wind within the storm itself. Any observations I have had the opportunity of making are totally inadequate to determine any of these elements, and can only leave the subject in the hope that others having better opportunities will work it up.

Art. LVII.—*On Periodic Vertical Oscillations in the Earth's Atmosphere, and the Connection existing between the Fluctuations of Pressure, as indicated by the Barometer, and Changes in the Weather.* By H. Skey, Government Meteorological Observer at Dunedin.

[*Read before the Otago Institute, August* 9, 1870.]

That vast commotions take place in this aerial ocean, at the bottom of which we live, is proved not only by the fluctuations of the barometer, but by every gale that blows; and the study of those laws which have been given to nature, by which all the meteorological phenomena we perceive are effected, is engaging the attention of many. Many kindred sciences meet in atmospheric investigations, but it is proposed, on this occasion, to consider only some of the mechanical, thermal, and chemical laws which influence the weather.

Great differences in the amount of solar heat received by the earth occur at different latitudes, and also in different degrees at the same latitudes, arising from the varying power of the air to transmit heat; and it has been shown by Tyndall that though air laden with aqueous vapour may retain its transparency to light, yet the heat rays are nearly all checked in their transmission, being absorbed by the watery vapour.

When, therefore, masses of air are thus differently heated, the more heated portion expanding, ascends, and denser air rushes under to restore equilibrium. But the motion imparted to the atmosphere does not end here. If we suspend a weight by an elastic string, we shall be enabled in some measure to illustrate the effect of motion imparted to elastic substances. Mark, first, the position of the weight while free; this will indicate mean pressure and equilibrium. If it is now pulled down, the maximum pressure will be shown; and when relieved of the maximum pressure, the weight not only goes back to the mean, but nearly as far above as it was pulled down below it, and will continue to vibrate vertically until brought to rest by friction. Observe, also, how regular is the time of vibration. In such a highly elastic medium as the earth's atmosphere, any portion of it being compressed and then relieved from pressure will expand in virtue of its elasticity; and from its inertia, as expressed in the first Newtonian "law of motion," will continue its expansion until it exceeds its original volume, after which it will again contract, and thus oscillate on alternate sides of its mean volume. Now, when any large mass of the air is raised above the mean height of the atmosphere, the direction of the main component or force afterwards acting on the mass would be towards the earth's centre, or vertically downwards, owing to the attraction of gravitation. Take a straight vertical glass tube, open at the top and closed at the bottom, the lower portion containing air, above which is a column of mercury. Choose a tube with a bore not exceeding one-eighth of an inch in diameter, in order to take advantage of the cohesive attraction of the mercury, which prevents its separating into small drops and falling to the bottom of the tube; if, now, the tube be raised suddenly, then, from the inertia of the mercury, the column of air is compressed, and if we keep the tube motionless, the compressed air will react on the mercury, which will then indicate every change of pressure in the column of the air.

It is considered, in what is called the wave theory of the atmosphere, that the point of greatest elevation, or crest of the air, corresponds to the highest reading of the barometer, and that the lowest point, or trough, corresponds to the least pressure. It must be borne in mind, however, that we are not considering the case of an incompressible liquid, but that of a compressible gas, varying from a state of extreme tenuity in its highest regions, to that state of elasticity which it exhibits at the earth's surface.

It follows, therefore, that if we start with an atmosphere free from all vibration, and that for simplicity we suppose a single impulse to be given to a column, the time between each oscillation would be uniform; and from examination of barometrical observations at this and other stations, it appears that there is a very frequent oscillation of about three and a-half days, that is from maximum to minimum pressure. We will neglect, for the present, the small horary variations so well established, which are also observable at this station, and take the barometrical tables for 1869, at Dunedin. The lowest pressure for the month of January (reduced) was 29·263 inches on the 20th; the highest being 30·252 on 23rd; while on the 26th it was down to 29·416. In the month of February, the barometer was at 29·689 on the 5th, and the highest reading for the month (and year) was 30·462 on the 8th; while three days subsequently, on the 11th, the pressure was 29·8. On the 20th, or nearly three vibrations afterwards, it was as high as 30·34; while on the 24th it was down to 29·417, which was the lowest for the month, and on the 27th it stood at 29·8 inches. In the month of March the pressure was 30·239 on the 20th, and 29·130 on the 24th, while it rose to 30·147 on the 28th. In April we have 29·89 on the 1st, and 30·430, the highest for the month (and near the highest for the year), on the 5th. Then 29·978 on the 9th; 30·223 on the 11th; and four days later, 29·142, being the lowest for the month, occurred on the 15th, while on the 18th it stood at 30·036. In May, 29·706 on the 16th, and 30·390, being the highest for the month, on the 20th, while the lowest for the month, and also for the year, namely, 29·027, occurred on the 24th, and on the 29th it rose to 30·031. In June, the highest reading for the month was 30·370 on the 21st, and the lowest was 29·293 on the 30th, which will allow for three vibrations.

In July, on the 5th the pressure was 30·129; on the 7th it was at 29·376, which was at the lowest for the month, while on the 10th it rose to 30·123; on the 14th, instead of lowering, it rose to 30·304, which was the highest for the month, and the difference of time between the highest and lowest readings is in this case contradictory to the generality of the oscillations previously noted, their regularity being partly neutralized by others. In August, the pressure ou the 7th was 30·069; on the 10th, 29·374, being the lowest for the month; on the 14th, 30·131; on the 17th, 29·447; on the 19th and 20th, 30·23, which was the highest for the month; on the 23rd, 29·937, when it commenced rising till the 25th. In September the lowest reading was 29·428 on the 2nd, and the highest 30·446 on the 19th, this interval would allow of five vibrations, while on the 24th the pressure was 29·695.

In October, on the 13th the pressure was 29·527, then on the 18th, 30·354, which was the highest for the month, while four days after we have the lowest for the month, 29·279 for the 22nd. Then, six days after that, which would allow of near two vibrations, the pressure was again as low as 29·466 on the 28th; on the 31st it rose to nearly 30·2, and in this case continued to rise till it attained 30·328 on the 2nd November; in which month the vibrations were irregular on the whole, but it may be remarked that on the 23rd the pressure was 29·727; on the 28th it sank lowest for the month—namely, 29·253; while on the 1st December it rose to 29·980, and then continued to rise slightly, but on the 5th it was down to 29·734; on the 8th it rose to 30·062; on the 13th down to 29·727, then on the 21st and 22nd up to the highest for the month—namely, 30·372; on the 25th down to 29·792; on the 27th up to 30·032, and on the 29th down to the lowest reading for the month, which was 29·553.

It may be interesting to mention a series of minimum barometrical readings recently taken, which, from their regularity as regards the time of their occurrence, sufficiently prove that the atmosphere is amenable to the general laws regulating the action of elastic media. On the morning of the 5th June, 1870, the reading was 29·392, when, after rising to 29·935 on the 7th, it again fell on the 12th to 29·250. The minimum oscillation is then apparently lost for the 19th, being probably neutralized by others, but it appears again on the 25th, the interval being one day less than that obtained between the previous oscillations, when we have a minimum reading of 29·164. It again appears on the 2nd and 3rd July, when the pressure was below 29·3. These oscillations have a large range, and must be considered as compounded with many others, which would affect the time and range.

It would be difficult to prove these oscillations to be the result of periodic changes either of temperature or winds, although their time and range must be modified thereby. It has been ascertained that there is less range of pressure in proportion to the mean pressure at great altitudes than near the earth's surface. Referring to the Meteorological Statistics of the Colony, an abstract of which is given at the end of *Transactions of the New Zealand Institute*, Vol. ii., on "The Climate of New Zealand," it will be seen that the height of Bealey Station, above the sea-level, is 2100 feet, and the barometrical range for 1869 is 1·132 inches, while the mean annual range at the other stations in the South Island is 1·4; and it will be found by dividing the mean observed pressure by the mean range, that the fluctuations of pressure are less at great altitudes. Complete observations at different altitudes near the same station are, however, yet wanting, which would throw light upon the manner in which the variations of pressure are communicated from lower to upper regions and *vice versa*. It is known also that the air is subject to different horizontal motions at different altitudes at the same time, where it would only be in a column of air which is perfectly stationary that the barometer at the bottom would give the absolute weight thereof at any given instant. That the barometer informs us of changes and expected changes of weather is generally conceded; superior pressure indicating fine weather, and low pressure the reverse. But what is the nature of the connection? When aqueous vapour is added to a given weight or column of dry air, that column must be so much heavier, why should not therefore the barometer rise?

Again, when the temperature of the air rises, which it often does before and during storms, why does not that increase of temperature keep the watery vapour in it from precipitating as rain? Again, chemists have succeeded in liquefying many gases by subjecting them to pressure. When, therefore, the atmospheric pressure increases, why should not its aqueous vapour (if at its point of maximum density) be precipitated as rainfall? With reference to the first question, when watery vapour is taken up into the air, why should not the barometer rise? It must be remembered that heat has accompanied the moisture in its evaporation, which leads to the expansion of the column beginning at the bottom; it is therefore a moving column upwards, in which case its absolute weight could not be given by the barometer, but only its pressure at the given instant.

It has been shown by Dové, that the warm moist air of the equatorial regions is in an expanded state, and would flow in the higher regions towards the poles; and since the equatorial regions of the earth revolve about 1000 miles per hour, while at the poles the motion is at the minimum, it follows that the currents of equatorial air in southing have a tendency to keep their easterly motion, and thus form a wind, which, in this latitude, would come from a north-westerly direction, often at a considerable height; whereas the cold polar currents, being continually left behind while passing towards the equator near the earth's surface, would reach us as a dry, cold, south-easterly wind.

It is therefore obvious that the oscillations above alluded to would have this effect:—the upward one would take the moist north-west currents, or portions of them, into higher and colder regions; the barometer falls, and there is a greater probability of rain. It would be different when the return or downward oscillation takes place, for then, according to this view, the upper strata of air are brought nearer to the earth's surface, where they gain in heat, and their watery vapour is consequently more likely to be held in suspension; the barometer rises, and fine weather generally occurs. It is remarkable, however, that some of our heavy rainfalls take place when the wind is south-east, possibly from its flowing under and lifting up moist and rare strata to greater heights, similar to the effect which a range of mountains has if extending across the route of moist winds. The air is compelled to rise to such a height that its watery vapour is quickly condensed, and falls as rain or snow. We have an instance of this in our own West Coast, where the rainfall is considerably more than on the East Coast, and this without any marked difference of pressure. Referring to the second question, why the increased temperature of the air (for the season) often observed before and during storms, does *not* keep its vapour from precipitating as rain? This increase is sometimes attributed to the latent heat of the aqueous vapour being made sensible when changed into liquid, but this would not account for the increase of heat which is observed before rain actually falls.

In fine bright weather, and especially under the influence of dry winds, the air must be storing up more aqueous vapour, and Professor Tyndall shows that the power of aqueous vapour to transmit heat rays of high refrangibility, but to absorb the less refrangible and obscure ones (such as terrestrial heat) situate beyond the red end of the light spectrum, is the chief and potent means of preventing the undue dissipation of terrestrial heat from the earth's surface. Moreover, the clouds which form before rain falls, and also when the pressure is low, prevent the radiation of terrestrial heat at night in a very marked degree. It may be therefore inferred, that the lowest stratum of air would rise in temperature as the aqueous vapour accumulated therein.

Referring now to the third anomaly—of many gases being liquefied by pressure, whereas increased atmospheric pressure generally indicates less probability of rain. The amount of pressure used by Faraday for the liquefaction of gases was sometimes as high as fifty atmospheres, and provision was made for the removal of the heat arising from compression. But the fluctuations of atmospheric pressure do not often exceed one-twentieth of the whole. Some bodies, however, are only retained in a liquid state by the atmospheric pressure. Alcohol and ether, for instance, if placed under the air-pump, commence boiling. Under the ordinary pressure, however, they still pass into the air, but by the slower process of evaporation from their surface. Water, also, if placed in a vacuum, fills it up at once to the point of its greatest density for the given temperature ; and, if the same vacuum be filled with air, though just the same amount of watery vapour would rise if the temperature is kept the same, yet it would take a considerable time. It follows, therefore, that the diffusibility of watery vapour is rendered much more rapid when the pressure of the air is reduced by its upward oscillations; it is taken more rapidly into the cold upper regions where it is condensed. It may be interesting to note the experiments of Dulong, which show that "equal volumes of all gaseous fluids, at the same temperature and pressure, on being suddenly compressed or dilated to any equal volumes, disengage or absorb the same amount of heat, and the amount of heat required to raise a gas to a certain temperature increases the more it is allowed to expand. If there be no source of heat from which this additional supply can be obtained, the gas is cooled." And there does not appear to be this source of heat in the highest regions of the atmosphere, where the air is rare, for its diathermancy if dry, as we must suppose it to be in these regions, allows of the transmission of the heat rays of the sun through it, no heat is absorbed by it, therefore none can be radiated, and we have already seen that terrestrial radiation is much diminished by passing upwards through the aqueous vapour near the earth's surface.

Referring once more to the miniature column of the atmosphere contained in the glass tube, if the air be heated it will expand, and if cooled it will contract, and conversely (from what Faraday terms "the Correlation of Physical Forces"); if it be mechanically compressed, its temperature rises, and if rarefied its temperature lowers. With suitable apparatus, the column could be made to show not only a reduction of temperature when mechanically expanded, but also a loss of transparency arising from partial condensation of its watery vapour.

Art. LVIII.—*Notes on the Chatham Islands and their Inhabitants.*

By Gilbert Mair.

[*Read before the Wellington Philosophical Society, November* 12, 1870.]

The Chatham Islanders, or Morioris, or, more correctly, Maiorioris, state that they came to the Chathams in five canoes, viz:—*Rangitane*, *Rangihona*, *Rangimata*, *Ruapuke*, and *Okahu*. They say that they came from the villages of Tahurimanuka and Wharepapa, at Hawai, whence they were driven by tribal quarrels; that upon their arrival at the Chathams they found the islands thickly populated by natives, differing very considerably from themselves.

There were two tribes of them,—the Rongomaitere and the Rongomaiwhenua. At first, and for some years after, they had numerous fights with these people, but they eventually made peace with each other, and by intermarriages became as one people.