

1 **Air-traffic restrictions at the Madeira International Airport due to adverse winds: links to**  
2 **synoptic scale patterns and orographic effects**

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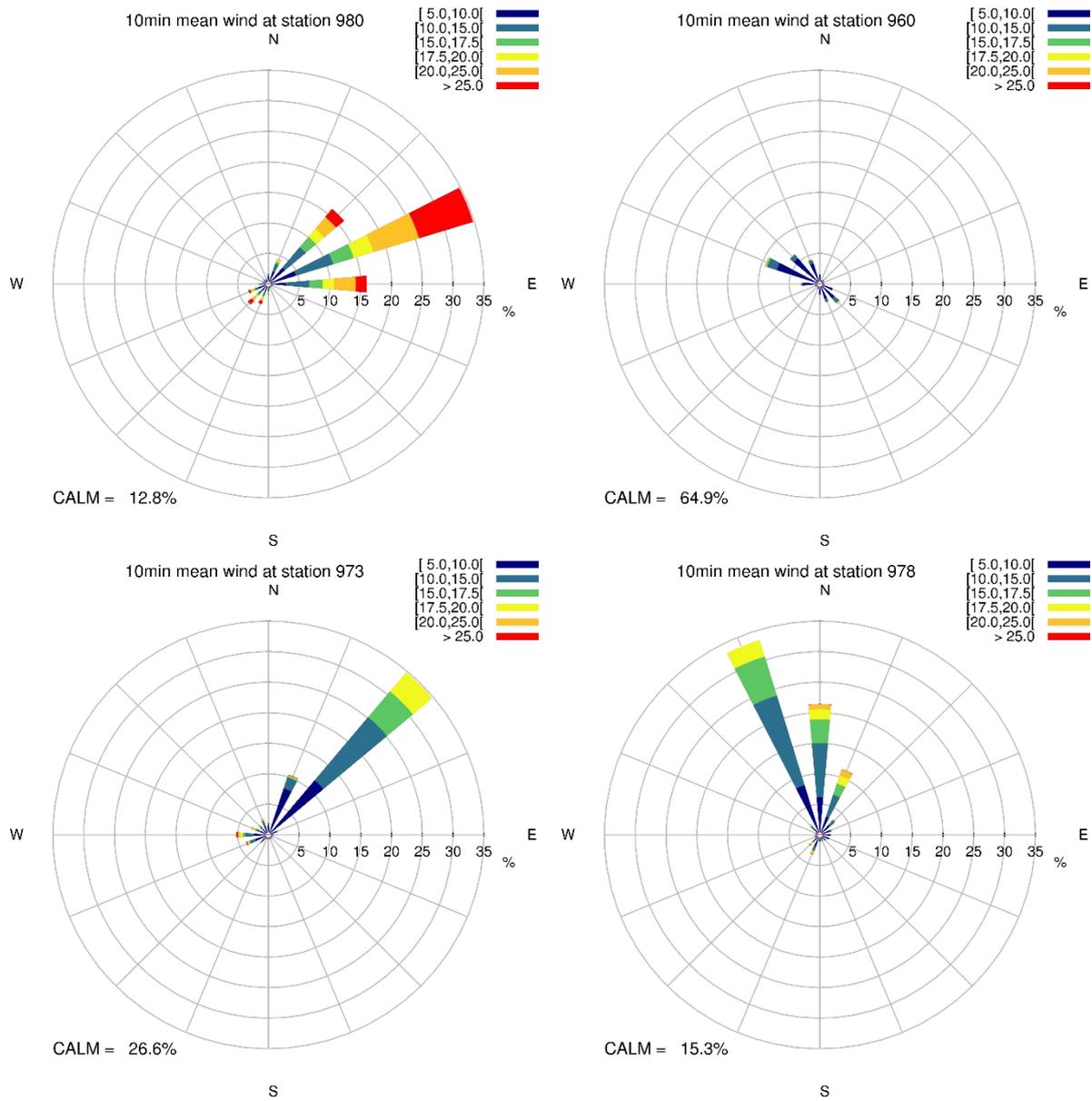
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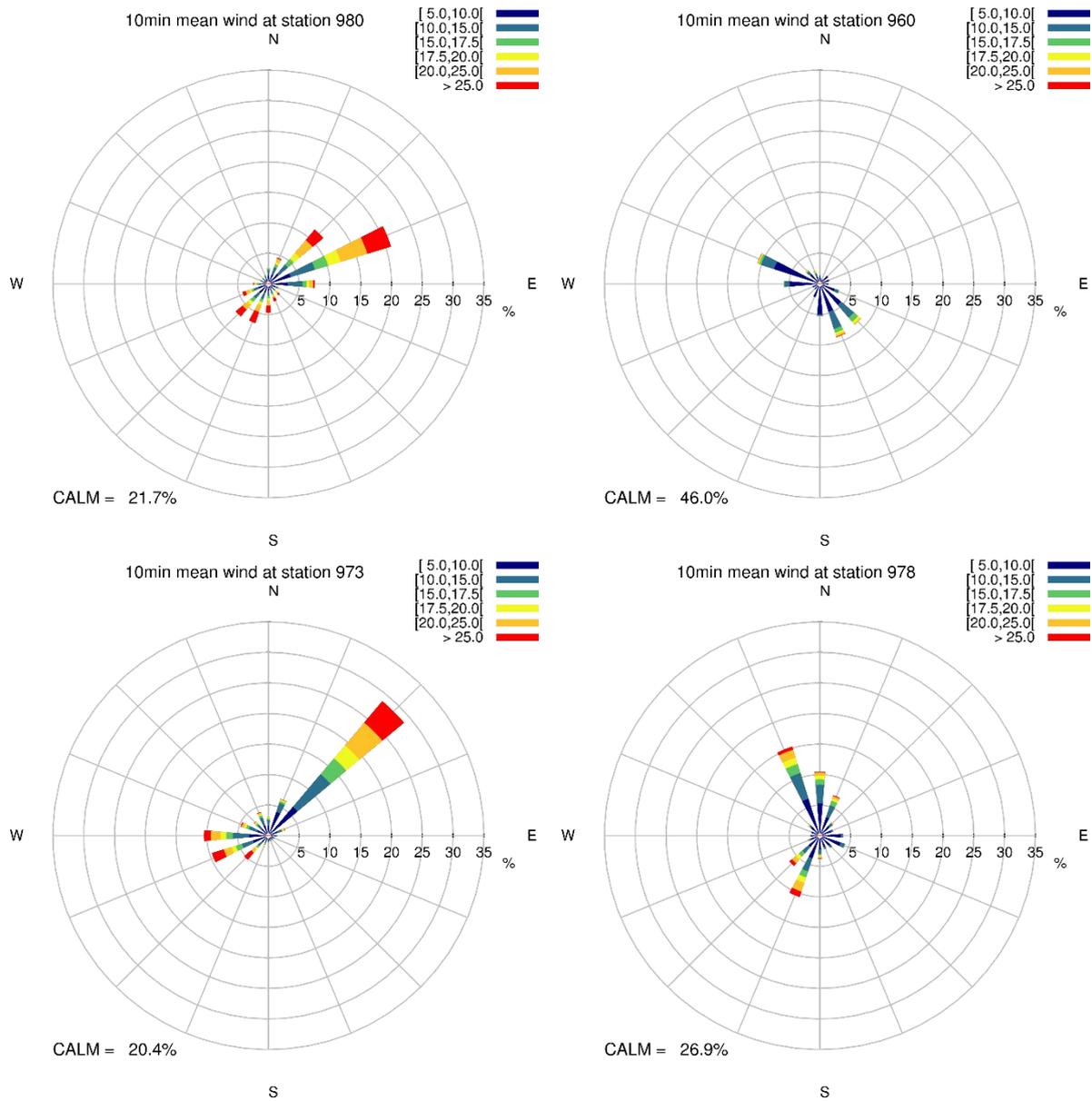
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**Supplementary data**

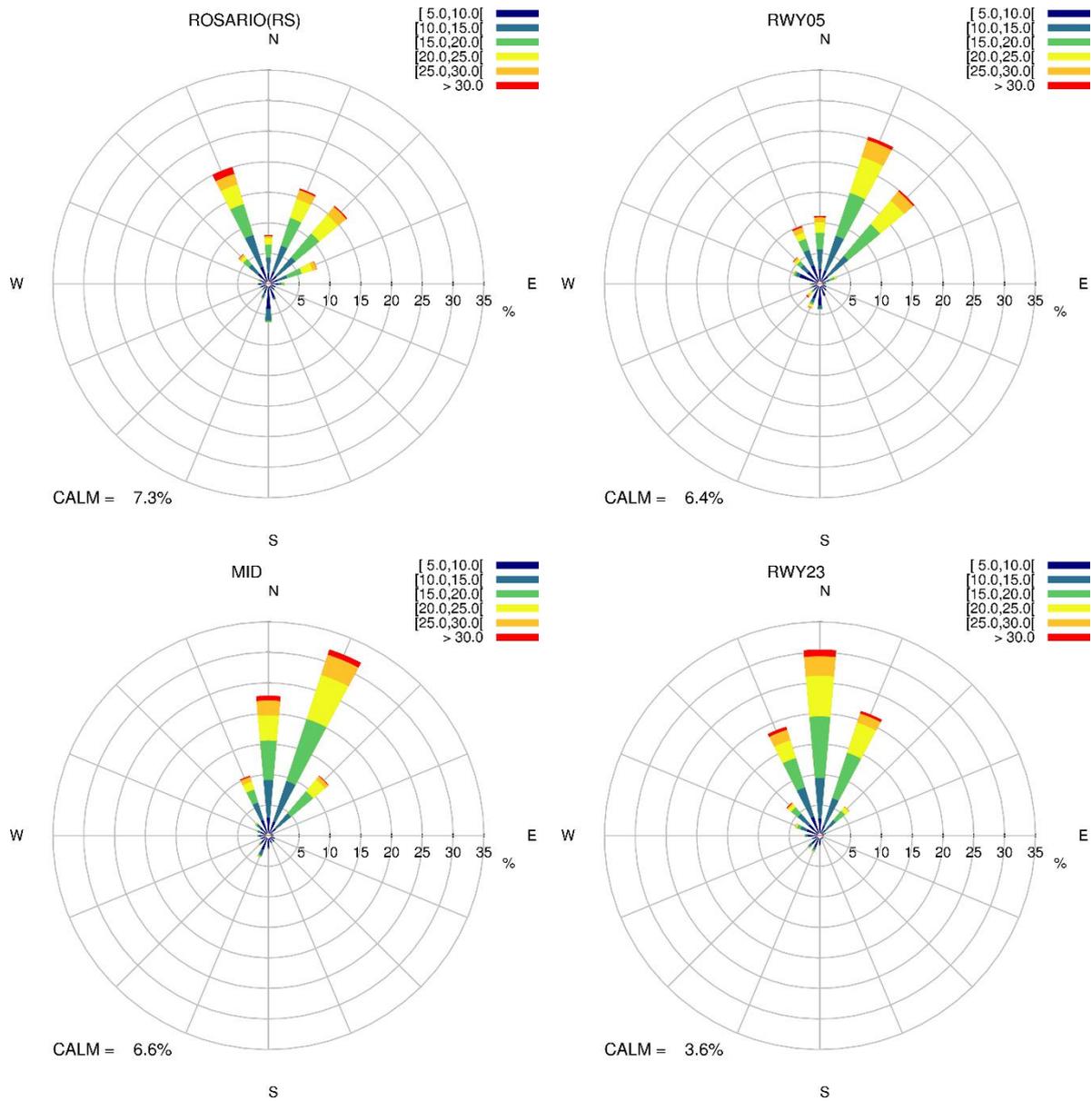
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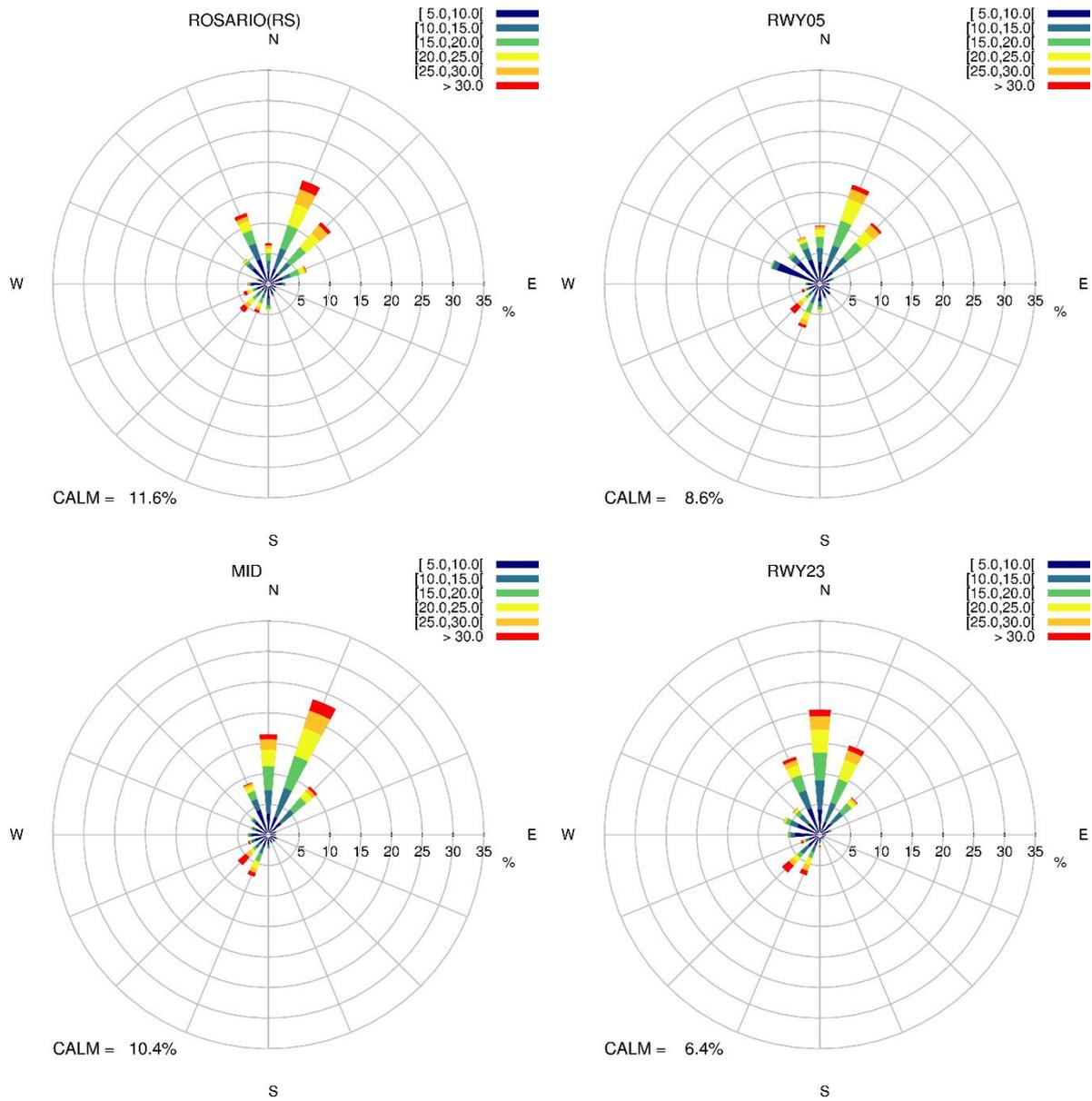
16 **Figure S1.** Wind roses screening the relative frequencies of occurrence (in percent) of the average 10-minutes  
 17 wind (in kt,  $\sim 0.51 \text{ m s}^{-1}$ ) at the different locations of the Madeira Island, in summer (April-September).  
 18 Locations are indicated in Figure 1.  
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21 **Figure S2.** Wind roses screening the relative frequencies of occurrence (in percent) of the average 10-minutes  
 22 wind (in kt) at different locations of the Madeira Island, in winter.  
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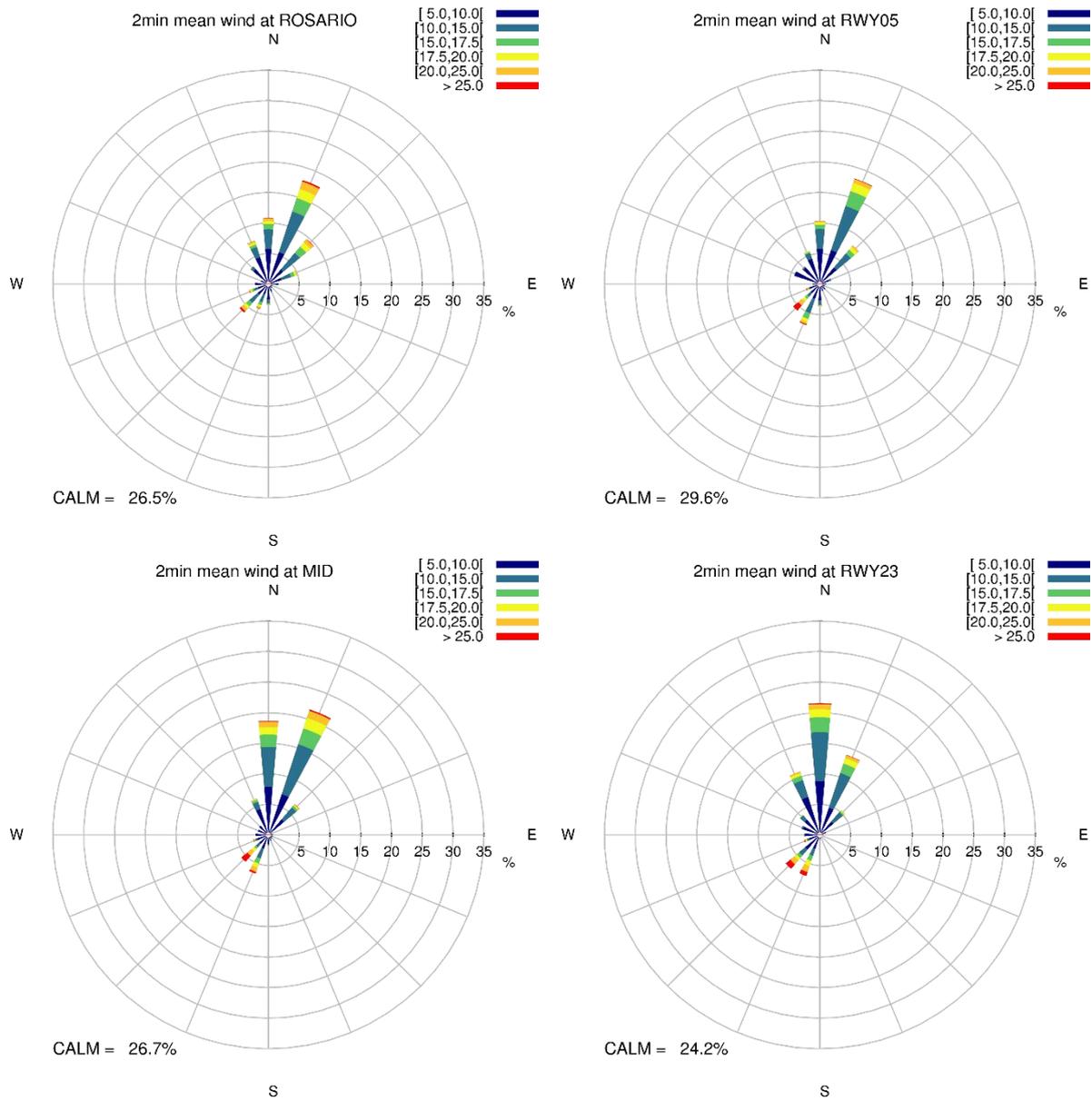


25 **Figure S3.** Wind roses screening the relative frequencies of occurrence (in percent) of the wind gust, in  
 26 summer, at Rosario (top left panel) and at three sites at the Madeira Airport: RWY05 (top right panel), MID  
 27 (bottom left panel) and RWY23 (bottom right panel). Six wind speed classes (in kt) are also shown, as well as  
 28 the percent of calm (< 5kt) events.



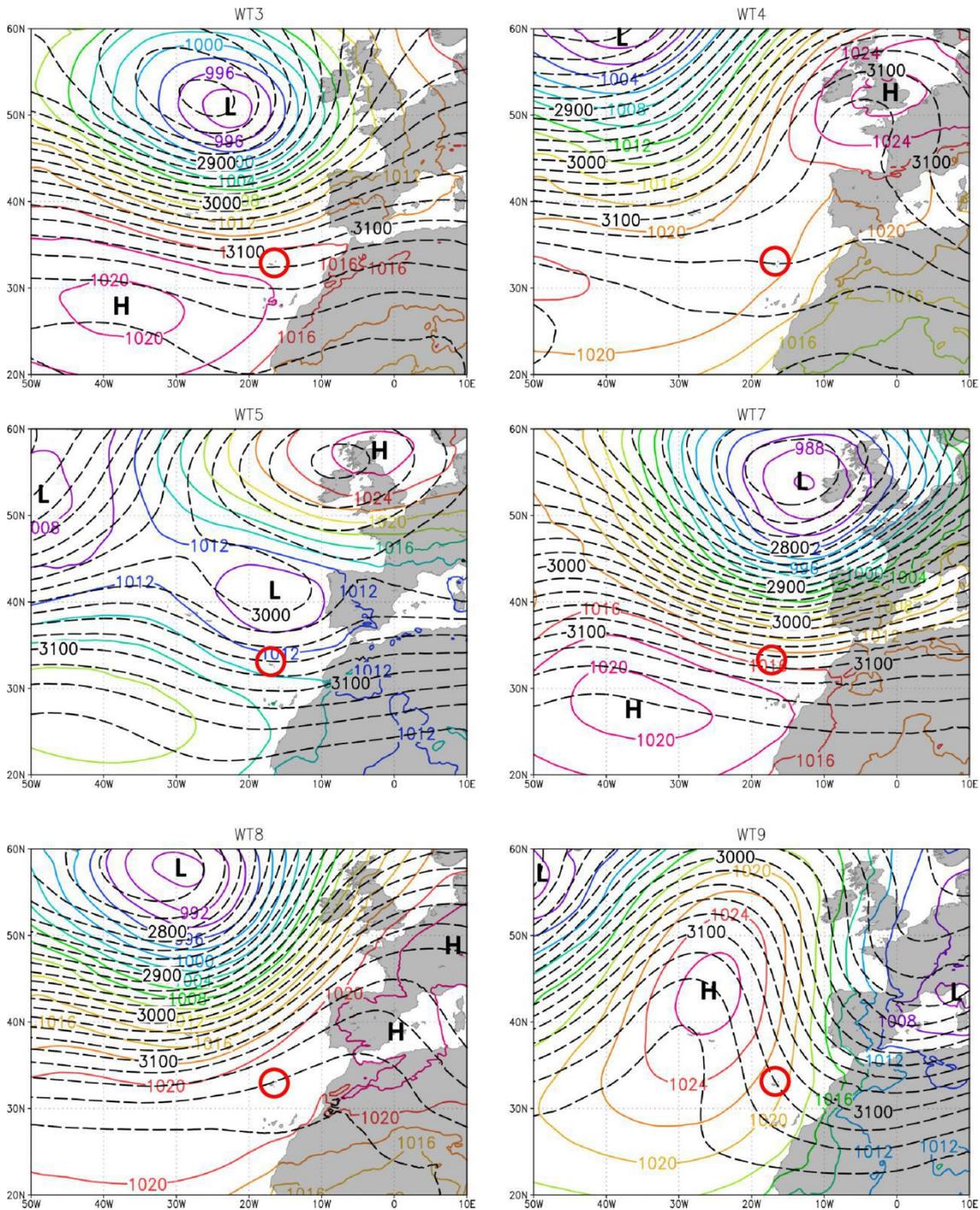
29 **Figure S4.** Same as figure S3, but for winter (October-March).

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31 **Figure S5.** Wind roses screening the relative frequencies of occurrence (in percent) of the average 2-minutes  
 32 wind in winter, at Rosario (top left panel) and at three sites at the Madeira Airport: RWY05 (top right panel),  
 33 MID (bottom left panel) and RWY23 (bottom right panel).

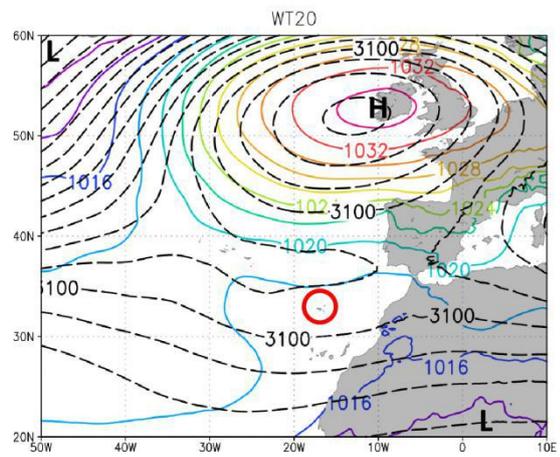
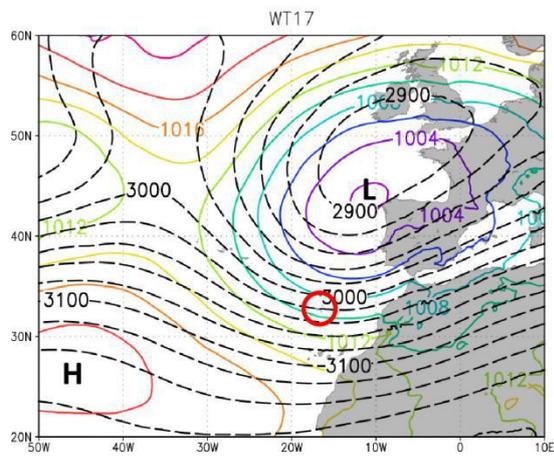
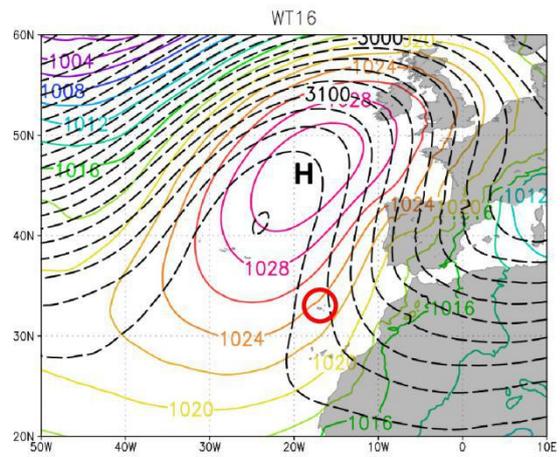
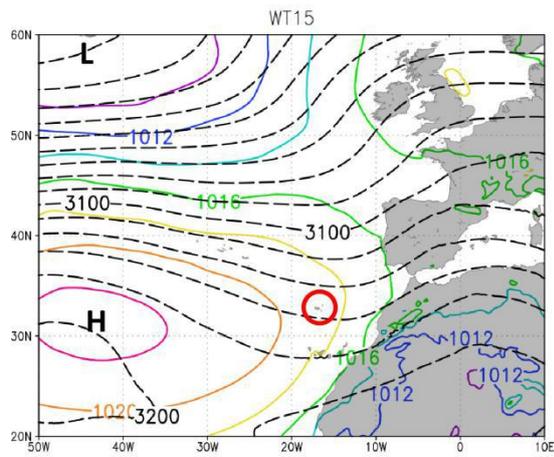
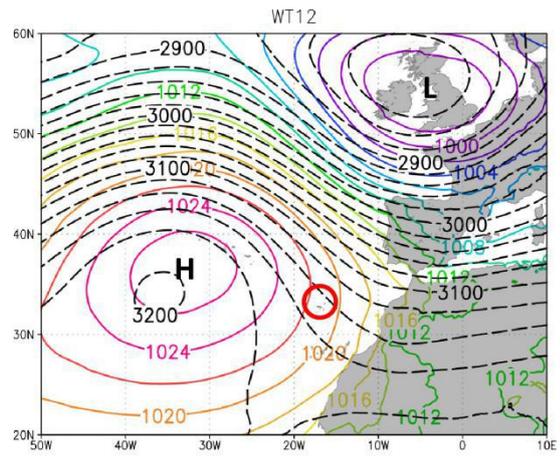
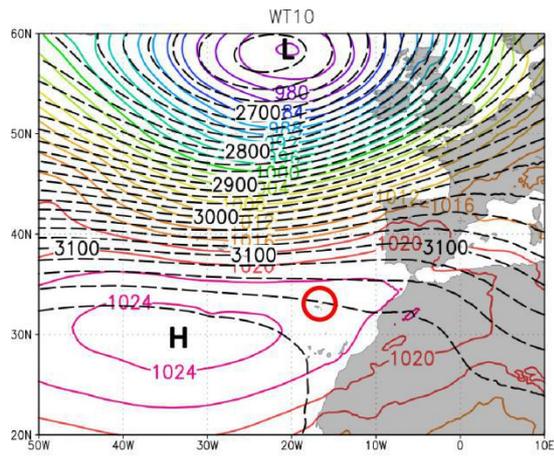
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40 **Figure S6.** Composites of the daily mean sea level pressure (solid contours) and 700 hPa  
 41 geopotential height (dashed contours) over the eastern North Atlantic and adjacent landmasses for  
 42 the outlined weather types (WT) not shown in Figure 5.

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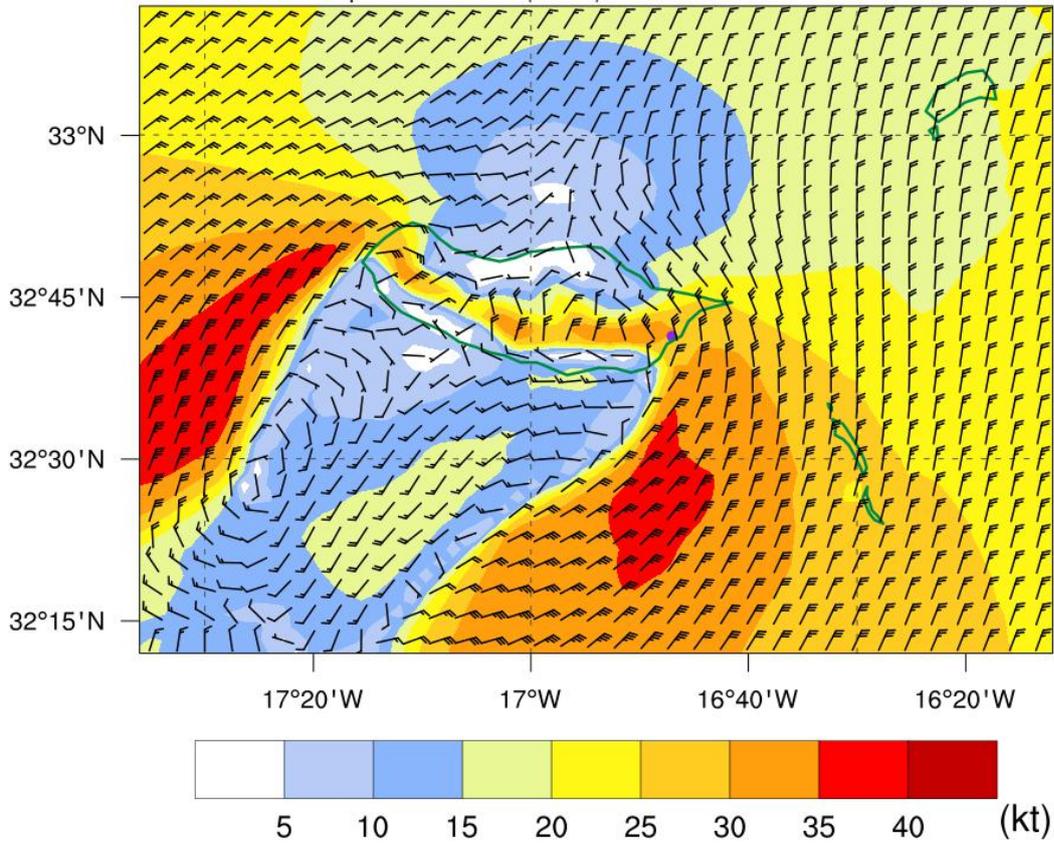


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45 **Figure S6** (continuation).

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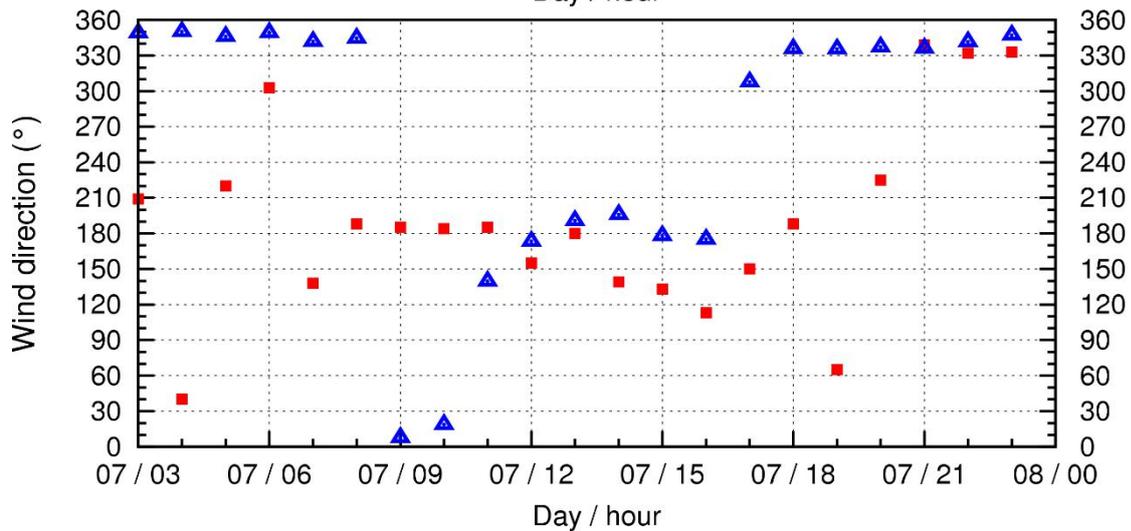
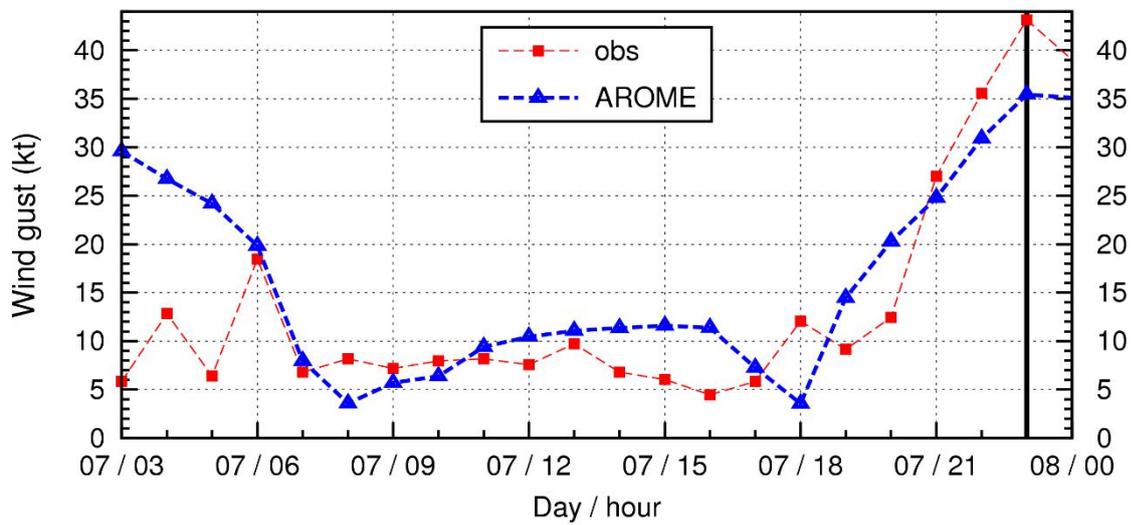
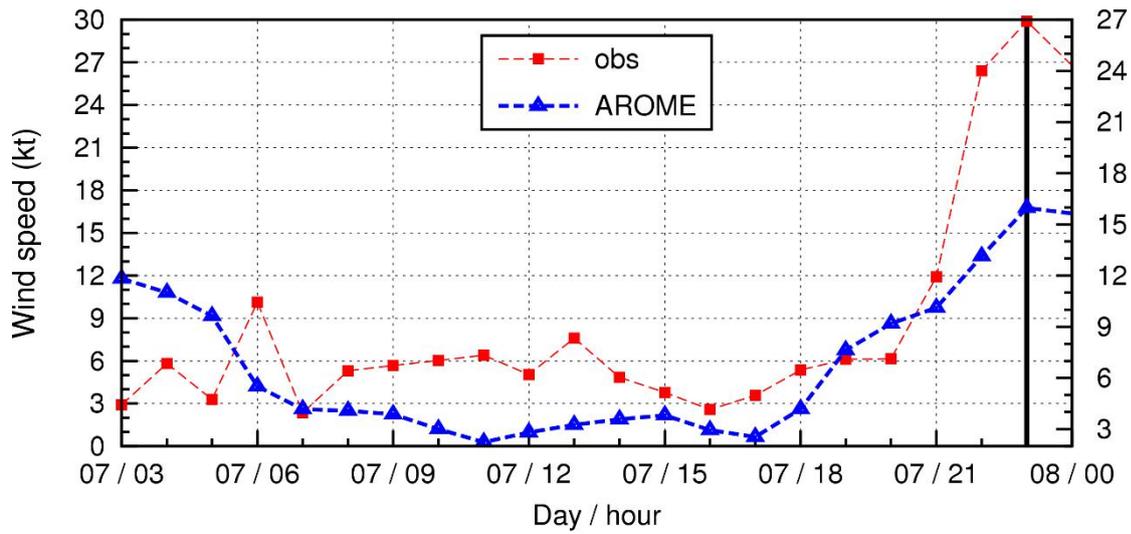
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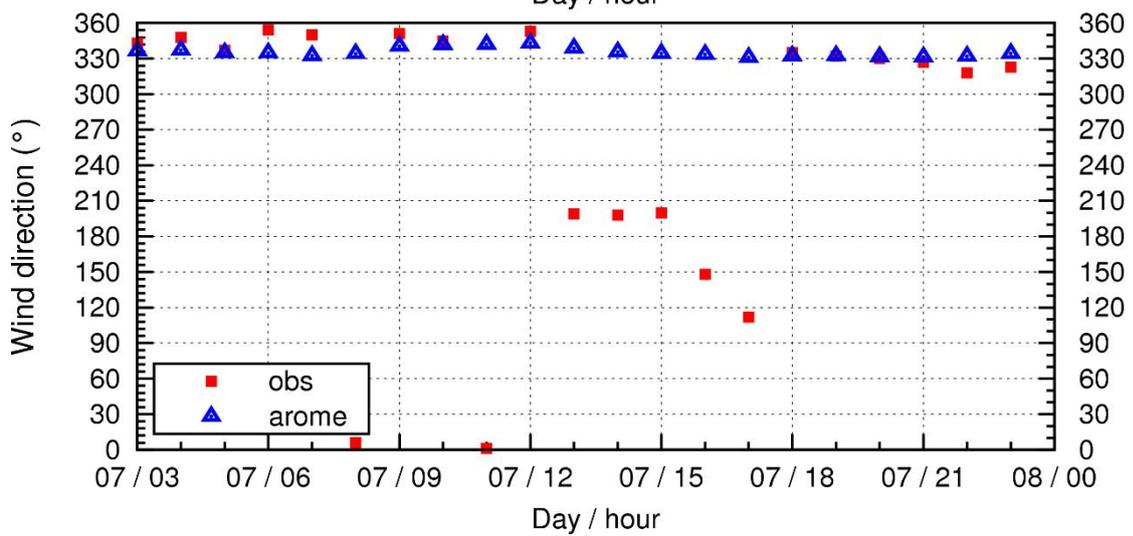
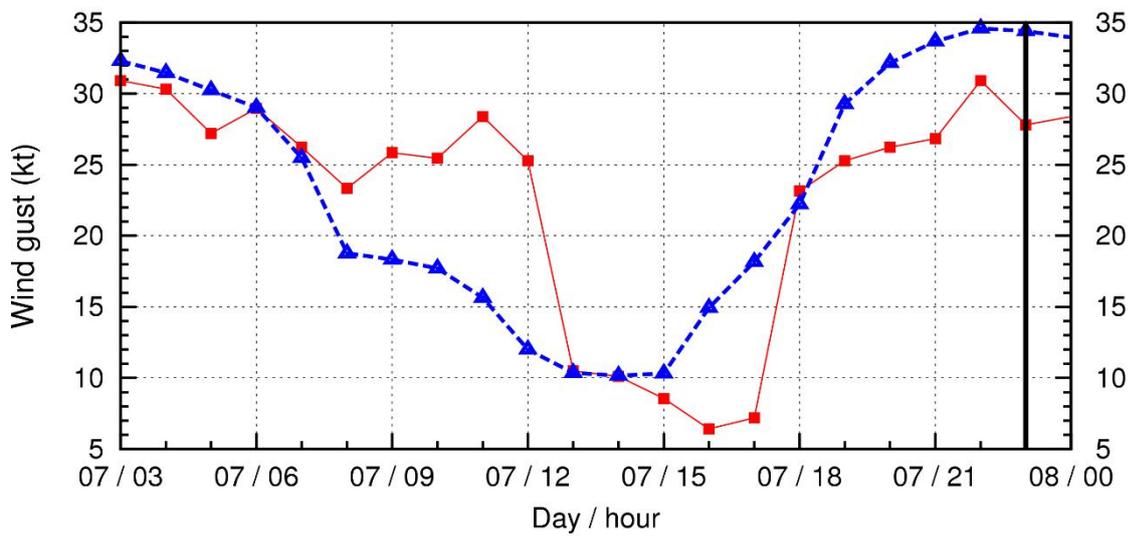
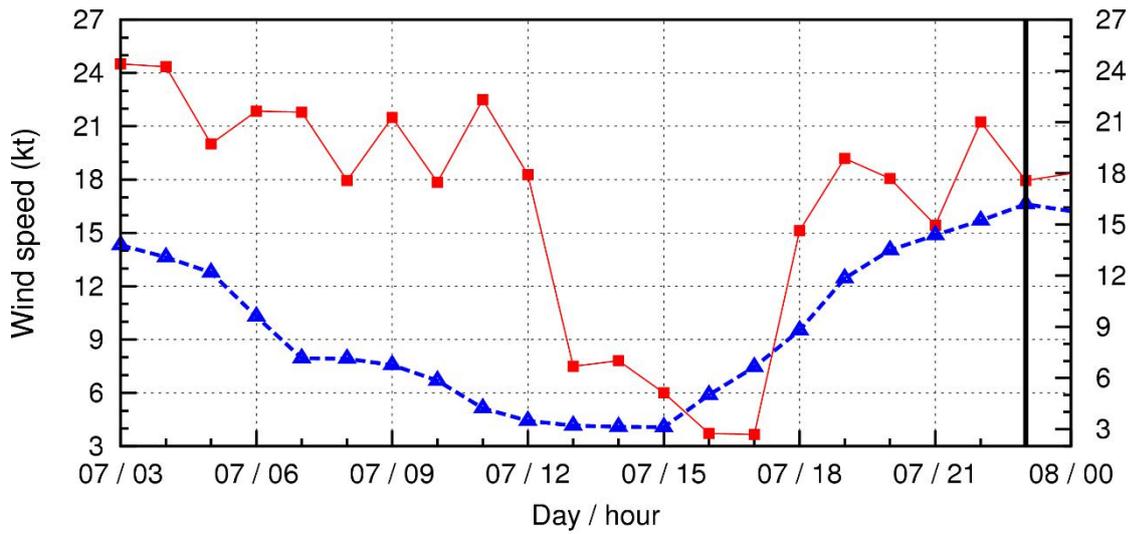
49 **Figure S7.** AROME forecast of the wind gusts at 10m-height at 03UTC on 7 August 2016.

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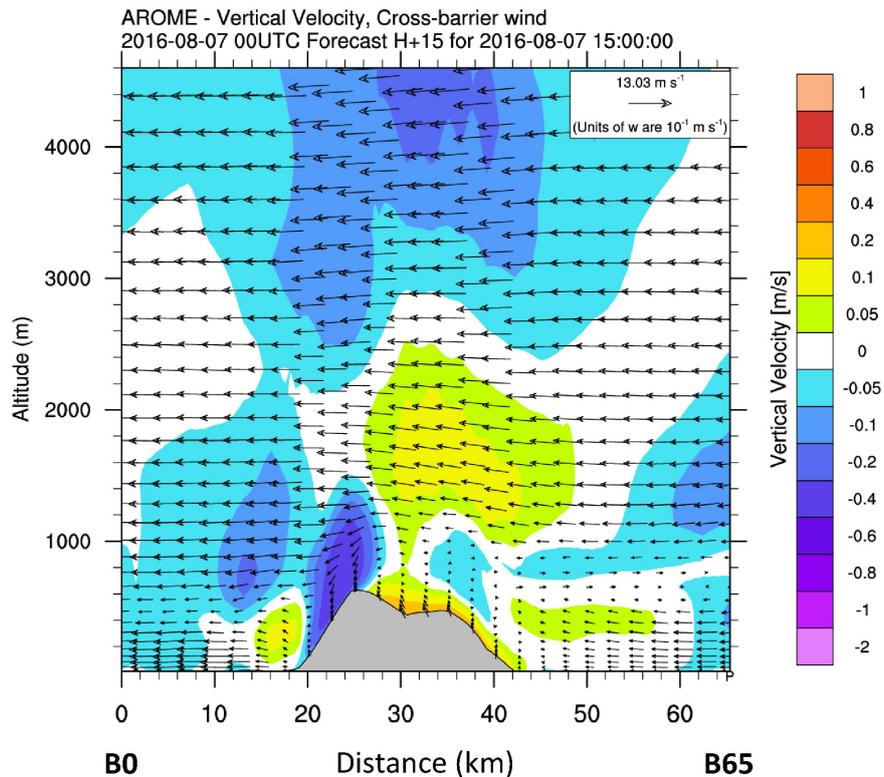
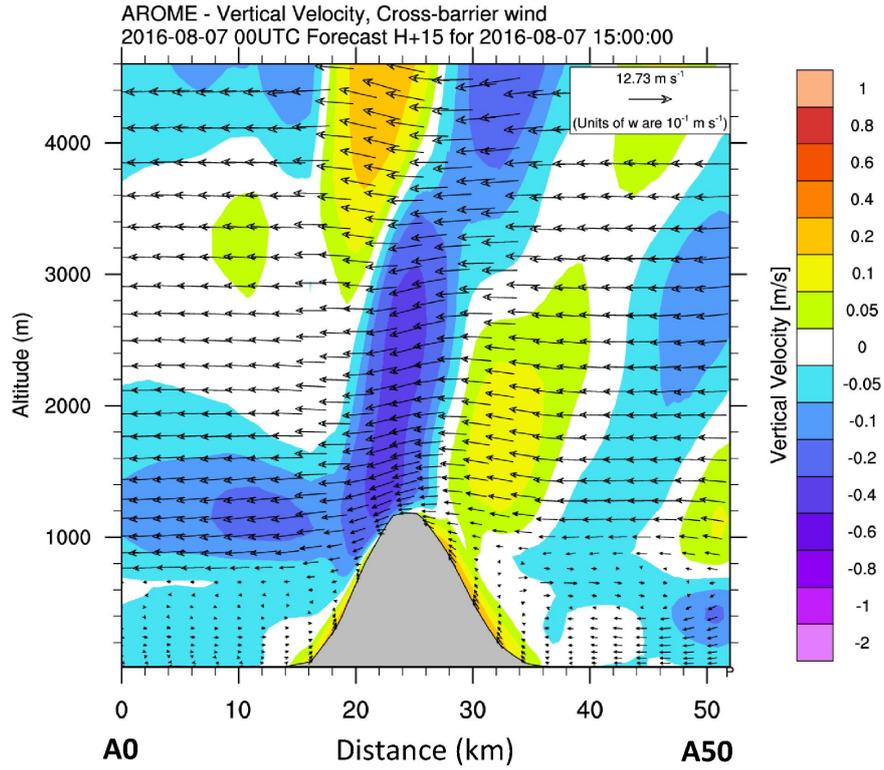
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52 **Figure S8.** Time evolution of wind speed, wind gust and wind direction at 10-m height, from AROME forecast  
 53 and observations at RS site, on 7 August 2016. The time of a missed approach is marked as an impulse (vertical  
 54 thick line).



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Figure S9. Same as figure S8, but at RWY23 site.



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**Figure S10.** AROME vertical cross-sections of vertical velocity ( $w$ ) and cross-barrier wind at 15 UTC on 7 august 2016, along A50-A0 (top) and B65-B0 (bottom) lines. Shading represents vertical velocity in  $\text{m s}^{-1}$ , positive values indicate upward vertical wind and negative values represent downward vertical wind. The locations of lines A50-A0 and B65-B0 are depicted respectively in Figure 1a and 1b.

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69 **Table S1.** Relative frequency of each WT during summer (April to September). Percentage of days with daily  
70 precipitation above 5 mm (NR5), 20 mm (NR20) and 30 mm (NR30), and the percentage of events with gusts  
71 exceeding 30 kt (NG30), 35 kt (NG35) and 40 kt (NG40) in summer, for each weather type, at RWY05.  
72 Maximum wind gust ( $Gust_M$ , in kt) and 24-h maximum precipitation (RR) are also indicated.

WT	FREQ	NR5	NR20	NR30	NG30	NG35	NG40	$Gust_M$	RR
1	16.0	1.1	0.8	0.4	20.2	8.0	1.9	47.8	45.4
2	13.4	0.0	0.0	0.0	11.8	2.3	0.5	42.0	4.4
3	3.3	1.9	0.0	0.0	7.4	3.7	0.0	39.2	12.2
4	5.1	2.4	0.0	0.0	8.3	2.4	1.2	40.2	11.8
5	2.6	14.3	4.8	2.4	16.7	4.8	2.4	42.0	61.0
6	0.9	7.1	7.1	0.0	21.4	7.1	0.0	36.7	20.6
7	0.6	0.0	0.0	0.0	0.0	0.0	0.0	27.8	2.6
8	3.0	0.0	0.0	0.0	4.1	4.1	2.0	40.2	2.8
9	4.2	5.8	1.5	1.5	10.1	1.5	0.0	35.6	46.6
10	0.7	0.0	0.0	0.0	0.0	0.0	0.0	22.8	0.3
11	14.2	3.4	0.0	0.0	32.5	6.4	0.4	43.5	18.0
12	4.2	7.3	1.5	0.0	14.5	2.9	0.0	36.2	20.4
13	0.5	0.0	0.0	0.0	75.0	62.5	37.5	45.9	0.0
14	12.5	2.0	0.5	0.0	30.2	8.3	1.0	53.7	29.2
15	12.1	6.0	1.0	1.0	5.0	1.5	0.5	46.7	74.5
16	1.7	0.0	0.0	0.0	17.9	14.3	0.0	39.3	1.4
17	2.1	8.6	0.0	0.0	28.6	5.7	0.0	39.1	9.6
18	0.5	0.0	0.0	0.0	37.5	0.0	0.0	34.8	0.0
19	1.2	0.0	0.0	0.0	45.0	10.0	0.0	37.9	0.2
20	1.4	4.4	0.0	0.0	8.7	0.0	0.0	33.8	11.8

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76 **Table S2.** Same as Table S1, but for winter (October to March).

WT	FREQ	NR5	NR20	NR30	NG30	NG35	NG40	Gust <sub>M</sub>	RR
1	3.2	11.5	5.8	3.9	9.6	1.9	0.0	35.8	54.5
2	2.9	10.6	4.3	4.3	12.8	4.3	0.0	39.8	35.6
3	4.1	16.7	3.0	1.5	15.2	7.6	4.6	49.0	31.0
4	6.0	7.2	1.0	0.0	5.2	1.0	0.0	39.3	23.8
5	5.8	26.6	9.6	5.3	30.9	16.0	8.5	53.5	55.1
6	8.2	3.0	0.0	0.0	3.0	1.5	0.8	43.4	17.5
7	4.7	17.1	4.0	0.0	36.8	21.1	11.8	56.2	25.0
8	6.4	6.7	1.0	0.0	7.7	2.9	2.9	42.4	23.1
9	4.8	20.5	9.0	6.4	30.8	10.3	1.3	47.0	58.2
10	5.2	6.0	1.2	1.2	3.6	1.2	0.0	39.1	35.8
11	1.9	16.1	6.5	0.0	16.1	6.5	3.2	47.2	26.2
12	3.2	9.6	1.9	0.0	17.3	5.8	1.9	41.7	25.0
13	8.2	6.8	0.8	0.0	22.0	5.3	3.8	56.8	29.0
14	4.7	7.9	4.0	2.6	13.2	5.3	2.6	45.3	41.0
15	2.2	11.4	5.7	5.7	11.4	8.6	5.7	48.8	78.4
16	6.0	14.4	2.1	2.1	25.8	12.4	2.1	49.4	55.0
17	3.2	49.0	19.6	13.7	41.2	29.4	21.6	66.91	179.2
18	8.2	6.0	0.8	0.8	11.3	4.5	1.5	41.4	34.0
19	5.7	4.4	0.0	0.0	7.6	0.0	0.0	35.0	10.8
20	5.5	18.0	4.5	3.4	11.2	3.4	2.3	45.4	129.0

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<sup>1</sup> The maximum value at RWY23 was 74.5 kt