Preprint

Short Report: a damaging downslope wind storm in western Wales 1-2 March 2018

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Abstract

Sustained, strong and damaging wind gusts affecting the coastal region of western Wales overnight 1-2 March 2018. Using output from a weather forecast model the origin of the strong winds is attributed to a turbulent downslope wind storm to the lee of the Welsh mountains in an easterly flow regime.

Overnight on 1-2 March 2018 western Wales experienced a prolonged period of extremely strong and gusty easterly winds resulting in disruption to the transport infrastructure, power cuts, damage to properties and the felling of trees. Damage to roofs of homes in the coastal town of Tywyn was extensive and the roof of the local leisure centre torn off (BBC News, 2018a). Although the precise circumstances are unclear (John Mason, pers. comm.) many boats were severely damaged, some sunk, in gale force winds at the sheltered Holyhead marina, Anglesey (BBC News, 2018b). Anecdotally, winds were reported to have reached 80 mph (70 kn, 36 ms^{-1}) at the marina. The strong winds were accompanied by heavy snowfall and severe cold across much of Wales and England (see the special issue of *Weather* vol. 74, March 2019).

Table 1 shows the strongest winds on 2 March obtained from a search of weather station records. All the strongest winds were observed at stations to the lee of the Welsh mountains on the Welsh coast and hinterland. Gusts in excess of 38 knots (44 mph, 19 ms^{-1}) were consistently observed from the early evening of the 1st to mid-morning of the 2nd although the variation in speed was highly erratic (not shown). Gusts at Tywyn appeared to have peaked near 06 UTC at 68 knots (78 mph, 35 ms^{-1}). The wind direction was generally easterly, although at Tywyn gusts tended to back north-easterly. Gust ratios at the lowland coastal stations were typically ~1.5, however ratios at higher elevations were closer to 2. The strongest winds appear to have abated by mid-day on the 2nd. Mean winds and gusts recorded at the NERC (National Environmental Research Council) facilities outside of Aberystwyth were not notable although some damage was reported in the town itself.

The synoptic background to this event will not be discussed in detail here but features of note include a blocking anticyclone over Scandinavia and a low pressure system in Biscay moving poleward with a centre lying in the western Channel by 12 UTC 2 March. This resulted in a tightening pressure gradient and a cold, easterly flow over south-west England and Wales overnight 1-2 March. The question arises as to the origin of the strongest wind gusts and to answer this a brief analysis of mesoscale forecast model output was undertaken.

The model used was an up-to-date version of the WRF (Weather Research and Fore casting) model initialised with GFS (Global Forecast System) data. The high-resolution

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domain had a grid spacing of 3km in the horizontal and 51 levels in the vertical. The model physics package included a full set of parametrisations. Figure 1 shows a 300 km long west-east cross-section of part of the 3 km grid roughly centred on Aberystwyth. Striking features of this plot include a deep mountain wave over the Welsh mountains with a couplet of strong ascent and descent (exceeding +0.5 /- 1.5 ms^{-1}) resulting in cloud clearance (low relative humidity) above the mountain and a 40 ms^{-1} wind speed maximum just above the lee slopes. The bold green contour delineates where the Richardson number (Ri) equals 0.25. Low values of Ri (< 1) near the ground are associated with a significant risk of severe turbulence resulting in the transport of high momentum air to the surface in the form of turbulent wind gusts, see for example Stull (1988), p175-179. Indeed a model gust diagnostic exhibits extensive areas of gusts > 35 ms^{-1} west of the Cambrian mountains (not shown).

In summary a case of strong damaging wind gusts in a cold, easterly flow regime over the Welsh mountains has been examined. This brief study suggests they were the result of a *downslope wind storm* associated with a mountain wave. Following the pioneering work of Manley (Manley, 1945; Veale and Endfield, 2014) on the 'Helm Wind' there have been a number of studies of stably stratified easterly flow over the Pennines in northern England. A non-exhaustive search of the literature suggests easterly downslope wind storms in the lee of the Cambrian range are a less well-documented and possibly unusual phenomenon.

Acknowledgements

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References

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Location	Time of peak gust 2 March (UTC)	Mean windspeed **ms^{-1} (mph)**	Max gust **ms^{-1} (mph)**	Gust ratio	Comments
Tywyn	547	22 (49)	35 (78)	1.59	Gusts tending to back NEly from ESEly
Caernarfon	0	17 (38)	34 (76)	2	CWOP 53.07 N -4.23 W, alt. 304 m. Gusts above 50 mph overnight to mid-day
Nantile	500	14 (31)	29 (65)	2.07	CWOP 53.05 N 4.24 W, alt.108 m. Gusts above 44 mph overnight to mid-day
Aberdaron	300	20 (45)	29 (65)	1.45	Gusts above 31 mph overnight to mid-day
RAF Valley	300	19 (43)	29 (65)	1.53	Anglesey
RAF Mona	1100	18 (40)	25 (56)	1.39	Anglesey. Gusts above 43 mph overnight to mid-day
Aberporth	100	13 (29)	22 (49)	1.69	

Table 1: Selected observations of maximum gust speeds from western Wales on 2 March 2018. CWOP- Citizen Weather Observer Program station. Source: http://weatherobs.com/ (accessed 03/03/2018).

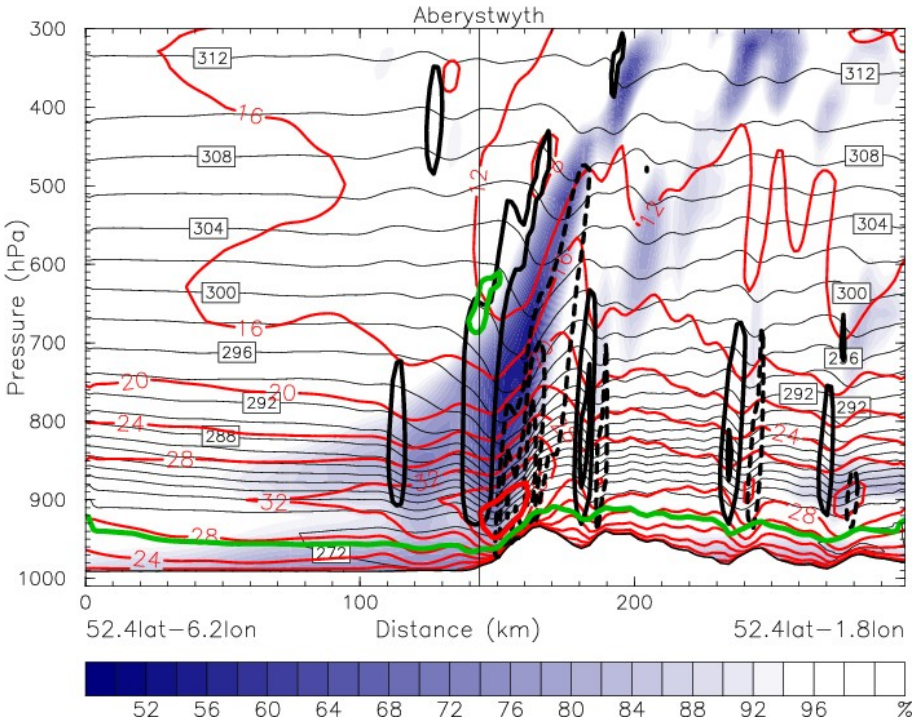

Figure 1: Model cross-section at the latitude of Aberystwyth from a T+12h forecast valid at 06 UTC 2 March. Relative humidity (%) shaded according to colour scale; dry-bulb potential temperature (K) thin, black contours; horizontal windspeed (ms^{-1}) red contours, 40 ms^{-1} isotach highlighted in bold; vertical velocity (cm s^{-1}) bold black contours every 50 cm s^{-1}, descent dashed; Richardson number = 0.25 green contour. The location of Aberystwyth in the plane of the cross-section is indicated by the vertical line.