# 1

# Researching Extreme Weather in the United Kingdom and Ireland: The History of the Tornado and Storm Research Organisation, 1974–2014

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## 1.1 Introduction: The Early Years

TORRO was launched in Britain in 1974 as the Tornado Research Organisation. The seeds had been sown a long time earlier, in 1950, when I became a 15-year-old amateur meteorologist at grammar school in Trowbridge, Wiltshire. Before then, I had decided to become a scientist or archaeologist for which a university education would be needed, and so I had embarked on preparing the necessary background. Because physics is the quintessential science, I made it my forte, while being attracted nonetheless to the problem-solving challenges of archaeology for its discoveries of the prehistoric human past. By 1948 the schoolteachers knew that Oxford University was my ambition. In April 1950, Trowbridge Boys High School purchased a Stevenson Screen, thermometers, a rain gauge and a subscription to *Weather* Magazine. New vistas appealed. By January 1951, I had bought a good rain gauge and built my first thermometer screen for a home station. I also subscribed to *Weather* and have done so ever since. The Meteorological Office's *British Rainfall* accepted my rainfall data from 1951 to 1966, and, because I enjoyed thunderstorms and studying tornadoes, I joined Morris Bower's Thunderstorm Census Organisation.

For some years, I ran two weather stations. In February 1951, the editor of the county newspaper *Wiltshire Times* announced that its weather correspondent was leaving the county and asked for a replacement. I immediately supplied a detailed monthly weather report and became the newspaper's weather correspondent for the 3 years until I went to Oxford. This initiative at writing for the press and reporting the weather was appreciated by the schoolteachers and Oxford dons, and undoubtedly helped me, age 17, at the interviews for the entrance examination in January 1953.

At Oxford I read physics where I got to know meteorologist Professor Alan Brewer (1915–2007) who proposed me as a Fellow of the Royal Meteorological Society (FRMetS) in December 1957. Doctoral research followed (1957–1961) (Figure 1.1) and then a post-doctoral fellowship funded by the Atomic Energy Research Establishment at Harwell. In 1963 I left to pursue low temperature physics research at the University of Grenoble in France and afterwards got a tenured position as a Professor of Physics at Dalhousie University in Halifax, Canada. I even took my Stevenson screen and Snowdon rain gauge to Canada, encouraged by the prospect of measuring very low winter temperatures, savage wind chills and high cyclonic rainfalls from which the Maritime Provinces suffered.[1]

Back in Oxford, in 1972 and 1973, I specialised in studying the incidence of tornadoes in Britain. I was impressed by the number of well-documented historical cases scattered through volumes in the Radcliffe Science Library. Britton (1937) in his chronology of British weather to the year 1450 aided research for the medieval centuries, and Ralph Edwin Lacy's paper in *Weather* 1968 appealed for its listing of tornadoes from 1963 to 1966. Among

[1] The wettest 24 hours I recorded was a deluge in December 1970 with over 7 in. (180 mm) of rain.

*Extreme Weather: Forty Years of the Tornado and Storm Research Organisation (TORRO)*, First Edition. Edited by Robert K. Doe.

Companion website: www.wiley.com/go/doe/extremeweather

***Figure 1.1*** *Terence Meaden in 1961 (*left*) and in 2013 (*right*).*

the long runs of magazines, George Symons' *Meteorological Magazine* included hundreds of storm cases and many tornado events in the early issues from 1865 to 1914.

Seeing that tornado and thunderstorm research was not being done by the Meteorological Office, here was a worthy area of study with obvious prospects of long-lasting usefulness. At the time I thought that a series of severe-storm books might develop, but instead a weather magazine (*The Journal of Meteorology*) was launched.

It felt necessary to compile data on severe-storm and tornado events as they were being reported countrywide in order to inspect fresh damage with minimum delay, so I subscribed to a press-clipping service using search words like tornado, whirlwind, waterspout, freak wind and hurricane wind. The database soon held hundreds of tornado cases. As best as possible, details of track length, direction, path width and damage were summarised. Regarding the latter, an expanded version of the Beaufort scale at first proved helpful for estimating wind speeds of the mostly weak tornadoes, but something more specific and relevant to the reality of characteristic tornado damage was needed. At this point, in 1972/1973, it proved easy to devise a practical tornado intensity scale that would maintain the advantages offered by the scientific strengths of Beaufort, and would, moreover, be achievable by introducing only a minor rearrangement of the basic Beaufort velocity formulation. The International T-Scale was born.

## 1.2 International T-Scale: Theoretical Basis

The Beaufort scale is the recognised scientific international wind-speed scale. It began two centuries ago in 1805, for use at sea. A land-based version followed later. The International T-Scale was designed in Europe for practical use with weak and strong tornadoes, whereas Fujita's system was initially planned to characterize strong North American tornadoes in view of potential hazards to nuclear power stations.[2]

The T-Scale is as universally valid as the Beaufort scale because the T-Scale is simply the universal Beaufort scale in a form rendered practical for tornado-strength winds. It embraces the digit range from T0 to T10 where each T number stands for tornado maximum strength (Table 1.1). The Beaufort scale is supported by the authority of the World Meteorological Organisation, so the T-Scale stands to benefit similarly. The basic velocity equation is the same. The T-Scale avoids the big code numbers that would arise if the ordinary Beaufort scale was used to assess tornado winds.

The Beaufort scale was formalised in the 1920s at international meetings by agreeing that velocity, $v = 0.837\,B^{3/2}$ metres per second – the measurements made at 10 m above ground level.

Hence the T-Scale formula:

$$v = 0.837\left(2T + 8\right)^{3/2} \text{ or } v = 2.365\left(T + 4\right)^{3/2}$$

Thus, the T-Scale is the Beaufort scale modified for tornado wind-speeds in which T0 equals B8 gale force at $18.9\,ms^{-1}$ (for 3-second gusts).

This automatically makes T2 *exactly equal* to hurricane-speed B12 or $34.8\,ms^{-1}$.

Note that T-Scale and B-Scale numbers are exactly equivalent in whole digits.

[2]An American scale by Prof. T.T. Fujita was devised (1972/1973) to assign maximum known strengths to US structures including, especially, nuclear power stations and other vulnerable high-risk structures (Fujita, 1973). The T-Scale or International Tornado Intensity Scale, (1972/1973), was intended to apply to all the world's tornadoes (Meaden, 1975–1976). Previously, the whole world had made use of the Beaufort Scale to assess wind speeds at least up to hurricane-speed B12 but beyond as well.

***Table 1.1*** *The international tornado intensity scale.*

| T-scale | Wind speeds | Characteristic Damage Intensity (Descriptive; for General Guidance only) |
|---|---|---|
| T0 | Light tornado 17–24 $ms^{-1}$ | Loose light litter raised from ground in spirals. Tents, marquees seriously disturbed; the most exposed tiles, slates on roofs dislodged. Twigs snapped; trail visible through crops |
| T1 | Mild tornado 25–32 $ms^{-1}$ | Deckchairs, small plants, and heavy litter become airborne; minor damage to sheds. More serious dislodging of tiles, slates, chimney pots. Wooden fences flattened. Slight damage to hedges and trees |
| T2 | Moderate tornado 33–41 $ms^{-1}$ | Heavy mobile homes displaced, light caravans blown over, garden sheds destroyed, garage roofs torn away, much damage to tiled roofs and chimney stacks. General damage to trees, some big branches twisted or snapped off, small trees uprooted |
| T3 | Strong tornado 42–51 $ms^{-1}$ | Mobile homes overturned/badly damaged; light caravans destroyed; garages and weak outbuildings destroyed; house roof timbers considerably exposed. Some big trees uprooted or snapped |
| T4 | Severe tornado 52–61 $ms^{-1}$ | Vehicles levitated. Mobile homes airborne/wrecked; sheds airborne for considerable distances; entire roofs removed from some houses; roof timbers of stronger brick or stone houses totally exposed. Strong trees can be snapped or uprooted |
| T5 | Intense tornado 62–72 $ms^{-1}$ | Heavy motor vehicles levitated. More serious building damage than for T4, yet most house walls usually remaining. The oldest, weakest buildings may collapse entirely |
| T6 | Moderately-devastating tornado 73–83 $ms^{-1}$ | Strongly built houses lose entire roofs and perhaps a wall or two; more of the less strong buildings collapse, as with wooden frame houses |
| T7 | Strongly-devastating tornado 84–95 $ms^{-1}$ | Wooden frame houses wholly demolished; walls of stone or brick houses may collapse or be beaten down. Steel-framed warehouse-type constructions may buckle slightly. Locomotives can be thrown over. Considerable debarking of trees by flying debris |
| T8 | Severely-devastating tornado 96–107 $ms^{-1}$ | Motor cars hurled great distances. Wooden-framed houses and their contents dispersed over great distances; stone or brick houses irreparably damaged; steel-framed buildings buckled |
| T9 | Intensely-devastating tornado 108–120 $ms^{-1}$ | Many steel-framed buildings badly damaged. Locomotives or trains thrown and tumbled great distances. Complete debarking of any trees left standing |
| T10 | Super tornado 121–134 $ms^{-1}$ | Entire frame houses and similar structures lifted bodily from foundations and carried some distances. Steel-reinforced structures may be badly damaged |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| T | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| B | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 |

This makes the T-Scale wholly practical and especially useful for rating the weaker tornadoes from T0 to T6. Most European tornadoes range from T0 up to T6 or T7, while all the world's tornadoes span the range T0 to T9 or T10. The paper by Meaden *et al.* (2007) provides a full explanation.

The F-Scale, and its revised version the EF-Scale, ranges from 0 to 5. Fujita set his force F1 at minimum hurricane speed (not at Beaufort's average hurricane speed). This means F1 = Beaufort 11.5 (instead of B12) and ensures that there is never whole-number equivalence, for example F2 = B15.37; F3 = B19.22; F4 = B23.06; F5 = B26.91.

Even for the United States, 92% of tornadoes are recorded as F0, F1 and F2, while more than 98% are F0, F1, F2 and F3. Only between 1 and 2% have been rated F4, and only one in a thousand reaches F5. Worldwide, much fewer in percentage terms reach F4 and F5. Indeed, most of the world's tornadoes are only F0, F1 and F2 – which is better expressed as T0–T5.

The T-Scale was put to strict and timely use when preparing the Sizewell tornado risk study in 1984–1985 (Meaden, 1985) and recently when tornado risk calculations were needed for Electricité de France Energy Plc at Hinkley Point in 2010–2011 (Meaden, 2011). It is important to note that if TORRO's 40 years had been spent applying the F-Scale to assess British tornado strengths, the risk calculations for British nuclear power stations would not have been possible through an insufficiency of available intensity-data points. To summarise, a truly universal scale requires a sound theoretical basis to deserve universal acceptance – and it should apply readily to all the world's tornadoes. The decimal T-Scale meets the necessary strict scientific requirements, just as the MKS system does for scientific work everywhere. It is a truly international scale.

### 1.2.1 Hailstorm Research

The compilation of hailstorm statistics is a major division of TORRO. Initiated by Michael Rowe, the databank has been well maintained by Jonathan Webb for three decades. Important publications in international journals have resulted, including collaborations with international scientists (e.g., Sioutas *et al.*, 2009). The hailstone size scale and the Hailstorm Intensity Scale created by TORRO have proved very helpful in Britain and worldwide (Webb *et al.*, 1986; 2009) (see Chapter 9 for details).

### 1.2.2 Temperature Extremes for the British Isles

In 1984, TORRO published a list of Britain's highest temperatures for every day of the year (Meaden and Webb, 1984). This led to an invitation to update and republish the study (including the lowest known temperatures) in the Royal Meteorological

Society's Millennium Year's *Weather* (Webb and Meaden, 2000). Since then, the paper has had a demonstrable positive influence on the presentation of weather information by forecasters and press reporters countrywide. Similar research culminated in the publishing of daily extreme values for rainfalls across Britain (Ross, Webb and Meaden, 2009).

## 1.3 Tornado Research Organisation

The Tornado Research Organisation was the original name and hence the acronym TORRO. The launch of *The Journal of Meteorology* soon followed, starting with the first issue in October 1975. At once, weather-forecaster Bob Prichard began providing monthly thunderstorm reports – which he is still doing 39 years later – and so the name was changed to the Tornado and Storm Research Organisation and the acronym TORRO retained.

The intention was that TORRO would be *a self-funded research body serving the international public interest*. The main objective was to ensure the publication and dissemination of the huge amount of data on severe storms and tornadoes that was being gathered. The quantity of information was so vast that no existing magazines could publish everything in any detail. Soon after launching TORRO, I got to know Mr. Michael W. Rowe and a long fruitful collaboration began. Independently, he had been gathering tornado data in much the way that I had. We merged our databases and shared everything new that came to our attention. The content of the database stretched back to the 11th century. The earliest date for a tornado known for the United Kingdom is 1091 (London) and for Ireland 1054 (Rosdalla, County Westmeath).

Later, in the 1990s, David Reynolds was helpful during the years when he was working for his PhD at the University of South Wales, and Paul Brown in recent years has been brilliant at industriously rewriting and extending the tornado/whirlwind-related database. His archival research of newspapers has greatly augmented the known cases for the 18th and 19th centuries. By 2014 we could say that the totality of archived British and Irish events number more than 3800 tornadoes and waterspouts. Additionally, there are many hundreds of reported funnel clouds and other whirlwinds (land devils, water devils, eddy whirlwinds, fire devils, gustnadoes). Rowe (1999) published a summary article on tornadoes in the British Isles to 1660. The current number of tornadoes being *reported and recorded* annually for the British Isles averages nearly 50; and so one may ask 'how many more are still being missed – unseen in the countryside or taking place at night'?

The general work of the Tornado and Storm Organisation has been reviewed several times, for example by Elsom *et al*. (2001) and Meaden and Rowe (2006). Besides the tornado work, data collections were made of the following:

- Severe hailstorms and details of big and giant hail (*see* Webb, 1993)
- Lightning injuries and deaths (Derek Elsom and Jonathan Webb)
- Thunderstorm occurrences and distribution (Bob Prichard, Jonathan Webb and Keith Mortimore)
- Thunderstorm rains (various, including Jonathan Webb and John Mason)
- Heavy snowfalls (Richard Wild)
- Ball lightning (initially Michael Rowe and Terence Meaden, then Mark Stenhoff, Adrian James, Peter Van Doorn and Chris Chatfield)
- Coastal storm impacts and floods (*see* Doe, 2002)
- Historical cases of other early storms in Britain (e.g. during the invasion by Julius Caesar in 55 BC, *see* Meaden, 1976) and early weather monitoring in Britain (e.g. in the years 1269–1270 and 1337–1343, *see* Meaden, 1973). Also Webb (1987) for Britain's highest daily rainfalls by county and month.

In 1985, TORRO executives included Michael Rowe, Bob Prichard, Derek Elsom, Jonathan Webb, Keith Mortimore, Adrian James, Chris Chatfield and Albert Thomas. By 1990/1995, additional executives and key personnel were Peter Matthews, Alan Rogers, Wendy Rogers, Ellie Gatrill-Smith, Mark Stenhoff, David Reynolds, Ray Peverall, and Richard Muirhead. Figure 1.2 shows the attendance at the June 2002 staff meeting.

By 2005 further personnel were Paul Knightley, Helen Rossington, Nigel Bolton, Robert Doe, Matthew Clark, Tony Gilbert, Stuart Robinson, Stephen Roberts, Richard Wild, John Mason, Sam Jowett, Mark Humpage, Stuart Robinson, Peter Van Doorn, Paul Domaille, Ian Loxley, Ian Miller, John Tyrrell, John Wilson, Chris Warner, Samantha Hall and Martin Collins. Figure 1.3 shows the staff at the August 2005 staff meeting and Figure 1.4 in November 2006. Since 1994, the Heads of TORRO have been either academics (Prof. Derek Elsom, Oxford Brookes University, followed by Dr John Tyrrell, University College Cork) or, as now, a professional meteorologist and forecaster (Paul Knightley).

## 1.4 The Inaugural Issue of *The Journal of Meteorology*

October 1975 saw the first issue of *The Journal of Meteorology* (Figure 1.5). The issue for July/August 1985 was the hundredth. The intention was to publish for the public benefit details of every tornado event known for Britain from 1960 onwards and to report major site investigations regarding tornadoes and damaging hailstorms, and this has been done ever since.

Upon its launch, the journal had a warm reception from the renowned, much-liked Professor Gordon Manley (1902–1980) (Figure 1.6). He wrote saying how pleased he was at this enterprise and the prospect of such storm research advancing the cause of meteorology and weather forecasting. Professor Hubert Lamb (1913–1997) (Figure 1.6), too, immediately supported the young journal, and at the time of TORRO's first conference (1985) (see Figures 8.1–8.9) and the journal's 100th issue, he wrote a timely piece about the importance of independent meteorological research (Lamb, 1985).

The mounting information about the high frequency of tornado occurrences was impressive. The journal would ensure that TORRO would publish all incoming data about new and past events, and this has been achieved in some detail for the

***Figure 1.2*** *Staff meeting in Devon, 8 June 2002; (*left *to* right*) Wendy Rogers, Terence Meaden, Derek Elsom, Robert Doe, Tony Gilbert, Stephen Roberts, Nigel Bolton, Harry McPhillimy (TORRO Archives).*

***Figure 1.3*** *Staff meeting, 6 August 2005, in Devon, hosted by Alan and Wendy Rogers. From left to right,* standing*: Chris Chatfield, Mike Rowe, Alan Rogers, David Bowker, Jonathan Webb, Robert Doe, Nigel Bolton, Derek Elsom, Ian Loxley, Richard Wild, Steve Roberts and John Mason;* kneeling*: Wendy Rogers, Terence Meaden, Paul Knightley, Peter Matthews, Tony Gilbert and Ian Miller (TORRO Archives).*

*Figure 1.4* Staff meeting in Oxford, 18 November 2006; (left to right) Richard Pearson, Alan Rogers, Wendy Rogers, Jonathan Webb, Chris Chatfield, Robert Doe; (front row) Mike Rowe, Peter Matthews, Terence Meaden, Derek Elsom (TORRO Archives).

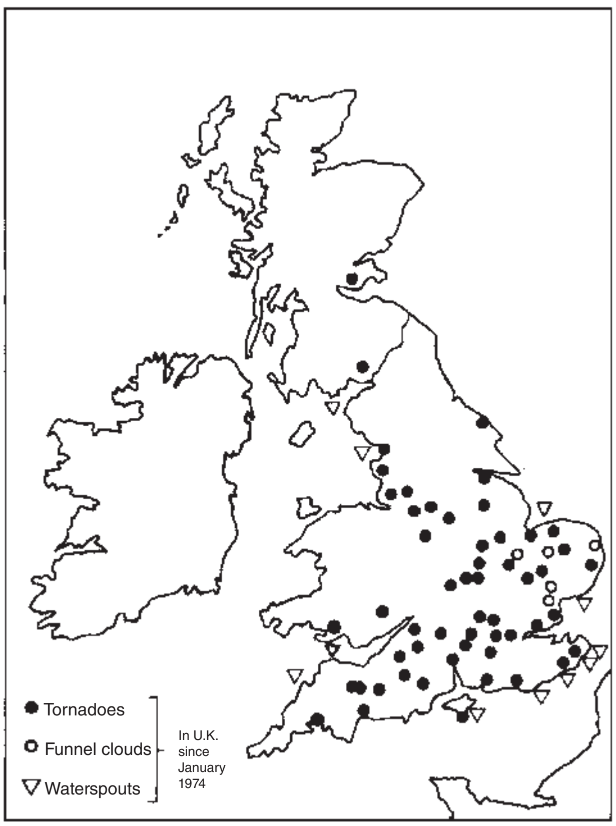


*Figure 1.5* The front cover of the inaugural issue of The Journal of Meteorology (October 1975) depicted the locations of tornadoes, funnel clouds and waterspouts in the United Kingdom between January 1974 and mid-September 1975.

years 1960–2013, also the principal data from the TORRO Hailstorm Division for the period 1980–2013 by Jonathan Webb. The Blizzard and Snowstorm Division has published summaries from 1870 to 2013 (Richard Wild), while the Lightning Deaths and Injuries Division has published everything from 1985 to 2013 (Derek Elsom and Jonathan Webb). Through the work of Bob Prichard and the TORRO Thunderstorm Division, the journal published British thunderstorm general reports monthly from 1975 to 2013. Moreover, the Thunderstorm Census Organisation (TCO), founded by Mr. Morris Bower of Huddersfield in 1924, was taken over by TORRO after his death.[3] Editors of the Journal since 2002 are as follows: Robert Doe, 2002–2006; Samantha Hall, 2006–2011; Paul Knightley and Helen Rossington, 2012 to present. *The Journal of Meteorology* was renamed *The International Journal of Meteorology* in 2005 (Figure 1.7).

## 1.5 Storm-Damage Site and Track Investigations

Hundreds of site investigations have been done by TORRO members in the 40 years from 1974 to 2014, studying tornado tracks and damage. The first sites studied were earlier, in 1966 at Headington (north Oxford) and in 1967 (Trowbridge to Melksham, Wiltshire) during brief spells when I was visiting England (Meaden, 1984). In addition to

[3] TORRO has in its collection all TCO thunderstorm records from 1924 to 1980.

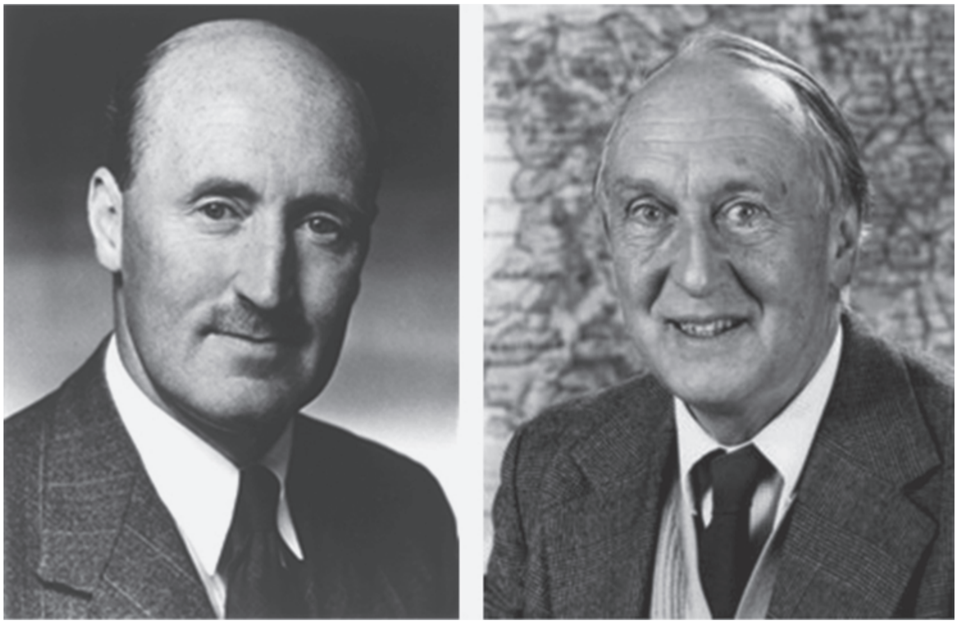

*Figure 1.6* Prof. Gordon Manley (1902–1980) and Prof. Hubert Lamb (1913–1997), friends of TORRO. Images courtesy of Royal Holloway, University of London and the University of East Anglia.

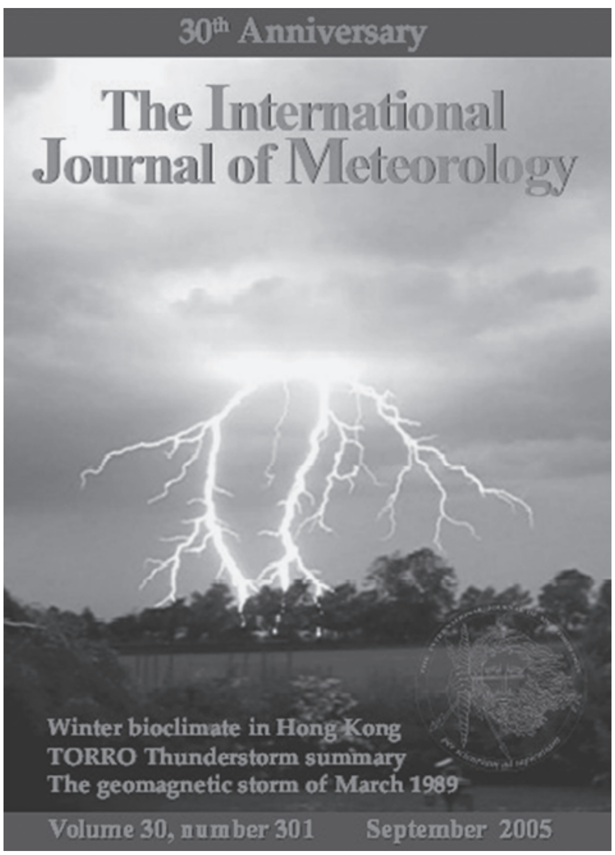


*Figure 1.7* The International Journal of Meteorology*, celebrating its 30th anniversary in September 2005.*

tornado site investigations, TORRO members have examined occurrences of storm damage by lightning, hail, rainfall deluges and snow. Ball lightning has received much serious attention (see Chapter 11).

To exemplify in the case of tornadoes, consider the day of 3 November 2009 for which Tony Gilbert had forecast the possibility of tornadoes in the south of England. Because numerous sites needed to be investigated, the following TORRO members from the regional network shared the tasks:

| | |
|---|---|
| Matthew Clark | Coombe Bissett (S. Wiltshire) S.W. of Salisbury |
| Brian Montgomery | Charlton All Saints (S. Wiltshire) S. of Salisbury |
| Brian Montgomery | Romsey/Timsbury (West Hampshire) |
| Daniel Mellor | South of Timsbury (West Hampshire) |
| Nigel Paice | North of Romsey (West Hampshire) |
| Tony Gilbert | Ampfield (Hampshire) |
| Helen Rossington with Paul Knightley | West Meon → Owslebury (Hampshire) |
| Matthew Clark | Several areas of mid-Hampshire including Monkswood |
| Sarah Horton | Northchapel (Hampshire) |

The paper by Clark (2010) records the study behind the meteorological and site investigations. More generally, countrywide, a network of regional coordinators exists, details of which can be found on the TORRO website together with information as to other aspects of TORRO's work. By the late 1990s, tornado forecasting became a feature of TORRO's activities. At various times, forecasters have been David Reynolds, Tony

*Figure 1.8* Tornado at King's Heath, Birmingham, 28 July 2005. Photograph supplied to TORRO. © Ian Dunsford, Birmingham City Council.

Gilbert, Nigel Bolton and Paul Knightley. Examples of site investigations are indicated next.

## 1.6 Birmingham Tornado of 28 July 2005

A thousand properties were damaged and many destroyed during the Birmingham tornado of 28 July 2005 (Figure 1.8). Over 50 homes were condemned for demolition. Figure 1.9 shows the tornado track through the city of Birmingham, with reference to previous events.[4] Indeed, this was not the first time Birmingham experienced such a severe tornado. Figure 1.10 shows Pathé news from an event on 14 June 1931. Sadly this resulted in a fatality in Sparkhill, Birmingham, where a woman, sheltering in the doorway of a shop, was killed instantly by a falling wall. Property damage was extensive, but confined to a narrow swathe. Many roofs were completely lost, with houses and shops being demolished (Figure 1.11).

Seventy-four years later, in 2005, the TORRO forecaster issued the following warning:

**TORRO TORNADO WATCH No. 2005-020**

**TORNADO WATCH issued at 1400 UTC Thurs. 28 July 2005**

*VALID: 1400–1900 GMT on Thursday 28th July 2005 for the following regions of England: North and East Midlands, Lincolnshire, Yorkshire*

*SYNOPSIS: Thunderstorms have developed across the Midlands, and will track north-east. CAPE, shear and veer on Larkhill and Brize Norton ascents suggest possible tornado development to strength T3. The S.E. edge of the storm is approaching Birmingham, and is expected to track N.E. to the Humber and be the focal point of any development.*

**THREATS: Risk of isolated tornadoes to T3 in path from Birmingham to Lincolnshire**. © Copyright TORRO 2005

## 1.7 TORRO Conferences

TORRO has held conferences in Oxford annually since 1985 and biannually since 1995.[5] Figures 1.12, 1.13 and 1.14 show selected events in 2003 and 2006. Staff also meet regularly to

[4] Other major tornadoes of recent years include the Selsey tornado of January 1998 investigated by Meaden (1998) and Matthews (1999) and the T5 tornado of 7 December 2006 at Kensal Rise, West Central London, investigated by Kirk (2013).

[5] *Tornadoes and Storms* I, II, III, IV, V (being TORRO conference proceedings 1985–1999) [ed. G. T. Meaden and Derek Elsom]. Special Issues of the Journal of Meteorology, Artetech Publishing Company, Bradford-on-Avon, Wiltshire.

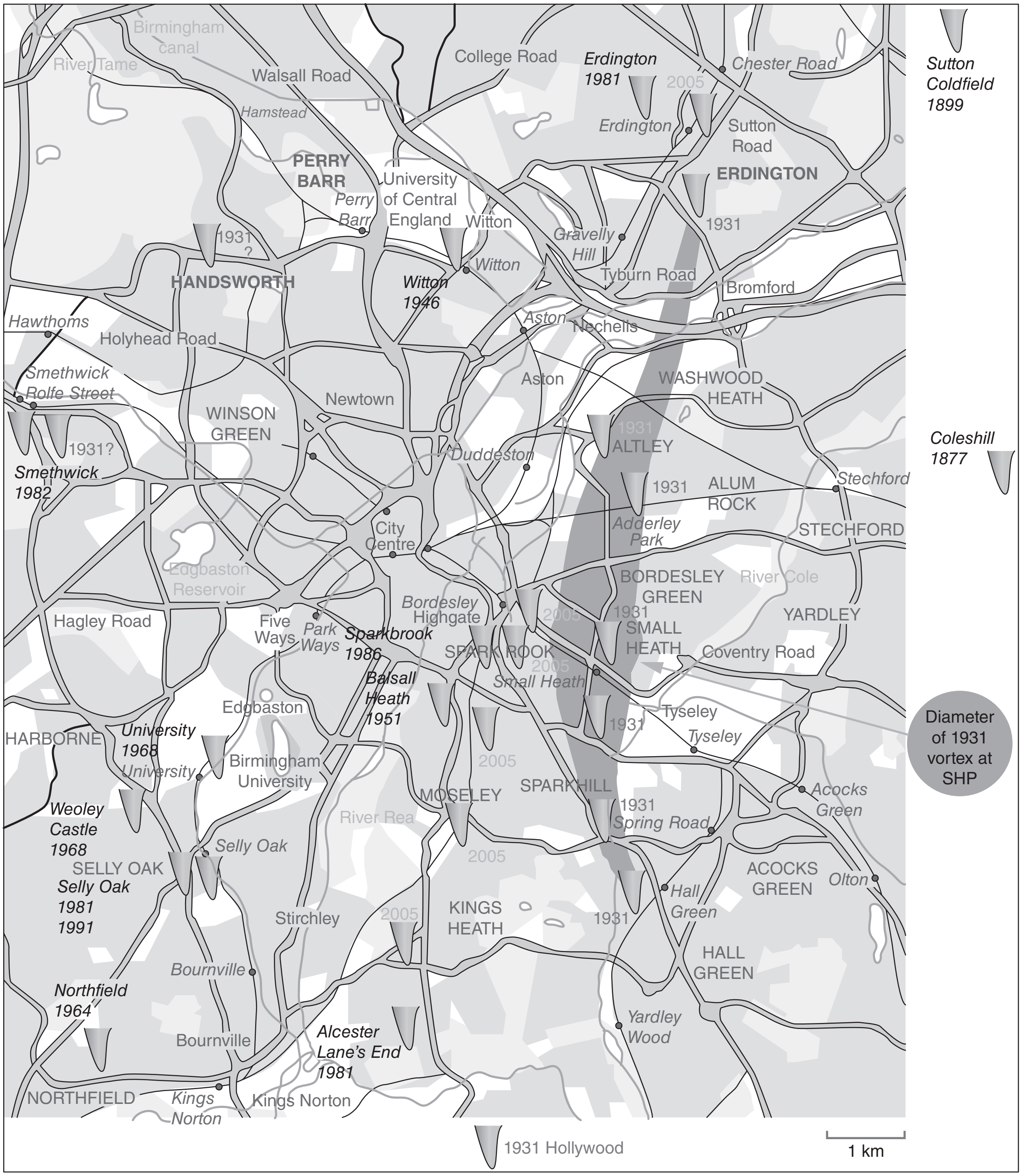


***Figure 1.9*** *The map shows the tornado track of 28 July 2005 through the city of Birmingham. Maximum intensity was T5/6 on the International T-Scale. Sites of tornado damage in preceding years are indicated too. Chief investigators were Ian Brindle, Matthew Capper and Peter Kirk. Details are given in papers by Knightley (2006), Kirk (2006), Pearson (2006), Smart (2008) and Meaden and Chatfield (2009). (See insert for colour representation of the figure.)*

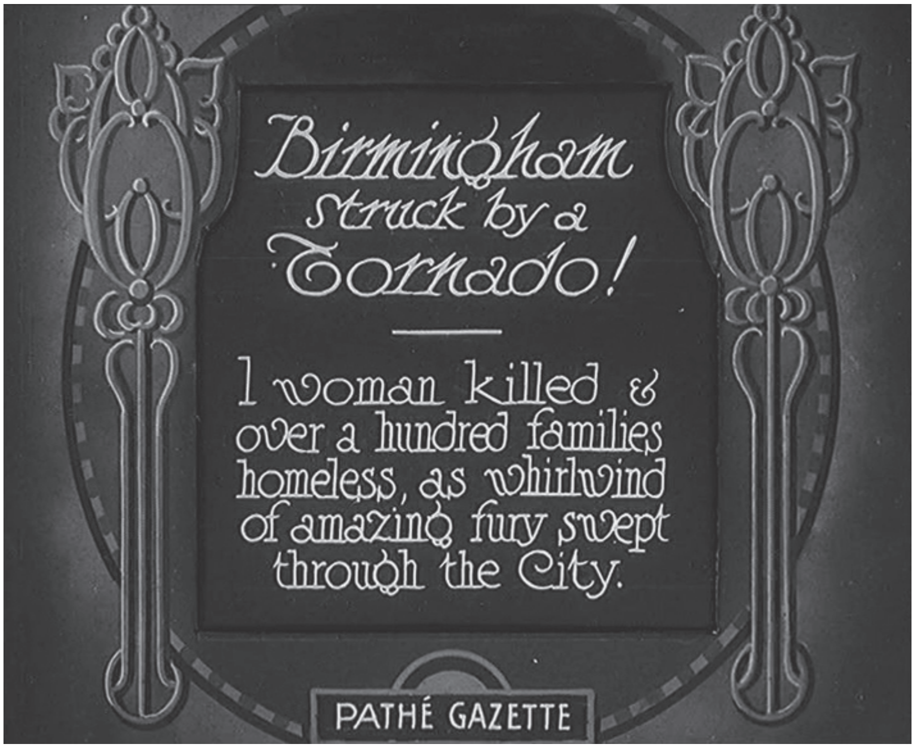


***Figure 1.10*** *News footage of the Birmingham tornado of 14 June 1931. © British Pathé.*

***Figure 1.11*** *Structural property damage as a result of the Birmingham tornado of 14 June 1931. Shops and houses on the Coventry Road received severe damage. © British Pathé.*

*Figure 1.12* *TORRO's Alan Rogers with Weather Forecaster Ian McCaskill at the 2003 annual autumn conference in Oxford, UK (TORRO Archives).*

oversee the effective running of the organisation (Figure 1.15). TORRO members have attended most meetings of the *European Conferences on Severe Storms* that began in 2002. More recently, in May 2014, Drs. Robert Doe and Terence Meaden presented at the *First International Summit on Tornadoes and Climate Change* held in Chania, Crete (see photographs in Appendix B).

## 1.8 The Future

It is intended that the work of TORRO will continue far into the future. TORRO's mission statement is steadfast and decisive because the organisation is a privately-supported research body *serving the international public interest*. The dangers posed by tornado-strength winds are an eternal problem for architects involved with designing engineered structures including ordinary house buildings at one extreme and nuclear-plant new buildings at the other. Calculating return-period risks is at the heart of these

*Figure 1.13* *The TORRO conference of 2006. Top picture, audience. Lower picture, speakers (*sitting, left to right*), Chris Chatfield, Tony Gilbert, Nigel Bolton, Michael Rowe, Peter Van Doorn, Paul Knightley, John Tyrrell, Jonathan Webb, (*at back, standing*) Derek Elsom, Terence Meaden, John Mason (TORRO Archives).*


*Figure 1.14* Question time in Birmingham in 2006, on the first anniversary of the T5/6 tornado of 28 July 2005: Paul Knightley and Chris Chatfield at the right, Terence Meaden at left. © Robert Doe.

*Figure 1.15* TORRO Staff meeting of 29 June 2012; (left to right) Jonathan Webb, Robert Doe, Paul Knightley (and James Glaisher (the sculpture)) at the meetings room of The Royal Meteorological Society in Reading, UK. Photograph by Terence Meaden.

problems for which the maintenance of a sound database is essential. Another principal objective is improved forecasting of tornadoes for which a climatology is needed and a better understanding of atmospheric dynamics. The question of whether tornadoes will become more frequent in response to climatic change has already been raised (*First International Summit of Tornadoes and Climate Change* at Chania, Crete, May 2014), and to answer it, the best possible tornado databases are needed.

As in the past, TORRO's fortunes depend on having a thriving, pro-active membership, and strong scientific leadership. All weather enthusiasts, whether amateur or professional, are welcome to join and partake in the activities.

## Acknowledgements

The Directors of TORRO wish to thank the hundreds of members and professional meteorologists who, over the many years, have contributed to TORRO's undoubted success. The encouragement and support of professional meteorologists in universities, research institutes and weather forecasting have been much appreciated and repeatedly acknowledged.

## Additional information

In addition to the mentioned publications in *The (International) Journal of Meteorology* and the reference list below, the following are also key TORRO publications:

Meaden, G.T. (1985) *Tornadoes in Britain (with assessments of the general tornado risk potential and the specific risk potential at particular sites including Sizewell)*. Nuclear Installations Inspectorate, Great Britain. Health and Safety Executive, Tornado and Storm Research Organisation, 131pp.

Meaden, G.T. (ed.) (1990) *Ball Lightning Studies*. Artetech Publishing Co., Bradford-on-Avon. 84pp.

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Meaden, G.T. (2011) *Assessing the Tornado-Risk Potential for Coastal Somerset at Hinkley Point in Southern Britain*, for EDF Energy PLC and Nuclear New Build Generation Company Ltd.

For more detailed information about TORRO, readers should visit the TORRO and the *International Journal of Meteorology* web sites at:

www.torro.org.uk

www.ijmet.org

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Elsom, D. M., Meaden, G. T., Reynolds, D. J., Rowe, M. W. and Webb, J. D. C. (2001) Advances in tornado and storm research in the U.K. and Europe: The role of the Tornado and storm research organisation. *Atmos. Res.*, **56**, 19–29.

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