XII. *On the Effect of the Pressure of the Atmosphere on the Mean Level of the Ocean.*

By Captain Sir James Clark Ross, *R.N., D.C.L., F.R.S. &c.*

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In September 1848 Her Majesty's ships Enterprize and Investigator entered the harbour of Port Leopold, in latitude 74° N. and longitude 91° W., for the purpose of establishing there a depôt of provisions, and of extending, in boats, the examination of the north, south, and west coasts of North Somerset, in search of the missing expedition under the command of Sir John Franklin. No sooner, however, were the ships anchored, than a heavy pack of ice was driven down upon, and completely closed the harbour's mouth, and this effectually preventing their egress, they were compelled there to pass the winter of 1848–49.

It was during that period that the series of observations, which I have now the honour of submitting to the consideration of the Royal Society, on the effect of the pressure of the atmosphere on the level of the ocean, was obtained, and as it was made under peculiarly favourable circumstances, which I shall presently point out, I have no doubt it will contribute to throw some light on the movements of the tides, and on some of the causes of their apparent irregularities, not only in the Polar regions, but also along our own coasts, which have not hitherto been detected, or have not received that attention their importance demands.

It originated in the following circumstances:—Soon after the harbour had been completely frozen over, a very heavy pressure from the main pack forced the newly-formed sheet of ice, which covered the bay, far up towards its head, carrying the ships with it into such shallow water that at low spring-tides their keels sometimes rested on the ground.

It is well known that from many causes great differences in the rise or fall of the tides occur in nearly all latitudes, and as any extraordinary depression, in our case, might seriously injure the ships with so great a weight of ice attached to their sides, the movements of the tides necessarily became to me an object of great anxiety and of careful observation, in order, if possible, to ascertain the amount of irregularities to which they were liable in this particular locality, and to investigate the cause.

The first few days' observations evidenced much larger differences in the elevation or depression of successive high or low waters than could be accounted for by any of the generally received causes of disturbance; and I was at once led to connect them with the changes of pressure of the atmosphere, from perceiving that high water was not so high, and that low water was lower, on the days that the pressure of the atmosphere was greater, and that high water was too high, and low water not so low as it ought to have been, on the days of smaller atmospheric pressure.

The observations during September and October were limited to the register of

high and low water, but various causes of disturbance so frequently masked the effects of the pressure of the atmosphere, that the four observations on each day were not sufficient to determine the amount of effect of its variations: and also, owing to the semidiurnal inequality and other causes of derangement, the usual mode of determining the level, by taking the mean between successive high and low waters, was found inadequate to the detection of small quantities arising from variation of pressure. I therefore adopted a different system of observation from any that has heretofore been practised, in order to determine the mean level of the ocean on each day.

I began by instituting simultaneous observations of the height of the tide and of the mercury in the barometer at every quarter of an hour throughout the day and night, and from these I found that the mean level of the ocean for each day could be determined with a great degree of accuracy, and that the variation in the daily mean level and in the mean pressure of the atmosphere, as indicated by the barometer, followed each other in a very remarkable manner, but in an inverse ratio, which could only be accurately obtained by a much more extended series of observations.

But the fatigue of making a long-continued series of observations of this nature, at every quarter of an hour, during the inclemency of an arctic winter, was greater than I could expect the officers to endure who had thenceforward to continue the observations which I had begun. Hourly observations were at length determined on. Those which I had previously made having been several times interrupted by the necessity of moving the ships into deeper water, could not be brought into strict comparison with each other without such a complication of corrections to be applied to each set as would have greatly and uselessly extended this communication; they have, therefore, not been employed, and the conclusions which have been arrived at are entirely derived from the observations contained in the following tables.

The peculiar advantages of our position at Port Leopold, to which I have before alluded, for making tidal observations were,—

1st. In the great width of the entrance of the harbour admitting the free ingress and egress of the waters, combined with the large field of ice which covered the whole extent of the bay, containing more than ten square miles of surface, and completely subduing those undulations of the water, which in other places render tidal observations uncertain.

2nd. In the steady movement of this immense platform of ice, rising and falling with such singular regularity and precision as to admit the reading off the marks of the tide-pole with the greatest exactness, even to the tenth of an inch; although such minuteness was not always attempted, the nearest quarter of an inch being generally deemed sufficient.

3rd. The shallowness of the water, and the evenness and solidity of the clay bottom admitting the fixture of the tide-pole with immoveable firmness.

4th. The whole surface of the ocean in the neighbourhood being, for the greater part of the time, covered by a sheet of ice, preventing those irregularities which occur in other localities from the violence of the wind raising or depressing the ocean in as many different degrees as it varies either in strength or direction.

The ships were not finally placed in their winter position until the middle of October, when the operation of fixing the tide-pole engaged our first attention.

A hole, 2 feet square, was cut through the icy platform, a strong pole, nearly 40 feet long, passed through it, and driven firmly down several feet into the clay, and fixed by heavy iron weights, which also rested on the clay and prevented any movement of the pole. It was placed in about 21 feet depth of water at the time of mean level of the sea, and by the end of the month was considered, and afterwards proved to have been so perfectly immoveable, that we began the regular series of observations on the 1st of November.

Another tide-pole was in like manner fixed through a hole in the ice close to the Investigator, for the sake of reference and comparison. Hourly observations of the tide and the barometer were made by the officers and petty officers of that ship, exactly corresponding with those made by the officers of the Enterprize, throughout the whole of the nine following months, to the end of July, and they proved of great value in many instances, where very large and apparently unaccountable irregularities of the tides occurred, and which otherwise might have been attributed to inaccuracy of observation, or of registry, or of the shifting of the tide-pole, had they not also been observed in every case, at exactly the same time and precisely to the same amount at both the tide-poles.

The reduction of the double series of observations, however, would have so greatly increased the labour of preparing this paper as well as its length, that the Investigator's observations have, for the present, been only used for comparison in several cases of uncertainty above alluded to, and for the purpose of refixing the tide-pole of the Enterprize when it was lifted by the ice on the 18th of December. But the whole of the observations of both the ships are preserved in the proper office at the Admiralty, and may at any time be referred to for any purposes of further investigation.

The hourly observations which were commenced on the 1st of November, were continued uninterruptedly until the morning of the 18th of December, when the tide-pole having been frozen to the underpart of the ice was drawn out of the ground as the tide rose, and thus made the first break in the series, after forty-seven complete days. The amount of displacement of the pole was easily determined by comparison with that of the Investigator, but several days elapsed before it could be satisfactorily fixed at the same point in which it originally stood.

Subsequent observations serve to show that from this time to the middle of July there was a progressive elevation of the mean level of the ocean, and, although of small amount, the difference from month to month was sufficiently evident to render subdivisions of the series desirable, in order that the individual observations of each separate division should be strictly comparable with the others; so that this early interruption is the less to be regretted.

The method of observation was as follows:—At the exact hour of mean time the heights of the tide and of the mercury in the barometer were taken; the former by the quarter-master, and the latter by the officer of the watch, who immediately entered both the observations in the meteorological journal, from which the following tables were constructed.

TABLE I.—Showing the height of the sea, and the corresponding height of the mercury in the barometer, for every hour, during the month of November 1848, at Port Leopold.

Hour.	November 1.		November 2.		November 3.		November 4.		November 5.		November 6.	
	Tide.	Barom.	Tide.	Barom.	Tide.	Barom.	Tide.	Barom.	Tide.	Barom.	Tide.	Barom.
A.M.	ft. in.	inches.	ft. in.	inches.	ft. in.	inches.	ft. in.	inches.	ft. in.	inches.	ft. in.	inches.
1	21 11·5	30·122	21 3·0	30·034	21 7·0	29·355	20 8·0	29·379	19 6·5	29·980	19 4·0	30·286
2	22 2·0	30·122	21 9·0	30·017	22 1·0	29·356	21 1·0	29·388	19 10·0	30·004	19 1·0	30·294
3	21 8·5	30·127	21 10·0	30·000	22 5·0	29·350	21 6·0	29·397	20 2·0	30·026	19 4·0	30·299
4	21 3·5	30·132	21 6·0	29·978	22 4·0	29·352	21 8·0	29·404	20 6·0	30·045	19 9·0	30·300
5	20 1·5	30·139	20 10·0	29·951	22 0·0	29·318	21 8·0	29·432	20 9·0	30·054	20 2·0	30·308
6	19 2·0	30·147	19 11·0	29·926	21 6·0	29·320	21 6·0	29·469	20 11·0	30·070	20 9·0	30·301
7	18 5·5	30·142	19 2·0	29·897	20 11·0	29·324	21 1·5	29·505	20 10·5	30·097	21 0·5	30·295
8	18 2·0	30·129	18 11·0	29·868	20 4·5	29·342	20 8·5	29·520	20 7·0	30·102	21 1·5	30·296
9	18 5·5	30·103	18 11·5	29·833	20 1·0	29·354	20 4·0	29·548	20 2·5	30·118	20 10·0	30·285
10	19 2·2	30·100	19 6·0	29·779	20 2·5	29·364	20 1·0	29·574	19 10·5	30·154	20 7·0	30·272
11	20 4·0	30·113	20 5·0	29·746	20 6·0	29·362	20 0·5	29 603	19 8·0	30·166	20 1·5	30·265
Noon	21 6·0	30·108	21 6·0	29·683	21 1·5	29·362	20 4·5	29·637	19 8·0	30·186	19 8·0	30·265
1	22 11·0	30·110	22 7·0	29·655	22 0·5	29·354	21 0·0	29·658	20 1·0	30·207	19 6·0	30·272
2	23 6·5	30·104	23 5·0	29·619	22 10·0	29·356	21 9·0	29·689	20 8·0	30·213	19 7·0	30·272
3	23 8·5	30·102	23 11·0	29·609	23 5·0	29·348	22 2·0	29·713	21 1·0	30·225	20 0·0	30·270
4	23 4·0	30·092	23 11·0	29·547	23 9·0	29·355	22 11·0	29·723	21 11·0	30·229	20 8·0	30·260
5	22 6·0	30·085	23 7·0	29·503	23 7·5	29·353	23 1·0	29·751	22 5·0	30·241	21 5·0	30·258
6	21 6·0	30·090	22 11·0	29·452	23 2·0	29·351	22 10·0	29·799	22 9·0	30·265	22 3·5	30·267
7	20 6·5	30·080	22 1·0	29·437	22 6·0	29·349	22 7·0	29·819	22 9·0	30·263	22 7·5	30·260
8	19 8·5	30·074	21 4·0	29·412	21 7·0	29·350	22 2·0	29·836	22 4·5	30·271	22 9·0	30·254
9	19 5·0	30·067	20 10·5	29·385	21 3·0	29·351	21 6·0	29·863	21 9·0	30·281	22 6·0	30·238
10	19 7·0	30·056	20 8·0	29·375	20 7·0	29·364	20 8·0	29·883	21 0·0	30·273	21 11·0	30·234
11	19 11·5	30·046	20 10·5	29·346	20 4·0	29·369	20 0·0	29·906	20 3·0	30·273	21 0·0	30·228
Midnight	20 8·0	30·034	21 2·0	29·356	20 5·0	29·374	19 7·5	29·953	19 8·5	30·278	20 2·5	30·214
Mean ...	20 9·9	30·101	21 4·4	29·683	21 8·3	29·351	21 3·5	29·643	20 9·7	30·168	20 8·1	30·270

Hour.	November 7.		November 8.		November 9.		November 10.		November 11.		November 12.	
	Tide.	Barom.	Tide.	Barom.	Tide.	Barom.	Tide.	Barom.	Tide.	Barom.	Tide.	Barom.
A.M.	ft. in.	inches.	ft. in.	inches.	ft. in.	inches.	ft. in.	inches.	ft. in.	inches.	ft. in.	inches.
1	19 5·0	30·212	19 9·5	29·934	20 6·0	29·656	21 6·5	29·761	22 6·5	29·823	23 5·0	29·892
2	18 11·5	30·215	18 11·0	29·902	19 4·0	29·667	20 1·0	29·769	21 1·0	29·827	21 11·0	29·901
3	18 10·5	30·215	18 6·5	29·882	18 5·0	29·675	18 10·0	29·771	19 4·5	29·855	20 5·5	29·903
4	19 2·0	30·206	18 7·0	29·843	18 1·0	29·680	17 10·0	29·774	18 1·0	29 865	18 10·5	29·916
5	19 7·5	30·185	18 11·0	29·840	18 5·0	29·681	17 8·2	29·756	17 4·0	29·877	17 6·0	29·913
6	20 8·5	30·182	20 2·0	29·809	19 1·5	29·683	18 6·0	29·754	17 6·0	29·886	17 2·5	29·921
7	21 3·5	30·177	21 4·0	29·782	19 5·5	29·686	19 5·5	29·758	18 8·0	29·898	17 7·5	29·925
8	21 9·0	30·167	22 2·0	29·770	21 9·5	29·683	21 0·0	29·775	20 1·0	29·902	18 10·0	29·939
9	21 10·5	30·162	22 10·5	29·745	23 2·0	29·675	22 10·0	29·752	22 0·5	29·899	20 10·0	29·962
10	21 7·5	30·161	22 11·5	29·723	23 8·5	29·683	23 10·5	29·742	23 7·0	29·907	22 0·0	29·976
11	21 1·5	30·159	22 7·5	29·718	23 9·0	29·694	24 0·0	29·733	23 8·0	29·915	24 5·0	29·995
Noon	20 6·0	30·136	22 1·0	29·718	23 1·5	29·694	23 10·5	29·730	23 9·0	29·915	25 4·0	30·023
1	19 9·5	30·114	20 11·0	29·711	22 0·5	29·707	23 0·0	29·728	23 8·5	29·919	25 4·0	30·047
2	19 4·5	30·132	19 11·7	29·721	20 10·0	29·723	21 9·0	29·739	22 10·0	29·919	24 6·0	30·093
3	19 5·5	30·112	19 4·5	29·719	19 9·0	29·703	20 3·0	29·745	21 3·5	29·921	22 11·5	30·122
4	19 9·0	30·114	19 4·0	29·721	19 2·5	29·745	19 5·0	29·746	19 8·0	29·916	21 5·5	30·141
5	20 6·0	30·094	19 7·5	29·727	19 3·5	29·730	18 10·0	29·749	18 6·0	29·923	19 8·0	30·172
6	21 3·5	30·066	20 9·0	29·740	19 6·0	29·746	18 10·0	29·749	18 1·0	29·916	18 6·0	30·192
7	22 1·0	30·087	21 8·0	29·725	20 3·5	29·744	19 9·5	29·756	18 6·0	29·914	18 3·5	30·193
8	22 8·5	30·057	22 7·0	29·717	21 10·0	29·735	21 0·0	29·773	19 2·0	29 912	18 8·0	30·215
9	22 10·5	30 010	23 3·0	29·693	23 1·0	29·729	22 2·0	29·786	21 0·0	29·906	19 7 0	30·227
10	22 11·5	30·001	23 6·5	29·671	23 8·0	29·734	23 4·0	29·788	22 4·5	29 896	20 11·0	30·241
11	21 11·0	29·986	22 11·5	29·665	23 7·5	29·744	23 10·0	29·796	23 5·0	29·877	22 3·0	30·248
Midnight	20 10·5	29·963	22 0·0	29·661	22 9·0	29·750	23 8·5	29 806	23 9·5	29·877	22 11·5	30·271
Mean ...	20 9·2	30·123	21 0·4	29·756	21 0·4	29·706	21 0·7	29·759	20 10·0	29·894	20 11·7	30 064

TABLE I.—November 1848. (Continued.)

Hour.	November 13.		November 14.		November 15.		November 16.		November 17.		November 18.	
	Tide.	Barom.	Tide.	Barom.	Tide.	Barom.	Tide.	Barom.	Tide.	Barom.	Tide.	Barom.
A.M.	ft. in.	inches.	ft. in.	inches.	ft. in.	inches.	ft. in.	inches.	ft. in.	inches.	ft. in.	inches.
1	22 10·0	30·277	23 2·0	30·090	22 5·5	30·058	21 2·0	30·105	20 3·0	29·840	20 0·0	29·697
2	22 1·0	30·287	23 2·0	30·079	22 11·0	30·076	21 11·5	30·098	21 1·0	29·817	20 5·0	29·699
3	20 10·0	30·290	22 4·0	30·058	22 8·5	30·081	22 3·2	30·081	21 7·0	29·813	20 9·5	29·704
4	19 7·0	30·298	20 11·0	30·063	21 10·0	30·095	22 0·0	30·069	21 9·5	29·795	21 5·0	29·714
5	17 7·0	30·297	19 5·0	30·042	20 7·0	30·135	21 4·0	30·062	21 8·5	29·765	21 8·0	29·719
6	16 8·0	30·299	18 4·0	30·030	19 3·5	30·155	20 3·0	30·043	21 1·5	29·749	21 9·0	29·719
7	16 6·0	30·299	17 3·0	30·024	18 3·0	30·188	19 2·0	30·026	20 7·0	29·742	21 6·5	29·725
8	17 1·5	30·294	17 4·0	30·017	17 7·5	30·208	18 6·0	29·997	19 5·0	29·741	20 11·0	29·727
9	18 8·5	30·292	18 2·0	30·025	17 11·0	30·226	18 3·0	29·985	19 1·0	29·727	20 3·5	29·753
10	20 6·0	30·289	19 7·5	30·029	19 1·0	30·245	18 8·5	29·971	19 0·0	29·705	19 8·0	29·759
11	22 4·5	30·279	21 6·0	30·035	20 9·0	30·250	19 7·5	29·956	19 3·5	29·713	19 6·5	29·779
Noon	24 0·5	30·277	23 3·0	30·028	21 5·0	30·246	20 11·0	29·942	19 11·5	29·701	19 8·0	29·789
1	24 9·2	30·239	24 8·0	30·039	23 6·0	30·254	22 5·5	29·935	21 3·5	29·705	20 3·5	29·802
2	24 9·0	30·221	25 0·5	30·052	24 6·0	30·260	23 9·0	29·931	22 3·5	29·705	20 10·5	29·808
3	23 9·0	30·188	24 8·0	30·056	24 8·5	30·258	24 3·5	29·906	23 2·5	29·705	21 9·5	29·804
4	22 3·0	30·185	23 8·0	30·058	24 4·0	30·258	24 6·0	29·902	23 11·0	29·691	22 7·0	29·814
5	20 8·0	30·194	22 2·5	30·060	23 0·0	30·244	24 0·0	29·904	23 11·0	29·686	23 1·0	29·832
6	19 0·0	30·168	20 6·5	30·063	21 3·0	30·223	23 0·5	29·902	23 6·0	29·686	23 2·5	29·827
7	18 3·0	30·149	19 2·0	30·056	20 1·0	30·195	21 6·5	29·890	22 10·0	29·686	22 11·5	29·835
8	18 2·0	30·142	18 7·0	30·048	19 1·0	30·191	20 7·0	29·860	21 11·0	29·684	22 5·0	29·850
9	18 9·5	30·122	18 6·0	30·038	18 6·0	30·175	19 7·0	29·848	21 0·5	29·695	21 9·0	29·845
10	19 11·0	30·115	19 1·0	30·040	18 6·0	30·146	19 1·5	29·844	20 1·5	29·696	20 9·5	29·845
11	21 4·0	30·101	20 3·0	30·043	19 0·0	30·146	19 3·0	29·835	19 8·0	29·696	19 11·0	29·844
Midnight	22 3·5	30·091	21 6·0	30·045	20 1·0	30·123	19 7·5	29·838	19 7·0	29·696	19 4·0	29·848
Mean ...	20 6·4	30·225	20 11·2	30·047	20 10·7	30·185	21 1·0	29·957	21 2·1	29·727	21 1·2	29·780

Hour.	November 19.		November 20.		November 21.		November 22.		November 23.		November 24.	
	Tide.	Barom.	Tide.	Barom.	Tide.	Barom.	Tide.	Barom.	Tide.	Barom.	Tide.	Barom.
A.M.	ft. in.	inches.	ft. in.	inches.	ft. in.	inches.	ft. in.	inches.	ft. in.	inches.	ft. in.	inches.
1	19 1·0	29·858	19 4·5	29·672	19 8·0	29·771	19 10·0	29·924	20 6·0	29·961	21 2·5	29·901
2	19 4·0	29·850	19 2·5	29·677	18 11·0	29·790	18 11·0	29·929	19 7·0	29·949	20 1·0	29·903
3	19 10·0	29·847	19 5·5	29·671	18 9·5	29·797	18 6·0	29·931	18 7·0	29·954	19 0·5	29·908
4	20 6·0	29·830	19 10·0	29·651	19 0·5	29·799	18 5·0	29·937	18 3·0	29·957	18 6·0	29·909
5	21 1·0	29·822	20 6·0	29·652	19 8·0	29·799	18 11·0	29·934	18 7·0	29·962	18 0·5	29·919
6	21 5·5	29·819	21 2·0	29·656	20 6·0	29·804	19 9·0	29·929	19 8·0	29·955	18 9·5	29·910
7	21 6·0	29·800	21 10·0	29·662	21 4·5	29·808	20 9·0	29·932	20 6·0	29·957	19 9·0	29·900
8	21 5·0	29·798	22 2·0	29·672	22 0·0	29·815	21 10·5	29·924	21 8·0	29·957	20 11·0	29·898
9	21 1·0	29·774	22 0·0	29·687	22 5·0	29·811	22 7·0	29·929	22 9·5	29·957	22 5·0	29·889
10	20 7·5	29·760	21 8·0	29·696	22 3·0	29·816	22 10·0	29·937	23 5·0	29·960	23 5·5	29·879
11	20 2·0	29·757	21 1·0	29·696	21 10·0	29·822	22 7·0	29·937	23 6·0	29·952	23 11·5	29·870
Noon	19 11·2	29·738	20 3·0	29·712	21 1·5	29·831	22 0·5	29·929	23 1·0	29·934	23 9·2	29·880
1	19 11·5	29·748	20 0·5	29·712	20 5·5	29·853	21 1·5	29·935	22 2·0	29·920	22 6·0	29·891
2	20 3·0	29·766	19 11·0	29·712	19 8·5	29·861	20 2·5	29·937	21 2·0	29·922	21 11·5	29·897
3	20 11·0	29·751	20 1·0	29·717	19 6·5	29·875	19 6·5	29·953	20 1·0	29·927	20 7·0	29·896
4	21 7·0	29·700	20 7·0	29·717	19 9·0	29·881	19 4·0	29·951	19 5·5	29·922	20 3·0	29·880
5	22 3·5	29·701	21 3·0	29·717	20 2·0	29·888	19 6·5	29·943	19 3·0	29·919	19 3·0	29·897
6	22 9·0	29·699	21 11·5	29·725	21 0·0	29·899	20 2·0	29·943	19 8·0	29·936	19 3·5	29·888
7	23 0·5	29·700	22 8·0	29·723	21 9·0	29·903	21 1·0	29·945	20 6·0	29·930	19 9·0	29·898
8	22 10·0	29·682	22 11·0	29·730	22 2·5	29·903	21 10·5	29·948	21 4·0	29·930	20 9·0	29·897
9	22 5·0	29·664	22 7·5	29·740	22 6·0	29·896	22 3·5	30·034	22 1·0	29·922	21 9·0	29·894
10	21 8·5	29·664	22 4·0	29·737	22 3·5	29·896	22 7·0	30·084	22 8·0	29·908	22 7·0	29·892
11	20 8·0	29·669	21 6·5	29·751	21 9·0	29·898	22 3·5	30·128	22 9·0	29·902	22 10·5	29·901
Midnight	20 0·0	29·669	20 7·5	29·777	20 11·0	29·913	21 7·0	30·006	22 2·0	29·898	22 10·0	29·908
Mean ...	21 0·2	29·753	21 0·5	29·703	20 9·8	29·847	21 2·3	29·953	20 11·2	29·937	21 0·2	29·896

Table I.—November 1848. (Continued.)

Hour.	November 25.		November 26.		November 27.		November 28.		November 29.		November 30.	
	Tide.	Barom.	Tide.	Barom.	Tide.	Barom.	Tide.	Barom.	Tide.	Barom.	Tide.	Barom.
A.M.	ft. in.	inches.	ft. in.	inches.	ft. in.	inches.	ft. in.	inches.	ft. in.	inches.	ft. in.	inches.
1	21 9·5	29·908	22 1·0	29·930	22 6·0	29·861	22 4·5	29·822	22 4·0	29·701	22 1·0	29·840
2	20 8·0	29·914	21 2·0	29·940	21 8·0	29·853	21 11·0	29·821	22 3·5	29·706	22 2·5	29·854
3	19 7·0	29·889	20 1·0	29·946	20 6·0	29·849	20 11·0	29·799	21 6·5	29·708	21 10·0	29·854
4	18 7·0	29·891	19 0·0	29·944	19 5·0	29·847	19 11·0	29·791	20 9·0	29·712	21 2·5	29·856
5	18 2·0	29·886	18 3·0	30·025	18 5·0	29·858	18 8·0	29·819	19 7·5	29·717	20 1·5	29·863
6	18 1·5	29·868	18 1·0	30·052	18 1·0	29·847	18 2·0	29·821	18 9·0	29·719	19 1·0	29·866
7	19 1·0	29·872	18 8·0	30·033	18 3·0	29·836	17 11·5	29·821	18 3·0	29·693	18 7·0	29·862
8	20 3·5	29·874	20 5·0	30·006	19 1·0	29·830	18 5·5	29·821	18 5·0	29·691	18 4·5	29·869
9	21 4·5	29·875	21 3·5	29·939	20 7·0	29·827	19 9·0	29·823	19 4·5	29·681	18 11·5	29·874
10	23 3·0	29·862	22 1·0	29·933	22 1·5	29·823	21 4·0	29·814	20 8·0	29·685	20 1·0	29·887
11	24 2·0	29·858	24 0·5	29·931	23 3·5	29·822	22 7·0	29·789	21 10·5	29·684	21 3·0	29·901
Noon	24 4·5	29·878	24 7·0	29·919	24 3·0	29·785	23 9·0	29·775	23 5·0	29·708	22 6·0	29·910
1	23 10·0	29·865	24 5·0	29·917	24 5·0	29·785	24 4·5	29·763	24 4·0	29·720	23 9·0	29·913
2	22 10·0	29·867	23 9·0	29·921	23 11·0	29·809	24 4·0	29·754	24 6·5	29·730	24 2·5	29·906
3	21 7·5	29·871	22 6·5	29·924	23 0·0	29·808	23 5·0	29·755	24 1·5	29·723	24 2·5	29·912
4	20 4·0	29·873	21 2·5	29·917	22 4·0	29·803	22 5·5	29·745	23 3·0	29·728	23 7·0	29·920
5	19 5·0	29·883	20 1·5	29·912	20 6·0	29·821	21 5·0	29·757	22 3·0	29·752	22 6·0	29·928
6	19 1·0	29·894	19 3·5	29·915	19 5·0	29·826	20 3·0	29·753	20 10·5	29·764	21 7·0	29·937
7	19 4·0	29·904	19 2·0	29·915	19 0·0	29·831	19 5·0	29·745	19 11·0	29·764	20 5·5	29·941
8	20 0·5	29·906	19 8·0	29·907	19 0·2	29·840	19 2·5	29·738	19 2·0	29·778	19 7·5	29·945
9	20 11·5	29·912	20 5·0	29·904	19 9·0	29·847	19 6·0	29·719	19 2·0	29·801	19 5·0	29·947
10	21 10·5	29·926	21 6·0	29·892	20 8·0	29·836	20 2·5	29·710	19 10·0	29·803	19 6·0	29·957
11	22 6·5	29·928	22 3·0	29·897	21 9·0	29·837	21 1·0	29·705	20 8·0	29·815	20 1·5	29·957
Midnight	22 7·5	29·928	22 6·5	29·850	23 1·0	29·837	22 0·0	29·698	21 6·0	29·821	20 10·5	29·962
Mean ...	21 0·0	29·889	21 1·3	29·936	21 0·5	29·830	20 11·6	29·773	21 1·5	29·733	21 1·1	29·903

December 1848.

Hour.	December 1.		December 2.		December 3.		December 4.		December 5.		December 6.	
	Tide.	Barom.	Tide.	Barom.	Tide.	Barom.	Tide.	Barom.	Tide.	Barom.	Tide.	Barom.
A.M.	ft. in.	inches.	ft. in.	inches.	ft. in.	inches.	ft. in.	inches.	ft. in.	inches.	ft. in.	inches.
1	21 7·0	29·959	20 11·5	29·919	20 3·5	29·983	19 10·0	29·886	19 0·5	29·815	18 10·0	29·835
2	21 11·2	29·966	21 7·0	29·930	21 0·0	29·971	20 3·5	29·859	19 4·5	29·811	18 7·5	29·860
3	21 11·0	29·978	21 11·0	29·932	21 6·0	29·967	20 11·0	29·864	19 10·5	29·810	18 10·0	29·877
4	21 6·0	29·980	21 9·0	29·938	21 10·0	29·946	21 6·0	29·865	20 6·0	29·803	19 6·0	29·896
5	20 9·0	29·997	21 2·0	29·934	21 9·0	29·938	21 8·0	29·867	21 0·0	29·808	20 3·0	29·939
6	19 11·0	30·002	20 7·5	29·947	21 4·5	29·935	21 10·0	29·869	21 5·5	29·797	21 1·0	29·943
7	19 1·0	30·000	19 10·0	29·961	20 9·5	29·931	21 8·5	29·876	21 7·0	29·799	21 9·0	29·964
8	18 8·0	30·162	19 2·0	29·975	20 2·5	29·935	20 10·5	29·864	21 6·0	29·784	22 0·5	29·962
9	18 10·0	29·971	19 0·0	29·979	19 7·0	29·933	20 5·0	29·861	21 1·5	29·784	21 10·0	29·967
10	19 6·0	29·958	19 2·5	29·989	19 4·0	29·934	20 0·5	29·859	20 8·0	29·780	21 6·0	29·976
11	20 6·5	29·957	19 10·5	30·002	19 6·0	29·954	19 10·5	29·846	20 3·0	29·772	20 9·0	29·995
Noon	21 8·0	29·952	20 10·0	30·018	20 1·5	29·947	20 0·0	29·826	19 11·0	29·776	20 0·5	30·007
1	22 10·5	29·953	21 11·5	30·041	21 0·5	29·950	20 6·0	29·826	19 9·5	29·750	19 6·0	30·021
2	23 9·0	29·953	22 10·0	30·041	22 0·5	29·950	21 3·0	29·830	20 0·5	29·758	19 3·5	30·039
3	24 1·5	29·950	23 6·5	30·049	22 9·5	29·949	22 0·0	29·822	20 9·0	29·773	19 8·0	30·045
4	23 10·5	29·945	23 8·0	30·051	23 4·0	29·949	22 5·5	29·837	21 3·5	29·778	20 2·5	30·055
5	23 2·5	29·937	23 5·5	30·057	23 4·0	29·950	22 11·5	29·824	22 2·0	29·788	20 10·5	30·061
6	22 5·5	29·914	22 9·0	30·053	23 1·0	29·939	23 2·0	29·824	22 8·0	29·789	21 8·5	30·079
7	21 2·5	29·912	21 11·0	30·048	22 11·0	29·929	22 9·0	29·824	22 10·5	29·793	22 6·0	30·078
8	20 6·5	29·907	21 0·0	30·053	21 7·0	29·931	22 3·0	29·824	22 7·5	29·811	22 8·5	30·084
9	19 9·0	29·902	20 2·0	30·068	20 9·0	29·911	21 5·0	29·826	22 0·0	29·799	22 5·0	30·097
10	19 8·0	29·910	19 9·0	30·044	19 11·0	29·891	20 5·0	29·822	21 2·5	29·801	21 9·0	30·096
11	20 0·5	29·902	19 8·0	29·995	19 6·0	29·898	19 8·5	29·822	20 2·5	29·818	20 10·0	30 094
Midnight	20 5·0	29·904	19 10·0	30·010	19 5·0	29·891	19 3·0	29·813	19 3·5	29·822	19 9·0	30·111
Mean ...	21 1·9	29·957	21 1·2	30·002	21 1·5	29·938	21 1·3	29·843	20 10·6	29·792	20 8·1	30·001

TABLE I.—December 1848. (Continued.)

Hour.	December 7.		December 8.		December 9.		December 10.		December 11.		December 12.	
	Tide.	Barom.	Tide.	Barom.	Tide.	Barom.	Tide.	Barom.	Tide.	Barom.	Tide.	Barom.
A.M.	ft. in.	inches.	ft. in.	inches.	ft. in.	inches.	ft. in.	inches.	ft. in.	inches.	ft. in.	inches.
1	18 9·0	30·122	19 4·0	30·054	20 10·0	29·738	21 9·0	29·828	22 6·0	29·909	23 1·5	29·870
2	18 2·0	30·142	18 0·0	30·061	19 6·0	29·743	20 4·0	29·849	21 2·0	29·910	22 4·0	29·883
3	18 1·0	30·141	17 11·0	30·056	18 4·5	29·745	18 9·0	29·854	19 8·0	29·914	21 0·0	29·891
4	18 6·0	30·151	17 11·0	30·043	17 9·5	29·751	17 9·0	29·856	18 5·0	29·896	19 6·0	29·901
5	19 4·0	30·146	18 8·0	30·035	17 11·0	29·753	17 3·5	29·873	17 3·5	29·917	18 2·0	29·888
6	20 4·0	30·145	19 7·5	30·032	18 8·5	29·755	17 7·0	29·887	16 11·5	29·912	17 2·0	29·888
7	21 5·0	30·147	21 0·5	30·010	20 2·0	29·758	18 3·0	29·891	17 8·0	29·914	17 1·5	29·893
8	22 3·0	30·139	22 5·5	29·987	21 10·0	29·755	20 5·5	29·895	19 1·0	29·901	18 0·0	29·896
9	22 9·0	30·132	23 2·5	29·966	23 6·0	29·750	22 3·0	29·900	20 10·5	29·867	19 9·5	29·888
10	22 6·0	30·132	23 11·0	29·953	24 4·0	29·754	23 11·0	29·914	23 0·5	29·866	21 9·5	29·785
11	21 11·0	30·130	23 8·5	29·921	24 9·0	29·751	24 10·0	29·912	24 4·0	29·865	23 8·0	29·787
Noon	21 0·0	30·123	22 6·5	29·911	24 3·0	29·745	24 11·5	29·914	25 4·0	29·862	25 0·0	29·889
1	20 2·0	30·124	21 10·0	29·899	23 11·0	29·755	24 3·0	29·917	25 3·0	29·858	25 3·5	29·886
2	19 5·0	30·117	20 7·5	29·881	21 10·0	29·768	23 0·0	29·924	24 2·0	29·862	25 0·5	29·895
3	19 2·0	30·115	19 10·0	29·856	20 6·0	29·755	21 4·0	29·928	22 10·5	29·860	24 2·0	29·894
4	19 5·0	30·115	19 5·0	29·849	19 6·0	29·769	20 2·0	29·924	21 1·0	29·869	22 7·5	29·898
5	20 0·0	30·111	19 5·0	29·820	19 1·0	29·781	18 11·0	29·927	19 6·0	29·862	20 10·0	29·903
6	20 10·0	30·109	20 1·0	29·814	19 3·0	29·780	18 4·0	29·938	18 7·0	29·867	19 4·0	29·901
7	21 8·5	30·108	20 11·0	29·803	19 10·0	29·782	18 8·0	29·940	18 5·0	29·862	18 5·0	29·906
8	22 3·5	30·106	22 1·0	29·792	20 10·5	29·793	19 7·0	29·966	18 10·5	29·862	18 4·0	29·909
9	22 8·0	30·099	22 10·0	29·746	22 2·5	29·795	20 10·0	29·926	19 11·0	29·869	18 7·0	29·908
10	22 6·0	30·095	23 4·0	29·728	23 0·0	29·793	22 0·5	29·924	21 4·0	29·874	20 1·0	29·900
11	21 8·0	30·085	23 0·0	29·728	23 3·5	29·805	22 11·5	29·929	22 5·0	29·867	21 3·0	29·910
Midnight	20 7·0	30·079	22 2·0	29·733	22 10·0	29·822	23 0·0	29·908	23 1·5	29·868	22 8·0	29·930
Mean ...	20 7·7	30·121	20 11·9	29·903	21 2·0	29·766	20 10·6	29·905	20 11·0	29·879	20 11·6	29·887

Hour.	December 13.		December 14.		December 15.		December 16.		December 17.		December 18.
	Tide.	Barom.	Tide.	Barom.	Tide.	Barom.	Tide.	Barom.	Tide.	Barom.	
A.M.	ft. in.	inches.	ft. in.	inches.	ft. in.	inches.	ft. in.	inches.	ft. in.	inches.	
1	22 11·0	29·914	22 7·0	29·847	21 10·5	29·736	20 9·0	29·762	19 10·0	29·936	Tide-pole frozen into the ice, and lifted with the rising tide above 4 inches.
2	22 10·0	29·910	23 0·5	29·833	22 7·0	29·726	21 8·5	29·769	20 8·0	29·942	
3	21 11·0	29·915	22 9·5	29·825	22 9·5	29·718	22 3·0	29·776	21 5·0	29·953	
4	20 7·5	29·911	21 10·0	29·823	22 6·5	29·721	22 5·0	29·778	21 11·0	29·965	
5	19 0·0	29·926	20 6·5	29·805	21 7·5	29·717	22 1·0	29·788	21 10·0	29·961	
6	17 11·0	29·925	19 4·5	29·808	20 7·0	29·715	21 4·0	29·802	21 6·0	29·968	
7	17 8·0	29·911	18 3·0	29·808	19 6·0	29·710	20 6·0	29·797	21 1·0	29·982	
8	17 5·0	29·899	17 11·0	29·808	18 10·0	29·711	19 5·0	29·808	20 6·0	29·995	
9	18 6·0	29·894	18 5·0	29·793	18 9·0	29·705	19 2·5	29·805	19 11·5	30·010	
10	20 3·0	29·878	19 4·0	29·783	19 1·0	29·710	19 0·0	29·803	19 6·0	30·028	
11	22 2·0	29·875	21 1·0	29·776	20 1·0	29·710	19 6·0	29·812	19 5·5	30·043	
Noon	23 10·5	29·875	22 9·0	29·774	21 3·0	29·707	20 5·5	29·827	19 8·0	30·050	
1	25 1·0	29·886	24 3·0	29·792	22 11·0	29·697	21 6·0	29·845	20 1·0	30·075	
2	25 5·0	29·895	25 1·0	29·823	24 1·0	29·705	22 9·0	29·848	21 2·0	30·094	
3	25 0·0	29·878	25 1·0	29·802	24 10·0	29·700	23 8·5	29·849	22 1·2	30·106	
4	23 11·0	29·872	24 8·0	29·800	24 8·0	29·692	24 0·5	29·858	22 8·5	30·101	
5	22 3·5	29·890	23 7·0	29·784	24 2·0	29·711	23 11·0	29·859	23 1·0	30·111	
6	20 11·0	29·889	22 6·0	29·771	23 0·5	29·719	23 2·5	29·873	22 10·5	30·120	
7	20 3·0	29·885	20 7·0	29·769	21 8·0	29·731	22 3·0	29·883	22 1·0	30·120	
8	18 6·0	29·879	19 5·5	29·758	20 3·0	29·727	21 2·5	29·883	21 7·0	30·128	
9	18 7·0	29·863	18 9·0	29·761	19 5·5	29·742	20 0·0	29·902	20 7·0	30·136	
10	19 1·0	29·853	18 11·0	29·743	19 2·0	29·740	19 4·0	29·908	19 8·0	30·148	
11	20 4·5	29·847	19 8·0	29·739	19 5·0	29·740	19 0·0	29·922	19 2·0	30·140	
Midnight	21 8·0	29·827	20 9·0	29·736	19 11·0	29·742	19 3·5	29·930	18 11·0	30·144	
Mean ...	21 1·0	29·887	21 3·6	29·790	21 4·5	29·718	21 2·4	29·837	20 10·7	30·052	

Explanation of Tables A. and B. which follow:—

From the preceding Tables, the arithmetic mean of the hourly observations of the height of the sea for each day is taken as the mean level of the ocean for that day, and the mean of the hourly observed heights of the barometer as the corresponding mean pressure of the atmosphere; these mean levels, and corresponding mean pressures, are brought together in the following Table A., arranged in the order of the days of observation.

In Table B., commencing with the day of greatest mean pressure, they are arranged in the order of the mean heights of the barometer, with the corresponding mean levels, without regard to the dates of observation, for the purpose of showing the dependence the latter have on the former.

In the diagram of curves which is formed from Table A., the abscissæ represent the days of the month, from the 1st of November to the end of December 1848; the ordinates in the upper half of the diagram the observed mean level of the ocean, and in the lower half the corresponding mean height of the barometer on each day during that period.

TABLE A.

Date. 1848.	Observed level.		Observed Barom.
	ft.	in.	inches.
Nov. 1.	20	9·9	30·101
2.	21	4·4	29·683
3.	21	8·3	29·351
4.	21	3·5	29·643
5.	20	9·7	30·168
6.	20	8·1	30·270
7.	20	9·2	30·123
8.	21	0·4	29·756
9.	21	0·4	29·706
10.	21	0·7	29·759
11.	20	10·0	29·894
12.	20	11·7	30·064
13.	20	6·4	30·225
14.	20	11·2	30·047
15.	20	10·7	30·185
16.	21	1·0	29·957
17.	21	2·1	29·727
18.	21	1·2	29·780
19.	21	0·2	29·753
20.	21	0·5	29·703
21.	20	9·8	29·847
22.	21	2·3	29·953
23.	20	11·2	29·937
24.	21	0·2	29·896
25.	21	0·0	29·889
26.	21	1·3	29·936
27.	21	0·5	29·830
28.	20	11·6	29·773
29.	21	1·5	29·733
30.	21	1·1	29·903
Dec. 1.	21	1·9	29·957
2.	21	1·2	30·002
3.	21	1·5	29·938
4.	21	1·3	29·843
5.	20	10·6	29·792
6.	20	8·1	30·001
7.	20	7·7	30·121
8.	20	11·9	29·903
9.	21	2·0	29·766
10.	20	10·6	29·905
11.	20	11·0	29·879
12.	20	11·6	29·887
13.	21	1·0	29·887
14.	21	3·6	29·790
15.	21	4·5	29·718
16.	21	2·4	29·837
17.	20	10·7	30·052

TABLE B.

Date. 1848.	Observed Barom.	Observed level.		Correc-tions.	True level.		Remarks.
	inches.	ft.	in.	inches.	ft.	in.	inches.
Nov. 6.	30·270	20	8·1	+5·24	21	1·34	Barom. .....30·227
Nov. 13.	30·225	20	6·4	+4·64	20	11·04	ft. in.
Nov. 15.	30·185	20	10·7	+4·11	21	2·81	Level .....20 8·4
Nov. 5.	30·168	20	9·7				Correction ... +4·66
Nov. 7.	30·123	20	9·2			3·19	Corrected level...21 1·06
Dec. 7.	30·121	20	7·7	Mean ...	21	1·06	
Nov. 1.	30·101	20	9·9				
Nov. 12.	30·064	20	11·7				
Dec. 17.	30·052	20	10·7				
Nov. 14.	30·047	20	11·2				
Dec. 2.	30·002	21	1·2				
Dec. 6.	30·001	20	8·1				
Nov. 16.	29·957	21	1·0				
Dec. 1.	29·957	21	1·9				
Nov. 22.	29·953	21	2·3				
Dec. 3.	29·938	21	1·5				
Nov. 23.	29·937	20	11·2				
Nov. 26.	29·936	21	1·3				
Dec. 10.	29·905	20	10·6				
Nov. 30.	29·903	21	1·1				
Dec. 8.	29·903	20	11·9				
Nov. 24.	29·896	21	0·2				
Nov. 11.	29·894	20	10·0				
Nov. 25.	29·889	21	0·0	.....	.....		
Dec. 12.	29·887	20	11·6	.....	.....		
Dec. 13.	29·887	21	1·0	.....	.....		inches. Barom. .....29·867
Dec. 11.	29·879	20	11·0	.....	.....		ft. in.
Nov. 21.	29·847	20	9·8	.....	.....		Level.....21 0·16
Dec. 4.	29·843	21	1·3	.....	.....		
Dec. 16.	29·837	21	2·4	.....	.....		
Nov. 27.	29·830	21	0·5				
Dec. 5.	29·792	20	10·6				
Dec. 14.	29·790	21	3·6				
Nov. 18.	29·780	21	1·2				
Nov. 28.	29·773	20	11·6				
Dec. 9.	29·766	21	2·0				
Nov. 10.	29·759	21	0·7				
Nov. 8.	29·756	21	0·4				
Nov. 19.	29·753	21	0·2				
Nov. 29.	29·733	21	1·5				
Nov. 17.	29·727	21	2·1				
Dec. 15.	29·718	21	4·5				
Nov. 9.	29·706	21	0·4				
Nov. 20.	29·703	21	0·5				inches.
Nov. 2.	29·683	21	4·4	−2·53	21	1·87	Barom. .....20·559
Nov. 4.	29·643	21	3·5	−3·05	21	0·45	ft. in.
Nov. 3.	29·351	21	8·3	−7·02	21	1·28	Level .....21 5·4
Mean ...	29·874	21	0·21			·60	Correction ... −4·17
				Mean ...	21	1·2	Corrected level..21 1·23

The result of these forty-seven days of hourly observations gives for the mean height of the barometer 29·874 inches, and the mark of the mean level of the ocean 21 feet 0·21 inch.

In order to avoid the effects of accidental irregularities, the means of the three days of greatest and of least pressure are taken to compare with the mean level of

the ocean on the corresponding days, and from the difference of the pressures and the difference of the levels to determine the relation of each to the other.

	inches.		ft.	in.
The mean of three days' greatest pressure was	30·227	Of corresponding level	20	8·4
The mean of three days' least pressure was.....	29·559	Of corresponding level	21	5·4
Difference.....	·668	Difference.....		9·0

Thus a difference of pressure equal to ·668 of an inch in the barometer, produces a difference of 9 inches in the mean level of the ocean, from which we can of course readily compute the exact relation of cause and effect. Thus the difference of level, 9 inches, divided by the difference of pressure 0·668 of an inch, equals 13·467. The effect, therefore, of the pressure of the atmosphere on the level of the ocean is 13·467 times greater than the effect it produces on the mercury in the barometer, or very nearly in the inverse ratio of the specific gravity of the two bodies; that of the sea-water being 1·026, and that of mercury 13·566, or as 1 to 13·224.

This remarkable coincidence of the results must, however, in this case be considered in a great measure accidental, for if instead of the three days' greatest and least pressure we were to take seven days of each, from which a better result might be expected, we find, instead of the ratio being as 1 to 13·467, it would by these means become as 1 to 12·562; and if we take the mean of twelve highest and twelve lowest barometers, the ratio would be still further reduced as 1 to 11·60; but these differences in the result are chiefly caused by the evident irregularities of the mean level on the 9th and 20th of November, occasioned by a heavy gale of wind, in each case of two days' continuance. This circumstance, although accounted for in this particular instance, seems to indicate the necessity of multiplying observations of this nature before exact results can be determined.

I may here remark, that the effect produced appears from these observations to be strictly uniform in its progression from the greatest to the least pressure. By combining the mean of the three days' observations of next greater and three days of less pressure with that nearest to the mean pressure for the whole period, we find the result corresponds nearly with the mean pressure, and the ratio between the extremes almost equal; thus, on December 11, the mean pressure was 29·879, differing very little from the mean of the whole period; and the three days' observations above and below combined with it, give a mean of 29·867, the corresponding mean level of the seven days being 21 ft. 0·16 in., which so closely approaches that of the whole period, that they may be deemed identical, and would tend to show that the effect from the greatest to the mean pressure, and from the mean to the least pressure, is in strict progression. It is not possible, however, from so limited a number of observations, to determine this point with certainty, or to attempt any intermediate inferences.

We have, from these observations, been able to deduce results which plainly point to the law which governs the effect of the pressure of the atmosphere on the

mean level of the ocean, and may be encouraged to pursue the investigation through a more extended series of observations, in order that we may at length arrive at the most accurate conclusion that the observed facts may justify.

For all practical purposes, it may in the mean time be well to assume, what the preceding observations seem to indicate, that the ocean is a water barometer on a vast scale of magnificence, and that the level of its surface is disturbed by every variation of atmospheric pressure, inversely as the mercury in the barometer, and exactly in the ratio of the relative specific gravities of the water and the mercury. And as all observations of the tides, before they can be safely employed to investigate the laws by which they are governed, should in the first place be corrected for the large and hitherto mysterious irregularities which the variations in the pressure of the atmosphere produce, the following formula may be used to determine the correction z to be applied to all observations of the height of the tide, or the mean level of the ocean deduced from them, to reduce them to the mean pressure of the atmosphere.

$$(1)\ z=(B-\beta)D, \text{ or } (2)\ L=\lambda\pm(B-\beta)D,$$

positive when β is greater than B, and negative when less.

In which B denotes the mean pressure of the atmosphere.
L the correct height of the tide or mean level of the ocean.
D the relative specific gravity of sea-water and mercury.
λ the observed height of the tide or observed level of the ocean.
β the corresponding height of the barometer.

And if we assume B=29·874 inches, the mean of the preceding observations; L=21 ft. 0·21 inch, the mean of the preceding observations; and D=13·224, we can readily compute the correction z to be applied to any observed tide, having the corresponding height of the barometer. For example, on the 3rd November the mean barometer for the day was β 29·351 inches, and the corresponding mean level of the sea λ=21 ft. 8·3 inches; then $B-\beta\times D=-6{\cdot}92$, which applied to λ= 21 ft. 1·38 inch; and on the 13th November the mean barometer was β 30·225 inches, and the corresponding observed level λ=20 ft. 6·4 inches; again, $B-\beta\times D=+4{\cdot}64$ added to λ=20 ft. 11·04 inches.

On these two days the observed level of the ocean differed no less than 14 inches; but by the application of the correction found by the above formula, the observed level in each day is brought to agree with the true mean level to little more than 1 inch. I may further observe, that much greater irregularities are to be hereafter noticed in the more extensive series of observations which followed this, and by the same formula are capable of being reduced to an equally near accordance with the mean level, as deduced from the whole of the observations.

Thus it is evident that one of the many causes of the apparent irregularities of the tides (and at Port Leopold certainly the greatest of all) is clearly traceable to a well-established and invariable law.

Postscript.

When this paper was drawn up some years ago I was ignorant of the researches of M. Daussy on the same subject, or the confirmation of his discovery by Sir John Lubbock, whose valuable treatise on the Tides having been long out of print is, unfortunately, too little known to naval officers. Dr. Whewell directed my attention to it when I mentioned to him the result of my deductions from the observations at Port Leopold, and although the investigations of these eminent philosophers relate only to the effect of the pressure of the atmosphere on the height of high water, and differ widely in their results, owing to the localities in which the observations were made being unfavourable for the detection of the universal law which governs the amount of apparent irregularities, I have extracted from Sir John Lubbock's work a paragraph which clearly shows the exact state of the question previous to my investigations. He says, p. 48, "M. Daussy has ascertained that at Brest the height of the high water varies inversely as the height of the barometer, and that the British Channel there rises more than 8 inches for a fall of about half an inch in the barometer. I have found that at Liverpool a fall of a tenth of an inch in the barometer corresponds to a rise in the River Mersey of about an inch, and that at the London Docks a fall of one-tenth of an inch in the barometer corresponds to a rise in the River Thames of about seven-tenths of an inch. So that with a low barometer the tides may be expected to be high, and *vice versâ cæteris paribus.*"

Thus M. Daussy found the height of high water to be affected

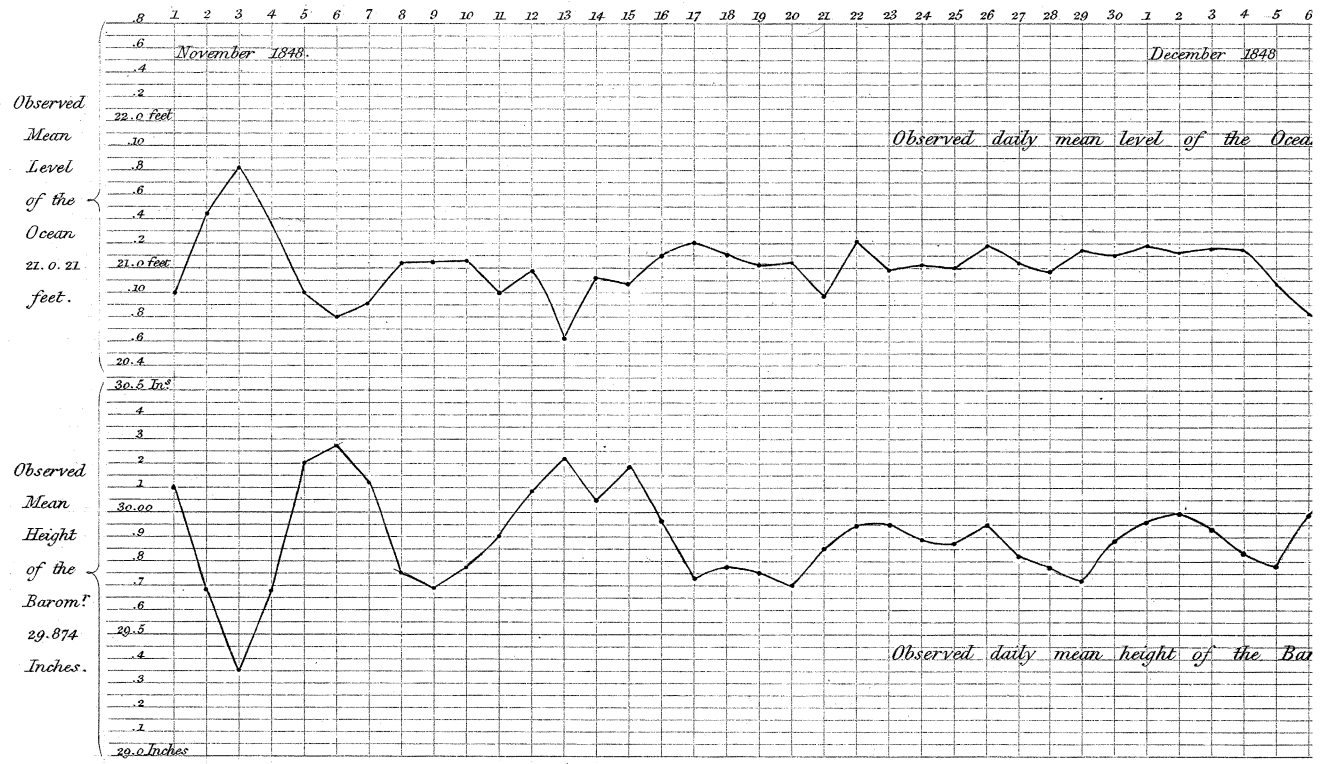
At Brest in the ratio of	1 : 16
Sir John Lubbock at Liverpool . . .	1 : 10
And at London	1 : 7

The results of their investigations at these three places differed so much from each other, that their practical application became limited to the correction of the height of high water at the places where the observations were made.

The result of the deductions from the observations at Port Leopold is, I have no doubt, of more universal application in all harbours where the ocean has free ingress and egress, as a comparison with the extensive series of tidal observations made at New Zealand, Cape Horn and the Falkland Islands, during my voyage to the Antarctic Seas in 1839 to 1843, tends to show. But the subject is well worthy of investigation in other localities, as doubtless a different ratio will be found to obtain in proportion as the ingress of the waters of the ocean is free, or obstructed by narrow channels or sand-banks.

J. C. R.

Aston-Abbott's House, Aylesbury,
November 6, 1854.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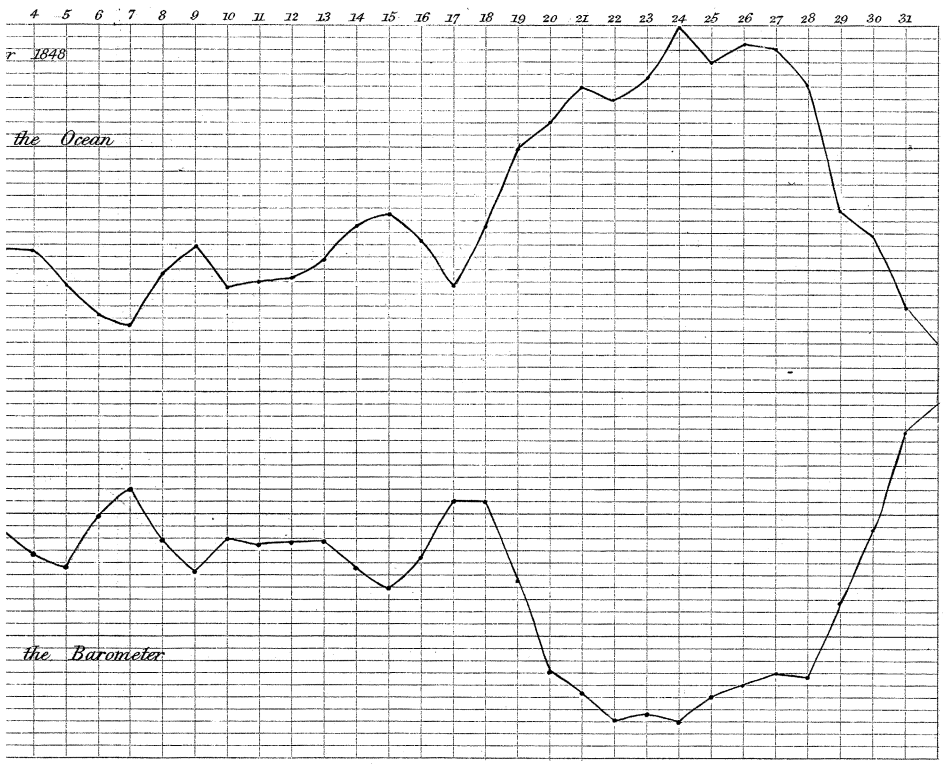
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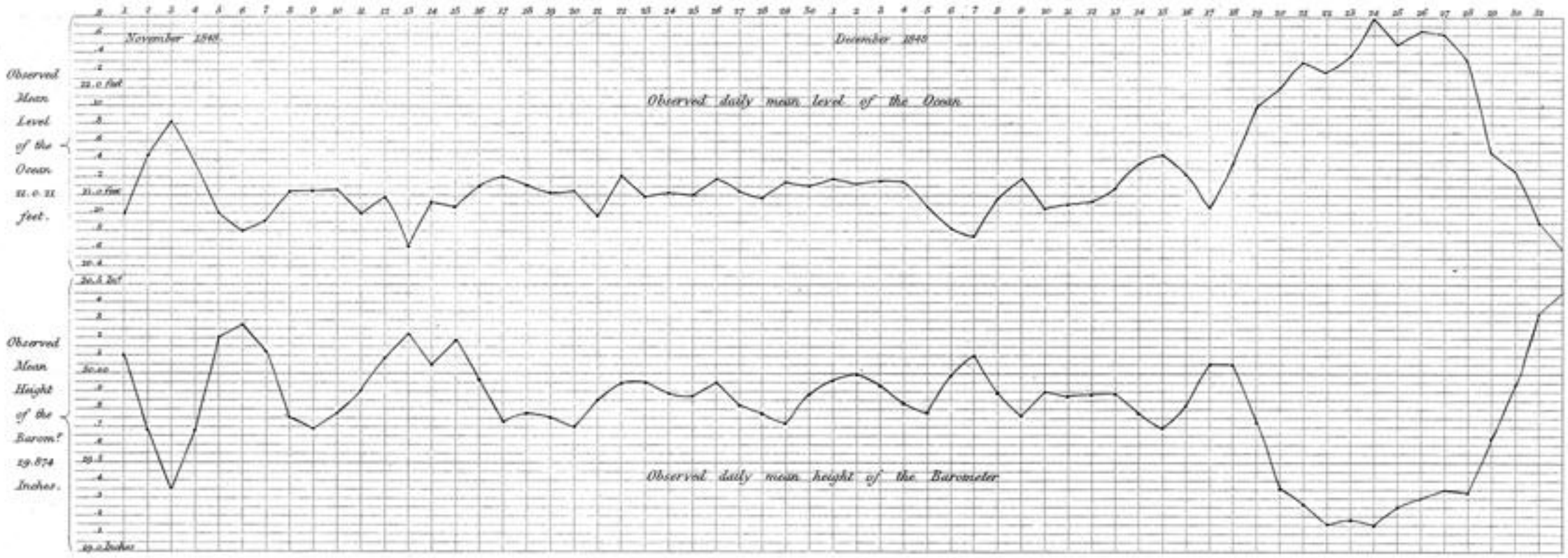
J. Basire sc.


November 1848.
December 1848.
Observed daily mean level of the Ocean.
Observed daily mean height of the Barometer.
Observed Mean Level of the Ocean. 22. 0 feet.
Observed Mean Height of the Barom.r 29.874 Inches.
22. 0 feet
21. 0 feet
20. 8
20. 0 Inches
29. 0 Inches

J. Basire sc.