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Unexpected Meteorological Extremes

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29th May 1998

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Yours Faithfully,

Dr John Tyrrell

Unexpected Meteorological Extremes: The Limerick Tornado of 1851

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ABSTRACT

An analysis of contemporary documentary sources and meteorological observations show that a T4 tornado event occurred in Limerick during October 1851 ahead of a cold front in unstable air. The path of the tornado through the city is reconstructed and its impacts are described. Although the scientific community in Ireland was engaged during 1851 in a nation-wide experiment to define the monthly and seasonal patterns of weather, it saw no significance in this event beyond its curiosity value. In the search for order, regularity and scientific laws, extreme meteorological conditions appear to have sustained little scientific interest.

Key Index Words: tornado, Limerick, historical climatology.

Introduction

Some recent climate change scenarios have suggested that an increase in storminess over the British Isles would be an outcome of any future global warming (Hulme and Barrow, 1997). The storm profile of the region includes extreme phenomena such as tornadoes (Meaden and Elsom, 1985). The possibility of an increase in the frequency and/or intensity of these must be taken seriously if climate change model projections, such as those of the Hadley Centre, are to be used effectively to prepare us for the future. At present there is a strong perception that tornadoes are not associated with the Irish climate. However, there is a growing database of modern tornado events which shows this to be otherwise. In itself this is not an indicator of climate change. To establish this a longer historical database would also be required. Although such a database is lacking, it is clear that tornadoes are already part of the recent climatic history of Ireland. One of the most dramatic of these was the tornado that swept through the centre of Limerick in October, 1851. This paper reconstructs the event, the meteorological conditions which gave rise to it and the reactions of the scientific community to what was a most unexpected extreme meteorological condition.

The tornado occurred on Sunday, 5th October at 5.20 pm. It is recorded in a number of different sources, from which it is possible to gain a detailed picture of its main characteristics and the impact it had on the city. The impact was, in fact, considerable, because its track took it right through the heart of the city. This is one of the major reasons why there is so much detail available about it. The reconstruction and assessment of the event that follows is based upon information contained in the *Limerick Reporter* of Tuesday 7th October, the *Limerick Chronicle* and the *Munster News* both of Wednesday 8th October, *Freeman's Journal* of Cork with two reports written on Sunday 5th October and a report to the Royal Irish Academy in Dublin by Dr Neil Griffin of Limerick, dated 26th November, 1851. In addition, weather information recorded across Ireland at the time is used to examine the meteorological environment of the event.

The tornado track

All the written accounts are based on observations made from within the city. This makes the start and end points of the tornado track uncertain, because undoubtedly both were located in the countryside beyond the city. The tornado had formed by the time of its arrival and there is no clear evidence of where it terminated.

Visual observation of the tornado was much easier by eyewitnesses close to the relatively wide, more open banks of the river Shannon, than in the city centre. There, its progress was marked by a swathe of damage and destruction. The streets were too narrow and the upward view of the sky too restricted to provide potential witnesses with a clear view. There were few of these around in any case, because the tornado occurred late on Sunday afternoon, when commercial activity was minimal and most people in the area were inside their homes or public houses. It was not a day to be outdoors in any case, being "cold and blowing, with occasional showers" (*Munster News*), the showers being very thundery.

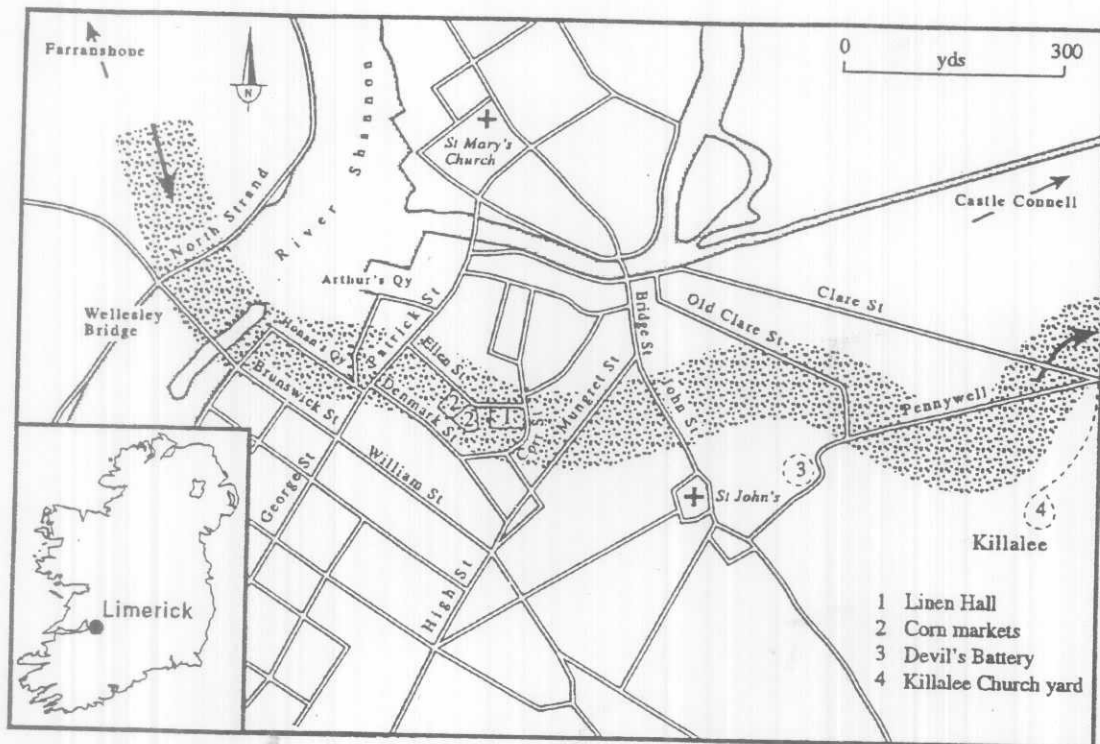


Figure 1: The Tornado Track across Limerick.

The tornado track can be traced from the western side of the river into the countryside beyond the eastern suburbs. All the sources agree that it came from the north-west and crossed the North Strand, which bordered the river (Figure 1; note that many of the names were different compared with those used today). There is some evidence of it before it reached the North Strand as there was a report that "a woman and a cow were twirled around near Little Kilrush" (*Limerick Reporter*), while further to the north-west in a Farranshane orchard a watchman and his hut were carried away (*Freeman's Journal*). From the North Strand the tornado passed close to the toll house at the approach to the Wellesley Bridge, then crossed the bridge itself, to Wellesley Quay on the eastern side of the river, thence tracking to Harvey's Quay (Honan's Quay), Arthur's Quay, across the northern end of George Street and Patrick Street, into Denmark Street, Newtown Market, Ellen Street, Carr Street, Market Street and to the Linen Hall, across High Street and Mungret Street and on to St John's Square, close to the Fever Hospital and the Devil's Battery, passing Old Clare Street thence towards Pennywall, the Killalee graveyard and on towards Castle Connell. The track was less well marked in the countryside, but it still left a trail of damage; "in the country trees were prostrated" (*Limerick Reporter*), although it certainly did not reach Castle Connell. The track was not straight, but was described as being "zig-zag" (*Limerick Chronicle*). The trail of damage that marked the track was up to 150 feet (46 metres) on either side of the tornado, the boundary between damaged and undamaged areas being quite sharp (Griffin, 1851).

Allowing for the diameter of the tornado funnel itself, the total track width was estimated to be 400 feet wide (122 metres). The effects of that were somewhat wider, since on the northern edge of the track the bells of St Mary's cathedral were rocked (*Limerick Reporter, Munster News*), and there were effects in the vicinity of St John's church on the southern edge (*Limerick Chronicle*). From the map it can be estimated that its traceable length was at between 1 and 1.5 miles (1.6 to 2.4 km), and the event lasted for between five and ten minutes (Griffin, 1851). This puts its speed of movement at between 8 and 15 miles per hour (12 and 24 km per hour).

The intensity of the tornado

The intensity of tornadoes is measurable by the damage that they inflict. The Tornado Intensity Scale, used by TORRO (Tornado Research Organisation), is widely used to measure European tornadoes. The effects used by the scale include the damage caused by the wind field, but exclude the explosive effects that may occur, because they are strongly dependent upon the design and structural characteristics of buildings (Meaden, 1976). The first reports of significant damage occurring along the tornado track were on the North Strand. Here Mr Harrison Lee lost his chimney stack and window glass, much of the debris being lifted into the air for a short distance before being deposited on another property on the Strand, belonging to Mr Gleeson, shipping agent (*Limerick Chronicle*). Here, trees in front of Mr Gleeson's house (*Freeman's Journal*) were torn up by the roots, one report describing the trees as 'large' (*Limerick Chronicle*). Reports varied as to whether they were carried to great heights themselves (*Freeman's Journal*) or whether it was mainly the strong branches that were torn off and whirled through the air (Griffin, 1851; *Limerick Chronicle*). Certainly, there were many separate reports of large branches being "driven through the air", and elsewhere trees were also torn up by their roots (*Munster News*). By the time the tornado reached the Wellesley Bridge, the swirling debris was a considerable additional hazard to the violence of the tornado.

On reaching the river Shannon, very close to the toll house, the progress of the tornado noticeably slowed, "at the bridge it struggled and warred for some time, and at length burst under the dry arch with redoubled fury" (*Munster News*). Its impact upon the river was quite different and added new types of flying debris and caused different types of damage. The river water rolled like the sea and at least four of the smaller boats capsized (*Limerick Chronicle*). Other reports record a number of boats being lifted from the water to a great height and descending with great violence, while the larger ships rocked violently. A large sail was torn from the mast of one vessel, carried over the roofs into Denmark Street (which is several streets away from the river) and left on top of Mr Ellard's house there (*Munster News*). A large spar from a ship near the bridge was carried up Brunswick Street for 60-70 yards (*Limerick Reporter*). But several reports record that the damage to vessels on the river was much less than it might have been because of an observant ship's captain, who had travelled in the tropics, recognised what was approaching, quickly trimmed his own sails and rushed to warn the masters of other vessels to do the same (*Munster News, Limerick Reporter*). Despite injuries from "trees that passed over them" (*Freeman's Journal*), the few people that were crossing Wellesley Bridge had fortunate escapes. Some were only knocked down, although one sailor was caught by a passer-by as he was being swept up (*Limerick Reporter*) and another "would have been swept over the battlement but for prostrating himself on the pathway and holding on by the iron pailing" (*Limerick Chronicle*). A similar escape was reported by the toll-house keeper who saw that two women "passing over the bridge in a donkey cart were lifted out of the cart, blown across the bridge, and one of them would have been carried over the battlement had she not held fast by one of the turned stone pillars that supported it" (Griffin, 1851). The report that "a fruit woman was raised several feet from the ground, and blown into Brunswick Street, without sustaining injury" (*Limerick Chronicle*) is one of a number of other reports of people being lifted from the ground without serious injury. The turf boats suffered particularly badly, not having the warning that others received, being alongside Arthur's Quay. The tornado swept off the sails and rigging, which fell upon the house tops of Denmark Street. One turf boat had a main sail which "lay over a rick of turf, black-tarred and heavy, being made of strong canvas, was lifted up, carried over the houses, and left upon the roof of a house in Denmark street, about 150 yards off" (Griffin, 1851).

The greatest damage occurred in the city centre. Structures along the river quays bordering the centre were particularly open and vulnerable to the impact of the tornado. There were specific reports of damage to the large shop of Mr Gleeson, shipping agent, which had the windows, shutters, and most of the shop front blown out and its wooden frame torn two feet away from the main wall of the dry bridge archway on Wellesley Quay (*Munster News, Limerick Reporter*). Considerable damage also occurred on Honan's Quay (or Harvey's Quay) to the stores of Mr Spaight and Mr Osborne which lost their roof slates, timbers and tiles (*Limerick Reporter, Limerick Chronicle*), and to the outoffices of Mr Finnuacane, tobacconist, which were completely demolished. As the tornado moved from there towards Arthur's Quay, on the corner of Denmark Street a poor applewoman, with her stall of apples, was whirled about, although apparently without serious injury (*Munster News, Freeman's Journal*). Thereafter, roofs of houses, stores and mills were extensively stripped of slates, windows were blown out, stacked timber (particularly some 20 ft x 4 inch planks) was levitated from Ellen Street to Carr Street (*Limerick Reporter*) and Michael Street (*Limerick Chronicle*). Other structural damage was reported, particularly between Patrick Street and the Linen Hall, along Ellen Street, Denmark Street, Market Street and Carr Street. The market areas were badly affected, particularly the meat market, the cattle market and the corn market where sheds, stands and implements were quickly swept into the air (*Freeman's Journal*). Flying debris accounted for several injuries, while some people were blown over or lifted into the air and carried along for short distances (*Limerick Reporter, Freeman's Journal*). There was one fatality by the corn market in Carr Street, of Thomas Ryan, who was struck on the head by a flying slate. These circumstances were recorded at the inquest and reported in all the newspapers.

The vivid description of the debris in the air captured something of the terror that it instilled in everyone who experienced it: "at this period it was awful to behold timber, trees, slates, brick, sheafs of corn, hay, straw and other matters floating in the air like a dense swarm of disturbed demons from another region" (*Limerick Chronicle*). This debris was being deposited on the ground all along the track of the tornado. One particular deposit was about half a mile east of the town near the Killalee churchyard where there were "fragments of trees, shrubs, glass, slates, timber, stones, and mortar" which had "fallen from the clouds ... with a noise resembling the approach of a railway carriage" (*Freeman's Journal, Limerick Chronicle*).

One of the significant features of the damage to buildings was its explosive nature. This was noted in passing by some of the newspaper reports, because it was curious how windows were shattered yet no glass or frame debris was found within the rooms, as if an explosion had occurred (*Freeman's Journal, Limerick Chronicle, Limerick Reporter*). Dr Griffin documents this in particular detail in the damaged buildings between Wellesley bridge and Arthur's Quay and shows it to be a particularly unusual feature of the event. In fact, this is yet another distinguishing feature of a tornado in contrast to any other type of storm.

Matching these effects to the tornado intensity scale makes this at least a T3 event (a 'strong' tornado). This is associated with outbuildings being destroyed, house roof timbers being exposed and some larger trees being uprooted, all of which occurred here. It also has some of the characteristics of a T4 event (a 'severe' tornado), such as entire roofs being removed for some houses, roof timbers of stronger houses completely exposed and numerous trees uprooted or snapped, so it was probably a weak T4 event. Such tornadoes normally have funnel wind speeds of 115 mph (52 m/sec) or greater.

The appearance of the tornado

Although the exact location of the point where the tornado funnel first touched down is not known, it is clear that it did form within sight of the city. Dense clouds dramatically darkened the sky immediately before the event and then, "the clouds opened, and discharged, towards the earth, a weighty body of matter, resembling a large hayrick, in a revolving position, which, as it issued forth, occasioned a loud rumbling noise similar to that of a railway train in full motion" (*Limerick Chronicle*). One of those who saw its development was certainly the captain with experience of tropical weather, who warned the masters of other vessels before it

reached them (*Munster News*). As it crossed the North Strand it was both heard, "something like an engine blowing off steam, or the rattle of coaches along the pavement" (*Limerick Reporter*) and then actually *seen* (the *Munster News* put the word into italics to emphasise this). It appeared as a thick, white cloud, close to the ground, before passing onto the river (*Limerick Reporter*). It was described as "an aerial column" moving rapidly (*Limerick Chronicle*). Others saw it initially as a dense column of smoke (Griffin, 1851), and some thought the steam mills had exploded (*Munster News*). At this early stage of its life, part of the funnel also consisted of debris, for it "ascended to a great height, carrying up bricks and mortar revolved in the air" (*Limerick Chronicle*), and after the destruction of several large trees, "the branches and leaves being whirled about with such velocity that they actually formed a portion of this novel phenomenon, and were born along with fearful violence" (*Limerick Chronicle*). As it hit the river those very close to the track said that it threw up "a dense white vapour, like a fog" (Griffin, 1851), while more distant observations noted that "a convulsive heave sent it spouting 50 yards in the air" (*Freeman's Journal*). Most observers described the funnel as a cloud. It was observable as such throughout most of its length, even in the more confined spaces of the city centre, where it was also described by some as "resembling a heavy body of dust thrown up from the earth" (*Freeman's Journal*).

Synoptic conditions

Daily synoptic maps are not available until 1862, but it is possible to piece together information about the general synoptic situation in which the tornado occurred. The principal source of information is unpublished data that was collected by the Royal Irish Academy throughout 1851 as part of a countrywide climatological investigation. Among the observations made for that exercise were those for atmospheric pressure, wind direction and wind strength. The units of measurement and wind scales used in that study are shown in the synoptic reconstruction for 9am on the 5th October (Figure 2). There are further data for later in the day (9 pm) on 5th October, but they are not as complete as the morning data. However, they confirm the main features of the morning synoptic situation. A low pressure system had partly crossed Ireland from the south-west to north-east so that by the morning of 5th October it was centred off north-east Ireland and produced a relatively marked pressure gradient over the west of Ireland. During the previous day most of the observing stations across Ireland recorded their lowest pressure for this particular weather system. As the trough of low pressure thereafter moved eastwards, the winds veered towards the west and north-west, as illustrated for Kilrush (Figure 3).

The changes in weather that this brought about varied for different parts of Ireland. In the Shannon region the evidence suggests that there may have been the development of strong convergence where north-westerly and south-westerly air-streams met. The convergence would have produced an environment favourable for uplift, particularly because the wind in the region was both strong and turbulent, having crossed broken terrain to the north-west (Figure 2).

A second important feature of the synoptic situation was the relative humidity of the air. Based on dry and wet bulb temperatures the relative humidity of the air over the Shannon region appears to have been close to 100 percent from the evening of 4th October until 6th October. Markree (Co. Sligo) also experienced very high relative humidity. Elsewhere, the relative humidity varied between 70-90 percent (Table 1). The cooling of the low level saturated air in the Shannon region as it was lifted would have been slow, resulting in a high level of instability, deep convection and heavy rain showers with a high potential for thunderstorms.

It is clear that in the Limerick region a highly unstable atmosphere had prevailed for some time. The 4th October was noteworthy for its widespread thunder and lightning (*Limerick Reporter*, *Munster News*). The 5th was a day of heavy rain showers and strong gusts of wind, interspersed with substantial periods of bright skies and sunshine, although feeling cold in the blustery wind (*Freeman's Journal*, *Limerick Reporter*, *Munster News*). Thus, when the clouds piled up again and it suddenly became dark, thunder and lightning were anticipated again (*Limerick Reporter*). Indeed, thunder and lightning were reported at nearby Castle Connell

at the time of the tornado in Limerick (*Limerick Chronicle*). These conditions may have been limited to the west of Ireland, because in the east of Ireland there are no records of thunder having occurred.

Some temperature changes did occur which suggest the movement of a cold front across Ireland, as south and south-westerly tropical maritime air was replaced by polar air from the north-west. A clear distinction can be made between those stations north of a line between Westport, Armagh and Donaghadee and the rest of Ireland. Those north of this line experienced lower temperatures at 9 pm compared with 9 am, while those south of the line had higher temperatures (Figure 4). Dublin is rather an ambiguous case. There are temperature records for three Dublin sites on 5th October. Since they did not all follow the same pattern of temperature change during the day an average was taken. Most of the east coast of Ireland experienced colder air rather later than the west and the north. If this was a cold front the tornado outbreak occurred ahead of it as it was advancing from the north-west.

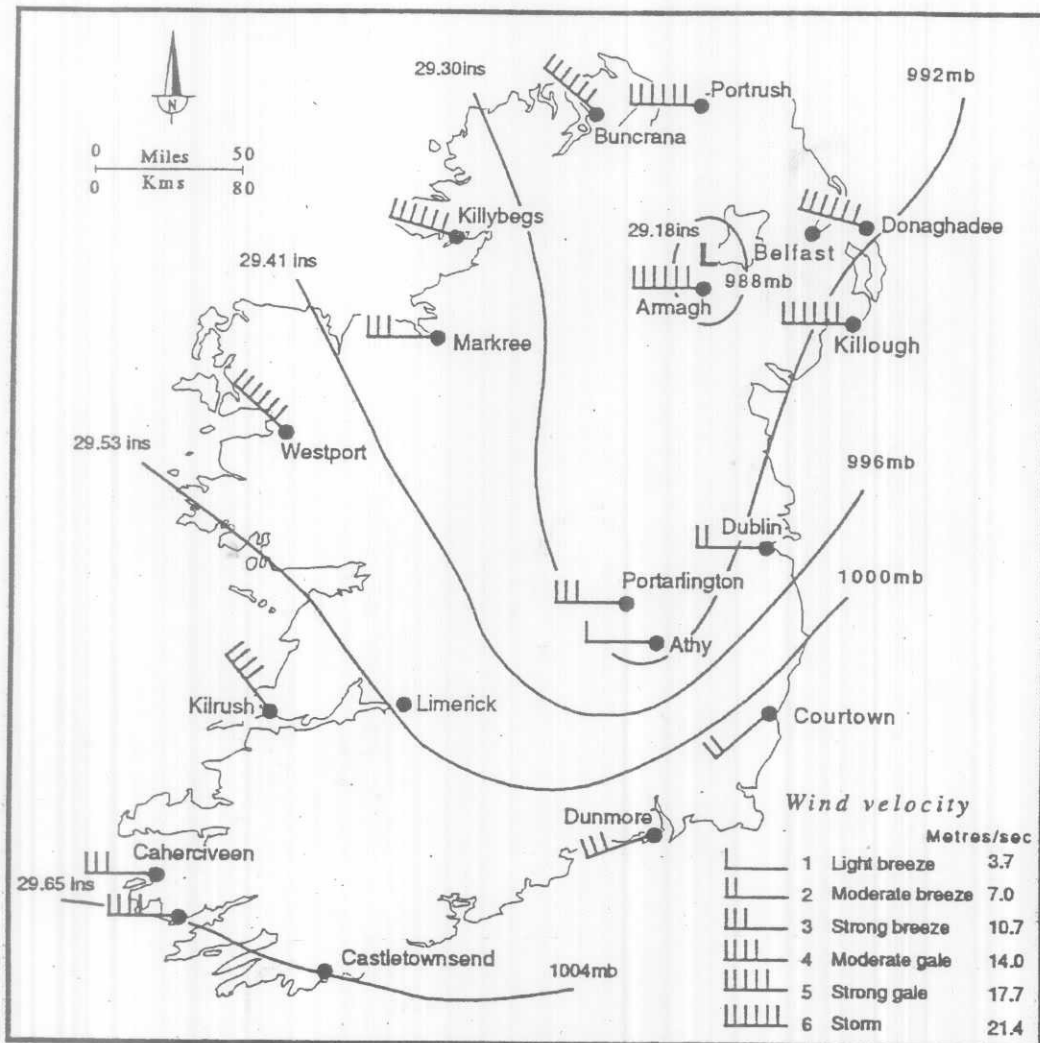


Figure 2: Atmospheric pressure and wind direction at 9 am.

Table 1: Relative humidity (%) values for October 1851, as recorded in meteorological registers.

	October 4 th		October 5 th	
West of Ireland:	9 am	9 pm	9 am	9 pm
Kilrush	93	100	100	100
Markree*	85.6	98.8	95.1	97.2
Westport	96.7	88	84.2	87
Other regions				
Castletownsend	88.5	85	80.5	87.5
Dublin	77.6	85.4	82.1	88.2
Armagh	82.1	86.7	77.8	83.9
Belfast	85.6	90.2	88.2	87.4

*observations taken at 10 am and 10 pm

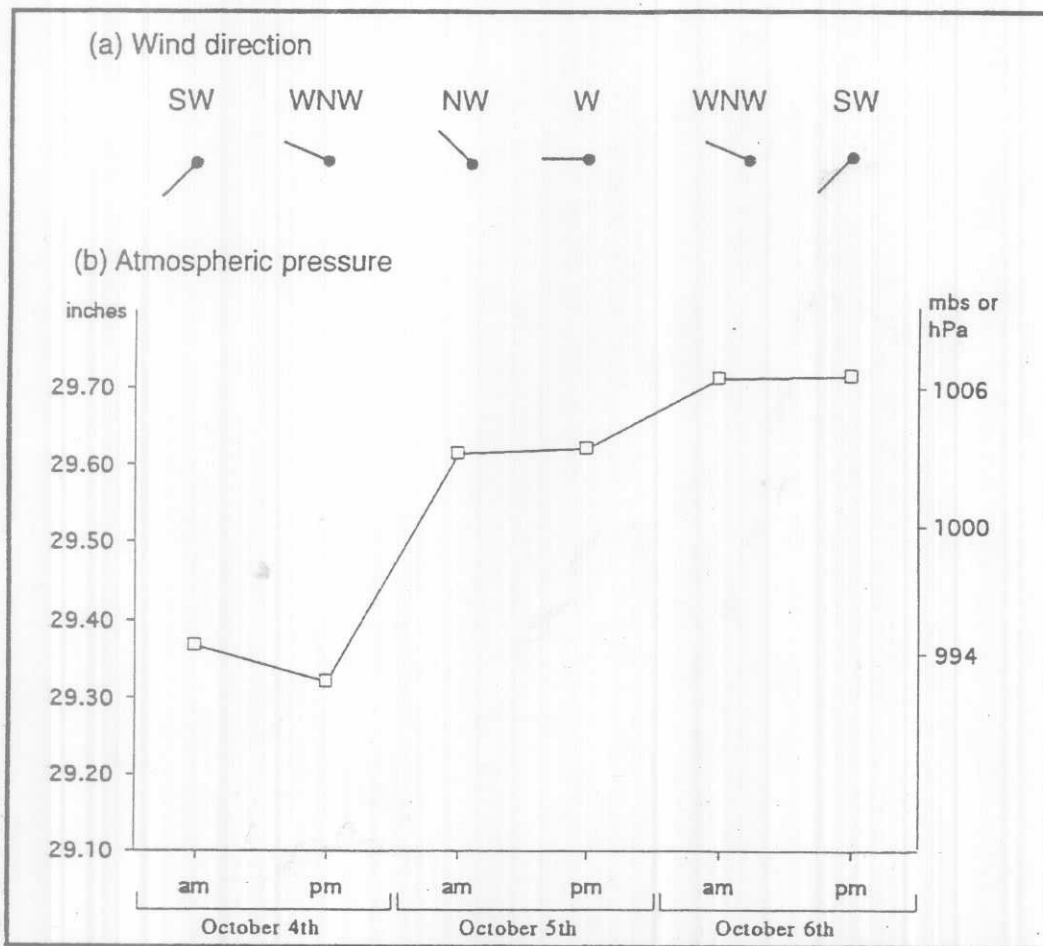


Figure 3: Observations at Kilrush, October 1851.

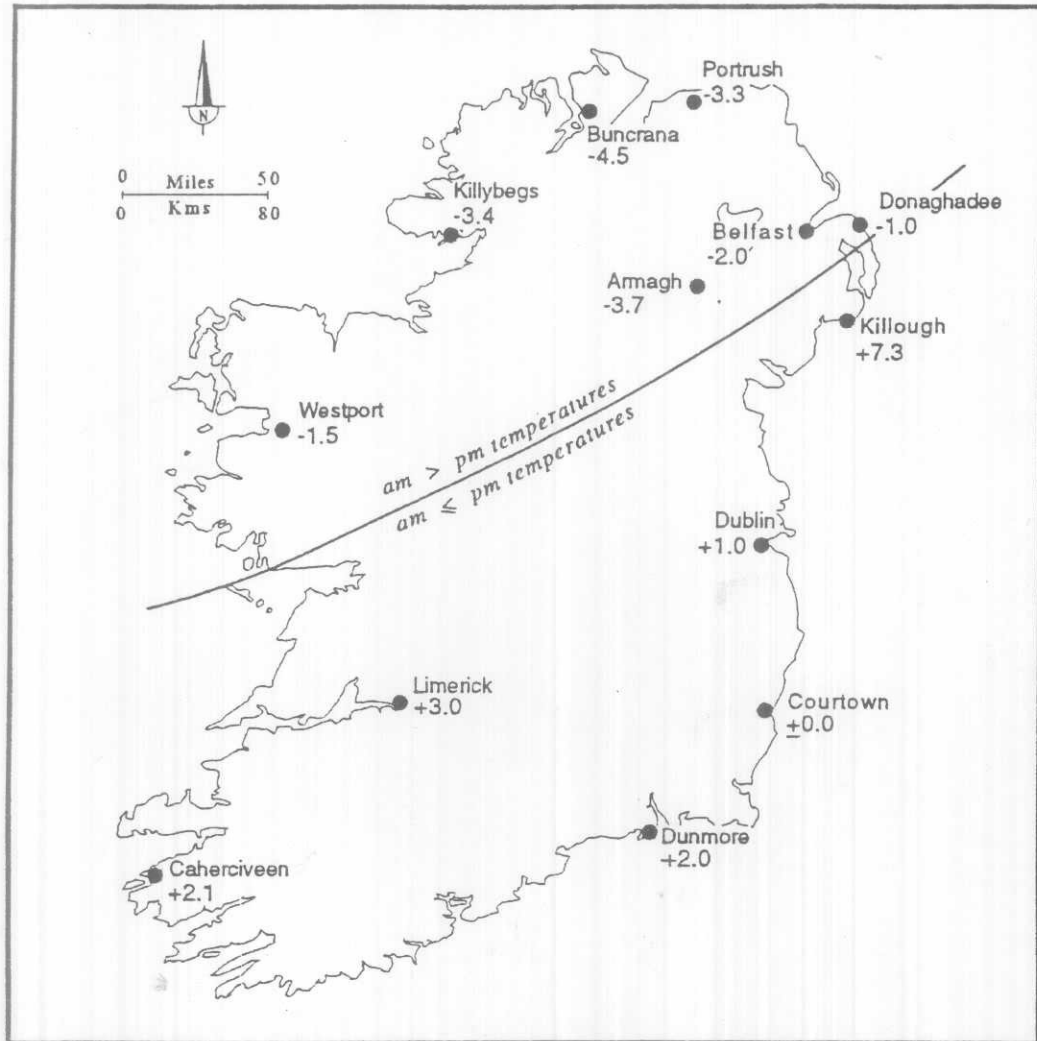


Figure 4: Air temperature differences (°F) between morning and evening, 5th October 1851.

The nineteenth century climatology of tornadoes

It is clear from the way in which the event was reported that what occurred was exceptional and outside the expected range of weather conditions. This is partly reflected in the terminology used to describe it. While reports frequently used the term 'whirlwind', it is significant that the cloud was also described as a tornado. Here one detects the possible input of the experienced captain to whom mention is made by most accounts and who had immediately realised the potential damage of the event that was about to descend upon the city. Chronologically, the first reports were written on Sunday and Monday 5th and 6th October and appeared in the *Freeman's Journal*. No use of the term 'tornado' was made in either of these, nor was any reference made to the captain as a witness to the event. The term is first used in a report produced on Tuesday 7th October, in the *Limerick Reporter*, which also carried the eyewitness account of the captain. This additional dimension to the understanding of the event was given particular emphasis by having the term 'tornado' included in the newspaper headline. Inevitably, this was then repeated in subsequent coverage in the *Limerick Chronicle* and the *Munster News*. In significant contrast, the caution of the scientific community was reflected in the fact

that in his report to the Royal Irish Academy, Dr Griffin did not use the term at all. Instead, the event was described as a whirlwind and compared with a waterspout. Clearly a tornado was a feature with which the scientific community was as unfamiliar as most other people at that time.

The validity of the claim that this phenomenon was "hitherto unknown in this country" (*Limerick Chronicle*), is not borne out by the evidence. Surprisingly, only one month earlier there had been a tornado outbreak on the edge of the city of Cork which had spawned more than one funnel and lasted longer than the Limerick tornado (Tyrrell, 1998). Mercifully, it did not pass through the city so the damage was minimal. This shows that knowledge of these events was not communicated widely, even between members of the scientific community in different parts of Ireland.

At this time the Royal Irish Academy, under the inspiration of its president, the Rev. Humphrey Lloyd, was engaged in a country-wide systematic observation of daily meteorological conditions, characterised by the same scientific rigour as earlier European and American schemes of meteorological observations. One of the six objectives set for this programme was to investigate "the phenomena and laws of storms, whether revolving or otherwise" (Lloyd, 1854). This resulted in the identification of all occasions during the year when cyclonic phenomena occurred. One of these occasions was 4th and 5th October. However, no evidence of the tornado was forthcoming from the data recorded at the sixteen stations used in the survey, particularly the closest station to Limerick, namely Kilrush. This is not very surprising given the relative coarseness of the observation network compared with the dimensions of the tornado. Significantly, when the results of the RIA exercise were published in 1854, the report of the tornado received no mention. Dr Griffin's report to the RIA, presented later in 1851, appears to have been the only occasion that the event was considered by that body. The lack of any subsequent consideration of the tornado is surprising, given the accepted environment of enquiry which gave rise to the survey in the first place.

Regional climatic descriptions and meteorological science during the middle of the nineteenth century were concerned with defining the orderliness of the environment, and identifying the laws which governed the working of the atmosphere. As elsewhere, the drive behind this endeavour in Ireland was the application of scientific knowledge to the well-being of the population particularly in the areas of agricultural production and health. Lloyd was particularly conscious at this time that the application of meteorological science for the benefit of the common good had been neglected and that it was regarded as a barren science. He was anxious to defend it and to develop it to the point where it could make its expected contribution to society. This gave little place for the consideration of extreme events, even of a hazardous nature, whose duration was very short and geographical impact confined to a relatively small area.

Both unfamiliarity and very low frequency appear to have contributed to the lack of awareness of tornadoes in Ireland. They appeared to have raised few scientific questions of lasting interest. It was as if this event did not belong in Ireland – it belonged in the tropics. Even its possible recurrence was, therefore, of little concern in the brief discussion of the event that followed.

Conclusion

All the features of the storm of 5th October 1851 in Limerick clearly show that it was a tornado which reached an intensity of T4 and that it occurred ahead of a cold front in regionally very humid air with a sharp vertical temperature profile. However, it was seen as a climatological aberration which did not belong to the Irish climate. The prevailing paradigm for atmospheric and climatic studies in Ireland had no place for it. The obsessive search for laws as a basis for understanding the atmosphere, as laudable and important as that was, led to the interest of the scientific community in tornadoes being almost as short-lived as the event itself.

Acknowledgements

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