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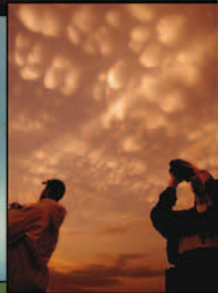
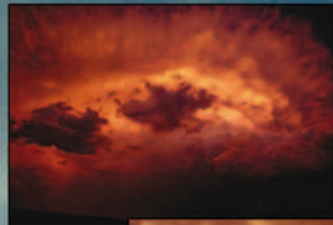
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The International Journal of Meteorology

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STATISTICAL INTERPRETATION FORECAST
AND ITS SKILL DURING MONSOON SEASON IN INDIA

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Abstract: A forecasting system for objective medium range location specific forecast of surface weather elements is evolved at NCMRWF. The basic information used for this is the output from the general circulation model (GCM). Statistical Interpretation (SI) forecast is one of the tools. It is obtained by using dynamical-statistical methods like Perfect Prog Method (PPM) in which prediction of upper air circulation from GCM around the location of interest is used. Finally the evaluation of the forecast skill for rainfall and minimum/maximum temperature during monsoon (June-September) 2006 and some of the future plans are presented.

Keywords: NCMRWF, GCM, SI, PPM, monsoon.

INTRODUCTION

The work on SI of model output was started in 1990 after the installation of the first GCM, R-40, at the National Centre for Medium Range Weather Forecasting (NCMRWF) in 1989. The SI forecast was started and used for the preparation of the final forecast for five stations for the first time in the monsoon of 1991 (Kumar and Maini, 1996). Later on in the 1994 monsoon, T-80 model based SI forecast began as T-80 model was installed in 1993. The SI forecast for winter began in 1995-1996. At present, the SI forecast is obtained on an operational basis and is used for the preparation of final forecast for 45 stations during monsoon seasons and 16 stations during winter seasons. Present SI forecast is obtained by using PPM models, which were developed by using six years (1985-1990) of ECMWF analysis data.

STATISTICAL INTERPRETATION APPROACH

Surface weather elements like rainfall, maximum temperature and minimum temperature are highly dependent on local topographic and environmental conditions. As in Numerical Weather Prediction (NWP) models and particularly in GCM it is very difficult to include each and every aspect of these local conditions at all the locations, therefore Direct Model Output (DMO) forecasts obtained from NWP models may have problems. However, upper air circulation at a specific location is not so dependent on local conditions and can be obtained from the analysis or forecast of a GCM easily. A statistical relation developed between upper air circulation around the location of interest and observed values of the surface weather element at the location will definitely account for the effect of these local conditions. This indicates that SI forecasts obtained will have better skill compared to DMO forecasts. Basically two methods are used for SI forecast. These are Perfect Prog Method (PPM), (Klien *et al.*, 1959) and Model Output Statistics (MOS) (Figure 1) (Klien *et al.*, 1959).

In PPM approach, (Klien and Glahn, 1974) a statistical relation is derived that relates large samples of observed surface elements (predictands) to concurrent observed surface and upper air reports i.e. analysis (predictors).

In order to get a forecast for the appropriate valid time, values of the predictors obtained from NWP models is substituted in the relation developed. This approach assumes that the model forecasts are "perfect". Hence this approach is a disadvantage in that it does not account for systematic biases and errors of the model. This problem can be solved by using the unbiased model forecast, which can be obtained just on the basis of model analysis and forecast data for last one or two months. A major advantage of this method is that stable forecasting relations can be derived from a long period of record. Its forecast improves as NWP model forecast is improved.

In MOS approach, (Glahn and Lowry, 1972) a statistical relation is developed using observed surface weather elements (predictands) and NWP model forecasts for upper air circulation variables (predictors). As such, separate MOS relation is developed for a particular day forecast. To make operational forecasts, MOS relations are usually applied to the same dynamical model that provided the developmental sample. It has an advantage that MOS relations account for some of the biases and systematic errors found in the NWP model. A disadvantage of this technique is that model output data for a sufficiently longer period is required so as to derive a stable relation. Hence it cannot be applied immediately when a new NWP model is made operational. Also if the NWP model undergoes a major change the MOS relations will have to be developed again.

DATA

In order to cover all types of variability for a season, at least five to six years of data is required. Monsoon season for most of the Indian stations varies from three to four months only. Carter (1986), in his paper accepts that three seasons of six months duration are sufficient for giving stable statistical relationships. Hence PPM models are developed for only 45 stations during monsoon season and 16 stations during winter season by using six years (1985-1990) of analysis data obtained from the ECMWF, as the observed data could only be obtained for these stations only. Analysis data used is at 2.5x2.5 latitude-longitude grid. The period of the monsoon season is taken as June-August or June-September depending upon the location of the station.

Predictands chosen for development of PPM models are the observed values of Quantitative Precipitation (QP), Probability of Precipitation (PoP), Maximum Temperature and Minimum Temperature. Due to high variability in the distribution of rainfall values, the model is developed by taking cube root of quantitative precipitation. 47 meteorological parameters are chosen as a possible set of predictors (Table 1), these includes basic analysis fields such as geopotential height, temperature, u-component and v-component of wind, vertical velocity and relative humidity at 1000, 850, 700 and 500 hPa. Besides these fields, many other derived weather parameters obtained by using the known meteorological relations are also considered. These derived parameters include vorticity, advection of vorticity, temperature gradient, advection of temperature, advection of temperature gradient, thickness, mean sea level pressure (MSLP), 1000-500 hPa precipitable water (PPW), saturation deficit (SD) and rate of change of moist static energy (RMSE).

Rainfall reported at 0300 GMT on a particular day is the accumulated rain in the past 24 hours. Similarly maximum and minimum temperatures recorded at 0300 GMT on a particular day pertains to the past 24 hours. On the other hand the predictor values are available only at 0000 GMT and 1200 GMT. Keeping the above facts in view, the reference times at which the predictors are to be considered for different predictands is as given below:

-00 GMT of the same day for minimum temperature

-1200 GMT of the previous day for maximum temperature

-0000 GMT of the same day, 1200 GMT of the previous day and average of the two for rainfall.

Table 1. Meteorological parameters considered as possible predictors.

Parameters	Level
Relative humidity	1000,850,700,500
Temperature	1000,850,700,500
Zonal wind component	1000,850,700,500
Meridional wind component	1000,850,700,500
Vertical velocity	1000,850,700,500
Geopotential	1000,850,700,500
Saturation deficit	1000-500
Precipitable water	1000-500
Mean sea level pressure	-----
Temperature gradient	850-700, 700-500
Advection of temperature gradient	850-700, 700-500
Advection of temperature	1000,850,700,500
Vorticity	1000,850,700,500
Advection of vorticity	1000,850,700,500
Thickness	850-500
Horizontal water vapour flux divergence	1000-500
Mean relative humidity	1000-500
Rate of change of moist static energy	1000-500

A "day" in this case is the calendar date on which 24-hour rainfall is reported (Figure 2). This means that there are 47 predictors each for maximum and minimum temperatures and 141 (47x3) predictors for rainfall.

FORECAST EQUATIONS

Development of forecast equations involves two major steps. The first step is the interpolation of predictor fields to the station location and the second step is the development of multiple regression equations through a screening procedure. Since the predictors are available at a regular (2.5°x2.5°) grid and the stations are located irregularly, the predictor field ought to be interpolated to the station location.

PREDICTOR'S VALUE AT THE STATION LOCATION

Value of a particular predictor at a station is obtained by using the values of that predictor at the nine grids surrounding the station, Figure 3 (Tapp *et al.*, 1986; Woodcock, 1984). This is achieved by employing canonical correlation. In this technique the first canonical variate, which is the best linear combination of the values of a predictor at the nine grid points that has maximum correlation with the predictand, is taken as the value of a particular predictor at the station (Rousseau, 1982). These canonical variates are found for each of the predictors to give a new set of potential predictors.

PREDICTORS SELECTED

Predictors that explain most of the variance are selected from the set of all potential predictors by using a stepwise selection procedure. In this procedure, the selection of predictors is terminated if the new candidate predictor contributes less than a critical value, to the percentage of variance explained by the predictors already selected.

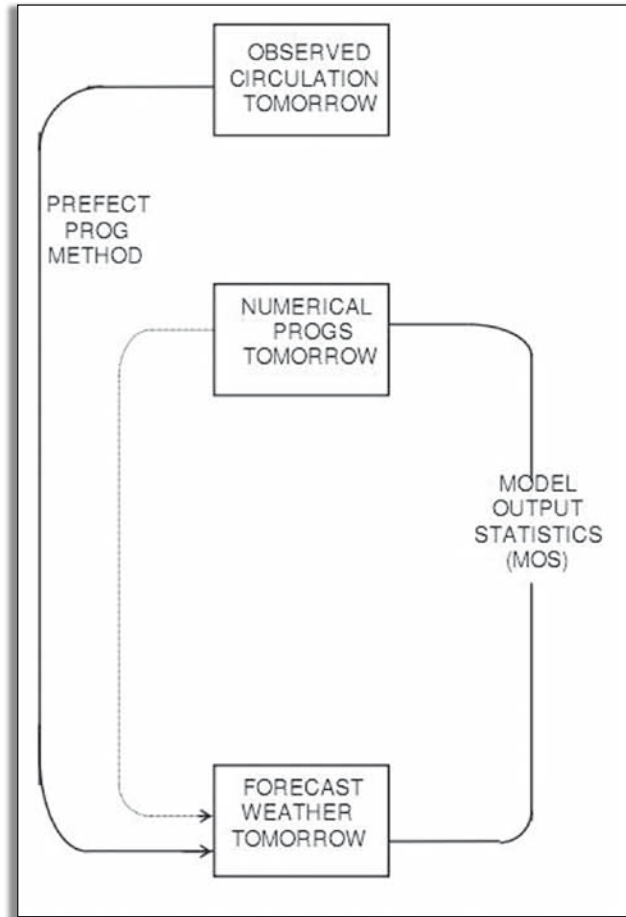


Figure 1. Two methods of combining numerical and statistical weather forecasting in schematic form.

In order to have a significant percentage of variance explained by the predictors selected and to have less noise in the predictions, this critical value is taken as 1.0 % for maximum/minimum temperature and probability of precipitation and 0.5 % for quantitative precipitation. (Wilks, 1995; Kumar and Maini, 1993,1996).

Generally two to three variables are selected for prediction of maximum temperature in which 1000-500 hPa saturation deficit and 850 hPa temperature are the most important predictors. In the case of minimum temperature, three to seven variables are selected and 850 hpa temperature and 850-500 hpa thickness are generally selected. Five to 10 variables are selected for PoP and for QP five to 14 variables are selected. Mean relative humidity and 850 hpa meridional wind component play an important role in case of both PoP and QP. 850 hPa vorticity is also an important variable in the prediction of QP.

These selected predictors are then used for developing the PPM models. Simple linear regression equations of the form (1) are obtained relating one predictand to the set of selected predictors.

$$Y = a_0 + a_1X_1 + a_2X_2 + \dots + a_nX_n \tag{1}$$

where a_i is the multiple regression coefficients and X_i is the value of the predictors at the station. Here Y provides the probability of precipitation for a given set of predictors.

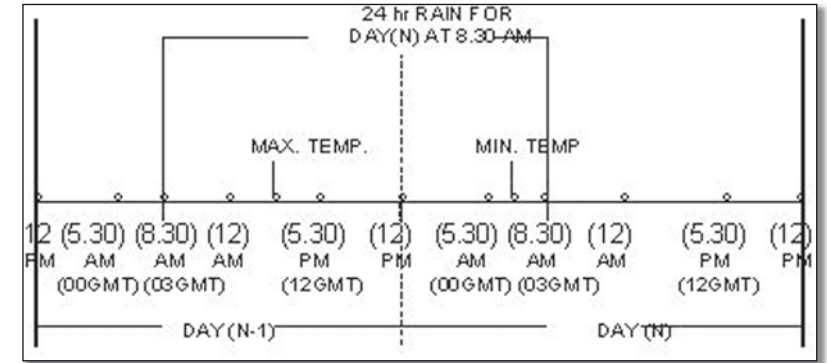


Figure 2. Reference time for predictors.

SI FORECAST

For obtaining SI forecast from these PPM models, the post processed output at the same resolution i.e. (2.5x2.5), from the NWP model operational at NCMRWF is used. Earlier R-40 model with resolution (2.5x2.5) was operational at the centre (Kumar and Maini, 1996). Later in 1993, the T-80 model with higher resolution was made operational. Hence post processed output of T-80 model was obtained. SI forecast for 24, 48, 72 and 96 hours is obtained for maximum and minimum temperature, QP and POP by substituting the X_i 's in Equation 1 by the respective forecast values from the operational NWP model output. Therefore,

$$Y_{24} = a_0 + \sum_{i=1}^n a_i X_i \tag{2}$$

where n is the number of selected predictors. Similarly Y_{48} , Y_{72} and Y_{96} are also obtained. As PPM model equations are developed based upon ECMWF analysis and SI forecast is obtained using the T-80 model forecast, hence forecasts so generated have an inherent bias. For getting a bias free SI forecast during any season, the forecasted and observed values of the predictand during recent one or two seasons are considered and correction factors are obtained by trial and error method so that the skill of the forecast gets maximised. Same correction factors are used while obtaining the SI forecast on operational basis during the current season.

RAINFALL FORECAST BIAS

For QP, optimal threshold value is set so as to maximise the skill score. Optimal threshold value implies that if the rainfall amount is less than the threshold then QP is taken as zero otherwise it is taken as the forecasted value. After deciding about the rainy or non-rainy days, a regression is fitted based upon the previous seasons in order to correct the QP amounts. For PoP a constant factor is added to the forecasted probability, so that skill scores for PoP and also for the Yes/No forecast derived from it gets maximised. The Yes/No forecast from probability is derived by using the criterion that if PoP is less than 0.5 then it is considered as no rain case otherwise it is considered as rain case.

For giving rainfall forecast more weight is given to PoP that is if PoP is greater than or equal to 0.5 and QP is zero, the forecasted value of QP is set to 0.1 and if PoP is less than 0.5 and QP is non zero, then the forecasted value of QP is set to zero. If PoP is greater than or equal to 0.5 and QP is some positive quantity then forecasted value of QP is equal to that positive quantity (Kumar *et al.*, 1999; Tapp *et al.*, 1986).

TEMPERATURE FORECAST BIAS

In the case of temperature forecasts, bias is removed based on mean error, which is calculated by using the previous season's data. This is done so that original temperature trends remain unchanged. Mean error is calculated as follows,

$$ME = \bar{f} - \bar{x}$$

where \bar{f} is mean of the forecasted values and \bar{x} is the mean of the observed values during the previous season. This value of ME is added to forecasted temperature values in order to get bias free forecast during the current season. This method is followed both for maximum and minimum temperature.

FORECAST SKILL

Evaluation of SI forecast during monsoon 2006, has shown that the skill of the forecast is considerably good (Table 2 - 5). For rainfall, ratio score varies from 55 to 80 % and HK score varies from 0.1 to 0.7 for most of the stations. Similarly, the correlation of the order 0.1 to 0.7 for minimum temperature and 0.2 to 0.8 for maximum temperature is attained for most of the stations, although the forecast skill decreases with forecast lead times.

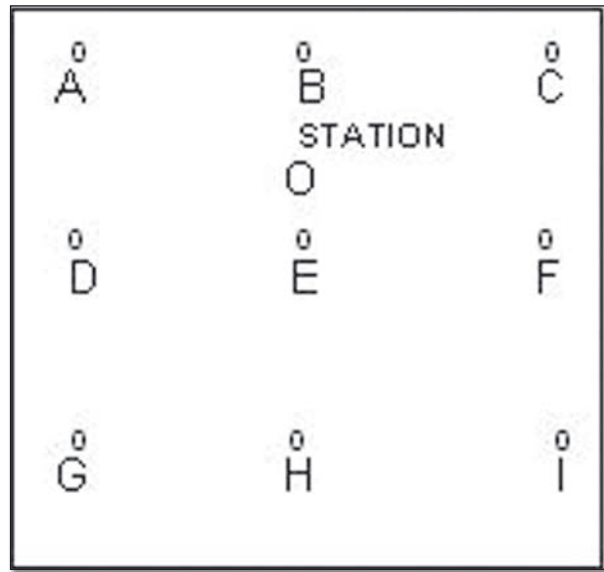


Figure 3. The grids considered around a station for canonical variates.

Table 2. Skill score for statistical interpretation forecast for 24 hr rainfall, minimum/maximum temperature, monsoon (June-September, 2006).

Sn	Station	Rain		MIN T		MAX T	
		Ratio (%)	HK	RMSE	Corr	RMSE	Corr
1	Aduthurai	77	0.41	1.17	0.53	1.57	0.59
2	Anantpur	78	0.22	1.39	0.25	1.44	0.44
3	Bangalore	70	0.02	1.28	0.12	1.54	0.30
4	Coimbatore	75	0.17	1.08	0.46	1.64	0.55
5	Dapoli	79	0.77	2.04	0.33	2.02	0.27
6	Dharwad	56	0.34	1.19	0.59	1.81	0.79
7	Delhi	79	0.35	2.52	0.59	3.06	0.59
8	Hissar	80	0.28	2.27	0.65	3.04	0.64
9	Junagadh	76	0.54	2.20	0.33	2.25	0.75
10	Kanpur	69	0.14	1.52	0.51	3.32	0.61
11	Kovilpatti	78	0.42	1.56	0.51	1.44	0.49
12	Ludhiana	63	0.21	1.82	0.69	3.15	0.54
13	Nadia	65	0.42	0.86	0.50	1.76	0.71
14	Sindewahi	69	0.35	2.19	0.55	2.73	0.82
15	Raichur	74	0.19	1.46	0.23	2.10	0.50

Table 3 (continues on next page). Skill score for statistical interpretation forecast for 48 hr rainfall, minimum/maximum temperature, monsoon (June-September, 2006).

Sn	Station	Rain		MIN T		MAX T	
		Ratio (%)	HK	RMSE	Corr	RMSE	Corr
1	Aduthurai	78	0.51	1.17	0.26	1.62	0.40
2	Anantpur	72	0.17	1.40	0.14	1.46	0.27
3	Bangalore	64	0.04	1.26	0.38	1.56	0.22
4	Coimbatore	74	0.12	1.10	0.15	1.72	0.19
5	Dapoli	73	0.66	2.05	0.35	1.98	0.19
6	Dharwad	54	0.29	1.21	0.61	1.79	0.52
7	Delhi	80	0.39	2.70	0.10	3.20	0.41
8	Hissar	81	0.24	2.53	0.15	3.27	0.35
9	Junagadh	77	0.54	2.21	0.20	2.25	0.70
10	Kanpur	67	0.15	1.61	0.21	3.43	0.51
11	Kovilpatti	83	0.44	1.55	0.52	1.47	0.22
12	Ludhiana	65	0.20	1.91	0.23	3.24	0.31

13	Nadia	62	0.35	0.89	0.10	1.83	0.34
14	Sindewahi	70	0.37	2.26	0.36	2.71	0.72
15	Raichur	73	0.16	1.49	0.19	2.10	0.12

Table 4. Skill score for statistical interpretation forecast for 72 hr rainfall, minimum/maximum temperature, monsoon (June-September, 2006).

Sn	Station	Rain		MIN T		MAX T	
		Ratio (%)	HK	RMSE	Corr	RMSE	Corr
1	Aduthurai	77	0.50	1.19	0.34	1.65	0.32
2	Anantpur	69	0.15	1.41	0.47	1.46	0.20
3	Bangalore	65	0.02	1.28	0.33	1.58	0.21
4	Coimbatore	73	0.08	1.12	0.32	1.79	0.12
5	Dapoli	74	0.66	2.04	0.38	2.00	0.15
6	Dharwad	54	0.23	1.22	0.27	1.90	0.43
7	Delhi	75	0.36	2.91	0.21	3.43	0.31
8	Hissar	82	0.15	2.79	0.31	3.48	0.23
9	Junagadh	78	0.56	2.20	0.29	2.25	0.67
10	Kanpur	67	0.17	1.69	0.33	3.60	0.46
11	Kovilpatti	85	0.41	1.54	0.50	1.49	0.12
12	Ludhiana	65	0.19	2.06	0.34	3.37	0.20
13	Nadia	60	0.28	0.92	0.43	1.91	0.24
14	Sindewahi	69	0.37	2.22	0.29	2.74	0.69
15	Raichur	73	0.18	1.47	0.38	2.11	0.04

Table 5 (continues on next page). Skill score for statistical interpretation forecast for 96 hr rainfall, minimum/maximum temperature, monsoon (June-September, 2006).

Sn	Station	Rain		MIN T		MAX T	
		Ratio (%)	HK	RMSE	Corr	RMSE	Corr
1	Aduthurai	77	0.44	1.22	0.43	1.65	0.32
2	Anantpur	69	0.15	1.41	0.56	1.48	0.18
3	Bangalore	65	0.01	1.29	0.44	1.56	0.20
4	Coimbatore	73	0.06	1.12	0.40	1.82	0.11
5	Dapoli	73	0.66	2.03	0.39	2.01	0.14
6	Dharwad	53	0.24	1.25	0.35	2.00	0.40
7	Delhi	71	0.29	3.07	0.29	3.65	0.28
8	Hissar	80	0.08	2.98	0.35	3.71	0.17

9	Junagadh	78	0.57	2.21	0.39	2.27	0.65
10	Kanpur	65	0.17	1.79	0.40	3.76	0.43
11	Kovilpatti	86	0.33	1.53	0.57	1.50	0.08
12	Ludhiana	64	0.21	2.17	0.38	3.54	0.13
13	Nadia	58	0.25	0.94	0.50	1.99	0.20
14	Sindewahi	68	0.35	2.17	0.46	2.79	0.67
15	Raichur	72	0.16	1.46	0.46	2.12	0.10

FUTURE PLANS

Efforts will be made in order to improve the quality of SI forecasts so that the final forecasts are improved. The efforts will be made to improve the operational NWP model and a regional model may also be considered. A better approach and more suitable data will be considered for improvement in SI forecast. Better statistical techniques will also be tried in order to have an improvement in the SI forecasts.

SI forecasts must be improved up to the level or better than the final forecast issued from NCMRWF by man-machine-mix approach, then one can hope for automation of the SI forecasts.

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A NOTE ON THE TORNADO AND FUNNEL CLOUDS OBSERVED IN POLAND IN 2006

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Abstract: This research details one tornado observed in the neighbourhood of Pobiedziska near Poznań during June 2006 and funnel clouds observed in July 2006 in Łeba in the Polish coastal area and associated synoptic conditions leading to their development. The factors which caused the tornado were similar to those leading to the occurrence of violent thunderstorms and tornadoes on the territory of Poland.

Keywords: tornado, Poland, Funnel Cloud, June 2006, July 2006

In 2006, a tornado occurred in the territory of Poland in the afternoon hours on the 21st June (circa 17.00), in the vicinity of Pobiedziska (Figure 1).



Figure 1 Location of tornado and funnel clouds observed in 2006 in Poland.

The tornado appeared in a synoptic situation typical for the occurrence of such phenomena as well as violent thunderstorms in the territory of Europe and similar to those in middle latitudes of the USA (Changnon 2001, Changnon and Changnon 2001, Kolendowicz 2007, Walkner A. 1992). Before the tornado occurred, warm and humid masses of tropical air, with a day temperature of approximately 28 °C (Fig. 2), converged over the country.

In turn, on the date of the occurrence, the skies over Poland were covered by cool masses of old polar marine air, preceded by a cool

atmospheric front (Figure 3). The speed of movement of the cold atmospheric front was not very considerable, amounting to approximately 30 km/h. The tornado originated at the base of the storm cloud and moved over an uninhabited area spanning a few hundred metres, without causing any substantial material damage. Descriptions given by eyewitnesses and observations of its effects allow us to state that its intensity on the TORRO scale totalled T0/T1, i.e. it was weak.

In turn, on the 14th July at night, at circa 19.00, the funnel clouds phenomenon was observed in the vicinity of Łeba. This was characterised by the appearance of a few small funnels which protruded from the base of the cumulus clouds. These clouds created a clear line, and they formed behind the passing atmospheric fronts, in the mass of cool polar marine air (Plate 1 and 2). This mass, preceded by two cold atmospheric fronts, reached the territory of Poland from a north-westerly direction.

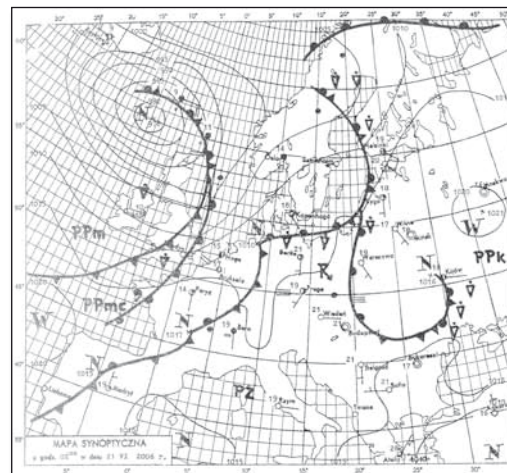


Figure 2. Synoptic map of 21 June 2006 at 0200 hours, courtesy Codzienny Biuletyn Meteorologiczny MGW.

Figure 3. Synoptic map of 22 June 2006 at 0200 hours, courtesy Codzienny Biuletyn Meteorologiczny MGW.

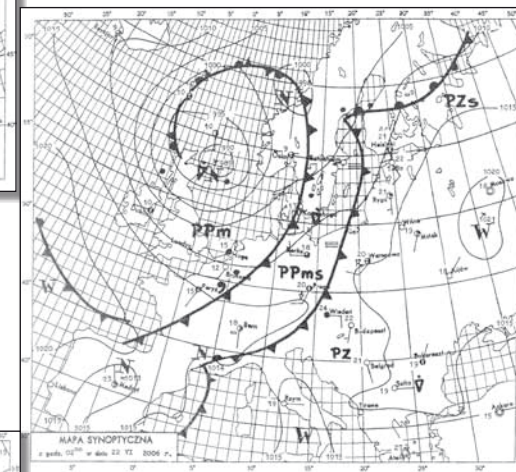


Figure 4. Synoptic map of 14 July 2006 at 0200 hours, courtesy Codzienny Biuletyn Meteorologiczny MGW.

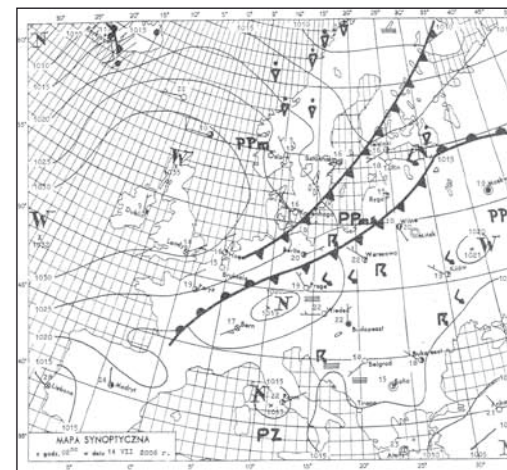
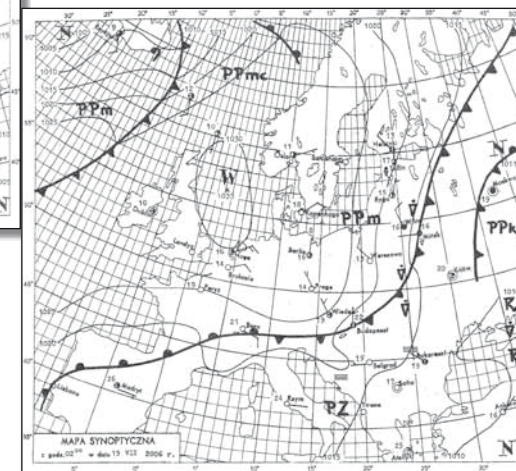


Figure 5. Synoptic map of 15 July 2006 at 0200 hours, courtesy Codzienny Biuletyn Meteorologiczny MGW.



Before the advection of polar marine air, storms occurred in the warm and humid tropical air located in front of the cool atmospheric fronts (Figures 4 and 5). Aerological observations conducted at the Łeba station show that the incoming polar marine air in which the funnel clouds phenomenon developed was characterised by considerable instability up to a height of approximately 8,500 metres above sea level. The phenomenon itself was observed on the coastline when the clouds moved from over the sea towards land, which could result in an additional power impulse and increase the instability of air.



Plate 1. The funnel visible at the bottom of cumuli cloud.



Plate 2. The cumuli clouds line.

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A REVIEW OF GLOBAL HEAVY SNOWFALL AND BLIZZARDS IN 2006: PART 2

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WEDNESDAY 7 JUNE 2006

Heavy snow impact closed roads and caused road traffic accidents around Punta Arenas, Chile.

SUNDAY 11 JUNE 2006

Hundreds of pilgrims were temporarily halted by heavy snow on their trip to a Himalayan cave to celebrate the Amarnath Yatra pilgrimage.

SUNDAY 11 JUNE 2006 - MONDAY 12 JUNE 2006

The Tekapo village community near Canterbury, New Zealand were cut off due to heavy snowfall of up to 75-90 cm. The snowfall severed communications within the area, as the weight of the snow brought down electricity poles and closed roads. As many as 19,000 homes lost their power and telephone links. Other areas affected were Twizel, near Mount Cook and the Mackenzie and Waimate districts. The heavy snow also claimed the lives of two rare wading birds in Twizel. The birds in question, Kaki, were killed when the aviary they were housed in collapsed under the weight of the snow. Certain areas of South Island experienced the heaviest snowfall since August 1973. The snow also caused Christchurch Airport to close for a time.

SATURDAY 17 JUNE 2006 – MONDAY 19 JUNE 2006

Further heavy snow caused chaos across New Zealand. A man died in a car accident due to the snow between Stratford and Inglewood on the 19th. The snow caused many areas to lose their power and roads were closed, for example, State Highway 48.

FRIDAY 23 JUNE 2006

Heavy snow affected the eastern region of North Island, New Zealand. The snow impact closed many schools and roads in the mountain range around the Gisborne and Hawkes Bay area.

TUESDAY 4 JULY 2006

More heavy snow caused problems to farmers in particularly in South Island, New Zealand. Up to 50 cm of snow fell in the Whakapapa and Turora region stranding snowboarders and skiers alike for a time on Mount Ruapehu.

FRIDAY 21 JULY 2006

In New Zealand, heavy snow of up to 10 cm fell across the Queenstown and Arrowtown districts causing the closure of schools, the local airport and several roads.

FRIDAY 21 JULY 2006 – SUNDAY 23 JULY 2006

Heavy snow up to 50 cm fell across the Boland and Hex River Mountains, South Africa on Friday and Saturday causing the closure of the roads near Ceres, Touws River and Calvinia. Heavy snow also fell across the high ground of the Eastern Cape and the Swartberg mountains.

WEDNESDAY 2 AUGUST 2006

Heavy snow fell across the Eastern Cape of South Africa and Lesotho trapping several residents across the region of Thaba-Tseka.

MONDAY 7 AUGUST 2006

Heavy snow across North Island, New Zealand resulted in the closure of the Desert Road.

WEDNESDAY 16 AUGUST 2006 – FRIDAY 18 AUGUST 2006

Heavy snow fell across the Eastern Cape of South Africa blocking roads and forcing many motorists to abandon their vehicles. Several roofs of houses and buildings across the area collapsed due to the weight of snow upon them.

THURSDAY 17 AUGUST 2006

Heavy snow killed a US student close to the peak of Mount Kenya, Kenya.

TUESDAY 22 AUGUST 2006

Heavy snow fell in the hillier districts of Christchurch, Otago and Southland, New Zealand disrupting transport, farmland and schooling.

THURSDAY 21 SEPTEMBER 2006 – FRIDAY 22 SEPTEMBER 2006

Heavy snow up to 60 cm in places fell across the higher mountainous regions of Colorado, USA. The snow forced an 80 km stretch of Interstate 70 to close between Vail and Georgetown for a time on Friday.

WEDNESDAY 27 SEPTEMBER 2006

In South Africa, heavy snow affected the Carletonville and Westonaria area in Gauteng for the first in 25 years.

MONDAY 9 OCTOBER 2006

Heavy snow of up to 30 cm fell across the high ground of south-central Montana, Canada. The heaviest snow fell across the Nye region.

MONDAY 9 OCTOBER 2006 – TUESDAY 10 OCTOBER 2006

Heavy snow fell across many higher districts of South Island, New Zealand. The areas that saw the heaviest snowfalls of up to 15 cm were Fiordland, Southland and South Otago.

TUESDAY 10 OCTOBER 2006

Heavy snow fell across the Sierra Nevada Mountains of California, USA.

WEDNESDAY 11 OCTOBER 2006

Heavy snow fell across Manitoba, Canada. The snow caused many roads to close around the city of Winnipeg.

THURSDAY 12 OCTOBER 2006 – FRIDAY 13 OCTOBER 2006

A rare early October snowstorm left parts of western New York State and Michigan, USA with up to 60 cm of snow in places, forcing schools to close and halting traffic. The snow downed tree branches and toppled power lines severing electricity to 380,000 homes and businesses. The snow forced Buffalo's Niagara International Airport in New York to close for two hours late Thursday evening. Buffalo also saw its snowiest October day since records began some 137 years ago when 20 cm of snow fell. In Chicago and Detroit, Michigan, the snowstorm on Thursday caused brief white-out conditions and marked the earliest measurable snow on record. The snowstorm claimed three lives across New York State, two in traffic accidents and one person was killed by a falling tree branch while shovelling snow.

SUNDAY 15 OCTOBER 2006

Up to 13 cm of snow fell across the state of Oregon, USA.

TUESDAY 17 OCTOBER 2006

Heavy snow fell across many districts of central and southern Utah and North Dakota, USA Cedar City in Utah and Trotters, North Dakota received nearly 15 cm of snow, while the mountain area of Utah received nearly 40 cm.

WEDNESDAY 18 OCTOBER 2006

Heavy snow affected the state of Colorado, USA The impact of the snow actually killed an individual, downed power lines and led to several traffic accidents.

SATURDAY 21 OCTOBER 2006

Further heavy snow affected the state of Colorado in the USA.

WEDNESDAY 25 OCTOBER 2006 – THURSDAY 26 OCTOBER 2006

Heavy snow affected many northern states of the USA. The snow caused power lines to snag and resulted in power loss to many districts across Indiana and Michigan. In Alaska, Deirdra Higgins was killed after her car left a snow covered road after 7 cm of snow fell. In Utah and Colorado, heavy snow fell across some districts, particularly across the Rockies. The snow forced many schools and roads to close including Interstate 25 and 70. Approximately 100 flights were cancelled at Denver Airport, while the town of Evergreen, Colorado received 65 cm of snow.

SATURDAY 28 OCTOBER 2006 – SUNDAY 29 OCTOBER 2006

Snow fell in Bicheno, Tasmania, for the first time in over 30 years. Snow also affected the Australian states of New South Wales and Victoria, while the capital city Canberra also experienced some snow flurries.

SUNDAY 29 OCTOBER 2006

Heavy snow affected northern districts of New York State, USA. Up to 25 cm of snow fell at Old Forge in Herkimer County.

WEDNESDAY 1 NOVEMBER 2006 – THURSDAY 2 NOVEMBER 2006

Heavy snow affected Sweden, particularly the capital Stockholm, where public transport was radically restricted during Wednesday evening. Road traffic accidents brought roads to a standstill and railway services were also disrupted.

THURSDAY 2 NOVEMBER 2006 – FRIDAY 3 NOVEMBER 2006

Heavy snow affected Finland, the Baltic States and Poland. The snow caused 200 reported traffic accidents across Latvia and Estonia.

SATURDAY 4 NOVEMBER 2006

Heavy snow affected Ohio, USA causing several traffic accidents across the area.

FRIDAY 10 NOVEMBER 2006 – SATURDAY 11 NOVEMBER 2006

Up to 40 cm of snow fell across southern Minnesota, north-eastern Iowa and south-western Wisconsin, USA. The areas that saw the heaviest snow were Albert Lea, Mantorville and Rochester in Minnesota and Osseo in Wisconsin. The snow's impact caused 24 traffic accidents within the state of Wisconsin, causing one fatality of an 84-year-old.

SUNDAY 12 NOVEMBER 2006

Up to 30 cm of snow fell in places across eastern Pakistan and Kashmir.

SUNDAY 12 NOVEMBER 2006 – MONDAY 13 NOVEMBER 2006

Heavy snow up to 30 cm in places fell across the Cascades in Washington, USA.

MONDAY 13 NOVEMBER 2006

In Juneau, Alaska, USA heavy snow caused the postponement of a special legislative session on state benefits for same-sex partners. Only approximately a dozen of the 60 lawmakers due to attend the meeting arrived in the capital city before the snowstorm forced the airport to close during the morning.

TUESDAY 14 NOVEMBER 2006

Parts of Colorado, USA saw heavy snow. The snow caused the closure of Interstate 70 between Vail and Georgetown for eight hours due to snow related accidents. Up to 30 cm of snow fell at Eisenhower Tunnel, 80 km west of Denver.

TUESDAY 21 NOVEMBER 2006

Sleet fell at approximately 2100 local time in central Florida, USA according to the National Weather Service. The last time the region saw snow was in 2003, when snowflakes fell over Brevard and Volusia counties. It was Florida's first November snowfall since 1912 when Tallahassee received snow flurries on the 27-28th November.

THURSDAY 23 NOVEMBER 2006

Parts of Oregon and Washington, USA experienced heavy snow.

FRIDAY 24 NOVEMBER 2006 – SATURDAY 25 NOVEMBER 2006

Heavy snow fell in northeast and northwest China. The worst hit areas were central and eastern Inner Mongolia Autonomous Region and parts of the provinces of Qinghai, Shaanxi, Shanxi, Liaoning, Jilin and Heilongjiang. Snow also fell across the north and east of Xinjiang Uygur Autonomous Region, eastern and north-western parts of the Qinghai-Tibet plateau, as well much of north China and southern and eastern parts of northeast China. The heavy snow caused significant disruption to traffic and damage to property as up to 70 cm of snow fell in places.

SATURDAY 25 NOVEMBER 2006 – MONDAY 27 NOVEMBER 2006

Parts of British Columbia, Canada received up to 45 cm of snow.

© **Conor McDonald** (top and bottom)
Brisbane, Australia
(6 December 2008)

*Conor's other lightning picture is featured
in the inside rear cover

"On Sat 6 Dec 2008 I had been watching the clouds brewing up hour by hour before the storms kicked off later. It didn't take long after darkness before the action started and the cells started moving in from the south-west. The main storm which I captured was very slowing moving and passed just to my north, this gave me great shooting conditions, no rain, no wind but plenty of lightning. It arrived on its own and was hammering CGs out every 3-4 seconds, I could see the rock solid towers climbing from the base and hear the sirens of the city fire service as the excitement rushed through my body. I managed to capture some nice shots of the lightning which really shows what a little beauty this cell was."

© **Matthew Taylor**
Taken from Las Vegas Airport
(October, 2004)



© Howard Kirby
 Low level moisture evident after frontal clearance. Taken from Mortimer Forest, UK
 (13 December 2008)

A Harbour Air seaplane flying 13 Rolling Stones fans from Victoria to Vancouver was forced to make an emergency landing due to the blinding snowstorm at Tsawwassen. During Monday, the heavy snow forced at least 65,000 primary and secondary school pupils to stay at home in Vancouver.

SUNDAY 26 NOVEMBER 2006

In Kashmir, heavy snow claimed the death of two people trying to walk across the Zojilla Pass in the Himalaya Mountains.

TUESDAY 28 NOVEMBER 2006 – WEDNESDAY 29 NOVEMBER 2006

Up to 30 cm of snow fell in parts of Nevada and Washington, USA. The snowstorm caused significant traffic chaos.

FRIDAY 1 DECEMBER 2006

Snowstorms affected many USA states from Texas to Michigan causing the death of 13 people. Most of the victims who died were involved in car crashes or were crushed by falling trees. The snow also caused the loss of electricity to over 2.5 million residents at some point during the day. Up to 45 cm of snow fell in some districts forcing airports and schools to close.

TUESDAY 5 DECEMBER 2006

Heavy snow fell in parts of Illinois and Missouri, USA. The snow caused power lines to fall, resulting in power loss to over 300,000 people.

WEDNESDAY 6 DECEMBER 2006

Heavy snow fell in northern India. The snow caused the closure of several roads and mountain passes across the states of Jammu and Kashmir, as up to 210 cm of snow fell. The heavy snow caused avalanches to occur that resulted in the death of six people. In Europe, the first significant snowfall of December occurred across the Pyrenees. Up to 15 cm of snow fell across the Aragon, Sierra Nevada and Catalonia region of Spain.

THURSDAY 7 DECEMBER 2006

Cheryl Cassatt of Philadelphia, USA crashed into a tree and died as she travelled in a snowstorm across the city. In many southern districts of Ontario, Canada, many hours of blizzard conditions occurred. Up to 40 cm of snow fell across London. The snow forced many schools and colleges to close on the 8th December. The snow also caused a 20 car pile up on one of the highways across the city.

SATURDAY 9 DECEMBER 2006

Up to 20 cm of snow fell across the State of Maine, USA causing 70 traffic accidents.

TUESDAY 12 DECEMBER 2006

Heavy snow fell across Oregon, USA particularly over the Rocky Mountain region.

MONDAY 18 DECEMBER 2006

A snowstorm affected the states of Utah and Nevada in the USA Salt Lake City, Utah received 60 cm of snow. Only minor injuries to property and people were reported, however over 100 traffic accidents were recorded due to the inclement weather.

WEDNESDAY 20 DECEMBER 2006

Heavy snow disrupted much of Colorado, eastern New Mexico and parts of Texas, USA. The snow forced the Governor of Colorado, Bill Owens to declare a state of emergency and mobilize the National Guard to rescue any stranded motorists. The snow also closed Denver and Albuquerque International Airports for several hours. Up to 30 cm of snow fell across New Mexico, while 60 cm fell across the higher regions of Colorado.

THURSDAY 21 DECEMBER 2006

Across the Valencia region of Spain, heavy snow closed several roads. The snow also forced 10,000 children across the district to stay at home after schools were forced to close.

MONDAY 25 DECEMBER 2006

In Australia, snow fell on Victoria's Mount Buller and Tasmania's Mount Wellington.

TUESDAY 26 DECEMBER 2006

Snow fell across the USA state of California. The Sierra Nevada Mountain region reported a fresh snowfall of 60 cm.

WEDNESDAY 27 DECEMBER 2006

The Turkey region of Antolian saw heavy snow causing several villages across the area to be isolated.

SUNDAY 31 DECEMBER 2006

Heavy snow affected the USA state of Colorado. An avalanche occurred trapping a father and son hiking in the Loveland Pass area.

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DAILY RAINFALL EXTREMES FOR GREAT BRITAIN AND NORTHERN IRELAND: PART 1

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Abstract: Part 1 of this paper, presented here, aims to bring together all available data on heavy one-day rainfalls in Great Britain (including the crown dependencies of the Channel Islands and Isle of Man) and Northern Ireland to produce a record of maximum daily rainfall totals for each day of the year. Part 2 of this paper (see March 2009 IJMet) also highlights notable rainfalls for durations of less than 24 hours (principally two hours or less). Finally, Part 2 of the paper will cover some more general analyses of the rainfall data gathered.

Keywords: Rainfall, Great Britain, Northern Ireland.

INTRODUCTION: DATA COLLECTION AND INCLUSION

There is no single, continuous data source for extreme rainfall since reliable records of rain began in the 1860s. Data for this paper were collected from three main sources plus various subsidiary sources, resulting in a combined period of cover from 1864 to the present day. Where data sources were overlapping, any disagreements were carefully investigated.

It is anticipated that there may be further rainfall data which this study did not identify and which could include extreme daily rainfalls not represented in the table below. The authors would welcome information regarding such additional data.

The authors have primarily used the current ceremonial county definitions rather than the definitions in place when the record was set. This is to enable a comparison by county if desired. For Scotland, the corresponding 1974-1996 "region" is noted in brackets, while for Wales we have included both the ceremonial (post 1974) county and (if different) the current administrative sub-divisions (the latter are widely used, as most of them closely relate to the pre 1974 historic counties). Daily rainfall extremes for each county have been previously presented by Webb (1987) and an updated list is in preparation.

In Part 1 of this paper, Table 1 presents a list of maximum recorded rainfalls for each day of the year. Table 2, in Part 2 of this paper (see March 2009 IJMet), presents a list of extreme falls within two hours by month, while Table 3 lists the maximum recorded falls for specific durations from five minutes to four hours (Part 2). The main sources of data have been:

(a) British Rainfall (1864-1968):

This comprehensive survey, founded in 1860 as Symons' British Rainfall, was produced by George, J. Symons for 40 years, then by Dr. H. R. Mill until 1919 when responsibility passed over to the Meteorological Office (Pedgley, 2002). It published full details of all heavy rainfalls on rainfall days. An official "rainfall day" is the 24 hours ending 0900 GMT with values "thrown back" to credit the day in which the period began. The publication also included details of heavy rainfalls in short periods, especially two hours or less. Given the rigour and expertise which went into these compilations and analyses, we have accepted the values in all but a few exceptional cases where there was compelling contradictory evidence. However, as further validation, we have checked all the relevant daily synoptic re-analysis charts (see Test 1 below).

(b) Monthly and annual rainfall totals (1969-1985) and Rainfall (1986-1991): These compilations were published by the Met Office following the cessation of British Rainfall, and although providing rather less detail, they included the highest daily rainfall totals at each individual station during each year.

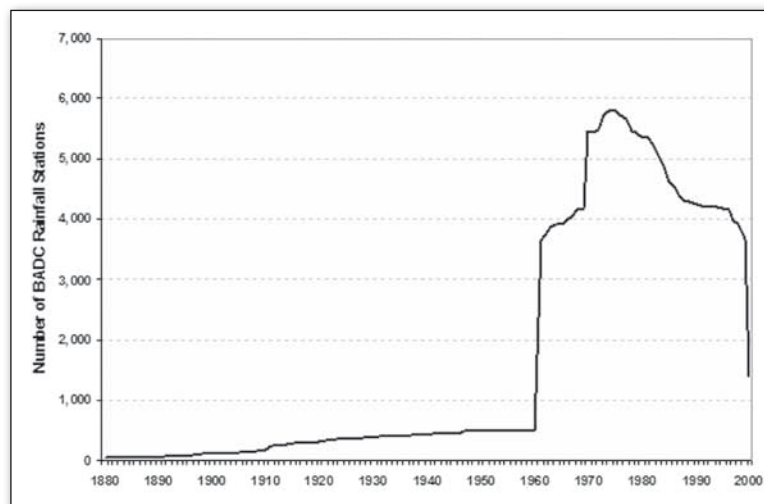


Figure 1. Number of BADC database stations by year.

(c) Met Office Land Surface Observations Station Dataset, via BADC (1864-2007): Using the British Atmospheric Data Centre (BADC) download site, Met Office Land Surface Observation Station data were obtained with each stored rainfall reading extracted. The dataset consists of daily rainfall totals in 0.1 mm units from over 11,000 sites, each covering various periods within the range 1864 to 2007. Figure 1 shows the number of active stations in each year from 1880 to 2000. It can clearly be seen that the majority of this data source is concentrated over the period 1961 to date, and it's main use has been to complement the other sources by providing coverage from 1961 to 2007 (and especially since 1992).

Table 1 (over several pages). Maximum recorded rainfall for each date of the year 1864 - 2008.

Notes: 7th May¹ Unofficial, but well corroborated by rainfall map (Allot, Hand and Lee, 2001); 6th June² See Jackson (1979); 9th June³ see note in Table 2 (March 2009 IJMet); 25th June⁴ This was from a gauge normally read monthly but which "contained 6 ins more after the storm than before" (*British Rainfall* 1935, page 65). The fall was well corroborated by the rainfall footprint from adjacent stations and by the numerous landslides in the vicinity. Based on data for Lower Swainswick, the fall occurred within three hours; 3rd July⁵ There were almost certainly higher, but unrecorded, falls in Gwynedd on this day, see Mason (2001); 17th July⁶ See Briscoe (1975); 28th July⁷ 168.8 mm reported at Fernworthy Res (Dartmoor) in 1969 but with some doubt over accuracy of gauge (Bridge, 1969); 16th Aug⁸ see Doe (2004), Burt (2005); 22nd Sept⁹ See Pike, 1993; 29th Oct¹⁰ 187 mm at Ottery St Mary-Kings School (Devon) in 27 hours to 1200 GMT on 30 October 2008; 22nd Nov¹¹ Some doubt as this reading was not well corroborated by reports from neighbouring stations.

Date	Rainfall (mm)	Year	Place	County/Region
January				
01-Jan	155.5	1992	Achnagart	Ross and Cromarty (Highland)
02-Jan	146.5	1982	Honister Pass	Cumbria

03-Jan	124.2	1982	Honister Pass	Cumbria
04-Jan	123.0	1974	Waen Sychlwych	Powys
05-Jan	171.8	1999	Honister Pass	Cumbria
06-Jan	142.7	2005	Kinlochewe	Ross and Cromarty (Highlands)
07-Jan	180.4	2005	Rydal Hall	Cumbria
08-Jan	154.9	1921	New Dungeon, Ghyll	Cumbria
09-Jan	112.3	1965	Cwm Dyli	Gwynedd
10-Jan	115.6	2006	Honister Pass	Cumbria
11-Jan	166.6	2000	Honister Pass	Cumbria
12-Jan	117.3	1948	Castell Reservoir	Rhondda, Mid Glamorgan
13-Jan	101.6	1989	Cassley	Sutherland (Highland)
14-Jan	156.5	1989	Achnagart	Ross and Cromarty (Highland)
15-Jan	138.4	1908	Llyn Llydaw, Snowdon	Gwynedd
16-Jan	130.3	1993	Kinloch Hourm, The Garde	Inverness-shire (Highland)
17-Jan	238.4	1974	Loch Sloy – Main Adit	Argyll & Bute (Strathclyde)
18-Jan	132.3	1899	Seathwaite	Cumbria
19-Jan	132.0	1973	Ballymaghera	Co Down, N Ireland
20-Jan	124.0	1969	Bryn Gwynant	Gwynedd
21-Jan	135.6	1957	Cwm Dyli	Gwynedd
22-Jan	119.4	1944	Oakeley Quarry	Gwynedd
23-Jan	85.6	1928	Llechwedd Quarry	Gwynedd
24-Jan	142.2	1868	Camusinas	Strathclyde
25-Jan	101.9	1920	Loch Quoich	Inverness-shire (Highland)
26-Jan	116.8	1901	Rhayader	Powys
27-Jan	95.3	1943	Llydaw Intake, Snowdon	Gwynedd
28-Jan	156.2	1906	Seathwaite	Cumbria
29-Jan	127.0	1898	Llechwedd Quarry	Gwynedd
30-Jan	119.9	1903	Loch Quoich	Inverness-shire (Highland)
31-Jan	139.7	1933	Watendlath Farm	Cumbria
February				
01-Feb	109.5	2002	Libanus	Powys
02-Feb	164.1	1909	Loch Quoich	Inverness-shire (Highland)
03-Feb	135.9	1938	Loch Quoich	Inverness-shire (Highland)
04-Feb	120.7	1928	Llechwedd Quarry	Gwynedd
05-Feb	185.5	1989	Kinloch Hourm	Inverness-shire (Highland)
06-Feb/1	196.6	1894	Ben Nevis Obs	Inverness-shire (Highland)
06-Feb/2	148.8	1989	Clunes Forest	Inverness-shire (Highland)
07-Feb	157.5	1946	Llydaw Intake, Snowdon	Gwynedd
08-Feb	106.5	1982	Honister Pass	Cumbria
09-Feb	173.0	1920	New Dungeon, Ghyll	Cumbria
10-Feb	154.0	2002	Honister Pass	Cumbria
11-Feb	178.8	1998	Keil	Argyll (Highland)
12-Feb	131.7	1998	Broadford	Skye, Highland

13-Feb	126.0	1893	Seathwaite	Cumbria
14-Feb	109.2	1926	Llydaw Intake, Snowdon	Gwynedd
15-Feb	156.5	1935	New Dungeon, Ghyll	Cumbria
16-Feb	103.9	1907	Ambleside	Cumbria
17-Feb	120.0	1997	High Snab Farm	Cumbria
18-Feb	79.8	1935	Fort William	Inverness-shire (Highland)
19-Feb	113.8	1990	Waen Sychlwch	Powys
20-Feb	74.6	1997	Stobo March	Borders
21-Feb	113.5	1918	New Dungeon, Ghyll	Cumbria
22-Feb	133.5	1991	Llanymawddwy	Gwynedd
23-Feb	104.3	1991	Honister Pass	Cumbria
24-Feb	115.2	1976	Kinlochewe	Ross and Cromarty (Highland)
25-Feb	101.6	1872	Amhall	Grampian
26-Feb	117.3	1885	Seathwaite	Cumbria
27-Feb	138.2	1933	Glen Muick (Inchnahobart)	Aberdeenshire (Grampian)
28-Feb	146.1	1955	Loch Ailort, Inverailort	Inverness-shire (Highland)
29-Feb	71.9	1928	Mourne Mountains (Fofanny Reservoir)	Co. Down, N Ireland
March				
01-Mar	95.3	1910	Patterdale	Cumbria
02-Mar	136.2	1979	South Laggan	Inverness-shire (Highland)
03-Mar	114.3	1986	Cwm Dyli	Gwynedd
04-Mar	116.6	1983	Gobernuisgach Lodge	Sutherland (Highland)
05-Mar	155.8	1983	Gobernuisgach Lodge	Sutherland (Highland)
06-Mar	90.5	1998	Moel Cynned	Powys
07-Mar	108.2	1926	Loch Quoich	Inverness-shire (Highland)
08-Mar	149.2	1979	Honister Pass	Cumbria
09-Mar	135.2	1982	Honister Pass	Cumbria
10-Mar	108.2	1981	Waen Sychlwch	Powys
11-Mar	81.5	1996	Man: Sulby Reservoir	Isle Of Man
12-Mar	88.2	1996	Spelga Dam	Co. Down, N Ireland
13-Mar	106.4	1947	Llydaw Intake, Snowdon	Gwynedd
14-Mar	85.8	1982	Llyn Llydaw	Gwynedd
15-Mar	187.0	1990	Kinloch Hourn	Inverness-shire (Highland)
16-Mar	108.0	1907	Seathwaite	Cumbria
17-Mar	75.9	1993	Loch Sloy	Argyll & Bute (Strathclyde)
18-Mar	117.6	1991	Honister Pass	Cumbria
19-Mar	112.5	1971	West Hopes	Lothian
20-Mar	125.0	1976	Spelga Dam	Co. Down, N Ireland
21-Mar	146.1	1981	Waen Sychlwych	Powys
22-Mar	108.0	1951	Loch Sloy	Argyll & Bute (Strathclyde)
23-Mar	152.4	1968	Cowlyd	Gwynedd
24-Mar	106.2	1967	Kinloch Hourn	Inverness-shire (Highland)

25-Mar	83.8	1899	Rhiwbryfdir	Gwynedd
26-Mar	164.3	1968	Glen Etive	Argyll & Bute (Strathclyde)
27-Mar	110.5	1968	Ratagan	Ross and Cromarty (Highland)
28-Mar	108.4	1999	Honister Pass	Cumbria
29-Mar	139.0	1993	Doune	Dunbartonshire (Strathclyde)
30-Mar	94.0	1977	Fasnachoich	Argyll & Bute (Strathclyde)
31-Mar	110.0	1948	Seathwaite	Cumbria
April				
01-Apr	95.3	1945	Castell Reservoir, Rhondda	Mid Glamorgan
02-Apr	165.1	1933	Loch Carron	Ross and Cromarty (Highland)
03-Apr	132.1	1949	Cwm Dyli	Gwynedd
04-Apr	109.7	1912	Loch Awe	Argyll & Bute (Strathclyde)
05-Apr	82.5	1947	Afton Reservoir, Filters	Strathclyde
06-Apr	101.1	1947	Glenshiel	Ross and Cromarty (Highland)
07-Apr	99.1	1947	Llydaw Intake	Gwynedd
08-Apr	70.7	1972	Lagafater Lodge	Ayrshire (Strathclyde)
09-Apr	93.2	1915	Seathwaite	Cumbria
10-Apr	114.3	1919	Corran Lighthouse	Argyll & Bute (Strathclyde)
11-Apr	70.1	1949	Coniston	Cumbria
12-Apr	86.6	1970	Yeoman Hey	Greater Manchester
13-Apr	103.0	1981	Fulking	West Sussex
14-Apr	130.3	1926	Snowdon (Llydaw Copper Mine)	Gwynedd
15-Apr	105.9	1970	Blaenau Ffestiniog	Gwynedd
16-Apr	69.1	1937	Cwm Dyli	Gwynedd
17-Apr	78.7	1925	Dunoon Reservoir	Argyll & Bute (Strathclyde)
18-Apr	83.6	1975	Esgair Y Maen	Powys
19-Apr	84.6	1944	Seathwaite	Cumbria
20-Apr	135.4	1975	Honister Pass	Cumbria
21-Apr	104.1	1880	Wanlockhead	Dumfries & Galloway
22-Apr	182.1	1970	Seathwaite	Cumbria
23-Apr	128.0	1971	Bedale – Craggs Lane Farm	North Yorkshire
24-Apr	90.0	1981	Sedbusk	North Yorkshire
25-Apr	93.0	2000	Ystradfellte Reservoir	Powys
26-Apr	136.4	1913	Llyn Fawr Reservoir	Rhondda, Mid Glamorgan
27-Apr	77.6	2000	Tarland	Aberdeenshire (Grampian)
28-Apr	88.5	1972	Honister Pass	Cumbria
29-Apr	66.5	1882	Fylingdales Moor	North Yorkshire
30-Apr	108.2	1891	Castell Reservoir	Rhondda, Mid Glamorgan
May				
01-May	114.3	1944	Loch Quoich	Inverness-shire (Highlands)
02-May	82.3	1974	Trekeivesteps	Cornwall
03-May	89.6	2003	Honister Pass	Cumbria
04-May	77.5	1929	Lluest Wen Reservoir	Rhondda, Mid Glamorgan

05-May	122.9	1920	Llechwedd Quarry	Gwynedd
06-May	93.1	1977	Couldoran	Highlands
07-May/1	87.0	2000	Bracknell	Berkshire ¹
07-May/2	71.9	1961	Glen Lochy	Argyll & Bute (Strathclyde)
08-May	172.2	1884	Seathwaite	Cumbria
09-May	83.8	1924	Buttermere	Cumbria
10-May	78.8	1979	Cwmrheidol	Dyfed
11-May	106.2	1992	Honister Pass	Cumbria
12-May	80.0	1932	Blaenau Ffestiniog	Gwynedd
13-May	84.0	1993	North Stainmore	Cumbria
14-May	101.2	1993	Ballypatrick Forest	Co. Antrim, N Ireland
15-May	130.6	1922	Ardgour House	Argyll & Bute (Strathclyde)
16-May	136.1	1962	Gobernuisgach Lodge	Sutherland (Highland)
17-May	105.9	1881	Aberdare	Rhondda, Mid Glamorgan
18-May	78.7	1930	Loch Quoich	Invernesshire (Highland)
19-May	193.2	1989	Walshaw Dean Lodge	West Yorkshire
20-May	98.3	1924	Clifton	Bedfordshire
21-May	100.6	1932	Ecclesfield	South Yorkshire
22-May	106.7	1941	Llydaw Intake, Snowdon	Gwynedd
23-May	109.5	1941	Linlithgow	West Lothian (Lothian)
24-May	128.0	2002	Honister Pass	Cumbria
25-May/1	132.1	1890	Tiverton	Devon
25-May/2	128.7	1993	Uffington (Sower Hill)	Oxfordshire
26-May	81.8	1911	Fareham	Hampshire
27-May	150.4	1902	Ben Nevis Obs	Inverness-shire (Highland)
28-May	74.7	1979	Waen Sychlwych	Powys
29-May	119.1	1920	Elkington Hall	Lincolnshire
30-May	162.8	1865	Seathwaite	Cumbria
31-May	134.9	1924	Hanmer	Flintshire, Clwyd
June				
01-Jun	82.4	1978	Heythrop College	Oxfordshire
02-Jun	97.0	1948	Farndale	North Yorkshire
03-Jun	103.1	1908	Upper Banden Reservoir	West Yorkshire
04-Jun	95.0	1966	Llechwedd Quarry	Gwynedd
05-Jun	144.8	1931	Annalong	Co. Down, N Ireland
06-Jun/1	150.0	1963	Southery	Norfolk ²
06-Jun/2	96.0	1982	Skipton – Embsay Reservoir	North Yorkshire
07-Jun	108.0	1910	Churchill School	Oxfordshire
08-Jun	203.2	1957	Camelford	Cornwall
09-Jun/1	132.1	1910	Wheatley	Oxfordshire ³
09-Jun/2	112.3	1913	Pen-y-Gwryd, Snowdon	Gwynedd
10-Jun	138.4	1926	Llydaw Intake, Snowdon	Gwynedd
10-Jun	137.0	1993	Conwy, Mussel Tanks	Conwy, Clwyd

11-Jun	165.1	1956	Hewenden Reservoir, Bradford	West Yorkshire
12-Jun	104.1	1919	Devil's Bridge	Ceredigion, Dyfed
13-Jun	120.0	1984	Honister Pass	Cumbria
14-Jun/1	97.7	2007	Harlow Hill Reservoir	West Yorkshire
14-Jun/2	94.0	1914	Richmond Park	Greater London
15-Jun	144.8	1931	Annalong	Co. Down, N Ireland
16-Jun	118.1	1917	Kensington	Greater London
17-Jun	185.0	1972	Honister Pass	Cumbria
18-Jun	109.5	1943	Llechwedd Slate Caverns	Gwynedd
19-Jun	91.1	1985	Balsham	Cambridgeshire
20-Jun	101.3	1936	Ciliau Aeron	Ceredigion, Dyfed
21-Jun	112.0	1936	St. Albans	Hertfordshire
22-Jun	113.0	1941	Newcastle-upon-Tyne	Tyne & Wear
23-Jun	140.7	1935	Llandwrog – Glynlliron Gardens	Gwynedd
24-Jun	130.0	1911	Lake Eigian	Gwynedd
25-Jun/1	152.4	1935	Swainswick	Somerset ⁴
25-Jun/2	127.0	1935	Great Chalford Manor	Wiltshire
26-Jun	125.0	1966	Llyn Stwlan	Gwynedd
27-Jun	105.7	1893	Stewartstown	Co. Tyrone, N Ireland
28-Jun	242.8	1917	Bruton	Somerset
29-Jun	74.2	1978	Tumby Woodside	Lincolnshire
30-Jun	127.0	1932	Princetown	Devon
July				
01-Jul	99.3	1914	Tibberton Court	Gloucestershire
02-Jul	148.1	1968	West Baldwin Reservoir	Isle of Man
03-Jul	105.2	2001	Voelas Hall (Bettys-y-Coed)	Conwy, Clwyd ⁵
04-Jul	130.0	1928	Llechwedd Slate Caverns	Gwynedd
05-Jul	122.7	1970	Ardgour House	Argyll (Highland)
06-Jul	128.8	1960	Slaidburn	Lancashire
07-Jul	116.8	1964	Llyn Stwlan	Gwynedd
08-Jul	127.0	1890	Sanday	Orkney Islands (N Isles)
09-Jul	120.7	1908	Fforest Fawr	Powys
10-Jul	173.0	1968	Chewstoke (Nempnett Thrubwell)	Somerset
11-Jul	135.4	1932	Barnoldswick	Lancashire
12-Jul	137.2	1900	Ilkley	West Yorkshire
13-Jul	97.8	1934	Wrexham	Wrexham, Clwyd
14-Jul	139.4	1965	Trevinson	Cornwall
15-Jul	146.3	1937	Waltham on the Wolds	Leicestershire
16-Jul	128.0	1947	Wisley	Surrey
17-Jul	120.7	1975	Aylsham	Norfolk ⁶
18-Jul	279.4	1955	Martinstown	Dorset
19-Jul	99.3	1947	Shrewsbury (Frodesley Hall)	Shropshire

20-Jul	147.0	2007	Sudeley Lodge	Gloucestershire
21-Jul	104.6	1964	Botolph Claydon	Buckinghamshire
22-Jul	160.1	1972	Ratlinghope, Coates	Shropshire
23-Jul	112.0	1903	Dartford	Kent
24-Jul	123.2	1904	Huddersfield	West Yorkshire
25-Jul	106.7	1930	Wetherby	West Yorkshire
26-Jul	121.4	1867	Hartlip	Kent
27-Jul	95.2	1909	Wynford House	Dorset
28-Jul	145.0	1969	Ellbridge	Cornwall ⁷
29-Jul	181.4	1938	Buttermere	Cumbria
30-Jul	127.3	1967	Oakeley Quarry	Gwynedd
31-Jul	140.0	1972	Costessey	Norfolk
August				
01-Aug	121.5	2002	East Scrafton	North Yorkshire
02-Aug	127.0	1969	Southam	Warwickshire
03-Aug	148.8	1938	Bovey Tracy (Hedgebarton)	Devon
04-Aug	140.0	1977	Honister Pass	Cumbria
05-Aug	169.7	1973	Waen Sychlwch	Powys
06-Aug	126.7	1875	Pontypridd	Mid Glamorgan
07-Aug	137.7	1907	Llydaw Intake, Snowdon	Gwynedd
08-Aug	161.3	1914	Pen-y-Gwryd, Snowdon	Gwynedd
09-Aug	115.9	2004	Castle Bytham	Leicestershire
10-Aug	136.7	1957	Llansadwrn	Anglesey, Gwynedd
11-Aug	129.5	1938	Strathaven	South Lanarkshire (Strathclyde)
12-Aug	157.7	1948	Kelso	Borders
13-Aug	106.7	1966	Sweetshaw	South Lanarkshire (Strathclyde)
14-Aug	170.8	1975	Hampstead	Greater London
15-Aug	228.6	1952	Longstone Barrow	Devon
16-Aug	200.4	2004	Otterham	Cornwall ⁸
17-Aug	109.5	1982	Llydaw Intake, Snowdon	Gwynedd
18-Aug	238.8	1924	Cannington	Somerset
19-Aug	140.5	1968	Oakeley Quarry	Gwynedd
20-Aug	118.4	1939	Blandford – Bryanston School	Dorset
21-Aug	109.7	1913	Seathwaite	Cumbria
22-Aug	101.0	1993	Exford, Church Hill	Somerset
23-Aug	166.0	2005	Honister Pass	Cumbria
24-Aug	156.0	1891	Seathwaite	Cumbria
25-Aug	134.9	1986	Aber (College Farm)	Gwynedd
26-Aug	185.7	1912	Brundall	Norfolk
27-Aug	152.4	1927	Llechweidd Slate Caverns	Gwynedd
28-Aug	100.1	1910	Rimpton	Somerset
29-Aug	111.3	1916	Donhead St Mary	Wiltshire
30-Aug	105.7	1976	Thorney, Nuts Grove Farm	Cambridgeshire

31-Aug	146.8	1994	Ditchingham	Norfolk
September				
01-Sep	125.2	1891	Ben Nevis Obs	Inverness-shire (Highland)
02-Sep	171.0	1983	Cowlyd	Gwynedd
03-Sep	114.3	1966	Washwater Hotel	Cumbria
04-Sep	135.4	1942	Seathwaite	Cumbria
05-Sep	131.3	1958	Knockholt	Kent
06-Sep	122.4	1980	Glenfinnan	Inverness-shire (Highland)
07-Sep	170.2	1898	Morpeth (Angerton)	Northumberland
08-Sep	103.1	1908	Strathmore	Caithness (Highland)
09-Sep	90.2	1978	Loch Winnoch STW	Renfrewshire (Strathclyde)
10-Sep	120.9	1955	Glenbrittle	Skye (Highland)
11-Sep	145.0	1976	Kildale-East Green Beck	North Yorkshire
12-Sep	91.2	1968	Low Byrness	Northumberland
13-Sep	157.7	2005	Broadford, Skye	Skye, Inverness-Shire (Highland)
14-Sep	114.3	1968	Hadlow Sewage Works	Kent
15-Sep/1	161.8	1968	Northchapel	West Sussex ¹
15-Sep/2	129.5	1968	Bromley	Greater London
16-Sep	139.7	1940	Oakeley Quarry	Gwynedd
17-Sep	153.9	1913	Doncaster P.S	South Yorkshire
18-Sep	147.3	1892	Seathwaite	Cumbria
19-Sep	110.7	1946	Llydaw Intake, Snowdon	Gwynedd
20-Sep	190.7	1973	West Stourmouth	Kent
21-Sep	90.9	1976	Exton	Somerset
22-Sep	113.3	1992	Walcot, Lodge Farm	Lincolnshire ⁹
23-Sep	115.1	1950	Llyn Morwynion	Gwynedd
24-Sep	119.6	1975	Honister Pass	Cumbria
25-Sep	179.3	1915	Croy	Highlands
26-Sep	131.1	1933	Fleet	Hampshire
27-Sep	106.3	1982	South Barrule	Isle of Man
28-Sep	118.3	1996	Grasmere, Tanner Croft	Cumbria
29-Sep	109.5	1883	Skegness	Lincolnshire
30-Sep	172.5	1890	Seathwaite	Cumbria
October				
01-Oct	142.5	1981	Ballure Reservoir	Isle of Man
02-Oct	185.2	1890	Ben Nevis Obs	Inverness-shire (Highland)
03-Oct	135.9	1918	Buttermere	Cumbria
04-Oct	153.0	1970	Dalness	Argyll (Strathclyde)
05-Oct	142.2	1916	Llyna Llydaw Copper Mine, Snowdon	Gwynedd
06-Oct	135.1	1874	Bryn Gwynant	Gwynedd
07-Oct	183.9	1960	Horncastle	Lincolnshire
08-Oct	129.9	1981	Waen Sychlwch	Powys

09-Oct	119.4	1942	Rydal	Cumbria
10-Oct	133.3	1980	Durrington	West Sussex
11-Oct	208.3	1916	Loch Quoich	Inverness-shire (Highland)
12-Oct	129.5	1938	Llechwedd Quarry	Gwynedd
13-Oct	125.7	1916	Loch Arkaig	Inverness-shire (Highland)
14-Oct	126.5	1877	Portree	Skye, Highlands
15-Oct	115.8	1983	Stonethwaite Mter	Cumbria
16-Oct	174.8	1961	Ratagan	Ross & Cromarty (Highland)
17-Oct	120.0	1976	Spelga Dam	Co. Down, N Ireland
18-Oct	120.3	1987	Waen Sychlwych	Powys
19-Oct	121.9	1908	Treharris	Merthyr Tydfil, Mid Glamorgan
20-Oct	113.4	1989	Maerdy W.Wks	Mid Glamorgan
21-Oct	188.2	1971	Glen Cassley	Sutherland (Highland)
22-Oct	115.4	1980	Llydaw Intake	Gwynedd
23-Oct	121.3	1977	Ennerdale, Bleach Green W.Tr. Wks	Cumbria
24-Oct	134.6	1936	Waterdlath Farm	Cumbria
25-Oct	150.5	1987	Kinloch, Isle of Rhum	Rhum (Highland)
26-Oct	116.4	1961	Llydaw Intake	Gwynedd
27-Oct	132.1	1888	Wythburn Vicarage	Cumbria
28-Oct	121.9	1949	Cheviot-in-Hope	Northumberland
28-Oct	114.3	1954	Kettleton	Dumfries and Galloway
29-Oct	177.8	1911	Seathwaite	Cumbria* ¹⁰
30-Oct	182.4	1977	Thirlmere, The Nook	Cumbria
31-Oct	158.9	1968	Tollymore Forest Park	Co. Down, N Ireland
November				
01-Nov	134.1	1927	Cwm Dylli	Gwynedd
02-Nov	158.2	1940	Llyn Fawr Reservoir	Rhondda, Mid Glamorgan
03-Nov	184.2	1931	Trecastle (Blaenau Hydfer)	Powys
04-Nov	147.4	1986	Waen Sychlwych	Powys
05-Nov	113.8	1979	Buttermere W.Wks	Cumbria
06-Nov	115.6	1953	Glenleven	Argyll & Bute (Strathclyde)
07-Nov	92.7	1918	Knock (Mull)	Argyll & Bute (Strathclyde)
08-Nov	142.7	1904	Ambleside	Cumbria
09-Nov	172.0	1972	Honister Pass	Cumbria
10-Nov	120.2	1989	Cowlyd	Gwynedd
11-Nov	211.1	1929	Lluest Wen Reservoir	Rhondda, Mid Glamorgan
12-Nov	204.0	1897	Seathwaite	Cumbria
13-Nov	170.2	1869	Seathwaite	Cumbria
14-Nov	125.0	1980	Honister Pass	Cumbria
15-Nov	108.0	2002	Torwinny	Highlands
16-Nov	162.1	1866	Seathwaite	Cumbria
17-Nov	130.5	1978	Honister Pass	Cumbria

18-Nov	112.2	1978	Swincombe	Devon
19-Nov	146.1	1901	Jura	Argyll & Bute (Strathclyde)
20-Nov	159.5	1947	Loch Quoich	Inverness-shire (Highland)
21-Nov	138.0	1969	Ballybraddy Forest	Co Antrim, N Ireland
22-Nov	217.9	1908	Llyn Llydaw, Snowdon	Gwynedd ¹¹
22-Nov	98.5	1995	Achnagart	Ross and Cromarty (Highland)
23-Nov	173.5	1946	Princetown	Devon
24-Nov	87.4	1929	Ilington	Devon
25-Nov	185.3	1979	Honister Pass	Cumbria
26-Nov	165.1	1953	Snowdon (Cwm Dylli)	Gwynedd
27-Nov	120.1	1979	Broadford, Skye	Skye, Highland
28-Nov	147.8	1917	Loch Quoich	Inverness-shire (Highland)
29-Nov	158.0	1972	Honister Pass	Cumbria
30-Nov	93.4	2006	Benmore Younger (Botanic Gardens)	Argyll (Strathclyde)
December				
01-Dec	132.1	1944	Llydaw Intake, Snowdon	Gwynedd
02-Dec	98.2	1986	Sloy	Dunbartonshire (Strathclyde)
03-Dec	154.2	1960	Taf Fechan	Powys
04-Dec	164.3	1864	Seathwaite	Cumbria
05-Dec	106.7	1921	Loch Quoich	Invernesshire (Highlands)
06-Dec	97.2	1984	Ardgour House	Argyll & Bute (Strathclyde)
07-Dec	105.2	1937	Newport	Isle of Wight
08-Dec	171.3	1983	Greenfield S.Wks	Greater Manchester
09-Dec	160.5	1909	Lochbuie	Argyll & Bute (Strathclyde)
10-Dec	168.6	2006	Honister Pass	Cumbria
11-Dec	99.0	1972	Honister Pass	Cumbria
12-Dec	188.0	1964	Oakeley Quarry	Gwynedd
13-Dec	144.8	1912	Seathwaite	Cumbria
14-Dec	137.7	1881	Sligachan	Skye, Highland
15-Dec	138.4	1928	Foffany Reservoir, Mourne Mountains	Co. Down, N Ireland
16-Dec	131.6	1932	Seathwaite	Cumbria
17-Dec	199.1	1966	Dalness	Argyll (Highland)
18-Dec	145.8	1965	Lluest Wen Reservoir	Rhondda, Mid Glamorgan
19-Dec	153.4	1949	Glenshiel	Ross and Cromarty (Highland)
20-Dec	138.0	1985	Honister Pass	Cumbria
21-Dec	123.1	1974	Waen Sychlwch	Powys
22-Dec	118.4	1909	Taf Fechan	Powys
23-Dec	118.8	1971	Achnagart	Ross and Cromarty (Highland)
24-Dec	111.0	1893	Buttermere	Cumbria
25-Dec	108.0	1914	Foffany Reservoir, Mourne Mountains	Co. Down, N Ireland
26-Dec	153.7	1924	Buttermere	Cumbria

27-Dec	127.3	1954	Loch Quoich	Inverness-shire (Highland)
28-Dec	129.5	1916	Dungeon Ghyll	Cumbria
29-Dec	170.0	1986	Glaspwll	Powys (North)
30-Dec	111.3	1921	Loch Arkaig	Inverness-shire (Highland)
31-Dec	119.2	1983	Cassley	Sutherland (Highland)

In total, 63,000,000 unique daily rainfall totals were selected, after removing records that covered more than one day and duplicate records. A minimum daily rainfall of 50 mm was then applied, which resulted in a database of just over 50,000 records. This database was then cleansed for obvious errors, such as those readings in excess of the official highest daily rainfall total (Martinstown, 1955 - 279.4 mm) and monthly totals rather than daily (some gauges, especially in more remote areas, are only routinely read monthly). The information was then sorted to give the highest rainfall for each day of the year. This output was compared to the highest daily rainfall for each day of the year generated by the other sources. Where the daily total from the BADC data was higher, a series of quality control 'tests' as described below were performed to decide whether to accept or reject the data. Examples of the testing were:

Test 1 (all data): Firstly, the synoptic situation for all the relevant days (regardless of the source of a reading) were reviewed, using information in British Rainfall and in the invaluable NCEP re-analysis charts (Wetterzentrale 2008, Meteociel, 2009). Any signs of potential for heavy rainfall, such as (for "dynamic" events) the track and depth of depressions with active frontal systems, would give the observation more weight than, say, if high pressure covered the country. Upper air information is also relevant, i.e. regarding the potency of frontal systems and, especially, with convective events in summer which are often associated with "slack" areas of surface low pressure. Re-analysed upper air charts, available since 1948, were consulted. Test 1 was especially useful with "marginal cases". Hand (2005) discussed the synoptic background to the most extreme 20th century events. Some of these historic events are also discussed by the NERC (1975) with particular reference to aerial extent.

Test 2: Was the BADC dataset daily record registered during the period of sources (a) and (b)? If yes, then it is likely to have been included there if genuine.

Test 3: How much support does the BADC dataset daily record have from other nearby stations? If there were a number of comparatively high readings from stations close by, more weight was given to the observation.

Test 4: Readings for preceding and following days were checked for any evidence that the reading related to more than one day. Some stations (as noted above) are not read daily and this is usually noted in the "day count" column of the raw data output.

Test 5: Was the reading verified in the column which records the Met Office's quality control check? If not, the reading was rejected.

(d) Monthly Weather Report, 1884-1993:

Details of notable daily rainfalls were included within the front page narrative. This source was especially useful from 1969 to 1993 in complementing the data in source b.

(e) Met Office Web-Based Monthly Weather Summaries (1999-present):

Since 1999 the Met Office has published monthly summary reports on their website. Although these summaries cover all aspects of the weather, exceptional daily rainfall totals are often individually mentioned. Any such reading which exceeded the highest daily total derived from the other sources was generally accepted, although, as with all readings, the synoptic situation was checked.

(f). Detailed Annual Summaries:

Published in the *Journal of Meteorology* for 1977 and 1978 (Mortimore, 1978; Burt, 1980).

(g) Other rainfall observations that have been suitably investigated and verified (see notes with Tables 1, 2 and 3):

This category includes those observations used in various "case study" papers. Indeed, in the investigation of severe convective rainstorms, appeals for information can be invaluable in identifying additional reliable but otherwise unknown rainfall readings which can supplement the official network in producing a detailed rainfall map (e.g. Pike, 1994).

Part 2 will be published in the next issue and will include the full lists of acknowledgements and references for Parts 1 and 2.



TORRO TORNADO DIVISION REPORT: June to August 2008 (Part 1)

By PAUL R. BROWN and G. TERENCE MEADEN

Synoptically, June 2008 was an average month: there were no known tornadoes, but there were 10 reports of funnel clouds and one of a pair of waterspouts. July was mostly unsettled with westerly or cyclonic types, but with a hot spell in the last week: the month produced two tornadoes (one definite, one probable), 11 reports of funnel clouds, and two land devils. August was very unsettled (and exceptionally cloudy), with depressions frequently over the British Isles: there was one definite tornado, 11 reports of funnel clouds, and one land devil (a report of a tornado in County Armagh on the 11th was discounted). N.B. All the foregoing figures exclude any events in the Irish Republic.

FC2008Jun(early) *Brecon Beacons, Powys (51° 53' N 3° 26' W, SO 0021)*

The BBC published an undated photograph of a funnel cloud descending from a thunder cloud, taken by Mr Nick Williams over the Brecon Beacons. The picture shows a slender funnel reaching to below the mountain summits but not (apparently) to the valley floor. The date of publication was the 11th June, so we assume it was taken earlier in the same month.

fc/tn2008Jun05(or earlier) *Near Bury St Edmunds, Suffolk (c 52° 14' N 0° 43' E, TL 8564)*

Mr Nigel Spencer contacted the BBC about what he thought was a tornado that he saw while travelling from Bury St Edmunds to Cambridge. He said "... as I came out of Bury you could see it was black and it was obviously coming out of the sky and then going down to the ground rather than being held up in the clouds."

The evidence is not strong enough to document this as more than a probable funnel cloud. The report was published late on the 5th June, but does not say if that was the date of occurrence, nor does it give a time of day. At 1200 GMT on the 5th a slack pressure pattern covered the British Isles, with a small low of 1013 mb over Cardigan Bay. There was some rain or showers in the west, but other areas were mainly dry.

fc2008Jun06/I *Doncaster, South Yorkshire (53° 30' N 1° 07' W, SE 5702)*

Tim Prosser of TORRO sent in photographs of shower clouds taken from Doncaster in the early evening, one of which appears to show a funnel cloud. At 1800 GMT there was a weak ridge of high pressure over western Ireland and a weak northwesterly airflow over England; there were shower troughs over eastern Ireland and eastern England. Scattered showers affected Ireland and central England, while more persistent rain occurred near the east coast.

fc2008Jun06/II *Maghera, County Derry (54° 50' N 6° 41' W, C 8500)*

A correspondent to the UKweatherworld forum submitted photographs of what appeared to be a small funnel cloud (time not stated).

2FC2008Jun11 *Airth, Stirlingshire (56° 04' N 3° 46' W, NS 8987) and Bo'Ness, West Lothian (56° 00' W 3° 36' W, NS 9981)*

A correspondent reported these two funnel clouds seen within five minutes of each other at 1822 (1722 GMT), length about 20% of cloud-ground. They appeared on the leading edge of a squall. At 1800 GMT a cold front, introducing a northerly airstream, was moving south over Scotland close to the area of observation. There were showers on and just ahead of this front.

2WS2008Jun13 *English Channel, north of St Brieuc (c 48° 40' N 2° 40' W)*

Mr Peter Paxton reported seeing two well-defined funnel clouds with waterspouts while flying about 12 (nautical?) miles (c 22 km) north of the Brittany coast, off St. Brieuc, at 0815 GMT. (Information from Mr Frank Le Blancq of Jersey Meteorological Office.) At 0600 GMT a weak northerly airflow covered the British Isles between a high, 1031 mb, off west Iceland, and a low, 1002 mb, in the Skagerrak. There was broken cloud and a few showers in the English Channel (e.g. at Alderney) at the time of the sighting.

2FC2008Jun15/I *Scunthorpe (to north), Lincolnshire (c 53° 35' N 0° 38' W, SE 8910)*

Photographs of these two funnels, seen together just north of Scunthorpe, were submitted to The Weather Outlook forum. One of them was said to have reached at least halfway to the ground. Other reports and photographs of what were evidently the same funnels were received from Mr Paul Thackray and Mr Ian Coates, while the *Scunthorpe Telegraph* published an account, with picture by Mr Colin Pumfrett. There is some variation in the reported times of sighting, but they seem to have been seen shortly after 1 pm (1200 GMT).

At 1200 GMT a weak northerly airstream covered the British Isles between a complex low, 1000 mb, over Norway and another low, 1007 mb, in sea area Finisterre. Occasional showers developed over eastern England and parts of the south (and also highland Scotland), but elsewhere the day was dry with sunny periods.

FC2008Jun15/II *Brough, East Riding of Yorkshire (c 53° 43' N 0° 35' W, SE 9326)*

Mr Paul Thackray (see above) also saw a third funnel in the Humber/Brough area some time after the other pair (he was not specific about how much later this was, and we have therefore treated it as a separate event).

FC2008Jun15/III *Woodhall Spa, Lincolnshire (53° 09' N 0° 12' W, TF 1963)*

The *Lincolnshire Echo* of the 16th June published a photograph of a funnel cloud (described as a 'mini-tornado'), submitted by Mr Mike Casey and Ms Jackie Casey. It was seen at about 2.30 pm (1330 GMT), and the picture shows a long diagonal funnel reaching a good way towards the ground.

2FC2008Jun15/IV *Hayling Island (offshore), Hampshire (c 50° 48' N 0° 58' W, SU 7201)*

Photographs of another pair of funnel clouds, one very short, the other at least halfway to the sea, were submitted to the UKweatherworld forum. They were seen over the English Channel from Hayling Island between about 1823 and 1840 BST (1723-1740 GMT). A report in the *Chichester Observer* of the 26th June appears to relate to the same event.

FC2008Jun15/IV *Littleport, Cambridgeshire (52° 27' N 0° 18' E, TL 5686)*

A correspondent to The Weather Outlook forum submitted a photograph of a very slender funnel cloud about a quarter of the way to the ground, which was visible for 10 minutes. Time of day not stated. (Another correspondent in the same discussion mentioned that he had seen something 'similar' after visiting Chesil Beach in the afternoon, but this seems rather too vague to be documented separately.)

Part 2 concludes in the next issue of IJMet

LETTERS

A DEVASTATING TORNADO IN THE NORTH OF FRANCE - 3 AUGUST 2008

By DR. JEAN DESSENS

Centre de Recherches Atmosphériques, 65300 Campistrous, France

The most violent tornado of these past 40 years in France occurred in the late evening of Sunday, 3 August 2008, in a populated area near Maubeuge (North). The tornado touched down at Pont-sur-Sambre (03°50'E, 50°13'N) then followed the Sambre valley on an 18 km SW-NE path until Boussois. In the middle part of its life, at Hautmont, 20.30 UTC, the tornado reached the F4 intensity on the enhanced Fujita scale, which corresponds to T8 on the TORRO scale. Neuf-Mesnil and Boussières are the other villages located in the core of the disaster. Altogether, three people were killed in the collapse of their house, another committed suicide after the complete destruction of his house, and 18 were injured, four of them very seriously. The fact that the tornado occurred at the beginning of the night certainly did not facilitate the rescue operations.

It was not a "mini-tornado", as it was called in some newspapers (including *Le Monde* in its edition dated 5th August). The Minister of the Interior, Michèle Alliot Marie, who visited the devastated country the next day, summarizes the sight as follows: "Ca ressemble à ce que j'ai vu dans le sud du Liban, on a l'impression que des bombes sont tombées" (*Le Monde*, 6 Aug.) ["It looks like what I saw in southern Lebanon, it is as if bombs had exploded"]. On the tornado path of about 100 to 200 m width, 2000 people have been directly affected by the tornado and 250 housings have been made uninhabitable.

The tornado path is in direct continuation of the Busigny-Pommereuil F4 (T8) tornado of June 27, 1967, and not far from the F5 (T9) tornado of the same day at Palluel, which confirms that this region is really concerned by tornadoes. The day was characterized by the penetration on the north of France of an undulating front along which a mesocyclone developed in the afternoon. The formation of a supercell storm was favoured by warm temperatures near the surface, and by a jet stream at upper level (108 kt at 11.6 km, Brest, 4th August, 0000 UTC).

For more information, I recommend the website of Keraunos (<http://www.keraunos.fr>), and viewing the excellent report made by Pierre Mahieu and Emmanuel Vesolek. In 100 pages of text, figures and photographs, they report in detail the damages along the tornado course, they analyze the meteorological situation in a very modern way (including numerical simulations), and they illustrate the disaster by many tragic photographs. It is interesting to note that the forecast for a tornado situation was correctly made and displayed on the web on Sunday morning by KERAUNOS, and also by the German forecasters of ESTOFEX.

With this letter, I want to inform your readers of this meteorological disaster which occurred only 200 km from England in an early night of this past summer. I also want to acknowledge associations like TORRO in England, KERAUNOS and ANELFA in France, which contribute to the improvement of scientific knowledge, forecast and prevention of severe storms in Europe.



BOOK REVIEW

By PETER ROGERS

GREAT BRITISH WEATHER DISASTERS BY Philip Eden ISBN 978-0-8264-7621-0 2008 Continuum UK, The Tower Building, 11 York Road, London SE1 7NX 2008 hb pp 351. £16.99.

This latest book by Philip Eden, well known as a writer and broadcaster on weather topics is a most topical contribution to the debate on British weather disasters and how they are treated by the media.

It falls into two Parts. The first has 10 chapters. The first three are entitled "*Setting the Scene*"; "*Coping with the Hazard*" and "*The Nature of the Hazard*" and these are followed by five chapters in which Philip covers two case studies on Snowstorms; Fog and Smog; Summer Floods; Destructive Gales and Droughts. This section then ends with two chapters entitled respectively, "*Compare and Contrast*" and "*...the next disaster please*".

The second part consists of a chronology of disaster: severe weather events in the UK from 1901 to 2008. This section is extremely comprehensive, occupying 140 pages, and mentioning virtually every severe weather event in the period covered.

Philip's choice of disasters for his pairs frequently cover events that are not at all well documented, such as The "Great Stinking Fog" of 1873 and The Gale of 26 January 1884. One of the strength of these chapters is the author's re-assessment of the synoptic situations of the various events, as illustrated by charts and tables containing much detail. There are also, where appropriate, small black and white photographs, usually of the more recent events.

The theme running throughout this book is that the media are constantly thirsting for records and sensational stories and that they will not hesitate to "spin" weather stories to that end, very often resulting in the public getting a misleading picture of what is happening to our weather and climate.

Although I enjoyed the entire book, I found the last two chapters in Part 1 to be the most thought-provoking, particularly Philip's thoughts on how climate change is likely to result in the UK experiencing more frequent and hotter summers and fewer cold winters in the present century.

I can unhesitatingly recommend this fascinating book that is written with the interested layman particularly in mind. The price puts it well within the reach of most individuals and I am certain that readers of this Journal would be both entertained and educated by reading it.

Send your stunning photographs to our Photography Director,
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