

BETWIXT
***Built EnvironmenT: Weather scenarios for
investigation of Impacts and eXTremes***

**BETWIXT Technical Briefing Note 5
Version 1, August 2004**

Appendices

PREDICTING FUTURE CHANGES IN WIND

C. HANSON and C.M. GOODESS*

Climatic Research Unit, University of East Anglia
Norwich, NR4 7TJ

*Corresponding author: c.goodess@uea.ac.uk

TABLE OF CONTENTS

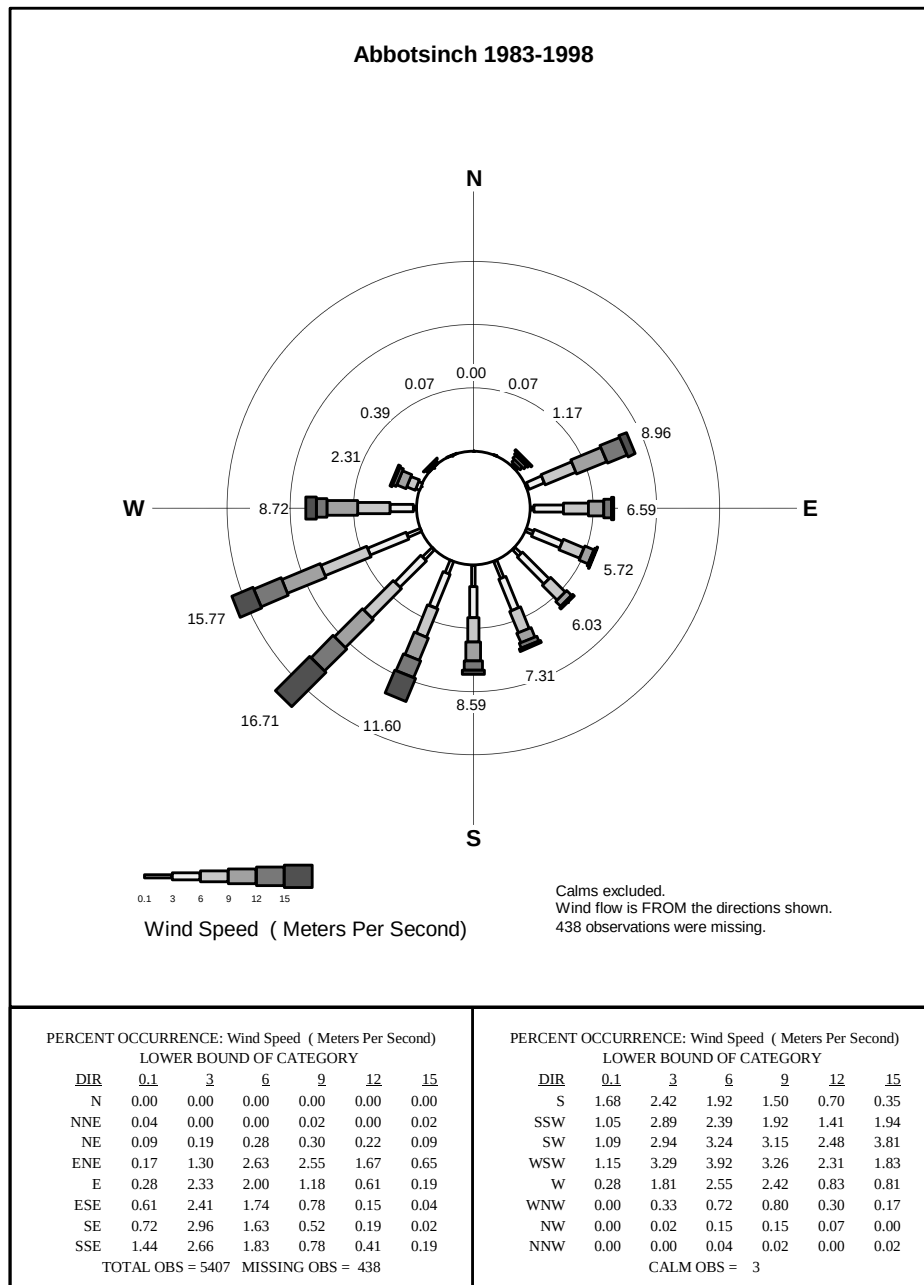
APPENDIX 1: OBSERVED ANNUAL WIND ROSES.....	2
APPENDIX 2: HadRM3H ANNUAL WIND ROSES	11
APPENDIX 3: OBSERVED 95 TH PERCENTILE ANNUAL WIND ROSES	20
APPENDIX 4: HadRM3H 95 TH PERCENTILE ANNUAL WIND ROSES	29
APPENDIX 5: OBSERVED 5 TH PERCENTILE ANNUAL WIND ROSES	38
APPENDIX 6: HadRM3H 5 TH PERCENTILE ANNUAL WIND ROSES	47
APPENDIX 7: OBSERVED SEASONAL WIND ROSES.....	56
APPENDIX 8: HadRM3H SEASONAL WIND ROSES.....	65
APPENDIX 9: SUMMARY OF SEASONAL CHANGES IN WIND SPEED	83
APPENDIX 10: SEASONAL CHANGES IN WIND DIRECTION.....	86

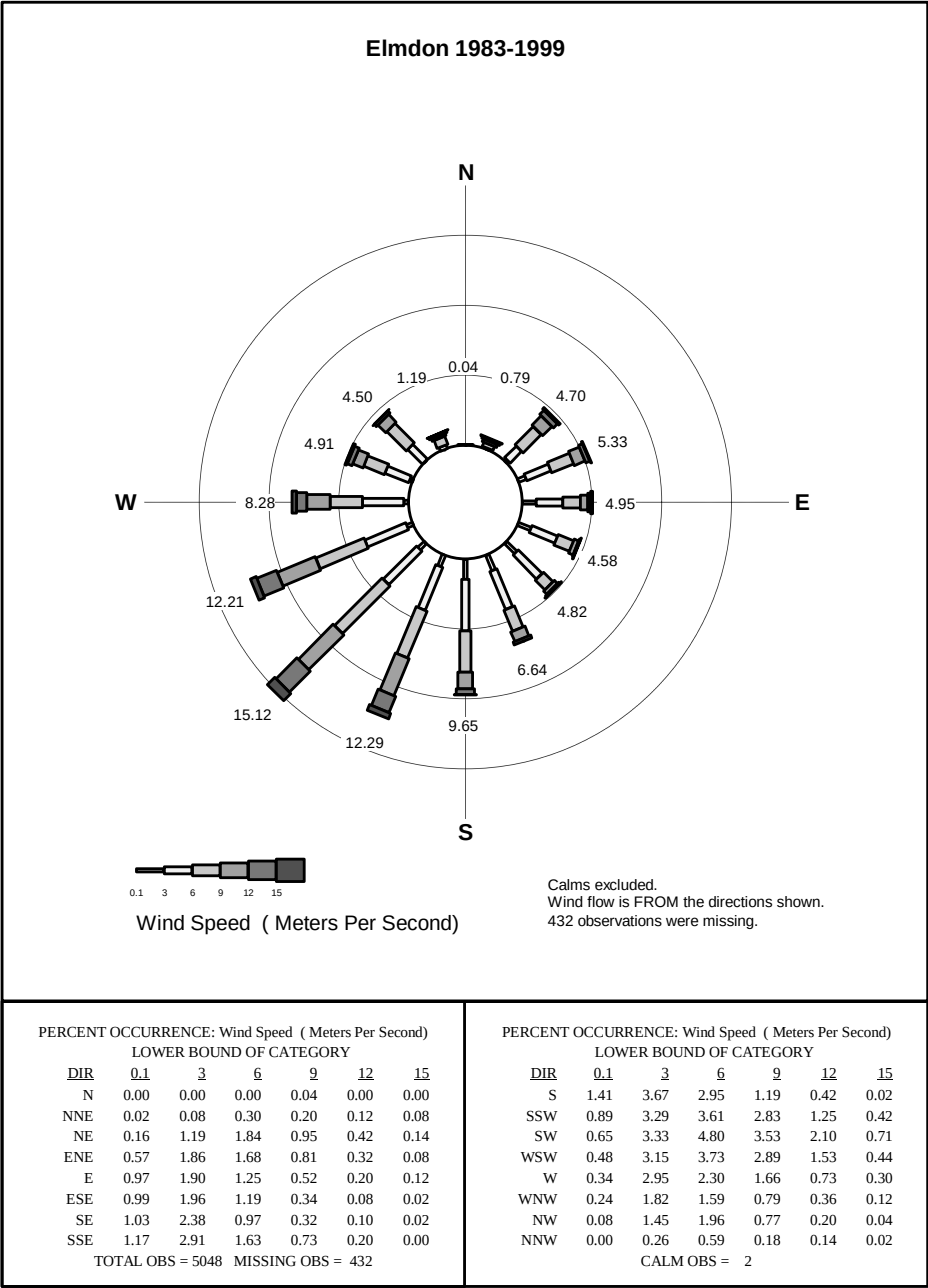
Table 1: Temporal extent of the observed data and the number of missing hourly records for each station.

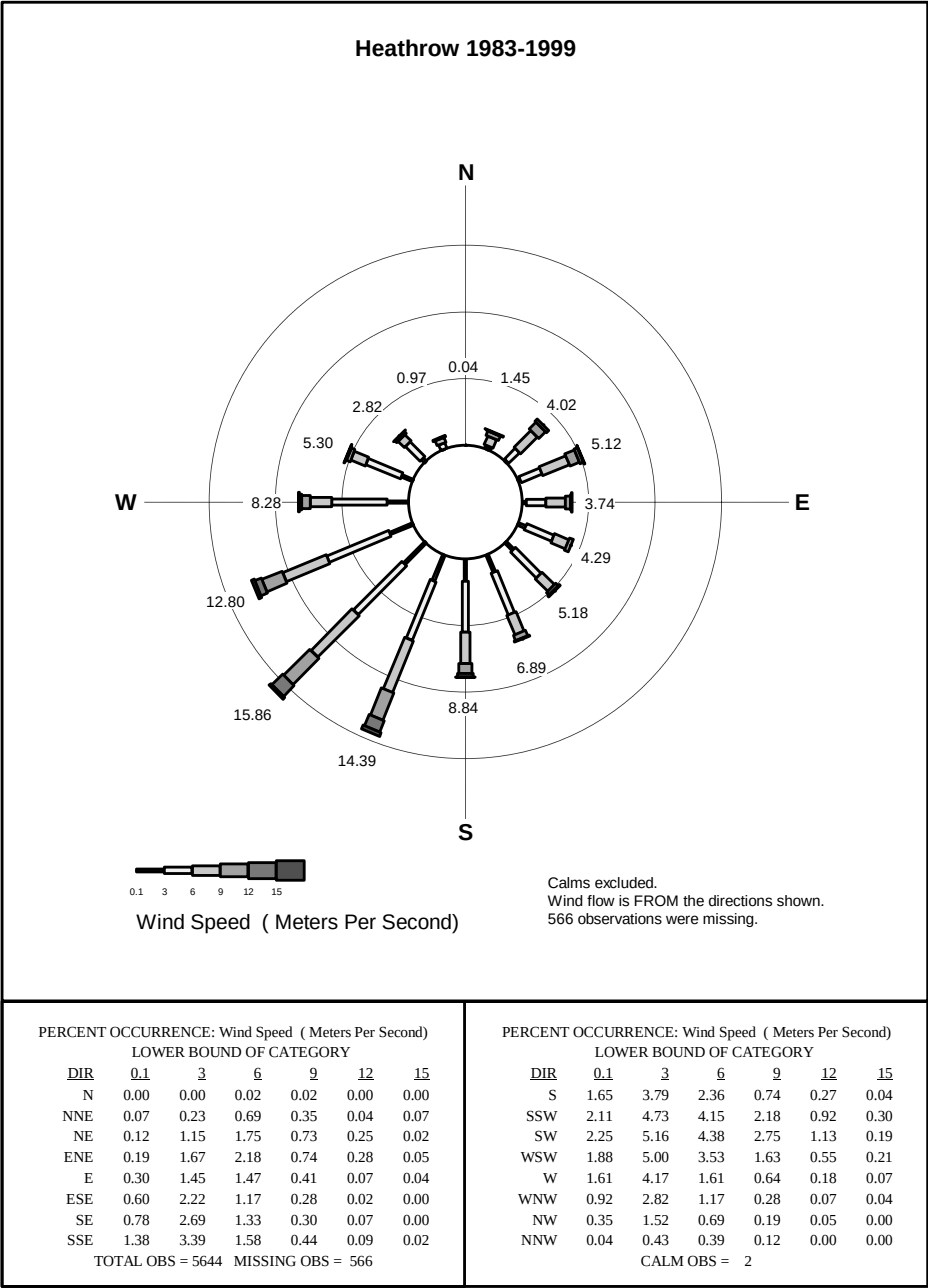
<i>Station Name</i>	<i>Temporal Extent</i>	<i>Number of missing data (hours)</i>
Abbotsinch	1983-1998	438
Elmdon	1983-1999	432
Heathrow	1983-1999	566
Hemsby	1983-1999	373
Herstmonceux	1983-1999	1311
Leeds	1987-1999	218
Ringway	1983-1999	390
St. Mawgan	1983-1999	342
Yeovilton	1983-1999	391

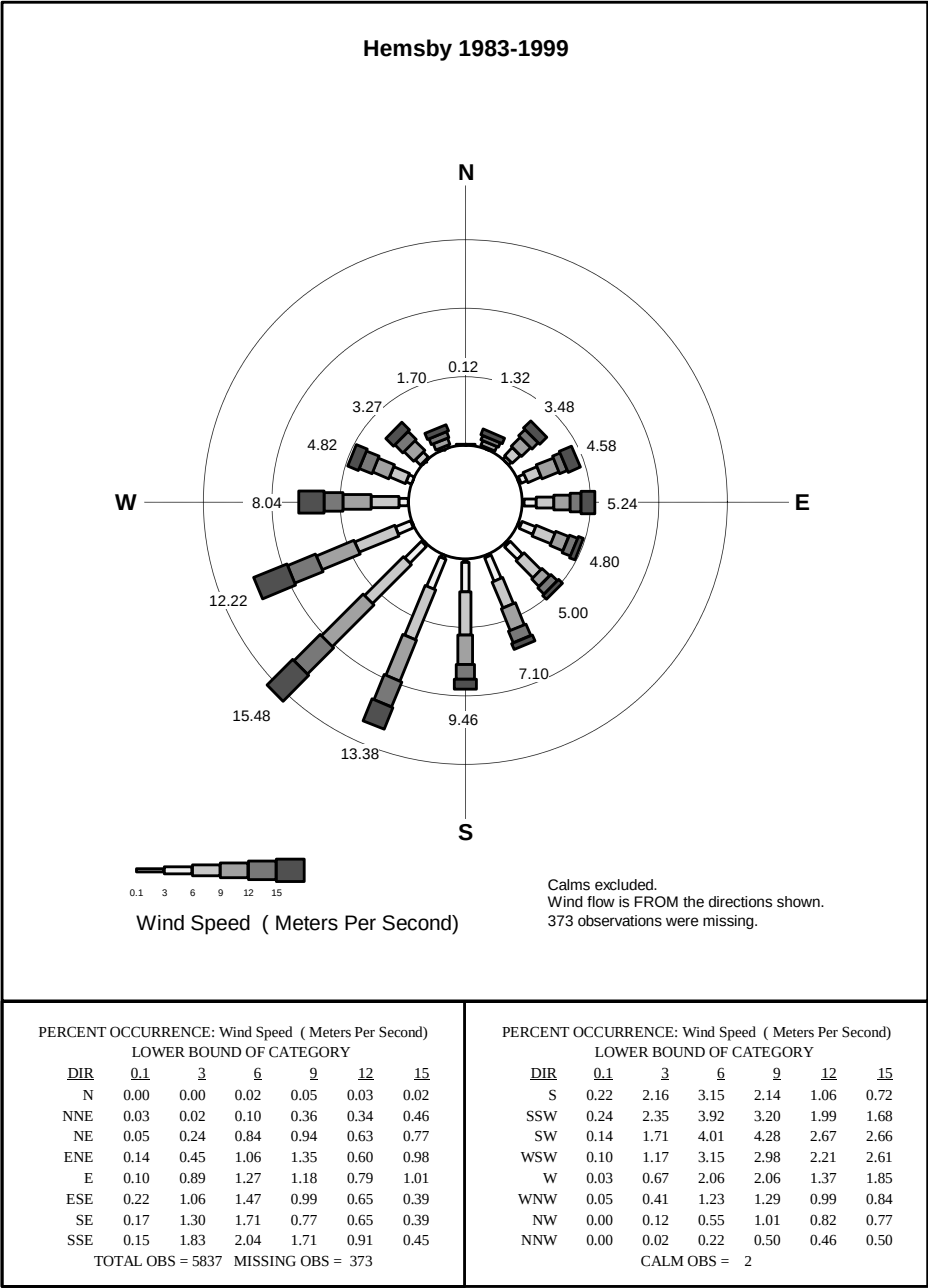
APPENDIX 1: OBSERVED ANNUAL WIND ROSES

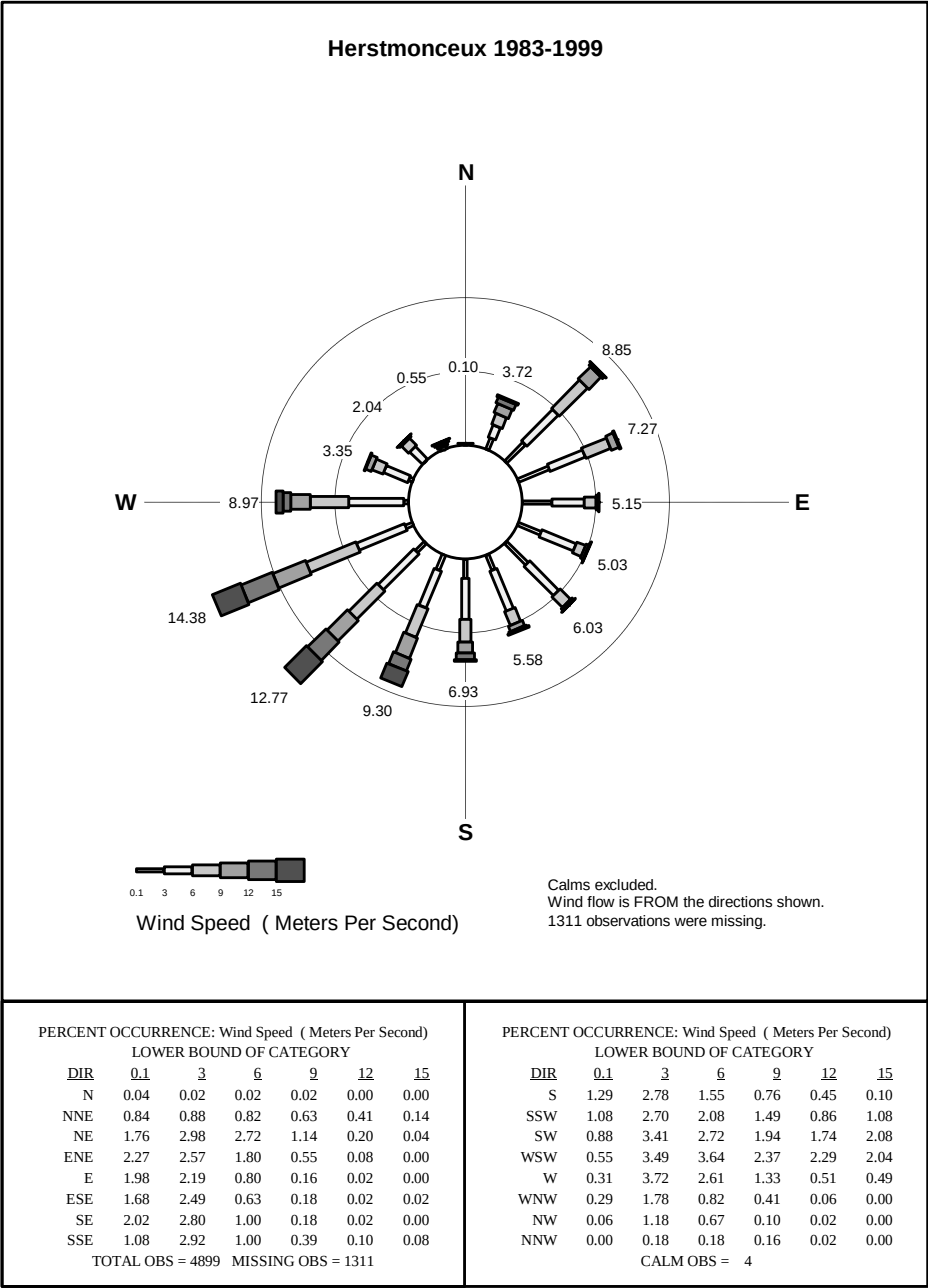
Observed mean annual wind speed (m/s) and direction (degrees) for the nine stations and time periods listed in Table 1.

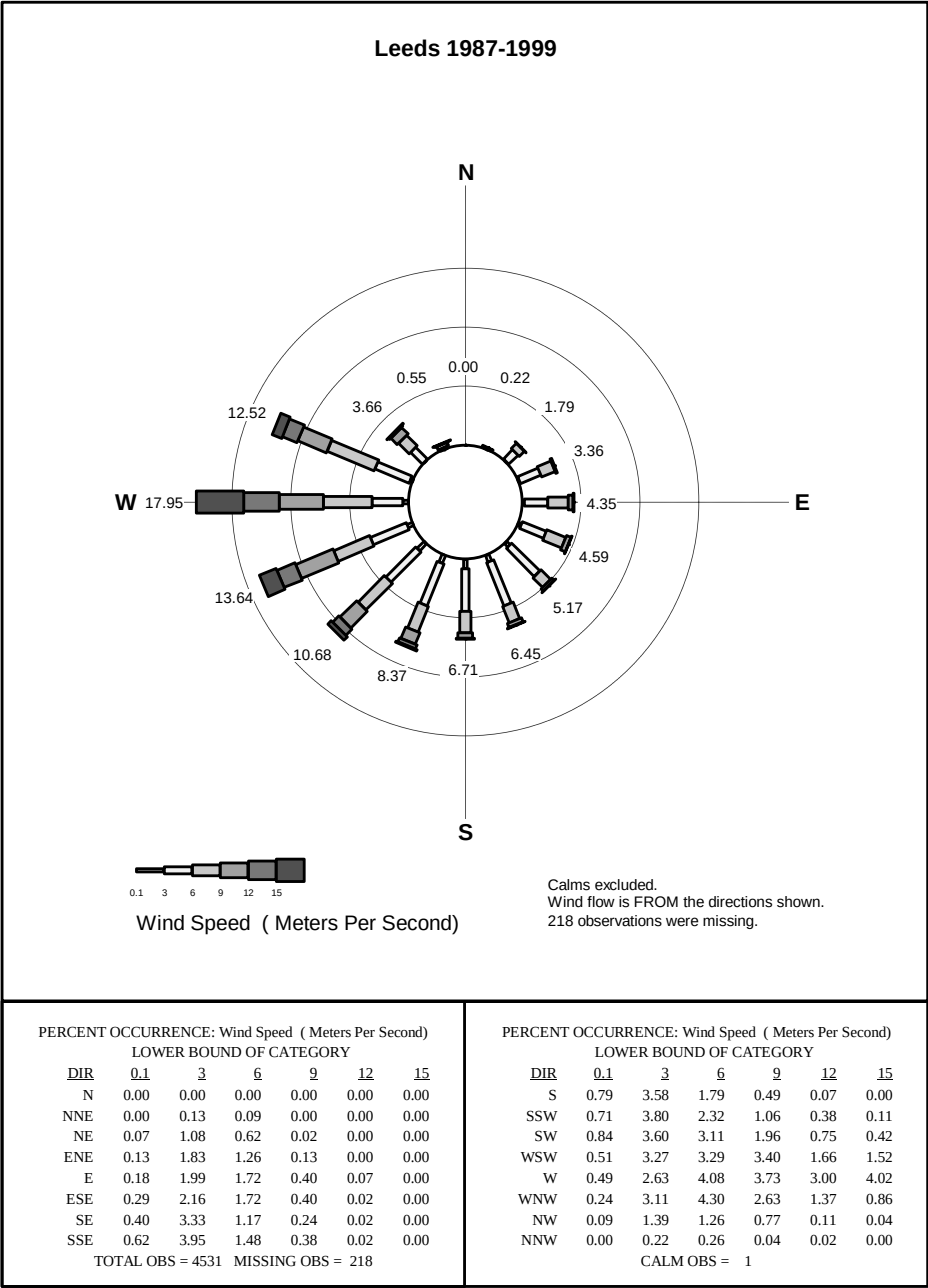


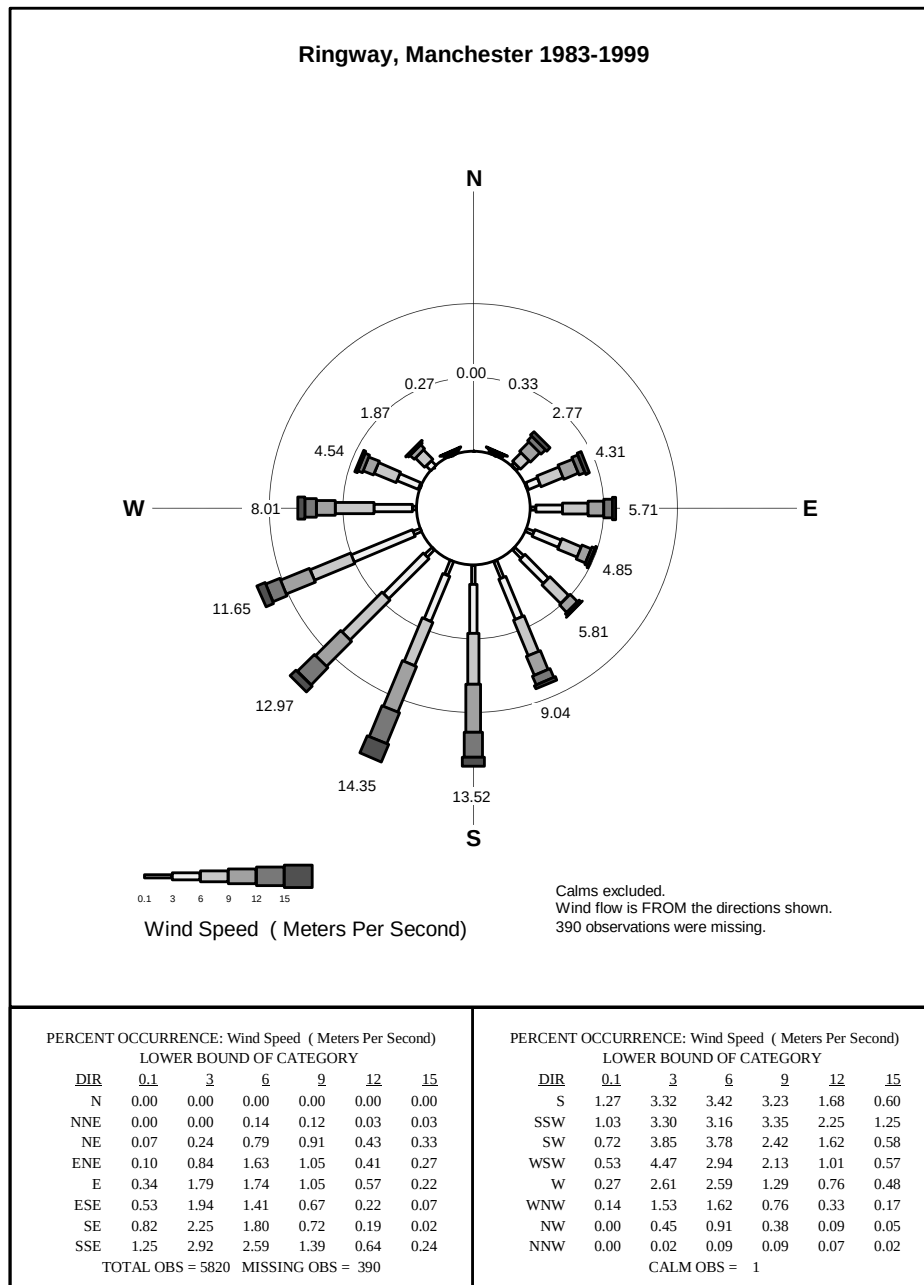


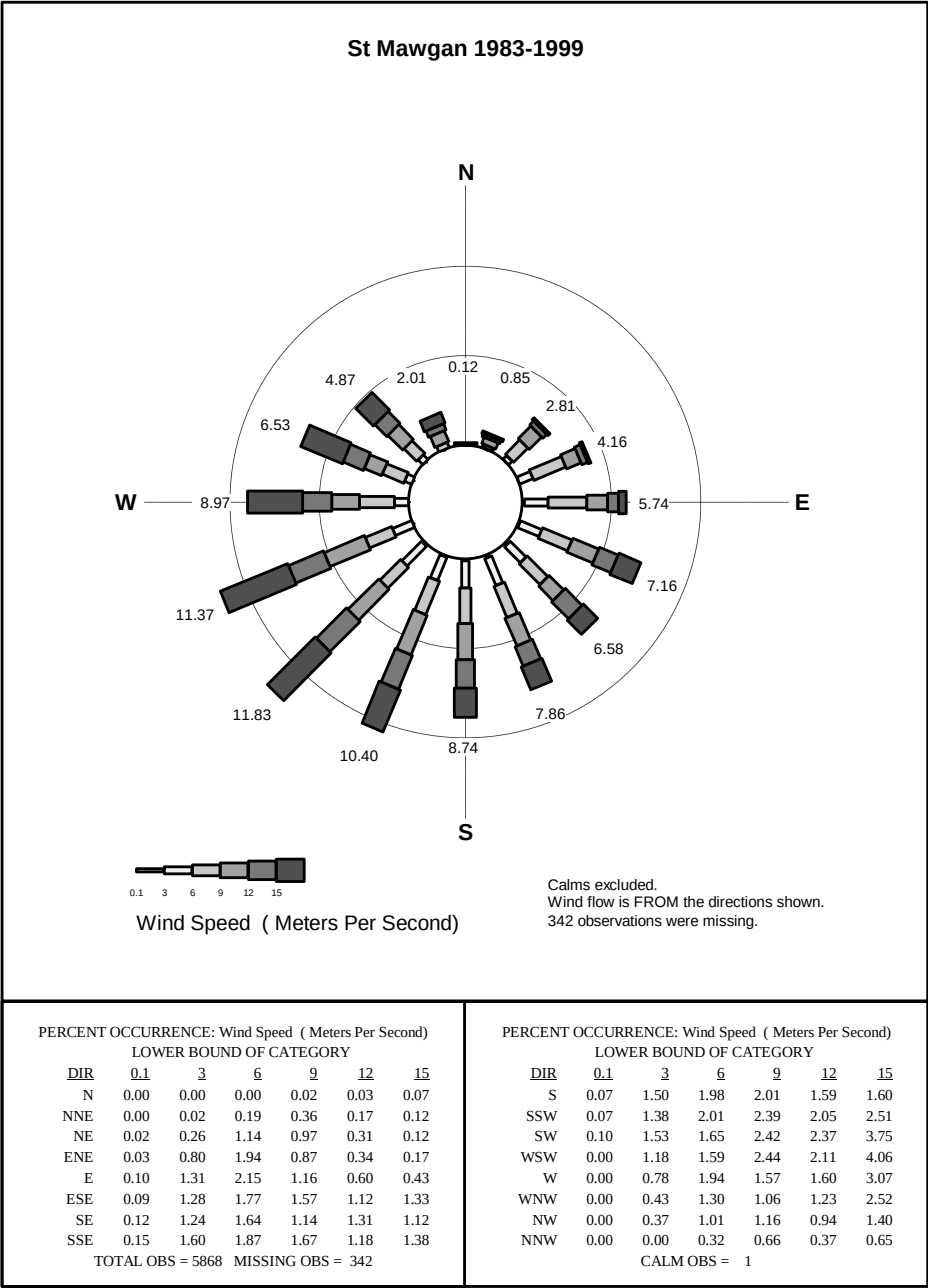


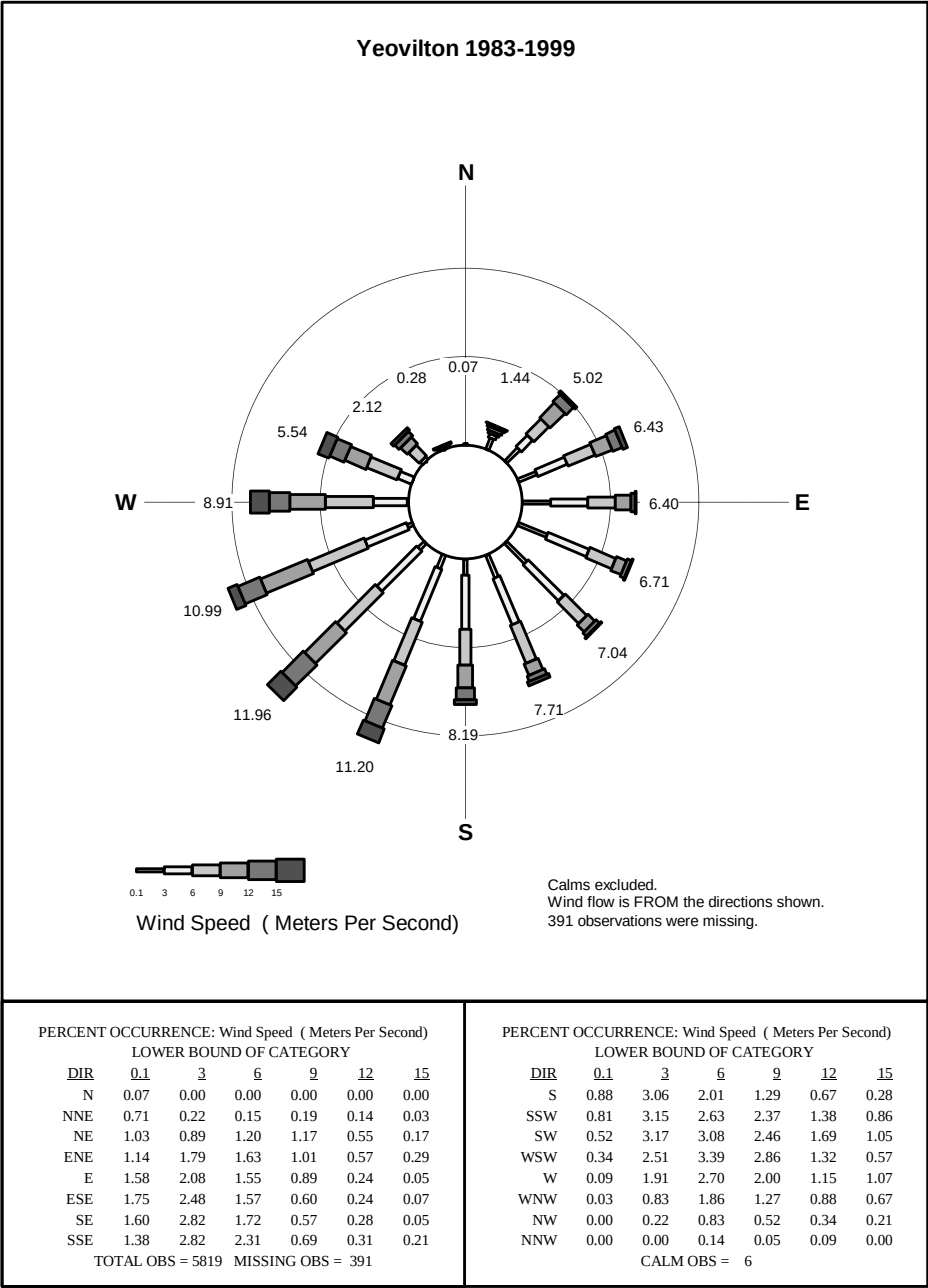






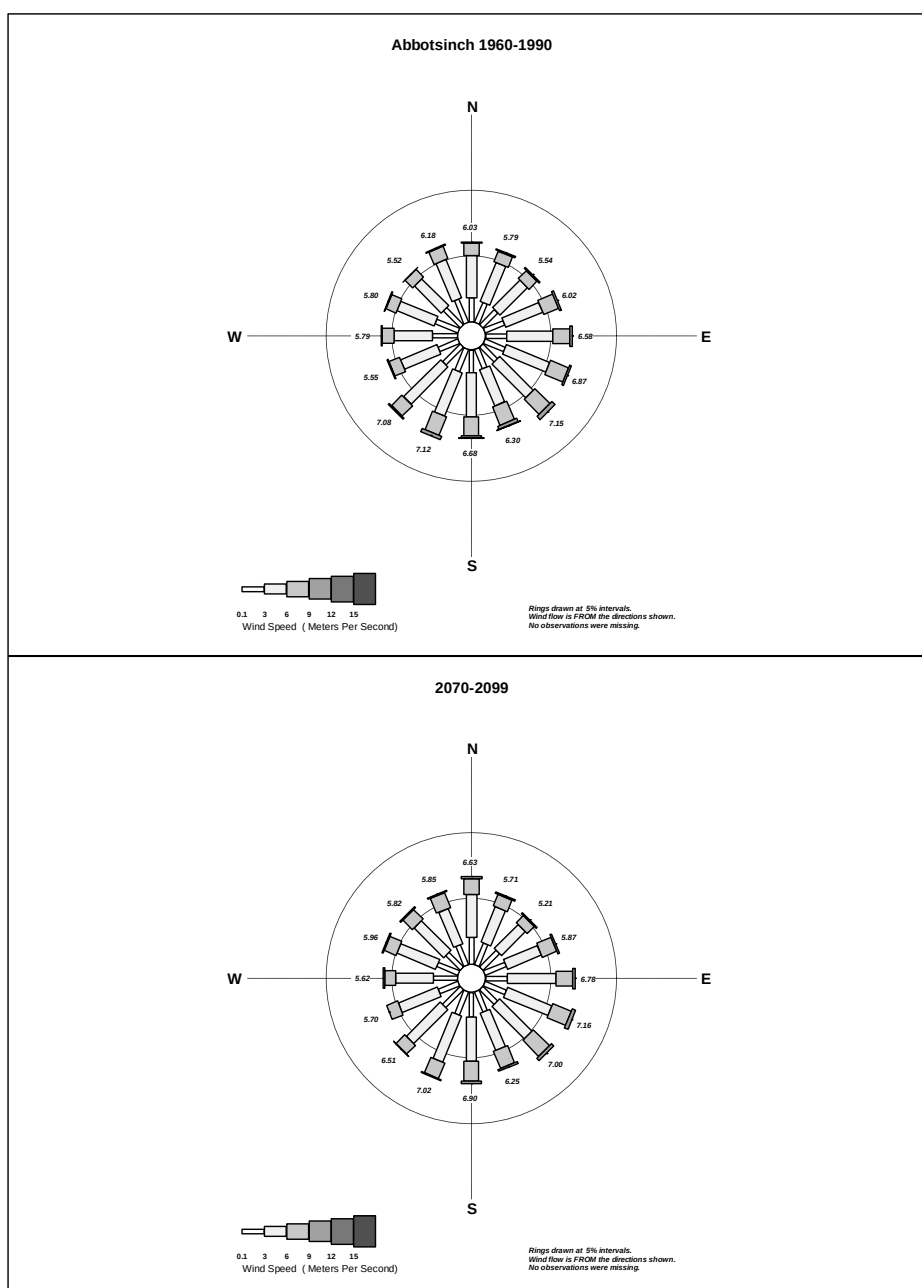


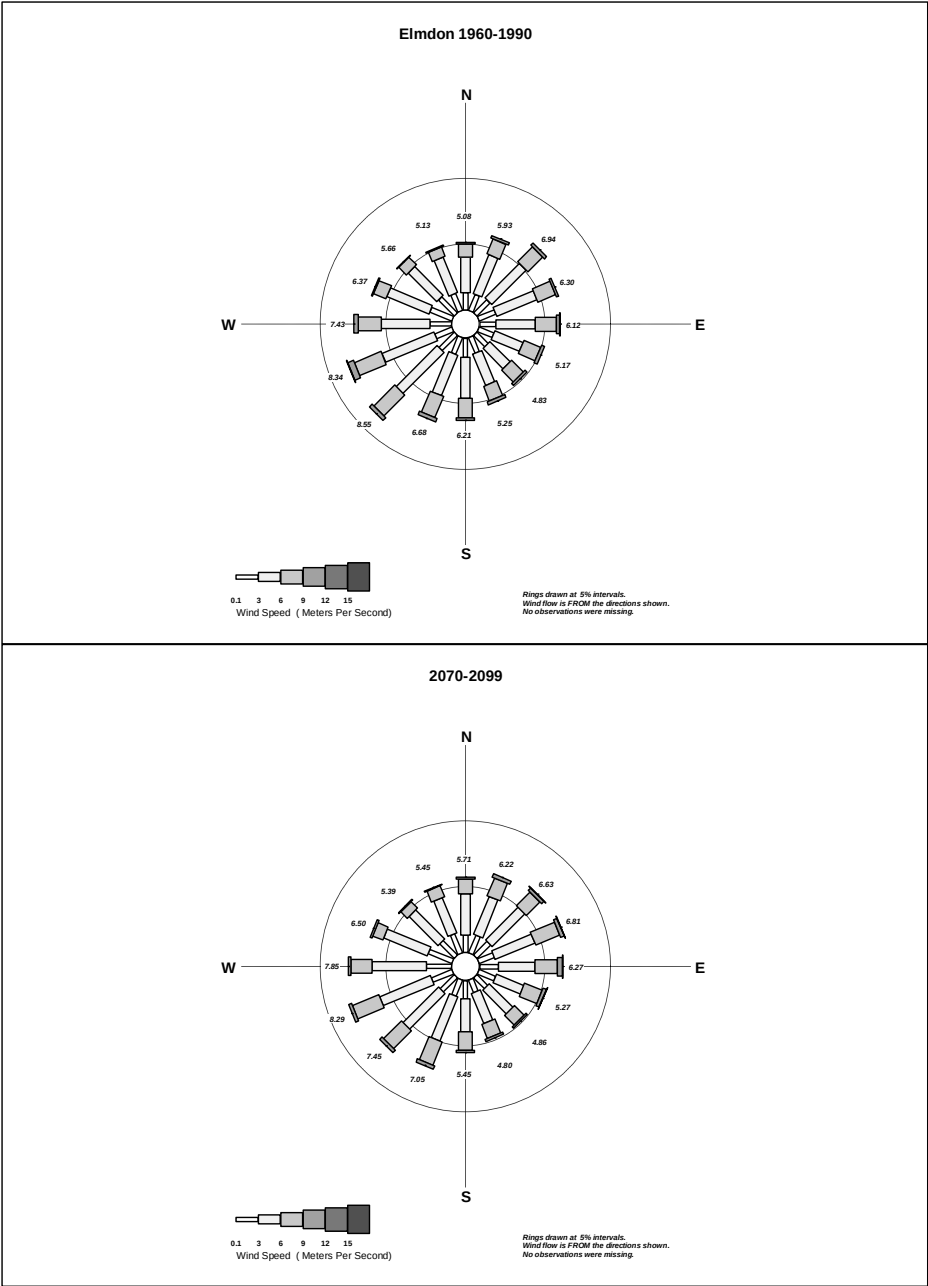


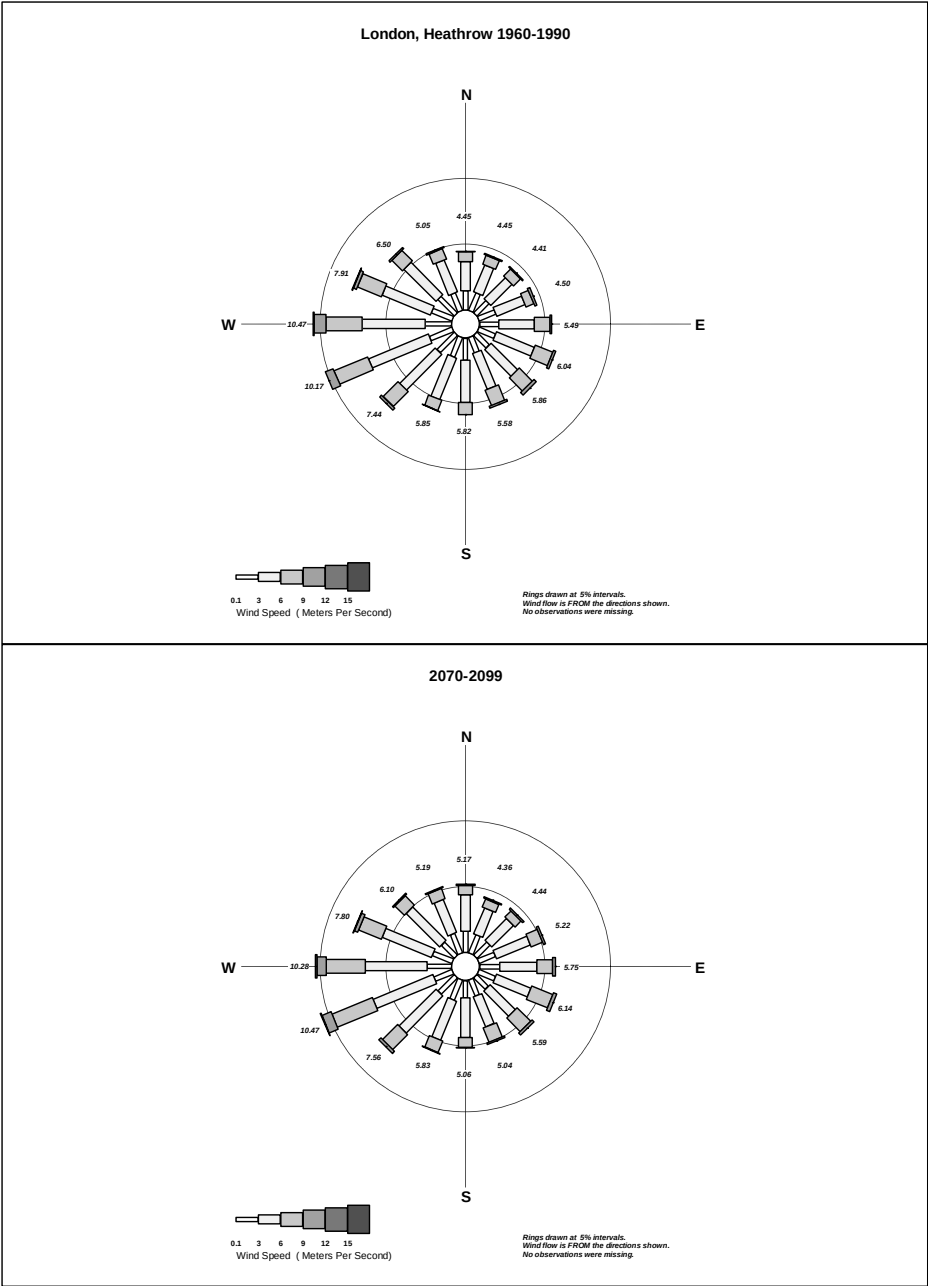


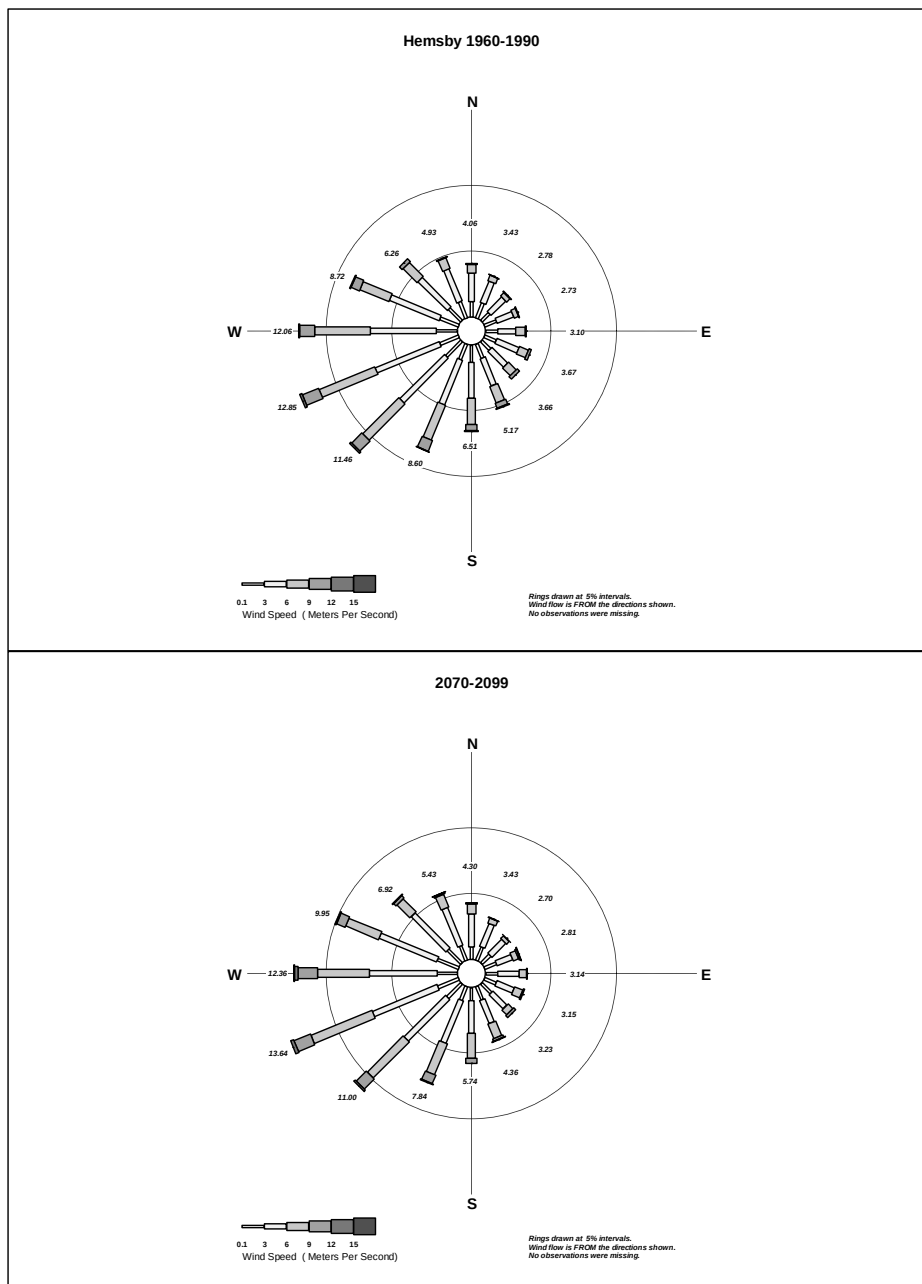
APPENDIX 2: HadRM3H ANNUAL WIND ROSES

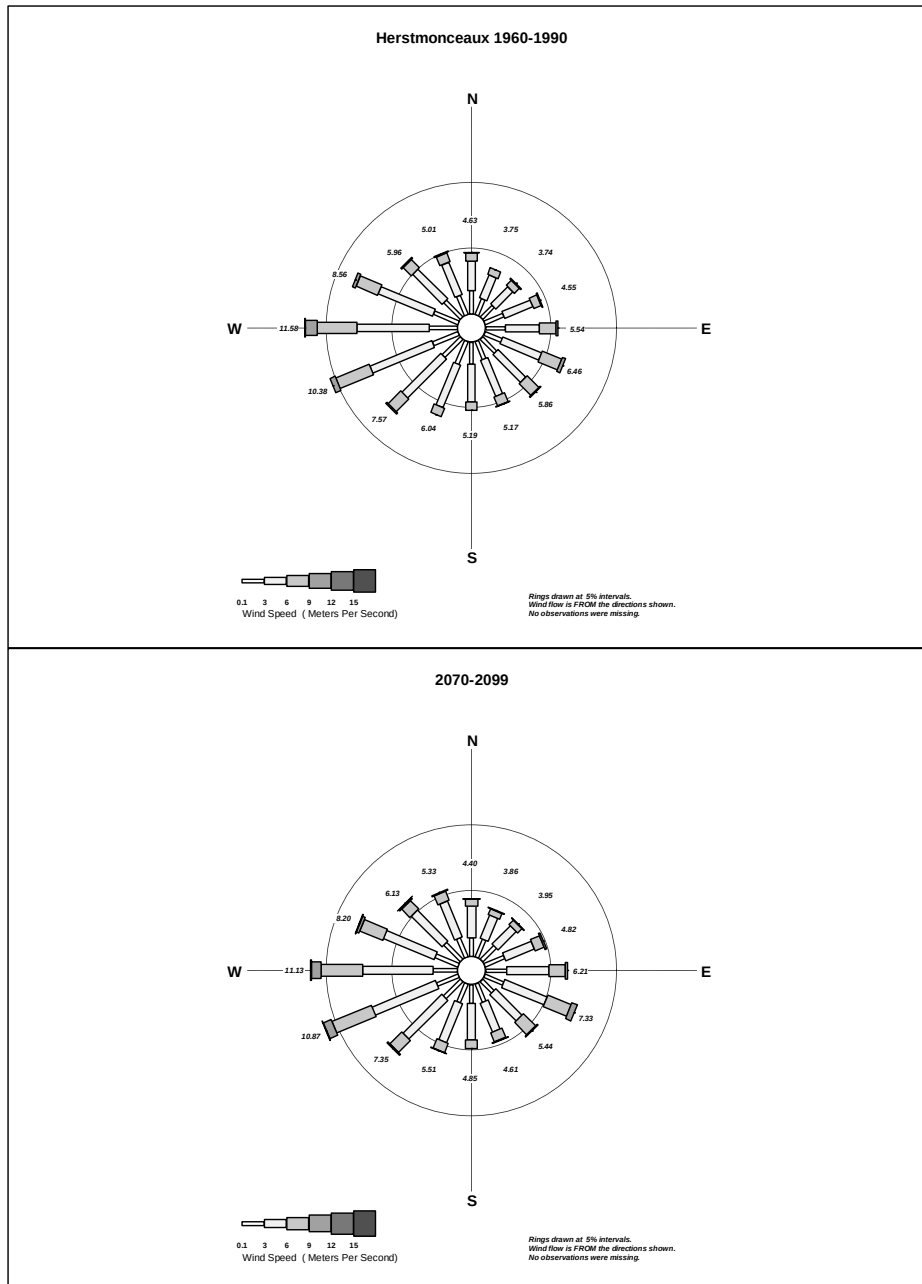
HadRM3H simulated mean annual wind speed (m/s) and direction (degrees) for the 1961-1990 baseline period (upper panels) and the 2070-2099 scenario period (lower panels) for the nine stations.

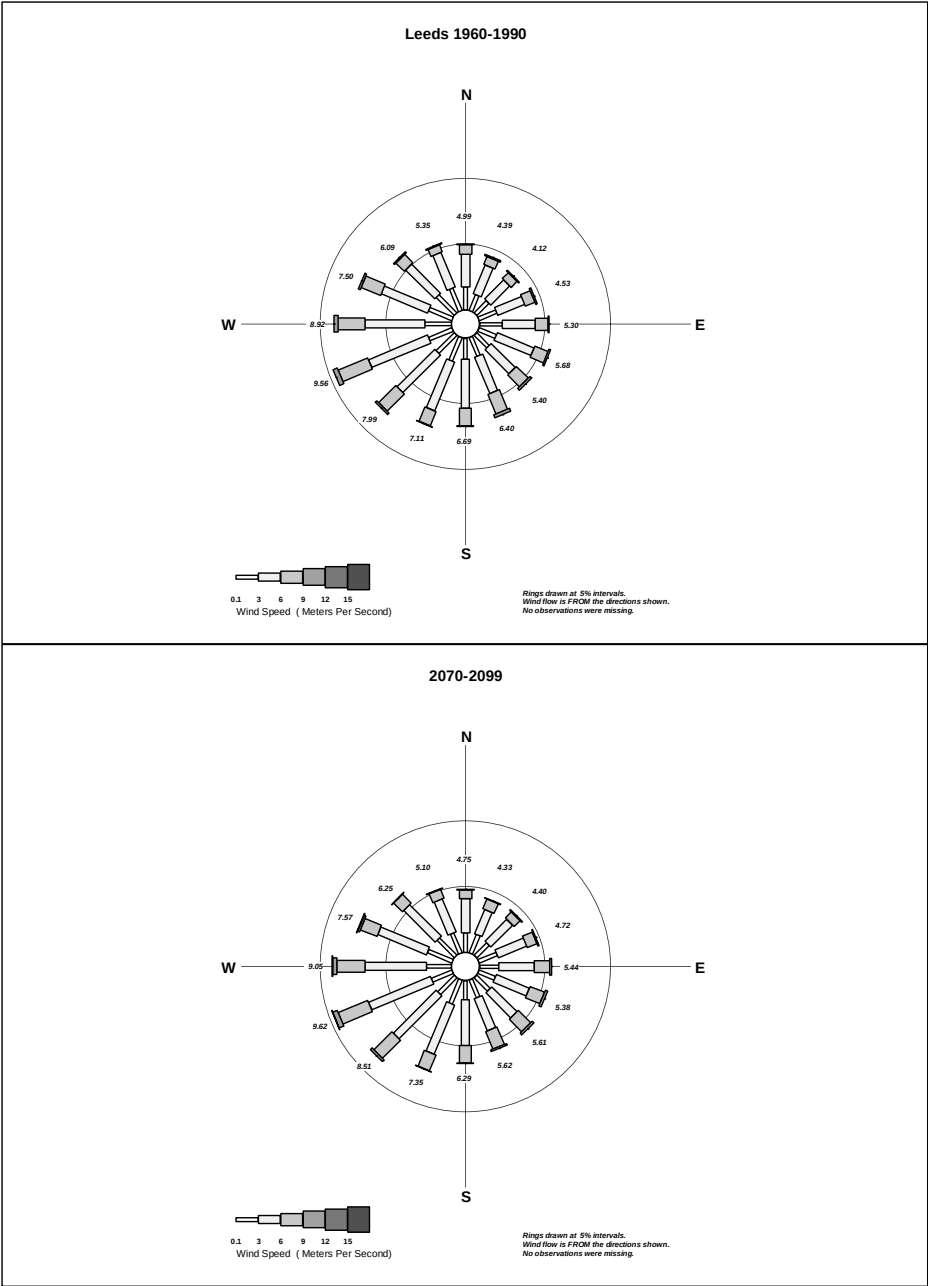


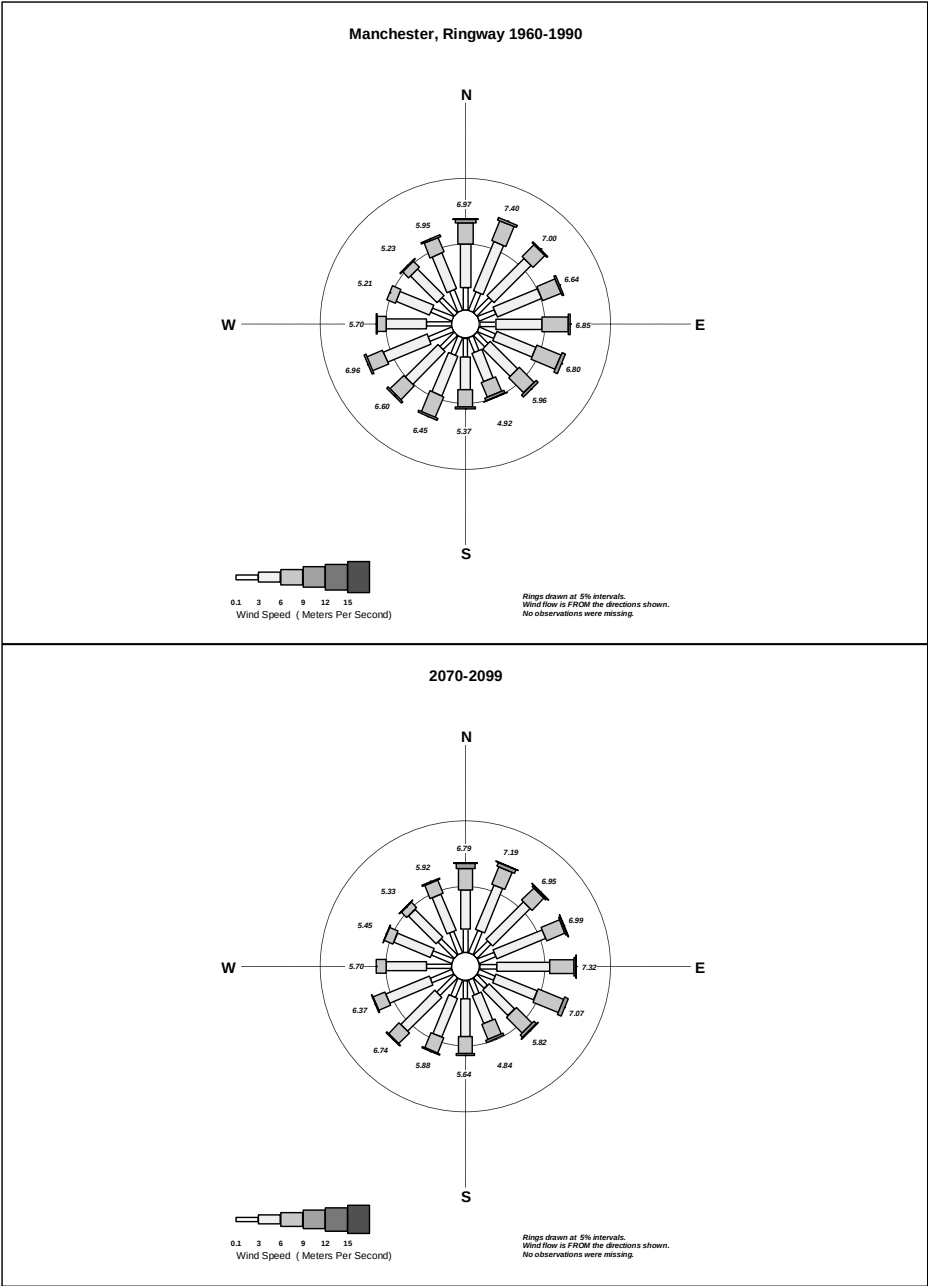


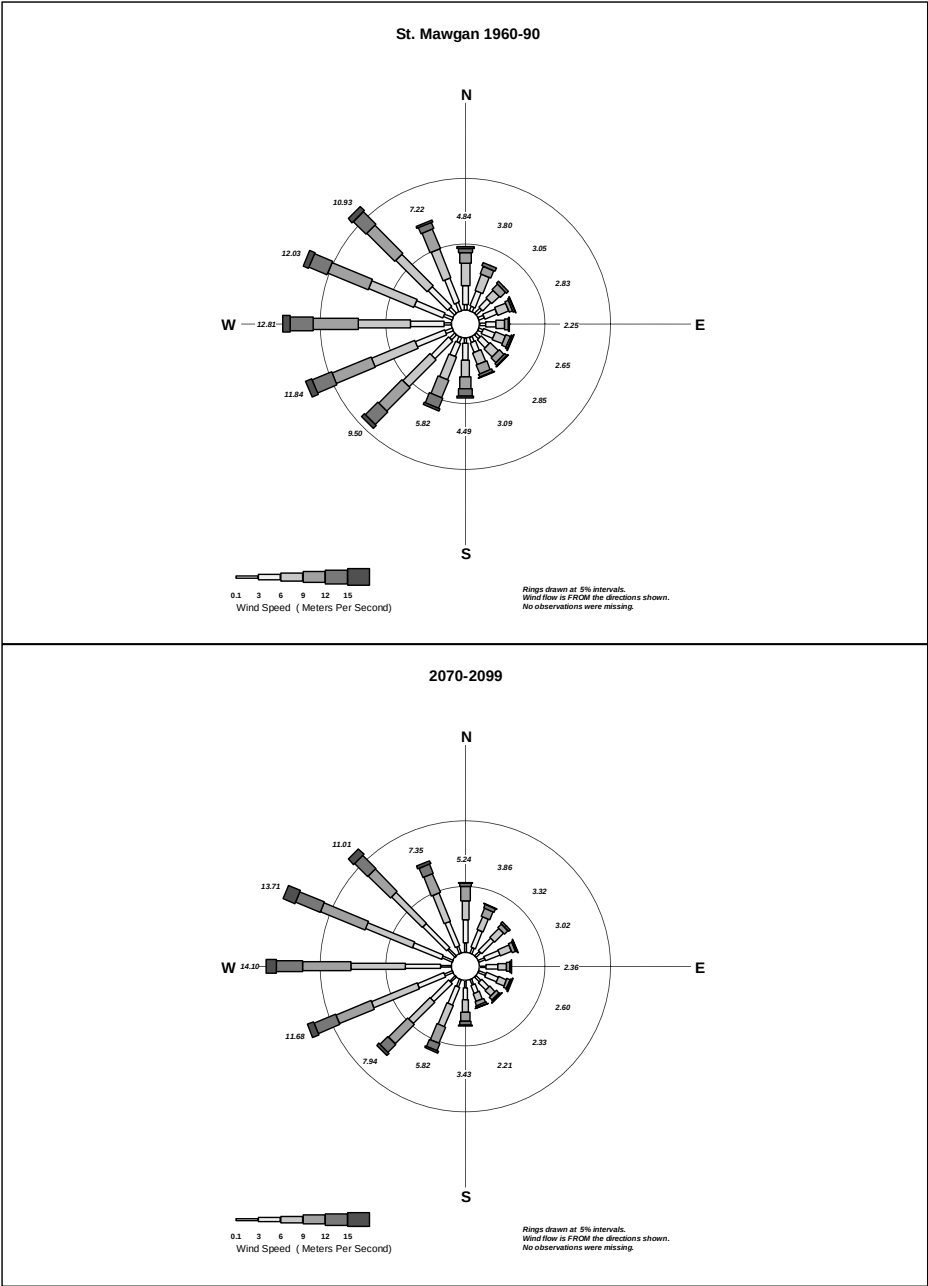


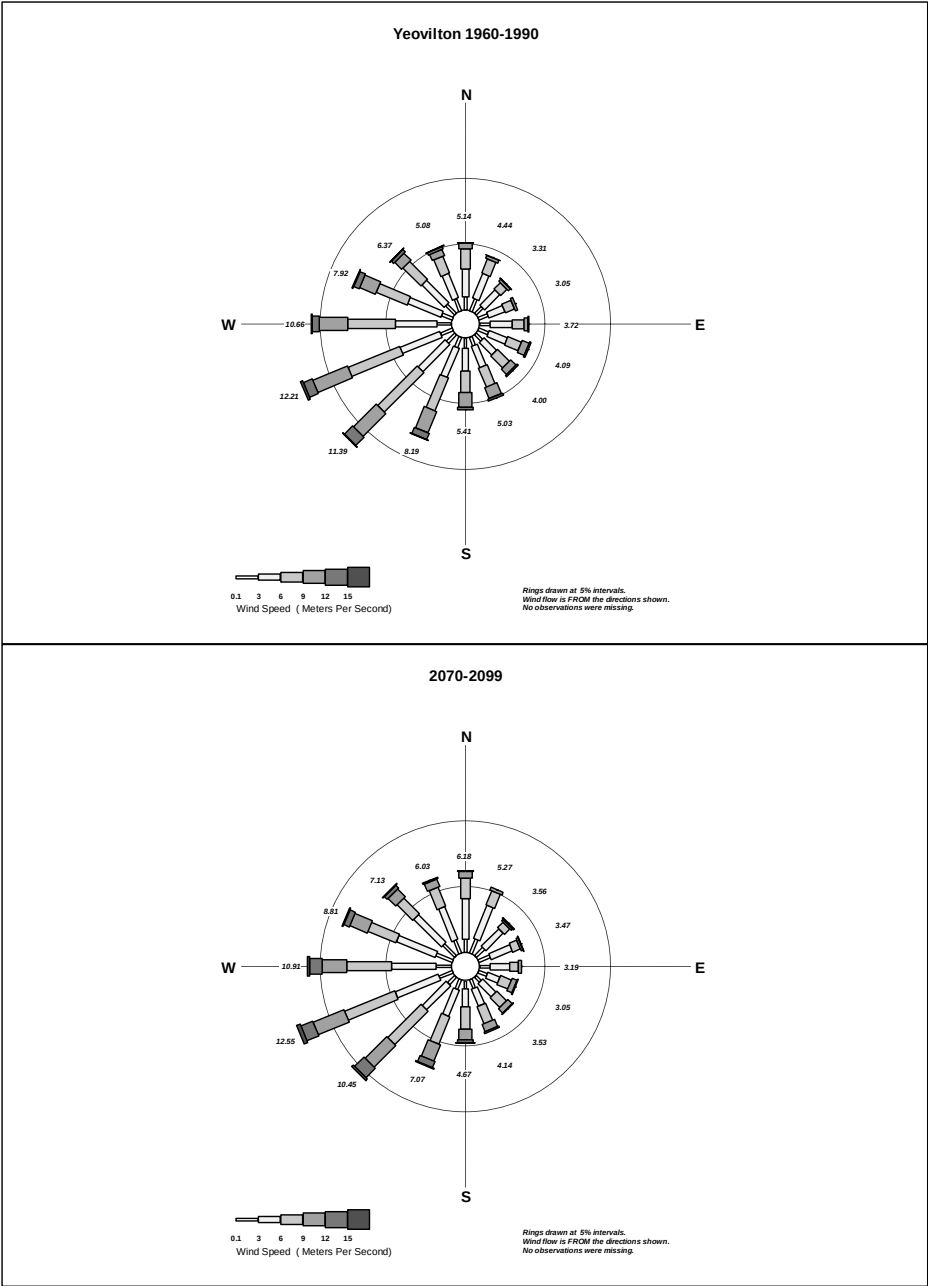






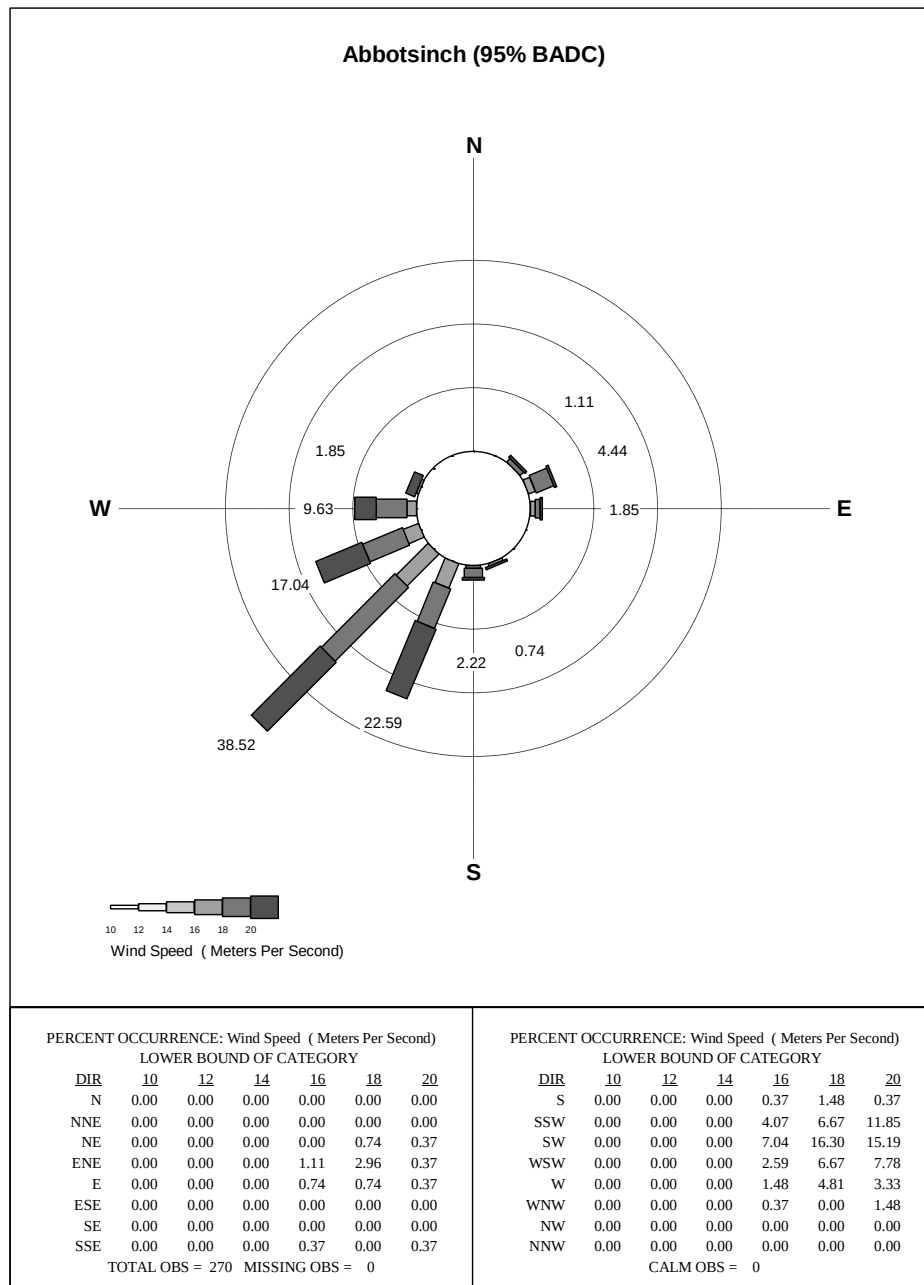


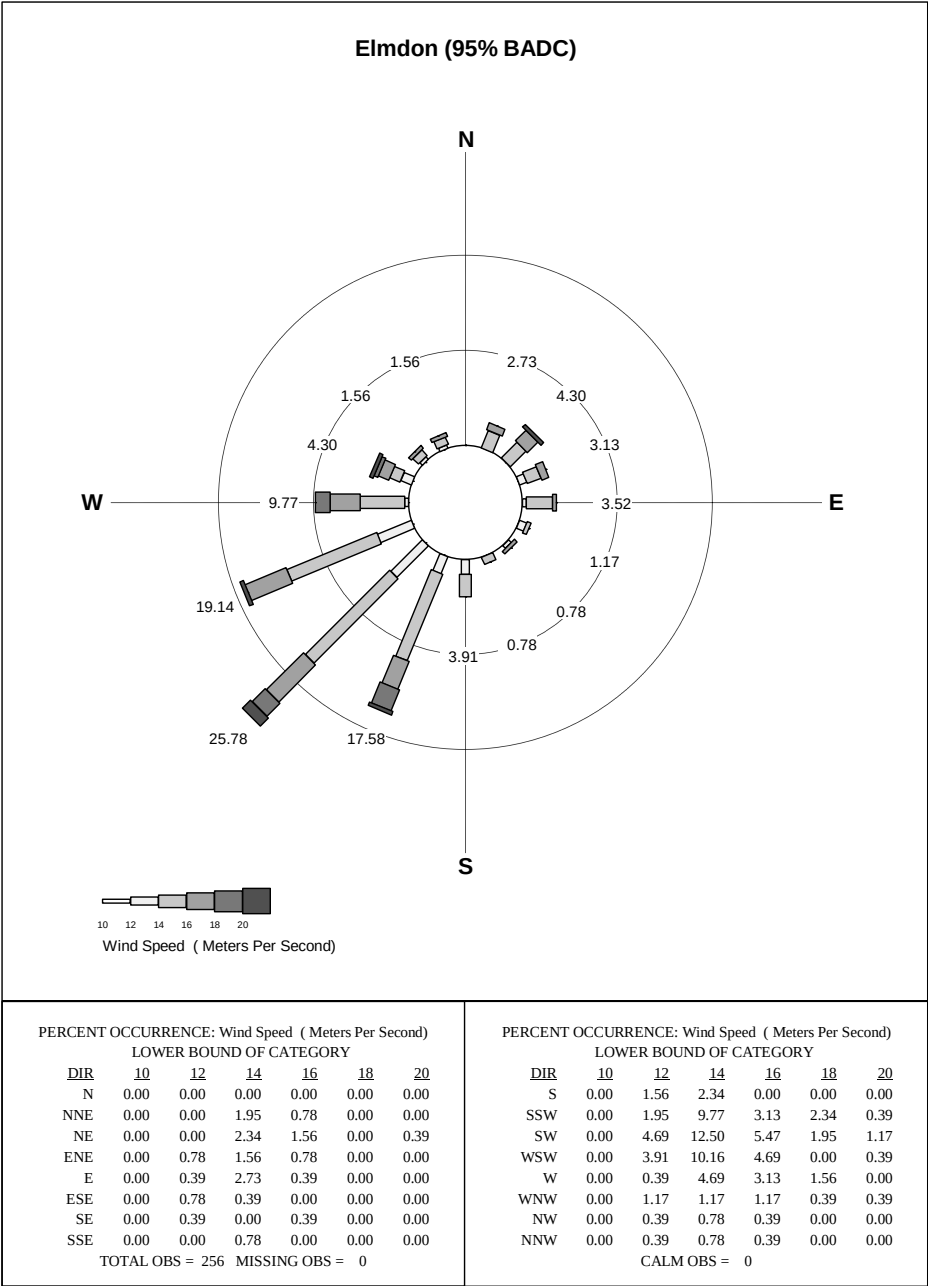


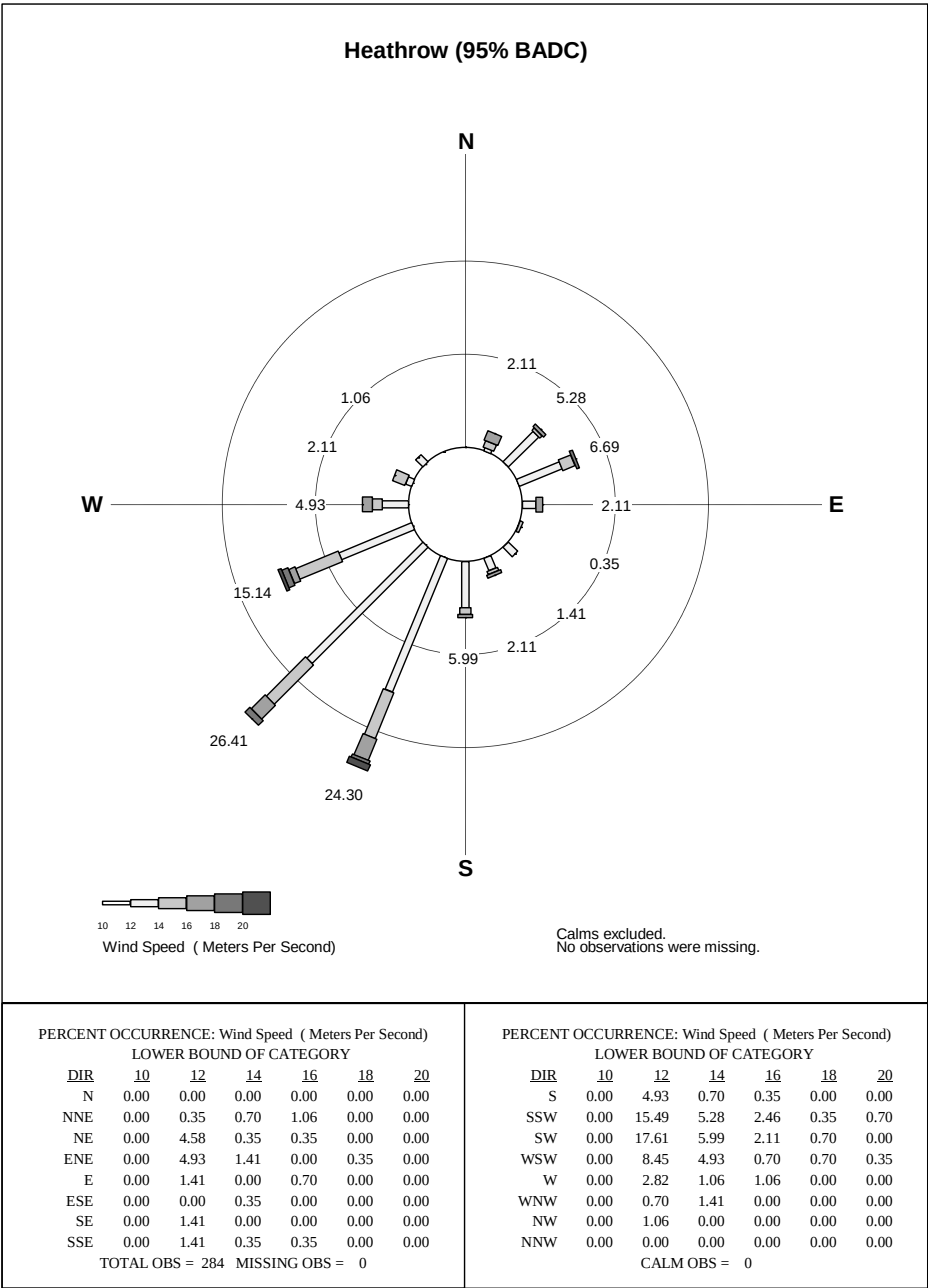


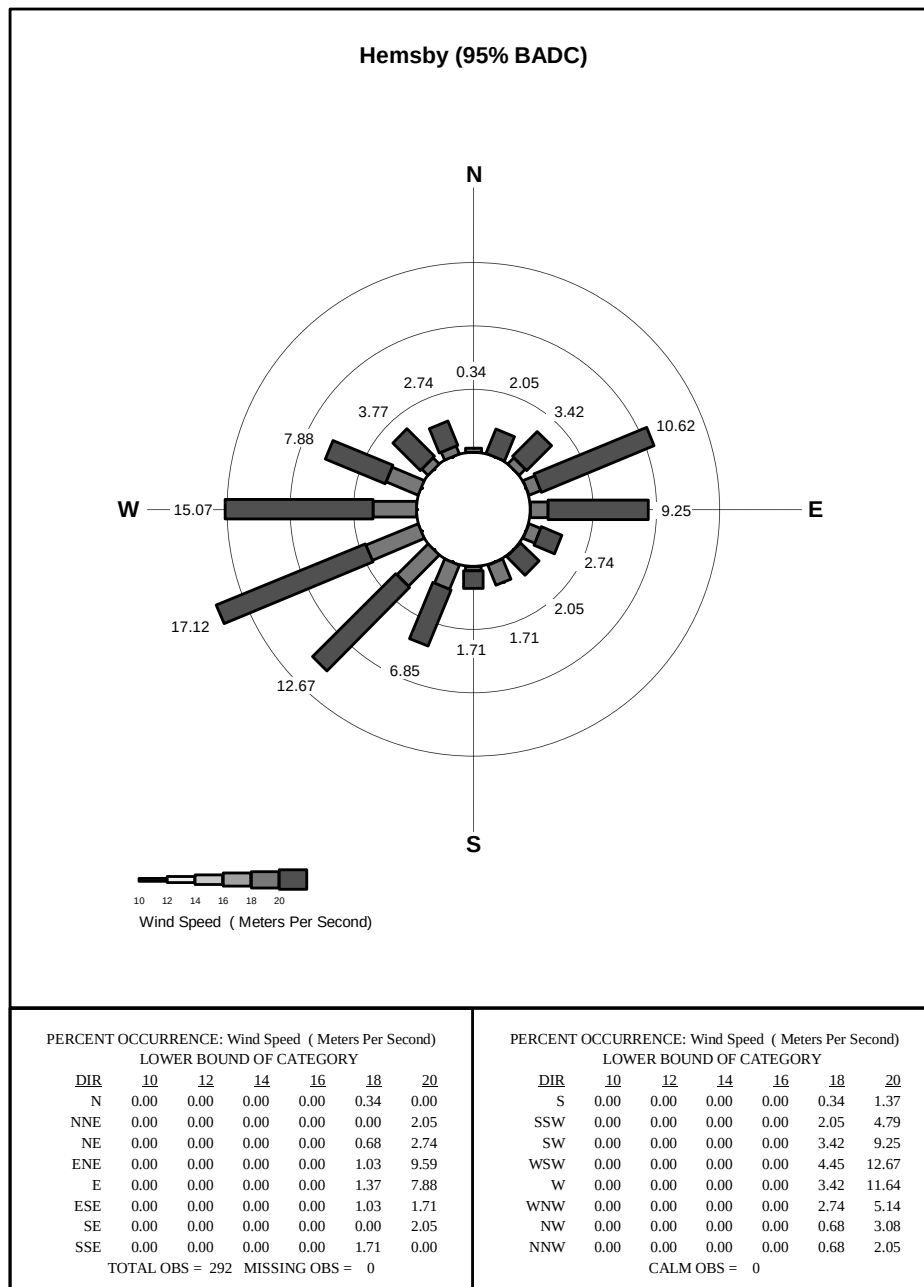
APPENDIX 3: OBSERVED 95TH PERCENTILE ANNUAL WIND ROSES

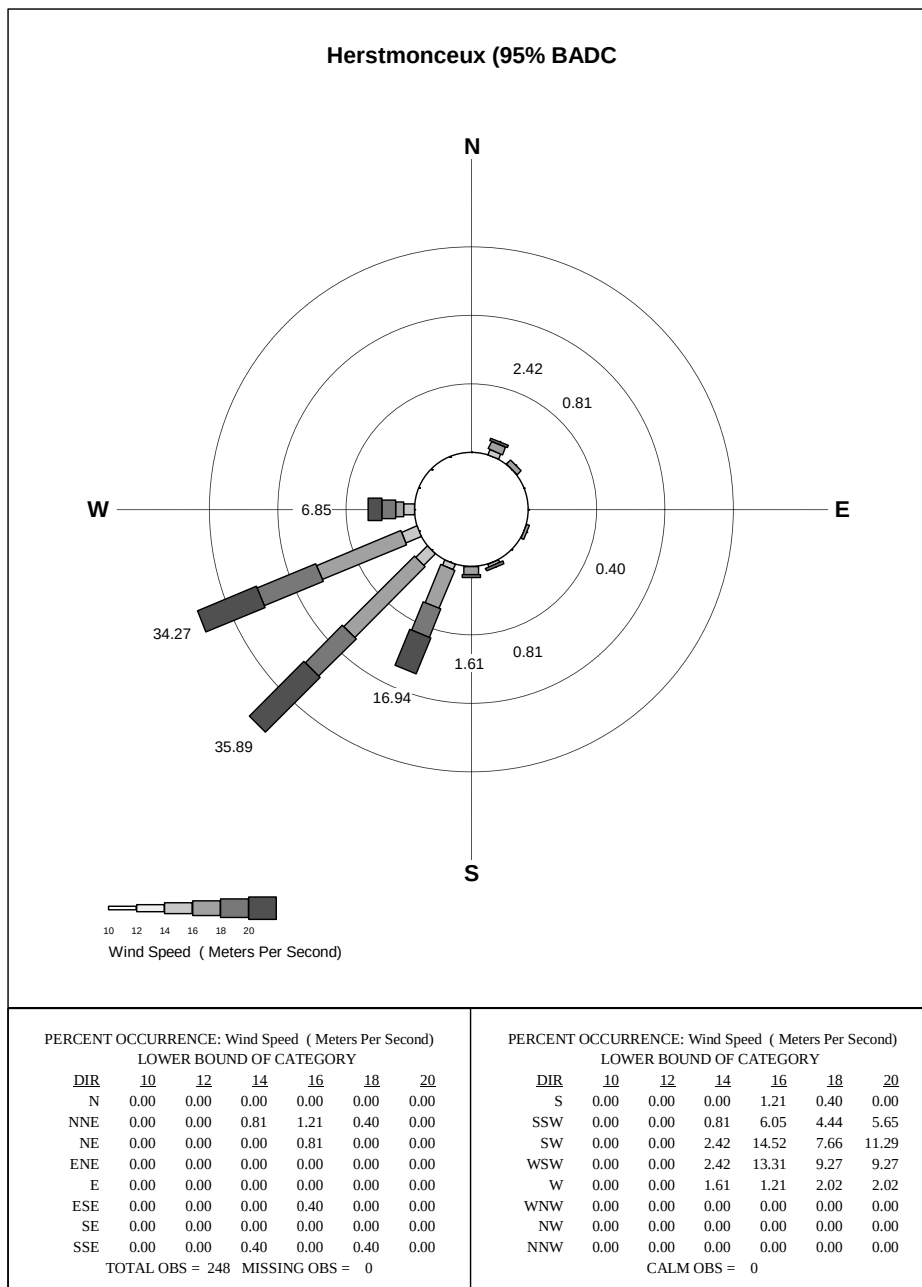
Observed 95th percentile of mean annual wind speed (m/s) and direction (degrees) for the nine stations and time periods listed in Table 1.

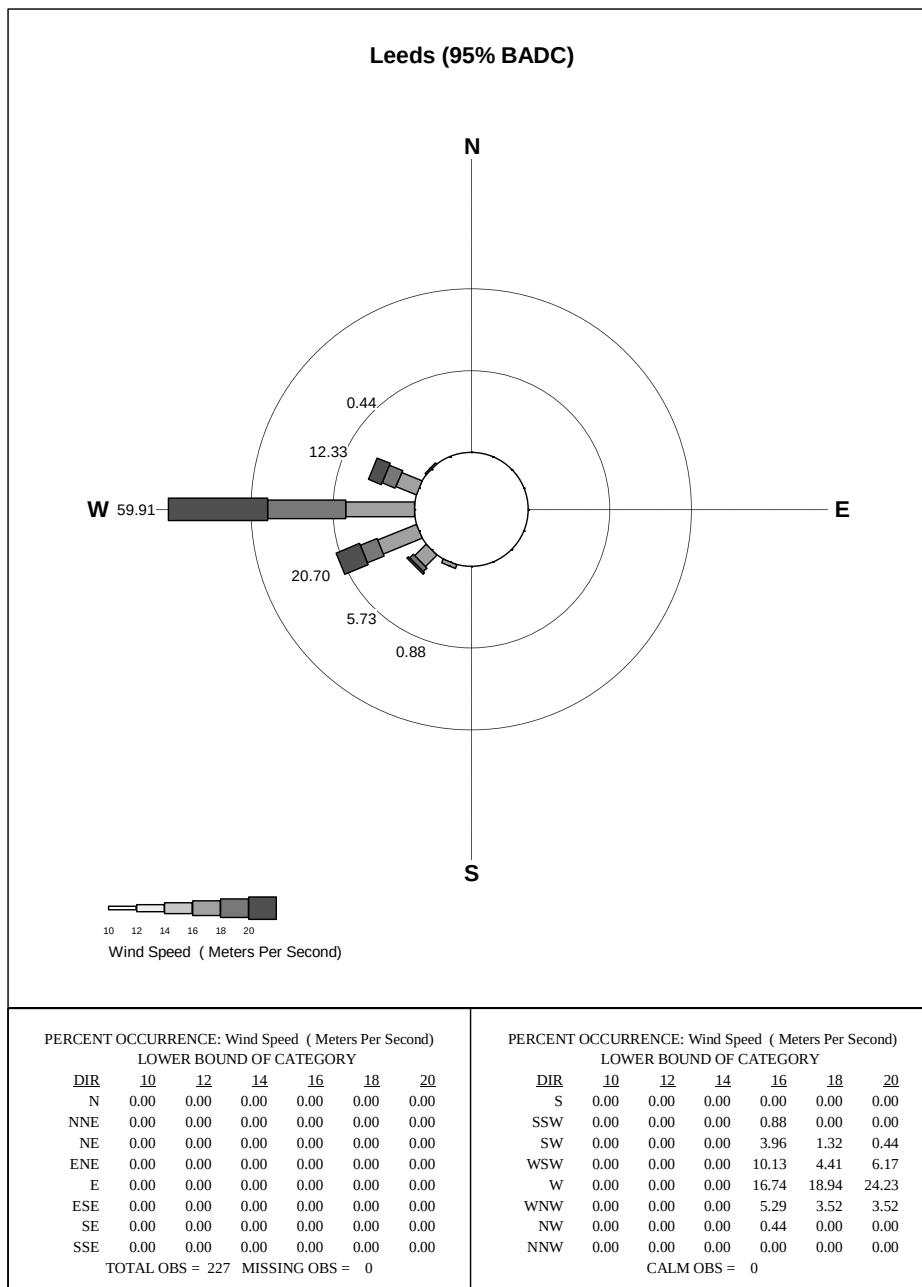


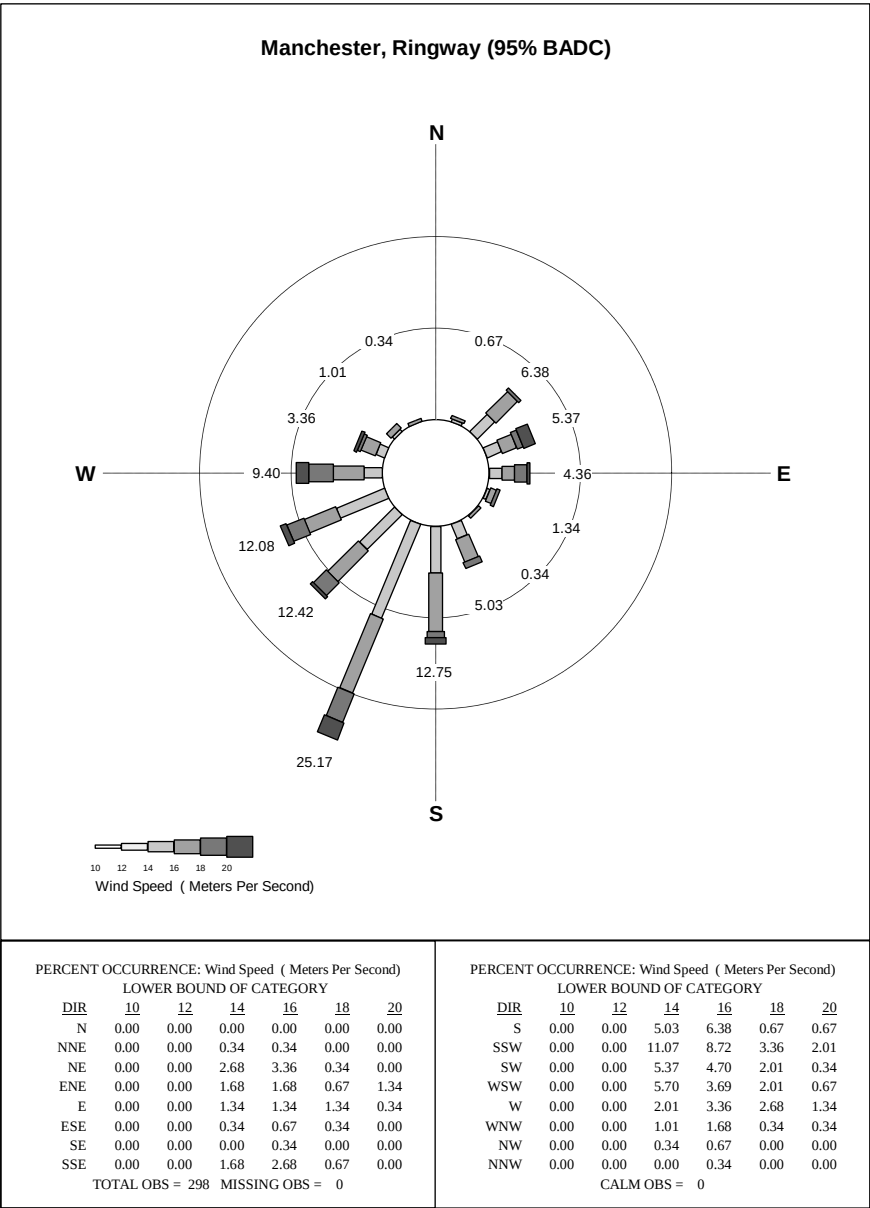


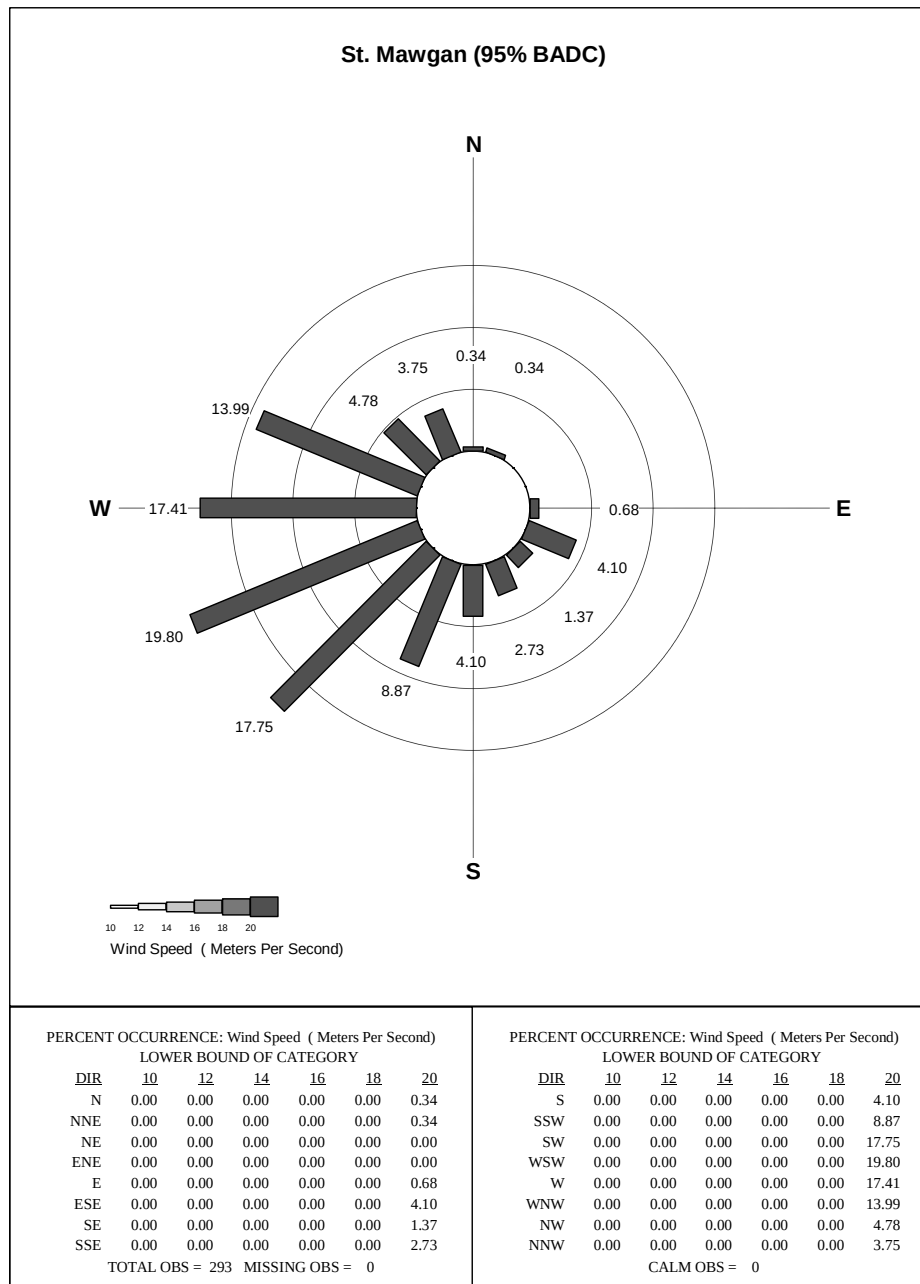


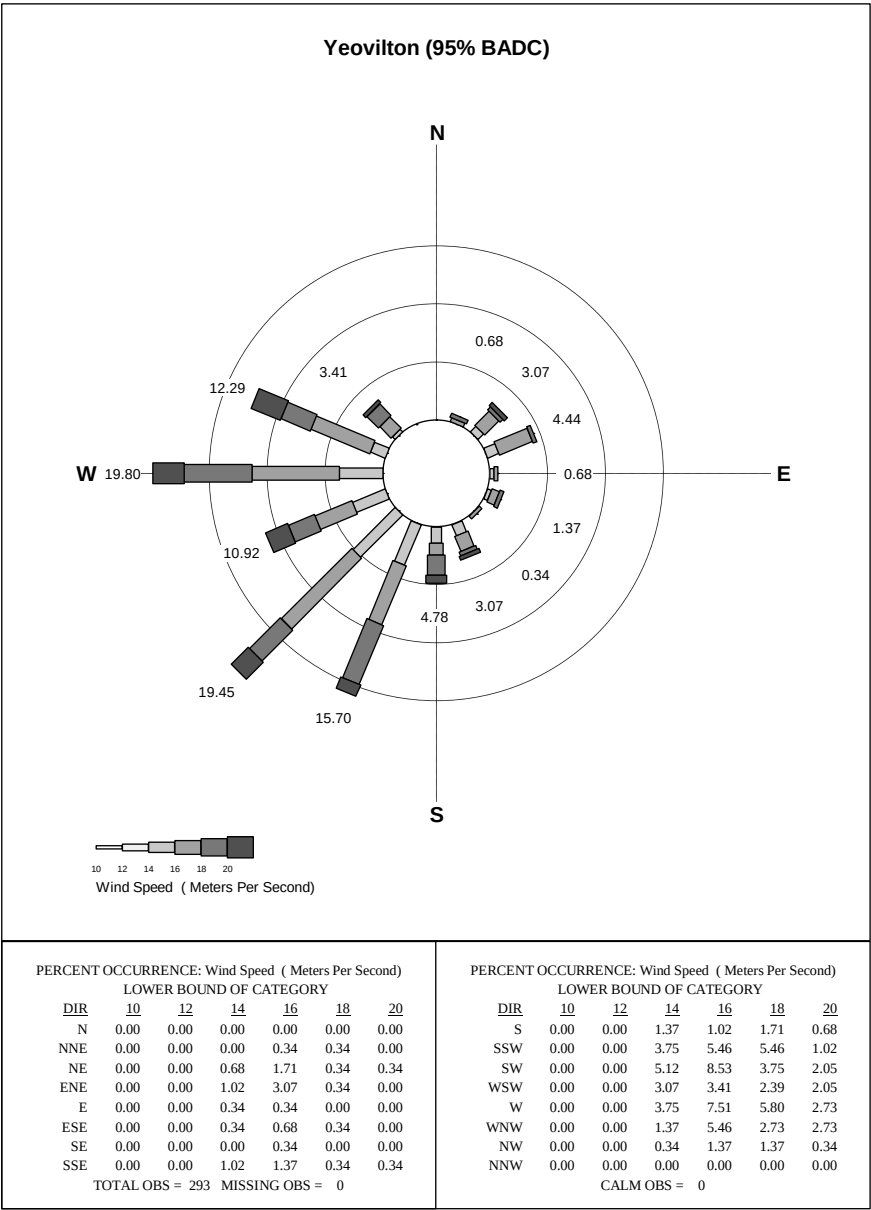






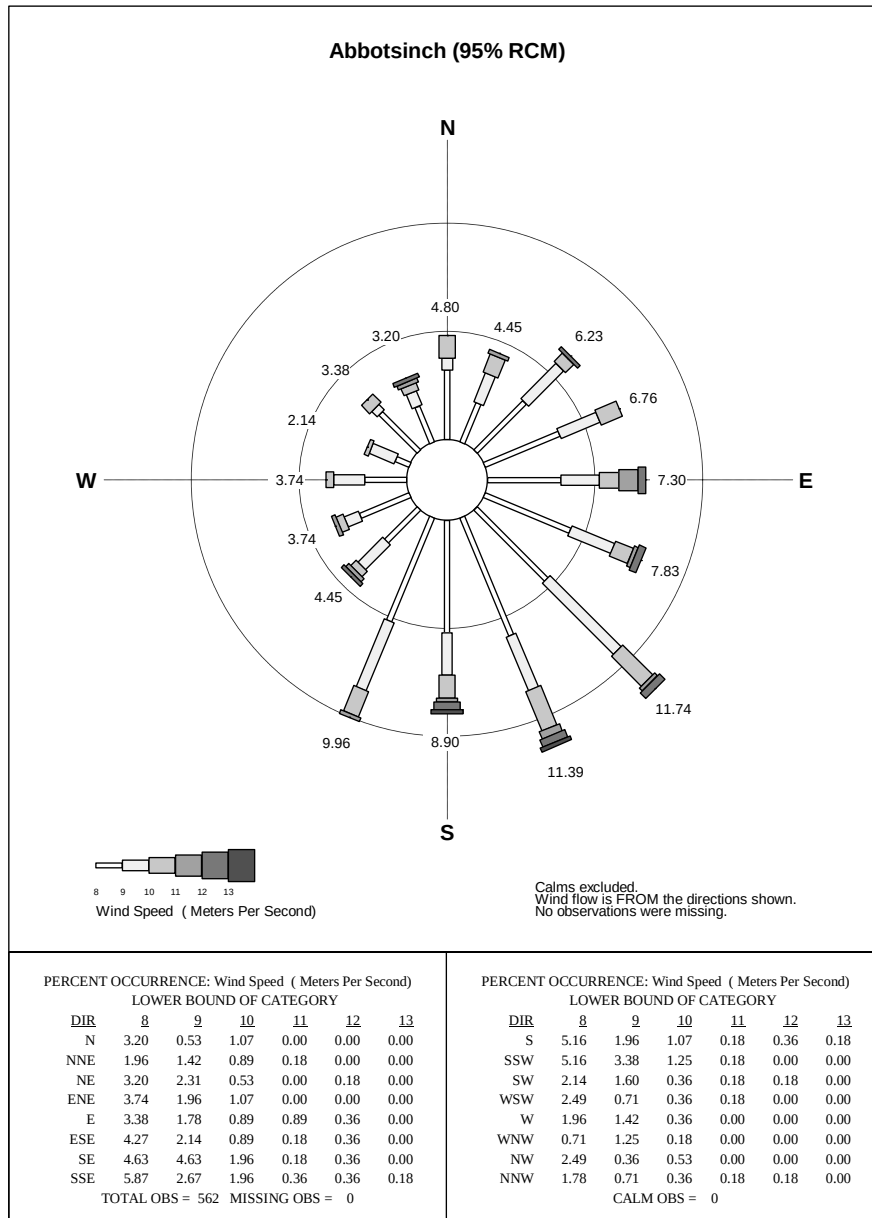


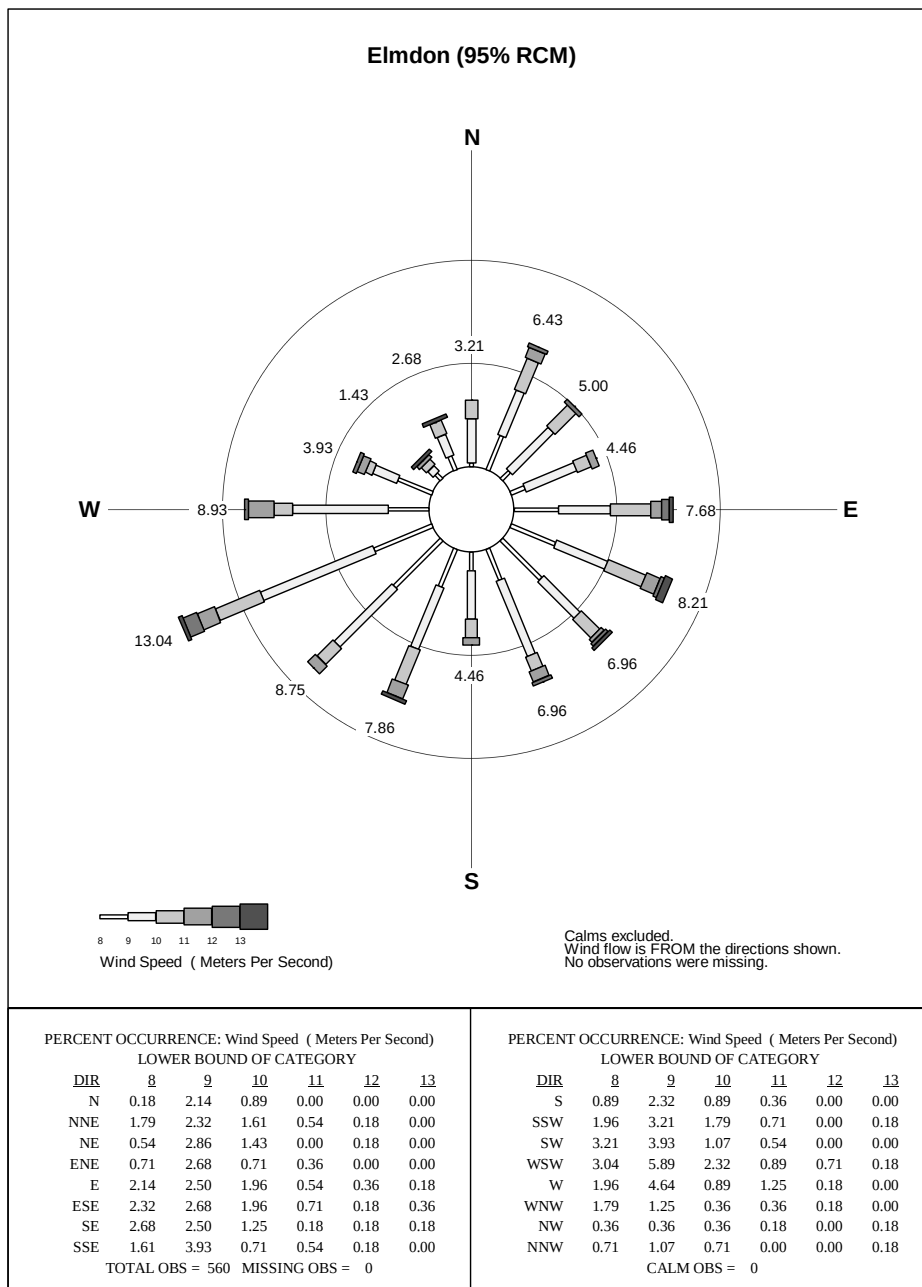


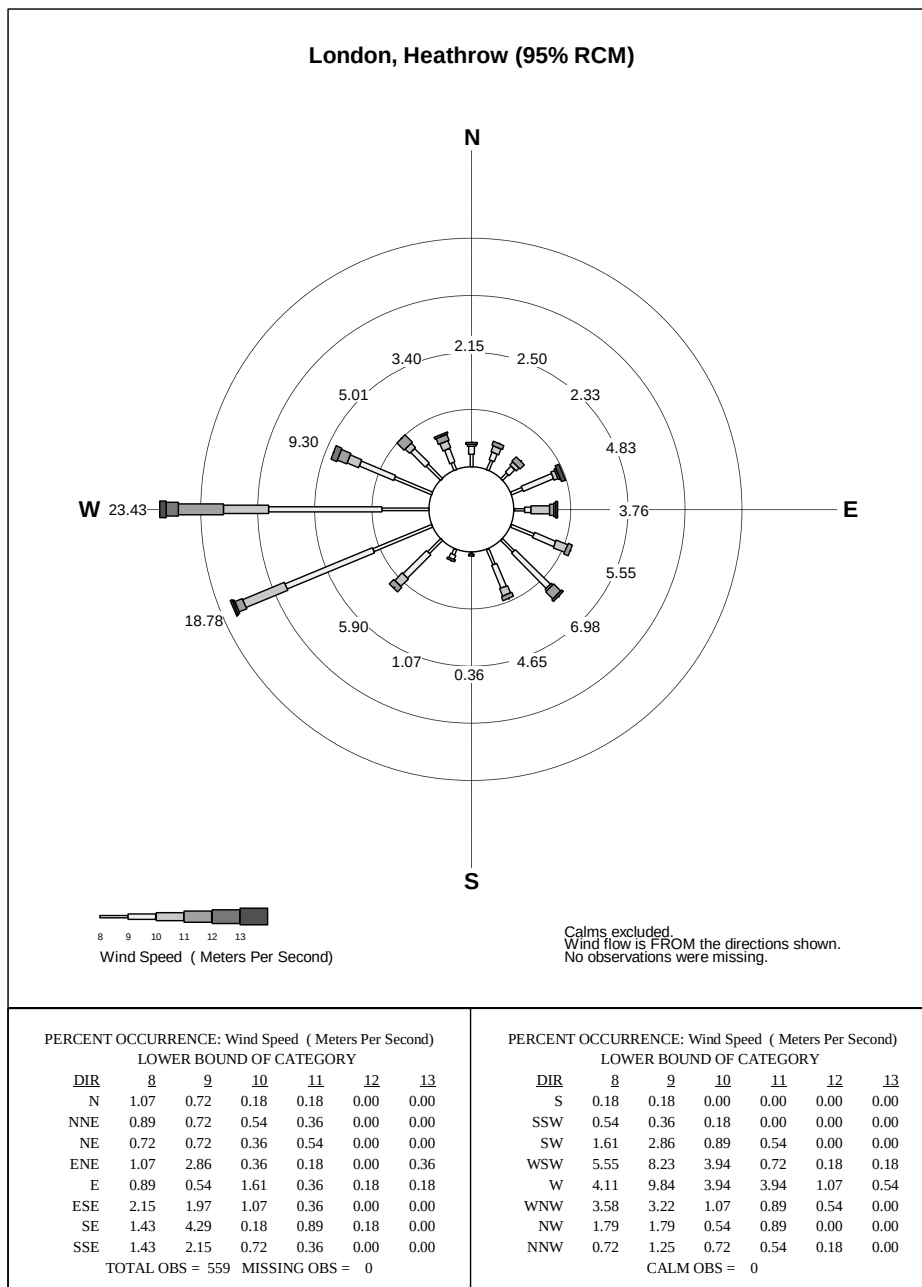


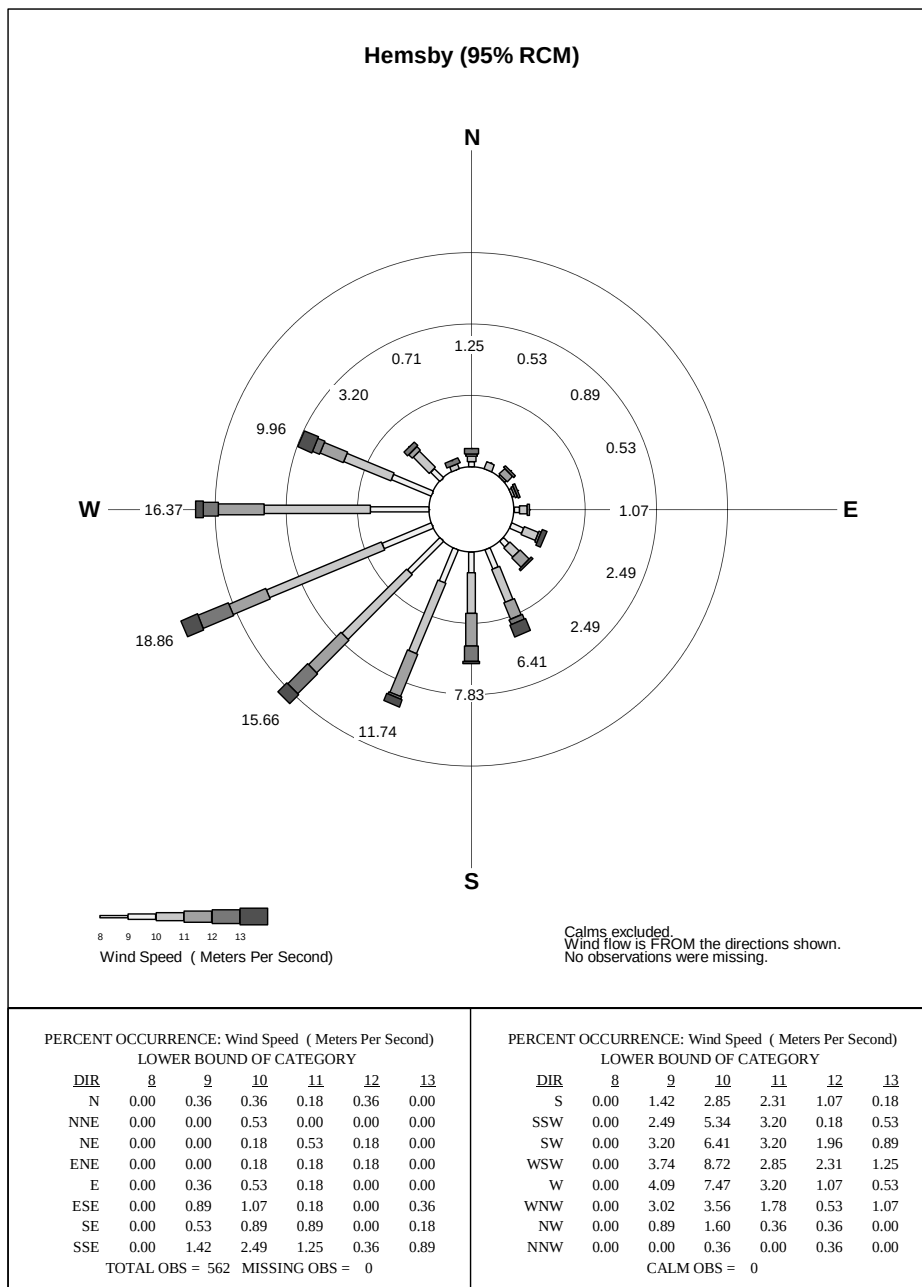
APPENDIX 4: HadRM3H 95TH PERCENTILE ANNUAL WIND ROSES

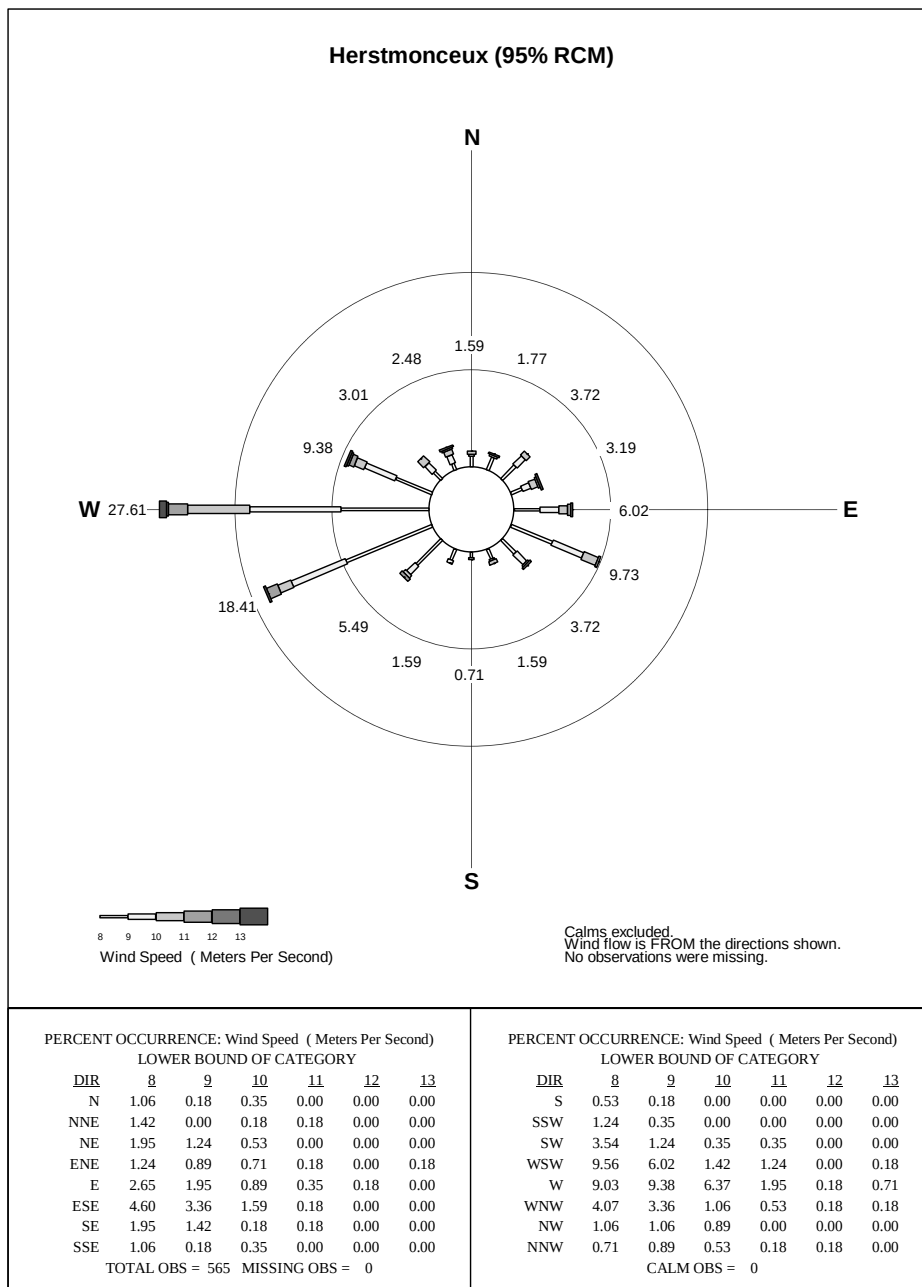
HadRM3H simulated 95th percentile of mean annual wind speed (m/s) and direction (degrees) for the nine stations and the baseline period 1961-1990.

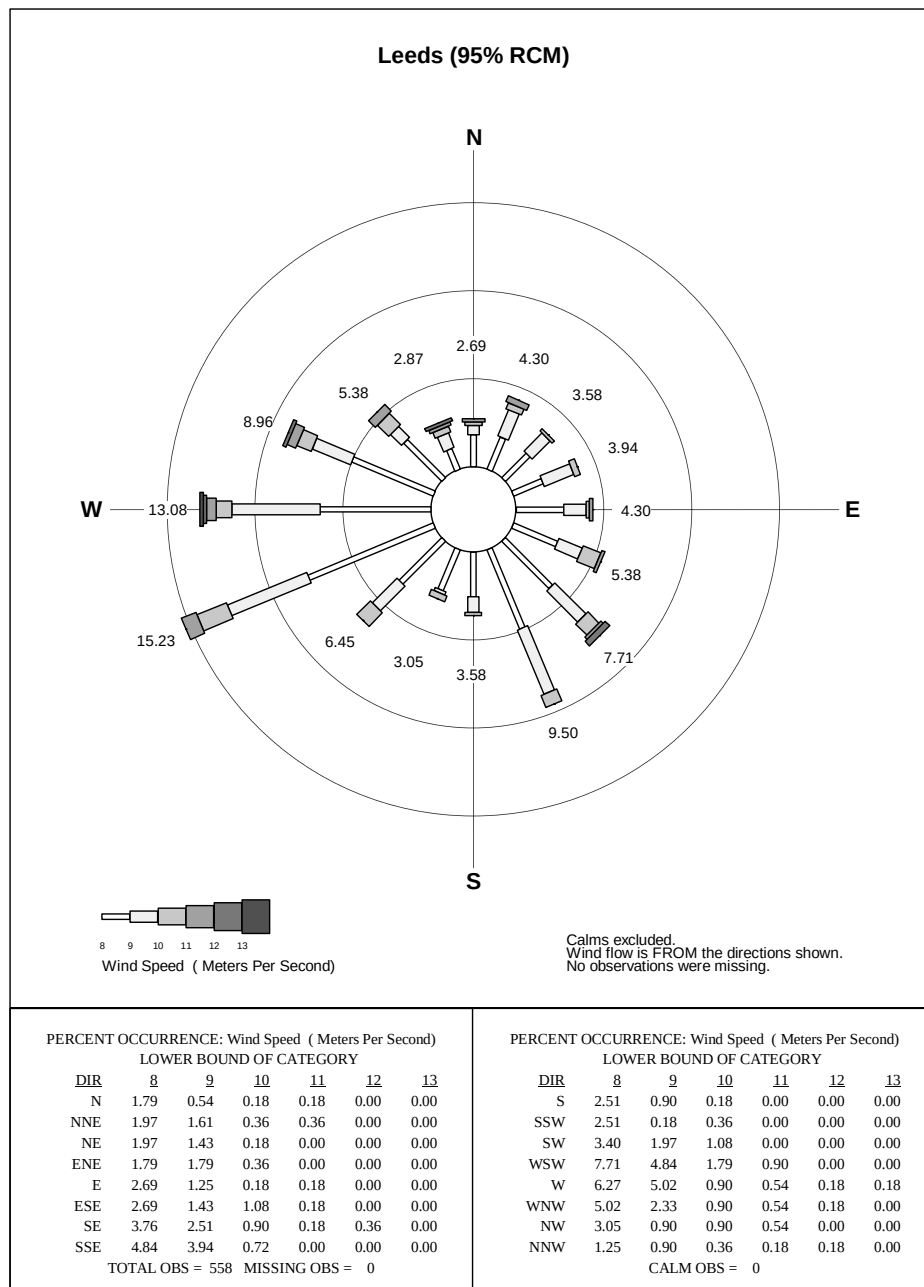


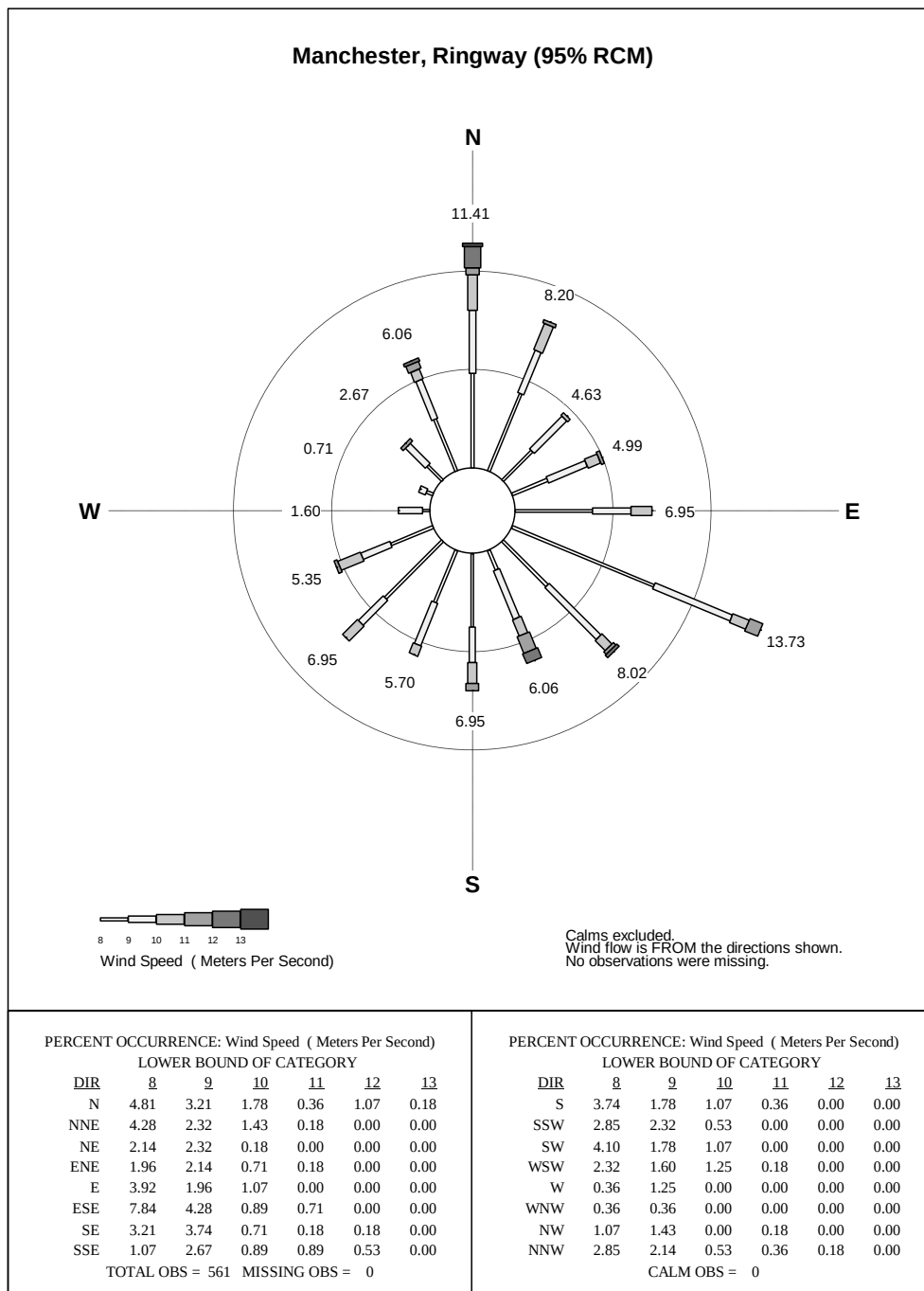


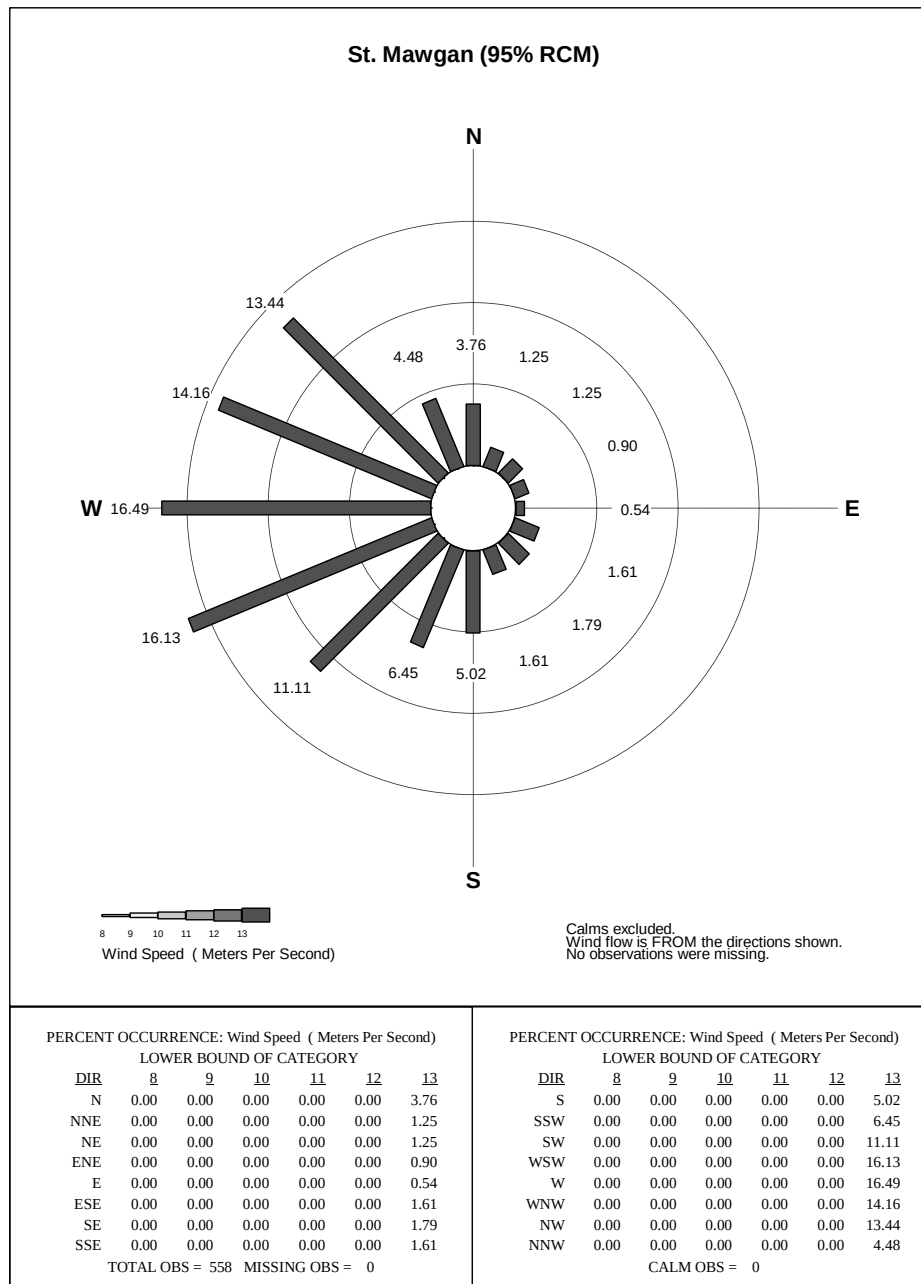


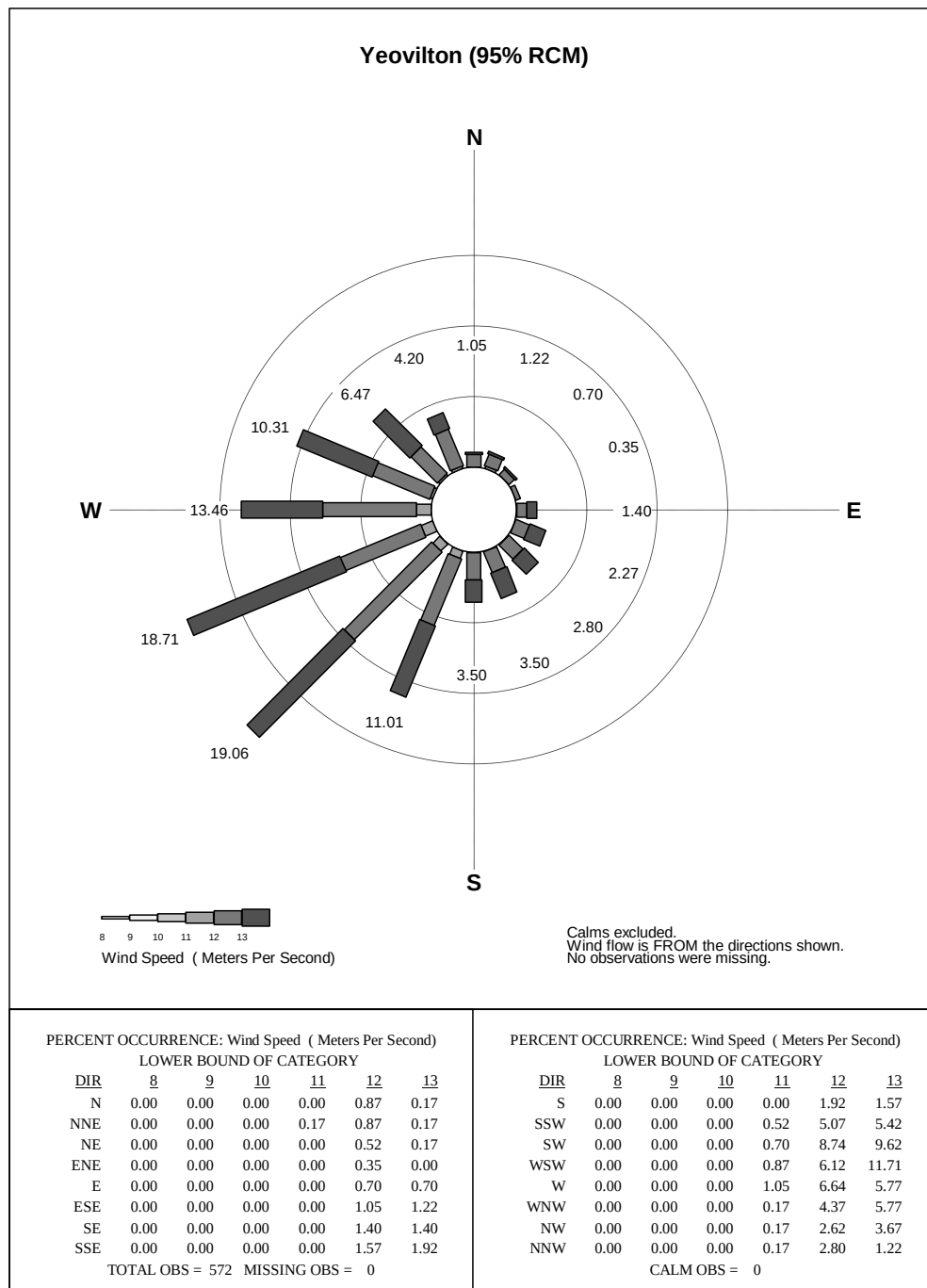






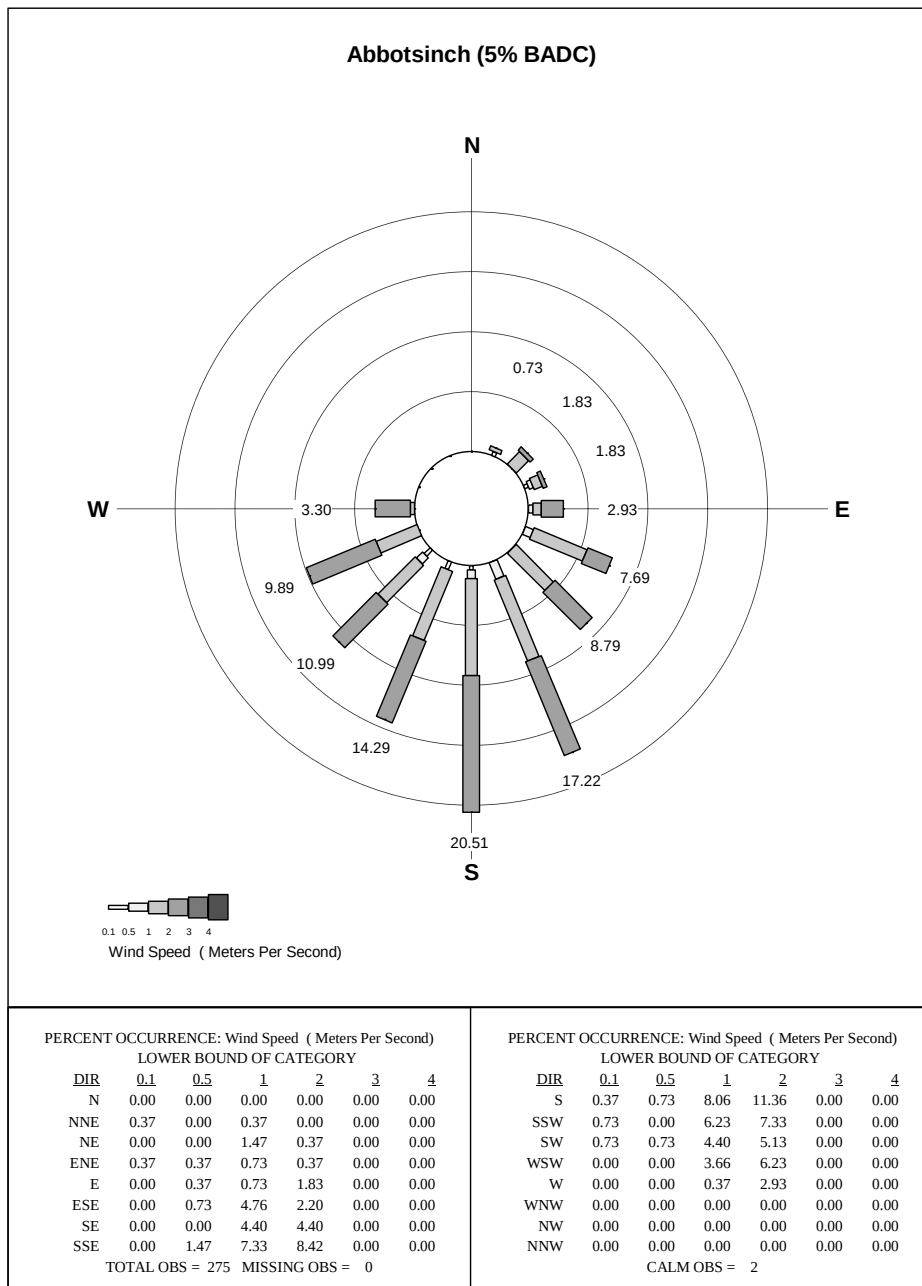


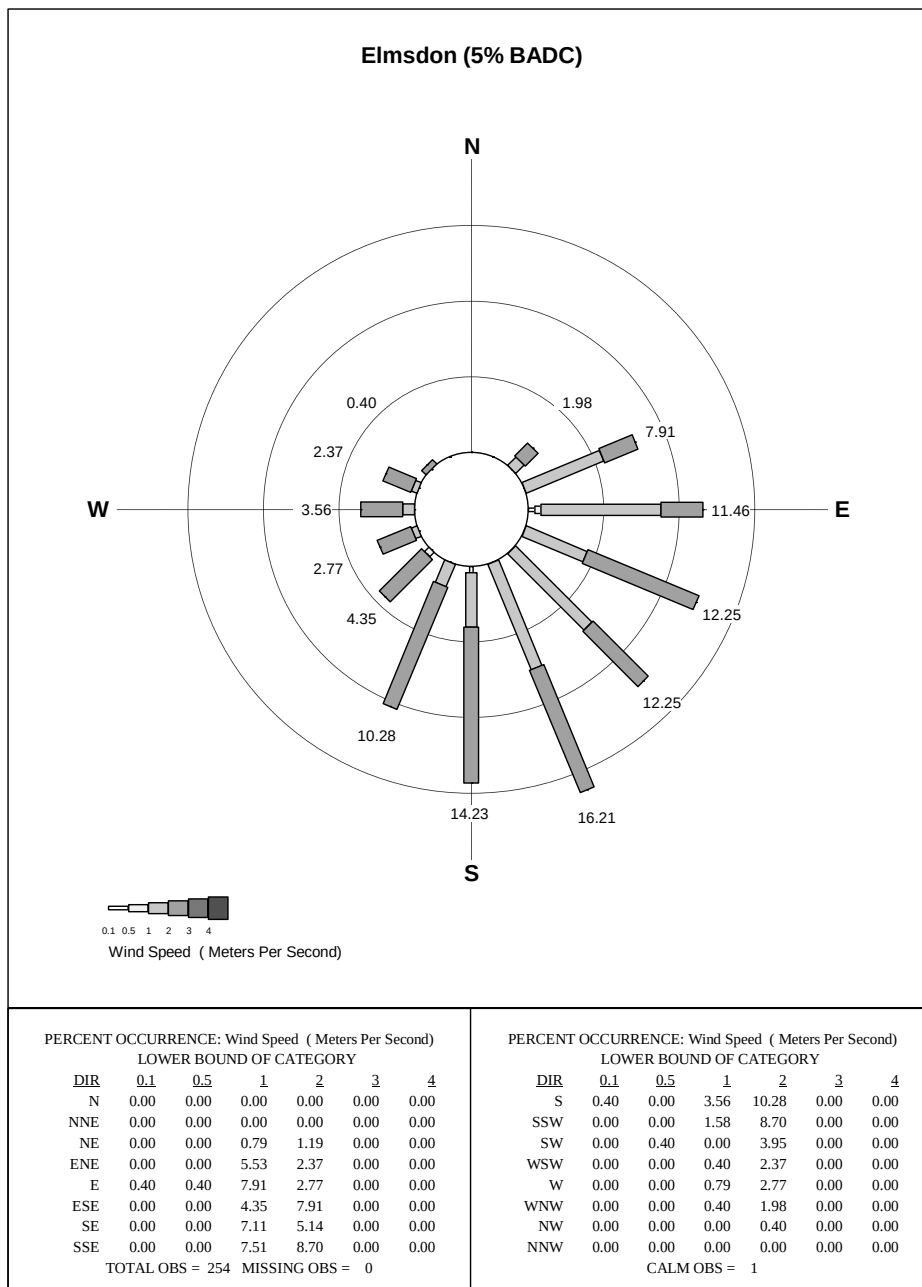


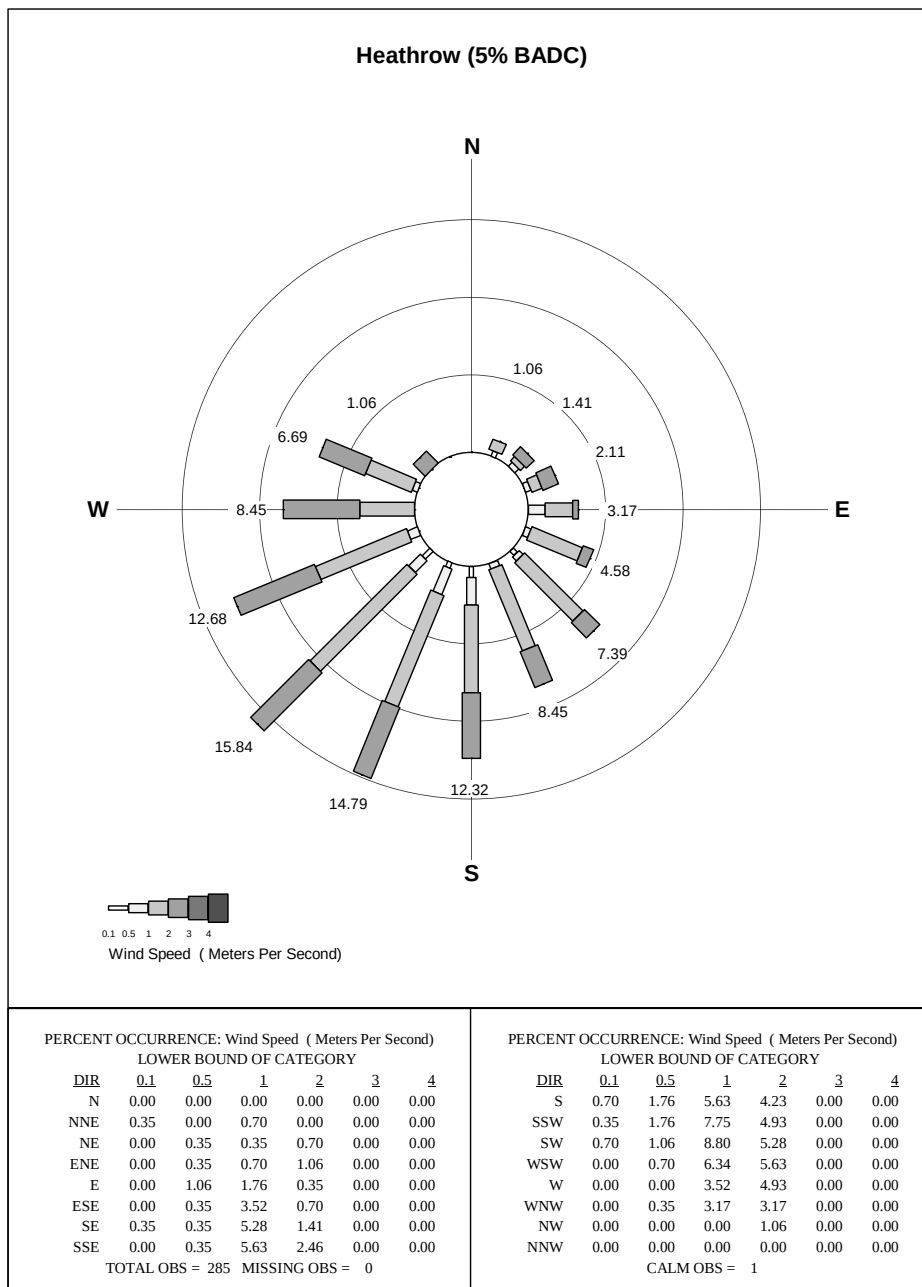


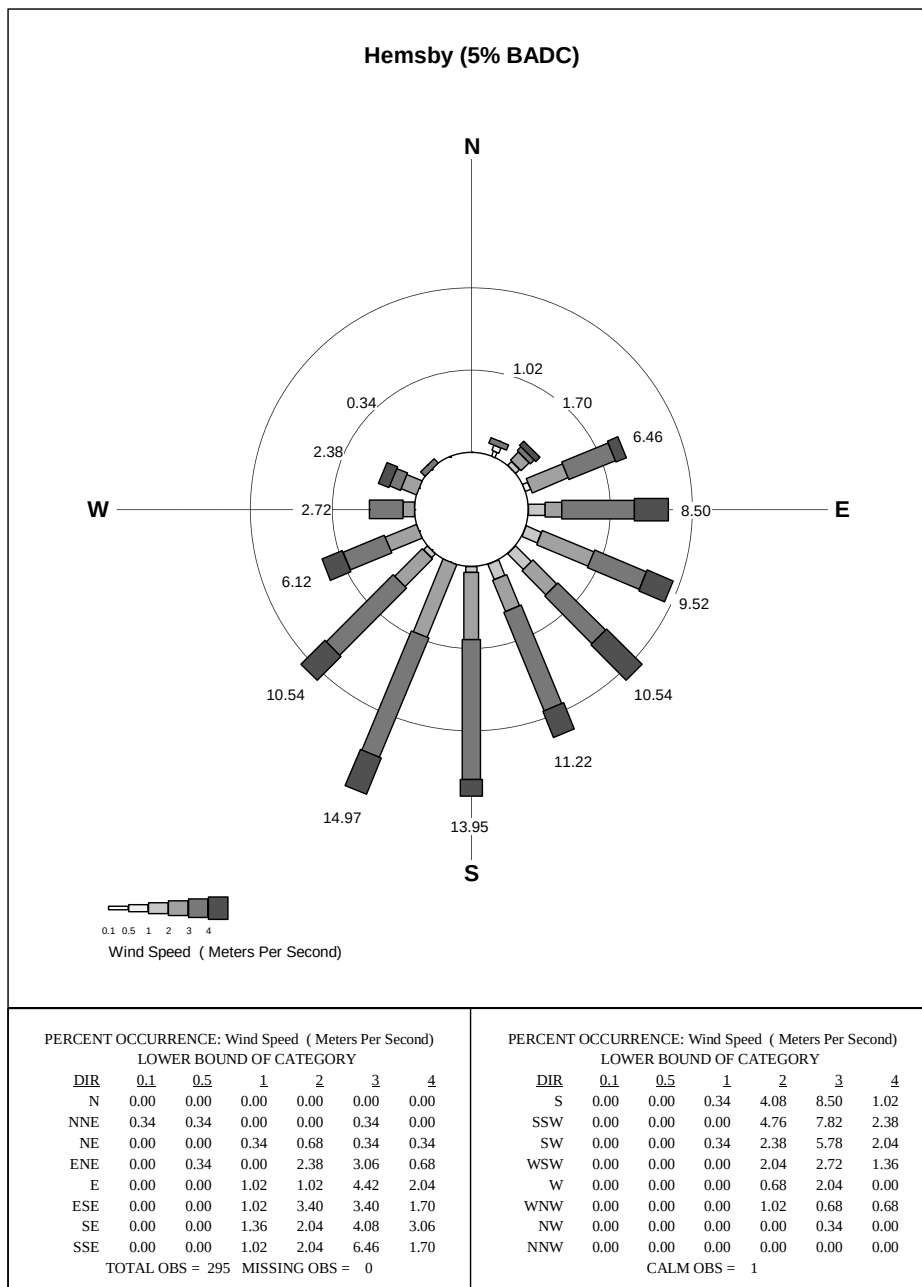
APPENDIX 5: OBSERVED 5TH PERCENTILE ANNUAL WIND ROSES

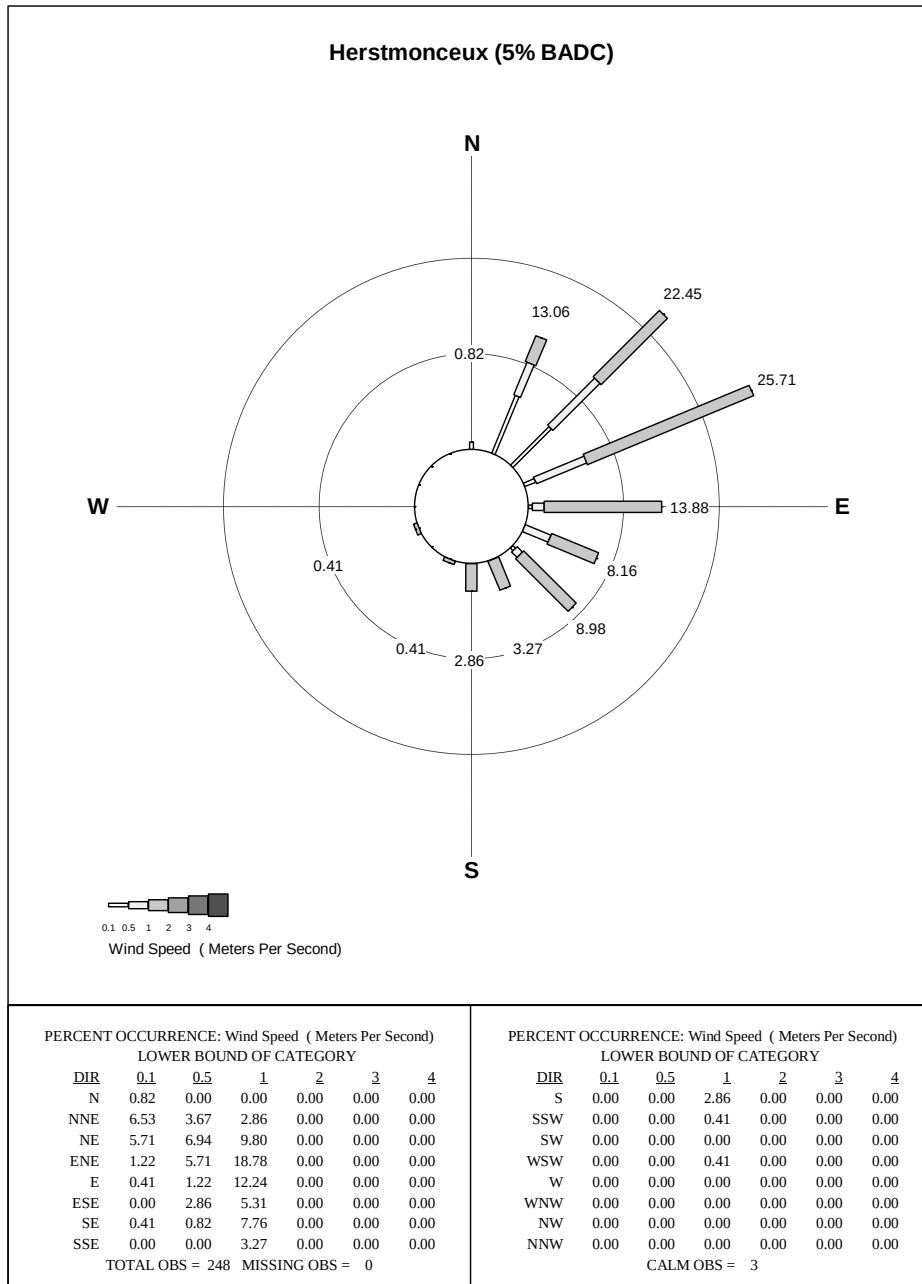
Observed 5th percentile of mean annual wind speed (m/s) and direction (degrees) for the nine stations and time periods listed in Table 1.

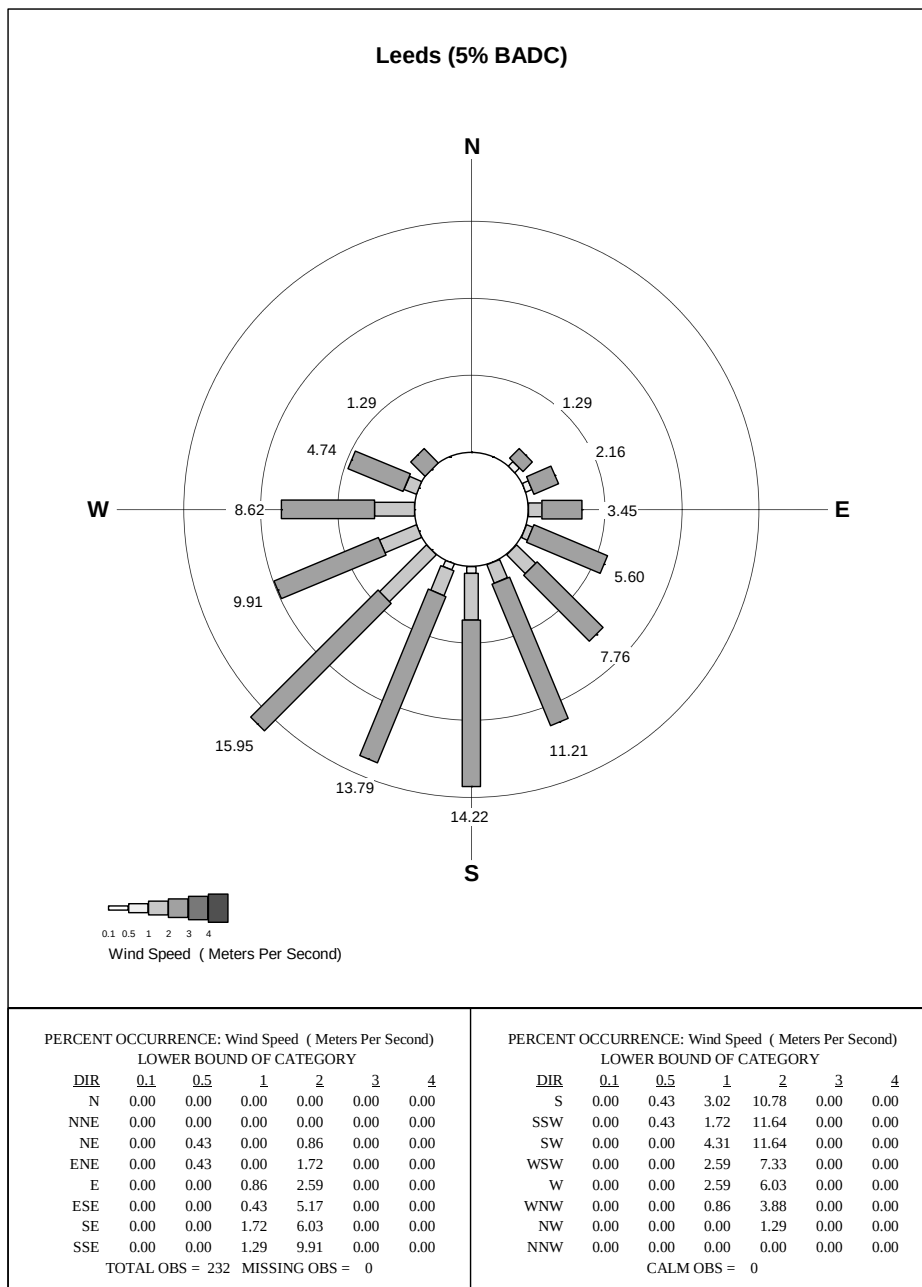


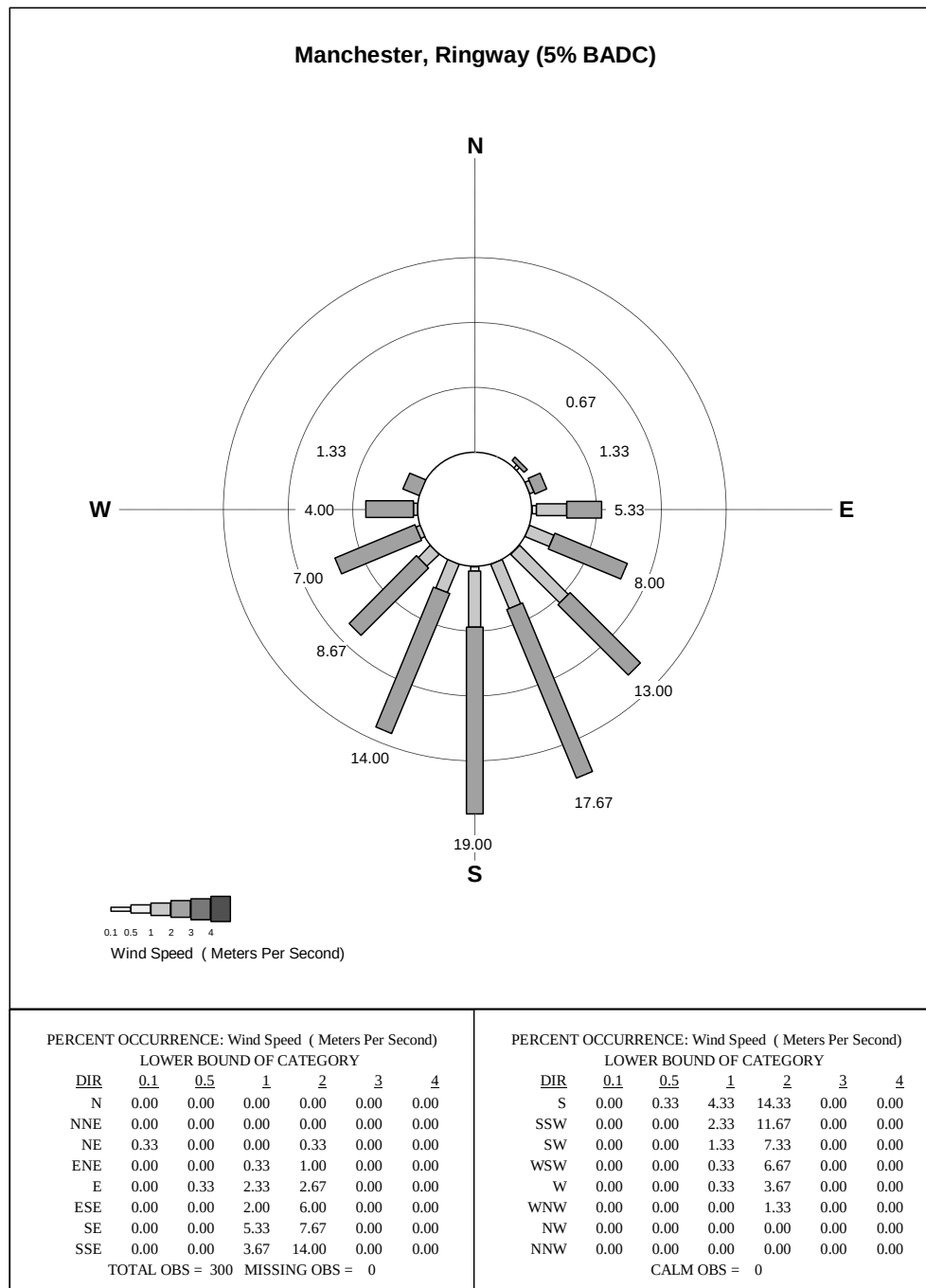


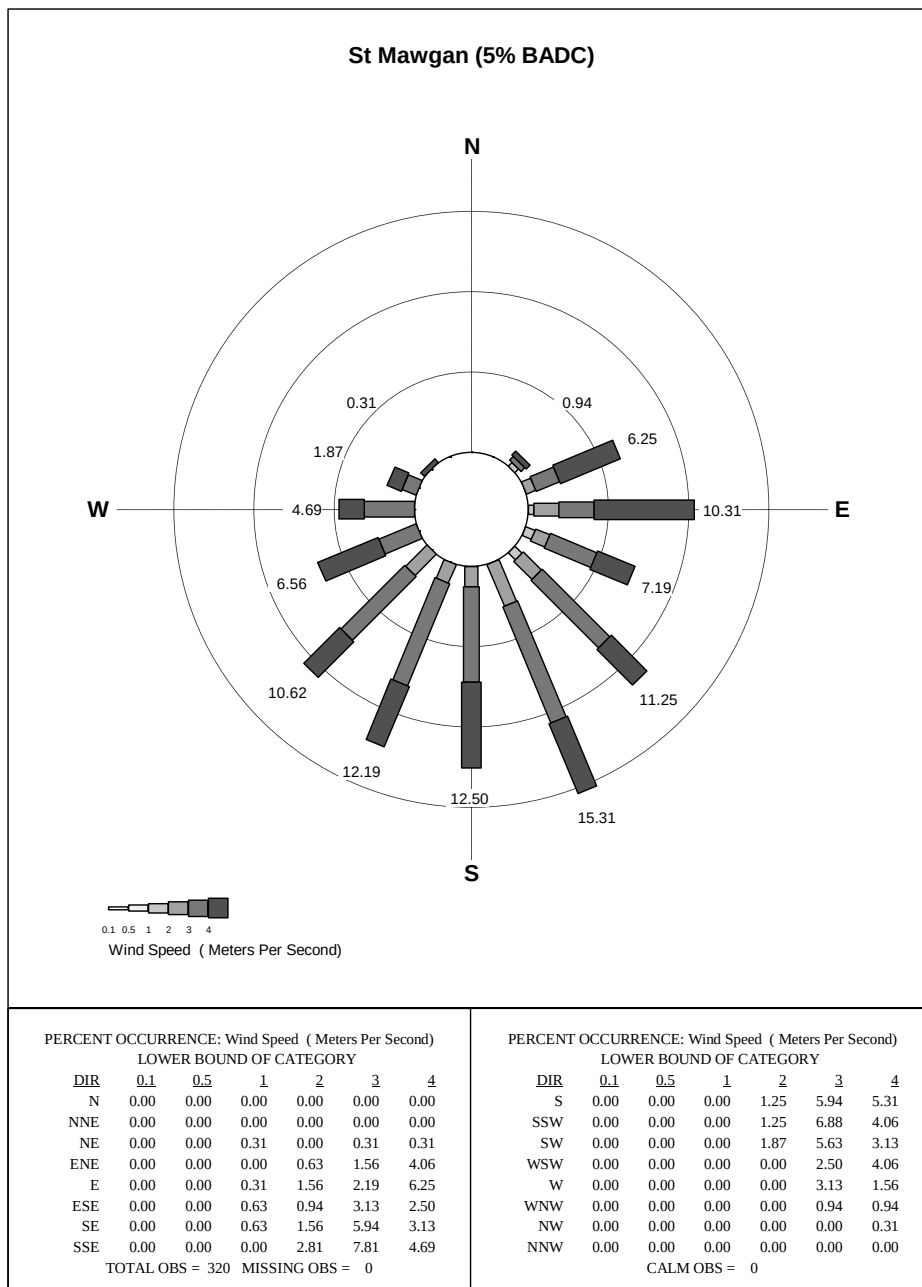


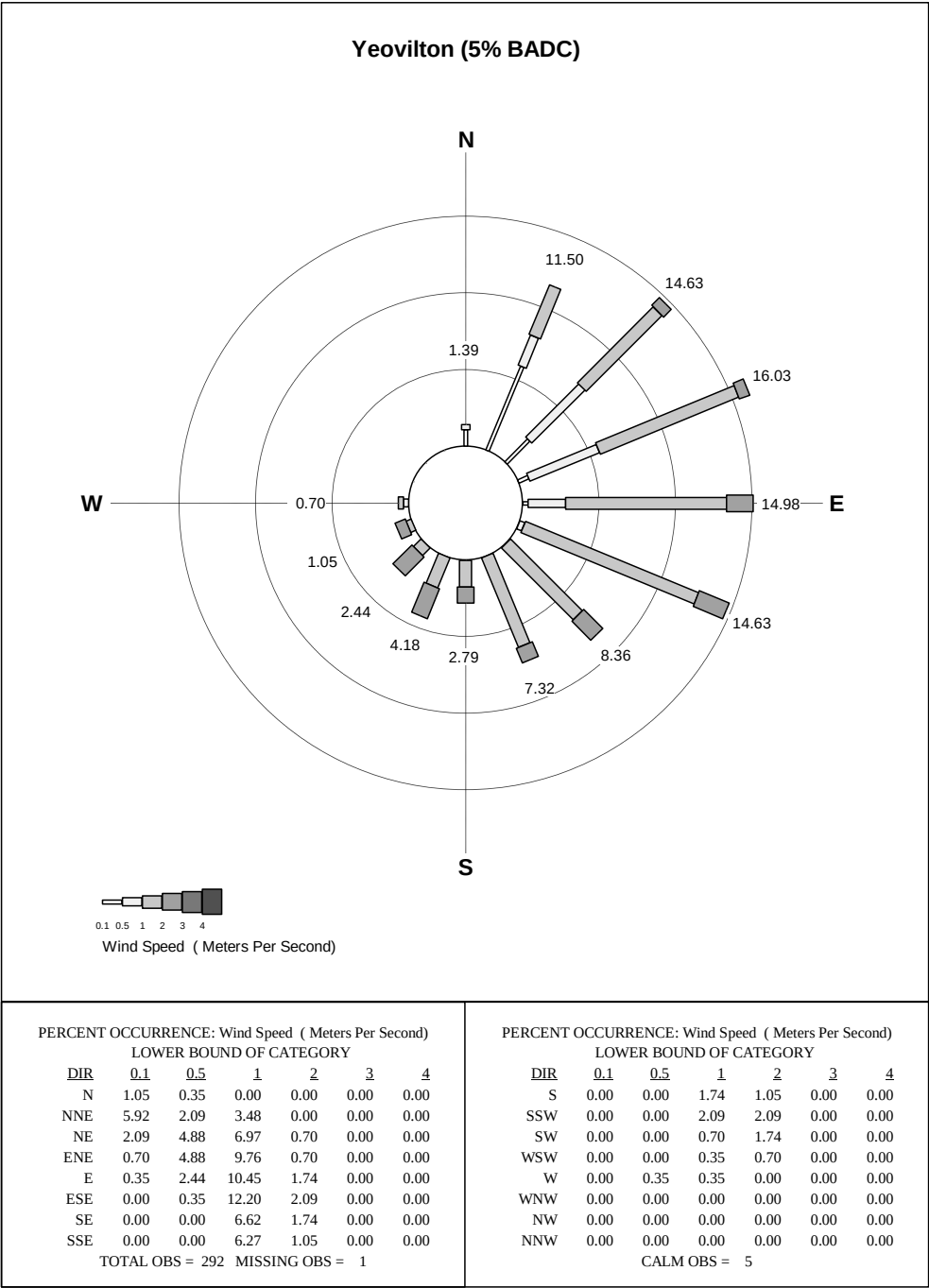






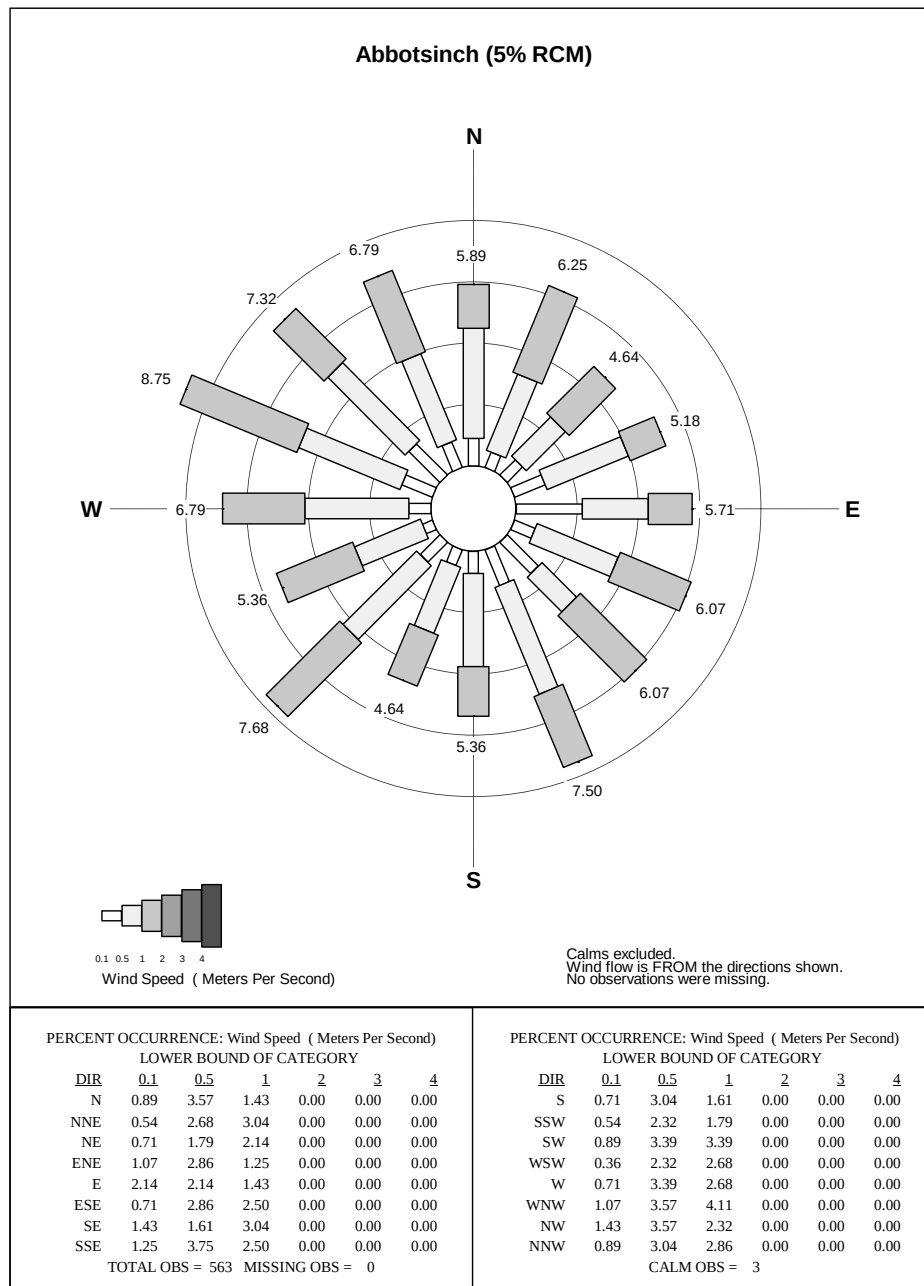


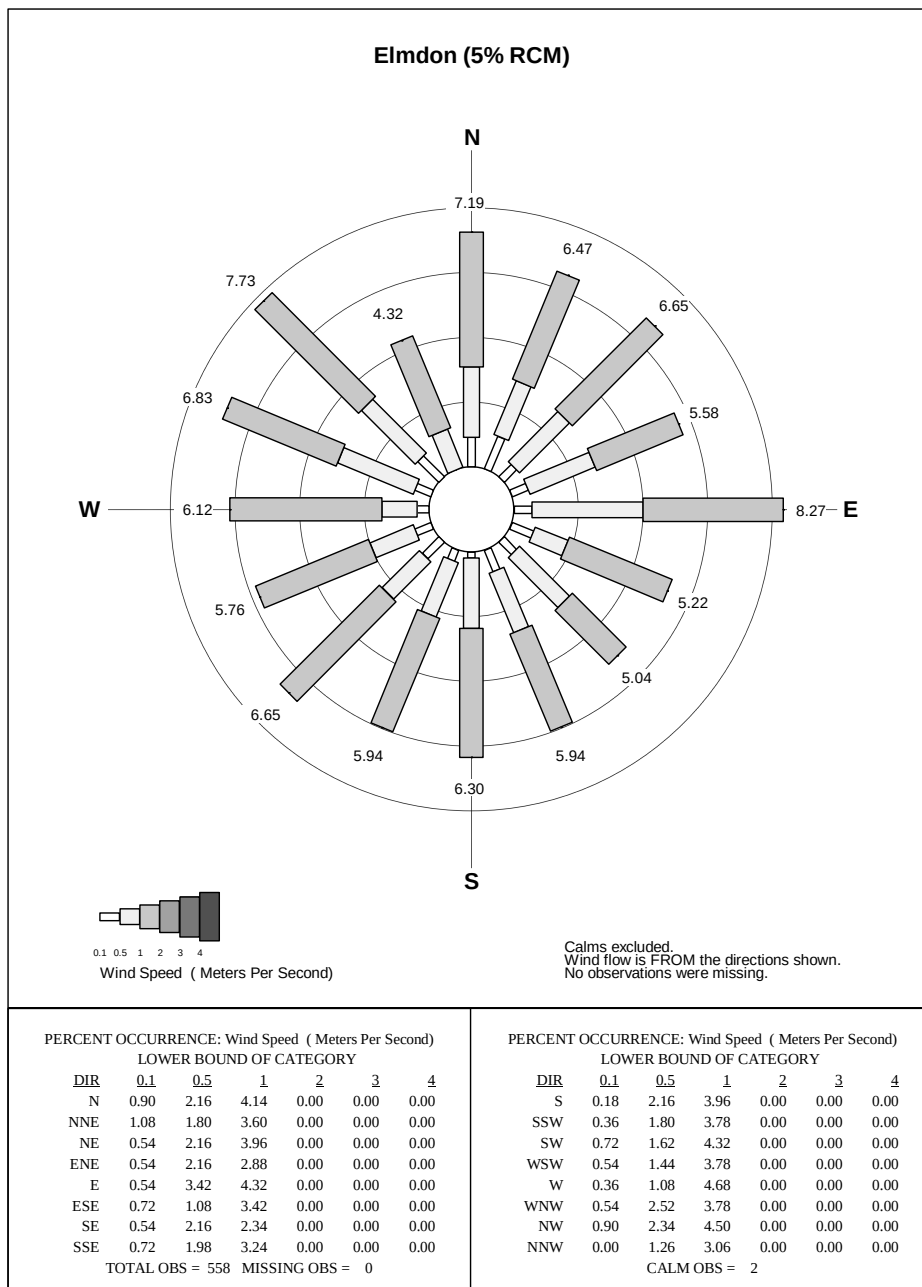


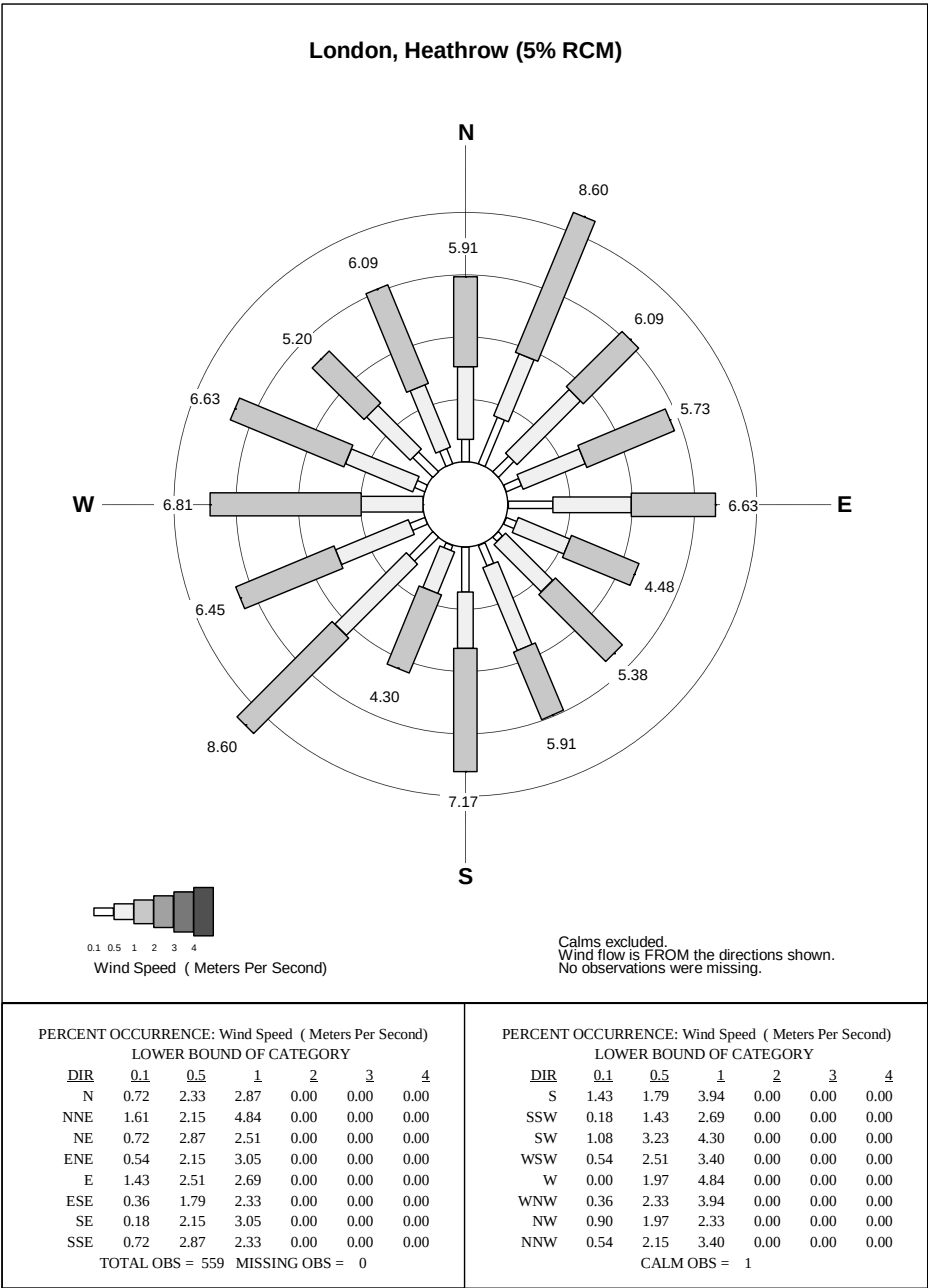


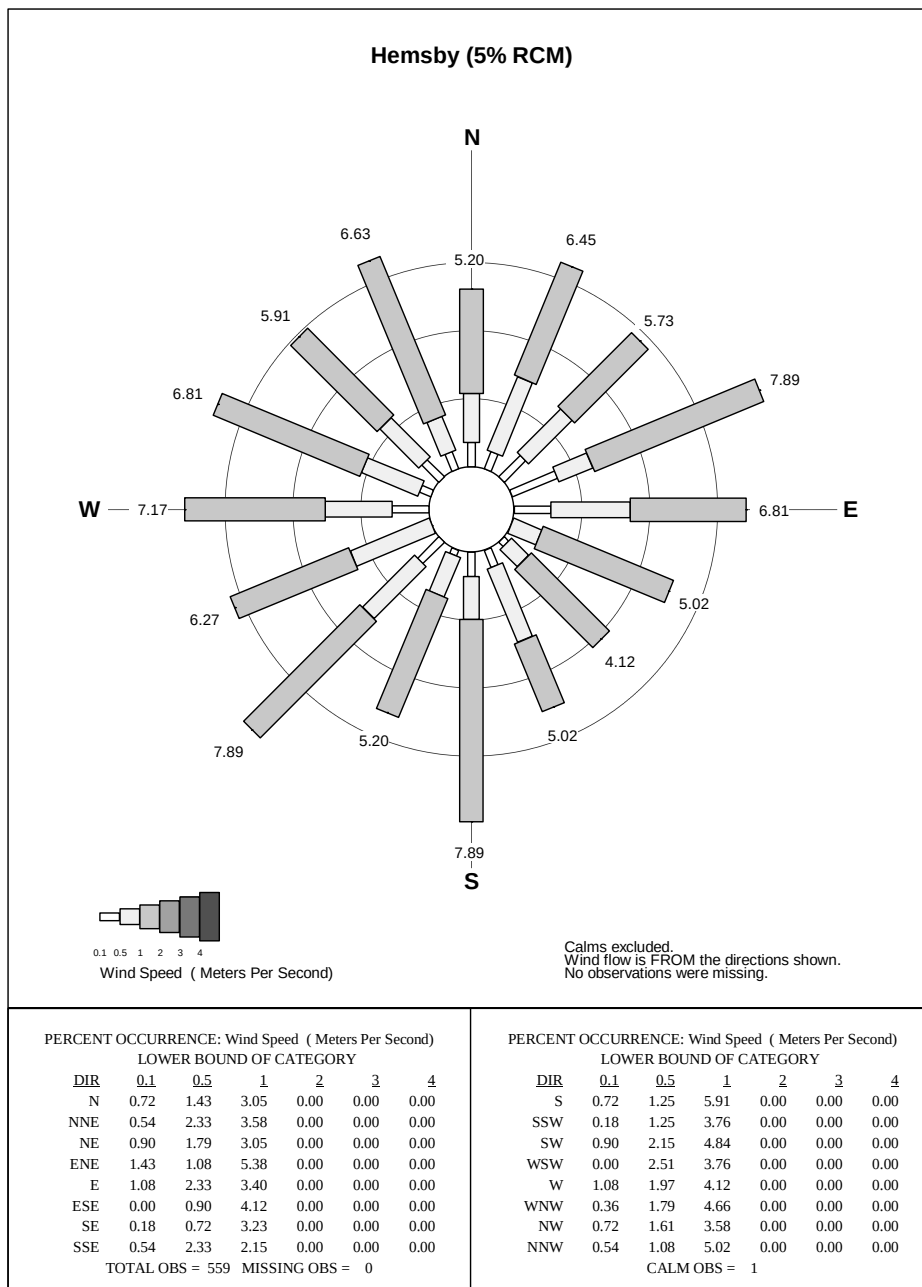
APPENDIX 6: HadRM3H 5TH PERCENTILE ANNUAL WIND ROSES

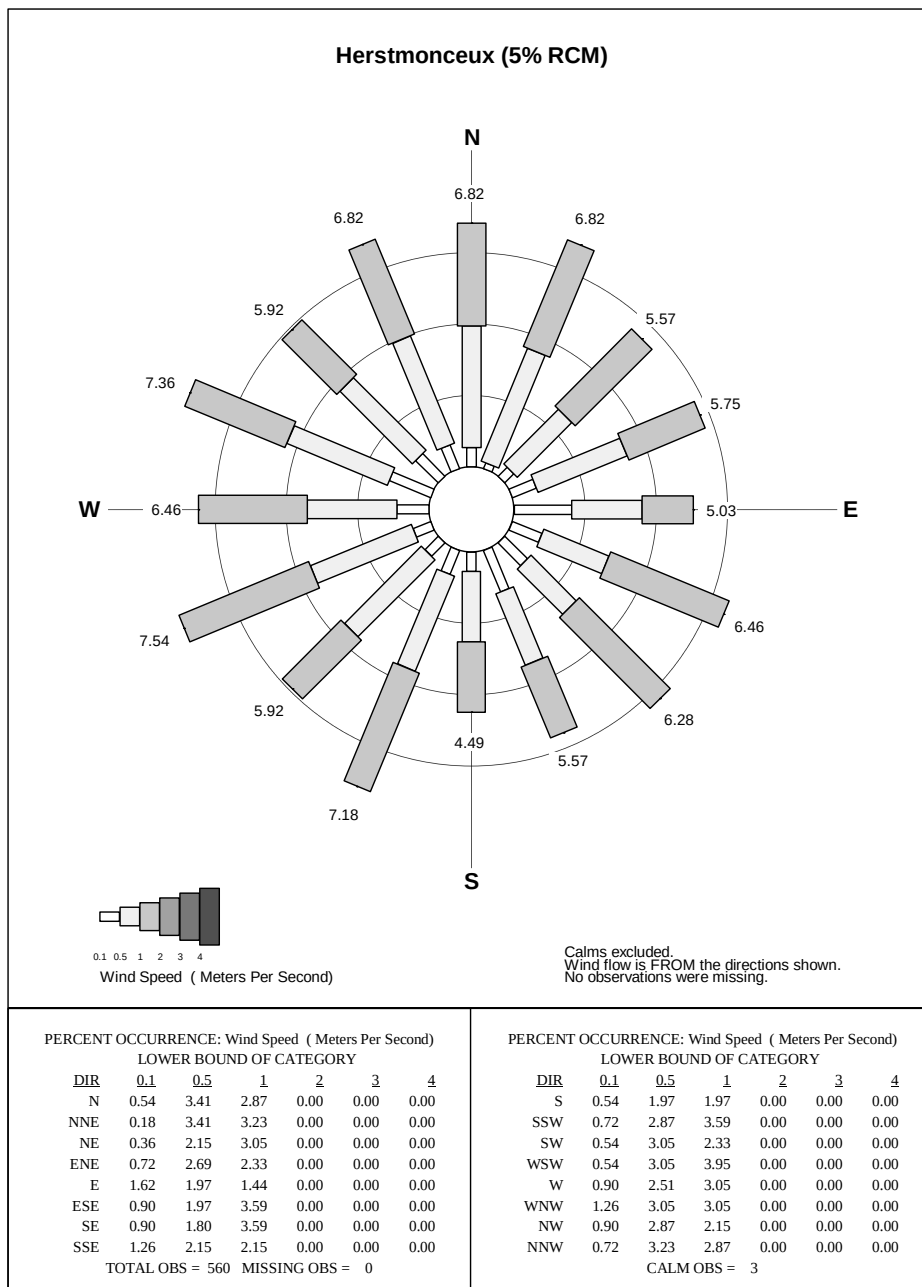
HadRM3H simulated 5th percentile of mean annual wind speed (m/s) and direction (degrees) for the nine stations and the baseline period 1961-1990.

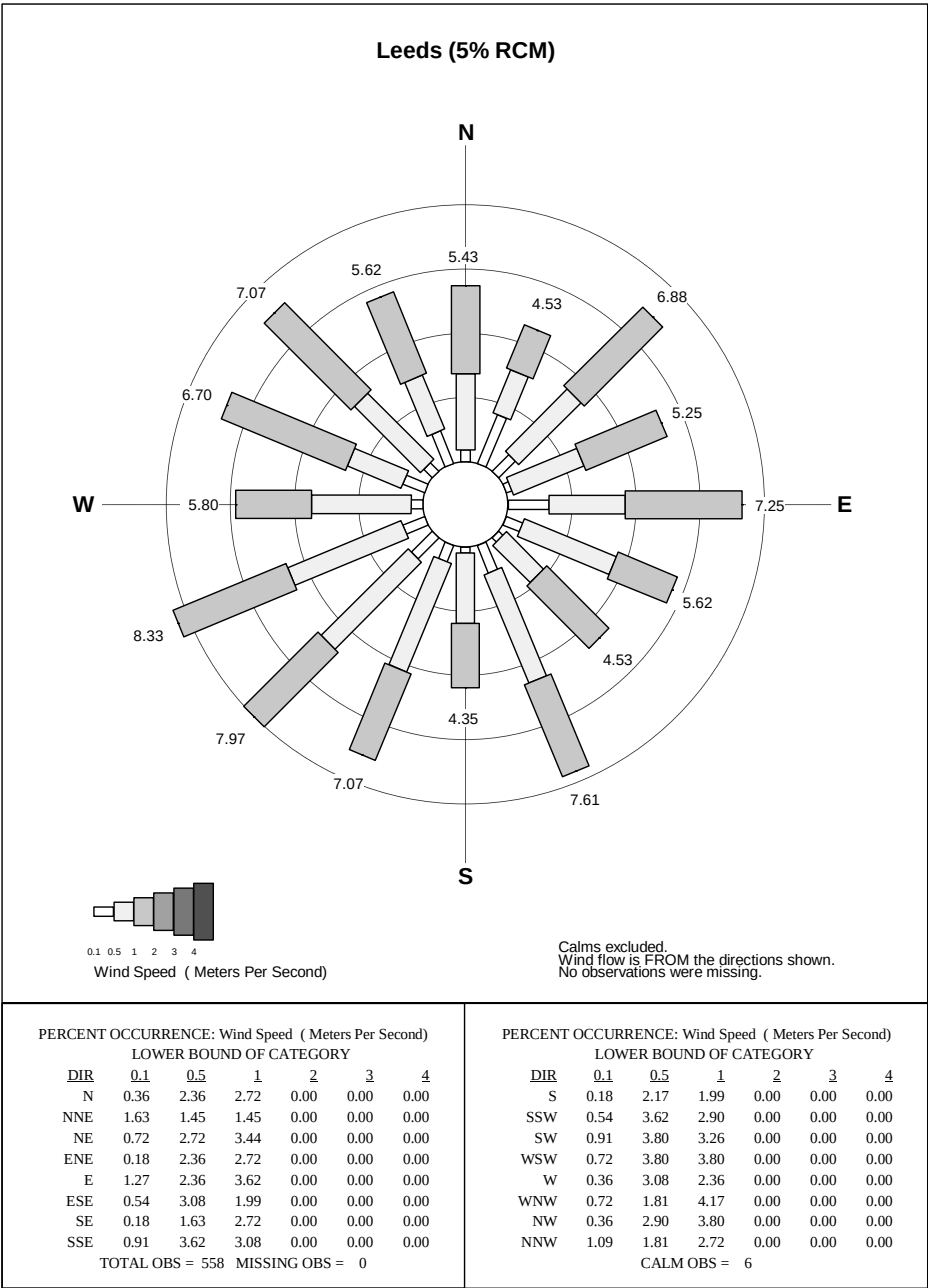


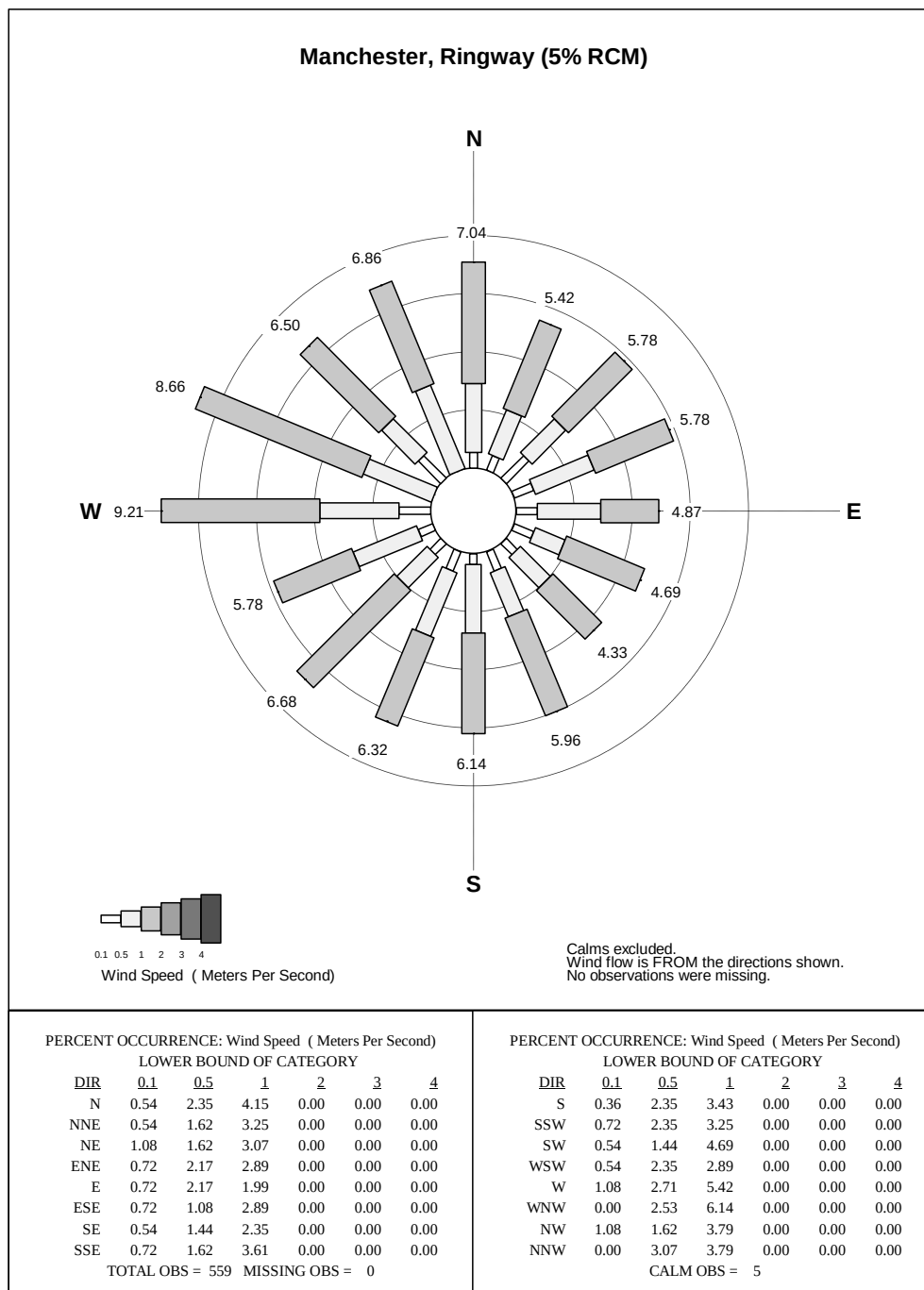


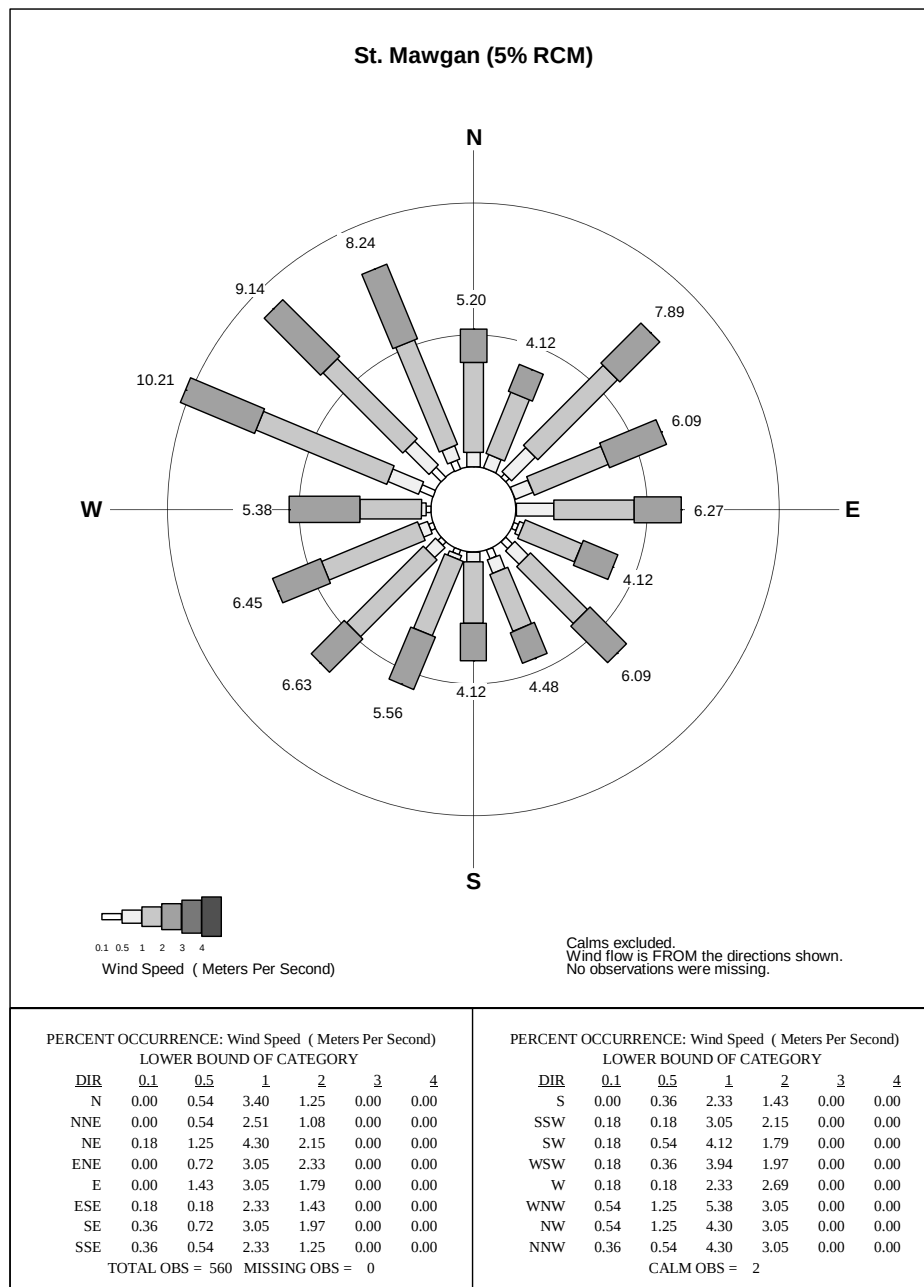


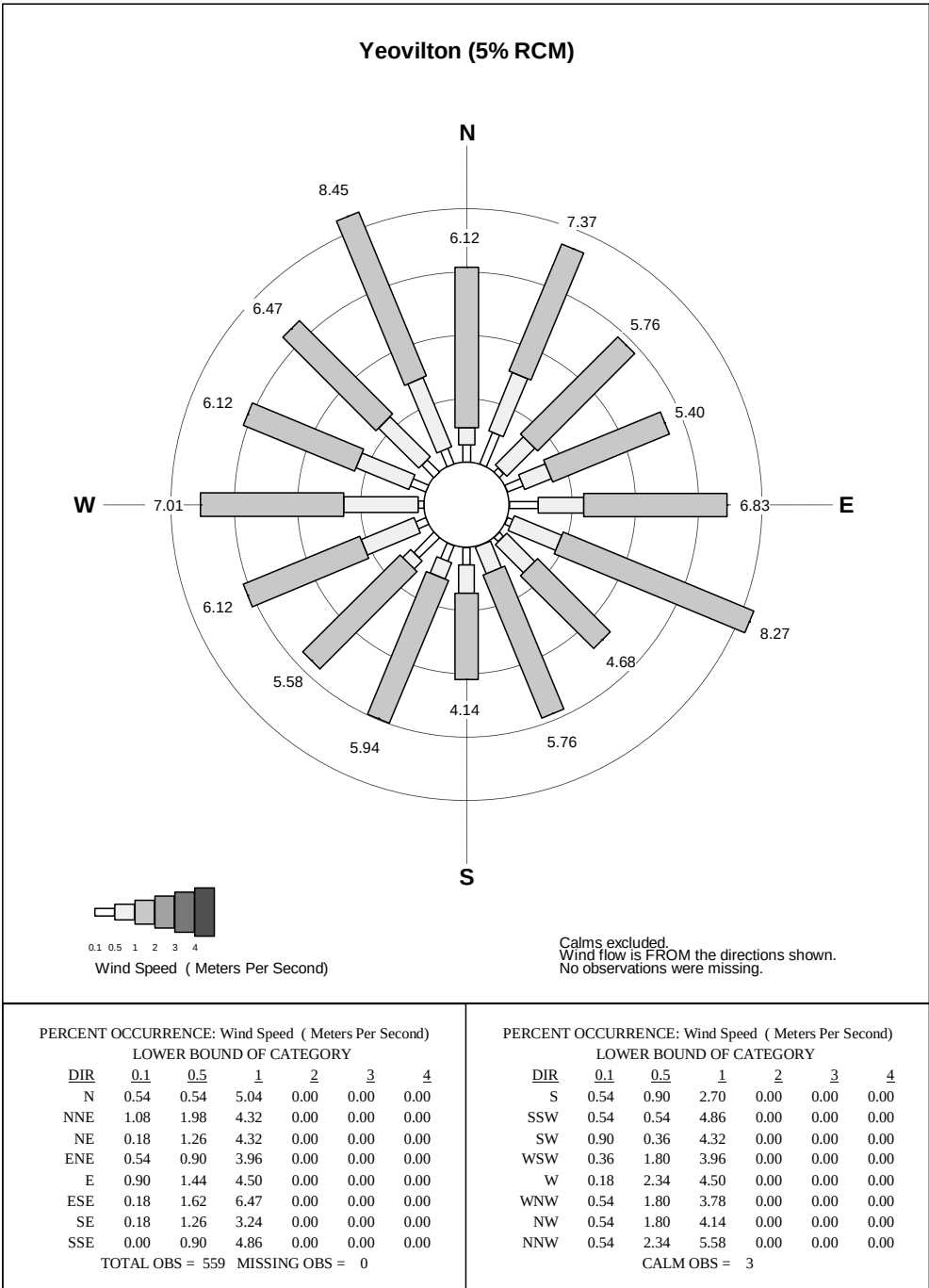






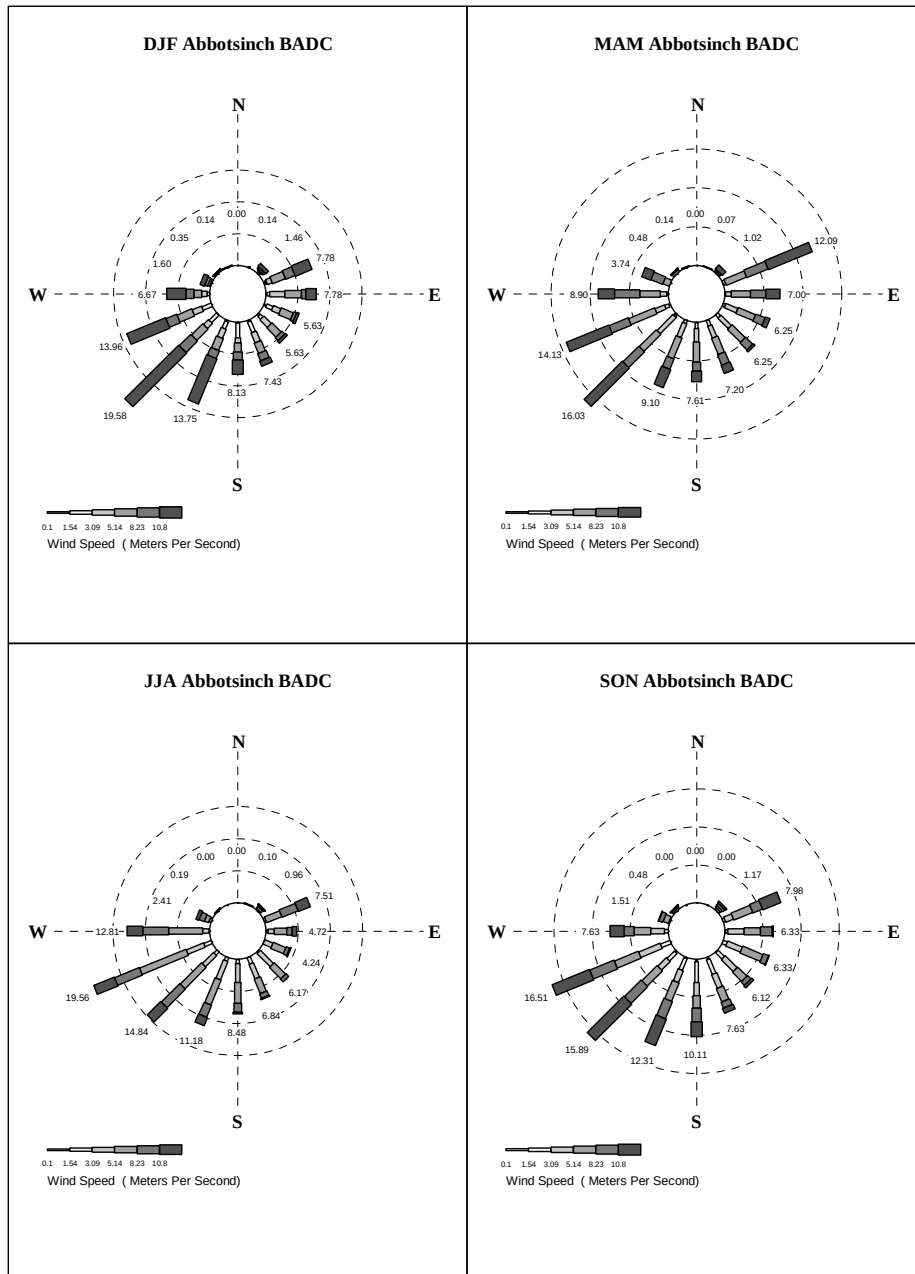


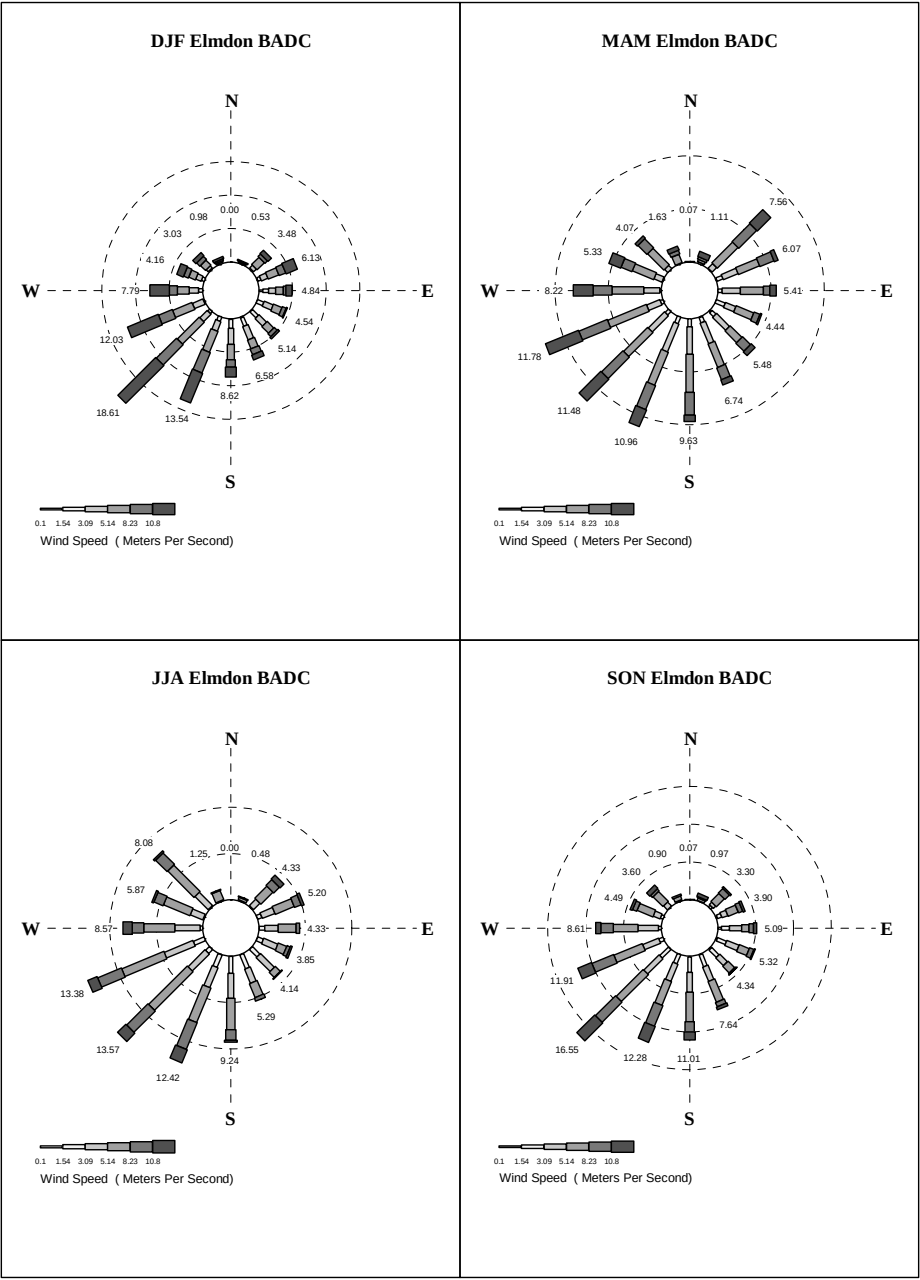


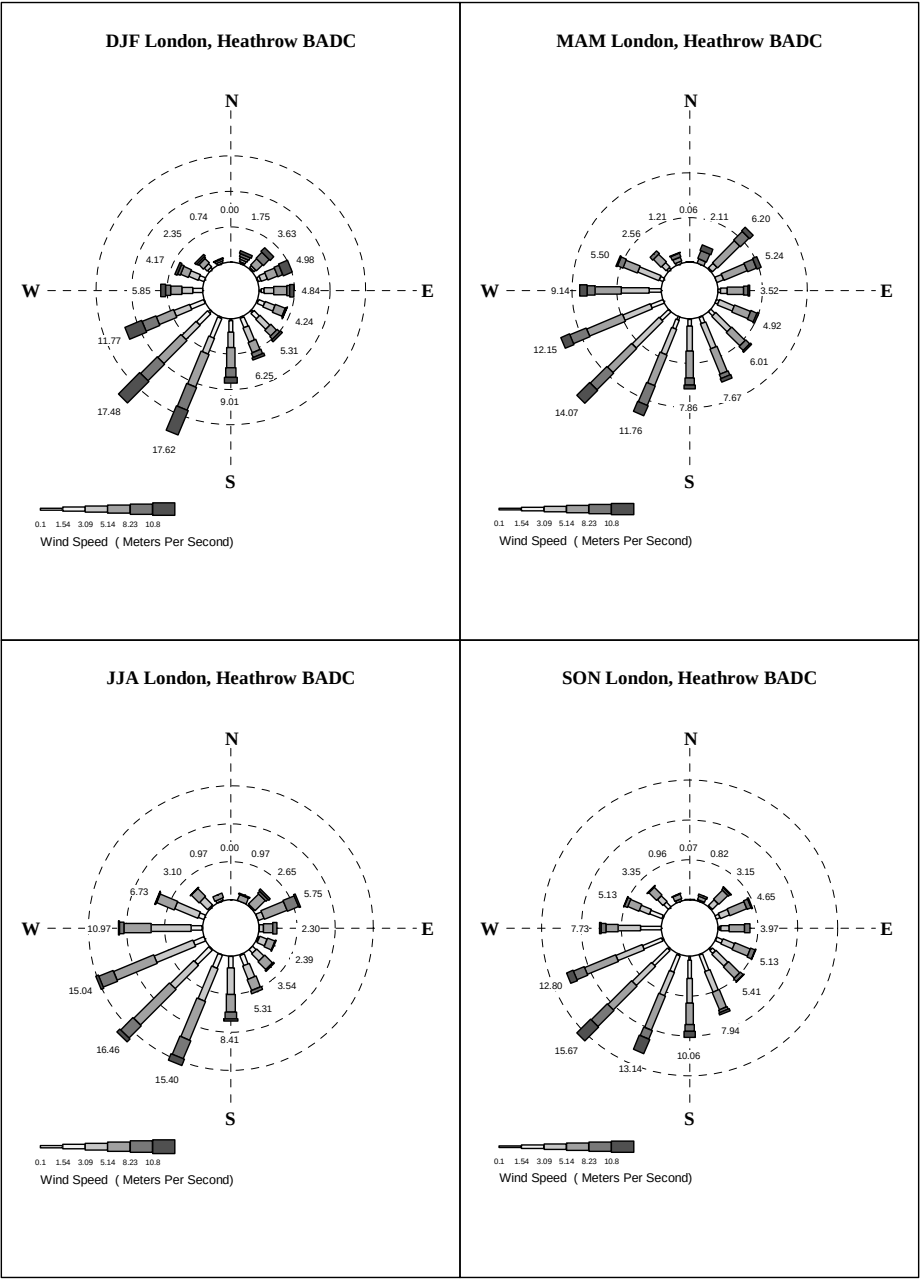


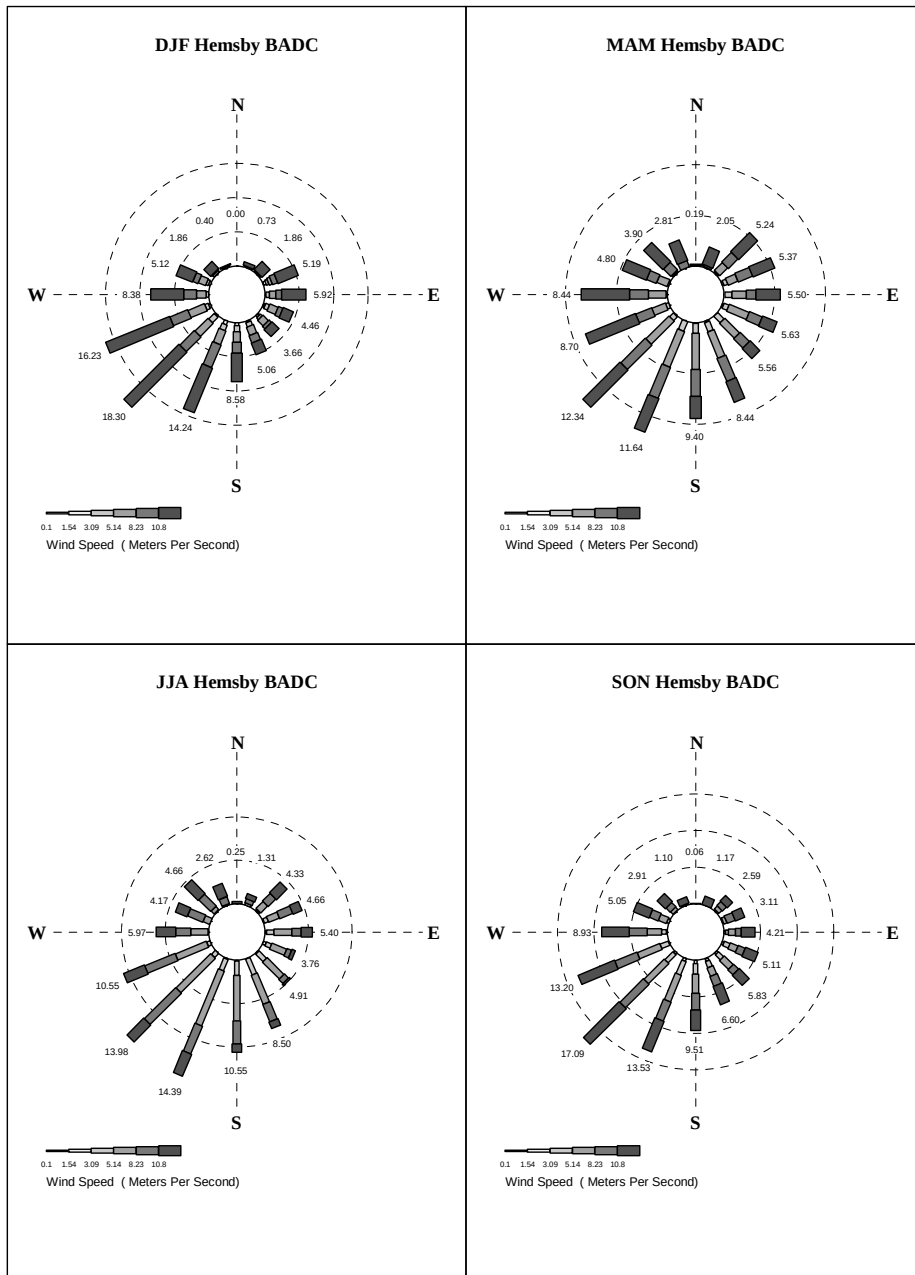
APPENDIX 7: OBSERVED SEASONAL WIND ROSES

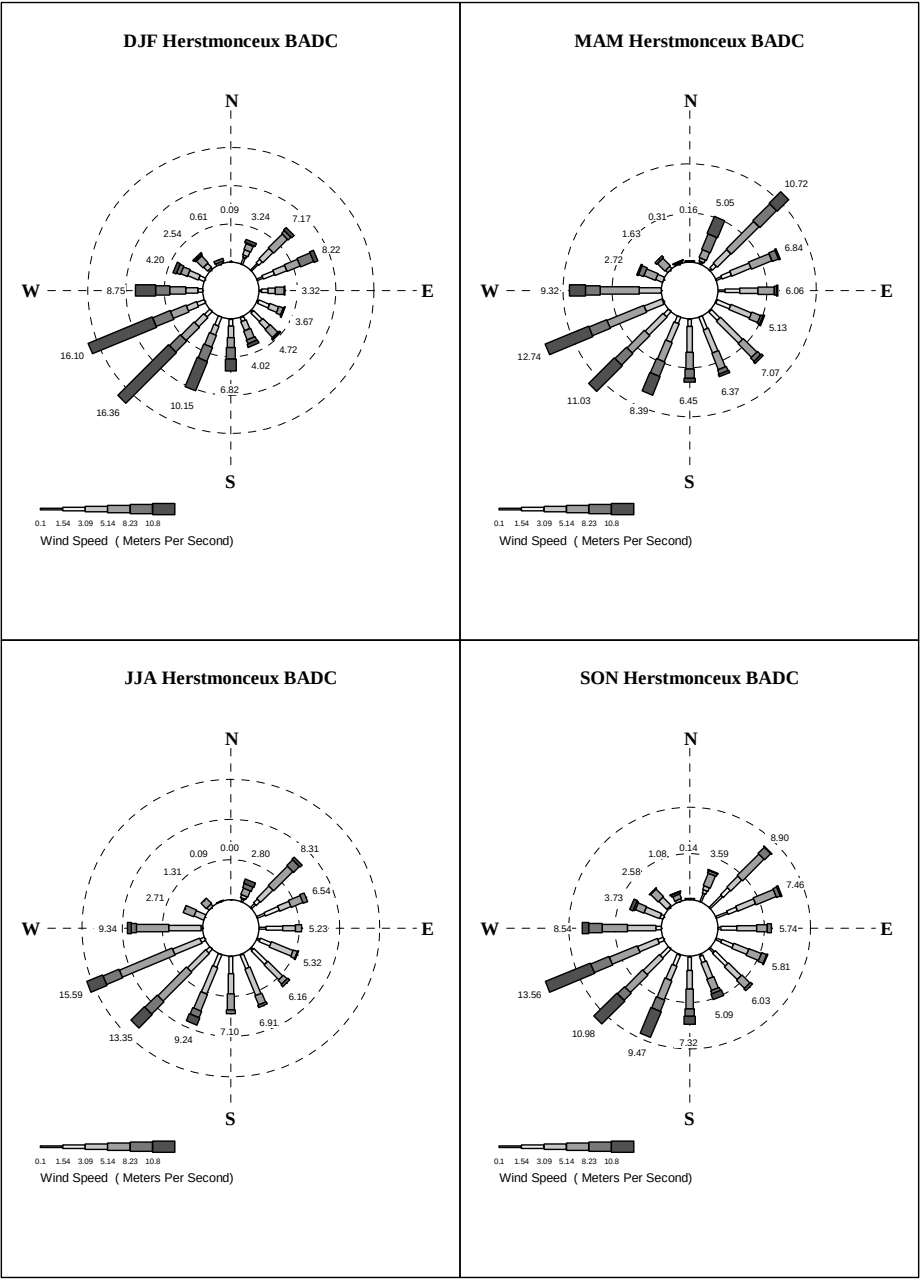
Observed seasonal wind speed (m/s) and direction (degrees) for the nine stations and time periods listed in Table 1.

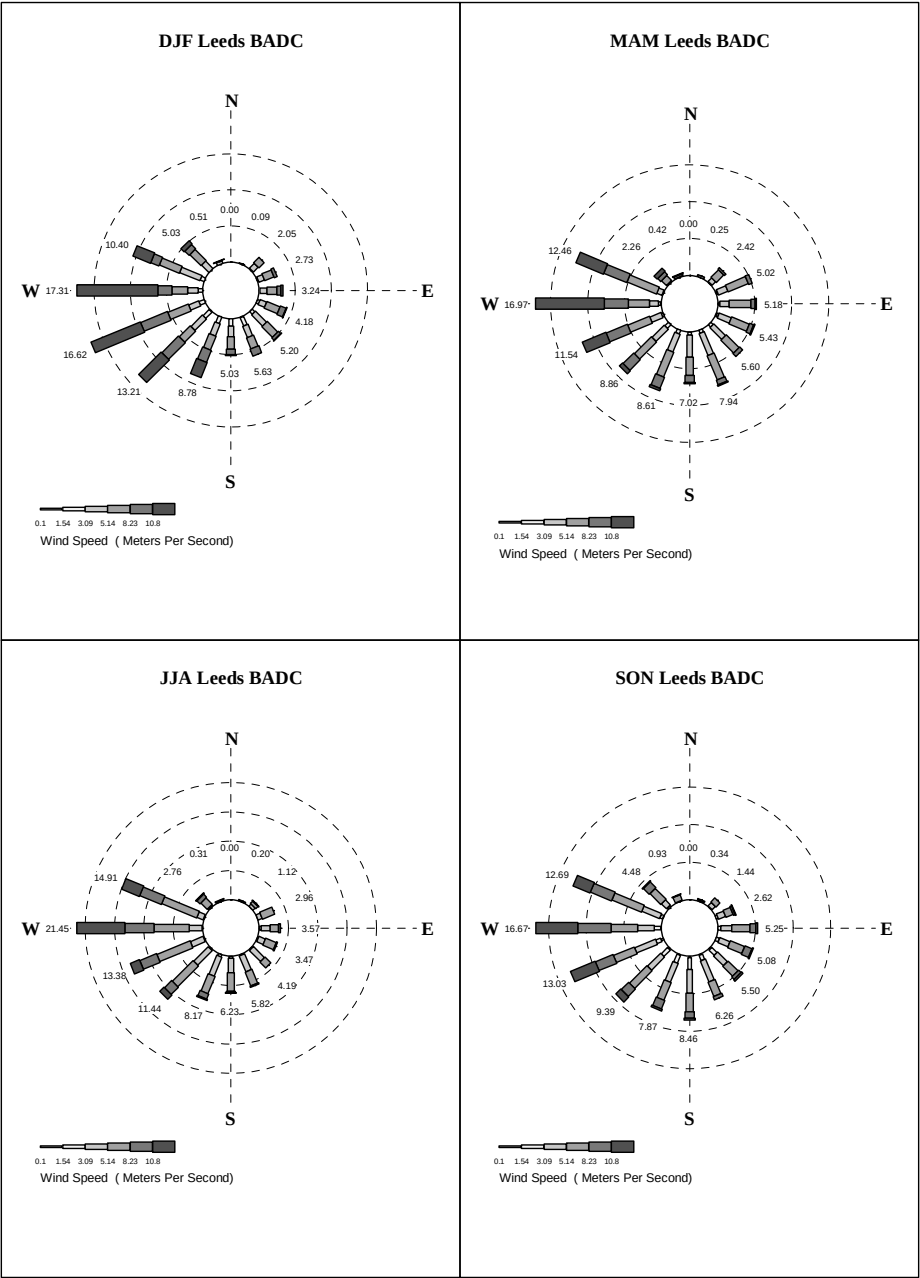


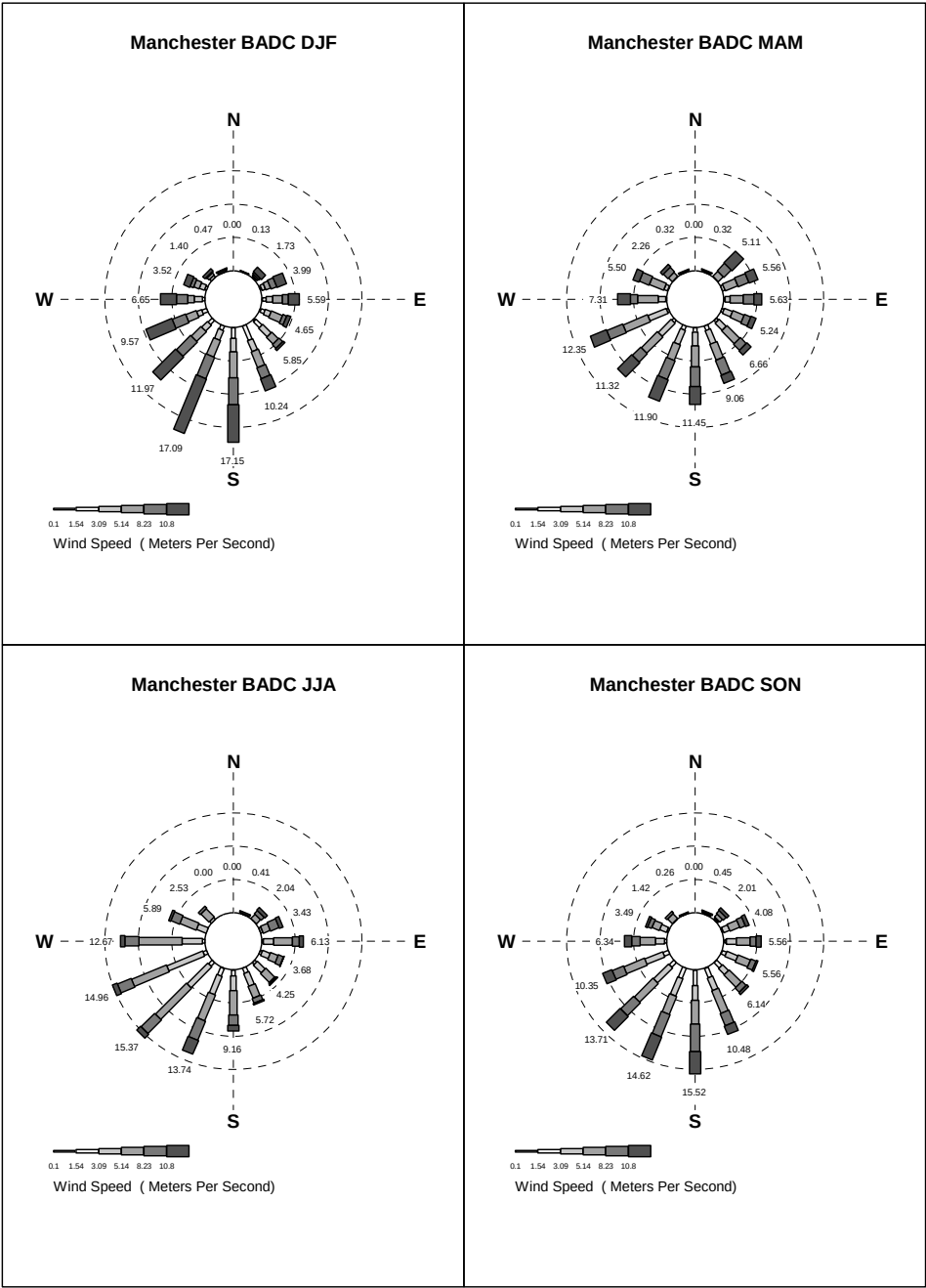


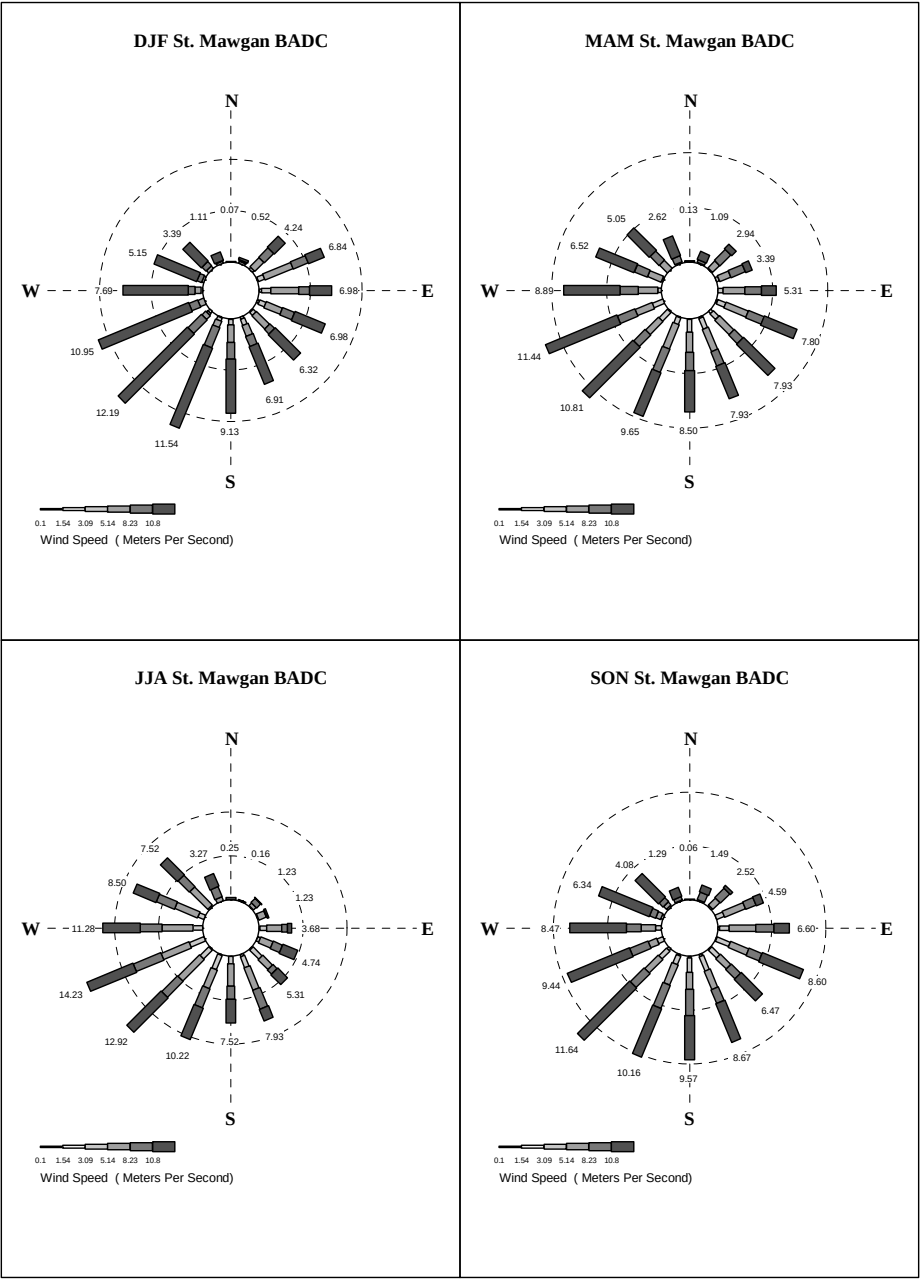


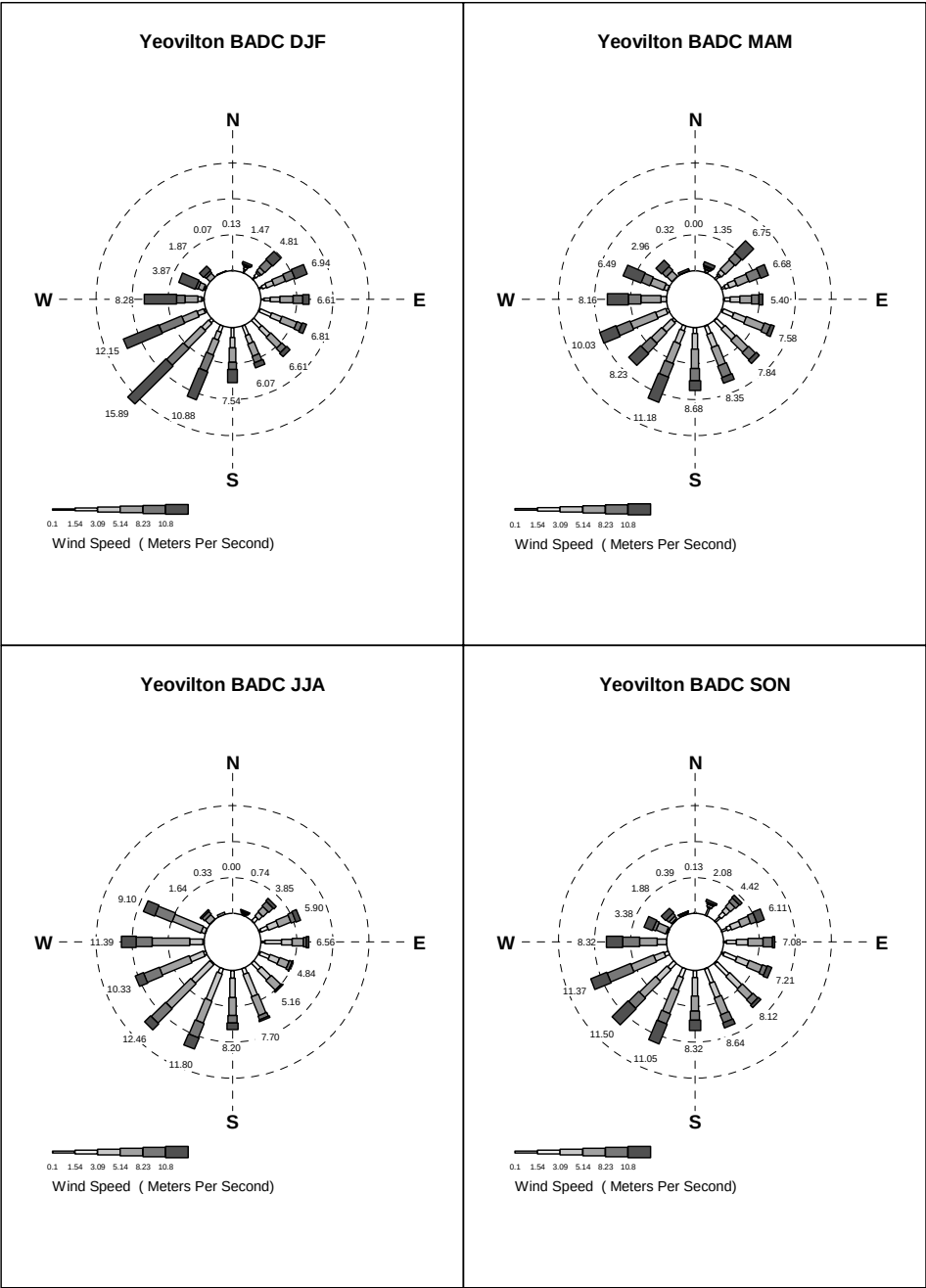






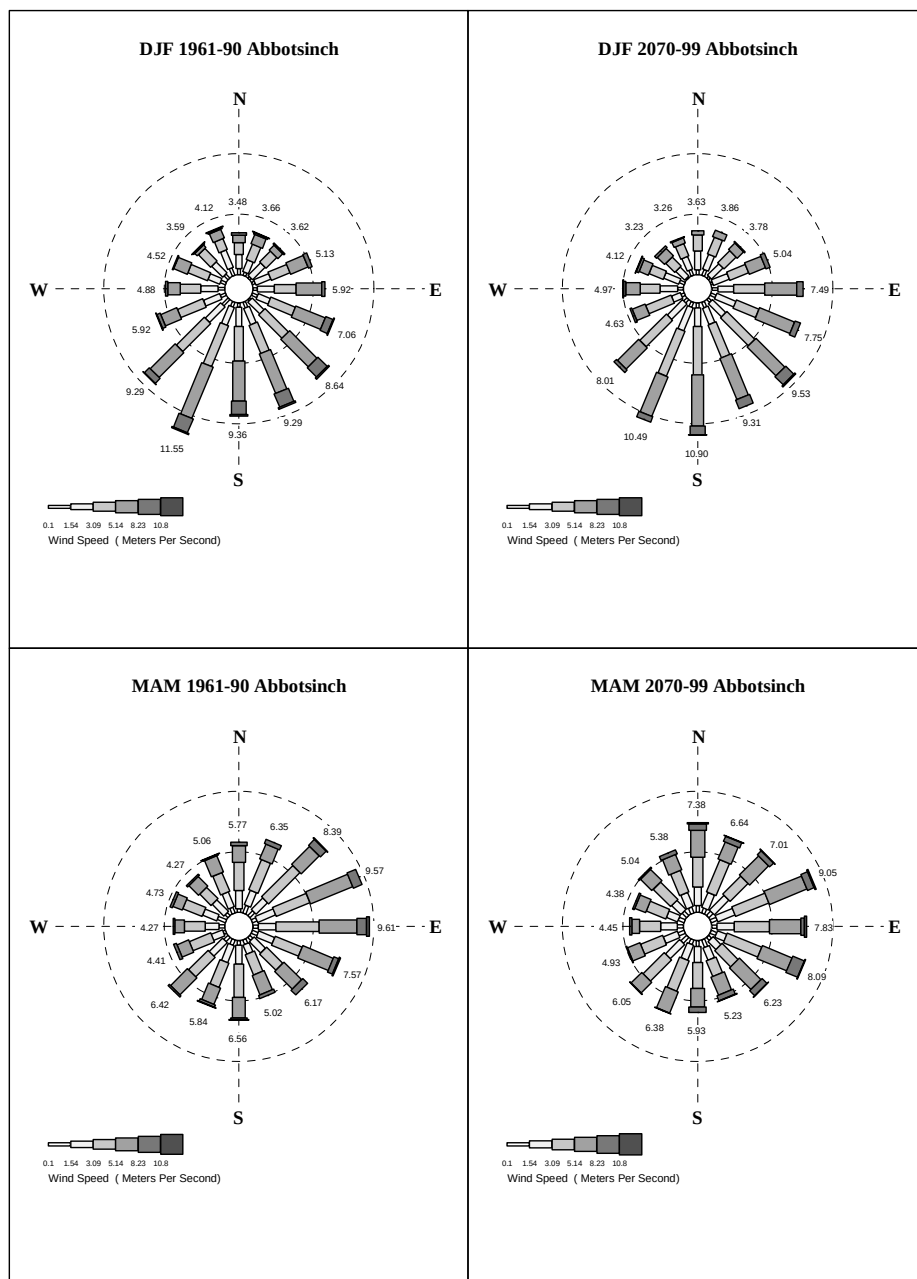


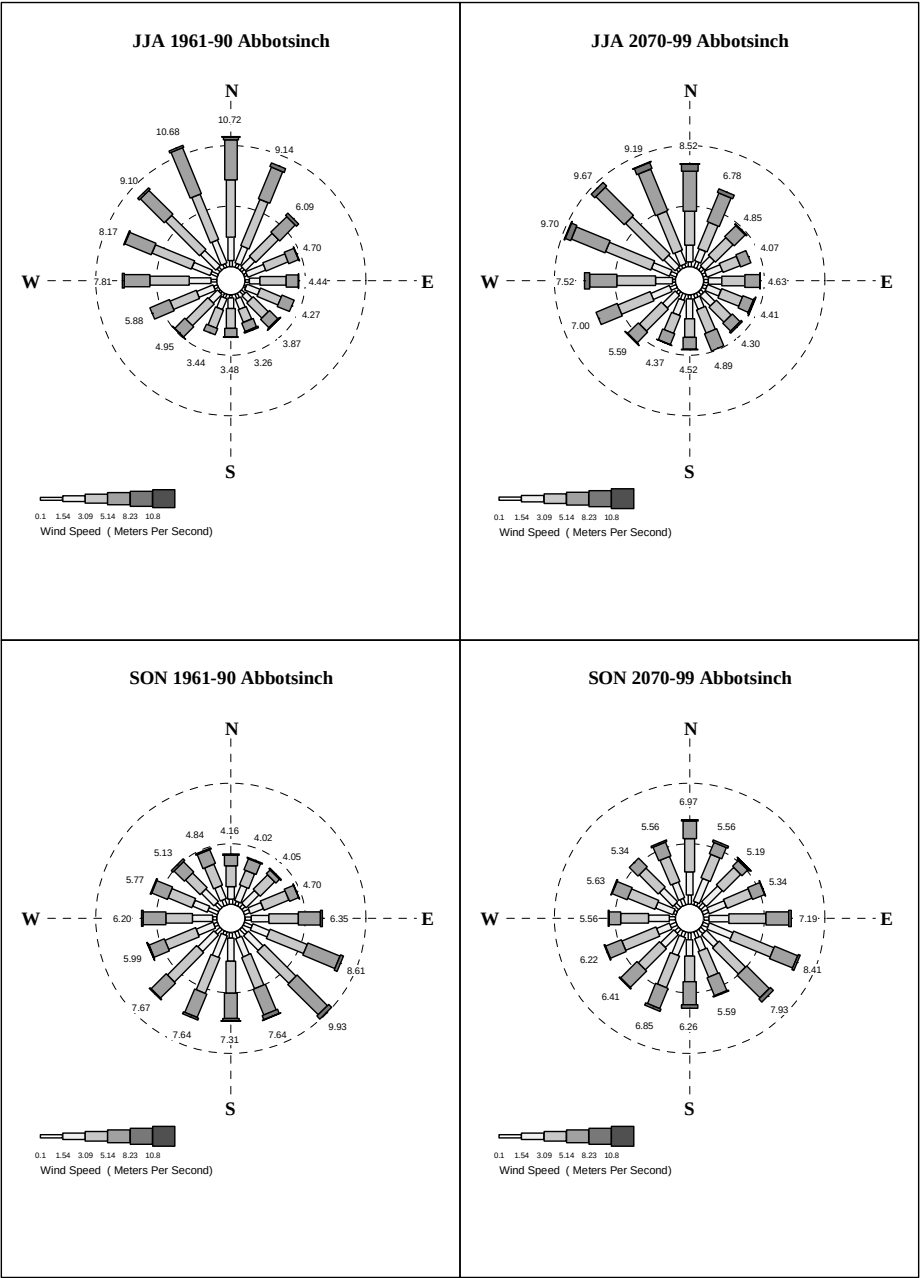


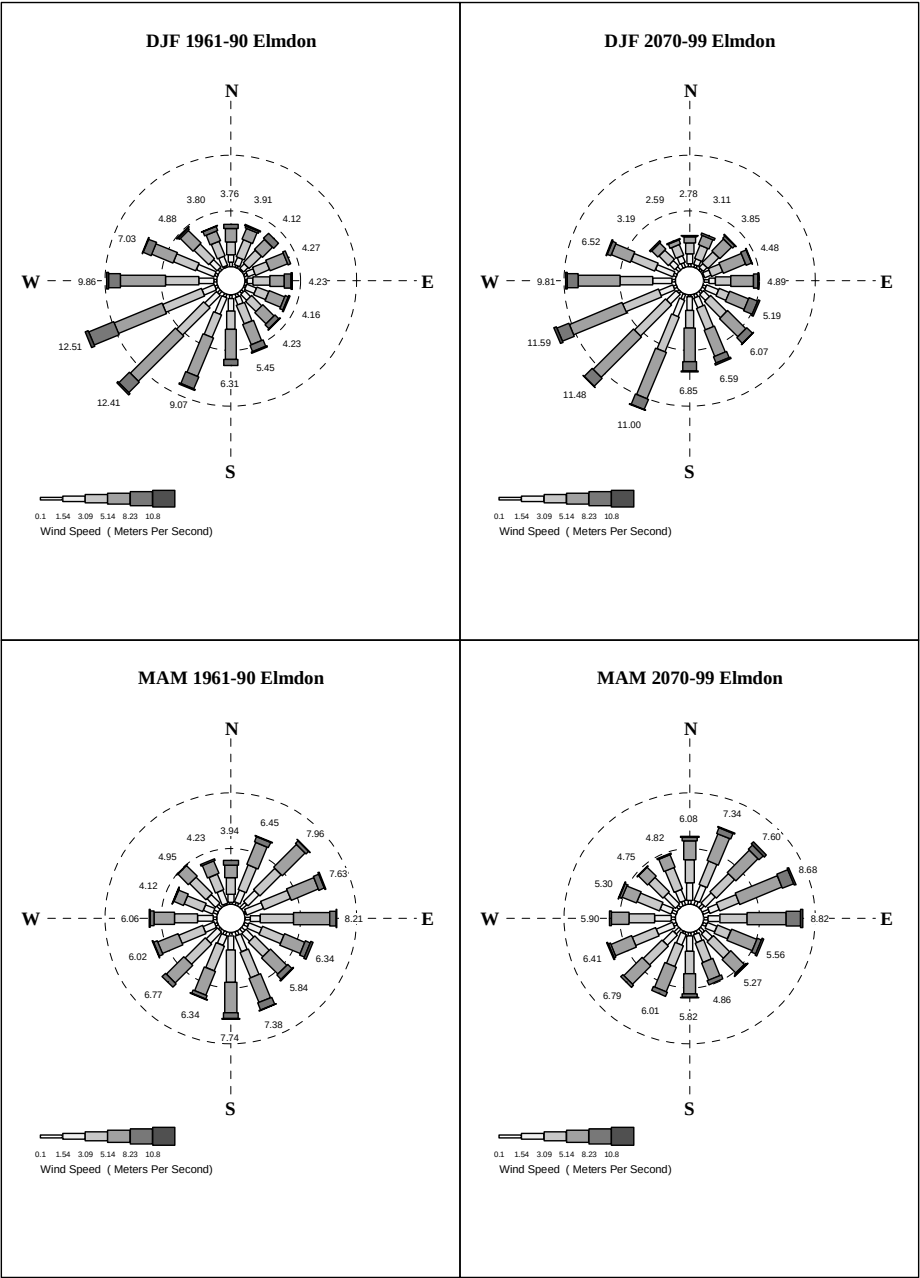


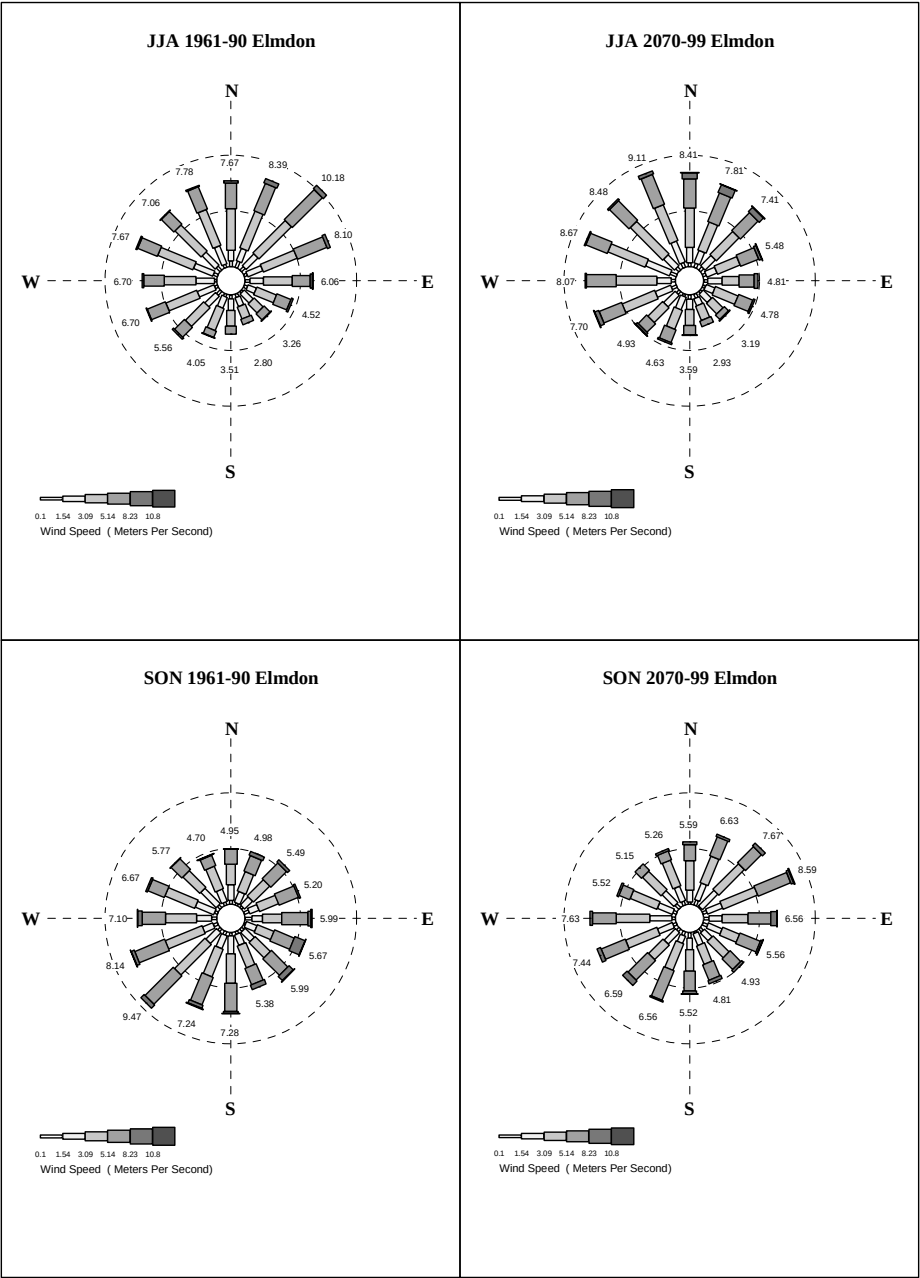
APPENDIX 8: HadRM3H SEASONAL WIND ROSES

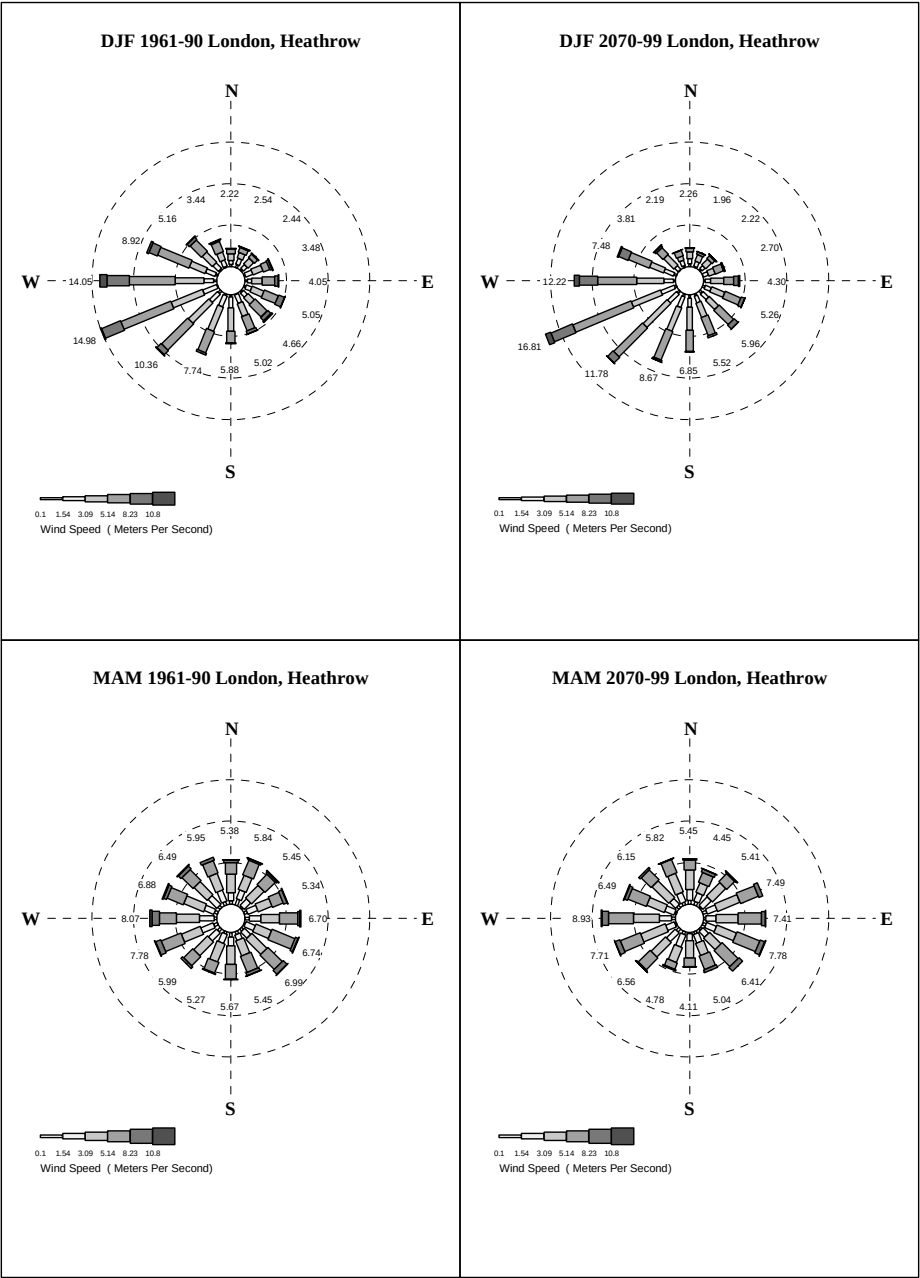
HadRM3H simulated seasonal wind speed (m/s) and direction (degrees) for the 1961-1990 baseline period (left-hand panels) and the 2070-2099 scenario period (right-hand panels) for the nine stations.

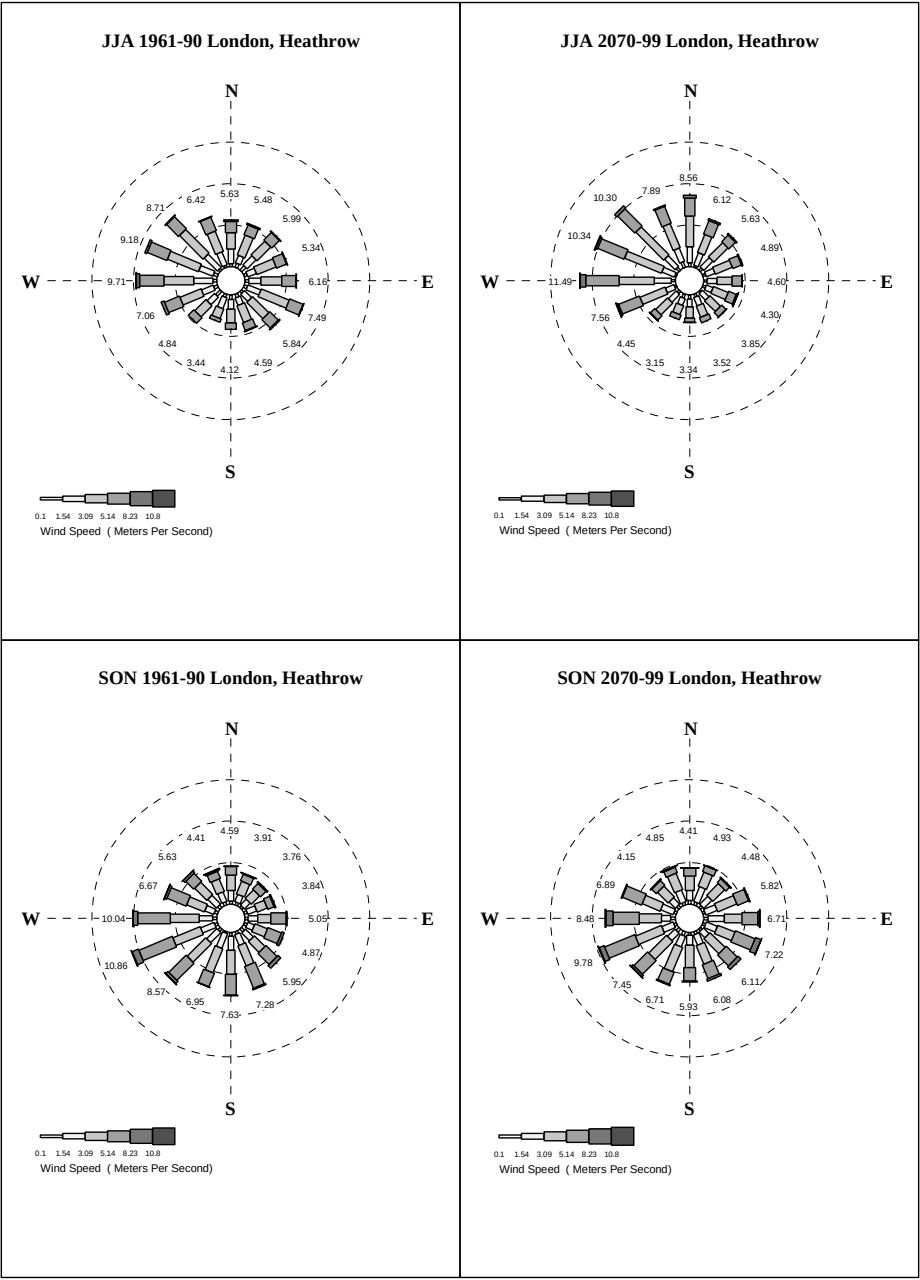


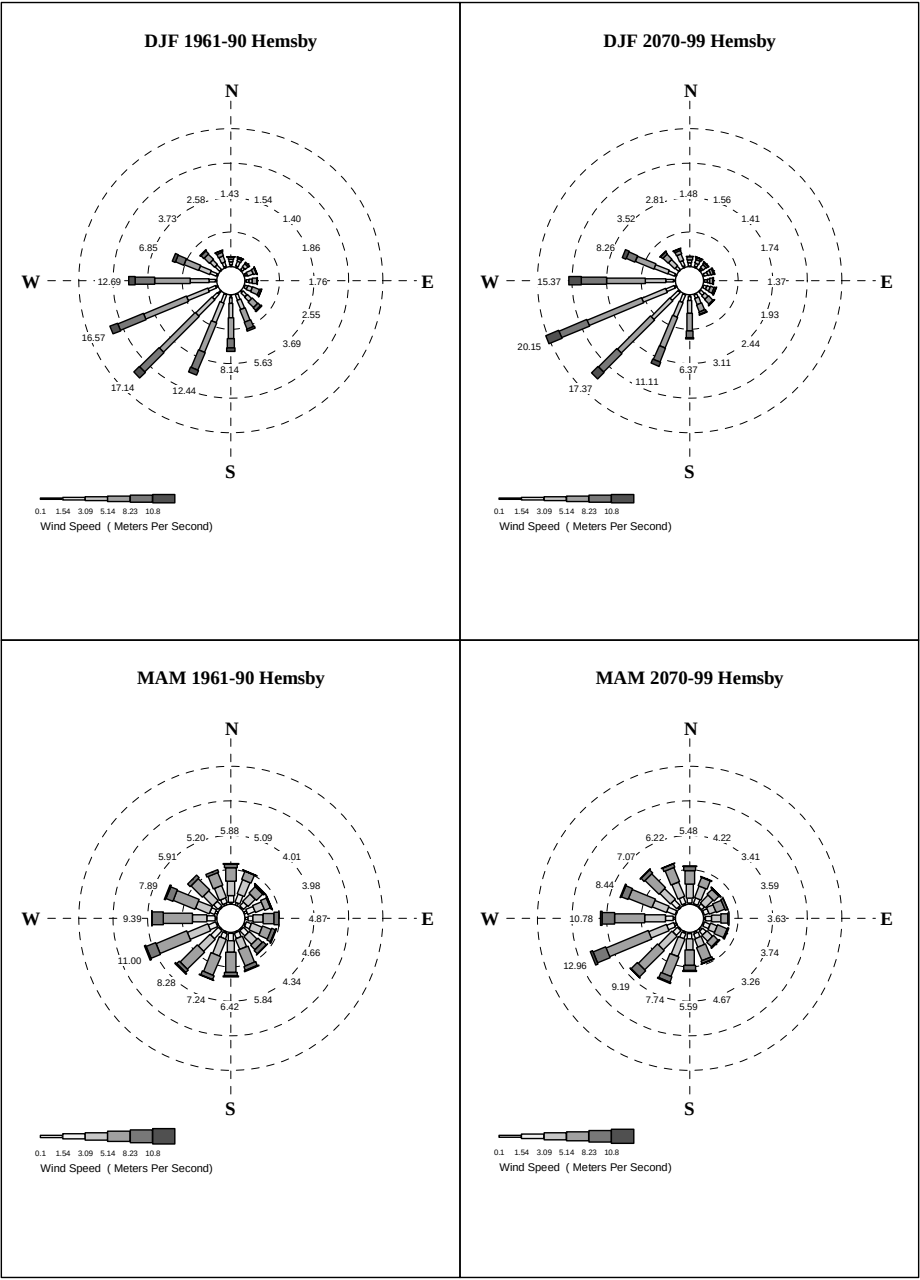


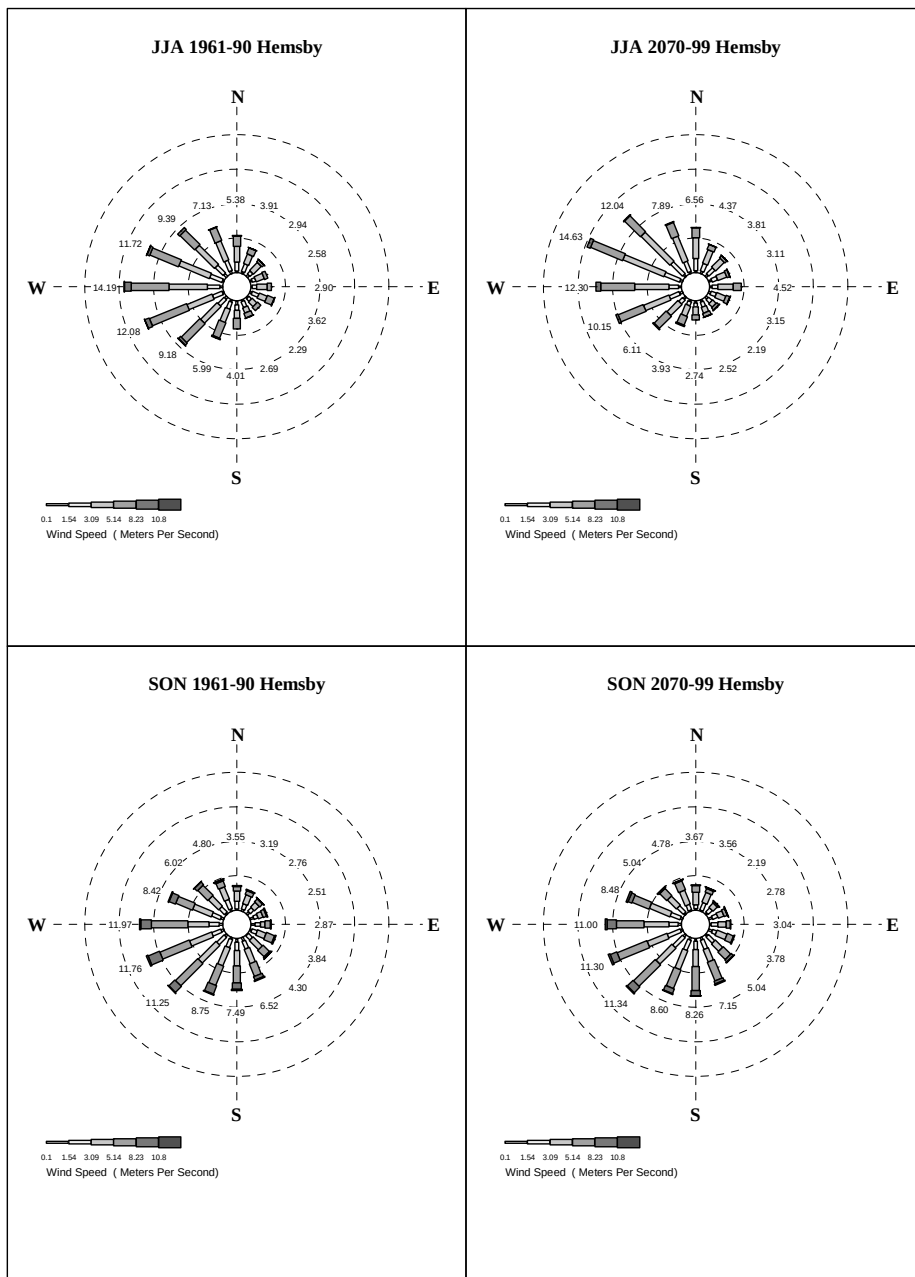


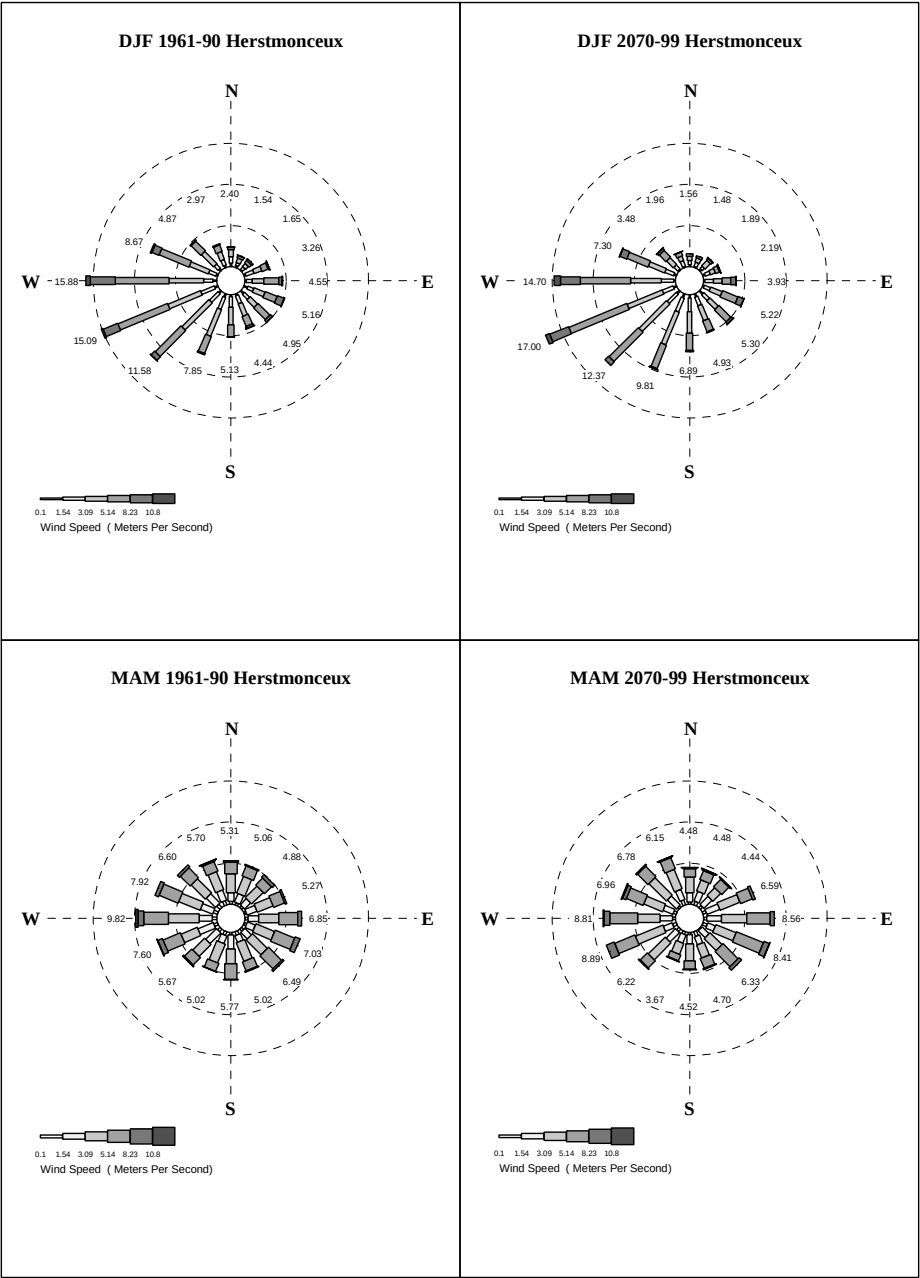


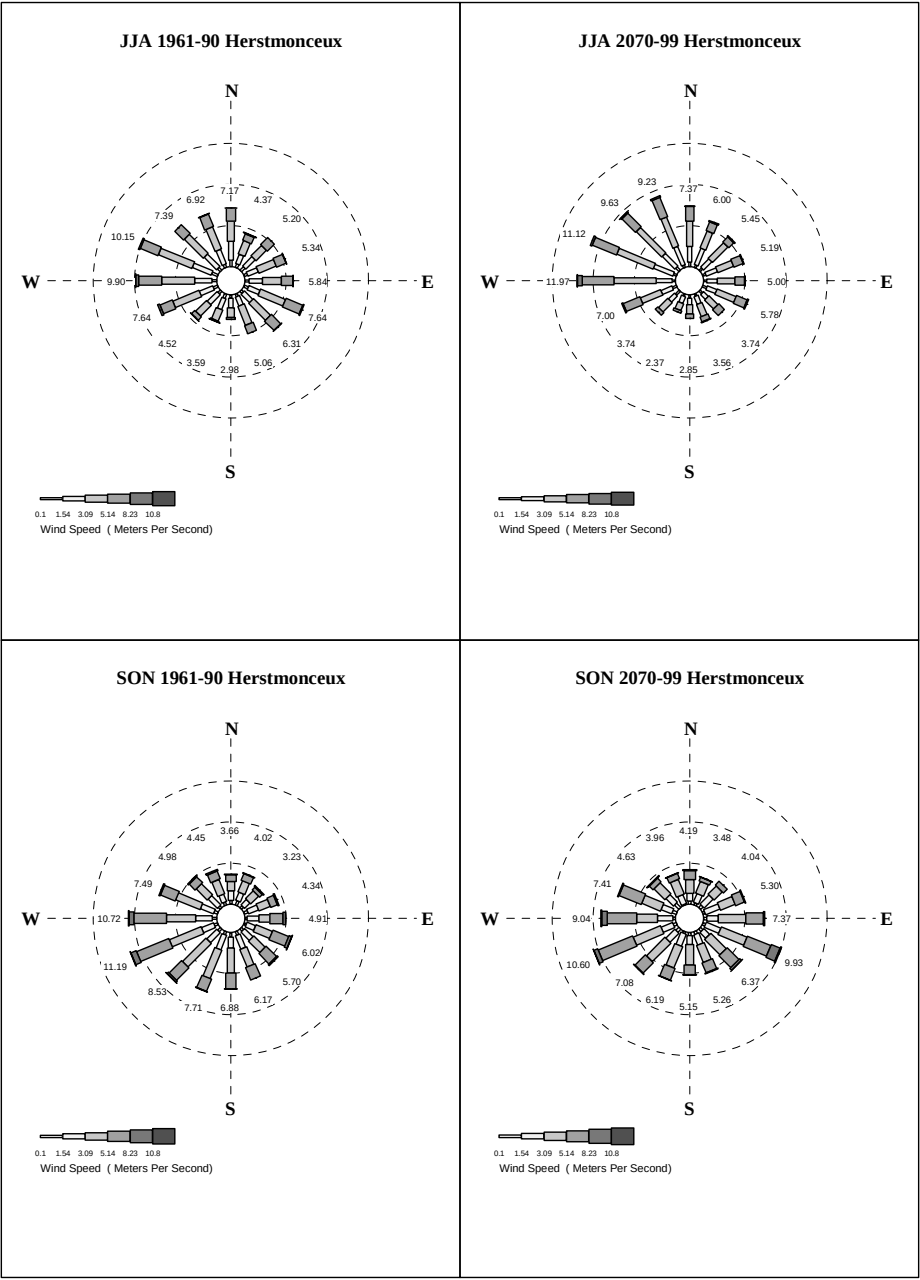


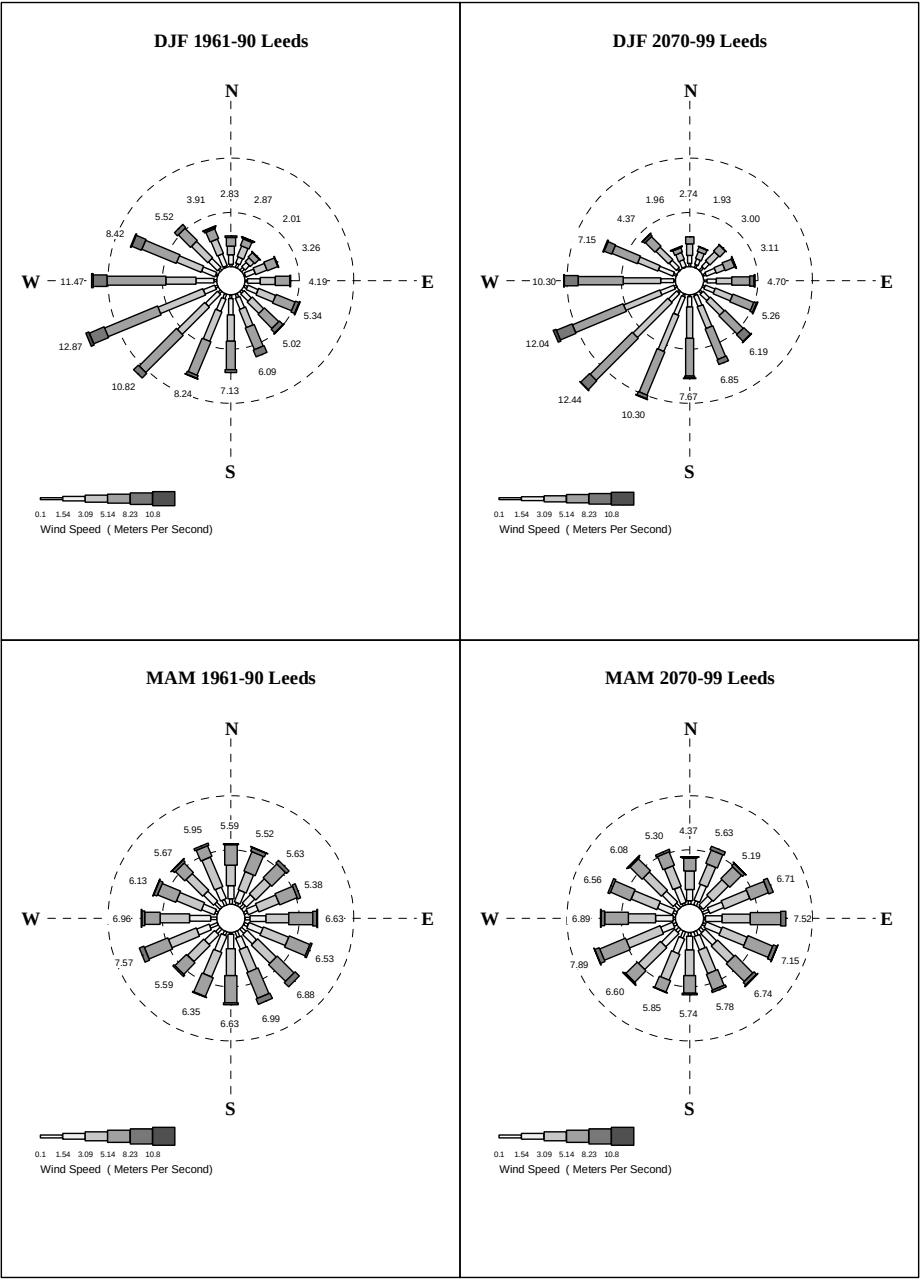


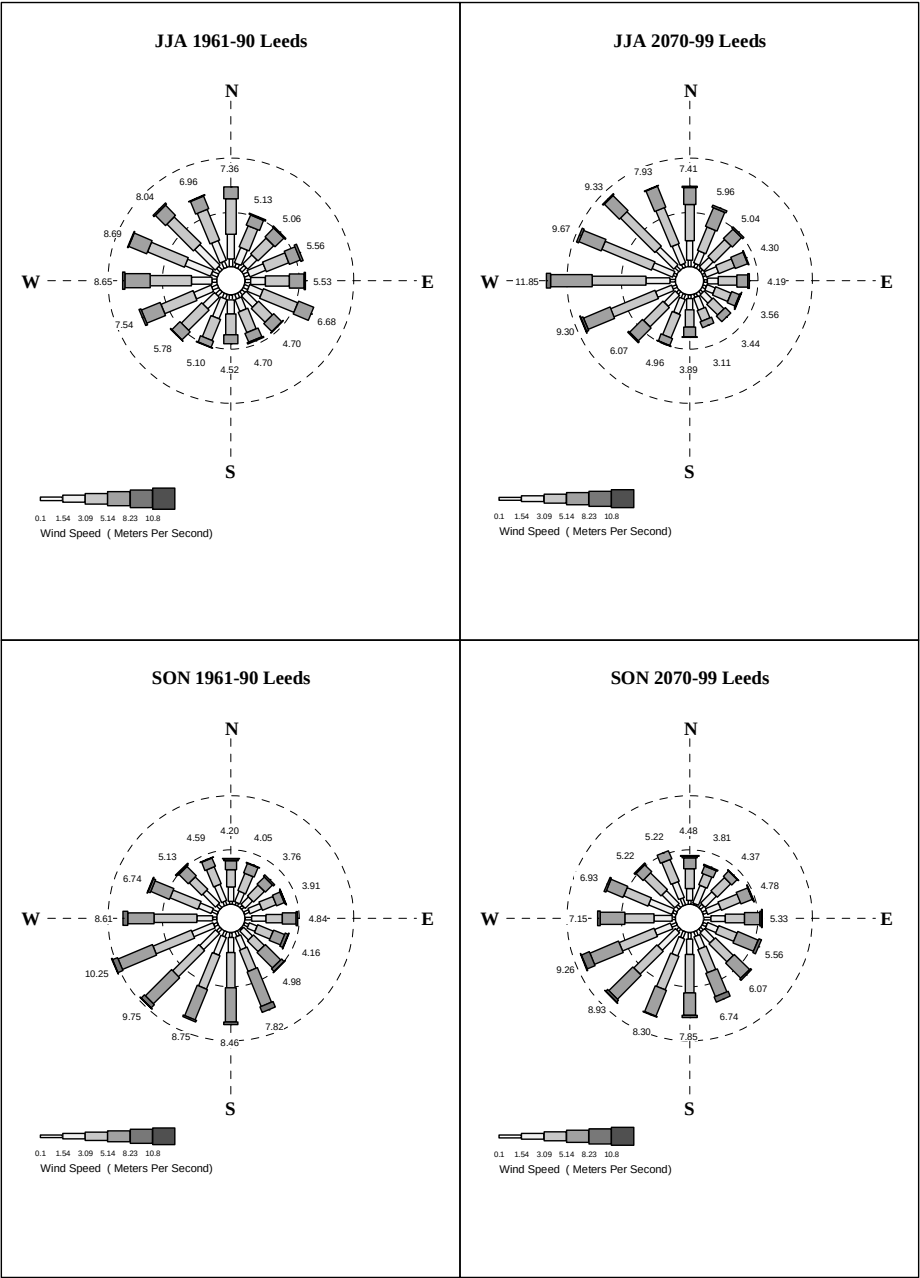


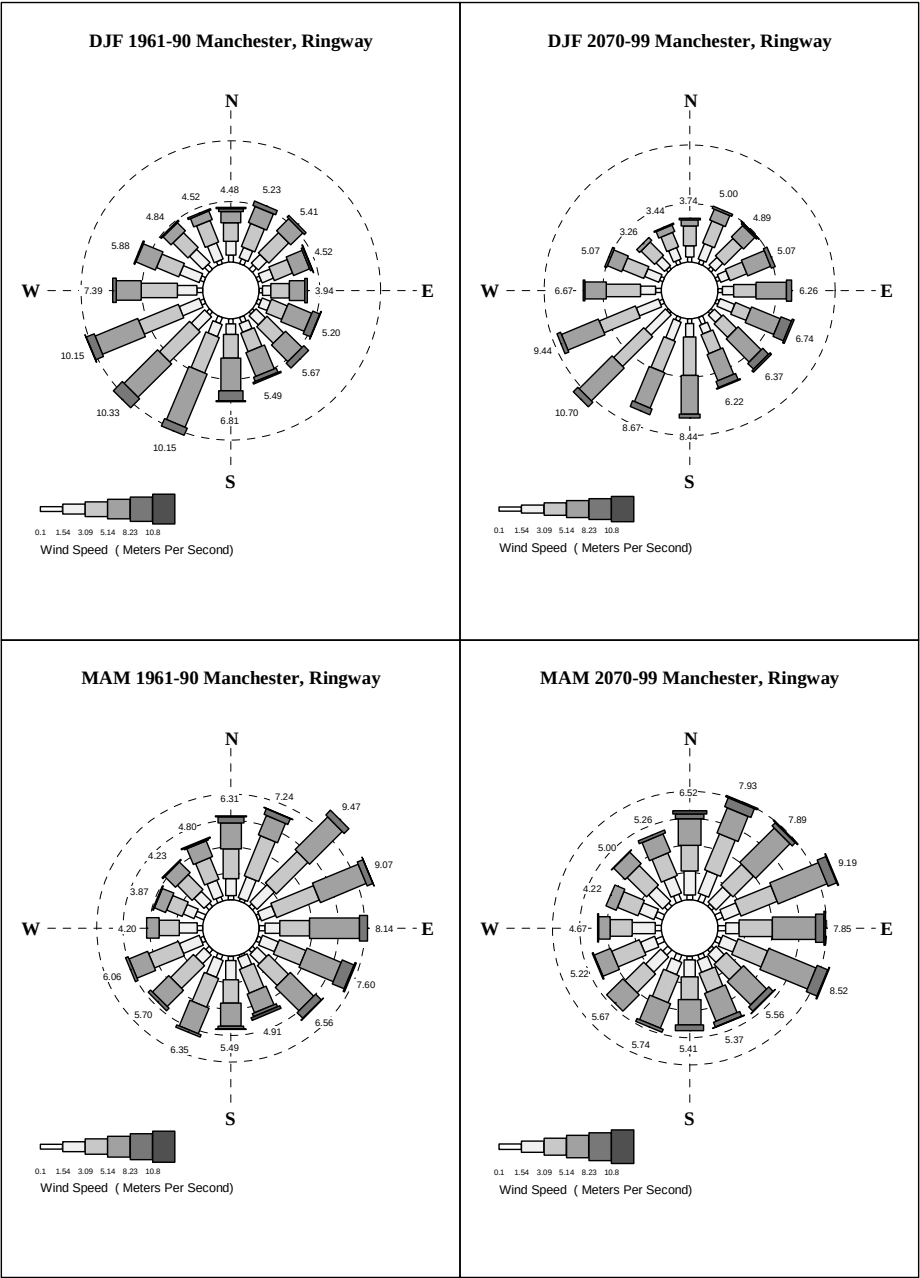


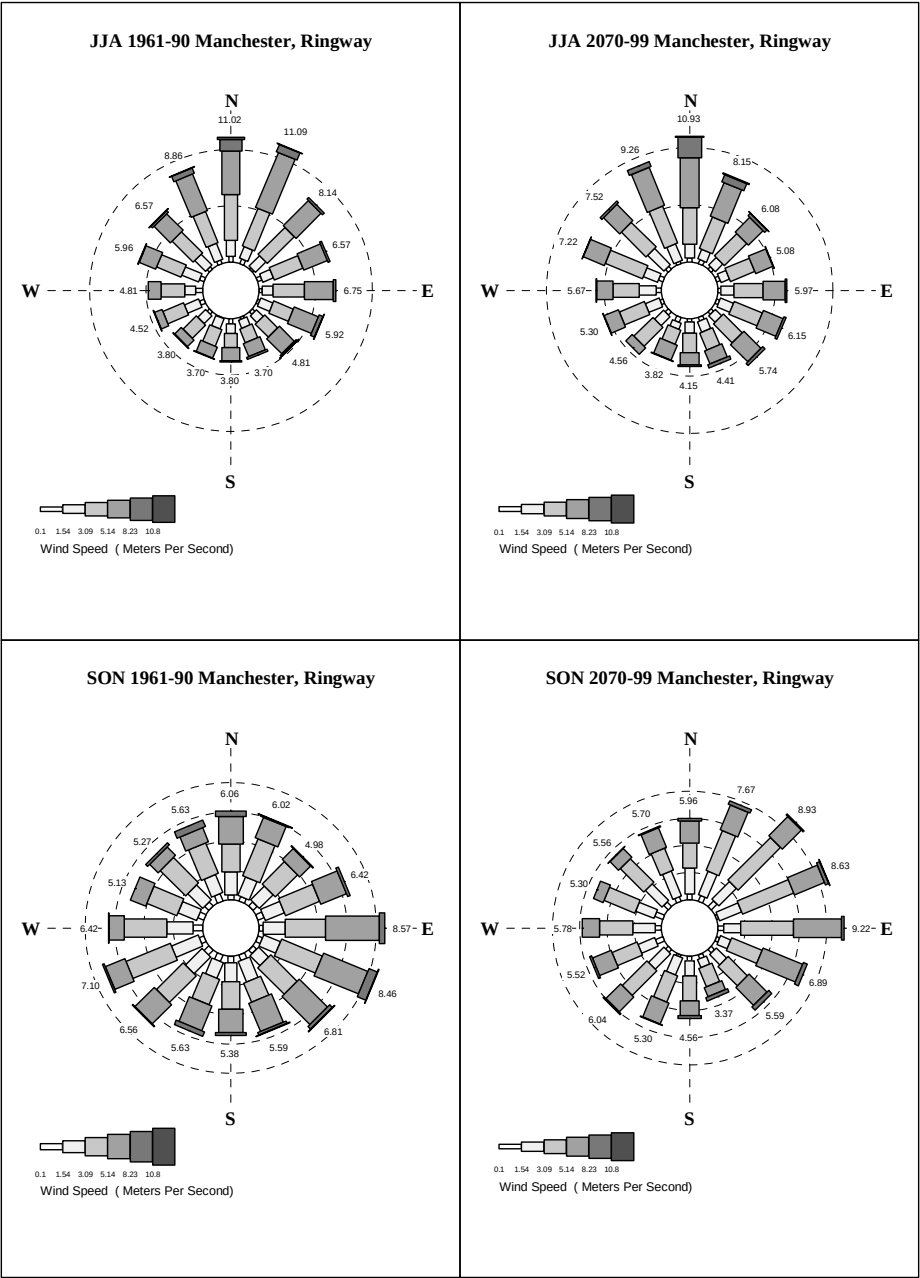


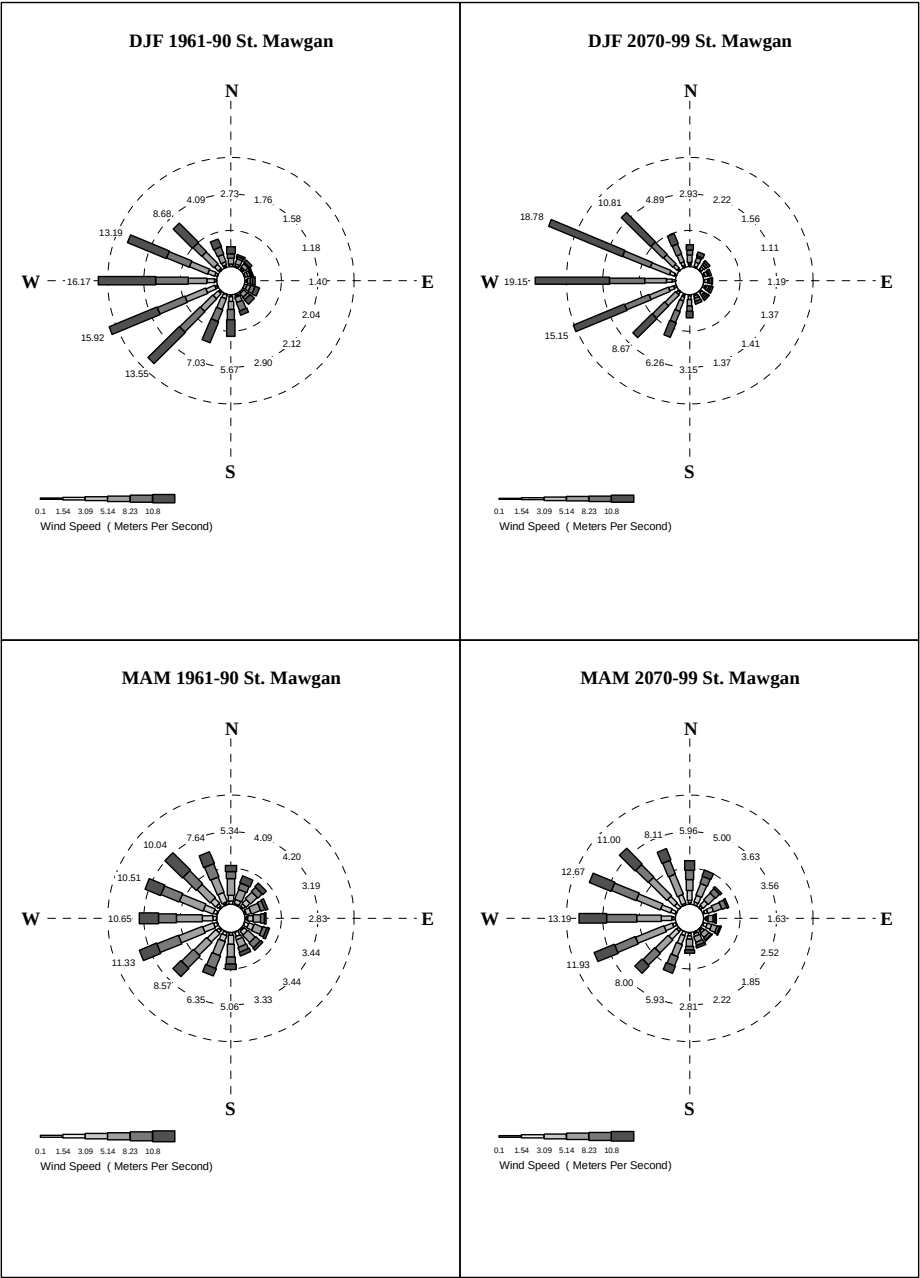


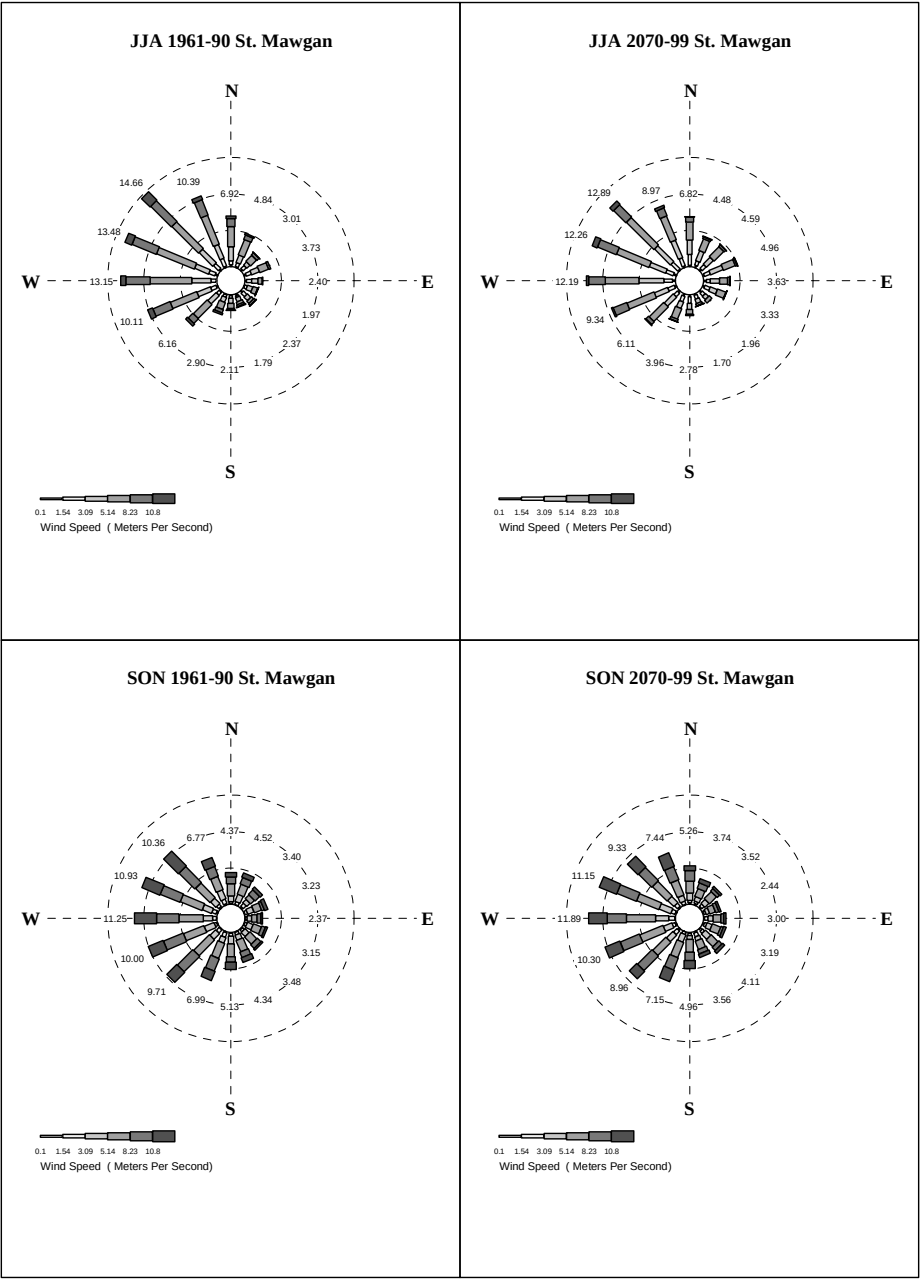


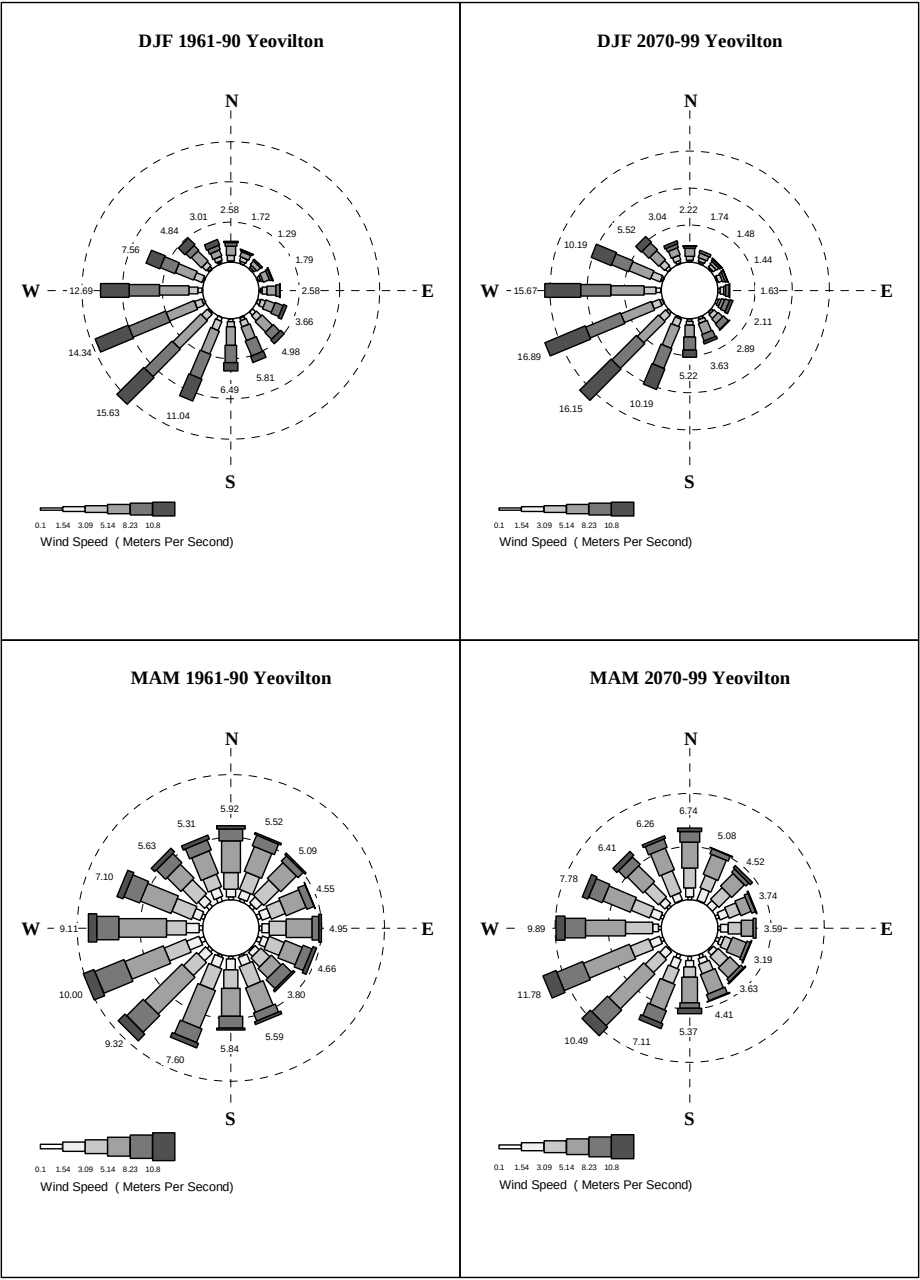


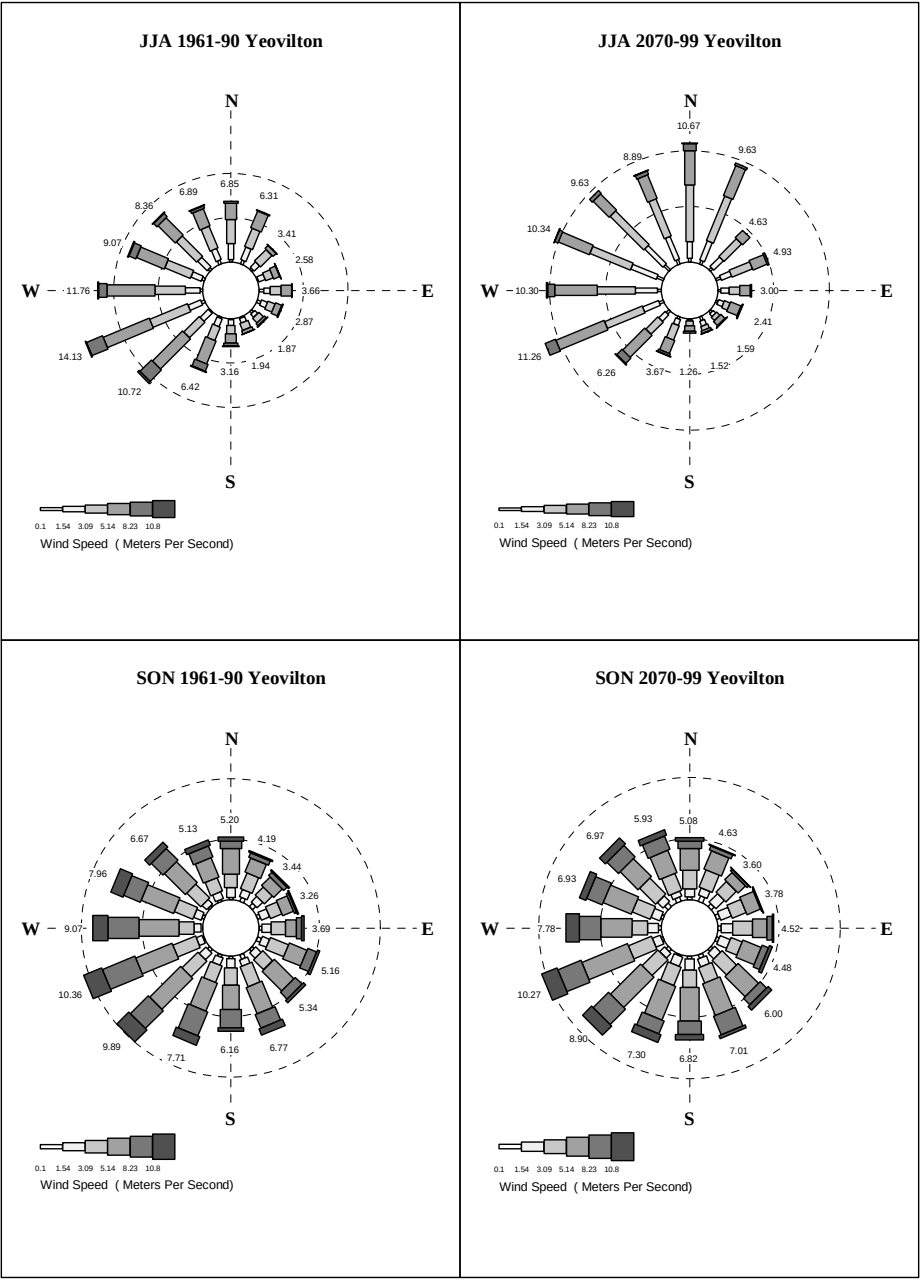












APPENDIX 9: SUMMARY OF SEASONAL CHANGES IN WIND SPEED

Present day (1961-1990) and future (2070-2099) HadRM3H simulated wind speeds (m/s) for the nine stations.

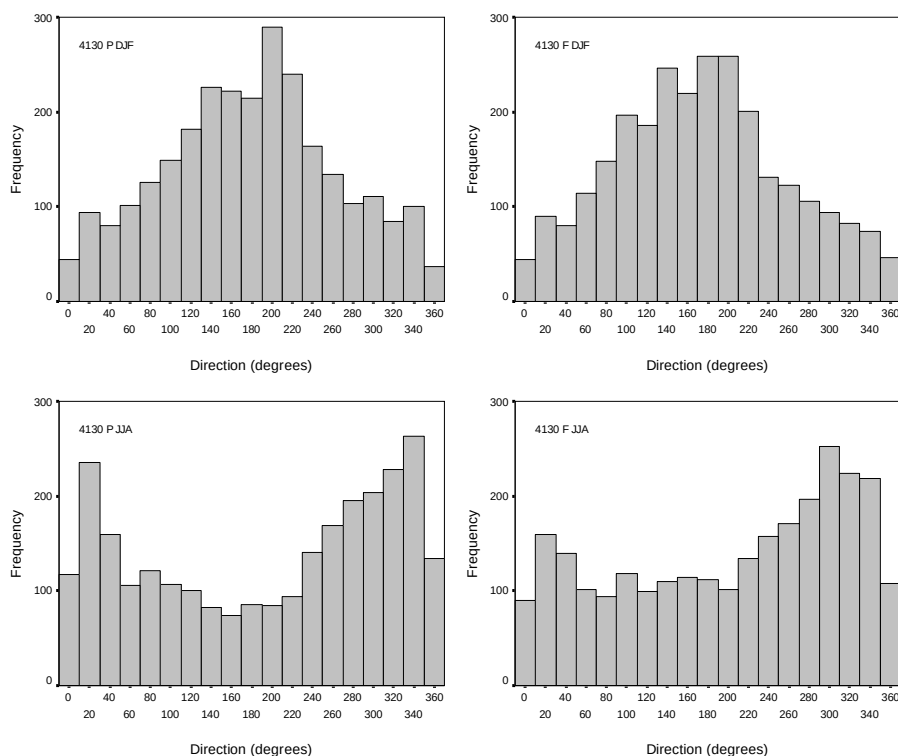
		Mean speed	Max. speed	Min. speed	1 st % speed	5 th % speed	10 th % speed	25 th % speed	50 th % speed	75 th % speed	90 th % speed	95 th % speed	99 th % speed
PRESENT 1961-90													
Abbotsinch	DJF	4.68	13.32	0.06	0.53	1.33	1.80	2.88	4.41	6.33	7.96	8.88	10.66
	MAM	4.47	13.32	0.02	0.55	1.29	1.83	2.88	4.23	5.76	7.50	8.46	10.28
	JJA	4.27	11.59	0.22	0.69	1.50	1.98	3.00	4.16	5.41	6.61	7.45	8.95
	SON	4.13	10.96	0.07	0.49	1.15	1.71	2.74	3.99	5.39	6.65	7.42	9.00
Elmdon	DJF	5.31	16.65	0.05	0.78	1.78	2.34	3.48	5.13	6.94	8.55	9.42	11.28
	MAM	4.78	15.38	0.16	0.75	1.52	2.06	3.14	4.60	6.20	7.75	8.73	10.63
	JJA	4.30	11.29	0.17	0.68	1.46	2.04	3.00	4.19	5.45	6.75	7.55	9.11
	SON	4.59	13.28	0.07	0.72	1.54	2.09	3.10	4.41	5.95	7.35	8.30	9.83
London, Heathrow	DJF	5.32	14.60	0.22	0.83	1.76	2.33	3.50	5.15	6.94	8.62	9.52	11.51
	MAM	4.63	13.82	0.06	0.65	1.40	1.91	2.99	4.44	5.95	7.59	8.76	10.81
	JJA	4.07	11.46	0.17	0.56	1.23	1.84	2.77	3.91	5.23	6.50	7.35	9.07
	SON	4.50	13.27	0.12	0.73	1.43	1.97	2.98	4.30	5.86	7.25	8.12	9.85
Hemsby	DJF	6.15	15.64	0.10	0.82	1.86	2.48	3.98	6.02	8.18	9.89	10.95	12.80
	MAM	5.24	14.56	0.19	0.69	1.67	2.25	3.49	5.06	6.84	8.46	9.30	11.10
	JJA	4.57	12.76	0.18	0.85	1.50	2.10	3.15	4.44	5.86	7.16	7.90	9.22
	SON	5.01	14.32	0.12	0.65	1.39	2.01	3.23	4.75	6.63	8.43	9.37	11.10
Herstmonceux	DJF	5.12	13.87	0.14	0.66	1.57	2.19	3.43	4.93	6.61	8.31	9.27	10.96
	MAM	4.45	13.37	0.10	0.66	1.38	1.88	2.87	4.25	5.78	7.30	8.24	10.29
	JJA	3.91	13.12	0.06	0.52	1.20	1.72	2.59	3.80	5.07	6.26	7.07	8.45
	SON	4.29	13.46	0.05	0.62	1.36	1.84	2.87	4.09	5.53	7.01	7.88	9.61
Leeds	DJF	4.82	12.37	0.24	0.71	1.45	1.96	3.12	4.63	6.31	7.91	8.75	10.53
	MAM	4.24	11.59	0.03	0.55	1.23	1.83	2.85	4.13	5.48	6.82	7.65	9.36
	JJA	3.72	9.49	0.17	0.55	1.24	1.66	2.51	3.63	4.80	5.88	6.60	7.96
	SON	3.90	11.20	0.07	0.52	1.18	1.62	2.51	3.70	5.12	6.46	7.29	8.80
Manchester	DJF	4.70	13.00	0.06	0.63	1.40	1.95	3.09	4.54	6.26	7.72	8.63	10.10
	MAM	4.67	15.88	0.09	0.72	1.51	1.99	3.05	4.45	6.12	7.58	8.46	10.42

	JJA	4.61	12.68	0.06	0.67	1.48	2.08	3.19	4.55	5.87	7.17	8.10	9.83
	SON	4.33	12.92	0.17	0.75	1.35	1.86	2.84	4.14	5.64	7.05	7.97	9.45
St. Mawgan	DJF	9.87	23.09	0.09	1.52	3.55	4.81	7.15	9.95	12.55	14.75	15.99	18.53
	MAM	7.86	19.31	0.02	1.14	2.51	3.42	5.30	7.73	10.21	12.46	13.72	15.79
	JJA	6.37	15.63	0.19	1.01	1.85	2.66	4.26	6.30	8.35	10.09	11.08	12.90
	SON	7.74	19.95	0.25	1.18	2.36	3.25	5.15	7.66	10.15	12.36	13.46	15.90
Yeovilton	DJF	8.28	19.63	0.38	1.23	2.90	4.01	6.03	8.32	10.56	12.42	13.53	15.61
	MAM	6.09	17.27	0.10	0.78	1.72	2.51	3.97	5.90	8.05	9.80	11.00	13.22
	JJA	4.99	14.14	0.04	0.61	1.61	2.05	3.29	4.77	6.55	8.1	8.92	10.81
	SON	6.49	17.54	0.15	0.81	1.81	2.58	4.19	6.26	8.61	10.70	11.84	14.01
FUTURE 2070-99													
Abbotsinch	DJF	4.51	11.67	0.08	0.56	1.33	1.88	2.84	4.27	5.96	7.50	8.42	10.06
	MAM	4.49	12.86	0.06	0.55	1.21	1.72	2.90	4.27	5.89	7.46	8.49	10.20
	JJA	4.39	11.78	0.18	0.72	1.40	1.93	2.98	4.28	5.69	6.99	7.80	9.32
	SON	4.04	11.10	0.06	0.60	1.23	1.70	2.68	3.88	5.23	6.58	7.30	8.89
Elmdon	DJF	5.16	13.71	0.12	0.76	1.56	2.19	3.41	5.04	6.70	8.26	9.11	10.84
	MAM	4.78	13.61	0.04	0.63	1.38	1.94	3.07	4.59	6.24	7.72	8.76	10.94
	JJA	4.41	11.64	0.12	0.71	1.45	2.00	3.02	4.27	5.63	7.01	7.97	9.72
	SON	4.46	11.94	0.21	0.64	1.44	2.03	3.00	4.27	5.75	7.17	8.09	9.82
London, Heathrow	DJF	5.29	15.01	0.13	0.73	1.69	2.32	3.52	5.14	6.80	8.52	9.52	11.63
	MAM	4.66	13.41	0.06	0.65	1.49	1.98	3.10	4.47	6.12	7.57	8.49	10.18
	JJA	4.28	15.07	0.06	0.61	1.28	1.95	2.92	4.11	5.43	6.82	7.76	9.47
	SON	4.42	13.44	0.04	0.67	1.40	1.90	2.92	4.20	5.80	7.18	8.13	10.17
Herstmonceux	DJF	5.13	13.68	0.28	0.70	1.59	2.22	3.39	4.94	6.63	8.30	9.26	11.30
	MAM	4.51	12.46	0.18	0.59	1.39	1.91	2.97	4.33	5.90	7.34	8.36	10.09
	JJA	4.09	13.02	0.10	0.59	1.27	1.81	2.79	3.92	5.26	6.57	7.30	9.32
	SON	4.36	12.59	0.10	0.75	1.42	1.95	2.90	4.12	5.59	7.05	7.95	9.92
Hemsby	DJF	6.28	15.50	0.22	1.07	2.00	2.60	4.03	6.14	8.23	10.17	11.39	13.40
	MAM	5.40	13.77	0.12	0.82	1.76	2.39	3.69	5.29	6.93	8.52	9.45	11.17
	JJA	4.37	10.78	0.21	0.64	1.40	2.01	3.11	4.25	5.59	6.80	7.67	9.01
	SON	4.91	15.58	0.08	0.72	1.48	2.03	3.13	4.67	6.45	8.05	9.04	11.57
Leeds	DJF	4.96	12.68	0.04	0.64	1.48	2.02	3.18	4.80	6.52	8.13	9.13	10.81
	MAM	4.34	11.03	0.19	0.74	1.36	1.87	2.89	4.23	5.65	6.93	7.66	8.91
	JJA	3.68	8.73	0.08	0.53	1.22	1.62	2.45	3.60	4.80	5.83	6.39	7.67

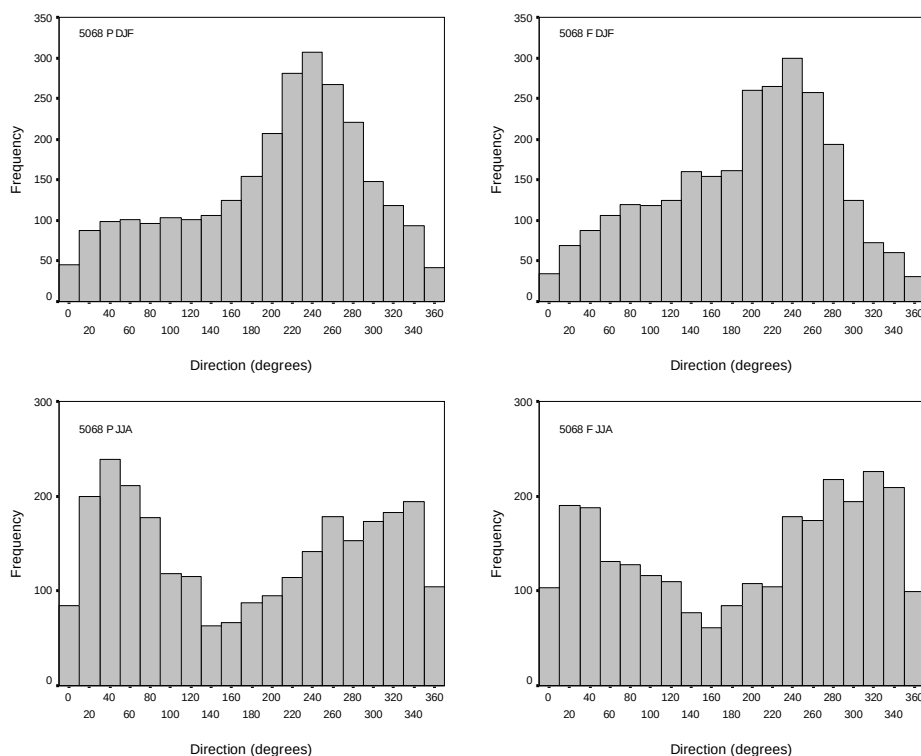
	SON	3.88	10.88	0.11	0.50	1.19	1.62	2.54	3.72	5.00	6.39	7.30	8.78
Manchester	DJF	4.68	12.76	0.16	0.62	1.45	2.02	3.06	4.58	6.07	7.54	8.51	9.98
	MAM	4.65	14.35	0.12	0.67	1.31	1.83	2.92	4.50	6.11	7.55	8.53	10.42
	JJA	4.58	12.53	0.09	0.73	1.49	2.08	3.18	4.41	5.82	7.29	8.19	9.87
	SON	4.24	13.19	0.11	0.72	1.38	1.93	2.85	4.12	5.44	6.80	7.62	8.98
St. Mawgan	DJF	10.23	23.64	0.30	1.52	3.36	4.79	7.52	10.40	13.13	15.19	16.44	18.91
	MAM	7.92	23.63	0.18	1.22	2.50	3.46	5.36	7.78	10.28	12.43	13.65	15.74
	JJA	5.58	19.22	0.03	0.69	1.61	2.33	3.60	5.41	7.37	9.00	10.02	12.18
	SON	7.67	20.45	0.11	0.87	2.08	3.09	5.09	7.63	10.07	12.23	13.78	16.35
Yeovilton	DJF	8.52	19.14	0.40	1.52	3.36	4.79	7.52	10.40	13.13	15.19	16.44	18.91
	MAM	6.11	15.83	0.10	0.79	1.77	2.43	3.99	5.91	7.94	9.99	11.31	13.41
	JJA	4.55	14.07	0.06	0.69	1.61	2.33	3.60	5.41	7.37	9.00	10.02	12.18
	SON	6.15	17.99	0.03	0.78	1.65	2.40	3.85	5.87	8.10	10.33	11.60	14.20

APPENDIX 10: SEASONAL CHANGES IN WIND DIRECTION

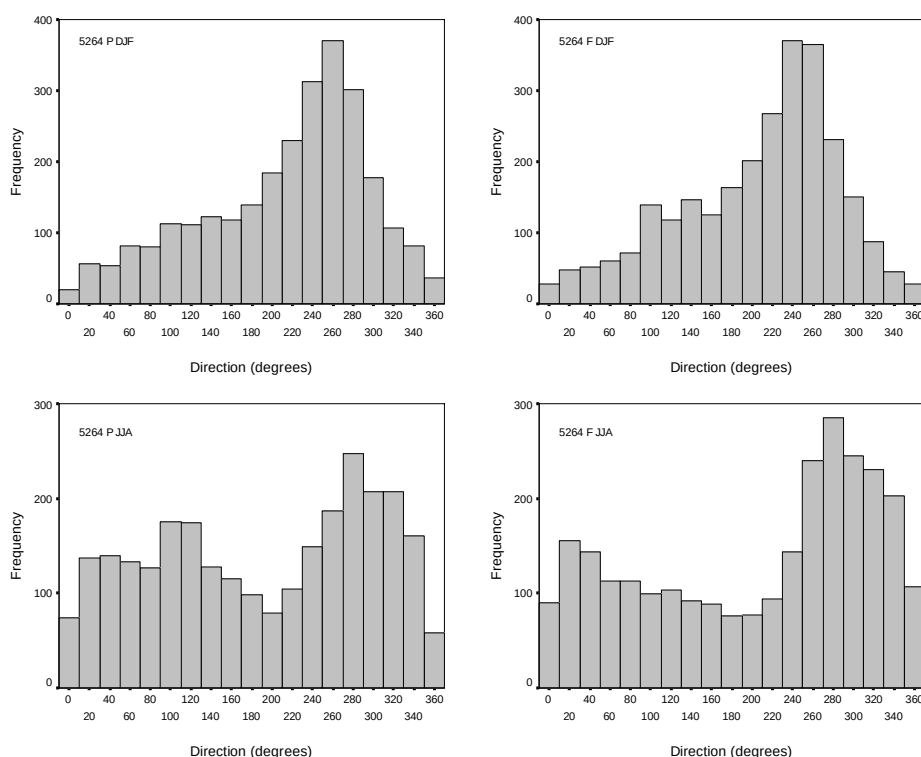
Changes in winter (upper panels) and summer (lower panels) mean daily wind direction as simulated by HadRM3H for the nine stations. Baseline (1961-1990) wind direction is shown on the left and future (2070-2099) wind direction is shown on the right.



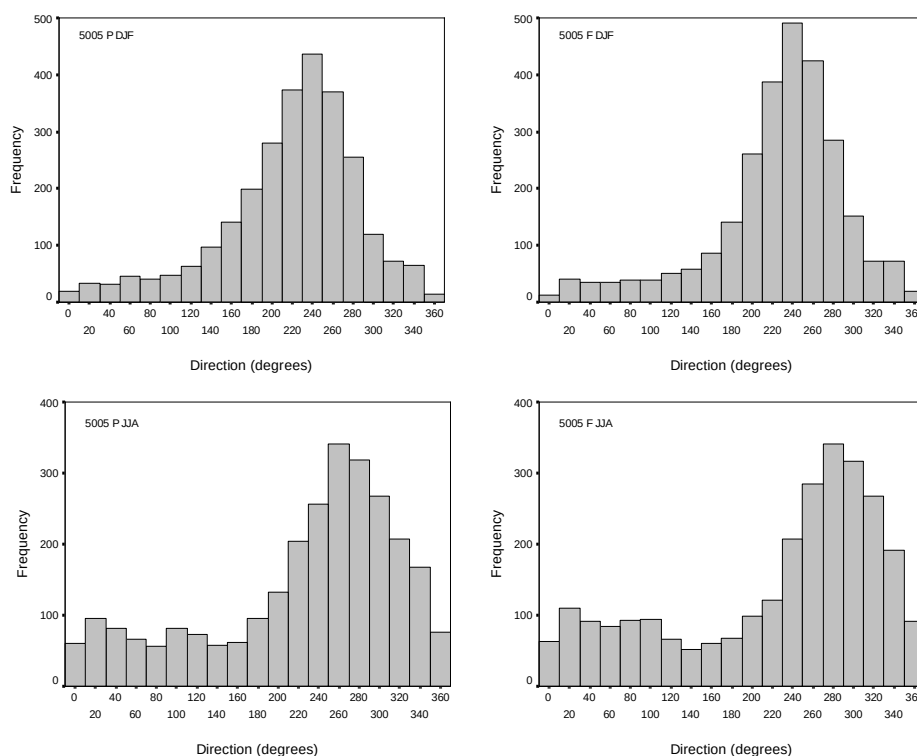
Changes in winter (top) and summer (bottom) mean daily wind direction as simulated by HadRM3H for Abbotsinch. Baseline (1961-90) wind direction is shown on the left and future (2070-99) wind direction is shown on the right



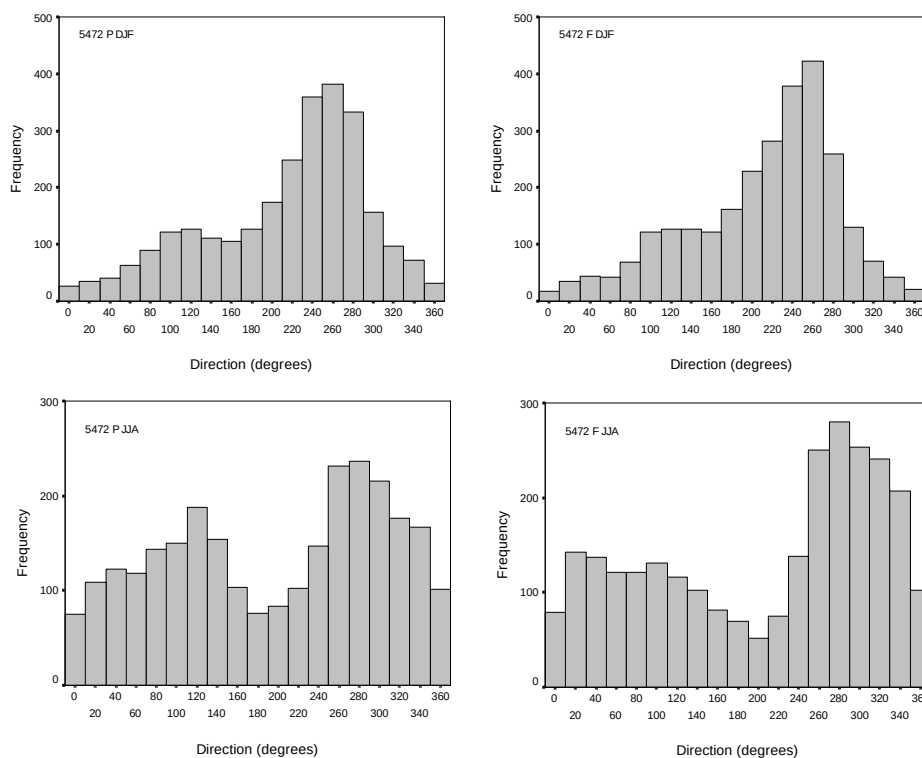
Changes in winter (top) and summer (bottom) mean daily wind direction as simulated by HadRM3H for Elmdon. Baseline (1961-90) wind direction is shown on the left and future (2070-99) wind direction is shown on the right



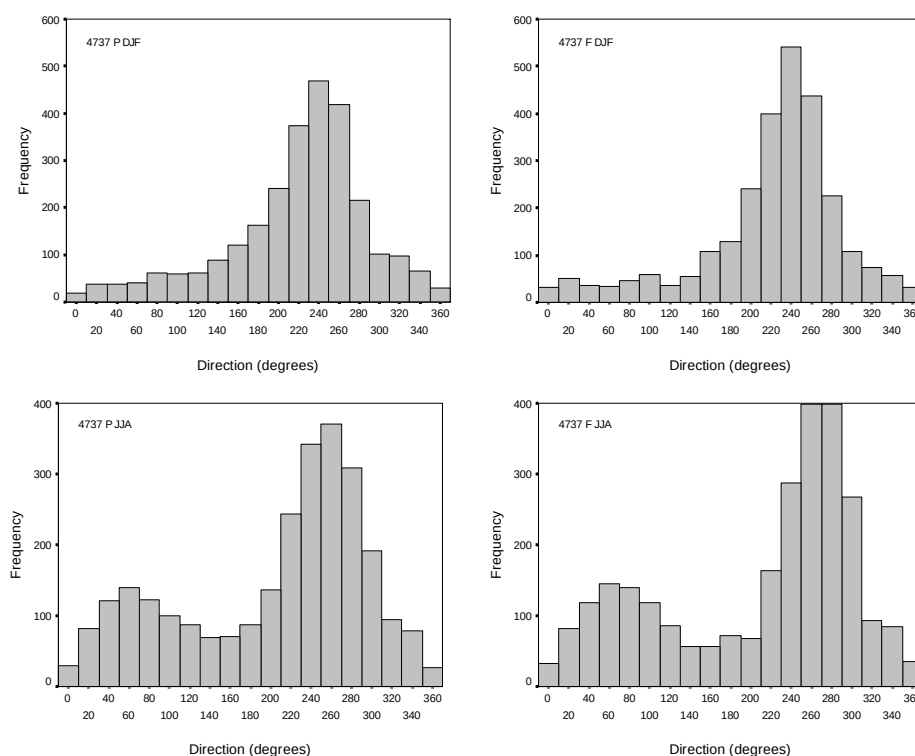
Changes in winter (top) and summer (bottom) mean daily wind direction as simulated by HadRM3H for London, Heathrow. Baseline (1961-90) wind direction is shown on the left and future (2070-99) wind direction is shown on the right



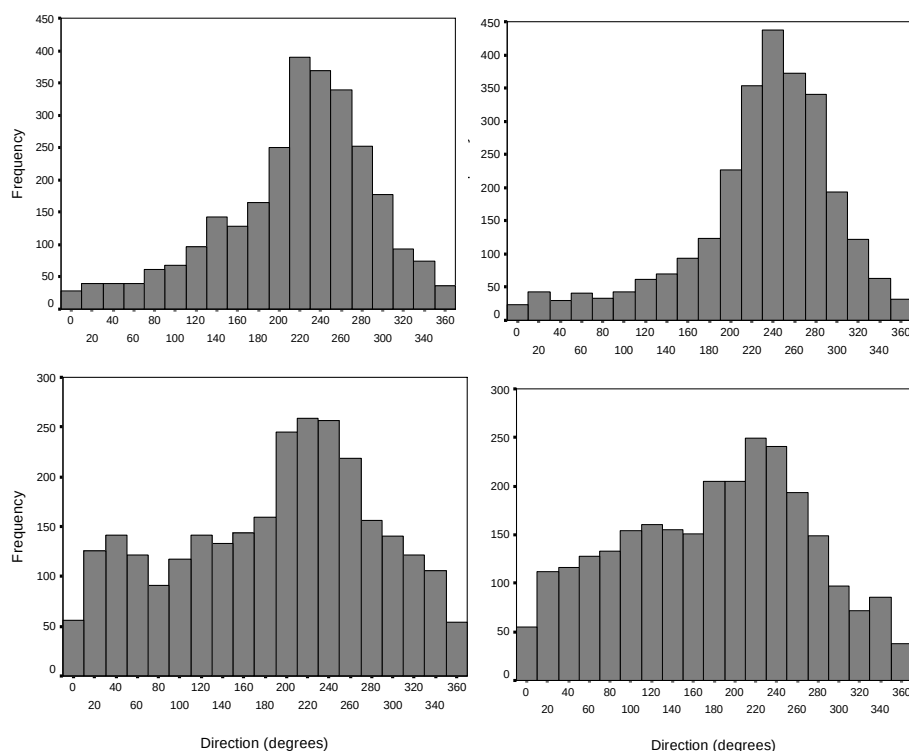
Changes in winter (top) and summer (bottom) mean daily wind direction as simulated by HadRM3H for Hemsby. Baseline (1961-90) wind direction is shown on the left and future (2070-99) wind direction is shown on the right



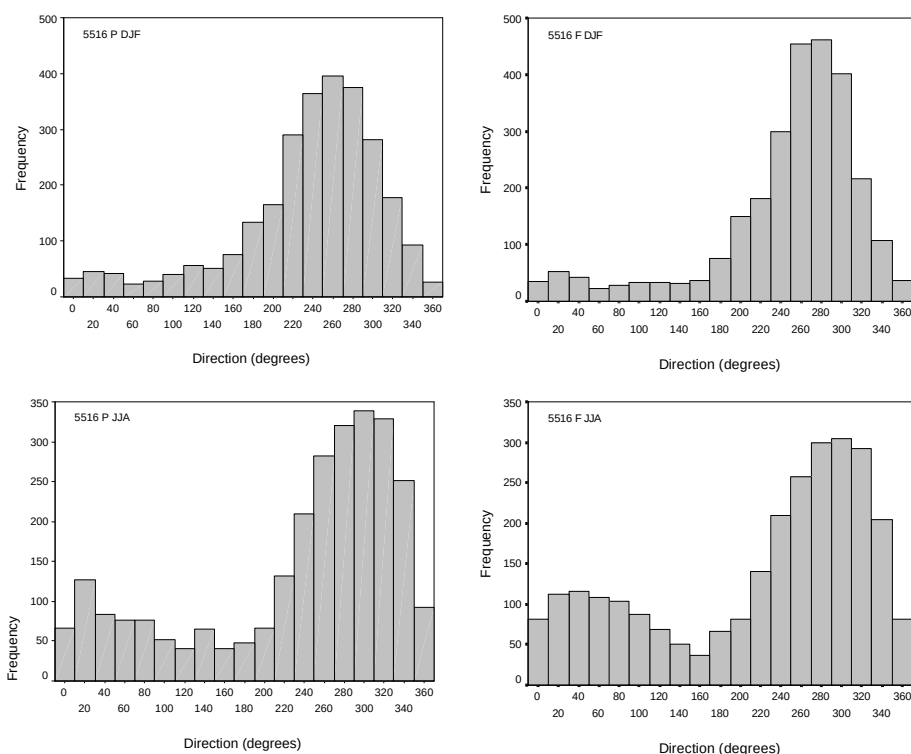
Changes in winter (top) and summer (bottom) mean daily wind direction as simulated by HadRM3H for Herstmonceux. Baseline (1961-90) wind direction is shown on the left and future (2070-99) wind direction is shown on the right



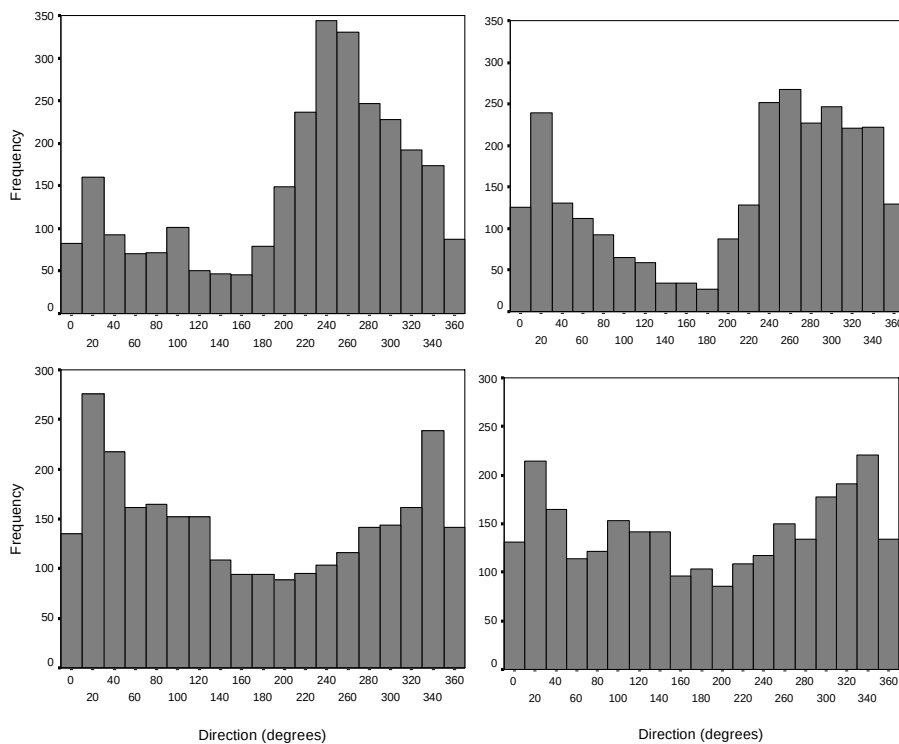
Changes in winter (top) and summer (bottom) mean daily wind direction as simulated by HadRM3H for Leeds. Baseline (1961-90) wind direction is shown on the left and future (2070-99) wind direction is shown on the right



Changes in winter (top) and summer (bottom) mean daily wind direction as simulated by HadRM3H for Manchester, Ringway. Baseline (1961-90) wind direction is shown on the left and future (2070-99) wind direction is shown on the right



Changes in winter (top) and summer (bottom) mean daily wind direction as simulated by HadRM3H for St. Mawgan. Baseline (1961-90) wind direction is shown on the left and future (2070-99) wind direction is shown on the right



Changes in winter (top) and summer (bottom) mean daily wind direction as simulated by HadRM3H for Yeovilton. Baseline (1961-90) wind direction is shown on the left and future (2070-99) wind direction is shown on the right