

1. ABOUT THE DATASET

Title: Atmospheric electricity data for El Niño-Southern Oscillation studies

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Description: The global atmospheric electric circuit responds to related internal climate variability such as that from the El Niño-Southern Oscillation. Long series of atmospheric electricity data from the twentieth century are needed for comparison purposes. Here, annual values of Potential Gradient (PG) from Lerwick Observatory, Shetland during 1927-1954 and 1968-1983, and also from Watheroo Observatory, Western Australia during 1924-1934, have been digitised and collated.

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Related publications: R. Giles Harrison, Keri A. Nicoll, Manoj Joshi, Ed Hawkins, Empirical evidence for multidecadal scale Global Atmospheric Electric Circuit modulation by the El Niño-Southern Oscillation (in preparation, 2022)

2. TERMS OF USE

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3. PROJECT AND FUNDING INFORMATION

This dataset contains atmospheric Potential Gradient (PG) data from Lerwick Observatory, Shetland, and Watheroo Observatory, Western Australia. The Lerwick data was originally obtained by the Met Office, and the Watheroo data by the Carnegie Institution, Washington.

These data were collected and keyed as part of ongoing research by Prof Giles Harrison in the Department of Meteorology, University of Reading, during the past twenty years. No external project funding has been received.

4. CONTENTS

This data repository submission contains observations of the Potential Gradient (PG), made at Geophysical Observatories at Lerwick, Shetland and Watheroo, Australia. There are three data files:

Filename	Contents
LerwickEarly_DecPG_hourly.csv	Hourly PG values from Lerwick, for Decembers 1927-1954
LerwickLate_DecPG_hourly_means.txt	Hourly averages of fair weather PG, for Decembers 1968-1983
WatherooPGMonthly_1924-1934.txt	Monthly averages of PG derived from hourly measurements made on undisturbed days, 1924-1934

The PG is a measure of the vertical fair weather electric field in the atmosphere. It is determined from the equivalent potential at 1 m above the surface over open, flat ground, with units of volts per metre (Vm^{-1}). In fair weather the PG is positive, and typically 100 Vm^{-1} to 150 Vm^{-1} . Principles and methods of PG measurement are given in Harrison and Bennett (2021).

At many established observatories the practice has been to measure the PG hourly, and also to record whether the conditions were undisturbed at the time, or if they met agreed criteria for “fair weather”. Some sites have recorded the PG for a long time, notably in the UK (Harrison, 2003). It has subsequently been found that there is a close association between the PG measured at Lerwick in December, and a major source of internal climate variability, the El Niño-Southern Oscillation (ENSO).

The PG data in this repository entry allow this effect to be investigated over an extended period, from 1927 to 1984, and includes southern hemisphere data, from Watheroo Observatory, Australia.

Lerwick data

At Lerwick Geophysical Observatory, the atmospheric Potential Gradient (PG) was measured hourly between 1927 and July 1984, as described by Harrison and Riddick (2022). The values obtained were recorded on daily and monthly summary sheets, which were then transcribed for the annual Met Office publication *The Observatories' YearBook* (OYB). The last year of the OYB publication was 1967: the data values continued to be published by the Hydrological Service of the USSR. The observatory summary sheets from throughout the period are stored in the National Meteorological Library and Archive. For long term preservation, these summary sheets were scanned by the Hadley Centre of the Met Office in 2003, with supervision from Prof Harrison: the scanning generated images only, and the data values were not keyed. Scanned images of the OYB for Lerwick from 1927 to 1967 have been made by the British Geological Survey (BGS, see references).

Since then, some of the data values have been keyed in from time to time by Prof Harrison, various collaborators and students, most notably Dr Keri Nicoll. This has been an entirely ad hoc activity, however the scrutiny resulting from different individuals at different times has helped identify erroneous values, which have been removed: further incorrect values will no doubt remain. The limited selection of the Lerwick data set entered to date is presented here.

The process used for keying the data has been, for some chosen months and years of interest relevant to different projects and topics, to construct a blank Excel spreadsheet with an identical layout to the original observatory summary sheets. Values were entered into this spreadsheet, with basic checks made on the number of values and the mean values. Each of the completed spreadsheets were saved as a plain text file. The set of text files generated were read by a processing program which assembled them into a combined, continuous file, in which the data values still to be entered were filled with a numeric value which signifies that the value is Not Available (NA).

(a) Early Lerwick PG data (1927-1954)

The early Lerwick PG data provides hourly values from the month of December. The values entered are only for those days originally classified as “0a”, “1a” or “2a”, which were considered the least locally disturbed by weather.

The associated data file is called

LerwickEarly_DecPG_hourly.csv.

This is a plain ascii text file, with each line of data values in columns running from left to right, comma separated. The files are organised as described in Table 1. The file has two header lines, and Not Available (NA) data values are signified with an entry of -6999.

Table 1. Early Lerwick data

Column number	Quantity	Description	unit
1	Year	Time variable (value runs from 1927 to 1954)	GMT
2	Day of year	Time variable (value runs from 1 to 365 in a non-leap year, and to 366 in a leap year)	GMT
3	month	Time variable (value runs from 1 to 12)	GMT
4	Day of month	Time variable (values runs from 1 to 31)	GMT
5 to 28	Measured value for hour of day from 1 to 24	Potential Gradient	Vm^{-1}
29	Classification of day's data	0, 1 or 2, corresponding to "0a", "1a" or "2a". These codes denote: 0 - a day (midnight to midnight) with no negative PG recorded, 1 - a day with negative PG excursions totalling less than three hours, 2 - a day with negative PG totalling more than three hours. In any of the hourly periods of the day, <i>a</i> signifies that the PG range did not exceed 1000 Vm^{-1} .	

(b) Late Lerwick PG data (1968-1983)

The later Lerwick PG data provides mean values for each hour of the day, for December 1968 to December 1983, and selected for "fair weather" according to the standard criteria (Harrison and Nicoll, 2018). These fair weather hourly mean values were taken directly from the observatory summary sheets without any data processing.

These values are contained in the file:

LerwickLate_DecPG_hourly_means.txt.

This is a plain ascii file, with the data columns separated by tabs. The first four lines are header lines, after which there are twenty-four lines for the hourly mean values, with the data values for each specific year in a separate column. Table 2 summarises the organisation of the data file.

Table 2. Late Lerwick data

Column number	Quantity	Description	Unit
1	Hour of day	Hour of day for which the mean value is calculated	GMT
2..17	Mean PG values	Fair Weather mean PG for year considered (column 2 = 1968 ... column 17=1983)	Vm ⁻¹

Watheroo data (1924-1934)

The Carnegie Institution of Washington operated several terrestrial geophysics Observatories, as well as a research ship, the *Carnegie*. Annual PG data between 1924 and 1935 demonstrated good agreement from three measurement sites, at Ebro, Huancayo and Watheroo (Wait and Mauchly, 1937). The data from Watheroo was tabulated in the annual Observatory reports, published by the Carnegie Institution in a single volume for 1924-1934, which also provides a summary of the site and measurement system (Wait and Torreson, 1948). From this volume, the PG values averaged each month from undisturbed days have been keyed, and presented in the file:

WatherooPGMonthly_1924-1934.txt.

This is a plain ascii text file, with columns of tab-separated data, after six header lines. Table 3 summarises the data in this file.

Table 3. Watheroo PG data

Column number	Quantity	Description	unit
1	Year	Year for which the data provided (1924 to 1934)	GMT
2..13	Mean PG values	Mean PG by month (column 2 = January ... column 13=December) from “selected values”.	Vm ⁻¹

5. REFERENCES

BGS (British Geological Survey)

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