

**APPENDIX N:
WIND ANALYSES**

Appendix N: Wind Analyses

The National Park Service Air Resources Division provided hourly local surface wind data for four of the study sites: Acadia National Park, Great Smoky Mountains National Park, Mammoth Cave National Park, and Shenandoah National Park. This data, when combined with the source apportionment output, can be used to help identify source types/direction. (See Figures 5.5.1 through 5.5.8 for maps of the sites.)

The analyses in this section start by identifying the days with the 10 percent highest source strengths for each of the sources identified with either PMF or UNMIX at the four sites. The plots, shown below, summarize the wind directions with respect to those days. Specifically, they show the probability of a high source day, in the top 10 percent for the source, given that the wind is blowing from a particular direction. The directions are divided into 12 reference direction groups: 0° to 30° , 30° to 60° , The distance from the origin in each case is the number of hours during high source days that the wind was from the particular direction divided by the total number of hourly measurements with a wind direction in that group. If the wind direction has no association with high source days, then the observed ratio should be about 10 percent. Hence, in each plot there is a 10 percent reference circle. Also, for each reference direction group, a “+” located radially outward from the wedge indicates that the probability estimate is significantly larger than 10 percent. These directions indicate likely directions toward a source.

The directional range of the significant source directions are summarized in Tables N-1 through N-8 and are repeated in Tables 5.4.1 and 5.4.2. In addition, there is a general classification of the source type for each solution. These were defined as follows:

- Area - A source was called an area source if the conditional probabilities ranged from 5 percent to 17.5 percent.
- Regional - A source was called a regional source if at least 2 of the conditional probabilities were less than 7.5 percent and at least 4 were greater than 9 percent.
- Point - The source was considered a (single) point source if at least 5 of the conditional probabilities were less than 7.5 percent, 1 to 3 of the directions were significantly larger than 10 percent and these were in a contiguous range.
- Multi Point - A source was called a multi-point source if at least 3 of the conditional probabilities were less than 7.5 percent, and there were at least 2, non-contiguous directions that were significantly greater than 10 percent.

These classifications do not necessarily cover all possibilities and in many cases overlap. The distance from the source to the receptor certainly influences the classifications. For example, a regional source should appear as a point source from a long distance and as an area source if the receptor is within the boundaries of the source. The tables also note any case where the source strengths from one tool correlate highly with the source strengths from the other tool. (See Appendix M.)

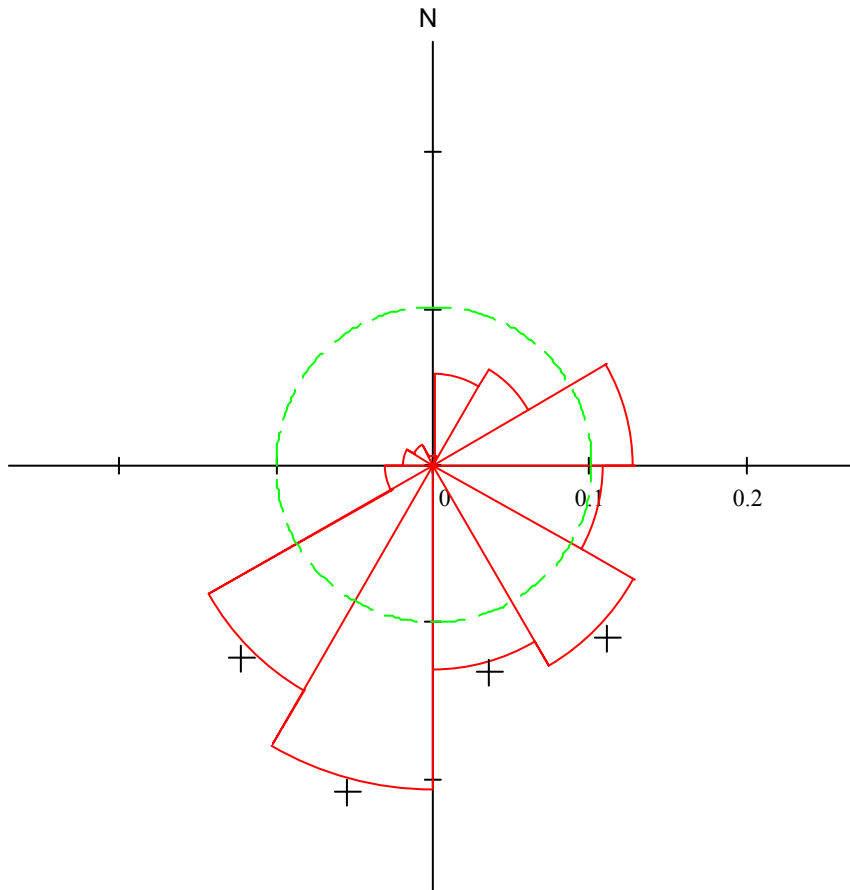


Figure N-1. The probability of a high source day (top 10 percent) given the hourly wind direction for UNMIX source 1 at Acadia National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

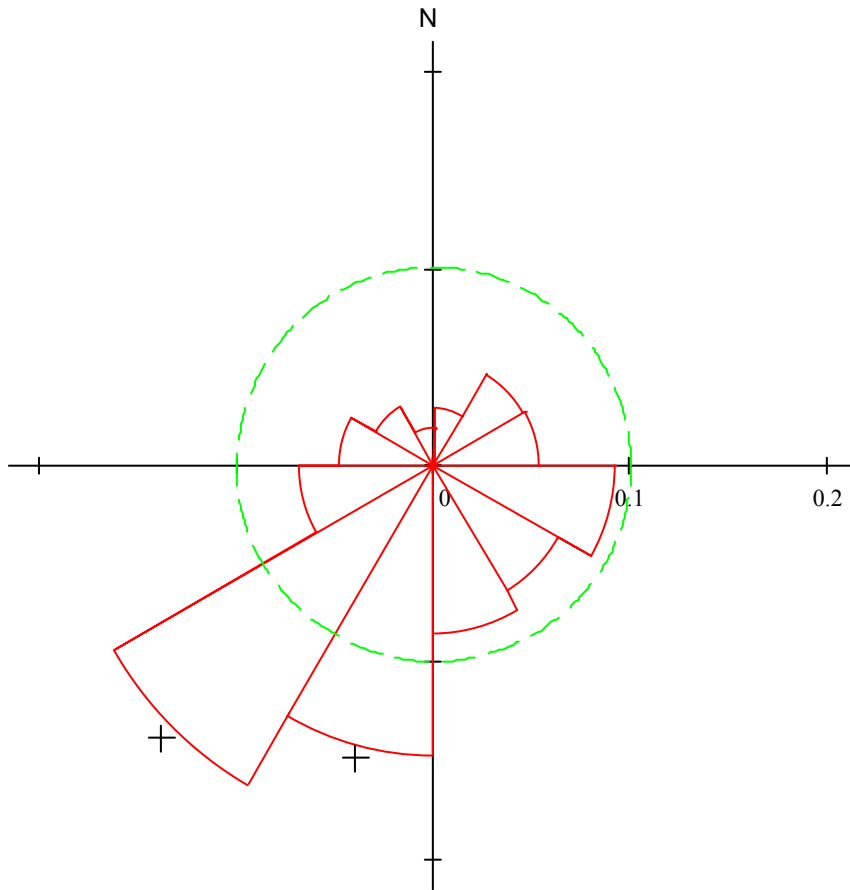


Figure N-2. The probability of a high source day (top 10 percent) given the hourly wind direction for UNMIX source 2 at Acadia National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

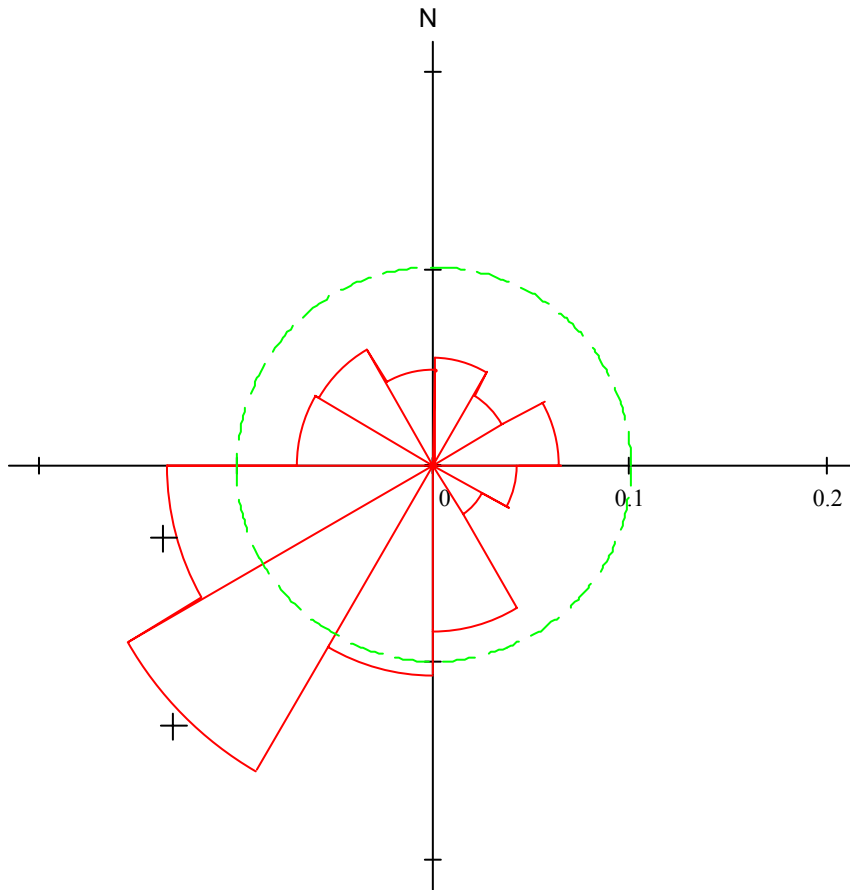


Figure N-3. The probability of a high source day (top 10 percent) given the hourly wind direction for UNMIX source 3 at Acadia National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

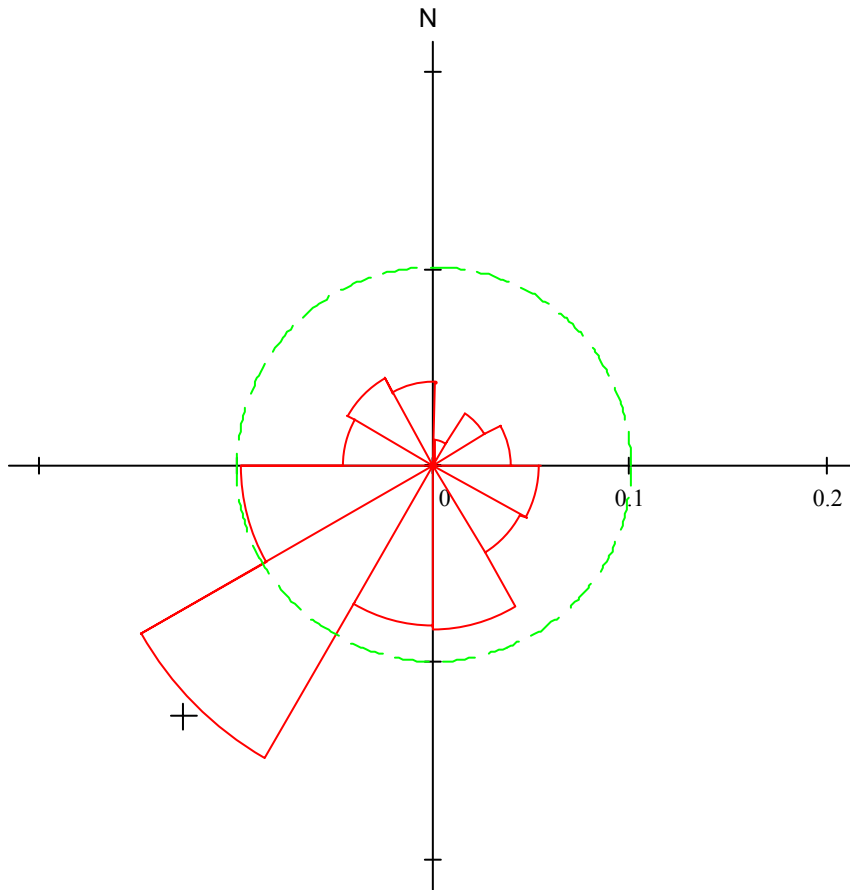


Figure N-4. The probability of a high source day (top 10 percent) given the hourly wind direction for UNMIX source 4 at Acadia National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

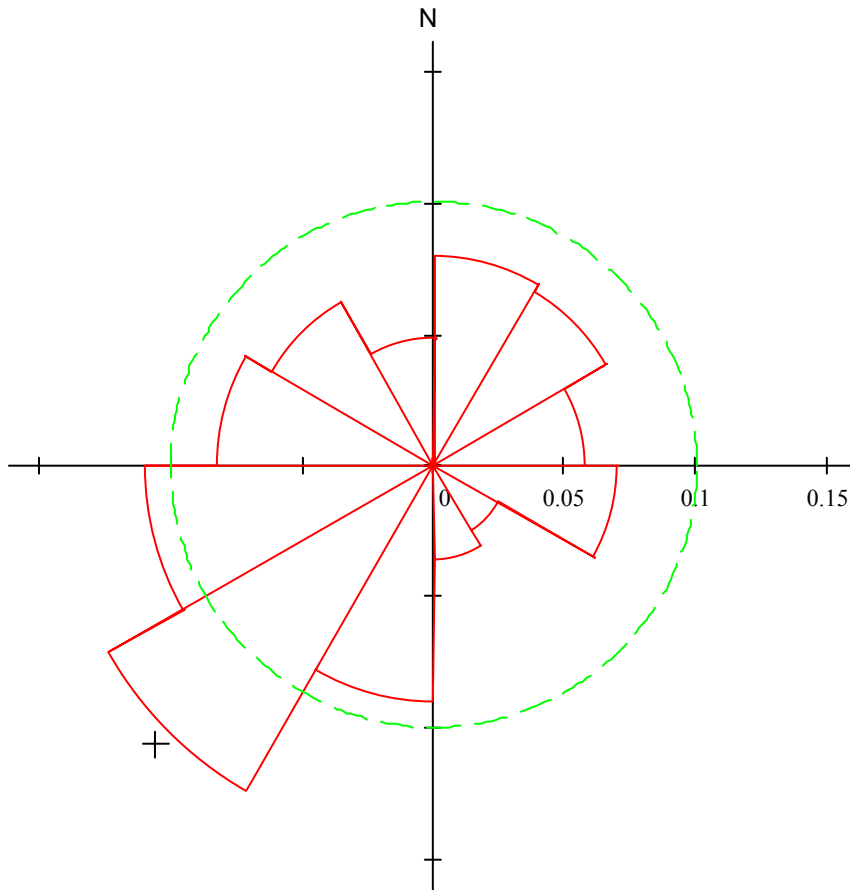


Figure N-5. The probability of a high source day (top 10 percent) given the hourly wind direction for UNMIX source 5 at Acadia National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

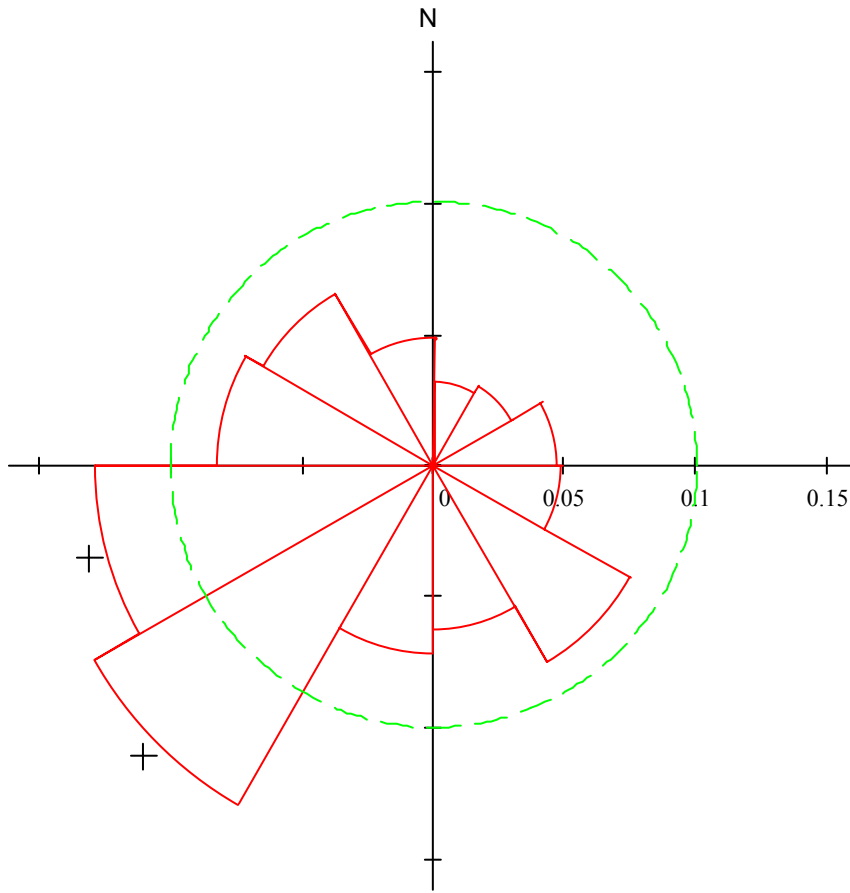


Figure N-6. The probability of a high source day (top 10 percent) given the hourly wind direction for UNMIX source 6 at Acadia National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

Table N-1. Summary of source type and direction for UNMIX at Acadia National Park

Source number	Directional range (degrees to the east of north)	Source type	Comments
1	120-240	Regional	Sea Spray, PMF 3
2	180-240	Point	
3	210-270	Point	PMF 6
4	210-240	Point	PMF 2
5	210-240	Point	PMF 8
6	210-270	Point	PMF 4

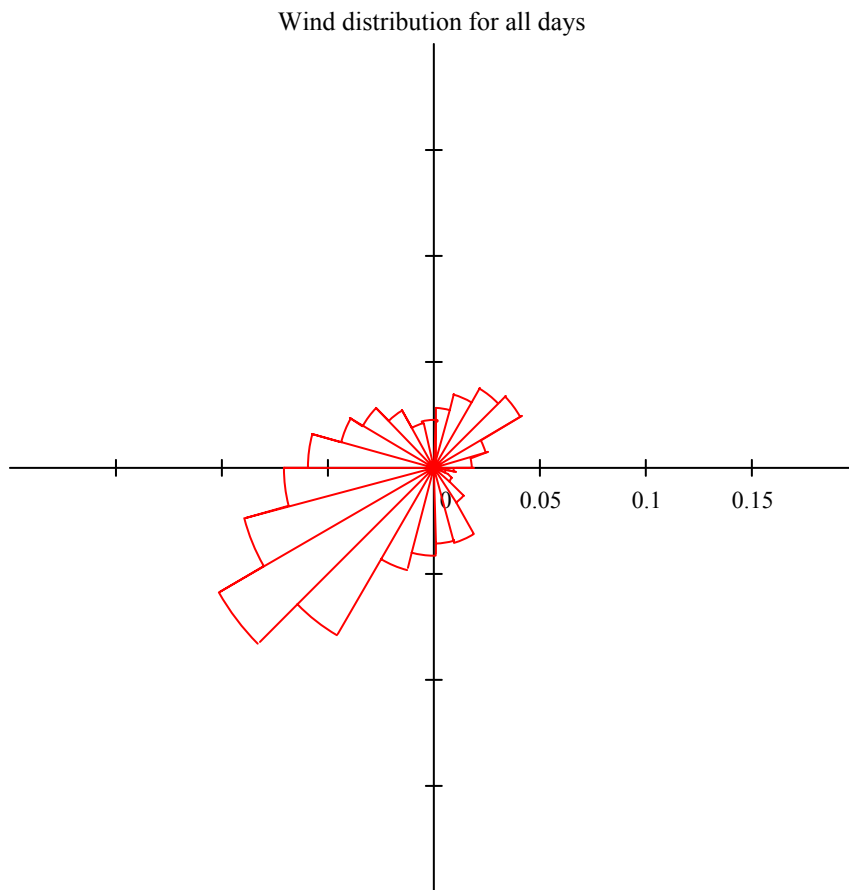


Figure N-7. The distribution of the wind directions at Acadia National Park

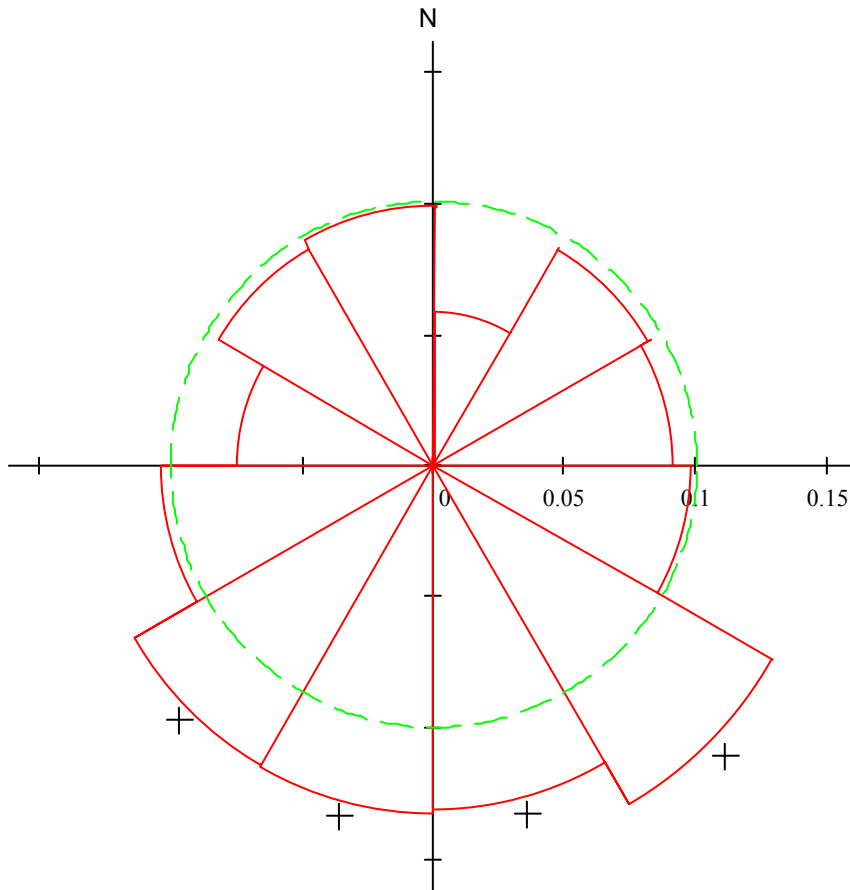


Figure N-8. The probability of a high source day (top 10 percent) given the hourly wind direction for UNMIX source 1 at Great Smoky Mountains National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

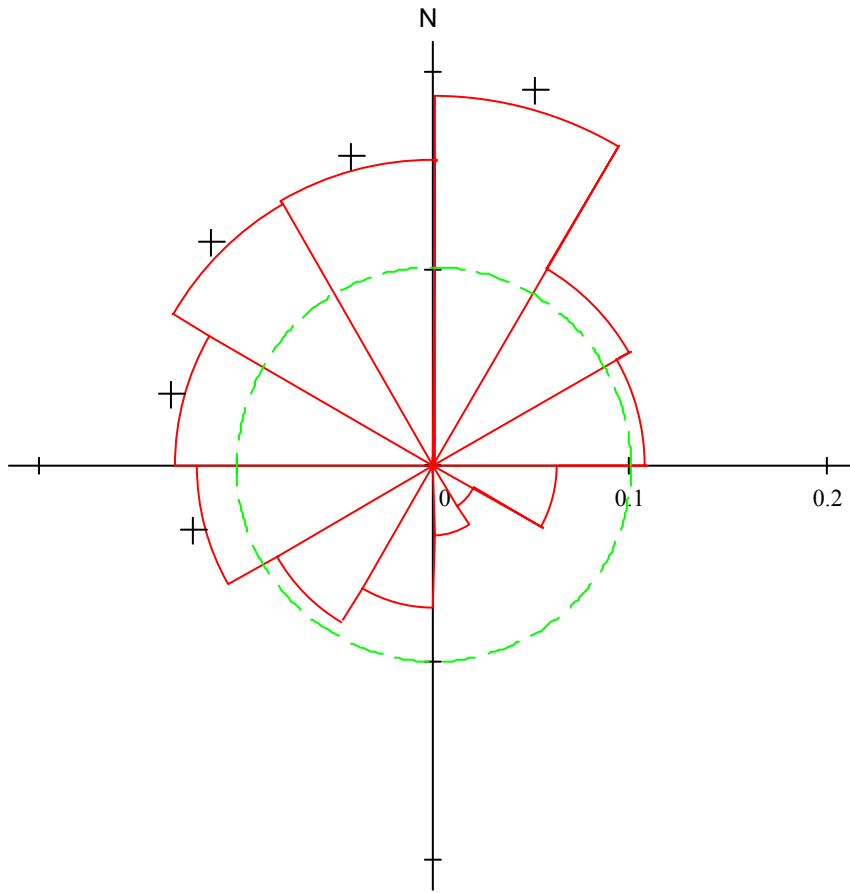


Figure N-9. The probability of a high source day (top 10 percent) given the hourly wind direction for UNMIX source 2 at Great Smoky Mountains National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

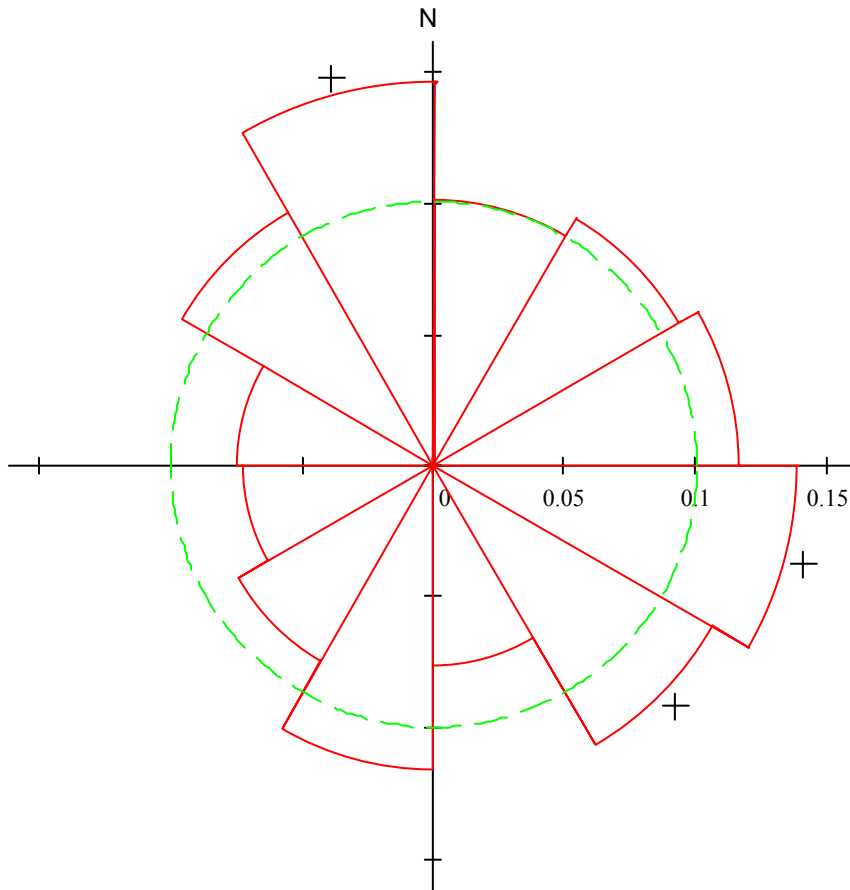


Figure N-10. The probability of a high source day (top 10 percent) given the hourly wind direction for UNMIX source 3 at Great Smoky Mountains National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

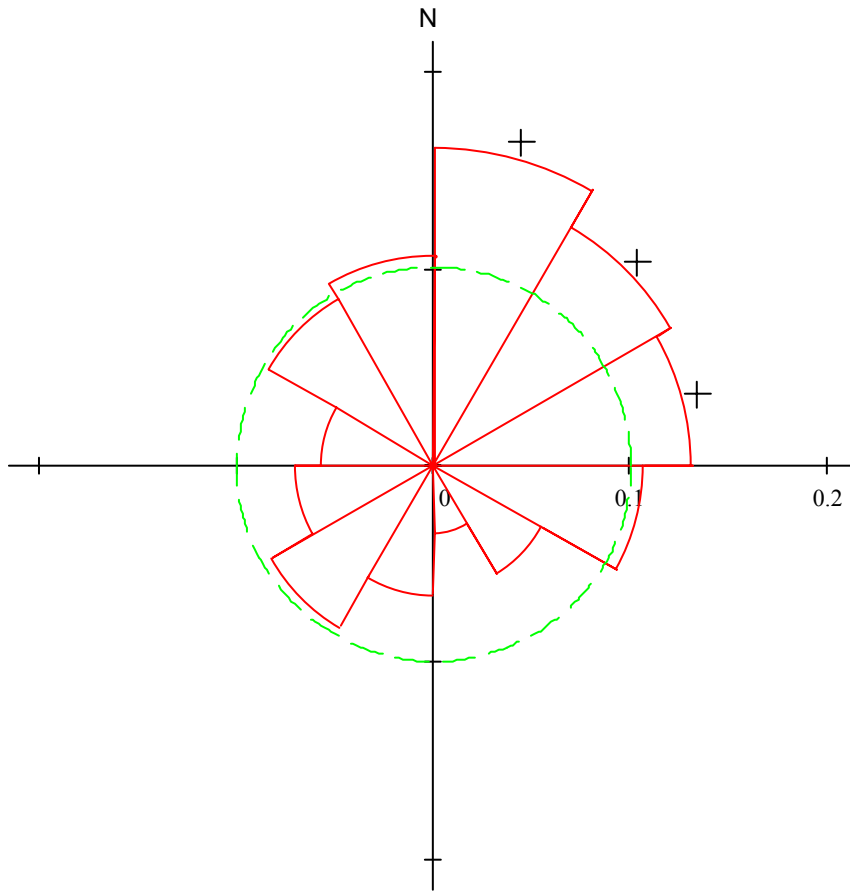


Figure N-11. The probability of a high source day (top 10 percent) given the hourly wind direction for UNMIX source 4 at Great Smoky Mountains National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

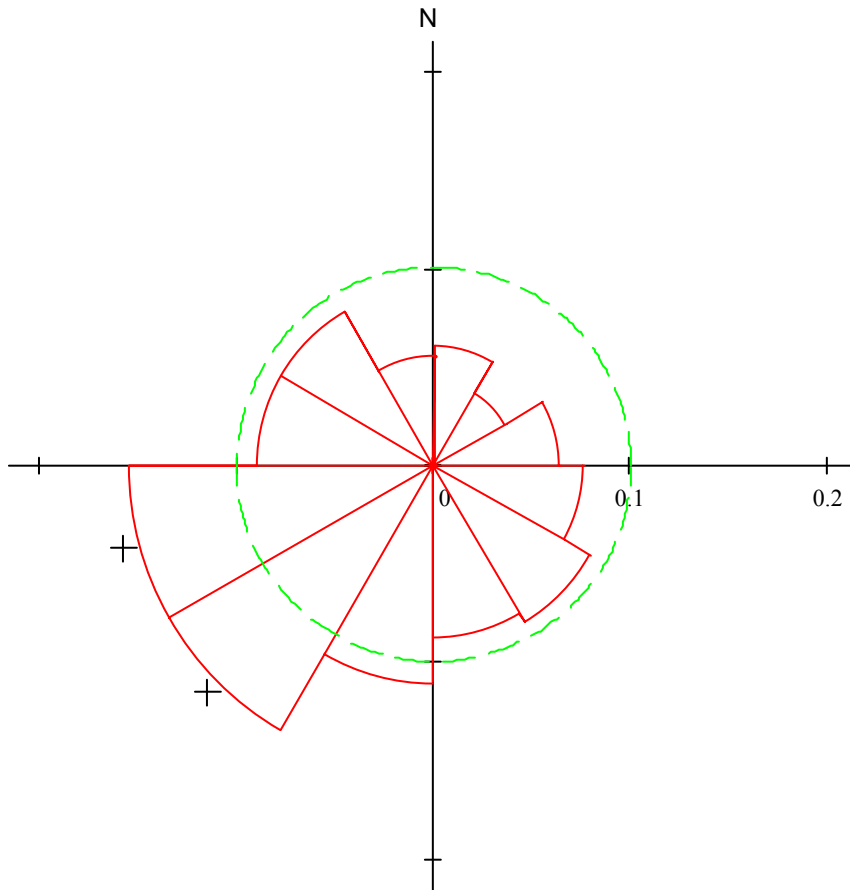


Figure N-12. The probability of a high source day (top 10 percent) given the hourly wind direction for UNMIX source 5 at Great Smoky Mountains National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

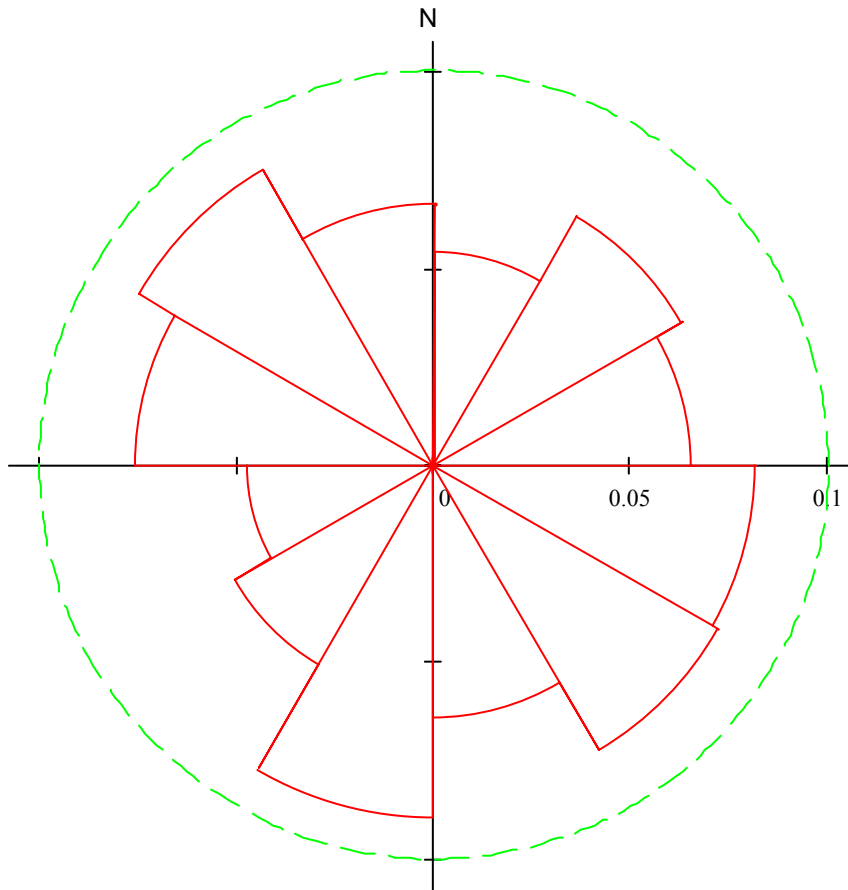


Figure N-13. The probability of a high source day (top 10 percent) given the hourly wind direction for UNMIX source 6 at Great Smoky Mountains National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

Table N-2. Summary of source type and direction for UNMIX at Great Smoky Mountains National Park

Source number	Directional range (degrees to the east of north)	Source type	Comments
1	120-240	Area	PMF 7
2	240-360, 0-30	Regional	
3	90-150, 330-360	Area	
4	0-90	Regional /Point	PMF 8
5	210-270	Regional	PMF 5
6	-	-	PMF 4

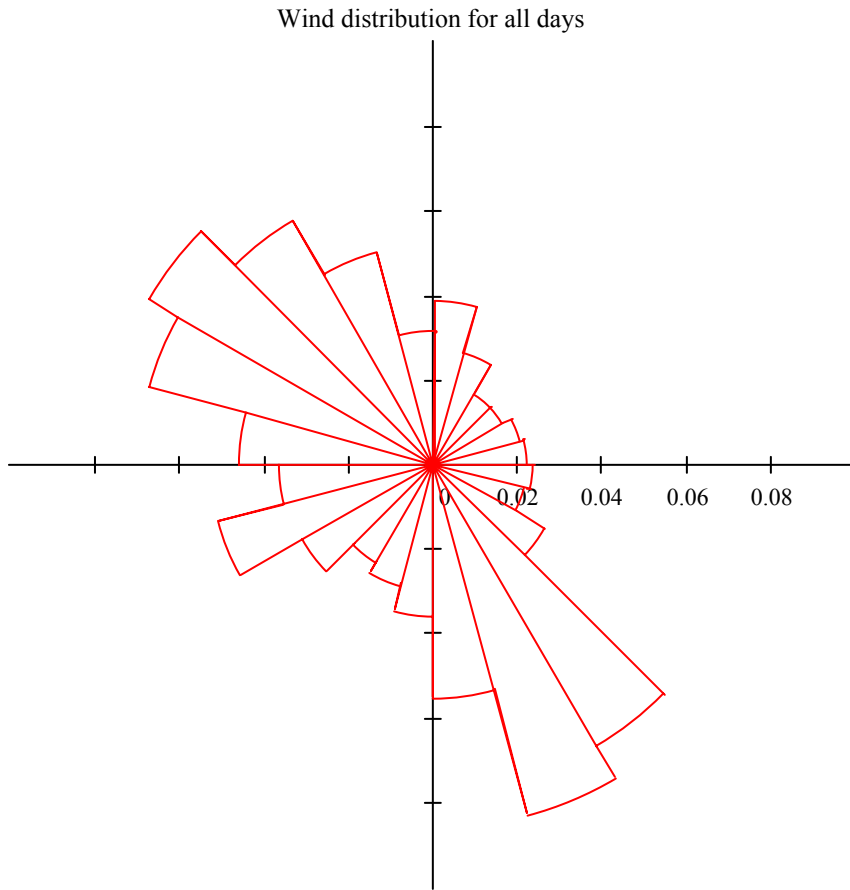


Figure N-14. The distribution of the wind directions at Great Smoky Mountains National Park

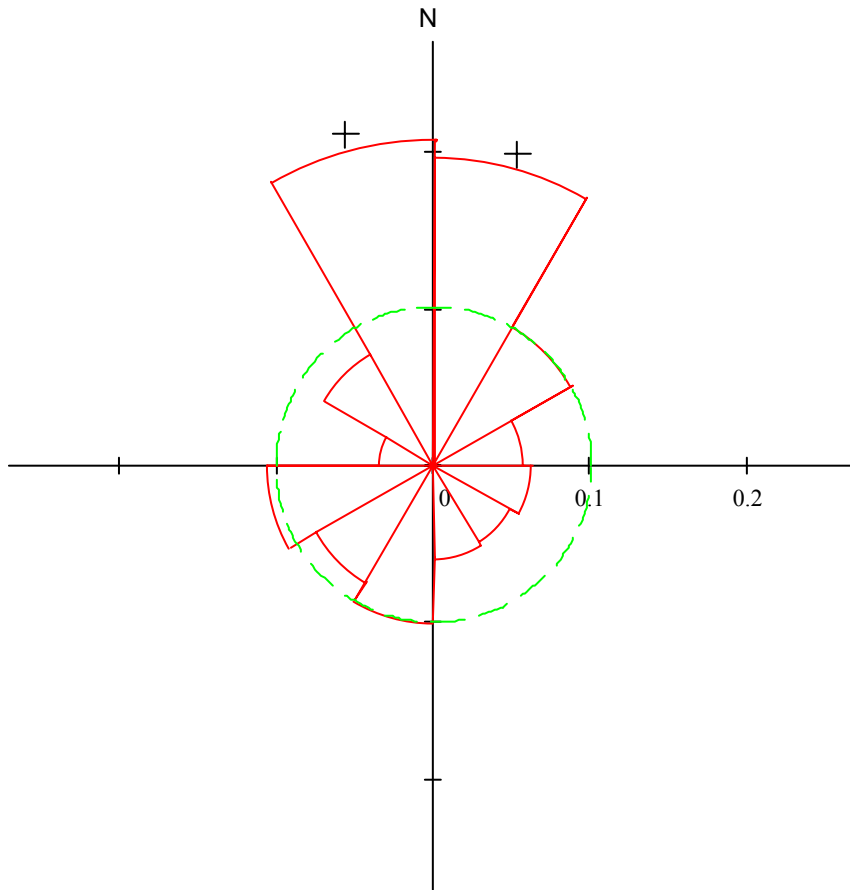


Figure N-15. The probability of a high source day (top 10 percent) given the hourly wind direction for UNMIX source 1 at Mammoth Cave National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

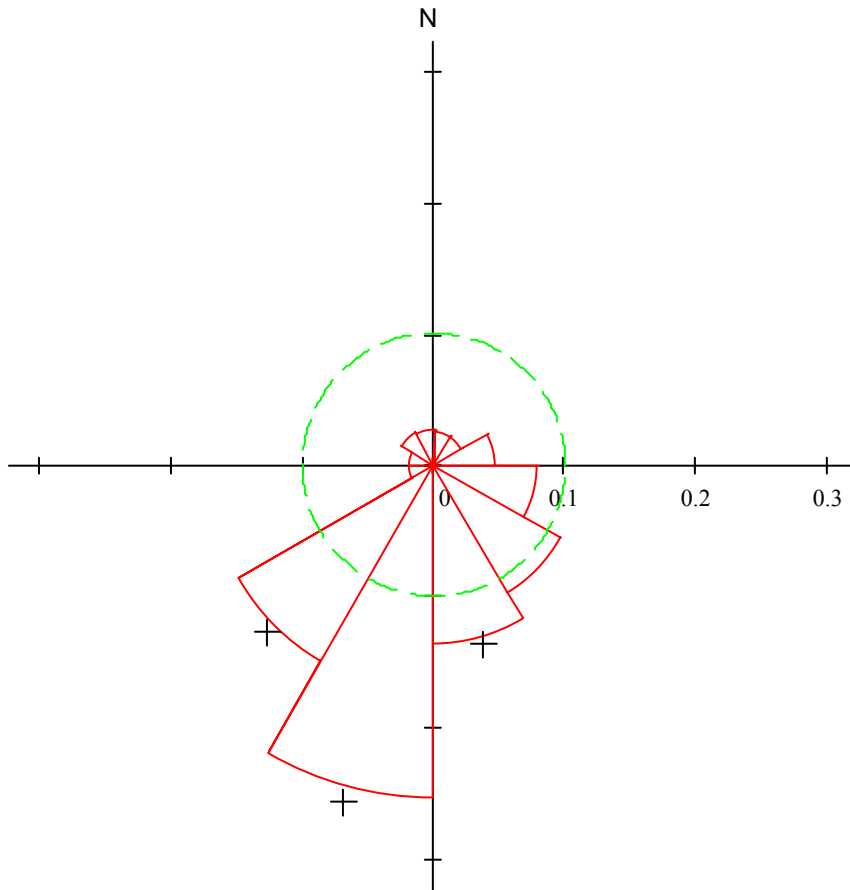


Figure N-16. The probability of a high source day (top 10 percent) given the hourly wind direction for UNMIX source 2 at Mammoth Cave National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

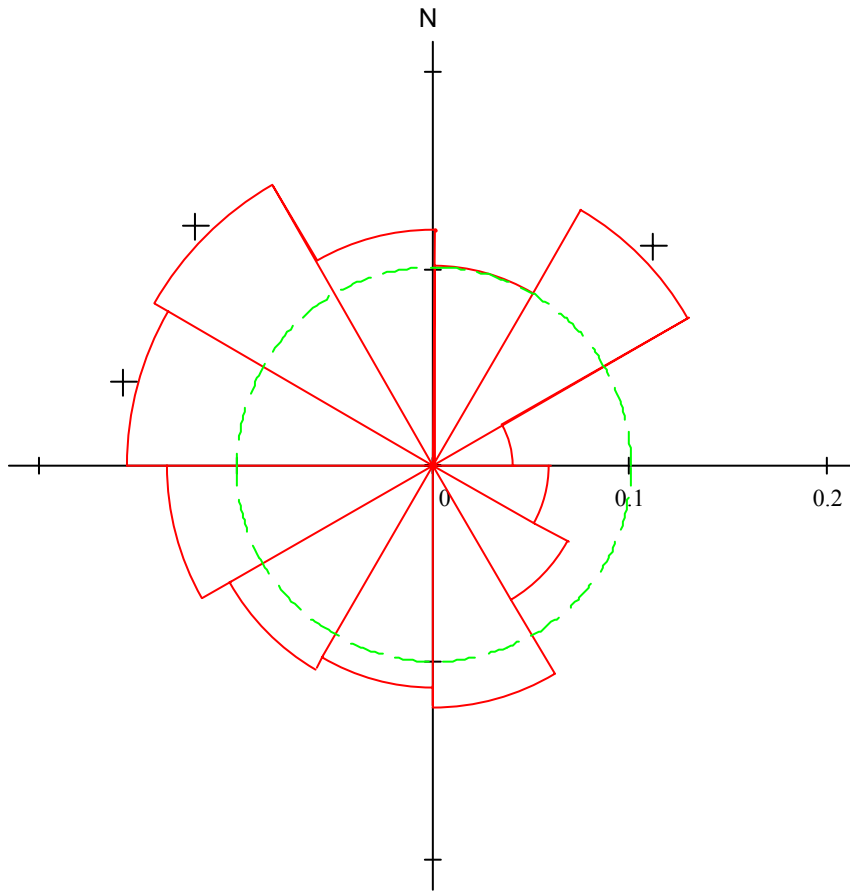


Figure N-17. The probability of a high source day (top 10 percent) given the hourly wind direction for UNMIX source 3 at Mammoth Cave National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

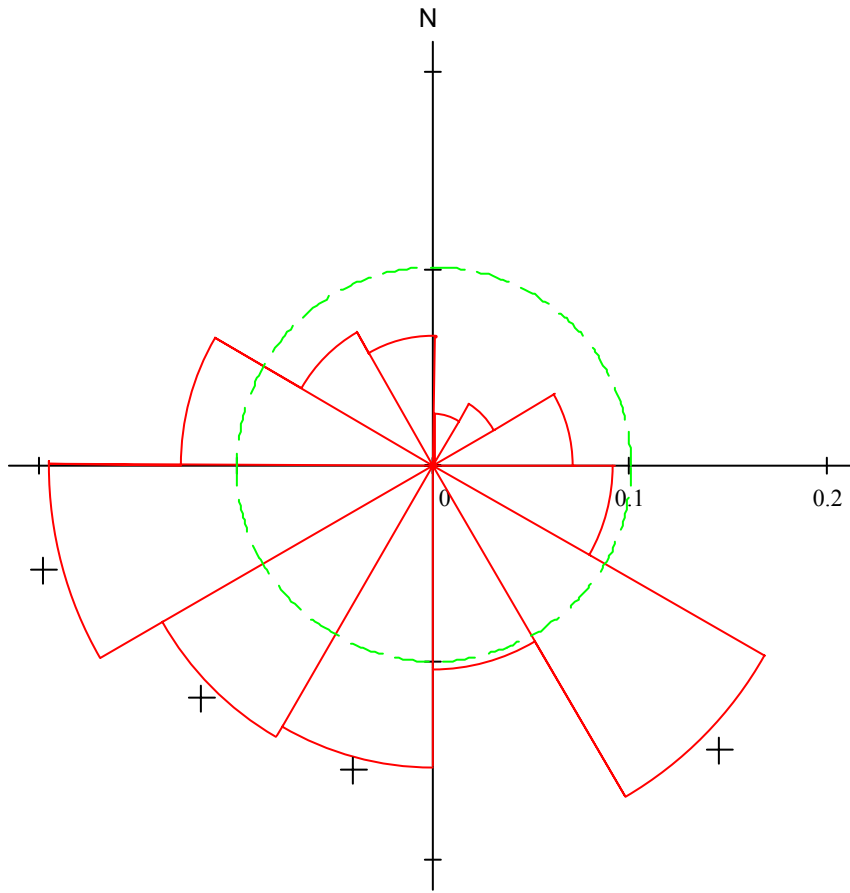


Figure N-18. The probability of a high source day (top 10 percent) given the hourly wind direction for UNMIX source 4 at Mammoth Cave National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

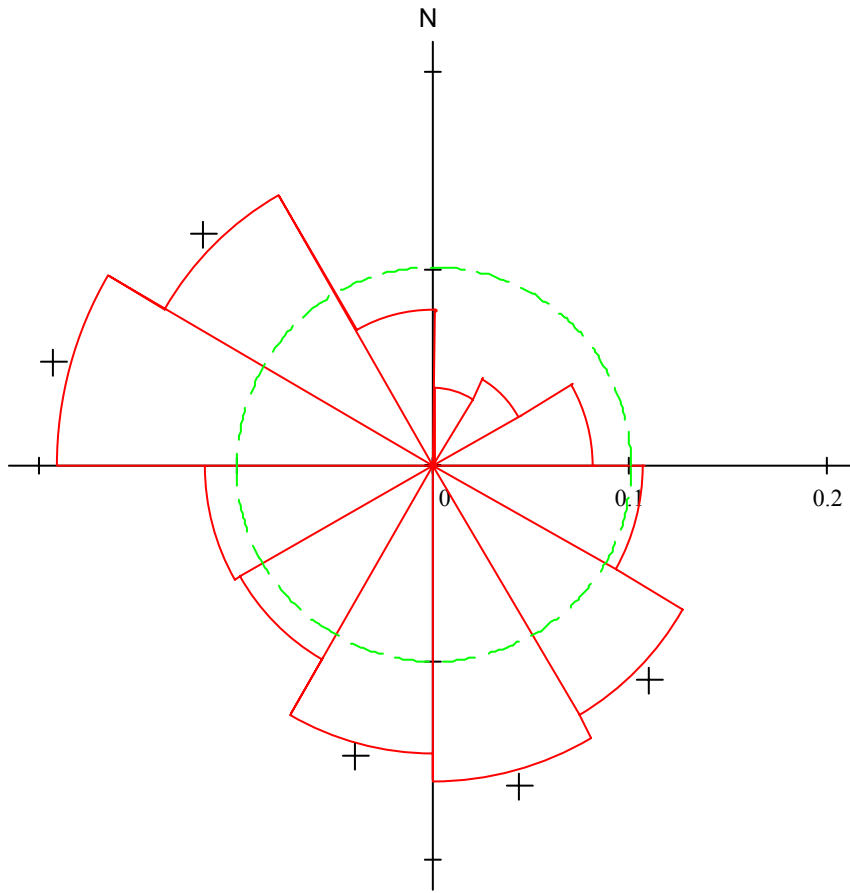


Figure N-19. The probability of a high source day (top 10 percent) given the hourly wind direction for UNMIX source 5 at Mammoth Cave National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

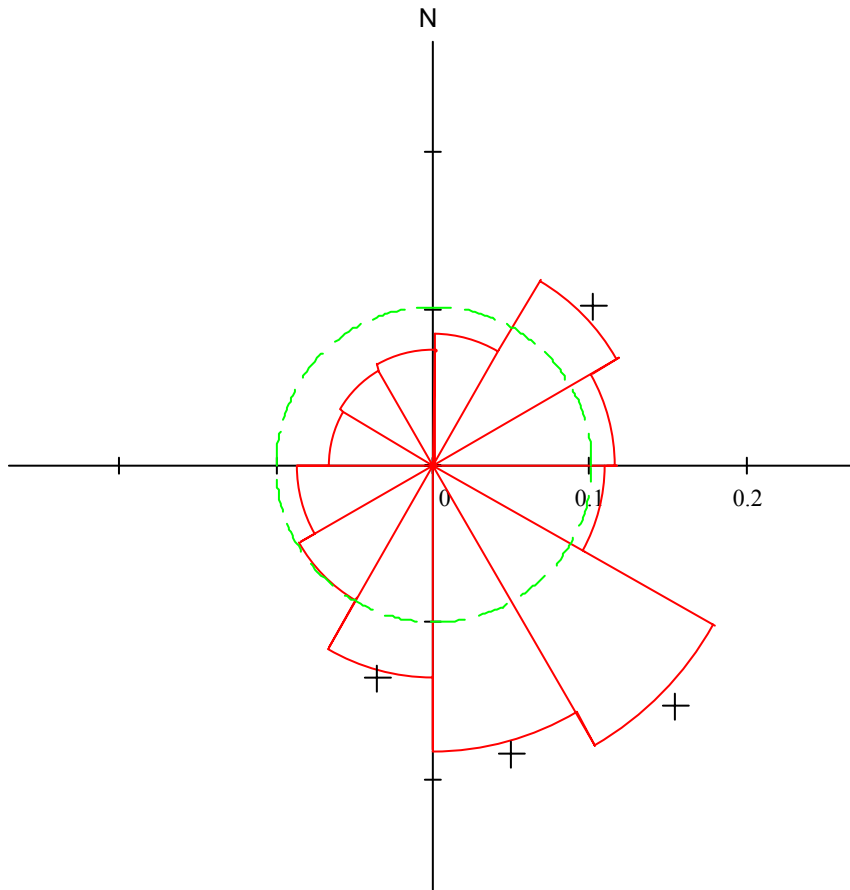


Figure N-20. The probability of a high source day (top 10 percent) given the hourly wind direction for UNMIX source 6 at Mammoth Cave National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

Table N-3. Summary of source type and direction for UNMIX at Mammoth Cave National Park

Source number	Directional range (degrees to the east of north)	Source type	Comments
1	330-360, 0-30	Regional /Point	
2	150-240	Regional /Point	
3	30-60, 270-330	-	
4	120-150, 180-270	Regional /Multi Point	PMF 1
5	120-210, 270-330	-	PMF 2
6	30-60, 120-210	Regional /Multi Point	

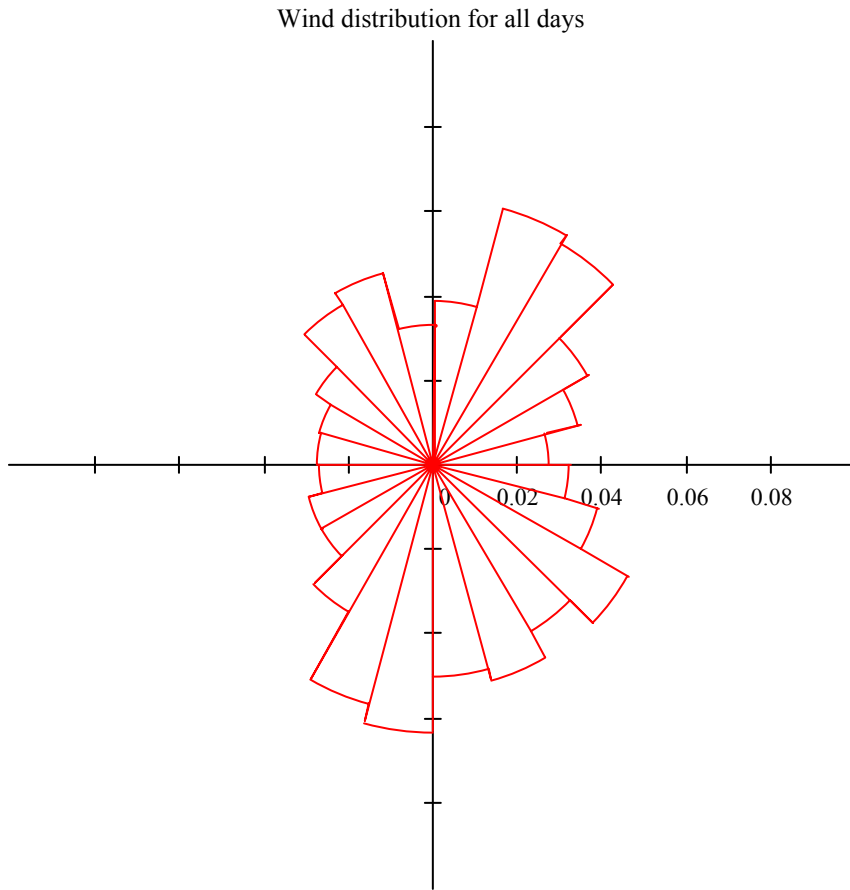


Figure N-21. The distribution of the wind directions at Mammoth Cave National Park

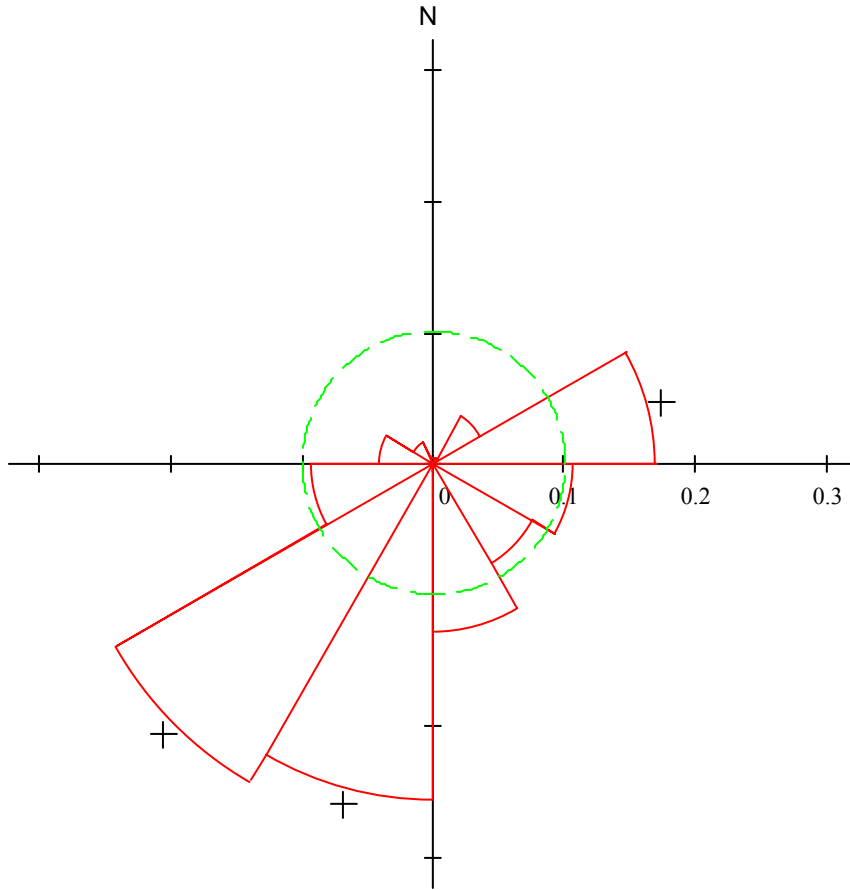


Figure N-22. The probability of a high source day (top 10 percent) given the hourly wind direction for UNMIX source 1 at Shenandoah National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

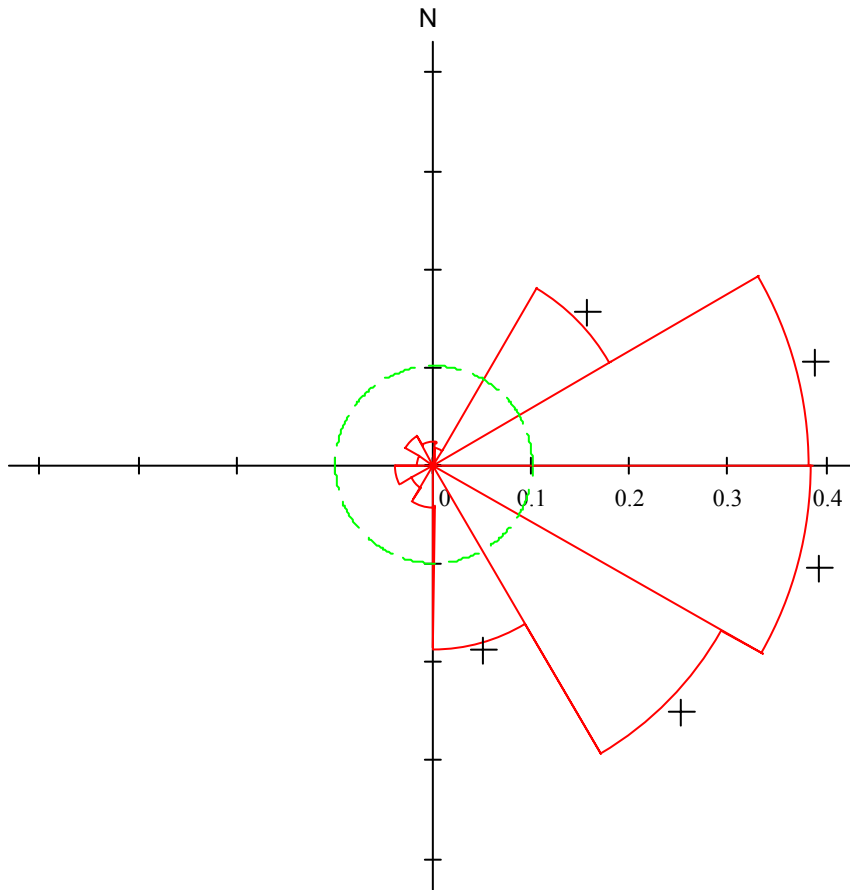


Figure N-23. The probability of a high source day (top 10 percent) given the hourly wind direction for UNMIX source 2 at Shenandoah National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

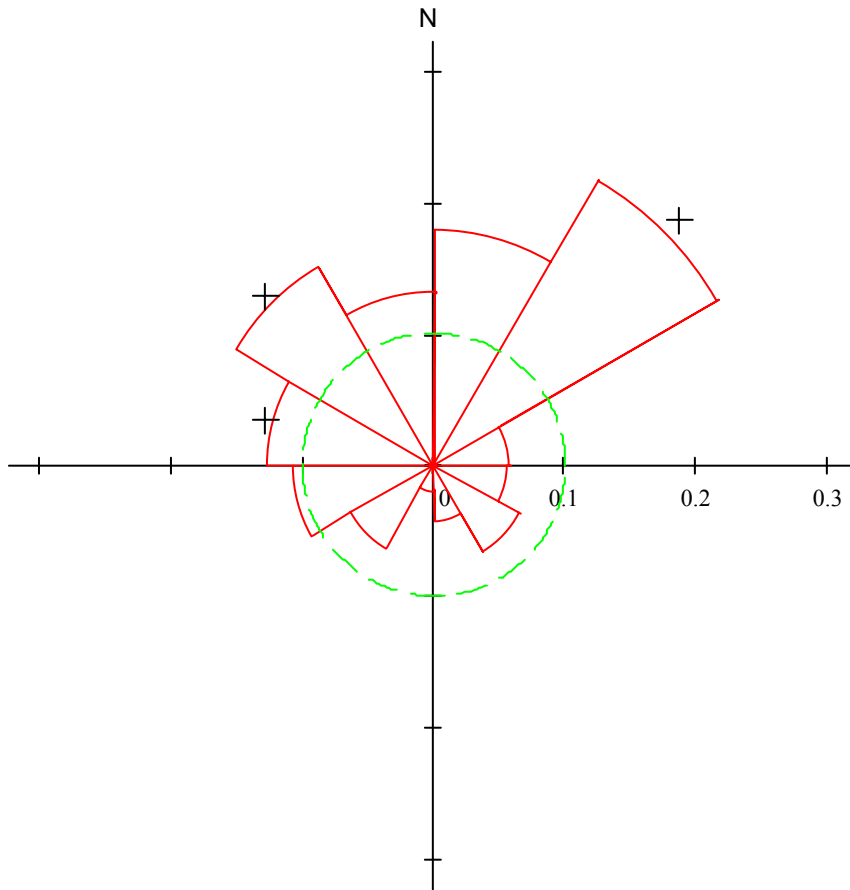


Figure N-24. The probability of a high source day (top 10 percent) given the hourly wind direction for UNMIX source 3 at Shenandoah National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

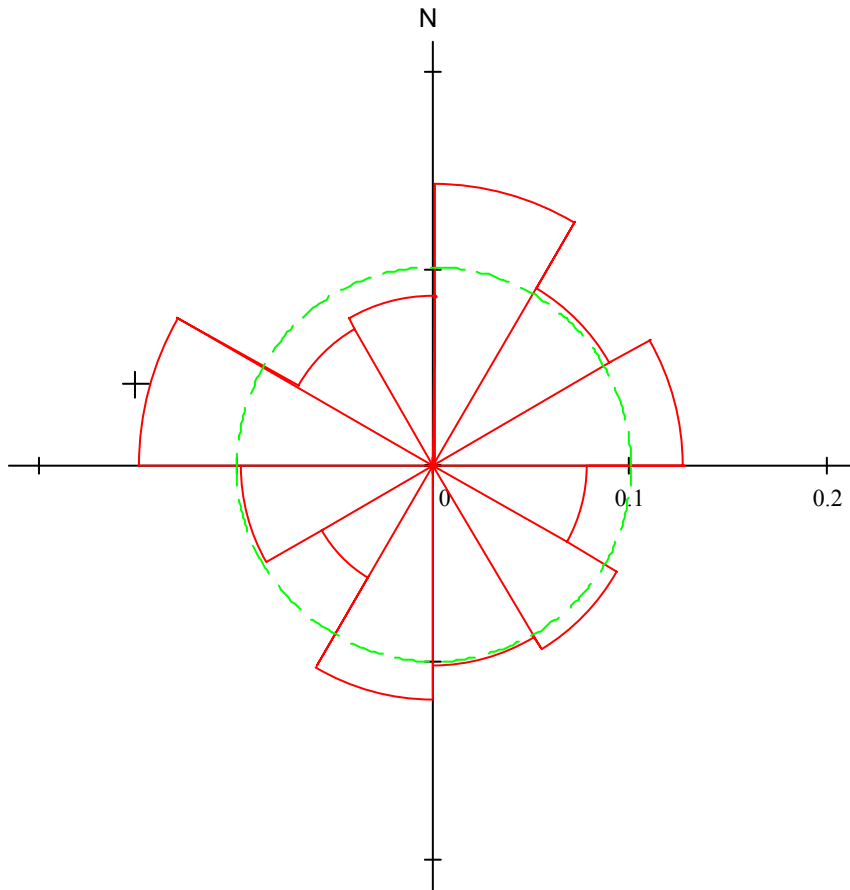


Figure N-25. The probability of a high source day (top 10 percent) given the hourly wind direction for UNMIX source 4 at Shenandoah National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

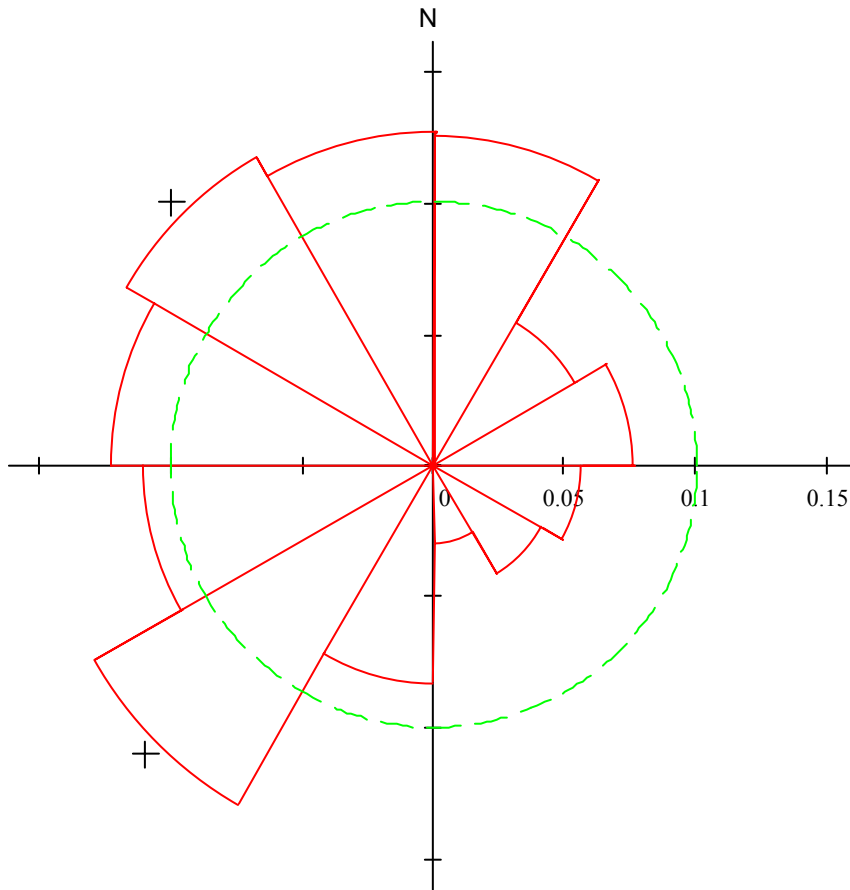


Figure N-26. The probability of a high source day (top 10 percent) given the hourly wind direction for UNMIX source 5 at Shenandoah National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

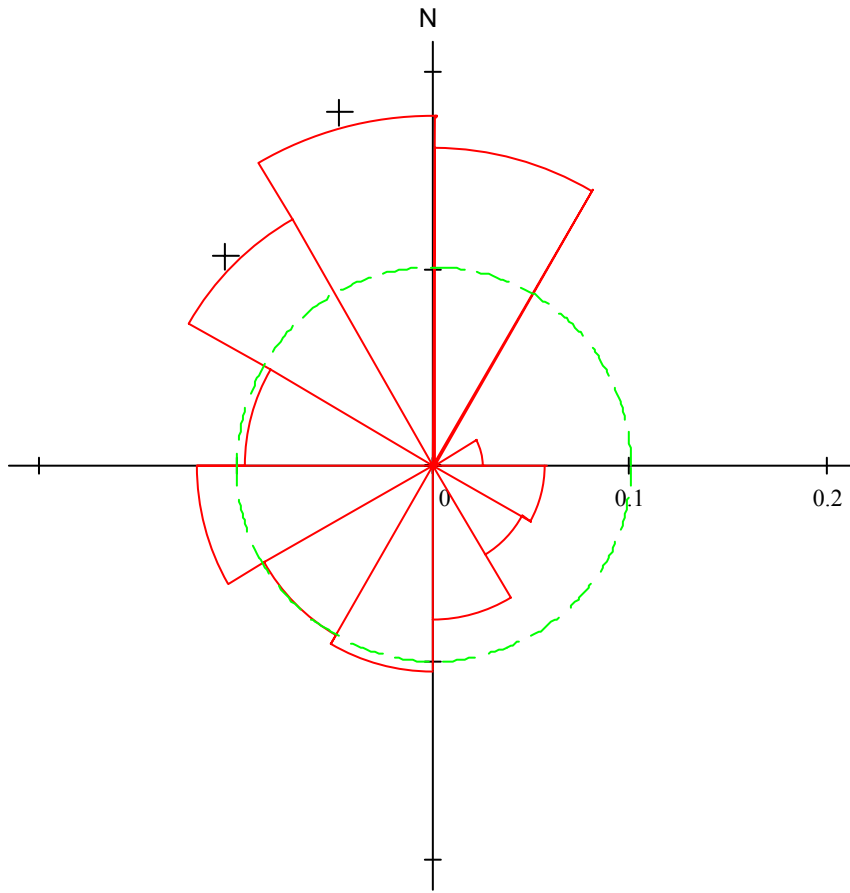


Figure N-27. The probability of a high source day (top 10 percent) given the hourly wind direction for UNMIX source 6 at Shenandoah National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

Table N-4. Summary of source type and direction for UNMIX at Shenandoah National Park

Source number	Directional range (degrees to the east of north)	Source type	Comments
1	60-90, 180-240	Regional /Multi Point	PMF 2
2	30-180	Regional	
3	30-60, 270-330	Regional /Multi Point	
4	270-300	Area	PMF 7
5	210-240, 300-360	Regional /Multi Point	PMF 1
6	330-360	Regional	PMF 9

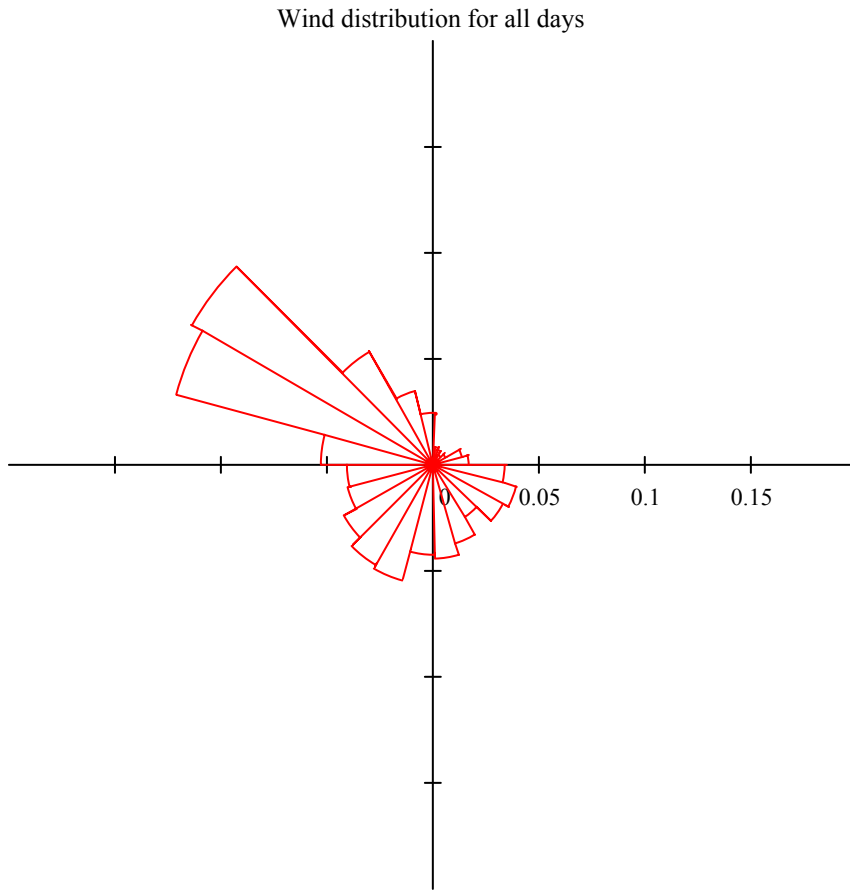


Figure N-28. The distribution of the wind directions at Shenandoah National Park

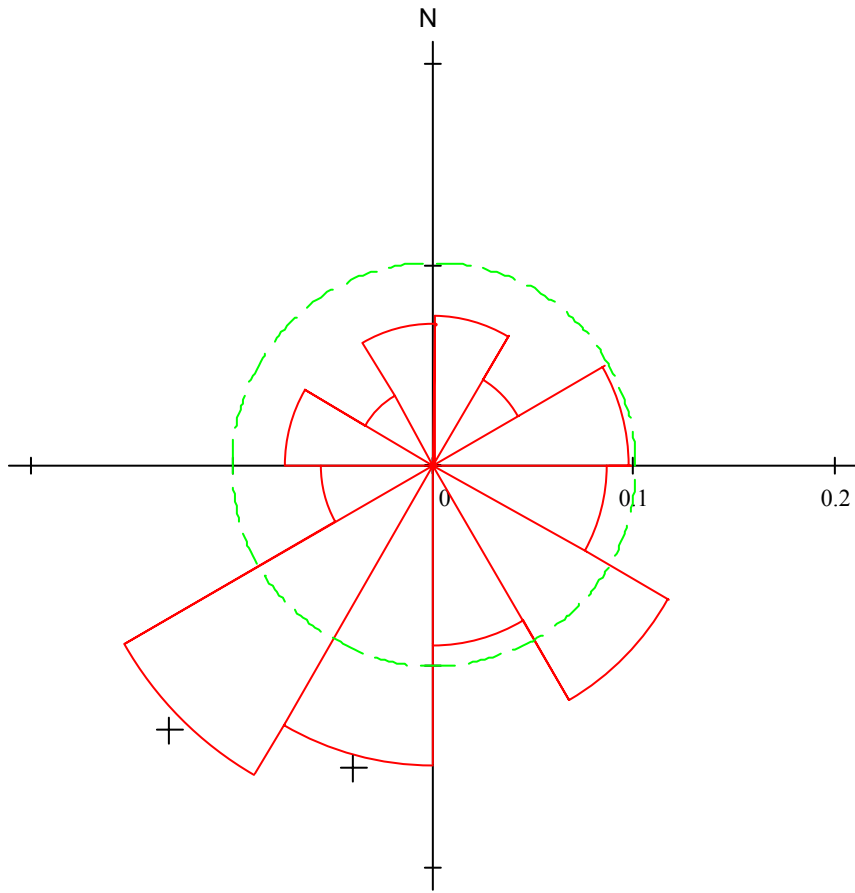


Figure N-29. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 1 at Acadia National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

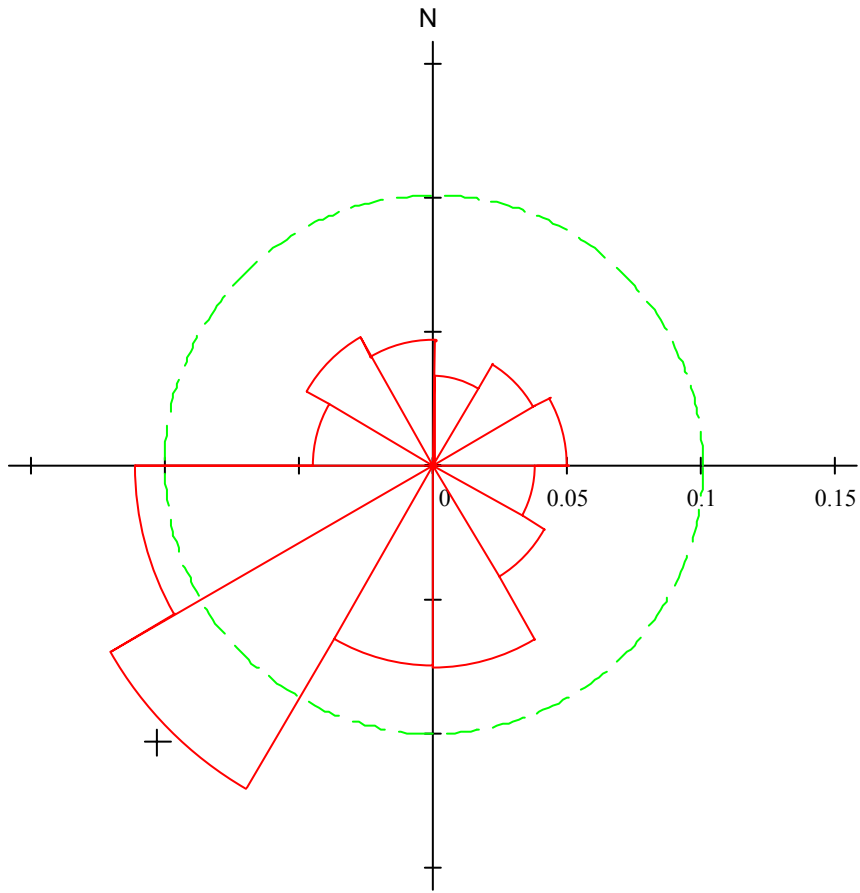


Figure N-30. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 2 at Acadia National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

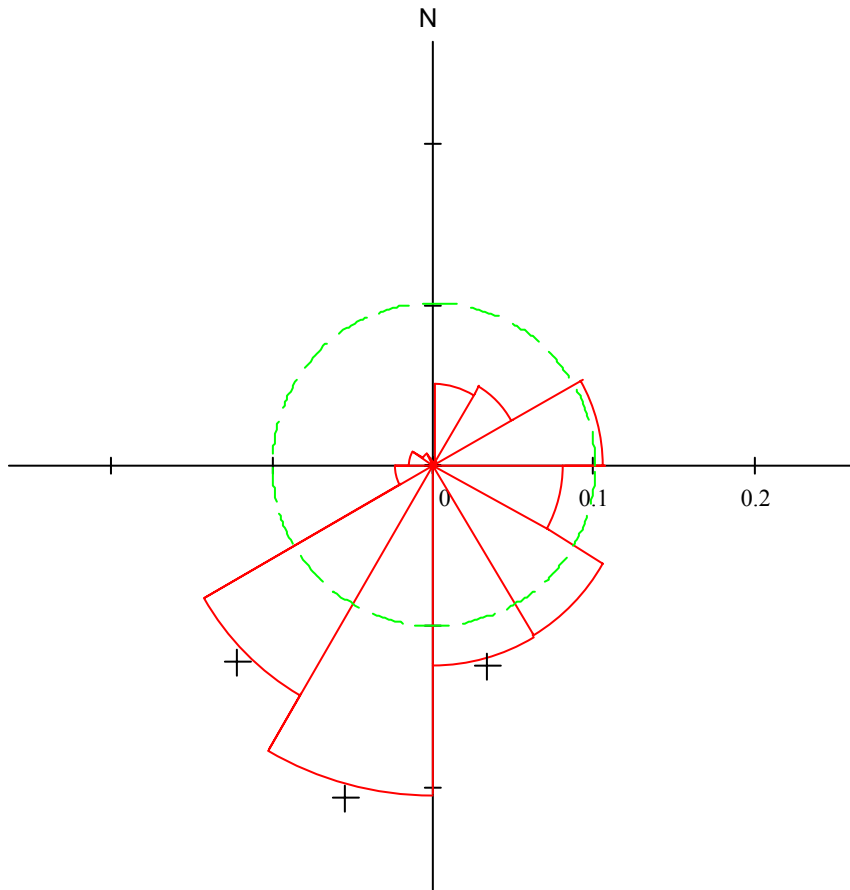


Figure N-31. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 3 at Acadia National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

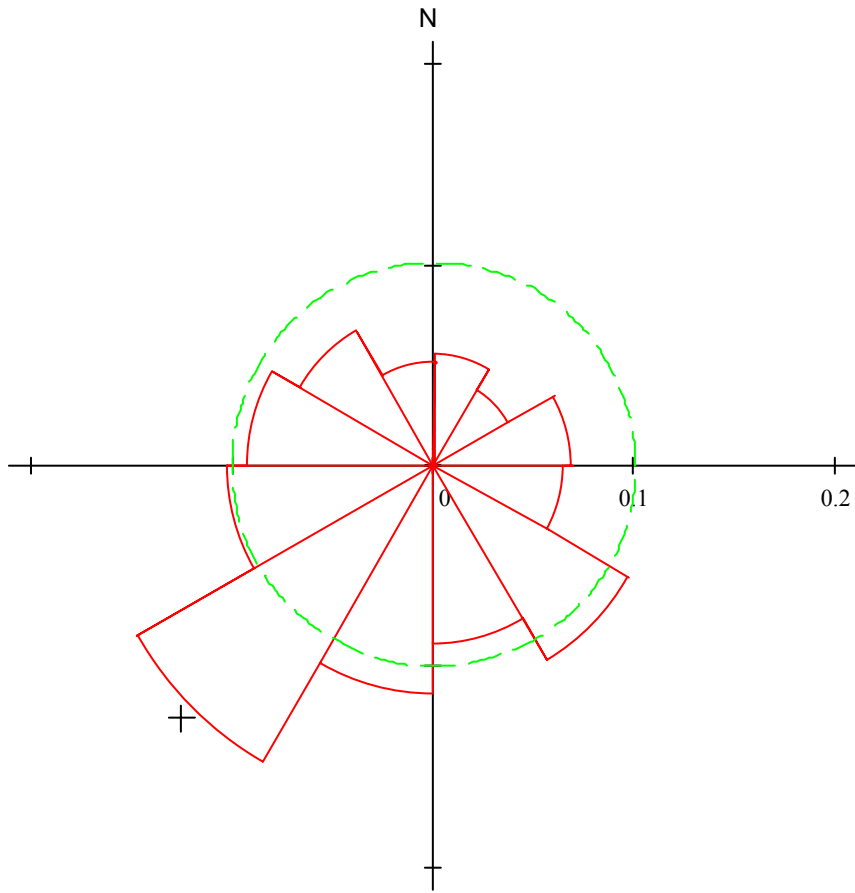


Figure N-32. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 4 at Acadia National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

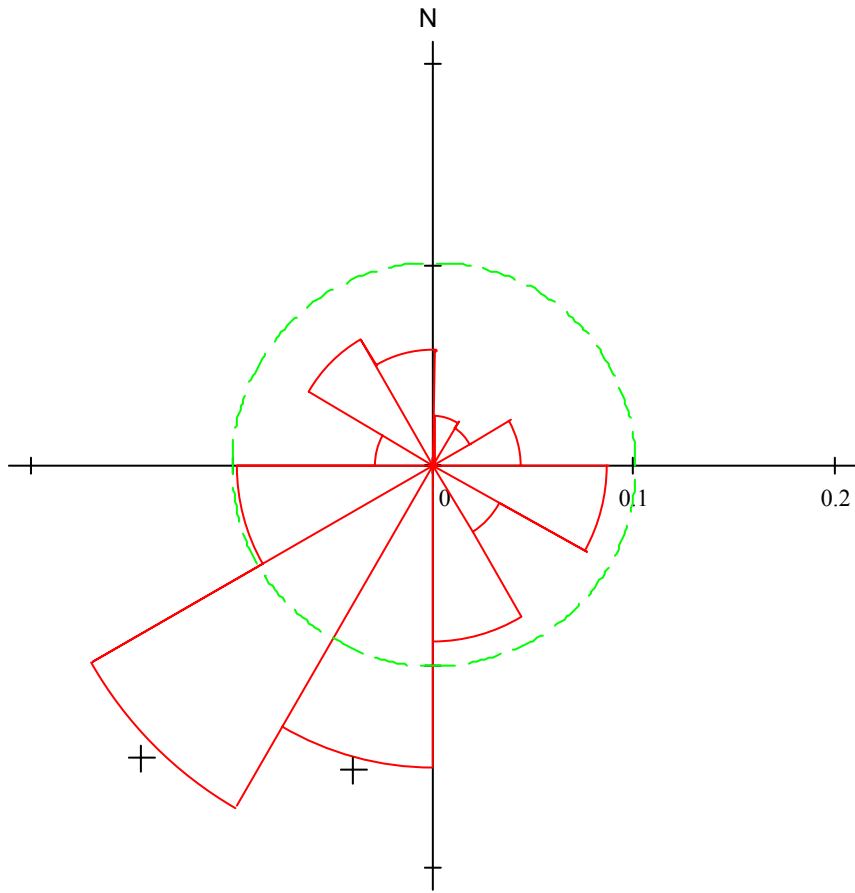


Figure N-33. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 5 at Acadia National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

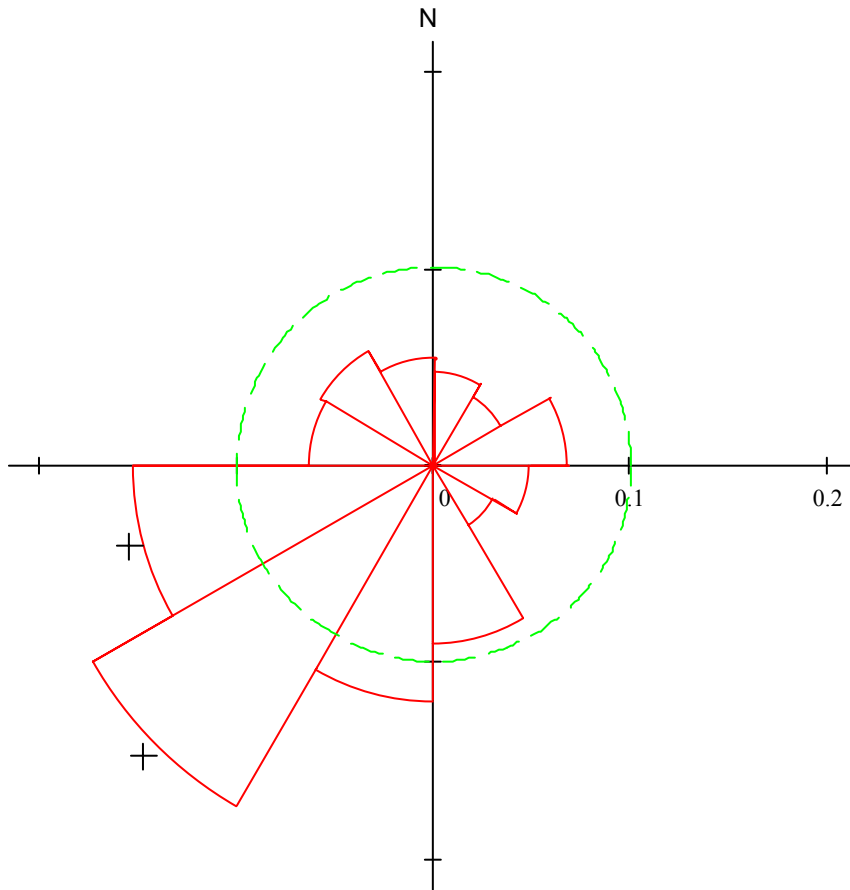


Figure N-34. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 6 at Acadia National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

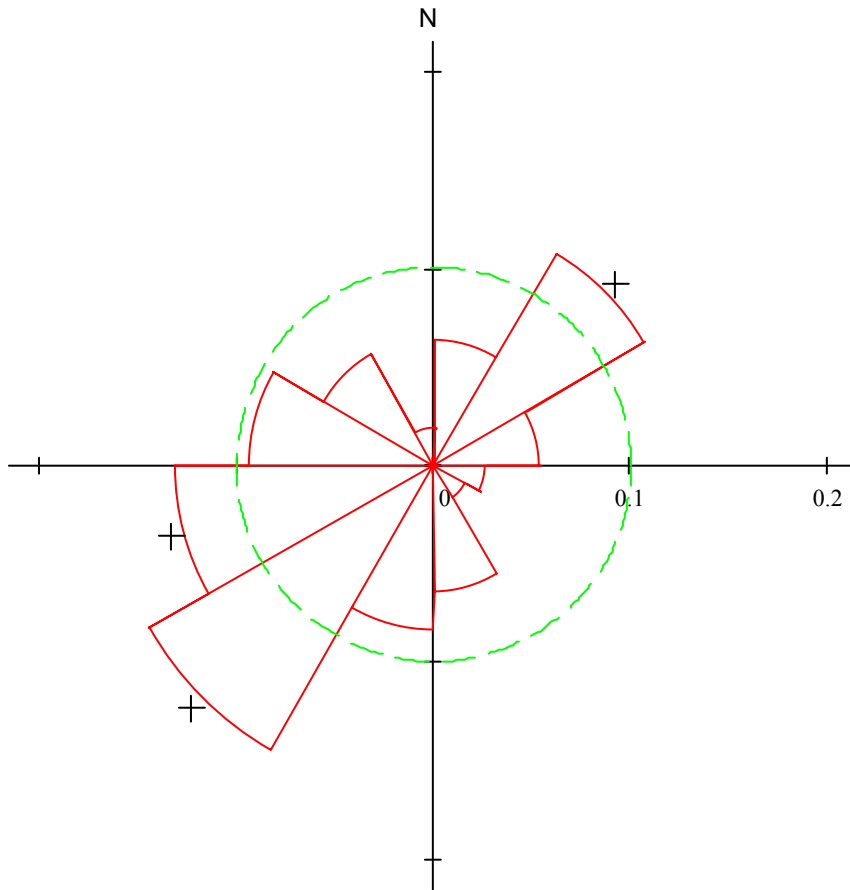


Figure N-35. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 7 at Acadia National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

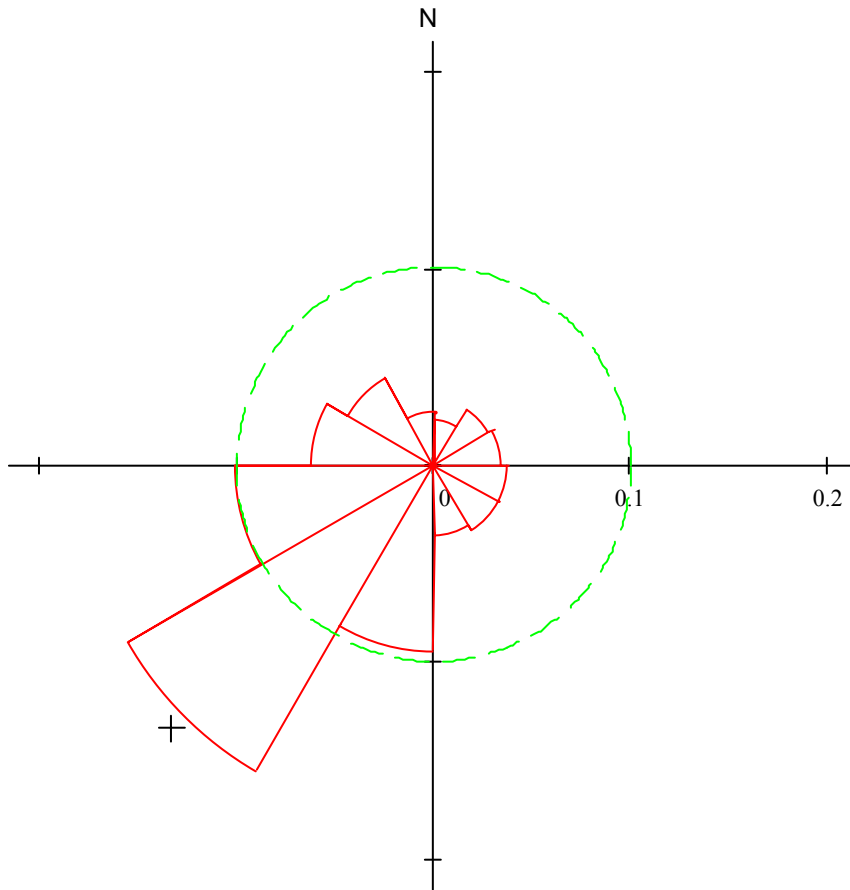


Figure N-36. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 8 at Acadia National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

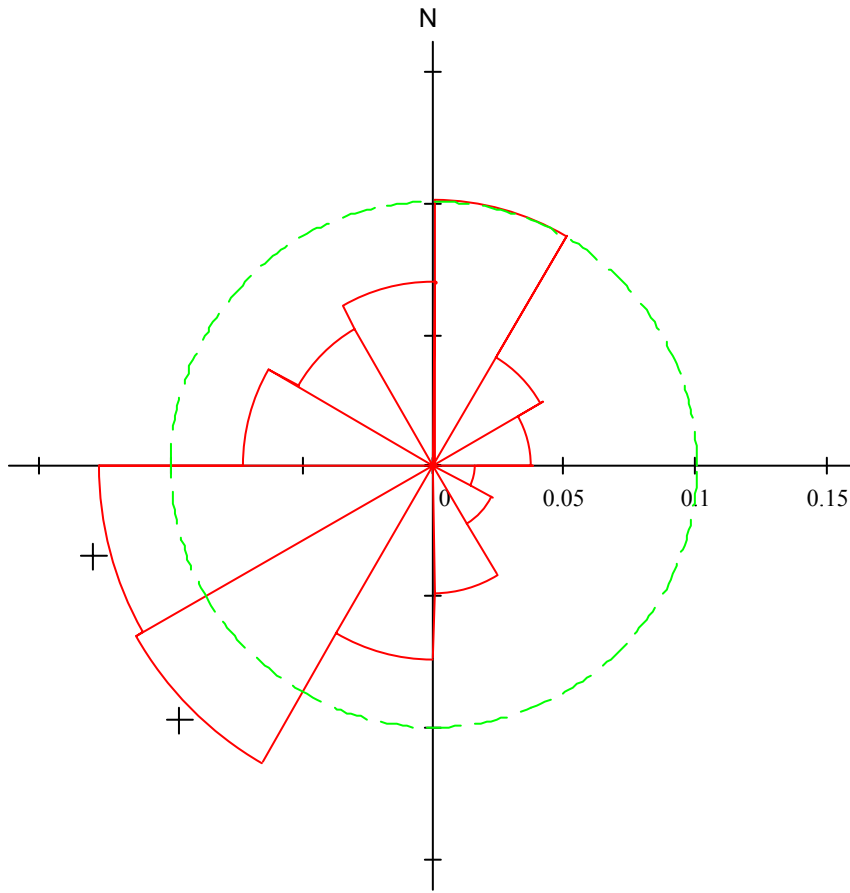


Figure N-37. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 9 at Acadia National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

Table N-5. Summary of source type and direction for PMF at Acadia National Park

Source number	Directional range (degrees to the east of north)	Source type	Comments
1	180-240	Regional/Point	
2	210-240	Point	UNMIX 4
3	150-240	Regional/Point	Sea Spray UNMIX 1
4	210-240	Regional/Point	UNMIX 6
5	180-240	Point	
6	210-270	Point	UNMIX 3
7	30-60, 210-270	Regional/Multi Point	
8	210-240	Point	UNMIX 5
9	210-270	Point	

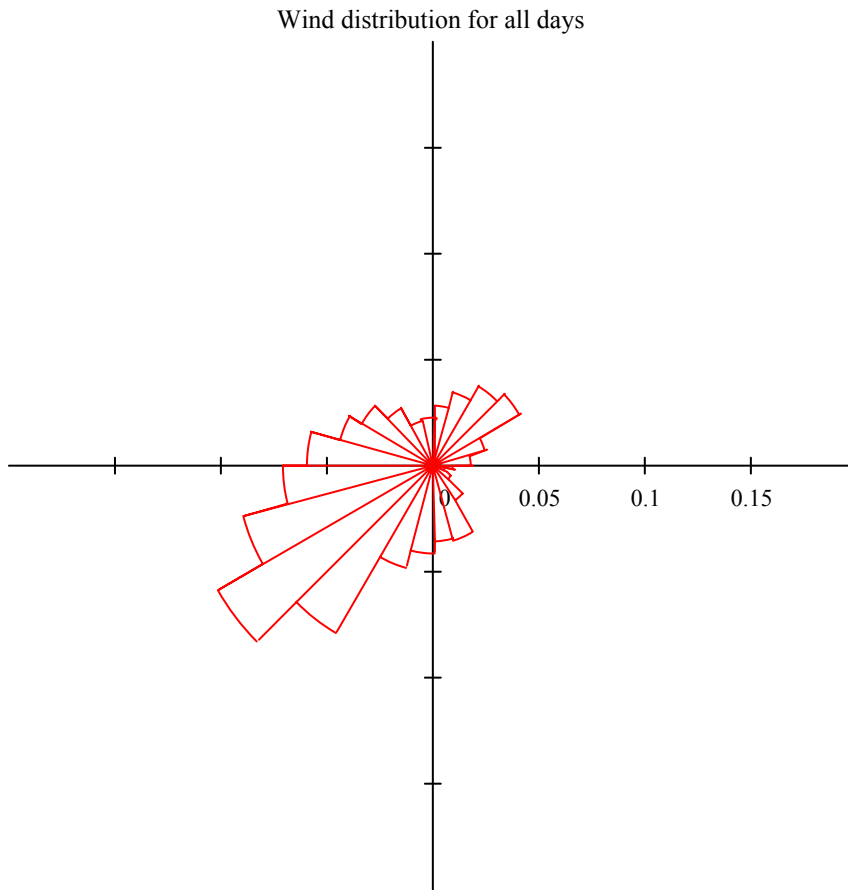


Figure N-38. The distribution of the wind directions at Acadia National Park

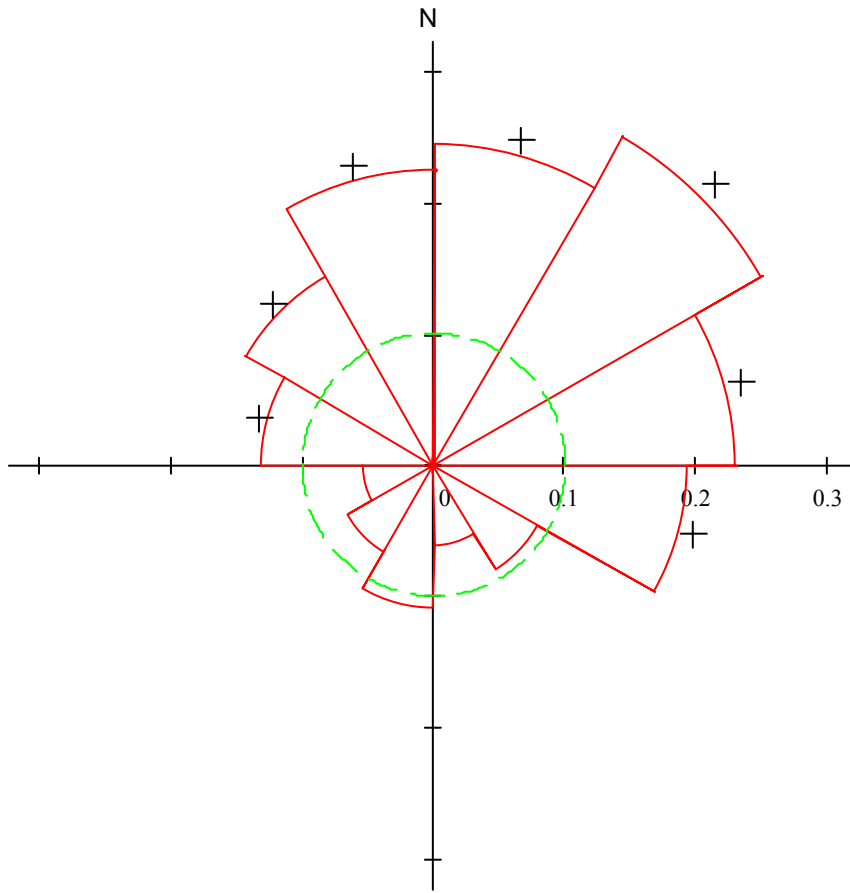


Figure N-39. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 1 at Great Smoky Mountains National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

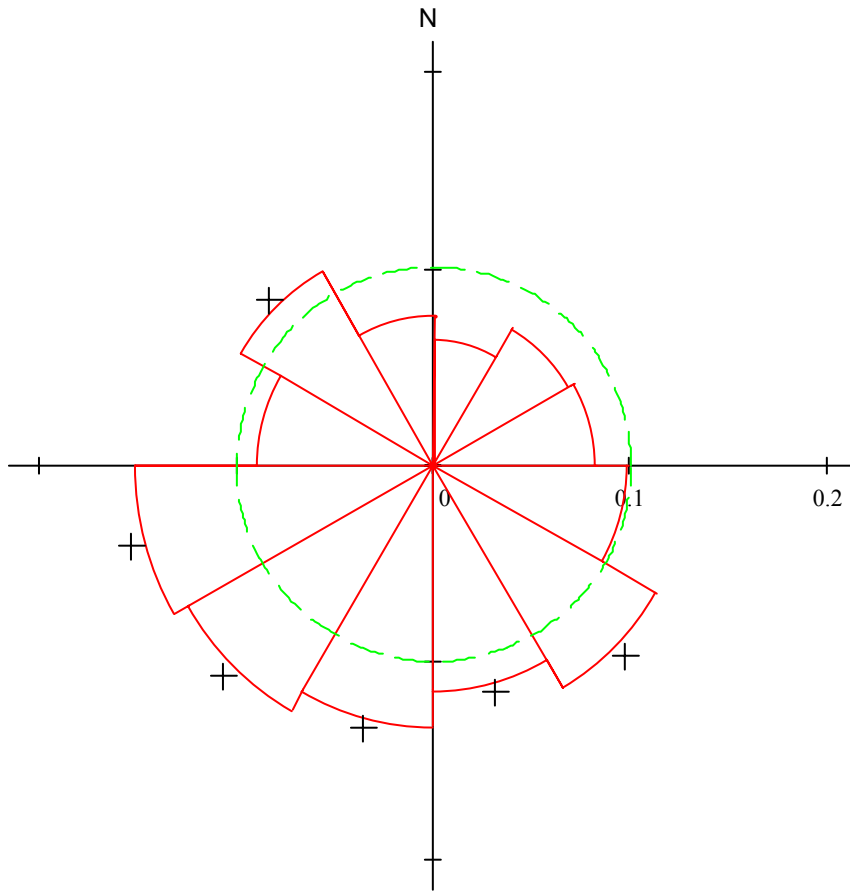


Figure N-40. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 2 at Great Smoky Mountains National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

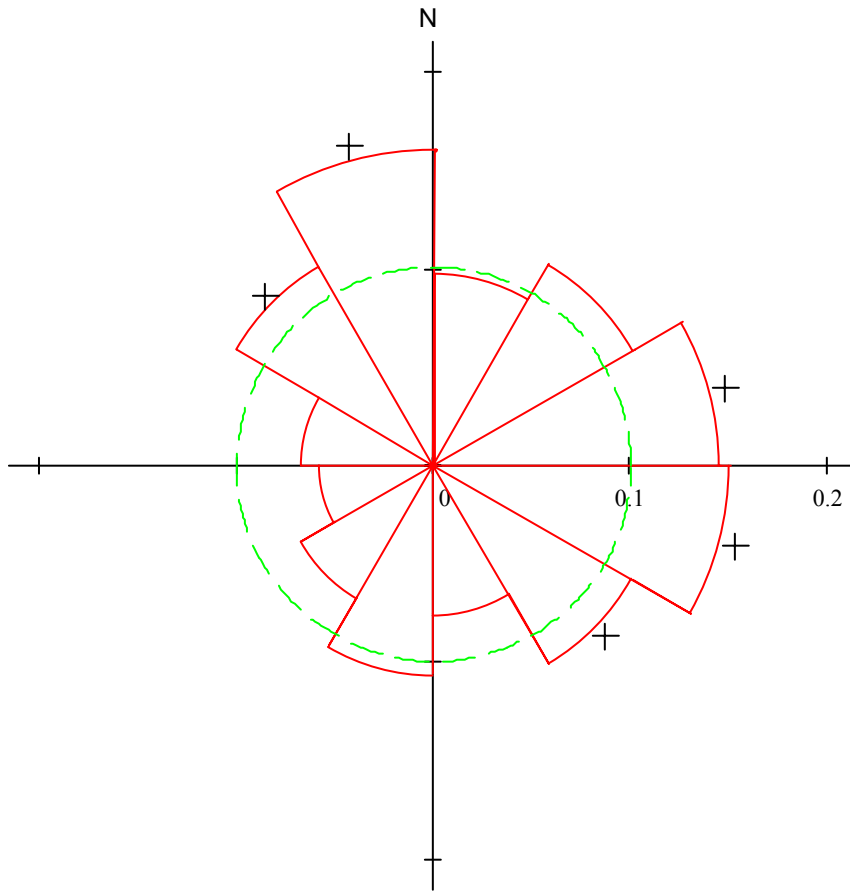


Figure N-41. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 3 at Great Smoky Mountains National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

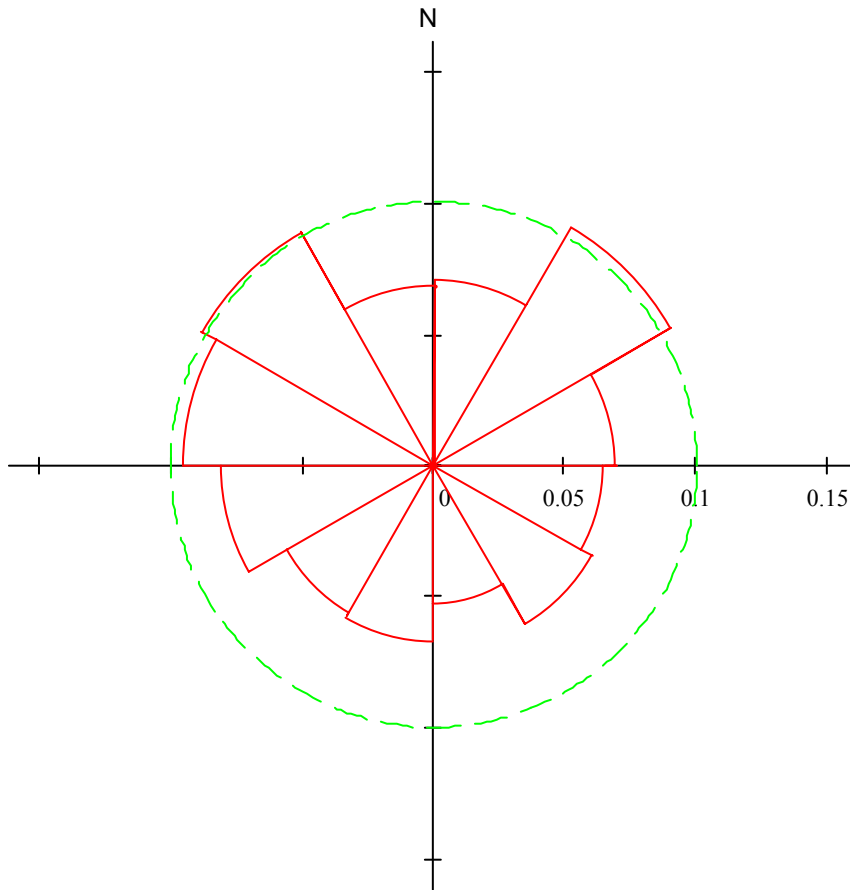


Figure N-42. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 4 at Great Smoky Mountains National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

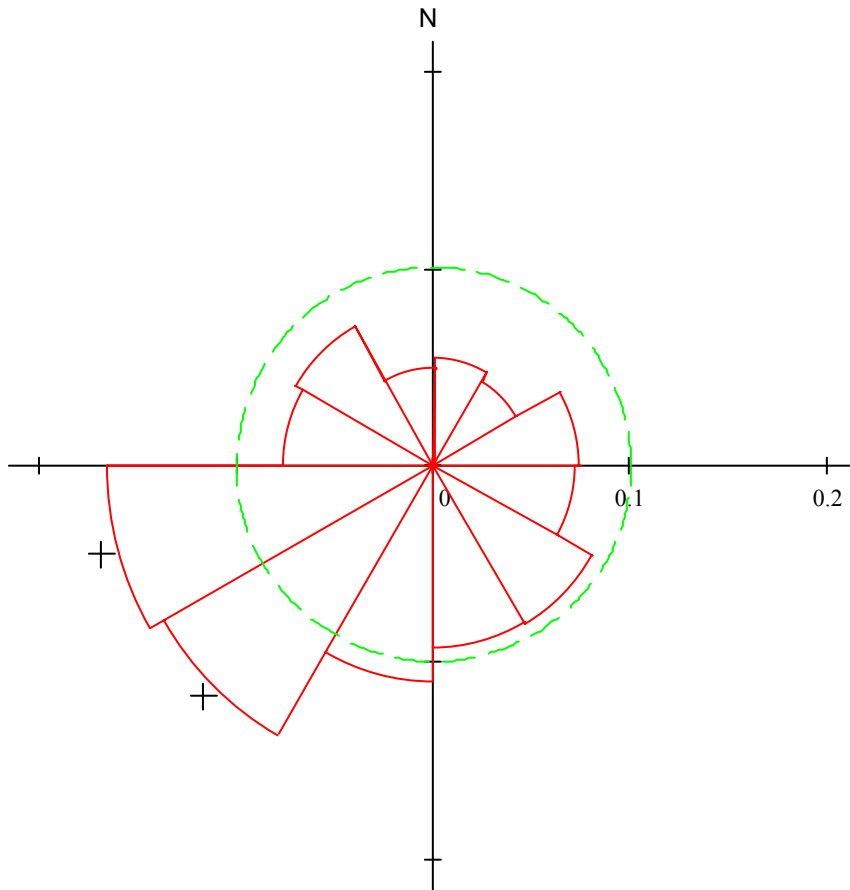


Figure N-43. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 5 at Great Smoky Mountains National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

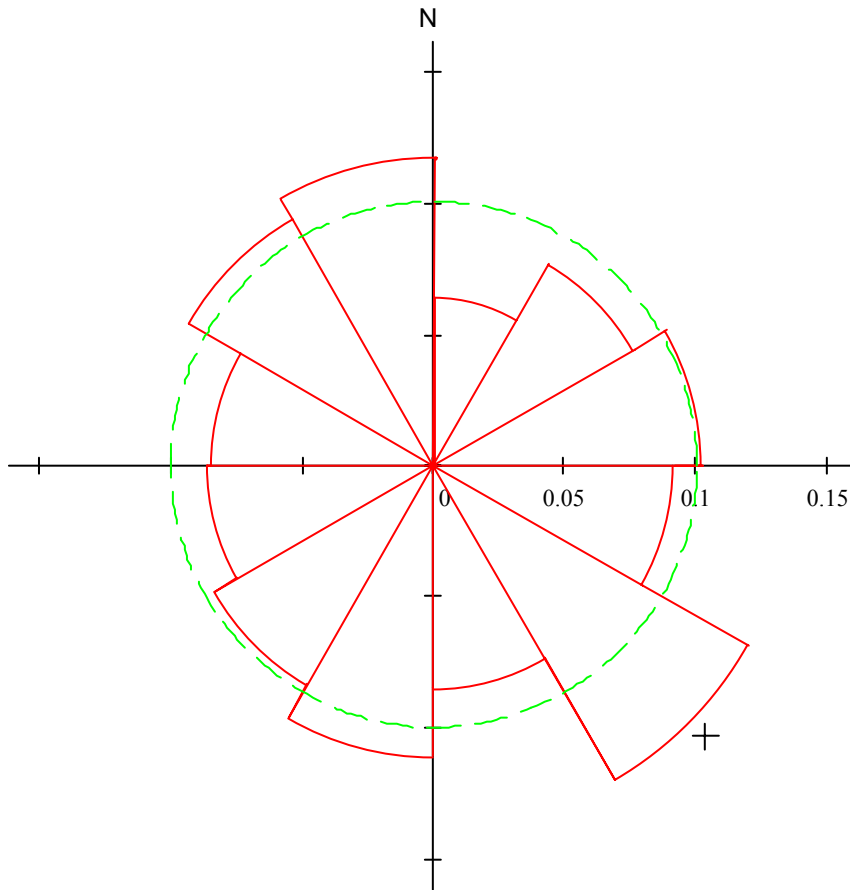


Figure N-44. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 6 at Great Smoky Mountains National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

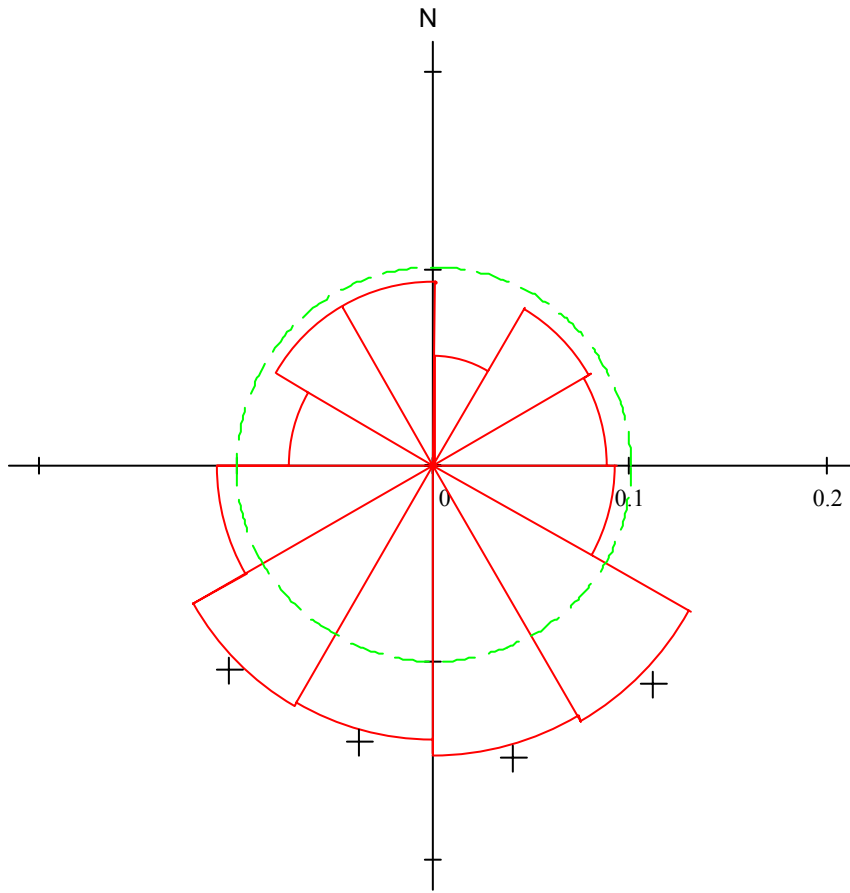


Figure N-45. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 7 at Great Smoky Mountains National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

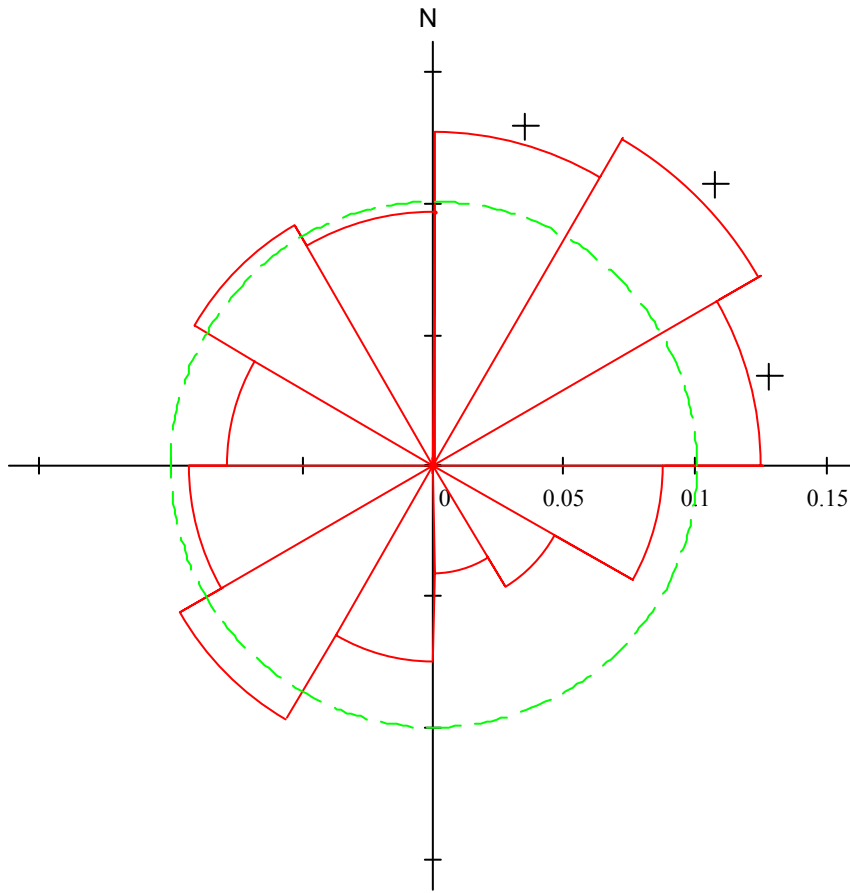


Figure N-46. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 8 at Great Smoky Mountains National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

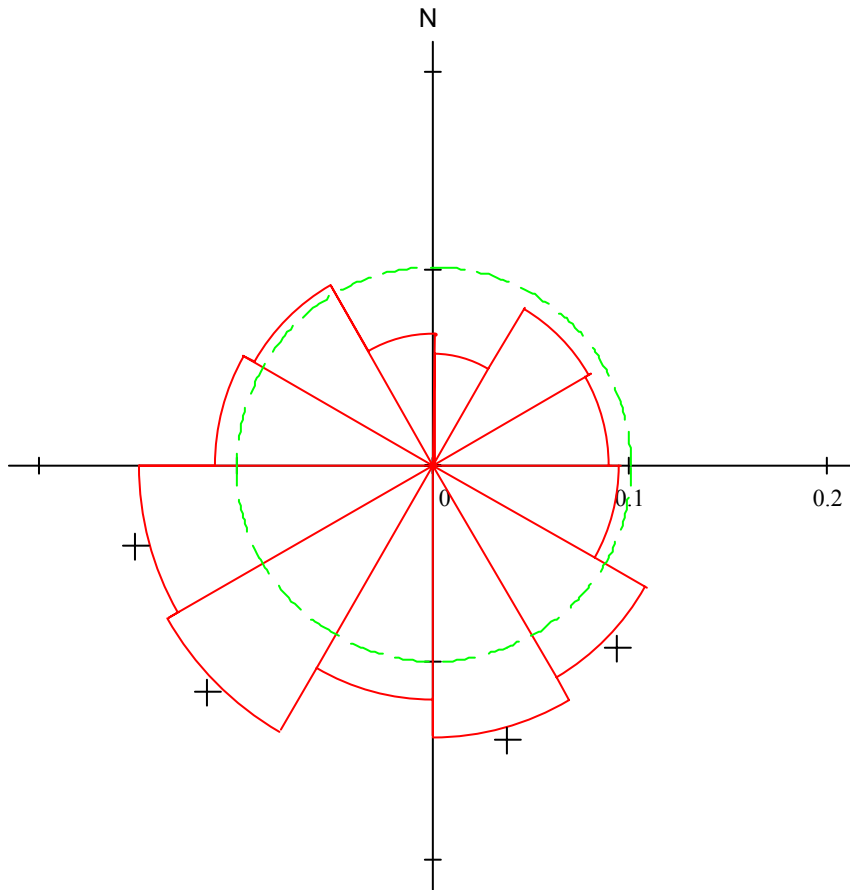


Figure N-47. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 9 at Great Smoky Mountains National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

Table N-6. Summary of source type and direction for PMF at Great Smoky Mountains National Park

Source number	Directional range (degrees to the east of north)	Source type	Comments
1	270-360, 0-120	Area	
2	120-270, 300-330	Area	
3	60-150, 300-360	Area	
4	-	Area	UNMIX 6
5	210-270	Point	UNMIX 5
6	120-150	Area/Multi Point	
7	120-240	Area	UNMIX 1
8	0-90	Area/Multi Point	UNMIX 4
9	120-180, 210-270	Area	

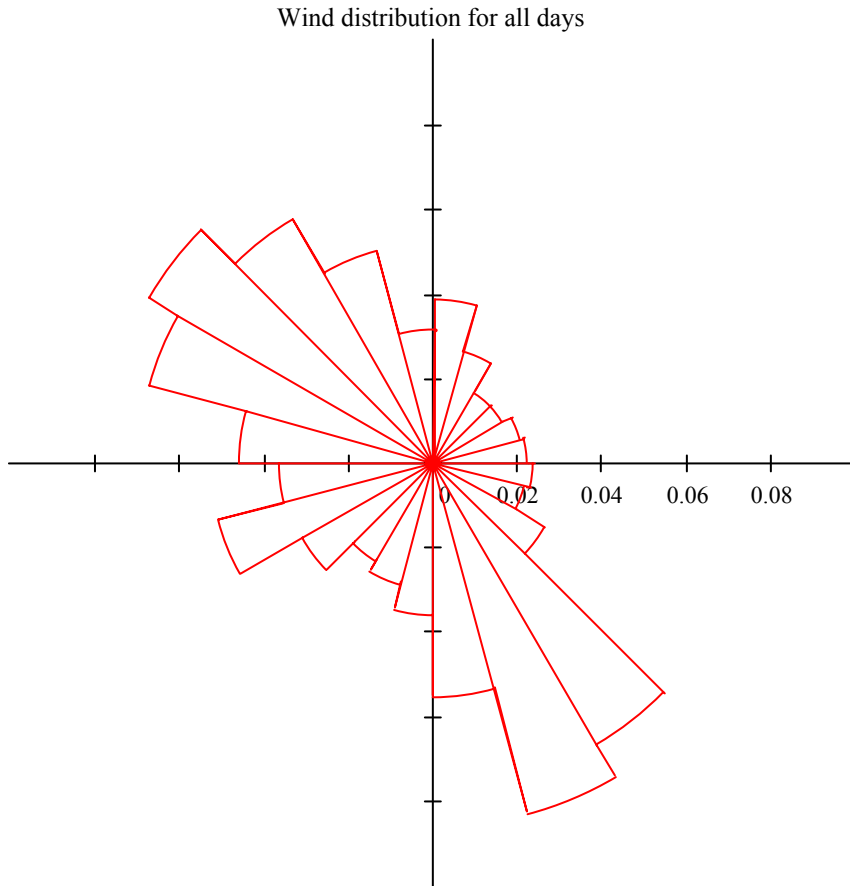


Figure N-48. The distribution of the wind directions at Great Smoky Mountains National Park

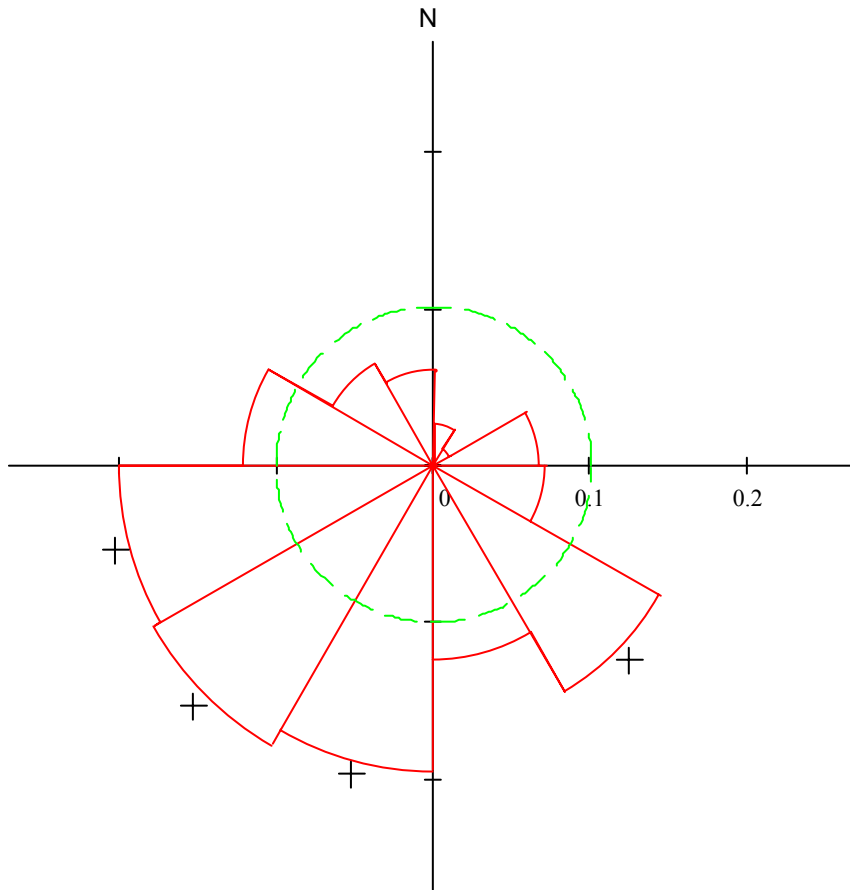


Figure N-49. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 1 at Mammoth Cave National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

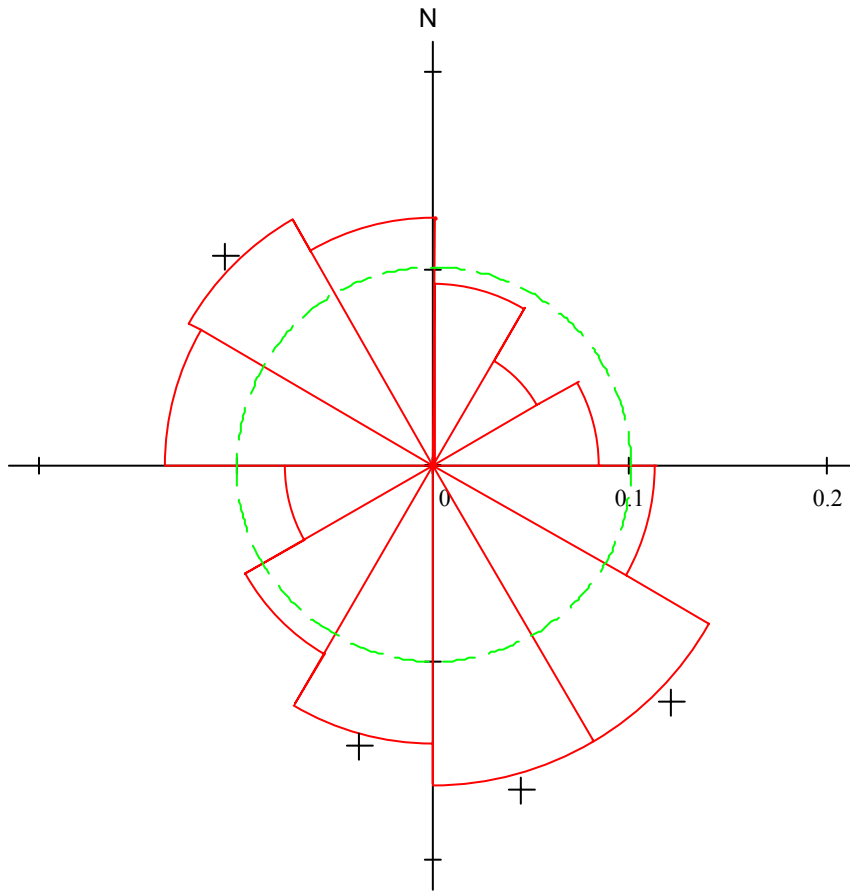


Figure N-50. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 2 at Mammoth Cave National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

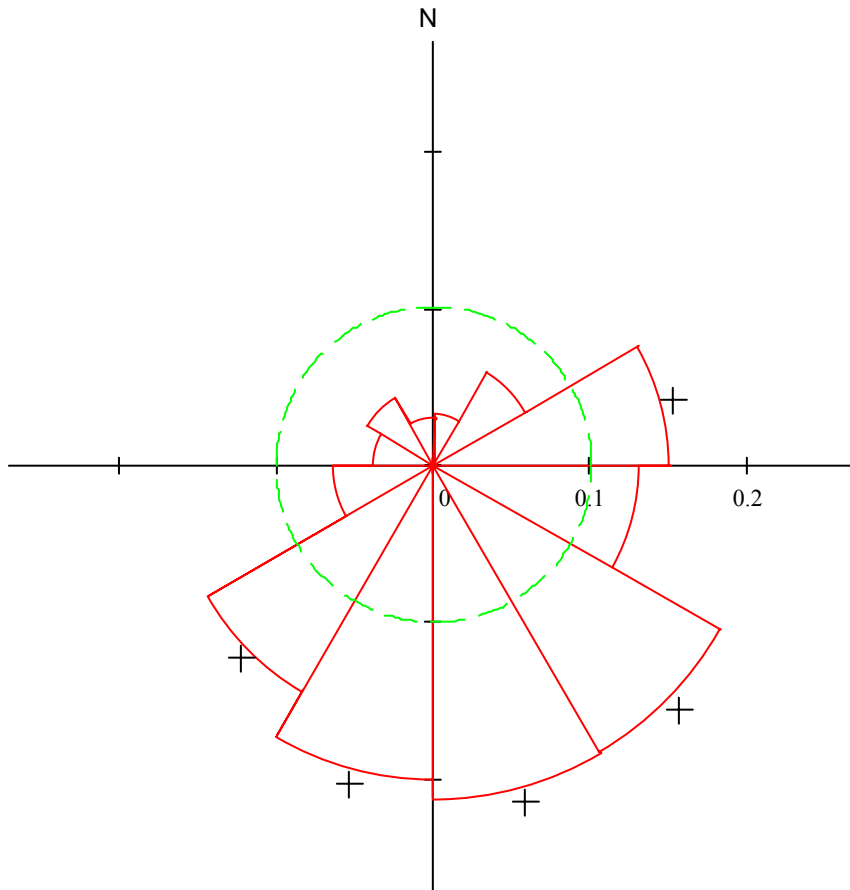


Figure N-51. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 3 at Mammoth Cave National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

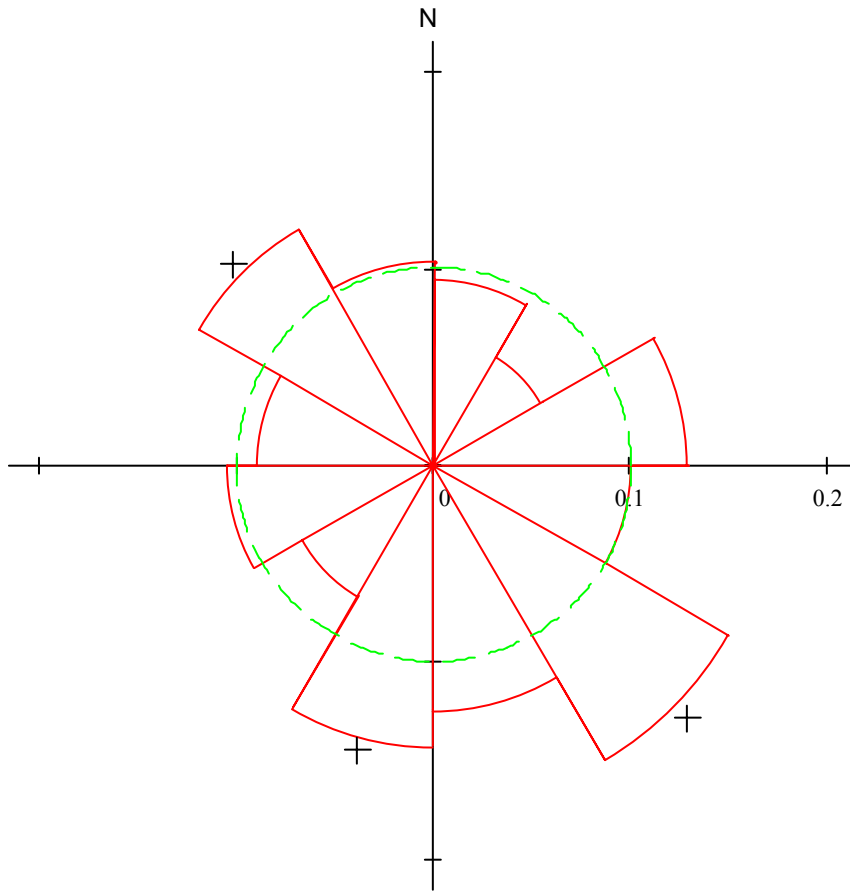


Figure N-52. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 4 at Mammoth Cave National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

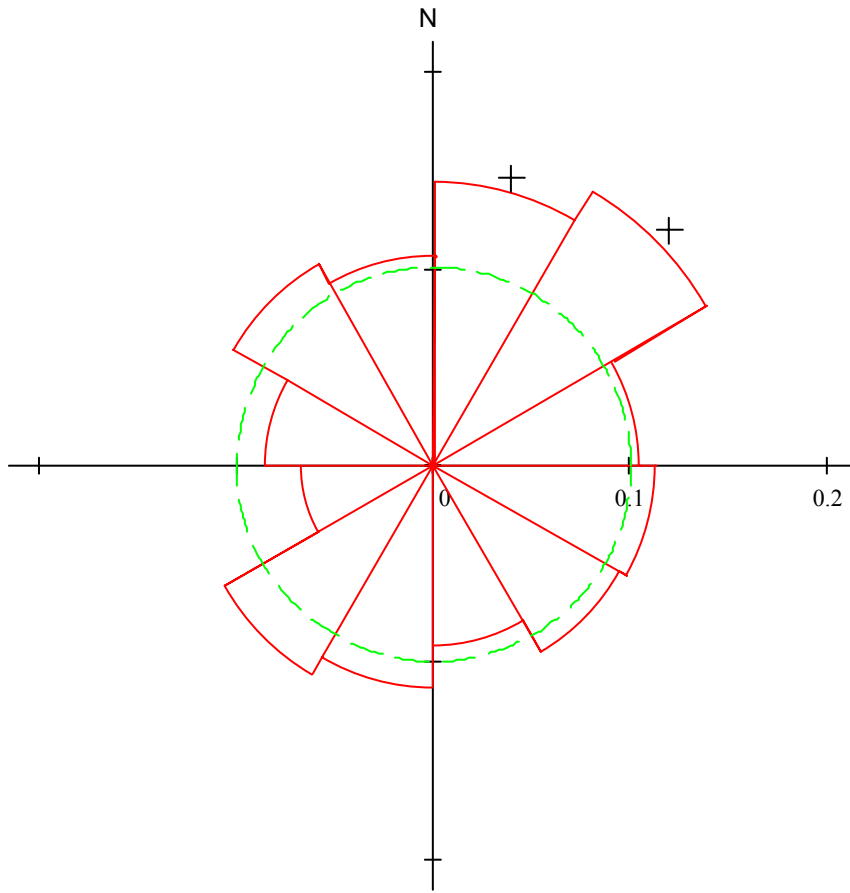


Figure N-53. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 5 at Mammoth Cave National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

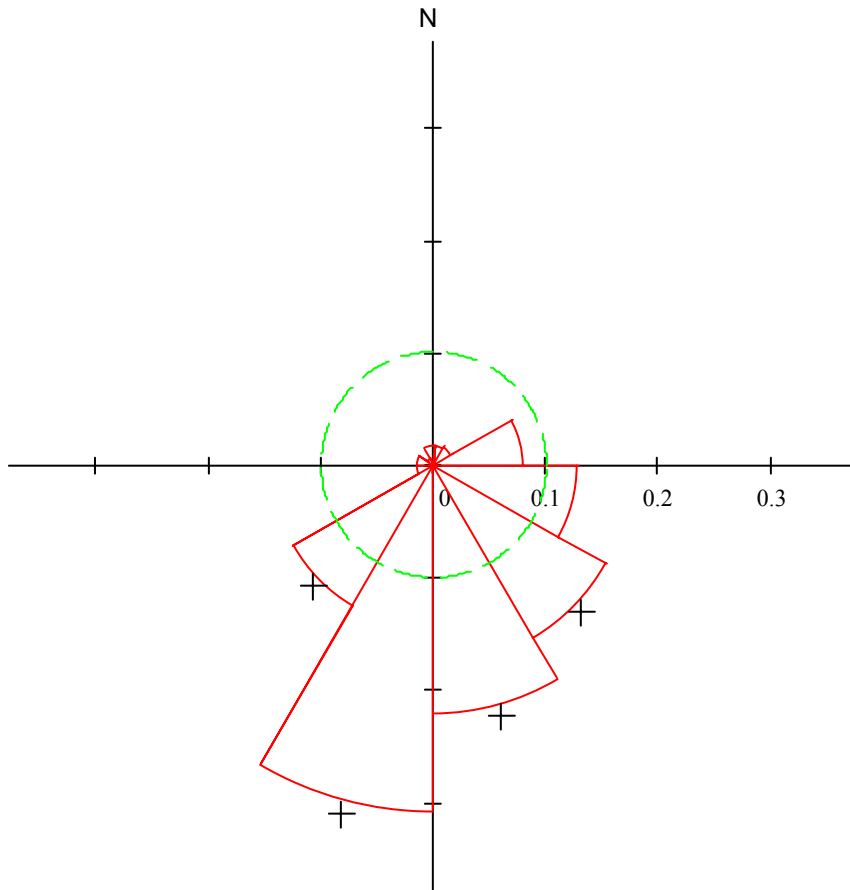


Figure N-54. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 6 at Mammoth Cave National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

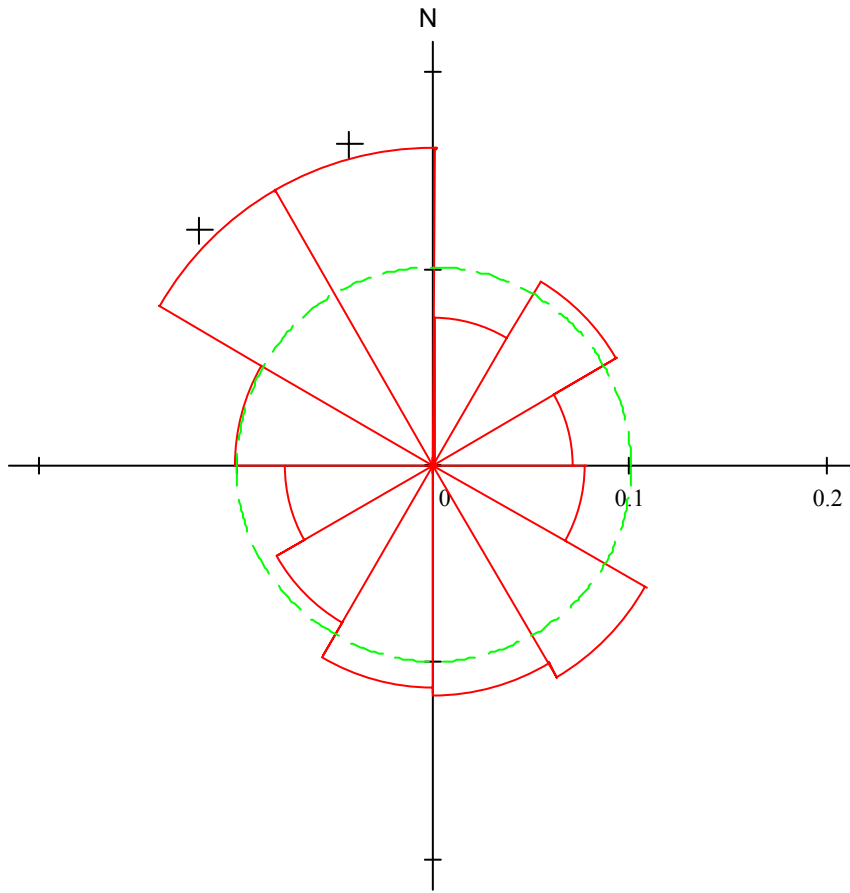


Figure N-55. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 7 at Mammoth Cave National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

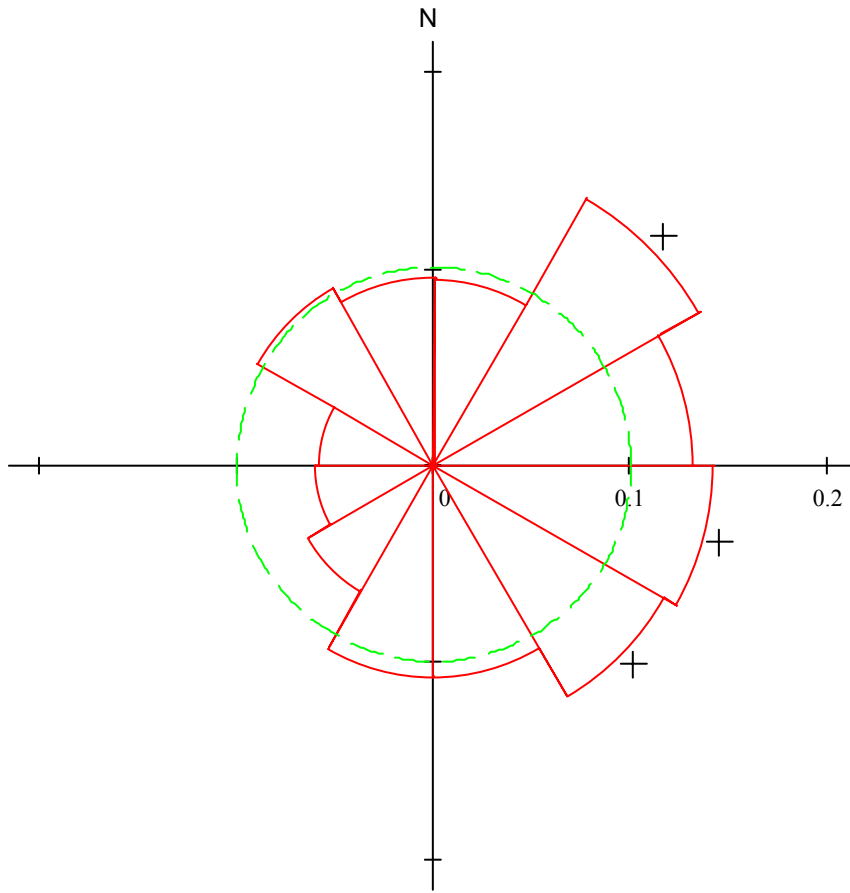


Figure N-56. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 8 at Mammoth Cave National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

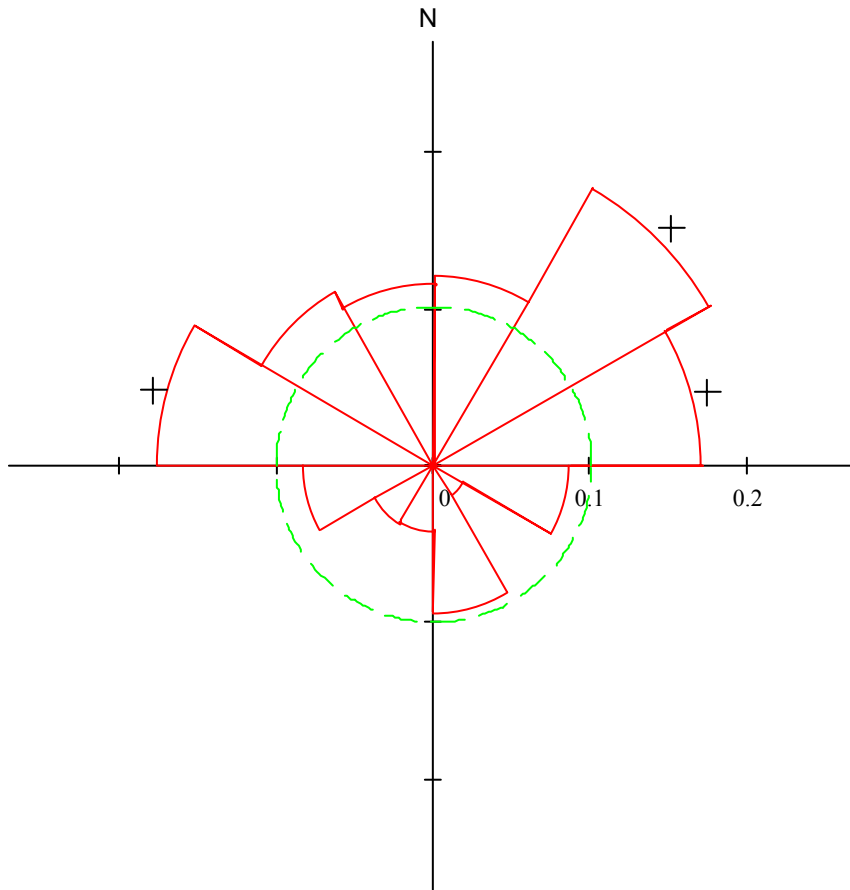


Figure N-57. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 9 at Mammoth Cave National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

Table N-7. Summary of source type and direction for PMF at Mammoth Cave National Park

Source number	Directional range (degrees to the east of north)	Source type	Comments
1	120-150, 180-270	Regional/Multi Point	UNMIX 4
2	120-210, 300-330	Area	UNMIX 5
3	60-90, 120-240	Regional/Multi Point	
4	120-150, 180-210, 300-330	Area	
5	0-60	Area	
6	120-240	Regional	
7	300-360	Area/Regional	
8	30-60, 90-150	Area/Regional/Multi Point	
9	30-90, 270-300	Regional/Multi Point	

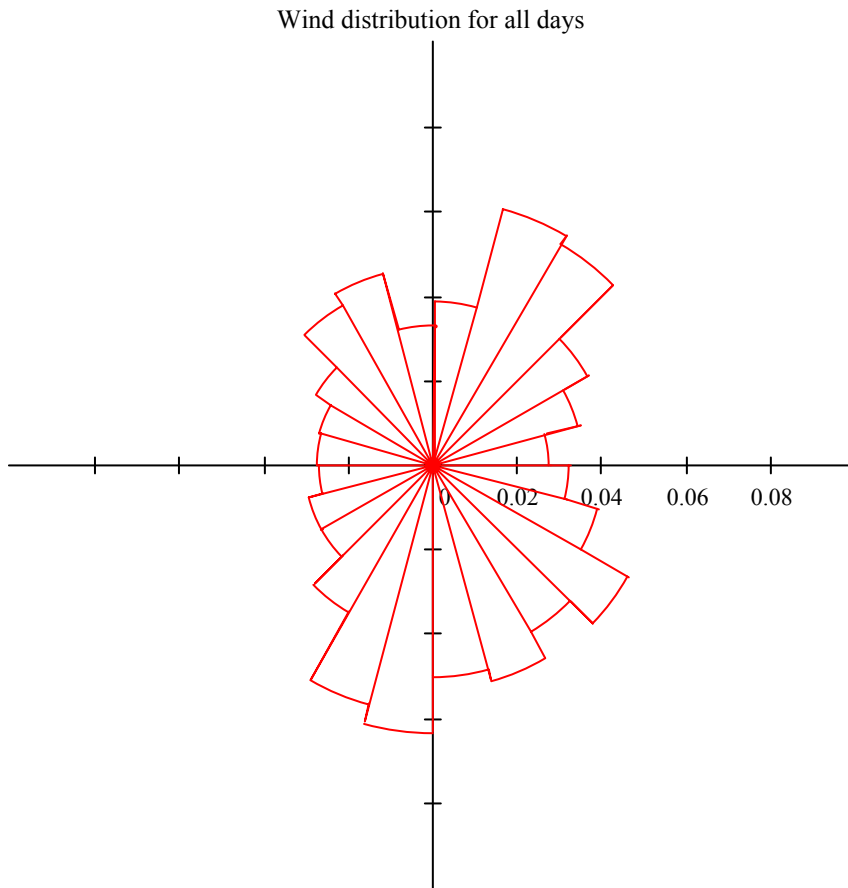


Figure N-58. The distribution of the wind directions at Mammoth Cave National Park

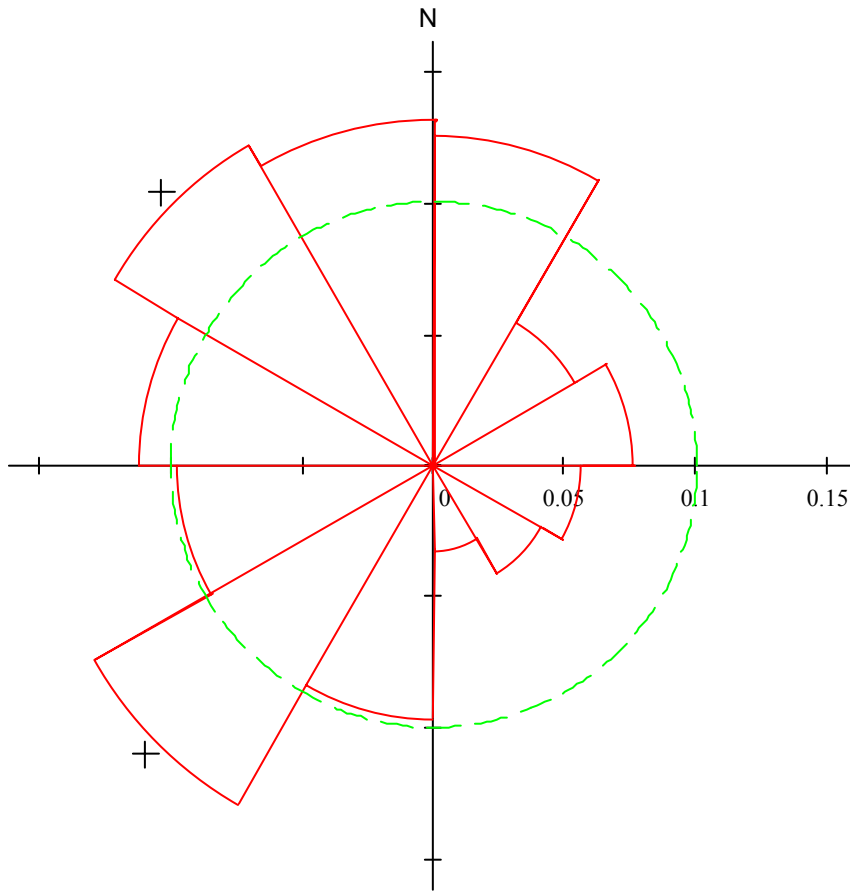


Figure N-59. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 1 at Shenandoah National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

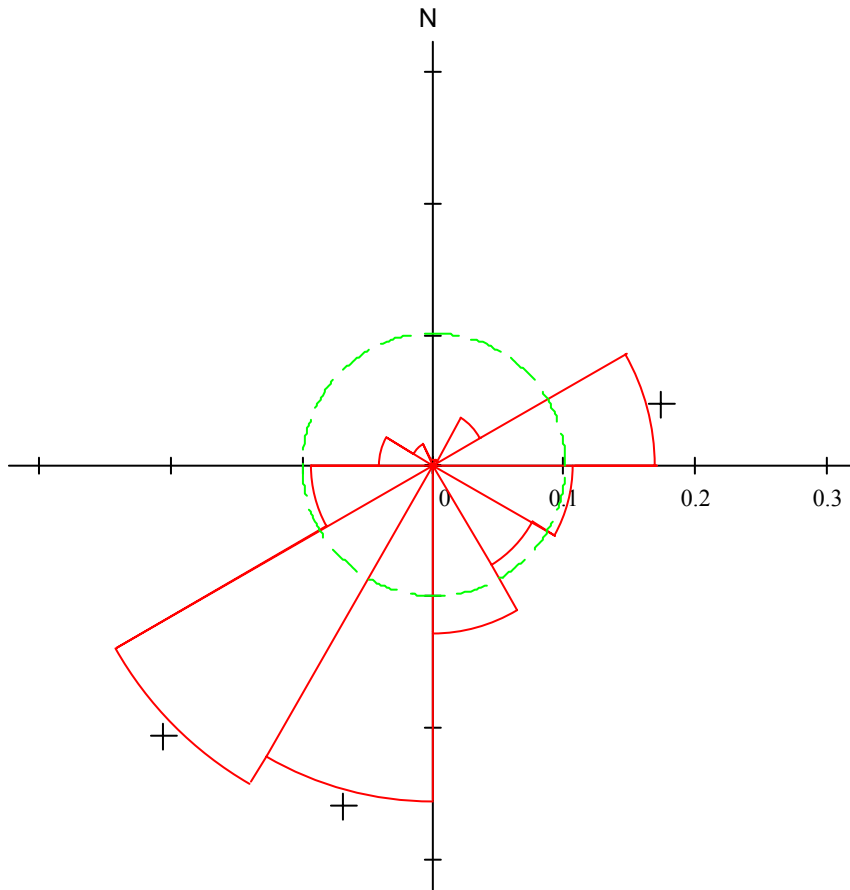


Figure N-60. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 2 at Shenandoah National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

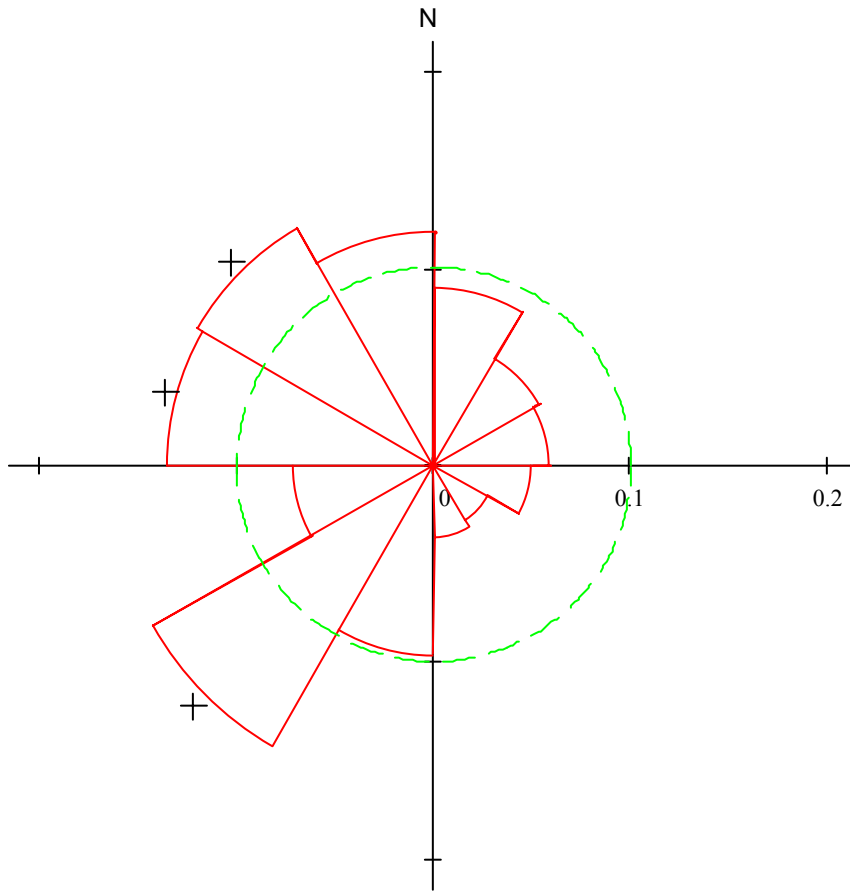


Figure N-61. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 3 at Shenandoah National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

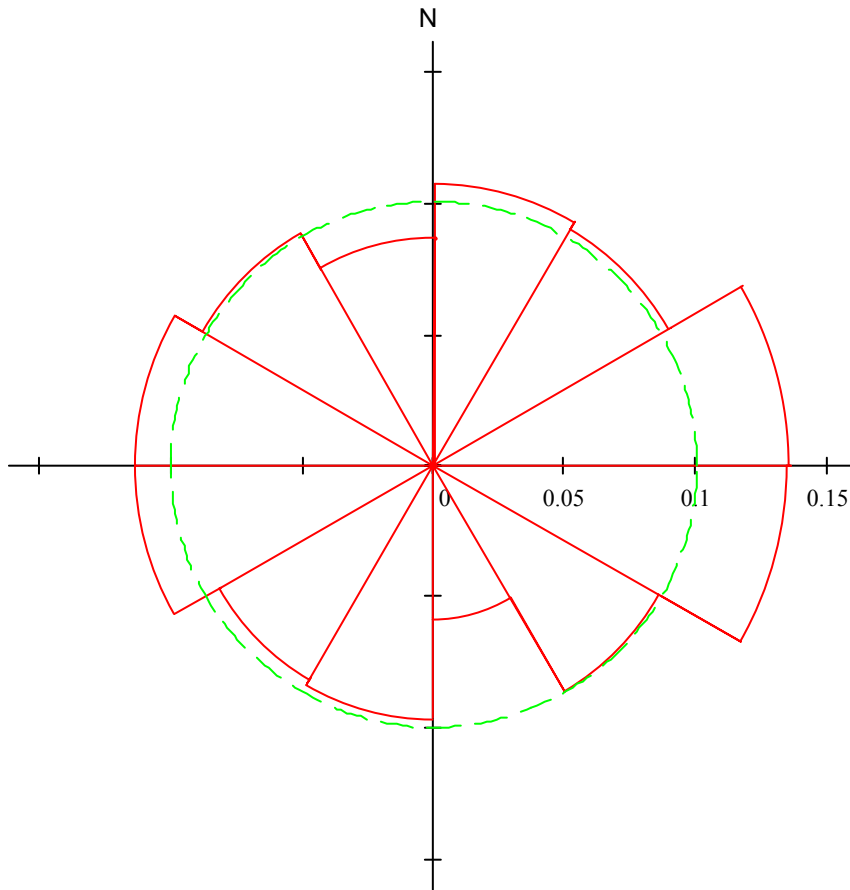


Figure N-62. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 4 at Shenandoah National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by "+")

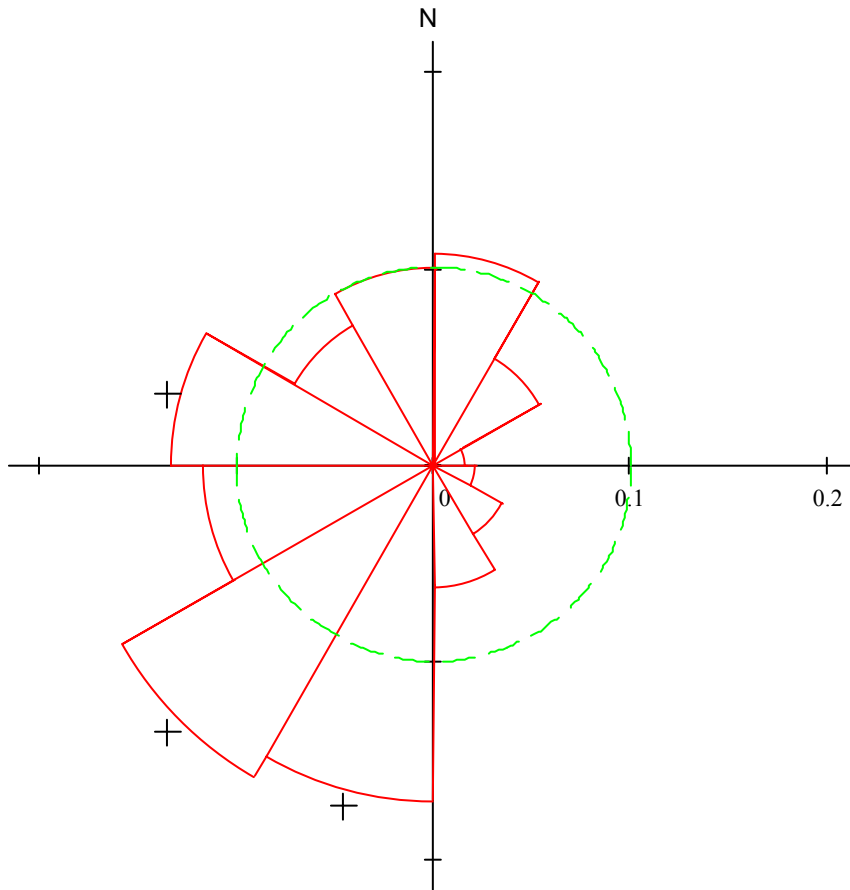


Figure N-63. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 5 at Shenandoah National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

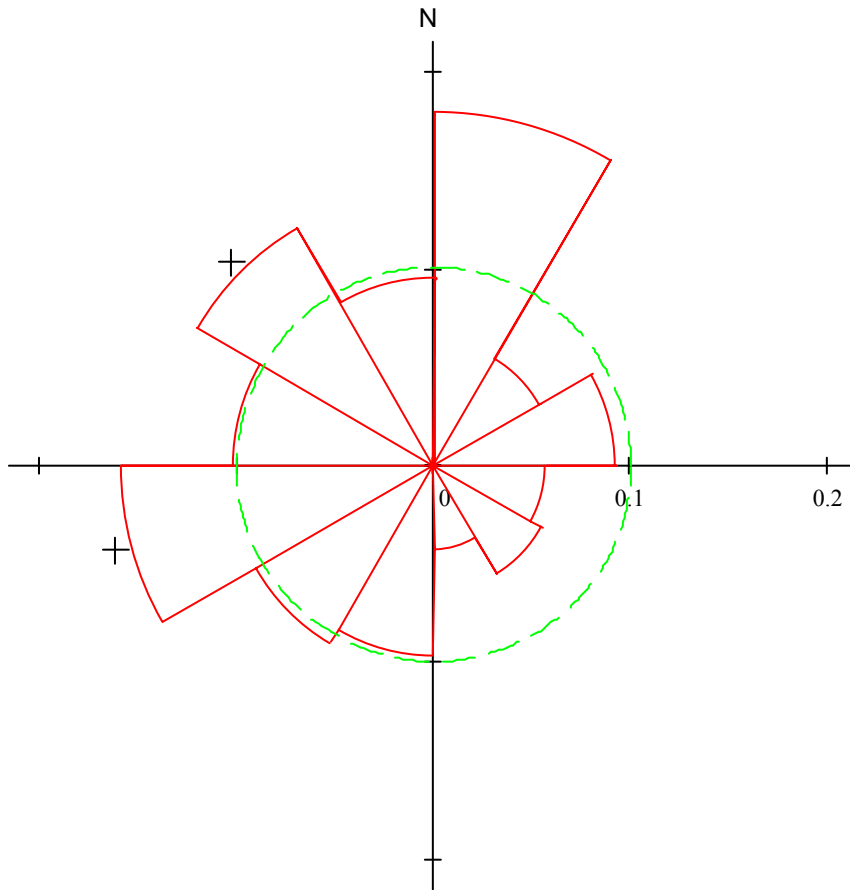


Figure N-64. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 6 at Shenandoah National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

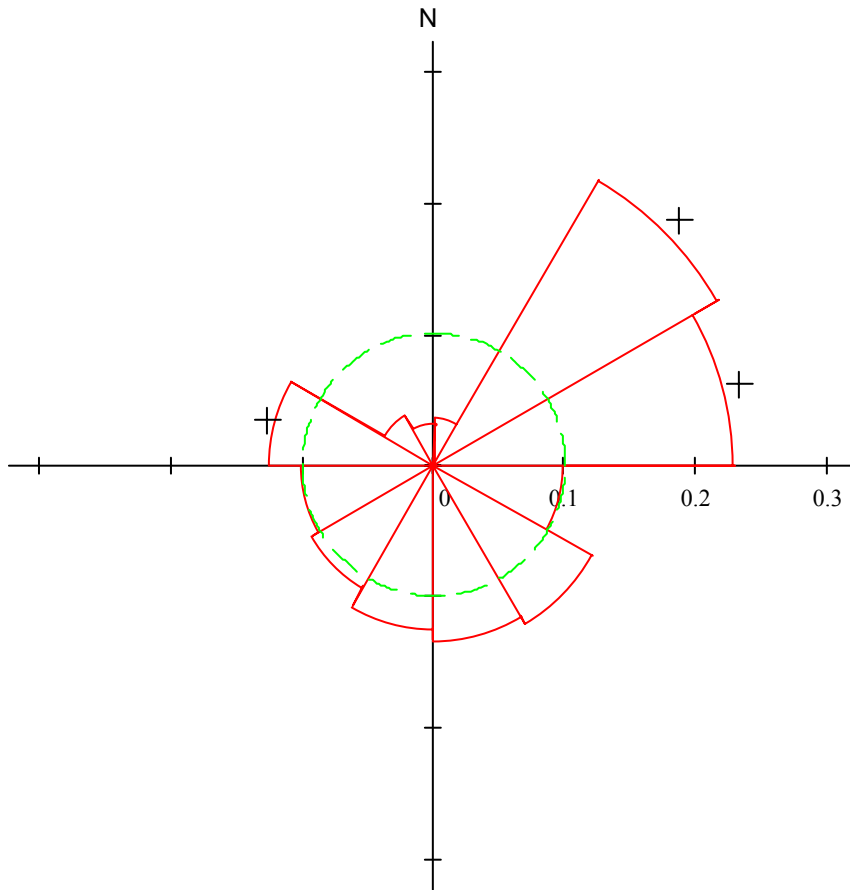


Figure N-65. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 7 at Shenandoah National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

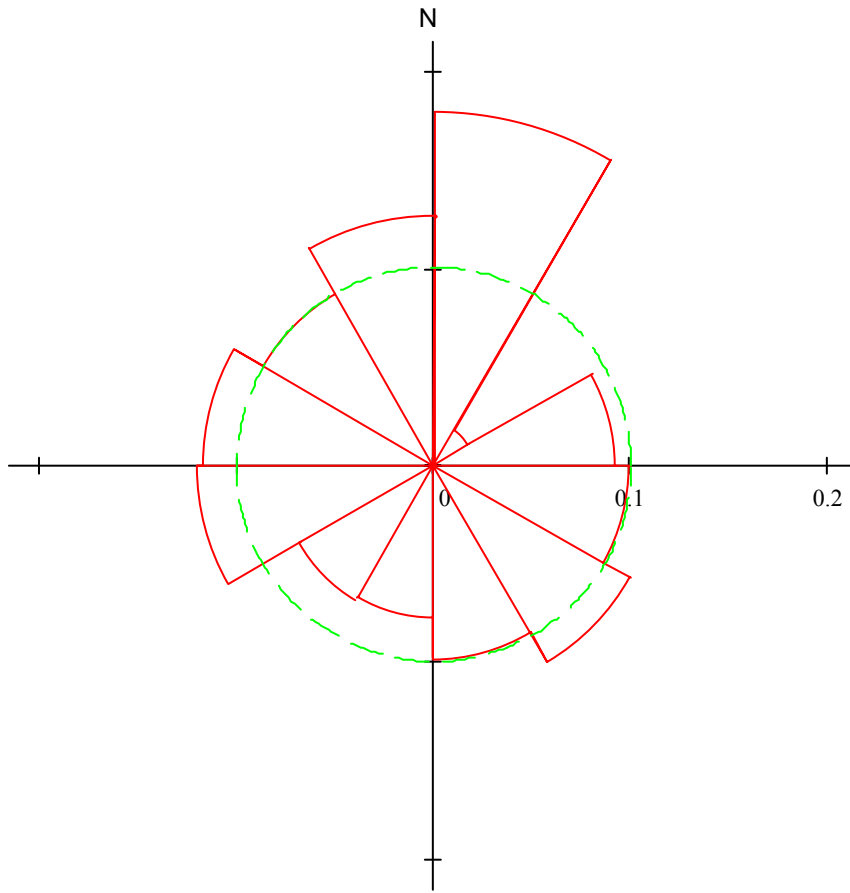


Figure N-66. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 8 at Shenandoah National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

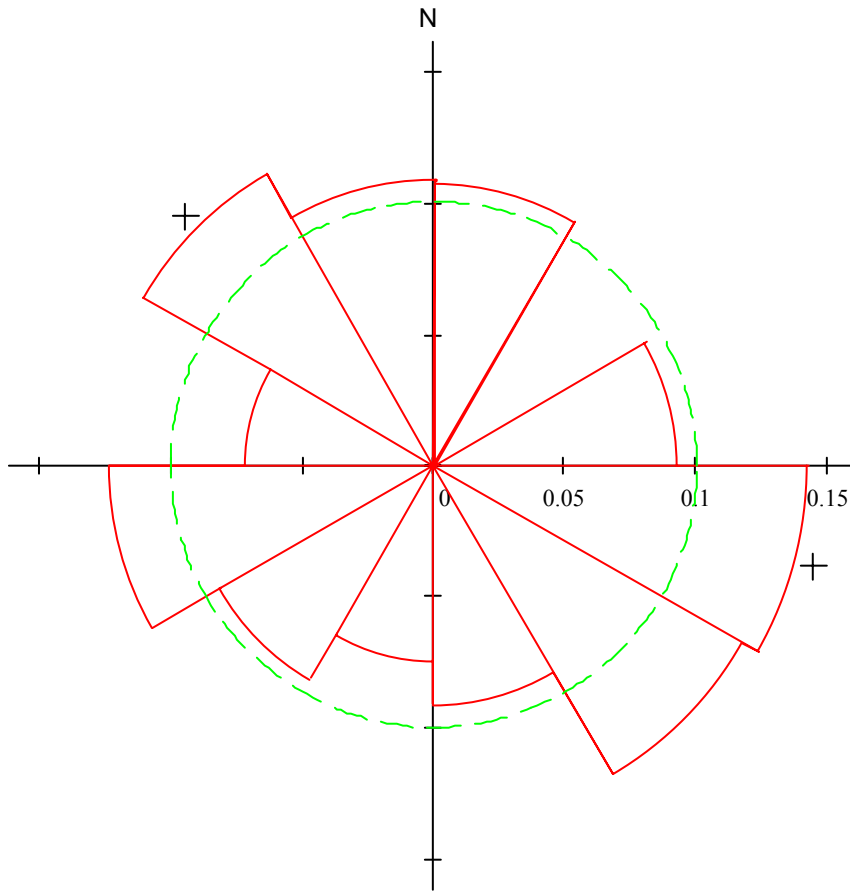


Figure N-67. The probability of a high source day (top 10 percent) given the hourly wind direction for PMF source 9 at Shenandoah National Park and the wind directions with probabilities that are significantly greater than 10 percent (indicated by “+”)

Table N-8. Summary of source type and direction for PMF at Shenandoah National Park

Source number	Directional range (degrees to the east of north)	Source type	Comments
1	210-240, 300-330	Regional/Multi Point	UNMIX 5
2	60-90, 180-240	Regional/Multi Point	UNMIX 1
3	210-240, 270-330	Regional/Multi Point	
4	-	Area	
5	180-240, 270-300	Regional/Multi Point	
6	240-270, 300-330	Regional/Multi Point	
7	30-90, 270-300	Regional/Multi Point	UNMIX 4
8	-	-	
9	90-120, 300-330	Regional/Multi Point	UNMIX 6

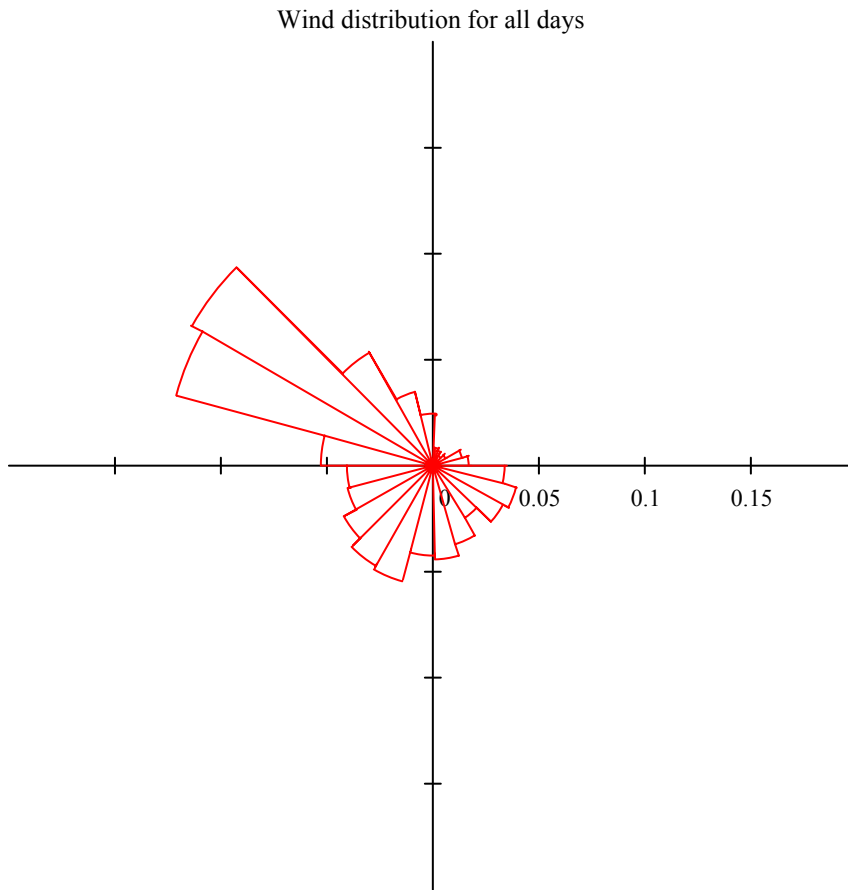


Figure N-68. The distribution of the wind directions at Shenandoah National Park