

Storm Barra

Tuesday 7 and Wednesday 8 December 2021

Second named storm of the 2021/2022 season. Named by Met Éireann on Sunday 5 December 2021

Date issued: Thursday 1 September 2022

Storm Barra brought widespread severe and damaging winds across Ireland on Tuesday 7 and Wednesday 8 December 2021, with Met Éireann issuing red, orange and yellow level wind warnings. An active cold front associated with the storm also brought widespread heavy rain, preceded by snow in places. The storm centre tracked directly over the country between Galway and Louth in an east-northeast direction on Tuesday 7, bringing violent storm force 11 winds, with gusts of up to 135 km/h (73 knots) and mean wind speeds of up to 104 km/h (56 knots). A 2-minute mean wind speed of 111 km/h (60 knots) was reported on the morning of Tuesday 7 at Sherkin Island, Co Cork. Five counties reached red wind warning levels, with a further two counties reaching orange wind warning levels and a further six counties reaching yellow wind warning levels. There were no national wind records broken during Storm Barra, but the widespread nature of the storm and its longevity were notable and unusual. It was the strongest wind storm to affect Ireland since Strom Ellen in August 2020. Storm Barra began as a weak low-pressure system on the

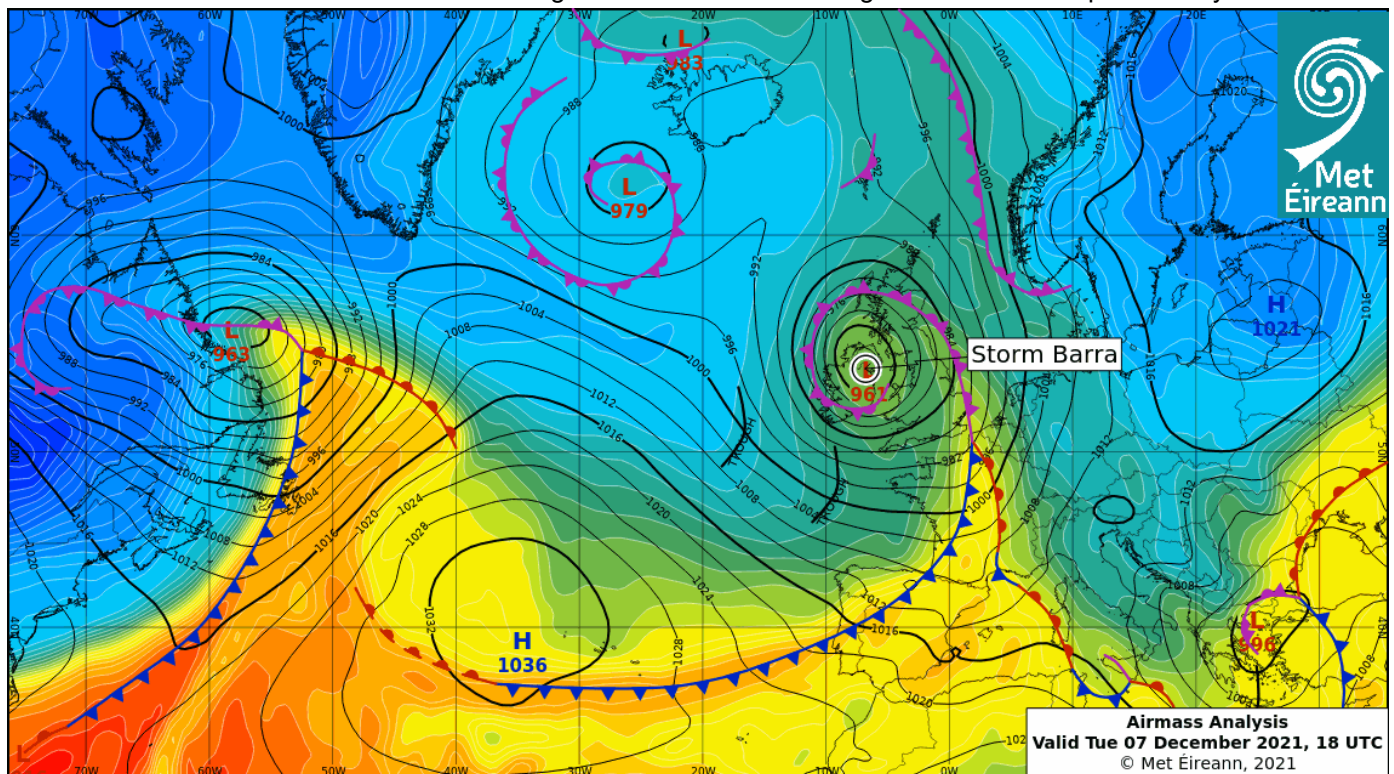


Figure 1. Analysis Chart closest to hour (18 UTC) on Tuesday 7, when the highest sustained wind speed was reported (104 km/h at Mace Head, Co Galway)

southern side of the North Atlantic jet stream off the east coast of Canada on Sunday 5 December. The low-pressure underwent explosive cyclogenesis on Monday 6 December and the early hours of Tuesday 7 December as it crossed to the northern side of the jet stream in the mid-Atlantic and engaged with the left exit region of a powerful jet streak. It deepened by 55 hPa in 24 hours, easily reaching the criteria for a bomb cyclone (a drop of 24 hPa or more in 24 hours). The storm reached its maximum intensity just before reaching the west coast of Ireland. It then disengaged with the jet stream and slowed down as it came up against a blocking high pressure system over Scandinavia. It slowly weakened as it tracked across the country on Tuesday 7. The winds close to the centre of the storm were relatively weak, which meant many places experienced a lull in the strong winds as the centre passed over the country, with the winds strengthening again from a different direction once the storm centre passed by.

Storm Barra brought widespread damage and disruption with coastal flooding in a number of locations, due to a combination of spring tides, storm surge, high waves and onshore wind flow. The longevity of the storm meant that many places received strong winds from the storm over a two-day period in the cyclonic flow, with the South, Southwest and West worst affected. In the Northwest of the country, Malin head, Co Donegal recorded its highest sustained wind speed of 95 km/h (50 knots) from an easterly direction at 10am Tuesday 7 before Storm Barra made landfall, while Finner, Co Donegal recorded its highest sustained wind speed of 75 km/h (42 knots) from a west north-westerly direction at 8am Wednesday 8. In the East, Casement, Co Dublin recorded its highest sustained wind speed of 67 km/h (36 knots) from a south-southeast direction at 9am Tuesday 7 as the active cold front passed over, while Dublin Airport, Co Dublin recorded its highest sustained wind speed of 65 km/h (35 knots) the following day at 12pm Wednesday 8 from a westerly direction. Mace Head, Co Galway experienced gusts of over 89 km/h (48 knots) lasting for at least 28 hours.

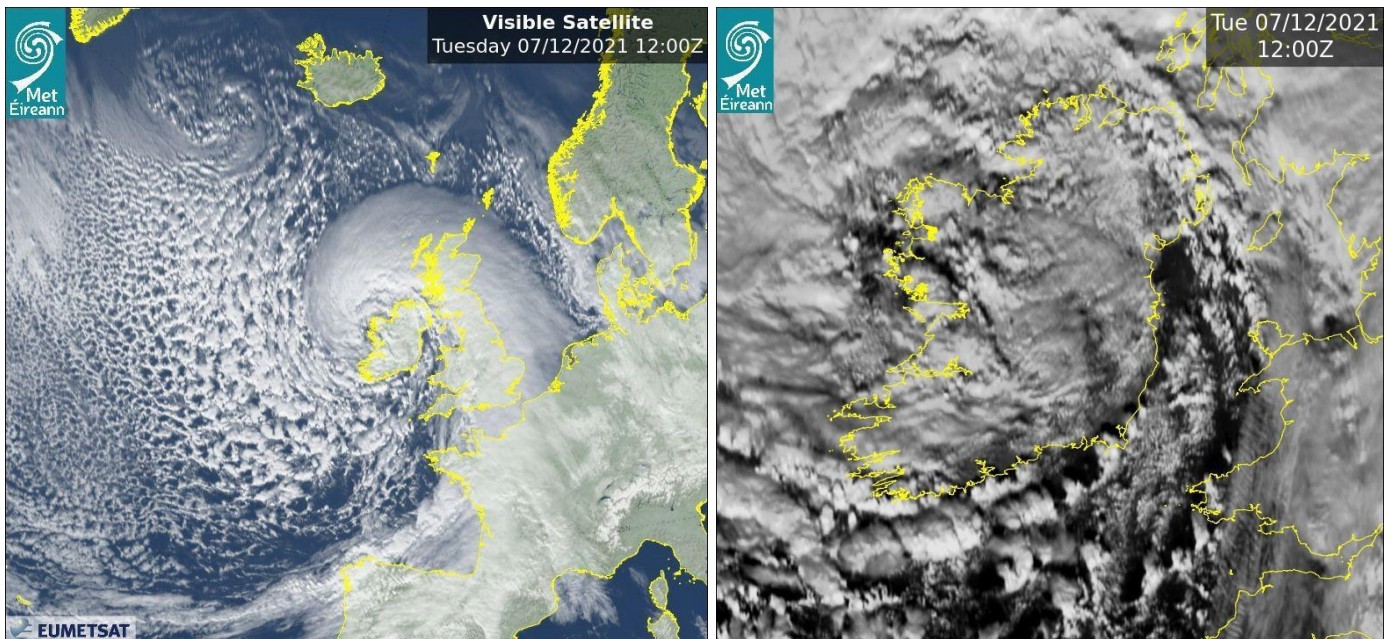


Figure 2 and 3. EUMETSAT Visible Satellite images closest to hour (1200 UTC) of the lowest mean sea level pressure **957.2 hPa** at Mace Head, Co Galway on Tue 7 Dec 2021

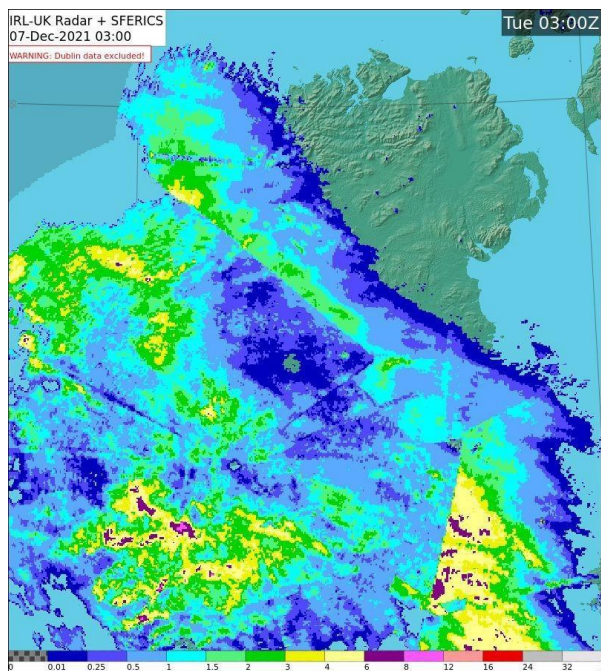


Figure 4. On Tue 7 Dec 2021 in the hour ending 03 UTC
7.2 mm of rain fell at Valentia Observatory, Co Kerry

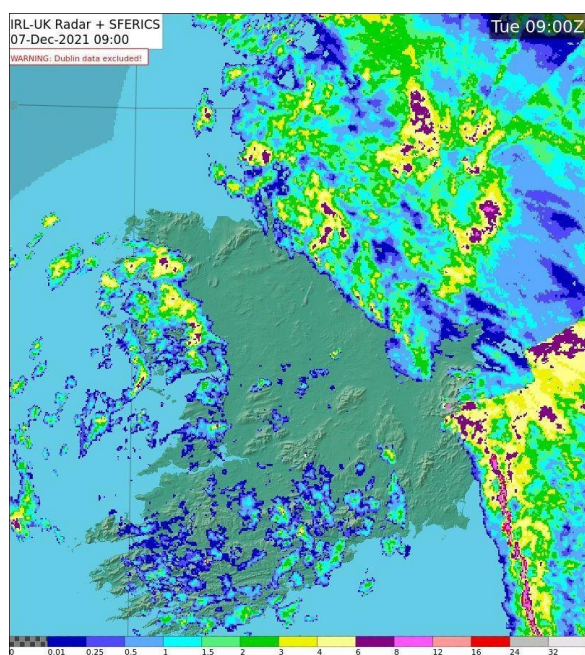


Figure 5. On Tue 7 Dec 2021 in the hour ending 09 UTC
6.3 mm of rain fell at Knock Airport, Co Mayo

Atmospheric Pressure

While rapidly intensifying over the Atlantic Storm Barra deepened by 55 hPa in 24 hours. The minimum mean sea level pressure (MSLP) observed in Ireland during Storm Barra was at Mace Head, Co Galway with 957.2 hPa on Tuesday 7. A pressure drop of approximately 50 hPa occurred at Mace Head, Co Galway over a 16-hour period between 20:15 on Monday 6 and 12:15 on Tuesday 7, when the low-pressure centre made landfall in Galway.

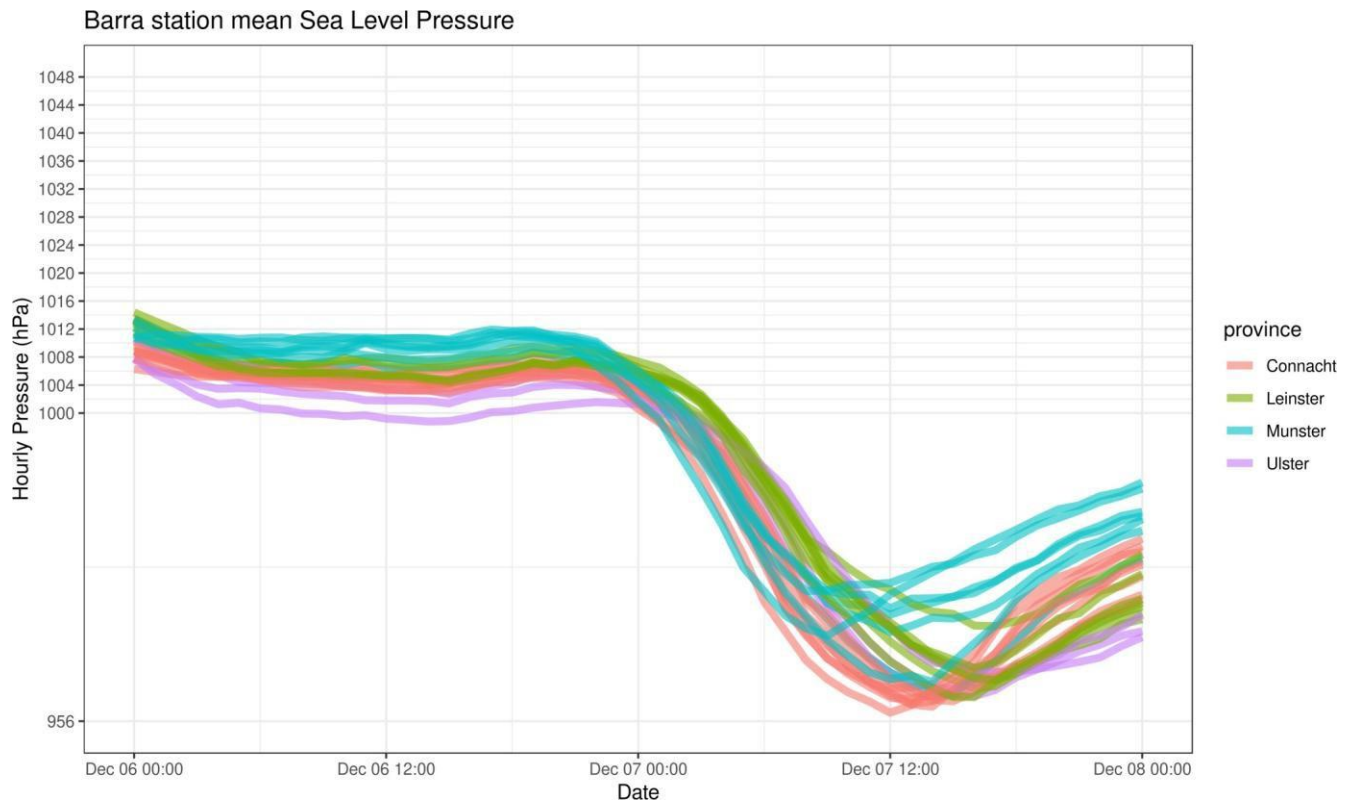


Figure 6. Atmospheric pressure (before correction to MSLP is made) recorded at Mace Head, Co Galway on Tuesday 7 December 2021

Impacts

- **Power Outages:** ESB Power Check showed 49,000 customers without power at 12:45 pm on Tuesday 7. On the morning of Wednesday 8, ESB Power Check revealed more than 59,000 customers were without power.
- **Flooding:** Some flooding in Cork, Kerry, Waterford and Dublin overnight of Monday 6 and during the day on Tuesday 7.
- **Travel:** Some air travel flights cancelled and delays experienced. Ferry cancellations reported. Bus services in red warning counties suspended on Tuesday 7. On the morning of Wednesday 8 bus services country-wide faced delays due to falling debris. Irish Rail remained open on Tuesday 7 but at reduced speeds with suspended rail services for a short time between Dalkey and Dun Laoghaire, Co Dublin. On Wednesday 8 storm damage on the Howth Dart line suspended rail services to the north side of Dublin.
- **Services:** On Tuesday 7 HSE services closed and appointments cancelled. Covid 19 vaccination centres closed in status red and orange counties. Ambulance services restricted due to debris on the roads.
- **Schools & Crèches:** On Tuesday 7, most schools and colleges shut in status red & orange counties. Creches shut country wide. On Wednesday 8, schools in 12 counties remained closed.

Table 1. Observations at SYNOPTIC STATIONS

The following table contains wind speeds and rainfall observations for the SYNOPTIC stations for 3 days, Monday 6-December-2021 and Wednesday 8 December-2021. Some of the observations have weather warning thresholds and these are highlighted. See the weather warnings page on www.met.ie.

Station location	Sustained (10-min mean) Wind Speed	Date highest mean	Wind Direction Highest sustained	Gust (3-sec mean) Wind Speed	Date Highest Gust	Wind Direction Highest Gust	Daily Rain (mm)	Total Rain (mm)
Mace Head** Co Galway	104 km/h Violent Storm Force (56 knots or 64 mph)	Tue 7 Dec 2021 16UTC	310° (NW)	133 km/h (72 knots or 83 mph)	Tue 7 Dec 2021 1622 UTC	310° (NW)	22.4 Tue 7 Dec 2021	26.6
Sherkin Is- land Co Cork	100 km/h Storm Force (54 knots or 62 mph)	Tue 7 Dec 2021 09UTC	240° (WSW)	135 km/h (73 knots or 84 mph)	Tue 7 Dec 2021 1158 UTC	250° (WSW)	11.6 Tue 7 Dec 2021	15.7
Malin Head* Co Donegal	93 km/h Storm Force (50 knots or 58 mph)	Tue 7 Dec 2021 10UTC	100° (E)	119 km/h (64 knots or 74 mph)	Tue 7 Dec 2021 0926 UTC	100° (E)	15.1 Tue 7 Dec 2021	29.4
Valentia Observatory Co Kerry	89 km/h Storm Force (48 knots or 55 mph)	Tue 7 Dec 2021 10UTC	250° (WSW)	130 km/h (70 knots or 81 mph)	Tue 7 Dec 2021 1025 UTC	250° (WSW)	29.4 Tue 7 Dec 2021	42.9
Roches Point Co Cork	89 km/h Storm Force (48 knots or 55 mph)	Tue 7 Dec 2021 08UTC	200° (SSW)	120 km/h (65 knots or 75 mph)	Tue 7 Dec 2021 1020 UTC	230° (SW)	16.8 Tue 7 Dec 2021	22.3
Newport Co Mayo	81 km/h Strong Gale Force (44 knots or 51 mph)	Wed 8 Dec 2021 00UTC	300° (WNW)	120 km/h (65 knots or 75 mph)	Tue 7 Dec 2021 2338 UTC	290° (WNW)	31.0 Tue 7 Dec 2021	38.1
Finner Co Donegal	78 km/h Strong Gale Force (42 knots or 48 mph)	Wed 8 Dec 2021 08UTC	300° (WNW)	111 km/h (60 knots or 69 mph)	Wed 8 Dec 2021 0236 UTC	320° (NW)	21.2 Tue 7 Dec 2021	46.2
Shannon Airport Co Clare	76 km/h Strong Gale Force (41 knots or 47 mph)	Tue 7 Dec 2021 18UTC	290° (WNW)	113 km/h (61 knots or 70 mph)	Tue 7 Dec 2021 1652 UTC	290° (WNW)	18.4 Tue 7 Dec 2021	27.9
Cork Airport Co Cork	72 km/h Gale Force 8 (39 knots or 45 mph)	Tue 7 Dec 2021 11UTC	220° (SW)	119 km/h (64 knots or 74 mph)	Tue 7 Dec 2021 1235 UTC	240° (WSW)	21.3 Tue 7 Dec 2021	26.1
Knock Air- port Co Mayo	72 km/h Gale Force 8 (39 knots or 45 mph)	Tue 7 Dec 2021 20UTC	310° (NW)	106 km/h (57 knots or 66 mph)	Tue 7 Dec 2021 1928 UTC and Wed 8 Dec 2021 0034 UTC	310° (NW) and 300° (NW)	22.8 Tue 7 Dec 2021	31.4
Belmullet Co Mayo	69 km/h Gale Force 8 (37 knots or 43 mph)	Tue 7 Dec 2021 22UTC	320° (NW)	102 km/h (55 knots or 63 mph)	Wed 8 Dec 2021 0016 UTC and Tue 7 Dec	330° (NNW) and 320°	16.8 Tue 7 Dec 2021	19.4
Casement Aerodrome Co Dublin	69 km/h Gale Force 8 (37 knots or 43 mph)	Wed 8 Dec 2021 03UTC	260° (W)	102 km/h (55 knots or 63 mph)	Wed 8 Dec 2021 1345 UTC	260° (W)	13.8 Tue 7 Dec 2021	23.8
Dublin Air- port Co Dublin	65 km/h Gale Force 8 (35 knots or 40 mph)	Wed 8 Dec 2021 12UTC	280° (W)	93 km/h (50 knots or 58 mph)	Wed 8 Dec 2021 1145 UTC	280° (W)	10.8 Tue 7 Dec 2021	21.7

*Caution: Malin Head wind speeds are observed (using an anemometer) at a non-standard height of 23m while all others are at 10m. This will cause Malin Head's wind speeds to be higher in a strong air flow. ** Caution: Mace Head anemometer is situated above exposed rock at the coastline.

Station location	Sustained (10-min mean) Wind Speed	Date highest mean	Wind Direction Highest sustained	Gust (3-sec mean) Wind Speed	Date Highest Gust	Wind Direction Highest Gust	Daily Rain (mm)	Total Rain (mm)
Oak Park Co Carlow	63 km/h Gale Force 8 (34 knots or 39 mph)	Tue 7 Dec 2021 13UTC	190° (S)	89 km/h (48 knots or 55 mph)	Tue 7 Dec 2021 1225 UTC and Wed 8 Dec 2021 0322 UTC	180° (S) and 280° (S)	18.0 Tue 7 Dec 2021	21.2
Gurteen Co Tipperary	63 km/h Gale Force 8 (34 knots or 39 mph)	Tue 7 Dec 2021 18UTC	270° (W)	87 km/h (47 knots or 54 mph)	Tue 7 Dec 2021 1831 UTC	270° (W)	14.9 Tue 7 Dec 2021	19.6
Claremorris Co Mayo	61 km/h Near Gale (33 knots or 38 mph)	Tue 7 Dec 2021 21UTC	300° (WNW)	96 km/h (52 knots or 60 mph)	Wed 8 Dec 2021 0228 UTC	300° (WNW)	14.6 Tue 7 Dec 2021	17.5
Athenry Co Galway	61 km/h Near Gale (33 knots or 38 mph)	Tue 7 Dec 2021 17UTC	290° (WNW)	91 km/h (49 knots or 56 mph)	Tue 7 Dec 2021 1730 UTC	290° (WNW)	13.2 Tue 7 Dec 2021	18.9
Johnstown Castle Co Wexford	59 km/h Near Gale (32 knots or 37 mph)	Tue 7 Dec 2021 15UTC	230° (SW)	102 km/h (55 knots or 63 mph)	Tue 7 Dec 2021 1607 UTC	210° (SSW)	11.2 Tue 7 Dec 2021	20.2
Moore Park Co Cork	56 km/h Near Gale (30 knots or 35 mph)	Tue 7 Dec 2021 14UTC	250° (WSW)	98 km/h (53 knots or 61 mph)	Tue 7 Dec 2021 1436 UTC	240° (WSW)	28.1 Tue 7 Dec 2021	35.8
Mount Dillon Co Roscommon	56 km/h Near Gale (30 knots or 35 mph)	Wed 8 Dec 2021 02UTC	280° (W)	87 km/h (47 knots or 54 mph)	Wed 8 Dec 2021 0211 UTC	280° (W)	20.2 Tue 7 Dec 2021	43.0
Dunsany Co Meath	56 km/h Near Gale (30 knots or 35 mph)	Wed 8 Dec 2021 01UTC	260° (W)	80 km/h (43 knots or 49 mph)	Tue 7 Dec 2021 1221 UTC	190° (S)	14.3 Tue 7 Dec 2021	26.6
Mullingar Co Westmeath	50 km/h Strong Breeze (27 knots or 31 mph)	Tue 7 Dec 2021 08UTC	130° (SE)	91 km/h (49 knots or 56 mph)	Tue 7 Dec 2021 0847 UTC	120° (ESE)	17.0 Tue 7 Dec 2021	35.8
Ballyhaise Co Cavan	48 km/h Strong Breeze (26 knots or 30 mph)	Tue 7 Dec 2021 09UTC	130° (SE)	76 km/h (41 knots or 47 mph)	Tue 7 Dec 2021 0917 UTC	130° (SE)	17.0 Tue 7 Dec 2021	33.2

Marine Impacts

Buoy M2 (east coast/Irish sea) observed a maximum individual wave of 9.84 m, this equaled the record set there on 2 March 2018 during Storm Emma.

Buoy M2 has been observing individual waves since February 2011.

Buoy M3 (southwest coast) observed 87 km/h (47 knots), where its previous record was 89 km/h (48 knots) on 9 December 2007.

No significant wave and maximum individual wave height extremes were surpassed at other buoys.

Table 2. Buoy Observations - 7 December 2021

Buoy	Max Mean Winds	Max Gust	Max Sig. Wave	Max Individual Wave
M2	74 km/h Gale Force 8	102 km/h 55 knots 63 mph	6.4 m	9.8 m
M3	87 km/h Strong Gale Force	115 km/h 62 knots 71 mph	12.6 m	19.9 m
M4	72 km/h Gale Force 8	104 km/h 56 knots 64 mph	10.4 m	16.7 m
M5	65 km/h Gale Force 8	109 km/h 59 knots 68 mph	9.2 m	14.2 m
M6	74 km/h Gale Force 8	100 km/h 54 knots 62 mph	8.4 m	13.0 m

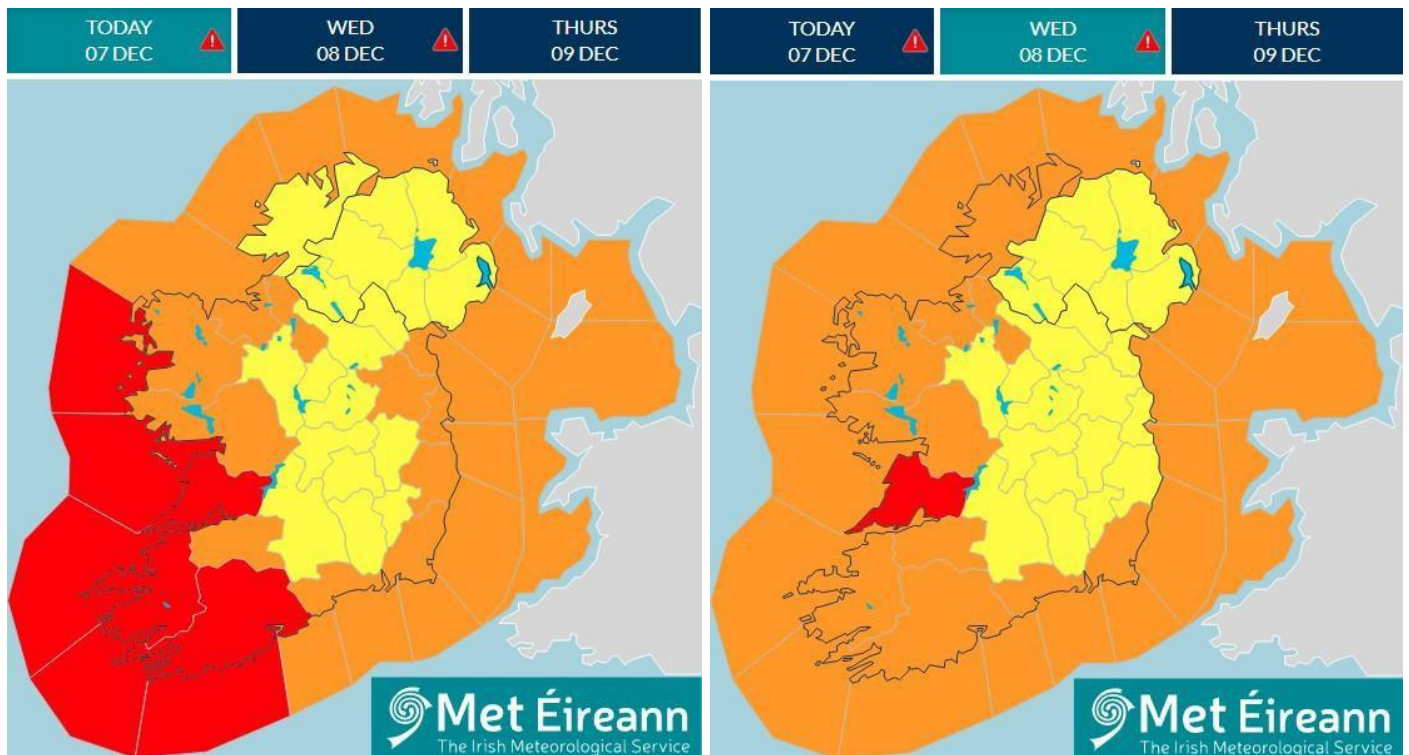


Figure 7 and 8. Wind warnings and advisories for Tuesday 7 December and Wednesday 8 December 2021. See the weather warnings page on www.met.ie

Climate projections for Ireland

Due to its geographic location along the Western edge of Europe, Ireland is affected by mid-latitude wind storms. Latest future projections indicate an overall decrease of 10% in the number of less severe storms affecting Ireland by the middle of the 21st century (Nolan and Flanagan, 2020).

These projections also show there will be an eastward extension of the more severe wind storms over Ireland. As our planet warms, so does our atmosphere. Warmer air has the ability to hold more moisture. In Ireland, we have seen an increase in average annual rainfall by about 6% over the last 30 years (compared to the previous 30 years).

Latest future climate projections for Ireland indicate a decrease in mean rainfall by mid-century; a decrease in mean annual and spring and summer rainfall (Nolan and Flanagan, 2020) while heavy rainfall events are expected to become more frequent. Rainfall is expected to become more variable, with projected increases in frequency of both heavy rainfall events and dry periods also. These projections are in line with those carried out previously (e.g. Nolan 2015, Nolan 2017).

These projections were downscaled from CMIP5 output of the EC-Earth global climate model (Hazeleger 2012).

References

Hazeleger, W, X Wang, C Severijns, S Stefanescu, R Bintanja, A Sterl, K Wyser, T Semmler, S Yang, B van den Hurk, T van Noije, E van der Linden, and K van den Wiel (2012), EC-Earth V2: description and validation of a new seamless Earth system prediction model. *Climate Dynamics*, 39, 2611-2629

Nolan P, 2015. Ensemble of Regional Climate Model Projections for Ireland. Environmental Protection Agency, Johnstown Castle, Ireland. Nolan P and McKinstry A Nolan P, Flanagan J (2020).

[Research 339: High-resolution Climate Projections for Ireland. A Multi-model Ensemble Approach.](#)

EPA report 339 Nolan P, O'Sullivan J, and McGrath R (2017). Impacts of climate change on mid-twenty-first-century rainfall in Ireland: a high-resolution regional climate model ensemble approach. *International Journal of Climatology*

Definitions

Gust wind speeds are an average of 3-second wind speeds.

Sustained wind speeds are an average of 10-minute wind speeds. For observations of sustained wind speeds:

- Storm Force 10 $\geq$ 89 km/h (48 knots)
- Violent Storm Force 11 $\geq$ 103 km/h (56 knots)
- Hurricane Force 12 $\geq$ 117 km/h (64 knots)