observers. In fact, one ought to organize a special thunderstorm service for Delaware Bay and southern New Jersey. It is quite impossible for one person, by observations at one station, to determine anything more than the apparent limit of that edge of the storm that is visible to him. The other edge and the center of the storm are usually hidden.

As it is impossible to establish thunderstorm stations on Delaware Bay itself, it may be that it will always be impossible to determine the path of the storm over the bay with sufficient accuracy to establish the truth of Mr. Lovett's theory as to the action of the tides. We hope that he will not fail to secure the cooperation of voluntary thunderstorm observers, and report to the readers of the MONTHLY WEATHER REVIEW the actual paths of the centers of thunderstorms, as well as the advancing fronts of the storms.—*C. A.*

THE DIURNAL VARIATION OF THE BAROMETER AT MILWAUKEE.

In 1868 Maj. R. S. Williamson published his memoir on the use of the barometer in surveys, as Professional Paper No. 15, of the Corps of Engineers, U. S. Army. Among other things he attemped to derive true mean daily pressures by eliminating the diurnal periodicity, and maintained that a close approximation to the diurnal variations could be obtained from a few days' work by a special process of eliminating the slower variations by virtue of which the pressure rises and falls rather regularly for several days at a time, owing to the passage over the country of the so-called areas of high pressure and low pressure. In Williamson's method a straight line is drawn connecting two points on the barometric curve that are twenty-four hours apart, as, for instance, 7 a. m. and 7 a. m. This line, therefore, represents the slower variation; the departures of the curve from this straight line represent approximately the effect of the semidiurnal periodicity.

We have lately received from Miss Mary Lapham, of Oconomowoc, Wis., a manuscript left by her father, the late Prof. I. A. Lapham (apparently written in 1870), in which he gives his hourly barometric readings for one day in each month and the result of treating them by Williamson's method. The manuscript is not entirely in shape for publication, but the following extracts will serve to present the more important features and show the author's train of thought.—*C. A.*

THE ATMOSPHERIC TIDE AT MILWAUKEE, WIS.

By the late I. A. LAPHAM.

Atmospheric tides are caused or modified by several influences :

1. The attraction of the moon varying with its declination and distance, and its position with regard to the sun.
2. The attraction of the sun.
3. The earth's orbital motion.
4. The earth's diurnal rotation.
5. Changes of atmospheric temperature.
6. Changes in the amount of atmospheric moisture.

In order to ascertain whether the hourly oscillations of the barometer, indicating a tidal wave in the atmosphere, could, as suggested by Maj. R. S. Williamson, be determined by a single day's observations, I made such observations at Milwaukee, commencing at 7 a. m., October 19, 1868. The moon reached the meridian three hours after the sun—had 18° south declination—the sun's declination 10° south. The abnormal oscillation was manifested by a pretty uniform rise of the barometer during nearly the whole day. The temperature did not vary much during the twenty-four hours, being at 7 a. m., 41°; at 2 p. m., 45°; at its maximum, 49°; at 9 p. m., 43°; and at its minimum depression during the night, 41°. But little of the atmospheric tide can, therefore, be attributed to the change of temperature between the day and night. The sky continued to be uniformly cloudy, wind moderate, the air contained from 61 to 77 per cent of the amount of aqueous vapor it was capable of holding; the pressure of vapor was equivalent to from 0.181 to 0.198 inches of mercury. So the wave could not have been much affected by changes in the hygrometrical condition of the atmosphere.

Hence, these observations were favorable for showing the effect of astronomical causes upon the atmosphere.

The observations for November 14-15, 1868, were taken under circumstances equally favorable with those of October for avoiding the effect of great changes of temperature and moisture. They show a much more prominent morning maximum, which may be owing to the nearness of the sun and moon. The evening maximum is scarcely discernible. The same nodes are observed upon comparison with observations at Thunder Bay and Toronto, but at a different time, being about noon and midnight. The great depression between 2 p. m. and 10 p. m. must be owing to some uneliminated, abnormal, fluctuation.

The remainder of the manuscript is summed up in Tables 1 and 2, compiled in March.

In 1869, Professor Lapham sums up the results of his observations "taken hourly one day in each month at the time of the new moon," and concludes, "Thus it appears that when the latitude of the moon is north, the atmospheric tide is considerably less than when it is south."

Apparently Professor Lapham returned to this subject in 1870, as we find among his papers a few additional sheets, giving hourly readings for six days, June 28–July 4. But in this latter series very few actual observations were taken between 10 p. m. and 6 a. m., inclusive, so that he filled in this portion of the record by simple interpolation. The figures given by Professor Lapham for these days are reproduced in Tables 3 and 4, to which we have added a column of means. The hourly corrections in Table 4 are deduced from the actual observations of Table 3 by assuming, with Williamson, that the total change in pressure from 7 a. m. to the next following 7 a. m. has gone on at a uniform rate. After applying to each hourly observation its proportional part of this daily change, the observations are said to have been reduced "to level." The average of the 24 observations, as thus reduced, gives the mean pressure for the day, and the difference between this mean and the individual observations corrected to level gives the departure due to diurnal tide, or the diurnal periodic variation of pressure freed from the irregular variations due to highs and lows.

Of course, the few days of hourly observations secured by Professor Lapham during these years can not give us a satisfactory determination of the diurnal period, but they afford a very good illustration of an effort to carry out the suggestions made by Major Williamson. During these same years, 1868–70, and subsequently, the officers of the battalion of engineers stationed at Willetts Point, New York Harbor, maintained a series of hourly observations and published the results in successive general orders issued at that post. A similar record was kept at Jefferson Barracks, Mo., and occasionally there was printed a comparison between the horary curves at Jefferson Barracks, Willetts Point, and the Dudley Observatory, Albany, where Prof. G. W. Hough kept his self-registering and printing barometer in activity. This publication is now very rare, only one copy being on file in the office of the Chief of Engineers, United States Army.

In general, however, it should be stated that this method of determining the diurnal period of pressure, or temperature, has not been widely adopted by meteorologists, and the exhaustive studies on this subject by Professor Hann have been based upon the older and less laborious methods of procedure.

Figures in italic are interpolated values.—*C. A.*

TABLE 1.—*Hourly barometrical observations at Milwaukee, Wis.*

Hour.	1868.			1869.									Mean.
	Oct. 19-20.	Nov. 14-15.	Dec. 13-14.	Jan. 13-14.	Feb. 11-12.	Mar. 13-14.	Apr. 11-12.	May 11-12.	June 9-10.	July 9-10.	Aug. 7-8.	Sept. 6-7.	
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
7 a. m	29.440	29.545	29.713	29.422	29.526	29.225	29.548	29.992	29.319	29.230	29.721	29.263	29.495
8 a. m	29.455	29.544	29.705	29.431	29.546	29.221	29.549	29.989	29.309	29.241	29.734	29.262	29.499
9 a. m	29.471	29.541	29.703	29.450	29.547	29.211	29.550	29.985	29.301	29.240	29.735	29.290	29.502
10 a. m	29.474	29.532	29.698	29.460	29.557	29.213	29.556	29.981	29.282	29.240	29.734	29.300	29.502
11 a. m	29.478	29.514	29.667	29.456	29.558	29.197	29.555	29.976	26.264	29.242	29.738	29.306	29.496
12 noon	29.481	29.482	29.638	29.439	29.539	29.184	29.549	29.960	29.253	29.245	29.721	29.314	29.484
1 p. m	29.485	29.467	29.601	29.426	29.522	29.158	29.545	29.958	29.243	29.244	29.720	29.326	29.475
2 p. m	29.492	29.449	29.588	29.412	29.501	29.125	29.534	29.950	29.213	29.222	29.700	20.318	29.459
3 p. m	29.497	29.454	29.586	29.421	29.500	29.098	29.525	29.935	29.215	29.298	29.688	29.321	29.461
4 p. m	29.506	29.450	29.591	29.429	29.500	29.079	29.519	29.940	29.227	29.189	29.665	29.328	29.452
5 p. m	29.515	29.442	29.569	29.434	29.483	29.060	29.516	29.945	29.236	29.173	29.650	29.336	29.447
6 p. m	29.527	29.438	29.552	29.441	29.463	29.044	29.506	29.950	29.248	29.166	29.645 29.635	29.345	29.443
7 p. m	29.537	29.444	29.531	29.444	29.446	29.019	29.499	29.956	29.275	29.143	29.633 29.635	29.347	29.440
8 p. m	29.548	29.436	29.500	29.446	29.428	29.021	29.502	29.959	29.294	29.152	29.630	29.355	29.439
9 p. m	29.557	29.434	29.480	29.441	29.398	28.996	29.504	29.976	29.311	19.154	29.633	29.359	29.437
10 p. m	29.564	29.430	29.447	29.442	29.373	28.966	29.508	29.971	29.325	29.156	29.623	29.367	29.431
11 p. m	29.569	29.451	29.401	29.447	29.339	28.930	29.500	29.963	29.318	29.149	29.620	29.359	29.420
12 midnight	29.575	29.464	29.372	29.434	29.321	28.916	29.484	29.958	29.309	29.135	29.620	29.349	29.411
1 a. m	29.574	29.466	29.328	29.438	29.305	28.911	29.472	29.953	29.297	29.124	29.615	29.345	29.402
2 a. m	29.576	29.468	29.286	29.453	29.310	28.906	29.462	29.955	29.288	29.088	29.616	29.345	29.396
3 a. m	29.578	29.465	29.269	29.456	29.292	28.923	29.444	29.956	29.280	29.052	29.624	29.341	29.390
4 a. m	29.574	29.464	29.256	29.465	29.273	29.000	29.437	29.946	29.289	29.026	29.628	29.333	29.391
5 a. m	29.565	29.461	29.243	29.459	29.289	29.062	29.430	29.946	29.300	28.985	29.629	29.332	29.392
6 a. m	29.568	29.470	29.239	29.456	29.297	29.124	29.434	29.950	29.322	28.942	29.639	29.335	29.398
7 a. m	29.573	29.475	29.240	29.451	29.320	29.150	29.438	29.941	29.338	28.900	29.638	29.328	29.399
Mean													29.440

TABLE 2.—*Atmospheric tide at Milwaukee, Wis., as shown by hourly barometric observations made on one day in each month.*

Hour.	1868.			1869.									Mean.
	Oct. 19-20.	Nov. 14-15.	Dec. 13-14.	Jan. 12-13.	Feb. 11-12.	Mar. 13-14.	Apr. 11-12.	May 11-12.	June 9-10.	July 9-10.	Aug. 7-8.	Sept. 6-7.	
	Inch.	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*
7 a. m	+.022	—.041	+.013	+.006	+.003	—.123	+.010	—.007	—.051	+.084	—.016	+.034	—.006
8 a. m	+.013	—.043	+.001	—.002	—.026	—.122	+.005	—.006	—.040	+.059	—.032	+.032	—.013
9 a. m	+.002	—.043	—.016	—.020	—.036	—.116	—.001	—.004	—.031	+.047	—.037	+.012	—.020
10 a. m	+.004	—.037	—.031	—.028	—.055	—.121	—.012	—.002	—.012	+.033	—.039	+.005	—.025
11 a. m	+.006	—.022	—.020	—.023	—.064	—.108	—.015	.000	+.007	+.017	—.047	+.002	—.022
12 noon	+.008	+.007	.011	—.005	—.053	—.098	—.014	+.014	+.009	+.000	—.033	—.003	—.015
1 p. m	+.010	+.020	+.007	+.009	—.044	—.075	—.014	+.014	+.030	—.012	—.036	—.013	—.008
2 p. m	+.008	+.035	.000	+.024	—.032	—.045	—.008	+.020	+.061	—.004	—.019	—.002	+.003
3 p. m	+.008	+.027	—.017	+.017	—.039	—.021	—.004	+.031	+.059	+.006	—.011	—.002	+.005
4 p. m	+.006	+.028	—.042	+.010	—.048	—.005	—.002	+.026	+.048	+.001	+.009	—.007	+.002
5 p. m	+.002	+.033	—.040	+.006	—.040	+.011	—.004	+.019	+.040	+.004	+.020	—.012	+.003
6 p. m	—.004	+.034	—.042	.000	—.028	+.023	+.002	+.012	+.029	—.003	+.032	—.018	+.003
7 p. m	—.009	+.025	—.041	—.002	—.020	+.045	+.004	+.003	+.003	+.006	+.028	—.018	+.002
8 p. m	—.015	+.030	—.031	—.002	—.011	+.040	—.003	—.002	—.016	—.017	+.030	—.023	—.001
9 p. m	—.018	+.029	—.030	+.004	+.010	+.062	—.010	—.021	—.032	—.032	+.024	—.024	—.003
10 p. m	—.020	+.030	—.017	+.004	+.026	+.089	—.019	—.018	—.045	—.049	+.031	—.029	—.001
11 p. m	—.020	+.006	+.009	.000	+.052	+.122	—.015	—.012	—.037	—.055	+.030	—.019	+.005
12 midnight	—.020	—.010	+.019	+.014	+.061	+.133	—.004	—.009	—.027	—.055	+.027	—.006	+.011
1 a. m	—.013	—.014	+.043	+.012	+.069	+.135	+.004	—.006	—.015	—.057	+.028	+.001	+.016
2 a. m	—.010	—.019	+.065	—.002	+.055	+.137	+.009	—.010	—.005	—.035	+.024	+.003	+.018
3 a. m	—.005	—.019	+.063	—.004	+.065	+.116	+.022	—.014	+.004	—.013	+.012	+.010	+.020
4 a. m	+.005	—.021	+.056	—.012	+.075	+.036	+.025	—.006	—.004	—.001	+.004	+.021	+.015
5 a. m	+.018	—.021	+.049	—.005	+.051	—.029	+.027	—.008	—.014	+.024	—.009	+.024	+.010
6 a. m	+.021	—.033	+.034	.000	+.034	—.094	+.019	—.014	—.036	+.066	—.014	+.024	+.001

TABLE 3.—*Hourly barometrical observations at Milwaukee, Wis.*

TABLE 4.—*Atmospheric tide at Milwaukee, Wis.*

Hour.	1870.						1870.						6-day mean, June 28 to July 4.
	June 28-29.	June 29-30.	June 30, July 1.	July 1-2.	July 2-3.	July 3-4.	June 28-29.	June 29-30.	June 30, July 1.	July 1-2.	July 2-3.	July 3-4.	
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*
7 a. m	29.367	29.277	29.044	39.194	29.429	29.366	—.013	—.009	—.102	+.024	+.003	—.003	—.017
8 a. m	29 369	29.264	29.031	29.218	29.434	29.353	—.019	—.006	—.083	+.010	—.005	+.002	—.017
9 a. m	29.358	29 262	29.021	29.226	29.438	29.340	—.012	—.013	—.067	+.012	—.012	+.006	—.014
10 a. m	29.350	29.263	28.996	29.255	29.443	29.331	—.009	—.024	—.036	—.007	—.019	+.007	—.015
11 a. m	29.346	29.273	28.970	29.280	29.431	29.328	—.009	—.044	—.003	—.023	—.010	+.001	—.015
12 noon	29.326	29.248	28.959	28.283	29.438	29.320	+.007	—.029	+.014	—.016	—.015	+.001	—.006
1 p. m	29.311	29.201	28.934	29.316	29.436	29.309	+.017	+.009	+.045	—.039	—.020	+.003	+.002
2 p. m	29.291	29.189	28.935	29.318	29.430	29.298	+.033	+.011	+.051	—.031	—.017	+.006	+.009
3 p. m	29.279	29.183	28.900	29.341	29.423	29.300	+.041	+.007	+.092	—.045	—.013	—.003	+.013
4 p. m	29.271	29.147	28.861	29.326	29.415	29.280	+.045	+.034	+.137	—.020	—.008	+.009	+.033
5 p. m	29.273	29.149	28.845	29.352	29.408	29.295	+.039	+.019	+.160	—.016	—.003	—.019	+.030
6 p. m	29.284	29.134	28.871	29.338	29.401	29.277	+.024	+.027	+.140	—.012	+.001	—.005	+.029
7 p. m	29.308	29.135	29.002	29.341	29.394	29.260	—.004	+.017	+.015	—.006	+.006	+.003	+.005
8 p. m	29.307	29.137	28.997	29.344	29.386	29.257	—.007	+.005	+.029	+.001	+.012	—.003	+.006
9 p. m	29.304	29.137	29.015	29.339	29.379	29.245	—.009	—.005	+.014	+.016	+.016	+.001	+.005
10 p. m	29.301	29.125	29.033	29.348	29.378	29.237	—.011	—.003	+.003	+.021	+.015	.000	+.004
11 p. m	29.298	29.113	29.051	29.357	29.377	29.229	—.012	—.002	—.009	—.017	+.013	.000	—.005
12 midnight	29.294	29.102	29.069	29.366	29.376	29.221	—.013	+.001	—.021	—.018	+.017	—.001	—.006
1 a. m	29.290	29.093	29.087	29.374	29.375	29.213	—.013	.000	—.033	—.020	+.010	—.001	—.010
2 a. m	29.286	29.083	20.105	29.383	29.373	29.204	—.013	.000	—.044	—.021	+.009	—.001	—.012
3 a. m	29.282	29.074	29.123	29.392	29.372	29.195	—.014	.000	—.056	—.021	+.007	.000	—.014
4 a. m	29.278	29.068	29.141	29.400	29.370	29.187	—.014	—.004	—.068	—.023	+.007	—.001	—.017
5 a. m	29.274	29.055	29.158	29.409	29.369	29.179	—.014	—.001	—.078	—.024	+.005	—.001	—.019
6 a. m	29.270	29.049	29.176	29.419	29.367	29.171	—.015	—.004	—.090	—.024	+.004	—.002	—.022
7 a. m	29.264	29.044	29.194	29.429	29.366	29.163							

+ add to, — subtract from, observed height to produce the mean.