

TABLE 4.—Greatest daily rainfall.

Stations.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Peking .....	7.3	2.3	6.2	42.5	16.6	148.5	154.0	86.3	59.3	30.6	11.5	3.0
Wonsan .....	40.0	30.0	39.8	61.7	52.1	83.0	119.8	114.5	382.5	94.7	56.9	19.7
Houki .....	18.2	10.2	20.3	45.9	55.9	81.3	177.5	166.5	96.6	41.9	27.9	12.4
Chefoo .....	15.0	14.0	26.7	40.7	23.8	66.6	105.5	110.0	69.9	46.2	40.1	22.3
Chemulpo .....	38.1	29.2	19.0	63.4	45.7	87.6	108.0	106.7	104.3	43.3	44.5	15.2
Shantung Cape, N.E.	26.2	22.9	24.4	55.9	22.9	78.7	74.7	141.2	88.8	53.3	44.1	27.9
Shantung Cape, S.E.	28.7	16.0	27.9	48.3	59.4	78.5	104.7	115.5	96.9	36.6	45.0	17.5
Tintau .....	7.3	12.3	55.5	32.5	40.2	39.7	116.3	152.5	40.0	132.6	13.1	21.9
Fusan .....	39.0	89.5	36.5	79.0	83.5	129.0	87.0	118.0	168.0	96.0	52.0	46.0
Chinkiang .....	40.1	42.8	52.7	59.1	68.6	146.2	182.7	80.7	78.7	65.3	49.3	23.8
Shaweshan .....	44.5	30.9	37.6	60.8	50.8	60.8	55.5	127.0	120.7	83.8	73.8	16.5
Wuhu .....	31.0	40.6	45.7	44.5	51.4	78.2	136.7	62.0	60.8	50.0	54.7	26.0
Zi-ka-wei .....	55.8	24.6	54.9	57.0	54.1	135.6	76.4	113.2	68.7	53.3	49.2	24.1
North Saddle .....	38.1	23.9	33.5	55.1	65.6	74.9	47.4	85.3	90.8	84.4	47.6	19.0
Gutzluff .....	45.7	27.9	48.7	45.3	81.3	110.2	63.5	103.9	152.4	50.8	40.9	25.4
Hankau .....	22.1	28.5	80.0	75.0	94.0	183.4	154.5	55.9	98.3	53.8	53.3	43.2
Ichang .....	10.2	30.0	29.4	73.7	69.7	59.7	116.8	92.3	70.9	58.2	17.3	30.4
Steeep Island .....	45.5	41.8	40.3	65.9	48.5	57.2	73.8	44.0	55.4	54.9	40.2	30.3
Ningpo .....	35.2	38.1	44.5	38.1	43.0	94.3	114.4	88.9	127.0	129.5	51.8	26.3
Kiukiang .....	35.1	40.9	44.1	54.4	30.3	177.0	113.8	76.2	155.8	142.6	45.7	38.2
Chungking .....	6.8	10.2	23.4	81.3	71.7	74.5	99.5	81.0	64.9	35.1	32.9	14.0
Wenchow .....	43.2	54.1	33.5	42.0	44.5	95.2	148.6	81.3	61.2	73.8	44.5	30.4
Pagoda .....	40.7	29.1	38.1	53.1	97.7	94.0	70.7	77.5	103.2	24.4	50.5	28.4
Middledog .....	14.0	29.8	44.5	103.2	35.6	94.8	35.5	114.3	88.9	132.0	63.2	29.2
Tournabout .....	36.9	29.1	53.8	98.3	213.4	363.3	95.2	143.1	292.2	132.1	48.5	96.3
Ockseu .....	34.5	27.7	33.2	63.0	132.1	73.8	94.5	122.4	200.7	139.0	40.7	37.8
Amoy .....	23.1	81.9	61.7	45.7	118.1	115.3	122.0	102.0	102.0	101.0	49.3	27.2
Chapel Island .....	15.3	35.6	57.2	78.2	75.3	104.2	106.7	108.7	44.5	165.2	38.1	21.6
Wuchow .....	11.4	14.5	29.2	114.3	123.2	69.7	134.1	47.2	75.0	5.3	7.9	10.7
Swatow .....	30.2	91.2	80.0	169.9	252.3	166.4	118.5	68.9	124.8	114.3	55.3	20.6
Lamocks .....	30.5	24.6	29.0	55.9	270.7	85.1	159.5	162.6	72.4	85.8	54.3	28.0
Breakerpoint .....	43.0	38.1	21.1	67.3	360.2	137.2	170.2	208.3	127.0	219.3	120.5	42.4
Longchow .....	14.0	8.1	49.1	56.1	111.8	71.2	115.0	167.1	31.6	28.3	32.8	4.3
Hongkong .....	71.5	55.4	22.4	107.4	142.9	214.6	158.5	132.5	108.4	307.7	149.3	30.5
Macao .....	66.1	37.8	49.6	86.5	180.4	164.3	158.4	126.9	108.2	112.0	152.0	17.5
Waglan .....	22.9	50.8	27.5	43.3	102.4	136.7	55.9	150.0	50.8	79.5	40.6	8.9
Pakhoi .....	23.4	26.4	26.7	85.9	138.8	200.0	245.1	185.5	103.7	135.8	97.2	36.1

bane, and Sydney is meteorology divorced from astronomy, and even in the case of Sydney the acting meteorologist still holds his position subject to the general control of the acting astronomer. Since this sketch practically emanates from the Sydney Observatory, New South Wales, the writer is placed somewhat at a disadvantage with regard to essential details bearing upon the progress of meteorology in the other Australian states. This fact should be emphasized in justice to the other states.

NEW SOUTH WALES.

Meteorological observations in Australia were probably first recorded systematically with reliable instruments at Sir Thomas Brisbane's private astronomical observatory, Paramatta, New South Wales, beginning in October, 1822, and continuing till March, 1824. Then occurs a break in the meteorological record at that observatory till the appointment (imperial) of Mr. Dunlop, who recommenced observations on January 1, 1832, and carried them on uninterruptedly till the year 1838. (See page 143, Rain, River, and Evaporation Results made in New South Wales during 1888.) In the meantime Captain King, during residence at Dunheved, New South Wales, from 1832 to 1839, and at Tahlee, New South Wales, up to 1848, kept a record of pressure, temperature, and hygrometric conditions, apparently giving much time, in collaboration with Mr. Dunlop, of Paramatta, to a study of the diurnal variation of pressure. Captain King was evidently a close student of meteorology and did much to foster an interest in it during those early years. When the erection of the present Sydney Observatory was under contemplation he advised the government as to where it should be placed. P. E. de Strzelecki, in his Physical Description of New South Wales and Van Diemens Land (London, 1845), draws extensively upon Captain King's observations for his discussion of the circulation of the winds round the coast of Australia. This work contains a valuable summary of the meteorological data available for the years 1838 to 1842, inclusive.

In April, 1840, the New South Wales government started three substations, viz, South Head (five miles east of Sydney), Port Macquarie, and Port Phillip (situated in what is now the state of Victoria). Educated convicts, who had been instructed by the astronomer at Paramatta, were placed in charge of these stations, and observations were carried on uninterruptedly, at South Head to 1855 and at Ports Macquarie and Phillip to 1850. In the meantime Capt. J. C. Wickham kept a record at Brisbane from 1840 to 1846, inclusive, the results being published in the Morton Bay Courier for January 23, 1847. Australian meteorology is greatly indebted to the Rev. W. B. Clarke for his untiring efforts in its behalf during those early years, beginning with his observations at Paramatta in the year 1839 and continuing long after the inauguration of the New South Wales service under government auspices in the year 1858. During this period Mr. Clarke read eighteen papers on meteorology before the local Royal Society and contributed a great many more to the daily papers. In the year 1842 alone he wrote twenty-one articles, covering a wide range of the subject, for the Sydney Morning Herald. From 1841 to 1847 he gave a large amount of time to the study of thunderstorms, and at his own expense established four observing stations in different parts of the colony for that purpose. The 19-year cycle theory, elaborated by Mr. Russell in more recent

THE DEVELOPMENT OF METEOROLOGY IN AUSTRALIA.

By ANDREW NOBLE, Esq.

Dated Meteorological Branch, Sydney Observatory, Sydney, N. S. W., November 9, 1905.

The acting meteorologist of New South Wales, Mr. H. A. Hunt, recently received a letter from the Editor of the MONTHLY WEATHER REVIEW, asking that some one prepare for publication in that journal "a sketch of the development of meteorology in Australia." The following notes have been compiled in response to that request:<sup>1</sup>

It is necessary to explain at the outset that meteorology in Australia is still running under state auspices, and that the government astronomers at Sydney, Melbourne, Adelaide, and Perth, the hydraulic engineer at Brisbane, and the government meteorologist at Hobart are the recognized official heads of meteorology in their respective states. Only at Hobart, Bris-

<sup>1</sup> In communicating this most instructive article by Mr. Noble, Mr. H. A. Hunt, the acting meteorologist, writes:

"Prior to receiving your letter no record of the verifications or otherwise of the forecasts for New South Wales had been kept in this office. We were rather diffident about keeping such a record here, and thought it advisable to test the feeling of those who are supposed to use the forecasts. Accordingly we sent copies of a circular requesting figures, showing approximately the percentage of verification, to a number of gentlemen. As the notice was so short we did not get figures from all, but the replies were generally most encouraging. Hereunder is a table showing the results as received from certain towns in New South Wales:

Place.	Verified.	Verified partially.	Failure.
Carcoar .....	75	15	10
Glen Innes .....	85	10	5
Temora .....	60	30	10
Bundarra .....	90	5	5
Breadalbins .....	71	28	3
Inverell .....	85	10	5
George Street North Post-office, Sydney ..	70	20	10
Peak Hill .....	70	20	10
Yass .....	85	10	5
Cowra .....	80	15	5
Average result .....	77.1	16.1	6.8

<sup>2</sup> As a Lieutenant, in 1817, he was sent to complete the surveys on the coast of New South Wales, being engaged in that work till 1822. During this time, we are told, he "gave much attention to the physical condition and climate of the various parts of the coast which he visited." See his Maritime Geography of Australia, read before the Philosophical Society of Australia on October 22, 1822, and reproduced in Baron Field's Geographical Memoirs; also his Narrative of a Survey of the Intertropical and Western Coasts of Australia (London, 1827).

<sup>3</sup> Votes and Proceedings, New South Wales, 1852.

years, was advanced by Mr. Clarke in the Sydney Morning Herald of May 1, 1846.

William Stanley Jevons,<sup>4</sup> who held a position at the Royal Mint, Sydney, from 1854 to 1859, also kept a meteorological record. His observations fill a rather important gap between the closing of South Head as an observing station and the opening of Sydney Observatory. During his five years' residence in Sydney Mr. Jevons frequently contributed papers on meteorology to the daily press and to the Sydney Magazine of Science and Art. His valuable essay on "Some data concerning the climate of Australia and New Zealand" may be found in Waugh's Almanac for the year 1859.

Sydney Observatory was opened by the Rev. W. Scott, M. A., as astronomer, under government auspices, in the year 1858, and twelve meteorological substations were established in the same year, viz, Rockhampton, Brisbane, Casino, Armidale, Maitland, Bathurst, Paramatta, Sydney, Goalbwin, Deniliquin, Albury, and Cooma. Rockhampton and Brisbane, being situated in what is now known as Queensland, were subsequently passed to the government of that state, and the others were maintained until 1864, each station being fitted with a standard barometer, wet and dry bulbs, maximum, minimum, and solar radiation thermometers, and rain gage. Mr. Scott resigned early in the year 1862, and Mr. H. C. Russell, B. A., acted temporarily, pending the appointment of Mr. G. R. Smalley, B. A., on January 7, 1864. Mr. Smalley devoted considerable time to magnetic observations and expanded the meteorological work at the chief observatory, beginning publication of the results monthly in the year 1867, but unfortunately the number of country stations was reduced and for a time these results were not published. Mr. Smalley died in July, 1870, and Mr. H. C. Russell, who had joined the observatory in 1859, was appointed government astronomer. The stations which Mr. Smalley had closed were revived and voluntary observers were invited to cooperate, ultimately leading to a large growth in the service.

From February, 1877, to March, 1888, Mr. Russell published a daily weather map in the Sydney Morning Herald, showing by means of symbols the condition of weather, wind, and sea at 9 a. m. the previous day at a number of stations in South Australia, Victoria, New South Wales, and Queensland. In 1880 a diagram was added to the map showing by means of a curved line the corrected barometrical readings at the chief coastal stations round Australia. But Mr. Russell was apparently opposed to the issue of daily weather forecasts. These were originated in April, 1887, by Mr. Charles Egeson, meteorological assistant in the observatory, during Mr. Russell's absence in Europe. Upon the astronomer's return, an unsuccessful attempt was made to stop these forecasts. Mr. Egeson, in a statement subsequently published,<sup>5</sup> which Mr. Russell did not contradict, said:

When Mr. Russell returned at the end of that year I was severely taken to task for lending myself to so progressive an institution, and was obliged to take leave of absence in order to put an end to the forecasting of the weather. The Evening News, however, insisted upon its continuance, and during my absence Mr. Russell had to attend to my former duties of forecasting the daily weather, which he has continued ever since.

The first daily isobaric charts of Australia and New Zealand drawn at the Sydney Observatory were also initiated by Mr. Egeson during Mr. Russell's absence in Europe.

Observations in New South Wales are taken at 9 a. m., excepting at a majority of the second order and climatological stations, where instruments are read at 8:30 a. m., so that transmission of the readings by telegraph may be expedited to the central office, where the forecast is issued at noon. Additional telegraphic information is also received from cer-

tain selected stations within the state, showing conditions at 3 p. m., 6 p. m., and 8 p. m., in order to compile press reports, and if necessary alter the forecast made at an earlier hour during the day. At the present time returns are received by mail regularly at the end of each month from 1903 stations distributed over the state. These stations are classified<sup>6</sup> as follows, viz: 28 second order, 168 climatological, and 1707 having a rain gage only. The results from all country stations have been regularly published in annual volumes practically since the foundation of the service, and a copy of this publication has been supplied to each observer at the end of the year in return for his cooperation in the work.

Owing to ill health, Mr. Russell went on leave of absence on October 14, 1903, and finally retired from the service on February 28, 1905, after 46 years' connection with the meteorological department in New South Wales. During the absence of Mr. Russell, the government of his state decided to temporarily sever the meteorological from the astronomical department, and on January 20, 1904, appointed Mr. H. A. Hunt to the office of acting meteorologist. [The reader is here referred to a note in the Quarterly Journal, Royal Meteorological Society, April, 1905, page 95, showing the progress made since Mr. Hunt's appointment.]

#### SOUTH AUSTRALIA.

Meteorological observations were begun at Adelaide, South Australia, by Sir George Kingston, in January, 1839, or three years after the foundation of that colony, and carried on by the same observer until 1878. In the meanwhile a record more or less complete was kept at the survey office until the establishment of the Adelaide Observatory under Sir Charles Todd, as Government Astronomer, in November 1856. During his lengthy direction of meteorology and astronomy in South Australia, Sir Charles has also held concurrently the office of superintendent of telegraphs and postmaster general. In his interesting paper<sup>7</sup>, he writes:

Since May, 1860, all the observations have been made at the west terrace observatory. For several years I had no assistant, and having a growing telegraph department to look after and control, the area of my work was necessarily restricted, and I labored under many disadvantages, but I early established meteorological stations at Clare, Kapunda, Strathalbyn, Goolwa, Robe, and Mount Gambier, and placed rain gages at the different telegraph offices. I also introduced the system of publishing at the head telegraph office in Adelaide daily reports of the weather and rainfall from all stations. • \* • At Adelaide isobar maps have been issued daily since 1882, and we exhibit a diagram showing the barometric curve at selected stations along the south coast line from Albany to Cape Howe during the month, which enables persons to see at a glance the westerly progressive march of coastal depressions; and we have recently added a map which shows the distribution of rain in the colony on each wet day. We also publish monthly a statement of the rainfall at every station throughout the colony, compared with the average of the corresponding month in previous years, accompanied by a complete discussion of the characteristics of the month in regard to temperature, pressure, the passage of "highs" and "lows," and the weather generally, in which comparisons are made between the month under review and previous seasons, attention being drawn to any abnormal features that may have presented themselves.

The annual volumes give in detail the observations at Adelaide, the principal results at outstations, and maps showing in graduated tints the general distribution of rainfall during the year.

According to Sir Charles Todd's last report issued, i. e., 1900-1901, observations at Adelaide are taken at 9 a. m., 3 p. m., and 9 p. m. There are 22 second order stations, at four of which observations are taken every three hours, commencing at midnight; at six others observations are taken at 9 a. m., noon, 3 p. m., and 6 p. m.; and at the remaining twelve, read-

<sup>6</sup> The central office in each state is of the first order, i. e., the instrumental equipment is complete and self-registering instruments are in operation. At second order stations the instruments in use are: Barometer (mercurial), dry and wet bulbs and maximum and minimum thermometers, and rain gage, while at climatological stations the equipment consists of maximum and minimum thermometers and rain gage, also, in some cases, dry and wet-bulb thermometers.

<sup>7</sup> Australasian Association for the Advancement of Science, 1893.

<sup>4</sup> In after years professor of logic, mental and moral philosophy at Owens College, Manchester.

<sup>5</sup> Evening News, October 1, 1890.

ings are taken at 9 a. m., 3 p. m., and 9 p. m. There are also 474 stations equipped with rain gages.

For the 12 years (1891-1902) the forecasts issued by the Adelaide Observatory have been verified to the extent of 83 per cent, while only 17 per cent were partially or wholly wrong.

#### TASMANIA.

A magnetic and meteorological observatory was founded at Hobart, Tasmania, on January 1, 1841, by Captain Kay, R. N., under imperial auspices, as part of an international scheme. Hourly instrumental readings were taken until the end of 1848, and regular observations up to December 31, 1854, when the Imperial Observatory was closed; but Mr. Francis Abbott continued the meteorological record until the year 1880, when Captain Shortt, R. N., was appointed government meteorologist, holding office until his death in 1892. He established eight climatological and about fifty rainfall stations in various parts of the island. Upon his death, the present director, Mr. H. C. Kingsmill, M. A., was appointed. In the year 1904, the service on the island state was classified as one first order and eight second order stations, while rainfall was recorded at ninety-one stations.

#### VICTORIA.

A nautical observatory was established under Mr. R. L. J. Ellery at Williamstown (about four miles southwest of Melbourne), Victoria, on July 13, 1853. It was at first used mainly for the determination and distribution of time, and rating of chronometers, but Mr. Ellery added a set of meteorological instruments to his equipment in March, 1854, and began observations of pressure and temperature in connection with his astronomical work. A meteorological record was also kept at Melbourne by Mr. Brough Smith from 1856 to the end of February, 1858, when the new magnetic and meteorological observatory on Flagstaff Hill was opened by Professor Neumayer,<sup>8</sup> and on February 28, 1859, the whole of the meteorological work in Victoria was placed under his charge. Hourly observations in meteorology and terrestrial magnetism during day and night were taken at the chief observatory without interruption to February 28, 1863. Neumayer established many stations inland and at light-houses on the coast. He also collected and published a valuable series of marine observations from the logs of ships trading between the different Australian and other ports. For this purpose instruments had been made, tested, and issued under his supervision at the Flagstaff Observatory. In the course of five years more than 600 logs had been examined, extracted, or copied. He also devoted considerable time to magnetic work, made extended trips into the country for that purpose, determined the magnetic elements at 230 stations, from sea level to 7200 feet above, and distributed in such a manner that the greatest distance between them was not more than 30 miles, and frequently only eighteen or twenty miles. By the commencement of February, 1864, Neumayer had completed his magnetic survey of Victoria. During these journeys, which extended over an aggregate of 11,000 miles, determinations of geographical positions, meteorological observations, and hypsometrical measurements were also undertaken. In June, 1863, the observatory at Williamstown was dismantled; Mr. Ellery removed his equipment to the new building now known as the Melbourne Observatory<sup>9</sup> and therewith the meteorological and magnetic observatory, hitherto under Neumayer, became absorbed. Mr. Ellery, as government astronomer, was given charge of the combined service, and thenceforward for a period of 32 years he directed the meteorology of Victoria. During this time, with the steady growth of the new colony, the

service increased in size and importance. In January, 1881, a monthly publication on the meteorology and terrestrial magnetism of Victoria was initiated, and subsequently the regular issue of daily weather charts, together with forecasts of approaching weather changes. Mr. Ellery resigned in June, 1895, and was succeeded by Mr. P. Baracchi, the present director, who had joined the observatory 22 years previously. In his last report issued, i. e., March, 1904, Mr. Baracchi writes:

This service (meteorological) has been continued practically under the same system and conditions as in previous years. The total number of stations existing at present under the official weather service is as follows, viz: One first order (Melbourne); 31 second order, making observations daily at 9 a. m., 3 p. m., and 9 p. m.; 42 climatological stations making observations daily at 9 p. m.; 748 rain-gage stations; 39 wind and weather stations, not provided with instruments, sending daily reports by telegraph.

#### QUEENSLAND.

Upon the foundation of Queensland as a separate colony the observing stations at Brisbane and Rockhampton, which had been started by the parent colony of New South Wales in the year 1858, were transferred, and Mr. Edmund MacDonnell was subsequently appointed meteorologist to the new colony, holding office till the end of 1886, and in the meantime establishing several climatological and rainfall stations. On January 1, 1887, Mr. Clement L. Wragge<sup>10</sup> was appointed government meteorologist, and speedily reorganized the whole of the Queensland service, adding many new and better equipped stations, which were well distributed over the colony. Shortly after his appointment Mr. Wragge began the regular daily issue of weather charts, reports, and forecasts,<sup>11</sup> not only for Queensland, but also for the other Australian colonies, including Tasmania, New Zealand, and New Caledonia, where the forecasts were telegraphed and published in the leading daily papers. During his régime in Queensland he classified his stations as follows, viz: 17 first order, taking observations at 3 a. m., 9 a. m., 3 p. m., and 9 p. m.; 44 second order, taking observations at 9 a. m. and 9 p. m.; 96 climatological, taking observations at 9 a. m. only; 511 rain-gage stations. He also established first order stations in New Guinea, New Caledonia, Fiji, and Norfolk islands, and a second order station in New Hebrides. With characteristic energy he also founded high level observatories on Mount Wellington, Tasmania, and Mount Kosciusko, New South Wales, together with their companion low level stations. At Kosciusko observations were regularly taken at midnight, 4 a. m., 8 a. m., noon, 4 p. m., and 8 p. m., from December 8, 1897, to July 1, 1902, when the station was unfortunately closed owing to a want of funds; and on July 1, 1903, the Queensland Weather Bureau ceased to exist for a similar reason. Mr. Wragge subsequently left Australia and the supervision of the Queensland service passed to the control of the hydraulic engineer, who has continued the practise of exchanging daily telegrams with the other states, showing weather conditions in Queensland, but no forecast is issued in that state at present.

#### WEST AUSTRALIA.

Rain and temperature observations were originated in Perth by Dr. H. Knight in 1860, and by the same observer continued to 1869. Toward the end of the year 1875 the government established a meteorological observatory at Perth under the direction of the surveyor-general, Sir Malcolm Fraser, and in 1877 Mr. M. A. C. Fraser was appointed observer, holding that office till February, 1896. During this period second order and rainfall stations were established from time to time as opportunity allowed. At the end of 1895 there were fifteen such stations. Mr. Fraser published a report regularly at the end of each year containing the results. In the year 1896 Mr. W. Ernest Cooke, M. A., formerly of Adelaide Observa-

<sup>8</sup> In after years Director of the Deutsche Seewarte, Hamburg.

<sup>9</sup> The site of this observatory was selected by Professor Neumayer as early as 1857, but the building was not completed till 1862.

<sup>10</sup> Formerly of Ben Nevis Observatory, Scotland.

<sup>11</sup> Mr. Wragge claimed 80 to 85 per cent verifications for his forecasts.

tory, was appointed government astronomer of West Australia, and immediately reorganized the meteorological department in that state, visiting nearly every outstation for that purpose. During his inspection the service was found to be in such an unsatisfactory condition, owing to the scant appropriations hitherto allowed, that he decided to keep the results so far obtained apart from those in future publications, excepting the rainfall at outstations and the climatic data for Perth. Mr. Cooke summarized the results for the years 1876 to 1899, inclusive, in a useful work on *The Climate of Western Australia*, published in 1901, and since his appointment he has also brought out complete annual reports containing the meteorological observations made in that state. Daily weather forecasts also form an important part of the work under Mr. Cooke's direction, as may be seen from the following results:<sup>12</sup>

*Percentage of verification.*

	Correct.	Partially correct.	Wrong.
General forecasts for the whole state, issued at noon.....	94	4	2
General forecasts for the whole state, issued at 4 p. m. ....	93	6	1
Special forecasts for the gold fields, issued at noon.....	94	5	1
Special forecasts for the gold fields, issued at 4 p. m. ....	91	6	3
Special forecasts for Murchison, issued at noon.....	95	3	2
Special forecasts for Perth and neighborhood, issued at 9 a. m. ....	95	4	1

During the year 1903 the outstations were classified as follows, viz: 36 second order, 11 climatological, and 286 rain-gage stations. At Perth and all second order stations observations are recorded at 9 a. m. and 3 p. m. Additional readings are taken at 8 a. m. at all second order stations, also at a majority of the telegraph offices in the state, and wired to the chief observatory in order to assist in the preparation of the usual weather reports, isobar charts, and forecasts. The 3 p. m. observations are also transmitted from certain selected stations for a similar purpose. The barometer is read every two hours and the temperature every four hours at Cape Leeuwin and Breaksea Island for forecast purposes. In winter, especially, the forecast sometimes depends almost entirely upon the readings at these two stations, taken in consideration with the barograph curve at Perth and the general direction of the wind.

Mr. Cooke, in conjunction with Sir Charles Todd, has also established an observing station at the Cocos Islands, in approximate latitude 12° south, longitude 97° east, from which a report is received daily and repeated to the eastern states.

PRESENT CONDITIONS.

Unfortunately there has hitherto been a want of uniformity in the methods followed by the several meteorological services in the Australian states. This defect becomes apparent when we compare the observation hours of these services. In Australia we do not adhere to the standard time of a single meridian, as is done by the service under the control of the Weather Bureau at Washington, D. C. Here we have three different standards: Queensland, New South Wales, Victoria, and Tasmania are governed by the mean local time of the one hundred and fiftieth meridian; South Australia is governed by the one hundred and thirty-fifth meridian, and West Australia is governed by the one hundred and twentieth meridian. A want of uniformity is also shown when we contrast the different modes of publication, and the time they make their appearance. These defects are probably incidental to the gradual settlement and improvement of a new country, over which the population is unevenly distributed. Federation has only recently been achieved, and meteorology has not yet passed under the control of the National Government. Since colonization began in Australia, the greater part of our public

funds have been absorbed in the opening up of roads, the construction of bridges, railways, buildings, and other public works. Meteorology has, therefore, not yet received that financial encouragement accorded it in older and more densely populated countries. The discussions at the intercolonial conferences of the several directors of meteorology held in the years 1879, 1881, and 1888, show an earnest desire to remedy existing defects, as far as the local exigencies of the different colonies permitted; but the Australian services have had to labor under many disadvantages, owing to the want of funds, and everything has had to give way to that consideration. The Board of Visitors to the Melbourne Observatory in their last report issued April, 1904, write:

For a number of years the more important work of the Melbourne Observatory, both astronomical and meteorological, was regularly published by authority of the Government. In 1895, owing to retrenchment, these publications were limited to the annual meteorological statistics, and even these have been stopped since the year 1901. We now find a great accumulation of matter ready for the printer, in the procuring of which thousands of pounds have been expended, and which can be of no practical utility until it has been published and distributed. It comprises results of international value which are constantly asked for by observatories in different parts of the world.

In New South Wales the manuscript containing the results of the meteorological observations made during the year 1903 have just been returned to the Sydney Observatory, with an official note stopping publication, owing to a shortage in funds.

Since the advent of federation the telegraph service in Australia has passed to the control of the Commonwealth Government, which has imposed the following restrictions:

METEOROLOGICAL TELEGRAMS.

1. Subject to these regulations meteorological telegrams may be transmitted free of charge—

- (a) From the principal meteorological officer of a state to the principal meteorological officer of another state; or
- (b) From the principal meteorological officer of a state to an authorized observer at a reporting station; or
- (c) From an authorized observer at a reporting station to the principal meteorological officer of a state.

Where cable charges have to be paid on meteorological telegrams they must be paid by the sender.

2. A meteorological telegram shall be sent as a message, and shall contain current meteorological information only, and must be in code and be concisely expressed, and, if a weather report, must contain not more than twelve words; and, if not a weather report, must contain not more than twenty words.

3. Meteorological telegrams shall only be sent when necessary, and shall not take precedence of ordinary telegrams.

4. All places from which meteorological reports were, before the 9th day of September, 1902, sent periodically to the principal meteorological officer of a state shall be deemed to be reporting stations, and the person in charge of any such station shall be deemed to be an authorized observer.

5. New reporting stations may be established with the consent in writing of the Postmaster-General, but not otherwise.

6. The words "principal meteorological officer of a state" shall include the principal of a meteorological department subsidized by a state.

7. The value of the services to be performed by the Postmaster-General's Department shall not, as regards any state, exceed in any year the value of the like services performed in the year ending on the 31st day of October, 1902, and, if the latter value is exceeded, the principal meteorological officer of the state shall pay to the Deputy Postmaster-General in that state the amount of the excess.

8. Meteorological telegrams not complying with these regulations shall be charged for as ordinary telegrams.

At the present time Australian meteorology is under state jurisdiction, and each service is therefore only authorized to collect information within its own particular boundaries, but the chief observatories in each state keep up a regular daily exchange of telegrams showing conditions at about 8 to 8:30 a. m. for a limited number of stations. This interstate data is used for the construction of the usual isobaric chart, upon which the forecast is mainly based. The greatest difficulty the Australian forecaster has to contend against is the irregular transmission of his data by telegraph. At Sydney for example, we never receive the West Australian observations

<sup>12</sup>From the report for the year 1903.

(taken at 8 a. m.) before 1 p. m., and sometimes not until the following day; while our forecast, issued at 4 p. m., is sometimes not received at important country centers before 9 or 10 p. m. Australian meteorology is greatly indebted to the Eastern Extension Cable Company for many concessions. During upward of twenty years this company allowed weather cablegrams from New Zealand to pass free of charge. This data was a great advantage to the forecaster at Sydney, in the case of impending east to southeast gales, which sometimes visit our east coast, as the prevision of these gales depends largely upon the knowledge of the fluctuations in atmospheric pressure which take place between Australia and New Zealand; the data formerly received from three stations in New Zealand often completed the information required by the forecaster in order to warn shipping interests, but the cable company terminated their concessions on April 30, 1904, consequently we are now without knowledge as to conditions beyond our eastern coast line.

The ultimate solution of present difficulties may be worked out by the establishment of a Federal Weather Bureau to assume control of the different state services now existing. The Australian Commonwealth Constitution, adopted on January 1, 1901, gives the Federal Parliament power to make laws concerning many questions, and amongst these we find "Meteorological Observations;" but in meteorology the Federal Government is, apparently, very slow to act. Doubtless there are many other questions of greater national importance, demanding more urgent attention in a country which claims to be the newest among the nations. But, on the other hand, state politicians give the explanation that meteorology is non-revenue producing, and for this reason, it is said, the Federal Government will be slow to pass laws for the establishment of a National Weather Bureau. The question of having such a bureau was apparently first considered by the Federal Cabinet about eighteen months after the inauguration of federation, or on May 15, 1902, but legislation was deferred apparently for three years. In May of the present year the several directors of meteorology in Australia held a conference in Adelaide for the purpose of reporting "on existing conditions and to make recommendations for the future conduct of the services," presumably in order to guide the Hon. Dugald Thomson, Minister for Home Affairs, who proposed to introduce a bill during the following session enabling the Federal Government to take over the astronomical as well as the meteorological departments in the several states. But the conference was not unanimous; only one director, Mr. Baracchi of Victoria, being desirous of separating meteorology from astronomy. A report of the proceedings contains the following recommendations:

(7) That a central institution be established for theoretical and scientific meteorology.

(8) That in each state there shall be an official whose duty it shall be to see that observations are properly taken, and all necessary local information supplied to the public. This official, in Sydney, Adelaide, and Perth, to be the Government Astronomer; but in Melbourne (as the Government Astronomer and his "Board of Visitors" desire to be relieved of all meteorological duties, on account of his more extended astronomical and scientific work), also in Brisbane and Hobart, where there is no Government Astronomer, the Weather Department shall be in charge of an officer appointed for the purpose, to be styled "State Meteorologist."

(Mr. Baracchi dissented.)

(9) That the weather service of Queensland and Tasmania be placed on a basis similar to that of other states.

(10) That weather forecasts shall be issued by each meteorologist for his own state, and for that state only, and shall be telegraphed immediately to the meteorologists of the other states, who shall see to their prompt publication.

(11) That a system of storm warnings for coastal districts shall be established upon some uniform basis for the whole of Australia, the warnings to be issued when considered necessary by the forecasting officials, each for his own state.

(12) That a definite period, say half an hour, shall be reserved each

day by the Telegraph Department during which weather telegrams shall have precedence. (This is the practise in the United States.)

(13) That weather forecasts and storm warnings shall likewise have precedence over all other telegrams.

(14) That astronomical and meteorological telegrams shall continue to be transmitted free throughout the Commonwealth, but under amended regulations, in order to avoid the delays and difficulties which now occur.

(15) That meteorological reports be transmitted and exchanged on Sundays, in order that weather charts, forecasts, and synopses of the weather may be available for all days of the year, without interruption.

(16) That postmasters having charge of meteorological instruments shall take all necessary readings, etc., and forward reports as required, without any special remuneration, as is now done in several of the states.

(17) That it is essential that meteorological outstations be periodically inspected.

(18) That uniform methods of publishing the daily weather information are desirable, similar forms to be used in each state.

(19) That each State Meteorological Department should have a room at the general post office of the state, to which all telegrams shall be transmitted, so that no delay may occur in publishing the same for the information of the public. Facilities should also be provided by the postal authorities of each state for exhibiting at the general post office and other selected offices weather maps and bulletins.

(20) That daily reports should again be exchanged with New Zealand, and similar information should also be supplied by New Caledonia, Norfolk Island, and Fiji.

(21) That meteorological and ocean current forms be distributed to oversea shipmasters, the results to be discussed and published by one state or the central bureau.

(22) That each observatory shall not, as at present, issue an annual statistical report, but until the establishment of a central bureau, as recommended in (7), the observations shall be collected by one of the Government Astronomers, and published upon some uniform basis as a report upon the meteorology of Australia. It is suggested that this work be done by the Adelaide Observatory.

(Mr. Baracchi dissented.)

A change took place in the Federal Government shortly after the above conference was held, and the following note appeared in the Sydney Daily Telegraph of August 9, 1905:

The proposal for the creation of a Commonwealth Meteorological Department and Weather Bureau is still under consideration. Mr. Groom, Minister for Home Affairs, stated in the House of Representatives today that the Federal Government would again communicate with the State Premiers to see to what extent, in view of the report of the Inter-State Astronomical Conference, it would be practicable to establish a Federal department. A bill was in preparation with a view to introduction, if possible, this session.

The information in this paper has been drawn from many sources, but the writer is under special obligations to the following:

1. History and Progress of Sydney Observatory. By H. C. Russell. 1882.
2. Astronomical and Meteorological Workers in New South Wales. By H. C. Russell. 1888.
3. A Review of Meteorological Work in Australia. By Sir Charles Todd. 1893.
4. The Annual Reports issued by the Australian Observatories.
5. Wragge's Almanacs. 1898 to 1902.
6. The Australian Year Books. 1883 to 1904.

#### STORM WARNINGS FOR LAKE VESSELS.

By Prof. E. B. GARRIOTT.

The lesson that may be learned from the unparalleled series of disasters of the closing months of the present season of lake navigation is that modern vessels of low steam power can not safely brave the severer storms of the Great Lakes.

Shipping losses of previous years have been almost wholly confined to sailing vessels and old-fashioned steamers, and the escape from disaster during the last few years of low power steamers of the modern type has been due solely to the fact that they have not been subjected to gales of the violence that marked the Lake Superior storm of November 28. It is apparent, also, that a more perfect system of storm warnings and advices would lessen the liability of disaster, and it is equally apparent that a hearty and intelligent cooperation with the Weather Bureau by shipmasters is essential to the enlargement and more perfect operation of this service.