Barometric pressure during the Irish storm of 6–7 January 1839

Stephen Burt
Stratfield Mortimer, West Berkshire

The depression which passed north of Ireland and across northern Scotland on 6–7 January 1839 resulted in one of the most severe gales to affect Ireland in recorded history. Rohan (1975, pp. 104–5) described the havoc caused by this storm, concluding "it … probably caused more widespread damage in Ireland than any storm in recent centuries. This night has become legendary as 'The Night of the Big Wind'". Lamb (1991) considered it the most severe storm to affect Ireland within the last 500 years, pointing out "far less effect was felt there from the 1703 and 1987 storms which are much more famous in England."

A detailed account of the storm was assembled to mark its 150th anniversary by the Irish Meteorological Service (Shields and Fitzgerald 1989) to which readers are referred for an account of the severity of the gale, which caused immense damage and considerable loss of life in Ireland, Scotland and north-west England and subsequently passed into popular folklore. In their paper the authors assembled sufficient wind and weather observations and barometer readings to attempt the construction of two synoptic charts (for 00 h and 09 h on 7 January 1839). The results were very similar to the analysis suggested by Lamb (1991, pp. 131–3) working independently at that time. Based upon contemporary published accounts containing a selection of barometer readings, both analyses agreed in their conclusion that this appeared to have been one of the deepest depressions ever recorded in the immediate vicinity of the British Isles. Based largely upon the lowest published barometer readings (922.8 mbar at Sumburgh Head, Shetland at 14 h on 7 January and 925.2 mbar at Cape Wrath, Sutherland at 00 h on 7 January*) the central pressure of the depression was suggested by Shields and Fitzgerald to be about 918 mbar at 58½° N, 11° W at 00 h on 7 January. This would place it as one of the deepest cyclones on record in the North Atlantic (see Burt 1987; 1993), while the Sumburgh Head barometer reading would be the lowest on record for the British Isles by almost 3 mbar. The depression passed close to the Orkney Islands before moving out into the North Sea and eventually into the Baltic.

This brief analysis examines the validity of the barometric pressures reported in contemporary accounts, and presents evidence to suggest that the barometric pressure values published at the time (and subsequently republished in the subsequent accounts of Shields and Fitzgerald and Lamb, *op cit*) were almost certainly 'station level' values rather than corrected to mean sea-level (MSL). Retrospective corrections to MSL are proposed and the reconstructed synoptic analyses of Shields and Fitzgerald modified slightly to suggest a minimum central pressure of the storm closer to 930 mbar. The lowest observed MSL pressure at Sumburgh on 7 January 1839 was probably close to 931 mbar; the lowest MSL pressure yet observed in the British Isles remains the 925.6 mbar at Ochertyre, near Crieff, Tayside (56°23′ N, 3°53′ W, 101 m AMSL) at 2145 h on 26 January 1884 (Buchan 1884).

Extant observational data

Records of barometric pressure for this event survive from 38 sites in the British Isles (Table 1). Lamb used 'additional data points' from sites in Europe and in Scandinavia in his analysis of the event; it is not known how many of these 38 sites were used in his analysis. The majority of the extant records (22 sites) were from lighthouses run by the Commissioners of Northern Lights (now the Northern Lighthouse Board, NLB) in Scotland and the Isle of Man, and were published by Espy (1841, pp. 531–532) based upon information communicated to the Royal Society by Robert Stevenson. Robert Stevenson had built many of these lighthouses; he was the father of Thomas Stevenson, who in 1866 invented the Stevenson screen. (For an excellent and very readable account of the Stevenson dynasty and the development of the Scottish lighthouses, see Bathurst 1999). The table published by Espy included wind observations at all 22 sites together with the 'Lowest state of barom.' and the time of the minimum pressure at all but one of the sites; more detailed accounts of wind and weather at several of the sites were also given in text form. These sites are mapped in Fig. 1. As these observations were closest to the centre of this exceptional depression, this analysis concentrates on these 21 pressure readings.

Although it is quite possible that hourly or three-hourly barometer readings were

Table 1

Sites for which at least one barometric pressure reading is available for the storm of 6–7 January 1839

Source	*Locations*
Espy (1841)	SCOTLAND – Glasgow; Applegarth Manse, Dumfriesshire; Dundee; Edinburgh; Aberdeen; Orkney; and the 21 sites in the Stevenson table
	IRELAND – Birr; Limerick
	ENGLAND – Whitby; London; Leeds; Thwaite, Suffolk; New Romney, Kent
Shields and Fitzgerald (1989)	Carrickfergus, Co. Antrim; Dublin (Phoenix Park and North Frederick St)
Armagh Observatory	MS records available online at climate.arm.ac.uk

* The original measurements made in inches of mercury (in Hg) have been converted to millibars throughout; most are to a precision of 0.01 in Hg ~ 0.3 mbar.

RMetS Royal Meteorological Society

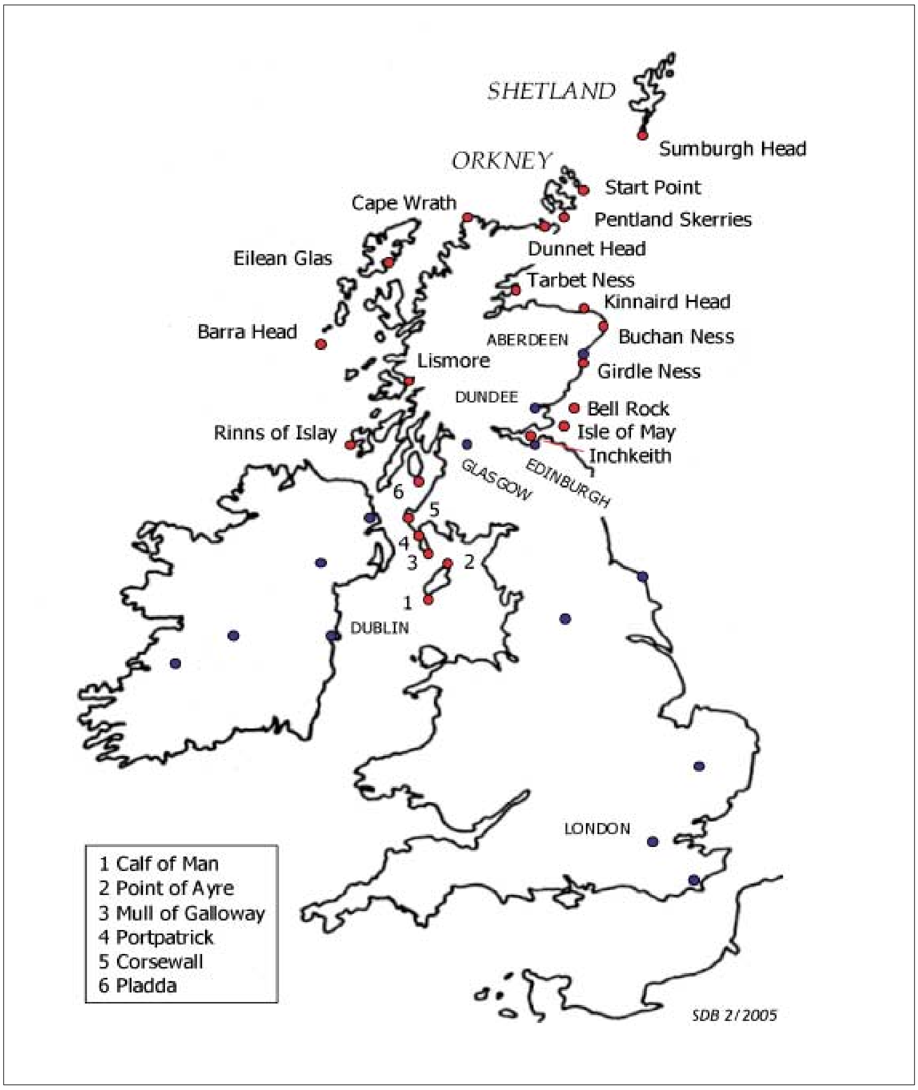

Fig. 1 Locations of places referred to in the text. Red circles show the locations of NLB lighthouses (named); blue circles show other sites where one or more barometric pressure readings are known (see Table 1 for locations)

made at most of the lighthouse sites, enquiries to the archives of the Northern Lighthouse Board (now in the National Archives of Scotland) confirmed that the original lighthouse logbooks no longer exist; neither does the Archive of the Royal Society in London or the National Library of Scotland in Edinburgh retain the original of Robert Stevenson's communication, which may have contained additional relevant information. Thus Espy's published table remains the only surviving record of barometric pressures close to the depression centre during this notable storm.

Sources of error

It is standard practice today to 'reduce' barometer readings to mean sea level by applying corrections to the observed reading. Many terms are included in the total correction, of which the altitude of the barometer and (for mercury barometers) the temperature of the mercury column are normally the two largest (Meteorological Office 1956). The published barometer readings from the Scottish lighthouses during this storm are potentially subject to several sources of error as the contemporary records do not state that any corrections were applied. The most likely sources of error are summarised below.

True minimum error

It is not known how often the barometers at the lighthouses were read, but at all but three of the 21 observations the time of minimum is an exact hour, which would suggest that the barometer was read hourly (at least on this occasion). At two of the other three sites the minimum was identified at the half-hour and at one at 45 minutes past the hour, implying that at a few sites the barometer was at least watched if not read more frequently and a reading close to the true minimum obtained. At the stations closest to the depression centre, a period of light winds or calm was observed as the centre of the depression passed nearby. We might therefore expect that for stations nearest the depression, the rate of change of pressure near the minimum would be relatively small, say 2 mbar/hr or less; therefore a 'time of reading minimum' error of 30 minutes would introduce an error of perhaps only 1 mbar into the 'true minimum'. At stations further from the centre the rate of pressure change would be greater, perhaps up to 5 mbar/hr, implying perhaps 2–3 mbar uncertainty for these sites. At only one site (Corsewall) does the observed minimum seem so high in comparison with other observations as to suspect the true minimum was missed.

Barometer calibration

The calibration error of the barometers used is not stated in Stevenson's communication and, at a distance of almost 170 years and in the absence of the original logbooks, is impossible to determine. It is probably a reasonable assumption that the instruments used were robust and of professional quality and that index errors were small, almost certainly less than 1 mbar.

Temperature of the barometer

The barometer temperature also affects the height of the mercury column. Modern practice is to reduce the observed reading of the mercury column to the value it would be at 0 °C, using the temperature indicated by a thermometer attached to the barometer. Stevenson's table does not state whether or not the observed readings have been reduced to 0 °C (or any other temperature). On the assumption that all the lighthouse barometers were at between about 12 and 17 °C when read, the readings would be approximately 2 mbar too high. (This may be too warm and the likely error less than this. The Armagh Observatory logbook for January 1839, available online, shows the average 'attached thermometer' reading for the evening (22 h) observations to be a chilly 3.5 °C.)

Pitot tube errors

Barometer readings in lighthouses are prone to Pitot tube errors, particularly where the instrument is mounted at a considerable height in a tall lighthouse column. These errors can be substantial in strong winds and are negative in sign i.e. the barometer reads too low. This probably accounts for the inconsistency in some of the observed values at sites reporting strong winds throughout the storm, although the effect is probably insignificant at the locations where light winds were reported for a time close to the centre of the depression.

Correction to mean sea-level

For all except those sites located very close to sea-level, the height correction is likely to be the most substantial error, amounting to approximately 1 mbar per 8 metres altitude at an air temperature of 5 °C and an observed pressure of 1000 mbar (Meteorological Office 1956). Thus the error from altitude is likely to dwarf possible calibration, barometer temperature and 'time of minimum' errors combined for all sites more than about 30–40 m above sea-level – none of the 21 is lower than 25 m above MSL. The altitudinal correction varies with external air temperature, but even for a site at 100 m altitude the variation is only ±0.2 mbar for a change in air temperature of about 5 degC on either side of 5 °C and is thus much less significant than the other errors considered here.

The practice of 'mean sea-level correction'

There is no evidence from Stevenson's table in Espy (*op cit*) that the quoted readings had been reduced to mean sea-level; indeed, the heights of the ground on which the lighthouses stood was probably not even known accurately enough at that time to attempt such a correction. Shields and Fitzgerald quoted values from Espy's original table verbatim, stating "no attempt has been made here to adjust the readings …" and Lamb appears to have done the same.

That the air has weight and that barometric pressure decreases with height has been known since Torricelli's famous experiment in 1644. What is not clear, however, is when correcting barometer readings to a standard datum level (such as mean sea-level) became standard practice. For this to take place, two items must be known reasonably accurately, viz. the height of the barometer above the datum point, and the size of the correction to be applied for the difference in altitude*. It seems unlikely that either were known with sufficient accuracy in 1839 to attempt a standardised correction to mean sea-level.

Several contemporary accounts of other notable depressions around this time confirm that no such corrections were applied to 'as read' barometer readings. One of the earliest storms to be mapped in a recognisable 'synoptic chart' format was the exceptionally deep depression of 25 December 1821 (during the passage of which the barometer in London fell below 950 mbar – Burt 1989). The map of this storm published by Brandes (1826) has some claim to be the world's first weather map (Monmonier 1999). A student of Brandes, Heinrich Dove, formulated one of the earliest explanations of mid-latitude storms as resulting from the contest between opposing warm and cold air currents in his classic work *The Law of Storms* (Dove 1828, transl. FitzRoy 1858) following detailed analysis of this event and others, but crucially the basis for pressure mapping he utilised was not as a 'reduction to sea-level' but as 'differences from normal' (although exactly what normal was not stated), thereby largely removing the effects of (unknown) altitude. Isobars and thus presumably also an understanding of standard datum corrections are also 'conspicuously absent' from the contemporary work of Espy (Monmonier, *op cit*, p. 35) who was attempting to derive a workable theory on the circulation of storms at this time, and used the 1839 storm as a case study (Espy 1841, *op cit*). In a much later reference to the low barometer readings over England on 13 January 1843 (Symons 1892), prefixing a verbatim reprinted contemporary account from William Ick of the Birmingham Philosophical Institution, stated "Unfortunately there had then been no general levelling throughout the country, and the values given in Mr Ick's table are not reduced to sea level."

We don't know for sure when barometric corrections to mean sea-level did become the norm. Monmonier (*op cit*) in his excellent study of the evolution of the weather map is silent upon this crucial point. He includes (on p. 45) Urbain Le Verrier's map for 16 September 1863, credited with the first use of isobars on a telegraphic weather map, depicting an anticyclone over south-east France. As many of the plotted observations are from inland rather than coastal locations this necessarily assumes some knowledge of barometer altitude and a correction to mean sea-level. Le Verrier, who was an astronomer and the Director of the Paris Observatory, is also credited with the introduction of the term *isobar* as the concept of joining places with equal pressure (Gribbin and Gribbin 2003, p. 325). In Britain, Robert FitzRoy established the Meteorological Department of the Board of Trade (now the Met Office) in August 1854. We know from FitzRoy's *The Weather Book: a manual of practical meteorology* (FitzRoy 1862) that telegraphic observations of the main meteorological elements received from his network of reporting stations were "immediately read and *reduced, or corrected*, for scale-errors, *elevation*, and *temperature* …" (my italics) - as quoted in Gribbin and Gribbin (*op cit*) p. 270. As this network was established from about 1857 this seems most likely to mark the beginning of today's standard practice of correcting barometer readings to MSL. The first handwritten *Daily Weather Report* of the British Met Office, published on 3 September 1860, included a footnote to the 10 observations stating 'Barometer corrected and reduced to 32° [F] at sea-level (mean)'; this is the earliest reference I can find to this being accepted standard practice. (For more than a decade the *Daily Weather Report* was only a tabular presentation of observations from FitzRoy's observing network; isobaric pressure maps were not included until March 1872. For a more complete account, see Lewis 1982.)

On the basis of the available contemporary evidence, therefore, it would appear most unlikely that Stevenson's table of barometer readings in the Scottish lighthouses in the January 1839 storm were corrected to mean sea-level, for such corrections did not become established practice until about 20 years later.

This being the case, and as the error due to altitude was likely to be the most significant term, the barometer readings from the Scottish lighthouses for this storm were re-examined and a retrospective mean sea-level pressure correction applied.

Proposed corrections to the 1839 lighthouse barometer data

The altitudes of each of the lighthouses was determined from two sources. The first, the lighthouse directory on www.nlb.org.uk, gives useful information on all the NLB lighthouses including altitude, although it is not always clear exactly what this 'altitude' refers to – sometimes it is clearly the height of the lantern itself above sea-level rather than the land on which the lighthouse stands. Many of the Board of Northern Lights lighthouses also had other meteorological equipment and most of them can be found listed in the annual volumes of *British Rainfall*, together with the site (raingauge) altitude. In most cases these agreed closely with the NLB value, but for a few where there were significant differences one or the other was chosen based partly upon the site descriptions and photographs in Krauskopf (2001) or on the NLB site, and partly on the 'best fit' of the observed barometer readings themselves. All are presented together with the

* For the resulting MSL value to be accurate to 0.1 mbar, additional corrections for outside air temperature, gravity corrections for latitude and height and instrument index error must also be included – see for example Met Office (1956)

derived MSL corrections in Table 2 and Figs. 2 and 3*. The published values from Espy were also corrected for mercury column temperature, assuming a barometer temperature of 14 °C (a reduction of 2.1 mbar; at 10 °C the reduction would be 1.5 mbar, and at 20 °C 3.1 mbar).

In most cases, the consistency of the observations and the fit to the postulated synoptic pattern was greatly improved. In particular, the range of values between the five lighthouses closest to the centre of the depression along the northern coasts of Scotland, the Orkney Islands and Shetland was reduced to 5 mbar, compared with an unlikely 12 mbar from the uncorrected observations.

In Fig. 4 the observed and proposed corrected values from the five lighthouses in

* The altitude of the lighthouse was relatively straightforward to determine; less clear is where the barometer itself would have been located. The NLB website has photographs of most of these lighthouses; it appears that most have (had) keeper working/accommodation areas (and thus presumably the barometer) located in single-storey buildings at ground level, except at 'rock' sites where only the lighthouse itself protrudes above the sea (such as at Bell Rock). In a tall columnar lighthouse such as Bell Rock (36 m tall), the instrument may have been 20–25 m or more above nominal mean sea level; for example, Burt (2004) states that at Bell Rock a thermometer screen was located 25 m above mean high water until 1972. In all cases, errors owing to the barometer being at a greater height than the nominal altitude of the lighthouse base would result in a higher MSL pressure by approximately 1 mbar for every 8 m. Barometer observations from such columnar lighthouses would also be most likely to be affected by Pitot-tube errors in strong winds.

Table 2

Approximate mean sea level pressures at the 'Northern Lighthouses' for the storm of 7 January 1839. See text for details of assumptions and corrections applied

Location	Alt (m)	Stevenson min	Time	Corrections TT	Corrections MSL corr'n	Corrected MSL
Inchkeith	67	931.3	05h 7th	−2.1	+7.6	936.8
Isle of May	73	936.0	09h 7th	−2.1	+8.3	942.2
Bell Rock	28	932.9	06h 7th	−2.1	+3.3	934.1
Girdle Ness	27	938.6	09h 7th	−2.1	+3.1	939.6
Buchan Ness	40	927.9	06h 7th	−2.1	+4.6	930.4
Kinnaird Head	25	929.2	0830 7th	−2.1	+3.0	930.1
Tarbat Ness	53	932.3	04h 7th	−2.1	+6.2	936.3
Pentland Skerries	21	934.6	04h 7th	−2.1	+2.5	935.1
Sanday, Start Point	8	932.9	09h 7th	−2.1	+0.9	931.8
Sumburgh Head	91	922.8	14h 7th	−2.1	+10.3	931.0
Dunnet Head	105	926.2	07h 7th	−2.1	+11.9	936.0
Cape Wrath	114	925.2	00h 7th	−2.1	+12.9	935.9
Scalpay, Eilan Glas	9	940.1	17h 6th	−2.1	+1.1	939.1
Barra Head	208	927.9	21h 6th	−2.1	+23.8	949.5
Lismore	31	932.9	04h 7th	−2.1	+3.6	934.5
Rinns of Islay	46	929.2	03h 7th	−2.1	+5.2	932.3
Pladda	40	933.3	04h 7th	−2.1	+4.7	935.9
Corsewall	34	953.3	05h 7th	−2.1	+4.0	955.2
Portpatrick	N/A	953.3	03h 7th			
Mull of Galloway	100	929.2	0145 7th	−2.1	+11.4	938.6
Point of Ayre	32	944.5	04h 7th	−2.1	+3.8	946.1
Calf of Man Low	114	931.3	0230 7th	−2.1	+13.0	942.2

Stevenson min = 'Lowest state of barom,.' from Robert Stevenson's table in Espy (1841) p 531, converted from the original inHg

Time = Time of lowest barometer (6/7 January), taken from Stevenson's table

TT = Temperature correction (mbar) assuming a barometer temperature of 14 °C and that no reduction to 0 °C had already been included

MSL corr'n = MSL correction (mbar) owing to altitude given in column 2, assumIng an air temperature of 5 °C and station-level pressure

The final column gives the estimated MSL pressure. Although quoted to a precision of 0.1 mbar, the original values are themselves stated to 0.01 in Hg (~0.3 mbar) and, based upon the assumptions made, the MSL correction is probably only accurate to 1 mbar at best.

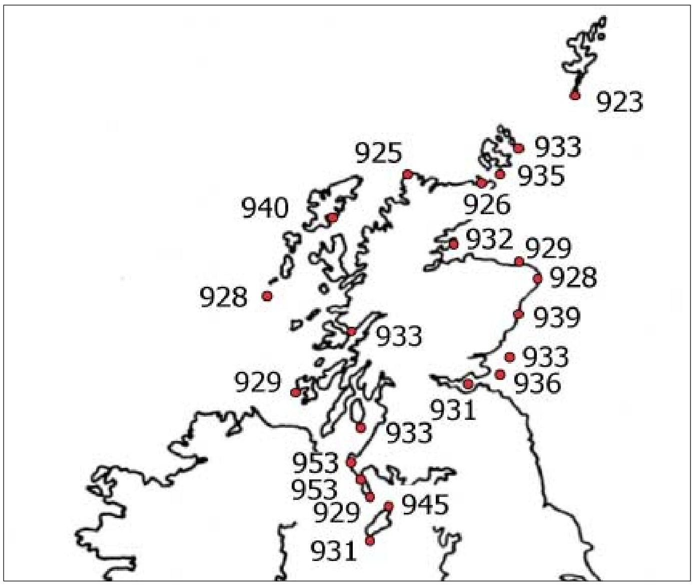

Fig. 2 Uncorrected minimum observed pressure (mbar) at the Board of Northern Lights lighthouses during the storm of 6–7 January 1839

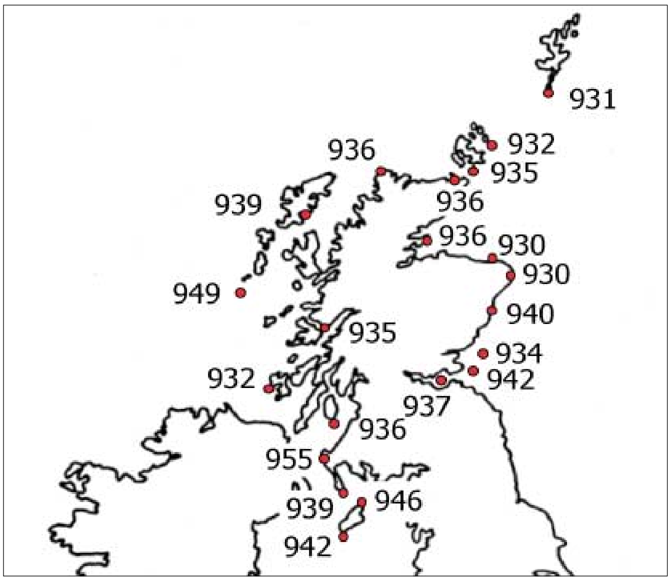

Fig. 3 Minimum observed pressure (mbar) during the storm of 6–7 January 1839, corrected to mean sea-level as described in the text; compare with Fig 2

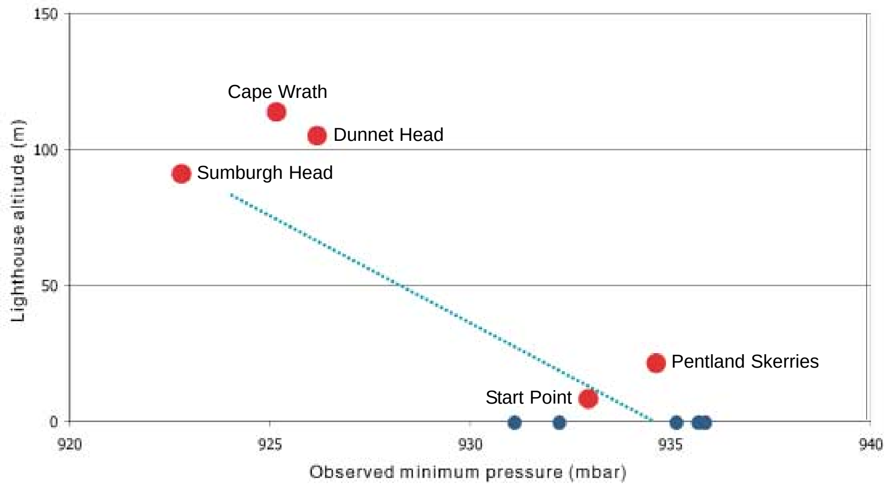

Fig. 4 Observed minimum barometric pressure versus observation altitude (red circles) at five lighthouses in northern Scotland, the Orkney Islands and Shetland on 7 January 1839. The blue circles show the corrected MSL values (corrections and assumptions as described in the text) at these five sites. The dotted line indicates the approximate barometric pressure with height for a surface pressure of 934 mbar

this area (Sumburgh Head on Shetland, Start Point on Sanday, Pentland Skerries in Orkney, and Dunnet Head and Cape Wrath on the north coast of Scotland) are plotted against the lighthouse elevation. It is immediately obvious that the lowest barometer readings are all from the highest stations. This also removes the difficulty of Shields and Fitzgerald in rejecting the Start Point value (uncorrected 932.9 mbar) when compared to Sumburgh Head (uncorrected 922.8 mbar, a difference of 10.1 mbar from Start Point) as, when corrected as described, both agree within 1 mbar (Sumburgh Head 931.0 mbar, Start Point 931.8 mbar). The corrected MSL values from Pentland Skerries, Dunnet Head and Cape Wrath now also agree within 1 mbar.

Away from the closest approach of the depression, there remain several inconsistencies. The values for Kinnaird Head (930 mbar) and Buchan Ness (930 mbar), although in good agreement, appear to be too low; Girdle Ness (not far south, at 940 mbar) is supported by a land-based observation at Aberdeen. It may simply be that the 'high' values do not reflect the true minimum, and some of the 'low' values may be Pitot-tube effects in the strong winds around the intense depression. There are a few additional barometric observations from land-based weather registers in Scotland which assist in determining the true minimum values. Lamb quotes 936 mbar in Aberdeen although the source is unstated; it is probably from the journal of George Innes (Espy, p. 521 – 936.2 mbar at 08 h), but unfortunately as the site altitude is unknown this cannot be reliably corrected to MSL. Buchan (1884) quotes 938.6 mbar 'near Peterhead', but this is identical to Stevenson's Girdle Ness figure (and is thus uncorrected). Buchan also quotes 941.6 mbar 'at the Firth of Forth lighthouses' but this figure does not tally with Stevenson's data for the Isle of May or Inchkeith although it is very close to the corrected Isle of May figure derived here. In Edinburgh, Espy quotes 945 mbar (p. 519), in Dundee 951.6 mbar at 08 h (p. 296, p. 519), in Glasgow 944.8 mbar at 07 h (p. 530), and in Dumfriesshire 957.0 mbar at 09 h (p. 530). All of these must be regarded as station-level observations in the absence of any evidence to the contrary; again, as the locations of the observations and thus the altitudes of the barometers cannot be as easily determined as that of the extant lighthouses, the readings cannot be easily corrected to MSL.

Synoptic reconstruction

Shields and Fitzgerald attempted the preparation of synoptic charts for 00 h and 09 h on 7 January, whilst Lamb (*op cit*, p. 132) suggested a probable synoptic distribution at 15 h on this date. Based partly upon these previous reconstructions and utilising the corrected barometric pressures as described above, Figs. 5, 6 and 7 suggest the synoptic situation at 00 h, 09 h and 15 h on 7 January 1839. The main differences from the analysis prepared by Shields and Fitzgerald are in the maximum depth of the depression and the likely track of the storm centre.

The maximum depth of the depression was suggested by Shields and Fitzgerald to be about 918 mbar at 58½° N, 11° W at 00 h on 7 January. This conclusion appeared to be heavily influenced by the observed barometer readings of 927.9 mbar at Barra Head at 21 h and 925.2 mbar at Cape Wrath at 00 h (see Fig. 1 for locations). However, Barra Head is 208 m above MSL and the

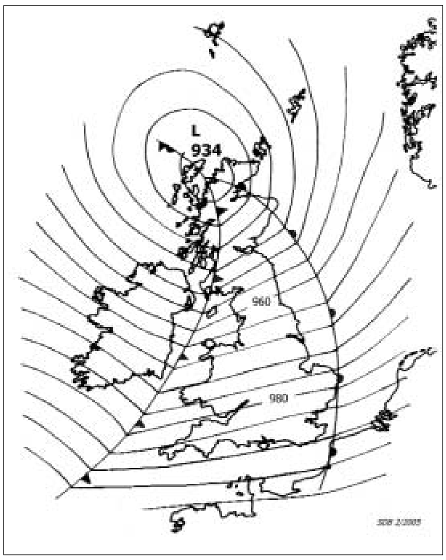

Fig. 5 Reconstructed synoptic situation at approximately 00 h on 7 January 1839. Isobars are at 4 mbar intervals

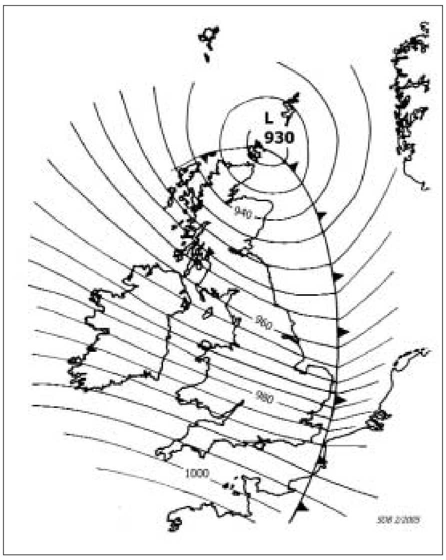

Fig. 6 Reconstructed synoptic situation at approximately 09 h on 7 January 1839

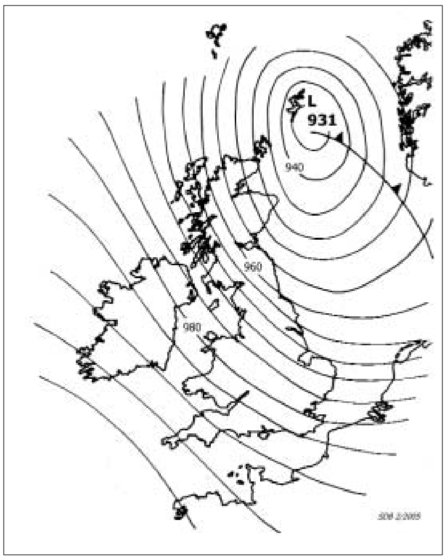

Fig. 7 Reconstructed synoptic situation at approximately 15 h on 7 January 1839

RMetS
Royal Meteorological Society

corrected MSL value is 949.5 mbar. This appears somewhat high (Fig. 3), possibly due to this lighthouse's extremely exposed position at the summit of a high rocky crag. The Cape Wrath value, corrected for altitude and assumed temperature, is a more reasonable 935.9 mbar and it seems probable that the depression centre lay closer to north-west Scotland at midnight (Fig. 5) than suggested by Shields and Fitzgerald, with a central pressure perhaps 934 mbar. (Fig. 8 shows Espy's own chart construction for about this time – Espy (*op cit*) p. 296.)

The lighthouse observations of wind and weather show the centre passing close to the coast of northern Scotland and over the Orkney Islands during the morning. At 09 h 7 January it probably lay in eastern Orkney; the minimum pressure at Start Point lighthouse on Sanday, 931.8 mbar, was noted at this time, and here winds were light 08 h to 1130 h. At Pentland Skerries lighthouse in the Orkney Islands at 09 h "... not a breath of air; smoke going straight up. At 11 h, wind went round to NW, and at noon, the storm was strong. Snow." The depression probably reached its maximum depth, close to 930 mbar, around this time. From the Orkneys the depression appeared to move more slowly eastwards and began to fill, passing south and east of Shetland during the early afternoon: Sumburgh Head recorded its minimum pressure, about 931 mbar at MSL, at 14 h.

Summary and conclusions

On the basis of the available contemporary evidence, it appears most unlikely that Stevenson's table of barometer readings in the Scottish lighthouses in the January 1839 storm were corrected to mean sea-level. Based upon several assumptions, approximate and retrospective mean sea-level corrected values are derived for the 21 Board of Northern Lights lighthouses and a revised minimum pressure and storm track for this notable event are derived. The corrected values generally offer a more consistent geographical pattern of the minimum observed pressure during this storm. The lowest corrected barometer reading would appear to be 931 mbar at Sumburgh Head at 14 h on 7 January 1839: this is the third-lowest barometric pressure yet recorded in the British Isles.

Data sources and acknowledgements

I offer a posthumous acknowledgement to the anonymous lighthouse keepers for their careful observations on that stormy night almost 170 years ago: they could certainly never have envisaged that their observations would be so carefully scrutinised many years later. They (and Robert Stevenson) would be pleased to find that not only their lighthouses but their observations have stood the test of time. Once again I am grateful to Martin Kidds from the National Meteorological Library in Exeter for his help in tracing a number of references. I also offer my grateful thanks to Joanna Corden from the Library and Archives of the Royal Society in London, Leanne Swallow from the National Archives of Scotland in Edinburgh and Sheila Mackenzie from the National Library of Scotland, also in Edinburgh, for their assistance in searching their archives for the original of Robert Stevenson's 1839 letter to the Royal Society.

Chart, showing the course of the Wind in Great Britain and Ireland, on the night of the 6th of January, 1839, between 10 and 12 o'clock.

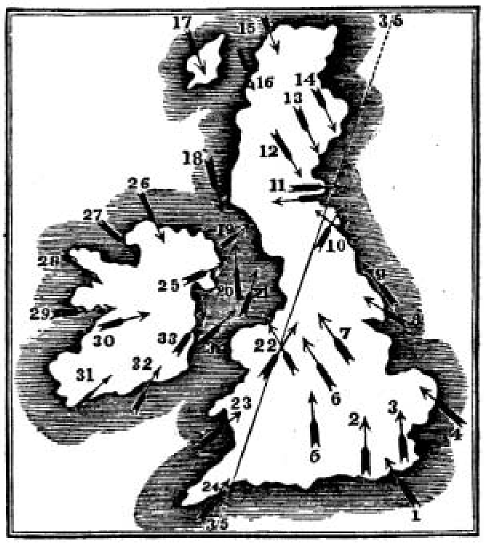

Fig. 8 Espy's own chart construction for around midnight on 6/7 January 1839 – compare with Fig. 5

References

Bathurst, B. (1999) *The lighthouse Stevensons*. HarperCollins, London

Brandes, H. W. (1826) *Dissertatio physica de repentinis variationibus in pressione atmospherae observatis* [Published in Latin: Scientific discussion of rapid changes in atmospheric pressure]. Leipzig. See also Monmonier (1999)

Buchan, A. (1884) The recent storm. *Nature*, London, 31 January 1884

Burt, P. J. A. (2004) The Bell Rock. *Weather*, **59,** pp. 183–4

Burt, S. D. (1987) A new North Atlantic low pressure record. *Weather*, **42,** pp. 53–56; also *Marine Observer*, **57,** No. 297, pp. 122–125

—— (1989) London's lowest barometric pressure in 167 years. *Weather*, **44,** pp. 221–5

—— (1993) Another new North Atlantic low pressure record. *Weather*, **48,** pp. 98–103

Dove, H. W. (1828) *The law of storms*. Translated by Robert FitzRoy in 1858. London, Board of Trade: Third Number of Meteorological Papers. Copy available in National Meteorological Library.

Espy, J. P. (1841) *The Philosophy of Storms*. Little, Brown, Boston

FitzRoy, R. (1862) *The Weather Book: A manual of practical meteorology*. Longman, Roberts & Green, London

Gribbin, J. and Gribbin, M. (2003) *FitzRoy: The remarkable story of Darwin's Captain and the invention of the weather forecast*. Hodder Headline, London

Krauskopf, S. (2001) *Scottish lighthouses*. Appletree Press, Belfast

Lamb, H. H. (1991) *Historic storms of the North Sea, British Isles and Northwest Europe*. Cambridge University Press

Lewis, R. P. W. (1982) *The Daily Weather Report* and associated publications: 1860–1980. *Meteorol. Mag.,* **111,** pp. 103–121

Meteorological Office (1956) *Handbook of Meteorological Instruments: Part 1, Instruments for surface observations*. Her Majesty's Stationery Office, London

Monmonier, M. (1999) *Air apparent: How meteorologists learned to map, predict and dramatize weather*. University of Chicago Press

Rohan, P. K. (1975) *The climate of Ireland*. Stationery Office, Dublin

Shields, L. and Fitzgerald, D. (1989) The 'Night of the Big Wind' in Ireland, 6–7 January 1839. *Irish Geography*, **22,** pp. 31–43

Symons, G. J. (1892) The low barometer of January 12th 1843. *Symons Monthly Meteorol. Mag.,* **27,** pp. 164–167

doi: 10.1256/wea.53.05