WEATHER AND COASTAL FLOODING HISTORY: THE UISTS AND BENEBECULA

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Commissioned report for Comhairle nan Eilan Siar, South Ford Hydrodynamics Study

September 2011

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1. Introduction

This report has the object of trying to understand the meteorological context of the storm of January 11th 2005 within the longer-term context of weather and climate changes that have taken place in the Outer Isles since the first written records. An attempt is made to address the issue of whether the 2005 storm was a unique 'rogue' event or whether there have been other similarly large storms during the historic past. In this report a discussion on storminess change is presented on the basis of newly-constructed daily time series of air pressure measurements from the Monach Isles lighthouse (AD 1869-1913) and Lews Castle, Stornoway (AD 1867-2011). Time series of gale measurements are also used in addition to transcribed records of average monthly wind speed, highest hourly wind speed and gust data for the last 30 yr in order to investigate recent trends in storminess. Historical documentary records of past storms in the Outer Isles extending back to the start of the 17th century are also used as interpretive sources (Appendix 1). Complete records of transcribed daily air pressure data are provided in Appendices 2 and 3.

The initial parts of the report present a summary of the meteorology and climatology associated with the North Atlantic storm track. The first section provides a summary account of how mid-latitude depressions are produced, their evolution and decay, together with a discussion of processes responsible for latitudinal changes in the position of storm tracks. This is followed by a discussion of the North Atlantic Oscillation (NAO) and its role in weather and climate changes across the North Atlantic region, and some discussion about historic cyclones in the Outer Isles. Thereafter, an analysis is presented of the daily time series of air pressure from the Monach Isles lighthouse and for Stornoway. This analysis focuses on the most extreme storms to have affected the Outer Isles during the last 144 yr. The analysis of air pressure data is followed by a presentation of wind speed and gust data for the last ca. 30 yr for Stornoway and the South Uist Rocket range. The report concludes with a brief discussion on the status of the 2005 storm within the context of weather and climate changes that have taken place over the last 144 yr including some discussion of older events.

2. North Atlantic climate – key processes

The atmospheric processes responsible for the existence of the North Atlantic climate across the mid-latitudes of the northern hemisphere are complex in detail yet are simple in concept. The atmospheric turbulence associated with the development of mid-latitude cyclones arises principally from the interaction of cold polar air with warmer air from lower latitudes. Since cold air is denser than warm air and both do not mix easily, the warm air is forced to rise above the cold air. The collision of air masses of contrasting temperature and density results in the development of frontal weather with the air mass boundaries represented respectively by warm, cold and occluded fronts. These atmospheric processes place northern Europe within the North Atlantic storm track. During winter, this results in the passage of numerous frontal cyclones, the occurrence of high winds and associated periods of higher than average rainfall.

Changes in the latitudinal position of the North Atlantic storm track are normally associated with a change in the position of the jet stream in the upper atmosphere. When this type of circulation occurs, as during the winter of 2010-11, the prevailing SW airstream can be replaced by a northerly and NE airflow. When this type of synoptic climate occurs, Scotland tends to experience long periods of extremely cold weather and few storms. During summer months, the vigour of atmospheric circulation is reduced. Storms are less frequent and are commonly replaced by anticyclonic circulation that is associated with spells of fine weather. Cyclones also develop during summer but, when they occur, are typically less intense and associated with much lower wind velocities than during winter.

3. North Atlantic Oscillation (NAO)

In recent years patterns of winter weather and storminess change have been associated with changes in the behaviour of the North Atlantic Oscillation (NAO). The NAO is measured as the monthly difference in surface air pressure between Iceland and the Azores-Gibraltar area (Hurrell 1995) (Figure 1). Two extreme states (positive and negative) of the NAO exist.

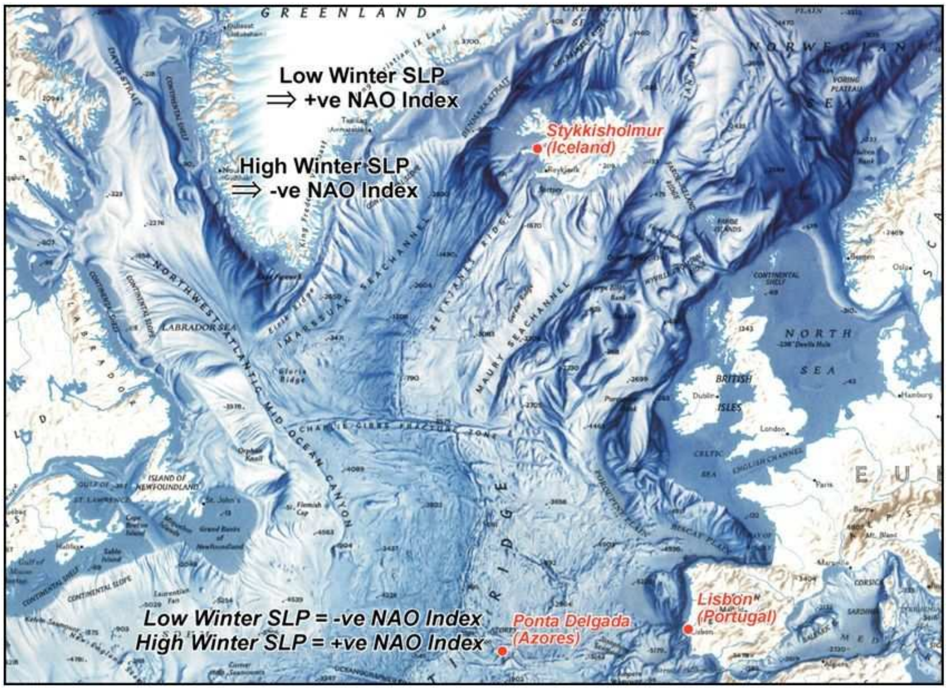

Figure 1: Key features of the North Atlantic Oscillation (NAO). Stormy winters tend to be associated with a strongly positive NAO Index (typically greater than +2.0). Such winters also tend to be mild as a result of a dominantly SW air stream and with high rainfall. Winters associated with a negative NAO Index tend to be characterized by cold weather, calm conditions and low rainfall, but often with higher than average snowfall.

During winters when the NAO Index is strongly negative, monthly air pressure is reduced over the Azores high pressure cell and increased over the area where the Icelandic Low normally occurs. A negative NAO Index therefore corresponds to a period of time that is not particularly stormy across the northern North Atlantic but with an equivalent storminess increase across the Azores and Mediterranean. By contrast, winters when the NAO Index is strongly positive generally coincide with the stormiest winters across northern Europe and are associated with a strengthened Icelandic Low (Figures 1 and 2). These winters also tend to be associated with elevated air temperatures (mild weather), a dominantly SW airstream and higher than average rainfall.

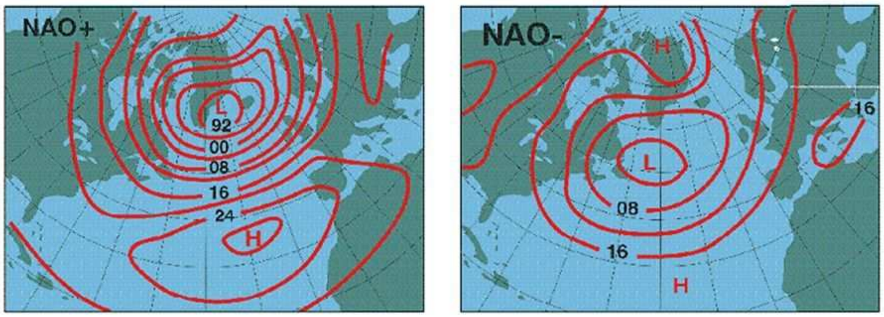

Figure 2: Contrasting states of the North Atlantic Oscillation. Left – synoptic climate generally associated with a positive NAO Index. Note the development of low pressure over the northern North Atlantic and strengthened cell of high pressure over the Azores. Right – a negative NAO Index is generally associated with a weakening of the Azores anticyclone and a less vigorous North Atlantic storm track, a part of which is a weakened area of low pressure over Iceland.

Using the NAO Index as a proxy for past winter weather in Scotland is not straightforward. The key difficulty relates to the changing position of the jet stream in the upper atmosphere. Changes in the degree of meandering of the mid-latitude jet stream across the northern hemisphere exert a powerful influence on the nature of seasonal weather across northern Europe. For example, the development of an extremely vigorous jet stream and a strongly positive NAO Index (on occasions in excess of +5.0) during the winter of 1982-83 led to one of the stormiest winters in living memory across the whole of Scotland (Figure 3). By contrast, the winter of 2010-11 was associated with a highly meandering mid-latitude jet stream that resulted in the development of a winter anticyclone over northern Europe for long periods of time. This, in turn, led to long periods of northerly winds, relatively calm conditions and exceptionally high snowfall.

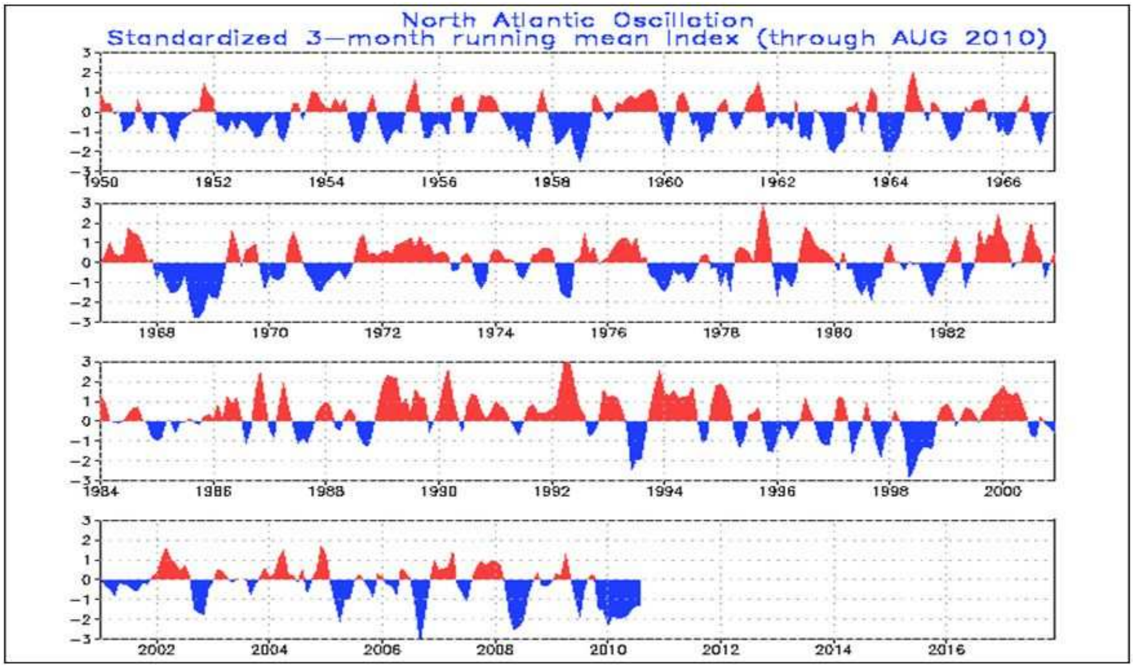

Figure 3: Chronology of fluctuations in the NAO Index, 1950 to present. Note the preponderance of winters with positive Index values between ca. 1982–1995 as well as the greater frequency of negative Index values since 2005 and culminating with the strongly negative winters of 2009−11 (data acknowledged to J Hurrell).

Regional patterns of air temperature change are also responsive to short-term changes in the NAO. For example, the passage of a North Atlantic cyclone across the North Atlantic towards Scotland would lead to marked temperature changes if the area was characterized by an anticyclone in advance of the arrival of the frontal weather system. In this way, cold air during winter would be replaced by a SW airstream and mild air in conjunction with the arrival of a warm front. These circumstances would continue until the cold front associated with the cyclone had crossed the area – causing a shift to a NW airstream and a return to cold conditions. The NAO Index values are therefore, monthly averages of these changing states of weather characterized by high spatial variability (Figure 4). For Scotland, one might expect that a winter associated with many storms would also be characterized by above average air temperatures. Conditions during summer are less sensitive to changes in the NAO Index. This is due principally to much weaker Icelandic low pressure during summer compared to winter.

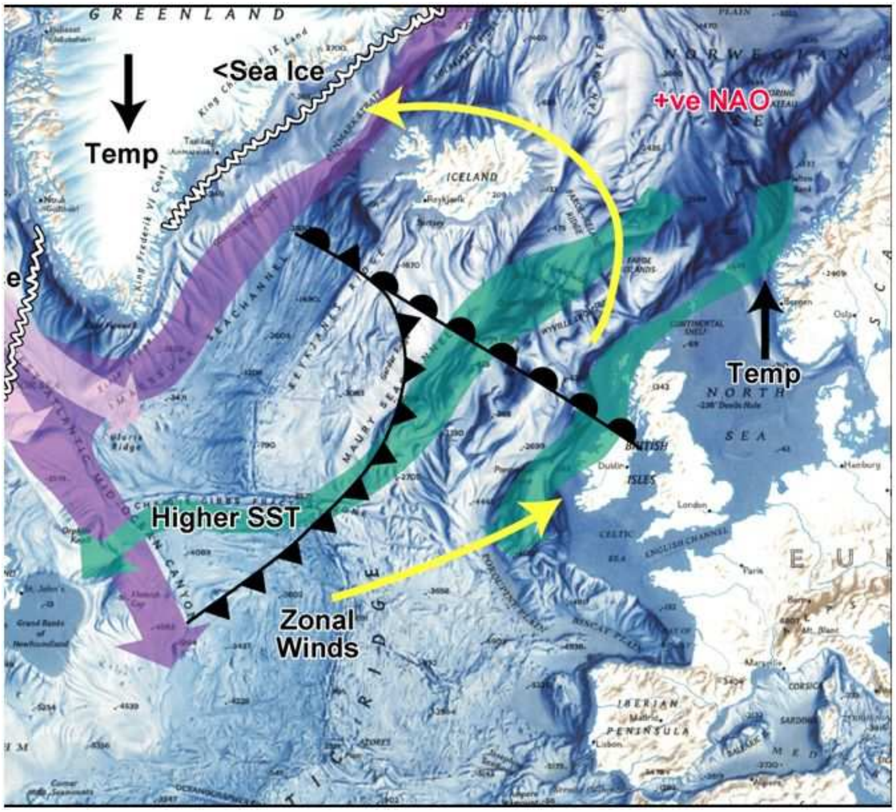

Figure 4: Synoptic weather characteristic of a stormy winter. Anticlockwise wind rotation associated with the passage of a cyclone results in a) a south-westerly airflow along the southern flank of the cyclone and b) easterly and south-easterly winds along its northern edge. These processes lead, in turn, to higher than average air temperatures across NW Europe but lower than average air temperatures over Greenland.

Changes in the track of the mid-latitude jet stream can also lead to marked changes in air temperature. For example, a meandering jet can frequently result in the position of the mid-latitude jet being displaced considerably further south than normal. Under such circumstances, a weather situation can develop where high levels of storminess are experienced over southern England and northern France while at the same time Scotland can experience calm and cold conditions. During the 17^{th} and 18^{th} centuries this was a common feature of British weather, the harsh conditions across Scotland resulting in the exceptionally low temperatures of the 'Little Ice Age' yet wet and milder conditions much farther south (Figure 5).

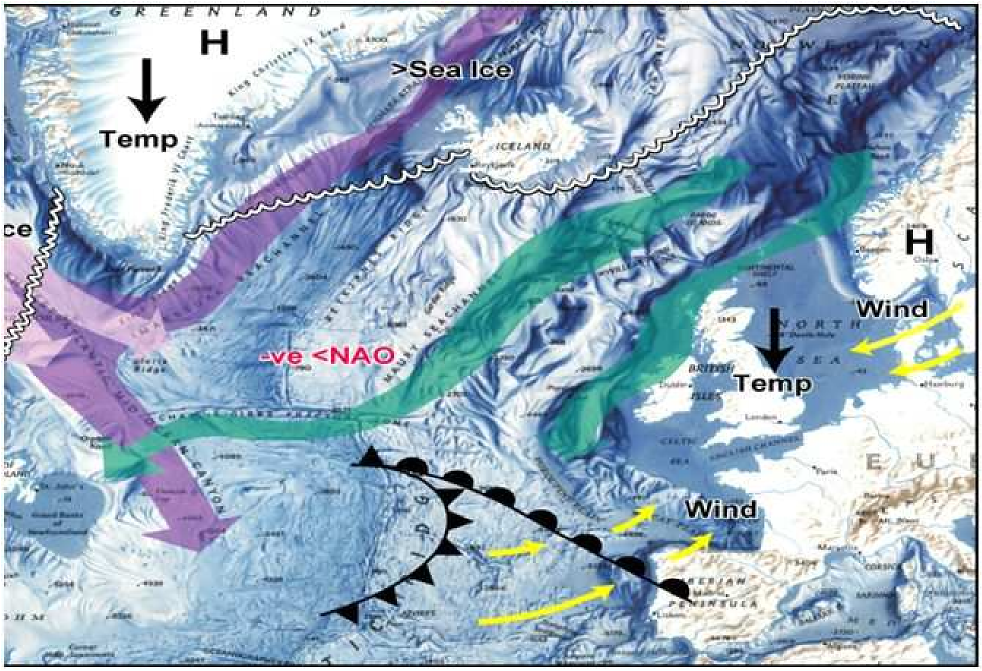

Figure 5: Southward displacement of North Atlantic storm track associated with negative NAO Index. The storm track is often displaced by a cell of high pressure across northern Europe.

4. Historic cyclones in the Outer Isles

A compilation of written records of historic storms in the Outer Isles between ca. AD 1600-1950 reveals an apparently random pattern of events (Appendix 1). A major difficulty in discerning trends in past storminess is due to the scarcity of written accounts recording extreme events that took place during the 17th and 18th centuries. Therefore, it is not possible to answer the question on the basis of written records alone, whether the storm of 2005 was the most destructive event that has taken place in the Outer Isles during the last ca. 400 years. Furthermore, available records point to the 1830s, 1840s, 1870s and 1880s as periods of exceptional winter storminess (Appendix 1).

According to local descriptions, the 2005 storm was the worst in living memory. The 2005 storm represented a classic illustration of a mature cyclone that developed within the North Atlantic storm track (Figure 6).

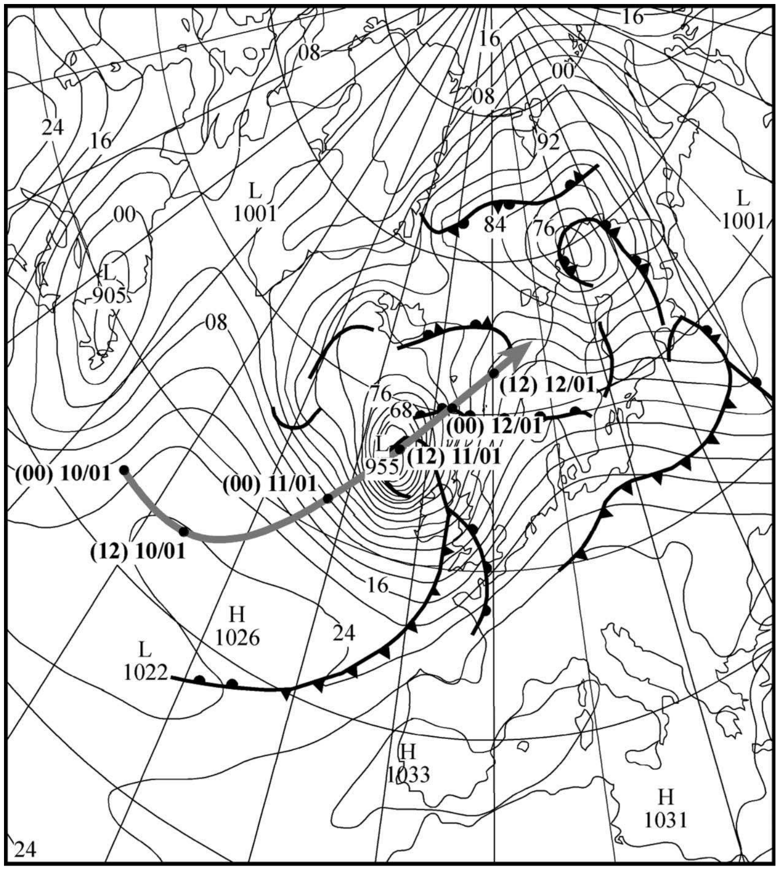

Figure 6: Meteorological conditions associated with storm of 11 January 2005 (noon) and showing track of the storm between 10 – 12 January. Source: Adapted from UK Meteorological Office data

The cyclone tracked from SW to NE west of the Outer Hebrides. The UK Met Office chart shows a central low pressure of 955 mb (though Angus and Rennie (2009) cite a value of 941 mb). The isobar contour for 968 mb on the chart is aligned parallel to the Atlantic coastline illustrating clearly that the main body of the depression was located west of the island chain.

In order to understand if the storm of January 2005 represents part of a trend of increasing storminess, a record of gale frequency for Stornoway was reconstructed for the period AD 1876-1996 (Dawson et al., 2002) (Figure 7). The Stornoway winter gale day series (October to March) for 1884-1996 has been smoothed using a statistical function in order to take account of the various historical changes in the way that gale days were recorded. The data appears to show quite clearly that gale frequency was much higher during the latter part of the nineteenth century than at present and to a lesser extent during a period of two to three decades centred on AD 1940.

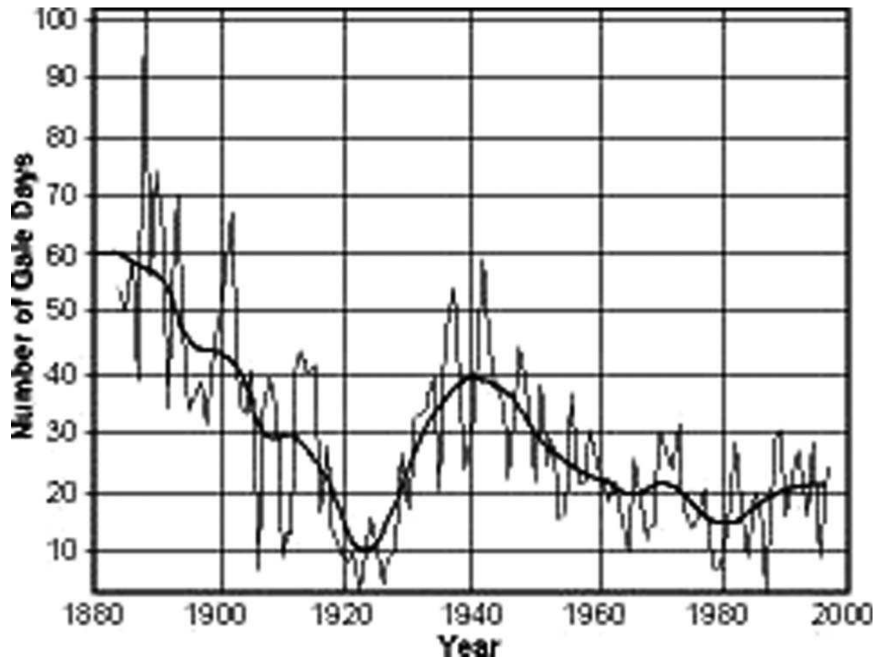

Figure 7: Stornoway gale days, winter 1884 to 1996, with LOWESS smoothing function (after Dawson et al., 2002). The data show storminess maxima centred on (a) the late nineteenth century and (b) the 1940s with distinct minima during the 1920s and 1960s

The Stornoway gale day frequency time series (1876-1996) shows some remarkable patterns (Figure 7). First, the data appears to show that the exceptional storminess that characterised the latter decades of the nineteenth century was never again equalled during the twentieth century. Exceptionally low values for gale frequency characterise the winters between 1905-12. For the time interval 1929-present, the pattern of storminess at Stornoway has been one of strong inter-annual variability and, unlike the years of the 1880s, there have been relatively few winters since 1929 when winter gale frequency has exceeded 40 gale days (October – March inclusive). The graph also indicates a period of two to three decades centred on the 1940s during which gale day frequencies reached their highest levels during the twentieth century. The graph also highlights the surprising trend that since the 1940s Stornoway has experienced an overall decline in storminess, with gale day frequencies during the 1990s being less than half the rates of the late nineteenth century.

Historical documents identify three exceptional storm events during the last 150 years that were well known to have caused severe coastal damage across the Outer Isles. The first was described by MacDonald (1971: 39) for North Uist as having taken place during 1869 when, ‘‘...an exceptionally high tide with gales washed away a large portion of the common land'' (note: we now identify this storm as having taken place on December 13th, 1869). The second was described in the Minutes of the Napier Commission (1884: 826) as having occurred during November 1882 when, ''…a large tract of land was completely carried away by the tide…''. The third was described by MacDonald (1971: 41), also for North Uist, where high tides during 1921 left large areas of land strewn with shingle and no longer available for tillage…''. Inspection of the Meteorological Register for 1921 shows the occurrence of two exceptionally stormy intervals. The first took place during March when 29 of 31 days recorded wind velocities between Beaufort Force 4-7 with nearly all of these having been between WSW and SW. During the 23-24 March, the most extreme category of sea state (6) was recorded. In December (16th-20th) 1923 hurricane-force winds were associated with the highest recorded sea state (16th, 17th and 20th) with prevailing winds between WSW and WNW.

5. Daily air pressure time series

Given the inherent inaccuracies associated with changes in the definition of a gale day over time, an attempt was made to understand more clearly patterns of storminess change through the analysis of instrumental records of daily air pressure. As stated earlier, destructive winter storms with the potential for significant coastal erosion and flooding across the Outer Isles are nearly always deep low pressure systems that are generated over the North Atlantic and which then decay over the North Sea and Norwegian Sea. On most occasions, the eastern margins of cyclones are those associated with the most severe weather over the Outer Isles. Typically, this cyclonic sector is associated with SW, S or SE winds and a track that can extend from south to north (as was the case with the 2005 storm) to a more SW to NE alignment. Accordingly, an attempt was made to construct daily air pressure time series for as long a time period as possible. Two meteorological stations were used for the analysis: one located in Lews Castle, Stornoway, and the other located in the Monach Isles lighthouse, west of North Uist. Prior to this study, a digital record of daily air pressure for Stornoway was only available for the period 1921-2005. Here we made use of hand-written records of daily air pressure for Lews Castle (stored in the archive of the UK Met Office, Edinburgh) covering the period between AD 1867-1920 plus new data for the period 2006-2011. The air pressure data was digitised, thus enabling a daily time series of air pressure (both for 9 am and 9 pm) to be constructed for the period AD 1867-2011.

The time series for the Monach Isles is based on lighthouse keepers' records that are available for the period AD 1867-1913. Here also, a daily air pressure time series data was digitised from the original records for both 9 am and 9 pm. As with Stornoway, the use of daily air pressure readings at 12 hr intervals enables the tracking of individual cyclones as they crossed the island chain (Appendices 2 and 3).

The air pressure data was further analysed by extracting lists of those days where air pressure fell below 954.99 mb. This information, marking the passage of deep cyclones, is of considerable value since it provides an indication whether the frequency of passage of such cyclones during recent decades has been greater than that which prevailed during the late 19th century. The data is also informative in the sense of providing a list of the days during the last ca. 140 years when air pressure fell to levels below those associated with the storm of January 2005.

5.1 Results

In this section, attention is focused on the occurrence of days when air pressure fell to exceptionally low levels. To this end, a list was compiled of all days since AD 1867 when air pressure fell below 959.99 mb. These days were further subdivided into those that were characterised by air pressures between 955-959.99 mb, 950-954.99 mb, and 945-949.99 mb. Separate calculations were made in respect of the 9 am and 9 pm measurements. Having identified the days when such extreme low pressure occurred, an additional search was made for those days when air pressure remained below 954.99 mb for at least 24 hr (either a series of 9 am-9 pm-9 am readings or a series of 9 pm-9 am-9 pm readings). These storm events are of particular significance since, having remained intense for at least 24 hr, they are bound to have lasted for the duration of an entire tidal cycle and hence are almost certain to have been associated with coastal flooding and beach erosion.

For Stornoway for the period 1867-2011, the 9 am readings of air pressure show that there were 3 days in 144 years when air pressure at sea level fell below 950 mb, 15 days when air pressure was between 950 and 954.99 mb and 25 days when daily air pressure was between 955 and 959.99 mb. The value recorded for Stornoway at 9 am on January 11th 2005 was 1005.9 mb. The Stornoway data for 9 pm readings between AD 1867 and 2011 indicates 6 days when air pressure fell below 950 mb, 22 days when it occurred between 950 and

954.99 mb and 22 days also when it occurred between 955 and 959.99 mb. These data can be compared against the 9 pm value for January 11th 2005 of 959.3 mb.

The Stornoway data show that between AD 1867-2011 for the set of 9 am air pressure values, there were 38 days when values fell below the 959.3 mb threshold value cited above for the January 11th 2005 storm. Similarly, in respect of the 9 pm values, there were 45 days between AD 1867 and 2011 when daily air pressure fell below that associated with the January 2005 storm in Stornoway.

Further inspection of the data shows that of the 38 days of 9 am readings of values below 959.3 mb, only 18 occurred during the 20th century and 2 during this present century. Similarly for the 9 pm Stornoway air pressure readings, of the 45 days with extremely low air pressure values the majority occurred during the 20th century and the minority during the 21st century. For both the 9 am and 9 pm air pressure readings, the majority of values below 959.3 mb occurred during the last 33 years of the 19th century (between AD 1867 and 1899).

The air pressure data for the Monach Isles exist only for a much shorter period of time between AD 1867 and 1913. In this respect, the Monach data have two particular uses. First the dates of extreme low pressure can be compared with the dates of extreme low pressure at Stornoway and used to test whether the recorded dates of low values coincide with the Stornoway data showing the tracking from south to north or SW to NE of individual severe weather systems. Second, the location of the Monach Isles several km west of the Atlantic coastline of the Outer Isles hints at the possibility that the islands may have been located closer to the centres of low pressure systems moving across the North Atlantic Ocean. In other words, one might expect that the most extreme daily low pressure measurements for the Monach Isles are lower than those for Stornoway.

For the Monach Isles, the readings of air pressure between AD 1867 and 1913 show for the 9 am readings, 8 days when values fell below 950 mb, 17 days when air pressure occurred between 950 and 954.99 mb and 10 days when values occurred between 955 and 959.99 mb. For the 9 pm readings, there were 10 days when air pressure fell below 950 mb, 12 days when it occurred between 950 and 954.99 mb and 11 days when values lay between 955 and 959.99 mb. Indeed every day of the two time series (35 days for the 9 am time series and 33 days for the 9 pm time series) experienced air pressure values lower than the 959.3 mb value cited above for Stornoway for January 11th (pm) 2005.

For purposes of comparison with the Stornoway data, the Monach isles experienced 26 days (9 am data) during the 19th century (starting in AD 1867) when air pressure was below 959.3 mb compared with 18 days for Stornoway. Similarly, the 9 pm time series of readings for the Monach Isles shows that the islands experienced 18 days between AD 1867 - 1899 when air pressure fell below 959.3 mb (compared with the same value for Stornoway). In general, the Monach time series of extreme low pressure values is similar to that of Stornoway with a minor tendency for daily air pressure values during the passage of deep cyclones to be slightly lower of the west coast of North Uist than over Stornoway.

Closer inspection of the air pressure extreme data (values below 954.99 mb) enables the identification of specific storms that register first with a fall in pressure over the Monach Isles and subsequently in Stornoway. The largest storms are registered over at least 12 hr (both morning and evening of the same day or evening of one day and morning of the next), some are evident as 9 am – 9 pm – 9 am sequences, others ordered as 9 pm – 9am – 9 pm and in one case over 4 consecutive extreme values track the passage of a storm over at least 36 hr. We present below a list of the most extreme storms that we can demonstrate to have lasted at least 24 hr and due to the crossing of a complete tidal cycle were highly likely to have been associated with significant coastal damage. Included also is data on the storm of December 1869 since this is the storm referred to by McDonald (1970) as having caused extensive coastal damage but which did not last 24 hr using the aforementioned criteria.

Storm 1: December 13th 1869 – this storm registers on the Monach Isles on the morning of the 13th as a ‘strong gale from the WSW’ at 953.3 mb. By 9 pm it appears on the Monachs as a ‘strong gale from the NW’ at 953.3 mb. On December 13th in Stornoway at 9 am the storm is described as ‘grade 5’ from the SW and by 9 pm as associated with an air pressure of 947.9 mb.

Storm 2: January 16-17th 1871 – this storm is described in the Monach Isles lighthouse record as a ‘strong gale from the SE’ at 9 am with an air pressure of 941.4 mb. It is recorded for 9 pm as a ‘gale from the SW’ with a pressure of 948.9 mb. On January 17th at 9 am it is registered as having a pressure value of 952.6 mb. It is inferred that this extreme storm lasted at least 24 hr (9 am – 9 pm – 9 am).

Storm 3: January 17-18th 1872 – this storm shows on the Monach Isles record with an air pressure of 952.9 mb at 9 pm on January 17th and 957.0 mb at Stornoway. By 9 am on

January 18th it has fallen to 949.9 mb at the Monach Isles and 949.3 mb at Stornoway. By 9 pm the storm continues to appear on the Stornoway record as 950.1 mb. This storm also appears to have lasted at least 24 hr (9 pm – 9 am – 9 pm).

Storm 4: January 18-19th 1873 – in the Monach Isles this storm is described as a ‘gale from the SW’ at 9 pm on the 18th. The 9 am record for January 19th is shown as a ‘gale from the NW’ with an air pressure of 951.6 mb. At the Monach Isles, the storm continues through the morning of the 19th with a 9 am value of 948.2 mb. The Stornoway time series shows the morning of the 19th as 951.9 mb and lowered to 948.6 mb by 9 pm of the same day thus giving a 9 pm -9 am -9 pm sequence.

Storm 5: March 8-9th 1876 – air pressure is recorded for 9 pm on March 8th as 958.3 mb at the Monach lighthouse. By the morning of March 9th it had fallen slightly to 952.6 mb and had risen slightly to 952.2 mb by that evening. The storm is also recorded in Stornoway where at 9 pm on March 8th it is at 957.4 mb and at 9 am on the 9th at 952.9 mb. The storm therefore extended over at least 24 hr (9 pm – 9 am – 9 pm).

Storm 6: November 11-12th 1877 – the Monach Isles shows this exceptional storm appearing first in the 9 am record for the 11th as a ‘gale from the SSE’ with an air pressure of 955.6 mb. By 9 pm on the 11th the storm was being recorded as a ‘gale from the S’ at 936.3 mb. At 9 am on the morning of the 12th it shows at the Monach Isles as a ‘storm from the S’ with air pressure of 943.1 mb. By 9 pm on the 12th, it was recorded as a ‘gale from the SW’ at 956.7 mb. In Stornoway at 9 pm on the 11th the storm is registered as ‘grade 6 hurricane force from the south’ at 942.5 mb and at 9 am on the 12th the gale is recorded as a ‘grade 5 southerly storm’ at 952.6 mb. This storm is the most extreme in the entire record over the last 144 yr. Not only did air pressure remain exceptionally low over at least 36 hr (9 am -9 pm – 9 am – 9 pm) but it was also associated with lowest daily air pressure ever recorded (936.3 mb).

Storm 7: November 26-27th 1881 – this storm first appears as an extreme low air pressure value (948.2 mb) in the Monach Isles at 9 pm on the 26th. By 9 am on the 27th air pressure at the Monachs has fallen to 938.7 mb and remained low on the following morning (9 pm on the 27th) at 951.6 mb. This storm does appear in the Stornoway record as having been associated with exceptionally low air pressures but at the Monach Isles it registers as a storm that lasted at least 24 hr (9 pm – 9 am – 9 pm).

Storm 8: December 19-20th 1982 – this storm is first recorded in Stornoway as an extreme low pressure value at 942.0 mb for 9 pm on the 19th. By the following morning it is registered as 945.4 mb and had risen slightly to 953.7 mb by that evening. The storm thus registers as one that lasted at least 24 hr (9 pm – 9 am – 9 pm).

Storm 9: January 11-12th 2005 - the UK Met Office chart for this storm shows a central low pressure of 955 mb (though Angus and Rennie (2009) also cite a value of 941 mb) (Figure 6). The isobar contour for 968 mb on the chart is aligned parallel to the Atlantic coastline illustrating clearly that the main body of the depression was located west of the island chain. There is thus some uncertainty just how low the air pressure reached at the centre of the depression. Whatever the value (955 or 941 mb), the lowest pressure associated with the 2005 storm was exceeded during the 1877 storm (and by the storm of January 6-7th, 1839) (Appendix 1).

6. Recent weather and climate: 1980 – present

The plot of mean monthly winter wind velocities for the period 1980 – 2005 in Stornoway remarkably shows that since 1980 the monthly values highlight seven anomalously high windy months, of which four are conspicuous (January 1983; January 1989; January 1993, February 1997) (Figure 8).

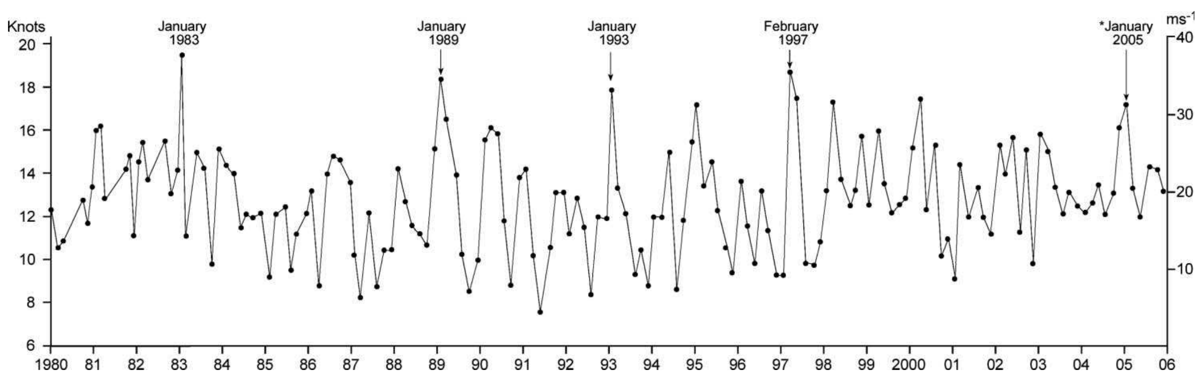

Figure 8: Average monthly wind velocities, Stornoway, 1980 – 2005, also showing the months with highest values

In order to investigate any relationship that may exist between the occurrence of the stormiest months and the timing of the most intense severe storms, a separate plot was constructed for Stornoway of the highest monthly wind gust velocities (Figure 9).

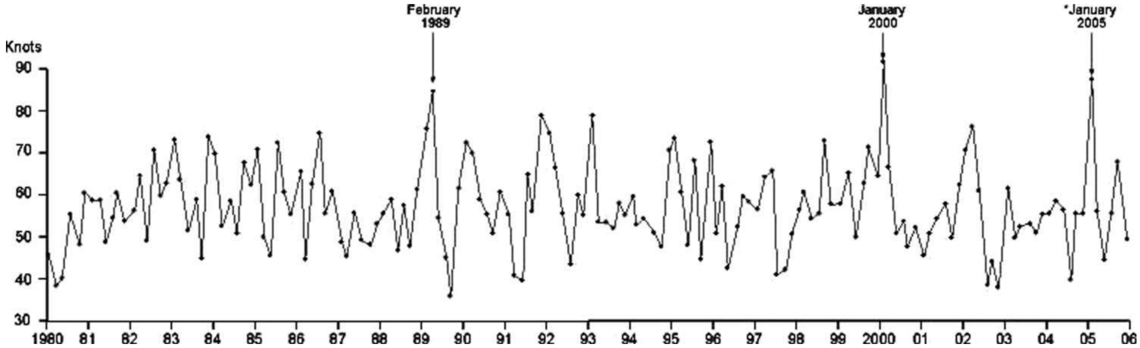

Figure 9: Highest gust velocities for Stornoway per month, 1980 – 2005, showing three distinctive peaks for February 1989, January 2000 and January 2005

This plot identifies the January 2005 storm quite clearly, together with two other earlier events during February 1989 and January 2000. The five stormiest months are shown in Table 1 together with the highest hourly mean wind speeds, highest hourly wind gust velocities for each of these months. To this has been added wind data for two additional months when the recorded gust velocities exceeded 26 m/s.

Table 1 Stormiest months and the highest hourly wind speeds, AD 1980-2005 (m/s).

Date	Mean monthly velocity	Highest hourly gust	Highest hourly mean
January 1983	10	38	23
January 1989	9	39	20
January 1993	9	41	22
February 1997	9	33	23
January 2005	9	45	30
January 1989	8	44	28
January 2000	8	47	26

The results shown above are internally consistent in that they point to no marked trend in winter storminess during recent decades. Indeed the key pattern of change evident in the AD 1980-2005 data is of a ‘steady state’ time series with 5 months of exceptional storminess. The longer-term trend shown in the AD 1885-2005 trend of gale days for Stornoway appears to point to a long-term decline in storminess since the 1870s. If correct, this information is indicative of a quite different pattern of storminess change than the popular view that winter storminess is presently increasing as a result of recent changes in climate (e.g. Gunther et al. 1998; IPCC 2007; Lowe et al. 2009).

7. Discussion

The data presented here are remarkable in several respects. First, although the storm of January 2005 is generally regarded as the worst in living memory, there is evidence of several major storms that affected the Outer Isles beyond living memory. The nature of these storms is not known in detail. However, the daily air pressure time series for the Monach Isles and Stornoway enables the identification of the specific days on which the most destructive storms occurred. Furthermore the use of air pressure data to identify such storms is much more precise than descriptions of contemporary wind strength that is, particularly for the 19th century, highly qualitative. From the time when instrumental records started (AD 1867) at the Monach Isles lighthouse and in Lews Castle, Stornoway, we identify here 7 major storms for the 19th century (here derived from the AD 1869 -1899 time series for the Monach lighthouse) and 1 for the 20th century that were similar in scale to the 2005 event. We are confident that the eight storm events identified here had the potential to cause considerable damage since, in addition to meeting the criteria of sustained air pressure below 954.99 mb, it can be demonstrated that each of the storms experienced extreme low air pressure for at least 24 hr on each occasion. In so doing, each of the storm events was longer than a complete tidal cycle, thus giving support to the argument that each depression had the potential to cause considerable coastal erosion and flooding.

The complete daily air pressure time series for both the Monach Isles and Stornoway highlight many other storm events that individually persisted beyond 12 hr (9 am – 9 pm or 9 pm to 9 am). For these events, further research will demonstrate which storms were coincident with high tide and, therefore, which ones may also have been associated with coastal erosion along the Atlantic coastline of the Uists and Benbecula. From this part of the analysis the key observation is that, over the last 144 years, the 2005 storm was one of nine major storms capable of having caused significant coastal erosion and flooding. Prior to a major storm in December 1982, one has to go back in excess of 100 yr to find a North Atlantic cyclone with similar air pressure characteristics to the 2005 event. Seven such storm events appear to have occurred between 1869-1881 while one of these (the November 11-12th event, 1877) was associated with the lowest air pressure recorded since 1839 (936.3 mb). Expressed in a different way, the relatively high frequency of severe storms that characterised the 1870s and 1880s was never repeated in the 20th century. That said, the storm of 6-7th January 1839 may have been the most extreme event of the last ca. 200 yr.

It is within this context that patterns of storminess change over the last 30 years need to be considered. A useful method of investigating trends in recent storminess is through measurement of average monthly wind speeds, highest hourly wind speed and highest gust velocities. The results highlight five months of exceptional high storminess since 1980 that do not display any clustering within a specific time interval. In addition, the 30-yr time series does not exhibit any trend of increasing or decreasing storminess. This empirical data, if regarded as a reliable measure of monthly storminess change, demonstrates quite clearly that there has been no obvious recent increase in winter storminess due to global climate change.

Based on the above, it is reasonable to infer that the frequency of severe storms is considerably less than it was during the latter decades of the 19th century. Furthermore, considered from the standpoint of the last 30 yr of winter storminess in the Outer Isles, the January 2005 event took place within one of 5 months during the last 30 yr when storminess was higher than normal yet within a period when there was no change in overall storminess. Given these considerations, there no obvious reason to expect a major storm in the Outer Isles, similar to the 2005 event, to occur in the near future (next several decades). Equally, we demonstrate here that the storm of November 11-12th 1877 was, from a meteorological standpoint, a more severe storm that that which occurred during 2005 and that the latter event, despite being the worst storm in living memory, has not been the only event over the last ca.140 yr to have had a destructive effect on the Atlantic coastline of the Outer Isles.

Acknowledgements:

The authors are grateful to Alison Sandison for cartographic assistance in preparing this document. Sincere appreciation is also extended to Lynn Chambers, UK Meteorological Office, Edinburgh, for access to unpublished documents. Thanks are also extended to colleagues who have contributed information on past storm events, in particular Stewart Angus, Scottish Natural Heritage. The report is also a contribution to EU Project Coastadapt of the Northern Periphery Programme (NPP).

References and Supplementary Reading:

Angus, S. & Rennie, A. F. (2007) An Ataireachd Ard: The Great Sea Surge. The Natural Heritage Impact of the Storm of 11 January 2005 in the Uists and Barra, Outer Hebrides. Scottish Natural Heritage commissioned Report (Perth: Scottish Natural Heritage).

Barnett, C., Hossell, J., Perry, M., Procter, C. & Hughes, G. (2006) A Handbook of Climate Trends Across Scotland. SNIFFER project CC03 (Scotland and Northern Ireland Forum for Environmental Research).

Dawson, A. G., Smith, D. E. & Dawson, S. (2000) Potential Impacts of Climate Change on Sea Levels in Scotland. Scottish Natural Heritage commissioned Report (Perth: Scottish Natural Heritage).

Dawson, A. G., Hickey, K., Holt, T., Elliott, L., Dawson, S., Foster, I. D. L., Wadhams, P., Jonsdottir, I.,Wilkinson, J., McKenna, J., Davis, N. R. & Smith, D. E. (2002) Complex North Atlantic Oscillation (NAO) Index signal of historic North Atlantic storm track changes, The Holocene, 12, pp. 363 – 369.

Gunther, H., Rosenthal, W., Stawarz, M., Carretero, J. C., Gomez, M., Lozano, I., Serrano, O. & Reistad, M. (1998) The wave climate of the northeast Atlantic over the period 1955 – 1994: the WASA wave hindcast, The Global Atmosphere and Ocean System, 6, pp. 121 – 163.

Hulme, M. & Jenkins, G. (2002) Climate Change Scenarios for the United Kingdom. The UKCIP02 Scientific Report, April (Norwich: Tyndall Centre, University of East Anglia).

IPCC (Intergovernmental Panel on Climate Change) (2007) Climate Change 2007: The Physical Science Basis, Summary for Policymakers, pp. 1-18. Available at http://www.ipcc.ch

Lamb, H. H. (1972) Climate: Present, Past and Future, Volumes 1 and 2 (London: Methuen).

Lowe, J.A., Howard, T.P., Pardaens, A., Tinker, J., Holt, J., Wakelin, S., Milne, G., Leake, J., Wolf, J., Horsburgh, K., Reeder, T., Jenkins, G., Ridley, J., Dye, S. & Bradley, S. (2009) UK Climate Projections science report: Marine and Coastal Projections. Met Office Hadley Centre, Exeter, UK, pp. 95-102

MacDonald, W. (1971) A study of two Hebridean townships, MA Thesis (unpublished), Department of Celtic Studies, University of Aberdeen.

Minutes of Evidence to the Highlands and Islands Napier Commission (1884) Blue Book, p. 826.

Moore, H., Wilson, G., Dawson, A. & Dawson, S. (2005) Western Isles (South) Coastal Zone Assessment Survey, Grimsay, Benbecula and South Uist. Commissioned Report for Historic Scotland and Scottish Coastal Archaeology and the Problem of Erosion (SCAPE) (Edinburgh: EASE Archaeological Consultants).

Werritty, A., Black, A., Duck, R., Finlinson, B., Thurston, N., Shackley, S. & Crichton, D. (2002) Climate Change: Flooding Occurrences Review (Edinburgh: Scottish Executive Central Research Unit).

APPENDIX 1. Historical Records of Outer Isles Storms: ca. AD 1600 -1968

(Note: included below are written accounts of historic storms to have affected Outer Isles. These include effects of 'sand drift' also associated with windstorms but which may also have been affected by other processes. Also included are descriptions of harvests, crop damage that may also contribute to our understanding of past weather and climate. The list includes record of weather events from neighbouring islands in the Inner Hebrides since these episodes of extreme weather may also have affected the Outer Isles. The list ends at AD 1968 since more recent storms are well-documented through instrumental meteorological measurements).

<u>1602</u>

Fraser (1905: 236) '...The next yeare, 1602, was a dearth and famin all the North and Highlands over; a mildew blasted the barley, and the oates and peese never filled to any perfection, the straw blancht, and such corn as it afforded yelded no male [meal] but lick-dusted trash, without any ailment or food for man or beast. This was called by the vulgar *Blean in Chaa*, the sidd yeare [the year of the corn husks], because the corn yelded no meale, but seeds [sidds]. There ensued a great mortality all the north highlands over, but that milkness gave them some subsistance'.

<u>1625</u>

Maclean (1977) describes that a huge storm took place this year and was responsible for the drowning of the Chief of the Clan MacLeod on Easter Monday and also that on Skye this storm was associated with the deposition of thick banks of shingle, for example, that opposite Stenscholl on Skye.

There are two permanent memorials in this area to what must have been a terrific hurricane in the Hebrides. The first landmark is a long stretch of very rough shingle (Moll in Gaelic) near Monkstadt. It is locally referred to as "Moll Fada na Dubhaird". This imposing mound, according to tradition, was raised during the fearful tempest which drowned Iain Garbh MacIlle Chaluim - Macleod of Raasay. The same storm caused the piling up of the rough shingle beach at Moll Staiseall Staphin - opposite Stenscholl (by Staffin). The drowning of the Macleod Chief is still vividly remembered in song and story relating to Di-luain Caisge, that fateful Easter Monday 350 years ago.

<u>1634</u>

The winter is described as "the most tempestuous and stormy that has been seen in Scotland these sixty years past". Snow lay from the 9th of December to the 9th of March, the fall being particularly heavy from January 26 to February 16 (Dawson 2009).

<u>1652</u>

Outer Hebrides: Angus (1977) quotes Ritchie who refers to increased sand drift and erosion of machair in the years following an extremely severe summer drought that took place during this year.

<u>1671</u>

Fraser (1905: 492) 'This was a very afflicting yeare [1671] in many places; great losse by raines, winds, frosts, the Spring too drye, snow and hard frost, the seed time cold and wett, the summer and fore-Harvest constant rain; then ensued tempestuous winds, that all our costs south and north had incredible losse by shakeing; and many parts in our Highlands rotting, blasting, and mildew destroyed corns'.

<u>1688</u>

North Skye: Another grim reminder of the influence of the elements on standards of living nearly three centuries ago. This year, like so many others, will long be remembered throughout Skye for its raging storms and destructive rains. It is recalled about a century later by the Rev. Mr Marting of Kilmuir, who summarised 1688 as follows. "The seasons were so eminently unfavourable and the corn so deficient in quantity and quality that the poor actually perished in the highways, from want of ailment" (Maclean, 1977: 32).

<u>1697</u>

<u>21-22 September (Old Style) 1-2 October (New Style)</u>

North Sea, especially the northern and northeastern parts, probably also Hebrides and northern parts of the British Isles.

It may be significant that a very great gale 'in the autumn of 1697' is reported to have buried in sand Udal on the island of North Uist (57½°N, 7½°W) - that shows archaeological evidence of more or less continuous habitation for almost 4000 years until that time. Trouble with drifting sand, which has left great bands of nearly white, loose sand from the shore burying the earlier cultural levels, seems to have begun about AD1400, presumably due to increasing storminess but probably also through the greater tidal range about that time than for many hundreds of years before that or at any time since. There was a return to more stable conditions around 1500, but by 1542 the storms were increasing again. And the depth of sand that covered the place in the gale of Autumn 1697 caused the site to be abandoned. The sand depth on the site reached 6m. This storm in 1697 was probably more strongly developed than any of the mature cyclones in 1588 (Lamb (1991: 57-58).

Outer Isles: Walker (in McKay 1980:13) that in 1697 great damage was done in the south of Pabbay, Harris and the farm of Middleton disappeared from the rent rolls; on Berneray, Sheapie was overblown to a depth of several feet, again in 1697. Walker (p.54) also describes that “...in several parts of Harris, the Sand Drift from the sea shore, has made great encroachments upon the land. There are about 300 Acres of what was formerly the best arable and pasture land in the island of Pabbay, that are at present overwhelmed with sand...there are about 300 acres of the best land in the island of Bernera, entirely blown up with sand in the same manner, and the drift has encroached so much upon Loch Buist, a freshwater lake in the island, that it is now firm ground, where there was formerly a great depth of water interspersed with islands. The sand drift is continuing to make great devastation in the same way, along the west coast of the main land of Harris, and in all the other lesser islands which are adjacent. (AGD notes that the above observations of Walker were written in 1764 and therefore cannot refer to a specific storm eg. the 1697 event).

Harris: (Morrison (1967-68: 47) reports that in the Sound of Harris on the island of Pabbay ‘...in the great sandstorm of 1697 there was considerable damage done in South Pabbay by blown sand so that the farm of Middleton disappeared from the Rent Rolls. The other three farms continued right through the 18th century. The fourth farm (AGD quotes Morrison, page 47) that ‘...the four farms were Kirkton (Baile na Cille), Lingay (Baile Lingaidh), Middleton (Baile Meadhonach), and Northton (Baile Mu Thuath).

1714

Jupp (p129) refers to bad harvests and poor weather on Islay throughout the period 1714-1721.

1720 http://www.paparproject.org.uk/hebrides8.html) describes a storm in 1720, ‘..we, the wadsetters tacksmen, and possessors undersubscrivers attest and deliver-That in regarde of the extreme poverty reigning amongst the haill tennants and possessors within the Barony of North Uist occasioned by a murain in our cattle first in 1717 but more especially this year by a second murrain whereby a great many of our cattle have perished to the number of seven hundred and fourtie five cows, five hundred and seventy three horse, eight hundred and twentie sheep. And moreover we attest and deliver that about Candlemass last the sea overflowed severall parts of the countrie breaking down many houses to the hazard of some lives which hase impaired the lands to such a degree as its possible it may happen more and more that they cannot answer to the worst sett in former times (Attestation by the Gentlemen of North Uist, 1721) Donna Morrison: Both entries are from North Uist Parish Council Admin R0001.074 Minute Book 1914-1921). Angus (1977:131) also reports that during Candleness there was an episode of severe sea flooding in North Uist.

1726

Coll: Walker (in McKay 1980:13) reports that on Coll “a tiend decreet of 1726 mentions two farms having to be removed a mile or two owing to inundation (AGD notes that this area almost certainly refers to the district of Crossapol earlier described by Boswell and also mentioned indirectly in the Old Statistical Account for Scotland: Western Isles). McKay

(1980; 242) notes that Scottish Office Manuscript TE/9/13 records that “...By 1726 two farms had been so overblown that the houses had to be moved a mile away.”

<u>1739</u>

This was the last winter of a decade that had been characterised by a great frequency of winds from between W and S affecting Britain and western and northern Europe, and in several cases the winter were very stormy. The unusually mild conditions seem generally to have extended even to Iceland (Lamb 1991: 82).

<u>1749</u>

Outer Hebrides: Reports of a severe hurricane which took place on 19th February affecting Barra (Angus 1977:126). In 1764, Walker (cited in Mackay (1980:87) describes this event, “..From the first of September, to the first of March the wind seldom varies above two or three from SW. On the 19th February 1749, a hurricane from that quater, with a high tide, broke over for the first time, an isthmus which divides the island (of Barra) into two parts. The isthmus was very extensive, and consisted of excellent land, but ever since that inundation has been a blowing sand, though the sea has never again forced its way over it. The same tide, made also great devastation in (the) Clyde, and at Greenock and Inverary flowed into houses.” Also Walker (in McKay 1980) refers to “...houses in the Baleshare township on North Uist being blown up to the roofs; on Barra good land had been covered following a great storm in 1749, and entire villages had to be removed in several parts of the island. The initial cause of the dunes appears to be tidal and climatic but their repeated blowing depends on how well plants can form a stabilising cover to resist the wind.”

Coll: Walker (1764) (quoted in McKay 1980:170) describes, “The soil partakes greatly of sand everywhere, except upon the hills, and in some parts, the sand driving from the shore, has become very detrimental. In one place, there is near 500 acres of excellent land, laid entirely desolate. The sand being now several yards deep, where people yet alive, have reaped the best grain on the island.” (AGD notes that, considered together, the statements above, probably refer to Crossapol and may possibly be connected to the great sand storm of 1697?).

<u>1750</u>

Outer Hebrides: Reports of major coastal sand drifts having taken place during the decade 1750-1760 and known to have affected Barra (Angus (1997) quoting Walker in Mackay 1980:86-88).

<u>1756</u>

Outer Hebrides: Reports of a severe sea flood followed by sand drift at Baleshare, Benbecula (Angus 1997:132-133). Walker (1764) quoted in McKay (1980:64) describes at severe sea flood for this year as "Such a tide, in the year 1756 broke over an extensive isthmus, and turned it into a heap of sand which before would have pastured 100 cows in summer for a fortnight or three weeks. By this irruption, the peninsula of Inchenish, which is two miles long and a mile and a half broad, was disunited from North Wist and turned it into an island, and by the breaking of the isthmus a deluge of sand has been poured in upon the farm town of Ballyshar. The houses in this village are now blown up to the roofs, so that there will soon be a necessity of having it removed further into the country. Near this place the sand drift has also choked up a canal, which had been dug 7 or 8 feet deep and half a mile long in order to drain two lakes which are now by that means destitute of level."

1763

Outer Hebrides: Reports that in August of this year there were exceptionally high winds which led to significant sand drift (Angus 1997:128). Walker, cited in Mackay 1980: 74-5) reported that "...it was indeed melancholy in the beginning of last August, after a tract of high winds, to see some excellent fields of bear (AGD barley), turned in a few days into fields of sand, in some places a yard deep...the violent surge of the western ocean in this shallow water, both forms and pushes on the sand to the shore. When it arrives there, the west winds being predominant, and of great strength, it is hurried forward upon the flat country...in South Wist the foundations of stone walls are to be seen at the lowest ebb, above half a mile from the present floodmark." Walker (1974) (In Mackay 1980:85) also describes "Vatersay, a very fertile spot.." (AGD notes -later to be inundated by sand drift after storms at the start of the 19th century).

1764

Outer Isles: North Uist. Walker (1764) quoted in McKay (1980:64) observed that, "The sand drift has made great devastation in many parts of North Wist, and continues yearly to be more and more formidable. Several parts of the Country which are but little raised above the ordinary level of the sea, have also suffered greatly by extraordinary tides, which are frequently occasioned by the great violence of the SW winds, combined at the full or change with the heavy swell of the Atlantick."

Outer Isles: South Uist. Walker (1764) in Mackay 1980:74) describes, "The west coast of South Wist for the extent of 33 miles is a dead plain; in most places, about 2 miles broad, and of so deep a sand, that there are no springs in it, but what rise in the lakes to which the inhabitants must have recourse for their water. The shore is fenced with vast banks of blowing sand, with which the whole country is flooded in time of storms. This sandy deluge, is of the utmost detriment here, and it is indeed all along the west coasts of this long island, and no effectual means have ever been used to restrain its devastation."

Storms: ".. there were very severe storms in the spring of 1770 so that many cattle starved to death, the price of cattle fell, disease was rife and the sub-tenants were unable to pay their rents.." "Although herrings had been caught in Lochinver Bay in the early months of the year, Thomas Pennant noted that the people were still starving in July for there was no corn to be had in this area which usually had a surplus. Many substantial farmers in the Highlands were said to be ruined (Dawson 2009).

<u>1780</u>

Outer Hebrides: Reports that during the decade 1780-1790 there was considerable destruction of low-lying coastal areas as a result of sand drift. In particular the areas of Burnary, Pabbay and Luskentyre appear to have been seriously affected (Angus 1997:137).

<u>1822</u>

Outer Hebrides: Reports of a severe storm and sea flood in November of this year that affected Balashare, Benbecula. Reports also that the effects of the storm were devastating at Vatersay where a passenger ship was dashed onto the rocks during a storm and approximately 350 people lost their lives. The shipwreck is now mostly buried beneath dunes the deposition of which was associated with a period of later sand drift (Angus 1997).

<u>1826</u>

On the 22nd-24th November there was a severe storm that hit the western Highlands with terrible gusts of wind and snow (Dawson 2009).

<u>1827</u>

On St Kilda on 8th July 1827 Dr MacDonald (quoted in Seton, 1980) reported "..a hurricane..".

<u>1836</u>

Outer Hebrides: Angus (1997) reports that in January of this year a 42 tonne boulder was observed to have been transported and deposited during a storm in Barra.

<u>1838</u>

Bathurst (1999:166) describes the construction of Skerryvore lighthouse off Tiree that Alan Stevenson received a letter from Mr Hogben the storekeeper at Hynish 'Dear Sir,' it began, 'I am extremely sorry to inform you, that the barrack erected on Skerryvore Rock has totally disappeared.' It had been visible on 31 October, but the three following days had brought a driving west coast rain during which no one had been able to see the rock from Hynish. On the evening of 3 November, 'the wind increased to a gale, with a great swell, and an extraordinary high tide. Yesterday (Sunday the 4th) … Mr Scott and Charles Barclay … got a momentary glimpse of the Rock through the spray, and both were of opinion that the barrack was gone. This was not credited by the workmen who had been employed at it, but this morning we found it to be the case; the Rock was pretty clearly seen, but no trace of the barrack.' A whole year's work was lost; a season's labour flung to the winds in one day's gale. Alan took sparse comfort from Mr Hogben's assurance that the islanders hadn't seen such a severe storm for over sixteen years. As he later pointed out, 'Thus did one night obliterate the traces of a season's toil, and blast the hopes which the workmen fondly cherished of a stable dwelling on the rock, and of refuge from the miseries of sea-sickness, which the experience of the season had taught many to dread more than death itself.'

1839

6-7 January: The Atlantic fringe of the British Isles, especially western and northern Ireland, much of Scotland (some reports suggest especially southern Scotland), northwest England and North Wales; a little later much of England, then the whole width of the North Sea and on to Denmark and the Baltic. A great storm: in Ireland considered the severest of the whole record (far less effect was felt there from the great 1703 and 1987 storms which are much more famous in England). Barometric pressure values are available from at least 25 points in the British Isles besides others on the continent and in Scandinavia. This was clearly one of the deepest depressions ever recorded so near the British Isles. The Armagh records describe "…a tremendous gale in the night.." of Jan 6 preceded and accompanied by snow. Observations assembled by the Irish Meteorological Service for a study of the storm to mark its 150th anniversary revealed lowest pressures about 922.8mb at Sumburgh Head, Shetland about 14h on the afternoon of the 7th and 925.2mb at Cape Wrath around 0h on that day. At Aberdeen 936mb was observed. The storm cyclone is thought to have been at its deepest around midnight 6-7 January, *centred near 58½°N 11°W, off the Hebrides,* with a central pressure at that time about 918mb (Lamb 1991).

1847

Hurricane storm during April (see below). Chapplin (1997) describes a severe hurricane in the Inner Hebrides at this time. In particular she describes a ship, the Exmouth set sail from Londonderry on Sunday 25th April 1847. During the Tuesday evening (27th April) the Exmouth was caught in mountainous seas and was wrecked on the rocks of the Rhinns of Islay with the loss of 251 lives. The Armagh records shows this hurricane clearly with gale force 11 winds from S on April 25, force 10 winds on April 26 (S), force 10 winds on April 27 from W. Air pressure minimum occurred on April 26 as 28.978 inches (981.3 mb). During the early autumn the weather broke and for several weeks the whole of the NW Highlands and Islands were swept by almost incessant rain and gales.

1855

A severe hurricane throughout Scotland on 4th January (Caledonian Mercury).

1859

Outer Hebrides: Reports of a severe sea flood which affected Baleshare, Benbecula (Angus 1997:136).

1868

Bathurst (1999: 230) describes how Robert Louis Stevenson observing the results of a winter gale at Dhu Heartach 'The end of the work displays gaps, cairns of ten ton blocks, stones torn from their places and turned right round. The damage above water is comparatively little: what there may be below, *on ne sait pas encore*. The roadway is torn away, cross-heads broken, planks tossed here and there, planks gnawn and mumbled as if a starved bear had been trying to eat them, planks with spales lifted from them as if they had been dressed with a ragged plane, one pile swaying to and fro clear of the bottom, the rails in one place sunk a foot at least. This was not a great storm, the waves were light and short. Yet when we were standing at the office, I felt the ground beneath me *quail* as a huge roller thundered on the work at the last year's cross-wall.'

1869

MacDonald (1971:39) describes a storm in North Uist as having taken place during 1869 associated with extensive coastal flooding. (AGD notes this may be the storm of December 13th 1869 – this storm registers on the Monach Isles on the morning of the 13th as a 'strong gale from the WSW' at 953.3 mb. By 9 pm it appears on the Monachs as a 'strong gale from the NW' at 953.3 mb. On December 13th in Stornoway at 9 am the storm is described as 'grade 5' from the SW and by 9 pm as associated with an air pressure of 947.9 mb).

1871

Stornoway: Jan 1 is described as a 'hurricane force 12'. Hurricane force winds are also recorded for January 16-17th 1871 – this storm is described in the Monach Isles lighthouse record as a 'strong gale from the SE' at 9 am with an air pressure of 941.4 mb. It is recorded for 9 pm as a 'gale from the SW' with a pressure of 948.9 mb. On January 17th at 9 am it is registered as a pressure value of 952.6 mb. It is inferred that this extreme storm lasted at least 24 hr (9 am – 9 pm – 9 am). Further hurricane force winds are recorded for February 22 (hurricane 12), March 12 , August 22, October 22, November 20 and December 31.

1872

January 17-18th 1872 – this storm is shows on the Monach Isles record with an air pressure of 952.9 mb at 9 pm on January 17th and 957.0 mb at Stornoway. By 9 am on January 18th it has fallen to 949.9 mb at the Monach Isles and 949.3 mb at Stornoway. By 9 pm the storm continues to appear on the Stornoway record as 950.1 mb. This storm also appears to have lasted at least 24 hr (9 pm – 9 am – 9 pm). Hurricane force winds also recorded for January 1 and 3, 30 and 31, March 2 and 17, October 29 and 30 and November 5.

1873

January 18-19th 1873 – in the Monach Isles this storm is described as a 'gale from the SW' at 9 pm on the 18th.The 9 am record for January 19th is shown as a 'gale from the NW' with an air pressure of 951.6 mb. At the Monach Isles, the storm continues through the morning of the 19th with a 9 am value of 948.2 mb. The Stornoway time series shows the morning of the 19th as 951.9 mb and lowered to 948.6 mb by 9 pm of the same day thus giving a 9 pm -9 am -9 pm sequence. Winds recorded as hurricane force on January 7 and 18.

1874

Maclean (1977) describes an exceptionally severe storm during October in N Skye.

Stornoway record reports hurricane force winds on October 21

1875

Stornoway: hurricane force winds reported for December 21 and 24.

1876

Stornoway, hurricane force winds recorded for January 23. March 8-9th – air pressure is recorded for 9 pm on March 8th as 958.3 mb at the Monach lighthouse. By the morning of March 9th it had fallen slightly to 952.6 mb and had risen slightly to 952.2 mb by that evening. The storm is also recorded in Stornoway where at 9 pm on March 8th it is at 957.4 mb and at 9 am on the 9th at 952.9 mb. The storm therefore extended over at least 24 hr (9 pm – 9 am – 9 pm). Hurricane force winds also reported for December 3.

1877

Outer Isles: November 11-12th 1877 – the Monach Isles shows this exceptional storm appearing first in the 9 am record for the 11th as a 'gale from the SSE' with an air pressure of 955.6 mb.By 9 pm on the 11th the storm was being recorded as a 'gale from the S' at 936.3 mb. At 9 am on the morning of the 12th it shows at the Monach Isles as a 'storm from the S' with air pressure of 943.1 mb. By 9 pm on the 12th, it was recorded as a 'gale from the SW' at 956.7 mb. In Stornoway at 9 pm on the 11th the storm is registered as 'grade 6 hurricane force from the south' at 942.5 mb and at 9 am on the 12th the gale is recorded as a 'grade 5 southerly storm' at 952.6 mb. This storm is the most extreme in the entire record over the last 144 yr. Not only, did air pressure remain exceptionally low over at least 36 hr (9 am-9 pm – 9 am – 9 pm) but it was also associated with lowest daily air pressure ever recorded.

Hurricane force winds also reported for November 15 and December 26 (hurricane 12)

1878

Stornoway: hurricane force winds recorded for March 7 (NW and WNW) and 24 (NNE and N) as well as September 15 (S), October 13 (S) and November 9 (S) and 10 (NE).

1879

Stornoway: hurricane force winds reported for January 17 (SE), February 5 (SW), 6 (S), March 4 (SW), September 23 (S) and December 13 (SW) and 27 (SW).

1881

November 26-27th 1881 – this storm first appears as an extreme low air pressure value (948.2 mb) in the Monach Isles at 9 pm on the 26th. By 9 am on the 27th air pressure at the Monachs has fallen to 938.7 mb and remained low on the following morning (9 pm on the 27th) at 951.6 mb. This storm does appear in the Stornoway record as having been associated with exceptionally low air pressures but at the Monach Isles as a storm that lasted at least 24 hr (9 pm – 9 am – 9 pm). Numerous reports that describe how this storm accompanied by marine flooding in Argyllshire led to the flooding of the slate quarries at Easdale (numerous sources). MacDonald (1982: 11) describes how one of the worst storms ever to hit the west coast of Scotland took place on the night of November 23rd 1881 and resulted in the destruction of the slate quarries of both Easdale and Eilean A'Beithich. Huge waves swept over the entire island and by morning the quarry workings lay flooded and useless. Later attempts were made to salvage the industry but it was never again to flourish as in the past (AGD notes that if this storm was coincident with high tides as seems to have been the Easdale, it is reasonable to infer that this storm may have been associated with significant coastal flooding across the Outer Isles).

1882

Severe Storm - Highlands and Islands: Hunter (1976: 131) also observed that "..Crofters' corn, most of which had remained unharvested because of prolonged rain in August and September, was largely flattened and destroyed by an exceptionally severe southerly gale. All the islands and entire north-west coast of the mainland were affected by the storm which, as well as adding to the agricultural havoc already wrought by the blight, caused no less than 1,200 boats to be damaged or destroyed and brought about the loss of an immense quantity of nets and other fishing gear.' (References: Scotsman 4th Oct 1882; The Times 5 Oct 1882; Obvan Times 7th Oct 1882. Also N.C.Q.46056; Fishery Board for Scotland, 1st Report 1883,xxii; Alleged Destitution, 1883,2). In addition, the Minutes of the Napier Commission (1884:826) describe a severe storm as having occurred during November 1882 when, ‘‘. . . a large tract of land was completely carried away by the tide’.

1883

6 March: northerly gales were observed across the whole area from the Hebrides (Lewis) to the coast of Norway (Lamb 1991).

1884

The whole period from 19 January to the 27th was very stormy in the British Isles. A record fall of barometric pressure by 32.5mb in just 4 hours, from 1021.5 to 989mb, was noted at Stornoway in the Hebrides at the beginning of the sequence of storms, on the evening of the 19th. During the 26th the cyclone became largely occluded and its progress slowed to a mere 600 nautical miles in the 24 hours to the morning of the 27th, when the centre was about 59½°N between 1°W and 1°E, near Shetland, the lowest pressure then being 930-932 mb. This storm occurred in the midst of a long spell of prevailingly westerly weather in the British Isles that lasted from 5 January to 8 February 1884. Until the 18 January it had been combined with an anticyclonic tendency but then became subject to cyclonic intrusions until 1 February. Lamb (1991:144-145).

1885

On 16th September 1885 a letter was washed ashore on Lewis. It was addressed to Dr Rainy, one of the leaders of the Free Church of Scotland, and was written by the minister of St. Kilda, the Reverend John Mackay. 'I beg leave to intimate to you,' he wrote, 'that I'm directed by the people of this island to tell you that their corn, barley and potatoes are destroyed by a great storm which passed over the island on Saturday and Sabbath last. You will be kind enough to apply to Government in order to send a supply of corn seed, barley and potatoes. They never saw such a storm at this time of year.' (Dawson 2009).

1893

Storm across British Isles, North Sea and neighbouring sea and coastal areas, including on the 17th a wide area of the Atlantic between Ireland and Iceland, with extensions to the Bay of Biscay and French coast on the 17th-19th and along the continental seaboard into the southern Baltic on the 20th. Lamb (1991:147).

1903

Maclean (1977) describes this year as exceptionally stormy and wet in N Skye. On South Uist: '..near the road between Carnan Inn and Iochdar, during the beginning of 1903 an embankment near Roderick Morrison's croft broken by the sea. District Committee refused to repair breach - took steps to have it removed from the list from the Inn to where it is joined by the Bualadubh road. Lady C *(Gordon Cathcart)* repaired embankment at own expense (K Muir pers. comm.).

1904

Maclean (1977) describes N Skye for the month of February was exceptionally stormy.

1920

26-27 January. Mainly the British Isles, and at times the North Sea, also the eastern Atlantic between 45° and 55°N, and the Bay of Biscay. Later on the 27th also Danish coasts, notably Skagen in the north and Bornholm in the east. A S'ly gale, Beaufort force 8 in the Hebrides, force 9 in Shetland and with SSE force 9 at the southwest coast of Norway, was reported on the evening of the 26th. Gale force from SW was reached that night also on the coasts of Ireland, and on the morning of the 27th S force 8 was reported on the coasts of northeast England and East Anglia. During the 27th the gale was very severe in Ireland, Scotland, and the west of England, particularly violent near the west and south coasts of Ireland. This had become a very big depression, which dominated the whole Atlantic between latitude 30°N and the pole or beyond and from Labrador to Europe at 10-20°E. Lamb (1991: 155).

Barra: Damage to roads: submitted letter dated 22/11/20 from the road surveyor, Barra, as to damage to roads on the west side of Barra by the storms of November last, the damage being estimated at £70 (K Muir pers. comm.). Letter also submitted dated 17/12/20 from Angus Maclean, crofter, Balnambodach, Barra, complaining that the side drains of the road at his holdings require immediate attention. The road surveyor was directed to see this matter (Meeting of South Uist and Barra District Committee held at Lochboisdale on 25th January 1921).

1921

Maclean (1977) describes a destructive hurricane in N Skye that took place on 16th March. Damage by gale: '..the Committee feel compelled to direct the attention of the Board of Agriculture for Scotland to the extraordinary damage and loss occasioned to houses and provender for cattle by the recent gale, the consequence of which loss are in their opinion serious enough at present and are likely to be still further intensified in the very near future. They suggest that the Board should immediately make such arrangements as would enable the people to preserve their cattle by the provision of suitable feeding stuffs on the most favourable terms (Meeting of South Uist and Barra District Committee held at Cregorry Hotel on Tuesday 19th April 1921). MacDonald (1971:41), also describes for North Uist, where high tides during 1921 left large areas of land strewn with shingle and no longer available for tillage…''.

Inspection of the Meteorological Register for 1921 shows the occurrence of two exceptionally stormy intervals. The first took place during March when 29 of 31 days recorded wind velocities between Beaufort Force 4 – 7 with nearly all of these having been between WSW and SW. During the 23 – 24 March, the most extreme category of sea state (6) was recorded. In December hurricane-force winds occurred between 16 – 20 December with the highest recorded sea state on 16, 17 and 20 December with prevailing winds having varied between WSW and WNW (AGD note that the 1921 storms of March and December appear to have been associated with an unusual synoptic weather situation where the southern flank of an area of high pressure located in the northern Atlantic was juxtaposed against a low pressure cell to the south. West of the Hebrides this led to a sustained wind regime from the W and WNW that, as far as one can tell from the fragmentary historical accounts led to significant coastal flooding in the Uists and Benebecula).

1927

28 January: Storm. The British Isles and neighbouring seas between latitudes 50° and 60°N. As in the previous winter, there was a great predominance of W'ly and SW'ly winds over Britain and northern Europe with a continual succession of depressions often of great size and considerable intensity. This storm is illustrated here by very wide-area maps of the meteorological situation over eastern North America, the Atlantic and Europe, to show the commanding size of the circulation systems. Lamb (1991:156).

1951

30 December: northern and eastern Scotland and northern Ireland and the neighbouring sea areas about the Hebrides, Pentland Firth, and the northern North Sea. Violent gale caused extensive and widespread damage, also some flooding in coastal districts. Considered the most extensive and severe gale in Scotland since 1927 (report in Weather 1952, 7(1), p. 21). There were several deaths caused. The strongest gusts reported in this storm were: 94 knots at Millport on the island of Bute, 87 at Bell Rock lighthouse in the North Sea 20km east of Dundee, 85 at Benbecula and Tiree in the Hebrides, and 88 knots at Edinburgh airport (Turnhouse). The wind at Benbecula averaged 73 knots (force 12) over a one hour period in the forenoon. Lamb (1991:169).

1952

17 December: Scotland and northern and eastern England, with nearby parts of the North Sea. The strongest gusts noted were 96.4 knots at Cranwell, Lincolnshire, 91 at Liverpool airport, 87 at Tiree in the Inner Hebrides, 80 at Stornaway, 79 at Fleetwood, Lancashire and 76 at Sellafield on the coast at the southwest side of the Lake District. The gust at Cranwell was reputedly the strongest ever measured anywhere inland in Britain to that time. Lamb (1991:170).

North Skye: (Maclean, 1977:5) January 1952. There was a severe storm on the 14th, with gusts up to 119 mph reported from Stornoway. North Skye: (Maclean, 1977: 24) December 1952. Probably one of the worst storms of wind and snow ever experienced in the Highlands in December, on the 16th and 17th.On the night of the 17th there was a storm which caused extensive structural damage. There were 100mph gusts in parts of the Hebrides.

1954

21-23 December: North Sea, Scotland, eastern England, the Low Countries and Germany. The jetstream at heights of about 10km and above over Scotland was of exceptional strength, close to 200 knots (100m/sec): 198 knots was measured at about 11km over Leuchars on the east coast on the evening of the 22nd and 196 knots over Stornoway the previous evening. These speeds were described as 'among the highest figures that have (ever) been observed over the British Isles'. North Skye: (Maclean, 1977:22) November 1954. Pressure was extremely low during the last 9 days of the month. On Tuesday 30th a deep and vigorous depression west of Scotland, moving north, reduced pressure to 27.96 inches.

<u>1955</u>

North Skye: (Maclean, 1977:9) March 1955. On Sunday 20th and Monday 21st a deep depression west of the Hebrides, moving south, brought a blizzard coupled with a strong south-east wind. The remainder of the month was mostly cold and frosty.

<u>1957</u>

23-25 August: a small, rather complex, depression (centre 998mb at noon) west of Ireland on the 22nd deepened rapidly to about 965mb as it moved quite slowly (at 25 knots slowing to about 10 knots) northeast to near Cape Wrath by the 24th. Lamb (1991) page 173. North Skye: (Maclean, 1977:21) October 1961. On 23rd/24th a two-day storm reached a peak of 90mph. The disturbance was accompanied by very high tides, especially pm the 24th when the piers at Armadale and Raasay were awash, and many low-lying houses were flooded by the sea.

<u>1967</u>

6 March: Atlantic fringe of northwestern and northern Ireland, and all Scotland and, later, Norway coast. Sea areas off these coasts were affected by a notable SW'ly gale, with fierce gusts recorded. First reports of Beaufort force 9 SW'ly came from Blacksod Point and Malin Head on the coasts of Ireland already at 0h on the 6th. The gale then swept across the whole of Scotland, producing gusts of 79 knots at Tiree in the Hebrides (56½°N) soon after midnight and 78 knots at Stornoway (58°N) in the Outer Isles at 2.30h, both of these from about S by W, and at 8.35h a gust of 124 knots from W by S was measured on the Cairngorm summit (1245m at 57°N) in eastern Scotland. The greatest hourly mean wind speed noted was 61 knots between 8 and 9h, also on top of Cairngorm. Lerwick in Shetland reported WSW winds of gale force from 9 to 18h on the 6th, and from about 18h to the early hours of the 7th SW'ly Beaufort force 8 or 9 was reported on the coast of Norway about 62°N. Lamb (1991:176).

<u>1968</u>

14-15 January: from the eastern Atlantic about 48° to 53°N around midday on the 14th this SW'ly gale affected the northwestern fringe of Ireland between about 18h and midnight. It then swept the whole of Scotland and northern England, producing great gusts, gradually turning to WSW and WNW, between 0h and 9h on the 15th, and passing on across the central North Sea it reached Denmark about the middle of that day. A SW'ly gale force 9 was reported at Blacksod Point, on the coast of Ireland, by 18h on the 14th and Malin Head and

Tiree in the Hebrides at midnight. Tiree had gusts of 89 knots at 23.50h and 102 knots at 2.25h, while gusts of over 93 knots from about W were recorded on the top of Cairngorm (1245m in 57°N) in eastern Scotland at 1.15h and 3.30h on the 15th. Great Dun Fell (54°41'N 2°27'W 847m) on the high Pennines in northern England had a gust of 116 knots from SW about 3h and Lowther Hill (55°23'N 3°45'W 754m) one of 108 knots from W at 4.25h. A gust of 94 knots was measured on the Forth Road Bridge at 5.05h, and Bell Rock lighthouse in the North Sea, off Dundee, had 96 knots at 4.10h. Gusts of 90 knots were also measured at Prestwick and Edinburgh (Turnhouse) airports. Lamb (1991:177).

2005 January 11th storm.

References:

Angus, S. (1997) The Outer Hebrides: the shaping of the islands. White Horse Press, 264 pp.

Bathurst, B. (1999) The Lighthouse Stevensons. Harper Collins Publishers, London, 284 pp.

Chapplin, J. (1997) The Hurricane of '47', Scots Magazine, 146, 4, pp. 388-391.

Dawson, A.G. (2009) So Foul and Fair a Day: a history of Scotland's weather and climate, Birlinn, Edinburgh.

Fraser, J. (1905) Chronicles of the Frasers: The Wardlaw Manuscript Entitled 'Polichhronicon Seu Policratica Temporum, or, The True Genealogy of the Frasers' 916-1674. Scottish History Society, University Press.

Hunter, J. (1976) The making of the Crofting Community, John Donald Publishers, Edinburgh.

Jupp, C N. (1994) The history of Islay from earliest times to 1848, Museum of Islay Life, Port Charlotte, 234 pp.

Lamb, H.H. (1991) Historic Storms of the North Sea, British Isles and Northwest Europe. Cambridge University Press, Cambridge, 204 pp.

MacDonald, W. 1971 A study of two Hebridean townships. M.A.thesis (unpublished), Department of Celtic Studies, University of Aberdeen, 87 pp.

MacDonald, N. (1982) The Islands of Nether Lorn, West Highland Series No. 3, 24pp, West Highland Publications, Oban, Argyll.

Maclean, D.A. (1977) The Weather in North Skye. Highland Herald Limited, 1 Friars Street, Inverness.

Minutes of Evidence to the Highlands and Islands Napier Commission, 1884 Blue Book, p. 826.

Morrison, A. (1967-68) Harris Estate Papers 1724-1754. Transactions of the Gaelic Society, Inverness, Vol. XLV, pp. 33-97.

McKay, M. (ed.) (1980) "The Rev. Dr. John Walker's Report on the Hebrides of 1764 and 1771", John Donald Publishers Ltd., Edinburgh, 256 pp.

Seton, G. (1980) St Kilda. Mercat Press, Edinburgh, 346 pp.

APPENDIX 2. Extreme daily air pressure

Monach 9 am (1867-1913) dates of air pressure < 960 mb plus some wind notes.

	Date			Pressure (MB)	Wind speed (Gales)	Wind Direction
Under 950 mb	16	JANUARY	1871	941.4	strong gale	SE
	18	JANUARY	1872	949.9		
	22	JANUARY	1875	903.8		
	12	NOVEMBER	1877	943.1	storm	S
	27	NOVEMBER	1881	938.7		
	6	JANUARY	1882	948.2	storm	W
	8	DECEMBER	1886	941.4		
	8	DECEMBER	1893	947.2		
950 - 954.99 mb	29	JANUARY	1869	954.3	storm	S
	13	DECEMBER	1869	953.3	strong gale	WSW
	17	JANUARY	1871	952.6		
	19	JANUARY	1873	951.6	gale	NW
	20	JANUARY	1873	952.9	gale	N
	9	MARCH	1876	952.6		
	26	NOVEMBER	1880	955.0	gale	SSE
	27	JANUARY	1884	953.6	gale	NNW
	10	FEBRUARY	1884	954.3	storm	SW
	3	NOVEMBER	1887	954.3		
	30	DECEMBER	1897	952.2		
	13	FEBRUARY	1904	955.0		
	15	MARCH	1905	953.3		
	17	FEBRUARY	1910	954.3		
	5	NOVEMBER	1911	951.6	9	W
	26	NOVEMBER	1912	951.6		
	19	MARCH	1913	954.3		
	19	SEPTEMBER	1869	959.0	strong gale	N

	Date			Pressure (MB)	Wind speed (Gales)	Wind Direction
955 - 959.99 mb	23	OCTOBER	1870	959.7		
	2	OCTOBER	1874	957.7	gale	W
	11	NOVEMBER	1877	955.6	gale	SSE
	25	NOVEMBER	1883	958.3		
	25	JANUARY	1890	956.3		
	3	MARCH	1896	956.0		
	27	DECEMBER	1898	958.3		
	16	FEBRUARY	1900	956.7		
	15	OCTOBER	1902	959.0	gale	S

Monach 9 pm (1867-1913) dates of air pressure < 960 mb plus some wind notes.

	Date			Pressure (MB)	Wind speed (Gales)	Wind Direction
Under 950 mb	29	JANUARY	1869	947.5	storm	SSW
	16	JANUARY	1871	948.9	strong gale	SW
	19	JANUARY	1873	948.2		
	11	NOVEMBER	1877	936.3	gale	S
	26	NOVEMBER	1881	948.2		
	26	JANUARY	1884	931.9	gale	NNW
	8	DECEMBER	1886	944.8	storm	NE
	11	FEBRUARY	1894	949.9		
	2	JANUARY	1903	948.2		
950 - 954.99 mb	13	DECEMBER	1869	953.3	strong gale	NW
	24	NOVEMBER	1870	954.6		
	17	JANUARY	1872	952.9		
	9	MARCH	1876	952.2		
	27	NOVEMBER	1881	951.6		
	18	JANUARY	1890	953.3		
	13	OCTOBER	1891	953.3		
	8	DECEMBER	1893	953.3	storm	SW
	20	DECEMBER	1900	953.3	gale	S
	15	MARCH	1905	955.0		
	4	DECEMBER	1907	955.0		
	20	FEBRUARY	1910	954.3		
955 - 959.99 mb	23	OCTOBER	1870	957.3		
	23	NOVEMBER	1872	957.3		
	18	JANUARY	1873	958.0	gale	SW
	2	April	1874	957.3		
	8	MARCH	1876	958.3		
	12	NOVEMBER	1877	956.7	gale	SW

Date			Pressure (MB)	Wind speed (Gales)	Wind Direction
12	FEBRUARY	1883	957.7	gale	S
31	JANUARY	1885	957.3		
3	MARCH	1896	958.3		
8	DECEMBER	1907	959.7		
19	FEBRUARY	1910	956.7		

Stornoway 9 am (1867-2011) dates of air pressure < 960 mb plus some wind notes.

	Date			Pressure (MB)	Wind speed (Gales)	Wind Direction
Under 950 mb	18	JANUARY	1872	949.3		
	20	DECEMBER	1982	945.4		
	3	JANUARY	1998	949.2		
950 - 954.99 mb	6	FEBRUARY	1867	955.0		
	30	JANUARY	1869	955.0	5	SW
	16	JANUARY	1871	952.7	6	SW
	17	JANUARY	1871	953.8		
	19	JANUARY	1873	951.9		
	20	JANUARY	1873	952.0		
	9	MARCH	1876	952.9		
	12	NOVEMBER	1877	952.6	5	S
	27	JANUARY	1884	954.3		
	8	DECEMBER	1886	950.2		
	8	DECEMBER	1893	955.0		
	5	NOVEMBER	1911	952.9		
	19	DECEMBER	1949	954.1		
	11	JANUARY	1962	954.2		
	9	FEBRUARY	1988	953.7		
955 - 959.99 mb	1	FEBRUARY	1868	958.3		
	27	DECEMBER	1868	956.7		
	13	DECEMBER	1869	957.1	5	SW
	3	APRIL	1874	959.8	5	WNW
	10	MARCH	1876	959.7		
	1	MARCH	1880	959.4	5	W
	3	NOVEMBER	1887	959.0		
	19	JANUARY	1890	956.7		
	25	JANUARY	1890	958.3		

Date			Pressure (MB)	Wind speed (Gales)	Wind Direction
14	OCTOBER	1891	957.0		
2	FEBRUARY	1892	959.4		
29	DECEMBER	1902	958.7	8	NW
2	JANUARY	1915	958.6	7	SE
12	JANUARY	1920	959.7		
5	NOVEMBER	1926	956.8		
18	DECEMBER	1945	955.4		
1	APRIL	1948	958.7		
5	FEBRUARY	1951	958.6		
17	JANUARY	1965	959.1		
25	FEBRUARY	1989	959.6		
26	FEBRUARY	1989	956.6		
17	DECEMBER	1989	957.8		
31	MARCH	1994	955.4		
3	DECEMBER	2006	958.0		
25	NOVEMBER	2009	959.0		

Stornoway 9 pm (1867-2011) dates of air pressure < 960 mb plus some wind notes.

	Date			Pressure (MB)	Wind speed (Gales)	Wind Direction
Under 950 mb	13	DECEMBER	1869	947.9		
	19	JANUARY	1873	948.6		
	11	NOVEMBER	1877	942.5	6	S
	26	JANUARY	1884	931.9		
	8	DECEMBER	1886	945.1		
	19	DECEMBER	1982	942.0		
950 - 954.99 mb	6	FEBRUARY	1867	953.3		
	19	DECEMBER	1869	954.7		
	18	JANUARY	1872	950.1		
	22	OCTOBER	1873	954.3		
	1	NOVEMBER	1873	953.3		
	14	MARCH	1876	953.6		
	13	OCTOBER	1881	951.6		
	6	JANUARY	1882	955.0		
	9	DECEMBER	1886	955.0		
	25	JANUARY	1890	953.3		
	30	JANUARY	1894	953.7		
	11	MARCH	1894	955.0		
	5	DECEMBER	1895	951.6		
	3	MARCH	1896	950.9		
	28	DECEMBER	1902	954.3	8	W
	19	FEBRUARY	1907	954.3		
	22	FERBRUARY	1908	951.6		
	26	NOVEMBER	1939	954.7		
	18	JANUARY	1948	954.3		
	1	JANUARY	1949	954.8		
	19	DECEMBER	1982	954.2		

	20	DECEMBER	1982	953.7		
955 - 959.99 mb	29	JANUARY	1869	957.0	5	SW
	23	OCTOBER	1870	959.5		
	17	JANUARY	1872	957.0		
	18	JANUARY	1872	957.4		
	2	APRIL	1874	957.9		
	2	OCTOBER	1874	958.8		
	8	MARCH	1876	957.4		
	18	JANUARY	1890	956.3		
	30	DECEMBER	1897	958.7	8	WSW
	27	DECEMBER	1898	955.3		
	15	MARCH	1905	956.3		
	17	DECEMBER	1945	958.2		
	31	MARCH	1948	959.4		
	31	JANUARY	1983	956.0		
	2	JANUARY	1984	958.2		
	22	NOVEMBER	1986	959.8		
	17	JANUARY	1995	957.1		
	24	FEBRUARY	1997	955.4		
	1	JANUARY	1998	959.9		
	11	JANUARY	2005	959.3		
	3	DECEMBER	2006	958.6		
	17	JANUARY	2009	958.7		