

pdata.txt

262004.7079	-4855113.8121	4114363.8331			APPROX POSITION XYZ
4	C1	L1	P2	L2	# / TYPES OF OBSERV
07 11 01 00 00	0.0000000	0	8G02G04G05G10G12G13G17G30		
20225226.998	106284328.33149	20225222.875	82818966.89449		
21917328.456	115176394.97448	21917326.811	89747859.52549		
21682195.964	113940728.11148	21682194.047	88784981.06649		
21388155.713	112395536.09949	21388154.149	87580955.55949		
21451904.418	112730569.458 9	21451901.841	87841984.699 9		
23948332.172	125849349.50946	23948330.142	98064426.83447		
24524079.801	128874937.377 6	24524078.323	100422050.952 7		
22405514.322	117741782.73348	22405512.754	91746845.35248		
07 11 01 00 15	0.0000000	0	8G02G04G05G10G12G13G24G30		
20290892.579	1066229403.72449	20290888.453	83087856.89649		
22341839.168	117407213.75948	22341837.624	91486159.84049		
21697504.829	114021176.70649	21697502.930	88847668.25849		
20941308.568	110047340.68749	20941306.857	85751193.44149		
21591793.984	113465693.464 9	21591791.426	88414808.508 9		
23878862.135	125484283.84447	23878859.960	97779960.42547		
24041335.572	126338077.48447	24041335.085	98445246.59047		
22201390.200	116669104.17348	22201388.582	90910992.14548		
07 11 01 00 30	0.0000000	0	9G02G04G05G06G10G12G13G24G30		
20408095.243	107245308.31749	20408091.165	83567782.59949		
22785289.914	119737562.47248	22785288.308	93302015.88548		
21814582.317	114636422.93249	21814580.604	89327080.82449		
24256593.483	127469263.82145	24256592.168	99326691.64246		
20578440.468	108140457.51549	20578438.649	84265310.81749		
21826119.808	114697083.356 9	21826117.288	89374332.898 9		
23907744.099	125636060.37147	23907741.999	97898228.08047		
23594350.619	123989160.76846	23594350.096	96614922.90547		
22100640.211	116139659.15348	22100638.535	90498437.60749		
07 11 01 00 45	0.0000000	0	10G02G04G05G06G07G10G12G13G24G30		
20574032.375	108117313.70749	20574028.279	84247267.30849		
23243197.084	122143880.17447	23243195.556	95177068.45348		
22027512.395	115755376.76648	22027510.473	90198992.66949		
23709897.726	124596361.13446	23709896.320	97088066.75347		
24583103.276	129185070.73545				
20307616.336	106717268.15849	20307614.451	83156332.40749		
22146240.920	116379329.938 9	22146238.494	90685174.037 9		
24036665.605	126313547.83046	24036663.119	98426140.51547		
23171944.578	121769405.00647	23171943.875	94885243.70248		
22105351.100	116164414.82748	22105349.530	90517727.62749		

```

* 2007 11 1 0 0 0.00000000
P 1 -15247.651735 19056.005251 10595.041183 163.837336
P 2 992.384345 -15968.052424 21050.231159 147.786923
P 3 -4577.658504 20839.552187 -15836.660470 137.695111
P 4 14485.438903 -9655.770599 20075.615110 -19.585248
P 5 -15341.833295 -14323.924219 16098.733495 509.486534
P 6 -21001.425567 1849.435822 16351.986428 226.902310
P 7 -21703.464211 4416.788097 15021.838048 -34.169760
P 8 20913.074711 -2511.700434 -16563.455761 -128.322281
P 9 -19293.731123 -15113.804424 -11074.462266 94.627496
P 10 -714.950911 -26163.716400 3215.532350 -127.423555
P 11 21910.277868 12249.270057 -9265.644088 25.471207
P 12 -12018.793971 -19768.397574 13197.893057 -346.772838
P 13 21188.885188 -2628.221004 15679.971173 217.917841
P 14 -21504.308356 15484.795079 -488.881331 -323.073473
P 16 -2918.867142 24921.726045 8522.681669 122.561585
P 17 21807.600366 -14891.581016 -1987.109008 50.142873
P 18 -15495.113906 -1630.510467 -21369.677780 -228.160061
P 19 4244.473754 15188.198994 -21262.731663 4.470814
P 20 13540.007681 17068.554121 15116.419690 126.979769
P 21 -25232.741566 -5070.036724 -7552.102281 77.031214
P 22 -12317.626986 13846.371842 -18848.137017 201.984774
P 23 14171.512678 7351.316578 21197.142487 305.157155
P 24 -22860.289452 -12932.892365 2865.740588 42.696018
P 25 25534.642509 6839.614383 -1119.617540 471.848063
P 26 -1589.561774 -16042.297574 -21440.339338 80.469530
P 27 25198.353255 3013.799248 -7520.674856 144.871417
P 28 13065.956391 -10280.327513 -20284.328617 -9.585638
P 30 -15707.560567 -8166.589476 19499.294813 50.889328
P 31 -11267.894611 11430.686372 21373.963916 4.039146
P 32 -6734.516005 22724.961278 -11659.139516 121.712685
* 2007 11 1 0 15 0.00000000
P 1 -16167.125576 19549.015659 7941.403666 163.840201
P 2 3324.646785 -15152.840481 21379.904158 147.789378
P 3 -5947.217306 21852.992844 -13829.551699 137.699920
P 4 16538.537138 -8751.577371 18905.933004 -19.588932
P 5 -15583.076397 -16091.674506 14119.691082 509.509965
P 6 -19685.659092 407.948118 18019.371513 226.895659
P 7 -20556.252145 3043.462266 16898.162113 -34.161267
P 8 22471.423689 -1726.900112 -14522.490923 -128.323304
P 9 -17996.278929 -14866.319365 -13454.196583 94.629031
P 10 -379.117939 -25659.826639 6035.838476 -127.435424
P 11 20683.250270 12397.067384 -11596.269062 25.471514
P 12 -12048.569940 -21142.144835 10815.879529 -346.773964
P 13 19731.372336 -1378.344376 17611.848075 217.920297
P 14 -21434.171827 15197.958277 -3394.677869 -323.071222
P 16 -3317.777564 23853.102979 11086.617431 122.563325
P 17 21671.902942 -14436.821480 -4813.782743 50.141850
P 18 -15776.781950 -4065.399181 -20868.150228 -228.158117
P 19 2245.993110 16543.717274 -20533.668197 4.472758
P 20 13624.471582 18704.363667 12970.357874 126.979155
P 21 -25802.359568 -5583.080645 -4895.334061 77.030908
P 22 -12724.166478 11617.822222 -20039.417465 201.985593
P 23 12294.503604 8948.845296 21725.639678 305.160327
P 24 -22313.448585 -13011.440514 5670.556675 42.698678
P 25 25470.066429 7095.849154 1747.370237 471.853895
P 26 285.920759 -17384.540352 -20354.340403 80.480683
P 27 25877.187953 3453.129589 -4782.076527 144.873566
P 28 13507.214101 -7873.693306 -21075.158149 -9.586252
P 30 -16029.557926 -10367.597123 18177.653609 50.890556
P 31 -13457.439497 10564.140260 20535.547734 4.037816
P 32 -7050.999790 21217.546880 -13975.663663 121.725372
* 2007 11 1 0 30 0.00000000
P 1 -16823.172728 19893.638530 5151.443562 163.843066
P 2 5712.886396 -14447.711252 21335.624387 147.791834
P 3 -7114.045736 22749.584237 -11583.822994 137.704729
P 4 18488.090849 -7997.974978 17412.353851 -19.592615
P 5 -15836.763232 -17616.327388 11895.399013 509.533395
P 6 -18321.739820 -1214.836206 19381.189201 226.889008
P 7 -19345.273160 1477.085741 18490.902369 -34.152775
P 8 23841.937525 -1113.087095 -12238.531024 -128.324327
P 9 -16446.944800 -14624.469536 -15612.105882 94.630565
P 10 47.165970 -24864.255573 8749.908619 -127.447292
P 11 19217.440908 12566.239585 -13731.683074 25.471821
P 12 -12086.687655 -22240.909699 8249.171951 -346.775089
P 13 18194.267199 86.369252 19238.036942 217.922752
P 14 -21136.436702 14688.461070 -6241.598180 -323.068971
P 16 -3830.433349 22533.745295 13458.722212 122.565064
P 17 21326.907586 -13761.571431 -7556.864675 50.140827
P 18 -16165.556527 -6403.031506 -20004.063704 -228.156173
P 19 398.600642 17935.055803 -19447.446460 4.474702
P 20 13730.146471 20084.671121 10600.248078 126.978541
P 21 -26111.630729 -5969.257045 -2156.977281 77.030601

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sdata.txt

P 22	-13261.864333	9298.154531	-20880.700063	201.986411
P 23	10475.906817	10672.858982	21878.559933	305.163499
P 24	-21478.085228	-13009.666898	8376.518478	42.701338
P 25	25102.489089	7287.891828	4584.108651	471.859727
P 26	1980.227903	-18743.616577	-18926.248128	80.491835
P 27	26270.626715	3777.254698	-1960.924706	144.875715
P 28	14084.282903	-5427.201991	-21490.012145	-9.586865
P 30	-16415.202746	-12384.012930	16536.043732	50.891784
P 31	-15581.394034	9847.951425	19350.388668	4.036486
P 32	-7487.065291	19477.234278	-16046.326216	121.738060
*	2007 11 1 0 45	0.00000000		
P 1	-17228.618953	20050.703326	2272.817599	163.845931
P 2	8109.983220	-13865.598331	20917.223277	147.794290
P 3	-8080.486498	23489.643517	-9137.437069	137.709538
P 4	20290.608576	-7388.585137	15621.345170	-19.596298
P 5	-16067.284689	-18879.598781	9465.136363	509.556826
P 6	-16949.953515	-3002.044283	20414.632849	226.882358
P 7	-18110.793246	-268.442602	19773.959213	-34.144282
P 8	24986.847511	-650.756210	-9750.043839	-128.325350
P 9	-14668.980897	-14423.899101	-17513.785559	94.632100
P 10	594.965793	-23801.346229	11309.914855	-127.459161
P 11	17535.770898	12784.470761	-15635.859161	25.472128
P 12	-12095.504256	-23051.720424	5541.494236	-346.776215
P 13	16624.967647	1754.114736	20530.139553	217.925208
P 14	-20645.298510	13935.037261	-8980.169339	-323.066720
P 16	-4480.961890	20997.956844	15598.297819	122.566803
P 17	20807.241433	-12849.464596	-10168.740837	50.139804
P 18	-16641.670739	-8600.392173	-18793.581540	-228.154229
P 19	-1271.410633	19322.145247	-18022.703020	4.476646
P 20	13821.170804	21191.516413	8047.242894	126.977927
P 21	-26143.156660	-6259.393566	617.246484	77.030294
P 22	-13932.407296	6935.263755	-21357.207316	201.987230
P 23	8753.484059	12490.416309	21652.527337	305.166670
P 24	-20358.265417	-12965.928943	10936.878176	42.703999
P 25	24432.732963	7453.584623	7341.787440	471.865560
P 26	3472.611835	-20075.221995	-17177.955274	80.502988
P 27	26364.371623	4020.950857	893.845124	144.877863
P 28	14791.804271	-2991.740938	-21522.356138	-9.587479
P 30	-16833.813250	-14183.277075	14604.220616	50.893012
P 31	-17593.276597	9279.391405	17838.343775	4.035156
P 32	-8064.332956	17542.623162	-17833.311129	121.750747

p1.txt

1	20225226.998	02	992.384345	-15968.052424	21050.231159	147.786923
1	21917328.456	04	14485.438903	-9655.770599	20075.615110	-19.585248
1	21682195.964	05	-15341.833295	-14323.924219	16098.733495	509.486534
1	21388155.713	10	-714.950911	-26163.716400	3215.532350	-127.423555
1	21451904.418	12	-12018.793971	-19768.397574	13197.893057	-346.772838
1	23948332.172	13	21188.885188	-2628.221004	15679.971173	217.917841
1	24524079.801	17	21807.600366	-14891.581016	-1987.109008	50.142873
1	22405514.322	30	-15707.560567	-8166.589476	19499.294813	50.889328

```

gpsnav20.m

% gpsnav20.m 5-dec-07
% derived from gpsnav16.m
% solve gps pseudorange problem for 1 epoch
% adapted from brian yentes 2004 solution
% now 2005 problem from bvg & jen-yu han
% make the units m & sec (meters & seconds)

[epoch,c1,satnum,xx,yy,zz,dt]=textread('p1.txt','%d %f %d %f %f %f %f');
[m,n]=size(epoch);

nobs=m;
npar=4;
n=nobs;
n0=npar;
r=n-n0;

% Xs,Ys,Zs (km), c1 (m), DT(us)
% we solve in km & us
Xs=xx;
Ys=yy;
Zs=zz;
rawpr=c1/1000; % convert to km
DT=dt;
%
sig=0.025; % km
sig0=0.025;
sig_sqr=sig*sig;
sig0_sqr=sig0*sig0;
W=eye(nobs)*(sig0_sqr/sig_sqr);

% units
% c1 (unrefined pseudorange) is in meters in file
% xs,xs,zs in km
% DT 1e-06 sec, i.e. us or microseconds
c=0.299792458; % km/us (km / u-second)

pr=rawpr + c*DT;

% initial approximations to receiver coords
% found in the observation file header
% convert from given m to km
Xo= 262004.7079/1000;
Yo= -4855113.8121/1000;
Zo= 4114363.8331/1000;
rdt=0.0;

old_phi=9.99e+09;
threshold=1.0e-06;
converged=0;

for iter=1:10
    B=zeros(nobs,npar);
    f=zeros(nobs,1);
    for i=1:nobs
        D=sqrt((Xs(i)-Xo)^2 + (Ys(i)-Yo)^2 + (Zs(i)-Zo)^2);
        B(i,1)=(Xs(i)-Xo)/D;
        B(i,2)=(Ys(i)-Yo)/D;
        B(i,3)=(Zs(i)-Zo)/D;
        B(i,4)=-c;
        F=pr(i) - D - c*rdt;
        f(i)=-F;
    end
    % B
    % f
    % W
    condJ=cond(B)
    N=B'*W*B;
    condN=cond(N)
    t=B'*W*f;

    del=inv(N)*t;
    Xo=Xo + del(1);
    Yo=Yo + del(2);
    Zo=Zo + del(3);
    rdt=rdt + del(4);
    disp del=[iter; del(1); del(2); del(3); del(4)]
    v=f-B*del;
    phi=v'*W*v;
    if(abs(phi-old_phi)/phi < threshold)
        disp('we have converged');
        converged=1;
        break;
    end
end

```

```
old_phi=phi;
end

if(converged == 0)
    disp('we did not converge');
else
    % we converged
    % show results
    disp('receiver location (km)');
    [Xo Yo Zo]
    disp('receiver clock bias (usec)');
    [rdt]
end

disp('residuals (km)');
v
rms=sqrt(v'*v/nobs)

% make global test
test_stat=phi/(sig0_sqr);
P=chi2cdf(test_stat,r);
alpha=0.05;
Plow=alpha/2;
Phigh=1 - alpha/2;
disp('2-sided global test');
disp('test_stat   dof   P');
[test_stat r P]
disp('alpha Plow Phigh');
[alpha Plow Phigh]
if((P>Plow) & (P<Phigh))
    pass_test=1;
    disp('we pass the global test');
else
    pass_test=0;
    disp('we fail the global test');
end
```

```
gpsnav20
condJ =      8.58508516148295
condN =      73.7036872299147
disp_del =
      1
      0.0497769270468225
      -0.00548384286405468
      0.00902302661618518
      0.0184495255770475
condJ =      8.58507089719932
condN =      73.7034423099389
disp_del =
      2
      -3.14232248488858e-009
      -5.92010610960922e-008
      2.4282229501391e-009
      -3.72359587271211e-008
we have converged
receiver location (km)
ans =
      262.054484823905      -4855.11929600206      4114.37285612904
receiver clock bias (usec)
rdt =
      0.0184494883410887
residuals (km)
v =
      0.00595121630573536
      0.0106884714894767
      0.00649880582498671
      -0.0370475971056425
      0.0221859366005298
      -0.0276420842323919
      0.0292032828946901
      -0.00983803177738426
rms =
      0.0217092679845078
2-sided global test
test_stat  dof  P
ans =
      6.03254165021665      4      0.803268811701514
alpha Plow Phigh
ans =
      0.05      0.025      0.975
we pass the global test
diary off
```