**Report of the meteorological observations taken at Kenilworth, Kimberley, during the year 1901**

*To the Secretary of the Meteorological Commission.*

SIR, - In accordance with your request I have prepared, and give below, a return of the more important meteorological observations conducted by me during the year 1901, for publication in the Annual Report of the Meteorological Commission.

The matter included in the report is divided into two parts, namely, (1) Daily observations arranged in monthly tables, and (2) Appendices giving hourly and monthly summaries.

In the observation, Column 1 gives the daily readings of the Standard Barometer, reduced to 32 °, at viii. The Standard Barometer is by Negretti & Zambra, No. 1, 921, with a Kew verification. In this fine instrument, the cistern is fixed, while the scale scale-which terminates in a fine zero point of ivory-is caused to slide up and down the frame by means of a rack and pinion. The inside of the diameter of the tube is about 0.7 inch. Monthly and Annual Pressure values, derived from the indications of the Standard, are given for the three different hours. One observation of the Standard Barometer was missed during the year, for a reason that will probably be thought sufficient, e.g.: - “April 24th.- Standard Barometer reading at xiv. Interpolated from the Photo-barogram; the observer (Mrs. Sutton) falling and breaking her arm while on the way to take the observation.”

Column 2 of the Observations gives the mean pressure of the day derived from the hourly values measured on the Phot-barograms, beginning with midnight and ending with xxiii. The Barograph is a very good one of the usual pattern, by Negretti & Zambra. The rays from a paraffin lamp are reflected by a concave spherical mirror through a condenser, passing across the Torricellian vacuum, between the jaws of a long, vertical, narrow slit, whence a compound camera objective brings them to a focus upon a sheet of bromide paper wrapped round a rotating drum. By means of a piece of mechanism attached to the clock of a shutter cuts off the light for a few minutes every two hours, forming upon the barogram a series of equi-distant narrow white lines as time indicators. Temperature compensation is affected by the agency of a delicate system of zinc and glass rods so arranged as to cause the base line of reference photographed upon the barograms to undulate proportionately to the temperature. The charts are changed every second day at a few minutes past xxiii., and developed and measured every one or two weeks. The hourly ordinates are measured with a metal templet to the nearest ·0005 inch, and are converted into approximately true pressures in inches after comparison with the regular control observations, taken three times daily, of the Standard Barometer. Ultimately, therefore, the results may be regarded as very nearly the same as those from hourly observations with the Standard would be. In case of any temporary failure of the photographic record, the pressures are interpolated either from the indications of a Recording Aneroid by Ross or from the Standard, according as the failure was not or was anticipated. This supplementary aid was only required for a few hours during the year. On the 4th, 5th and 6th of June many of the pressure-values at the “odd” hours are from the Recording Aneroid record, as the shutter of the Phot-barograph was working badly, only giving an image every two hours. The clock was dismounted for repairs from xx., June 6th, to xx., June 7th, and in the meanwhile the values were taken from the Standard and from the Aneroid.

Appendix 1 gives the hourly mean pressures, month by month, for the year, and also the greatest and least of the mean daily pressures: the extremes of pressure appearing in Appendix 3.

The mean pressure for the year is very near the average; but the total range, from the highest observed to the lowest, is unusually large, and fully one-sixth greater than the range of the previous year. The mean pressure for the year was 26·141 inches; the maximum daily mean was 26·490 inches and the minimum 25·752 inches; the highest pressure observed was 26.545 inches (in June) and the lowest 25·615 inches (in November). These numbers are from the Barograph; had they been taken instead from the Standard Barometer they would probably have given a range slightly less.

The pressure of 25·615 inches is the lowest on record for this place. The highest on record is 26·508 inches at 8 a.m. C.M.T by the Lee Standard, for Kimberley, in July 1894. This would be nearly 26·608 inches at 8 a.m. C.C.M.T for Kenilworth, and nearly 26·622 inches at 10 a.m. It appears, therefore, that the greatest range of pressure to be anticipated here is almost exactly an inch.

All the barometers are mounted in an outside room of raw brick, whose walls are nearly a foot thick. It contains no window, but is well ventilated. The diurnal range of temperature in this room is about 5°.

Columns 3 and 4 of the Observations give the respective Minimum and Maximum Shade Temperatures of the day. The Thermometers from which they are derived are of the standard pattern, by Negretti & Zambra, and Kew verified. They are:-

Standard Maximum, No. 81,229, mounted 5 ft. 2 in. above the ground. Index-error = - 0°·1 at 32°

Standard Minimum, No. 81,580, mounted 4 ft. 9 in. above the ground. No index-error.

Up to December 31st, 1901, the zero point of the Standard Maximum was not appreciably displaced.

These thermometers are mounted in a large, handsome, single-louvred wooden screen, of 8 × 8 × 8 feet, about two feet from the louvres, and so arranged, consistently with firmness and security , as to be as nearly as possible floating in free air. A board behind and below them serves to cut off possible radiation from the ground.

The lowest Shade Temperature of the day failed to fall below 70° twice only during the year, *i.e*., on January 24th and February 4th. It rose above 100° only once-on February 2nd, when it stood higher than 90° for nine hours. This was the hottest day of the year , the mean of the twenty-four hourly observations being 82°·6. It fell below freezing twice in May, three times in June, and fifteen times in July. On only one occasion did the highest temperature of the day fail to rise above 50°, *i.e*., on June 2nd. This was the coldest day of the year, the mean of the twenty-four hourly observations being 38°·4.

Comparison observations are taken with Kew-verified Maximum and Minimum Thermometers in a Stevenson Screen (not of the latest pattern as adopted by the Royal Meteorological Society). This small screen has been used in two different positions during the year.

The readings of Maximum and Minimum Temperature are taken at xxiii., and an additional reading of Minimum at viii. for the Minimum Shade Temperature of the night hours only. This last is for the purpose of comparison with the minimum on grass. A list of such differences have occurred during the year between the Minimum Shade Temperature for the whole day of twenty-four hours (xxiii.-xxiii.) and that for the night hours only (xxiii.-viii.), is given in Table 1. It will be useful whenever the daily values of ma – mg are required.

In Appendix 4 will be found the mean and extreme readings of m, M, M – m, (M + m), and ma , for the large screen, together with some comparison readings for the Stevenson Screen.

Column 5 of the Observations gives the Mean Dry Bulb Temperature of the day, and Column 6 the Mean Wet Bulb, derived from the twenty-four hourly readings beginning at midnight and ending at xxiii. About two-thirds of these are from eye-observations of a Standard (including nearly all between viii. And midnight, and an occasional one between midnight and vii) ; the others are obtained from the readings of two sets, of twelve each, of Negretti & Zambra’s patent Reversing Thermometers, with long, slender, cylindrical bulbs, one set mounted for Dry Bulb Observations, the others for Wet. These thermometers are in a large screen; the clock regulating the apparatus is in the Barometer-house, and joined to the Thermometers by a system of wires. At each hour the clock completes an electric circuit, which, drawing back the armatures of the electro-magnets above the Thermometers (one Dry and one Wet) whose turn has come to act, release the hooks supporting them, thus allowing the Thermometers to reverse upon their axes and register the temperature.

Each Wet Bulb is enclosed in a sewn muslin jacket, a loose tuft of which extends below the bulb, serving to collect nearly all the incrustration that would otherwise settle upon the lower end of the bulb. This device has proved so successful that although the jackets are only renewed every two or three weeks, the bulbs nearly always emerge quite clean and bright from their old coverings.

The Standard readings are taken from two Kew-verified Board of Trade Thermometers with short cylindrical bulbs, by Negretti & Zambra, the Wet Bulb in this case also having the loose tuft of muslin below the bulb. And partly for the purpose of testing whether different positions in the screen give identical results, a second Dry and Wet pair, but with spherical bulbs, by Casella, is mounted upon a different aspect.

Control Dry and Wet Observations are secured by:-

1. A small reversing apparatus of one pair, with spherical bulbs, which can be set to act at any assigned hour;
2. A Richard Thermograph; and
3. A Richard Hygrograph.

Each of the two last marks a continuous record upon a drum rotating in twenty-four hours.

To collect the incrustration that would otherwise settle upon the spherical Wet Bulbs two strands of wick-cotton (No.10 ‘knitting”) are threaded through the lowest point of each jacket and left to hang. It is fully as successful as the tuft of muslin in the other case.

Columns 7 and 8 of the Observations give respectively the Daily Mean Dew Points and Humidity-percentages deduced from the simultaneous readings readings of Dry and Wet Bulbs by the aid of Greenwich Factors. Appendices 6, 7, 8, 9, give respectively the hourly means of Dry Bulb, Wet Bulb, Dew Point, and Humidity, for the year.

The quantity of aqueous vapour in the air was at the maximum for the day on February 18th, the Dew Point on this day averaging 61°·8. The highest computed Dew Point for any hour was on the same day; its value was 66°·8. The Mean Dew Point for the year was appreciably the same as that of the year before, being, however, on the whole, rather greater in summer and less in winter. There seems not to be much annual variation in this element.

The air was at its maximum of dampness on March 21st, with an average humidity for the day of 96·4 %. This is an exceptionally high ratio. From xx. On March 20th continuously until ix., March 22nd, the ratio was above 90 %, and, indeed, nearer to 100 % than 90 % throughout. Needless to say, it was raining hard at the time.

Column 9 of the observations gives the minimum radiation temperature of the night over short grass. The Spirit Thermometer used for this purpose has a spherical bulb, and is mounted upon a stand provided by the makers, which raises it about three inches above the ground. Comparison observations are taken with a similar instrument, resting on the grass; but these are not formally entered in the Register, although they are preserved in the Note Book. Usually the thermometer touching the grass registers much the lower temperature, but occasionally, on a wet night, it may be the other way about. Without venturing so far as to assert that observations made with this instrument are worthless, still it seems certain that they are least in value of any included in the routine of the meteorologist.

Column 10 of the observations gives the maximum temperature in the sun registered by a Black-bulb Thermometer in *vacuo* (without a test-gauge) mounted on a tripod about five feet above the ground.

Appendix 4 contains the monthly means and extremes of grass minima, together with the mean and extreme daily ranges of Ma – Mg; the monthly means and extremes of solar maxima, together with the mean and extreme daily ranges of S—M. The mean and extreme monthly values of an open maximum Black Bulb over grass also appear.

Earth temperatures under bare sand have been observed at five different depths, from one inch to six feet. The observations made at depths of one and two inches with ordinary thermometers planted in the ground were discontinued early in the year. Their place in the Observations is taken by readings of registering maximum and minimum thermometers pushed into long horizontal copper pipes sunk below the surface, the axes of which are one inch deep. This system seems to give better conditions of observation, although leaving much to be desired. The temperatures at deeper levels are obtained by means of slow-action thermometers hung by chains in vertical iron pipes according to the method introduced by the late Mr. G.J. Symons.

Four sets of readings are made daily, via: -

At VIII. 1 foot, 2 feet;

At XIV. 1foot, 2 feet;

At XX. 1 foot, 2 feet, 4 feet, 6 feet;

At XXIII. 1inch, maximum and minimum.

Columns 11-16 give daily readings of one inch, maximum and minimum of one and two feet read at XIV., and of four and six feet read at XX. Yearly means of the daily observations appear in Appendix 5. Some disturbance of the orderly sequence of earth temperatures will be detected in the observations during the last week of January. It is due to the fact that the Earth Thermometers were transferred to a better site on January 22nd. The disturbance seems to have been most keenly felt by the four-foot Thermometer, but they all show it more or less.

Column 17 of the Observations contains the daily amounts of sunshine, in minutes, taken from the records of A Jordan Twin Hemi-cylinder Photographic Recorder; and Column 18 contains the corresponding amounts taken from the records of a Campbell

Column 17 of the Observations contains the daily amounts of Sunshine, in minutes, taken from the records of a Jordan Twin Hemi-cvlinder Photographic Recorder; and Column 18 contains the corresponding quantities taken from the records of a Campbell-Stokes Burning Recorder with a crown-glass bail. Both Sunshine Recorders are mounted together, about 40 feet above the ground, upon a bracket attached to the Anemometer Post. Their records have been interfered with to some extent in the hours of sunrise by growing trees. A temporary improvement was effected by an extensive pollarding of the trees in the middle of April.

Monthly summaries of Sunshine appear in Appendices 10 and 11. The percentages in the columns following the monthly totals show the monthly ratios of the duration of Sunshine recorded to the total amount that would be recorded on a per. feet instrument if no cloud or haze ever obscured the sky.

The Campbell-Stokes record was broken September 19-28, and again December 29-31, in consequence of the supply of cards having run out. For the purpose of making up the monthly totals, the missing values were interpolated from the Jordan record.

Column 19 of the Observations gives the average amount of Cloud, expressed in percentages of the visible hemisphere, from observations made at viii., xi., xiv., xvii., xx., and xxiii. ; the summary appearing in Appendix 10. Hourly observations of Cloud, both by eve and instrument, are much to be desired.

The routine observations of Evaporation have been continued as usual. Three instruments were in regular use : —

1. A Piche Evaporator of the usual form. It is assumed that the evaporation is equal from equal areas all over the exposed part of the paper disc above and below. The tube is graduated on the glass to equal volumes, and the factor required to reduce the scale readings to depths in inches has been computed equal to ·004147. This instrument is suspended in the Large Screen.

2. An iron tub about 14 inches diameter and 18 inches deep, coated with white bath enamel inside and out, was in use until the middle of June when it was burst by the frost. It was replaced on June 28 by a much stronger galvanised iron tub of similar dimensions. The first tub was cylindrical in outline; the second, upon the advice of Mr. Gardner Williams, was made to taper slightly with the ides of offering a better resistance to the pressure.

The routine observations of Evaporation have been continued as usual, with one exception, that the eight-inch copper pan has been discontinued. Three instruments were in regular use :-

1. A Piche Evaporator of the usual form. It is assumed that the evaporation is equal from equal areas all over the exposed part of the paper disc above and below. The tube is graduated on the glass to equal volumes, and the factor required to reduce the scale readings to depths in inches has been computed equal to ·004147. This instrument is hung in the large screen.

2. An iron tub about 14 inches diameter and 18 inches deep, coated with white bath enamel inside and out. It has a tap at the bottom for the purpose of adjusting the water surface quickly and accurately to zero. It stands alone in a single-louvred screen, whose dimensions are 46 inches long, by 34 inches wide, by 6 feet high over all. The amount of evaporation is read off twice daily, at VIII. and XX., from a lever which, actuated by a float, travels over a graduated dial, and magnifies the fall in level ten times.

3. A circular steel tank, rather over 46 inches diameter, and 29 inches deep, coated inside and out with bath enamel, and placed in the centre of a cemented brick cistern of about seven feet square. The walls of the cistern rise some eight inches higher than the rim of the tank. The outer cistern is supplied with water up to a level about equal to that of the evaporating surface of the tank, but there is no communication from one to the other. An iron pipe opens under the centre of the evaporating surface in the tank, passes through the side of the tank-to which it is secured by water-tight check-nuts-onward through the wall of the cistern, and thence underground to a vertical cylindrical vessel set under the floor of the Barometer room. A large copper ball floating in the cylinder carries a vertical wooden rod which is attached to one end of a light brass lever balanced upon knife edges. A pen at the other end of the lever writes a magnified record of the fluctuations in the level of the water on a long drum rotated by clockwork. Thus the records are of both evaporation and rainfall, the pen rising for the one and falling for the other. The drum and clockwork comprise the beautiful Auxanometer of the Cam-bridge Scientific Instrument Company; the lever, by the same makers, being specially adapted for evaporation experiments, and so arranged upon its supports that the pen pressed with nearly constant force, whatever its altitude, upon the drum.

Daily amounts of evaporation from the tank are given in Column 20 of the Observations, the monthly summaries of hourly rates in Appendix 12. A few hours only were lost from the record, when the tank was being cleaned out, between X. and XIX. on June 16th. Appendix 13 gives the monthly summaries of evaporation from the smaller gauges, together with the maximum and minimum daily quantities.

Appendix 14 gives the monthly totals of rainfall in hourly values, and also the hourly frequency. These are got, as far as possible, from the Raingauge, or if not the Raingauge, then from the records of the Auxanorneter corrected as closely as circumstances allow to the catch of the Gauge. The hourly totals must therefore be regarded as approximate ratios. A recording rain gauge is badly wanted. Often I find it impossible to remain up all night to measure the hourly fall of rain.

Column 21 of the Observations gives the daily quantities of rainfall collected in an eight-inch Gauge of the Meteorological Office pattern, whose rim is three feet above the surface of the ground. It is read at VIII. and XX., the latter hour being here considered the end of a rain day of twenty-four hours. The quantity ·000 appearing here and there, signifies rain of too small a quantity to admit of measurement-i.e., something less than ·005 inch. The " Comparative Table of Rainfall," in Appendix 15, returns from the Premier, Bultfontein, Du Toit's Pan, De Beers, and Kimberley Mines, and also from Kenilworth. The country gauges have not yet been restarted. The Mine Gauges are "Snowdon" five-inch, and are read at VIII. The returns received from them are on the whole fairly good, and in one or two cases excellent. The variation for the year is from 19·13 inches at Premier to 24·44 inches at Kimberley. The deficiency at Premier seems to arise in great part out of a conflict between art and science-a very aesthetic-looking flagstaff having been erected to improve the scenery of the mine, close by the inartistic and grossly gauge.

The Kenilworth return in Appendix 15 is made up as follows:-

A. The number of days upon which ·01 inch, or more, rain fell ;

B. The number of days upon which any rain fell, including all falls of ·000 inch ;

Night rain from XX. to. VIII. ;

Day rain from VIII. to XX. ;

Total rain for days ending at XX.;

Maximum fall for days ending at XX.

The last column of the Observations gives the velocity of the wind in miles per

day. It is derived from the records of a Kew-pattern Robinson Anemometer, whose cups are forty-two feet above the ground. The recording part of this instrument was designed and made for me by Mr. Henderson, formerly of the De Beers Company, and is so arranged that a pen rises from zero to its highest point once for each two and a half miles of wind, writing its record on a Richard drum. Monthly summaries are given in Appendix 16.

Wind directions and pressure are recorded by an Osler Anemograph. For want of a duplicate anemometer occasional hours of record are lost now and then.

Appendix 17 contains the approximate hourly distribution of Thunder with Lightning, Thunder without Lightning, and Lightning without Thunder, for the year from eye and ear observations. The amounts given between VI. and midnight cannot be far short of completeness, but from midnight to VI. it has not always been possible to set a regular watch.

Time has been kept by means of an Oliver's Mean-time Sundial. The approximate position of the observatory is:-

Long. 24° 27' E.

Lat. 28° 42' S.

Altitude, about 3,950 feet.

The routine and also the arrangements for preventing any break in the records remain the same. The arrears of computing have been materially reduced. The seismic equipment is now as complete as it is ever likely to be, but the various pendulums have not been brought into use, because of the necessity of first bringing the meteorological work up to date. For the same reason the Equatorial is still standing idle: this to my regret most of all. But it is a question whether it would not be more advantageous in the end if I were to try to sell these instruments that have been so costly and idle, and devote the money to meteorological literature more urgently needed. Hitherto, however, I have been loth to cut the painter to all other sciences save Meteorology.

J. R. SUTTON,

M.A., Cantab.

TABLE 1.-List of occasions upon which the minimum shade temperature of the

24 hours ending at XXIII. differed from that of the 9 hours ending at VIII. :-

Min. in Shade.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 1901. | Min. in Shade | | 1901. | Min. in Shade | |
| XXIII. | VIII. | XXIII. | VIII. |
| January 1 … | 65.0 | 70.6 | May 25 … | 42.0 | 47.9 |
| February 4 … | 71.0 | 71.2 | ’’ 29 … | 47.9 | 48.3 |
| ’’ 5 … | 67.0 | 68.3 | June 1 … | 34.9 | 40.0 |
| ’’ 7 … | 64.5 | 64.9 | ’’ 12 … | 44.0 | 45.2 |
| ’’ 18 … | 66.9 | 68.3 | July 2 … | 38.1 | 42.8 |
| March 17 … | 58.0 | 60.1 | Sept. 16 … | 45.9 | 51.0 |
| ’’ 20 … | 59.3 | 60.5 | October 10 … | 52.5 | 54.2 |
| April 3 … | 60.3 | 60.6 | ’’ 27 … | 54.6 | 58.1 |
| ’’ 6 … | 61.0 | 62.1 | ’’ 30 … | 53.0 | 53.5 |
| ’’ 29 … | 50.0 | 55.1 | Dec. 1 … | 61.1 | 65.9 |
| May 10 … | 38.5 | 38.9 | ’’ 13 … | 62.0 | 65.1 |
| ’’ 13 … | 37.0 | 44.3 |  |  |  |

ERRATA IN PREVIOUS KENILWORTH REPORTS.

1898. The September mean barometric pressure at XVII. Should be 26·124 inches instead of 26·144 inches. Whence the year’s mean at XVII. Becomes 26·100 inches instead of 26·101 inches.

The August mean Dry Bulb at III. Should be 42°·o instead of 41°·8.

1899. The March mean Dry Bulb at VII. Should be 61°·6 instead of 61°·9.

1900. The July mean Dry Bulb at XIII. Should be 61°·6 instead of 63°·2.

Whence the year’s mean at XIII. Becomes 77°·7 instead of 77°·8.

The mean amount of cloud on August 7th should be 20 percent. Instead of ··. Whence the month’s mean becomes 21 percent. Instead of 20 percent.