Menorcan waterspout ▪ *Historic floods* ▪ *Scottish waterspouts*

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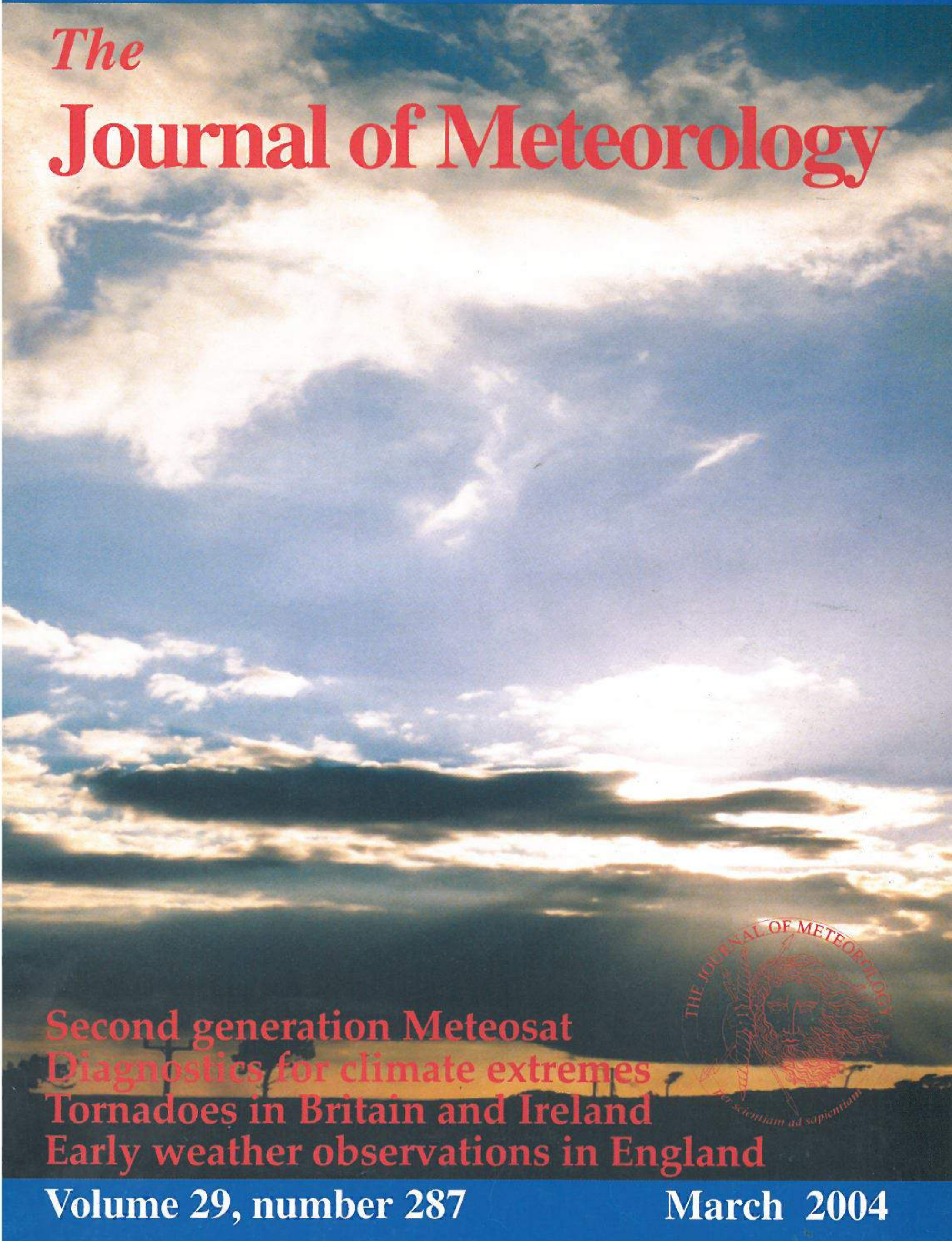

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Volume 29, number 287 **March 2004**

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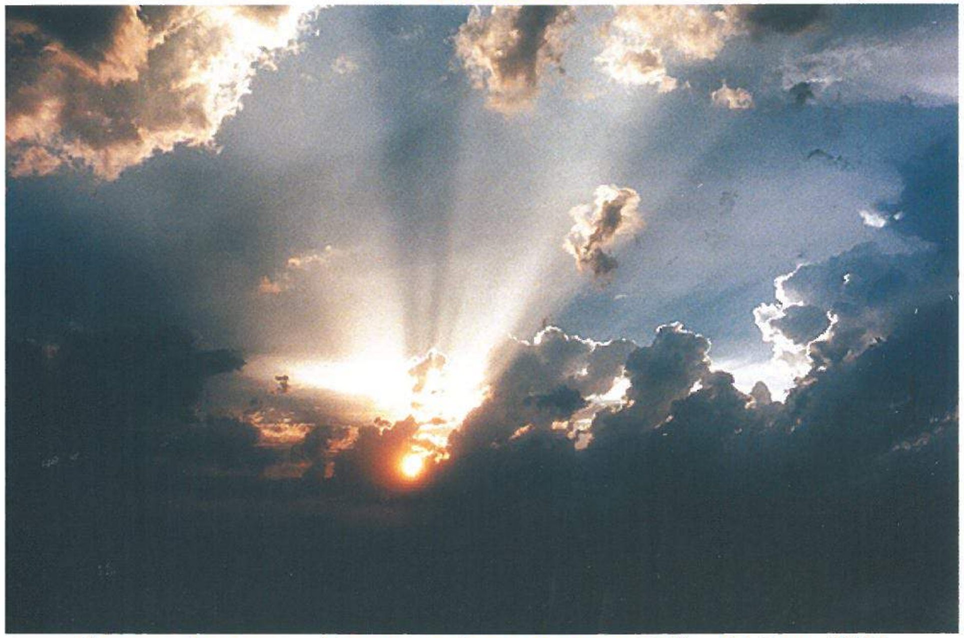

Crepuscular rays - Aberdeen, South Dakota, USA - 23 June 2002

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EARLY WEATHER OBSERVATIONS IN NORTHERN ENGLAND: PART 5

By LANCE TUFNELL
4 Holmcliffe Avenue, Huddersfield, UK

Abstract: Bibliographical details and contents summaries are given for ten sources of information about the weather of northern England during the 18th century. Some of the article follows the layout of those which appeared in the first four parts of the series (Tufnell 1987, 1991, 1995 and 1998), but there is in addition an evaluation of the 50 references so far described.

INTRODUCTION

Recent years have seen further progress in understanding the weather of northern England during the 18th century. A number of hitherto unknown descriptive sources have been identified (Dyson 1980; Wrangham 1983; Kirk 1996) and access to some of the material previously discovered has been improved. This most notably entails the issuing on microfilm of Hutchinson's valuable weather record from Liverpool (Woodworth 2000; no.41 below). There has equally been the reappearance, in a more attractive and informative edition, of Gell's 1797 tour in the Lakes (Rollinson 2000; no.39 in Tufnell 1998). On the other hand, despite much searching, recent years have provided little additional information which records the 18th century weather of northern England using instruments. As this part of the series completes the discussion of 50 sources, it seems appropriate that it should include an examination of how well their contents promote an understanding of 18th century weather in northern England. The survey will indicate where further data are most needed.

MAJOR SOURCES

41) William Hutchinson's Liverpool journal, 1768-93 *(Central Library, Liverpool; Garnett 1796; Woodworth 2000)*

Although the first four years of this journal have been lost, there survive over twenty five and a half years of detailed observations on tides and the weather. These were carried out every morning, noon and evening throughout the period 1.1.1768 to 10.8.1793. The weather parameters monitored are wind (direction and speed), pressure, temperature and (from June 1774) rainfall: there are also brief descriptions of the weather in both the morning and evening sections of the journal. However, although these weather parameters were observed every day, they were not each recorded three times a day. Even so, the detail is such that Hutchinson's journal constitutes one of the most useful records of 18th century weather in northern England. Its value is enhanced by a description of the methods used to observe the weather, even though these would not gain the full approval of present-day meteorologists (eg. "The Thermometer [was] kept in doors at the Top of a Stair Case four Stories high" - for further details see Garnett, 1796).

Surprisingly for a naval man, Hutchinson did not seem interested in using his journal to record how the weather was affecting people and the environment. While his original manuscript is in Liverpool's Central Library, the microfilm version that recently became available contains both this and a (somewhat more legible) copy made by J. Lang in 1814 (Hutchinson 1768-93; Woodworth 2000). There also exist the monthly summaries of Hutchinson's work that were published by Garnett in 1796.

42) Peter Crosthwaite's observations at Keswick 1787-92 *(John Rylands Library, Manchester)*

Science is fortunate to possess these observations, as they could easily have perished during an air raid in 1940, which destroyed the premises of Manchester's Literary and Philosophical Society, who at the time owned this manuscript. Furthermore, even though many pages show evidence of burning, the record has suffered no appreciable data loss. Indeed, the worst affected volume (1792) lacks only certain columns for the times of observations, plus a minority of figures from the barometer readings and words from the 'Remarks' column. In nearly all cases, the missing information can be confidently restored. Smyth (1997) has listed this manuscript under the heading 'works by [John] Dalton'. This, however, is an incorrect attribution, for the 'Remarks' column frequently mentions the Keswick area (not Kendal, where Dalton was living at this time) and the record includes annual summaries that were later published by Dalton (1793) as the work of Peter Crosthwaite, a man well known for the museum he established at Keswick (both Gell and Lockwood visited it in 1797: see items 39 and 47). Smyth (1997) also wrongly indicates a gap in the record from August to December 1790. In fact, the manuscript provides uninterrupted daily weather readings for all of the period between 22 September 1787 and 31 December 1792. On occasion, Crosthwaite altered the number of variables being monitored and the instruments he used. At its fullest, his record notes the years, months, days and hours of the observations, plus barometer, thermometer, wind, cloud, humidity and rain data and more general 'Remarks'. Crosthwaite's major change of instruments occurred on 1 April 1788 when he began "to use Rain Gage, New Barometer, & New Thermometer" and was "making ready the Hygrometer" (the first hygrometer readings appear on 10 April). This significant manuscript (which is an early copy of the original) provides detailed and largely instrumental observations of weather in the Keswick area for over 1900 days.

43) Jonathan Dalton's Kendal observations 1793-1810 *(John Rylands Library, Manchester)*

Although this is another record caught in the fire which destroyed the premises of Manchester's Literary and Philosophical Society in 1940, burning appears to have produced only a very small loss of data that is confined to the volume for 1805. The record is the work of Jonathan Dalton, who was continuing observations started at Kendal by his illustrious brother, John (these latter did, unfortunately, perish in the 1940 fire). Basically, it covers the years 1793 to 1810, though thinning out of data occurs at both ends of the record. Consequently, there are full monthly and annual summaries for 1793, but the daily observations do not begin until 2100 hours on 2 September of that year (thus presumably indicating a loss of data for the previous eight months, though not necessarily in the fire of 1940).

From 1794 to the end of the century, monthly and annual summaries and the daily observations are complete, apart from a very occasional small gap. Thinning out of the record also occurs as the monthly and annual summaries finish in 1807 and the full sets of daily observations stop on 22 October 1809. From then until 7 February 1810, when readings ceased altogether, there are only daily rainfall data. The record's monthly summaries provide values of temperature (mean, highest and lowest monthly figures for each of three daily observation times, plus the overall monthly mean), pressure (mean, highest and lowest monthly values), total monthly rainfall and number of wet days in the month (i.e. days with precipitation). Daily observations follow a similar pattern, though with details not only of temperature, pressure and rainfall, but also of wind (direction and strength) and a descriptive 'Remarks' column. In all, Dalton provides instrumental observations of the weather at Kendal for 2300 days in the 1790s and for 3500 days in the early 1800s.

44) John Gough's Kendal observations, 1788-9 *(Kendal Museum)*

The blind natural philosopher, John Gough, is credited with having encouraged the young John Dalton's study of meteorology (Manley 1968). Unfortunately, Gough's own observations of the weather, in the late 18th and early 19th centuries, have survived only in part. Monthly values from 1787 to 94 appeared in Garnett's compilations of 1793 and 1796, and there also exist Gough's thrice-daily readings (still only in manuscript) for the period October 1788 to May 1789. These are arranged in columns for pressure, temperature, wind, rainfall and a description of each day's weather. Some of Gough's record for the early 19th century also survives in both published and manuscript form.

SOURCES OF SECONDARY IMPORTANCE

45) Fragments of a diary from Sessay Parks, near Thirsk *(Dyson 1980)*

The record of local events as here published is all that survives of a much longer diary kept by William Metcalfe, who farmed for over 30 years near Thirsk, in north Yorkshire. It was compiled on a daily basis, though not on every day, and provides information about the years 1786, 1787, 1796, 1797, 1798 and 1799. Weather observations relate to 778 (i.e. just over one-third) of the days in the six years covered. On most occasions, these are described in less than five words and only a handful mention weather impact. As with several 18th century observers, Metcalfe includes a number of tantalisingly short references to his barometer (e.g. on 13 September 1787 he noted that "it began to fall this morn").

46) William Hillary's observations in the Ripon area, 1726-34 *(Hillary 1740)*

The largely descriptive weather commentary in this book forms an appendix which claims to give the "Principal Variations of the Weather" in the Ripon area from summer 1726 to autumn 1734 (except that no record survives between the Octobers of 1731 and 2, as this was lost by the author). For the most part, the commentary describes events on a monthly basis, though it also has a few remarks about the weather of particular days and seasons. These mention, for example, that the winter of 1730-1 was snowier than any in the previous 60 years and that during summer 1733 numerous springs dried up and rivers were much lower than Hillary had ever known. Scattered throughout the weather commentary are over 20 barometer readings (in inches) and there is frequent mention of a thermometer, though all references to temperature are verbal (e.g. on 26.6.1727 "The thermometer stood between warm and hot weather").

MINOR SOURCES

47) The diary of William Lockwood of Easingwold *(Kirk 1996)*

Weather observations in this diary span the period 20.1.1796 to 30.9.1797. 59 of them relate to Lockwood's home area of Easingwold, north of York. Two more were made during a visit to Scarborough and another 11 while touring the Lake District only a few weeks after William Gell (no.39 in Tufnell 1998). All these observations use a short phrase or sentence to describe the weather on a particular day. Well over half mention rain, with the remainder noting snow, frost and ice, the general temperature ("mild", "hot", etc.) and fine weather. A few record the impact of a weather event (e.g. on 29.4. 1797 it was "very wet & dirty walking").

48) William Wilberforce's tour of the Lake District in 1779 *(Wrangham 1983)*

This youthful journal, by the great campaigner against slavery, describes a journey made only 10 years after Thomas Gray's pioneering visit to the Lakes, which set a pattern for later travellers (Rollinson 2000). Of the 27 days on which it mentions the weather, almost three-quarters refer to the Lake District, while the rest are for other localities in northern England. Some of these observations consist of just a few words, but most are longer. Generally, they describe the weather on that part of the tour between 24 August and 25 September 1779, though a few mention conditions over earlier or more substantial periods (e.g. the freezing of Hardrow Force, near Hawes, during the extreme winter of 1739-40). Although the weather of the tour was variable, Wilberforce particularly recorded cloud and rain.

49) A storm and flood in the Vale of St John, near Keswick 22 August 1749 *(Old Style dating) (several authors)*

This, more than most weather events in Cumbria, appears to have exercised the minds of writers, presumably because of the erosion, damage and fear it caused. Contemporary details, published by Lock (1749-50), were soon followed by a rather different account (Smith, 1754). The latter was mostly reproduced in volume II (1797) of Hutchinson's History of Cumberland, together with a description of the event by Clarke, who maintained that "exaggerated circumstances have crept into the productions of hasty writers", but that his version of things is "very near the truth".Significantly, it includes almost all of the material published by Lock (1749-50). Descriptions of this storm and flood have also been provided by Gilpin (1808), West (1821), Parson and White (1829), Rose (1832), Mannix and Whellan (1847) and, in more modern times, Bouch and Jones (1968). This and similar events in Cumbria during the 18th and early 19th centuries have been discussed by Tufnell (1986).

50) A diary fragment from the Eden valley *(Blackett-Ord 2001)*

Weather notes were made on five days during November 1765 by William Preston in the Warcop-Ormside area of northern Cumbria. Although no more than a handful of surviving details, these are useful for two reasons. First, they describe the weather of 20 and 25 November 1765, unlike Williamson (no.2 in Tuffnell 1987) and Fletcher (no.31 in Tufnell 1998), the main observers of Cumbrian weather at this time. Secondly, they record an early "great snow" on 4 November, thus adding to Fletcher's remarks two days previously that "This week [was] mostly cold weather with hail & snow" (Winchester 1994).

DISCUSSION

The 50 sources examined to date offer what in their 18th century context is perhaps appropriately described as a "reasonable" amount of information on the weather of northern England, though their coverage is uneven, both over the century and the region. Fullest weather details come from the 1790s, with the Kendal area being particularly well served at this time. Its instrumental record contains monthly averages for the whole decade and thrice-daily observations from 3 September 1793 onwards (21; 22; 43) **[the numbers quoted here and in the rest of the discussion are those assigned to the 50 sources examined in the current series]**. Other detailed and continuous instrumental records exist for the three years 1790-92, thanks to work by Hutchinson at Liverpool (21; 41) and Crosthwaite at Keswick (22; 42). Some of Crosthwaite's monthly values for 1793 and 1794 are also extant (21), as are the last few months of Hutchinson's thrice-daily record, in 1793 (41). Smaller amounts of instrumental data exist for Brampton (15), Harrogate, York, Lancaster, the Windermere area (21) and Greater Manchester (21; 23). Of the descriptive sources examined, the most useful for weather in the 1790s is Murgatroyd's diary (11). This has relevant information for almost every day in 1790, 1791, 1794, 1796 and 1797. Less complete are the diaries of Rowbottom (34: best for 1797 and 1799), Metcalfe (45: most helpful for 1796, 1797 and 1798) and Lockwood (47: 1796 and 1797). Minor amounts of descriptive weather data for the 1790s are provided by Browne (13), Hutchinson (15), Hutton (19), Byng (38) and Gell (39). Together, descriptive sources cover best the weather of the five years for which Murgatroyd's diary survives and are least informative (i.e. have less than 100 daily observations) for 1792, 1793, 1795 and 1799. As a whole, the 1790s provide instrumental records mainly for around Kendal and to a lesser extent Liverpool and Keswick, while descriptive observations come principally from the Huddersfield, Thirsk-Easingwold and Oldham areas.

This leaves much of our northern region with few, if any weather details for the decade, a situation no doubt typical of many places at this early date. For the 1780s, the most useful weather record from northern England is that compiled throughout the decade by Hutchinson at Liverpool (21; 41). (John) Dalton and Gough in the Kendal area and Crosthwaite at Keswick also provide monthly and thrice-daily values. Together, these cover the 31 months beginning June 1787 (21; 22; 42; 44). Other instrumental data survive from work by Carlyle at Carlisle (5: monthly rainfall, 1780-3), Walker at Manchester (21: chiefly monthly rainfall 1786-9) and Campbell at Lancaster (21: principally monthly rainfall and temperatures, 1784-9). There also exist for the decade annual totals of days with rain and days fair recorded in the Manchester area (21). The best descriptive weather source of the period is Murgatroyd's diary from near Huddersfield, which has almost uninterrupted daily observations for 1781, 1782, 1786, 1788 and 1789 (11). More limited are the records of Williamson at Crosby Ravensworth (2) and Fletcher from near Cockermouth (31) (both have data for 1780 and 81), Ashworth in the Halifax area (7: 1782, 1783, 1785 and 1786) and Metcalfe from near Thirsk (45: 1786 and 1787). A few weather details for the 1780s come from remarks by Browne (13), Hutchinson (15), Hutton (19), Rowbottom (34) and Brown (36). Together, these instrumental and descriptive sources provide a record that is fuller in certain parts of the decade than others.

Hence, there are some important events that receive little attention (e.g. the effects on the region's weather of the Laki eruption in Iceland during 1783-4). Sources for the 1780s mostly come from west of the Pennines for instrumental data and from parts of Cumbria and Yorkshire for descriptive records.

When considering the 1770s, Hutchinson's Liverpool observations again prove to be the most useful instrumental record, though with the important limitation that rainfall figures are not available until June 1774 in the original (41) and January 1775 in the published monthly summaries (21). Other instrumental readings derive from work by Carlyle at Carlisle (5: monthly rainfall values for the decade), Dobson at Liverpool (24: monthly weather data for 1772-5), White at York (21: monthly pressure and temperature, 1771-4, with gaps) and Blades at Garsdale, north-east of Kendal (21: monthly rainfall, 1777-9). Annual totals of days with rain and fair days, recorded near Manchester, survive far the whole of the 1770s (21). Descriptive weather sources include the diaries of Williamson (2) and Fletcher (31) both of which have well over 1500 daily comments for the decade. Continuous descriptive weather records for individual years survive in the diaries of Poole (3: 1774 to mid-1778: provides over 1600 daily observations), Jackson (9: 1775) and Brooke (33: 1776-7). Minor amounts of weather data have been noted by Browne (13), Hutchinson (15), Wright (16), Hutton (19) and Wilberforce (48). The main sources of weather details for the 1770s come principally from Liverpool and to a lesser extent Carlisle for instrumental data and Greater Manchester, the Huddersfield area and several Cumbrian localities for descriptive records. As with the 1780s, these provide disappointing amounts of information for some of the decade's major weather events (e.g. the floods of autumn 1771).

Because the first four years of Hutchinson's instrumental series for Liverpool have been lost, all that survives from the 1760s is his record for the last two years of the decade (21; 41). This, therefore, enhances the value of a fairly detailed and largely instrumental survey of the weather at Carlisle during 1767 (14). Its author, Carlyle, has also provided, with his monthly rainfall totals, the only instrumental series from northern England that spans the 1760s (5). These few records clearly need to be supplemented by descriptive weather information, the most useful of which is from the diaries of Williamson (2: over 1400 daily observations for the decade) and Fletcher (31: more than 1100 such observations in the same period). Minor amounts of descriptive weather data have been recorded by Hutchinson (15), Hutton (19), Gray (28), Dawson (30) and Preston (50). Sources for the 1760s therefore provide instrumental weather readings for Liverpool and Carlisle and descriptive observations mainly from the Crosby Ravensworth and Cockermouth areas.

No instrumentally-recorded weather data for northern England appear to have survived from the first half of the 1750s. Thus, there exist only the daily weather observations for 1756-9 from an unnamed locality near Carlisle (4) and the first three years (i.e. 1757-9) of Carlyle's monthly rainfall totals for that city (5). It is, therefore, necessary to supplement these with descriptive records, the most useful again being the diaries of Williamson (2: over 900 daily observations spanning the decade) and Fletcher (31: almost 1200 such observations, though they cover only the years 1756-9). Lesser amounts of descriptive weather information occur in Ward (10), Browne (13), Cowper (18) and Thomlinson (40). Therefore, excluding two of these lesser sources, the weather details identified for the 1750s relate only to Cumbria.

As is to be expected, the first half of the 18th century yields significantly fewer weather data for northern England than does the second half. It is, therefore, hardly surprising that the 1740s provide no observations of the region's weather using instruments.

The most useful of the descriptive sources available is Jessop's diary from near Huddersfield (6: over 550 daily observations, 1740-6), followed by the records of Williamson (2: around 230 such observations, 1742-9) and Viney (12: 250 days covered in 1744, though a few are for localities outside northern England). Smaller amounts of descriptive weather information occur in the writings of Kay (17), Cowper (18), Stout (37), Lock (49) and Smith (49). As a whole, this descriptive material provides little more than 1000 daily observations for the entire decade (not all of which are for different days) and it applies to very few localities (chiefly the Huddersfield, Crosby Ravensworth and Leeds areas). Consequently, the 1740s would particularly benefit from the discovery of additional data. Even the unusually severe weather at the beginning of 1740 appears to have provoked surprisingly few written comments.

It would seem that, apart from a handful of barometer readings by Hillary in the Ripon area (46), no instrumental records survive of the weather in northern England during the 1730s. Hence, the region's most useful weather source for the decade should be Elmsall's descriptive observations from Dewsbury (1). Although these provide a daily and continuous account of the decade's weather, they are, unfortunately, in code and no easy-to-read transcription has yet been published. Of the remaining descriptive sources, Jessop (6) mentions weather on around 330 days over the decade and Hillary (46) gives a partial account of the weather during 1730-34. The other sources - Kay (17), Potts (27), Hobson (29) and Stout (37) - are much less informative. Nearly all of the weather details identified for the 1730s relate to Yorkshire. The only instrumental records of weather known to have been made in northern England during the 1720s are by Horsley (25: monthly rainfall, April 1722 to March 1723) and Hillary (46: scattered barometer readings, 1727-9). Again, therefore, Elmsall's descriptive record (1) is the key source for the decade. To this can be added Blundell's monthly reviews of weather from 1720 until March 1728 (32) and Hillary's essentially monthly, but less methodical description of the weather between 1726 and 1729 (46). A few relevant details also exist in the writings of Potts (27), Hobson (29) and Stout (37). Yorkshire is the area best represented by weather sources of the 1720s, though Blundell in particular offers some insight into conditions west of the Pennines.

Given the lack of instrumental records, Elmsall's diary (1) is the key weather source for northern England during the 1710s. Blundell (32) also supplies a fair amount of useful material, though he was away from Lancashire between November 1715 and September 1717. The remaining sources, by Tyldesley (35), Thomlinson (36) and Stout (37), contain much less weather data. Virtually all of this limited body of descriptive material from the 1710s relates to Yorkshire or Lancashire. Not surprisingly, the earliest decade of the 18th century yields only a small amount of weather information from northern England all of which is descriptive. Elmsall (1) gives details for 1708 and 9, while Meeke (8) refers to the weather on 530 days in the period 1700-1704. The other relevant source, Blundell (32), notes the weather of the occasional day from 1702 onwards, but does not begin regular monthly summaries until March 1709.

Because of the limited material available, there are several years, especially around the middle of the decade, which provide very few weather details. Moreover, those that do relate solely to Yorkshire or Lancashire.

FINAL COMMENTS

Every review is in a sense premature, as its conclusions are likely to be challenged by discoveries in the future. Yet, while the 50 sources so far discussed can be added to in part 6 of this series, investigations to date have uncovered nothing that will materially alter the conclusions presented above. On the other hand, the search for new data continues and the hope must always be that sources will be found which increase significantly our present knowledge.

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DIAGNOSTICS FOR CLIMATE EXTREMES
Case study: "Geofísico" Institute Station, Lisbon, Portugal (1876-2000)

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Abstract: The study of climate change puts forward the need for analysing the internal structure of chronological long-term extreme series. The behaviour of the mean temperature is not necessarily related to the one of the extreme values. It means that a small increase of the mean might have no influence on increasing the extreme values. To detect climate change one must identify the climate change signal that one wishes to detect, estimate the statistical properties of the natural climatic variability and then determine an optimal method for detecting the trends and drifts in climatological time series. Extreme value techniques are important in climatological applications. Climate impacts are likely to be determined by extreme events. The complex stochastic structure of climatological time series induces the application of extreme value modelling. The aim of this paper is to analyse whether the extreme values of time series can detect changes, which reflects the supposition of "global warming" during the target 125 years (1876-2000) in Geofísico Institute station, Lisbon - Portugal. Because the urban area around the site expanded in the last century, urban heat advection trends contaminate the long-term trend during the night temperature series of "Geofísico". The analyses suggest that this effect may have raised the annual absolute temperatures regarding cold nights by 1.9°C and cold days by 2.7°C during the 20th century, which probably corresponds to an increase of the mean temperature. For the long-term precipitation series, no trend pattern could be detected. In conclusion, annual air temperatures below 0.3°C and above 38.5°C, as well as monthly cumulate precipitation above 275mm and annual cumulate precipitation above 990mm can be classified as rare events for Lisbon in the Geofísico Institute station.

Keywords: climatology; extreme values distribution; return level; stationarity; threshold

INTRODUCTION

Methods for modelling monthly series of minimum and maximum air temperatures are analysed for a period of 125 years (1876-2000) as well as the monthly cumulate rainfall in the Geofisico Institute station in Lisbon, Portugal. The aim of the study is to verify whether extreme values of the time series show a change, which can reflect global "warming" or "changing" during these target years. Extreme monthly attributes are used as well as the clustering of extremes defined by the maxima Generalised Extreme Value (GEV) methodology for this study. Stationarity, the most important realistic assumption for many physical processes, corresponds to a series whose variables may be mutually dependent, but whose stochastic properties are homogeneous through time. Dependence in stationary series can present several different forms. Moreover, extremes events are nearly independent whenever they occur far enough apart. This property is often plausible for characterising physical processes. This is a heuristic argument to eliminate the long-range dependence at extreme levels. In the context of climate processes, non-stationarity is often apparent due to the seasonal effects or trends of long-term changes. Under specific limitations and some transformations or corrections, asymptotic extreme value characterisation is still applicable. For instance, a Generalised Extreme Value (GEV) distribution can be fitted to a linear or squared trend or the series can be split and the behaviour of winter, spring, summer and autumn seasons analysed (Coles, 2001; Reiss and Thomas, 1997).

In the case of short-range dependence, the basic idea is to diagnostic interpreting the propensity of the process to cluster at extreme levels and fit the extreme distribution for the cluster definition. It demands the introduction of the extremal index, which can be estimated by the ratio between the number of points in a cluster and the total number of exceedance, checking if the inference on return levels is robust in terms of stability. Climatological series often have a rich structure of temporal dependence and transformations are frequently realised in reducing non-stationarity. In the first part of this study, one examines some records of monthly temperatures data series and the rainfall behaviour from Lisbon over 125 years (from Jan 1876 to Dec 2000). The data are minimum and maximum monthly air temperatures (°C) and the amount of monthly precipitation (mm). In the second part one identifies, models and analyse the Autoregressive Integrated Moving Average (ARIMA) forecast regarding these data sets. Finally, in the third part one studies the diagnostic of extremes; characterising maxima/minima return levels

EXPERIMENTAL CONDITIONS

Lisbon (39°N; 9°W), the capital of Portugal, is located in the western coast of the country. The city and its surroundings form the metropolitan area of Lisbon covering a surface area of about 1,000km² and having more then 2,500,000 inhabitants. The region is characterised by a flat terrain close to the Tagus river estuary (facing south) and a complex system of hills reaching 500m height, mainly distributed in the northern part of the city. The classical meteorological station of the "Geofísico" Institute is located at the centre of Lisbon city at an altitude of 77m. It is one of the oldest classical meteorological stations in Portugal, set up at the end of the 18th century.

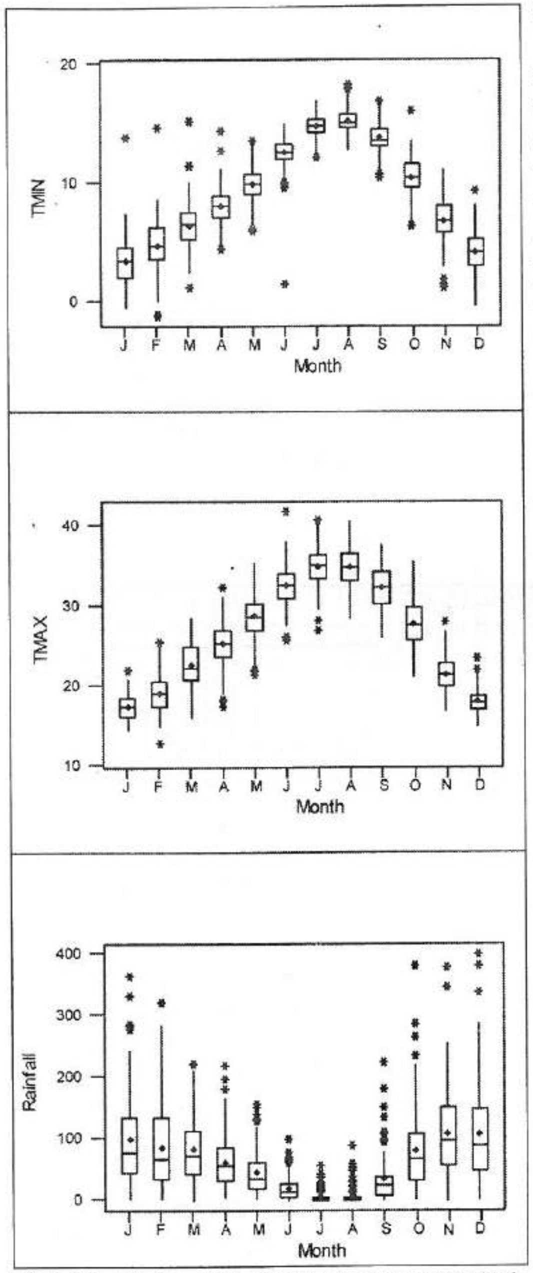

Fig.1: Monthly box-plots of extremes seasonality check-out for TMIN (cold/tropical night's), TMAX (cold/hot day's) and the rainfall R (rainy/drought). A typical "Mediterranean" climatic pattern can be observed, with winter rain and summer droughts.

EXPLORATORY DATA ANALYSES

The exploratory data analysis may begin with a visualisation tool for trend detection and seasonality confirmation. Fig.1 shows the seasonal behaviour of monthly minimum temperature, maximum temperature and cumulate precipitation recorded over the period from 1876 to 2000, where one can establish the typical "Mediterranean" climatic pattern of Lisbon, with warm winter rain (December and January) and hot summer droughts (July and August). Fig.2 shows clearly that particularly cold nights were observed in 1954 and 1956; hot nights in 1899, 1926, 1989 and 1994; the coldest day was in 1902; and hot days were observed in 1913, 1933, 1943, 1946, 1981 and 1991. To have a reliable structural information one may in effect detect and separate drift - a random appearance with several upward or downward segments of varying lengths by change points or intervention points in time series, and trend - a smooth monotone progression across an observation profile. Fig.2 (a) an increasing trend can be detected, the linear tendency is statistically significant (p-value< α=0.05) and the mainly contribution is due to the warming pattern detected from the beginning of the 70's.

Three patterns of drift can be recognised for cold nights: increasing (1876 - 1920); decreasing (1921 - 1959) and increasing (1960 - 2000). There is no significant trend regarding tropical nights (Fig.2 (b)), however one can detect two periods of strong drifts: decreasing (1900 - 1959) and increasing (1960 - 2000).

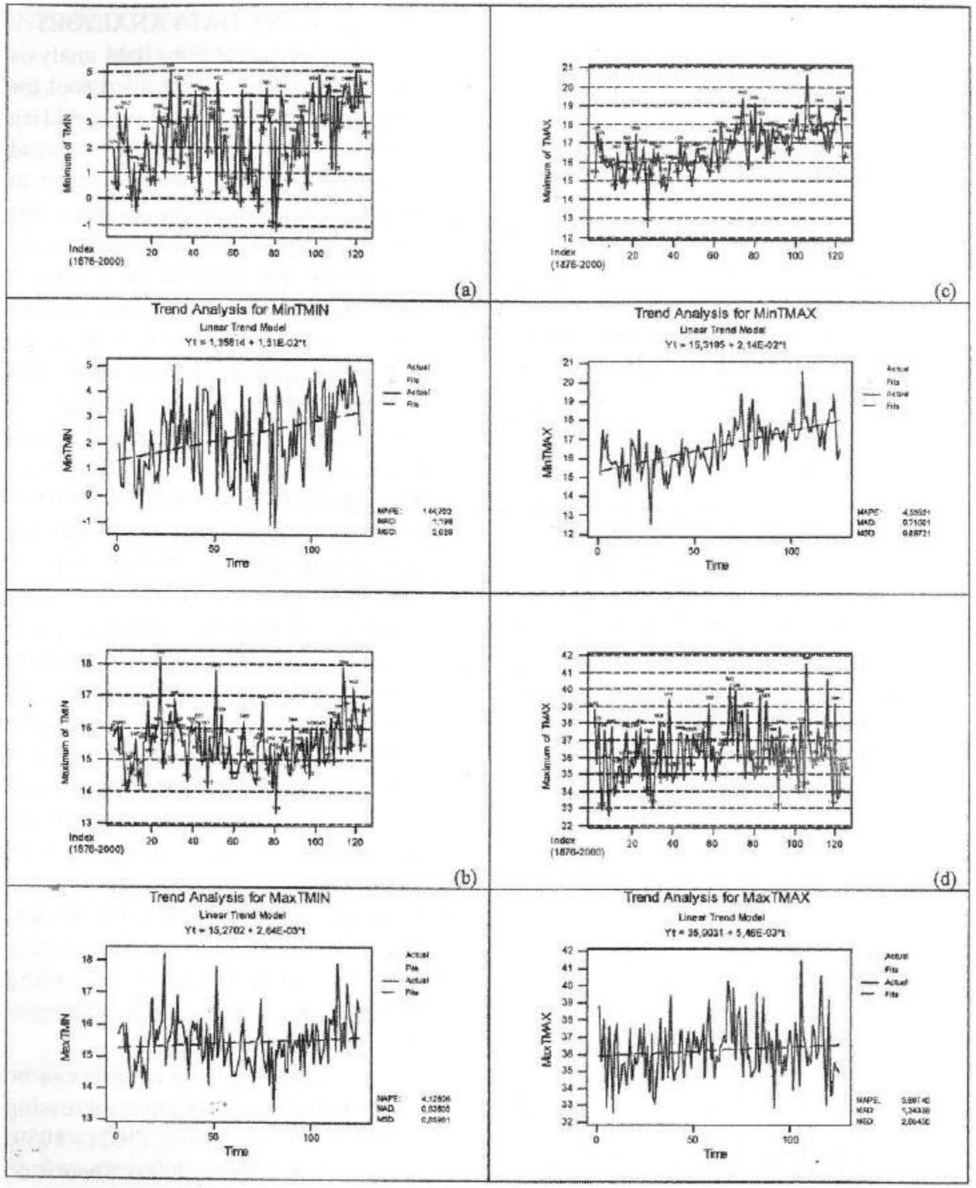

Fig.2: Annual trend analysis for extremes: (a) minimum of TMIN (cold nights) - R^2 =12.7%, the positive linear tendency is statistically significant (p-value << α=0.05); (b) maximum of TMIN (tropical nights) - R^2 = 1.4%, the positive linear tendency is not statistically significant (p- value > α = 0.05); (c) minimum of TMAX (cold days) - R^2 = 40%, the positive linear tendency is statistically significant; (d) maximum of TMAX (hot days) - R^2 = 1.3%, the negative linear tendency is not statistically

Fig.2 (c) shows an increasing linear trend, statistically significant (p-value< α = 0.5), no drift periods can be recognised for cold days. There is no significant trend regarding hot days (Fig.2 (d)), however one can detect two periods of slight drifts: increasing (1885 - 1945) and decreasing (1946 - 2000). There is no systematic trend in precipitation, one can observe a changing or intervention point in the annual cumulate rainfall: 1876 - 1945 a decreasing pattern, and 1946 - 2000 an increasing pattern; one also observed a change concerning the sill of the annual maxima of the minimum rainfall after 1920. The severe rainy years were: 1876, 1895, 1963, 1986, 1995 and 2000 as well as extremely droughts years: 1896, 1906, 1922, 1935, 1954, 1974 and 1982. The analyses suggest that this effect may have raised the annual absolute temperatures regarding cold nights by 1.9°C and cold days by 2.7°C during the 20th century, which probably corresponds to an increasing of the mean temperature. One can use an appropriated statistical model for these data, which might be extrapolated to high levels of the climatological process, as the Autoregressive Integrated Moving Average (ARIMA) modelling. In the absence of such information, one can use an asymptotical model as approximation defining an event as being extreme if it is bellow or above some low or high level, as indicated in the GEV diagnostic to determine return period for rare event levels.

ARIMA IDENTIFICATION - THEORETICAL BACKGROUND

ARIMA time series models are, in theory, the most general class of models for forecasting a time series which can be "stationarised" by transformations such as differencing and logging. Lags of the differenced series appearing in the forecasting equation are called "autoregressive" terms, lags of the forecast errors are called "moving average" terms, and a time series which needs to be differenced to be made stationary is said to be an "integrated" version of a stationary series. Random-walk and random-trend models, autoregressive models, and exponential smoothing models are all special cases of ARIMA models. In short, the autocorrelation function (ACF) and partial autocorrelation function (PACF) are important tools for describing the temporal dependence structure of a univariate time series; it reflects how much correlation is present between lagged observations.

ARIMA MODELLING - PRACTICAL ASPECTS

"Geofisico" Institute Station monthly air temperature extremes: Because both datasets (TMIN and TMAX) exhibit a strong 12-months seasonal component one takes a difference at lag 12 in order to induce stationarity and look at the auto-correlation of the differenced series. There may be some long-term trend in these data ensembles, but is magnitude appears to be small compared to the seasonal component. After taking a difference of lag 12 (seasonal term is removed ignoring the variability of the seasonal terms), the ACF for these data shows small positive significant spikes at lag 1 with subsequent positive auto-correlations that die off quickly, and an expected large negative significant spikes at lag 12. This pattern is typical of a seasonal autoregressive process integrated to moving-average. One analyses the PACF of the data sets, after taking a difference of lag 12, in order to help determine a likely ARIMA model. In these data, there are large spikes at seasonal lags exponentially decreasing with time, which is typical of a seasonal moving-average process of order one.

There was a significant spike at lag 1. The seasonal component associated to the moving-average is more evident than the seasonal component of the autoregressive part. Then, the ACF and the PACF of the data ensembles suggest an autoregressive model of order 1 with a seasonal component of order 12, and after taking a difference of order 12 a seasonal moving-average of order 1 is detected. One fits the model, analyses residual plots, and examines the goodness-of-fit. The ARIMA model converges after ten iterations for both ensembles, given the final estimates of parameters.

The Ljung-Box statistics give non-significant p-values (p-value <0.05), indicating that the residuals appeared to be uncorrelated. The ACF and PACF of the residuals corroborate this. One can assume that the spikes in the ACF and PACF of the residuals at lag 2 and lag 10 for TMAX are the result of random events and hence negligible. The rough adjustment of an ARIMA (1,0,0) $(0,1,1,)_{12}$ model appears to fit well. Then one uses the years 1876-1995 to forecast the years 1996-2000 and compares with the recorded air temperature leading to a mean-error magnitude around 1°C for TMIN and 0°C for TMAX. Hence, one uses the ARIMA (1,0,0) $(0,1,1,)_{12}$ model to forecast monthly extremes of air temperature in the following five years, 2001-2005. ARIMA gives forecasts, with 95% confidence limits. The seasonality dominates the forecast profile for the next 60 months with the forecast values being slightly higher compared to the previous months.

"Geofisico" monthly cumulate precipitation: Both datasets (R and lnR) exhibited a reasonable 12-months seasonal component, suggesting a difference at lag 12 in order to induce stationarity and look at the auto-correlation of the differenced series. After analysis, the ACF and PACF of the data ensembles suggest an autoregressive model of order 1 with a seasonal component of order 12, and after taking a difference of order 12 a seasonal moving-average of order 1 is detected. One fits the model, analyses diagnostic plots, and examines the goodness of fit. The Ljung-Box statistics give significant p-values (p-value >>0.05), indicating that the residuals appeared to be correlated. The adjustment of an ARIMA (1,0,0) $(0,1,1)_{12}$ model appears to fit well. Then one uses the years 1876-1995 to forecast the years 1996-2000 and compares with the recorded rainfall leading to a mean-error magnitude around 50mm for R and 0 for lnR. Hence, one uses the ARIMA (1,0,0) $(0,1,1)_{12}$ model to forecast monthly extremes of precipitation in the following five years, 2001-2005. ARIMA gives forecasts, with 95% confidence limits. The seasonality dominates the forecast profile for the next 60 months with the forecast values being slightly higher compared to the previous months.

ASYMPTOTIC GEV CHARACTERISATION

The generalised extreme value (GEV) theory aims at studying the statistics of extreme phenomena based on the Fisher-Tippet theorem (Fisher and Tippet, 1928). Extreme events are those rare events in the tail of the distribution, i.e., far from the bulk (the mean and the median) of the distribution. There is, however, no universal definition of extreme events. In many instances, extremes events can also be defined as the maxima (or minima) of a random variable Z over a certain period (Coles, 2001).

In many instances, extremes events can also be defined as the maxima (or minima) of a variable over a certain period, or extreme events can also be defined as those events exceeding in magnitude some threshold. Gumbel (1958) argued that the Fisher-Tippett distributions could be fitted to the set of annual maxima. These families of statistical extremes are usually characterized in the generalised extreme value (GEV) distribution of rare events by three tail parameters: location, scale and the shape, modelling block maxima (Coles, 2001, Reis & Thomas, 1997). In effect, one uses the asymptotic theory to get the most information from the tail behaviour. In practice, the blocks are chosen to correspond to a year time period and in this case the block maxima are annual minima or maxima. It is usually more convenient to interpret extreme value models in terms of quantiles or return levels, rather than in terms of the individual parameter estimates.

GEV DIAGNOSTICS - PRACTICAL ASPECTS

One has used GEV to model the samples of monthly minimum/maximum air temperature and the precipitation, using the maximum likelihood estimator (MLE) method (Coles, 2001; Reiss and Thomas, 1997). Each original ensemble has 1500 values from where 125 were extracted, and one knows that not all these days are contributing to the extremes characterization during the cold/rain or hot/drought seasons. The diagnostics of extremes have been assessed in greater detail by checking the stability with respect of the maximum likelihood estimates for the model. None of the diagnostic plots gives any real cause for concern about the quality of the fitted method. The goodness-of-fit in the quantiles plot seems convincing and the confidence intervals on the return level plot suggest not very large uncertainties that accrue once the model is extrapolated to higher levels. One observed 95% confidence intervals for obtained by the corresponding maximized log-likelihood. The thermal (TMIN and TMAX) ML estimates correspond to a bounded distribution, since the $CI_{95\%}$ is exclusively in the negative domain it is useful to carry out a detailed inference of the upper limit. The rainfall behaviours (R) ML estimates leads to a Gumbel family. The data are annual extremes, so the 10 -year return level corresponds to the m =10 -observational return level.

In all cases the surface can be considered symmetric, reflecting very low uncertainties about large values of the thermal and rainfall processes. The 95% confidence intervals for the 10 -years return level is obtained from the profile log-likelihood. From the graph, the estimate return levels are obtained as 0.3°C for cold nights and 16.6°C for cold days; 15°C for hot nights and 38.5°C for hot days. All of them seem to be highly plausible since the model and the empirical information are mutually consistent, concluding that the air temperatures below 0.3°C and above 38.5°C as rare situations for Lisbon in the "Geofísico" Institute station, as well as annual cumulative rainfall above 990mm or a monthly maxima above 275 mm. It is very important to note that the extremes may have a tendency to cluster in stationary sequences and the GEV model can underestimate the minima/maxima.

CONCLUSIONS

The analyses of long time monthly climatological series lead to the detection of time heterogeneities and "changes" in terms of tendency in the climate of Lisbon. Moreover one can distinguish between several behaviours of extremes that are present in the climatology of these climatological time series. The long-term trend detected for TMIN in Lisbon indicates that the magnitude of the air temperature for "winter" nights is increasing; whereas the long-term trend detected for TMAX indicates an increasing magnitude of the air temperature for "winter" days, detecting a periodicity about a return level of about 50 years. There is a natural tendency for extreme heat to occur close one to another. The analyses suggest that this effect may have raised the annual absolute temperatures regarding cold nights by 1.9°C and cold days by 2.7°C during the 20th century, which probably corresponds to an increase of the mean temperature. For the long-term precipitation series, no trend pattern could be detected. In conclusion, annual air temperatures below 0.3°C and above 38.5°C, as well as monthly cumulate precipitation above 275 mm and annual cumulate precipitation above 990 mm can be classified as rare events for Lisbon in the "Geofísico" Institute station.

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READER'S PICTURES: FLOODS

Fill material slid down mountain leaving track suspended during heavy rains, Southeast USA, - July 1916 © Archival Photography by Steve Nicklas (NOAA Central Library)

Broughton, Manchester, UK - 29 December 1927
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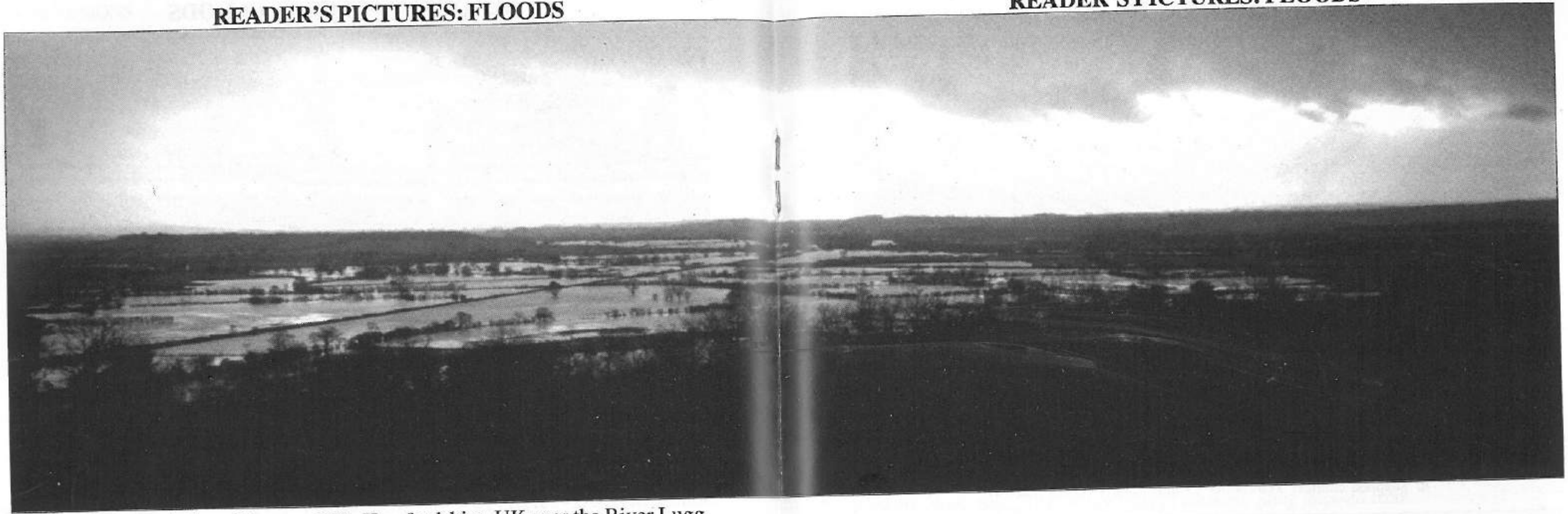

View looking south from Dinmore Hill, Herefordshire, UK near the River Lugg.
Railway line runs through flooded fields - 9 December 2000 © Howard Kirby

Main Road, Far Cotton, Northampton, UK - 10 April 1998
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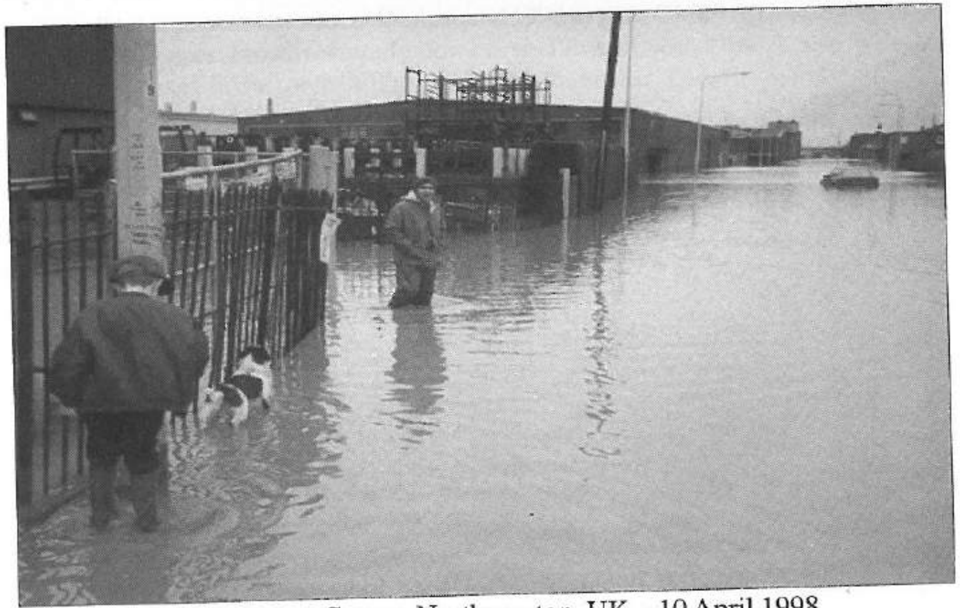


Main Road, Far Cotton, Northampton, UK - 10 April 1998
© Airflow Streamlines PLC. Supplied courtesy Sam Jowett

READER'S PICTURES: FLOODS

Greenwood Road, Wythenshawe, Manchester, UK - 1958

Chiswell (Chesil), Dorset, UK - 13 December 1947

TORRO TORNADO DIVISION REPORT FOR BRITAIN AND IRELAND: August 2001

by MICHAEL W. ROWE

August 2001 was a month with slightly above average temperature and rainfall. Whirlwinds were frequent throughout the month. TORRO received reports of seven tornadoes (six definite and one probable); six waterspouts; and 16 funnel clouds (12 definite and four probable). One event counts as both a tornado and a waterspout. The most remarkable day was 9 August with four definite tornadoes, one probable, three waterspouts (one of which became a tornado), three definite funnel clouds and two probable ones. In the Irish Republic a waterspout came ashore as a tornado on 17th, a date on which there were probably two other waterspouts, a funnel cloud and a land devil; and there was a funnel cloud on 16th. Synoptic data in this report are for 1200 GMT unless otherwise stated.

FC = funnel cloud WS = waterspout TN= tornado RC = rotating cloud (lower case initials denote probable events)

FC 2001 August 3. Maidenhead, Berkshire (c SU 8881)

TORRO member Mr. Steve Sergeant observed a large, cone-shaped funnel for two and a half minutes from 1259 GMT. At this time Maidenhead was close to a cold front associated with a low, 997 mbar, south of Iceland; another low, 1002 mbar, was over the northern North Sea. There was a band of showers along the cold front.

WS 2001 August 4. Deal, Kent (c TR 3852)

"A waterspout was seen at Deal around 1900 to 1930 GMT" (*COL*, August 2001: 3, 11). A rather slack, broadly westerly flow covered Britain, with a trough over Wales. It was fairly showery in the south of England in the afternoon.

FC 2001 August 4/I. Moira, County Down

Dr. John Tyrrell ("Tornadoes in Ireland during the year 2001", *J. Meteorology, 27: 183-186, May/June 2002*), established that this was a different event from the next one, and that it occurred about an hour earlier, around 1200 GMT. It moved from north-west to south-east. The 1200 ascent from nearby Hillsborough had a CAPE value of 362.2, which is high for Ireland.

FC 2001 August 4/II. Lisburn, County Antrim

Mr. Greg Lloyd saw "a lovely funnel cloud" at 1300 GMT. "It was a superb atmosphere. A really dark cumulonimbus base and the funnel was clearly visible against a lighter backdrop. There was thunder rolling up above, with some cloud-to-cloud lightning." The case was investigated by Dr. John Tyrrell (see the article quoted above), who obtained photographs and established that the time was 1312 GMT. Movement was from north-west to south-east. It is also mentioned in *COL*, August 2001: 3, 11, which gives the time as "around 1300 GMT". There were showers in Northern Ireland during the day.

TN 2001 August 6. Lairg, Highland (c NC 5806)

This tornado took place at 1130 GMT. Tony Gilbert spoke to the eyewitness, who has video footage.

The tornado lasted five minutes and could be seen sucking up debris over open fields. A larger piece of debris "appeared as a bulge within the vortex". A complex frontal system lay across England, Wales and Ireland. Scotland had a few light showers, mainly in the north.

FCs 2001 August 6. Orphir, Mainland, Orkney (c HY 3405)

The Orcadian, in its issue of 9 August (sent by Mr. Jeremy Godwin), published a photograph of a funnel cloud taken by 12-year-old Alan Corse from St. Ola (c HY 4409). He thought the funnel was over Orphir. He said there had been many funnels during the morning. "They started at around 10 am [0900 GMT] when my sister thought she saw smoke, but it was a twister. We spotted well over a dozen over the next hours." Mrs. Barbara Bruce also saw a funnel; hers was about 1100 GMT and she was looking from the Kirkwall area (c HY 4510) towards Orphir, so it was probably the one photographed by Alan Corse, especially as the newspaper report says that his was "around the same time" as Mrs. Bruce's. She described the funnel as "a long, pointed swirl of activity in the sky". It lasted one to one and a half minutes. *The Orcadian* comments that "similar sightings of funnel clouds were reported in a number of places in Orkney on Monday" (6 August). There were showers in Orkney during the morning.

FC 2001 August 7/I. Near Patchway, Avon (c ST 6183)

"Jack" saw a funnel cloud resembling an elephant's trunk from near the M4/M5 intersection, which is near Patchway on the northern outskirts of Bristol. A low, 998 mbar, was over the Irish Sea. Rain crossed the Bristol area in the morning, followed by showers.

FC 2001 August 7/II. Near Poyntzpass, County Armagh

A funnel cloud was reported in the *Belfast Telegraph*, 9 August, with a photograph. "It moved around the countryside between Poyntzpass and Tandragee for almost half an hour on Tuesday [7 August] ...Luckily this tornado did not develop enough to touch the ground."

RC 2001 August 8. Ware, Hertfordshire (c TL 3614)

A thunderstorm began at about 1245 GMT; rotating scud cloud was noticed about 1300 "and there seemed to be a sort of eye forming in the middle". There was very heavy rain, with disc-shaped hailstones 15-16 mm in diameter. Leaves were stripped from bushes and trees; "the leaves were actually being sucked up into the air rather than blown in any particular direction, which may account for the rotation of the cloud base directly above me." This may have been a very weak tornado (force T0) with no visible funnel. The previous day's low was 992 mbar over the North Sea, leaving southern England in a showery westerly airstream, with some thunderstorms developing.

WS-TN 2001 August 9/I. Gosport, Hampshire (SU 570994 - 589993)

Although this event was briefly mentioned in many national daily newspapers, by Philip Eden in the *Sunday Telegraph* (12 August) and in *COL* (August 2001: 3, 11), the most detailed account is by Anthony Gilbert, "Tornado at Gosport in southern England 9 August 2001," *J. Meteorology*, 27: 197-204, July/August 2002. This includes sketches of the funnel, photographs of the damage, a map of the track and an upper-air sounding, with analysis of the meteorological conditions at the time. Tony was lucky enough to see the funnel as he drove to work, and he later made a site investigation. Within the funnel "smaller ribbons of condensation appeared to branch downwards like talons, rapidly rotating around each other and converging at the base."

The funnel then developed the classic tornado shape and reached the ground (Gilbert, page 198, Fig. 1-3). No wall cloud was visible. The time was about 0800 GMT. The tornado was followed by exceptionally heavy rain for about ten minutes, with flooding on roads; there was also very loud thunder. Damage was chiefly confined to the Kingfisher Caravan Park. Two caravans were badly damaged when they were carried over a nearby car, landing upside down on top of another caravan. One occupant suffered minor injuries. An eyewitness, Mr. Murrell, described the vortex as looking "like a flock of birds," which he then realised was debris being sucked upwards. Doors were blown out, roof tiles removed, tents and heavy wooden benches lifted. Some debris was found in a field 300 metres away. Before reaching the caravan park the tornado (which clearly began as a waterspout) destroyed a conservatory at Browndown Training Camp. The final damage was on the Gomer estate, where nine garages were damaged; some lost their roofs and some had their doors buckled. The track was 2 km long, from west, and about 6m wide; force was T2. The rotation was cyclonic. *COL* (August 2001: 11) also mentions a funnel cloud seen from Portchester (c SU 6105) over the Solent at about 0800, from a thunderstorm developing over the area. The storm moved north-east through Portsmouth between 0730 and 0830. If the time for the funnel cloud is GMT this is probably a sighting of the Gosport tornado, as Portchester and Gosport are only about 5 km apart.

Britain was in a north-westerly airstream, with troughs in it, behind a low, 998 mbar, over south Norway. Showers and thunderstorms broke out in southern counties during the morning; further north the showers were more scattered and chiefly in the afternoon. Some of the showers were very heavy: Northolt (Greater London) had 34.3 mm in an hour, according to the *Daily Weather Summary*; while *COL* (page 3) mentions 30 mm in six hours at Benson (Oxfordshire) and flooding at Portsmouth - this may well have been due to the same storm that produced the Gosport tornado.

2TN 2001 August 9/II. Five Ash Down, Uckfield, East Sussex (TQ 4724)

TORRO Director Peter van Doorn investigated this event. A witness, Mr. Stephen Snowball, showed him where the tornado had approached from W.S.W. at 1315 GMT; it headed E.S.E. Then a second, smaller tornado approached, travelling from W.N.W. to E.S.E. At the end of the field the two tornadoes met and the larger seemed to absorb the smaller. They then approached Mr. Snowball as a single vortex, which rose and passed over his head. He said that the funnel was up to 10m in diameter, calm in the centre, with no electrical activity visible. The funnel touched down and lifted two or three times, then left the field. Just before it departed there was a massive blue lightning discharge to earth from the funnel. Although no other lightning was observed, there was almost continuous thunder. The event lasted about 20 minutes. The field was a recently-mown meadow: plant debris was raised several metres and trees were violently agitated, but undamaged. Force: T0.

tn 2001 August 9/III. Near Milton Keynes, Buckinghamshire (c SP 8537)

"A small tornado damaged crops near Milton Keynes, Bucks.," according to Philip Eden in the *Sunday Telegraph*, 12 August.

TN 2001 August 9/IV. Near Dunstable, Bedfordshire (c TL 0222)

It is possible that this case is the same as the previous one if the word "near" in both headings is interpreted very loosely.

TORRO possesses an impressive aerial photograph of the tornado's track across cereal fields. The track is very narrow. *COL* (August 2001: 3, 11) notes that "a small tornado was...reported near Dunstable," and the *Daily Telegraph* (10 August) mentions a tornado in Bedfordshire. It also seems likely that the "tornado" reported from Ivinghoe, Buckinghamshire (SP 9416), in the *Daily Mail* for 10 August, is the Dunstable event, as the two places are only 10 km apart. A village is shown in the aerial photograph of the tornado's track, but it does not appear to be Ivinghoe.

TN 2001 August 9/V. Sonning Common, Oxfordshire (SU 7080)

The description of this tornado is most interesting. An unnamed witness said: "I saw a whirlwind going along my drive and there were forks of lightning shooting from it ...It was whirling round and round, shaped a bit like a fir tree, and the colours of the lightning were a vivid yellow and orange. But the most scary thing was the sound it made, a really loud screeching. It was like a bomb going off during the war." No damage was mentioned (*Henley Standard*, 17 August, sent by Mr. Nick Verge). *The Daily Telegraph* of 10 August mentions a tornado in Oxfordshire, which may be the same.

2 WS 2001 August 9/I. Southwold, Suffolk (c TM 5176)

TORRO has several reports of a waterspout off Southwold. Mr. Patrick Gillard reported that there was a large thunderstorm one to two miles off the coast. He saw the funnel develop as "a triangle of cloud"; then there appeared "what looked like braids being twisted in the lower half of the finger of cloud. They weren't rotating very fast, from what I could see, but they were clearly rotating. As the finger reached about two thirds of the distance to the sea surface you could see spray starting to kick up off the surface. As the finger got lower the spray kicked higher." The visible vortex then became continuous from sky to sea, lasting about 10-15 minutes. Mr. R.H.P. Thornburgh added that two spouts were seen, one at Southwold and the other further north, and that the time was about 1300 GMT. TORRO member Mr. Andrew Scott sent in press reports (including photographs). Mentioned also in *COL*, August 2001: 3, 11.

WS 2001 August 9/II. Essex

Mentioned by Philip Eden, *Sunday Telegraph*, 12 August. No details are known.

fc 2001 August 9/I. Burnham-on-Sea, Somerset (c ST 2949)

"A very weak funnel cloud was observed over the British [Bristol?] Channel from the Balmoral cruising ship at 0745 GMT, to the N. or N.W. from Burnham-on-Sea and the mouth of the River Parrett" (*COL*, August 2001: 11).

3FC 2001 August 9/II. Bracknell, Berkshire (c SU 8668)

Three funnel clouds were seen from the Met Office at 1130 GMT; it is not known whether they touched down. Other references to three funnels seen in the Slough/Windsor area are probably to the same event, and the same is probably true of some of the "mini tornadoes" in Berkshire and Buckinghamshire reported by the *Daily Telegraph* (10 August). Slough is centred at SU 9979, and Windsor at SU 9576. *COL* (August 2001: 3, 11) has "three tornadoes" at Slough.

FC 2001 August 9/III. Auckley South Yorkshire (c SE 6501)

"A large funnel cloud was seen from Auckley, moving N.E. to S.W. with a rain squall; it had a good 'tornado-type' tube which lay diagonally across the sky (1340 GMT)" (*COL*, August 2001: 11).

fc 2001 August 9/IV. Lewes, East Sussex (c TQ 4110)

A funnel cloud at Lewes about 1500 GMT was mentioned by Mr. Paul Knightley. It is not unlikely that this is a sighting of the tornado at Five Ash Down, which is only 15 km from Lewes, but as the Lewes case is said to have been two hours after the Five Ash Down tornado it is here tentatively regarded as separate.

FC 2001 August 9/V. Essex

"The local press in Essex reported a tornado during the afternoon, after a local observer spotted a 'darkish vortex taking shape against the lighter clouds ...The rotating base appeared to be approximately 100 yards across and it was swirling anticlockwise'" (*COL*, August 2001: 11). As it is not totally clear that the vortex touched down (though the report suggests it did) it is here regarded as a funnel cloud.

fc 2001 August 17. Basingstoke, Hampshire (c SU 6352)

This funnel was observed for ten minutes, but no other details are known. Britain was on the edge of a high which covered much of the Continent. There were a few showers in the south, mostly in the late morning.

TN 2001 August 19. West Raynham, Norfolk (c TF 869252)

At about 1400 GMT, shortly before heavy rain arrived, The Drove, West Raynham was struck by a tornado. "It veered across from a south-westerly direction, bending trees, tearing tiles from the roof of one house and sending a 20 ft ash tree crashing into a garden shed." Mr. Kevin Kemp heard "a roar", while his wife, Joanne, heard a "whirring noise". She added: "You could see leaves and branches spinning around up to 100 ft in the air. I wasn't frightened - I was more excited than anything." This report appeared in the *Eastern Daily Press*, 21 August. The force was probably T1. A low, central pressure 999 mbar, was over south-west Scotland. The fronts had cleared England, but a trough was over eastern counties (at 1200). There were showers over most of England during the day; some were thundery.

FC 2001 August 19/I. Todmorden, West Yorkshire (c SD 9324)

A "snake-like" funnel was observed for one minute at 0900 GMT. Details were provided by Mr. Matt Hugo. Todmorden may have been close to the occlusion of the low mentioned in the previous entry. There was rain in the area in the early morning, then showers.

fc 2001 August 19/II. Moortown, Leeds, West Yorkshire (c SE 2939)

A thunderstorm, with frequent intense lightning, accompanied by heavy rain, lasted from 1300 to 1445 GMT. A probable funnel cloud was seen hanging from the cloud base for five minutes. No rotation was visible but it "looked very solid". It was observed and reported to TORRO by Mr. Chris Ingham. Northern England had showers, some heavy and thundery, during the afternoon.

FC 2001 August 19/III. Ragley Hall, near Alcester, Warwickshire (c SP 0755)

Mr. Alex Lyczkowski watched a funnel cloud for about five minutes at around 1430 GMT. He was not able to confirm whether it touched the ground. He was at Ragley Hall, 3 km south-west of Alcester.

FC 2001 August 30. North-east Reading, Berkshire (c SU 7673)

TORRO Executive Nigel Bolton saw a funnel extending a third of the way to the ground for three to four minutes at about 1830 GMT. It formed under the leading edge of a thunderstorm.

A cold front, associated with a low (1007 mbar) off east Greenland, lay from about Aberdeen to Exeter at 1200. By midnight it had reached a line from The Wash to London. The Reading funnel was near it but probably ahead of it. There were thundery showers in southern areas during the afternoon.

WS 2001 August 31/I. Hove, East Sussex (c TQ 2803)

This waterspout occurred between 1000 and 1200 GMT; the duration was less than five minutes. Mr. Peter Dunda described the spout as "narrow and rope-like; the funnel extended about half way from cloud base to sea surface. Spray was clearly visible at sea surface below the funnel. An inner core and outer funnel were visible below the cloud." There was infrequent thunder, but no lightning was seen, and there was no hail, but there were showers before and after the spout occurred; the wind was light north-westerly. Mr. Dunda estimated that the spout, which moved from west to east, was only a few metres wide at the base. He thought it was 1-2 km off shore; the grid reference given above is 1 km off Hove. A shallow low, 1007 mbar, was off the west coast of Denmark, with a north-westerly flow over England. There was a trough over south-eastern counties. There were thunderstorms in Sussex during the late morning and afternoon.

WS 2001 August 31 /II. Eastbourne, East Sussex (c TV 6198)

Mentioned on the *BBC 1* weather forecast.

Whirlwinds in the Irish Republic

FC 2001 August 4. Connemara

Mentioned by Dr. John Tyrrell in his annual summary, "Tornadoes in Ireland during the year 2001", *J. Meteorology*, 27: 183-186, May/June 2002 (on page 184).

FC 2001 August 16. Lucan, County Dublin

Seen by staff of Met Eireann at about 1100 GMT, and reported to TORRO by Mr. David Meskill. The precise locality, which is a few miles to the west of Dublin, is from John Tyrrell's article; he himself saw and photographed a well-developed wall cloud to the south-west of Dublin. A low of 1003 mbar was off south-west Norway. A showery south-westerly airflow covered Ireland. There were high CAPE values at Hillsborough, but very moderate wind shear at high levels.

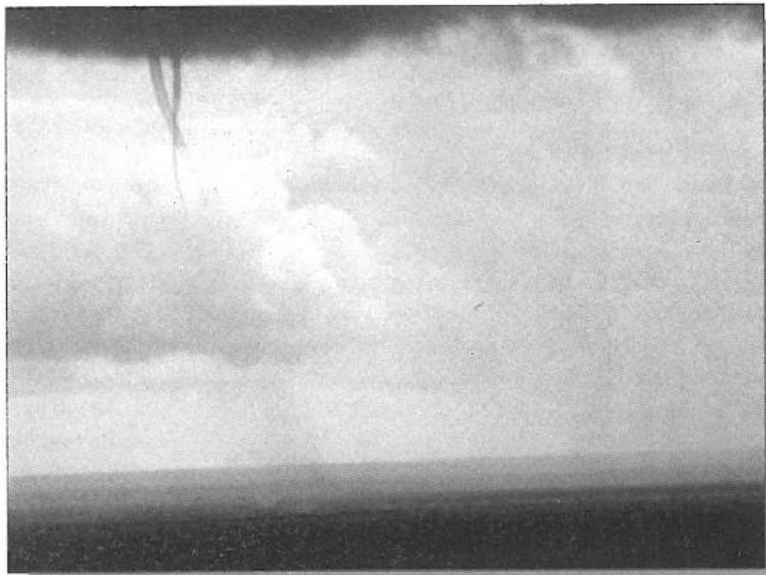
WS-TN 2001 August 17. Clontarf, County Dublin

A waterspout came ashore just before 1700 GMT and moved from Dollymount towards Raheny. Eyewitnesses said it was "a very black structure of between 200 and 300 ft high and about 70 ft wide. No injuries were reported, although one vehicle on the beach was damaged" (*Irish Times*, 20 August), A more detailed report appeared in the *Irish Examiner* on 21 August, based on an interview with Dr. John Tyrrell, who had just carried out a site investigation. The time was given as about 1530 GMT. Mr. Danny Toland, who was playing golf at the time of the tornado, said: "It was like a vertical column of swirling cloud ...It moved along the length of the shore until we couldn't see it any more. It came within a couple of hundred yards of us but we didn't even feel it." Dr. Tyrrell considered that the whole event comprised three waterspouts, one funnel cloud and a land devil.

JOURNAL OF METEOROLOGY
"An international magazine for everyone interested in weather and climate, and in their influence on the human and physical environment."

WATERSPOUTS

Wigtown Bay, Carsluith, Scotland
7 September 2003



Photographers: Chris Helson & Sarah Jackets

JOURNAL OF METEOROLOGY

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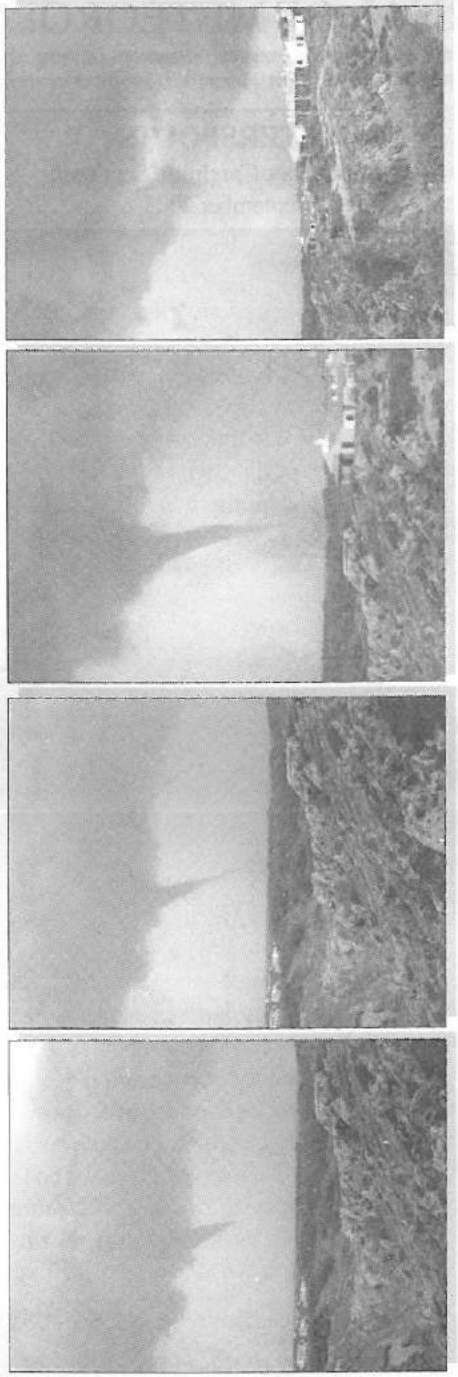
WATERSPOUT

Arenal D'en Castell, Menorca

14 September 2003



1. 1104hrs UTC 2. 1105hrs UTC 3. 1107hrs UTC 4. 1109hrs UTC

Photographer: Ben Cooke

Weather photographs, slides or collections on CD-ROM should be sent to: Picture Editor, The Journal of Meteorology, PO BOX 5161, Bournemouth, Dorset, BH10 4AS.

SHORT COMMUNICATION

RAIN OR SHINE?

ON THE RIVER ISIS, 4 JULY 1862: LEWIS CARROLL'S "ALICE'S ADVENTURES"

By PAUL G. EDEN

1356 Poplar Springs-Bargerton Road Lexington, Tennessee 38351 U.S.A.

Abstract: Contrasting details concerning a legendary holiday taken during uncertain weather conditions in central England are presented. The meteorological events which led to the conception of Lewis Carroll's literary masterpiece appear to be mysterious even today, with the participants, as well as the available reports, providing differing accounts.

On this historic day in English literature, most will know that one of the world's most famous book for children originated as a tale first told to a pretty trio of sisters, daughters of Oxford Dean Liddell, while on a rowing trip with Lewis Carroll and Canon Duckworth, going up the River Isis to Godstow from Oxford in the United Kingdom. The three little girls were Lorina, Alice, and Edith. Author Lewis Carroll's personal diary states that tea was had on the riverbank at Godstow under fine skies, "all in the golden afternoon".

Alice Liddell, later Mrs. Reginald Hargreaves, confirmed the weather conditions for readers of the St. James's Gazette, 1 March 1898, "I believe the beginning of 'Alice' was told one summer afternoon when the sun was so burning that we had landed in the meadows down the river, deserting the boat to take refuge in the only bit of shade to be found, which was under a new made hayrick. Here from all three came the old petition of 'tell us a story'- and so it began". However, Helmut Gernsheim (1969) is noted a saying, "In contrast, examination of the weather record for Oxford on 4 July 1862 indicated that the day was 'cool and rather wet'. The amount of rain which fell between 10 am on 4th July and 10 am on 5th measured .17 inch. According to the weather diary most of the rain appears to have occurred between 2 pm on 4th July and 2 am on 5th July.' The information was contained in a letter dated 17 January 1950 from the Meteorological Office of the Air Ministry." Shortly before Alice's Adventures came out in book form, the London Observer published a letter from a correspondent stating that Lewis Carroll's, "All in the golden afternoon" was at variance with the meteorological register for Oxford. It seems strange that anyone should doubt the goldenness of the afternoon which generations have accepted, but unfortunately there seems to be no way of reconciling Lewis Carroll's diary entry and the available evidence provided by existing meteorological records, so the question of rain or shine on 4th July, 1862, remains an enigma.

Lewis Carroll thoughtfully polishes a camera lens in 1862.
Portrait by Reverend Dodgson based on a photograph by Oscar G. Reijlander.

REFERENCE

GERNSHEIM, H. (1969) *Lewis Carroll.* Baylor University Press, Austin, Texas.

JOURNAL OF METEOROLOGY

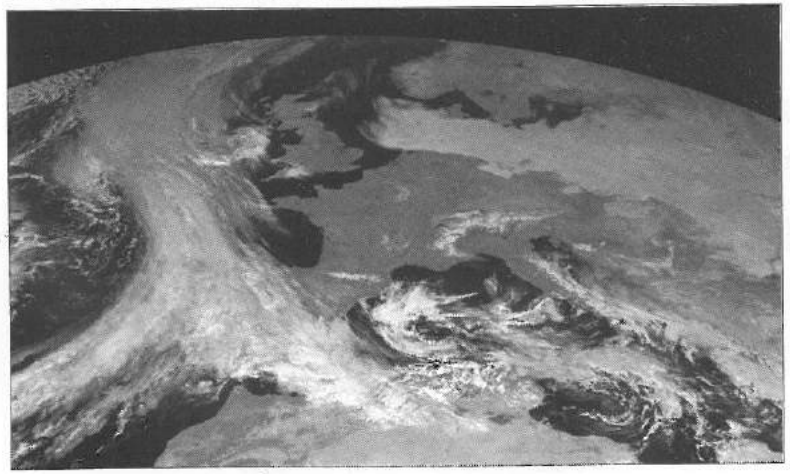
"An international magazine for everyone interested in weather and climate, and in their influence on the human and physical environment."

SECOND GENERATION METEOSAT (MSG-1) BECOMES OPERATIONAL

On 29 January 2004 the very first satellite in a new series of meteorological satellites became operational - offering improved and faster images and data to European forecasters on a daily basis. These data will undoubtedly help weather services give more accurate predictions of extreme weather. They will also help researchers gain a deeper understanding of physical processes important to weather and climate.

The first of the Meteosat Second Generation (MSG-1) satellites was launched in August 2002 and completed commissioning activities in December 2003, allowing the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) to declare the satellite operational at the end of January. In keeping with tradition, MSG-1 will be renamed Meteosat-8. The newly designed satellites are spin-stabilised in the geostationary orbit and will perform full-disc scans of the Earth like their predecessors. But, with MSG's 12 spectral channels, or "eyes" and a repeat cycle of only 15 minutes (instead of 30 minutes before), MSG can provide 20 times the information of the previous Meteosat system.

"For the first time ever, we can look at the Earth with 12 different "eyes" every 15 minutes - a major breakthrough in monitoring cloud development," said Johannes Schmetz, the Head of EUMETSAT's Meteorological Division. Each of the 12 channels offers a different perspective of the Earth and different combinations of channels can be used for novel meteorological products. MSG not only offers images of the full 'earth-disc' faster than other satellites, these images are greatly improved. Certain images of weather phenomena are available in colour after they are processed in the ground segment.

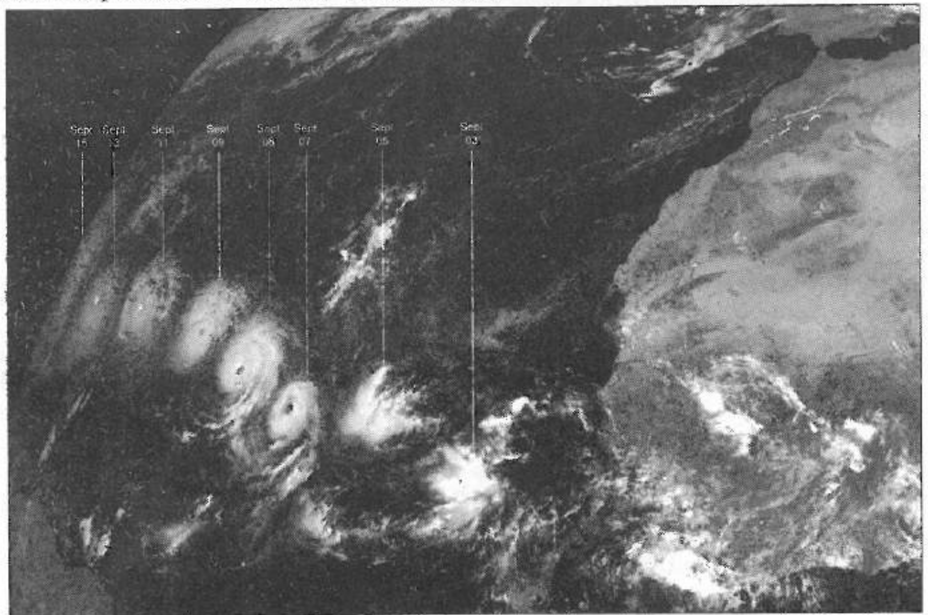


MSG-1 Image.of Europe - 18 February 2003, 13:00 UTC
The large white patch over north-eastearn Europe is fog or stratocumuli, sharply contrasting with snowed areas south of it. *(Original in colour)* © EUMETSAT

This colour coding of weather activity helps meteorologists monitor sweeping weather patterns.

MSG satellite information helps scientists find out when clouds begin to ice and hence helps them examine the cloud structure more deeply than before. By tracking the displacement of clouds in different channels, meteorologists can infer wind speed and direction. With MSG's improved imaging capabilities, meteorologists can produce false colour pictures that make their work easier. For example, ice clouds can show up as blue and dust clouds over the Sahara desert can be coloured yellow - making these weather phenomena easy to distinguish. Colours can be used to denote information that comes from a combination of different channels, allowing a more comprehensive view of weather phenomena. Meteorologists at airports will also benefit as short-term predictions become more accurate. The MSG scans allow forecasters to track if a cloud transforms from water to ice or, even more dangerous to aircraft, when a cloud consists of supercooled water. Because of its position in geostationary orbit, MSG supplies unprecedented coverage of weather events across Africa. These data are of interest to those studying changes in the climate, and they will help mitigate the effects of natural disasters in Africa.

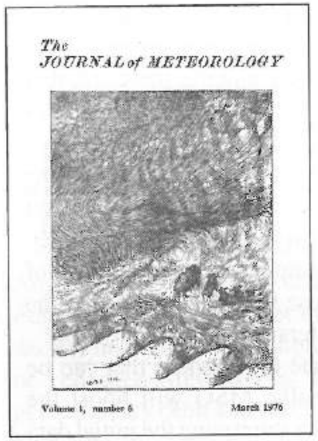
MSG satellites are equipped with a search and rescue transponder that can be used to relay distress messages to emergency centres. Finally, MSG will boost the effectiveness of Numerical Weather Prediction (NWP) models by improving the initial data for a model forecast. "When a model starts to run, it needs very accurate data on the initial conditions that prevail in the atmosphere. This is where MSG comes in - it can have a very positive impact on NWP models," Schmetz said.



Hurricane Isabel as observed by Meteosat-8. The tropical depression of the west coast of Africa detected on 5th September developed into Hurricane Isabel on 7th September and disappeared from the satellites field of view on 17th September. *(Original in colour)* © EUMETSAT

FROM THE ARCHIVE

Each month we delve into the archives of The Journal of Meteorology continuing with **Vol. 1 No. 6 March 1976**:



THE ONSET OF THE COMMON COLD IN RELATION TO METEOROLOGICAL PARAMETERS

"The effect of various meteorological parameters on the incidence and onset of the common cold in 198 families was studied during a period of 12 months at Wingerworth, Derbyshire. Temperature fluctuations, particularly when repeated, were found to be the most significant factor, with school terms contributing markedly to the morbidity. Outdoor relative humidity levels were not found to be significant. The failure of the thermoregulation of the body, and more specifically of the nasal mucosa, in response to temperature stress is suggested as a possible mechanism which facilitates virus proliferation to produce a common cold infection."

THE GREAT CHRISTMAS BLIZZARD AND AVALANCHES OF 1836

"With the help of contemporary newspaper reports, an account is given of the historic Christmas blizzard of 1836. The blizzard was particularly severe over the Sussex downland and culminated in a disastrous avalanche at Lewes, Sussex."

TORNADOES OF 12 JANUARY 1975 IN ENGLAND

"A general description is given of the surface-level features of the seven tornadoes which occurred in central and eastern England on 12 January 1975."

THE GREAT GALE OF 2 JANUARY 1976

"The severe gale which affected virtually the whole country on 2 January 1976 caused damage put at £100 million. Worst hit were the Midlands and the East coast. Luckily flood defences in the latter area which had been strengthened after the 1953 disaster saved many lives. 26 deaths were reported in England and Wales, many through car accidents involving fallen tress."

TWO STORM SURGES HIT DENMARK

"Denmark was struck by two storms surges in January on the 3rd and the 20th. On the first occasion the sea rose to 4.90m above normal water level at Hojer in SW Jutland and this was the highest ever recorded. 20,000 people were evacuated from the threatened areas. The water stopped only 10 cm below the tops of the dikes."

A STUDY OF BRITISH SUMMERS USING AN INDEX - I. TRENDS AND CYCLES

"The value and use of seasonal indices is reviewed and a new summer index is proposed. Applied to the Kew data 1881-1975, minor trends and several cycles are noted. Tentative predictions are made for the next 20 years." (RKD)

Further information: http://www.journalofmeteorology.com/fromthearchive.htm

NEWS

Complied by Greg Spellman

Sourced news and press releases on any aspects of weather and climate should be sent digitally to the News Editor: greg.spellman@northampton.ac.uk

Record retreat in Swiss glaciers in 2003 due to climate change

Switzerland's glaciers melted by a record amount during 2003, possibly due to long-term climate change. The retreat of the glaciers in the Swiss Alps reached up to 150 metres, with an overall melting exceeding that observed in any year since measurements began in 1880, according to the Swiss Academy of Natural Sciences. It is believed that the shrinkage of the mountain ice was not the direct result of record hot summer temperatures in Switzerland and Europe in 2003 but the result of a warming of the climate over several years. The Swiss length measurements were based on regular data recorded on 96 Alpine glaciers. *Source: Terra Daily 13th January 2004*

UK engineers study thunderstorm downbursts

Thunderstorm downbursts occur when a pocket of cold air up to two kilometres across falls rapidly to the ground during a storm. As it falls, it curls in on itself like a mushroom cloud in reverse, sending air at hurricane speeds in all directions, with destructive force. The mechanisms of this event are little known, at least not yet. University of Surrey researchers hope their work will help improve aircraft safety and open structures like pylons. Unlike tornadoes, downbursts are difficult to spot in the real world because they only last a few minutes. Very few have actually been witnessed. *Source: BBC 14th January 2004*

Rare snow in Shanghai

Snow covered China's eastern metropolis of Shanghai in January, an unusual sight following more than 10 years of warm winters. The event brought festive cheer four days ahead of the Spring Festival, the Chinese Lunar New Year. However people carrying large amounts of luggage on the way to their hometowns to join their families for the traditional festivities were inconvenienced. Although there has been some snowfall in recent years it only has lasted at most an hour or less. *Source: Terra Daily 18th January 2004*

Australia faces even hotter future

Parched and fire-ravaged Australia faces an even hotter future with more drought and bushfires. The Commonwealth Scientific and Industrial Research Organisation study has found that by 2030 there will be reduced rainfall, around double the number of very hot summer days in some states and fewer frosts in the regions that experience them. The release of the study, reported in "Nature" coincides with the anniversary of the devastating Canberra bushfires which killed four people and destroyed 507 homes last January 18. By the year 2030, most of Australia is expected to become 0.4 to 2.0 degrees Celsius warmer on average, with 10 to 50 percent more summer days over 35 degrees Celsius. In the south and east, which are just emerging from the worst drought in a century, up to 15 percent less rainfall is expected by 2030, especially in winter and spring, the report says. Hotter and drier conditions would lead to greater fire risk, more heat stress for humans, crops and livestock, greater energy demand for air conditioning, but there will also be less energy demand for winter heating and less frost damage, so there will be winners and losers. *Source: Terra Daily 18th January 2004*

Bad weather in the eastern Mediterranean

Storms in the eastern Mediterranean in mid-January lead to the following unusual conditions. Sandstorms reduced visibility on Egypt's roads to virtually zero; In Turkey, snow storms and gale-force winds shut roads around the country; Heavy rain flooded parts of Lebanon's capital Beirut, damaging some houses; Heavy snowfall hit Greece, causing widespread disruption; In Bulgaria, many drivers were trapped in blizzards and finally Cyprus was battered by days of gale-force winds, tornadoes and flash floods. *Source: BBC 23rd January 2004*

Severe flooding due to heavy rains in Brazil

At least 91 people have died and up to 117,000 have been forced out of their homes in the poor north-eastern states of Pernambuco, Bahia and Piaui in Brazil. Most of the victims either drowned or were crushed to death when mudslides caused their homes to collapse. About 4,200 houses have now been destroyed and a further 112,800 damaged since late December. 16 bridges were washed away and motorists swept off roads that turned into rivers. 29 people had died there. *Source: BBC 5th February 2004*

Snow hinders European transport

Snowfall across large parts of western and northern Europe caused chaos on the roads and at airports. The weather forced the cancellation of hundreds of flights in Germany, Denmark and Britain. The snow led to the opening of several downhill ski runs in Belgium's southern hills. The Franco-Belgian border was closed to lorries overnight due to the bad weather but re-opened later. In Germany, the heavy snows caused the cancellation of 76 flights at Frankfurt international airport, the country's largest. In Munich 40 flights were cancelled due to snow in the region or to weather-related delays in other parts of Germany or Europe. A rare snowfall in Britain's capital led to cancellation of around 90 flights at London's Heathrow airport and others faced serious delays. *Source: BBC 29th January 2004*

'Smog-gobbling' paint cleans city air

European scientists have devised a paint that soaks up nitrogen oxide gases emitted by vehicle exhausts, a pollution source that can cause smog and respiratory problems. The substance, Ecopaint, will go on sale next month and, when painted on the side of buildings, should be able to soak up nitrogen oxides (NOx) for five years until its novel coating is exhausted. An experiment conducted with a similar catalytic coating, which was painted on a stretch of road in Milan, Italy, in 2000, reduced levels of NOx at street level by 60 percent, and residents reported they found it noticeably easier to breathe. *Source: Terra Daily 4th February 2004*

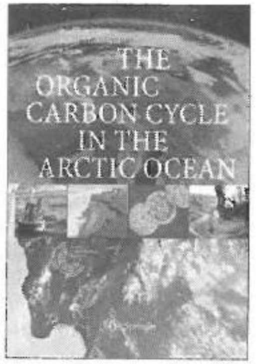
Ten dead in European winter storms

Romania has been worst hit by blizzard conditions, the worst snowstorms there in 40 years according to meteorologists. Some 60 towns and villages in the northeast remained without electricity. Seven people have died due to the bad weather, and three have died in Turkey. *Source: Terra Daily 26th January 2004*

Very warm early February in England

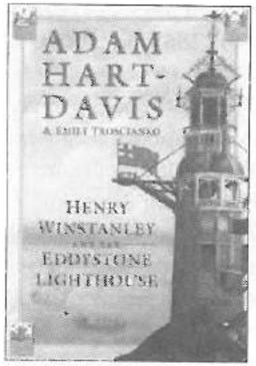
The Hadley Centre has released figures showing that the early February warm weather exceeded previous records. On the night of 3-4 February, the CET minimum temperature was 11.2 °C, beating the previous February figure of 10.3 °C. This series goes back to 1878. The CET for 4 February, reveals a mean temperature of 12.5 °C, beating the previous February record of 12.0 °C from 1960. This series goes back to 1772. It is particularly remarkable that these records have been broken so early in the month. Generally, temperatures across central and southern parts of the UK were around 8 °C above normal on 4 February 2004. The main reason for this exceptionally warm weather across southern Britain is the tropical source of the air - it has come from across the Atlantic Ocean, which is unusually warm for February. Figures show sea-surface temperatures around 2-3 °C above normal. *Source: UK Meteorological Office 6th February 2004*

BOOK REVIEWS



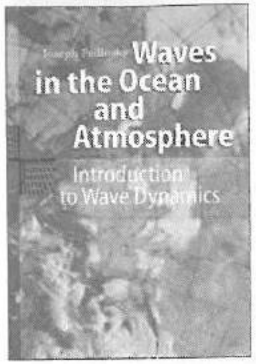
THE ORGANIC CARBON CYCLE IN THE ARCTIC OCEAN. By Ruediger Stein and Robie W. Macdonald (Eds.) (2004) 363pp hb. £107.50 E139.95 $169 ISBN 3540011536 Springer.

This text presents an overview of organic-carbon sources, pathways, and burial of the circum-Arctic continental margin and deep-sea areas. To understand the global oceanic carbon budget and related climate change, exact measurements of organic carbon flux in all oceans environments, especially the continental margins, are crucial. In fact, data have been available for some time on organic carbon sources, pathways, and burial for most of the world's oceans, with the notable exception of the Arctic. In this book, the editors remedy this gap in knowledge. Data from each Arctic shelf and basin are collated, presented in common and parallel formats and related to the global carbon cycle. Each chapter is authored by different scientist prominent in the field and is suitable for lecturers, graduate students as well as scientists interested in the organic-carbon-cycle and Arctic Ocean.



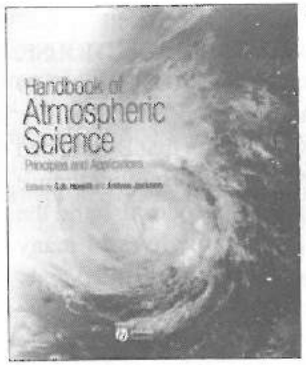
HENRY WINSTANLEY AND THE EDDYSTONE LIGHTHOUSE. By Adam Hart-Davis and Emily Troscianko. (2003) pbk £7.99 ISBN 0750933798 Sutton Publishing Ltd.

On 26 November 1703, during the worst storm that Britain had ever seen, Henry Winstanley died in his pioneering lighthouse as it was blown apart. He had defied incredible odds to build the first Eddystone Lighthouse in 1698, saving the lives of many sailors from the fate of the thousands who previously died upon the rocks. The Great Storm not only destroyed the man and his lighthouse, but also saw complete devastation throughout the land. Winstanley was an ingenious man. In 1695, two of his five ships were lost on Eddystone. He was determined that no more ships should founder and, though thwarted by weather and politics, he built a lighthouse, the first of its kind. It survived terrible winters and withstood devastating storms, guiding ships away from the treacherous rocks that lay ahead with its dim candlelight. After the great storm it was as if the lighthouse had never been. Ultimately, Winstanley's lighthouse led to the building of others on the Eddystone rocks and beyond, thus transforming the safety of shipping. This illustrated book vividly recreates the story of the Eddystone Lighthouse, the character of the man who built it with grim determination fighting against all odds, and the power of the elements that finally destroyed them both. Much has been written about The Great Storm and its impact and this text devoted to the Eddystone tragedy is a comprehensive insight into Winstanley the man and Eddystone the great lost lighthouse. The paperback version has pleasantly large print and makes an informative and interesting read.



WAVES IN THE OCEAN AND ATMOSPHERE. Introduction to Wave Dynamics. By Joeseph Pedlosky (2003) 260pp hb. £38.50 ISBN 3540003401 Springer

Waves in the Ocean and Atmosphere presents a study of the fundamental theory of waves appropriate for students in oceanography, meteorology and associated sciences, Starting with and elementary overview of the basic wave concept, specific wave phenomena and then examines surface gravity waves, internal gravity waves, lee waves, waves in the presence of rotation to name but a few. Each wave topic is used to introduce either a new technique or concept in general wave theory. Emphasis is placed on the connectivity between the various subjects and on the physical interpretation of the mathematical results. The book is a reworking of course notes prepared by the author with each chapter representing a lecture. Driven by formulae and mathematical illustrations the text does require some background knowledge of the processes in question. Suitably priced for the University library and student bookshelf Waves in the Ocean and Atmosphere will no doubt become a popular scientific text.



HANDBOOK OF ATMOSPHERIC SCIENCE. Principles and Applications, By C.N. Hewitt and Andrea Jackson (Eds) (2003) 633pp Hb £150 ISSN 0632052865 Blackwell Publishing

The alarming consequences of global climate change have highlighted the need to take urgent steps to combat the causes of air pollution. Hence, understanding the Earth's atmosphere is a vital component in man's emerging quest for developing sustainable modes of behaviour in the 21st century. Written by a team of expert scientists, the "Handbook of Atmospheric Science" provides a broad and up-to-date account of our understanding of the natural processes that occur within the atmosphere. It examines how anthropogenic activities have had a detrimental effect on the climate, and how measures may be implemented in order to modify these activities. The book progresses through chapters covering the principles of atmospheric science and the current problems of air pollution at the urban, regional and global scales, to the tools and applications used to understand air pollution. The "Handbook of Atmospheric Science" offers an overview of this multidisciplinary subject and should prove valuable to both students and researchers of atmospheric science, air pollution and global change. Its price may put it out the reach of the average reader but this substantial text is a valuable addition to any atmospheric science bookshelf.

BOOK / SCIENTIFIC REPORTS EDITORS

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WORLD WEATHER DISASTERS

OCTOBER 2003

3:	Storm hits North Island, New Zealand, killing 3
4-7:	Yellow River in China bursts banks in 3 places in Henan province. Floods threaten at least 100,000
5:	Tropical storm "Larry" hits southern coast of Gulf of Mexico, forcing hundreds to flee
5-7:	Continuous rain and strong winds lash Penang, Kedah and northern Perak in Malaysia. Three killed in floodwaters.
6:	Remnants of tropical storm "Larry" cause flooding in southern Mexican state of Chiapas.
7:	Heavy rains cause landslides in capital of Haiti killing at least 12 and leaving dozens homeless
8:	Almost 1,500 localities without electricity in European Russia after high winds.
10-12:	Severe storm hits coastal areas of Hebei province, China causing sea water to rush 5-10km inland, affecting more than 100,000 people and flooding 27 villages.
14:	Strong winds blow over cranes in two factories in Ibaraki Prefecture, Japan, killing one and leaving one missing.
14:	One hundred forestry students stranded in flash floods in Nakhon Ratchasima, Thailand. At least 4 dead in Prachin Buri.
14-22:	At least 44 dead in floods and landslides that sweep through central Vietnam.
15:	Storm in Maritimes of Canada knocks out electricity in parts of Nova Scotia and New Brunswick. Winds of between 70 and 90kmph.
15:	Thunderstorms with 70mph winds hit W. Pennsylvania, taking roofs off buildings, felling utility polls and trees and leaving thousands in the dark. Upstate New York also affected.
15-18:	At least 13 swept away by floods in central Algeria. Rains cut off key roads, including links to second largest city, Oran. *The Observer*.
17-19:	Three days of torrential rain sends flood waters through towns north of Vancouver, Canada, claiming at least 2 lives and forcing 800 to higher ground.
18-19:	Floods in Washington and British Columbia kill 3 and damage roads.
20:	Two dead, two missing and about 800 evacuated after heavy rain and flooding in Squamish, Pemberton and Mount Currie areas of Canada.
21:	Three die in floods in Phetchaburi and Prachuap Khiri Khan provinces of Thailand.
22:	Dublin, Ireland airport forced to close for 90 minutes due to sleet and hail on runways.
23:	Twenty fishermen missing from capsized trawler as depression affects southern provinces of Thailand.
25:	Severe storms cause complete black out in parts of southern New South Wales, Australia. Severe hailstorms sweep through parts of Sydney, causing extensive damage and local flooding.
27:	Many homes swamped by flooding in N.W. British Columbia, Canada.

Sources Lloyds List unless otherwise stated.

BRITISH WEATHER SUMMARY

OCTOBER 2003

This was the first colder than normal month countrywide since December 2001, with a tendency for air to be drawn into the country from the north and east. Mean monthly maxima were generally rather less than a degree below normal, but minima averaged close to two degrees below normal in many areas - arising from the predominantly clear skies in another very sunny month for most. Sunshine anomalies were close to 170% of normal in parts of the southeast, although it was a slightly dull month over Northern Ireland and northwest Scotland. Most places had another dry month. The first few days were unsettled; initially, low pressure drifted northeastwards close to southern Britain, then frontal systems crossed the country from the west.

It was mostly warm in the south (22 degrees in north Devon on the 2nd), but colder at times in the north and occasionally windy. Rainfall amounts were not generally large, and it dried up completely in most places towards mid-month as high pressure took over, with an anticyclone settling down northeast of Scotland. It became sunny in many areas and slowly turned colder with some night frost and fog, mainly in the north. By the 20th, the highest pressure had retreated well to the north, and much colder air pushed southwards over the country. Many places were still quite sunny, but the unstable air set off vigorous showers in coastal areas and there were some longer spells of heavy rain in the south around the 22nd, with snow reported over Exmoor and Dartmoor for a time. Snow fell more widely in northern areas, where there were also sharp frosts and patchy freezing fog; the temperature fell to -8 at Kinbrace (Highland) early on the 22nd. Towards the end of the month, a deep and complex area of low pressure lay off our southwestern coasts and areas of rain affected most of the country; around 70 millimetres fell in 48 hours on Bodmin Moor (Cornwall) on the 29th and 30th.

NOVEMBER 2003

This was an unsettled month, dominated by low pressure over the North Atlantic. The resulting prevalent south to southwesterly airflow meant that it was generally mild, with mean monthly temperatures close to two degrees above normal. Rainfall totals were rather variable; some northern and western areas were relatively dry, but there was around twice the normal in parts of the southeast. Many places had another sunny month, though there were several consecutive sunless days in the southeast after mid-month. Most of the country had a bright opening day, but a deep depression moved northeast off our northern shores during the 2nd and 3rd, bringing rain followed by blustery showers - then increasingly sunny skies during the 3rd. During the next few days, a large anticyclone drifted north to the east of Britain. Initially, very mild air covered the country in the southerly airflow, with a fair amount of sunshine, although it was wet in the far northwest. Temperatures of 18 to 20 degrees were recorded in various districts from the 5th to the 7th, the latter figure close to the Scottish record at Lochcarron in the Highlands on the 7th. However, as the wind developed more of an easterly component, it became less mild in the south and east and there were a few areas of fog and low cloud. There was patchy rain on the 9th, then, in the next few days, fronts crossing the country from the southwest brought a return of mild weather to all regions with spells of rain and sunny interludes. There were severe gales in the southwest on the 14th. The temperature reached 17 degrees in the Aberdeen area on the 18th, but severe gales affected northernmost Scotland. During the first twenty days of the month, rainfall amounts were small in the southeast, and around this time the Environment Agency warned of the potential for serious water shortages by next summer. This warning was immediately followed by very wet weather here, including around 48 hours of continuous rain in places from the 21st to the 23rd, as ripples ran along a slow-moving cold front; there were totals of close to 80 millimetres during this spell in Surrey. The north and west were brighter and colder, with sharp overnight frosts (-8 at Altnaharra on the 24th) and a few persistently foggy areas. The last week of the month was generally mild and unsettled, with heavy rain in some areas, but also a fair amount of sunshine and one or two frosty nights.

READER'S PICTURES

Anvil sunset - Bury St. Edmond, UK.

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October sunrise, Haddiscoe, UK

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