Seismic radiometer diagnostics

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Intro

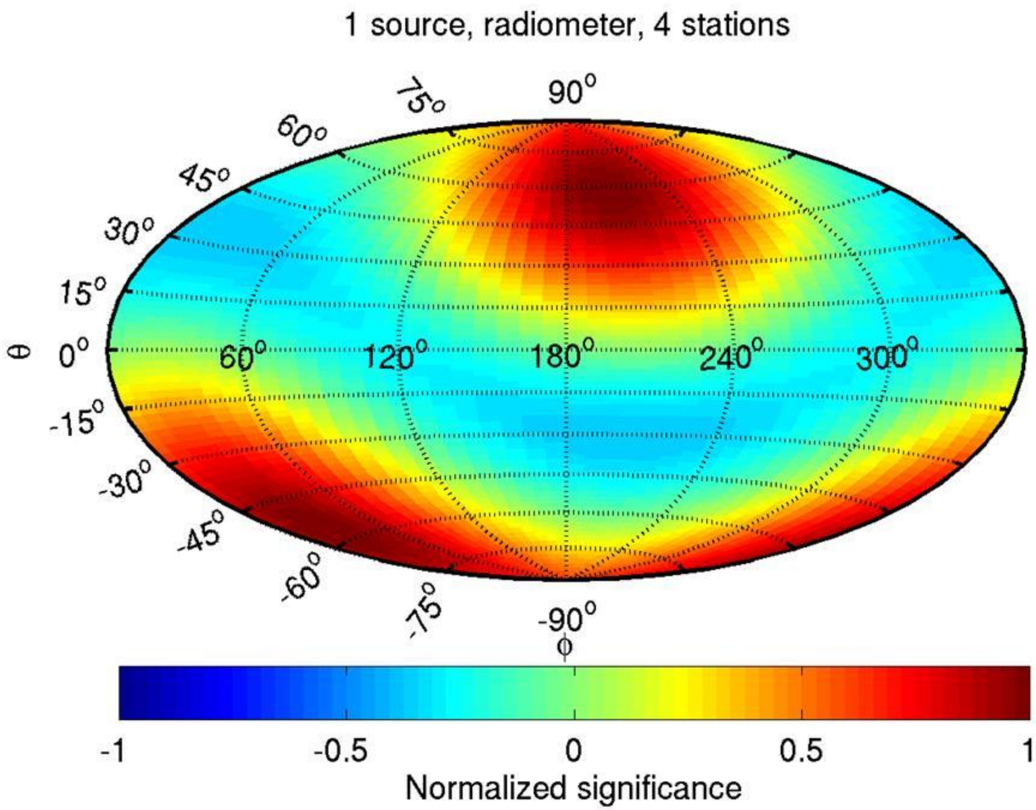
- Please fill in the following slides.
- Make eps and png versions of every plot.
- SVN commit the plots to the img/ directory.
- Include the plot filename in the “note” section for each slide, so we know which file goes with which slide.
- Include enough information in the slides so that we can reproduce each plot.

Detector spacing

- We fix the point source location at (θ,ϕ) = (20,200)
- We use four detectors with fixed locations:
    1. scale * (0, 0 , 0)
    2. scale * (0.5, 0, 0)
    3. scale * (0, 0.5, 0)
    4. scale * (0, 0, 0.5)
- We inject a monochromatic wave with f=xyz Hz.
- We vary scale and show how the reconstruction plots change.

Test 1

scale = 1



ndets = 4; detloc =

0	0	0
0.5	0	0
0	0.5	0
0	0	0.5;

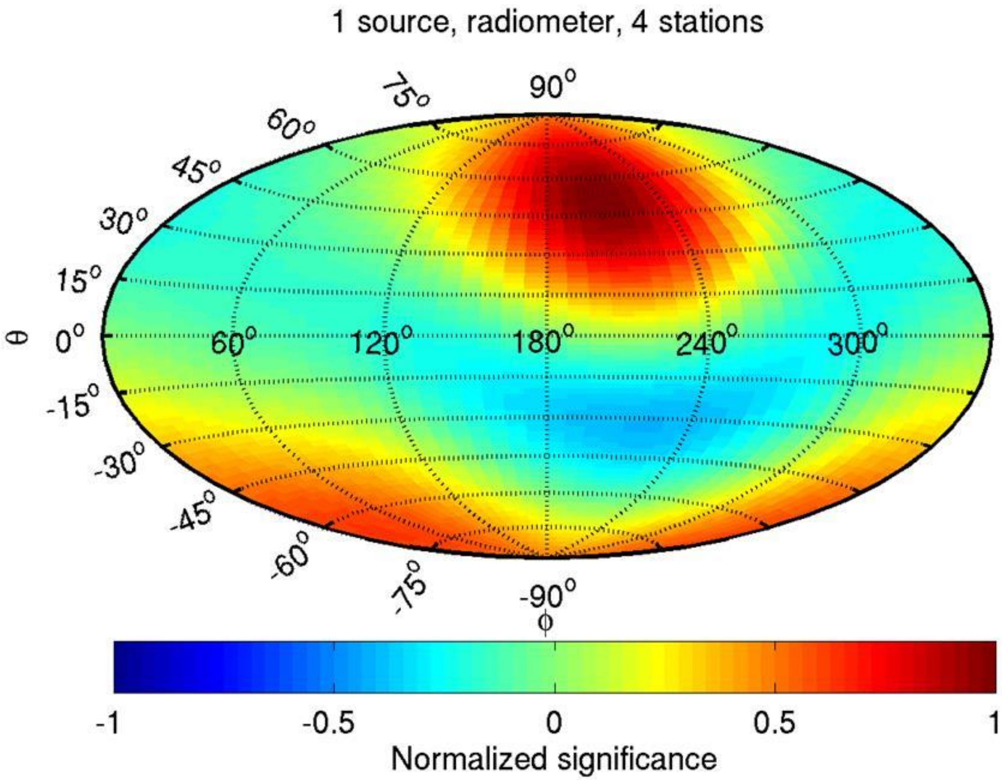
scale = 1; (theta, phi) = (20, 200); monochromatic source; frequency = 1; f_analyse = 1

***Amplitude is 10 for all trials

***Pwave speed is 3500

Test 2

scale = 10

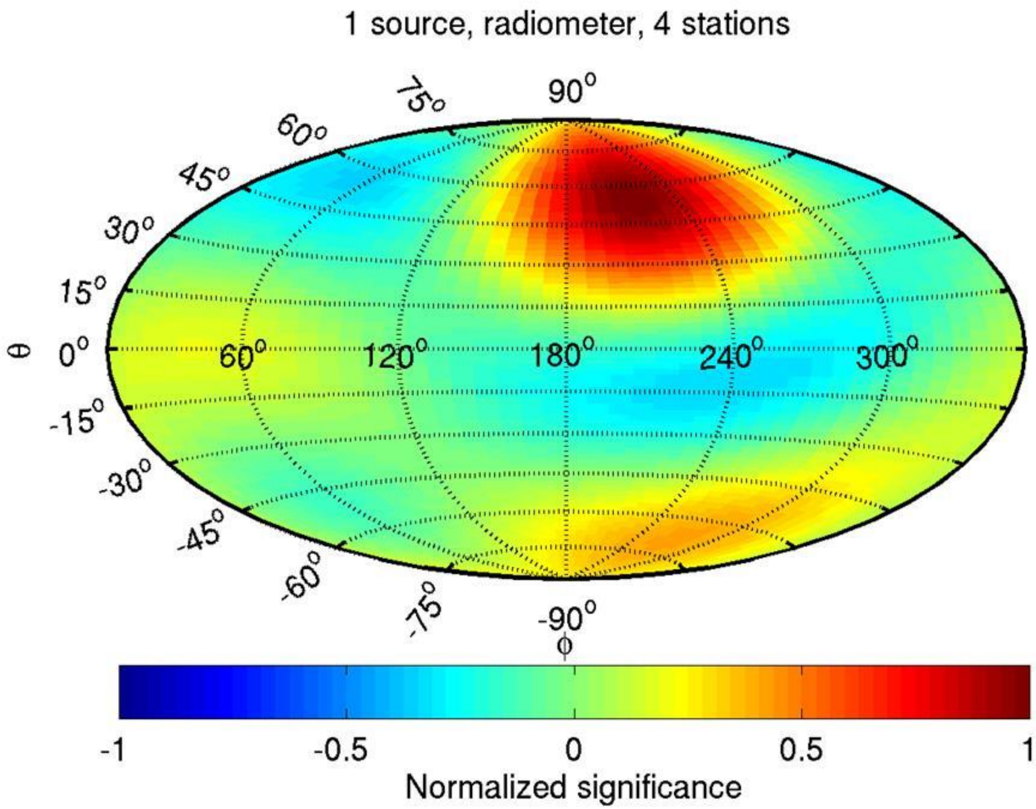


ndets = 4; detloc = $\begin{matrix} 0 & 0 & 0 \\ 0.5 & 0 & 0 \\ 0 & 0.5 & 0 \\ 0 & 0 & 0.5; \end{matrix}$

scale = 10; (theta, phi) = (20, 200); monochromatic source; frequency = 1; f_analyse = 1

Test 3

Scale = 100

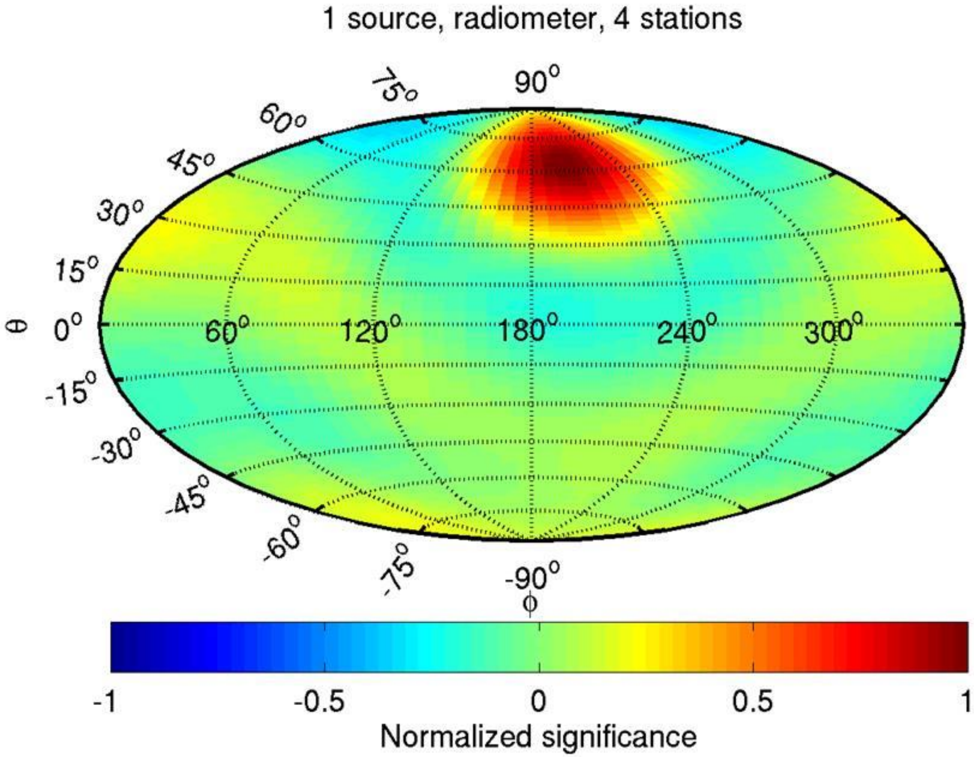


ndets = 4; detloc = 0 0 0
0.5 0 0
0 0.5 0
0 0 0.5;

scale = 100; (theta, phi) = (20, 200); monochromatic source; frequency = 1; f_analyse = 1

Test 4

Scale = 1000

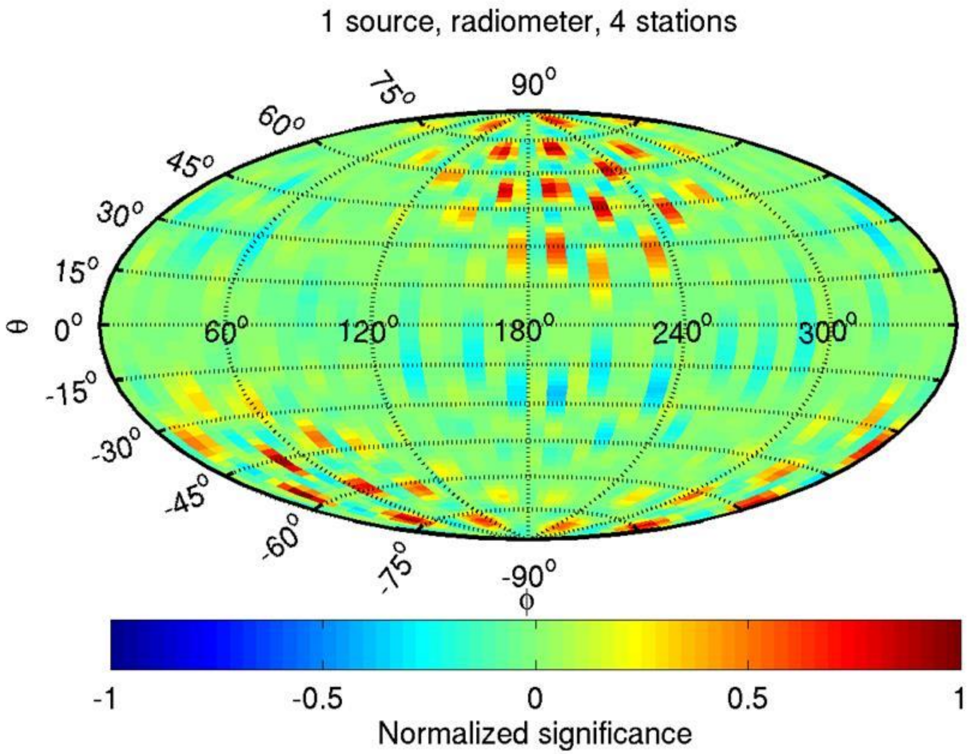


ndets = 4; detloc = $\begin{matrix} 0 & 0 & 0 \\ 0.5 & 0 & 0 \\ 0 & 0.5 & 0 \\ 0 & 0 & 0.5; \end{matrix}$

scale = 1000; (theta, phi) = (20, 200); monochromatic source; frequency = 1; f_analyse = 1

Test 5

Scale = 10000

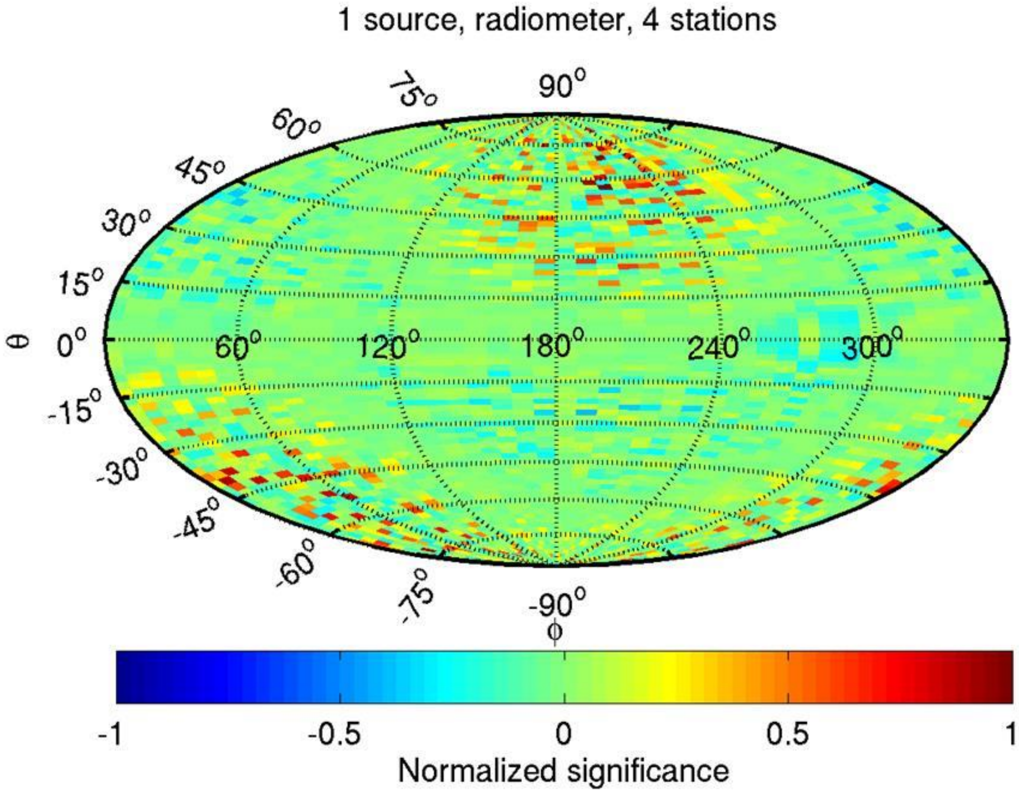


ndets = 4; detloc =	0	0	0
	0.5	0	0
	0	0.5	0
	0	0	0.5;

scale = 10000; (theta, phi) = (20, 200);
monochromatic source; frequency = 1;
f_analyse = 1

Test 6

Scale = 100000



ndets = 4; detloc = 0	0	0
0.5	0	0
0	0.5	0
0	0	0.5;

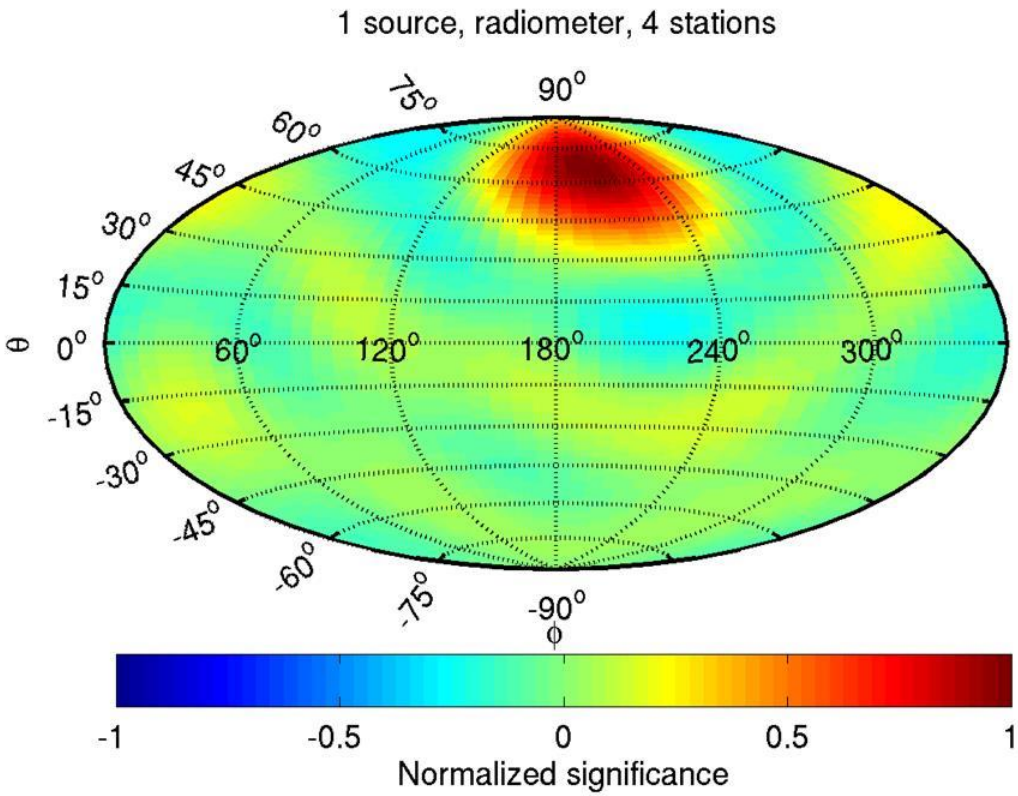
scale = 10000; (theta, phi) = (20, 200); monochromatic source; frequency = 1; f_analyse = 1

Different detector locations

- We fix the point source location at (θ,ϕ) = XYZ.
- We inject a monochromatic wave with f=xyz Hz.
- We chose random detector locations in a cube of length = xyz.
  – (Eric: chose cube length based on results of previous test.)

- Here are the results for several trials.
  – (Eric: include the detector locations in a text box on each slide.)

Test 7 Cube Size = 1000

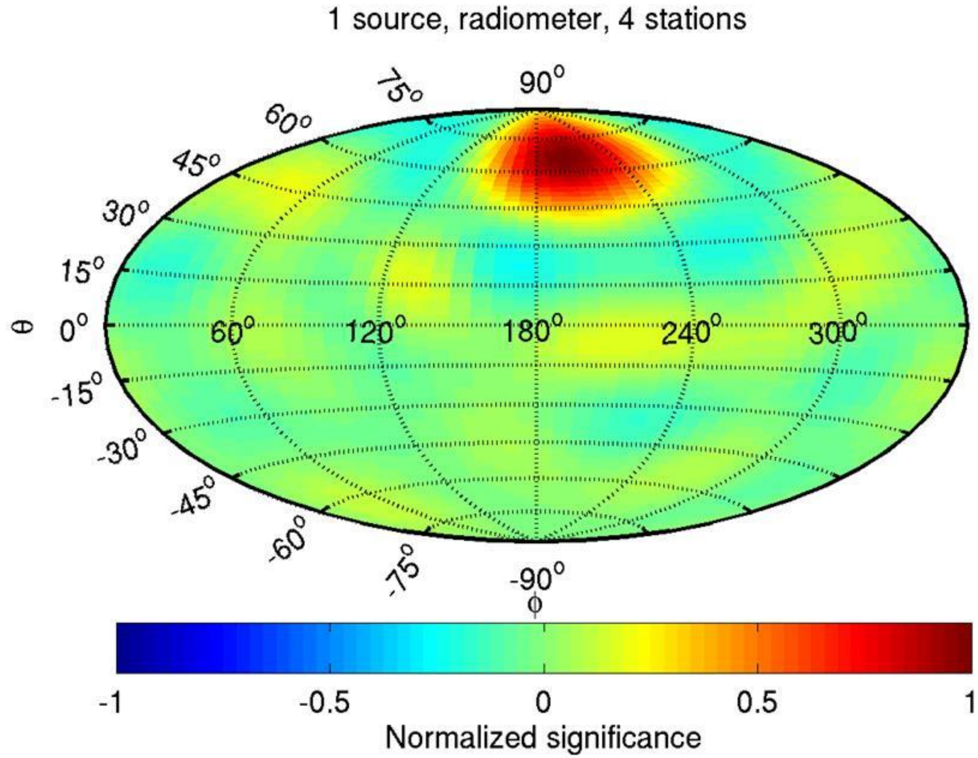


ndets = 4; detloc=

192.0105	471.7827	954.7844
847.1212	590.7783	592.5683
240.0817	882.8493	672.9253
740.7400	814.7358	344.3228

(theta, phi) = (20, 200); monochromatic source; frequency = 1; f_analyse = 1

Test 8 Cube Size = 1000

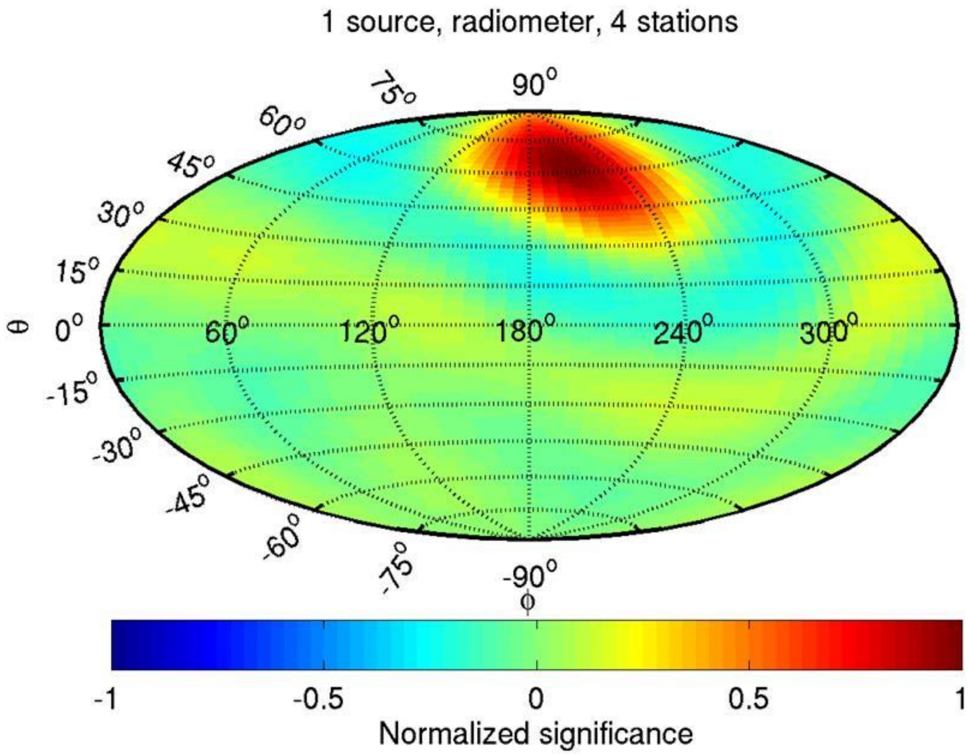


ndets = 4; detloc=

733.9419 892.4439 568.2117
406.2563 81.4616 874.6471
758.6489 551.8609 17.3356
61.3169 457.2167 274.1092

(theta, phi) = (20, 200); monochromatic source; frequency = 1; f_analyse = 1

Test 9 Cube Size = 1000

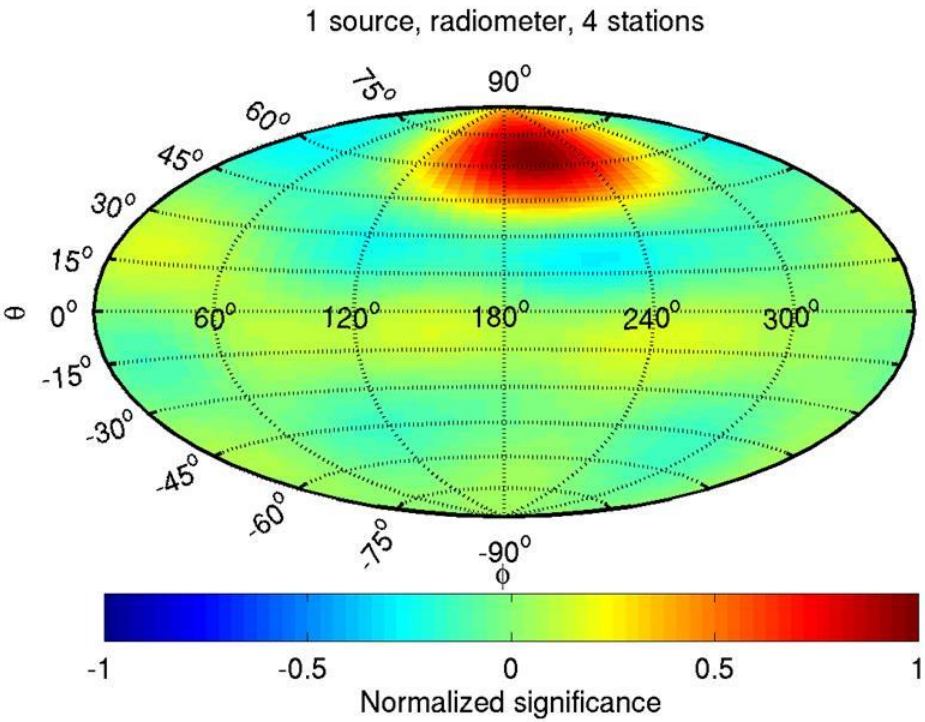


ndets = 4; detloc=

936.9177	388.0284	782.8762
507.7377	693.0414	344.1506
505.6836	227.9407	999.8049
545.7194	318.2782	689.9802

(theta, phi) = (20, 200); monochromatic source; frequency = 1; f_analyse = 1

Test 10 Cube Size = 1000

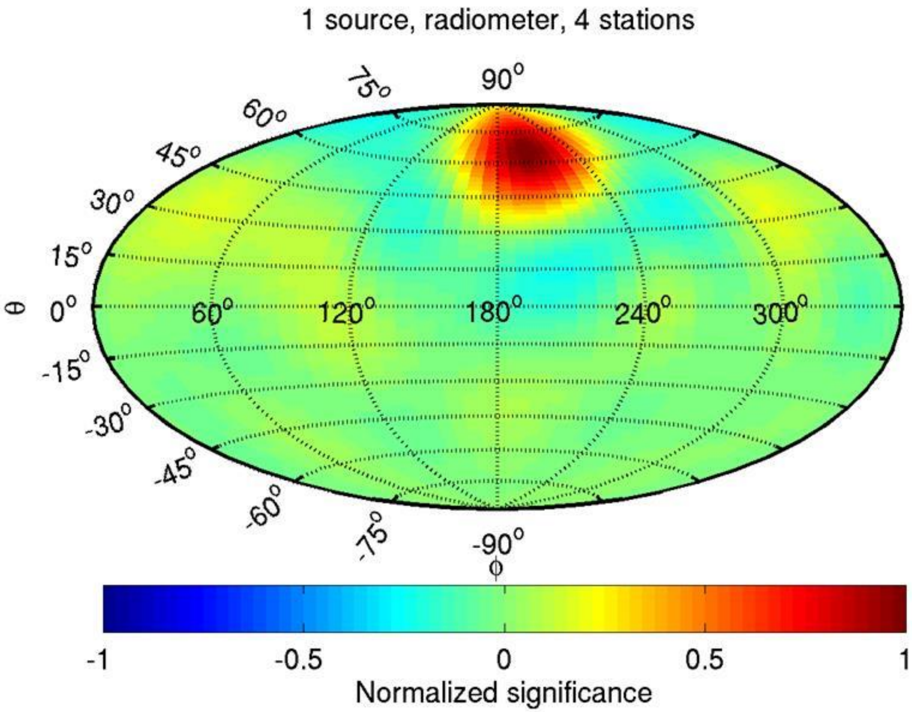


ndets = 4; detloc=

506.4977	349.1725	377.4747
735.0640	225.8991	248.4842
743.3625	579.1486	729.6963
905.6766	317.0631	987.3787

(theta, phi) = (20, 200); monochromatic source; frequency = 1; f_analyse = 1

Test 11 Cube Size = 1000



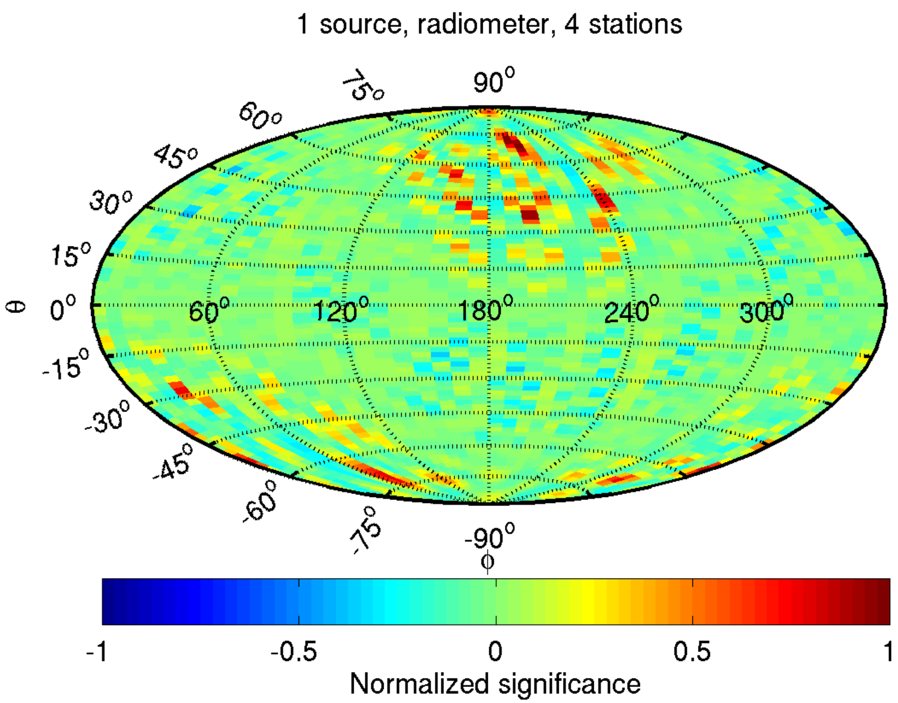
ndets = 4; detloc=

235.5845	225.6078	255.5607
225.6732	297.7716	134.9524
537.5434	983.3267	439.5840
989.0877	89.1858	175.5073

(theta, phi) = (20, 200); monochromatic source; frequency = 1; f_analyse = 1

Test 30

Cube Size = 10000



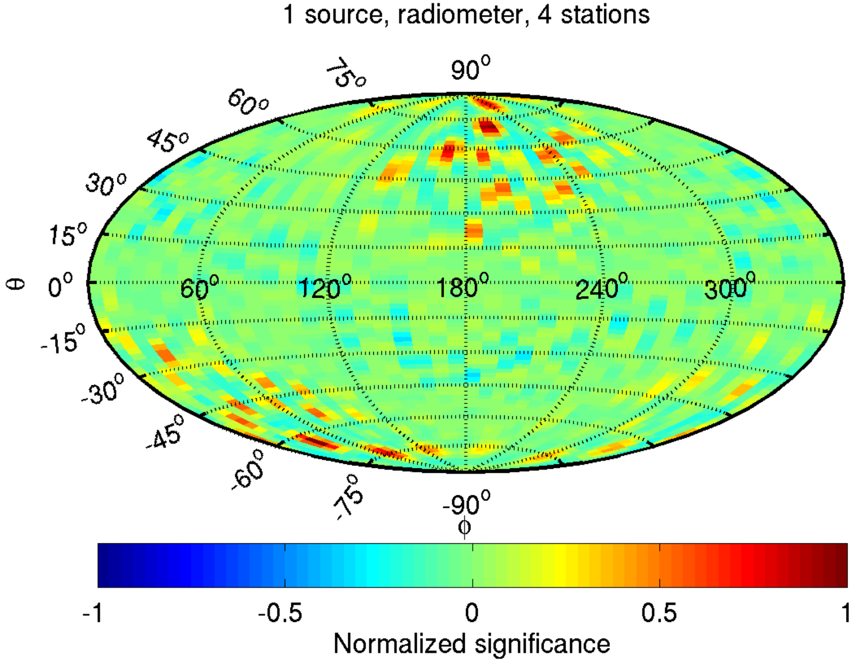
ndets = 4; detloc=

8147.2	9057.9	1269.9
2785.0	5468.8	9575.1
9648.9	1576.1	9705.9
9133.8	6323.6	975.4

(theta, phi) = (20,00);
Monochromatic source; frequency = 1;
f_analyse = 1

Test 31

Cube Size = 10000



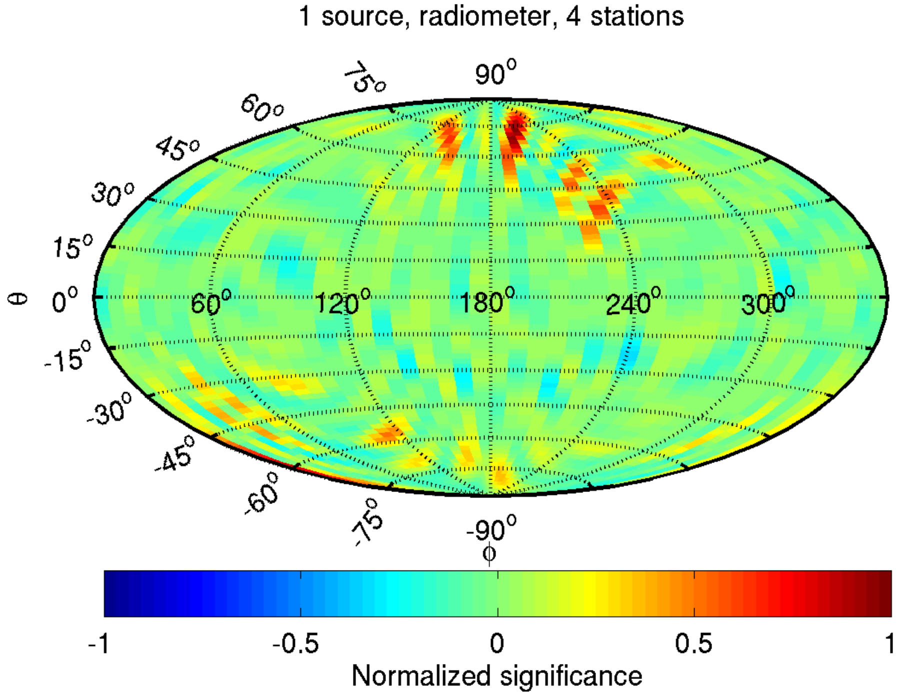
ndets = 4; detloc=

1638.9	6623.9	124.8
1461.4	2551.9	1582.0
7133.6	6004.0	1285.3
155.2	8773.4	6826.1

(theta, phi) = (20,00);
Monochromatic source; frequency = 1;
f_analyse = 1

Test 32

Cube Size = 10000



ndets = 4; detloc=

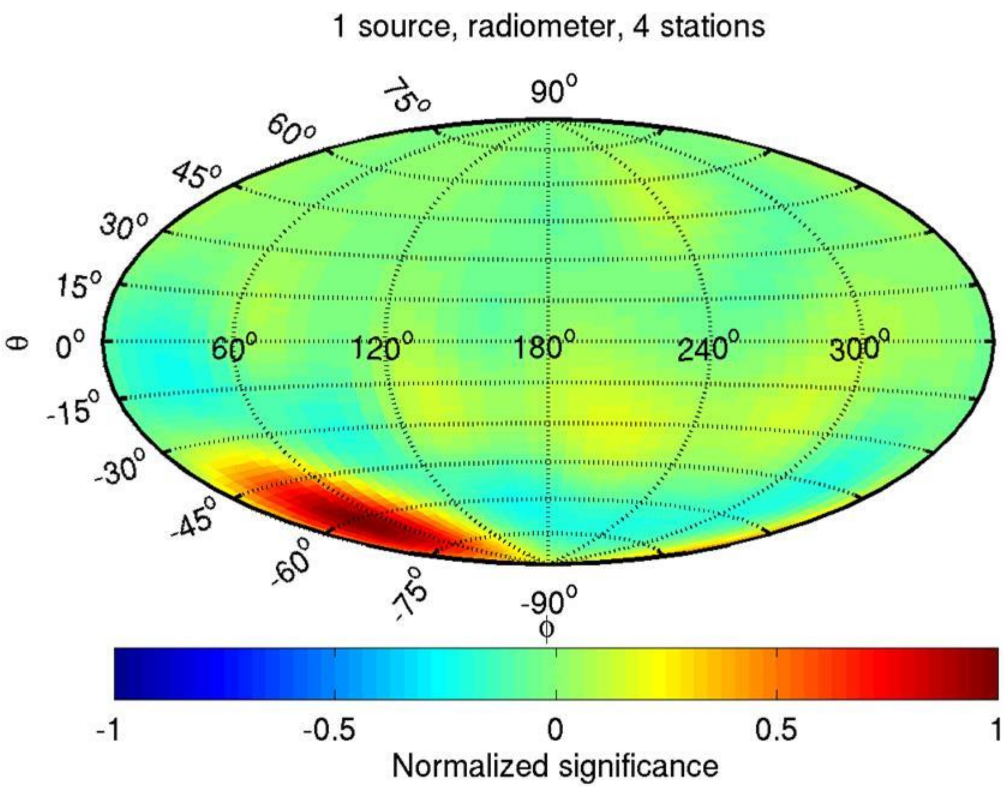
4055.7	4541.9	3281.0
3654.2	1287.2	3710.6
3284.3	8677.5	5490.5
1815.0	1338.0	5141.6

(theta, phi) = (20,00);
Monochromatic source; frequency = 1;
f_analyse = 1

Different source locations

- Based on the previous investigations, chose a fixed detector array that does a good job reconstructing.
- Now, vary the source direction.
- Keep the frequency fixed.
- Show several reconstruction plots.
  - Include the true source location on each slide.
- Do they all look comparably good?

Test 12

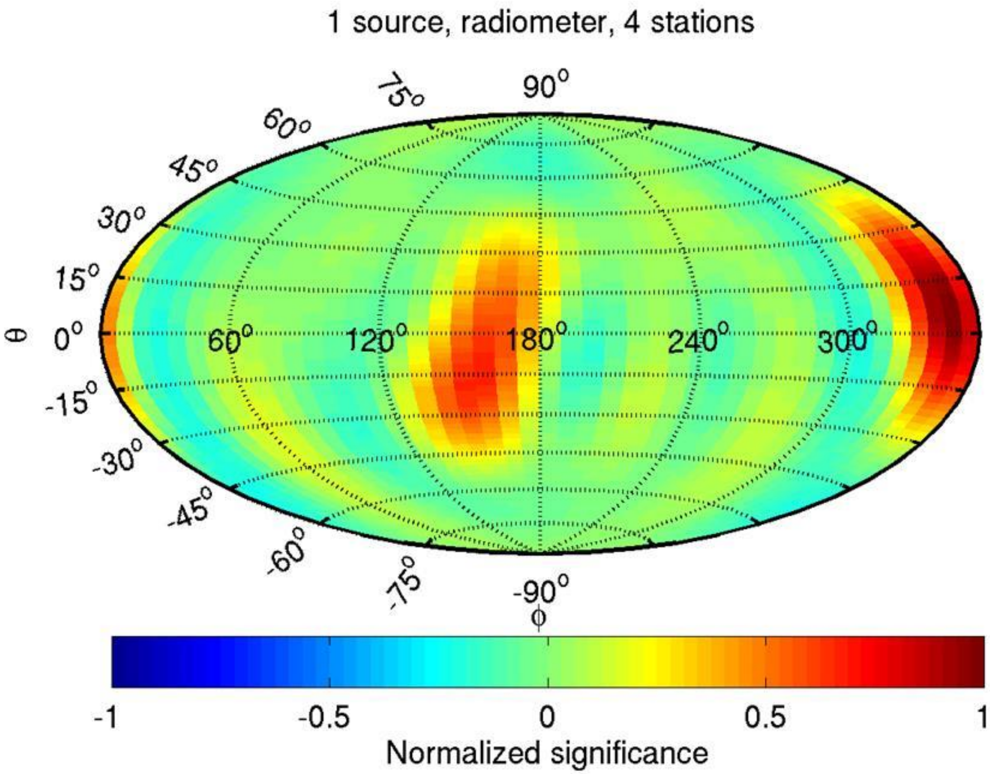


ndets = 4;   detloc=

235.5845	225.6078	255.5607
225.6732	297.7716	134.9524
537.5434	983.3267	439.5840
989.0877	89.1858	175.5073

(theta, phi) = (158.4275 37.2264); monochromatic source; frequency = 1; f_analyse = 1

Test 13



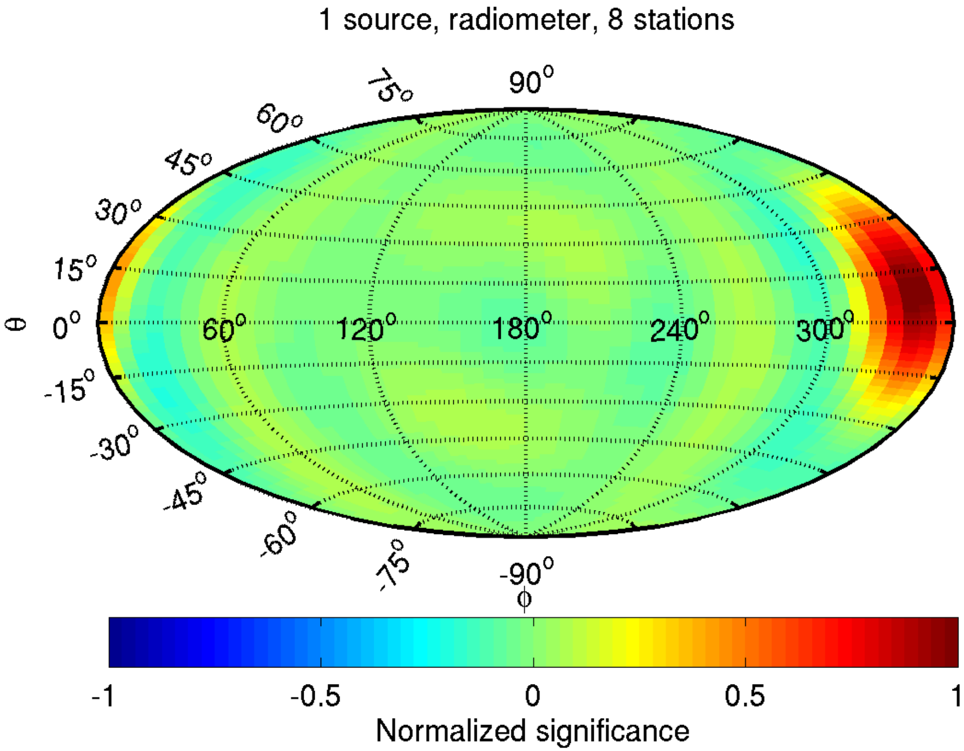
ndets = 4; detloc=

235.5845	225.6078	255.5607
225.6732	297.7716	134.9524
537.5434	983.3267	439.5840
989.0877	89.1858	175.5073

(theta, phi) = (81.5849, 338.5443);
monochromatic source; frequency = 1;
f_analyse = 1

Test 33

Repeat of Test 13 with more detectors

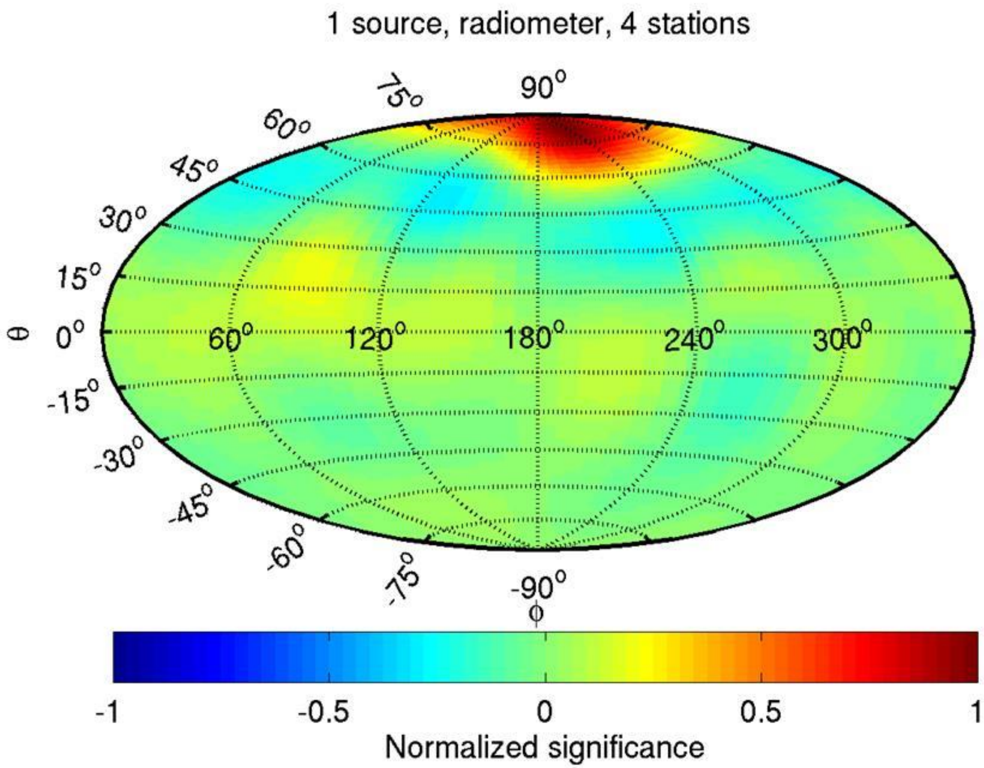


ndets = 8; detloc=

235.5845 225.6078 255.5607
225.6732 297.7716 134.9524
537.5434 983.3267 439.5840
989.0877 89.1858 175.5073
45.7240 38.6601 785.8624
69.5117 584.1036 258.9241
44.7931 10.2278 246.4084
429.3189 248.7073 623.1929

(theta, phi) = (81.5849, 338.5443);
Monochromatic source; frequency = 1;
f_analyse = 1

Test 14

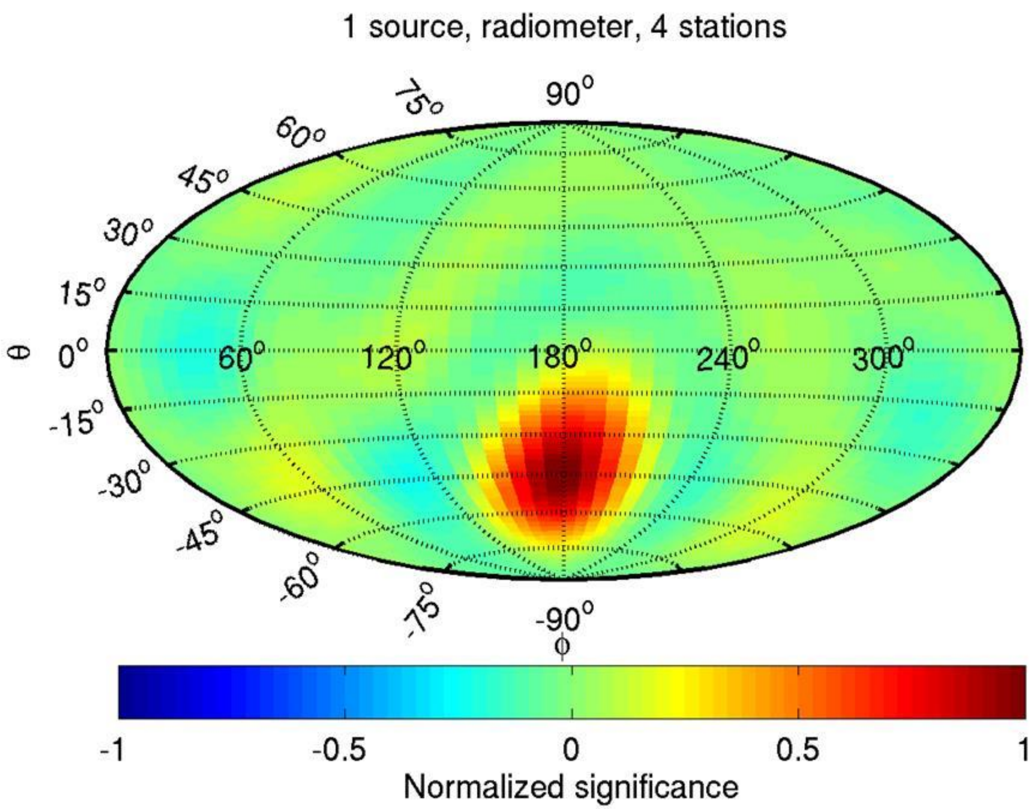


ndets = 4; detloc=

235.5845	225.6078	255.5607
225.6732	297.7716	134.9524
537.5434	983.3267	439.5840
989.0877	89.1858	175.5073

(theta, phi) = (4.2945 240.3571);
monochromatic source; frequency = 1;
f_analyse = 1

Test 15

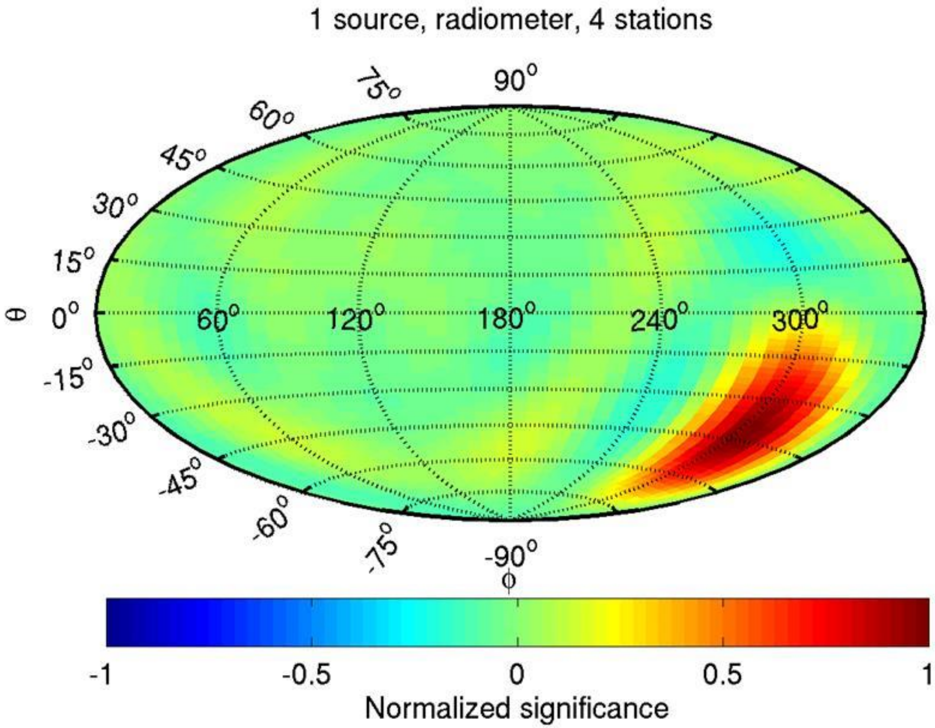


ndets = 4; detloc=

235.5845	225.6078	255.5607
225.6732	297.7716	134.9524
537.5434	983.3267	439.5840
989.0877	89.1858	175.5073

(theta, phi) = (137.8171 175.3984);
monochromatic source; frequency = 1;
f_analyse = 1

Test 16



ndets = 4;   detloc=

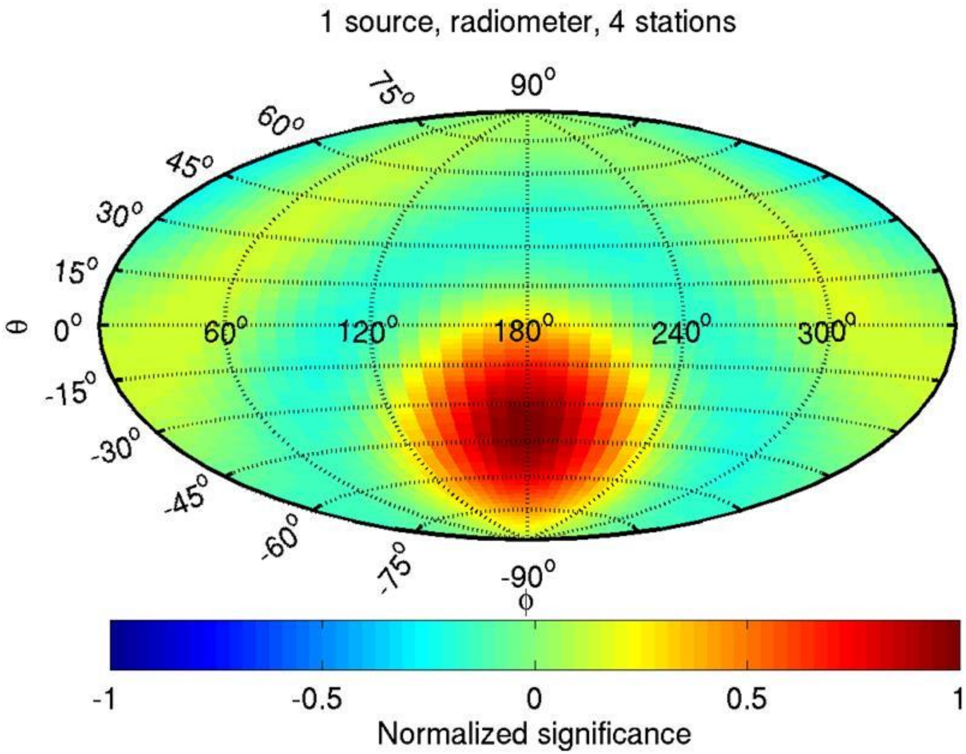
235.5845	225.6078	255.5607
225.6732	297.7716	134.9524
537.5434	983.3267	439.5840
989.0877	89.1858	175.5073

(theta, phi) = (135 300);
monochromatic source; frequency = 1;
f_analyse = 1

Frequency dependence

- Using the same detector configuration, and using a fixed source location, try varying the frequency of the signal.
- How do the results change?

Test 17

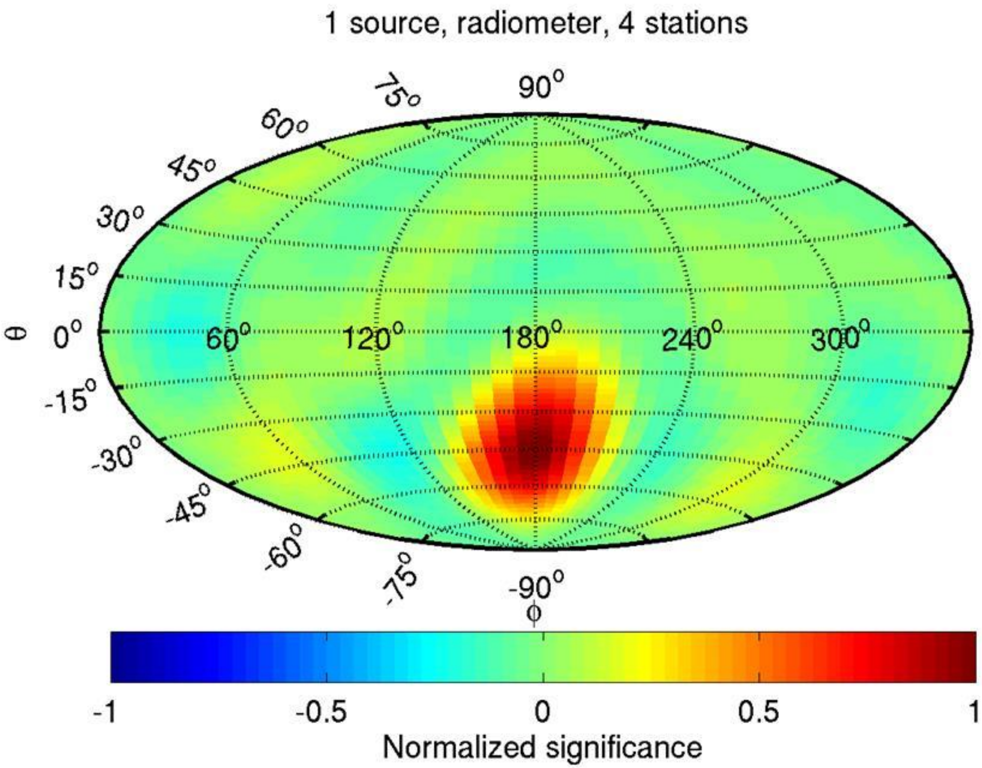


ndets = 4; detloc=

235.5845	225.6078	255.5607
225.6732	297.7716	134.9524
537.5434	983.3267	439.5840
989.0877	89.1858	175.5073

(theta, phi) = (137.8171 175.3984);
monochromatic source; frequency = 0.1;
f_analyse = 0.1

Test 18

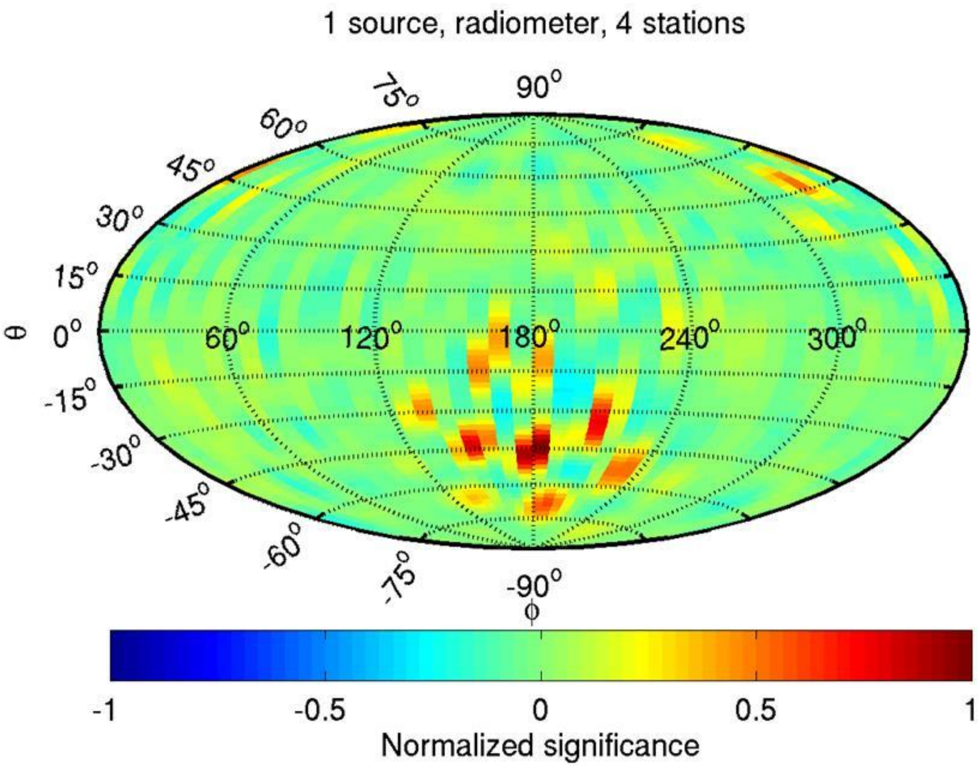


ndets = 4; detloc=

235.5845 225.6078 255.5607
225.6732 297.7716 134.9524
537.5434 983.3267 439.5840
989.0877 89.1858 175.5073

(theta, phi) = (137.8171 175.3984);
monochromatic source; frequency = 1;
f_analyse = 1

Test 19

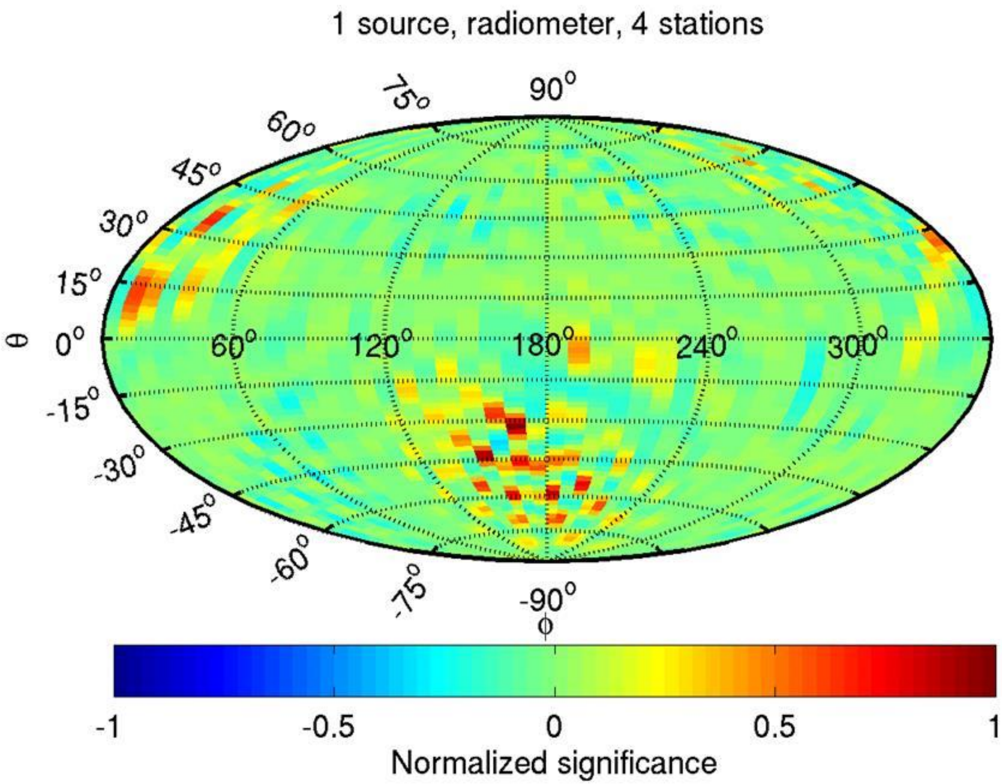


ndets = 4; detloc=

235.5845 225.6078 255.5607
225.6732 297.7716 134.9524
537.5434 983.3267 439.5840
989.0877 89.1858 175.5073

(theta, phi) = (137.8171 175.3984);
monochromatic source; frequency = 5;
f_analyse = 5

Test 20

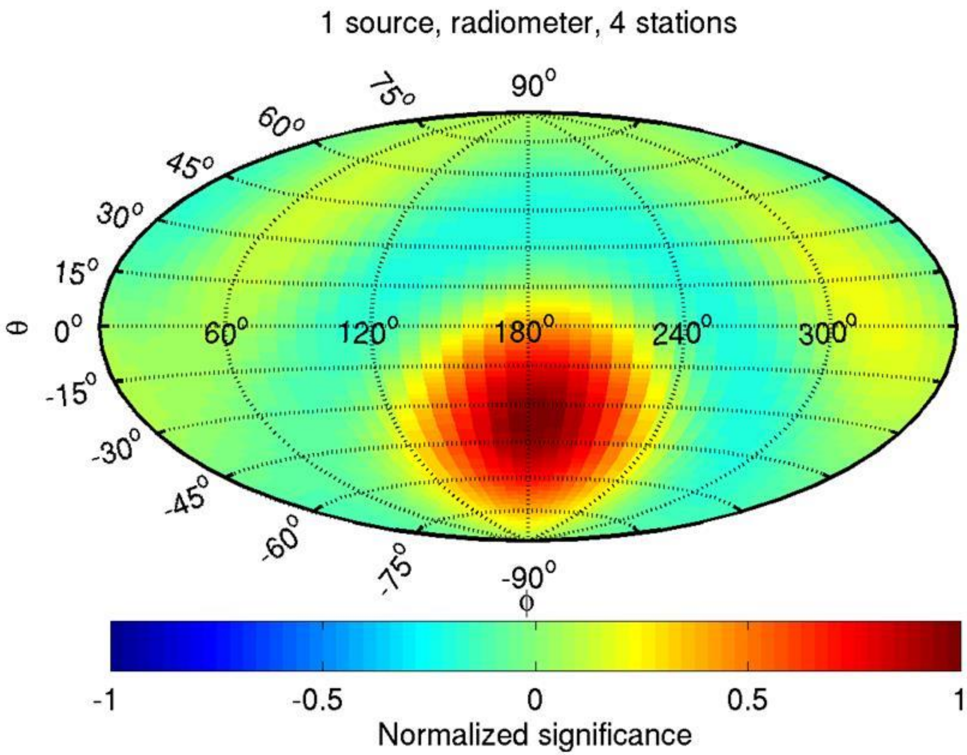


ndets = 4; detloc=

235.5845 225.6078 255.5607
225.6732 297.7716 134.9524
537.5434 983.3267 439.5840
989.0877 89.1858 175.5073

(theta, phi) = (137.8171 175.3984);
monochromatic source; frequency = 10;
f_analyse = 10

Test 21

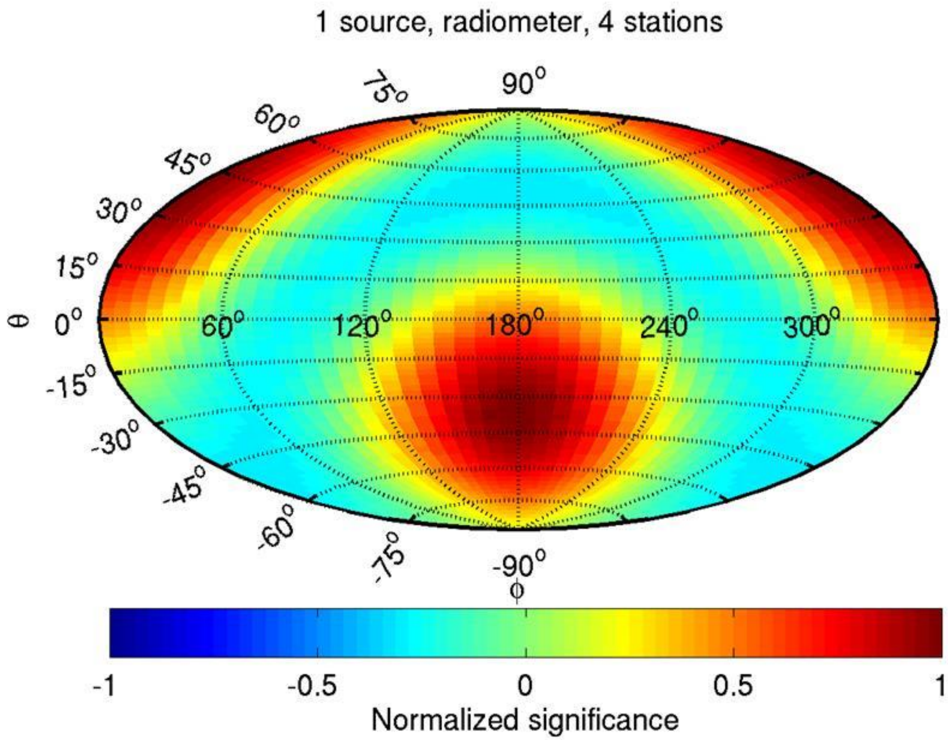


ndets = 4;   detloc=

235.5845	225.6078	255.5607
225.6732	297.7716	134.9524
537.5434	983.3267	439.5840
989.0877	89.1858	175.5073

(theta, phi) = (137.8171 175.3984);
monochromatic source; frequency = 0.01;
f_analyse = 0.01

Test 22



ndets = 4; detloc=

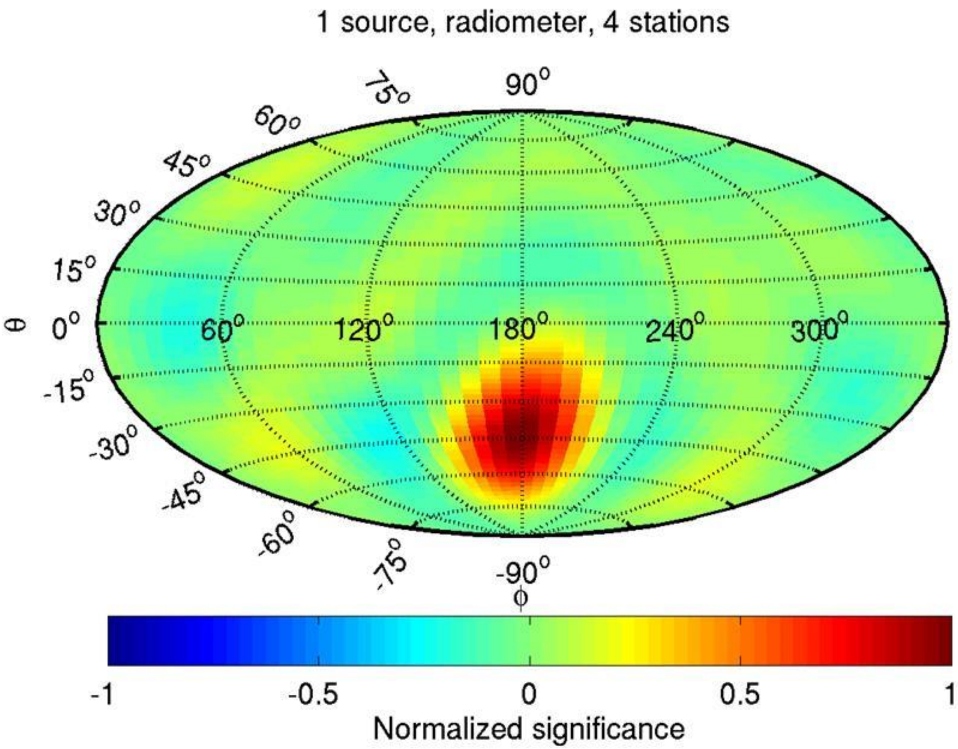
235.5845 225.6078 255.5607
225.6732 297.7716 134.9524
537.5434 983.3267 439.5840
989.0877 89.1858 175.5073

(theta, phi) = (137.8171 175.3984);
monochromatic source; frequency = 0.001;
f_analyse = 0.001

Broadband stochastic vs narrowband

- Fixed detectors
- Fixed source location
- Broadband stochastic source
- How does it compare to narrowband reconstruction?

Test 23

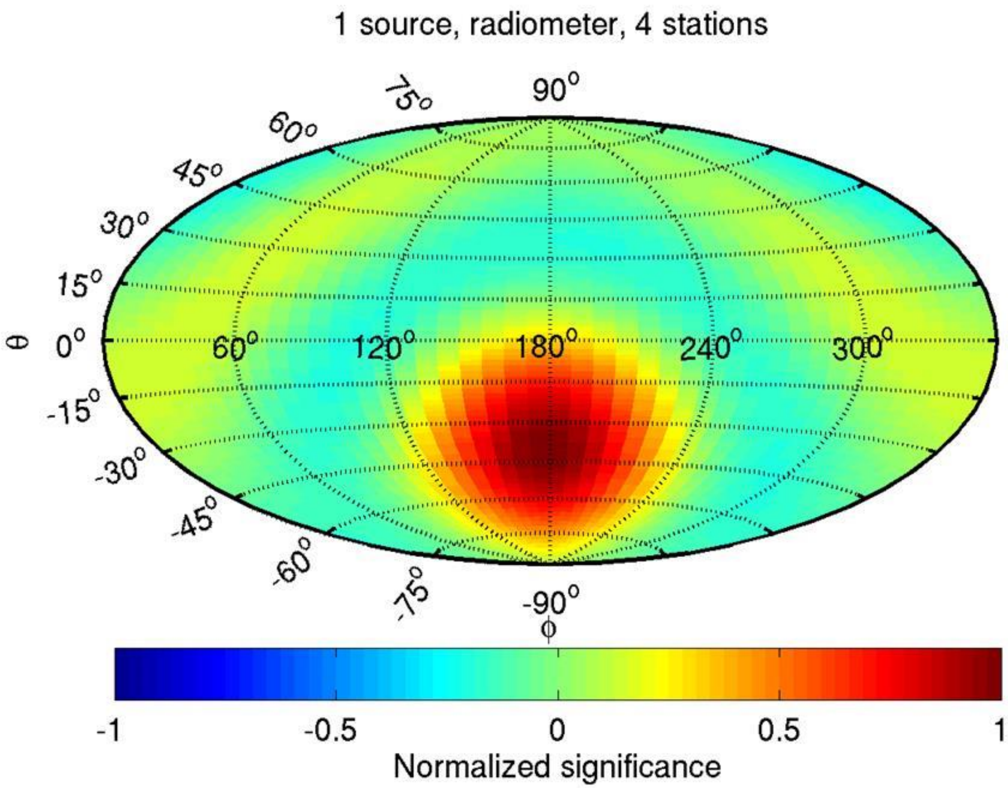


ndets = 4;   detloc=

235.5845 225.6078 255.5607
225.6732 297.7716 134.9524
537.5434 983.3267 439.5840
989.0877 89.1858 175.5073

(theta, phi) = (137.8171 175.3984);
Broadband source; f_analyse = 1

Test 24

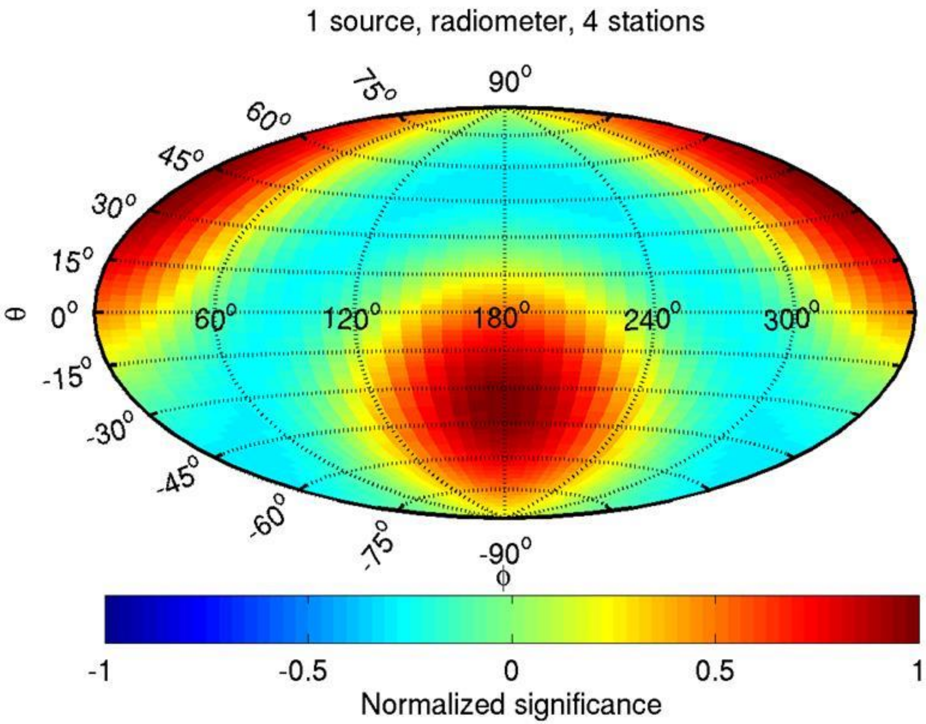


ndets = 4; detloc=

235.5845	225.6078	255.5607
225.6732	297.7716	134.9524
537.5434	983.3267	439.5840
989.0877	89.1858	175.5073

(theta, phi) = (137.8171 175.3984);
Broadband source; f_analyse = 0.01

Test 26

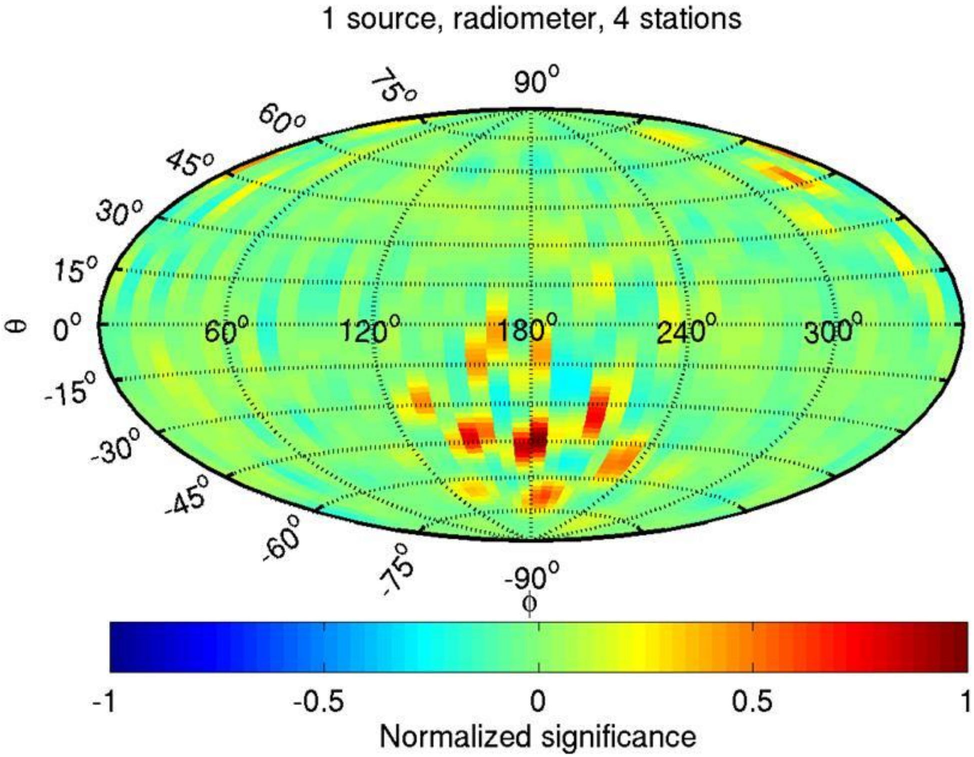


ndets = 4; detloc=

235.5845	225.6078	255.5607
225.6732	297.7716	134.9524
537.5434	983.3267	439.5840
989.0877	89.1858	175.5073

(theta, phi) = (137.8171 175.3984);
Broadband source; f_analyse = 0.001

Test 25



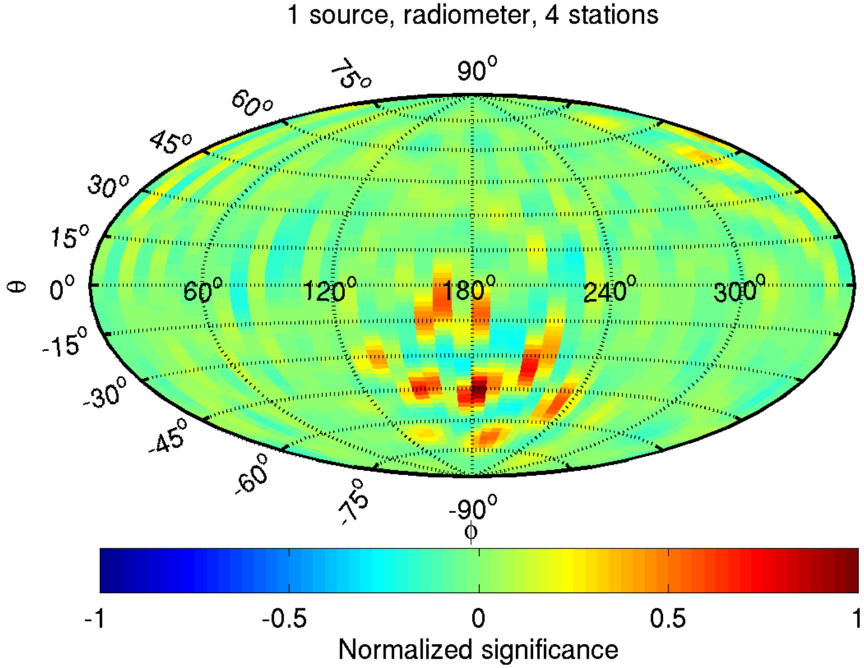
ndets = 4; detloc=

235.5845	225.6078	255.5607
225.6732	297.7716	134.9524
537.5434	983.3267	439.5840
989.0877	89.1858	175.5073

(theta, phi) = (137.8171 175.3984);
Broadband source; f_analyse = 5

Test 34

Repeat of Test 25 with New Broadband Signal



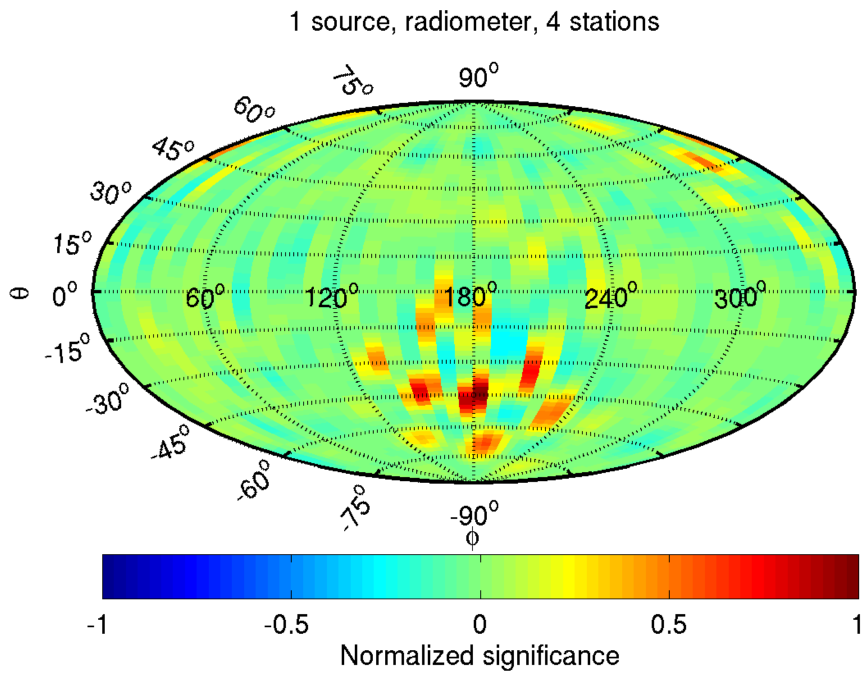
ndets = 4; detloc=

235.5845	225.6078	255.5607
225.6732	297.7716	134.9524
537.5434	983.3267	439.5840
989.0877	89.1858	175.5073

(theta, phi) = (137.8171, 175.3984);
Broadband source;
f_analyse = 5

Test 35

Repeat of Test 25 with New Broadband Signal



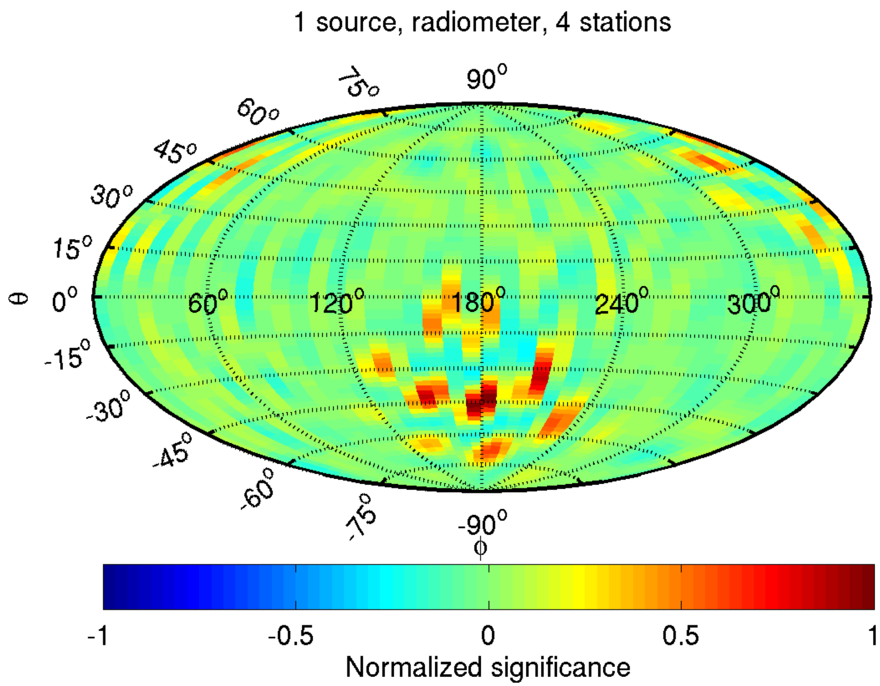
ndets = 4; detloc=

235.5845 225.6078 255.5607
225.6732 297.7716 134.9524
537.5434 983.3267 439.5840
989.0877 89.1858 175.5073

(theta, phi) = (137.8171, 175.3984);
Broadband source;
f_analyse = 5

Test 36

Repeat of Test 25 with Monochromatic Signal of Frequency 5



ndets = 4; detloc=

235.5845 225.6078 255.5607
225.6732 297.7716 134.9524
537.5434 983.3267 439.5840
989.0877 89.1858 175.5073

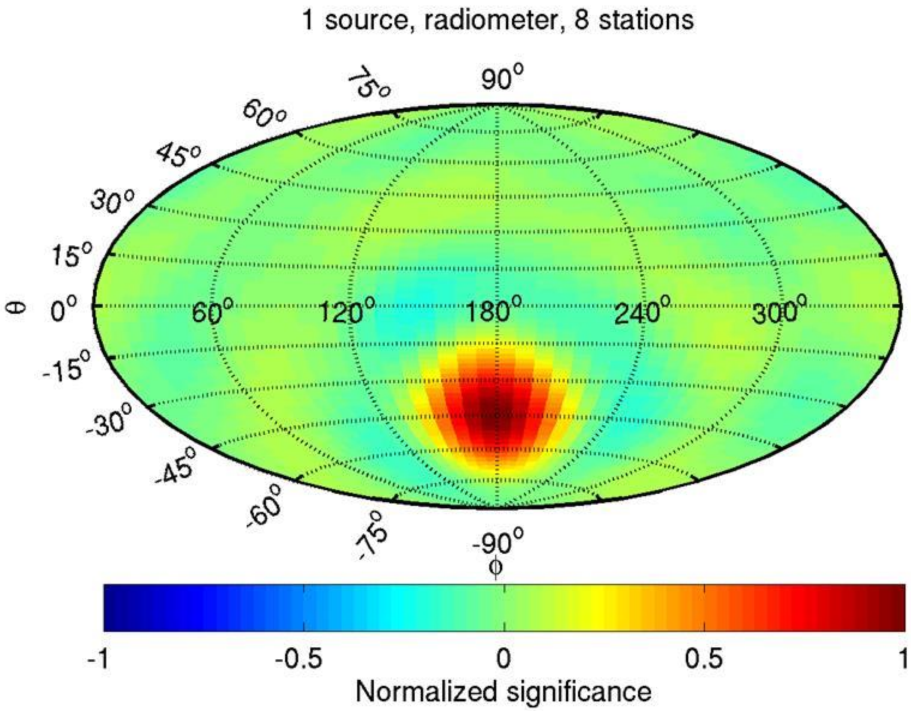
(theta, phi) = (137.8171, 175.3984);
Monochromatic source; frequency = 5;
f_analyse = 5

Number of detectors

- Fixed source location
- Fixed frequency content
- Show how reconstruction plot changes as detectors are added to array.
- Make sure to keep detectors fixed in place as you add new ones.

Test 27

ndets=8 detectors



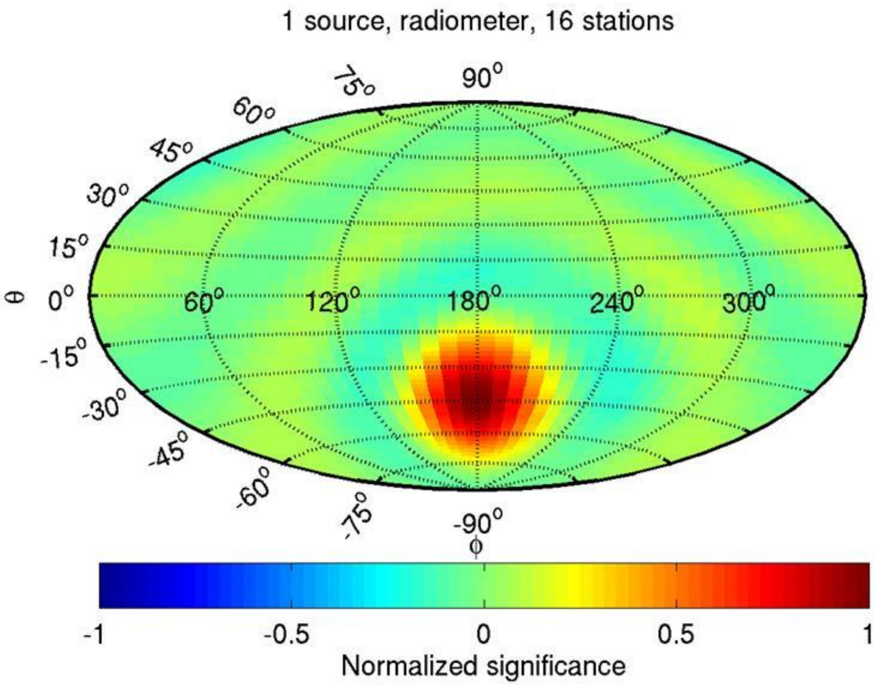
ndets = 8;   detloc=

235.5845	225.6078	255.5607
225.6732	297.7716	134.9524
537.5434	983.3267	439.5840
989.0877	89.1858	175.5073
45.7240	38.6601	785.8624
69.5117	584.1036	258.9241
44.7931	10.2278	246.4084
429.3189	248.7073	623.1929

(theta, phi) = (137.8171 175.3984);
monochromatic source; frequency = 1;
f_analyse = 1

Test 28

ndets=16 detectors



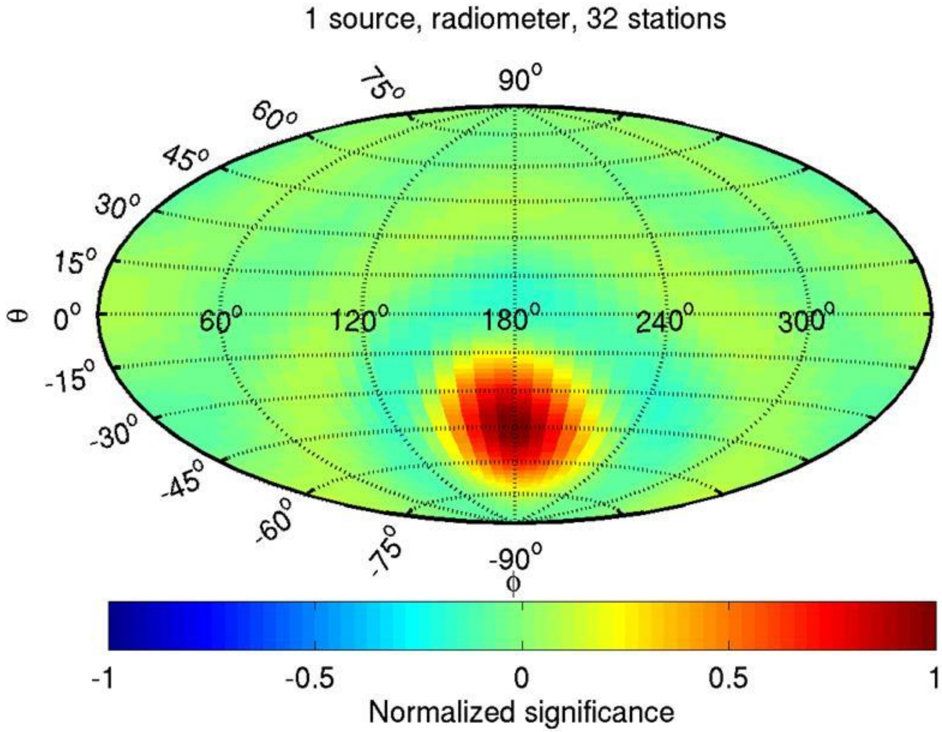
ndets = 16; detloc=

235.5845	225.6078	255.5607
225.6732	297.7716	134.9524
537.5434	983.3267	439.5840
989.0877	89.1858	175.5073
45.7240	38.6601	785.8624
69.5117	584.1036	258.9241
44.7931	10.2278	246.4084
429.3189	248.7073	623.1929
734.3862	971.0137	826.3307
445.2674	649.5887	502.2665
167.3122	391.2110	350.2711
806.0899	642.4234	422.2284
590.4269	583.6115	925.6891
795.5335	545.3141	402.6030
664.2426	638.9653	696.5490
200.6463	214.9071	300.1983

(theta, phi) = (137.8171 175.3984);
monochromatic source; frequency = 1; f_analyse = 1

Test 29

ndets=32 detectors



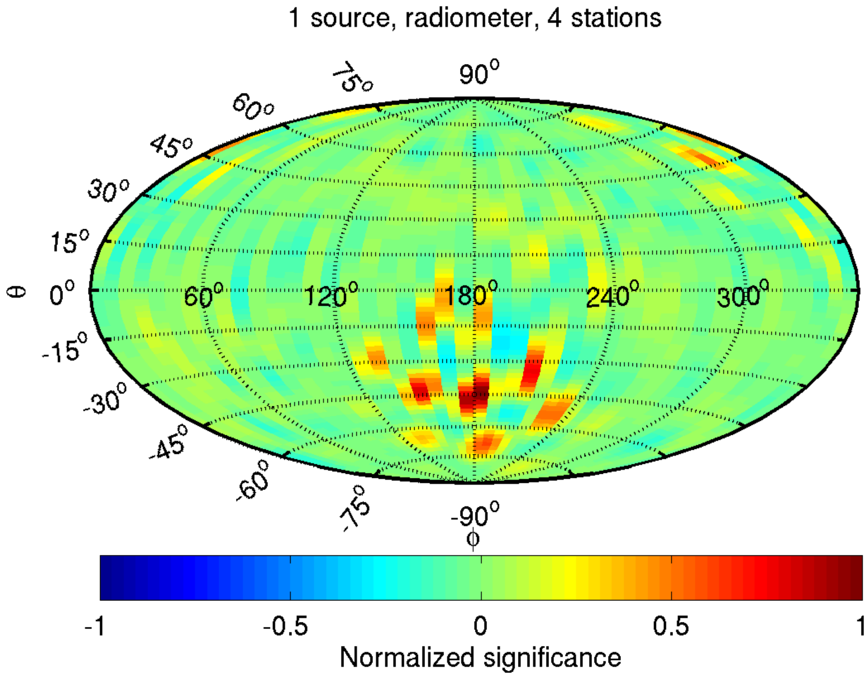
ndets = 32; detloc=

235.5845	225.6078	255.5607
225.6732	297.7716	134.9524
537.5434	983.3267	439.5840
989.0877	89.1858	175.5073
45.7240	38.6601	785.8624
69.5117	584.1036	258.9241
44.7931	10.2278	246.4084
429.3189	248.7073	623.1929
734.3862	971.0137	826.3307
445.2674	649.5887	502.2665
167.3122	391.2110	350.2711
806.0899	642.4234	422.2284
590.4269	583.6115	925.6891
795.5335	545.3141	402.6030
664.2426	638.9653	696.5490
200.6463	214.9071	300.1983
814.7237	421.7613	276.9230
905.7919	915.7355	46.1714
126.9868	792.2073	97.1318
913.3759	959.4924	823.4578
632.3592	655.7407	694.8286
97.5404	35.7117	317.0995
278.4982	849.1293	950.2220
546.8815	933.9932	34.4461
957.5068	678.7352	438.7444
964.8885	757.7401	381.5585
157.6131	743.1325	765.5168
970.5928	392.2270	795.1999
957.1669	655.4779	186.8726
485.3756	171.1867	489.7644
800.2805	706.0461	445.5862
141.8863	31.8328	646.3130

(theta, phi) = (137.8171 175.3984);
monochromatic source; frequency = 1; f_analyse = 1

Test 37

Starting with a recovered signal with a "checkerboard" pattern, these next few slides investigate the effect of adding more detectors

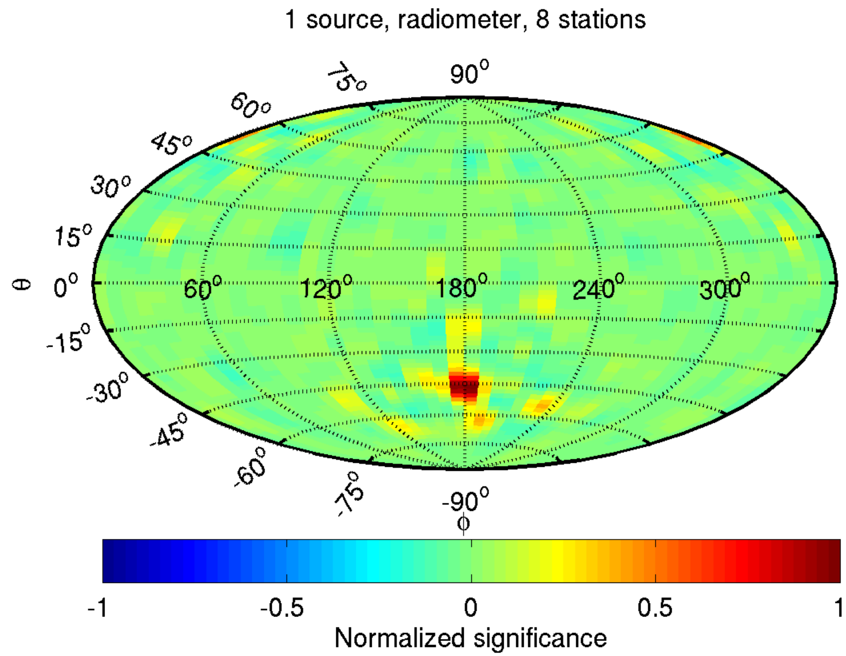


ndets = 4; detloc=

235.5845	225.6078	255.5607
225.6732	297.7716	134.9524
537.5434	983.3267	439.5840
989.0877	89.1858	175.5073

(theta, phi) = (137.8171, 175.3984);
Monochromatic source; frequency = 5;
f_analyse = 5

Test 38

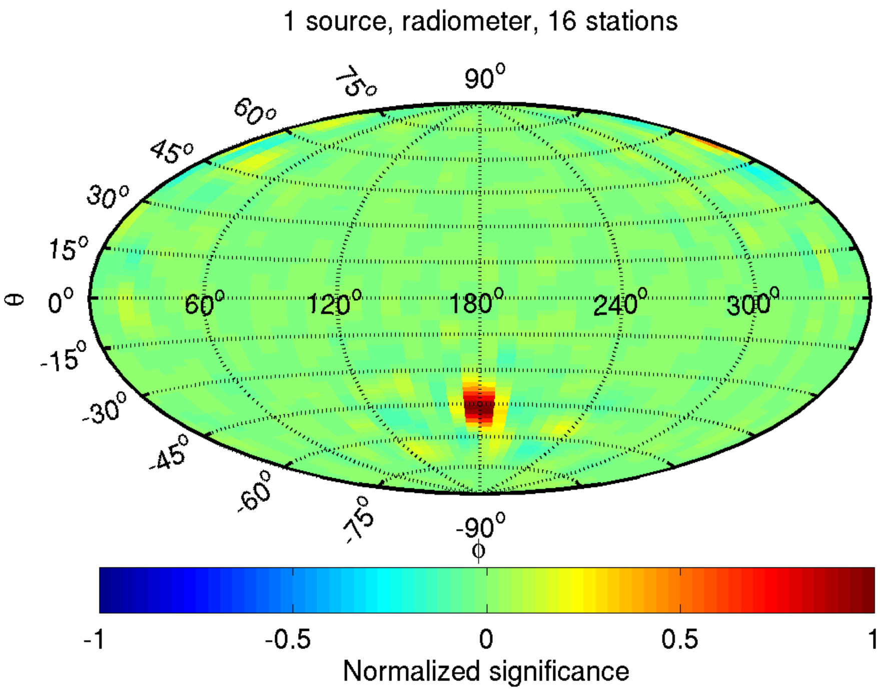


ndets = 8; detloc=

235.5845	225.6078	255.5607
225.6732	297.7716	134.9524
537.5434	983.3267	439.5840
989.0877	89.1858	175.5073
45.7240	38.6601	785.8624
69.5117	584.1036	258.9241
44.7931	10.2278	246.4084
429.3189	248.7073	623.1929

(theta, phi) = (137.8171, 175.3984);
Monochromatic source; frequency = 5;
f_analyse = 5

Test 39

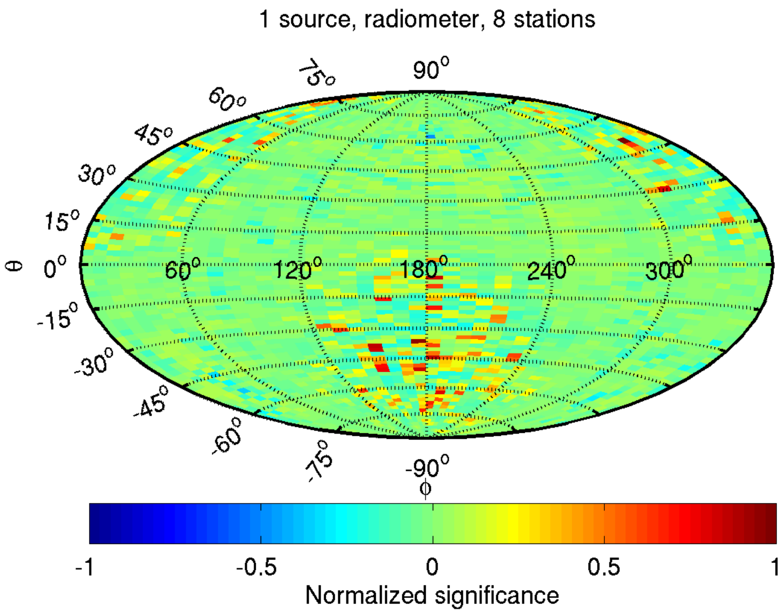


ndets = 16; detloc=

235.5845	225.6078	255.5607
225.6732	297.7716	134.9524
537.5434	983.3267	439.5840
989.0877	89.1858	175.5073
45.7240	38.6601	785.8624
69.5117	584.1036	258.9241
44.7931	10.2278	246.4084
429.3189	248.7073	623.1929
734.3862	971.0137	826.3307
445.2674	649.5887	502.2665
167.3122	391.2110	350.2711
806.0899	642.4234	422.2284
590.4269	583.6115	925.6891
795.5335	545.3141	402.6030
664.2426	638.9653	696.5490
200.6463	214.9071	300.1983

(theta, phi) = (137.8171, 175.3984);
Monochromatic source; frequency = 5;
f_analyse = 5

Test 40



ndets = 8; detloc=

235.6	225.6	255.6
225.7	297.8	135.0
537.5	983.3	439.6
989.1	89.2	175.5
1372.0	2698.6	1931.2
4049.6	3576.3	1639.5
1145.5	2334.4	4023.1
2776.6	482.8	4274.1

(theta, phi) = (137.8171, 175.3984);
Monochromatic source; frequency = 5;
f_analyse = 5

In this test, the 1000 m box which was previously used is expanded to 5000 m.

Conclusions

a) Tests 1-6 suggest that for a monochromatic source, aliasing occurs either due to detector arrangement or detector spacing. Tests 7-11 and 30-32 indicate that the latter is actually the case, since despite varying detector locations, aliasing occurs only when the cube size is sufficiently large.

b) Tests 12-16 show that, for the most part, different monochromatic source locations are recovered equally well. Test 13 is an exception, but test 33 shows that adding detectors alleviates the problem.

c) Tests 17-22 confirm (a), further implying that it is the spacing between the detectors relative to the injection/analyzed frequency which determines whether or not aliasing occurs.

d) Tests 23-26 confirm that for the broadband case, again it is the spacing between the detectors relative to the analyzed frequency which determines whether or not aliasing occurs.

e) Tests 25, 34, 35 and 36 demonstrate that over multiple trials for the same broadband source location, the recovery is essentially the same.

Conclusions cont.

f) Tests 27, 28, and 29 show that for a monochromatic source, in the case of a “good” recovery, adding detectors also gives a “good” recovery.

g) Tests 37, 38, 39 show that in the case of a “poor” recovery, adding detectors, so long as the spacing relative to the frequency is appropriate, increases the quality of the recovery.

f) Tests 40 shows that in the case of a “poor” recovery, adding detectors with too great of spacing decreases the quality of the recovery.