VLB ARRAY MEMO No. 205

March 28, 1983

To: VLBA Configuration Group

From: R. C. Walker

Subject: Final Configuration.

The time has come to try to freeze the configuration. We should have a final configuration in time for Volume III, drafts of which are due soon. Also serious site studies must begin if we are to be prepared to receive initial funding by the end of the year. In this memo, I propose a final configuration which I call M83 (for March 1983). It is based on the array that I suggested in VLBA Memo 143 and includes the modifications suggested by Mutel in VLBA Memo 194, with minor changes near the VLA.

I recently made an effort to find a good 13 station array that would fill the gap between the VLA and the VLBA in a way similar to that discussed for 14 station US-Canada arrays in VLBA Memo 181. The idea would be to choose 10 of the sites of the 13 station configuration to build now as the VLBA, covering the 200 to 8000 km baseline range specified in the original VLBA concept. If it should become possible to fill the gap to the VLA at some future date with 3 new antennas, we will know where to put them. In this search, I attempted to make as little change as possible to the optimized 10 station arrays of Memos 143 and 194. Array M83 is the final choice. The only change made to the 10 station arrays was to move the site closest to the VLA somewhat to the west. The performance of the final 10 station array when used with the VLA for baselines in the 50-300 km range was degraded slightly (it was already poor) but the performance in that range if and when the additional telescopes are built is improved. I do not consider the slight degradation to be significant.

The u-v coverages for array M83, on plots showing baselines to a maximum of 8000, 4000, 2000, 1000, 500, and 200 km. are shown on the attached plots. Three elements of the VLA (the ends of the arms in the A configuration and a site near the center) are included in the plots on the 1000, 500, and 200 km scales. The coverages for both the 10 and the 13 station versions of the configuration are shown. The additional capability offered by the three extra telescopes is very attractive and I hope that it will eventually be possible to add them. The individual sites are discussed below.

It might be possible to take a first step toward the 13 station array if the Owens Valley 130' antenna can be used as part of the VLBA. Of all of the existing telescopes, the 130' is perhaps the best choice for use as an array element. It has a large collecting area, a simple and reliable mechanical system, and a good surface (We should hear more about this soon from Caltech). An 11 station configuration with considerably improved short baseline coverage could be obtained if, instead of building a new telescope at OVRO as called for in the 10 station version of M83, we were to build the Roswell antenna of the 13 station design and, to the extent possible within the budget, equip the OVRO antenna with a VLBA backend. The remaining two antennas near the VLA in the 13 station design are very close to it and might be built later as a VLA extension. Figure 3 shows the coverage of a 10 station array that is M83 with Roswell instead of OVRO. As can be seen, the degradation in performance at the longer spacings is serious (as it is if any station is removed). However the degradation is in the form of several moderate holes, rather than a massive hole, in the u-v plane. It that regard, OVRO is probably one of the less disastrous antennas to lose. Figure 4 shows the coverage of 11 stations, including OVRO and Roswell on a 1000 km scale. The coverage of the short spacings is much better than it is without Roswell. We might consider using the construction funds to build the additional antenna, even if using the existing antenna at OVRO creates some problems and if we can only equip one of OVRO and Roswell with receivers at the start. Electronics can be built and structures can be beefed up later, but it will be hard to build new antennas later.

One of the constraints placed on the configuration of the VLBA has been that all antennas be on United States territory. That constraint limits the coverage of north-south spacings at the low declinations to approximately that obtained by array M83. An attractive addition that might be made to the VLBA at some future date is an antenna in northern South America. Figure 5 shows the coverage of M83 (10 stations) plus a station in Quito, Equador. The improved performance at low declinations is very attractive and, should such an addition to the VLBA become possible, it should be considered seriously. Such a project would be independent of the three antenna addition for filling the hole between the VLA and the VLBA.

Discussion of the sites of Array M83:

MAUI: A site near the IR facilities on Haleakala has been suggested as an attractive alternative to a site on the big island. The site is at 10,000 feet elevation and has utilities, roads, and local support. It also does not have the political/environmental problems of sites on or near Mauna Kea. (RFI may be bad)

PUERTO RICO: (Listed as Arecibo on the plots) We are still trying to to determine if we can live with the high water vapor levels in Puerto Rico (VLBA Memo 139). 6 cm VLBI results from recent experiments suggest that the coherence at that frequency is not much shorter than would be expected from the use of the Rubidium clock at Arecibo (A memo by Benson should appear shortly). Soon we will make water vapor radiometer measurements at about 3 different sites in Puerto Rico in an effort to determine if high frequency observations will be possible at all and, if so, which site is best. If we decide Puerto Rico cannot be used, we must return to an Alaska based array such as the one in the proposal and many of the other stations must be changed. Figure 6 shows the u-v coverage of M83 without Puerto Rico. As can be seen, the main effect is to remove coverage of the long northwest-southeast baselines. This is a relatively graceful degradation that might be tolerated at high frequencies much of the time for the improved performance at lower frequencies.

HAYSTACK: (Listed as HSTK) This site is at an existing observatory with very good local support. We need to determine if the high power radars on the site are a problem. If they are, a move to the Five College Radio Observatory might be considered. There should be very little effect on the u-v coverage and it might make millimeter wavelength VLBI experiments easier.

OROVILLE: (Listed as OROVILE) Oroville is very near the Canadian border in central Washington State. This is the only site in the configuration that is not near known local support. There is considerable freedom to move the site arround in central Washington so a site can be picked based on logistical factors. Note that this site is very near Penticton.

OVRO: The Owens Valley Radio Observatory is an existing VLBI site with good local support. The possibility of using the 130 foot antenna with appropriate upgrades as a VLBA antenna should be considered. OVRO has a possible serious problem with wind which should be studied carefully. If this site must be moved out of the Owens Valley, one or more other sites may also need to be moved.

IOWA: The North Liberty Radio Observatory is an existing facility with local support and strong interest in VLBI. The obvious, although probably not serious, hole in the coverage at Dec 64 at a little over 2000 km can be filled by moving this site to Illinois with some corresponding, but more subtle, degradation of performance in other parts of the u-v plane (My by-eye examination of the u-v coverage usually favors Illinois while the quantitative quality measures usually favor Iowa.). The difference is illustrated in Figure 7 which shows M83 using Illinois instead of Iowa on a 4000 km scale. There is consiberable freedom in the choice of the location of this site so local factors can be seriously considered.

FDVS: (Listed as FDVSNEW) The Fort Davis site could either be at the existing radio observatory (George R. Agassiz Station - Harvard) or at the University of Texas facilities on the mountain at McDonald Observatory.

KITT: Kitt peak is an existing NRAO site with good local support.

BERNAL: This site is along Interstate 25 between Santa Fe and Las Vegas, New Mexico. It was chosen as an alternative to the Lamy East of Memo 194 because it probably has better services and access and because it should be accessable by microwave link from Sandia Peak. This site would probably be operated remotely from the VLA and, despite its relative remoteness, would be quickly accessible by vehicle from the VLA for servicing (no wait for airline flights). If more local support is desired, the site could be moved to Los Alamos with minor effect on the performance of the array.

VLAE3: This site is near Winston, New Mexico and would also be operated remotely from the VLA. Access should not be too bad, although the road from the VLA is poor and will require use of a sturdy, 4-wheel-drive vehicle during part of the year. Such a vehicle is not expensive on the scale of the project. This site is a good location for the southern element of a three element extension of the VLA, although it is somewhat further south than might be optimal if the interaction with the VLBA is not considered.

The following three sites complete the 13 station version of M83.

VLAE4: This site is near Pie Town, New Mexico. It would be part of an extension to the VLA. It has good access from Rt. 60.

VLAE5: This site is near Bernardo, New Mexico, between Socorro and Albuquerque along Interstate 25.

ROSWELL: Roswell, New Mexico is east and a bit south of the VLA. There is some freedom in finding a specific site. We need information on the suitability of this site. It would probably be operated remotely from the VLA.

| | | |
|---|---|---|
| MAUI | 20.75 | 156.20 |
| ARECIBO | 18.34 | 66.75 |
| HSTK | 42.43 | 71.49 |
| OROVILE | 48.90 | 119.75 |
| OVRO | 37.05 | 118.28 |
| IOWA | 41.58 | 91.57 |
| FDVSNEW | 30.47 | 103.95 |
| KITT | 31.96 | 111.60 |
| BERNAL | 35.40 | 105.30 |
| VLAE3 | 33.30 | 107.70 |

Scale in km
( kilometers x $10^3$)

8000 km

M 83

10 Stations

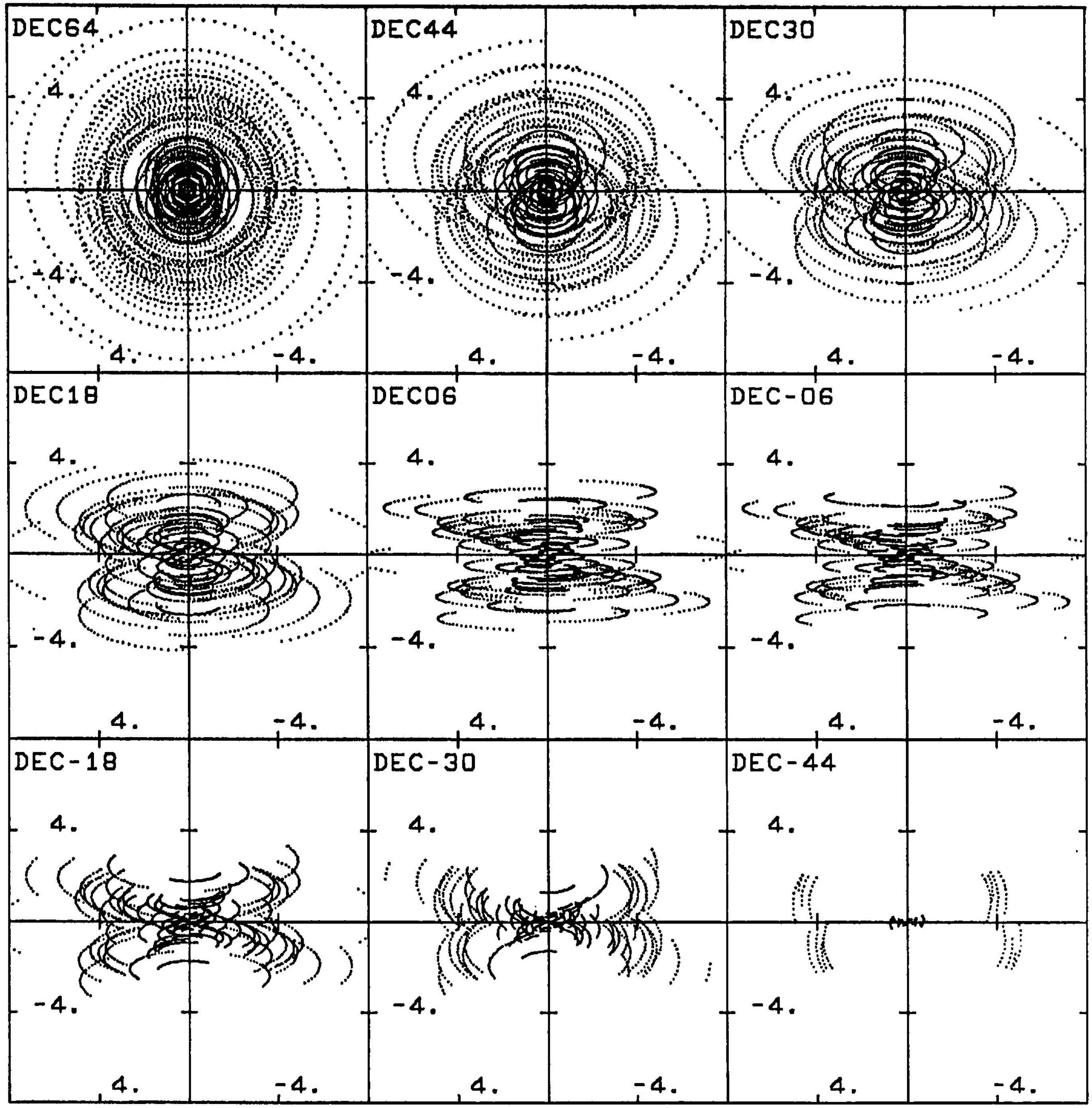


Figure 1a

| | | |
|---|---|---|
| MAUI | 20.75 | 156.20 |
| ARECIBO | 18.34 | 66.75 |
| HSTK | 42.43 | 71.49 |
| OROVILE | 48.90 | 119.75 |
| OVRO | 37.05 | 118.28 |
| IOWA | 41.58 | 91.57 |
| FDVSNEW | 30.47 | 103.95 |
| KITT | 31.96 | 111.60 |
| BERNAL | 35.40 | 105.30 |
| VLAE3 | 33.30 | 107.70 |

Scale in km
( kilometers x $10^3$)

4000 km

M 83

10 Stations

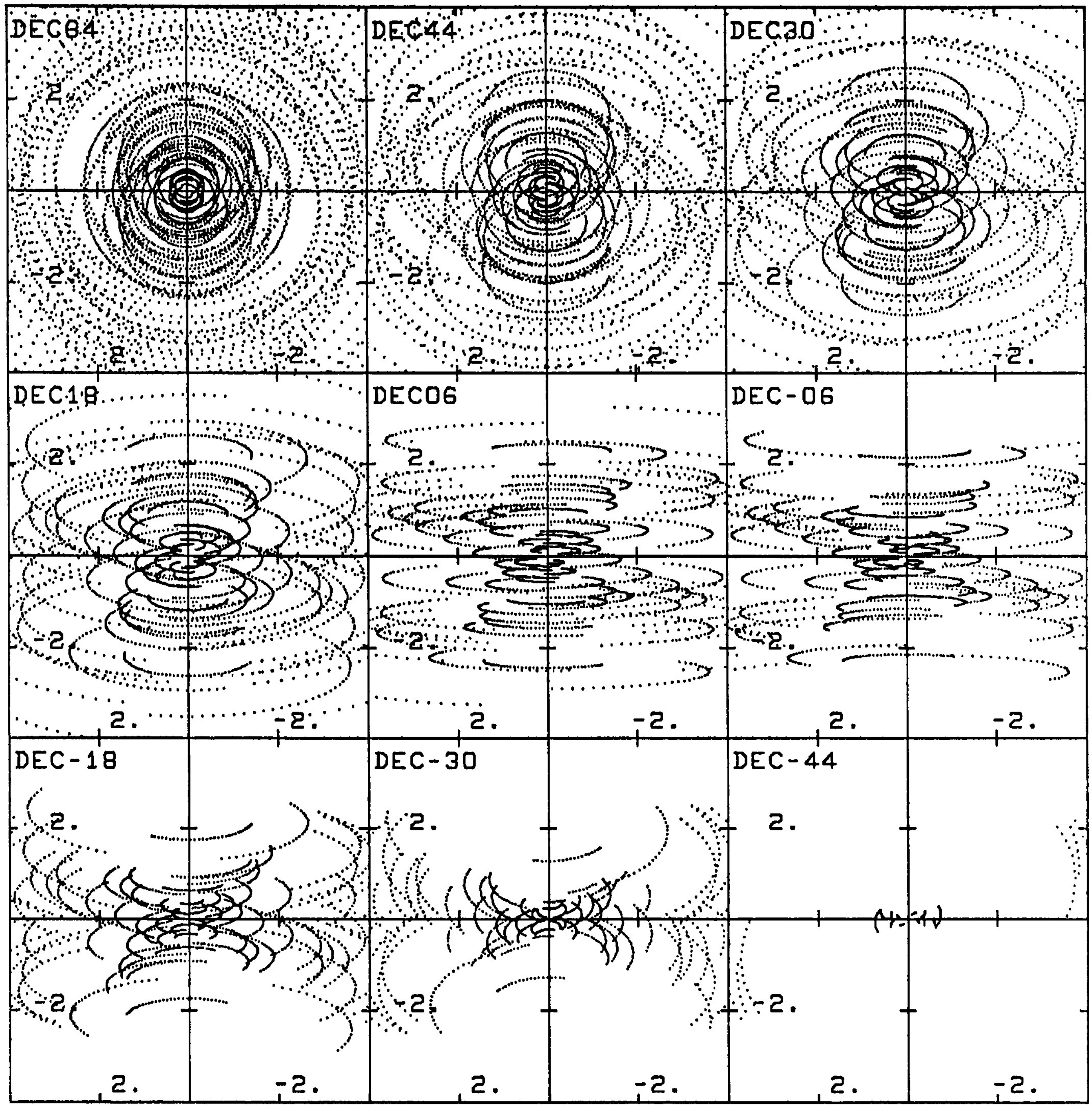


Figure 1b

| | | |
|---|---|---|
| MAUI | 20.75 | 156.20 |
| ARECIBO | 18.34 | 66.75 |
| HSTK | 42.43 | 71.49 |
| OROVILE | 48.90 | 119.75 |
| OVRO | 37.05 | 118.28 |
| IOWA | 41.58 | 91.57 |
| FDVSNEW | 30.47 | 103.95 |
| KITT | 31.96 | 111.60 |
| BERNAL | 35.40 | 105.30 |
| VLAE3 | 33.30 | 107.70 |

Scale in km
( kilometers x $10^2$)

2000 km

M 83

10 Stations

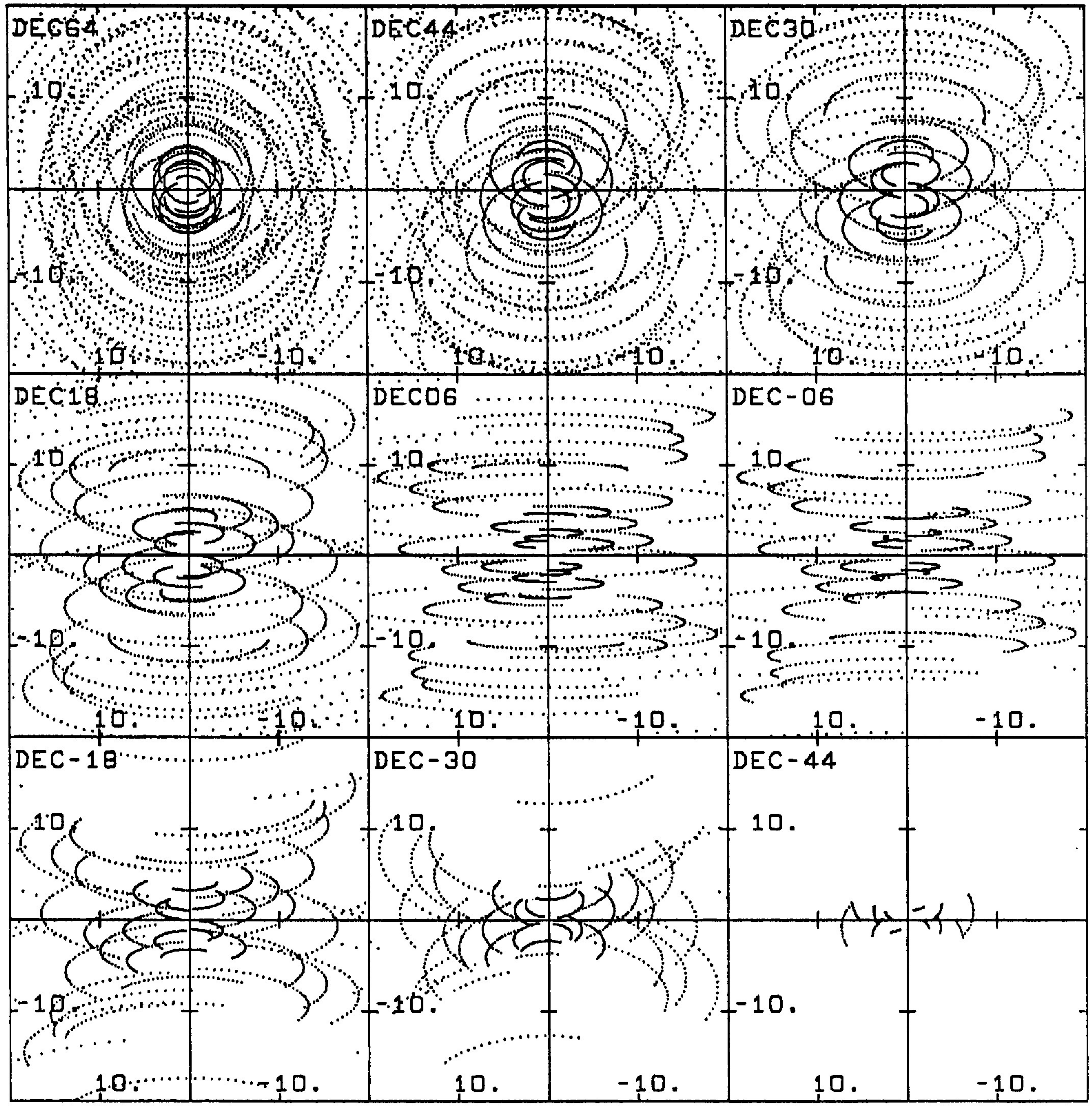


Figure 1c

| | | |
|---|---|---|
| MAUI | 20.75 | 156.20 |
| ARECIBO | 18.34 | 66.75 |
| HSTK | 42.43 | 71.49 |
| OROVILE | 48.90 | 119.75 |
| OVRO | 37.05 | 118.28 |
| IOWA | 41.58 | 91.57 |
| FDVSNEW | 30.47 | 103.95 |
| KITT | 31.96 | 111.60 |
| BERNAL | 35.40 | 105.30 |
| VLAE3 | 33.30 | 107.70 |
| AN9 | 34.24 | 107.63 |
| AW9 | 33.97 | 107.81 |
| AE9 | 34.00 | 107.41 |
| AW3 | 34.06 | 107.64 |

Scale in km
( kilometers x $10^2$)

1000 km

M83

10 Stations + 4 VLA

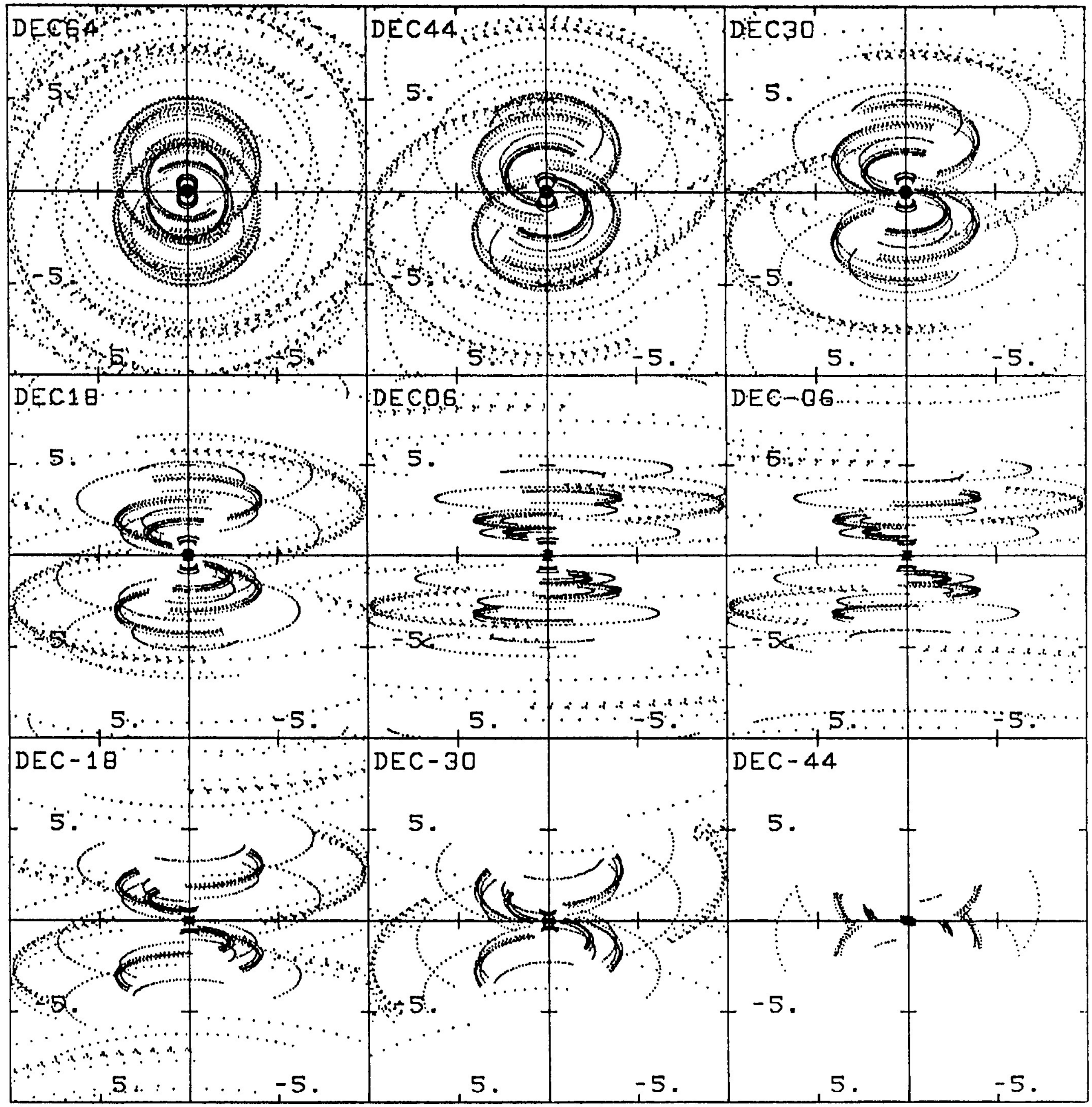


Figure 1d

| | | |
|---|---|---|
| MAUI | 20.75 | 156.20 |
| ARECIBO | 18.34 | 66.75 |
| HSTK | 42.43 | 71.49 |
| OROVILE | 48.90 | 119.75 |
| OVRO | 37.05 | 118.28 |
| IOWA | 41.58 | 91.57 |
| FDVSNEW | 30.47 | 103.95 |
| KITT | 31.96 | 111.60 |
| BERNAL | 35.40 | 105.30 |
| VLAE3 | 33.30 | 107.70 |
| AN9 | 34.24 | 107.63 |
| AW9 | 33.97 | 107.81 |
| AE9 | 34.00 | 107.41 |
| AW3 | 34.06 | 107.64 |

Scale in km
( kilometers x $10^2$)

500 km

m83

10 Stations + 4 VLA

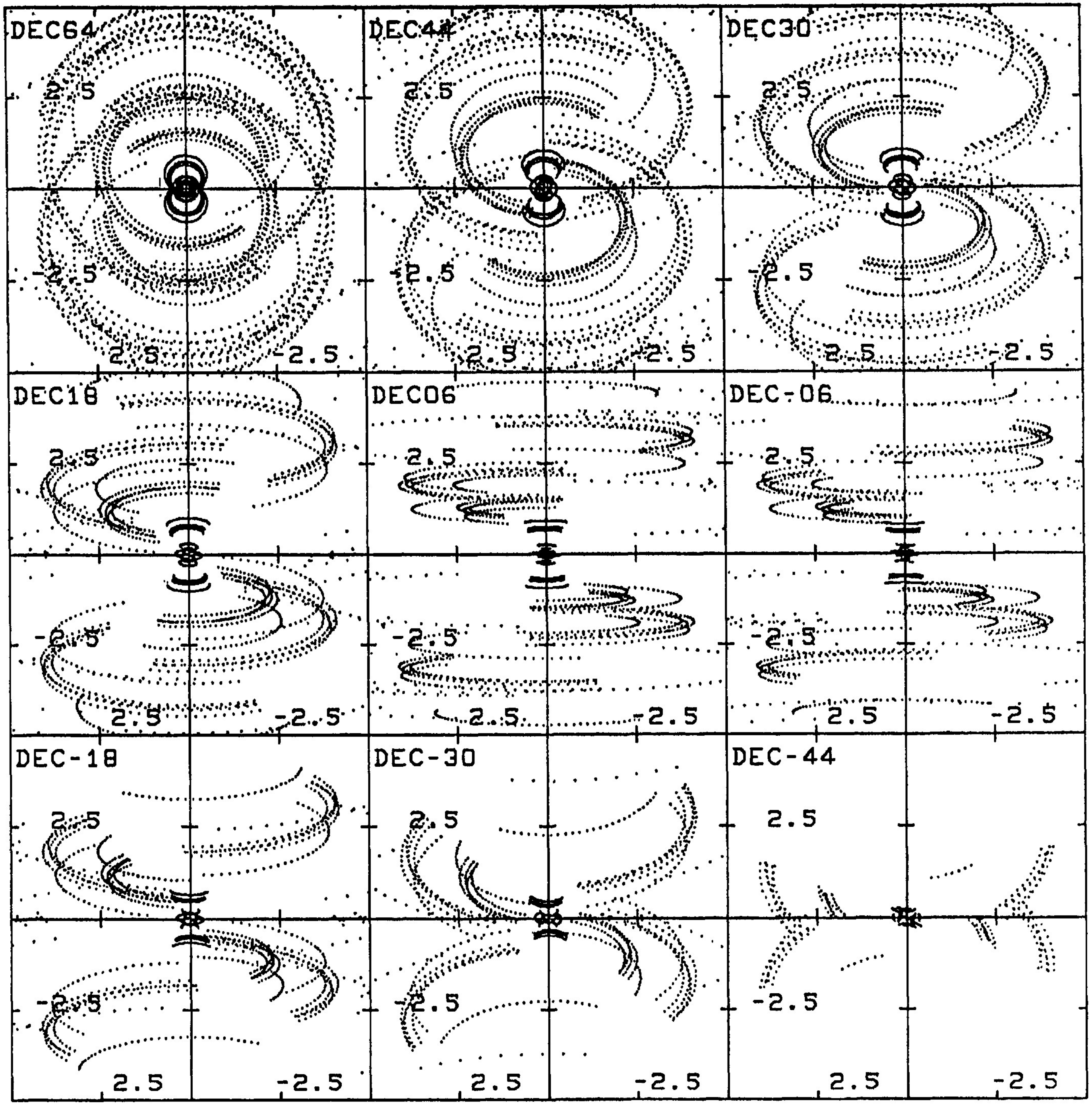


Figure 1e

| | | |
|---|---|---|
| MAUI | 20.75 | 156.20 |
| ARECIBO | 18.34 | 66.75 |
| HSTK | 42.43 | 71.49 |
| OROVILE | 48.90 | 119.75 |
| OVRO | 37.05 | 118.28 |
| IOWA | 41.58 | 91.57 |
| FDVSNEW | 30.47 | 103.95 |
| KITT | 31.96 | 111.60 |
| BERNAL | 35.40 | 105.30 |
| VLAE3 | 33.30 | 107.70 |
| AN9 | 34.24 | 107.63 |
| AW9 | 33.97 | 107.81 |
| AE9 | 34.00 | 107.41 |
| AW3 | 34.06 | 107.64 |

Scale in km
( kilometers x $10^1$)

200 km

M83

10 Stations + 4 VLA

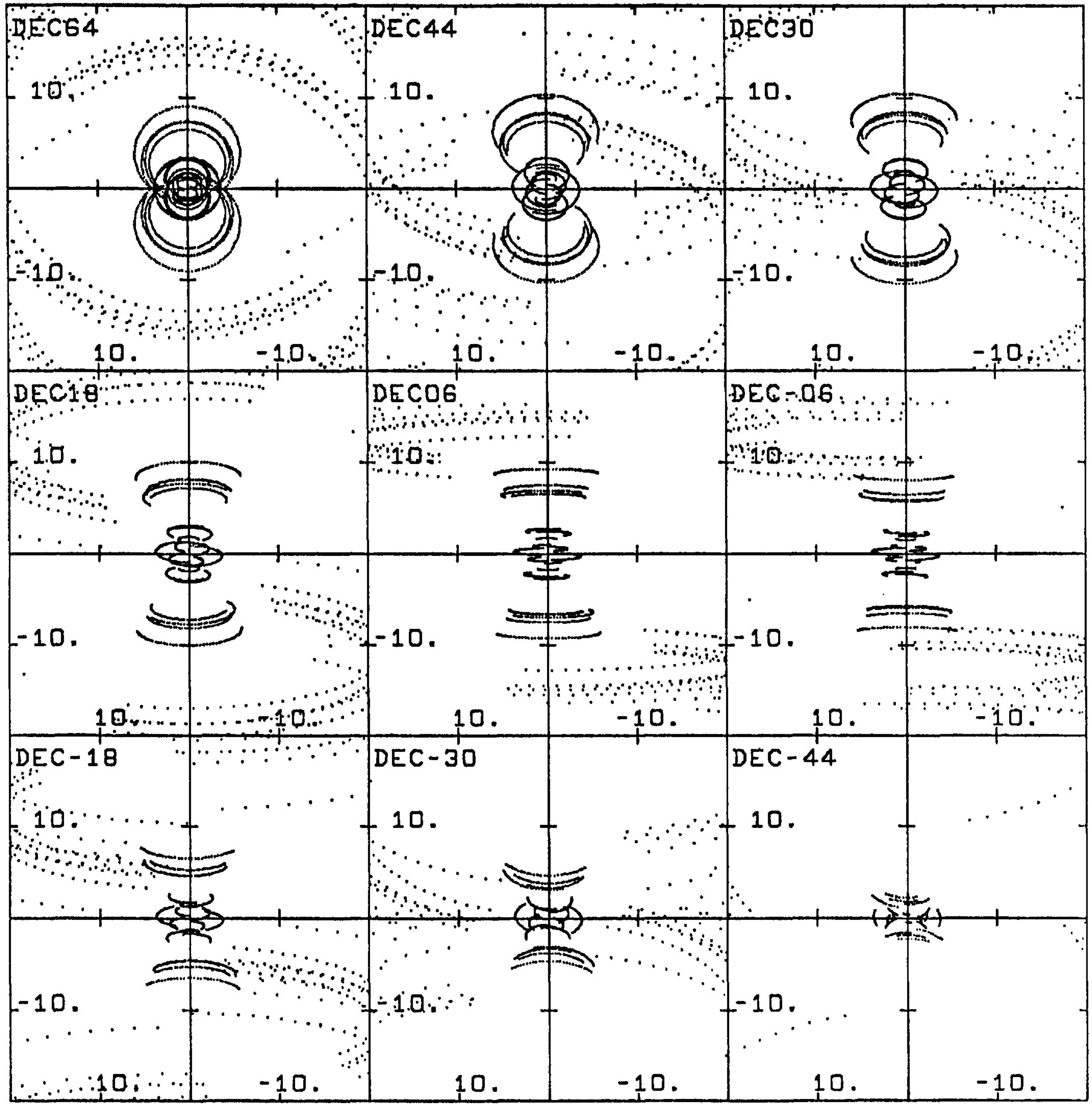


Figure 1f

| | | |
|---|---|---|
| MAUI | 20.75 | 156.20 |
| ARECIBO | 18.34 | 66.75 |
| HSTK | 42.43 | 71.49 |
| OROVILE | 48.90 | 119.75 |
| OVRO | 37.05 | 118.28 |
| IOWA | 41.58 | 91.57 |
| FDVSNEW | 30.47 | 103.95 |
| KITT | 31.96 | 111.60 |
| BERNAL | 35.40 | 105.30 |
| VLAE3 | 33.30 | 107.70 |
| VLAE4 | 34.30 | 108.30 |
| VLAE5 | 34.38 | 106.95 |
| ROSWELL | 33.40 | 104.55 |

Scale in km
( kilometers x $10^3$)

8000 km

13 Stations

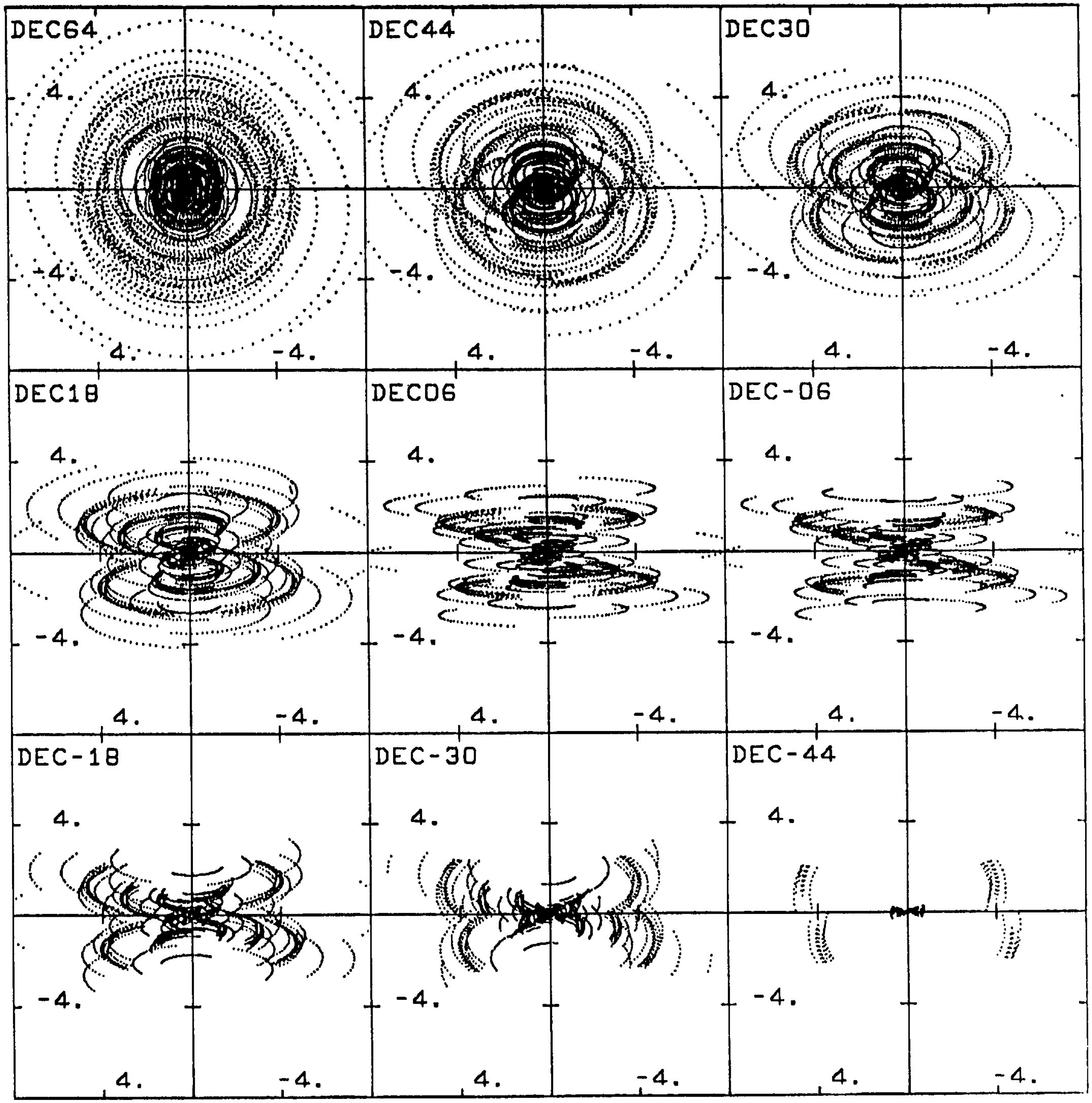


Figure 2a

| | | |
|---|---|---|
| MAUI | 20.75 | 156.20 |
| ARECIBO | 18.34 | 66.75 |
| HSTK | 42.43 | 71.49 |
| OROVILE | 48.90 | 119.75 |
| OVRO | 37.05 | 118.28 |
| IOWA | 41.58 | 91.57 |
| FDVSNEW | 30.47 | 103.95 |
| KITT | 31.96 | 111.60 |
| BERNAL | 35.40 | 105.30 |
| VLAE3 | 33.30 | 107.70 |
| VLAE4 | 34.30 | 108.30 |
| VLAE5 | 34.38 | 106.95 |
| ROSWELL | 33.40 | 104.55 |

Scale in km
( kilometers x $10^3$)

4000 Km

13 Stations

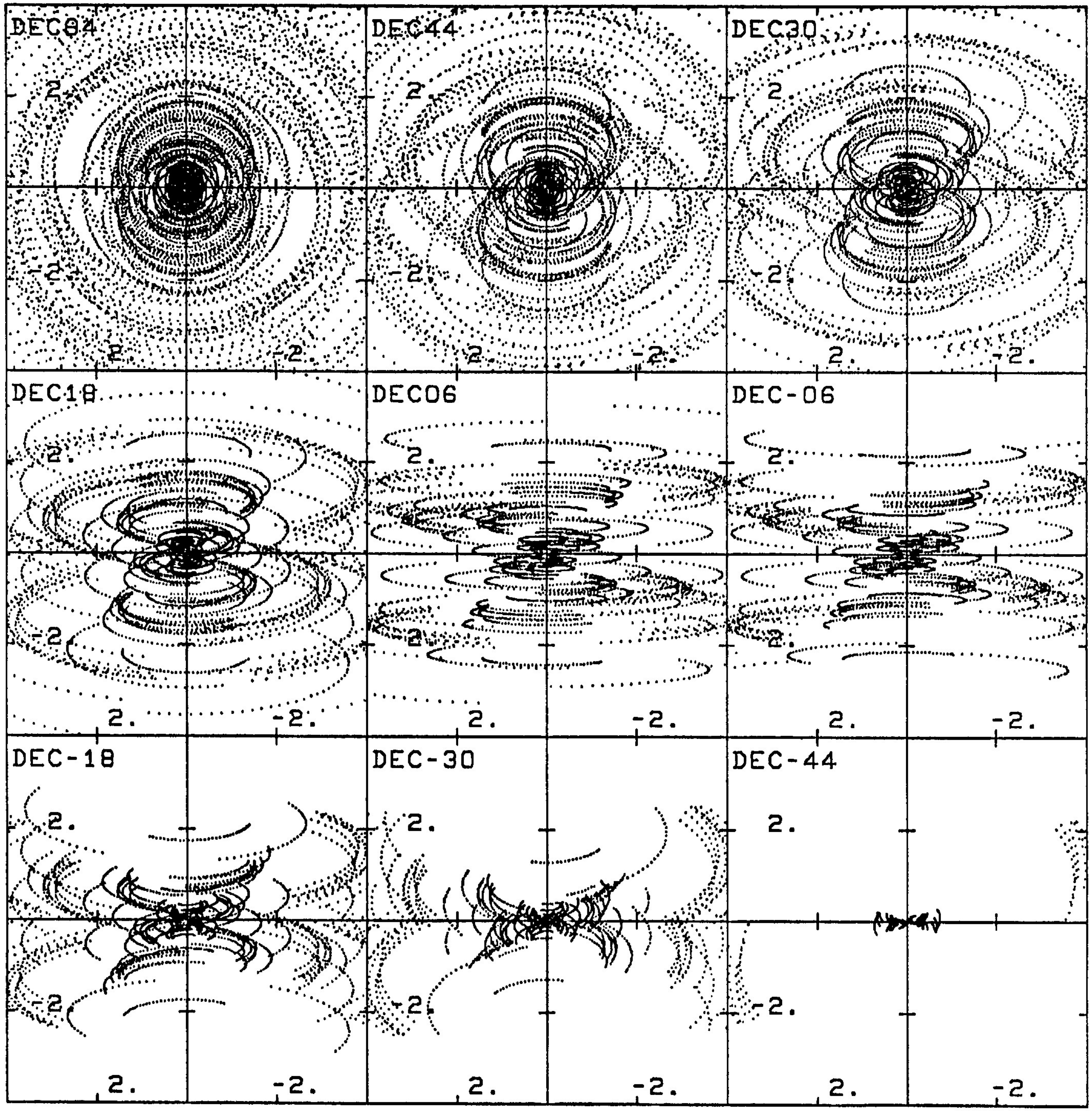


Figure 2b

| | | |
|---|---|---|
| MAUI | 20.75 | 156.20 |
| ARECIBO | 18.34 | 66.75 |
| HSTK | 42.43 | 71.49 |
| OROVILE | 48.90 | 119.75 |
| OVRO | 37.05 | 118.28 |
| IOWA | 41.58 | 91.57 |
| FDVSNEW | 30.47 | 103.95 |
| KITT | 31.96 | 111.60 |
| BERNAL | 35.40 | 105.30 |
| VLAE3 | 33.30 | 107.70 |
| VLAE4 | 34.30 | 108.30 |
| VLAE5 | 34.38 | 106.95 |
| ROSWELL | 33.40 | 104.55 |

Scale in km
( kilometers x $10^2$)

2000 km

13 Stations

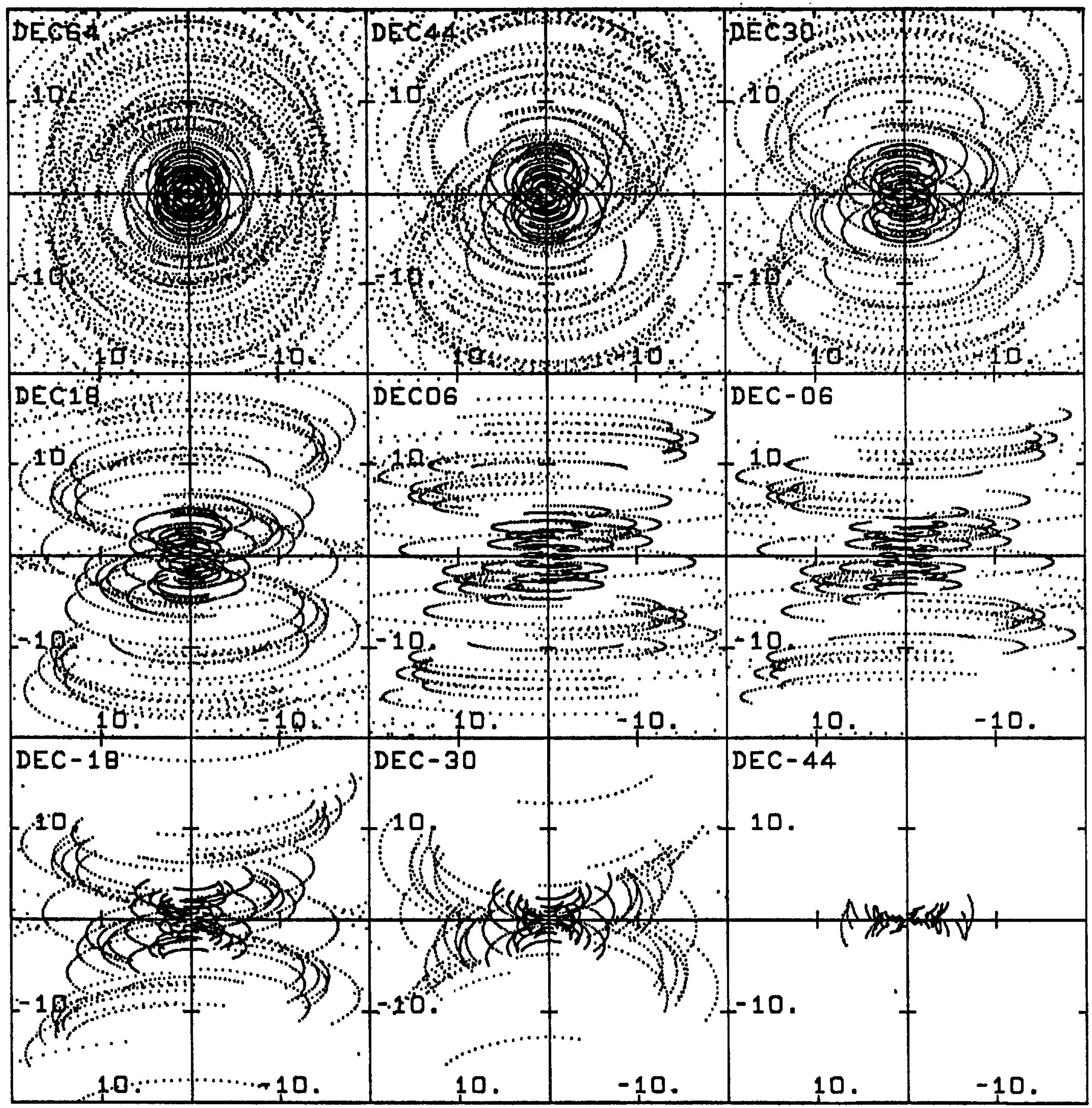


Figure 2c

| | | |
|---|---|---|
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| ARECIBO | 18.34 | 66.75 |
| HSTK | 42.43 | 71.49 |
| OROVILE | 48.90 | 119.75 |
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| KITT | 31.96 | 111.60 |
| BERNAL | 35.40 | 105.30 |
| VLAE3 | 33.30 | 107.70 |
| VLAE4 | 34.30 | 108.30 |
| VLAE5 | 34.38 | 106.95 |
| ROSWELL | 33.40 | 104.55 |
| AN9 | 34.24 | 107.63 |
| AW9 | 33.97 | 107.81 |
| AE9 | 34.00 | 107.41 |
| AW3 | 34.06 | 107.64 |

Scale in km
( kilometers x $10^2$)

1000 km

13 Stations + 4 VLA

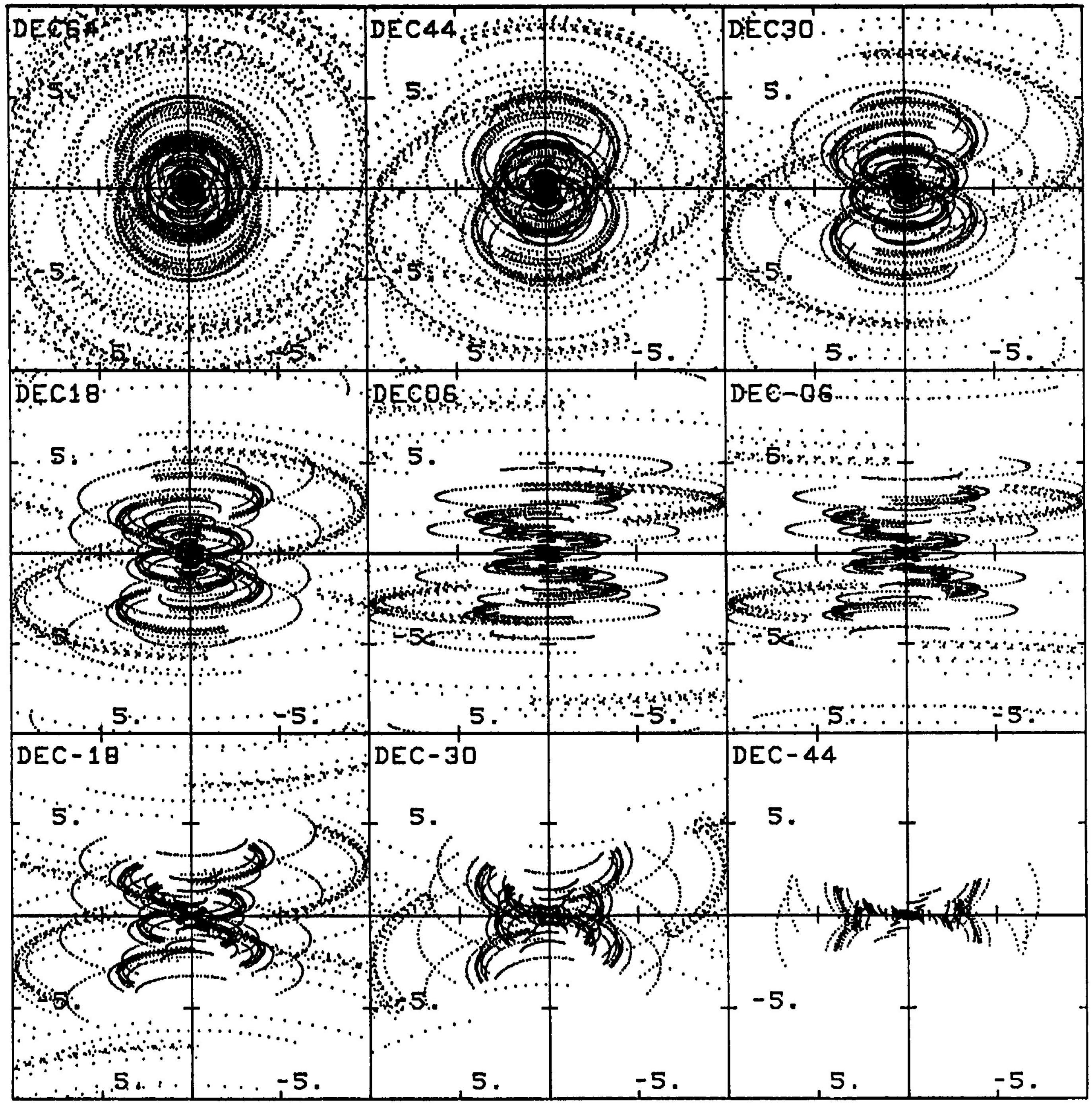


Figure 2d

| | | |
|---|---|---|
| MAUI | 20.75 | 156.20 |
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| KITT | 31.96 | 111.60 |
| BERNAL | 35.40 | 105.30 |
| VLAE3 | 33.30 | 107.70 |
| VLAE4 | 34.30 | 108.30 |
| VLAE5 | 34.38 | 106.95 |
| ROSWELL | 33.40 | 104.55 |
| AN9 | 34.24 | 107.63 |
| AW9 | 33.97 | 107.81 |
| AE9 | 34.00 | 107.41 |
| AW3 | 34.06 | 107.64 |

Scale in km
( kilometers x $10^2$)

500 km

13 Stations + 4 VLA

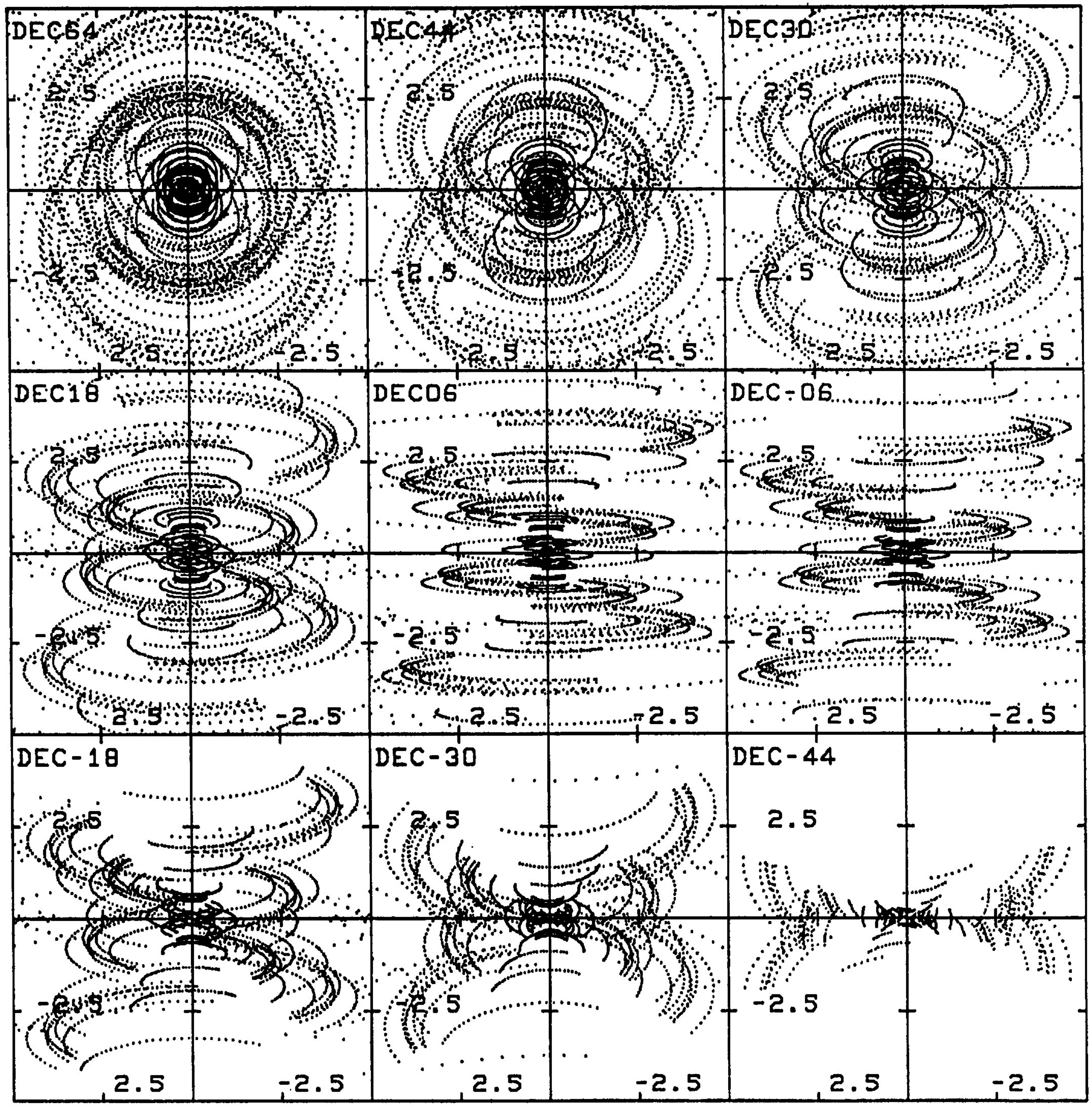


Figure 2e

| | | |
|---|---|---|
| MAUI | 20.75 | 156.20 |
| ARECIBO | 18.34 | 66.75 |
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| KITT | 31.96 | 111.60 |
| BERNAL | 35.40 | 105.30 |
| VLAE3 | 33.30 | 107.70 |
| VLAE4 | 34.30 | 108.30 |
| VLAE5 | 34.38 | 106.95 |
| ROSWELL | 33.40 | 104.55 |
| AN9 | 34.24 | 107.63 |
| AW9 | 33.97 | 107.81 |
| AE9 | 34.00 | 107.41 |
| AW3 | 34.06 | 107.64 |

Scale in km
( kilometers x $10^1$)

200 km

13 Stations + 4 VLA

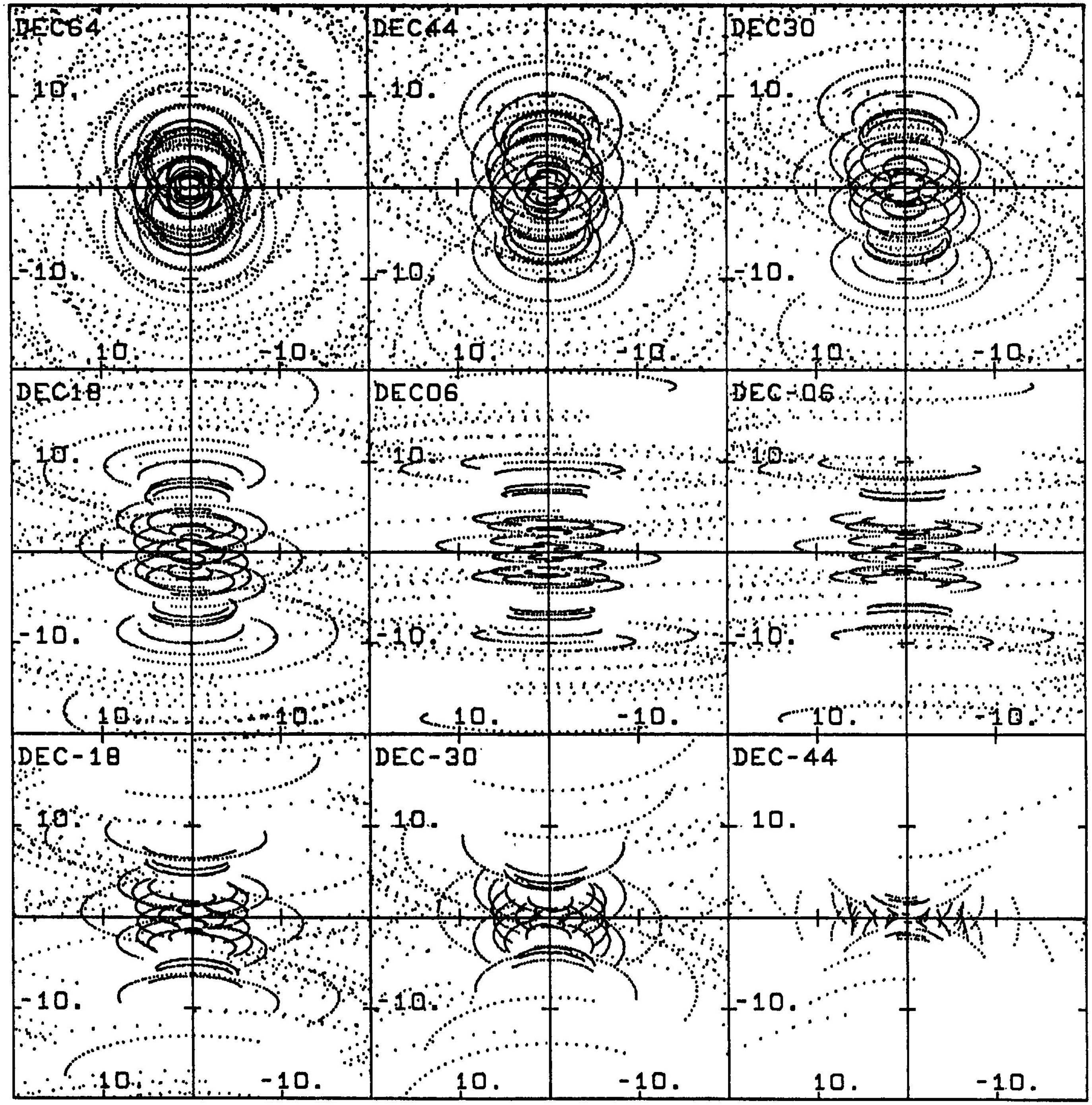


Figure 2f.

| | | |
|---|---|---|
| MAUI | 20.75 | 156.20 |
| ARECIBO | 18.34 | 66.75 |
| HSTK | 42.43 | 71.49 |
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| OROVILE | 48.90 | 119.75 |
| VLAE3 | 33.30 | 107.70 |
| KITT | 31.96 | 111.60 |
| FDVSNEW | 30.47 | 103.95 |
| BERNAL | 35.40 | 105.30 |
| ROSWELL | 33.40 | 104.55 |

Scale in km
( kilometers x $10^3$)

Includes Roswell
No OVRO

8000 km

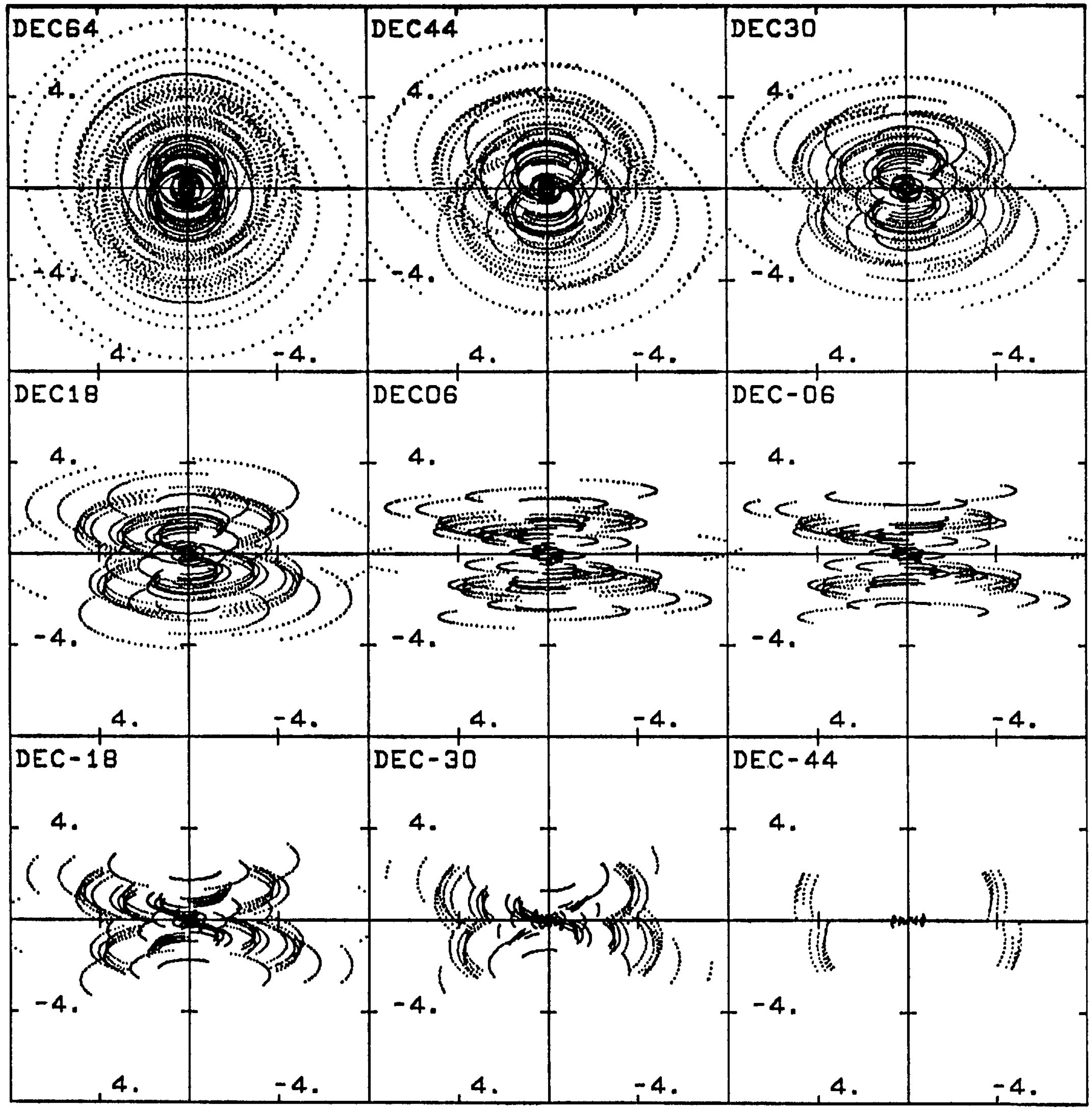


Figure 3

| | | |
|---|---|---|
| MAUI | 20.75 | 156.20 |
| ARECIBO | 18.34 | 66.75 |
| HSTK | 42.43 | 71.49 |
| IOWA | 41.58 | 91.57 |
| OVRO | 37.05 | 118.28 |
| OROVILE | 48.90 | 119.75 |
| VLAE3 | 33.30 | 107.70 |
| KITT | 31.96 | 111.60 |
| FDVSNEW | 30.47 | 103.95 |
| BERNAL | 35.40 | 105.30 |
| ROSWELL | 33.40 | 104.55 |
| AN9 | 34.24 | 107.63 |
| AW9 | 33.97 | 107.81 |
| AE9 | 34.00 | 107.41 |
| AE3 | 34.07 | 107.59 |

Scale in km
( kilometers x $10^2$)

1000 km

11 Stations + 4 VLA

M83 + Roswell

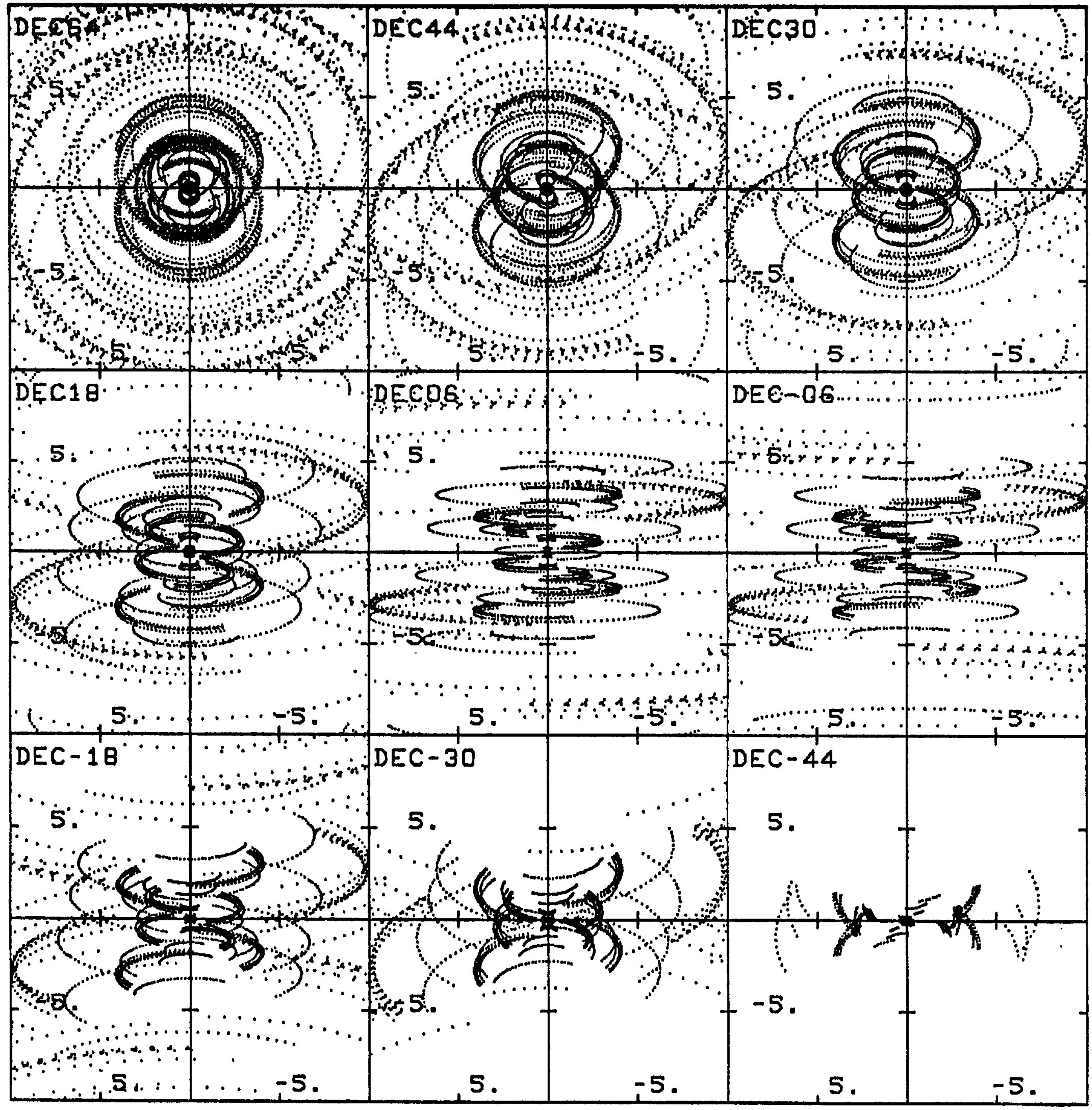


Figure 4

| | | |
|---|---|---|
| MAUI | 20.75 | 156.20 |
| ARECIBO | 18.34 | 66.75 |
| HSTK | 42.43 | 71.49 |
| IOWA | 41.58 | 91.57 |
| OVRO | 37.05 | 118.28 |
| OROVILE | 48.90 | 119.75 |
| VLAE3 | 33.30 | 107.70 |
| KITT | 31.96 | 111.60 |
| FDVSNEW | 30.47 | 103.95 |
| BERNAL | 35.40 | 105.30 |
| QUITO | -0.20 | 77.00 |

Scale in km
( kilometers x $10^3$)

8000 km

M83 + Quito

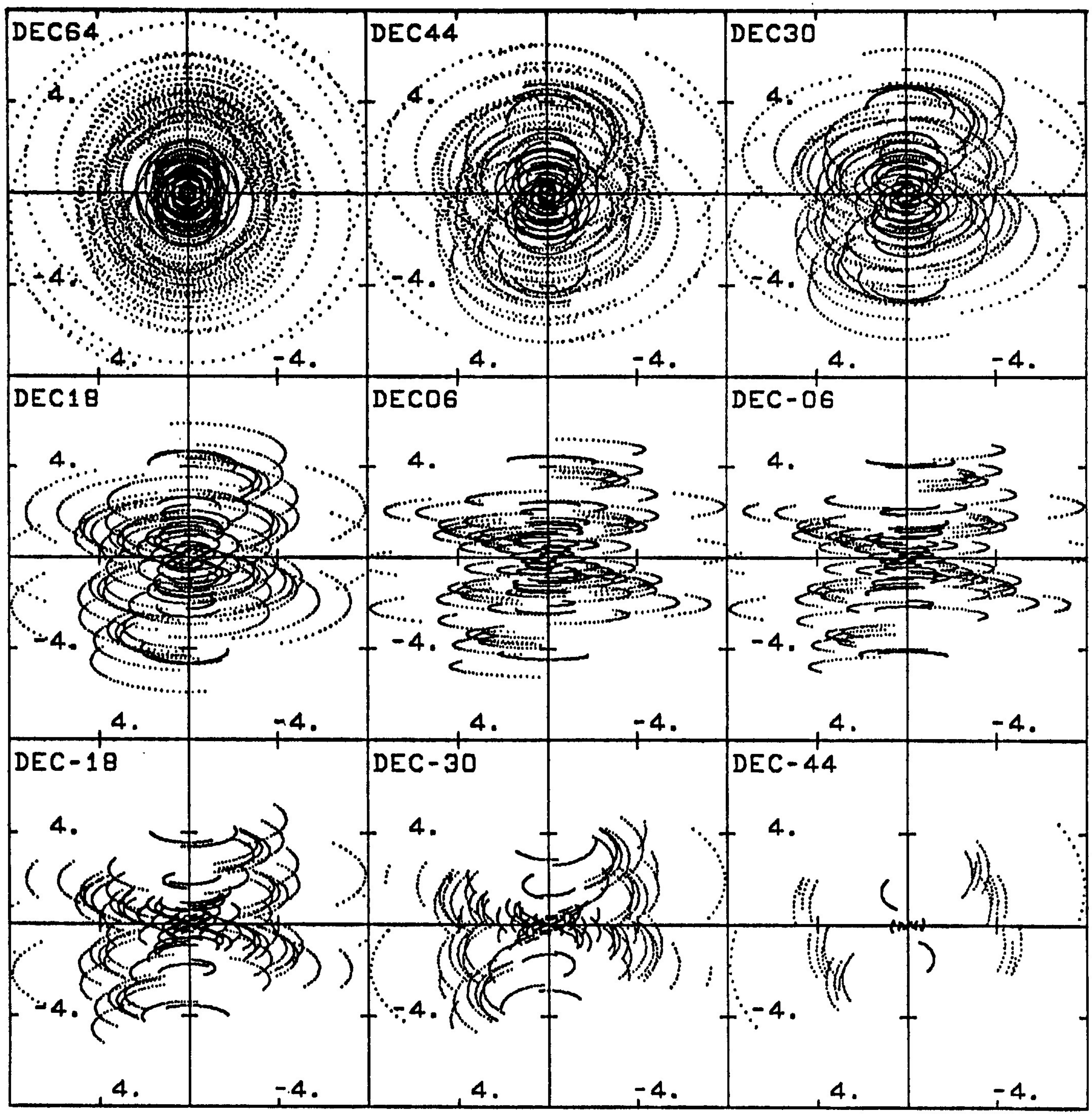


Figure 5

| | | |
|---|---|---|
| MAUI | 20.75 | 156.20 |
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| IOWA | 41.58 | 91.57 |
| OVRO | 37.05 | 118.28 |
| OROVILE | 48.90 | 119.75 |
| VLAE3 | 33.30 | 107.70 |
| KITT | 31.96 | 111.60 |
| FDVSNEW | 30.47 | 103.95 |
| BERNAL | 35.40 | 105.30 |

Scale in km
( kilometers x $10^3$)

8000 km

M83

NO Puerto Rico

9 Stations

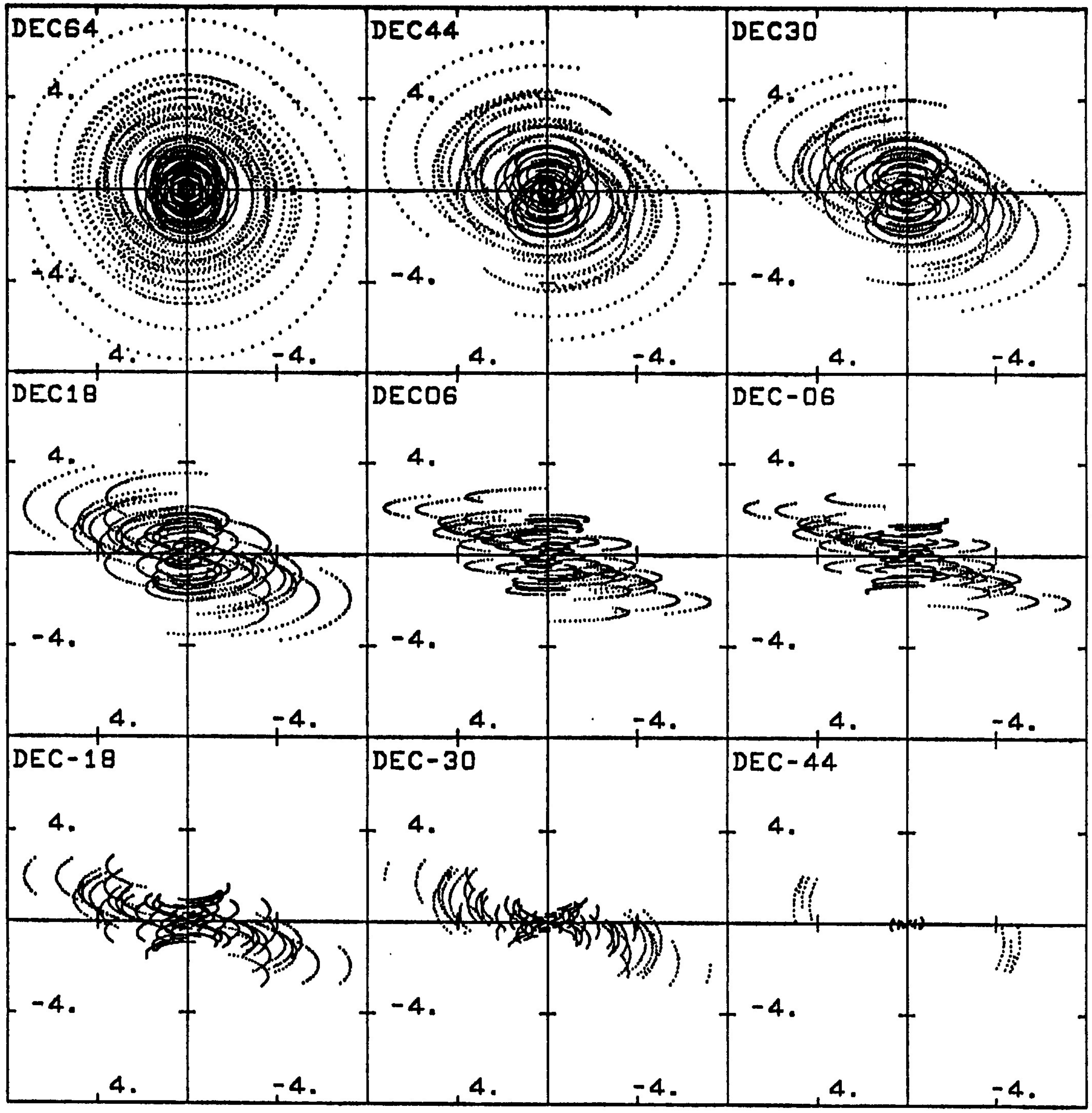


Figure 6

| | | |
|---|---|---|
| MAUI | 20.75 | 156.20 |
| ARECIBO | 18.34 | 66.75 |
| HSTK | 42.43 | 71.49 |
| ILLN | 40.06 | 87.57 |
| OVRO | 37.05 | 118.28 |
| OROVILE | 48.90 | 119.75 |
| VLAE3 | 33.30 | 107.70 |
| KITT | 31.96 | 111.60 |
| FDVSNEW | 30.47 | 103.95 |
| BERNAL | 35.40 | 105.30 |

Scale in km
( kilometers x $10^3$ )

4000 km

M83

IOWA → ILLN

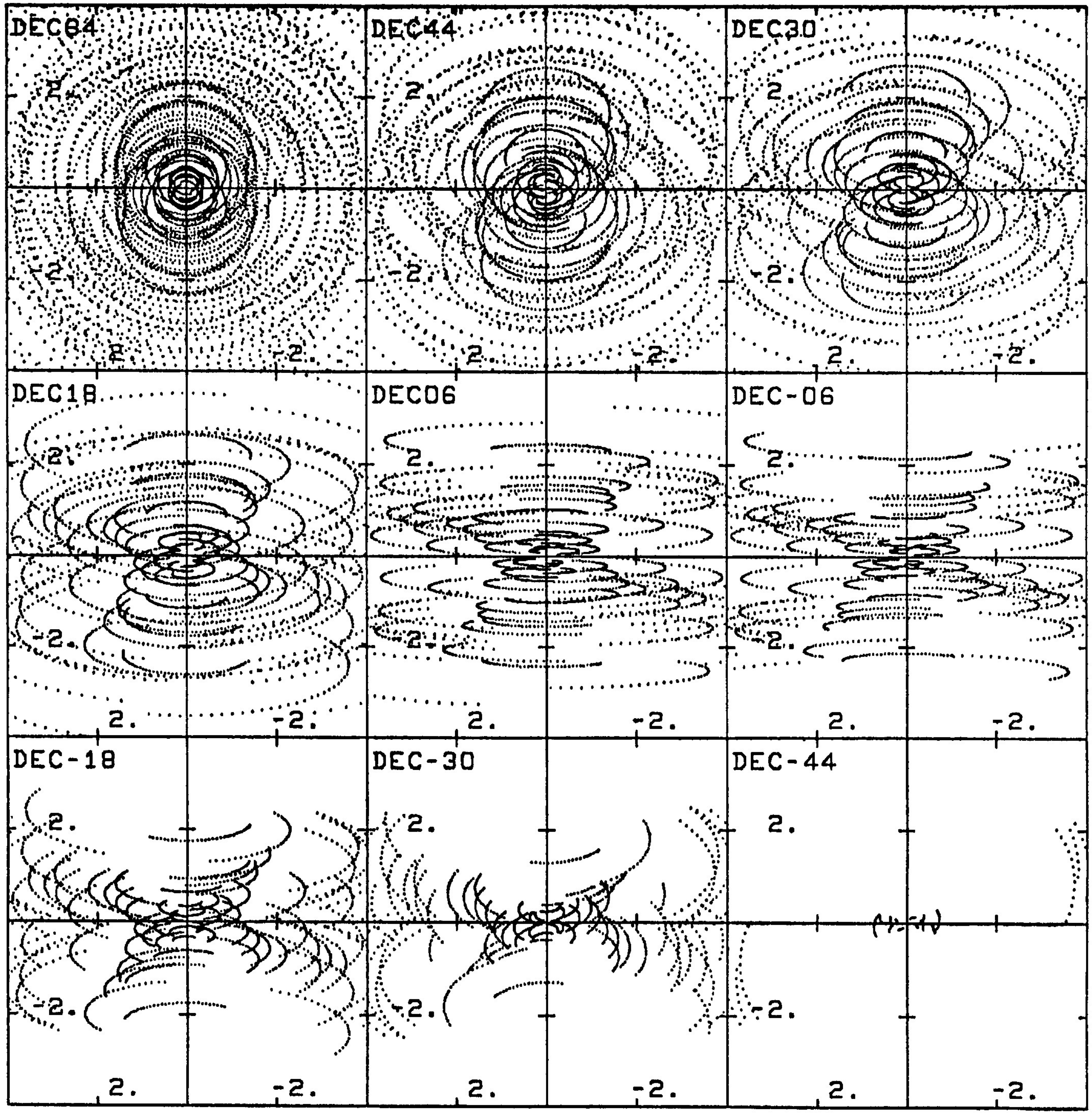


Figure 7