4790666e+00	1.00e+00	1.596e+02	0.0	4309
149	2.8139170e+03	1.4726912e+00	1.00e+00	1.593e+02	0.0	4264
150	2.8070158e+03	1.4513190e+00	1.00e+00	1.580e+02	0.0	4028
151	2.8033305e+03	1.1663664e+01	1.00e+00	6.725e+02	-0.3	4029
152	2.8046209e+03	1.1876833e+01	1.00e+00	6.756e+02	-0.3	4232
153	2.7959090e+03	2.0738621e+00	1.00e+00	1.903e+02	0.0	4351
154	2.7950997e+03	1.3558108e+00	1.00e+00	1.544e+02	0.0	4147
155	2.7932312e+03	1.3660634e+00	1.00e+00	1.541e+02	0.0	3988
156	2.7772484e+03	1.7905652e+01	1.00e+00	9.579e+02	0.0	3128
157	2.7748368e+03	1.5638495e+01	1.00e+00	8.518e+02	-0.3	3509
158	2.7624235e+03	2.0082321e+00	1.00e+00	1.828e+02	0.0	4110
159	2.7615111e+03	1.2058556e+00	1.00e+00	1.449e+02	0.0	3636
160	2.7599361e+03	1.1950614e+00	1.00e+00	1.446e+02	0.0	3343
161	2.7548143e+03	2.7374357e+00	1.00e+00	2.180e+02	0.0	3087
162	2.7609437e+03	1.2461408e+01	1.00e+00	6.864e+02	-0.3	3147
163	2.7586881e+03	1.2802092e+01	1.00e+00	7.028e+02	0.0	3257
164	2.7517012e+03	1.3365294e+00	1.00e+00	1.513e+02	0.0	3268
165	2.7513763e+03	1.1469524e+00	1.00e+00	1.422e+02	0.0	3179
166	2.7488456e+03	1.1275410e+00	1.00e+00	1.410e+02	0.0	3032
167	2.7450280e+03	5.5379359e+00	1.00e+00	3.534e+02	-0.3	3035
168	2.7434173e+03	2.9712592e+00	1.00e+00	2.271e+02	-0.3	3282
169	2.7405263e+03	1.8073101e+00	1.00e+00	1.735e+02	0.0	3489

```
  170  2.7400215e+03  1.0770305e+00   1.00e+00  1.389e+02     0.0    3244
  171  2.7394539e+03  1.0745990e+00   1.00e+00  1.386e+02     0.0    3141
  172  2.7348908e+03  3.7312618e+00   1.00e+00  2.630e+02     0.0    2826
  173  2.7337439e+03  1.6107056e+00   1.00e+00  1.633e+02    -0.3    2953
  174  2.7318292e+03  1.0439456e+00   1.00e+00  1.360e+02     0.0    2970
  175  2.7312964e+03  1.0422629e+00   1.00e+00  1.360e+02     0.0    2903
  176  2.7305309e+03  1.0317167e+00   1.00e+00  1.358e+02     0.0    2830
  177  2.7298503e+03  6.3798872e+00   1.00e+00  3.881e+02     0.0    2755
  178  2.7275381e+03  9.8671596e-01   1.00e+00  1.347e+02    -0.3    2819
  179  2.7262347e+03  9.9967587e-01   1.00e+00  1.345e+02     0.0    2830
  180  2.7255454e+03  9.9975287e-01   1.00e+00  1.344e+02     0.0    2754
  181  2.7241494e+03  1.4665538e+00   1.00e+00  1.564e+02     0.0    2720
  182  2.7235919e+03  1.5821620e+00   1.00e+00  1.615e+02    -0.3    2733
  183  2.7231729e+03  2.0138802e+00   1.00e+00  1.819e+02     0.0    2730
  184  2.7227787e+03  1.3160510e+00   1.00e+00  1.491e+02     0.0    2716
  185  2.7224533e+03  9.8197411e-01   1.00e+00  1.335e+02     0.0    2710
  186  2.7220820e+03  9.8053324e-01   1.00e+00  1.334e+02     0.0    2698
  187  2.7214398e+03  2.2379031e+00   1.00e+00  1.923e+02     0.0    2670
  188  2.7214396e+03  4.3461889e+00   1.00e+00  2.908e+02    -0.3    2665
  189  2.6519470e+03  5.2730113e+00   1.00e+00  2.119e+02     0.0   34146
  190  2.5441600e+03  1.0774755e+01   1.00e+00  4.072e+02     0.0   34253
  191  2.7119728e+03  5.8751841e+01   1.00e+00  1.971e+03     0.0   30358
  192  2.5564625e+03  4.7746911e+01   1.00e+00  1.628e+03     0.0   31352
  193  2.2908444e+03  2.8056141e+00   1.00e+00  1.158e+02     0.0   29509
  194  2.2801081e+03  2.7256487e+00   1.00e+00  1.159e+02     0.0   27539
  195  2.1731644e+03  6.5068491e+00   1.00e+00  2.072e+02     0.0   13372
  196  2.2306649e+03  3.9408538e+01   1.00e+00  9.593e+02    -0.3   14108
  197  2.1760037e+03  2.1183972e+01   1.00e+00  5.367e+02     0.0   15856
  198  2.1563438e+03  2.6881357e+00   1.00e+00  1.075e+02     0.0   14105
  199  2.1527225e+03  2.6686526e+00   1.00e+00  1.077e+02     0.0   13381
  200  2.1168526e+03  4.5952921e+00   1.00e+00  1.543e+02     0.0    9578

 ERROR EXIT -- Too many iterations

 Products with A     :     280        Total time   (secs) :   109.9
 Products with A'    :     201        Project time (secs) :     1.2
 Newton iterations   :       4        Mat-vec time (secs) :   107.1
 Line search its     :     131        Subspace iterations :       0


 ================================================================================
 PQNL1_SLIM v. 46  (Tue, 14 Jun 2011) based on v.1017
 ================================================================================
 No. rows              :     6400      No. columns           :    34341
 Initial tau           : 0.00e+00      Two-norm of b         : 1.41e+04
 Optimality tol        : 1.00e-04      Target objective      : 0.00e+00
 Basis pursuit tol     : 1.00e-06      Maximum iterations    :      200

     0  1.4084813e+04  0.0000000e+00   1.00e+00  9.574e+03     0.0       0

Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2        O
         1          1           4     2.50000e-01     1.36957e+04     2.590
         2          1          14     1.00000e+00     7.79483e+03     3.833
```

```
         3           1          24     1.00000e+00     7.63809e+03     3.445
         4           1          34     1.00000e+00     7.49893e+03     3.479
         5           1          42     1.00000e+00     7.44831e+03     3.337
         6           1          52     1.00000e+00     7.40478e+03     3.369
         7           1          62     1.00000e+00     7.37128e+03     3.300
         8           1          74     1.00000e+00     7.33864e+03     3.117
         9           1          89     1.00000e+00     7.31208e+03     3.126
        10           1         103     1.00000e+00     7.28791e+03     2.871
        11           1         115     1.00000e+00     7.26568e+03     2.559
        12           1         127     1.00000e+00     7.24765e+03     2.382
        13           1         138     1.00000e+00     7.23255e+03     2.259
        14           1         151     1.00000e+00     7.21979e+03     2.099
        15           1         164     1.00000e+00     7.20832e+03     2.044
        16           1         177     1.00000e+00     7.19815e+03     1.956
        17           1         190     1.00000e+00     7.18833e+03     1.869
        18           1         203     1.00000e+00     7.17902e+03     1.734
        19           1         217     1.00000e+00     7.17115e+03     1.600
        20           1         229     1.00000e+00     7.16352e+03     1.563
        21           1         244     1.00000e+00     7.15901e+03     1.495
        22           1         261     1.00000e+00     7.15284e+03     1.379
        23           1         275     1.00000e+00     7.14742e+03     1.319
        24           1         287     1.00000e+00     7.14320e+03     1.278
        25           1         301     1.00000e+00     7.13887e+03     1.201
        26           1         319     1.00000e+00     7.13536e+03     1.097
break of testUpdateTau    26  7.1353650e+03  7.9297600e-02   1.00e+00  1.7

Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2        O
        27           1           4     5.00000e-01     5.96522e+03     8.355
        28           1          16     1.00000e+00     4.84912e+03     8.951
        29           1          25     1.00000e+00     4.76862e+03     8.795
        30           1          38     1.00000e+00     4.61176e+03     7.185
        31           1          54     1.00000e+00     4.54177e+03     6.597
        32           1          69     1.00000e+00     4.46268e+03     6.462
        33           1          83     1.00000e+00     4.38276e+03     5.869
        34           1          98     1.00000e+00     4.32760e+03     5.618
        35           1         115     1.00000e+00     4.27937e+03     5.303
        36           1         125     1.00000e+00     4.22560e+03     4.785
        37           1         139     1.00000e+00     4.18439e+03     4.500
        38           1         159     1.00000e+00     4.14109e+03     4.167
        39           1         183     1.00000e+00     4.09556e+03     3.935
        40           1         202     1.00000e+00     4.06138e+03     3.754
        41           1         227     1.00000e+00     4.03206e+03     3.368
        42           1         256     1.00000e+00     4.00120e+03     3.203
        43           1         277     1.00000e+00     3.97958e+03     2.920
        44           1         297     1.00000e+00     3.96332e+03     2.678
        45           1         322     1.00000e+00     3.94885e+03     2.653
        46           1         342     1.00000e+00     3.93529e+03     2.614
        47           1         369     1.00000e+00     3.92098e+03     2.429
        48           1         390     1.00000e+00     3.90648e+03     2.235
        49           1         403     1.00000e+00     3.89535e+03     2.091
        50           1         417     1.00000e+00     3.88795e+03     2.025
        51           1         434     1.00000e+00     3.88027e+03     1.966
        52           1         460     1.00000e+00     3.87189e+03     1.936
```

```
          53           1         489     1.00000e+00     3.86479e+03     1.865
          54           1         511     1.00000e+00     3.85725e+03     1.701
          55           1         545     1.00000e+00     3.85158e+03     1.571
          56           1         577     1.00000e+00     3.84537e+03     1.486
          57           1         607     1.00000e+00     3.84001e+03     1.447
          58           1         639     1.00000e+00     3.83543e+03     1.394
          59           1         663     1.00000e+00     3.83082e+03     1.357
          60           1         685     1.00000e+00     3.82661e+03     1.280
          61           1         711     1.00000e+00     3.82201e+03     1.291
          62           1         729     1.00000e+00     3.81762e+03     1.262
          63           1         751     1.00000e+00     3.81541e+03     1.198
          64           1         779     1.00000e+00     3.81255e+03     1.103
          65           1         804     1.00000e+00     3.80991e+03     1.178
          66           1         820     1.00000e+00     3.80770e+03     1.113
          67           1         840     1.00000e+00     3.80524e+03     1.100
          68           1         859     1.00000e+00     3.80301e+03     1.104
          69           1         886     1.00000e+00     3.80084e+03     1.090
          70           1         920     1.00000e+00     3.79851e+03     1.110
          71           1         940     1.00000e+00     3.79644e+03     1.037
          72           1         975     1.00000e+00     3.79441e+03     9.731
          73           1        1007     1.00000e+00     3.79183e+03     1.005
          74           1        1031     1.00000e+00     3.78978e+03     9.349
          75           1        1064     1.00000e+00     3.78757e+03     8.579
          76           1        1101     1.00000e+00     3.78559e+03     9.436
          77           1        1134     1.00000e+00     3.78378e+03     9.404
break of testUpdateTau    77  3.7837756e+03  3.9803612e-01   1.00e+00  2.4

Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2        O
          78           1           4     6.25000e-02     3.72679e+03     1.317
          79           1          11     1.00000e+00     3.63120e+03     1.184
          80           1          22     1.00000e+00     3.37605e+03     1.239
          81           1          44     1.00000e+00     2.88798e+03     1.954
          82           1          57     1.00000e+00     2.70815e+03     1.614
          83           1          69     1.00000e+00     2.59875e+03     9.140
          84           1          80     1.00000e+00     2.56033e+03     1.075
          85           1          96     1.00000e+00     2.51115e+03     1.199
          86           1         119     1.00000e+00     2.42593e+03     1.118
          87           1         144     1.00000e+00     2.30241e+03     9.836
          88           1         163     1.00000e+00     2.26701e+03     6.427
          89           1         186     1.00000e+00     2.24004e+03     6.768
          90           1         205     1.00000e+00     2.21472e+03     7.341
          91           1         227     1.00000e+00     2.18209e+03     6.698
          92           1         251     1.00000e+00     2.14662e+03     5.126
          93           1         273     1.00000e+00     2.12242e+03     4.572
          94           1         297     1.00000e+00     2.10195e+03     4.464
          95           1         317     1.00000e+00     2.07817e+03     4.196
          96           1         331     1.00000e+00     2.05957e+03     4.010
          97           1         354     1.00000e+00     2.04224e+03     3.911
          98           1         376     1.00000e+00     2.02186e+03     3.523
          99           1         403     1.00000e+00     2.00619e+03     3.083
         100           1         422     1.00000e+00     1.99361e+03     3.083
         101           1         442     1.00000e+00     1.98035e+03     3.144
         102           1         462     1.00000e+00     1.96715e+03     2.820
```

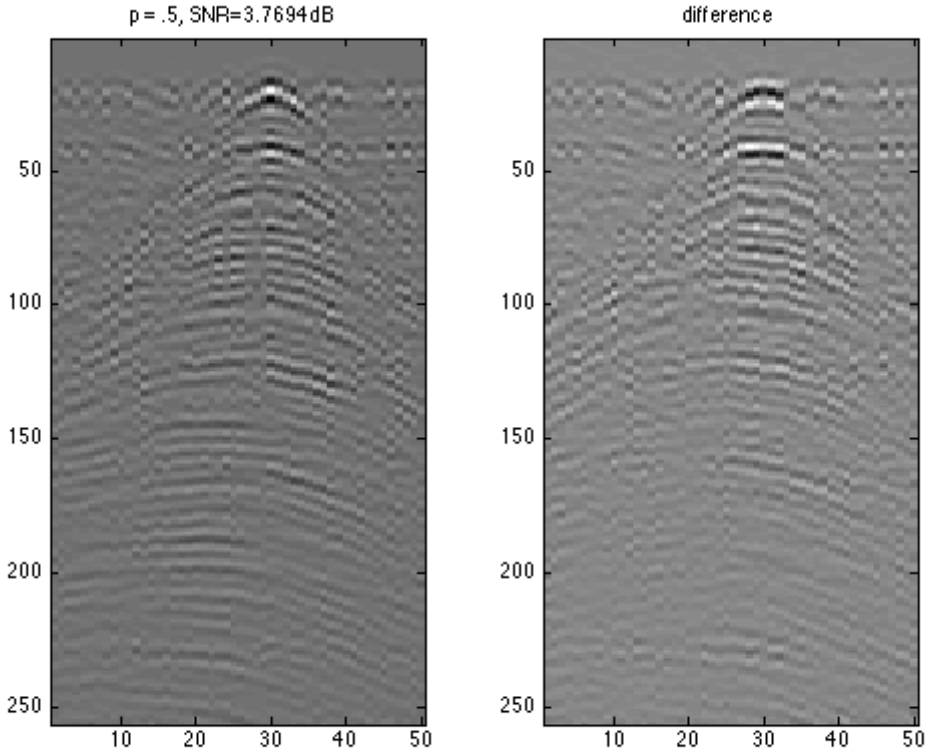
```
        103          1        482     1.00000e+00     1.95441e+03     2.536
        104          1        507     1.00000e+00     1.94459e+03     2.542
        105          1        533     1.00000e+00     1.93588e+03     2.525
        106          1        564     1.00000e+00     1.92565e+03     2.349
        107          1        596     1.00000e+00     1.91769e+03     2.186
        108          1        617     1.00000e+00     1.91050e+03     2.235
        109          1        644     1.00000e+00     1.90391e+03     2.176
        110          1        686     1.00000e+00     1.89742e+03     2.038
        111          1        715     1.00000e+00     1.89167e+03     1.970
        112          1        754     1.00000e+00     1.88554e+03     1.902
        113          1        786     1.00000e+00     1.88062e+03     1.832
        114          1        825     1.00000e+00     1.87621e+03     1.882
        115          1        862     1.00000e+00     1.87160e+03     1.782
        116          1        889     1.00000e+00     1.86651e+03     1.657
        117          1        894     1.00000e+00     1.86527e+03     2.137
        118          1        920     1.00000e+00     1.86264e+03     2.159
        119          1        957     1.00000e+00     1.85731e+03     1.722
        120          1        989     1.00000e+00     1.85281e+03     1.736
        121          1       1015     1.00000e+00     1.84992e+03     1.780
        122          1       1053     1.00000e+00     1.84637e+03     1.548
        123          1       1099     1.00000e+00     1.84309e+03     1.495
        124          1       1130     1.00000e+00     1.84038e+03     1.473
        125          1       1162     1.00000e+00     1.83776e+03     1.411
        126          1       1186     1.00000e+00     1.83547e+03     1.376
        127          1       1210     1.00000e+00     1.83270e+03     1.339
        128          1       1248     1.00000e+00     1.83019e+03     1.254
        129          1       1291     1.00000e+00     1.82737e+03     1.276
        130          1       1317     1.00000e+00     1.82462e+03     1.346
        131          1       1346     1.00000e+00     1.82200e+03     1.367
        132          1       1374     1.00000e+00     1.81980e+03     1.241
        133          1       1410     1.00000e+00     1.81791e+03     1.132
        134          1       1436     1.00000e+00     1.81603e+03     1.133
        135          1       1486     1.00000e+00     1.81391e+03     1.233
        136          1       1516     1.00000e+00     1.81161e+03     1.268
        137          1       1559     1.00000e+00     1.80902e+03     1.143
        138          1       1592     1.00000e+00     1.80698e+03     1.056
        139          1       1621     1.00000e+00     1.80537e+03     1.081
        140          1       1656     1.00000e+00     1.80395e+03     1.067
        141          1       1666     1.00000e+00     1.80307e+03     9.033
break of testUpdateTau   141  1.8030659e+03  1.0006624e+00   1.00e+00  6.0

Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2        O
        142          1          4     1.25000e-01     1.75259e+03     2.246
        143          1         16     1.00000e+00     1.65051e+03     1.525
        144          1         30     1.00000e+00     1.33839e+03     1.012
        145          1         59     1.00000e+00     1.13930e+03     1.461
        146          1         75     1.00000e+00     1.00978e+03     1.197
        147          1        101     1.00000e+00     9.78581e+02     8.075
        148          1        131     1.00000e+00     9.64685e+02     6.182
        149          1        150     1.00000e+00     9.40131e+02     3.917
        150          1        171     1.00000e+00     9.25190e+02     4.318
        151          1        196     1.00000e+00     9.11793e+02     4.569
        152          1        222     1.00000e+00     8.89043e+02     3.542
```

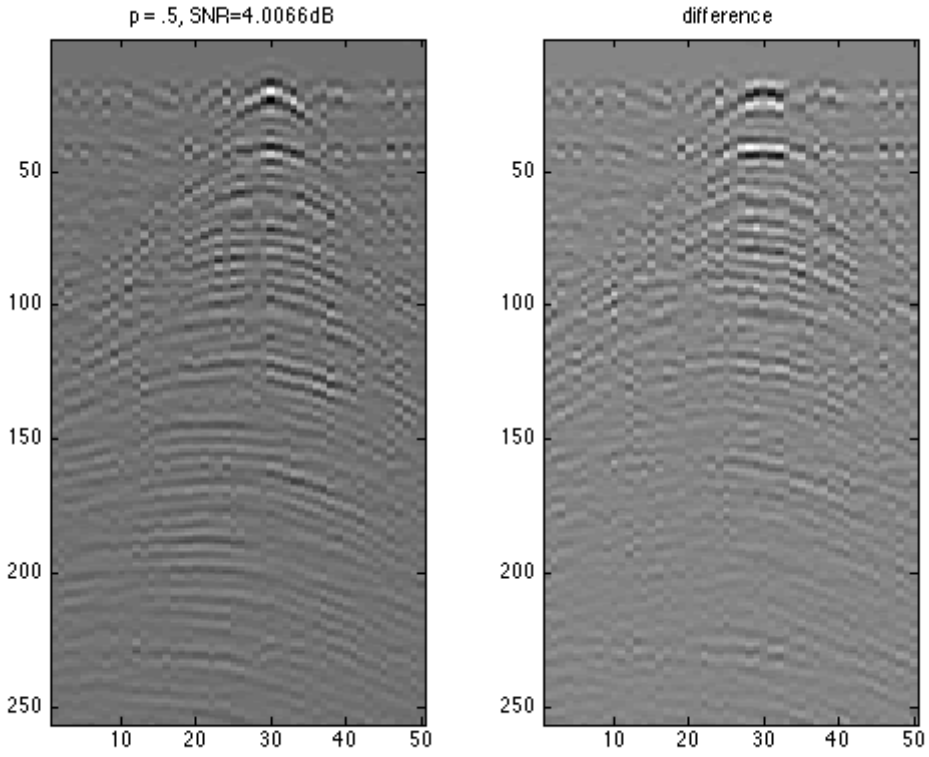
```
   153          1          248     1.00000e+00     8.74927e+02     3.343
   154          1          280     1.00000e+00     8.66669e+02     3.699
   155          1          309     1.00000e+00     8.55239e+02     3.362
   156          1          337     1.00000e+00     8.43472e+02     2.748
   157          1          373     1.00000e+00     8.35266e+02     2.315
   158          1          402     1.00000e+00     8.28392e+02     2.742
   159          1          433     1.00000e+00     8.21819e+02     3.076
   160          1          471     1.00000e+00     8.13214e+02     2.780
   161          1          510     1.00000e+00     8.05763e+02     2.179
   162          1          526     1.00000e+00     8.01619e+02     1.986
   163          1          561     1.00000e+00     7.97839e+02     2.387
   164          1          606     1.00000e+00     7.93784e+02     2.742
   165          1          647     1.00000e+00     7.88452e+02     2.551
   166          1          685     1.00000e+00     7.82368e+02     1.688
   167          1          736     1.00000e+00     7.78363e+02     1.692
   168          1          772     1.00000e+00     7.75059e+02     2.061
   169          1          792     1.00000e+00     7.72248e+02     2.185
   170          1          851     1.00000e+00     7.68296e+02     2.172
   171          1          878     1.00000e+00     7.63368e+02     1.716
   172          1          919     1.00000e+00     7.59326e+02     1.346
   173          1          965     1.00000e+00     7.56474e+02     1.479
   174          1         1016     1.00000e+00     7.53854e+02     1.601
   175          1         1054     1.00000e+00     7.50907e+02     1.599
   176          1         1114     1.00000e+00     7.47798e+02     1.349
   177          1         1153     1.00000e+00     7.45012e+02     1.426
   178          1         1186     1.00000e+00     7.43131e+02     1.721
   179          1         1233     1.00000e+00     7.40923e+02     1.994
   180          1         1270     1.00000e+00     7.38720e+02     1.869
   181          1         1302     1.00000e+00     7.36507e+02     1.466
   182          1         1334     1.00000e+00     7.34523e+02     1.123
   183          1         1385     1.00000e+00     7.32532e+02     1.133
   184          1         1430     1.00000e+00     7.30870e+02     1.274
   185          1         1487     1.00000e+00     7.29084e+02     1.372
   186          1         1519     1.00000e+00     7.27759e+02     1.125
   187          1         1553     1.00000e+00     7.25978e+02     9.832
   188          1         1585     1.00000e+00     7.24277e+02     1.249
   189          1         1620     1.00000e+00     7.22826e+02     1.231
   190          1         1666     1.00000e+00     7.20627e+02     1.204
   191          1         1707     1.00000e+00     7.18814e+02     1.145
   192          1         1745     1.00000e+00     7.16994e+02     9.950
   193          1         1794     1.00000e+00     7.15600e+02     9.338
   194          1         1856     1.00000e+00     7.14284e+02     9.795
   195          1         1880     1.00000e+00     7.13320e+02     9.485
   196          1         1936     1.00000e+00     7.11879e+02     9.793
   197          1         1981     1.00000e+00     7.10398e+02     1.084
   198          1         2041     1.00000e+00     7.08851e+02     1.072
   199          1         2091     1.00000e+00     7.07362e+02     1.008
   200          1         2142     1.00000e+00     7.05908e+02     9.449
 200  7.0590820e+02  5.9379470e+00   1.00e+00  2.121e+01     0.0    7651

ERROR EXIT -- Too many iterations

Products with A     :     215        Total time   (secs) :   411.0
Products with A'    :     215        Project time (secs) :   312.0
```

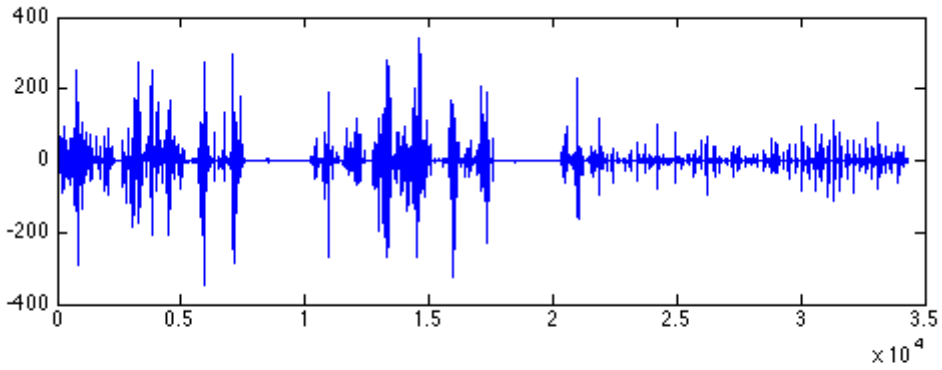
```
 Newton iterations   :       5        Mat-vec time (secs) :    97.8
```

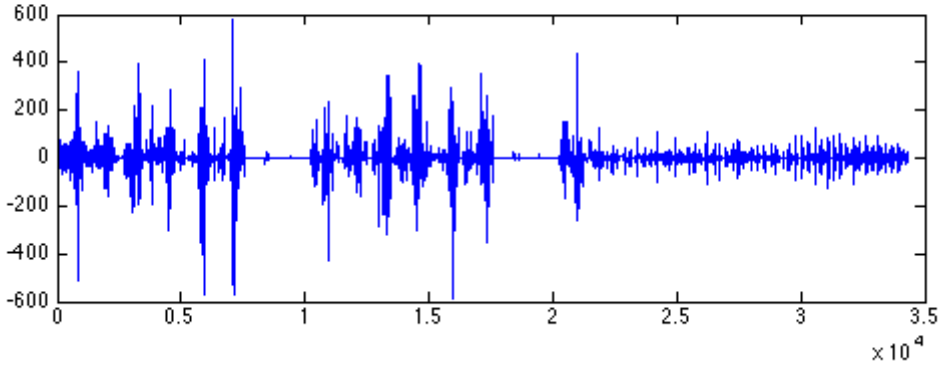
```
info_spg =

           tau: 1.0460e+05
         rNorm: 2.1169e+03
          rGap: 4.5953
         gNorm: 154.3037
          stat: 5
          iter: 200
        nProdA: 280
       nProdAt: 201
       nNewton: 4
   timeProject: 1.2461
   timeMatProd: 107.1231
       itnLSQR: 0
       options: [1x1 struct]
     timeTotal: 109.9000
         xNorm1: [200x1 double]
         rNorm2: [200x1 double]
         lambda: [200x1 double]
```

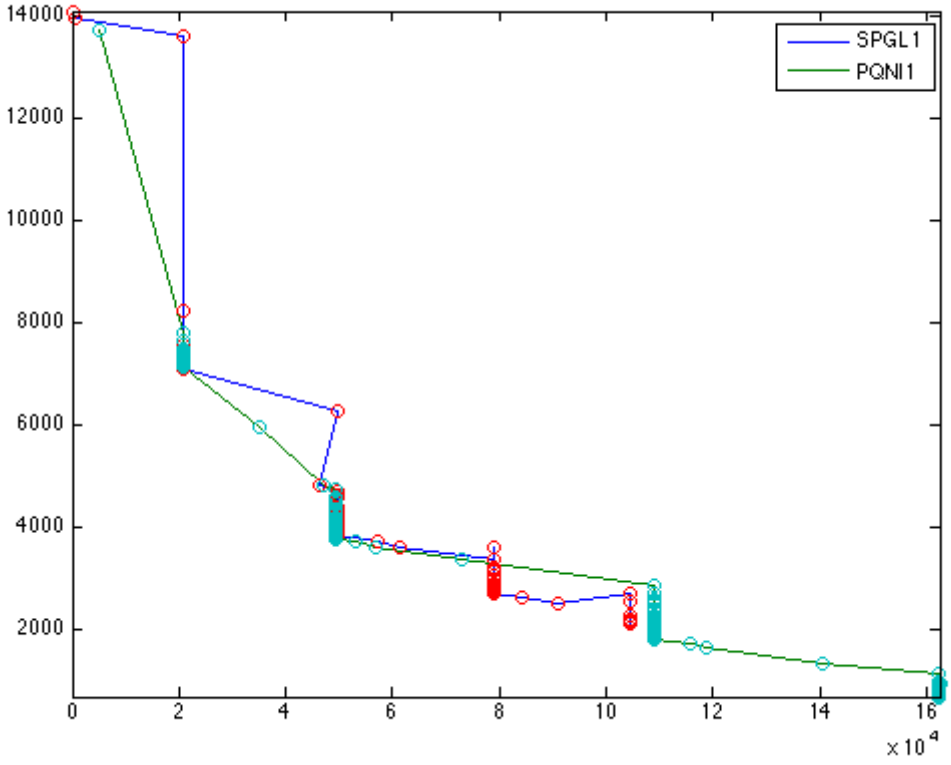
```
info_pqn1 =

           tau: 1.8589e+05
         rNorm: 705.9082
          rGap: 5.9379
         gNorm: 21.2061
          stat: 5
          iter: 200
        nProdA: 215
       nProdAt: 215
       nNewton: 5
   timeProject: 312.0170
   timeMatProd: 97.8327
       itnLSQR: 0
       options: [1x1 struct]
     timeTotal: 410.9630
         xNorm1: [200x1 double]
         rNorm2: [200x1 double]
         lambda: [200x1 double]
```


p = .5, SNR=3.7694dB
difference
50
100
150
200
250
10
20
30
40
50


p = .5, SNR=4.0066dB
difference
50
100
150
200
250
10
20
30
40
50


400
200
0
-200
-400
0
0.5
1
1.5
2
2.5
3
3.5
x 10^4


600
400
200
0
-200
-400
-600
0
0.5
1
1.5
2
2.5
3
3.5
x 10^4


SPGL1
PQNI1
14000
12000
10000
8000
6000
4000
2000
0
2
4
6
8
10
12
14
16
x 10^4

if given known strict sparse vector

```
[m n] = size(A); k = .2*round(n/log(m));
p = randperm(n); x0 = zeros(n,1); x0(p(1:k)) = sign(randn(k,1));
figure;plot(x0)
b0  = A*x0;

tau = norm(x0,1);

options = spgSetParms('optTol', 1e-4, 'iterations', 200);%, 'fid', fid);
xinit = zeros(size(A,2),1);

xestspg = spgl1(A,b0,tau,[],xinit,options);
xestpqn = pqnl1_2(A,b0,tau,[],xinit,options);
snrspg = SNR(x0,xestspg);
snrpqn = SNR(x0,xestpqn);

figure('Name','strcit sparse vector SPG');
subplot(2,1,1);plot(xestspg);
title(strcat(['p = .5, SNR=' num2str(snrspg) 'dB']))
subplot(2,1,2);plot(xestspg - x0);
title('difference')

figure('Name','strcit sparse vector PQN');
subplot(2,1,1);plot(xestpqn);
title(strcat(['p = .5, SNR=' num2str(snrpqn) 'dB']))
subplot(2,1,2);plot(xestpqn - x0);
title('difference')


% BPDN
[x_spg,r_spg,g_spg,info_spg] = spgl1(A, b0, 0, 0, zeros(size(A,2),1), options); %

[x_pqn1,r_pqn1,g_pqn1,info_pqn1] = pqnl1_2(A, b0, 0, 0, zeros(size(A,2),1), option

figure; subplot(2,1,1);plot(x_spg);subplot(2,1,2);plot(x_pqn1);
info_spg
info_pqn1

% show result
figure('Name','Solution paths')
plot(info_spg.xNorm1,info_spg.rNorm2,info_pqn1.xNorm1,info_pqn1.rNorm2);hold on
scatter(info_spg.xNorm1,info_spg.rNorm2);
scatter(info_pqn1.xNorm1,info_pqn1.rNorm2);hold off
legend('SPGL1','PQNl1')
axis tight
```

```
Warning: Size vector should be a row vector with integer
elements.
Warning: Integer operands are required for colon operator
when used as index

 ================================================================================
```

```
SPGL1_SLIM v. 46  (Tue, 14 Jun 2011) based on v.1017
================================================================================
No. rows              :     6400      No. columns           :    34341
Initial tau           : 7.83e+02      Two-norm of b         : 5.10e+01
Optimality tol        : 1.00e-04      Target one-norm of x  : 7.83e+02
Basis pursuit tol     : 1.00e-06      Maximum iterations    :      200

 Iter      Objective   Relative Gap      gNorm   stepG    nnzX    nnzG
    0  5.1038083e+01  1.9796465e+01  3.29e+01     0.0       0       0
    1  4.0314386e+01  4.0561824e+01  4.09e+01    -0.3    3814       0
    2  2.4399445e+01  1.9374727e+01  7.33e+00     0.0   21781       0
    3  2.3373169e+01  9.9834699e+00  3.52e+00     0.0   24138       0
    4  2.2775825e+01  1.0035158e+01  3.38e+00     0.0   26724       0
    5  1.2289066e+01  2.7514471e+01  3.01e+00     0.0   25171       0
    6  1.4135349e+01  5.9918509e+01  7.27e+00    -0.3   26300       0
    7  1.1156419e+01  3.7528042e+01  3.22e+00     0.0   27310       0
    8  1.0242876e+01  1.0601423e+01  8.11e-01     0.0   27207       0
    9  1.0136832e+01  1.0650021e+01  8.01e-01     0.0   27488       0
   10  1.0014642e+01  4.8204637e+01  3.49e+00     0.0   21156       0
   11  7.7292720e+00  3.8791694e+01  1.61e+00    -0.3   22675       0
   12  7.4514116e+00  1.9591045e+01  8.17e-01     0.0   23505       0
   13  7.3772236e+00  1.8794060e+01  7.78e-01     0.0   22904       0
   14  7.3271843e+00  1.8302722e+01  7.53e-01     0.0   22676       0
   15  6.5524537e+00  2.3182766e+01  6.93e-01     0.0   19146       0
   16  6.8684486e+00  5.1782380e+01  1.75e+00    -0.3   20911       0
   17  6.4145375e+00  1.2661087e+01  4.15e-01     0.0   19297       0
   18  6.3775690e+00  1.1635567e+01  4.03e-01     0.0   19373       0
   19  6.3503633e+00  1.1703933e+01  4.03e-01     0.0   19288       0
   20  5.7314581e+00  7.7942835e+01  1.75e+00     0.0   14435       0
   21  5.3886848e+00  9.4182832e+01  1.82e+00    -0.3   16501       0
   22  4.8985636e+00  4.9717526e+01  8.31e-01     0.0   17066       0
   23  4.7749463e+00  1.2107285e+01  2.52e-01     0.0   16533       0
   24  4.7599449e+00  1.2007051e+01  2.50e-01     0.0   16466       0
   25  4.6013953e+00  3.0544173e+01  4.68e-01     0.0   15312       0
   26  4.5617710e+00  2.9789094e+01  4.80e-01    -0.3   15745       0
   27  4.5030465e+00  1.2645863e+01  2.31e-01     0.0   15390       0
   28  4.4924307e+00  1.2178808e+01  2.27e-01     0.0   15384       0
   29  4.4690301e+00  1.1904414e+01  2.22e-01     0.0   15278       0
   30  4.2886819e+00  8.3554792e+01  1.05e+00    -0.3   14142       0
   31  4.1747147e+00  7.0689650e+01  8.54e-01    -0.3   14744       0
   32  4.1139784e+00  1.6302798e+01  2.40e-01     0.0   14455       0
   33  4.1039594e+00  1.1337011e+01  1.88e-01     0.0   14457       0
   34  4.0849186e+00  1.1863462e+01  1.91e-01     0.0   14365       0
   35  4.0823889e+00  1.3050510e+02  1.45e+00    -0.3   13994       0
   36  4.0249732e+00  9.7679223e+01  1.08e+00    -0.3   14246       0
   37  3.9574514e+00  1.1919537e+01  1.81e-01     0.0   14018       0
   38  3.9515635e+00  1.2098636e+01  1.84e-01     0.0   14007       0
   39  3.9143437e+00  1.0945420e+01  1.70e-01     0.0   13817       0
   40  3.8897622e+00  5.4225256e+01  5.81e-01    -0.3   13808       0
   41  3.8618814e+00  2.4435688e+01  2.95e-01    -0.3   13818       0
   42  3.8528265e+00  1.2718926e+01  1.81e-01     0.0   13797       0
   43  3.8437217e+00  1.2122568e+01  1.76e-01     0.0   13768       0
   44  3.7723659e+00  7.7754524e+01  7.65e-01     0.0   13500       0
   45  3.8229412e+00  2.0274508e+02  1.95e+00    -0.3   13553       0
```

46	3.7475969e+00	5.0071682e+01	5.08e-01	0.0	13496	0
47	3.7394941e+00	1.2162748e+01	1.68e-01	0.0	13489	0
48	3.7343115e+00	1.2048831e+01	1.67e-01	0.0	13463	0
49	3.3623406e+00	2.4256782e+02	1.80e+00	0.0	12181	0
50	3.2934811e+00	1.8719848e+02	1.35e+00	-0.3	12389	0
51	3.2322792e+00	2.1969563e+01	1.97e-01	0.0	12279	0
52	3.2274677e+00	1.0821619e+01	1.22e-01	0.0	12286	0
53	3.2158532e+00	1.2048382e+01	1.30e-01	0.0	12268	0
54	3.1892153e+00	1.2155886e+02	8.40e-01	-0.3	12178	0
55	3.2219772e+00	2.0139047e+02	1.38e+00	-0.3	12223	0
56	3.1545103e+00	2.4226479e+01	2.03e-01	0.0	12158	0
57	3.1508500e+00	1.1304824e+01	1.21e-01	0.0	12153	0
58	3.1449309e+00	1.1356208e+01	1.21e-01	0.0	12138	0
59	2.9504984e+00	2.0218323e+02	1.17e+00	0.0	11710	0
60	3.0624495e+00	3.5104039e+02	2.15e+00	-0.3	12005	0
61	2.8759804e+00	5.5240969e+01	3.36e-01	0.0	11805	0
62	2.8682851e+00	1.2534109e+01	1.11e-01	0.0	11835	0
63	2.8641143e+00	1.2240680e+01	1.09e-01	0.0	11821	0
64	2.8497040e+00	1.5586374e+02	8.52e-01	0.0	11618	0
65	2.8228942e+00	1.5990296e+02	8.57e-01	-0.3	12016	0
66	2.7474454e+00	1.7887333e+01	1.28e-01	0.0	11767	0
67	2.7436358e+00	1.2038613e+01	1.00e-01	0.0	11782	0
68	2.7364068e+00	1.2828957e+01	1.04e-01	0.0	11747	0
69	2.7216059e+00	5.5425916e+01	3.04e-01	-0.3	11729	0
70	2.7203890e+00	6.4310721e+01	3.47e-01	-0.3	11673	0
71	2.7028765e+00	1.4271640e+01	1.08e-01	0.0	11701	0
72	2.7004680e+00	1.1662224e+01	9.60e-02	0.0	11686	0
73	2.6932235e+00	1.2672415e+01	1.00e-01	0.0	11660	0
74	2.6487914e+00	2.4533584e+02	1.14e+00	-0.3	11412	0
75	2.6247102e+00	2.0414352e+02	9.37e-01	-0.3	11595	0
76	2.5790268e+00	2.3988796e+01	1.42e-01	0.0	11479	0
77	2.5764747e+00	1.2283069e+01	9.18e-02	0.0	11482	0
78	2.5669366e+00	1.2784597e+01	9.38e-02	0.0	11451	0
79	2.5691901e+00	1.8005569e+02	7.92e-01	-0.3	11383	0
80	2.5529990e+00	1.4696483e+02	6.55e-01	-0.3	11458	0
81	2.5238943e+00	1.4478828e+01	9.72e-02	0.0	11379	0
82	2.5220436e+00	1.2374104e+01	8.89e-02	0.0	11381	0
83	2.5081860e+00	2.0310178e+01	1.21e-01	0.0	11343	0
84	2.5072415e+00	6.5398546e+01	2.99e-01	-0.3	11330	0
85	2.5031891e+00	5.9015758e+01	2.76e-01	-0.3	11337	0
86	2.4940271e+00	1.7133779e+01	1.06e-01	0.0	11330	0
87	2.4922674e+00	1.2338905e+01	8.72e-02	0.0	11327	0
88	2.4855245e+00	1.2559256e+01	8.79e-02	0.0	11304	0
89	2.4304650e+00	2.1770790e+02	8.50e-01	-0.3	11100	0
90	2.3643784e+00	8.3303774e+01	3.36e-01	-0.3	11279	0
91	2.3494312e+00	1.5663983e+01	9.06e-02	0.0	11207	0
92	2.3472630e+00	1.3071669e+01	8.17e-02	0.0	11204	0
93	2.3298857e+00	4.0290713e+01	1.77e-01	0.0	11108	0
94	2.3416220e+00	8.3765754e+01	3.27e-01	-0.3	11098	0
95	2.3216639e+00	3.5518551e+01	1.58e-01	0.0	11116	0
96	2.3175711e+00	1.2100243e+01	7.69e-02	0.0	11100	0
97	2.3158474e+00	1.2912724e+01	7.96e-02	0.0	11100	0
98	2.2705358e+00	8.0278452e+01	3.01e-01	0.0	10983	0
99	2.2950328e+00	1.4034744e+02	5.06e-01	-0.3	11137	0

100	2.2532244e+00	3.1732211e+01	1.37e-01	0.0	10996	0
101	2.2504594e+00	1.2269419e+01	7.38e-02	0.0	10993	0
102	2.2484315e+00	1.3441697e+01	7.76e-02	0.0	10993	0
103	2.2515657e+00	2.0812920e+02	7.12e-01	0.0	10915	0
104	2.2080046e+00	1.3784813e+02	4.63e-01	-0.3	11162	0
105	2.1729548e+00	2.0987734e+01	9.64e-02	0.0	11037	0
106	2.1711317e+00	1.5009286e+01	7.84e-02	0.0	11046	0
107	2.1640215e+00	1.7096040e+01	8.40e-02	0.0	11001	0
108	2.1581382e+00	5.2289886e+01	1.89e-01	-0.3	10990	0
109	2.1527809e+00	2.7960416e+01	1.16e-01	-0.3	10955	0
110	2.1502559e+00	1.2708890e+01	7.03e-02	0.0	10952	0
111	2.1475440e+00	1.6747093e+01	8.21e-02	0.0	10933	0
112	2.1430427e+00	1.7948880e+02	5.57e-01	0.0	10900	0
113	2.1435450e+00	1.8443441e+02	5.75e-01	-0.3	10909	0
114	2.1222817e+00	1.5189796e+01	7.57e-02	0.0	10883	0
115	2.1211729e+00	1.2388818e+01	6.77e-02	0.0	10879	0
116	2.1114144e+00	2.0375803e+01	9.03e-02	0.0	10843	0
117	2.1097548e+00	8.1444948e+01	2.63e-01	-0.3	10853	0
118	2.1084278e+00	8.1640015e+01	2.64e-01	-0.3	10841	0
119	2.1024214e+00	1.7525051e+01	8.13e-02	0.0	10839	0
120	2.1013016e+00	1.2363649e+01	6.67e-02	0.0	10837	0
121	2.0968983e+00	1.2557132e+01	6.71e-02	0.0	10825	0
122	2.0448864e+00	4.5437114e+02	1.24e+00	-0.3	10553	0
123	2.0694896e+00	4.9144198e+02	1.38e+00	-0.3	10933	0
124	1.9434152e+00	4.9153904e+01	1.47e-01	0.0	10673	0
125	1.9400277e+00	1.2620478e+01	5.94e-02	0.0	10691	0
126	1.9369872e+00	1.4164338e+01	6.30e-02	0.0	10673	0
127	1.9293603e+00	8.3809761e+01	2.29e-01	-0.3	10635	0
128	1.9388553e+00	1.2988469e+02	3.39e-01	-0.3	10602	0
129	1.9147135e+00	1.9313887e+01	7.39e-02	0.0	10616	0
130	1.9134269e+00	1.2505000e+01	5.79e-02	0.0	10606	0
131	1.9111531e+00	1.2524331e+01	5.79e-02	0.0	10604	0
132	1.8849936e+00	2.3340950e+02	5.55e-01	0.0	10435	0
133	1.8386012e+00	8.9486605e+01	2.23e-01	-0.3	10586	0
134	1.8284308e+00	1.8054501e+01	6.58e-02	0.0	10485	0
135	1.8269379e+00	1.3077103e+01	5.52e-02	0.0	10488	0
136	1.8184963e+00	2.9912357e+01	8.97e-02	0.0	10467	0
137	1.8164435e+00	2.9343706e+01	8.87e-02	-0.3	10467	0
138	1.8146022e+00	2.8657027e+01	8.72e-02	0.0	10463	0
139	1.8131320e+00	2.2176235e+01	7.35e-02	0.0	10464	0
140	1.8116160e+00	2.6766021e+01	8.29e-02	0.0	10452	0
141	1.8099747e+00	5.3739215e+01	1.40e-01	0.0	10449	0
142	1.8121718e+00	1.3867030e+02	3.17e-01	0.0	10441	0
143	1.8068517e+00	5.2464490e+01	1.37e-01	0.0	10440	0
144	1.8053466e+00	1.3300237e+01	5.45e-02	0.0	10435	0
145	1.8045306e+00	1.2775391e+01	5.34e-02	0.0	10432	0
146	1.7655282e+00	8.7999209e+01	2.02e-01	0.0	10366	0
147	1.7967921e+00	3.4242745e+02	7.32e-01	-0.3	10462	0
148	1.7612178e+00	7.9980682e+01	1.84e-01	0.0	10375	0
149	1.7584214e+00	1.3176990e+01	5.20e-02	0.0	10374	0
150	1.7575846e+00	1.2955883e+01	5.16e-02	0.0	10375	0
151	1.7345397e+00	2.1942365e+02	4.50e-01	0.0	10320	0
152	1.7490457e+00	3.2127736e+02	6.53e-01	-0.3	10433	0
153	1.7128554e+00	3.9796828e+01	9.98e-02	0.0	10333	0

```
  154  1.7114510e+00  1.3062365e+01   4.98e-02     0.0   10353        0
  155  1.7100972e+00  1.4141082e+01   5.18e-02     0.0   10345        0
  156  1.7124419e+00  2.4456894e+02   4.81e-01     0.0   10276        0
  157  1.6790557e+00  8.6231736e+01   1.81e-01    -0.3   10363        0
  158  1.6728006e+00  1.6141514e+01   5.34e-02     0.0   10305        0
  159  1.6717185e+00  1.3250467e+01   4.82e-02     0.0   10309        0
  160  1.6651819e+00  7.0120815e+01   1.50e-01     0.0   10281        0
  161  1.6647432e+00  1.0326156e+02   2.07e-01    -0.3   10262        0
  162  1.6586204e+00  4.0514821e+01   9.58e-02     0.0   10271        0
  163  1.6572540e+00  1.3368871e+01   4.79e-02     0.0   10270        0
  164  1.6561076e+00  1.3319472e+01   4.78e-02     0.0   10269        0
  165  1.6389466e+00  1.9899298e+02   3.66e-01     0.0   10211        0
  166  1.6378891e+00  2.2533212e+02   4.10e-01    -0.3   10232        0
  167  1.6288905e+00  4.0779754e+01   9.29e-02     0.0   10215        0
  168  1.6279610e+00  1.3328840e+01   4.64e-02     0.0   10216        0
  169  1.6261862e+00  1.4019729e+01   4.76e-02     0.0   10214        0
  170  1.6175894e+00  2.8515724e+02   5.01e-01     0.0   10187        0
  171  1.6078231e+00  1.2791204e+02   2.35e-01    -0.3   10195        0
  172  1.6045682e+00  1.3438052e+01   4.58e-02     0.0   10182        0
  173  1.6038327e+00  1.3408040e+01   4.57e-02     0.0   10184        0
  174  1.5964709e+00  3.9744729e+01   8.77e-02     0.0   10170        0
  175  1.6006944e+00  1.4080303e+02   2.54e-01    -0.3   10164        0
  176  1.5951438e+00  1.0999827e+02   2.02e-01     0.0   10166        0
  177  1.5916357e+00  1.3444593e+01   4.51e-02     0.0   10163        0
  178  1.5909943e+00  1.3426366e+01   4.51e-02     0.0   10163        0
  179  1.5835486e+00  1.6896340e+01   5.06e-02     0.0   10145        0
  180  1.5853392e+00  1.5315856e+02   2.67e-01    -0.3   10157        0
  181  1.5782872e+00  2.0125853e+01   5.50e-02    -0.3   10148        0
  182  1.5768866e+00  1.3859786e+01   4.49e-02     0.0   10148        0
  183  1.5751497e+00  1.3468790e+01   4.46e-02     0.0   10151        0
  184  1.5673607e+00  7.1205411e+01   1.33e-01     0.0   10130        0
  185  1.5707249e+00  1.6429555e+02   2.83e-01    -0.3   10139        0
  186  1.5637561e+00  4.7986824e+01   9.78e-02     0.0   10135        0
  187  1.5627739e+00  1.3523763e+01   4.41e-02     0.0   10134        0
  188  1.5620919e+00  1.3340712e+01   4.37e-02     0.0   10129        0
  189  1.5362754e+00  3.5370004e+02   5.55e-01     0.0   10067        0
  190  1.5333277e+00  3.0950207e+02   4.87e-01    -0.3   10125        0
  191  1.5191842e+00  2.4867796e+01   5.89e-02     0.0   10087        0
  192  1.5185776e+00  1.3791073e+01   4.25e-02     0.0   10089        0
  193  1.5154512e+00  1.3230230e+01   4.16e-02     0.0   10080        0
  194  1.5122963e+00  1.0611261e+02   1.77e-01    -0.3   10079        0
  195  1.5105927e+00  7.9579670e+01   1.38e-01    -0.3   10074        0
  196  1.5083007e+00  2.2431686e+01   5.46e-02     0.0   10074        0
  197  1.5077503e+00  1.3804804e+01   4.21e-02     0.0   10074        0
  198  1.5049873e+00  1.3602113e+01   4.17e-02     0.0   10071        0
  199  1.4992777e+00  1.6472628e+02   2.58e-01    -0.3   10064        0
  200  1.4978912e+00  1.3952527e+02   2.22e-01    -0.3   10073        0

ERROR EXIT -- Too many iterations

Products with A     :     305        Total time   (secs) :   108.1
Products with A'    :     201        Project time (secs) :     1.2
Newton iterations   :       0        Mat-vec time (secs) :   105.5
Line search its     :     228        Subspace iterations :       0
```

```
================================================================================
PQNL1_SLIM v. 46  (Tue, 14 Jun 2011) based on v.1017
================================================================================
No. rows              :     6400      No. columns           :    34341
Initial tau           : 7.83e+02      Two-norm of b         : 5.10e+01
Optimality tol        : 1.00e-04      Target one-norm of x  : 7.83e+02
Basis pursuit tol     : 1.00e-06      Maximum iterations    :      200

  Iter      Objective   Relative Gap      gNorm   stepG    nnzX    nnzG
     0  5.1038083e+01  1.9796465e+01   3.29e+01     0.0       0       0
Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2        O
         1          1           4     1.56250e-02     4.84705e+01     7.922
         2          1          10     1.00000e+00     2.42071e+01     1.007
         3          1          16     1.00000e+00     2.37445e+01     1.013
         4          1          25     1.00000e+00     1.19455e+01     1.454
         5          1          43     5.00000e-01     1.15971e+01     1.505
         6          1          55     1.00000e+00     1.06259e+01     1.146
         7          1          78     1.00000e+00     1.00691e+01     1.056
         8          1         105     1.00000e+00     9.45681e+00     1.083
         9          1         136     1.00000e+00     8.72832e+00     1.116
        10          1         163     1.00000e+00     7.90151e+00     8.789
        11          1         196     1.00000e+00     7.44564e+00     8.152
        12          1         206     1.00000e+00     7.26106e+00     5.867
        13          1         232     1.00000e+00     6.85241e+00     7.058
        14          1         260     1.00000e+00     6.57949e+00     6.175
        15          1         298     1.00000e+00     6.15675e+00     7.195
        16          1         333     1.00000e+00     5.94701e+00     7.464
        17          1         368     1.00000e+00     5.64686e+00     7.136
        18          1         396     1.00000e+00     5.38230e+00     5.296
        19          1         455     1.00000e+00     5.18490e+00     5.301
        20          1         503     1.00000e+00     5.03210e+00     5.777
        21          1         547     1.00000e+00     4.82241e+00     5.664
        22          1         586     1.00000e+00     4.61159e+00     4.851
        23          1         637     1.00000e+00     4.45351e+00     4.602
        24          1         697     1.00000e+00     4.33723e+00     5.055
        25          1         725     1.00000e+00     4.23315e+00     4.561
        26          1         783     1.00000e+00     4.08169e+00     4.189
        27          1         846     1.00000e+00     3.96266e+00     4.278
        28          1         898     1.00000e+00     3.83289e+00     4.113
        29          1         963     1.00000e+00     3.71340e+00     4.009
        30          1        1015     1.00000e+00     3.59929e+00     3.841
        31          1        1069     1.00000e+00     3.49540e+00     3.742
        32          1        1112     1.00000e+00     3.41269e+00     3.255
        33          1        1136     1.00000e+00     3.34780e+00     2.312
        34          1        1193     1.00000e+00     3.26379e+00     2.659
        35          1        1245     1.00000e+00     3.19284e+00     3.313
        36          1        1330     1.00000e+00     3.09725e+00     3.495
        37          1        1380     1.00000e+00     2.96123e+00     3.439
        38          1        1419     1.00000e+00     2.86484e+00     1.892
        39          1        1460     1.00000e+00     2.80197e+00     1.518
        40          1        1550     1.00000e+00     2.73523e+00     1.904
```

41	1	1620	1.00000e+00	2.65409e+00	2.306
42	1	1657	1.00000e+00	2.58365e+00	2.363
43	1	1703	1.00000e+00	2.51161e+00	1.748
44	1	1745	1.00000e+00	2.45446e+00	1.255
45	1	1827	1.00000e+00	2.39866e+00	1.811
46	1	1852	1.00000e+00	2.36152e+00	1.860
47	1	1913	1.00000e+00	2.25192e+00	1.699
48	1	1985	1.00000e+00	2.19132e+00	1.290
49	1	2057	1.00000e+00	2.15733e+00	1.303
50	1	2100	1.00000e+00	2.10231e+00	1.092
51	1	2151	1.00000e+00	2.05239e+00	1.209
52	1	2192	1.00000e+00	2.02201e+00	1.294
53	1	2231	1.00000e+00	1.99704e+00	1.333
54	1	2297	1.00000e+00	1.95793e+00	1.245
55	1	2353	1.00000e+00	1.90591e+00	1.187
56	1	2458	1.00000e+00	1.84798e+00	1.155
57	1	2501	1.00000e+00	1.80944e+00	1.174
58	1	2572	1.00000e+00	1.77886e+00	1.325
59	1	2624	1.00000e+00	1.74652e+00	1.255
60	1	2683	1.00000e+00	1.71336e+00	1.119
61	1	2746	1.00000e+00	1.68748e+00	1.365
62	1	2835	1.00000e+00	1.66127e+00	1.508
63	1	2878	1.00000e+00	1.64320e+00	1.474
64	1	2959	1.00000e+00	1.61713e+00	1.513
65	1	3020	1.00000e+00	1.59436e+00	1.377
66	1	3047	1.00000e+00	1.57592e+00	1.122
67	1	3143	1.00000e+00	1.55059e+00	1.167
68	1	3196	1.00000e+00	1.53198e+00	1.032
69	1	3231	1.00000e+00	1.51140e+00	8.433
70	1	3316	1.00000e+00	1.48601e+00	9.396
71	1	3394	1.00000e+00	1.46175e+00	8.988
72	1	3436	1.00000e+00	1.43759e+00	7.580
73	1	3501	1.00000e+00	1.41968e+00	8.412
74	1	3529	1.00000e+00	1.40842e+00	8.069
75	1	3582	1.00000e+00	1.38967e+00	8.466
76	1	3654	1.00000e+00	1.36755e+00	8.327
77	1	3715	1.00000e+00	1.33756e+00	6.843
78	1	3808	1.00000e+00	1.31237e+00	7.104
79	1	3863	1.00000e+00	1.29750e+00	8.273
80	1	3937	1.00000e+00	1.28016e+00	9.040
81	1	4010	1.00000e+00	1.25969e+00	7.044
82	1	4070	1.00000e+00	1.24057e+00	6.503
83	1	4117	1.00000e+00	1.22975e+00	7.465
84	1	4165	1.00000e+00	1.21829e+00	7.306
85	1	4252	1.00000e+00	1.20323e+00	6.561
86	1	4304	1.00000e+00	1.18585e+00	6.005
87	1	4354	1.00000e+00	1.17435e+00	5.903
88	1	4415	1.00000e+00	1.15914e+00	5.564
89	1	4496	1.00000e+00	1.13698e+00	4.694
90	1	4591	1.00000e+00	1.11497e+00	4.161
91	1	4675	1.00000e+00	1.09472e+00	5.670
92	1	4743	1.00000e+00	1.08242e+00	6.354
93	1	4786	1.00000e+00	1.06281e+00	6.578
94	1	4802	1.00000e+00	1.05499e+00	4.866

95	1	4863	1.00000e+00	1.04610e+00	5.224
96	1	4940	1.00000e+00	1.03629e+00	6.401
97	1	5046	1.00000e+00	1.02157e+00	7.287
98	1	5130	1.00000e+00	1.00559e+00	6.807
99	1	5168	1.00000e+00	9.91068e-01	4.900
100	1	5208	1.00000e+00	9.83387e-01	5.115
101	1	5306	1.00000e+00	9.73436e-01	6.469
102	1	5356	1.00000e+00	9.66178e-01	7.132
103	1	5399	1.00000e+00	9.56798e-01	5.778
104	1	5490	1.00000e+00	9.41917e-01	3.768
105	1	5582	1.00000e+00	9.29988e-01	4.728
106	1	5646	1.00000e+00	9.21815e-01	4.707
107	1	5666	1.00000e+00	9.15160e-01	3.526
108	1	5753	1.00000e+00	9.02335e-01	3.442
109	1	5837	1.00000e+00	8.87560e-01	3.784
110	1	5887	1.00000e+00	8.77755e-01	4.583
111	1	5916	1.00000e+00	8.70183e-01	4.850
112	1	6017	1.00000e+00	8.56405e-01	4.135
113	1	6090	1.00000e+00	8.44030e-01	3.396
114	1	6178	1.00000e+00	8.33630e-01	3.678
115	1	6212	1.00000e+00	8.27826e-01	3.653
116	1	6240	1.00000e+00	8.21872e-01	3.444
117	1	6290	1.00000e+00	8.13956e-01	3.400
118	1	6385	1.00000e+00	8.02348e-01	3.655
119	1	6466	1.00000e+00	7.91547e-01	3.869
120	1	6552	1.00000e+00	7.80879e-01	4.186
121	1	6584	1.00000e+00	7.72964e-01	4.027
122	1	6668	1.00000e+00	7.62385e-01	3.248
123	1	6712	1.00000e+00	7.56890e-01	2.571
124	1	6801	1.00000e+00	7.48442e-01	3.488
125	1	6899	1.00000e+00	7.41756e-01	3.810
126	1	6929	1.00000e+00	7.35379e-01	2.870
127	1	7006	1.00000e+00	7.28416e-01	3.073
128	1	7078	1.00000e+00	7.21153e-01	3.276
129	1	7129	1.00000e+00	7.14104e-01	2.655
130	1	7165	1.00000e+00	7.08701e-01	2.000
131	1	7210	1.00000e+00	7.03013e-01	2.057
132	1	7315	1.00000e+00	6.91108e-01	2.735
133	1	7403	1.00000e+00	6.79819e-01	2.807
134	1	7487	1.00000e+00	6.70478e-01	2.559
135	1	7516	1.00000e+00	6.65674e-01	2.327
136	1	7539	1.00000e+00	6.62012e-01	2.402
137	1	7615	1.00000e+00	6.54023e-01	2.783
138	1	7681	1.00000e+00	6.47457e-01	2.360
139	1	7785	1.00000e+00	6.35934e-01	2.869
140	1	7818	1.00000e+00	6.32974e-01	3.166
141	1	7845	1.00000e+00	6.30266e-01	3.299
142	1	7863	1.00000e+00	6.27455e-01	2.175
143	1	7942	1.00000e+00	6.21204e-01	2.285
144	1	8027	1.00000e+00	6.15224e-01	3.013
145	1	8126	1.00000e+00	6.07324e-01	3.588
146	1	8221	1.00000e+00	5.97409e-01	3.176
147	1	8299	1.00000e+00	5.88779e-01	2.466
148	1	8338	1.00000e+00	5.85710e-01	2.574

```
      149          1       8381     1.00000e+00     5.83330e-01     2.732
      150          1       8425     1.00000e+00     5.79924e-01     2.932
      151          1       8506     1.00000e+00     5.74427e-01     3.207
      152          1       8574     1.00000e+00     5.67333e-01     2.695
      153          1       8647     1.00000e+00     5.57563e-01     1.921
      154          1       8717     1.00000e+00     5.53574e-01     1.748
      155          1       8821     1.00000e+00     5.48328e-01     2.089
      156          1       8831     1.00000e+00     5.46731e-01     1.908
      157          1       8925     1.00000e+00     5.41563e-01     2.156
      158          1       8959     1.00000e+00     5.38812e-01     1.753
      159          1       8990     1.00000e+00     5.35936e-01     1.953
      160          1       9046     1.00000e+00     5.33216e-01     1.893
      161          1       9106     1.00000e+00     5.26957e-01     1.557
      162          1       9215     1.00000e+00     5.20136e-01     1.806
      163          1       9264     1.00000e+00     5.14523e-01     1.721
      164          1       9338     1.00000e+00     5.10704e-01     2.015
      165          1       9420     1.00000e+00     5.06050e-01     2.356
      166          1       9472     1.00000e+00     5.02124e-01     1.983
      167          1       9589     1.00000e+00     4.96277e-01     1.827
      168          1       9682     1.00000e+00     4.92262e-01     1.999
      169          1       9773     1.00000e+00     4.87565e-01     2.032
      170          1       9882     1.00000e+00     4.83158e-01     2.155
      171          1       9958     1.00000e+00     4.79723e-01     2.036
      172          1      10010     1.00000e+00     4.76670e-01     1.712
      173          1      10076     1.00000e+00     4.73347e-01     1.843
      174          1      10178     1.00000e+00     4.69379e-01     2.022
      175          1      10272     1.00000e+00     4.65148e-01     1.946
      176          1      10295     1.00000e+00     4.62780e-01     1.441
      177          1      10335     1.00000e+00     4.60514e-01     1.329
      178          1      10349     1.00000e+00     4.58925e-01     1.112
      179          1      10418     1.00000e+00     4.55634e-01     1.284
      180          1      10447     1.00000e+00     4.53956e-01     1.430
      181          1      10493     1.00000e+00     4.49896e-01     1.357
      182          1      10549     1.00000e+00     4.45933e-01     1.436
      183          1      10594     1.00000e+00     4.42887e-01     1.870
      184          1      10661     1.00000e+00     4.39259e-01     1.755
      185          1      10725     1.00000e+00     4.35480e-01     1.406
      186          1      10834     1.00000e+00     4.31102e-01     1.475
      187          1      10888     1.00000e+00     4.28194e-01     1.286
      188          1      10913     1.00000e+00     4.26117e-01     1.428
      189          1      11006     1.00000e+00     4.22684e-01     1.656
      190          1      11039     1.00000e+00     4.19827e-01     1.959
      191          1      11105     1.00000e+00     4.16561e-01     1.522
      192          1      11222     1.00000e+00     4.12519e-01     1.423
      193          1      11315     1.00000e+00     4.09949e-01     1.819
      194          1      11369     1.00000e+00     4.08331e-01     1.923
      195          1      11405     1.00000e+00     4.05700e-01     1.381
      196          1      11502     1.00000e+00     4.02884e-01     1.211
      197          1      11543     1.00000e+00     4.00661e-01     1.142
      198          1      11642     1.00000e+00     3.97062e-01     1.543
      199          1      11708     1.00000e+00     3.93842e-01     1.596
      200          1      11780     1.00000e+00     3.90041e-01     1.208
  200  3.9004109e-01  5.5893763e+00   1.19e-02     0.0    9567       0
ERROR EXIT -- Too many iterations
```

```
Products with A     :     209        Total time   (secs) :  1031.4
Products with A'    :     209        Project time (secs) :   975.4
Newton iterations   :       0        Mat-vec time (secs) :   101.8


================================================================================
SPGL1_SLIM v. 46  (Tue, 14 Jun 2011) based on v.1017
================================================================================
No. rows              :     6400      No. columns           :    34341
Initial tau           : 0.00e+00      Two-norm of b         : 5.10e+01
Optimality tol        : 1.00e-04      Target objective      : 0.00e+00
Basis pursuit tol     : 1.00e-06      Maximum iterations    :      200

 Iter      Objective   Relative Gap  Rel Error      gNorm   stepG    nnzX
    0  5.1038083e+01  0.0000000e+00   1.00e+00  3.293e+01     0.0       0
    1  5.0584015e+01  1.7749241e+00   1.00e+00  2.826e+01    -0.3       1
    2  4.6601068e+01  1.7413829e+00   1.00e+00  2.323e+01    -0.3     462
    3  3.5535381e+01  9.8803097e-01   1.00e+00  1.292e+01     0.0    5983
    4  3.4941668e+01  4.4026207e-01   1.00e+00  8.449e+00     0.0    4992
    5  3.4576701e+01  3.2345571e-01   1.00e+00  7.704e+00     0.0    4090
    6  3.4130396e+01  6.7371414e-01   1.00e+00  1.013e+01     0.0    2765
    7  3.4574767e+01  2.3904972e+00   1.00e+00  2.328e+01    -0.3    2436
    8  3.3896576e+01  5.8550087e-01   1.00e+00  9.487e+00     0.0    2317
    9  3.3738299e+01  2.2836552e-01   1.00e+00  7.178e+00     0.0    2297
   10  3.3698924e+01  2.2762741e-01   1.00e+00  7.176e+00     0.0    2205
   11  3.3312500e+01  4.1880745e-01   1.00e+00  8.594e+00     0.0    1345
   12  3.3338601e+01  4.2980930e-01   1.00e+00  8.457e+00    -0.3    1387
   13  3.3254819e+01  6.7471118e-01   1.00e+00  1.038e+01     0.0    1352
   14  3.3213109e+01  1.4081762e-01   1.00e+00  6.633e+00     0.0    1344
   15  3.3197911e+01  1.3724061e-01   1.00e+00  6.625e+00     0.0    1313
   16  3.3167570e+01  1.3771203e-01   1.00e+00  6.625e+00     0.0    1248
   17  3.3017480e+01  7.9201816e-01   1.00e+00  1.112e+01     0.0     908
   18  3.3062547e+01  1.4041829e-01   1.00e+00  6.510e+00    -0.3     931
   19  3.2971171e+01  2.3035538e-01   1.00e+00  7.273e+00     0.0     927
   20  3.2964972e+01  1.0545131e-01   1.00e+00  6.413e+00     0.0     915
   21  3.2953900e+01  1.0114648e-01   1.00e+00  6.391e+00     0.0     903
   22  3.2900557e+01  1.3366636e-01   1.00e+00  6.528e+00     0.0     703
   23  3.2862940e+01  4.9380556e-01   1.00e+00  9.054e+00    -0.3     717
   24  3.2902426e+01  1.8001488e-01   1.00e+00  6.783e+00     0.0     724
   25  3.2834730e+01  2.0370710e-01   1.00e+00  7.103e+00     0.0     735
   26  3.2829563e+01  8.5573919e-02   1.00e+00  6.287e+00     0.0     723
   27  3.2826077e+01  6.9174695e-02   1.00e+00  6.173e+00     0.0     690
   28  3.2817759e+01  1.4391807e-01   1.00e+00  6.578e+00     0.0     586
   29  3.2786127e+01  2.1049972e-01   1.00e+00  7.133e+00    -0.3     604
   30  3.2781622e+01  5.9293769e-02   1.00e+00  6.080e+00     0.0     598
   31  3.2778012e+01  9.4247550e-02   1.00e+00  6.338e+00     0.0     581
   32  3.2776038e+01  4.9401236e-02   1.00e+00  6.027e+00     0.0     580
   33  3.2768639e+01  4.7785781e-02   1.00e+00  6.010e+00     0.0     564
   34  3.2760307e+01  7.2402933e-01   1.00e+00  1.062e+01    -0.3     482
   35  3.2774290e+01  8.4966891e-02   1.00e+00  6.160e+00    -0.3     520
   36  3.2738491e+01  1.5442890e-01   1.00e+00  6.726e+00     0.0     506
   37  3.2737096e+01  7.7388599e-02   1.00e+00  6.199e+00     0.0     503
   38  2.5689895e+01  7.6592955e+00   1.00e+00  7.720e+00     0.0    9663
```

39	2.1613946e+01	2.9576708e+00	1.00e+00	3.164e+00	0.0	18178
40	2.1132624e+01	3.2595093e+00	1.00e+00	3.108e+00	0.0	21800
41	2.0268329e+01	2.7155846e+00	1.00e+00	2.856e+00	0.0	19930
42	1.9173925e+01	2.8089268e+00	1.00e+00	2.273e+00	0.0	10497
43	1.8918852e+01	2.7311856e+00	1.00e+00	2.658e+00	-0.3	11828
44	1.8669111e+01	2.4271140e+00	1.00e+00	2.178e+00	0.0	10258
45	1.8488891e+01	2.5562267e+00	1.00e+00	2.393e+00	0.0	9933
46	1.8286535e+01	2.2997701e+00	1.00e+00	2.140e+00	0.0	8948
47	1.8185954e+01	5.6654781e+00	1.00e+00	4.509e+00	0.0	8015
48	1.7921852e+01	2.3233943e+00	1.00e+00	2.138e+00	-0.3	7725
49	1.7806593e+01	2.2013494e+00	1.00e+00	2.107e+00	0.0	7502
50	1.7730204e+01	2.1793012e+00	1.00e+00	2.075e+00	0.0	7244
51	1.7175607e+01	4.5612531e+00	1.00e+00	3.468e+00	0.0	5624
52	1.7224777e+01	7.9637811e+00	1.00e+00	5.395e+00	-0.3	5697
53	1.7037305e+01	3.5667013e+00	1.00e+00	2.847e+00	0.0	5615
54	1.6985289e+01	1.8298790e+00	1.00e+00	1.822e+00	0.0	5517
55	1.6928951e+01	1.8195121e+00	1.00e+00	1.810e+00	0.0	5370
56	1.6282651e+01	1.4443035e+01	1.00e+00	8.405e+00	0.0	3457
57	1.6729041e+01	2.5176470e+01	1.00e+00	1.495e+01	-0.3	3568
58	1.5975914e+01	1.4969442e+00	1.00e+00	1.604e+00	0.0	3751
59	1.5943243e+01	1.4142242e+00	1.00e+00	1.566e+00	0.0	3672
60	1.5883839e+01	1.2867250e+00	1.00e+00	1.489e+00	0.0	3514
61	1.5602095e+01	1.1780283e+01	1.00e+00	6.510e+00	0.0	2732
62	1.5598636e+01	1.1357268e+01	1.00e+00	6.283e+00	-0.3	2820
63	1.5413380e+01	1.7584865e+00	1.00e+00	1.672e+00	0.0	2829
64	1.5397353e+01	1.0840099e+00	1.00e+00	1.351e+00	0.0	2796
65	1.5358537e+01	9.7533175e-01	1.00e+00	1.304e+00	0.0	2749
66	1.5288889e+01	8.7072459e+00	1.00e+00	4.888e+00	0.0	2440
67	1.5225208e+01	4.2170257e+00	1.00e+00	2.840e+00	-0.3	2502
68	1.5146999e+01	1.0152163e+00	1.00e+00	1.335e+00	0.0	2466
69	1.5134963e+01	9.8537679e-01	1.00e+00	1.323e+00	0.0	2445
70	1.5085843e+01	9.1623843e-01	1.00e+00	1.289e+00	0.0	2358
71	1.5058070e+01	2.4314845e+00	1.00e+00	1.964e+00	-0.3	2368
72	1.5078505e+01	9.0148552e+00	1.00e+00	4.948e+00	-0.3	2338
73	1.5029232e+01	2.4906228e+00	1.00e+00	1.988e+00	0.0	2338
74	1.4998742e+01	7.3986287e-01	1.00e+00	1.209e+00	0.0	2329
75	1.4992783e+01	7.3609212e-01	1.00e+00	1.207e+00	0.0	2318
76	1.4922495e+01	7.1972515e-01	1.00e+00	1.196e+00	0.0	2148
77	1.4877655e+01	7.2174032e+00	1.00e+00	4.077e+00	-0.3	2132
78	1.4912094e+01	7.9658104e+00	1.00e+00	4.370e+00	-0.3	2227
79	1.4821753e+01	2.0672914e+00	1.00e+00	1.797e+00	0.0	2218
80	1.4814837e+01	6.2397299e-01	1.00e+00	1.165e+00	0.0	2182
81	1.4806477e+01	6.3635706e-01	1.00e+00	1.171e+00	0.0	2155
82	1.4717618e+01	4.2864588e+00	1.00e+00	2.719e+00	0.0	1802
83	1.4724156e+01	5.5707739e+00	1.00e+00	3.321e+00	-0.3	1873
84	1.4663521e+01	4.9013635e-01	1.00e+00	1.099e+00	0.0	1844
85	1.4653632e+01	4.6405042e-01	1.00e+00	1.094e+00	0.0	1834
86	1.4648238e+01	4.5115481e-01	1.00e+00	1.091e+00	0.0	1818
87	1.4629804e+01	4.8076470e-01	1.00e+00	1.105e+00	0.0	1775
88	1.4616468e+01	1.2404083e+01	1.00e+00	6.175e+00	0.0	1498
89	1.4556379e+01	2.7797049e+00	1.00e+00	2.076e+00	-0.3	1567
90	1.4514435e+01	1.5018275e+00	1.00e+00	1.545e+00	0.0	1603
91	1.4501915e+01	6.7061648e-01	1.00e+00	1.195e+00	0.0	1630
92	1.4482852e+01	1.4928896e+00	1.00e+00	1.536e+00	0.0	1652

93	1.4487927e+01	1.2099496e+00	1.00e+00	1.406e+00	0.0	1577
94	1.4486751e+01	5.6085779e+00	1.00e+00	3.255e+00	0.0	1568
95	1.4471726e+01	3.9134727e-01	1.00e+00	1.074e+00	0.0	1566
96	1.4470574e+01	5.1740670e-01	1.00e+00	1.127e+00	0.0	1562
97	1.4467724e+01	4.5630406e-01	1.00e+00	1.102e+00	0.0	1549
98	1.4437738e+01	3.2429616e+00	1.00e+00	2.234e+00	-0.3	1399
99	1.4451732e+01	5.2136993e+00	1.00e+00	3.085e+00	-0.3	1431
100	1.4416327e+01	3.3841816e-01	1.00e+00	1.038e+00	0.0	1412
101	1.4410364e+01	3.0487768e-01	1.00e+00	1.029e+00	0.0	1405
102	1.4408179e+01	3.9229614e-01	1.00e+00	1.068e+00	0.0	1401
103	1.4406070e+01	3.0379183e-01	1.00e+00	1.032e+00	0.0	1394
104	1.4390559e+01	1.2092194e+00	1.00e+00	1.407e+00	0.0	1348
105	1.4400933e+01	3.7064881e+00	1.00e+00	2.432e+00	-0.3	1368
106	1.4404446e+01	5.4337963e+00	1.00e+00	3.147e+00	0.0	1373
107	1.4385393e+01	1.0488768e+00	1.00e+00	1.340e+00	0.0	1373
108	1.4384238e+01	5.4180004e-01	1.00e+00	1.133e+00	0.0	1371
109	1.4383458e+01	3.8532209e-01	1.00e+00	1.069e+00	0.0	1366
110	1.4376447e+01	3.0666544e-01	1.00e+00	1.032e+00	0.0	1329
111	1.4373415e+01	1.5482188e+00	1.00e+00	1.546e+00	-0.3	1328
112	1.4375747e+01	3.7147323e-01	1.00e+00	1.057e+00	0.0	1343
113	1.4371056e+01	8.6009136e-01	1.00e+00	1.263e+00	0.0	1327
114	1.4370544e+01	4.3951231e-01	1.00e+00	1.090e+00	0.0	1327
115	1.3757533e+01	7.7396379e+00	1.00e+00	1.673e+00	-0.3	16574
116	1.3244770e+01	4.5279298e+00	1.00e+00	1.207e+00	0.0	17595
117	1.2908435e+01	5.7782351e+00	1.00e+00	1.317e+00	0.0	22031
118	1.1638890e+01	3.4703261e+00	1.00e+00	9.302e-01	0.0	27982
119	1.1412588e+01	8.8808099e+00	1.00e+00	1.409e+00	-0.3	27415
120	1.1061429e+01	3.7480181e+00	1.00e+00	8.919e-01	0.0	28232
121	1.0739399e+01	8.2223384e+00	1.00e+00	1.241e+00	0.0	28902
122	1.0493392e+01	4.8435198e+00	1.00e+00	9.316e-01	0.0	28461
123	1.0347040e+01	8.3651284e+00	1.00e+00	1.194e+00	0.0	26203
124	1.0217040e+01	4.4103430e+00	1.00e+00	8.590e-01	0.0	24584
125	1.0090887e+01	8.2694342e+00	1.00e+00	1.142e+00	0.0	23054
126	9.9808007e+00	5.5270775e+00	1.00e+00	9.175e-01	0.0	22090
127	9.8764640e+00	7.4399302e+00	1.00e+00	1.043e+00	0.0	20873
128	9.7478180e+00	5.2293714e+00	1.00e+00	8.765e-01	0.0	19245
129	9.8376129e+00	1.9951725e+01	1.00e+00	2.264e+00	0.0	17446
130	9.6613679e+00	1.3641063e+01	1.00e+00	1.789e+00	0.0	17457
131	9.4553675e+00	6.9560072e+00	1.00e+00	9.405e-01	0.0	16671
132	9.4180413e+00	6.7058510e+00	1.00e+00	9.194e-01	0.0	16321
133	9.0707535e+00	5.6594647e+00	1.00e+00	7.886e-01	0.0	13173
134	8.9721929e+00	2.4611230e+01	1.00e+00	2.457e+00	-0.3	13010
135	8.8582143e+00	8.3026908e+00	1.00e+00	9.654e-01	-0.3	12993
136	8.8154719e+00	6.6314884e+00	1.00e+00	8.151e-01	0.0	12766
137	8.7724820e+00	6.3084465e+00	1.00e+00	7.828e-01	0.0	12334
138	8.5460530e+00	2.4776809e+01	1.00e+00	2.304e+00	0.0	9897
139	8.6083566e+00	4.1515614e+01	1.00e+00	3.695e+00	-0.3	9951
140	8.4482558e+00	5.9448805e+00	1.00e+00	7.145e-01	0.0	9885
141	8.4324645e+00	5.9926218e+00	1.00e+00	7.131e-01	0.0	9790
142	8.3991269e+00	5.9978036e+00	1.00e+00	7.073e-01	0.0	9565
143	8.3772206e+00	6.4690340e+01	1.00e+00	5.464e+00	0.0	5113
144	8.0644531e+00	4.7305342e+01	1.00e+00	3.817e+00	-0.3	5632
145	7.6916566e+00	1.0584977e+01	1.00e+00	9.673e-01	0.0	6322
146	7.6486647e+00	3.2354748e+00	1.00e+00	4.596e-01	0.0	6646

147	7.6087155e+00	3.5126174e+00	1.00e+00	4.503e-01	0.0	6877
148	7.5680638e+00	7.6660804e+00	1.00e+00	7.007e-01	0.0	6489
149	7.6234488e+00	3.9364012e+01	1.00e+00	2.782e+00	-0.3	6089
150	7.5551930e+00	1.9615860e+01	1.00e+00	1.479e+00	0.0	6031
151	7.5244544e+00	2.9242234e+00	1.00e+00	3.904e-01	0.0	6000
152	7.5198028e+00	2.9145835e+00	1.00e+00	3.891e-01	0.0	5960
153	7.4377278e+00	2.5581280e+01	1.00e+00	1.763e+00	0.0	5122
154	7.4790604e+00	4.3634564e+01	1.00e+00	2.943e+00	-0.3	5283
155	7.3739041e+00	7.3613077e+00	1.00e+00	6.396e-01	0.0	5225
156	7.3661837e+00	3.0299155e+00	1.00e+00	3.727e-01	0.0	5209
157	7.3589442e+00	2.9373102e+00	1.00e+00	3.695e-01	0.0	5194
158	7.3177827e+00	1.0041512e+01	1.00e+00	8.382e-01	0.0	4830
159	7.3035183e+00	1.0102082e+01	1.00e+00	8.210e-01	-0.3	4987
160	7.2848699e+00	6.8424464e+00	1.00e+00	6.170e-01	0.0	4853
161	7.2783643e+00	2.8959273e+00	1.00e+00	3.777e-01	0.0	4888
162	7.2732716e+00	2.9019914e+00	1.00e+00	3.754e-01	0.0	4878
163	7.2413562e+00	1.5494764e+01	1.00e+00	1.093e+00	0.0	4668
164	7.2369899e+00	1.4660296e+01	1.00e+00	1.056e+00	-0.3	4745
165	7.2203219e+00	6.4561148e+00	1.00e+00	5.662e-01	0.0	4669
166	7.2162209e+00	2.8831868e+00	1.00e+00	3.574e-01	0.0	4669
167	7.2103503e+00	2.8709631e+00	1.00e+00	3.589e-01	0.0	4631
168	7.1702035e+00	2.7723544e+01	1.00e+00	1.827e+00	0.0	4387
169	7.1866872e+00	4.2585453e+01	1.00e+00	2.692e+00	-0.3	4447
170	7.1444748e+00	7.6041682e+00	1.00e+00	6.400e-01	0.0	4432
171	7.1411765e+00	2.8254843e+00	1.00e+00	3.624e-01	0.0	4427
172	7.1368320e+00	2.8256679e+00	1.00e+00	3.598e-01	0.0	4415
173	7.0936835e+00	1.8982480e+01	1.00e+00	1.245e+00	0.0	4219
174	7.1033457e+00	2.9530574e+01	1.00e+00	1.871e+00	-0.3	4302
175	7.0715575e+00	1.1411302e+01	1.00e+00	8.258e-01	0.0	4254
176	7.0661520e+00	2.6969477e+00	1.00e+00	3.343e-01	0.0	4255
177	7.0629757e+00	2.7020762e+00	1.00e+00	3.358e-01	0.0	4239
178	7.0396397e+00	1.3903311e+01	1.00e+00	9.904e-01	0.0	4127
179	7.0340278e+00	1.4617584e+01	1.00e+00	1.019e+00	-0.3	4191
180	7.0240708e+00	7.8943333e+00	1.00e+00	6.396e-01	0.0	4137
181	7.0207313e+00	2.7491928e+00	1.00e+00	3.501e-01	0.0	4146
182	7.0174364e+00	2.7278176e+00	1.00e+00	3.466e-01	0.0	4125
183	6.9992059e+00	1.6089259e+01	1.00e+00	1.070e+00	0.0	4055
184	7.0108130e+00	3.0503044e+01	1.00e+00	1.884e+00	-0.3	4072
185	6.9887097e+00	1.0280166e+01	1.00e+00	7.528e-01	0.0	4041
186	6.9852430e+00	2.6243477e+00	1.00e+00	3.301e-01	0.0	4045
187	6.9832600e+00	2.6254686e+00	1.00e+00	3.306e-01	0.0	4033
188	6.9426535e+00	2.3946627e+01	1.00e+00	1.511e+00	0.0	3850
189	6.9533914e+00	3.6091828e+01	1.00e+00	2.173e+00	-0.3	3907
190	6.9247583e+00	6.5626928e+00	1.00e+00	5.512e-01	0.0	3884
191	6.9225845e+00	2.6696371e+00	1.00e+00	3.387e-01	0.0	3886
192	6.9191984e+00	2.6267647e+00	1.00e+00	3.337e-01	0.0	3876
193	6.8982751e+00	2.2433980e+01	1.00e+00	1.373e+00	0.0	3804
194	6.9048759e+00	2.9766503e+01	1.00e+00	1.785e+00	-0.3	3858
195	6.8824897e+00	8.6013187e+00	1.00e+00	6.373e-01	0.0	3830
196	6.8796619e+00	2.4722885e+00	1.00e+00	3.100e-01	0.0	3824
197	6.8770395e+00	2.4800165e+00	1.00e+00	3.121e-01	0.0	3816
198	6.8591990e+00	1.2469343e+01	1.00e+00	8.664e-01	0.0	3721
199	6.8566346e+00	1.5021966e+01	1.00e+00	9.934e-01	-0.3	3761
200	6.8493485e+00	8.4727358e+00	1.00e+00	6.425e-01	0.0	3723

```
 ERROR EXIT -- Too many iterations

 Products with A     :     278        Total time   (secs) :   126.8
 Products with A'    :     201        Project time (secs) :     1.4
 Newton iterations   :       3        Mat-vec time (secs) :   123.2
 Line search its     :     153        Subspace iterations :       0


 ================================================================================
 PQNL1_SLIM v. 46  (Tue, 14 Jun 2011) based on v.1017
 ================================================================================
 No. rows              :     6400      No. columns           :    34341
 Initial tau           : 0.00e+00      Two-norm of b         : 5.10e+01
 Optimality tol        : 1.00e-04      Target objective      : 0.00e+00
 Basis pursuit tol     : 1.00e-06      Maximum iterations    :      200

     0  5.1038083e+01  0.0000000e+00   1.00e+00  3.293e+01     0.0       0

Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2        O
         1          1           4     6.25000e-02     5.07900e+01     8.404
         2          1          12     1.00000e+00     3.57901e+01     1.497
         3          1          19     1.00000e+00     3.51910e+01     1.471
         4          1          26     1.00000e+00     3.47044e+01     1.428
         5          1          35     1.00000e+00     3.44322e+01     1.378
         6          1          44     1.00000e+00     3.41765e+01     1.311
         7          1          54     1.00000e+00     3.39250e+01     1.252
         8          1          65     1.00000e+00     3.37131e+01     1.157
         9          1          75     1.00000e+00     3.35492e+01     1.090
        10          1          85     1.00000e+00     3.34062e+01     1.025
        11          1          95     1.00000e+00     3.32807e+01     9.442
        12          1         105     1.00000e+00     3.31876e+01     8.818
        13          1         116     1.00000e+00     3.31078e+01     8.015
        14          1         129     1.00000e+00     3.30335e+01     7.387
        15          1         143     1.00000e+00     3.29705e+01     6.656
        16          1         160     1.00000e+00     3.29237e+01     6.178
        17          1         178     1.00000e+00     3.28862e+01     5.796
        18          1         198     1.00000e+00     3.28541e+01     5.354
        19          1         218     1.00000e+00     3.28290e+01     5.033
        20          1         239     1.00000e+00     3.28066e+01     4.821
        21          1         253     1.00000e+00     3.27916e+01     4.466
break of testUpdateTau    21  3.2791618e+01  5.9988116e-02   1.00e+00  6.0

Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2        O
        22          1           4     5.00000e-01     2.88648e+01     4.230
        23          1          18     1.00000e+00     2.16489e+01     4.655
        24          1          26     1.00000e+00     2.12219e+01     4.558
        25          1          35     1.00000e+00     2.01573e+01     3.919
        26          1          49     1.00000e+00     1.96160e+01     3.636
        27          1          65     1.00000e+00     1.86273e+01     3.303
        28          1          82     1.00000e+00     1.78387e+01     3.057
        29          1          96     1.00000e+00     1.74161e+01     2.851
```

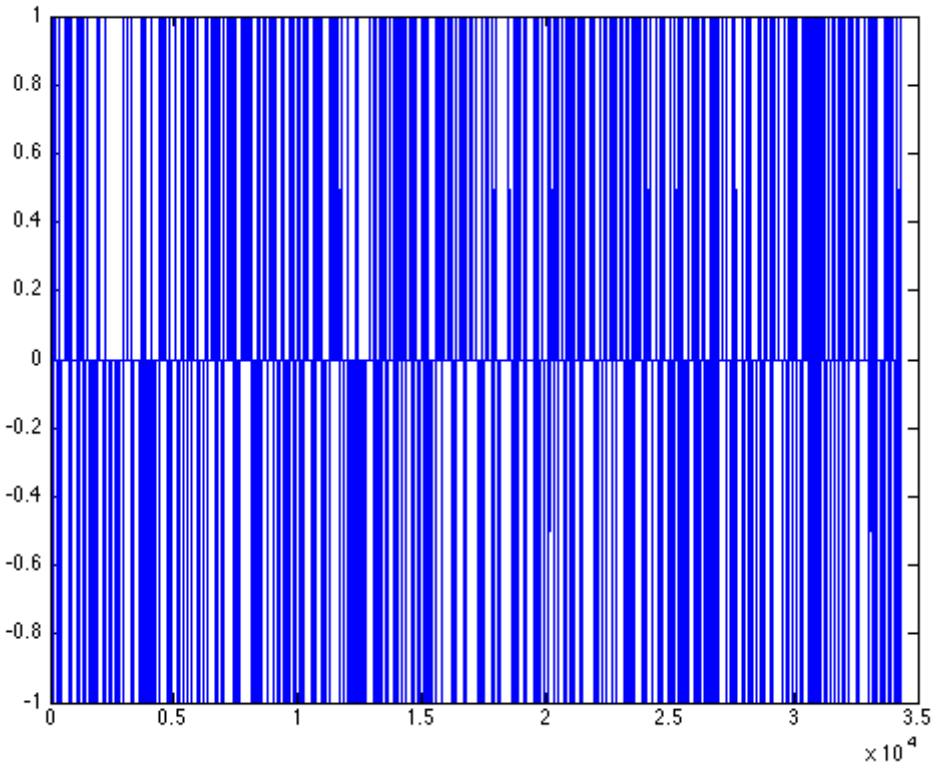
```
          30          1         106     1.00000e+00     1.69515e+01     2.710
          31          1         121     1.00000e+00     1.66298e+01     2.569
          32          1         137     1.00000e+00     1.61919e+01     2.217
          33          1         159     1.00000e+00     1.59000e+01     2.098
          34          1         182     1.00000e+00     1.56660e+01     1.949
          35          1         199     1.00000e+00     1.54018e+01     1.709
          36          1         216     1.00000e+00     1.52010e+01     1.577
          37          1         233     1.00000e+00     1.50453e+01     1.456
          38          1         254     1.00000e+00     1.49197e+01     1.368
          39          1         281     1.00000e+00     1.47775e+01     1.258
          40          1         299     1.00000e+00     1.46610e+01     1.159
          41          1         319     1.00000e+00     1.45733e+01     1.071
          42          1         337     1.00000e+00     1.45068e+01     9.811
          43          1         352     1.00000e+00     1.44480e+01     9.592
          44          1         366     1.00000e+00     1.43967e+01     8.964
          45          1         382     1.00000e+00     1.43504e+01     8.205
          46          1         397     1.00000e+00     1.43125e+01     7.532
          47          1         418     1.00000e+00     1.42813e+01     6.952
          48          1         439     1.00000e+00     1.42556e+01     6.720
          49          1         461     1.00000e+00     1.42374e+01     6.367
          50          1         488     1.00000e+00     1.42181e+01     5.981
          51          1         508     1.00000e+00     1.42037e+01     5.781
          52          1         525     1.00000e+00     1.41896e+01     5.696
          53          1         554     1.00000e+00     1.41761e+01     5.648
          54          1         587     1.00000e+00     1.41635e+01     5.466
          55          1         606     1.00000e+00     1.41539e+01     4.972
          56          1         629     1.00000e+00     1.41446e+01     4.477
          57          1         651     1.00000e+00     1.41390e+01     4.221
break of testUpdateTau    57  1.4139041e+01  4.7345498e-01   1.00e+00  1.0

Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2        O
          58          1           4     1.25000e-01     1.34617e+01     4.849
          59          1          15     1.00000e+00     1.30092e+01     4.371
          60          1          28     1.00000e+00     1.20196e+01     5.538
          61          1          47     1.00000e+00     1.07043e+01     6.021
          62          1          57     1.00000e+00     1.00105e+01     3.432
          63          1          73     1.00000e+00     9.70632e+00     3.388
          64          1          90     1.00000e+00     9.45551e+00     3.798
          65          1         113     1.00000e+00     9.14157e+00     3.915
          66          1         134     1.00000e+00     8.59274e+00     3.505
          67          1         158     1.00000e+00     8.35761e+00     2.445
          68          1         177     1.00000e+00     8.24476e+00     2.196
          69          1         196     1.00000e+00     8.09478e+00     2.132
          70          1         216     1.00000e+00     7.96669e+00     2.152
          71          1         236     1.00000e+00     7.83744e+00     1.897
          72          1         270     1.00000e+00     7.70863e+00     1.666
          73          1         286     1.00000e+00     7.62279e+00     1.525
          74          1         312     1.00000e+00     7.52535e+00     1.479
          75          1         341     1.00000e+00     7.43654e+00     1.451
          76          1         381     1.00000e+00     7.33978e+00     1.378
          77          1         412     1.00000e+00     7.25098e+00     1.301
          78          1         441     1.00000e+00     7.17976e+00     1.185
          79          1         465     1.00000e+00     7.11239e+00     1.117
```

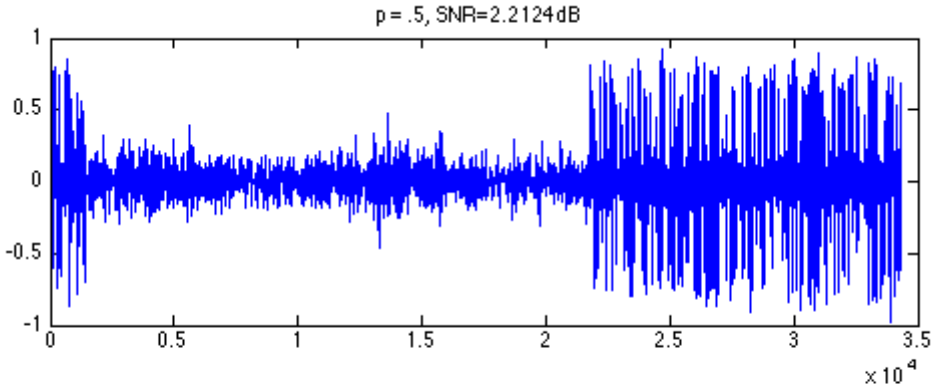
```
        80          1         484     1.00000e+00     7.04963e+00     1.094
        81          1         506     1.00000e+00     6.98455e+00     1.073
        82          1         550     1.00000e+00     6.92636e+00     1.032
        83          1         587     1.00000e+00     6.88279e+00     9.690
        84          1         605     1.00000e+00     6.84173e+00     9.412
        85          1         635     1.00000e+00     6.79953e+00     9.491
        86          1         669     1.00000e+00     6.75841e+00     8.921
        87          1         693     1.00000e+00     6.71945e+00     8.216
        88          1         719     1.00000e+00     6.69407e+00     7.809
        89          1         759     1.00000e+00     6.66628e+00     8.123
        90          1         802     1.00000e+00     6.63711e+00     8.140
        91          1         824     1.00000e+00     6.60806e+00     7.710
        92          1         852     1.00000e+00     6.58326e+00     7.120
        93          1         886     1.00000e+00     6.56191e+00     6.527
        94          1         914     1.00000e+00     6.54354e+00     6.288
        95          1         946     1.00000e+00     6.52705e+00     6.191
        96          1         978     1.00000e+00     6.50917e+00     6.455
        97          1        1002     1.00000e+00     6.49385e+00     5.960
        98          1        1038     1.00000e+00     6.47605e+00     5.353
        99          1        1071     1.00000e+00     6.46170e+00     5.183
       100          1        1095     1.00000e+00     6.44922e+00     5.100
       101          1        1119     1.00000e+00     6.43636e+00     4.847
       102          1        1141     1.00000e+00     6.42674e+00     4.595
       103          1        1161     1.00000e+00     6.41892e+00     4.365
       104          1        1192     1.00000e+00     6.40943e+00     4.470
       105          1        1219     1.00000e+00     6.40056e+00     4.457
       106          1        1256     1.00000e+00     6.39108e+00     4.306
       107          1        1282     1.00000e+00     6.38260e+00     4.115
       108          1        1308     1.00000e+00     6.37453e+00     3.902
       109          1        1335     1.00000e+00     6.36765e+00     3.619
       110          1        1354     1.00000e+00     6.36081e+00     3.680
       111          1        1383     1.00000e+00     6.35515e+00     3.973
       112          1        1413     1.00000e+00     6.34978e+00     3.796
       113          1        1439     1.00000e+00     6.34250e+00     3.440
       114          1        1467     1.00000e+00     6.33702e+00     3.225
       115          1        1491     1.00000e+00     6.33216e+00     3.204
       116          1        1519     1.00000e+00     6.32798e+00     3.128
       117          1        1550     1.00000e+00     6.32349e+00     2.965
       118          1        1585     1.00000e+00     6.31932e+00     2.933
       119          1        1611     1.00000e+00     6.31500e+00     3.016
       120          1        1648     1.00000e+00     6.31141e+00     2.943
       121          1        1679     1.00000e+00     6.30771e+00     2.758
       122          1        1709     1.00000e+00     6.30414e+00     2.738
       123          1        1736     1.00000e+00     6.30117e+00     2.707
break of testUpdateTau   123  6.3011669e+00  1.0654649e+00   1.00e+00  2.1

Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2        O
       124          1           4     1.25000e-01     6.10058e+00     6.842
       125          1          16     1.00000e+00     5.73943e+00     4.964
       126          1          38     1.00000e+00     4.54115e+00     3.195
       127          1          58     1.00000e+00     3.94760e+00     3.485
       128          1          71     1.00000e+00     3.60358e+00     4.296
       129          1          96     1.00000e+00     3.44934e+00     3.191
```

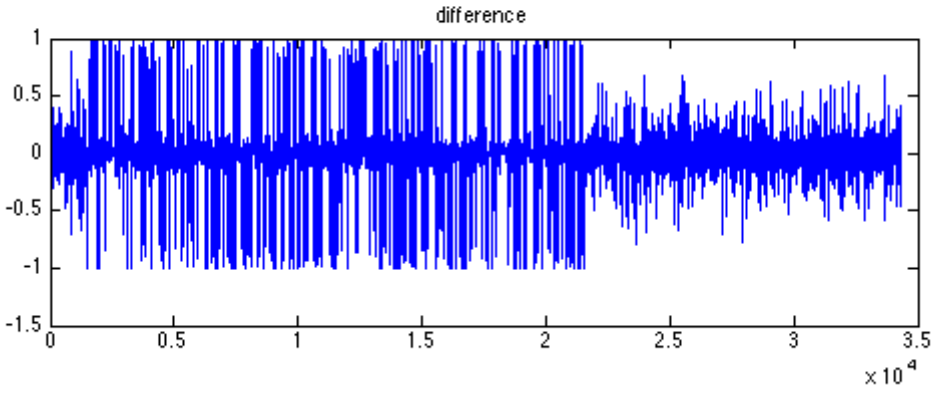
130	1	113	1.00000e+00	3.39459e+00	2.730
131	1	138	1.00000e+00	3.31359e+00	1.686
132	1	168	1.00000e+00	3.26286e+00	1.480
133	1	193	1.00000e+00	3.21200e+00	1.797
134	1	222	1.00000e+00	3.15364e+00	1.760
135	1	241	1.00000e+00	3.09192e+00	1.304
136	1	267	1.00000e+00	3.04983e+00	1.199
137	1	290	1.00000e+00	3.01501e+00	1.419
138	1	317	1.00000e+00	2.97759e+00	1.554
139	1	349	1.00000e+00	2.93063e+00	1.126
140	1	377	1.00000e+00	2.89737e+00	9.342
141	1	409	1.00000e+00	2.87484e+00	1.138
142	1	448	1.00000e+00	2.84996e+00	1.260
143	1	478	1.00000e+00	2.81648e+00	1.155
144	1	515	1.00000e+00	2.78165e+00	8.149
145	1	558	1.00000e+00	2.75948e+00	6.917
146	1	594	1.00000e+00	2.73877e+00	7.059
147	1	627	1.00000e+00	2.71767e+00	7.552
148	1	666	1.00000e+00	2.69575e+00	7.734
149	1	705	1.00000e+00	2.67430e+00	6.531
150	1	742	1.00000e+00	2.65703e+00	5.622
151	1	779	1.00000e+00	2.64183e+00	5.659
152	1	819	1.00000e+00	2.62622e+00	5.760
153	1	861	1.00000e+00	2.61031e+00	5.266
154	1	906	1.00000e+00	2.59589e+00	5.179
155	1	950	1.00000e+00	2.58272e+00	5.477
156	1	982	1.00000e+00	2.57007e+00	5.202
157	1	1011	1.00000e+00	2.55724e+00	5.014
158	1	1057	1.00000e+00	2.54469e+00	4.740
159	1	1104	1.00000e+00	2.53216e+00	4.506
160	1	1147	1.00000e+00	2.52100e+00	4.535
161	1	1193	1.00000e+00	2.51126e+00	4.573
162	1	1253	1.00000e+00	2.50079e+00	4.143
163	1	1286	1.00000e+00	2.49293e+00	3.891
164	1	1334	1.00000e+00	2.48403e+00	3.987
165	1	1374	1.00000e+00	2.47514e+00	3.968
166	1	1394	1.00000e+00	2.46728e+00	3.954
167	1	1425	1.00000e+00	2.45907e+00	4.441
168	1	1465	1.00000e+00	2.45096e+00	4.617
169	1	1510	1.00000e+00	2.44156e+00	4.189
170	1	1542	1.00000e+00	2.43424e+00	3.595
171	1	1575	1.00000e+00	2.42878e+00	4.091
172	1	1598	1.00000e+00	2.42305e+00	4.974
173	1	1634	1.00000e+00	2.41715e+00	4.911
174	1	1682	1.00000e+00	2.41019e+00	4.165
175	1	1708	1.00000e+00	2.40492e+00	3.544
176	1	1737	1.00000e+00	2.40021e+00	2.993
177	1	1789	1.00000e+00	2.39328e+00	3.335
178	1	1839	1.00000e+00	2.38728e+00	3.714
179	1	1881	1.00000e+00	2.38015e+00	3.573
180	1	1914	1.00000e+00	2.37403e+00	3.220
181	1	1964	1.00000e+00	2.36852e+00	3.279
182	1	2011	1.00000e+00	2.36366e+00	3.153
183	1	2051	1.00000e+00	2.35860e+00	3.002

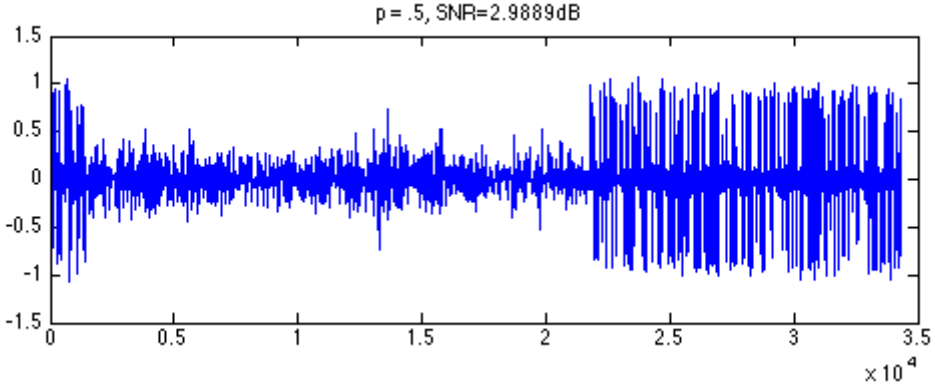
```
      184          1       2085     1.00000e+00     2.35400e+00     3.144
      185          1       2129     1.00000e+00     2.34940e+00     3.402
      186          1       2172     1.00000e+00     2.34468e+00     3.424
      187          1       2218     1.00000e+00     2.33947e+00     3.229
      188          1       2254     1.00000e+00     2.33509e+00     3.003
      189          1       2286     1.00000e+00     2.33122e+00     3.004
      190          1       2335     1.00000e+00     2.32754e+00     3.143
      191          1       2368     1.00000e+00     2.32375e+00     3.321
      192          1       2416     1.00000e+00     2.31994e+00     3.294
      193          1       2478     1.00000e+00     2.31533e+00     3.105
      194          1       2518     1.00000e+00     2.31146e+00     2.865
      195          1       2551     1.00000e+00     2.30775e+00     2.764
      196          1       2570     1.00000e+00     2.30600e+00     2.639
      197          1       2616     1.00000e+00     2.30290e+00     2.744
      198          1       2669     1.00000e+00     2.29849e+00     3.019
      199          1       2697     1.00000e+00     2.29443e+00     2.972
      200          1       2737     1.00000e+00     2.29021e+00     2.654
  200  2.2902062e+00  6.8675843e+00   1.00e+00  6.904e-02     0.0    5707

 ERROR EXIT -- Too many iterations

 Products with A     :     216        Total time   (secs) :   470.1
 Products with A'    :     216        Project time (secs) :   358.6
 Newton iterations   :       5        Mat-vec time (secs) :   107.9


info_spg =

           tau: 441.5278
          rNorm: 6.8493
           rGap: 8.4727
          gNorm: 0.6425
           stat: 5
           iter: 200
         nProdA: 278
        nProdAt: 201
        nNewton: 3
    timeProject: 1.3972
    timeMatProd: 123.2335
        itnLSQR: 0
        options: [1x1 struct]
      timeTotal: 126.7972
          xNorm1: [200x1 double]
          rNorm2: [200x1 double]
          lambda: [200x1 double]


info_pqn1 =

           tau: 707.1837
          rNorm: 2.2902
           rGap: 6.8676
          gNorm: 0.0690
           stat: 5
```

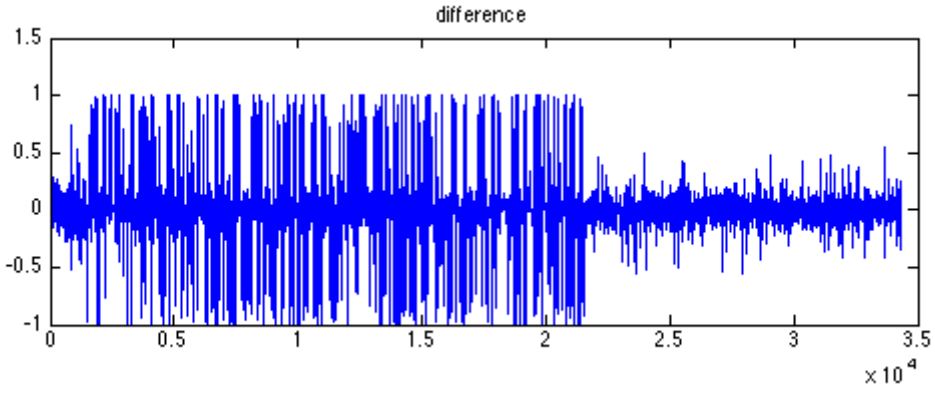
```
          iter: 200

         nProdA: 216
        nProdAt: 216
        nNewton: 5
    timeProject: 358.6004
    timeMatProd: 107.9154
        itnLSQR: 0
        options: [1x1 struct]
      timeTotal: 470.1089
         xNorm1: [200x1 double]
         rNorm2: [200x1 double]
         lambda: [200x1 double]
```

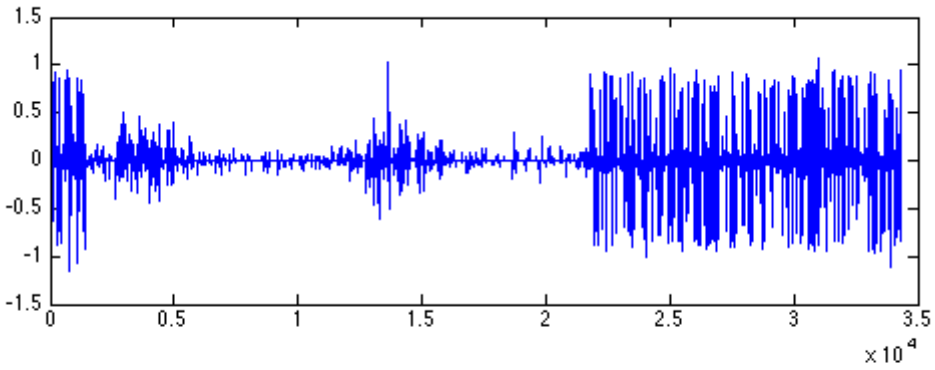


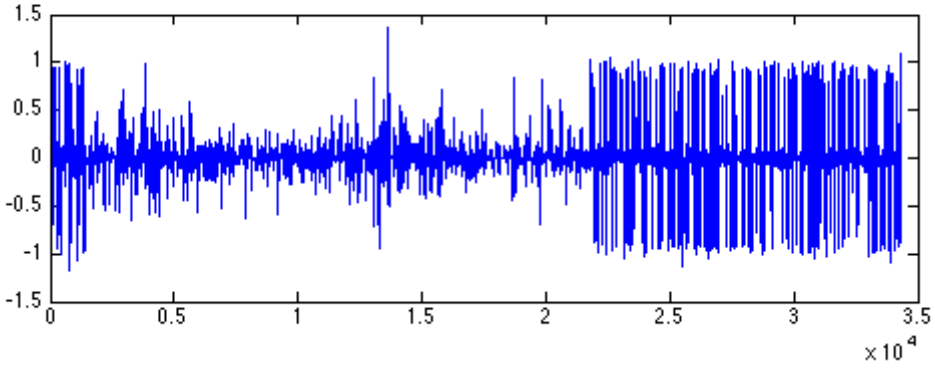

p = .5, SNR=2.2124dB
1
0.5
0
-0.5
-1
0
0.5
1
1.5
2
2.5
3
3.5
x 10^4

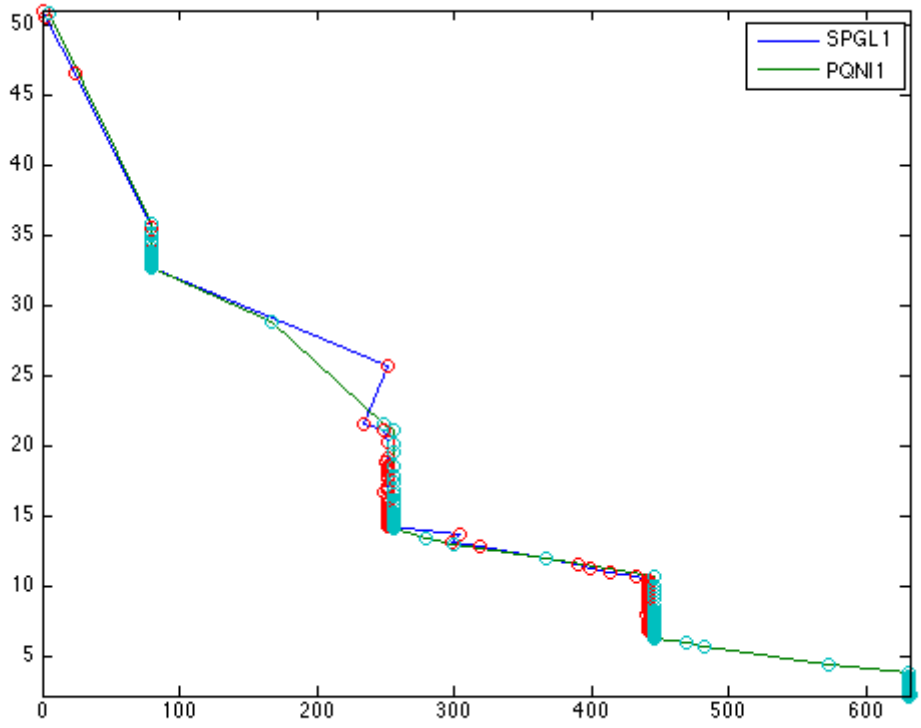

difference
1
0.5
0
-0.5
-1
-1.5
0
0.5
1
1.5
2
2.5
3
3.5
x 10^4


p = .5, SNR=2.9889dB
1.5
1
0.5
0
-0.5
-1
-1.5
0
0.5
1
1.5
2
2.5
3
3.5
x 10^4


difference
1.5
1
0.5
0
-0.5
-1
0
0.5
1
1.5
2
2.5
3
3.5
x 10^4


1.5
1
0.5
0
-0.5
-1
-1.5
0
0.5
1
1.5
2
2.5
3
3.5
x 10^4


1.5
1
0.5
0
-0.5
-1
-1.5
0
0.5
1
1.5
2
2.5
3
3.5
x 10^4


SPGL1
PQNI1
50
45
40
35
30
25
20
15
10
5
0
100
200
300
400
500
600

if given known compressible vector

```
nn = linspace(0,1,n);
x0_compress = exp(-nn.^.1);
x0_compress = x0_compress - min(x0_compress);
figure;plot(x0_compress)
x0_compress = x0_compress(:);
b_compress  = A*x0_compress + 0.005 * randn(m,1);


tau = norm(x0_compress,1);

options = spgSetParms('optTol', 1e-4, 'iterations', 200);%, 'fid', fid);
xinit = zeros(size(A,2),1);

xestspg = spgl1(A,b_compress,tau,[],xinit,options);
xestpqn = pqnl1_2(A,b_compress,tau,[],xinit,options);
snrspg = SNR(x0_compress,xestspg);
snrpqn = SNR(x0_compress,xestpqn);

figure('Name','compressible vector SPG');
subplot(2,1,1);plot(xestspg);
title(strcat(['p = .5, SNR=' num2str(snrspg) 'dB']))
subplot(2,1,2);plot(xestspg - x0_compress);
title('difference')

figure('Name','compressible vector PQN');
subplot(2,1,1);plot(xestpqn);
title(strcat(['p = .5, SNR=' num2str(snrpqn) 'dB']))
subplot(2,1,2);plot(xestpqn - x0_compress);
title('difference')


% BPDN
[x_spg,r_spg,g_spg,info_spg] = spgl1(A, b_compress, 0, 0, zeros(size(A,2),1), opti

[x_pqn1,r_pqn1,g_pqn1,info_pqn1] = pqnl1_2(A, b_compress, 0, 0, zeros(size(A,2),1)

figure; subplot(2,1,1);plot(x_spg);subplot(2,1,2);plot(x_pqn1);
info_spg
info_pqn1

% show result
figure('Name','Solution paths')
plot(info_spg.xNorm1,info_spg.rNorm2,info_pqn1.xNorm1,info_pqn1.rNorm2);hold on
scatter(info_spg.xNorm1,info_spg.rNorm2);
scatter(info_pqn1.xNorm1,info_pqn1.rNorm2);hold off
legend('SPGL1','PQNl1')
axis tight
```

```
================================================================================
SPGL1_SLIM v. 46  (Tue, 14 Jun 2011) based on v.1017
```

```
================================================================================
No. rows              :     6400      No. columns           :    34341
Initial tau           : 1.25e+03      Two-norm of b         : 1.04e+02
Optimality tol        : 1.00e-04      Target one-norm of x  : 1.25e+03
Basis pursuit tol     : 1.00e-06      Maximum iterations    :      200

 Iter      Objective   Relative Gap      gNorm   stepG    nnzX    nnzG
    0  1.0382664e+02  1.4308952e+01   6.16e+01     0.0       0       0
    1  4.4596368e+01  7.8872992e+01   5.83e+01    -0.3    1445       0
    2  4.9339101e+00  4.2084554e+02   4.28e+00     0.0   21600       0
    3  3.6167841e+00  1.2217917e+02   6.31e-01     0.0   21480       0
    4  3.5503211e+00  1.2451567e+02   6.20e-01     0.0   21582       0
    5  1.2119058e+00  1.1162295e+02   8.80e-02     0.0   23074       0
    6  7.7389961e-01  1.1930672e+02   9.64e-02     0.0   23385       0
    7  1.3989465e+00  2.2159631e+03   1.69e+00     0.0   23330       0
    8  5.7271179e-01  3.0704896e+02   2.58e-01    -0.3   23393       0
    9  5.3139660e-01  3.6229494e+01   2.87e-02     0.0   23390       0
   10  5.2780079e-01  3.5079847e+01   2.78e-02     0.0   23404       0
   11  3.9072130e-01  4.3498670e+01   3.47e-02     0.0   23875       0
   12  3.3004928e-01  1.0189060e+02   8.44e-02     0.0   24229       0
   13  3.8357647e-01  4.2196736e+02   3.22e-01    -0.3   24222       0
   14  3.2551732e-01  2.1630296e+02   1.81e-01     0.0   24227       0
   15  2.9198982e-01  3.6459968e+01   2.89e-02     0.0   24224       0
   16  2.8864989e-01  3.4884250e+01   2.78e-02     0.0   24231       0
   17  2.2256753e-01  1.4603706e+01   1.14e-02     0.0   24234       0
   18  2.4572844e-01  2.3448151e+02   1.97e-01     0.0   24347       0
   19  1.9422010e-01  5.7172524e+01   4.37e-02    -0.3   24344       0
   20  1.9115671e-01  9.4399999e+00   7.56e-03     0.0   24344       0
   21  1.9046522e-01  9.4803988e+00   7.58e-03     0.0   24351       0
   22  7.4448928e-02  9.1709184e+00   7.62e-03     0.0   24892       0
   23  1.7096117e-01  2.6636495e+02   2.03e-01    -0.3   24887       0
   24  1.1975404e-01  1.5469070e+02   1.30e-01     0.0   24902       0
   25  6.7512684e-02  2.5694065e+00   2.05e-03     0.0   24896       0
   26  6.7353887e-02  2.4950554e+00   1.99e-03     0.0   24897       0
   27  3.1899368e-02  2.4013800e+00   1.92e-03     0.0   25068       0
   28  4.4004030e-02  1.3634204e+01   1.12e-02     0.0   25300       0
   29  4.8026753e-02  5.5678098e+01   4.25e-02    -0.3   25297       0
   30  3.6961242e-02  1.9883453e+01   1.66e-02    -0.3   25298       0
   31  3.4437160e-02  5.5119370e+00   4.37e-03     0.0   25299       0
   32  3.3596254e-02  5.2334190e+00   4.17e-03     0.0   25294       0
   33  1.8431621e-02  4.2784095e+00   3.30e-03     0.0   25280       0
   34  3.4334528e-02  4.7229193e+01   3.96e-02    -0.3   25282       0
   35  2.3504972e-02  2.7949588e+01   2.13e-02     0.0   25281       0
   36  1.6416323e-02  1.3138526e+00   1.05e-03     0.0   25282       0
   37  1.6337067e-02  1.3312008e+00   1.06e-03     0.0   25279       0
   38  9.8647710e-03  6.1990048e-01   4.97e-04     0.0   25268       0

EXIT -- Optimal solution found

Products with A     :      53        Total time   (secs) :    21.3
Products with A'    :      39        Project time (secs) :     0.1
Newton iterations   :       0        Mat-vec time (secs) :    20.9
Line search its     :      22        Subspace iterations :       0
```

```
================================================================================
PQNL1_SLIM v. 46  (Tue, 14 Jun 2011) based on v.1017
================================================================================
No. rows              :     6400      No. columns           :    34341
Initial tau           : 1.25e+03      Two-norm of b         : 1.04e+02
Optimality tol        : 1.00e-04      Target one-norm of x  : 1.25e+03
Basis pursuit tol     : 1.00e-06      Maximum iterations    :      200

  Iter      Objective   Relative Gap      gNorm   stepG    nnzX    nnzG
     0  1.0382664e+02  1.4308952e+01   6.16e+01     0.0       0       0
Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2         O
         1          1           4     1.25000e-01     5.34951e+01     1.409
         2          1          12     1.00000e+00     1.00642e+01     1.511
         3          1          26     1.00000e+00     9.69369e+00     1.269
         4          1          46     1.00000e+00     8.99310e+00     1.192
         5          1          65     1.00000e+00     7.05020e+00     1.209
         6          1          90     1.00000e+00     4.49087e+00     1.238
         7          1         114     1.00000e+00     2.22926e+00     7.919
         8          1         139     1.00000e+00     2.06583e+00     3.891
         9          1         161     1.00000e+00     2.01814e+00     4.712
        10          1         193     1.00000e+00     1.88525e+00     6.125
        11          1         206     1.00000e+00     1.72249e+00     6.546
        12          1         227     1.00000e+00     1.25046e+00     5.394
        13          1         252     1.00000e+00     7.71177e-01     2.598
        14          1         285     1.00000e+00     6.05857e-01     9.030
        15          1         315     1.00000e+00     5.60538e-01     1.350
        16          1         346     1.00000e+00     5.25046e-01     1.353
        17          1         387     1.00000e+00     4.11570e-01     2.086
        18          1         404     1.00000e+00     2.77961e-01     1.083
        19          1         440     5.00000e-01     2.65788e-01     1.195
        20          1         467     1.00000e+00     2.49089e-01     4.558
        21          1         504     1.00000e+00     2.37046e-01     6.365
        22          1         543     1.00000e+00     2.23021e-01     7.683
        23          1         577     1.00000e+00     1.96930e-01     6.057
        24          1         613     1.00000e+00     1.59518e-01     2.304
        25          1         648     1.00000e+00     1.41944e-01     4.501
        26          1         689     1.00000e+00     1.29585e-01     4.485
        27          1         727     1.00000e+00     6.44624e-02     1.782
        28          1         757     1.00000e+00     4.46703e-02     7.491
        29          1         799     1.00000e+00     3.93359e-02     6.906
        30          1         820     1.00000e+00     3.44561e-02     7.935
        31          1         855     2.50000e-01     3.28872e-02     1.988
        32          1         885     1.00000e+00     2.70252e-02     5.066
        33          1         922     1.00000e+00     2.38792e-02     4.815
        34          1         950     1.00000e+00     2.20840e-02     3.637
        35          1         979     1.00000e+00     1.86156e-02     5.920
        36          1        1013     1.00000e+00     1.78226e-02     1.038
        37          1        1028     1.00000e+00     1.59356e-02     2.994
        38          1        1056     1.00000e+00     1.56571e-02     2.265
        39          1        1089     1.00000e+00     1.52356e-02     2.127
        40          1        1104     1.00000e+00     1.45285e-02     2.317
        41          1        1123     1.00000e+00     1.17013e-02     3.657
```

```
        42          1       1159     1.00000e+00     1.04030e-02     3.800
        43          1       1213     1.00000e+00     9.00093e-03     1.625
        44          1       1253     1.00000e+00     8.25437e-03     1.585
        45          1       1297     1.00000e+00     6.86232e-03     1.522
        46          1       1332     1.00000e+00     5.23242e-03     1.219
        47          1       1360     2.50000e-01     4.79600e-03     3.148
        48          1       1392     1.00000e+00     4.17630e-03     6.576
        49          1       1434     1.00000e+00     3.78953e-03     7.501
        50          1       1472     1.00000e+00     3.09181e-03     7.486
        51          1       1491     1.00000e+00     2.84694e-03     1.840
        52          1       1518     1.00000e+00     2.38056e-03     1.147
        53          1       1560     1.00000e+00     1.81499e-03     3.134
        54          1       1601     1.00000e+00     1.69223e-03     3.355
        55          1       1642     1.00000e+00     1.57147e-03     3.923
        56          1       1703     1.00000e+00     1.45323e-03     2.722
        57          1       1732     1.00000e+00     1.29451e-03     2.590
        58          1       1759     1.00000e+00     1.14609e-03     2.266
        59          1       1783     1.00000e+00     9.12037e-04     1.491
        60          1       1812     2.50000e-01     8.77638e-04     4.602
        61          1       1864     1.00000e+00     7.46660e-04     2.046
        62          1       1894     1.00000e+00     6.68202e-04     1.256
        63          1       1926     1.00000e+00     5.74640e-04     1.030
        64          1       1974     1.00000e+00     4.79369e-04     7.072
        65          1       2017     1.00000e+00     4.03978e-04     2.867
        66          1       2061     1.00000e+00     3.54060e-04     1.342
        67          1       2093     1.00000e+00     3.32187e-04     4.960
        68          1       2125     1.00000e+00     3.05414e-04     8.185
        69          1       2156     1.00000e+00     2.80351e-04     9.352
        70          1       2193     1.00000e+00     2.47567e-04     1.275
        71          1       2222     1.00000e+00     2.12096e-04     4.987
        72          1       2273     1.00000e+00     1.96225e-04     5.638
        73          1       2322     1.00000e+00     1.79131e-04     6.051
        74          1       2362     1.00000e+00     1.50574e-04     7.338
        75          1       2380     1.00000e+00     1.36387e-04     3.830
        76          1       2423     1.00000e+00     1.29874e-04     3.256
        77          1       2477     1.00000e+00     1.20393e-04     3.470
        78          1       2525     1.00000e+00     1.12455e-04     7.046
        79          1       2555     1.00000e+00     1.02507e-04     3.359
        80          1       2584     1.00000e+00     9.39152e-05     2.927
Optimal solution found
    80  9.3915180e-05  1.3144689e-02   1.04e-05     0.0   26044       0
 EXIT -- Optimal solution found

 Products with A     :      92        Total time   (secs) :   201.8
 Products with A'    :      92        Project time (secs) :   135.2
 Newton iterations   :       0        Mat-vec time (secs) :    42.6


 ================================================================================
 SPGL1_SLIM v. 46  (Tue, 14 Jun 2011) based on v.1017
 ================================================================================
 No. rows              :     6400      No. columns           :    34341
 Initial tau           : 0.00e+00      Two-norm of b         : 1.04e+02
 Optimality tol        : 1.00e-04      Target objective      : 0.00e+00
```

```
Basis pursuit tol     : 1.00e-06      Maximum iterations    :      200

 Iter      Objective   Relative Gap  Rel Error      gNorm   stepG    nnzX
    0  1.0382664e+02  0.0000000e+00  1.00e+00  6.158e+01     0.0       0
    1  1.0342195e+02  2.5891244e+00  1.00e+00  7.765e+01    -0.3       1
    2  8.1177425e+01  1.3724117e+01  1.00e+00  2.304e+02     0.0     773
    3  7.1829521e+01  1.3765270e+01  1.00e+00  1.913e+02     0.0    1170
    4  2.6734585e+01  2.9603868e+00  1.00e+00  1.331e+01     0.0    1568
    5  2.5808656e+01  1.8740045e+00  1.00e+00  1.038e+01     0.0    1463
    6  2.4577656e+01  1.6830070e+00  1.00e+00  9.195e+00     0.0    1384
    7  2.4660530e+01  2.8910533e+00  1.00e+00  1.120e+01     0.0    1296
    8  2.4556237e+01  5.2887640e+00  1.00e+00  1.534e+01     0.0    1325
    9  2.4327096e+01  5.3422229e-01  1.00e+00  7.161e+00     0.0    1325
   10  2.4301866e+01  5.1709851e-01  1.00e+00  7.134e+00     0.0    1309
   11  2.4284607e+01  3.5569729e-01  1.00e+00  6.852e+00     0.0    1283
   12  2.4169628e+01  2.0998207e+00  1.00e+00  9.699e+00     0.0    1168
   13  2.4278687e+01  1.0245902e+00  1.00e+00  7.851e+00    -0.3    1187
   14  2.4132237e+01  1.2990083e+00  1.00e+00  8.351e+00     0.0    1208
   15  2.4120613e+01  3.0015332e-01  1.00e+00  6.682e+00     0.0    1176
   16  2.4111380e+01  3.4032227e-01  1.00e+00  6.743e+00     0.0    1164
   17  2.3947439e+01  9.7400367e-01  1.00e+00  7.665e+00     0.0     877
   18  2.4114845e+01  1.9659655e+00  1.00e+00  9.306e+00    -0.3     920
   19  2.3938369e+01  1.1546751e+00  1.00e+00  7.984e+00     0.0    1056
   20  2.3920142e+01  2.6002319e-01  1.00e+00  6.518e+00     0.0    1003
   21  2.3916561e+01  2.0295396e-01  1.00e+00  6.422e+00     0.0     957
   22  2.3905155e+01  4.1595116e-01  1.00e+00  6.753e+00     0.0     881
   23  2.3900032e+01  2.8704175e-01  1.00e+00  6.542e+00    -0.3     881
   24  2.3897356e+01  3.3305473e-01  1.00e+00  6.615e+00     0.0     879
   25  2.3894145e+01  2.1955379e-01  1.00e+00  6.426e+00     0.0     878
   26  2.3893075e+01  1.5560895e+00  1.00e+00  8.597e+00     0.0     872
   27  1.9079461e+01  2.6744302e+01  1.00e+00  1.568e+01     0.0    3975
   28  1.1905592e+01  4.0249310e+00  1.00e+00  3.281e+00     0.0    8914
   29  1.1652356e+01  2.3788650e+00  1.00e+00  2.314e+00     0.0    7935
   30  1.1470307e+01  2.0245540e+00  1.00e+00  2.281e+00     0.0    6817
   31  1.0910180e+01  2.5664302e+00  1.00e+00  2.570e+00     0.0    4245
   32  1.0863339e+01  4.2962000e+00  1.00e+00  2.536e+00    -0.3    4230
   33  1.0888224e+01  9.1188280e+00  1.00e+00  4.437e+00     0.0    4111
   34  1.0750139e+01  4.3796220e+00  1.00e+00  2.700e+00     0.0    4038
   35  1.0704589e+01  2.2676124e+00  1.00e+00  2.320e+00     0.0    3940
   36  1.0680109e+01  1.7166305e+00  1.00e+00  2.188e+00     0.0    3852
   37  1.0506860e+01  4.7648305e+00  1.00e+00  2.927e+00     0.0    3252
   38  1.0641349e+01  1.1196283e+01  1.00e+00  4.350e+00    -0.3    3280
   39  1.0506639e+01  1.2144365e+01  1.00e+00  4.579e+00     0.0    3243
   40  1.0425772e+01  1.5972279e+00  1.00e+00  2.180e+00     0.0    3217
   41  1.0416019e+01  1.3201724e+00  1.00e+00  2.119e+00     0.0    3181
   42  1.0311674e+01  1.5190057e+00  1.00e+00  2.198e+00     0.0    2787
   43  1.0327207e+01  8.9847503e+00  1.00e+00  3.791e+00    -0.3    2798
   44  1.0336194e+01  4.8790268e+00  1.00e+00  2.909e+00    -0.3    2770
   45  1.0249523e+01  2.1253141e+00  1.00e+00  2.320e+00     0.0    2811
   46  1.0243261e+01  9.6053996e-01  1.00e+00  2.071e+00     0.0    2767
   47  1.0229692e+01  1.0569579e+00  1.00e+00  2.089e+00     0.0    2700
   48  1.0166647e+01  5.2333446e+00  1.00e+00  3.094e+00    -0.3    2389
   49  1.0149898e+01  4.3751969e+00  1.00e+00  2.784e+00    -0.3    2497
   50  1.0115755e+01  1.3969722e+00  1.00e+00  2.182e+00     0.0    2467
```

51	1.0112482e+01	6.2159111e-01	1.00e+00	2.023e+00	0.0	2446
52	1.0108340e+01	5.8758906e-01	1.00e+00	2.018e+00	0.0	2428
53	1.0046178e+01	4.0069534e+00	1.00e+00	2.831e+00	0.0	2039
54	1.0046176e+01	2.4917445e+00	1.00e+00	2.421e+00	-0.3	2111
55	4.5712347e+00	1.2341915e+01	1.00e+00	6.555e-01	0.0	10212
56	4.4406601e+00	6.8938098e+00	1.00e+00	5.019e-01	0.0	9922
57	4.2906066e+00	6.7871277e+00	1.00e+00	4.612e-01	0.0	9157
58	4.0629294e+00	1.3804682e+01	1.00e+00	6.587e-01	0.0	7643
59	4.0133411e+00	1.8354055e+01	1.00e+00	7.323e-01	-0.3	7569
60	3.9750149e+00	1.5365410e+01	1.00e+00	6.799e-01	0.0	7397
61	3.9407968e+00	1.3784626e+01	1.00e+00	5.997e-01	0.0	7198
62	3.9129912e+00	9.9805337e+00	1.00e+00	5.117e-01	0.0	7069
63	3.8823777e+00	1.2830046e+01	1.00e+00	5.699e-01	0.0	6887
64	3.8621168e+00	2.5575184e+01	1.00e+00	9.376e-01	0.0	6651
65	3.8952741e+00	4.6273650e+01	1.00e+00	1.439e+00	0.0	6508
66	3.7891090e+00	1.1789287e+01	1.00e+00	5.500e-01	0.0	6469
67	3.7748803e+00	5.6723594e+00	1.00e+00	3.899e-01	0.0	6421
68	3.7504952e+00	5.4716621e+00	1.00e+00	3.845e-01	0.0	6322
69	3.6467799e+00	9.2322190e+01	1.00e+00	2.890e+00	0.0	4807
70	3.3450095e+00	2.6549955e+01	1.00e+00	9.074e-01	-0.3	4842
71	3.2653631e+00	1.3703457e+01	1.00e+00	6.327e-01	0.0	4837
72	3.2509866e+00	4.4402350e+00	1.00e+00	4.531e-01	0.0	4819
73	3.2387153e+00	5.5276453e+00	1.00e+00	4.682e-01	0.0	4807
74	3.2248232e+00	7.6488211e+00	1.00e+00	5.006e-01	0.0	4769
75	3.2486616e+00	5.4326962e+01	1.00e+00	1.378e+00	-0.3	4732
76	3.2188495e+00	1.5294818e+01	1.00e+00	6.339e-01	0.0	4738
77	3.2035950e+00	4.0731510e+00	1.00e+00	4.332e-01	0.0	4725
78	3.2011319e+00	3.6298627e+00	1.00e+00	4.250e-01	0.0	4724
79	3.1285450e+00	7.4952304e+00	1.00e+00	4.767e-01	0.0	4541
80	3.1551158e+00	3.0586665e+01	1.00e+00	9.026e-01	-0.3	4546
81	3.1335538e+00	2.2130771e+01	1.00e+00	7.239e-01	0.0	4555
82	3.1148096e+00	3.6273127e+00	1.00e+00	4.119e-01	0.0	4534
83	3.1133310e+00	3.2620725e+00	1.00e+00	4.066e-01	0.0	4528
84	3.0905179e+00	4.0349109e+00	1.00e+00	4.127e-01	0.0	4439
85	3.0897053e+00	1.5418774e+01	1.00e+00	6.541e-01	-0.3	4443
86	3.0984354e+00	2.0898347e+01	1.00e+00	6.494e-01	-0.3	4416
87	3.0755265e+00	6.0170870e+00	1.00e+00	4.514e-01	0.0	4413
88	3.0738097e+00	2.8983313e+00	1.00e+00	3.986e-01	0.0	4407
89	3.0711972e+00	3.1134683e+00	1.00e+00	4.031e-01	0.0	4399
90	3.0137542e+00	4.1568502e+01	1.00e+00	1.061e+00	0.0	3869
91	2.9675891e+00	1.8029432e+01	1.00e+00	6.157e-01	-0.3	3896
92	2.9417213e+00	5.3955958e+00	1.00e+00	4.447e-01	0.0	3884
93	2.9400450e+00	3.1413224e+00	1.00e+00	4.117e-01	0.0	3886
94	2.9381707e+00	2.3865780e+00	1.00e+00	4.012e-01	0.0	3873
95	2.9335600e+00	3.1154394e+00	1.00e+00	4.106e-01	0.0	3859
96	2.9320676e+00	7.9395264e+00	1.00e+00	4.909e-01	-0.3	3851
97	2.9373497e+00	1.1758026e+01	1.00e+00	5.321e-01	0.0	3843
98	2.9292042e+00	7.4371616e+00	1.00e+00	4.784e-01	0.0	3835
99	2.9280464e+00	2.1610940e+00	1.00e+00	3.984e-01	0.0	3833
100	2.9274030e+00	2.1320429e+00	1.00e+00	3.980e-01	0.0	3832
101	2.8730125e+00	1.0309315e+01	1.00e+00	5.667e-01	0.0	3576
102	2.9145454e+00	3.4439826e+01	1.00e+00	8.252e-01	-0.3	3609
103	2.8658476e+00	7.3426890e+00	1.00e+00	4.873e-01	0.0	3597
104	2.8630472e+00	1.9987669e+00	1.00e+00	4.063e-01	0.0	3592

105	2.8624850e+00	1.8054419e+00	1.00e+00	4.046e-01	0.0	3591
106	2.8588558e+00	3.4031457e+00	1.00e+00	4.478e-01	0.0	3581
107	2.8570928e+00	3.8273402e+00	1.00e+00	4.221e-01	-0.3	3578
108	2.8562140e+00	2.7250285e+00	1.00e+00	4.263e-01	0.0	3579
109	2.8556224e+00	1.9757035e+00	1.00e+00	4.057e-01	0.0	3573
110	2.8549914e+00	3.0788134e+00	1.00e+00	4.277e-01	0.0	3574
111	2.8547612e+00	4.4812709e+00	1.00e+00	4.375e-01	0.0	3569
112	2.8553278e+00	1.0095850e+01	1.00e+00	5.327e-01	0.0	3568
113	2.8529701e+00	2.2321824e+00	1.00e+00	4.134e-01	0.0	3569
114	2.8526696e+00	1.6605115e+00	1.00e+00	4.046e-01	0.0	3568
115	2.8518754e+00	1.6376076e+00	1.00e+00	4.039e-01	0.0	3568
116	2.8477878e+00	3.7747950e+01	1.00e+00	9.728e-01	-0.3	3441
117	2.8305007e+00	1.2964553e+01	1.00e+00	5.603e-01	-0.3	3457
118	2.8210861e+00	2.1272005e+00	1.00e+00	4.139e-01	0.0	3453
119	2.8208206e+00	1.3430496e+00	1.00e+00	4.041e-01	0.0	3453
120	2.8201100e+00	1.3040601e+00	1.00e+00	4.050e-01	0.0	3453
121	2.8173731e+00	3.3708722e+00	1.00e+00	4.212e-01	0.0	3436
122	2.8175951e+00	5.0119728e+00	1.00e+00	4.788e-01	-0.3	3438
123	2.8163516e+00	2.2622206e+00	1.00e+00	4.120e-01	0.0	3437
124	2.8159766e+00	1.8628742e+00	1.00e+00	4.128e-01	0.0	3432
125	2.8157482e+00	1.3522717e+00	1.00e+00	4.058e-01	0.0	3432
126	2.8150135e+00	3.3937102e+00	1.00e+00	4.346e-01	0.0	3430
127	2.8147362e+00	2.2779787e+00	1.00e+00	4.190e-01	-0.3	3431
128	2.8144569e+00	2.4888984e+00	1.00e+00	4.221e-01	0.0	3429
129	2.8142047e+00	1.6397958e+00	1.00e+00	4.102e-01	0.0	3428
130	2.8138828e+00	2.7809265e+00	1.00e+00	4.263e-01	0.0	3424
131	2.8138602e+00	4.1488923e+00	1.00e+00	4.455e-01	0.0	3422
132	2.2626409e+00	7.9099786e+01	1.00e+00	4.199e-01	0.0	8878
133	1.9666610e+00	1.9627992e+01	1.00e+00	1.231e-01	0.0	6374
134	1.9448610e+00	2.0507323e+01	1.00e+00	1.180e-01	0.0	6570
135	1.8329059e+00	1.3377095e+01	1.00e+00	2.719e-01	0.0	8842
136	1.7528381e+00	3.6748530e+01	1.00e+00	1.689e-01	-0.3	8294
137	1.6831174e+00	1.5901268e+01	1.00e+00	1.482e-01	0.0	8174
138	1.6641907e+00	2.2266224e+01	1.00e+00	1.083e-01	0.0	8106
139	1.6556530e+00	1.8312878e+01	1.00e+00	1.037e-01	0.0	8116
140	1.6259300e+00	2.2429677e+01	1.00e+00	1.012e-01	0.0	8007
141	1.6194460e+00	1.9769513e+01	1.00e+00	1.858e-01	-0.3	7953
142	1.6039148e+00	3.9772109e+01	1.00e+00	1.308e-01	-0.3	7747
143	1.5866319e+00	1.6427785e+01	1.00e+00	9.640e-02	0.0	7805
144	1.5814157e+00	1.8948194e+01	1.00e+00	9.739e-02	0.0	7771
145	1.5441179e+00	1.3802411e+01	1.00e+00	9.516e-02	0.0	7599
146	1.5697927e+00	8.5059972e+01	1.00e+00	2.581e-01	-0.3	7359
147	1.5248233e+00	2.0573593e+01	1.00e+00	1.624e-01	-0.3	7468
148	1.5067209e+00	1.8518137e+01	1.00e+00	9.157e-02	0.0	7413
149	1.5029333e+00	1.7627268e+01	1.00e+00	9.098e-02	0.0	7390
150	1.4205073e+00	1.7091160e+01	1.00e+00	1.086e-01	0.0	6917
151	1.4617611e+00	1.0326758e+02	1.00e+00	2.885e-01	-0.3	6886
152	1.4603555e+00	5.4367925e+01	1.00e+00	3.409e-01	0.0	6978
153	1.3960901e+00	1.7391264e+01	1.00e+00	8.368e-02	0.0	6911
154	1.3934492e+00	1.5648750e+01	1.00e+00	8.244e-02	0.0	6898
155	1.3710464e+00	1.3860212e+01	1.00e+00	8.299e-02	0.0	6802
156	1.3688559e+00	3.6088708e+01	1.00e+00	1.007e-01	-0.3	6748
157	1.3719476e+00	2.2477992e+01	1.00e+00	1.719e-01	-0.3	6788
158	1.3491476e+00	1.5909685e+01	1.00e+00	7.698e-02	0.0	6746

```
  159  1.3469469e+00  1.3537068e+01   1.00e+00  7.617e-02     0.0    6742
  160  1.3373845e+00  1.3335983e+01   1.00e+00  7.582e-02     0.0    6681
  161  1.3080537e+00  1.8259342e+02   1.00e+00  7.032e-01     0.0    5802
  162  1.2279552e+00  6.6276863e+01   1.00e+00  3.951e-01    -0.3    5974
  163  1.1702634e+00  2.9319912e+01   1.00e+00  2.012e-01     0.0    5837
  164  1.1509599e+00  1.3658442e+01   1.00e+00  1.555e-01     0.0    5841
  165  1.1180159e+00  2.4836030e+01   1.00e+00  1.639e-01     0.0    5779
  166  1.1604344e+00  1.3158437e+02   1.00e+00  5.817e-01     0.0    5882
  167  1.0984421e+00  1.3449565e+02   1.00e+00  4.669e-01    -0.3    5766
  168  1.0724731e+00  7.5662194e+00   1.00e+00  8.664e-02     0.0    5807
  169  1.0707520e+00  6.7610111e+00   1.00e+00  8.233e-02     0.0    5810
  170  1.0573198e+00  7.8448315e+00   1.00e+00  8.153e-02     0.0    5822
  171  1.0548585e+00  1.7152344e+01   1.00e+00  9.316e-02    -0.3    5806
  172  1.0579868e+00  2.1423220e+01   1.00e+00  1.496e-01     0.0    5848
  173  1.0500419e+00  1.8051151e+01   1.00e+00  9.760e-02     0.0    5814
  174  1.0483952e+00  7.0646597e+00   1.00e+00  7.121e-02     0.0    5823
  175  1.0471514e+00  6.9183355e+00   1.00e+00  6.967e-02     0.0    5820
  176  1.0137867e+00  4.8644598e+01   1.00e+00  2.176e-01     0.0    5781
  177  1.0299173e+00  1.5426301e+02   1.00e+00  5.074e-01    -0.3    5770
  178  1.0025454e+00  1.1710257e+01   1.00e+00  7.595e-02     0.0    5789
  179  1.0012301e+00  6.7533893e+00   1.00e+00  5.590e-02     0.0    5788
  180  1.0001240e+00  6.6861274e+00   1.00e+00  5.662e-02     0.0    5787
  181  9.6570264e-01  4.2924015e+01   9.66e-01  1.983e-01     0.0    5707
  182  9.7738882e-01  1.3339085e+02   9.77e-01  4.810e-01    -0.3    5713
  183  9.6212355e-01  6.4565546e+01   9.62e-01  2.672e-01     0.0    5709
  184  9.5859339e-01  5.6133798e+00   9.59e-01  6.711e-02     0.0    5712
  185  9.5783453e-01  5.5530447e+00   9.58e-01  6.649e-02     0.0    5708
  186  9.4334955e-01  8.7855066e+00   9.43e-01  7.337e-02     0.0    5686
  187  9.4546148e-01  3.4541936e+01   9.45e-01  1.327e-01    -0.3    5682
  188  9.4653994e-01  2.5648148e+01   9.47e-01  1.513e-01     0.0    5693
  189  9.3818030e-01  1.1076839e+01   9.38e-01  7.343e-02     0.0    5689
  190  9.3757782e-01  5.5660876e+00   9.38e-01  5.761e-02     0.0    5689
  191  9.3602695e-01  5.7974266e+00   9.36e-01  5.890e-02     0.0    5686
  192  9.1524277e-01  1.4195171e+02   9.15e-01  4.957e-01    -0.3    5629
  193  8.9704865e-01  4.8348563e+01   8.97e-01  2.100e-01    -0.3    5636
  194  8.9242404e-01  5.0517273e+00   8.92e-01  5.832e-02     0.0    5631
  195  8.9185852e-01  5.0966394e+00   8.92e-01  5.856e-02     0.0    5629
  196  8.8689575e-01  8.8974917e+00   8.87e-01  7.148e-02     0.0    5630
  197  8.8547537e-01  8.6588950e+00   8.85e-01  6.573e-02    -0.3    5618
  198  8.8474667e-01  1.3417107e+01   8.85e-01  9.182e-02     0.0    5626
  199  8.8355186e-01  1.2055123e+01   8.84e-01  7.407e-02     0.0    5612
  200  8.8237466e-01  6.8300251e+00   8.82e-01  6.414e-02     0.0    5618

ERROR EXIT -- Too many iterations

Products with A     :     275        Total time   (secs) :   130.2
Products with A'    :     201        Project time (secs) :     1.4
Newton iterations   :       4        Mat-vec time (secs) :   126.8
Line search its     :     154        Subspace iterations :       0


================================================================================
PQNL1_SLIM v. 46  (Tue, 14 Jun 2011) based on v.1017
================================================================================
```

```
 No. rows              :     6400      No. columns           :    34341
 Initial tau           : 0.00e+00      Two-norm of b         : 1.04e+02
 Optimality tol        : 1.00e-04      Target objective      : 0.00e+00
 Basis pursuit tol     : 1.00e-06      Maximum iterations    :      200

     0  1.0382664e+02  0.0000000e+00   1.00e+00  6.158e+01     0.0       0

Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2        O
         1          1           4     2.50000e-01     9.19485e+01     2.188
         2          1          11     1.00000e+00     2.79824e+01     2.969
         3          1          20     1.00000e+00     2.72965e+01     2.767
         4          1          31     1.00000e+00     2.60515e+01     2.398
         5          1          40     1.00000e+00     2.59608e+01     2.335
         6          1          52     1.00000e+00     2.57241e+01     2.551
         7          1          76     1.00000e+00     2.54657e+01     3.060
         8          1          99     1.00000e+00     2.50826e+01     2.980
         9          1         114     1.00000e+00     2.47281e+01     2.164
        10          1         129     1.00000e+00     2.45402e+01     1.419
        11          1         149     1.00000e+00     2.44093e+01     1.422
        12          1         167     1.00000e+00     2.43115e+01     1.285
        13          1         194     1.00000e+00     2.41986e+01     1.287
        14          1         211     1.00000e+00     2.41396e+01     1.044
        15          1         233     1.00000e+00     2.40918e+01     9.717
        16          1         251     1.00000e+00     2.40573e+01     9.080
        17          1         273     1.00000e+00     2.40178e+01     9.525
        18          1         294     1.00000e+00     2.39870e+01     1.051
        19          1         313     1.00000e+00     2.39648e+01     9.866
        20          1         327     1.00000e+00     2.39462e+01     9.167
        21          1         343     1.00000e+00     2.39302e+01     9.509
        22          1         358     1.00000e+00     2.39128e+01     9.049
        23          1         372     1.00000e+00     2.38955e+01     7.500
        24          1         395     1.00000e+00     2.38722e+01     6.372
        25          1         415     1.00000e+00     2.38521e+01     6.933
        26          1         448     1.00000e+00     2.38355e+01     8.223
        27          1         484     1.00000e+00     2.38235e+01     6.467
        28          1         507     1.00000e+00     2.38100e+01     6.138
        29          1         536     1.00000e+00     2.37892e+01     7.922
        30          1         562     1.00000e+00     2.37779e+01     8.604
break of testUpdateTau    30  2.3777874e+01  3.2706145e-01   1.00e+00  6.5

Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2        O
        31          1           4     1.25000e-01     2.23531e+01     3.607
        32          1          12     1.00000e+00     1.02543e+01     4.382
        33          1          19     1.00000e+00     9.64550e+00     4.072
        34          1          27     1.00000e+00     9.10413e+00     3.595
        35          1          36     1.00000e+00     8.85315e+00     3.540
        36          1          45     1.00000e+00     8.62362e+00     3.348
        37          1          57     1.00000e+00     8.25496e+00     2.855
        38          1          71     1.00000e+00     7.94060e+00     2.610
        39          1          86     1.00000e+00     7.64065e+00     2.404
        40          1         103     1.00000e+00     7.30445e+00     2.293
        41          1         126     1.00000e+00     7.04382e+00     1.971
```

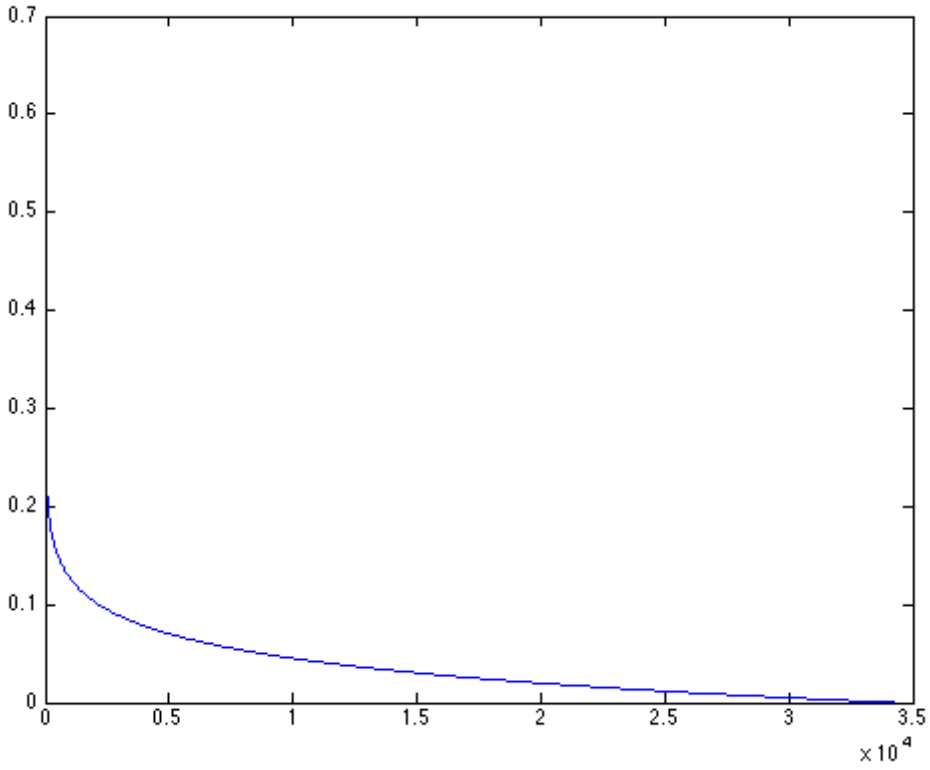
```
        42          1        147     1.00000e+00     6.89630e+00     1.679
        43          1        173     1.00000e+00     6.76431e+00     2.445
        44          1        196     1.00000e+00     6.70484e+00     1.071
        45          1        217     1.00000e+00     6.68295e+00     1.087
        46          1        239     1.00000e+00     6.65890e+00     1.113
        47          1        262     1.00000e+00     6.63059e+00     1.112
        48          1        282     1.00000e+00     6.60713e+00     9.318
        49          1        304     1.00000e+00     6.58275e+00     9.643
        50          1        324     1.00000e+00     6.54431e+00     9.202
        51          1        348     1.00000e+00     6.50857e+00     7.696
        52          1        386     1.00000e+00     6.48891e+00     1.015
        53          1        408     1.00000e+00     6.47867e+00     6.227
        54          1        446     1.00000e+00     6.47084e+00     4.844
        55          1        476     1.00000e+00     6.46452e+00     5.505
        56          1        502     1.00000e+00     6.45638e+00     4.919
        57          1        525     1.00000e+00     6.44884e+00     4.128
        58          1        550     1.00000e+00     6.44367e+00     3.949
        59          1        581     1.00000e+00     6.43827e+00     3.998
        60          1        612     1.00000e+00     6.43359e+00     3.525
        61          1        635     1.00000e+00     6.42987e+00     3.220
        62          1        656     1.00000e+00     6.42707e+00     2.902
break of testUpdateTau    62  6.4270741e+00  6.7407968e-01   1.00e+00  1.1

Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2        O
        63          1          4     5.00000e-01     5.11188e+00     5.467
        64          1         14     1.00000e+00     3.46068e+00     2.457
        65          1         24     1.00000e+00     3.41859e+00     2.424
        66          1         45     1.00000e+00     2.67533e+00     2.340
        67          1         62     1.00000e+00     2.52171e+00     2.393
        68          1         71     1.00000e+00     2.46647e+00     1.332
        69          1         91     1.00000e+00     2.41849e+00     1.159
        70          1        109     1.00000e+00     2.36459e+00     1.354
        71          1        137     1.00000e+00     2.26631e+00     1.073
        72          1        164     1.00000e+00     2.18609e+00     8.884
        73          1        190     1.00000e+00     2.13392e+00     9.099
        74          1        219     1.00000e+00     2.07378e+00     9.321
        75          1        247     1.00000e+00     2.00777e+00     7.801
        76          1        279     1.00000e+00     1.92921e+00     7.986
        77          1        311     1.00000e+00     1.85616e+00     9.426
        78          1        347     1.00000e+00     1.80078e+00     6.851
        79          1        388     1.00000e+00     1.75029e+00     7.110
        80          1        426     1.00000e+00     1.69484e+00     8.070
        81          1        460     1.00000e+00     1.65101e+00     8.324
        82          1        499     1.00000e+00     1.62464e+00     7.114
        83          1        543     1.00000e+00     1.58694e+00     6.894
        84          1        586     1.00000e+00     1.54932e+00     8.324
        85          1        633     1.00000e+00     1.51152e+00     7.057
        86          1        675     1.00000e+00     1.47462e+00     6.080
        87          1        710     1.00000e+00     1.44466e+00     7.162
        88          1        739     1.00000e+00     1.42066e+00     7.141
        89          1        768     1.00000e+00     1.39699e+00     8.059
        90          1        801     1.00000e+00     1.36594e+00     8.139
        91          1        861     1.00000e+00     1.32906e+00     6.046
```

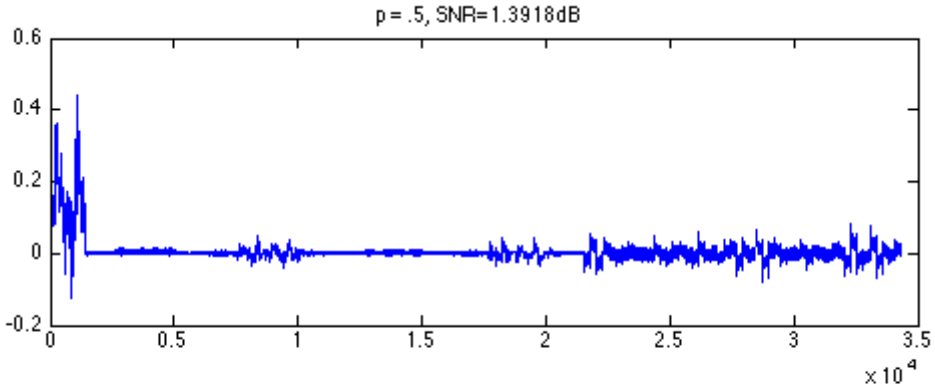
92	1	897	1.00000e+00	1.30322e+00	5.591
93	1	931	1.00000e+00	1.28789e+00	4.620
94	1	954	1.00000e+00	1.26893e+00	4.723
95	1	1000	1.00000e+00	1.25332e+00	4.202
96	1	1032	1.00000e+00	1.24044e+00	3.362
97	1	1071	1.00000e+00	1.22286e+00	4.079
98	1	1109	1.00000e+00	1.20845e+00	3.670
99	1	1158	1.00000e+00	1.18924e+00	3.332
100	1	1202	1.00000e+00	1.17598e+00	3.213
101	1	1248	1.00000e+00	1.16208e+00	3.009
102	1	1283	1.00000e+00	1.14701e+00	3.224
103	1	1332	1.00000e+00	1.13461e+00	3.127
104	1	1369	1.00000e+00	1.12503e+00	2.897
105	1	1408	1.00000e+00	1.11316e+00	2.995
106	1	1457	1.00000e+00	1.10268e+00	3.095
107	1	1493	1.00000e+00	1.09483e+00	2.928
108	1	1523	1.00000e+00	1.08603e+00	2.857
109	1	1556	1.00000e+00	1.07913e+00	2.369
110	1	1583	1.00000e+00	1.07317e+00	2.355
111	1	1616	1.00000e+00	1.06687e+00	2.532
112	1	1660	1.00000e+00	1.05930e+00	2.588
113	1	1699	1.00000e+00	1.05247e+00	2.729
114	1	1731	1.00000e+00	1.04607e+00	2.254
115	1	1796	1.00000e+00	1.03894e+00	1.974
116	1	1842	1.00000e+00	1.03316e+00	2.032
117	1	1883	1.00000e+00	1.02765e+00	1.995
118	1	1920	1.00000e+00	1.02313e+00	1.898
119	1	1966	1.00000e+00	1.01826e+00	1.758
120	1	1998	1.00000e+00	1.01385e+00	1.980
121	1	2038	1.00000e+00	1.01017e+00	1.876
122	1	2083	1.00000e+00	1.00547e+00	1.779
123	1	2117	1.00000e+00	1.00183e+00	1.999
124	1	2139	1.00000e+00	1.00019e+00	1.362
125	1	2157	1.00000e+00	9.98304e-01	1.367
126	1	2190	1.00000e+00	9.95502e-01	1.585
127	1	2227	1.00000e+00	9.92379e-01	1.661
128	1	2265	1.00000e+00	9.90094e-01	1.780
129	1	2295	1.00000e+00	9.88603e-01	1.412
130	1	2325	1.00000e+00	9.86808e-01	1.328
131	1	2355	1.00000e+00	9.85479e-01	1.388
132	1	2383	1.00000e+00	9.83713e-01	1.167
133	1	2412	1.00000e+00	9.82024e-01	1.060
134	1	2445	1.00000e+00	9.80619e-01	1.129
135	1	2476	1.00000e+00	9.78965e-01	1.205
136	1	2501	1.00000e+00	9.77884e-01	1.050
137	1	2543	1.00000e+00	9.76658e-01	9.468
138	1	2582	1.00000e+00	9.75557e-01	9.710
139	1	2609	1.00000e+00	9.74756e-01	1.088
140	1	2645	1.00000e+00	9.73794e-01	1.045
141	1	2682	1.00000e+00	9.72751e-01	8.600
142	1	2722	1.00000e+00	9.71989e-01	7.977
143	1	2752	1.00000e+00	9.71005e-01	7.753
144	1	2781	1.00000e+00	9.70192e-01	8.663
145	1	2809	1.00000e+00	9.69338e-01	8.887

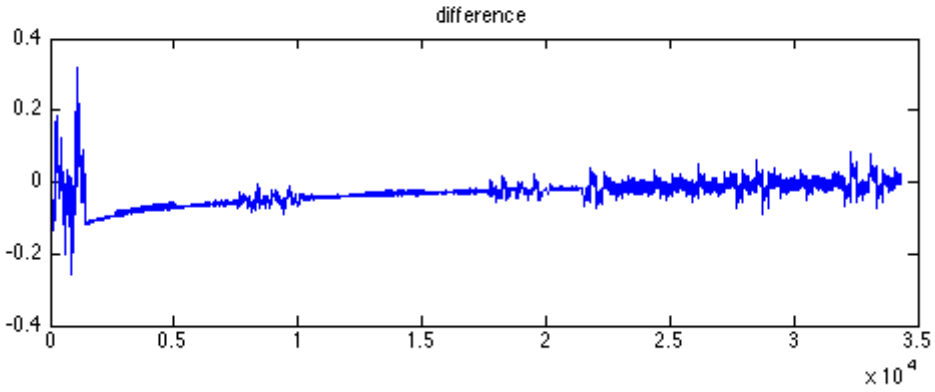
```
       146          1       2846     1.00000e+00     9.68485e-01     8.293
       147          1       2887     1.00000e+00     9.67681e-01     8.040
       148          1       2924     1.00000e+00     9.66792e-01     7.741
       149          1       2953     1.00000e+00     9.66279e-01     7.690
       150          1       2983     1.00000e+00     9.65776e-01     7.049
       151          1       3007     1.00000e+00     9.65379e-01     6.801
break of testUpdateTau   151  9.6537910e-01  2.4316262e+00   9.65e-01  1.1

Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2        O
       152          1          4     5.00000e-01     9.64975e-01     4.710
break of testUpdateTau   152  9.6497456e-01  2.7688388e+02   9.65e-01  8.0

Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2        O
       153          1          4     7.81250e-03     9.47600e-01     2.125
       154          1         11     1.00000e+00     7.41786e-01     6.828
       155          1         17     1.00000e+00     7.33124e-01     7.571
       156          1         26     1.00000e+00     6.53947e-01     7.816
       157          1         37     1.00000e+00     6.19736e-01     4.614
       158          1         54     1.00000e+00     5.96503e-01     3.763
       159          1         77     1.00000e+00     5.73372e-01     3.689
       160          1         92     1.00000e+00     5.54689e-01     5.252
       161          1        119     1.00000e+00     5.34396e-01     4.225
       162          1        147     1.00000e+00     5.07556e-01     3.349
       163          1        173     1.00000e+00     4.92984e-01     2.772
       164          1        202     1.00000e+00     4.81748e-01     2.938
       165          1        232     1.00000e+00     4.66381e-01     2.559
       166          1        263     1.00000e+00     4.49876e-01     3.573
       167          1        297     1.00000e+00     4.39468e-01     2.722
       168          1        336     1.00000e+00     4.27257e-01     2.459
       169          1        383     1.00000e+00     4.16497e-01     2.552
       170          1        415     1.00000e+00     4.03168e-01     2.817
       171          1        459     1.00000e+00     3.94421e-01     2.507
       172          1        501     1.00000e+00     3.88225e-01     2.311
       173          1        521     1.00000e+00     3.82556e-01     1.876
       174          1        562     1.00000e+00     3.75394e-01     2.283
       175          1        595     1.00000e+00     3.70266e-01     2.296
       176          1        640     1.00000e+00     3.63269e-01     1.899
       177          1        681     1.00000e+00     3.57151e-01     1.716
       178          1        695     1.00000e+00     3.53781e-01     1.281
       179          1        732     1.00000e+00     3.50073e-01     1.402
       180          1        768     1.00000e+00     3.46088e-01     1.581
       181          1        806     1.00000e+00     3.39015e-01     1.695
       182          1        841     1.00000e+00     3.33299e-01     1.674
       183          1        879     1.00000e+00     3.29940e-01     1.364
       184          1        932     1.00000e+00     3.26598e-01     1.322
       185          1        979     1.00000e+00     3.23373e-01     1.527
       186          1       1021     1.00000e+00     3.19225e-01     1.467
       187          1       1048     1.00000e+00     3.14889e-01     1.617
       188          1       1094     1.00000e+00     3.12091e-01     1.160
       189          1       1108     1.00000e+00     3.10415e-01     9.879
       190          1       1161     1.00000e+00     3.07672e-01     1.204
       191          1       1216     1.00000e+00     3.04252e-01     1.253
```

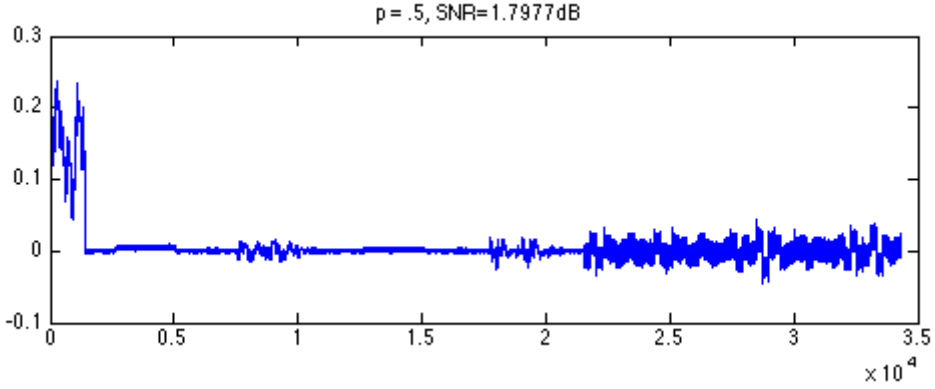
```
       192          1       1249     1.00000e+00     2.99610e-01     1.266
       193          1       1287     1.00000e+00     2.96404e-01     1.286
       194          1       1329     1.00000e+00     2.93402e-01     1.136
       195          1       1353     1.00000e+00     2.90905e-01     8.977
       196          1       1423     1.00000e+00     2.87932e-01     9.914
       197          1       1473     1.00000e+00     2.85081e-01     1.127
       198          1       1523     1.00000e+00     2.80926e-01     1.297
       199          1       1568     1.00000e+00     2.78343e-01     8.586
       200          1       1615     1.00000e+00     2.76052e-01     9.073
  200  2.7605175e-01  2.1738944e+00   2.76e-01  1.826e-02     0.0    6455

 ERROR EXIT -- Too many iterations

 Products with A     :     220        Total time   (secs) :   428.8
 Products with A'    :     220        Project time (secs) :   337.0
 Newton iterations   :       6        Mat-vec time (secs) :   101.1


info_spg =

           tau: 300.9311
         rNorm: 0.8824
          rGap: 6.8300
         gNorm: 0.0641
          stat: 5
          iter: 200
        nProdA: 275
       nProdAt: 201
       nNewton: 4
   timeProject: 1.3553
   timeMatProd: 126.8231
       itnLSQR: 0
       options: [1x1 struct]
     timeTotal: 130.1784
         xNorm1: [200x1 double]
         rNorm2: [200x1 double]
         lambda: [200x1 double]


info_pqn1 =

           tau: 309.3211
         rNorm: 0.2761
          rGap: 2.1739
         gNorm: 0.0183
          stat: 5
          iter: 200
        nProdA: 220
       nProdAt: 220
       nNewton: 6
   timeProject: 336.9629
   timeMatProd: 101.0724
       itnLSQR: 0
       options: [1x1 struct]
```

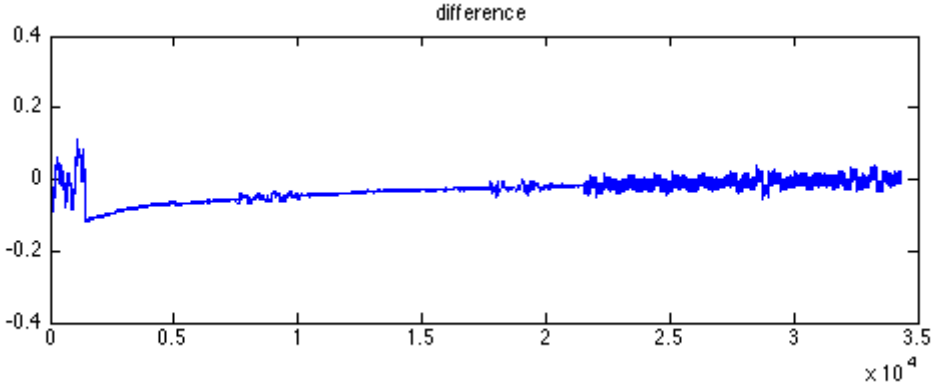
```
timeTotal: 428.8259

   xNorm1: [200x1 double]
   rNorm2: [200x1 double]
   lambda: [200x1 double]
```

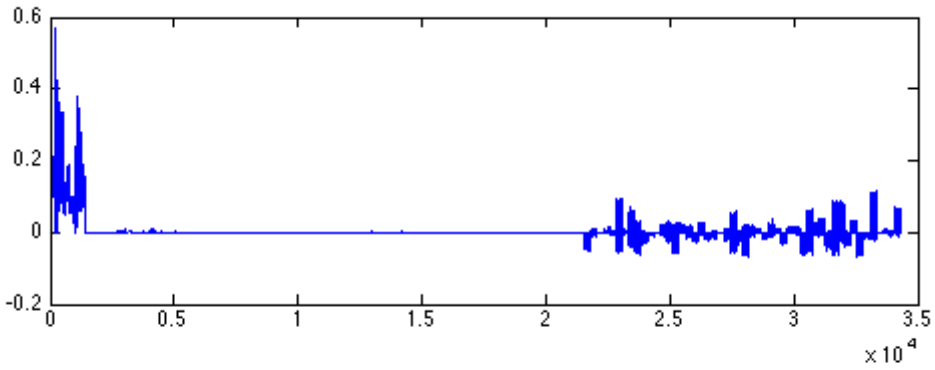


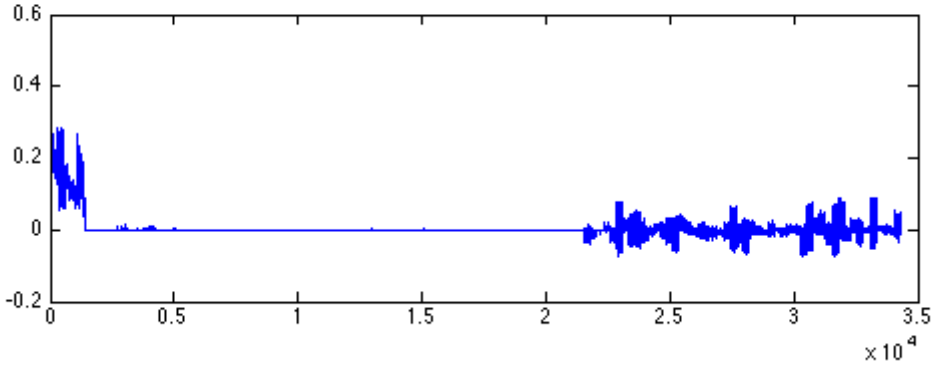

p = .5, SNR= 1.3918dB
0.6
0.4
0.2
0
-0.2
0
0.5
1
1.5
2
2.5
3
3.5
x 10^4

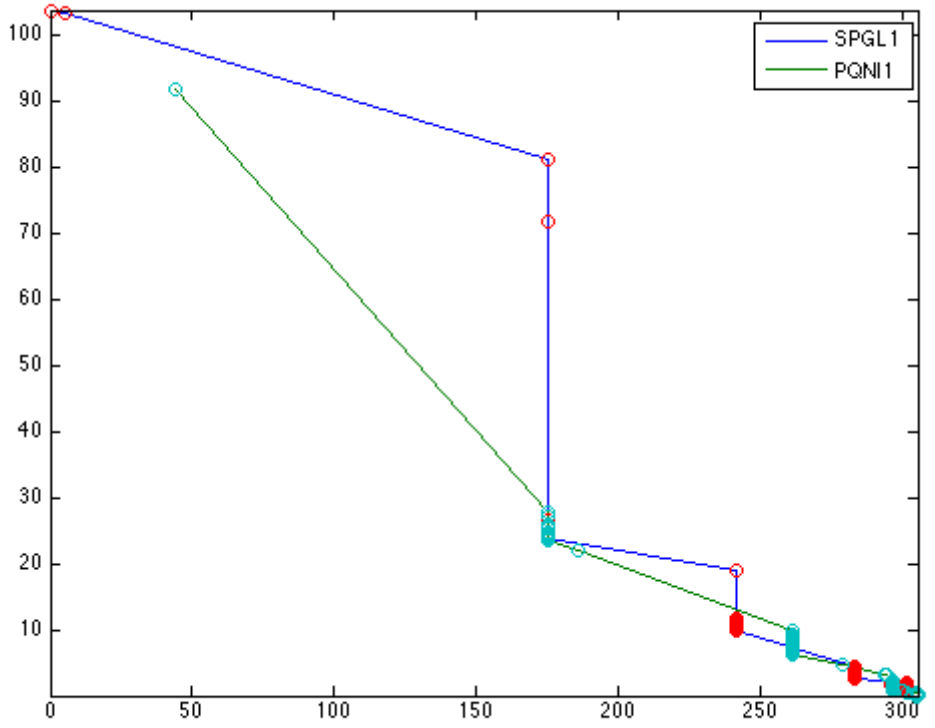

difference
0.4
0.2
0
-0.2
-0.4
0
0.5
1
1.5
2
2.5
3
3.5
x 10^4


p = .5, SNR= 1.7977dB
0.3
0.2
0.1
0
-0.1
0
0.5
1
1.5
2
2.5
3
3.5
x 10^4


difference
0.4
0.2
0
-0.2
-0.4
0
0.5
1
1.5
2
2.5
3
3.5
x 10^4


0.6
0.4
0.2
0
-0.2
0
0.5
1
1.5
2
2.5
3
3.5
x 10^4


0.6
0.4
0.2
0
-0.2
0
0.5
1
1.5
2
2.5
3
3.5
x 10^4


SPGL1
PQNI1
100
90
80
70
60
50
40
30
20
10
0
50
100
150
200
250
300

Published with MATLAB® 7.12