rule of similar movements at all the stations occurred on the 14th and 15th of February. From 10 A.M. of the 14th to 10 P.M. of the 15th, the mercury fell nearly 0·3 (three tenths) of an inch at Simla; no other fall of nearly equal amount occurred within the same space of time during the three months under consideration; yet this, the largest of all the atmospheric disturbances, was apparently unfelt at Madras and Singapore. On examining the weather registers at the three stations, it was found that there was a great thunderstorm at Simla, which began on the horizon on the 14th of February and continued throughout the 15th. There was nothing unusual at the other stations.

As the daily mean height of the barometer was less on Monday at noon than on Saturday at noon at Simla, the fall of the mercury probably continued during Sunday the 16th. This great atmospheric disturbance lasting during three days was not propagated even to Madras, the nearest station; while the smallest of the other movements, some less than 0·01 (one hundredth) of an inch, were felt nearly equally well, and nearly simultaneously, at all the three stations.

We see here a distinction between local causes of atmospheric disturbance and that other cause which produces so many nearly simultaneous movements; it is also easily understood that the larger deviations, of 16 or 24 hours, from absolute simultaneity may be due to similar though much smaller superposed local disturbances, a fact which an examination of the weather registers confirms.

On the other hand, the great continuous fall of the barometer at all the three stations, from the 19th to the 24th March, does not appear to have been accompanied by any other unusual atmospheric change at any one of the three stations.

V. "Supplementary Note on Simultaneous Barometric Variations." By J. A. Broun, F.R.S. Received June 20, 1876.

[Plate 1.]

It has been pointed out in the preceding note that as we leave the tropics and approach the higher latitudes we find greater apparent irregularity in the variations of the barometric height from day to day; these irregularities are due, I believe, to different causes—one being a change in the amount, and even in the direction, of the action of the cause which produces so frequently within the tropics similar and simultaneous movements. This change depends probably on local conditions which affect the medium through which the actions are produced. Other causes are to be found which produce variations in the mass of air above the barometer. It is not to be expected, then, that the agreement shown generally in the barometric movements at the Indian stations would appear were the investigation extended to higher latitudes; at the

same time the great similarity which has presented itself between the movements at St. Helena and at the Indian stations during the week March 31 to April 5, 1845, induced me to make a comparison for that week with the barometric movements at the Cape of Good Hope, nearly in the same longitude as St. Helena.

The results of this comparison were so important that observations at other stations were also examined.

The geographical coordinates of the different stations considered are as follow :—

Stations.	Latitude.	Longitude from Greenwich.	Height above Sea.
	° ′	h m	feet.
1. Hobarton	42 52 S.	9 50 E.	105 *
2. Pekin	39 54 N.	7 46 E.	Few †
3. Cape of Good Hope	33 56 S.	1 14 E.	,, *
4. St. Helena	15 57 S.	0 23 W.	1764 *
5. Makerstoun	55 35 N.	0 10 W.	213 ‡
6. Singapore	1 19 N.	7 16 E.	Few §
7. Madras	13 4 N.	5 21 E.	30 §
8. Simla	31 6 N.	5 9 E.	7096 §
9. Catherinenburg	56 50 N.	4 2 E.	1000 ? †
10. Bogoslowsk	59 45 N.	4 0 E.	1400 ? †

The observations made at these stations during the week March 31 to April 5 were discussed in the same manner as before, so as to obtain the daily means corresponding to each hour or two hours ‖.

The daily means thus obtained are projected, Plate 1. Since the daily movements were found much smaller within the tropics than in high latitudes, the curves are projected on different scales to make the variations equally distinct ¶. The following are the principal conclusions from these projections.

All the curves show a maximum near the beginning and another near the end of the week, with a minimum near the middle. The turning-points occur in the following order at the different stations :—

* 1, 3, 4. Observations made at the Mag. and Met. Obs. at Hobarton in Van Diemen Island, at the Cape of Good Hope, and at St. Helena, printed under the superintendence of Colonel E. Sabine.

† 2, 9, 10. Annuaire Mag. et Mét. publiées par A. T. Kupffer, Année 1845.

‡ 5. Observations in Mag. and Met. Edited by John Allan Broun. Trans. Roy. Soc. Edin. vol. xix.

§ Previously cited.

‖ At Pekin the observations were made two-hourly from 5^h A.M. to 9^h P.M., and the barometric heights for 11^h P.M., and 1^h and 3^h A.M. were found by interpolation for this discussion: similarly for Bogoslowsk, where observations were made from 8^h A.M. to 10^h P.M., the heights for the even hours from midnight to 6^h A.M. were obtained by interpolation.

¶ It should again be remarked that the hours at the head of the vertical lines are the local hours for each station: the vertical line corresponding to 12^h April 2^d, Greenwich mean time, is marked with an asterisk for each curve.

Stations.	Max. local time.	Stations.	Min. local time.	Stations.	Max. local time.
	d h		d h		d h
Madras	Mar. 30 20	Hobarton .	Apr. 2 10	Hobarton .	Apr. 4 7
St. Helena.........	,, 31 4½	Cape	,, 2 12	Pekin	,, 4 8?
Singapore	,, 31 8	Simla	,, 2 12	Cape	,, 4 11
Cape of G. Hope .	,, 31 9	Cather. ...	,, 2 12	Makers. ...	,, 4 16
Makerstoun	,, 31 11	Pekin	,, 2 14	Madras ...	,, 4 18½
Hobarton	,, 31 15	Singapore .	,, 2 19	Singapore .	,, 4 19
Pekin	,, 31 16	Madras ...	,, 2 19	Bogos. ...	,, 4 23
Simla	,, 31 23	Bogos. ...	,, 2 19	Simla	,, 5 0
Catherinenburg...	Apr. 1 3	St. Helena.	,, 3 1	Cather. ...	,, 5 3
Bogoslowsk	,, 1 9	Makers. ...	,, 3 8	St. Helena.	,, 5 12?

At Madras a secondary maximum appears at $31^d\ 19^h$, agreeing nearly with the mean of the epochs for Pekin and Simla. At Pekin a marked maximum occurs at $5^d\ 18^h$; the time given above refers to the inflection corresponding with the secondary maximum at Hobarton: the principal maximum at the latter station occurs nearly 24 hours later.

It will be seen that the succession is different for the different turning-points, so that no general law of precedence can be deduced relatively either to latitude or longitude.

The movements for the two most easterly stations, Hobarton and Pekin, have been projected first; and as the difference of latitudes is nearly 83°, the agreement of the two curves will appear very remarkable. The first maximum and the following minimum occur nearly simultaneously at the two places; while even the secondary maximum and minimum which follow at Hobarton are seen at Pekin in a distinct inflection, the mercury rising thereafter to a maximum at both stations.

At the Cape of Good Hope the curve is very regular with two equal branches, having the maxima and the minimum within a few hours of those for Hobarton and Pekin.

The curves for St. Helena and Makerstoun, the two most westerly stations, have been projected together; at both the minimum occurs later than at the other stations*.

* Differences were expected to be the rule and not the exception in this investigation, and it has not been thought necessary to give curves for some stations merely to show that such differences exist; as, however, the movements have been examined by me, I shall note that at St. Petersburg the first maximum occurs at the same time as at Bogoslowsk, which is nearly in the same latitude, but the second maximum occurs 12 hours and the minimum 24 hours later at the former than the latter station. Also at Nertchinsk, 11° north of Pekin, the first maximum occurs 4 hours later than at Madras, and the second maximum (at $5^d\ 5^h$) 8 hours later than at Catherinenburg (7 hours earlier than the last maximum at Pekin); but the principal minimum occurs 24 hours *before* that at Pekin, and is followed by a secondary maximum and minimum not shown at the other stations. In general at European stations the minimum appears to be retarded as at Makerstoun. At Toronto there are three maxima and three minima during the week. The object of this note has been to show the general action of the same cause over the earth; the deviations from the same types must be the subject of other researches.

When we consider the ranges of the oscillations at the different stations we find them to be as follows :—

Stations.	1st Max. to Min.	Min. to 2nd Max.
	in.	in. in.
Hobarton	0·397	0·146 or 0·600?*
Pekin	0·430	0·108?,, 0·244 *
Cape of Good Hope	0·305	0·294
Catherinenburg.....	0·343	0·475
Bogoslowsk	0·269	0·410
Makerstoun	0·189	0·145
St. Helena..................	0·070	0·050 ?
Singapore	0·083	0·054
Madras	0·069	0·059
Simla	0·066	0·103

Thus Simla, though in nearly as high a latitude as the Cape of Good Hope, belongs by the range to the tropical series.

It is of much importance to observe that we have here to deal with the great atmospheric movements experienced in high latitudes. Thus the change of observed barometric height from minimum to maximum at Catherinenburg was nearly 0·6 inch; while at Makerstoun, though the variation of the *daily mean* pressure was less than at the other

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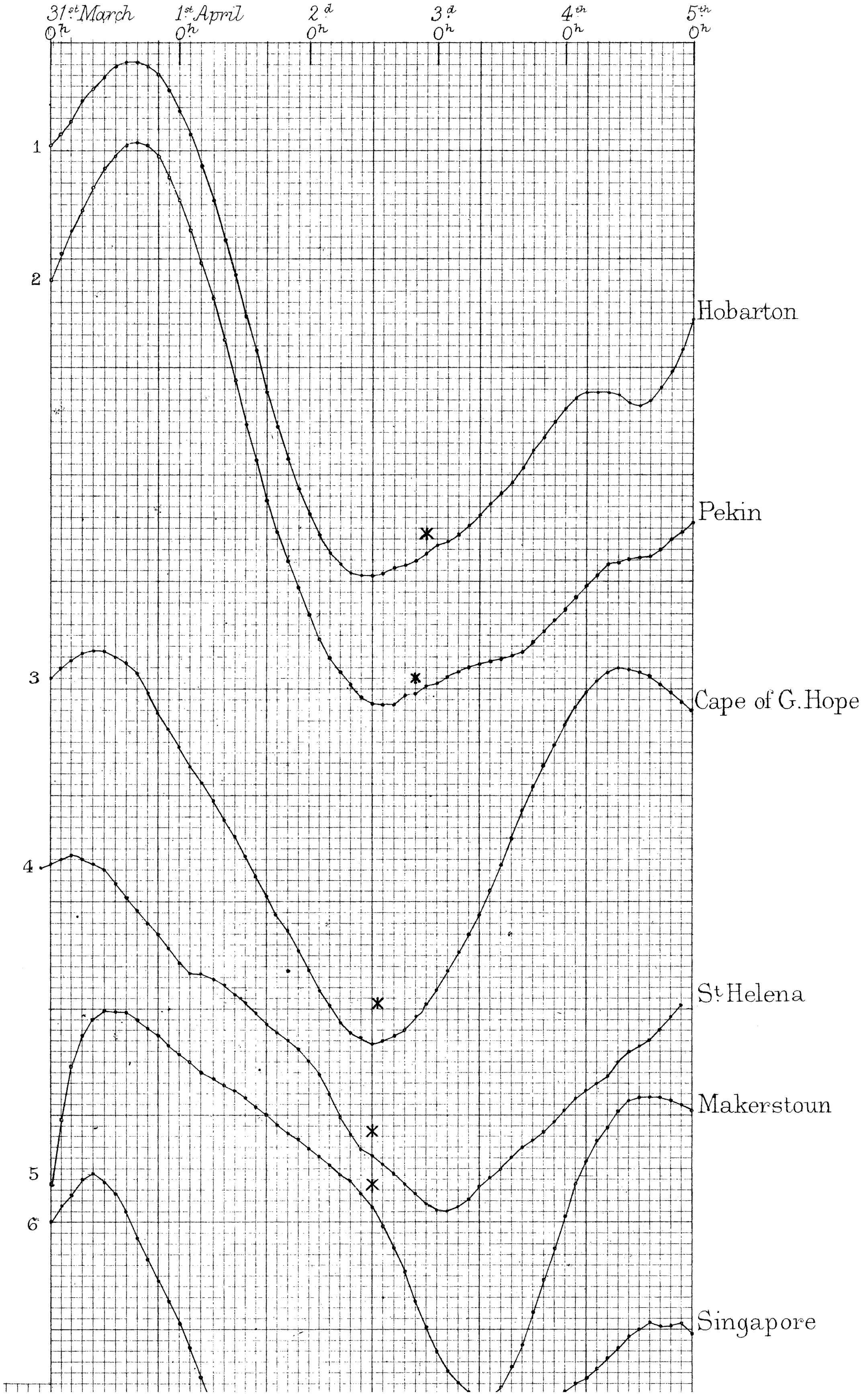
POSTSCRIPT, received 1st July.—Since writing the preceding note I have examined the barometric observations made at Sitka (latitude 57° 3′ N., longitude 14^h 58^m east of Greenwich). I find that there are two minima and two maxima within the week under consideration; these are as follow:—

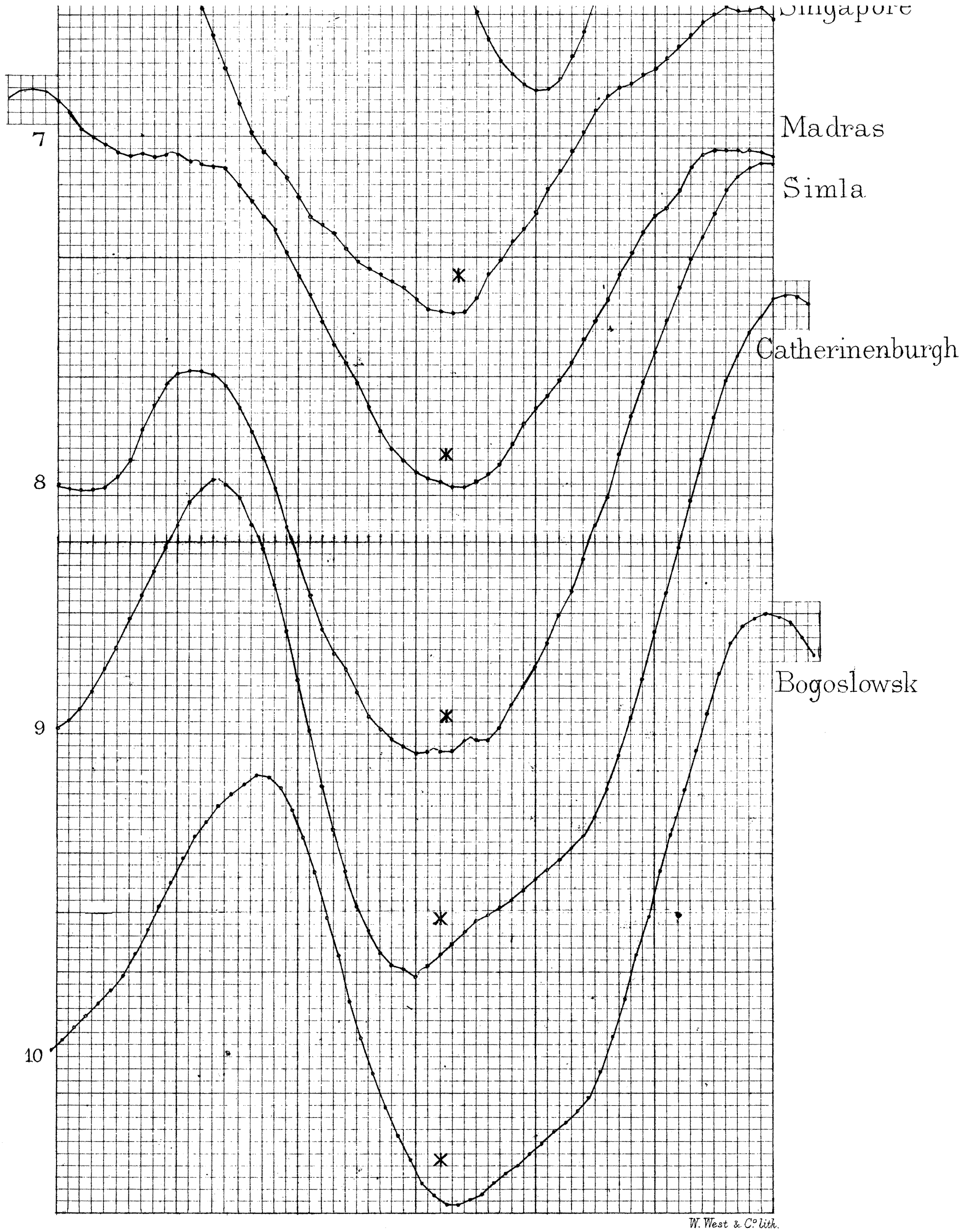
Local Mean Time.	Daily Mean.	Range.	Local Mean Time.	Observed Height.	Range.
d h	in.	in.	d h	in.	in.
Mar. 31 18	Min. 29·277		31 22	29·123	
		0·483			0·720
Apr. 1 21	Max. 29·760		1 22	29·843	
		0·269			0·531
,, 2 19	Min. 29·491		2 20	29·312	
		0·824			1·069
,, 4 12	Max. 30·315		4 11	30·381	

It will be seen that while the first minimum is not shown at any of the other stations *after* March 31^d 0^h, and the first maximum occurs twelve hours later than at Bogoslowsk, yet the second minimum occurs nearly at the same local hour as at the Asiatic stations, and the second maximum at the same local hour as at the Cape of Good Hope. The movements of the mercury are still larger than in any of the other cases, the change from the minimum, April 2^d 20^h, to the maximum observation, 4^d 11^h, being upwards of one inch. The whole series of facts leaves, it appears to me, no doubt that this great movement is connected with the same cause which produces the comparatively small variations within the tropics; and it may be noted that as we approach the poles the amount and irregularity of the barometric oscillations seem to increase, as in the case of the magnetic variations.

* These ranges refer to the maximum after 5^d 0^h.

Daily mean barometric height corresponding to each hour
March 31th to April 5th 1845.





Scales: ·8 *inch* = 0·1 *inch of Mercury for N^os 1, 2, 3, 9 & 10.*
3·2 „ = 0·1 „ — „ — „ — „ — „ 4, 6, 7, 8
1·28 „ = 0·1 „ — „ — „ — „ — „ 5.
✱ *April 2^d 12^h Greenwich mean time.*

northern stations, yet, to attain the maximum shown at 31^d 12^h, the mercury rose 0·40 inch within twelve hours during the 31st of March. I need scarcely point out the weighty bearing which these facts must have on all investigations with reference to the great barometric oscillations within our latitudes as well as to those of lesser magnitude within the tropics.

The following Table contains the daily mean height of the barometer at each station at the hours of maximum and minimum previously given, together with the mean height for the year.

Stations.	1st Max.	Min.	2nd Max.	Mean of year.
	in.	in.	in.	in.
Hobarton	30·067	29·670	29·816	29·794
Pekin	30·131	29·701	29·809 ?	30·015
Cape of Good Hope	30·155	28·848	30·142	30·058
St. Helena	28·309	28·239	28·289 ?	28·296
Makerstoun	29·959	29·770	29·915	29·586
Singapore	29·947	29·864	29·918	29·895
Madras	29·854 ?	29·785	29·844	29·853
Simla	23·184	23·118	23·221	23·195
Catherinenburg	28·967	28·624	29·099	29·023
Bogoslowsk	28·567	28·298	28·708	28·746

It will be perceived that the minimum height was less at all the stations, with the exception of Makerstoun, than the mean for the year.

VI. "On Clairautian Functions and Equations." By Capt. Allan Cunningham, R.E., Hon. Fellow of King's Coll. Lond. (Roorkee, India). Communicated by Prof. Cayley. Received April 18, 1876.

(Abstract.)

Notation.—In this paper D stands for $\frac{d}{dx}$; $y', y'' \ldots\ldots y^{(n)}$ stand for the differential coefficients of y (and therefore y^0 is equivalent to y itself); X, X_1, X_2, &c. stand for known functions of x; $X', X'' \ldots\ldots X^{(m)}$, $X_1', X_1'' \ldots\ldots X_1^{(m)}$, &c. stand for the differential coefficients of X, X_1, &c.; y_m stands for a particular integral of a linear differential equation; y_0 stands for the complete arbitrary portion of the solution of a linear differential equation.

1. *Clairautian Functions.*—It is proposed to apply the term Clairautian function to the following expressions (which possess properties similar to that on which the solution of "Clairaut's equation" is founded), viz.

$$y^{(n)},\ ky^{(n-1)}-xy^{(n)},\ \frac{k(k+1)}{\underline{|2}}y^{(n-2)}+\frac{k}{\underline{|1}}\cdot\frac{(-x)}{\underline{|1}}y^{(n-1)}+\frac{(-x)^2}{\underline{|2}}y^{(n)},\cdot \quad (1)$$

and to denote them by the symbols ${}^kU_{0,n}$, ${}^kU_{1,n}$, ${}^kU_{2,n}$, $\ldots {}^kU_{n,n}$, so that

Daily mean barometric height corresponding to each hour
March 31th to April 5th 1845.

Scales: ·8 inch = 0·1 inch of Mercury for Nos 1, 2, 3, 9 & 10.
3·2 „ = 0·1 „ — „ — „ — „ — „ 4, 6, 7, 8
1·28 „ = 0·1 „ — „ — „ — „ — „ 5.
✱ April 2d 12h Greenwich mean time.