

XIV. *On the Connexion between Volcanic Eruptions and Hurricanes.* By THOMAS DOBSON, ESQ., B.A., Head Master, High School, Hobart Town. [Read 12th May, 1852.]

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"The most important desiderata appertaining to the subject of Storms are certainly their *origin and termination*. Of these initial and terminal points in the course of great storms, we *absolutely know nothing*."—HERSCHELL'S *Admiralty Manual*, 1849, p. 335.

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In a former paper I stated that whirlwind storms, or cyclones, as Piddington has well designated them, probably take their rise in the great centres of volcanic action. It is found that, even in regions where volcanic eruptions are most frequent, the intervals of their recurrence are still considerable; the average period in most cases consisting of several years. The same observation applies equally to great hurricanes. Repeated instances of coincidence of the phenomena in question will therefore afford strong corroborative evidence of a connexion between them; for their simultaneous occurrence at considerable intervals would render their mutual independence in the highest degree improbable.

The following are the instances of coincidence which I have met with in support of the truth of the proposition, that "cyclones follow volcanic eruptions."

At Lancerote Island, near Teneriffe, a great *volcanic eruption* on 7th September, 1730. Lava ran into the sea with a terrible roaring; lapilli, sand, ashes, &c., thrown up. A storm also, which was *equally new* and terrifying to the inhabitants, as they had *never known one in the country before*.—Lyell, Prin. Geol. 2, p. 274.

1754, NOVEMBER and DECEMBER.—A most terrible volcanic eruption in the Phillippine Islands. Ashes, sand, mud, fire and water thrown up. Darkness, *hurricanes*, thunder, lightning; long-protracted, violent, and repeated *earthquakes*, alternated in frightful succession. Taal, and several villages, totally destroyed.—Edin. Phil. Journal.

1779.—Kamtschatka. No thunder and lightning during our stay, except on the evening of the eruption of the volcano. The general severity of the winter, and the *dreadful hurricanes of wind and snow* that season brings along with it, cannot be questioned. The *extraordinary violence and impetuosity* of the *winds* are attributed to the subterranean fires, the sulphureous exhalations, and the general volcanic disposition of the country.—Cook's Third Voyage.

1779.—AUGUST 7th.—Great eruption of Vesuvius. Sir W. Hamilton was on the mole at Naples, at 12 P.M., when the fermentation of the mountain was greatly increased, and a summer *storm*, called a *tropea*, came on suddenly. One of His Sicilian Majesty's gamekeepers who was out in the fields near Ottaiano whilst this *storm* was at its height found the drops of rain *scald* his face and hands.—Encyc. Brit.

1783, Iceland.—The most tremendous volcanic eruption on record, accompanied by *violent wind*, rain, and darkness. Three fire-spouts broke out on Mount Shapta; twenty-one villages were totally overwhelmed, and thirty-four others materially injured.—Haydn's Dict. of Dates.

1796.—In the *Aleutian Archipelago* eruptions are frequent. About thirty miles to the north of Unalaska, near the isle of Umnack, a *new island* was formed in 1796. It was first observed after a *storm* at a point in the sea from which a *column of smoke* had been seen to rise. Flames issued from the new islet, and a frightful *earthquake* shook the new-formed cone. Earthquakes of the most terrific

description agitate the land throughout this tract.—Lyell, Prin. of Geol. 2, p. 131.

1815, APRIL, Java.—A tremendous eruption of the Tom-boro mountain. Three distinct columns of flame burst forth near the top. Between 9 and 10 A.M. ashes began to fall, and soon after a *violent whirlwind* ensued, which blew down nearly every house in the village of Sangii, carrying up the roofs and light parts. Near Tom-boro its effects were much more violent, tearing up by the roots the largest trees, and carrying them into the air; together with men, horses, cattle, and whatever else came within its influence. This will account for the immense number of floating trees seen at sea. The *whirlwind* lasted about an hour. No explosions were heard till the whirlwind had ceased.—Raffles's Java.

1820, 11th June.—A frightful volcanic eruption at Banda. The spectacle became still more fearful in the evening by an *earthquake* and a *violent hurricane*.—Annale de Chimie.

*Iceland*, 1821.—On 19th December there was a violent eruption of the old volcano of Cape Hekla. The barometer fell on the 25th almost simultaneously all over Europe, and in some cases the *magnetic needle was agitated*. This volcano had been quiet since 1612: its height is 5666 feet. On the 19th December there was a discharge of an enormous and lofty column of flame; masses of rock, 50 lbs. weight, were thrown five miles from the crater: on the day after the principal eruption, grey ashes covered the country. The volcano was active for several weeks afterwards.

On 21st DECEMBER, a *violent storm* raged from the south, and on the 26th and 27th a *heavy storm* from the north-east. The barometer (observed by Dr. Thorsteinson, at Naes, near Reikiavig, about 74 miles N.W. of the volcano), had been gradually falling since the 18th December, when it was 29.16, and reached on 26th December its minimum,

28·49. On 8th February, 1822, the barometer was 27·25, though no *earthquake* was felt; but *near the volcano there were constant small shocks*. Up to the 23rd February the mountain emitted smoke like steam. The rivers in the neighbourhood were considerably enlarged, and there was a constant rumbling noise, with an occasional dreadful crash.

At Genoa, for several days before the 24th, when the *great tempest* occurred there, (wind S. and then S.E.), the air had been filled with thick vapours, which vented themselves in torrents of rain, and the wind blew from the S. with intense violence. The sea overflowed at Genoa, Leghorn, and Trieste. The loss of merchant ships, &c., was incalculable.

On 24th and 25th DECEMBER large igneous meteors appeared in France, Holland, &c. On 25th a *tremendous storm* in Switzerland, and at 8½ P.M. a shock of an *earthquake* at Mayence.

The following particulars of the eruption are by the Provost of Rangarvalla, given, along with several other accounts, in the Annals of Philosophy for June, 1822.

19th DECEMBER, twilight.—A red light seen in the east.

20th noon.—Thick and dark column of smoke, *calm weather*, and a *violent eruption*.

21st.—A *violent storm* from *south*, fire intense, and clouds of smoke rising with great violence.

22nd.—Same phenomena. 23.—Smoke and ashes.

24th and 25th.—Smoke and fire still discharged.

26th and 27th.—A *heavy storm* from *north-east*.

28th, more calm; 29th, calm and pleasant.

23rd FEBRUARY.—Clouds of smoke not yet disappeared, and to day increased. Since eruption the weather has become *worse*, owing to its unparalleled variableness,—*storms*, cold, and snow.

Since 1st January violence of eruption has been decreasing. The volcano was afterwards quiet until 26th June, 1822, when new eruptions occurred, with showers of ashes and currents of lava. On the north part of the island *frequent earthquakes* had been felt.

In vol. iii. of the *Annals of Philosophy* are given Dr. Thorsteinson's daily observations of the mean height of the barometer for December 1821, January and February 1822, taken at Naes. In vol. iv. are tables of observations for the same period made at *Newcastle-upon-Tyne* by Mr. Losh, and at London by Mr. Howard. Mr. Howard gives the maximum and minimum observations for each day, making in all 180 readings: Mr. Losh gives three daily readings, at 9, 2, and 10 respectively, making 270 readings. I have deduced the mean daily height from each series, and projected the three curves corresponding to the mean daily height of the mercurial column at Naes, Newcastle, and London for the three months.

Several interesting results would arise from the comparison of these curves, but that which more immediately pertains to our subject is, that every definite well-marked atmospheric disturbance in Iceland, during these three months, was followed shortly afterwards by an analogous disturbance in Britain; proving that, so long at least as the volcanic action lasted, the atmospheric disturbances *arising from that action* in Iceland were successively propagated to Great Britain in a few days, and with comparatively slight modifications.

With the knowledge which we now possess of the phenomena attending great storms, several important and well-founded inferences spring from the meteorological facts recorded during this period of unusual volcanic activity.

*1st Fact.*—On evening of 19th December, a *great volcanic eruption began*, and continued with irregular but decreasing



action during some weeks. On 21st and 22nd there was a violent storm from the *south*, with a *rapidly falling barometer*.

*Induction*.—The *eastern margin* of a *cyclone* passing over the place of observation, which is in the *northern hemisphere*.

*2nd Fact*.—On 23rd, 24th, and 25th, nothing recorded of state of weather: barometer 28·49.

*Induction*.—Weather *moderate* or *calm*, *centre* of cyclone passing over.

*3rd Fact*.—On 26th and 27th a *violent storm* from *N.E.*, with a *rapidly rising barometer*.

*Induction*.—The *north-west* quadrant of cyclone passing over, and cyclone progressing towards the *E.S.E.*

The successive propagation of atmospheric disturbances indicated by the barometric curves leads us to expect the appearance of this cyclone a few days afterwards in the parts of Europe lying to the S.E. of Iceland; and, accordingly, on the 24th we have its eastern margin at Genoa, the cyclone itself now moving to the S.S.E. down the western coast of Italy towards Vesuvius and Etna.

Its centre passes over France about 6 A.M. of the 25th, and the barometer falls unprecedently low. The second half of the cyclone follows, and ravages Europe until the 31st.

During its transit over Europe an earthquake occurs, and igneous meteors prevail.

1830, 16th MAY.—A sudden eruption of Etna, and a violent S.E. wind. A frightful *whirlwind* in desert of Africa destroyed a caravan. The same occurred in 1805, 1811, and 1813, during eruptions of Etna; and in 1807 during an eruption of Vesuvius.—Rev. W. B. Clarke, in vol. I., of Tasmanian Journal.

1840, FEBRUARY 16th. — *Earthquake* at Ternate I., one of the Moluccas.

1840, 23rd MARCH. — St. Matthew's Island, in  $22^{\circ} 24' S.$ ,  $172^{\circ} 35' E.$ , seen in *violent eruption*.—On 31st March, *earthquake* at Adelaide.

1840, APRIL 5.—Sixty miles from Mindinao, Phillippine Islands, a shower of *volcanic ashes*, (which *follows* an eruption.)

1840, FEBRUARY, MARCH.—Cyclone from Feejee Islands to New Zealand.—Wilkes.

MARCH 18.—Cyclone at Tutuila.

MARCH 25.—*Merope's* cyclone in  $35^{\circ} 4' S.$ ,  $158^{\circ} 35' E.$

1851, 5th AUGUST; night.—*Martinique*. A frightful *eruption* of the long-dormant volcano of the Pelée Mountain, accompanied by a noise like the approach of thunder, and a vibration.—*Illustrated London News*.

1851, AUGUST 18th.—West Indies. St. Thomas's experienced the tail of a *hurricane*, which began at daylight. From 9 A.M. to 9 P.M. it blew with terrific fury from N.E. to S.E. by E. The strength of the hurricane passed to the S. of St. Thomas's.

AUGUST 18.—A severe shock of an *earthquake* at Truxillo, Central America, which extended throughout Honduras.

*Jamaica*, (advices to 29th AUGUST).—A smart shock of an *earthquake* had been felt in Port of Spain.

[The above is a regular West Indian cyclone, passing off to the W.N.W.]

It is a well-established physical fact, that the paroxysmal eruptions of a volcano are accompanied by earthquake shocks; and if these be regarded as the transits of waves of elastic compression through the surface and crust of the earth, it is easy to conceive that earthquakes may occur almost immediately after an eruption, and at a considerable distance from

the volcanic orifice. Hence, in and near to regions subject to volcanic explosions, the cotemporaneous occurrence of an earthquake and a cyclone affords evidence corroborative of the supposition that the cyclone owes its origin to some distant and unrecorded volcanic paroxysm.

The following are the examples of this nature that I have met with :—

1693, *Calabria*.—Fearful *storms* succeeded the great *earthquake*. The same took place in 1783, and on night of 5th March, 1823.—Signor Ferrara, Silliman's Journal.

1711, Bosely, near Wenlock, Shropshire.—After a *great hurricane*, the inhabitants were awakened in the middle of the night by a *commotion of the earth*, accompanied with noise. *Eruptions* of hot water and inflammable air issued from the earth.—Trans. Roy. Soc., London.

1737, *Calcutta*, 11th, 12th OCTOBER.—A *furious hurricane* at the mouth of the Ganges, reached 60 leagues up the river. At same time there was a *violent earthquake*; 200 houses destroyed. It was computed that 200,000 ships, barques, sloops, boats, &c., were cast away. Three hundred thousand souls perished. Ships were blown two leagues up into the land over the tops of high trees. The Ganges rose 40 feet higher than ever known.—Gentleman's Mag., 1738-9.

1750, 8th MARCH, *London*.—An *earthquake*—morning was remarkably *calm*, but quickly after the shock the *wind rose*.—Dr. Doddridge in Phil. Trans.

1756, 18th FEBRUARY, 8h. 12m. A.M., an *earthquake* at the *Hague*. Wind S.W.: immediately after the shock it became N.E. (Probably a cyclone travelling to the S.E. from Iceland.)

1766, 13th AUGUST.—Great hurricane at Martinique. A shock of an earthquake in the night of the cyclone.



1780, OCTOBER.—Barbadoes, &c., great hurricane and an earthquake. At St. Lucia the earthquake happened some hours after the greatest severity of the gale.—Dr. Blane.

1790, 5th NOVEMBER, *Scotland*.—Comrie, in Perthshire. A violent shock of an earthquake. During the day the mercury rose and fell several times, and at 6 P.M. stood at 28·5; sky was perfectly serene, and hardly a breath of wind to be felt; but next morning, about 6, *a violent tempest* arose, and raged without intermission for 24 hours.

29th DECEMBER, 1 P.M.—A pretty smart *shock* during *a violent storm of wind* and rain, which continued the whole day, and was at its height during the time of the *earthquake*.—Dr. Finlayson, in Trans. of Roy. Soc. of Edinb.

1800, 19th OCTOBER.—*Ongole*, (India). *A hurricane*, and a severe shock of an *earthquake*.—Asiatic Annual Register, 1801.

1815, OCTOBER 18th.—Port Antonio, *Jamaica*. A *dreadful hurricane*, accompanied by two severe shocks of an *earthquake*. The wind may be literally said to have blown from every point of the compass.

October, November, and December is the *rainy season* and the *hurricane period*. Earthquakes, tempests, and storms frequently take place.—Dr. Arnold, in Ed. Phil. Journal.

1815, November.—A severe cyclone ravaged the northern part of the island of Ceylon, from Point Pedro to Manar. At Point Pedro several shocks of an earthquake were felt during the hurricane.

1819, NOVEMBER 23rd.—An awful *storm* at Montreal; rain of dark inky colour. People conjectured that a volcano had broken out in some distant quarter. On Tuesday there was a slight shock of an *earthquake*, with a noise like artillery, and much lightning.—Ed. Phil. Jour., 1820.

1819, AUGUST.—*Bagdad*. An *earthquake* after extreme *heat*, and then a *storm*, an event *quite unprecedented*. The river rose 7 feet, the water being *red* and *offensive*.

1820, DECEMBER 29th.—*Zante*. Atmosphere frightful, wind S.S.E. ; barometer 27·40, like an *American hurricane*. At midnight three violent shocks of an earthquake. A sudden *calm*, and then the *storm redoubled*. On night of 30th a *new hurricane*, such as I believe no one (here) ever before experienced ; wind S.E. Probable origin of earthquake in the sea.—Edin. Phil. Journal.

1821, 20th, 25th DECEMBER.—Earthquakes in Iceland, and at Mayence, on the Rhine. On Christmas Eve, after a long continuance of stormy weather, the barometer sunk so low in Europe that the attention of meteorologists was strongly drawn to the circumstance. Professor Dove, of Berlin, from a consideration of the meteorological registers kept at various places in Europe, (see *Annals of Phil.*,) made it appear that an explanation of all the phenomena was afforded by the assumption of one or more great *rotary currents* or *whirlwinds*. From this epoch may be dated the commencement of the Science of Cyclonology. (See *Volcanic Eruptions*, under date 1821.)

On the 25th December, 1821, a Troughton's mountain barometer at the Royal Observatory of Greenwich sunk as low as 27·89 inches. (Pond's Greenwich Obs.) A heavy rain of some hours, with wind at south east, preceded this fall ; and a gale at north-west followed, in which the mercury rose a few tenths.

1823.—*Sicily*. The shock of the 5th March was followed by a tremendous night of rain, thunder, snow, hail, and *wind*.

1828, 21st FEBRUARY.—Barometer at Geneva 28·69. During the 19th, 20th, 21st and 23rd February, furious tempests raged throughout the south of Europe ; and on

the 23rd the shock of an earthquake was felt on the north of France and in the Netherlands.—Bibl. Univ., March 1829.

1829.—*Scotland, Moray.* Unprecedented floods, preceded by tremendous *gales*, waterspouts, &c. Barometer 28·5. Thunder, lightning, and outbursts of subterranean water on the mountains. On the fourth and last day of the storm several distinct shocks of an *earthquake*.—Sir T. Dick Lauder.

1831, 21st DECEMBER.—I found at Savaii that the dreadful *hurricane* at Raratonga had raged with great fury at the Samoan Islands, accompanied by a violent shock of an *earthquake*, four of which had been experienced within the last 17 months. At Raratonga, during the hurricane, the whole island trembled to its very centre.—Williams' Missionary Enterprise.

1837, AUGUST.—Antigua hurricane. At St. Thomas' the hurricane appeared to have concentrated all its force and fury. In the midst of it, earthquake shocks were felt.—Log of H.M.S. Packet *Spey*.

1842.—*Sydney.* During the violence of the *storm*, about 2 o'clock on Tuesday morning, various persons, both in Sydney and on the North Shore, felt several distinct shocks of an *earthquake*. The rain fell in perfect torrents.

1843, 30th OCTOBER.—Manilla. Log of American Ship *Unicorn*. 7 P.M., thick and rainy, and has been so for 24 hours; felt two heavy shocks of an *earthquake*. Blowing fresh; barometer in morning at 29·90, now at 29·84. At 10 P.M. a severe hurricane commenced.—Piddington, p. 176.

1843, APRIL.—Rodriguez hurricane, &c. "A year famous for gales all over the Indian Ocean."—Thom.

1843, JANUARY.—Eruptions of Mount Etna. 15th January. A violent and destructive hurricane at Genoa, and in the Bay of Biscay. 12th January. Hurricane in

the British Seas ; the loss without a parallel in our mercantile marine. England 154 vessels, 196 lives. Ireland 5 vessels, 104 lives. Scotland 17 vessels, 30 lives. Coast of France 5 vessels, 100 lives. Total 181 vessels, 430 lives.

1843, 8th, 10th FEBRUARY.—Destructive earthquakes in all the West Indian Islands. At St. Kitts a part of the Brimstone Mountain was torn away, and the old *volcano emitted smoke*. At Guadaloupe, a volcano emitted dense volumes of smoke ; and the important town of Point à Pitre was entirely destroyed, with 2000 inhabitants.

11th FEBRUARY.—Ship *Cornubia* wrecked in a tempest off the Coast of North America. In crossing the Atlantic from Liverpool had met with a series of terrific gales.

16th FEBRUARY.—The *Thunder*, from Portland to Madeira, wrecked in a violent tempest.

28th FEBRUARY.—Earthquake shock at Manchester. 3rd, 5th March, earthquake at Guadaloupe.

1st MARCH.—Tremendous gale from N.W. Packet-ship *Toronto* struck by lightning, arrived at New York on 20th March.

25th MARCH.—Earthquake at Carlisle, and at Oban in Scotland.

31st MARCH.—Lerwick, Shetland. Violent gale from E.S.E. to E. Several fishing-boats and crews lost.

Shortly before 20th March, the Western Coast of the United States had been visited by a violent hurricane, with much damage.

About 48 hours before the appalling earthquake at Guadaloupe, &c., a terrific hurricane suddenly broke out in the British Channel, which lasted several hours, and extended over a considerable space both of sea and land, accompanied by a sudden and very heavy fall of snow.—*Illust. London News*, 1843.

1847.—*Tobago*, 11th OCTOBER, P.M. The severest and most desolating hurricane that has occurred here since 1780. A severe earthquake preceded the first outbreak.

1848, AUGUST.—*Antigua* hurricane. At midnight, wind raged furiously; thunder and lightning were incessant, with floods of rain. At this time a severe shock of an earthquake was felt, attended by very heavy gusts. By 1½ A.M. the mercury had fallen four-tenths, and the storm was dreadful. At 2 A.M. it abated.—*Annual Reg.*, 1848.

1848, 12th OCTOBER.—Earthquake at Melbourne.

16th, 19th OCTOBER.—Earthquakes at New Zealand.

*Wellington*.—The two-topsail schooner *Sarah Ann* from Otago driven back from off the Heads on the 13th October by a N.E. gale.

14th OCTOBER.—*Taranaki*. Tremendous S.E. gale. In night a perfect hurricane. About 2 A.M. of 15th, house shaken by an earthquake. Throughout the 15th wind blew without abatement; the sea boiled like a pot, and showers of foam blew across our premises. Fences, out-houses, &c., laid prostrate. On 19th, weather and sea calm.—Letter from the Rev. W. Woon.

18th OCTOBER.—*Auckland*. A raw wet blustering morning, increasing to a perfect hurricane at W.N.W. Moderate at daylight on the 19th.

The *Harriet Liethart*, from Auckland, wrecked at the mouth of the Wanganui River on the night of the 18th by a heavy south-easter. Captain Gilmore states that during October the weather in Bass's Straits was exceedingly tempestuous, the wind blowing a complete hurricane, with heavy rain.

A valuable record of the physical circumstances attending the series of earthquakes experienced at Wellington from 16th October to 18th November, 1848, from the journal of



H. S. Chapman, Esq., is published in the 51st volume of the Westminster Review. I have constructed a curve of the daily readings at 9 A.M. and 9 P.M., which exhibits distinctly the great depression *caused by the cyclone* of the 18th October, which is recorded as “a perfect hurricane from W.N.W.,” at Auckland, where the shocks were not felt; and “a strong S.E. gale,” at Wellington. This depression is not due to the shocks, for these on the 18th were insignificant; and no depression exists to indicate the occurrence of the great shocks of the 16th, 17th, and 19th.

In accordance with this interesting fact shown by the curve, is the remark, that “the shocks are clearly unaffected by the state of the atmosphere: they occur in all weathers, with all winds, in storms and in calms; nor can any inference be drawn from the state of the barometer.” This conclusion is formed from the observation of many hundreds of shocks during a period of five years in New Zealand; and is fully borne out by the instances recorded during 1846, 1847, and 1848. We are thus led to the important inference, that earthquakes and cyclones are concomitant, and in all probability mutually independent, effects of volcanic action. The earthquake travels through, or upon, the earth’s crust, and does not affect the barometer. The cyclone travels through the atmosphere, and its passage over any place is invariably recognized by the barometer, and characterized by a sudden and considerable shortening of the mercurial column.

The cyclones indicated by the minor depressions of the curve I have not yet sufficient data to establish. I extract from the journal a few meteorological remarks illustrative to the curve. During the first week of October the barometer ranged from 29.42 to 29.80, and fell slowly from the 1st until the evening of the 6th, when it began to fall more rapidly; wind N.W. From this time until the 18th No-

vember, (the latest date of the published observations), we find a succession of N.W. and S.E. *gales*; thus:—

OCTOBER 7, N.W. gale; 8th to 11th S.E. gale; 9th, very cold, and an immense quantity of rain fell; 12th and 13th, N.W. fresh; 14th and 15th, S.E. gale; 16th, a shock of an earthquake of greater force and duration than any we have hitherto felt in the colony. Wind S.E. to N.W. during the night, blowing a *fierce gale*, with heavy rain; 16th to 21st, strong S.E. gale. On 19th, very strong S.E. gale, and at 5 A.M. a strong shock; 22nd to 26th, wind N.W.; 27th to 29th, S.E., fresh; 30th to 31st, N.W., strong gale, &c.

The barometrical observations made six times a day on board Her Majesty's ship *Fly*, at Wellington, from the 15th to the 23rd October, are given in the *New Zealand Spectator*. The curve is analogous to that already given, but ranges much higher, on account of the considerable difference of altitude between the position of the ship and that of Mr. Chapman's house. On Wednesday P.M., at the time that the curve shows the centre of a cyclone, Captain Oliver, of the *Fly*, writes, "wind round and round the compass;" midnight, a gale at south."

From the 16th to the 24th October there occurred upwards of 1000 shocks. On the 18th November it is stated that, "taking the whole of the shocks during the five weeks, only four have occurred of sufficient force and duration to do damage, though at times as many as fifteen have been counted in an hour, and perhaps more than one hundred and fifty in the twenty-four hours." During November the number of shocks ranged from two or three to seven or eight a day. Now it appears to me that such a continued succession of small shocks implies the immediate proximity of an active volcanic orifice.

Humboldt felt periodic and very regular shocks of earth-

quakes on the edges of the craters of Vesuvius, and Pichincha, near Quito, on each occasion from 20 to 30 seconds before the burning scoria or gases were erupted ; the intensity of the shocks increasing in proportion to the time intervening between them, and consequently to the length of time in which the vapours were accumulating. During the eruption at Cape Hekla in 1821, frequent small shocks took place near the volcano, which were imperceptible at Reikiavig, 74 miles distant.

Several eruptions of flame, &c., were reported to have been observed in New Zealand in October 1848 ; but little credit was given to such reports, which evidently tended to increase alarm, and so to injure the colony. The meteorological phenomena, however, are happily independent of political bias, and clearly indicate a series of volcanic paroxysms, which is rendered highly probable by the nature of the locality of which this description is given :—" Across the centre of this island is a chain of volcanic disturbance in *constant activity*. It commences at Tongariro, a conical mountain about 10,000 feet high, visible from Wanganui and from Cook's Straits, which *continually emits jets of steam and smoke*. In January, 1845, Te Heu Heu told me that it was throwing out flame. From Tongariro, the chain extends along a line of lakes, hot springs, fissures, and steam jets of a very remarkable character, to the Bay of Plenty, where White Island is an active volcano, the crater being near the water's edge. This last I have seen. The direction from Tongariro to White Island is about N.E. Some of the hot springs must exist under pressure, for their temperature is  $216^{\circ}$  at the surface. Some of the mud jets are at the boiling point. One of the lakes is called Roto Mahame, or warm lake. Underground noises are continually heard : new openings occur from time to time, and extensive land slips are not

uncommon. In 1846, a mud slip destroyed the *pah* of Te Heu Heu, on Lake Taupo, and he, with 50 of his people, perished."

With such a physical constitution, ever tending to interrupt the state of atmospheric equilibrium, it is not surprising that New Zealand should be subject to frequent storms and occasional hurricanes. The volcanic islands to the north of Sicily (of which Stromboli has been constantly burning for more than 2000 years) were called by the ancients *Æolia*, and considered the peculiar dominions of *Æolus*, the king of winds and storms.

——— Hic vasto rex *Æolus* antro,  
Luctantes ventos, tempestatesque sonoras,  
Imperio premit, ac vinclis et carcere frænât.

New Zealand may well dispute with Cape Horn the honour of being the abode of *Æolus* in the Southern Hemisphere.

1849, 25th, 28th JANUARY.—Guam, Ladrone Islands. Severe shocks of an *earthquake*.

10th, 13th.—A *hurricane* travelling south-eastward overtakes the *Nimrod* in  $18^{\circ}$  S.  $161^{\circ}$  E.; and the *Scamander* in  $24^{\circ}$  S.  $168^{\circ}$  E.

1850, 24th SEPTEMBER.—3 A.M. Smart shock of an earthquake at Good Hope, on the Murrumbidgee.—Rev. W. B. Clarke in *Sydney Morning Herald*.

24th SEPTEMBER.—Sydney, noon. Very strong *South* wind.

25th SEPTEMBER. — New Zealand. *Acheron's* boat swamped in a heavy gale from E.; one officer and three men lost.

28th SEPTEMBER.—*Richmond*. A *whirlwind*; on shore the tempest tore up large trees by the roots, &c. On the river a fearful S.W. squall capsized and sunk the *Heroine*,

*Bramble*, and *Lucy Ann*, though fully prepared for a gale and all snug. 14 lives lost.

1850, 13th, 14th OCTOBER.—*Adelaide*. On morning of 14th, barometer fell 4 lines in a few minutes, shortly before the beginning of the gale and thunder-storm, and declined about 9 P.M. to 27 inch 4 lines. The storm and gale then increased, till they reached their climax at 41 P.M. Shortly before 11 there was a wave-like *moving of the earth* from S.S.W. to N.N.E., setting tables, &c., in motion. During each of the *earthquakes* the storm changed to W., but resumed its course S.W. directly after their cessation.—Dr. Schomburgh.

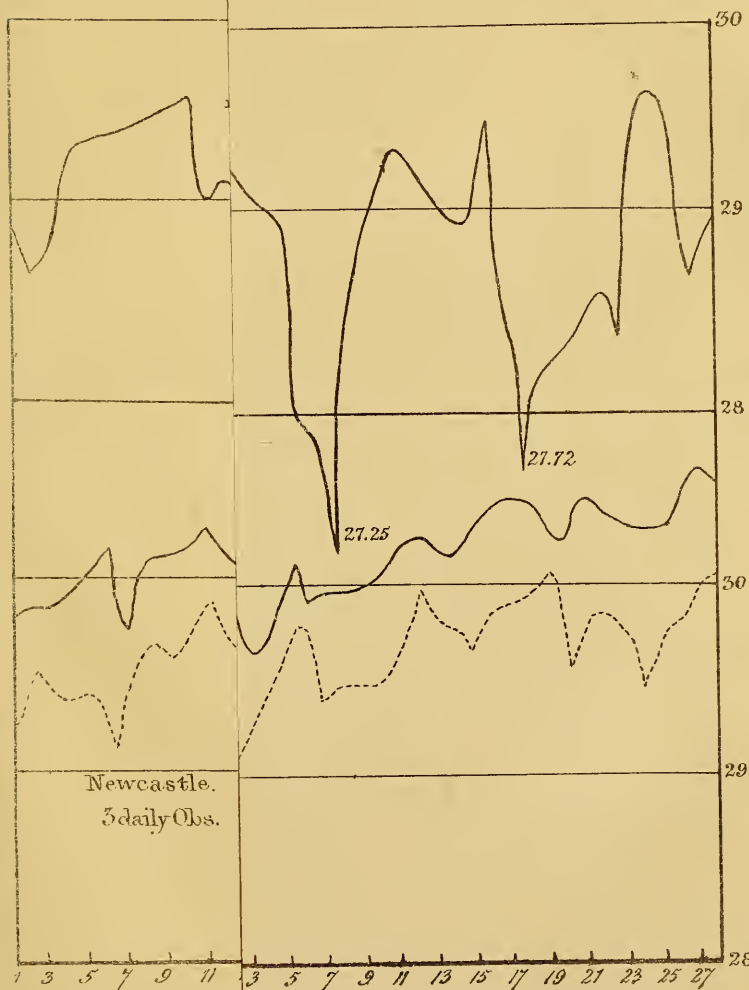
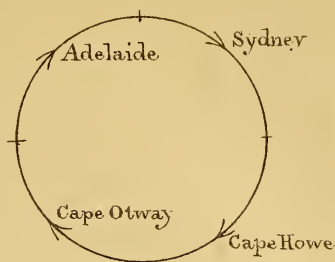
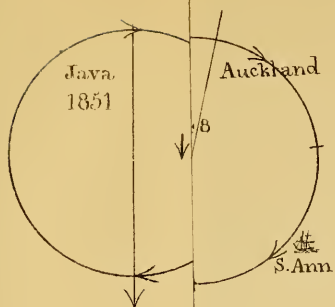
At the same time that the *Grecian* was wrecked at Adelaide (13th, 14th October) by a S.W. gale, the schooner *Captain Cook* had the gale from S. & S.W. off Cape Otway; the brig *Essington* had it from N.E. veering to E., calm, and then S.E., with a heavy cross sea off Cape Howe. At *Sydney*, the wind was northerly and westerly. The passage of the cyclone over Sydney is best shown by the barometric curve of the four daily readings from the 9th to the 20th October, in the annexed diagram.

1851.—*Jamaica*, under date 15th November. A gale of wind had done considerable damage. A slight shock of an earthquake had taken place.—*Illustrated London News*, December, 1851.

1851. *Java*, 4th MAY.—After an unusually high tide and calm weather, a succession of shocks of earthquake, followed by *strong winds* from the E., N., and W., with rain and *stormy weather*.—*Java Courant*, 25th June.

A perusal of the facts brought together in this paper can scarcely fail to suggest the existence of an intimate relation between cyclones and volcanic action. The attempt to develop the nature of this relation, to answer the question,

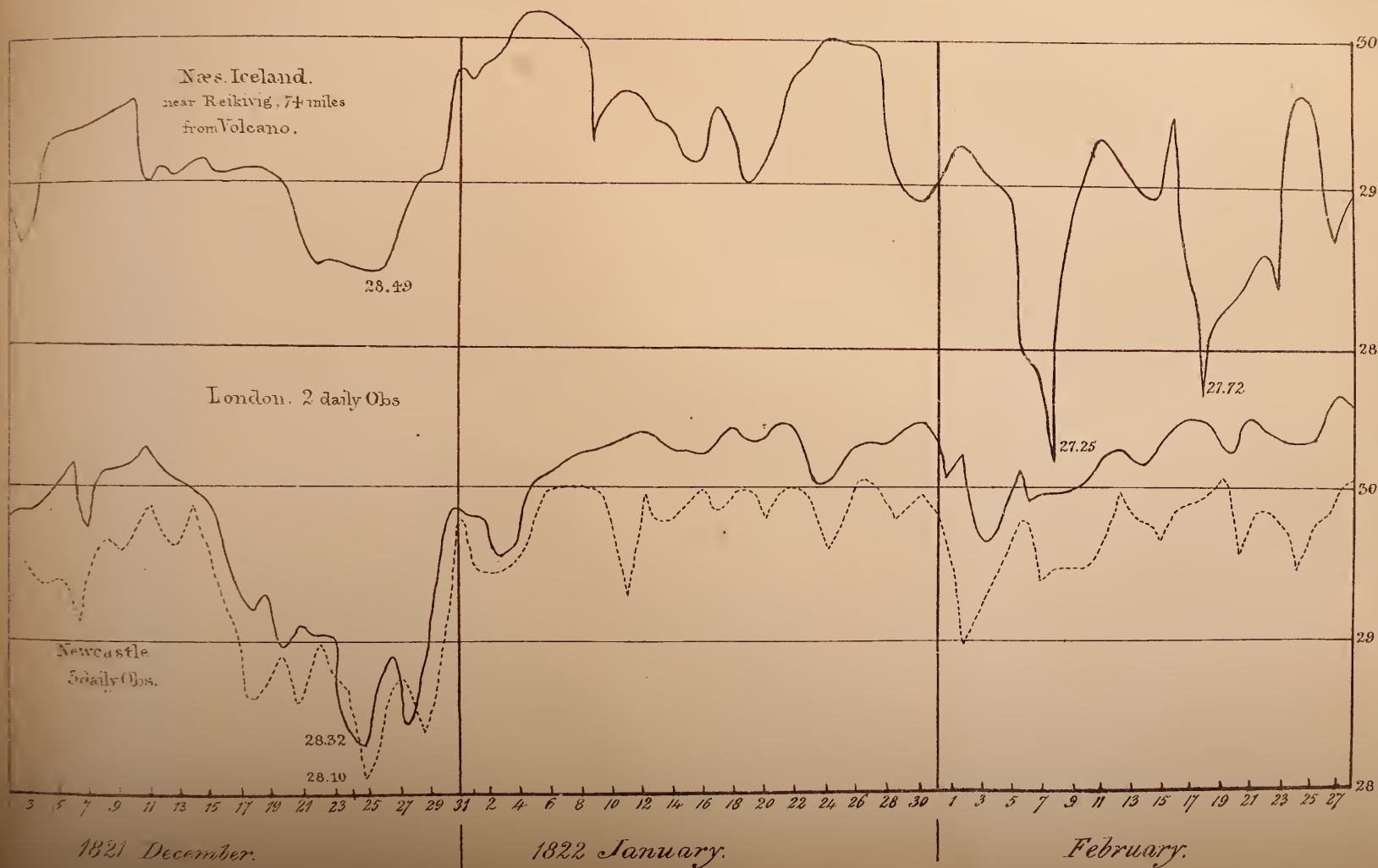
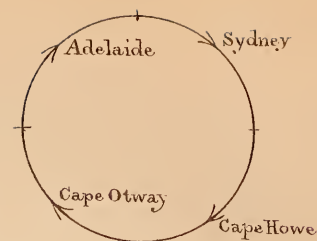
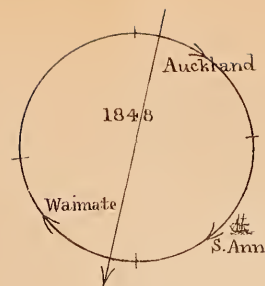
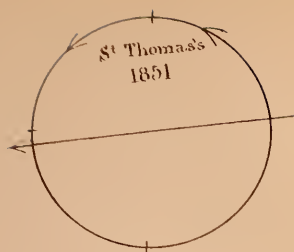
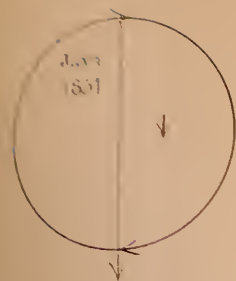




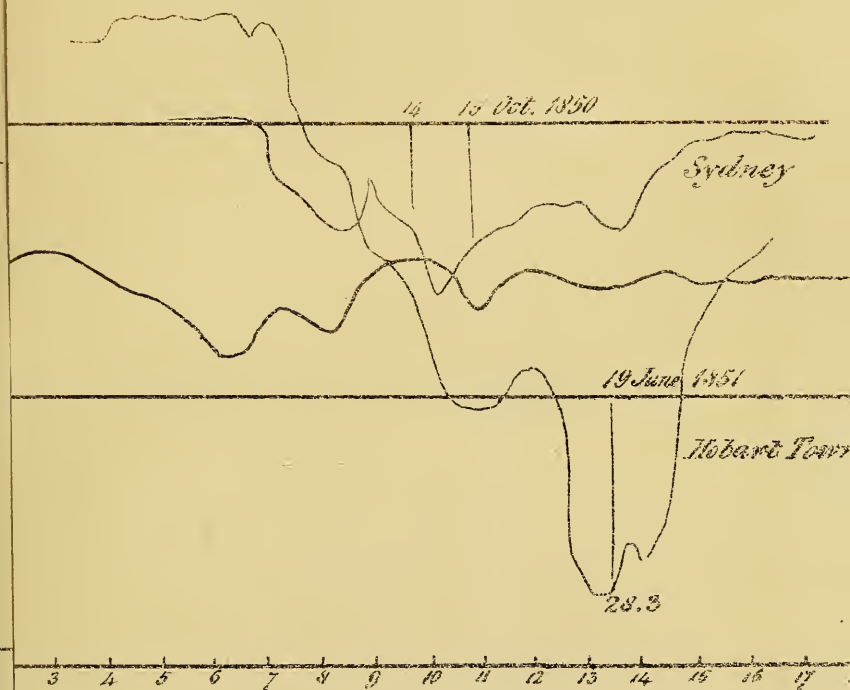
1821. Dec

February.





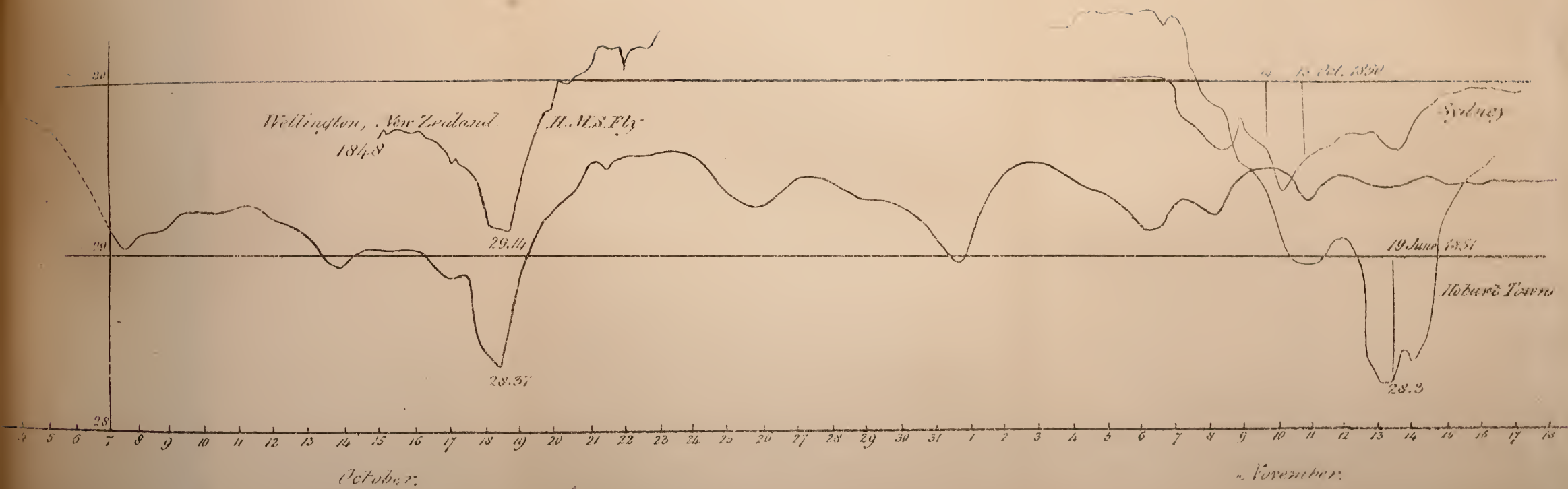




November.









“*how* do volcanic eruptions produce cyclones?” without more numerous and more careful observations than we possess at present, would be premature, and, therefore, unsuccessful.

It may be well to mention, that such a relation is countenanced by the geographical position of the hurricane regions with respect to the chief volcanic districts. The West Indian cyclones first settle upon the ocean near the Leeward Islands, a chain of active volcanic vents. The Mauritius cyclones proceed immediately from the great volcanic district of Java, Sumatra, &c. The cyclones of the Bay of Bengal, and the typhoons of the Chinese Sea, proceed from the neighbourhood of chains of volcanic islands situated on the eastern boundary of their respective localities. The majority of the hurricanes in the Southern Pacific Ocean which I have investigated appear to emerge from New Guinea, New Britain, and the other volcanic islands near to Torres' Straits.

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XV. *On some of the Species of Daphniadæ found in New South Wales.* By the Rev. R. L. KING, B.A. [Read 9th June, 1852.]

THE animals which I am about to describe belong to the crustaceous genera, which have been placed by Müller, Latreille, and later writers in the great division of the Entomostraca. My attention was directed to the search for them by reading the admirable memoir of the British Entomostraca, (by Mr. Baird), published in 1849 by the Ray Society. As the forms and various particulars of the British species have been so fully detailed in that work,